THE MOON

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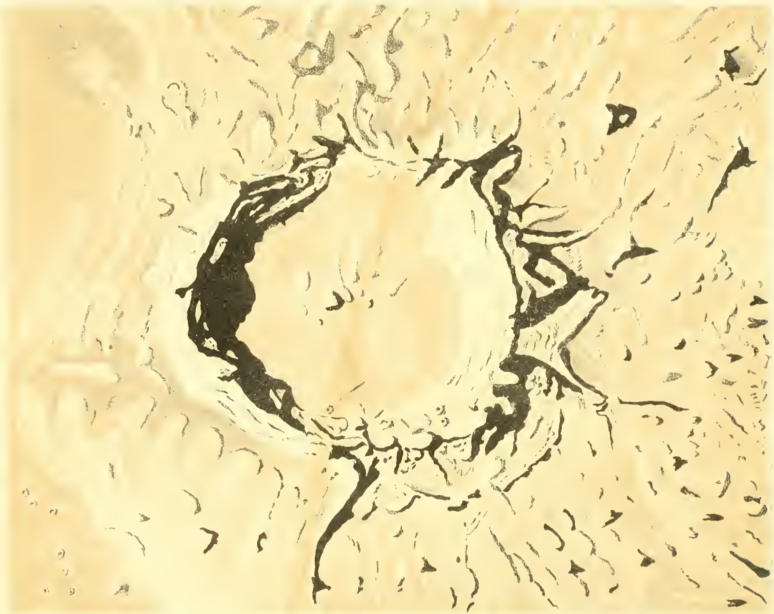
COPERNICUS

Scale, 100 inches to the Moon's Diameter.



Power, 530.

DAY AFTER SUNRISE.

THE MOON

AND THE

CONDITION AND CONFIGURATIONS OF ITS SURFACE

BY

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ILLUSTRATED by MAPS and PLATES

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PREFACE.

THIS WORK was undertaken with the view of promoting the study of Selenography, by supplying what has long been much wanted—namely, a work on the Moon which should treat of the present condition of the surface and deal with the configurations of the lunar crust with some degree of comprehensiveness. English selenographers have long felt the want of such a treatise on the Moon, and its absence has been often urged as a main cause of the slow progress that has been made in the study of the phenomena presented by the Moon. Hitherto the only work on this subject has been Beer and Mädler's grand 'Der Mond'—published forty years back, and, being in German, practically inaccessible to most English astronomers, besides standing much in need of revision and extension to bring it up to date.

It is trusted that the present work will supply this desideratum, and serve as an adequate treatise on that branch of Astronomy known as Selenography, which deals more particularly with the condition and topography of the surface of the Moon.

The 'Mond' of Beer and Mädler having been universally accepted as the standard book on Selenography, it has of necessity been taken as the basis of this, as it must be for long years of all future works on the subject; for no treatise can claim to be complete unless it incorporates the results of the seven years' observations of Mädler recorded in 'Der Mond.' As long as the present system of nomenclature remains in force, Mädler's names must also remain intact, for they have been too well established and too long in general usage to be now superseded.

Much information of interest and value has also been obtained from Mädler's predecessors, Schröter and Lohrmann, whose zealous labours are in general ignored by Beer and Mädler in their work. Many observations quoted by Schröter in his 'Selenotopographische Fragmente' possess great interest even now, and promise to throw much light on lunar questions; and to a less degree the same is true of Lohrmann's observations. Attention has therefore been drawn to these points.

The greater portion of the material forming the present work is, however, new, and has been mainly derived from eight years' constant selenographical observations. These were principally made with an excellent six-inch equatorial, of fine definition; but they have occasionally been made with refractors of smaller aperture, and towards the end with a nine and one-third inch With-Browning reflector of considerable excellence. These observations include a series of several hundred lunar sketches and drawings, which served as material for revising a considerable portion of the great lunar map of Beer and Mädler. For this purpose use has been also made of a collection of some hundred lunar sketches made of late years by different astronomers, and which from time to time have been sent to the Author. These sketches have afforded information of great interest and value, which has been incorporated in the work. The Author's thanks are especially due to the Rev. T. W. Webb for the general assistance he has received, and particularly for kindly placing at his service a long series of lunar observations. From this source much of great value has been derived.

As the work is primarily intended for the use of astronomers in the proper wide sense of the term, it has been thought unnecessary to introduce the consideration of the elements of general astronomy involved in the subject, or to enter into explanations of the meanings of the technical terms involved. A knowledge of the elements of general astronomy has throughout been pre-supposed, for this is invariably possessed by all working astronomers, even if not by all who take an interest in the science. After grave consideration, it has been decided to keep to what appeared to be recognised usage in regard to the lunar nomenclature, and to sacrifice what must be held to be strict accuracy. This has seemed especially desirable in the case of the word '*terminator*,' and the plural form of the term '*mare*.' As before stated, every endeavour has been made to follow Beer and Mädler in their standard nomenclature.

In the work much attention has been given to the question of the probable nature of the lunar surface, and stress has been laid on the view advanced, that the constitution of the Earth and that of its satellite were primarily identical in nature. The view has also been strongly urged that the processes of modification their respective surfaces have undergone have been entirely analogous, and only modified in their results by the differences in physical dimensions between the two bodies.

Many considerations have also been adduced as showing strongly that the Moon possesses a real atmosphere of great mass and greater magnitude, though of slight density;

and it has been pointed out that to neglect this is to render nugatory all attempts to explain the phenomena presented by the Moon.

It has not been considered necessary to include in the work the mathematical demonstration of the accuracy of the basis of this view, but this has been already published.[1] As it has been in general assumed, entirely without any foundation, that the Moon can have no atmosphere of any appreciable importance, it has been considered desirable to point out how entirely baseless this view is, and to show not only that the Moon may possess an atmosphere relatively little inferior to the Earth's, but also that the entire evidence we possess on this subject is strongly favourable to the Moon actually possessing such an atmosphere.

To the mathematical portion of Selenography much has been added, including nearly 400 measures of the position of points of the first order; the determination from some 200 measures of nearly 100 points of the second order; a considerable number of measures of the dimensions of different formations, and a number of determinations of the height of different lunar mountains. Most of Mädler's estimations of brightness have been revised, and a considerable number of new objects have had their brightness determined.

The lunar map contains several thousand new objects not included in Beer and Mädler's 'Mappa Selenographica,' including many new rills not contained in Schmidt's great catalogue 'Der Rillen auf dem Mond.' Several systems of long winding valleys possessing an intimate connection with the lunar rills have also been delineated in so far as the scale of the map rendered possible.

[1] 'Quarterly Journal of Science,' October 1874 and October 1875; 'Monthly Notices of the Royal Astronomical Society,' vol. xxxiv. 1, 15.

In the final chapter a complete series of selenographical formulæ is given, for the purpose of enabling observers to carry out the numerous series of micrometrical measures that are required for the further progress of Selenography. To a certain extent elegance of form has been sacrificed to convenience in practice in framing these formulæ, and approximations have been freely introduced where they are perfectly admissible and where simplicity could be gained. As this chapter only professes to be a collection of formulæ, the deduction of the formulæ has in no case been given. With some few exceptions the formulæ are original, unless where it has been stated to be otherwise. Throughout the chapter the same letter has been employed to denote one element, or possess one significance only.

Although of late powerful instruments have been employed in selenographical studies, those with less powerful appliances need not despair. Telescopes with apertures from three to five inches, if properly employed, may be made to yield work of the highest selenographical value, and are perfectly adequate to map and delineate the lunar surface in a manner that has not yet been approached either in accuracy or completeness. Even for the more recondite portions of Selenography—namely, the determination of the position and dimensions of lunar formations—telescopes with apertures of from three to five inches are perfectly capable of being used for carrying out this work. Even if not provided with a clock-motion, or even if not equatorially mounted, they can be made, by the aid of a properly-constructed and inexpensive micrometer, to give the positions of the principal points on the Moon's surface with a precision rivalling the results of Beer and Mädler.

In fact, in general, instruments of the sizes referred to will find upon the Moon better opportunities for doing valuable astronomical work than in any other direction, for the work to be done here is thoroughly within their grasp.

In conclusion, the Author would be obliged by all corrections or extensions the text or maps may require being communicated to him as soon as they are detected during further selenographical observations. Lunar drawings and observations would also be received with pleasure and acknowledged, so as to enable the results they may afford being incorporated in any future edition.

E. NEISON.

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THE MOON.

CHAPTER I.

MOTIONS, FIGURE, AND DIMENSIONS OF THE MOON.

FROM the earliest historical periods the Moon appears to have been a favourite object for study; first, in its phases and eclipses, with the conditions regulating their recurrence; next, in the various irregularities of its motions rendered manifest by the progress of observations; and finally, in its appearance and physical condition. For this study, its size, its considerable though not overpowering brilliancy, and its rapid motion render it very suitable; whilst its proximity to the earth—a fact that seems to have been recognised from an early period—presents it as perhaps the most favourably placed of all the celestial bodies for affording a clue to the real structure of the universe.

Before the discovery of the universality of the law of gravitation had been made, and until by its application to astronomy the law regulating the motions of the heavenly bodies had been ascertained, little progress was possible in obtaining a real mastery over the theory of the complex motions of the moon in its orbit. Although by careful examination of observations some of the principal of the great inequalities in the lunar motions had been discovered, those of a more minute character were and still are too intricately involved to be detected by observations alone, unless the general principles on which they depend are known. When once a basis had been laid by the theory of gravitation, the motions of our satellite were reduced to the effects of fixed laws, and the solution of the problem of the lunar motions was rendered possible; and through the labours of the great mathematicians of the last two hundred years a nearly complete mathematical theory of the orbital motions of the moon has been framed.

Were the moon to revolve around the earth unaffected by any other force than the mutual attraction of the two, the problem presented by the lunar motions would be comparatively simple, for its orbit under these conditions would be an ellipse whose form and position would be liable only to a very slow periodical change; thus permitting its velocity in this normal orbit, as it may be termed, to be ascertained without any difficulty of moment. But the conditions are not so simple; as, from the attraction of the other members of the solar system, other forces are introduced, whose effect upon the revolution of the moon around its primary must be considered, though fortunately only the action of the sun exerts other than very slight effects. Owing, however, to the solar attraction, or rather to the difference between its effects on the moon and on the earth, from the revolution of the former around the latter, the moon is subjected to the action of a force constantly varying in power and in direction, necessarily disturbing its normal motion around the earth, and thereby producing changes in both its orbit and position. From this perturbing action of the sun, the problem afforded by the consideration of the orbital velocity of our satellite is rendered one of the most recondite afforded by the whole range of physical astronomy that has ever received a satisfactory solution.

From the close proximity of the moon, the perturbing power of the sun falls far short of the direct power of the earth over its satellite; and it becomes possible, therefore, to regard the moon as moving in a normal orbit around its primary, and so to change the form and position of this orbit as to render it always coincident with the actual lunar motions. Regarding the orbit of the moon as an ellipse, its form and position with regard to the position of the plane of the earth's orbit may be considered as depending on five independent quantities, termed elements, which represent (1) the semi-axis major or mean distance; (2) the direction of this last or longitude of perigee; (3) the eccentricity of the ellipse; (4) the inclination of the plane of the ellipse to the plane of the ecliptic; and (5) the position of the intersection of these two planes or the line of nodes, afforded by the longitude of the ascending node. From the disturbing effect of the sun upon the motion of the moon around the earth, the position of the moon's orbit is constantly changing, so that the form and position of the instantaneous ellipse, as it is called, in which the moon may be regarded as moving at any instant, is always altering, or, what is the same, the elements above-mentioned which regulate these conditions must be considered to be continually undergoing variations, and by this means the assumed orbit always kept coincident with the actual motion. The effect of the perturbations produced by the disturbing forces is such, that the elements regulating the form of the moon's orbit undergo periodical variations. These variations always lie within certain small limits only, and thus the dimensions of the lunar orbit never differ materially from its mean conditions; but the elements determining the position of the orbit within the limits caused by the fact that the inclination never departs more than to a very small extent from its mean value, undergo periodical complete revolutions; whilst, considered as a whole, the moon's orbit is of greater dimensions than it would be if the disturbing effect of the sun had no existence.

The mean period of a complete revolution of the moon in its orbit around the earth is $27^d\ 7^h\ 43^m\ 11^s$, which constitutes a sidereal month; but, owing to the motion of the earth in its orbit during this time, the moon does not return to the same position with regard to it and the sun until a proportionately longer period, amounting to $29^d\ 12^h\ 44^m\ 3^s$, which forms a synodical month or lunation. From exactly analogous causes, the duration of a tropical month is shorter than a sidereal month by 7 seconds, and the duration of an anomalistic month or period before the moon returns to perigee is $27^d\ 13^h\ 18^m\ 37^s$, and the time of the revolution with respect to the ascending node or nodical month $27^d\ 5^h\ 5^m\ 36^s$.

The mean distance of the moon or the semi-axis major of its orbit, has for its mean value 60·27035 times the equatorial radius of the earth, or 238,840 miles; but, owing to the effect of the solar perturbations, it is liable to slight variations, which, however, never exceed a very small amount. The distance of the moon from the earth, moreover, is always varying, from the elliptical form of its orbit, and thus ranges between 252,972 miles and 221,614 miles, the actual distance being affected by all changes in the eccentricity of the lunar orbit.

The value above taken for the mean distance of the moon is obtained from the value of the constant of the lunar horizontal equatorial parallax, derived by Adams from theoretical considerations, which is $57'\ 2''\cdot325$, and which agrees remarkably closely with the results deduced from observation by Henderson, and found to be $57'\ 2''\cdot31$. The lunar parallax is the displacement in the apparent position of the moon owing to its being viewed from the surface and not from the centre of the earth, and thus depends on the ratio of the distance of the moon to the terrestrial radius. The direction of the semi-axis major of the lunar orbit is, as already mentioned, not constant, but undergoes a slow revolution, the period of which is 8·8505 years, and in the same direction as the motion of the moon in its orbit, but with variable velocity, the lunar perigee being occasionally before and then behind its mean place.

The eccentricity of the moon's orbit has for its mean value 0·05491, but, like the other elements of the orbit, it undergoes periodical variations, which carry it on either side of this value, though not to a marked extent; the outside limits may be taken as being 0·0660 and 0·0438, and the origin of this is the inequality known as the *evection.*

The inclination of the plane of the orbit of the moon to the plane of the ecliptic has a mean value of 5° 8′ 39″·96, but varies between the limits 5° 19′ and 4° 57′, the principal origin of this variation, as of the last, being the *evection.* The direction of the line of nodes, or the position of the ascending node of the moon, makes a complete revolution upon the ecliptic, its motion being retrograde or in a contrary direction to the motion of both the moon and its perigee, and its period being 18·5997 years; but, as in the case of the perigee, the velocity of the nodes is irregular, being sometimes in advance and at others after its mean place—the origin of this variation also being, as before, principally due to the *evection.*

In the preceding statements reference has been made to the variations that may be considered as produced in the elements of the moon's orbit due to the disturbing action of the solar attraction; and it now remains to refer to the principal periodical inequalities in the motion of the moon which are due to the same cause. Regarding the lunar orbit around the earth as an ellipse, the principal periodical inequalities in the motion of the moon are due to the *elliptic inequality* or *equation of the centre* arising from the form of the orbit, and to what have been termed the *evection*, *variation*, and *annual equation* produced by the disturbing action of the sun on the moon during its revolution around the earth.

The *elliptic inequality* discovered by Hipparchus is the principal origin of the difference between the lunar mean and true longitude; the last being, from its effects, before the mean longitude from perigee to apogee and behind it from apogee to perigee, the two being coincident at the apses, and the maximum difference being when the moon is at its mean distance. The whole period of the inequality is therefore an anomalistic month, and its value has been determined to be 6° 18′ nearly.

The principal periodical inequality originating in the perturbations produced by the sun was likewise noticed by Hipparchus, though first taken into consideration by Ptolemy. It was subsequently named by Boulliaud, in the seventeenth century, *the evection*, and was the only one of these irregularities in the moon's motion known to the ancients. Its effects are very complex, and in the lunar longitude and radius vector depend on the relative position of the sun, moon, and lunar perigee, whilst in the latitude the position of the moon's ascending node replaces that of the lunar perigee. Its result may be considered as rendering the eccentricity and inclination of the lunar orbit variable, and affecting the mean motion of the perigee and ascending node. These variations necessarily affect the moon's position and are very complex, the general result being to increase the moon's longitude when in syzygies (or when new or full), when the moon is between apogee and perigee, and to decrease the longitude when between perigee and apogee; whilst at quadratures (first or third quarters) exactly the reverse occurs. The amount of these changes depends on the position of the apsidal line with regard to the sun, and vanishes when the lunar perigee is in syzygy or quadrature at the same time as the moon; but its complete value has been determined to be 1° 16′ 27″. The effect upon the radius vector of the moon is exactly analogous to the action upon the moon's longitude. When considered with reference to the lunar latitude, the evection has the effect of rendering the inclination of the orbit variable, the inclination being greatest when the nodes are in syzygy with respect to the sun, and least when they are in quadrature; the amount of the variation being 8′ 57″. The period of the evection may be taken as rather over a synodical month in the longitude and a little less in the latitude. The influence of the evection upon the position of the lunar perigee and nodes is to introduce periodical inequalities into their motion, thus placing them before their mean position at some times and after it at others. Thus the lunar perigee is in advance of its mean place when in the second and fourth quadrants before the sun, and behind it in the other two quadrants; whilst with the ascending node exactly the reverse occurs, the period of each cycle being half a revolution of the sun with respect to the lunar perigee and ascending node respectively, or little more than half a year in the former and a little less in the latter case.

The second great periodical inequality in the moon's motion owing its origin to the solar perturbations is termed the variation, and seems to have been discovered originally by Aboul-Wefa, an Arabian astronomer, towards the end of the tenth century; but, exciting little attention, it fell entirely into oblivion, and was re-discovered by Tycho Brahé at the end of the sixteenth century. The variation depends on the difference between the mean longitudes of the sun and moon, and its effect upon the position of the moon is to place the true longitude before the mean from syzygies to quadratures, and behind the mean from quadratures to syzygies, the maximum effect occurring at the octants, and disappearing at syzygies and quadratures, whilst its amount is found to be 39′ 31″, and the period half a synodical month. The action of the variation upon the moon's radius vector is to increase it at quadratures and diminish it at syzygies; it remains unaffected at the octants, while its period is half a synodical month, as in the longitude. The variation exerts a comparatively slight effect upon the latitude, the changes being analogous to those in the longitude, but dependent also upon the position of lunar perigee with respect to the ascending node, so far as its amount is concerned which can rise to 35″.

The third great lunar inequality, known as the *annual equation*, was detected by Tycho Brahé, who much underestimated its extent; its true value was first found with any approach to accuracy by Horrocks, though Flamsteed was the first to regard it in its true light. The annual equation is considerably smaller than either of the preceding inequalities, and depends on the difference in the power of the sun, owing to the variation in its distance from the earth, due to the eccentricity of the terrestrial orbit. For this reason, the effect of the perturbing power of the sun in increasing the dimensions of the lunar orbit is lessened when the earth is in aphelion, and increased when in perihelion; with the result of leaving the moon more fully under the control of the earth in the first case—the effect of which is to decrease the mean distance and period of revolution—whilst under the latter condition exactly the reverse occurs. From these causes, therefore, the moon is necessarily in advance of its mean place whilst the earth moves from aphelion to perihelion, and behind it whilst it moves from perihelion to aphelion; and as the earth is now in aphelion in summer and in perihelion in winter, the moon is behind its mean place in the earlier part of the year, and before it in the later part; the maximum retardation occurring in spring and the greatest advance in autumn, the whole period being an anomalistic year, and the amount 11′ 10″. The effect of this inequality on the moon's radius vector is very much smaller than on the longitude, whilst its action on the latitude is still smaller.

Besides the above three principal inequalities in the moon's orbital motion due to the solar perturbations, there are a considerable number of smaller inequalities of very sensible value, and a great number of terms whose maximum effect is under three or four seconds of arc. One of the most interesting of the minor inequalities in the moon's motion is known as the *parallactic equation*, from depending on the value assigned to the solar parallax; being due to the difference between the perturbing action on the moon when at the nearest or farthest part of its orbit from the sun. This inequality depends, therefore, on the direct difference between the geocentric mean longitude of the sun and moon, and its effect is to decrease the moon's longitude in the first half of its revolution, and increase it in the second; the maximum effect being at the quarters, its amount being a little over 2′ 2″, and the period a synodical month. The action of this inequality on the radius vector is to decrease it during the period from the first to the third quarter and increase it in the other half of its orbit; whilst the result on the moon's latitude is analogous to that on the longitude, but depends also upon the distance between the node and perigee. Since the amount of this inequality depends on the ratio between the distances of the sun and moon from the earth, it can be employed to find the solar parallax; and from the value of the parallactic equation in the moon's longitude, Mayer and Laplace both deduced values for the solar parallax, and it was by this means Hansen subsequently showed the necessity for increasing the then received value of 8″·577 to 8″·92.

Other interesting terms are also to be found in the smaller inequalities of the moon's co-ordinates; for instance, a term in both the longitude and latitude shown by Laplace to arise from the oblateness of the earth, the former having been already detected by Mayer, though the cause remained unknown. The first of these depends on the position of the moon's ascending node, and its amount is $6''\cdot4$, whilst the second depends on the true longitude of the moon, and its value is $8''\cdot7$. The only irregularity in the moon's motion produced by the planets of any beyond the smallest value arises from the direct action of Venus upon the moon; it was discovered by Hansen in 1847, who has fixed its value at $15''\cdot34$, and its period as 273 years; results confirmed by Delaunay, who found $16''\cdot336$.

The moon's real diameter has not as yet been determined with absolute accuracy, though its value is known very approximately; but, owing to the irradiation at the limb, the real diameter is considered to be very slightly less than the apparent one. This irradiation is due to the moon's bright limb, from its brilliancy, encroaching on the dark sky; its amount, which varies inversely as the aperture and excellence of the telescope, has not yet been ascertained with any certainty, though known to be very small. It would appear probable that it may be due in part, and very likely in its entirety, to the effects of the minute spurious disc given by all telescopes to any bright point of light, and which varies in dimensions directly as the brightness of the object and inversely as the aperture; and in its effects resembles both in amount and variations the supposed irradiation at the limb of a bright object such as the moon. From a large number of observations the Astronomer Royal considered the value $31'\ 9''\cdot36$ to very accurately express the telescopic lunar diameter, but from the effect of irradiation the real diameter was considered to be less. In eclipses of the sun a means exists by which the minimum value of the moon's diameter can be found; for on these occasions the dark moon is thrown against the brilliant disc of the sun, and thus the effect of irradiation is exactly reversed; and just as in ordinary conditions the moon's limb, from its brightness, encroaches on the sky, in an eclipse of the sun the lunar diameter is diminished by the brilliant solar disc encroaching on the moon. Considering how much greater is the contrast between the extreme brilliancy of the sun and the almost black moon, than that between the bright moon and the sky, it appears certain that in a solar eclipse the moon, from irradiation, must have its diameter diminished much more markedly than under ordinary conditions it is augmented. A further circumstance tending in the same direction arises out of the nature of the two observations; as in the measures made during a solar eclipse the full effects of the irradiation are obtained, for the point measured is where the darkness ends, whereas under ordinary circumstances the apparent limb of the moon is measured, when it is difficult to make and easy to discover a slightly too large measure, while one slightly too small is easily made and difficult to detect.

From a long series of observations made at Greenwich during the eclipses of 1860 and 1870 with the great equatorial, it appears from the above conditions that the actual minimum lunar diameter may be fixed at about 31′ 8″·0, as the last eclipse, which was the most favourable, would indicate; and as this value agrees well with other results, it is perhaps the best value existing for the diameter of the moon. From the variation of the distance between the moon and the earth, the actual diameter of the former undergoes considerable changes, the limits being 33′ 33″·2 and 29′ 23″·6. Combining the mean distance of the moon as already stated with the value 31′ 8″·0 for the mean semi-diameter, the actual diameter of the moon must be 2,163·06 miles, or rather less than two-sevenths of the earth's, its volume only one forty-ninth, and its surface but one thirteenth of the earth's. The best determinations of the mass of the moon—namely, Peter's, Newcomb's, Leverrier's, and Stone's—agree in making it a little less than one eighty-oneth of that of the earth; the mean density of the moon can therefore be only about three-fifths of the mean density of the earth, or some three and a half times as heavy as water; whilst, from the relatively small average density of the moon, it results that the force of gravity on the lunar surface is rather less than one-sixth of that at the surface of the earth.

The moon's figure is, independently of surface irregularities, sensibly perfectly spherical; for, although it has been shown from theoretical considerations that it is ellipsoidal in form, owing to a very small elongation towards the earth, and to a still more minute polar compression, these variations are so very slight as to be utterly imperceptible. It has, indeed, been considered by Gussew that the moon may depart sensibly from the form of a sphere; but the evidence in favour of such a supposition, never in any way strong, has become still weaker and entirely inadequate for any purpose.

The lunar axis forms a small but sensibly invariable angle with a perpendicular to the plane of the ecliptic; though a small amount of uncertainty exists as to its mean value, the latest and best determinations give as the inclination of the plane of the equator to the orbit the value $1° 32' 9''$. Owing to a peculiar relation holding between the positions of the lunar orbit, equator, and the ecliptic, three planes drawn at any instant through the moon's centre, and representing respectively the ecliptic and the lunar orbit and equator, would intersect, in the same straight line, the line of nodes of the moon's orbit, and the plane representing the ecliptic would always lie between the other two. Thus, as a necessary sequence, the ascending node of the lunar equator coincides with the descending node of the orbit, and the mean plane of the equator makes a constant angle of $6° 40' 49''$ with the mean plane of the orbit.

Positions upon the surface of the moon are denoted, as on the earth, by their latitudes and longitudes, measured in the same way, the former being reckoned from the lunar equator, and the latter from the intersection of the selenographical first meridian with the equator, termed the mean centre of the disc : thus the latitude of a point is the arc between it and the equator measured on its own meridian, and the longitude is the arc between the intersection of this meridian with the equator and the mean centre, measured along the equator. South latitudes and east longitudes are considered negative, and north latitudes and west longitudes positive. At the centre of the disc of the moon one degree of selenographical latitude and longitude subtends an arc of $16''\cdot566$, when the lunar diameter has its mean value, being 18·871 miles in length ; but the arc subtended becomes gradually smaller as the degree of longitude approaches the limb, and the degree of latitude the poles ; and varies inversely as the apparent diameter.

From the coincidence between the periods of the lunar axial rotation and mean orbital revolution, were the lunar axis perpendicular to its orbit, supposed in the plane of the ecliptic, and its apparent velocity in its orbit, like its axial rotation, sensibly constant, the same face of the moon would always be presented towards the earth's centre, and the mean and apparent centre of the lunar disc would be the same. These conditions, it is known, do not hold, and, therefore, it is rarely that the apparent and mean centres of the moon, as seen from the centre of the earth, coincide. The former undergoes a continual variation in position, and this difference between the positions of the apparent and mean centres of the lunar disc constitutes the lunar libration. This may be divided into two portions : the distance of the apparent centre from the lunar equator, or libration in latitude ; and the arc between the mean centre and the point where the meridian through the apparent centre cuts the equator, which constitutes the libration in longitude: these being evidently the selenographical latitude and longitude of the apparent centre of the moon with the signs changed, as for easterly or southerly librations of the moon, when necessarily the true centre has moved east or south of the apparent centre, the position of the apparent centre will fall in the west or north quadrants.

The libration in latitude arises from the combined effects of the inclination of the lunar equator and orbit to the ecliptic; and, from the relation holding between these two, so that the ascending node of the equator is sensibly coincident with the descending node of the orbit, they both act in the same direction. Thus, when the moon possesses northern latitude the effect is to bring more of the southern portion of the moon into view, and carry the extreme northern portions out of sight, whilst at the same time, the lunar axis, from its inclination, is so directed as to turn the southern pole of the moon towards the earth, therefore producing exactly the same effect; and consequently the two combine in placing the apparent centre of the lunar disc south of the equator, or there arises a southerly libration in latitude. For southerly latitudes of the moon, the reverse result obviously must ensue, and northerly libration of the moon in latitude be produced, whilst in the ecliptic or at the nodes the libration in latitude vanishes. The maximum value for the mean geocentric libration in latitude is thus equal to the mean inclination of the orbit and the equator, or 6° 40′ 49″; but from the variations in the inclination of the moon, or the inequalities in its latitude, together probably with some slight variations in the inclination of the lunar equator, it may rise to about 6° 50′.

It has been already stated that, from the uniform rotation of the moon upon its axis once during every revolution around the earth, if the apparent motion in its orbit were constant, like the mean longitude, the same face would always in effect be turned towards the earth, in so far as variations in selenographical longitude were concerned. But it has been seen that the moon's actual motion in its orbit is not uniform, and its true longitude is sometimes in advance, and sometimes after its mean longitude, and thus a certain amount of libration in this direction must ensue. When the moon is in advance, or east of its mean longitude, a portion of the eastern surface is carried out of sight, and a new portion of the western surface brought into view, the effect being to make the apparent centre of the lunar disc shift west of the selenographical first meridian, or produce easterly libration in longitude; whilst when the moon is behind, or west, of its mean longitude, then, from exactly the reverse cause, the apparent centre of the disc is moved east, and westerly libration ensues; and obviously when the true and mean longitudes are coincident the libration in longitude disappears. The amount of the mean geocentric libration in longitude may be considered as equal to the difference between the moon's true and mean longitudes, and is therefore 6° 17′ 39″; but from the effects of the lunar perturbations, and from certain geometrical results of the libration in latitude, the maximum geocentric libration of the moon in longitude rises as high as 7° 53′.

An apparent libration of the moon in both latitude and longitude arises likewise from another source, and has been termed the diurnal or parallactic libration, as it arises from exactly the same cause as the moon's parallax, namely, the position of the observer on the terrestrial surface, and not at the centre of the earth. The parallactic libration due to this cause evidently corresponds exactly in its direction and amount with the parallax in the moon's latitude and longitude, and diminishes, the latter as it approaches the meridian, and the former the zenith, and thus, when the moon is well placed for observation, is always considerably less than its maximum effect, which varies in different portions of the earth, but cannot exceed 1° 2′.

From the combined effect of the lunar libration, the apparent centre of the moon is always moving to and fro, always within 6° 50′ of the equator and 7° 53′ of the first meridian, as seen from the centre of the earth, and thus its actual distance from the mean centre of the moon's disc cannot exceed 10° 26′. The effect of this optical movement of the moon is to cause all the lunar formations to undergo a similar apparent motion with respect to the apparent centre of the disc and the limbs, and thus the angle at which they are viewed from the earth is continually altered, a consideration of importance in examining their features.

CHAPTER II.

THE PHYSICAL CONDITION OF THE LUNAR SURFACE.

The similarity, if not identity, between the material of the earth and that of its satellite has long been recognised, and by the recent progress of science must now be considered a demonstrable fact, as it can be shown to be the only permissible supposition on which the known lunar phenomena are possible. In two essential particulars, however, the lunar surface presents a marked contrast to that of the earth, inasmuch as no water or atmosphere has yet been recognised for certain as existing upon the moon, though, apparently, the most marked indications of the action of these agents can everywhere be detected. This constitutes one of the most prominent difficulties in framing a consistent outline of the probable past history of our satellite; and many hypotheses have been propounded to account for the disappearance of the lunar oceans and atmosphere, whose former presence stands revealed in many formations, and whose effects are shown in the weather-beaten, ruined condition of the older portions of the surface, which are surrounded by *débris* ascribable to these causes. Of the present non-existence of masses of water upon the surface of the moon, there remains no doubt, though no evidence of its entire absence from the lunar crust can be adduced; and similarly, many well-established facts in reference to the moon afford ample proof of the non-existence of a lunar atmosphere, having a density equal to, or even much less than, that of the earth; but of the absence of an atmosphere whose mass should enable it to play an important part in the moulding of the surface of the moon, and comparable almost to that of the terrestrial atmosphere, in their respective ratios to the masses of their planets, little, if any, trustworthy evidence exists.

It may be reasonably supposed that the ratio of the mass of the primitive lunar atmosphere to the mass of the moon would be a similar ratio to that which obtains on the earth, considering the close connection between the two; but such are the conditions prevailing on the surface of the moon, that so far from the resulting atmosphere resembling in surface density that of the earth, it would only be one-fiftieth as dense; for not only is the surface of the moon as compared with its mass much greater, but the force of gravity at its surface is much less powerful, so that from these causes the atmosphere would occupy a much greater comparative volume, and consequently possess a very small density. An atmosphere possessing a density and physical influence of the same degree as the earth's could not thus be expected upon the lunar surface, and this removes the necessity of framing any explanation of the reason why the moon does not exhibit such an atmosphere; and attention need not therefore be directed to the many, and in some cases ingenious, hypotheses that have been advanced to explain the non-existence of atmospheric conditions upon the moon, which it would be unreasonable even to expect.

The disappearance of the lunar oceans is a more difficult subject to explain, and is one of which no hypothesis as yet advanced gives in any way a satisfactory explanation even of how it might have occurred. In one of the best of these, based on a theoretical view of Hansen, that the moon's centre of gravity and centre of figure were not coincident, but separated by a distance of 33 miles, the former being farthest from the earth, it is assumed that the effect of this would be to draw the entire lunar oceans, and the denser part of its atmosphere, to the further and invisible portion of our satellite; but this hypothesis, entirely inadequate for its purpose with regard to the atmosphere, is unsatisfactory with respect to the oceans, apart from the very slender foundations for the view of Hansen's on which it is based, whilst it affords no explanation of the absence of masses of aqueous vapour near the limb that would certainly reveal their presence in a most striking manner. On another hypothesis it has been assumed, that owing to the small size of the moon, a much more rapid cooling of our satellite must have ensued than in the case of the earth; whence it is considered that there would result great cavities in the interior, owing to the resistance to contraction afforded by the outer surface, and the unavoidable diminution in bulk of the interior owing to the loss of heat. From these premises it is assumed that not only all the lunar oceans, but even its entire atmosphere, may have retreated into these cavities, without leaving a trace of the cause of their disappearance behind on the surface. There are too many great difficulties involved, however, in this hypothesis to render it in any way satisfactory, and no attempt has as yet been made to show the practicability of the supposed conditions it assumes, and more especially with regard to the stability of the conformation considered to have resulted; whilst it is difficult to conceive the possibility that these vast energies, which it is assumed were brought into play, could effect the great changes supposed, and yet leave no trace on the surface in any way adequately representing them.

A probable explanation of the comparative rarity of the lunar atmosphere and of the entire disappearance of the primitive lunar oceans appears in the differences between the proportionate surface of the earth and moon; for there can be no doubt that the surface must have exerted the greatest influence on any primitive ocean or atmosphere. Locked up in the upper layers of the terrestrial surface are to be found immense quantities of what must have constituted portions of the early oceans and atmospheric envelope of the earth, which by the slow action of the formations constituting the primitive surface have been removed and have entered into permanent combinations. Thus the conjoint effect of the action of the terrestrial surface, oceans, and atmosphere, has been to form the present crust of the earth, where is to be found locked up an immense mass of water and of the constituents of our atmosphere, which originally formed part of the early terrestrial oceans and atmosphere; and by this means probably a very considerable portion of these must have been by now removed. A similar action would have ensued upon the moon, with this important difference, that as, relatively to their masses, the lunar surface is more than six times as great as the earth's, this absorption of the oceans and of the atmosphere would have been not only more rapid, but have been carried to six times the same extent under the same conditions. Considering the degree to which this action has taken place on the earth, it becomes apparent that on the moon it may reasonably be expected to have removed the entire oceans, and to have seriously diminished the atmosphere, supposing them proportionate to the masses of the two planets. It would appear, therefore, that to this should be ascribed the disappearance of the water from the lunar surface, as being an adequate and inevitable result of the conjoint action between the surface, atmosphere, and seas, exactly paralleled by what has occurred on the earth; and this fact appears to afford the most probable solution of the question as to the cause of the present non-existence of the seas and oceans the moon appears to have formerly possessed.

It has been already stated that even with atmospheres bearing the same ratio to their masses, that of the moon would possess only one-fiftieth of the surface density of that of the earth. Hence if it is remembered that this lunar atmosphere is exposed to the influence of a six times greater surface, and must therefore be far more rapidly and extensively decreased by its action than on the earth ; then considering the large amount of its atmospheric constituents that have entered into permanent combination with the terrestrial surface and have thus been removed, it is readily conceivable how the atmospheric envelope of the moon may have been reduced until proportionately only one-sixth, or less than on the earth, under which condition it would possess less than one-three-hundredth of the terrestrial atmospheric surface density. But this absorption cannot proceed until the entire lunar atmosphere has been removed by the influence of the surface, considering it from the view here adopted and supposing, as is probable, that its nature is similar to that of the earth's, for one constituent of the terrestrial atmosphere is but very slowly and partially acted on, and could not by this means be entirely removed. If, therefore, the moon ever possessed an atmosphere analogous to our own, and this appears an unavoidable conclusion, the moon must still possess some atmosphere, however seriously it may have been decreased in density, and, so far as can be foreseen in the present condition of science, must always retain one. But though it can be seen that the lunar atmospheric envelope is necessarily reduced to a very much less proportionate density than occurs on the earth, it cannot be determined to what extent this decrease has occurred, though it appears that, from the slight comparative density of any such atmosphere, its detection will only be possible by the aid of the most delicate methods which can be applied to such a purpose.

All astronomers who have devoted much time and attention to the detailed examination of the lunar surface, have recognised more or less direct indications of the existence of a rare lunar atmosphere, besides the more indirect evidence afforded by the known conditions of and phenomena presented by the surface. It has been therefore generally recognised by them that the moon possessed a true atmosphere, though much uncertainty was felt as to its possible density, which from theoretical considerations was regarded as certainly not greater than one-thousandth of our own. Usually it was considered that its actual density must be far less than this, and it was therefore supposed to be so small as to be utterly insignificant; but this opinion was coincided in by perhaps none of those astronomers to whom is due our knowledge of the condition of the moon, and they recognised that the lunar atmosphere seemed to possess a greater density than the theoretical considerations would appear to permit, so that this discrepancy was the cause of much doubt attaching to the whole subject. It was generally considered that the horizontal refraction produced by a lunar atmosphere of similar surface density to that of the earth, would be little less than on the earth, and Bessel's[1] was the only investigation made of the actual conditions regulating the variation in the density of the lunar atmosphere. In this research it was shown that, under what were supposed to be the most favourable conditions, the theoretical limit to the surface density of a lunar atmosphere must be considered as in round numbers one-thousandth of the density of our own; and that it could not exceed this, if of similar constitution to that of our own, which it, indeed, must be considered to be. This result is quoted by Beer and Mädler, and was perhaps the only reason which prevented them from recognising the existence

[1] 'Ast. Nach.' No. 263.

of an atmosphere of greater density which their observations appeared to reveal. The conclusions arrived at in this investigation were vitiated by an imperfection in the equation determining the limits to the surface density of the atmosphere corresponding to any given horizontal refraction, owing to the omission of a factor depending on the difference between the force of gravity at the surfaces of the earth and of the moon; and consequently the value found as the greatest surface density possible in any lunar atmosphere under the conditions assumed, requires to be very considerably increased, and becomes nearly one-three-hundred-and-fiftieth of the earth's surface density, instead of only one-thousandth. Both these results depend on the temperature of the atmosphere being considered as uniform throughout, whereas it is known that the temperature must fall considerably as the altitude increases; but as it appeared the density decreased quickest on this view, and therefore, for an atmosphere of given density at any height above the surface, the density at the surface would be greatest if a uniform temperature was assumed, Bessel supposed this to hold. In so doing the influence of the variation of the temperature upon the refraction was overlooked, for as the rate of decrease of temperature increases, the horizontal refraction for a given density at any point decreases rapidly, and this more than entirely counterbalances the smaller surface density corresponding to a given density at a fixed height. Therefore to obtain the maximum surface density from a given horizontal refraction at the summits of the mountains, which Bessel considered as perhaps five miles high and as forming the limb of the moon, instead of considering the temperature to be constant, the maximum legitimate rate of decrease of temperature should be assumed; and under these circumstances with the limits to the amount of horizontal refraction at the moon's limb (two seconds of arc) taken by Bessel, the maximum surface density possible to any lunar atmosphere becomes nearly one-two-hundredth of that on the earth, or five times greater than arrived at by Bessel. It has already been mentioned that, from the known conditions by which the surface density of a lunar atmosphere is regulated, the maximum surface density cannot reasonably be expected to be more than one-fiftieth of the earth's; while, owing to the influence of the greater proportionate surface, it is probable that the density would not much exceed one three-hundredth of the earth's, and thus, adopting the limiting condition assumed by Bessel, it appears that such an atmosphere is possible on the moon, and had this correct value been obtained at first, the conclusions which have been arrived at by various selenographers, and especially by Mädler, would have been materially altered.

It remains, however, to examine the results obtained, not by merely adopting provisionally, as hitherto, the condition supposed by Bessel to limit the density of an atmosphere to the moon, but by considering the light thrown on this question by the more recent results of astronomical observations, and so to ascertain more directly the maximum surface density possible under the conditions as now known.

Upon examination, it is evident that the only methods sufficiently delicate to detect a lunar atmosphere whose surface density did not exceed one-hundredth of the earth's, are those based on the refraction undergone by a ray of light in traversing it; and as this refraction is at its maximum when it is the horizontal refraction, this alone needs attention. And of these methods even, the only thoroughly trustworthy one that has been applied is likewise the most delicate, and is based on the observed times of lunar occultations; consequently the whole may be reduced to considering the results of this. When the moon's exact diameter is known, it is easy to compute the exact time at which a star would disappear behind the dark limb of the moon, were there no atmosphere; but if a lunar atmosphere exists, then, owing to this refracting the rays of light, the disappearance of the star will be delayed by nearly twice the horizontal refraction exerted by it; and accordingly the observed time of disappearance would be later than the computed. As before stated, in this difference of the calculated and observed times of occultation of stars at the dark limb, lies perhaps the only trustworthy method of detecting a lunar atmosphere of the density supposed; and if such a retardation of the time of disappearance be established, the existence of a lunar atmosphere appears certain. Even were no detectable difference found, it would at most show that the atmosphere was not sufficiently dense to be so revealed; as would be the case with a lunar atmosphere whose surface density was only one-thousandth of the earth's but whose proportionate mass would still be about one-twentieth of ours. And such an atmosphere would still remain capable of exerting the most marked action on the surface, whilst certainly not meriting the description of being only comparable in rarity to the vacuum of a good air-pump, which is very much less dense.

Unfortunately, the above method requires that the exact value of the lunar semi-diameter should be known; but this is still doubtful within very small limits, as the value determined by a long series of observations at Greenwich is regarded as being somewhat too large from the effects of irradiation. The real value is still uncertain. It has already been mentioned that perhaps too much weight has been laid on this irradiation as affecting the measurement of the lunar diameter, and that the probable minimum semi-diameter of the moon is 15′ 34″; it therefore only remains to ascertain whether with this semi-diameter the observed occultation of stars, by occurring later than the computed time of disappearance, affords evidence of the existence of such a difference as would render possible the existence of a lunar atmosphere of sufficient magnitude to be detected by this means. In 1865 the result of the reduction of the observations of 294 occultations of stars by the moon made at Cambridge between 1830–1835, and at Greenwich between 1834–1860, appeared,[1] and from this it appeared that a difference of $2''\cdot0$ existed between the semi-diameter of the moon derived from these occultations and that determined at Greenwich as being the most accurate value of the measured semi-diameter. From these results the Astronomer-Royal considered that a lunar atmosphere exerting a horizontal refraction of $1''$ might exist, though he was inclined to attribute the difference in part, at any rate, to the effects of irradiation ; but it is noteworthy that many of the earlier of these observations were less perfect than the later, and in a direction tending to decrease the difference between the two semi-diameters. Later,[2] the observations made at Greenwich, Oxford, and Cambridge, between 1860 and 1872, were reduced and combined with those more favourable observations made between 1850 and 1860 at Greenwich, when, from the results of the series of 303 occultations, it appeared that the correction to the assumed minimum semi-diameter was $-2''\cdot1$, and to the semi-diameter employed in the previous observation $-2''\cdot8$, whilst in the more powerful instruments, and under the more favourable conditions, the difference was considerably greater. It appears, therefore, that between the value of the moon's occultation and its measured semi-diameter there exists a difference of some magnitude, corresponding to a retardation of occultation of usually from five to ten

[1] By Hugh Breen, Esq., 'Greenwich Observation,' 1864, Appendix I.

[2] 'Monthly Notices of the Royal Astronomical Society,' vol. xxxiv.

seconds of time, and not apparently to be explained by the effects of irradiation. Consequently the existence of a lunar atmosphere of sufficient density to produce the difference found, is without doubt possible, and moreover, considering the consistent nature of the results obtained from the observations and the apparent inadequacy of their being explained by other causes, the actual existence of such an atmosphere is rendered probable.

The maximum amount of horizontal refraction at the limb, exerted by any atmosphere that the moon may possess, having been thus determined, the maximum density possible under these conditions can be ascertained without difficulty to be about one-two-hundredth of the surface density of the earth's atmosphere; but the most probable density at the surface of the moon under these conditions is somewhat less, owing to the circumstance that, theoretically, a rather less rapid decrease of temperature may be expected to exist, than that necessary to give the maximum surface density; consequently this may be assumed as being about one-three-hundredth of that of the earth. With regard to the actual density of the lunar atmosphere, which from diverse considerations appears must exist in the moon, it cannot be said, however, to be known in any way with certainty; the above value is merely the density which it appears it may probably possess; but with regard to its real density no definite results are obtainable with the observations at present existing, owing to the uncertainty as to the lunar semi-diameter. In ascertaining the conditions of a lunar atmosphere which may exist, a considerable step has been made, for it is possible to explain by its means many phenomena otherwise inexplicable. By the progress of observation materials will be obtained in course of time for a more adequate enquiry into the existence of a detectable refraction at the moon's limb than has hitherto been possible, and the result of future investigations may enable this refraction to be determined with some certainty, showing it to be perhaps less than it is now known it may possibly be.

The general effects of this atmosphere on the phenomena presented by the moon that have been considered as demonstrating the non-existence of an atmosphere, would be imperceptible except in the case of the retardation of occultations, though it would be possible to detect it perhaps by other observations of a similar nature that have not hitherto been employed. It has been suggested that no lunar atmosphere can exist, on account of the failure of the spectroscope to reveal its presence; but considering the long column of much denser terrestrial atmosphere traversed by the rays, any augmentation of the lines produced by the action of the atmosphere on the spectrum would be lost in the more marked effect produced by our own atmospheric envelope; consequently unless any new substance were contained in the lunar atmosphere—a highly improbable circumstance—the spectroscope would be powerless to reveal its existence. Similarly, the sole effect produced by it upon a solar eclipse would correspond to a very slight augmentation of the semi-diameter of the sun, though this effect would be considerably less than the uncertainty existing as to its real diameter; and in all other directions the very slight influence that a lunar atmosphere could exert on the visible phenomena would be, as in the previous case, lost in the greater effects due to our much denser atmosphere. It may also be remarked that the rays, after traversing any atmosphere to the moon, would not be convergent as in a lens, but, owing to the refraction diminishing rapidly with the distance from the surface, would be truly divergent; for the rays refracted by each spherical shell of atmosphere as it were, of indefinably small thickness, would reach a different focus.

The single remaining point where the presence of an atmosphere might be expected to be noticeable is during the occultation of a star or planet by the moon, when it has been considered that an atmosphere would reveal its presence by distorting their appearance. As far as a star is concerned, owing to the very slight refractive power of a column of lunar atmosphere, its utmost effect would be to produce a slight twinkling very much less than that arising from the action of the section of the terrestrial atmosphere it must traverse. While with regard to a planet not even this would appear, for the following reasons. The extreme rays of the pencil of light that form the minute details of the planet are reflected from points on the surface some hundreds or even thousands of miles apart; and though they traverse the terrestrial atmosphere only a few inches apart, thus being affected and distorted by every irregularity, in passing through that of the moon they are separated by nearly a mile, and consequently each of the small local disturbances, from which the distortion produced by our own atmosphere arises, can affect only an infinitesimal portion of the rays of light which give rise to the visible image, instead of nearly the whole, as on the earth, and are thus rendered imperceptible. Again, the disturbance produced even in these minute portions of the rays by each local transient want of homogeneity, cannot possibly exceed two or three hundredths of the effect arising on the earth, and are necessarily therefore even in amount perhaps always insensible. The only method by which the atmospheric envelope to the moon here considered, could affect a planet, would be in the extremely slight compression of its diameter in a direction normal to the surface at the point of occultation, owing to the difference of refraction at the two limbs; and this would possess its maximum amount in the case of Jupiter, where the compression might amount to a little over one-fortieth of its diameter, too small under these conditions to be ascertainable with a micrometer even.

The few other methods that have been considered as demonstrating the absence of a lunar atmosphere rarer than the vacuum of a good air-pump need not be considered, for either like those already mentioned—and they are even less delicate than these—they are inadequate for their purpose, or else they have given indecisive results.

This atmosphere, however, though its effect on the phenomena exhibited by the moon is so small, and its surface density so much less than the earth's, is not inconsiderable nor even incapable of exerting as powerful influences on the surface as the earth's; for the slow decrease in its density and its proportionate much greater volume, counterbalances its small surface density; consequently its mass in proportion to that of its planet is only a little less than a fourth of that of the earth's, and with regard to even a single square mile in area of the surface must be estimated by millions of tons. The importance of an agent of this nature in connection with the present condition of the moon and with reference to its past history is apparent, as affording an adequate explanation of some of the most interesting but otherwise inexplicable appearances presented by our satellite.

Direct evidence of the existence of a lunar atmosphere from its influence on the appearances presented by the moon exists to only a very slight extent, though this is not surprising considering the very slight density it necessarily possesses; and though not amounting to a proof in any case of the actual existence of such an atmosphere, it is important from having been detected by every selenographer who has studied with care the lunar surface, and adds considerable weight to the evidence in favour of the existence of a lunar atmosphere rendered certain from indirect consideration. It is well known that Schröter, with his powerful instrumental means, detected many appearances considered by him as proof positive of the existence of an atmospheric envelope to the moon. It has since been shown that most of these circumstances were due to other influences, principally differences in illumination and libration, whose full effects were little realised at the period of Schröter's observations; but several still remain unexplained, and have received further confirmation from later observers, though unnoticed by Mädler, who was perhaps too much engrossed in drawing to readily notice such minute and transient features, even had his optical means been adequate. And in comparing Schröter's observations with Beer and Mädler's, it must not be overlooked that while their Frauenhofer refractor of $3\frac{3}{4}$ inches aperture considerably surpassed Schröter's great telescope in definition, yet in light grasping power it would bear no comparison with the great reflector; and the smallness of their aperture may go far to account for Beer and Mädler's inability to detect many of the objects and phenomena described by Schröter that have since been seen by later observers with superior optical means.

The principal feature seen by Schröter, and regarded by him as indisputable evidence of a lunar atmosphere, was twilight at the cusps of the moon, and in his observations of this he has been confirmed by Gruithuisen and others; but Mädler failed to recognise this with certainty as distinct from the effect of the illumination by the earth's light, though inclined to admit its existence, which he endeavoured to explain by ascribing it to reflection from the sides of the valleys of the steep and lofty Leibnitz mountains—certainly an inadequate explanation. It would appear that in this as in many other instances, Mädler, accepting Bessel's value for the maximum density of a lunar atmosphere, was led to find some explanation as at any rate preferable to that of assuming an atmosphere of greater density than could be supposed possible. He could not, however, avoid the conclusion that an atmosphere must exist, and thought that possibly by its local condensation it might give rise to the phenomena that he had recognised, which indicated a greater density than that stated by Bessel to be possible. Many other observations were recorded by Schröter, in which certain localities became dim and obscure whilst all around were sharp and clear; and in this he has been confirmed by Mädler, who, however, considered that they might be explainable by difference in libration and illumination specially affecting some formations. Beer and Mädler mention several circumstances regarded by them as showing the existence of a lunar atmosphere, and more especially a blue transient fringe to crater walls at sunrise, quickly disappearing and entirely local in effect, being confined to one or two objects, whilst others, exactly similarly placed, are found without a trace. Schmidt has likewise observed this appearance, which he ascribes to the probable effects of the secondary spectrum of all achromatics; but it is questionable how far this can be regarded as explaining the phenomenon, seeing its local and rare visibility. It has also been seen by later observers, and occasionally only one of two neighbouring objects similarly placed and of equal brightness and form will appear dull and obscure, and surrounded by a bluish tint, whilst the other is sharp, clear, and colourless. Schröter and Schmidt have seen a grey border to the black shadow of some of the deep crater formations, which the latter considers probably due to their being thrown by a very ragged edge, though this cannot be held adequate to explain this appearance, seeing it is always the interior shadow and not the exterior, whilst it is visible under very varying conditions of illumination, and in no case have these supposed irregularities been detected, though to produce such an effect they must be very considerable. In several instances a misty appearance at sunrise has been detected within deep lunar formations, accompanied by the total disappearance of the usual details visible on the surface, and this has gradually disappeared as the sun rose, the interior resuming its ordinary appearance. At others, a broad penumbral fringe of light shadow has been detected bordering the real shadow, also disappearing soon after sunrise; and in other instances the interior has for a considerable period after sunrise appeared hazy and indistinct, whilst all around is sharply marked and distinct, which is the usual appearance of the interior also.

The observations mentioned above are in each case of considerable delicacy and of by no means a decisive nature, being only detectable by powerful instruments, and then only when the region is thoroughly familiar, the influence of this latter condition being very marked. From its at most slight density, any phenomena arising from the lunar atmosphere must belong to the most delicate and transient class visible on the surface of the moon, even in the case of a density considerably greater than it is known could possibly exist; consequently only under exceptionally favourable conditions could they be expected to be detected in studying the details of the formations of the surface of the moon. It is only when, by careful and continuous observations, the details of any particular lunar region have become well known, that the delicate appearances mentioned stand any chance of being seen and recognised as of abnormal character; for in a less familiar region they would certainly escape notice, and this is exactly similar to the circumstance recognised by selenographers with regard to the observations of the minute details of the lunar formations, it being only after the more marked features of the region have been rendered familiar that the faint differences in light gradations, indicating the smaller irregularities, are detected. Considering the few portions of the surface that have been studied with sufficient care to render probable the detection of direct evidence of this class of the action of a sensible atmosphere, the slight character of the result is not surprising. Hitherto, with the exception of Schröter's, these observations have been due to the accidental recognition of the features described when examining the details of the lunar formations, and until a systematic series of carefully designed observations are made with the express view of obtaining direct evidence of this nature, the decision of the question by this means is very improbable. It will be evident, therefore, that at present the direct evidence of the existence of a lunar atmosphere of sufficient density to be thus detected from the influence it might exert upon the appearance of the surface of the moon is indecisive ; and the same conclusion has been arrived at with regard to the more indirect results obtained from considerations as to the phenomena due to the refraction at the limb, which is insufficient to determine with any certainty the horizontal refraction ; consequently at present it must be considered, that though the moon may possess an atmosphere of sufficient density to render its presence detectable by these means, its actual density has not yet been ascertained.

The existence of an atmosphere to the moon must still, however, be regarded as certain, resting as it does on the evidence presented in so many forms by the present physical condition of the surface, and all that remains uncertain is what density it possesses; but though, from considerations founded on the results of its action on the lunar formations, it might be possible to determine with some probability both the minimum and maximum density it could possess, the limits are wide, and it is not possible with our present knowledge to fix, with any certainty whatever, its actual density. At present it can be taken with some degree of probability that the density of the lunar atmosphere does not differ much from between three and four hundredths of that of the earth's, and is therefore capable of exerting almost as powerful an effect upon the surface as the earth's, and proportionately to the mass of the moon is not much inferior in amount, whilst it is adequate to render the conditions prevailing on the lunar surface entirely different to their generally assumed nature.

Hitherto no reference has been made to a question of very considerable influence in the consideration of the questions connected with the lunar surface, and that is with regard to purely local atmospheric conditions; for from a number of different observations it has been considered that from local action some vapours may rise from the surface and play an important part in the questions connected with selenography. Reasoning from the known condition of the material constituting the terrestrial surface, it seems not unlikely that when exposed to the greater temperature to which it has been found that the surface of the moon is in part exposed, some such local atmospheric conditions may well arise; and that a purely local covering to the surface might well occur in the interior of a deep formation, from the presence of some constituent of the surface, first expelled by the heat and then reabsorbed on cooling. Of the terrestrial surface strata, for example, exposed to the condition under which the moon exists, few, if any, would be found where this might not be expected to occur in some degree, and such would be most naturally supposed to occur in the interior of the deeper lunar formations where the last influence of any aqueous vapour might be expected to be manifested.

It has been already seen that the primitive lunar oceans which it has generally been considered must have existed, and of whose former action so many marked indications seemingly remain, may with most probability be supposed to have disappeared owing to the strong absorbing power of the lunar surface, in the same manner as the earth's have been materially diminished; but it still appears probable that a very small residuum of aqueous vapour may, if not must, exist upon the surface at times and in places; for, owing to the tenacity with which such material as composes the surface retains moisture, it does not seem likely that by the influence of a portion of the surface already containing a certain amount of moisture, the extreme outer layer, that is most favourably placed for absorbing the aqueous vapour, could be entirely denuded of it. If this be so, then a certain amount of this moisture must be liberated when the temperature of the surface increases beyond a certain degree, to be eagerly reabsorbed on cooling, and so give rise to a temporary or local envelope. As has been already observed, it is in the interior of the deep formations that the last traces of the lunar seas must have lingered, and here accordingly would the most favourable condition exist for the liberation by the solar heat of a temporary vaporous covering; and under these conditions, appearances have been detected indicating the presence of some local covering of this nature. It is not probable, even were aqueous vapour extensively diffused over the whole surface of the moon, instead of being more or less localised—for where the area is large the process of diffusion is comparatively slow—that the spectroscope would be competent to deal with the small quantity present; for it is known that the rays of light must traverse a very considerable column of vapour before any detectable absorption lines are formed. The vapour being in this case supposed to be confined within the interior of a deep ring-plain, the surface would on cooling slowly reabsorb the whole. It is not, therefore, impossible from these causes that a certain very small amount of aqueous vapour may exist on the surface of the moon, and thus explain some of the otherwise inexplicable appearances that have been observed.

An important point in connection with the lunar surface is its temperature; for, exposed for fourteen days to the continuous action of the solar rays, the surface must become heated to a considerable degree, while from the radiation into space during a similar period the surface must reach a very low temperature. Many attempts have been made to obtain some data with reference to the amount of this variation of temperature, but with little success, until lately, with the aid of one of his powerful reflectors, Lord Rosse has determined with some precision the variations in the relative amounts of heat transmitted by the moon to the earth. The actual temperature of the lunar surface still remains, however, undetermined; but from the results obtained by Lord Rosse it is possible to arrive at some idea of the probable variation in the temperature of the surface.

From the periodical character of the variations undergone by the moon, it may be considered as possessing a mean temperature liable to only extremely slow secular changes, and as being raised above this by the heating action of the sun's rays, and then reduced below from the effect of the radiation into space. Viewing the question first apart from the influence of the lunar atmosphere, and disregarding the complication introduced by the inclination of the lunar axis to the elliptic, the heating effect of the solar rays on any portion of the moon may be regarded as depending solely on the latitude of the point; for as the latitude increases, the rays pour more obliquely on the surface, extend, therefore, over a greater surface, and produce proportionately less effect on a unit of area. The heating effect of the solar rays will thence be at a maximum at the equator and nil at the poles. The radiation of heat from the surface may be regarded as sensibly independent of the latitude and depending practically on the temperature of the surface. Consequently, assuming no lunar atmosphere, the surface of the moon would, during its long night, gradually cool, until it reached a nearly uniform degree of intense cold throughout, whilst during the long day the temperature of the regions near the equator would rise considerably, but the increase of temperature would become less and less towards the poles. With respect to the maximum and minimum temperature that the surface might reasonably be expected to reach under these conditions, they must be regarded as very problematical, depending as they do in both on the rapidity of radiation of the surface and on the assumed temperature of space; and by assuming this last to be not very low, + 300° and − 75° centigrade have been considered as best representing probability.

The presence of an atmosphere on the moon entirely alters the above, and exemplifies the influence of even an extremely rare atmosphere on selenographical questions; for the effect would be to not only decrease considerably the heating effect of the solar rays, especially in high latitudes, but to retard markedly the radiation of heat from the surface during the long lunar night, thus rendering the temperature more uniform by lowering the maximum and raising still more considerably the minimum temperature experienced by the surface. From its very much greater comparative extent, a lunar atmosphere would retard the lowering of the surface by radiation as completely as one a hundred times as dense on the earth, and in the same manner any local influence arising from the heating action of the solar rays on the surface would be very much increased. Another feature tending to make the temperature of the surface more uniform, and render the variations to which the lunar formations are exposed less extensive, would arise from the condition of the atmosphere, which by becoming more or less considerably raised in temperature would prevent materially the fall during the lunar night. From the great decrease in radiation produced by extremely rare vapours, there is no necessity to assume, as has commonly been done, that the temperature must be very low towards the end of the long lunar night, even were the moon to possess no atmosphere beyond one of extreme tenuity. Considering that the probable atmosphere would in its effects be not much if at all inferior to the earth's, together with the circumstance that in the terrestrial long arctic night, much exceeding in length the lunar, the radiation is not sufficient to produce more than a moderately low fall of temperature, it would seem unnecessary to suppose any considerable fall could occur upon the moon, and this is confirmed by the known condition of the variation in the amount of heat radiated by the lunar surface.

From the results obtained by Lord Rosse, the total amount of heat received by the earth from the moon, together with its approximate variation, may be considered in some way known ; but not so the law of variation in the temperature of any given portion of the surface, nor yet even its approximate maximum or minimum temperature ; and to obtain any idea of the probable value of these, it is necessary to have recourse to theoretical considerations or to assume from terrestrial analogies the values of various constants that must be employed, and make what appears to be the most probable hypothesis with regard to the state of the physical conditions existing at the lunar surface. Any conclusion, therefore, that can be thus obtained from Lord Rosse's results can only be regarded as perhaps probable but rough approximations ; but with regard to the maximum and minimum temperature that can be regarded as with any probability existing, it is easier to arrive at some idea from considering the nature of the values obtained by Lord Rosse for the total heat radiated from the moon.

From his results Lord Rosse finds that the amount of heat radiated to the earth from the moon when full is about equal to that which would be received from a globe of the same size and in the same position kept at a constant temperature of 110° C., and from this circumstance it would appear that the maximum surface temperature of the moon cannot exceed 200° C.; whilst it is probable that it must be considerably less. This value, therefore, may be considered to be the maximum surface temperature attained by the moon, and must diminish quickly as the latitude of the point on the surface becomes considerable. With regard to the minimum temperature reached by the surface, the same observation would show that it cannot be much under zero centigrade to allow of the agreement observed between the variation of light and heat during each lunation. At present, however, it has not been found possible from Lord Rosse's determination to deduce an in any way satisfactory law for the variation in temperature of the lunar surface.

There are, in fact, circumstances connected with these results that appear perplexing, especially in the law of the total radiation of the heat from the moon, and that seemingly indicate conditions prevailing upon the lunar surface of a very unusual character, or else the existence of conditions affecting the total amount of heat received from the moon that do not manifest themselves in the observations. It does not seem impracticable that a series of observations of the heat radiated from the moon might be conducted with a view of determining, with the aid of a more complete theoretical investigation of the conditions probably regulating the amount of heat received from the moon, some approximate values for the constants involved in the analytical treatment of the subject, and thus enable some satisfactory results to be obtained for the variation in the temperature of the surface. At present Lord Rosse regards his results as not affording any trustworthy means of determining the lunar temperature with any exactitude, and they do not appear sufficiently developed to do more than aid in results afforded by theoretical considerations. A fact in connection with the high temperature of the lunar surface requires mention, and that is that this high temperature could only arise after the practical disappearance of bodies of water from the lunar surface; so that during the earlier periods of its existence the temperature of the moon would be nearly the same as the temperature of the earth. For as the temperature rose much above the mean value of about 25° to 35° C., such immense quantities of aqueous vapour would rise into the upper strata of the lunar atmosphere as to entirely shield the lunar surface, and, intercepting in the main the solar heat, prevent the solid body of the moon ever rising materially above its mean value. In the same way, the fall of the lunar temperature during the long night would be prevented by a similar cause. The far greater proportionate depth of the lunar atmosphere would render this action much stronger than under similar causes would ensue upon the earth.

The probable physical conditions prevailing upon the surface of the moon have been considered at length, owing to the importance of these matters in relation to the conformations of the moon and to the appearances presented by the lunar surface, and the question has throughout been regarded from the point of view that was seemingly not only in itself the most probable, but which was that indicated most forcibly by the known condition of the surface of our satellite. The general identity in the nature of the material of the earth and the moon once granted, the application to the problem of the condition of the lunar surface, of the various branches of science, and in especial chemistry and physics, enables much to be deduced that astronomy alone could never afford ; and from considerations based on these branches of science it would appear that, if the earth and its satellite do differ in material, they must differ *in toto* to enable the observed features to be presented, and these features only.

The importance of the physical conditions prevailing upon the surface of the moon, in studying the nature of the formations, and the details presented by the various lunar regions, is apparent ; and until these have been in some way satisfactorily ascertained many difficulties of great moment must continually arise in interpreting lunar observations ; whilst, once the probable conditions thoroughly realised, through the course of selenographical investigation, they will, if true, receive full confirmation and demonstration ; or, if erroneous, admit of being rectified. Nothing has yet been said with reference to the forces by which the moon has been moulded to its present condition, for such considerations cannot become of any particular value until it has been satisfactorily determined what the real condition of the results of these forces is ; whilst the more general problem, considered by Hopkins, scarcely comes within the scope of the present work. Until, however, the real condition of the formation of the surface is known, results of value with regard to the forces from which they have arisen must be expected to be few.

The general impression with regard to the nature of the formations constituting the lunar surface is its entire dissimilarity to that of the earth, founded, perhaps, principally on Beer and Mädler's often quoted words, 'The moon is indeed no copy of the earth, much less a colony of the same,' containing neither oceans, seas, nor river systems, with the accompanying formations, but a desert containing innumerable craters and surface irregularities. All over the lunar surface, crowded especially into the south-west quadrant, appear circular deep depressions, ringed round by regular walls, and presenting the appearance of craters, evidence seemingly of the results of vast volcanic convulsions; whilst the remainder of the surface consists of comparatively level spaces, usually dark in colour, separated more or less from each other by mountainous regions, full of considerable peaks, which are united by smaller masses and long ridges; while in every direction are dispersed numbers of small craters of different sizes and depths.

When first attentively studied with adequate means this impression receives some confirmation from the appearance of many lunar formations; and though the general resemblance between the nature of the material composing its surface and that of the earth is readily recognised, yet the forms it has assumed appear very different—a conclusion similar to that of Beer and Mädler, who possessed, however, very inadequate means for the study of the minute details on which the recognition of its true character must be based. Under these conditions there appears little resemblance to the terrestrial surface; and though more prolonged study with means such as were then at Mädler's disposal shows the great irregularity of the smaller formations, and resolves the more considerable into aggregations of lunar mountains instead of volcanic craters, thus considerably modifying first impressions, the difficulty in observing the minuter details prevents materially the recognition of the real relation amongst the formations seen. Thus Mädler recognised in places many resemblances to terrestrial formations, but the general abundance of apparently small craters, with the absence of river-systems and their accompanying winding valleys, indicates a marked dissimilarity seemingly between the surface of the earth and its satellite.

Upon a still closer investigation with adequate means of the lunar formations, this remaining impression as to the dissimilarity between the configurations of the lunar and terrestrial surfaces loses much of its force, and still more points of resemblance become manifest. As Chacornac found, closer examination with powerful instrumental means reveals far greater terrestrial analogy in the structures of the moon than otherwise appears even possible; while a general analogy is often traceable between different terrestrial volcanic regions and the more disturbed portions of the surface. In the more level regions of the moon, especially on the great grey surfaces termed Mares by Hevelius, though known to have been long free from any covering of water, appear many traces of its action, as the formation of diluvial deposits recognised by Sir John Herschel, and detected by many selenographers; whilst Professor Phillips, no mean authority, traced many analogies between the apparent volcanic formations of the earth and moon, and found many indications of the action of a disintegrating atmosphere, in recognising which he agreed with Mädler and other selenographers.

The greater craters apparently existing upon the moon yield to close examination with powerful telescopes, and appear less and less like volcanic orifices or craters; their enclosing walls lose their regularity of outline and form, and appear as confused masses of mountains broken by valleys, ravines, and depressions, crossed by passes, and surrounded by low plateaux and an irregularly broken surface; whilst the seemingly smooth floors generally appear as diversely interrupted as the environing surface. These formations are then seen more in their true character, not as craters, but as low-lying spaces surrounded by mountain regions or disturbed highlands. Similarly with the more regular formations that have been termed *ring-plains*, which, not distinctly separated from the last class, or *wall-plains*, are manifestly not volcanoes in the ordinary acceptance of the term, but rather depressions surrounded by mountain ranges; and the moon presents every grade of this formation, from the mere depression without a wall and the level space enclosed by the intersection of two or more mountain ranges or even ridges, to the apparently perfect ring-plain; thus rendering the nature of these last more apparent than the difficulty of observing and uniting the minuter features of these formations would otherwise permit. The great number of apparently small craters upon the moon would seem to indicate a marked difference between the lunar and terrestrial formations; but it is very doubtful whether these supposed craters really possess the character generally ascribed to them; they are more probably mere shallow hollows such as are not uncommon on the earth, rather than the craters of lunar volcanoes. Extremely shallow, with very gently sloping declines and concave floors, enclosed by the merest bank if their edges are at all elevated above the surrounding surface, and consequently disappearing entirely except when rendered momentarily perceptible by very oblique-falling illumination, these formations present none of the characteristics of a true crater, but more appropriately have been termed 'pits,' a term retained here in the modified form of 'crater-pits.'

Yet true craters are not absent from the lunar surface, though much rarer than is usually considered; for in most disturbed districts they can be recognised rising steeply from the surface, with a precipitously falling conical aperture of small dimensions, whilst all around lies apparently ejected matter, visible often in long streaks radiating in various directions to the lower lying districts. These formations when perfect are usually readily distinguished by their brightness, which renders them even in high illumination distinctly visible, though under these conditions the crater pits disappear; but from the minuteness of the orifice of these crater cones, their detection is a matter of considerable difficulty, and thus they are easily confounded with bright mountain peaks. When imperfect and bearing indications of an older creation, these crater cones are less easily recognised, having usually lost most of their characteristic brilliancy, and from the edge of their orifice being often broken down its detection is only possible under rare conditions of illumination, whilst the surrounding disturbed region has usually, more or less, entirely lost its original character from the effects of newer activity and the general disintegration from which all the older formations have suffered. Under these conditions these ancient craters are generally undistinguishable from mountain peaks, and are not seldom found near the borders of an almost entirely ruined walled plain or analogous formation, both thus exhibiting the effects of these disintegrating forces that have left so many marks on the surface of the moon. Situated generally in the midst of a highly disturbed region appear examples of the great craters of the moon, surrounded by masses of apparently ejected *débris*, often with smaller crater-cones on their steep slopes, whilst far and wide into the surrounding region stretch irregularities of most diverse kinds, which exhibit various analogies to the long extinct volcanic regions of the earth. In these great craters appear some of the most difficultly explainable lunar formations, as they present features in many ways unlike the true volcanic crater, though they are paralleled by similar terrestrial formations.

Owing to the very different conditions under which the terrestrial and lunar formations are regarded, it is difficult to thoroughly realise their points of resemblance. The details of the lunar surface being only visible when thrown into relief by shadow, the whole is never to be seen at the same time, but the various irregularities and conformations of the surface have as it were to be pieced together into one united whole. Long gentle slopes, even if of considerable altitude, such as form the majority of the river valleys of our earth, are on the moon scarcely perceptible even with the most careful examination, and every little irregularity breaks their continuity and gives them a very different appearance to that which they would exhibit when viewed from a level; but under very favourable conditions regular systems of these valleys can be traced. The terrestrial formations generally regarded as absent from the lunar surface are usually of small dimensions and marked by no striking characteristics, such as would be necessary to reveal their existence when seen on the moon, where, moreover, they would reasonably be supposed to be much less marked than on the earth: they would thus be objects whose detection would not be easy. But their recognition would be rendered still more difficult from their being seen only in small portions at a time, and their real characters masked by the throwing into relief of every subordinate irregularity by the action of its shadow, so that the more important and extensive though less abrupt features are entirely disguised. Before, therefore, anything can be decided with respect to such comparatively delicate even if extensive features as lunar river systems, diluvial deposits, and gentle slopes, the endeavour must be made by systematic study of the minuter details of the moon to piece them together until the real conformation of the surface that they are the indications of has been ascertained. At present very little progress has been made in this direction, and no legitimate conclusion can be arrived at with respect to the absence of any terrestrial features, much less with respect to the non-existence of the cause to which such formations must be considered due.

Mädler has pointed out that formations possessing a north or south direction are much more easily seen upon the moon, than those extending east and west, a peculiarity tending to give an imperfect idea of the true nature of the surface, and accounting in some measure for the general meridional direction of numbers of the smaller formations of the moon, such as the ridges, land swells, and rills. It is likewise necessary in considering the appearance of the surface, to remember that even under the most favourable circumstances it is being examined as if it were at a distance of many hundred miles, and necessarily much of the smaller detail must remain invisible. It is true, as Mädler remarks, that a steep object, only fifty feet high, could be detected by its shadow, but only, however, when of considerable length and very favourably placed in an open region, as on a level portion of one of the great *Mares*; and under other conditions it would usually be quite invisible if two or three times as high, whilst in one of the more disturbed regions it would be scarcely detectable if ten times as elevated. As a general rule formations of a mile in length and a height of three hundred feet are the minimum visible in even powerful telescopes, though in places at times smaller objects may be rendered visible under favourable conditions, whilst in a great portion of the moon, objects of much more considerable dimensions, especially when with gentle slopes, are rarely to be seen.

A considerable number of examples of the class of formations usually supposed to be absent from the moon, such as valleys resembling the terrestrial river valleys, have of late been discovered, especially in the region near Hell, Fabricius, and the great Apennine highlands, and usually in connexion with the more delicate class of rills. These formations have, however, hitherto been overlooked, their true character being disguised by the numerous irregularities on their gently sloping sides, so that prolonged examination with powerful telescopic means is necessary for their detection. As the minuter details of the surface become properly studied and pieced together, it is probable that very numerous other examples of similar formations corresponding in nature to the terrestrial river valleys will be discovered, and it is already apparent that they all lead from the elevated mountain regions to the low-lying plains and Mares. On approaching the dark grey Mares, however, these valleys gradually sink and disappear, obeying a very generally observed tendency in this direction, which is as marked in the mountains and walled plains as in the valleys and hills. There are many indications, in fact, of the presence on the Mares of some especially powerful disintegrative agent; whilst, as already remarked by Chacornac and confirmed by most observers, the surface of the great grey Mares appears to have been fluid long after the principal formation of the moon had become permanently rigid. This is especially to be noticed in those cases in which the presence of some powerful disintegrative force seems to have broken down into ruins the wall bordering the Mare, whilst that abutting on the higher land remains intact, and the interior appears to have been filled up by the inrush of fluid material from off the Mare itself. In many other cases also, on the borders of the Mares, there are very strong and consistent indications of the originally semi-fluid condition of the Mares, in the form of filled-up ring-plains, submerged mountains, and walled plains, eruption of matter into valleys, &c.; and there are also indications of the gradual solidification of the Mare in the shape of less and less plasticity in the intruding matter.

These circumstances are particularly interesting in connection with the view as to the probable cause of the disappearance of water from the moon, as they are exactly in accordance with what would be expected to arise. For as the action of the surface removed the water from them, the Mares would gradually be reduced to the consistency of mud; and while their presence accounts for the greater disintegration observed towards the borders of the Mares, the semi-fluid condition of the surface would account for the irruption of plastic material into the formations, whenever gaps in their walls permitted this to occur. In this, however, as in all other questions connected with the present condition of the lunar surface, there are many difficulties from the existence of seeming inconsistencies. Many of these a more detailed and systematic acquaintance with the lunar surface may remove; others may be accounted for by a more complete development of the views that may from time to time be put forward; but there are numbers that seem to indicate the co-existence of more than one or even two of the agencies to which the principal formations of the moon are due.

The gradual progress in our knowledge of the present condition of the surface of our satellite is surely, if slowly, pointing out, in unmistakable terms, the entire analogy in nature, if not wholly in degree, of the forces that have moulded the surfaces of the earth and moon to their present state.

CHAPTER III.

THE LUNAR FORMATIONS.

The entire visible surface of the moon may be divided into three great classes, under which the whole of the diversely constituted lunar surface may for convenience be grouped; namely the plains, craters, and mountains; the term craters being used only in its usual conventional sense. The first class, which occupies more than half of the entire lunar surface, is divisible into the two great sub-classes of dark and light plains; the first including the lunar Mares with the smaller formations to which the terms Palus, Lacus, and Sinus have been applied; whilst the formations comprised in the latter class have received no distinct name, and seldom possess as definite borders as the former. Under the single term craters, in compliance with the conventional usage of the name, have been grouped the whole mass of the formations of the moon, which when viewed with a low power and a small aperture are supposed to bear some resemblance in appearance to the volcanic craters, though they are of the most diverse nature, and mostly without the slightest claim to be regarded as such. These formations will be divided into nine classes, namely, walled-plains, mountain-rings, ring-plains, crater-plains, craters, craterlets, crater-pits, crater-cones and depressions; each of which possess distinctive features, though the lines of demarcation are of necessity somewhat arbitrary. Finally, the mountain formations may also conveniently be separated into twelve classes, namely, the great ranges, highlands, mountains, and peaks constituting the greater elevations; and hill lands, plateaus, hills, and mountain ridges, forming the lesser elevations, whilst the numerous small irregularities of the surface are comprised in the four divisions of hillocks, mounds, ridges and landswells.

Mare.—This term, originally applied by Hevelius, was retained by Riccioli, to denote the comparatively vast level plains of the moon exhibiting some resemblance to the terrestrial seas, though already in Hevelius's time it was known that they were free from water. These great tracts are in full distinctly visible to the naked eye as dark grey spots, in portions sharply separated from the purer light of the brighter portions, and in others gradually fading into them. Examined closely, they are seen to be traversed by numerous long ridges, and to contain low hills and mounds, interspersed with small crater-pits, whilst in places the surface rises and falls in a wave-like form, resembling the rolling lands of America. Yet, although water is absent from the lunar surface, the Mares present in many places the appearance of alluvial deposits, and in many portions of their borders, distinct traces of the apparent action of water can be clearly detected. The two Mares that are completely enclosed are two of the smallest, the Mares Humorum and Crisium, the latter, especially, being walled in by lofty mountains, and in many places bordered by stupendous precipices; the former, however, being but slightly separated from the neighbouring Oceanus Procellarum. The greater Mares—as, for instance, the Mare Serenitatis—are, like the terrestrial oceans, united to one another, and also in places gradually merge into the brighter surrounding regions without any distinct line of demarcation, as is more especially the case with the Mares Nubium and Frigoris; but at others they are bordered by a rugged coast line as it were, rising in cliffs and peaks, and pierced by valleys and ravines, as is the case in the principal border of the Mare Serenitatis, and the greater portion of the Mare Imbrium. The two smallest Mares are the Mares Vaporum and Humboldtianum, and the largest is the Oceanus Procellarum, whilst the deepest is, perhaps, the Mare Crisium.

Palus (marsh) and *Lacus* (lake) have been applied by Riccioli to the smaller surfaces, possessing a dark colour, but perhaps somewhat clearer than the greater Mares, and not as well defined, whilst they are generally covered with small elevations of various kinds, thus presenting a greater variety of tint than the Mares.

Sinus (bay) has been used to denote deep bays in the borders of the great Mares, and whose form is generally well marked by being surrounded by a lighter region, or else, as in the magnificent Sinus Iridum, formed by a curve of immense mountains bordering a vast highland.

The great Mares and the smaller analogous grey plains occupy about two-fifths of the visible surface of the moon, and are most numerous on the north and east, smaller and sharper in outline towards the centre and west, and entirely absent in high southern latitudes.

The bright plains constitute a much smaller and far less prominent division of the lunar surface, covering perhaps one-sixth of the whole; and, owing to their similarity in colour to the surrounding mountainous districts, together with their smaller extent, easily escape notice. To this circumstance it is owing that they have received no special nomenclature, though, perhaps, Riccioli had them in view when naming some regions 'Terræ.' The principal of these extends from Messala to Endymion, and from Atlas towards the limb, and is in extent greater than the Mare Crisium; though, as is invariably the case with these bright plains, it is somewhat more disturbed than the darker Mares. Another, but smaller one, extends from Gauss; a third, south of Copernicus, and a number towards the south-west and south-east regions of the moon. Towards the north these bright plains are principally interrupted by mounds, hills, and ridges, but towards the south by hills and crater-pits, and in this feature resemble the great walled-plains, where a like result occurs.

The most remarkable class of formations are those grouped under the generic term of *craters*, and presenting, as a general type, a somewhat circular form, bordered by a wall with a feeble slope towards the outside and of a moderate height, though falling towards the interior steeper and deeper, to a level considerably below the immediate exterior environs, whilst in the centre rise one or more mountain masses, whose peaks never reach the altitude of the walls, with which they are not, as a rule, connected. Though the above presents their general character as seen with a small aperture and low power, they present various distinct features on close scrutiny which facilitate their being more properly grouped into a number of separate divisions.

Walled-plains extend from 40 to 150 miles in diameter, and are seldom surrounded by a single wall, but usually by an intricate system of mountain ranges, separated by valleys, crossed by ravines, and united to one another at various points by cross walls and buttresses ; all usually, however, subordinate to one or two principal ranges, forming a massive crest to the rest. Towards the exterior and interior extend numerous projections and arms, at times rising even above the wall, and at others low, short, and insignificant. Occasionally, as in Schiller and Posidonius, these arms extend throughout the greater portion of the interior, or even divide it into two portions. Towards the exterior, these branching arms and projecting buttresses occasionally unite two or more walled-plains together, and at times these rise into considerable ridges, often enclosing long valleys. The interiors of the walled-plains are as a rule comparatively level, sometimes, as in Plato and Archimedes, only broken by a few mounds, or perhaps by a crater cone or so; but more usually the interior is interrupted by a number of small irregularities, as ridges, mounds, or crater-pits, as in Maginus and Ptolemy; whilst at times these irregularities assume considerable dimensions, as in Posidonius, Gassendi, and Catharina. Though many are roughly circular in shape, others possess very irregular outlines, appearing more like several confluent plains, or like a space enclosed by intersecting mountain chains rather than as true independent formations.

Though commonly classed under the crateriform formations of the moon, the true walled-plains would appear to be related rather to the Mares or plains, more especially to those Mares bordered by great highlands and mountains like the Mares Crisium and Serenitatis, to which certain of the great walled-plains, as Clavius, Maginus, Ptolemaus, Hipparchus, and Schickhardt, bear a considerable resemblance, though on a smaller scale—a circumstance that did not escape Mädler. A close examination of such examples of the walled-plain as these, would suggest their being low-lying bright plains surrounded by mountain ranges and extensive highlands, rather than actual independent formations bearing any relation to true volcanoes; and, as Mädler remarks, had Clavius possessed a dark interior, and been nearer the centre, Riccioli would have probably classed it as a Mare, and the same holds good with some of the others.

The surrounding walls of the walled-plains are often very diverse in character, the differences being most marked where one side lies against an elevated mountainous plateau, and the other on the Mare; under these conditions one side often rising in a high wall broken by a few valleys and ravines, whilst on the other the wall gradually sinks into insignificance, and is broken by gaps, at times narrow, like passes, and at others wide. Most of the walled-plains lie on the southern half of the moon, and extend especially from Hipparchus and Ptolemaus to the neighbourhood of Maginus and Clavius, with hardly a break in a meridional direction, and thence in the group of Moretus may be traced a continuation. Similar meridional rows of great walled-plains lie on the west and east close to the limb. On the north and east, where the great Mares extend, the walled-plains are more regular and isolated, but fewer in number, and here they bear more resemblance to the next group but one of the so-called crateriform lunar formations.

Mountain-rings.—Closely allied in some ways to the walled-plains are the objects that have been thus termed, and which bear in some instances a distinct resemblance to ancient ruined walled-plains. At times, the surrounding mountain-ring is complex, and interrupted by considerable peaks, though many gaps exist in the circuit, and the interior bears some indications of having been filled up, as if it were by the *débris* of the ruined walls, and by the inpour of matter from the exterior regions. At other times they appear as veritable rings of mountains and hills, occasionally united together by some short ridges and projecting arms, whilst the interior is filled up by innumerable hills, mounds, and ridges. A third variety appears as a simple circle of low mountains lying on a plain or Mare, the inner and outer surfaces being on the same level, united to each other by numerous gaps in the ring, and presenting exactly the same appearance. In a few cases, more especially towards the north-west and south-west and east, within the mountainous districts, appear a fourth variety, formed by the intersection of several mountain ridges and peaks, and bearing a marked resemblance to the more irregular walled-plains, though their true character as mere portions of the general surface, enclosed by the intersection of branches from the surrounding mountains, is too marked for them to be ever considered in the light of craters of any kind.

Ring-plains.—The formations termed ring-plains, or ring-mountains, form the great majority of the so-called lunar craters, and though in themselves widely distinct from both the Mares and the true craters, yet through the great walled-plains and the smaller crater-plains respectively are, as it were, connected by nearly insensible gradations with both. Usually from twenty to thirty, or even fifty to sixty, miles in diameter, more uniform and circular than the walled-plains, and surrounded generally by a single principal wall, they present, perhaps, one of the most inexplicable of all the lunar formations. Their walls are tolerably regular and perfect, though of very unequal height, rising at points in high peaks, and on occasions sinking into a mere bank, whilst they are often broken by craterlets and crater-pits, and traversed by ravines and passes; but on closer examination they appear rather polygonal than circular, though usually with curved sides. Towards the exterior the walls are, especially in mountainous districts, very irregular, and the long, often terraced, slopes are disturbed and broken by formations of most diverse form, whilst ridges and hills radiate in various directions. The interior slope of the walls is invariably steeper and more regular than the outer, being generally broken by merely a few projections, and perhaps by a low terrace or two, though these projections and terraces are at times so increased in magnitude and number as to render both slopes of most intricate character; and even arms from the wall occasionally project right across the floor.

The true ring-plains, as distinguished from the crater-plains, present no appearance of being in reality craters in the general acceptance of the term, when examined critically with adequate means, and for a sufficient period to enable their real rather than apparent construction to be understood; and it must be remembered that at any one period of illumination scarcely one-fourth of the actual details are usually recognisable. Their moderately deep walls, very irregular in height, and much peaked, as well as the general configuration of the exterior slopes, appear to show them as due rather to the same origin as the walled-plains than as craters. The difficulty of drawing the line between them and the crater-plains is due to the existence of a few formations that have been considered as ring-plains from their general analogy to the others, though in many points they partake equally of the nature of the crater-plains. This absence of a marked division between the two classes of formations is not, however, any bar to their being supposed to have originated in two different manners; for the two extreme members towards the same direction under these conditions might be reasonably supposed to possess much in common, whilst there is no reason to believe that both methods may not have been brought equally into play in constructing a few formations.

In situation the ring-plains are very diversely placed: some, as Conon and Capella, are environed by immense mountain masses; while others lie on the borders of the greater highlands, as Mayer, Vittelo, and Menelaus, or else at the end of a great mountain chain, as Piccolomini and Eratosthenes, or perhaps on the floor of one of the great walled-plains, as in Clavius, or finally isolated on the great Mares, as Bessel, Lambert, and Kepler. More generally than in the case of the walled-plains, on the interior of the ring-plains there appears a definite central mountain, or more rarely a central crater or craterlet, as in Cassini, though on the walls, the summit as well as on both slopes, these are more numerous, and occasionally are found on the floor. The central mountain is, with rare exceptions, never united to the wall, unless by almost imperceptible formations, whilst the floor is often full of many minute ridges, mounds, and hillocks, though at times appearing completely level. Many remarkable anomalies present themselves, however, in these particulars, more especially as to the general independence of the central mountain from the wall, as in Encke, where a projection from the wall extends in a meridional direction nearly across the floor as a high wall ending in a peak, whilst in Delambre the central mountain is clearly connected to the wall; and in others, as Mersenius, the whole floor rises from the wall in a great convex elevation of moderate height.

Very often appear close to one another and more or less connected, two considerable ring-plains of very similar form, diameter, depth, steepness, &c., as Atlas and Hercules, Aristillus and Autolycus, Azophi and Abenezra, Godin and Agrippa, Ritter and Sabine, or Blancanus and Scheiner. At other places appear rows or groups of ring-plains, as the peculiar chain from Lacaille to Albetegnius. Many ring-plains are incomplete or encompassed by walls so imperfect as to stand united to the surrounding plains by many gaps, as, for instance, Parry, and appear related to the mountain rings, bearing in fact to the ring-plains almost exactly the relation of some classes of the mountain-rings to the walled-plains; and thus have been regarded by Mädler and others as ruined ring-plains not destroyed by new convulsions, but by the slow action of time and such weathering and crumbling forces as may exist on the surface of our satellite. In form, numbers of the ring-plains, though not proportionately so many as in the case of the greater walled-plains, bear distinct evidence of having resulted from the coalescence as it were of several mountain masses and mountain ridges.

In general the height of the walls of the ring-plains seems to be much greater on the inside than on the outside, often twice or thrice as high, and therefore the general level of the floor of the ring-plain would appear to be much lower than that of the outer surface. The outer slopes of these formations are, however, towards the foot of the wall very gentle, and this, therefore, renders the measurement of the height of the walls above the real exterior level excessively difficult, as, when at all well suited for measurement, it cannot be ascertained whether the shadow falls on the slope of the wall or on the outer surface. All Mädler's measures tacitly assume that the exterior slope of the wall is so short as not to interfere with the shadow which it is supposed rests on the exterior plain, but this is at the least very doubtful. With regard to the average slope of the walls of the ring and walled-plains very much uncertainty exists, for no measures have been executed to determine the point; and such measures are excessively difficult to make and involve much labour and computation. To find the mean slope of the steepest portions of the walls, that is nearest the summit, observations have been made of the duration of the shadows; but the period of the last visibility of the shadow is an extremely delicate point to ascertain, and the difficulty of determining this instant with any approach to accuracy is very great. In general it has been taken as the time when the interior slope of the wall that cast the shadow is comparable in brightness with the other wall, but this is invariably not until a considerable time must have elapsed since the real shadow had disappeared; for just as at the terminator the illuminated portion of the surface insensibly merges into the darkness, so the inner wall of the formation insensibly passes from shadow into light. The point to be taken in observations of this class is whenever the interior slope of the wall can be seen at all, and even this will necessarily be considerably after the epoch of the disappearance of the true shadow. Mädler gives no general estimate of the average slope of the exterior walls of the walled and ring-plains, though often ascribing a steepness of from 30° to 50° to the interior slopes of these objects. Schmidt considers 1° to 4° to represent the average slope of the outer, and 20° to 50° the average slopes of the inner walls, and on this point the estimate of Schmidt is more probable. From 1° to 3° towards the foot, and 2° to 6° towards the summit, best represents perhaps the average exterior slopes of the walled and ring-plains, and in regard to the interior slopes, the steepness of which Mädler often over-estimated, an average slope of from 8° to 12° towards the foot, and 15° to 25° nearer the summit, best seems to represent the true condition of the walled and ring-plains. In exceptional instances and in the case of terraces and ravines, greater degrees of steepness are not uncommon, and in a few cases 40° to 50° may be found, but very rarely, except in the case of short cliffs or terraces. Under these conditions the length of the outer slope of some of the ring-plains lying on the Mares may be very considerable, and the measures of the altitude obtained cannot be regarded as referring to the height above the exterior surface, but to that above the portion of the outer slope they fall on, and the difference between measures under different conditions of illumination strongly bears out this view.

Numerous examples exist on the moon of a class of seemingly regular circular formations, with moderately steep 4° to 6° bright walls rising to some height above the interior, and varying in diameter from 15 to as low as 5 miles. It is with ordinary telescopic means, always difficult to distinguish to which class of formations these belong, whether to that of the old craters or the small ring-plains, the comparative smallness of these objects rendering the distinguishing characteristics very minute in dimensions. Unless, therefore, they are examined under very favourable conditions by very powerful means, some uncertainty must attach to the classification of these formations; and as this examination has scarcely in half-a-dozen cases been effected, it is impossible to do more at present than arbitrarily treat these objects pending their proper scrutiny, which from their number must be a labour of time. The larger members of this class are best included amongst the ring-plains, as probably nine-tenths of them should be. For the smaller members, as they have hitherto been regarded as craters, it is most convenient to allow them to remain within that category, though little doubt can exist that the majority must possess a similar constitution to the lunar ring-plains. In these formations, in fact, is to be traced the connecting link between the ring-plains and crater-pits; in exactly the same manner as the more irregular and varied depressions form the intermediate steps between the ring-plain and rounded valleys. The term ring-plainlet, or preferably 'ringlet,' might well be employed to distinguish these smaller members of the ring-plain class; but the addition of a new species to the already numerous selenographical nomenclature would be premature, until it has been definitely ascertained which members of this large class are of such nature, and which are truly ancient craters.

Crater-plains are a class of formations generally included amongst the ring-plains, but differing in presenting indications of a volcanic origin not possessed, it may be said, by the true ring-plains — as Pallas, Colombo, Goclenius, Delisle, or Seleucus; though, as has been before observed, the line of separation between the two is in places difficult to fix. Of moderate size, seldom exceeding 15 to 20 miles in diameter, situated usually in the midst of a disturbed and broken region, the crater-plains rise steeply from the mass of *débris* around the foot of their walls to a considerable height, and then fall precipitously to the interior in a rough curved slope, whilst on their walls, especially on the exterior, craterlets and crater-cones often exist in considerable numbers. From the foot of the walls radiate in different directions numerous ridges, and often light-streaks, crossing and at times interfering with surrounding formations, whilst the entire environ is generally rich in craters, craterlets, and analogous formations. Though these crater-plains are probably essentially volcanic in character, it is doubtful whether they are truly analogous to volcanic craters from their great size; but they would appear to have more resemblance to volcanic regions where the entire surface has been elevated, disturbed, and thrown into vast convulsions by immense volcanic throes which have found vent in the generally numerous craterlets and crater-cones—a condition which appears to hold likewise on the earth. The crater-plains usually possess a greater steepness than the ring-plains, and more especially in the outer walls, which may be probably twice as steep as the average inclination of the ring-plains; they are likewise usually considerably brighter as a whole than these latter.

Craters.—The true lunar craters are small in diameter, varying from four to ten or twelve miles, the larger being in some points closely allied to the crater-plains, though here, as in most lunar formations, no distinct line of separation is possible. They are circular in form, rising steeply from the surface to a moderate height, and falling regularly to their comparatively small floors, whilst the whole wall is in general sharp, regular, and little broken, like the immediate neighbourhood, which is, however, generally uneven, and occasionally contains a craterlet or crater-cone. An interesting characteristic feature possessed by the craters is their brightness, which in some cases rivals that of the brightest lunar objects, and this character is usually also visible to a less degree in the surrounding surface, thus rendering the study of these formations somewhat difficult.[1]

Craterlet has been hitherto employed to indicate not only the smaller craters, but also the very numerous class of formations here termed *crater-pits*, and frequently designated by Beer and Mädler *pits* (Grübchen); but the typical classes of the two formations being so very distinct, the name has been retained for the former class only, and the latter, in accordance with Beer and Mädler, have been named 'crater-pits.' The true craterlet is a crater in miniature, a bright circular formation with moderately steep walls, remaining visible for a considerable period as a depression, and towards Full usually detectable as a bright spot of somewhat larger area than its own dimensions, which vary from under half-a-mile to five or six miles in diameter. Situated most diversely, their presence is a general indication of a disturbed locality, though seldom of very extensive area, whilst on the other hand few disturbed regions do not contain one or more of these craterlets. They are found not only on the walls and slopes of the ring-plains and crater-plains, but dispersed sparsely over the Mares and plains, yet usually always connected with some trace of sub-surface energy, as at the junction of two or more ridges, and in several places lying in chains close to one another on the crest of a ridge. The craterlets seem, in fact, the indication of the minor

[1] It has been already mentioned that it has been found necessary to include many small circular formations of doubtful character under the class crater; they having been hitherto always so classed, and the means of discriminating between the two classes of ancient craters and small ring-plains not existing at present as far as they are concerned. Under this class it has been also deemed advisable, in describing the details of the lunar surface, to include a very numerous class of circular depressions, which, on the south-west quadrant of the moon, assume to a very marked degree the character of craters, or rather the members of that numerous class of formation whose true nature is still doubtful.

sublunarian disturbance, as the craters and crater-plains are of the great convulsions that the surface of the moon exhibits.

Crater-pits are a distinct class of formation from the last, and are of very variable dimensions, being from only a few hundred yards to ten or even twelve miles in diameter, though not usually exceeding five or six; whilst they bear to the craterlet much the same resemblance as the ring-plains do to the crater-plains and craters. Approximately circular, though occasionally elliptical, or even approaching a square figure, their exterior walls are of such feeble slope or so small as to be barely perceptible; though towards the interior they are somewhat steeper, yet are so shallow as to be generally invisible twenty-four hours after sunrise, and perhaps never appear as white spots in higher illuminations, but remain undistinguishable from the general surface except close to the terminator. In places, especially towards the south of the moon, they are very numerous; most frequently, on level plains or the interiors of walled or ring-plains, as in Clavius, west of Maginus, Tycho, and Copernicus, &c., and occasionally, as near Copernicus and Bullialdus, they form confluent chains. In the brighter regions of the moon it is occasionally difficult to distinguish between the smaller craterlets and crater-pits, more especially as they are occasionally mixed, and the steeper walls and brighter appearance of the craterlets are not so marked when minute and in a region where the whole surface is bright. Many of these formations, as well as the craterlets, are so small as to admit of little beyond their actual existence being perceptible, and in hardly any case can the small details which go to make up a craterlet or crater-pit ever be seen, even though powerful instrumental means be employed. To distinguish between the older and more imperfect craterlets, which have lost much of their original steepness and brightness of colour, and the crater-pits, is therefore a task of no slight difficulty, and one in which, from the minuteness of the whole, considerable uncertainty must exist. That these crater-pits are not, like the craterlets, probably real lunar volcanic apertures, is nearly certain, and in many features they resemble more the depressions in the surface commonly met with on the earth; and this is what the manner of their distribution, their general identity in all characteristics with the surrounding surface, and other features would seem to indicate. Thus they would appear to be more directly connected with the depressions of the lunar surface than with the true craters.

Crater-cones.—Perhaps the true representatives upon the moon of the existing terrestrial volcanoes have only of late years had their distinctive features recognised, and even when exceptionally well placed, are only with difficulty distinguishable from the bright mountain peaks and minute white spots dispersed over the lunar surface. Steep conical hills or mountain peaks from one half to two or three miles in diameter, with deep cone-like central depressions scarcely one-half of this size in diameter, they remain in high illumination, visible as a white brilliant spot, of minute dimensions, and only under favourable condition can their central aperture be detected even in the most powerful instruments. They are occasionally to be found on the summit of a mountain mass as in Pallas or Gassendi, more usually on the slopes of a crater-plain or crater, or even a ring-plain, and not uncommonly on the floor of a ring or walled-plain, as in Plato and Fracastorus. Under any circumstances they are difficult to distinguish from bright mountain peaks and white spots, many of which may belong to this class of formations, whilst in many ways they bear a considerable resemblance to terrestrial volcanic cones, and it is therefore not without interest to find that many phenomena, perhaps indicating actual lunar changes, present themselves in observing these objects.

Depressions comprise a group of most diverse classes of lunar objects which are best embraced by the above term, and varying from valleys and spaces enclosed accidentally by ridges to what are possibly the ruins of the more ancient formations of all the above-described classes. They appear at times as mere holes in the surface, of often considerable depth and area, again in the form of shallow sinkings in the surface, usually somewhat circular in form, but merging insensibly into the surrounding surface without perceptible border, whilst others are found on the surface between two curved ridges, or occasionally between several hills, mounds, or peaks; and in these two cases under low illumination, they bear a considerable resemblance to a crater or to a ring-plain, according to their size. This group also includes the round and elliptically shaped valleys, not uncommon on the spaces at the junction of two cross valleys; and in fact exhibit an almost indefinitely large variety. But in many of these formations which are classed merely as depressions, there appear the characteristics in a less perfect form of those formations which when more complete are called ring-plains if large, crater-pits if small, and if not circular, valleys. In the southern quadrants of the moon, but especially in the south-western portion of the south-west quadrant, appear very numerous examples of a class of depressions of indeterminate character. Under low illumination and when circular they cannot easily be distinguished from the craters and smaller ring-plains, whilst in Full, like the majority of these last, they usually disappear; in particular conditions of oblique illumination, however, they can be seen to possess no true exterior walls; a peculiar characteristic. Though often circular, yet many are more or less elliptical, whilst others show two or more united into an irregularly formed depression. These formations, generally deep sinkings in elevated regions and without any sensible exterior wall, are occasionally surrounded by hills, ridges, and mountains, which in a marked manner disguise this want, and enable them to pass easily for craters; whilst some few appear to possess the remains of a true wall. Attentively studied, some few of these formations exhibit features of the greatest interest, and show masses of *débris* in their interiors, as if they had originally possessed walls which had slipped inwards, giving them the appearance of mere holes or depressions. In several cases the remains of the walls can be seen projecting in rugged masses from the edges, and this tendency of the walls of the ring-plains to fall inwards is shown by the existence of numerous landslips, whilst cases of the casual slipping downwards of the walls are not uncommon. Numbers of these depressions, therefore, may be the ruins of the ancient members of the class of small ring-plains, as the ruinous condition of the borders and irregular interiors would indicate. From their great resemblance to the indefinite class of seeming craters, it is probable that many of the more regular of these have been included among them, and this course has been generally adopted when any uncertainty has existed as to the true nature of the formation.

The various classes of elevations upon the moon coming under the term of mountains, bear so considerable a resemblance to the corresponding terrestrial formations as to require little general description.

The *mountain ranges* are sometimes of analogous formation to those of the earth, namely, in presenting a single chain with high peaks at intervals; and of this kind are the lunar Hercynian mountains, the Cordilleras, and the Pyrenees; but more usually they rise on the border of a great elevated mass of *highlands* divided by long valleys and intersected by numerous ravines and cross valleys, the whole constituting a great plateau rising at one side into a high crest, above which tower immense peaks, occasionally reaching an altitude of 20,000 feet, and very ordinarily 10,000 to 15,000 feet. The Alps, Apennines, and Caucasus constitute examples of this class of lunar mountains, which are not without analogy to the high plateaux and mountain ranges of Central Asia.

More generally the lunar *mountain* appears as a mass of moderate height but extensive base, rising in several peaks of unequal altitude, the highest being commonly from 5,000 to 6,000 feet, and these peaks are separated from each other by numerous ravines and valleys, which break up the base of the mass. Occasionally single *peaks* appear, rising from a rugged but united base to a height of from 3,000 to 5,000 feet, though sometimes, as in the case of Pico, they reach as great an altitude as 8,000 feet.

Hill-lands are considerable extents of surface, usually elevated, that are covered by hills and short ridges, with occasionally a mountain peak or crater, whilst the intermediate space is occupied by a complex system of valleys and cross valleys of every form and size. Such extents of surface are not uncommon, as east of Bode and north of Schröter, and only distinct from the highlands in the more moderate dimensions of the irregularities on their surface. Low *plateaux*, with more or less steeply rising sides, are frequent on the more level portions of the surface, and often contain on their summits a few hills or a crater-pit or so, with, perhaps, some low peaks along the borders.

The *mountain ridges* are most frequent around the more disturbed regions of the moon, often uniting two or more formations or enclosing valleys and depressions of considerable extent, whilst at times they rise to a height of several thousand feet, and extend one or two hundred miles, or even more; then, however, being usually much branched and rising at intervals into considerable peaks, occasionally reaching an elevation of 6,000 or 7,000 feet. Of whatever dimensions, they are crossed by numerous valleys, passes, and ravines, often so narrow or so close under the peaks as to be only detectable with difficulty; whilst in every direction from their foot radiate arms, branches, and spurs, often thus being united with other ridges. Occasionally surrounding depressed portions of the surface, they form apparent ring-plains, not always distinguishable from the real ones. The smaller *ridges* are not very dissimilar in general nature, but appear often as copies in miniature of the mountain ridges; but frequently they are of much less steepness, and with a broad summit which is often sinuous in form, thus standing halfway between the other ridges and the land swells or surface undulations. On the Mares these last three classes of formations are very numerous, and also around other objects, as the ring-plains.

As much uncertainty exists as to the general steepness of these lunar formations as there does with regard to that of the crateriform portion of the surface, and a true idea of their real steepness is harder to obtain; but though a great variety, as might be expected, appear in special cases, in average steepness the mountain slopes and those of the more moderate elevations would appear to stand midway between that of the interior and exterior slopes of the ring-plains. At their bases, however, the inclination is very much less in all cases, but the steepness of some of the peaks at times rises as high as 25° to 30°, whilst at places almost perpendicular cliffs and precipices are to be detected, only these are exceptional. The slopes of the smaller formations, as the mounds, ridges, plateaux, and hills, are usually very gentle, and comparable in this respect to the exterior slopes of the ring-plains. Sharpness of shadow, it has been several times pointed out, is no criterion of steepness of form; for even a round ball under low illumination will give a sharp-pointed shadow.

Mention has already been made of the central elevations of the walled and ring-plains, and crater-plains; and these have been divided by Beer and Mädler into central chains, central masses, and central peaks, with, on rarer occasions, central elevations. Of these the second and third are most numerous, and often rise exactly in the centre of the formation, and generally without any connection with the wall; the central chains are infrequent, and distinct from the cross walls that sometimes, as in Capella and Licetus, divide the floor into two or more portions, and which belong rather to the class of wall projections; the central masses are more numerous, and rise at times in several distinct peaks, whilst the base is divided by deep ravines and valleys into separate masses, as in Gassendi, Theophilus, Petavius, and Bullialdus. Some ring-plains possess two or more separate central mountains, as Copernicus and Tycho; but all these central formations are lower than the crests of the wall, and rarely surpass 5,000 or 6,000 feet in height, being usually much lower, and in deep formations, as Conon, are easily overlooked. Central elevations or convex interiors have been already referred to, and are very uncommon.

There is one class of formations that have not been placed under any of the three great classes described above, though possessing features rendering them in the highest degree interesting, but which, from their unknown nature, cannot well be classified. These are the *rills* or *clefts*, long, narrow, deep ravines, canals, or cracks, usually straight, often branched, sometimes curved, and not unusually intersecting one another; extending for considerable distances at times, generally traversing, without interruption, mound, ridge, or crater-pit in their path, though occasionally deflected by some object, or interrupted by others, when it recommences beyond and proceeds as before. One of the most difficultly visible, they are also one of the most inexplicable formations on the moon, and little information as to their origin can be derived from their situation, which is most diverse, at times lying on the open plains without anything to indicate beginning or end, often running through the midst of mountains, or extending from a crater to the open plain ; at others they appear to form an intricate network around a formation, or are situated on the floor of a walled-plain or ring-plain.

Schröter first discovered these formations, and named them rills, and from 1787 to 1801 detected eleven ; but the definition of his telescopes was probably not sufficiently sharp to permit of his observing any but the most prominent of these delicate objects. Lohrmann, during the period 1823–27, found no less than seventy-five new rills ; and Mädler, between 1832 and 1841, added fifty-five more ; whilst six seen by Kinau in 1847 and 1848, and 278 observed by Schmidt between 1842 and 1865, raised the total to 425, the number described in Schmidt's 'Rillen auf dem Mond.' Since this period a great number of new rills have been discovered, some during the construction of the lunar map of the British Association, where the term 'cleft' is introduced as preferable to 'rill,' but mostly independent of this, and their total number may be now considered as probably nearly 1,000 ; whilst every year the labours of a very few observers only, are adding fresh examples to those already known.

With regard to the true nature of these rills or clefts absolutely nothing is known, whilst they are too delicate objects to allow much, if any, of the details of their formation to be made out. It has been supposed they are cracks or fractures in the lunar surface ; but their intersection and general conditions of existence seem quite inconsistent with such a supposition, more especially in their behaviour with reference to the various formations they pass through, round, or over. In many points they bear some resemblance to the dried beds of lunar watercourses or rivers, but in many features do not seem in accord with such an origin, though perhaps it presents the most feasible explanation of their nature of all ; but their true nature will not be ascertained until they have been made the subject of a searching examination with a powerful telescope of the highest excellence, and thus details of the method of their construction have been obtained. Perhaps, unlike the terrestrial river beds, these rills may have arisen independently, but have served afterwards the purpose of river-beds, and their connection with the system of delicate valleys renders such a view somewhat probable. Thus many of these rills commence at the end of a system of branched valleys leading from a highland, whilst others can be detected winding along the bottom of extensive valley regions. At other times they appear, however, entirely independent of any such formations. Schmidt considers that these last, in particular, are rows of confluent craters, and draws many as crater-rills, though others have failed to recognise this with even more powerful means. The sides of many of these rills are usually, however, very rugged, and under particular illuminations this will give rise to the appearance of their being crater-chains, in the same manner as narrow rugged valleys are often scarcely to be distinguished from crater rows. The bottoms of these rills, even the most rugged, appear to be almost perfectly flat. An especial feature is their remarkable length, in some instances extending for over 200 to 300 miles.

For the purpose of recording the brightness or light-reflecting power of different portions of the surface of the moon, Schröter introduced in his 'Selenotopographische Fragmente' a scale comprising ten degrees, which he divided into 0° or the shadow of the mountains, 1° the darkest ash grey, 2° a medium grey, 3° a bright grey, 4° a brightly enlightened floor, 5° to 8° the bright lunar regions, 9° Proclus, and 10° Aristarchus, the last being considered by him as the most brilliant object on the moon. Lohrmann adopted a similar principle, though varying the value of the degrees, and put 0° for the darkest shadow, 1° for the darkest parts of the surface, 2° for the dark portion, 3° for a dark grey, 4° for a grey, 5° for a bright grey, 6° for the brightest grey portion of the surface, 7° 8° 9° for the more brilliant white portions, and 10° for the glittering white of Aristarchus. Beer and Mädler, retaining the same number of degrees as the earlier selenographers, divided them anew, as follows, in their 'Der Mond,' and this has been adopted as the standard scale and here retained for all estimations of brightness. 0° the dark lunar shadows, 1° to 3° degrees of grey, 4° to 5° gradations of light grey, 6° to 7° greyish white, 8° to 10° brilliant white. The degree 1°, an almost black grey, is rarely found, and usually only in parts of Riccioli and Grimaldi, though at times Plato and some smaller almost black spots on the Mare Vaporum approach very closely. A brightness between 1° and 2° is more common, and consists of a very dark grey, examples of which appear in Plato, Boscovich, and portions of Schickhardt, whilst 2°, a pure dark grey, exists in Julius Cæsar, and many spots around the Mare Vaporum. From 2° to 3° a darkish grey appears in most of the Mares, as the Mare Crisium and portions of the Mare Tranquillitatis and the border of the Mare Serenitatis. In all these greys a double degree appears to exist, namely, a pure grey sinking to a very dark cold steel grey, and a brownish-grey sinking to a blackish-brown colour, intermediate tints between these two often appearing. The 3° bright portions of the surface or medium grey vary from a white tinge to a decided yellow tinge, and constitute the principal portions of the large Mares and many of the interiors of the ring-plains. Some of the hill-lands of the moon, like those near Schröter, numbers of the valleys, and some hills near Pythagoras, appear from 2° to a full 3° bright. The floors of the greater number of ring and walled plains, with the majority of the valleys, vary between 3° to 4°, light greys with more or less of a cold yellowish tint.

The general tint of the elevated portions of the moon, as well as of numbers of the valleys, appears to be from 4°, a yellowish grey, to 6°, a light greyish-white, the intermediate tint 5°, a pure light grey, standing midway as it were between the light and dark portions of the surface, and is the usual tint of all the mountains, the borders of the walled and ring-plains, and the great majority of the bright rays and streaks, such as, for example, the bright surface around Kepler. It is only in places in the south-west quadrant or near the limb that the general brightness of the surface reaches as high as 6°, and only in the more disturbed and brighter regions that the walls of the ring-plains become of this degree of brightness.

The remaining degrees are 7°, a bright grey white, 8°, a pure white, 9°, a glittering white, and 10°, a dazzling white ; and comparatively few objects in the moon belong to these classes. Isolated mountains are often 6° to 7° and sometimes 8° bright, and the last two degrees are generally visible in every mountainous district, though the highest peaks are not even usually the brightest, whilst in a very few cases elevations not very remarkable for either position or height are even 9° bright, and may perhaps in some instances be really crater-cones. A great number of formations from 7° to 8° bright are the crater-plains, craters, and craterlets, generally the whole, walls, interior, and immediate environs, being of the brightness and appearing at full as a single rounded white spot; but in this appearance the smaller formations are exactly resembled by some of the mountains, and it remains then impossible to distinguish between the two. In various portions of the surface are likewise to be found small white spots and streaks from 6° to 8° bright, which cannot be identified on the terminator with any apparent formation or irregularity. Objects 9° bright are very infrequent, and, excepting the walls of Proclus, a portion of the surface near Lexell, and a few elevations, apparently peaks, comprise only craters and craterlets, which glitter in the sun in a most distinct manner under high illumination. The brightest region upon the moon is that of Aristarchus, the immediate environs being 9°, the outer walls and interior 9°–10°, the interior walls 10°, and the central peak perhaps still brighter.

One of the most remarkable appearances presented by the moon when its surface is under high illumination is due to the great *ray* or *streak* systems; seven of the principal formations of the moon, Tycho, Copernicus, Kepler, Byrgius, Anaxagoras, Aristarchus, and Olbers, being environed by numerous bright rays or streaks radiating from them far and wide, while to a less marked degree a similar appearance presents itself around Mayer, Euler, Proclus, Aristillus, Timocharis, and some others. These rays or streaks ordinarily commence at a slight distance from the walls, the immediate environs being comparatively dark, generally only 4° bright, or at Aristarchus only 2°, and then extend great distances, for 100, 200, and 500 miles, over plains, craters, mountains, valleys, and all formations without distinction, or without in any way being modified or modifying. Close to their origin the rays by their union form a kind of nimbus around the radiating centre of very variable dimensions, that at Kepler being largest and at Aristarchus hardly perceptible, whilst beyond this nimbus they extend usually straight but often branched, though occasionally curved as at Copernicus and Anaxagoras. In some cases the rays end sharply at a crater or ring-plain, others lose themselves in the bright regions of the limb, whilst many gradually disappear on the plains or amongst the mountains.

The most extensive system is that of Tycho, where many hundred separate rays can be distinguished, mostly ten to twenty miles broad, extending over nearly the entire SW. quadrant of the moon, and over a considerable portion of the SE. quadrant ; some of the rays losing themselves in the Mare Nubium and Oceanus Procellarum, after traversing a distance of 600 or 700 miles, while one crosses nearly the entire visible hemisphere, becoming nearly imperceptible at Menelaus, but very distinct again when passing over the Mare Serenitatis, and disappearing finally in the bright region of the limb beyond Thales, a distance of nearly 2,000 miles. When these rays are numerous they completely overpower all differences in light reflective power in the formations they traverse, and which consequently vanish in their light, from which circumstance few formations in a great portion of the SW. region of the moon are detectable under high illumination.

Beyond the seven principal systems of rays or streaks, which though not equally extensive are yet very analogous to one another, there are many incomplete systems and isolated streaks of various kinds. From Proclus, at nearly equal angles of 120°, extend three rays, of which two are feeble and difficultly visible, and the third distinct and branched. Messier has completely the form of a faint comet with a long double tail, the nucleus being Messier itself, and the tails two long white streaks of equal size, gradually widening and losing themselves in the mountains. In many places, especially on the Mares, where they alone are well visible, single bright streaks extend without clear connection or common origin, of which some may be very low ridges, but most appear to be entirely independent of surface irregularities. The true nature of these rays and the origin of the ray-systems is at present unknown, though it appears that they are not merely surface elevations, such as the mountain ridges, &c., and Beer and Mädler regard them as perfectly independent of all surface formations, which, however, later observations with more adequate means do not entirely confirm. The most obvious course would appear to be to connect them with some processes of weathering or surface action, but of what nature there does not appear to exist any evidence, and this alone affords no clue to the reason of their radiating from a centre, as shown in the most prominent systems. In some instances they seem connected not only with very delicate surface irregularities but with crater systems, as at Gassendi and near Kepler, Byrgius, and in the south-west, whilst at others they seem dependent on faults or disturbances of the surface. In several formations the rays seem to have been overwhelmed by the surface of the Mare, almost as if they had disappeared beneath through some irruption of material from the surrounding surface, whilst in one or two cases they have been disturbed by large formations, as Saussure, and in others by craters and craterlets. In several formations that have the appearance of having been filled up by some means by material from the surrounding Mare, the rays disappear abruptly at the wall. The true solution of the origin of these streaks or rays will probably not be found until their appearance has been made the subject of a thorough investigation, so as to make known the more delicate features they present.

In the Mare Nubium and on the north and west of the Oceanus Procellarum are many craters, from four to seven miles in diameter, surrounded by a bright glittering surface, extending from ten to thirty miles in every direction, and gradually fading into the surrounding surface. These craters, which are usually from 7° to 9° bright, are marked out as an especial class by Mädler, as 'light surrounded craters,' and the principal are Euclides, Parry A, Hortensius, Bessarion, &c.

Besides the differences in brightness of different portions of the surface which have been mentioned, there are quite as distinct specific differences in colour visible, more especially when favourable conditions are selected. Thus, the entire central portion of the Mare Serenitatis appears with a decided light green tinge, while in the Mare Humorum is a somewhat duskier tinge of green, and a fainter but similar appearance is noticeable in the Mare Crisium. The Mare Frigoris appears likewise to be of a dull dirty yellowish green, at times more brownish-yellow than green, and a similar appearance is, under favourable conditions, detectable in the Mare Imbrium, whilst the Palus Somnii exhibits a peculiar golden-brown colour, very noticeable under certain conditions. Mädler also draws attention to a reddish tint in the surface near Lichtenberg, though this is now barely detectable. The surface of the moon exhibits every kind of variation of pale yellow, grey, and white, and in many places the yellow merges almost into a pale brown. A very noticeable contrast appears between the greyish white and white of the brighter portions of the high mountain regions, and the walls of the great ring-plains. and the greyish white and white of the streaks; the former appearing as of considerable intensity and body, with a distinct tinge of yellow, whilst the latter seem to possess a thin bluish white of little intensity, and almost as if it were semi-opalescent. Similarly the white of the bright craters appears more bluish, than yellow like the ring-plains, though surpassing these in intensity.

CHAPTER IV.

LUNAR HISTORY.

The astronomy of the earlier civilisations appears to have been confined to the mere observation of the more marked phenomena of the heavens, and in a few cases of the periods regulating their recurrences. Thus in connection with the moon, attention was directed mainly to the recording of eclipses, and the period of revolution of the moon.

The earliest records of such astronomical occurrences are those of the Chinese, which commence with a solar eclipse of the supposed date of 2158 B.C.; but their annals contain little beyond the bare mention of events, whilst systematic series of observations were apparently never made. From what is known, the results of the Hindoo and Egyptian observations were still more incomplete than those of the Chinese, and quite as vague. The Chaldeans appear to have made and recorded regular series of observations, however, from a very early period, though only those of the later times at present have been made known, and may be said to commence with the lunar eclipse during 720-719 B.C., quoted by Ptolemy. They early arrived at a close approximation to the true length of the solar year, which they made equal to $365\frac{1}{4}$ days, whilst the period of the revolution of the moon must also have been closely approximated to; and they had deduced, probably from a long series of observations of solar eclipses, the celebrated cycle of $6585\frac{1}{3}$ days or a little over eighteen solar years, known as the Saros, in which the moon makes 223 synodical, 239 anomalistic, and 241 nodical revolutions, and after which the eclipses recur in the same order as before.

With the early Grecian philosophers, commencing with Thales, astronomy became principally theoretical, few attempts having been made during this period (650–300 B.C.) to obtain systematic series of observations; whilst as a natural result of the purely theoretical views thus held, a great variety of opinion prevailed at different epochs and in different schools of philosophy. The general resemblance in its nature of the moon to the earth was assumed by many of the principal philosophers, including Anaxagoras (500–430 B.C.), Philolaus (480–420 B.C.), and Democritus (459–350 B.C.), the latter holding that the lunar valleys and mountains were the cause of the lunar markings; and towards the later periods the probability of the general analogy between the earth and moon became widely admitted. Aristotle (384–322 B.C.) showed by considerations founded on its phases and eclipses, that the moon must be a sphere always turning the same face to the earth, and as evidence that the moon is nearer than Mars, records an occultation of the latter by the former.

Another point in connection with the moon to which much attention was directed, was the construction of celestial cycles, with the object of bringing into accord, after fixed periods, the sun, moon, and seasons. The Chaldean Saros seems to have been known to the Greeks as early as B.C. 600, when probably by its aid, Thales of Miletus predicted an eclipse, whilst by its use in later times, Helicon and others seem to have done the same. To Cleostratus of Tenedos (530–470 B.C.) is ascribed the introduction of the Octacteric cycle of 2,924 days, or eight lunar years of 354 days and three intercalary months of thirty days, making a period of eight solar years; and by this means the lunar year was brought into close accord with the solar, though a somewhat considerable error (thirty-six hours) with regard to the moon was left outstanding. To remedy this, Meton, an Athenian, in 432 B.C., introduced the use of the celebrated Metonic cycle of 6,940 days, divided into nineteen years and 235 lunations, a period departing only by nine hours from the sun, and seven from the moon, the difference between the two being only two hours; this cycle, therefore, enjoyed a great reputation amongst the early astronomers. In 330 B.C., Calippus improved the Metonic cycle by quadrupling it and subtracting one day, thus obtaining a period of 76 years or 27,759 days divided into 940 lunations, and agreeing still more closely with the actual returns of the sun, moon, and seasons; the error with regard to the sun being reduced to fourteen hours, and with regard to the moon to six hours; owing thus to its superior accuracy, this cycle was employed by the scientific astronomers of this period.

It was by the agency of the Alexandrian school of Greek philosophers that ancient astronomy made its great advance, both from the employment of superior and improved instruments, and by systematic series of observations. Aristarchus of Samos (320–250 B.C.) was the first astronomer of mark of the school, and was especially distinguished for proposing a heliocentric theory of the solar system, similar in principle to the Copernican, though unfortunately later astronomers did not accept it; whilst amongst other works, Aristarchus determined by sound methods the distance of the sun and moon from the earth. Owing to imperfect instruments, he obtained an entirely inadequate value for the former, but the latter he fixed with considerable approximity at fifty-six times the radius of the earth. He was less successful in determining the diameter of the moon, which he fixed at 2°, or more than three times too great, yet this was an observation of great delicacy with the then rough appliances. He was succeeded by Eratosthenes (276–196 B.C.), a mathematician of repute, who attempted to obtain the dimensions of the earth by observing the difference in the zenith position of two places at a known distance apart, and found it to correspond to a radius of 5,000 miles, a fourth too great; whilst from other considerations he fixed the distance of the sun at one hundred million miles, and the moon as some ninety-eight thousand, or somewhat more than a third of the real distance.

Hipparchus (190–120 B.C.) was, however, the greatest observational astronomer of this period, and by his observations carried the theory of the motions of the moon to a condition far superior to that at any previous epoch. He discovered the elliptical nature of the orbit, which he regarded as an eccentric arising from the earth not being situated exactly in the centre of the circle in which the moon moved. Hipparchus estimated the equation of the centre as being 5° 1′, whilst he deduced for the inclination of the orbit the value 5°, and by comparison with the ancient Chaldean observations computed the period of the revolution of the nodes at $18\frac{2}{3}$ years, finally determining the time occupied by the apogee of the lunar orbit in making a complete revolution to be a little under nine years. Hipparchus was also the first who is known to have recognised the existence of the lunar parallax, and from it he determined the distance of the moon to be 59 radii of the earth, whilst by a careful series of observations he fixed the diameter of the moon as 31′, an exact determination. It was by Ptolemy (100–170 A.D.), however, that the astronomy of the ancients was carried to its highest perfection, as he framed a skilful theory of the solar system found to agree well with the observations of this period, whilst by means of careful and systematic series of observations, combined with those made 300 years before by Hipparchus, the various astronomical periods and constants were determined with considerable approach to exactness. The lunar theory was improved by the discovery of the great irregularity known as the evection, whilst the values of the inclination of the orbit and equation of the centre were carefully computed; and new determinations of the lunar parallax and diameter were made, though these last were both too great.

From this epoch astronomy stood still and made no further progress for fourteen centuries, the great disturbances undergone during this period having diverted attention from physical science; and though the conquest of Western Asia and Egypt by the Arabians had the effect of transferring the scientific knowledge into the East, little improvement resulted in astronomy, and more especially the lunar theory remained where left by Ptolemy. Towards the end of the fifteenth century observational astronomy may be said to have been recommenced, mainly on the basis of knowledge derived from the Arabian details of the Ptolemaic system, and this mediæval epoch may be regarded as culminating in the work of Tycho Brahé (A.D. 1575–1600). By this celebrated observer astronomy was carried to a considerable further stage of delicacy by the employment of superior instruments. The lunar theory of Ptolemy was still further improved by his discovery of the periodical inequalities known as the variation and annual equation, the amount of the former being closely fixed, though the latter from its smallness was not so successfully determined. Tycho Brahé likewise detected the variation in the inclination of the lunar orbit, whose mean value he fixed at 5° 8′, and its deviation on each side of this as $9'\frac{1}{2}$, whilst he also discovered the unequal motion of the nodes; and by these improvements completed the theory of the lunar motions, as far as the then means of observation were concerned.

The modern stage of astronomy may be said to have originated with the discovery of the astronomical telescope by Galileo, by which astronomers were placed in a position not only to study the details of the physical nature of the solar system, but which afforded a means of increasing a thousandfold the delicacy of their observations.

Galileo on turning his telescope to the moon may be regarded as the first to substitute facts for conjecture with regard to the condition of the moon's surface, and he soon saw it was a mountainous region, not unlike in its nature the terrestrial surface, though the prevailing classes of formations on the earth and moon appeared to be widely different. From his observations Galileo constructed the first lunar map, the positions of the principal objects being laid down roughly by eye-estimates, though with sufficient exactness to enable him to discover the moon's libration in latitude, whilst he recognised that a diurnal or parallactic libration must also ensue from the same causes as produce the lunar parallax. By estimating how far beyond the terminator the summits of the high peaks remained visible, Galileo attempted to determine their height by simple trigonometrical principles; and as some of these peaks remained still visible when at a distance within the terminator estimated by him as one-twentieth of the lunar diameter, he computed that their height above the moon's surface must be fully 28,000 feet, or $5\frac{1}{4}$ miles, an estimate considerably above the truth.

Scheiner, a German professor of mathematics at the University of Ingolstadt at about the same period, made a number of lunar sketches of a similar character to those of Galileo; and during 1620–1640, Langrenus, who was attached to the Spanish Court, executed numerous special drawings of different spots, which he distinguished by calling them after celebrated men; but his observations, never widely known, sank into oblivion, whilst his system of nomenclature, rejected after consideration by Hevelius, was never accepted.

With Hevelius, the celebrated astronomer of Dantzic, may selenography be considered to originate, and he was the first, by long continued observation of the moon, to construct a satisfactory lunar map; the principal formations on it he designated by names derived from their supposed terrestrial analogies, the whole number so distinguished amounting to nearly 250. This map, though all the positions were laid down by estimation, is, considering the optical means at his disposal at this period—namely, a telescope magnifying only from 30 to 40 diameters—very accurate, and it remained for over 100 years the best map of the surface of our satellite.

Hevelius's 'Selenographia' contained, besides his principal map engraved by himself, a number of special drawings of the moon, together with a description of the principal of these. To determine the altitude of the lunar mountains Hevelius adopted the same method as Galileo, but with greater success: by estimating the distance within the terminator at which some of the mountain peaks remained visible, he deduced their height to be 17,000 feet or $3\frac{1}{4}$ miles, a tolerably satisfactory result, seeing they were probably the lunar Apennines and Caucasus. To Hevelius is likewise due the discovery of the libration in longitude, which he considered due to the centre of the moon's disc being always directed towards the centre of the lunar orbit, whilst the earth was situated in a focus.

Four years after the appearance of Hevelius's work, Riccioli of Bologna in 1651 published another lunar map in his 'Almagest,' where, adopting the principle already used by Langrenus, which was also the first idea of Hevelius, he boldly recast the whole lunar nomenclature. He substituted the names of the most distinguished astronomers and mathematicians for the feeble terrestrial analogies of Hevelius, except in the case of the great lunar surfaces already named seas by Hevelius ; these Riccioli named after various astrological influences supposed to be exerted by the moon, but retained the generic name of 'Mare'; whilst Hevelius's mountain ranges he named terra, an innovation in which he has not been followed, Hevelius's names still surviving. The nomenclature of Riccioli met with general acceptance on the Continent, though in England Hevelius's was common until after the publication of Schröter's work, after which period the Ricciolian nomenclature entirely superseded that of Hevelius. At the present time many of Riccioli's names have become lost, principally from the uncertainty as to the original formation intended, but over two hundred are still retained; whilst only six of Hevelius's names are now in use, namely, the Alps and Apennines and four promontories; many additions have, however, as it will be seen, been since made. Riccioli, though an inferior observer to Hevelius, has had the merits of his map much under-estimated; for it appears to have been the result of good lunar observations, and is in some particulars superior in completeness and accuracy even to Hevelius's, though from his less exact estimates of distances it is less so on the whole. But his labours have afforded results far superior to what would have been expected from the disparaging observations of Beer and Mädler. In his remarks as to the probable nature of the surface Riccioli is juster than most of his immediate successors; but in his estimate of the altitude of the lunar mountains, he is far wrong, having assigned a value in one case as great as ten miles.

Newton, in a letter to Mercator in 1675, published in a work on astronomy by the latter in 1676, considerably improved the explanation of Hevelius with regard to the origin of the lunar libration in longitude, by showing that it was a necessary sequence of the uniform rotation of the moon on its axis in the same time as a complete revolution of the moon about the earth, combined with the variable orbital motion; but like Hevelius, Newton believed the lunar axis to be perpendicular to the ecliptic. In 1687 appeared Newton's great work, the 'Principia,' containing an elaborate investigation of the laws of motion on the basis of the theory of gravitation, together with an application of his results to the theory of the moon's motions, and showing how they explained the lunar periodic inequalities. Newton's work included an investigation of the figure of the moon, which, he pointed out, must be elongated in a direction towards the centre of the earth, this form of the moon's figure being a sufficient cause for the identity of the mean periods of the axial rotation and orbital revolution; and he showed that from the endeavour of the earth to retain this major axis of the moon always directed towards the earth's centre, whilst the effect of the known libration was to move it by a small angle on either side, this longer axis must acquire a vibratory motion of very small extent, thus constituting a real lunar libration besides the already known optical librations. From his theoretical investigation, Newton computed fairly accurate values for the principal lunar inequalities and for the motion of the lunar nodes; but for the mean rate of progression of the perigee of the moon's orbit, he obtained a value only half that shown by observation.

During these brilliant researches of Newton's the great astronomer Dominic Cassini was engaged in lunar observations, on the basis of which he constructed a lunar chart some twenty inches in diameter, which was published in 1680; but though from his superior optical means this was more complete than Hevelius's, it was perhaps inferior in accuracy, the places being only laid down by eye-estimates. The map was little known, and, indeed, until its republication by Lalande in 1787, perhaps unknown, except in France and Italy. To Cassini selenography owed one of its greatest advances, for after an investigation of the known conditions affecting lunar observations, founded on the results of twenty-two years' labour, Cassini in 1693 announced his theoretical solution of the problem of the lunar optical libration, and discovered a highly interesting relation between the moon's equator and orbit. Cassini's theory stated that if three planes passed through the moon's centre, representing respectively the planes of the lunar orbit, equator, and the ecliptic, all three intersected one another in the same straight line, the line of nodes of the moon's orbit, whilst the third was always situated between the first two. From his observations he fixed the inclination of the lunar equator to the ecliptic at 2° 30′, and the inclination of the moon's orbit to the ecliptic at 5° 0′.

For half a century the mathematical investigation of the problems of physical astronomy rested where Newton had left them, for the geometrical method employed by Newton proved entirely unavailable for further progress in the hands of his successors; but during this period the labours of Leibnitz, the Bernouillis, &c., in the field of mathematical analysis, laid the foundations for the application of the then latent powers of the infinitesimal calculus to the questions of physical astronomy.

Euler was the first who, applying the powers of analysis to the question, endeavoured to carry the lunar theory beyond the point where it was left by Newton, and in 1746, as the result of his labours, he published new lunar tables; but, owing to the imperfect nature of the co-efficients used, which were derived from observation, they were little superior to the former tables, whose errors occasionally amounted to nearly a minute of time. In the seven years that followed, D'Alembert and Clairaut, two of the most eminent French mathematicians, devoted much attention to the lunar theory, and in 1749 Clairaut showed that the discrepancy between the computed and observed motion of the lunar perigee which had long baffled explanation, was due to the neglect of the terms of the third order arising from the second power of the disturbing force, which had been disregarded as being presumably very small.

From their theoretical investigations in 1754 D'Alembert and Clairaut computed new lunar tables, the latter's being of greater accuracy than any previous ones; but the former's were deficient, owing to the indifferent co-efficients for the inequalities employed, which were derived from too few observations. In the following year Euler, who had also been at work on the lunar theory, published fresh tables, not equal to Clairaut's, from the same cause as before, though in this case the co-efficients were mainly derived from theory.

In 1748 Tobias Mayer, the celebrated mathematician and astronomer of Göttingen, took up the confirmation by observation of Cassini's theory of the lunar libration as part of his lunar investigations, and between 1748 and 1749 obtained, by differences in right ascension and declination, twenty-seven measures of the position of the lunar formation Manilius, nine of Dionysius, and twelve of Censorinus. From these, by means of equations of condition, he deduced 1° 29′ for the inclination of the lunar equator to the ecliptic, and obtained a complete confirmation of Cassini's theory, except in finding a difference of $3°\frac{3}{4}$ between the nodes of lunar equator and orbit; a difference far within the errors of observation, and rightly regarded as ascribable to them. During some observations of the lunar eclipse in 1748, Mayer was led to feel the want of a trustworthy lunar map, and he determined to supply this by the construction of a complete lunar chart in twenty-five sections. With this object in view he made forty-seven additional measures of twenty-one lunar spots to serve as a foundation, supplementing them by most careful estimations, from the measured points, of the positions of sixty-three others, a method in which he excelled. The measured spots were, with the exception of eight, resting on more than two measures, little more accurately placed than those fixed by his very careful estimates; but from the care employed, the entire eighty-seven positions are generally within 1° of the true selenographical co-ordinate. Pressure of other engagements, especially his lunar tables, and his early death in 1762, prevented this work from ever being carried out, but in 1775, amongst the rest of his 'Opera Inedita,' was published a small lunar chart only eight inches in diameter, founded on his observations, which remained, until 1824, the only accurate map of the moon, though necessarily wanting in much detail. Employing the theory of the moon as developed by Euler, and deducing from a skilful discussion of observations more correct values for the co-efficients of the lunar inequalities, Mayer completed in 1755 new lunar tables of considerable superiority to all former ones, which, after being compared by Bradley with observations, were published in London in 1770, their errors not having exceeded five seconds of time.

In 1763 Lalande obtained from three careful micrometrical measures of the position of Manilius, conclusions similar to those of Mayer as to the accuracy of Cassini's theory of libration; but the number of observations employed was too small to give accurate results, as was shown by the value, 1° 43′, obtained for the inclination of the moon's equator to the ecliptic.

The theoretical investigation of the lunar librations was now taken up by Lagrange, whose memoir received the prize of the French Academy in 1764, and in which he showed that the moon's shape must be that of an ellipsoid, as besides the elongation in the direction of the earth, its polar axis must be compressed to the amount of one-third of this excess of the greatest axis over the mean ; whilst it also appeared that the major and mean axis would lie in the plane of the lunar equator. Lagrange also found that the action of the earth's attraction upon the moon in consequence of her ellipsoidal form would be to introduce into its rotation on its axis periodical inequalities corresponding to the known inequalities of the lunar longitude, though necessarily of very small extent, their actual amount depending on the exact ratio existing between the lunar axes ; and thus giving rise to a real libration. With regard to the coincidence in the mean periods of the moon's orbital revolution and axial rotation, Lagrange pointed out that the effect of the earth's attraction would have produced this coincidence even if it had not originally existed and the periods had differed somewhat, the only effect of this difference being to introduce a small periodical real libration, which, however, has never been detected, indicating perhaps that the original motions of rotation and revolution were sensibly alike. Lagrange failed to find the explanation of the observed coincidences of the nodes of the lunar equator and orbit in this investigation.

From a comparison of modern tables with ancient eclipses Halley had suspected that the moon's mean period was shortening, or its motion becoming more rapid, and this was confirmed by the memoirs of Dunthorne in 1749, Mayer in 1753, and Lalande in 1757, the secular acceleration being about 10″. It became, therefore, a matter of considerable importance to ascertain the physical cause of this acceleration of the moon's mean motion. In a memoir which received the prize of the Paris Academy in 1770 Euler investigated the question but failed to find any secular equation in the moon's mean motion, and Euler and Lagrange were no more successful in memoirs which obtained the prize at the Paris Academy in 1772, whilst in an investigation which again carried off the prize of the Academy in 1774 Lagrange was still unable to detect any adequate secular equation. Nor was Laplace, who was likewise engaged on this problem, more successful, and thus for more than ten years the question rested.

During the years 1777 to 1779 Herschel made a series of measures for determining the altitude of the lunar mountains, adopting a modified form of the method used by Hevelius, and substituting micrometrical measures for eye-estimations of the distances within the terminator that the summits of the peaks remained visible, using four inches aperture and power 222 on one of his reflectors. As a result he found for the height of the Prom. Acherusia 1,500 feet and for the peak Cassini η 4,000 feet, instead of 5,000 and 9,000 feet respectively, their real altitude; whilst for the principal peaks on the formations Ptolemaus, Sacrobosco, and Capuanus, he found a height of 3,500 and 7,000 feet, or the two former hardly a third of the true elevation above the floor of the formation. Beer and Mädler, who only seem to have seen an abstract of Herschel's paper, consider that he must have been unable to detect the mountain peaks whilst still faintly illuminated, or else have chosen only small peaks, the last an inadmissible supposition, when, as in the cases quoted, Herschel specifies the peak. Probably, however, Herschel measured the altitude, as compared with the outer surface, and seems to have avoided taking the height above the interior of the formation, and this would account for the greater portion of the differences between his results and those of later observers; but there can be no reasonable doubt, seeing the high power and small aperture employed by Herschel, that he must have lost sight of the peaks long before the sun had ceased to faintly illuminate them. It is curious to read Herschel's opinion as to the great probability, if not absolute certainty, of the moon being inhabited.

In 1780 Lagrange, who had again returned to the problem of the lunar librations, published a second memoir on the subject, completing the theory of the lunar librations. He showed how the effect of the earth's attraction was to maintain the observed relation between the mean nodes of the lunar equator and orbit, and he determined the equations regulating the moon's real libration and the small oscillation of the true node of the lunar equator. These results were afterwards confirmed by Laplace, who showed moreover that the lunar secular inequalities were without effect on the observed relations to which the moon's optical and real librations were due. In 1787 Laplace, in a brilliant memoir, announced the discovery by himself of a secular inequality in the moon's motion due to the secular decrease in the eccentricity of the earth's orbit, and its value he found to coincide exactly with that made known by observation, whilst he also demonstrated that a similar but smaller secular retardation of the lunar perigee and nodes arose from the same cause.

In 1791 appeared Schröter's 'Selenotopographische Fragmente,' the first contribution to the study of the details of the moon on an adequate scale, and containing a number of engravings of the appearance of the different lunar formations, with a full description of the same. Schröter commenced his observations at Lilienthal, in Hanover, in 1784, with a four-feet Newtonian reflector of Herschel's, and in 1786 obtained a second instrument from the same maker, of seven-feet focus and about six inches aperture; and with these two instruments, and powers generally of 134 and 161, the observations in his work, already mentioned, were made. In 1792 another seven-feet reflector, by Schräder of

Kiel, and later a thirteen-feet Newtonian of $9\frac{1}{2}$-inch aperture, and still later, a great reflector by the same maker, of twenty-six-feet focus and 19-inches aperture, were added. With these instruments and powers, from 150 to 300 usually, were made the observations in the second volume of his 'Selenotopographische Fragmente,' published in 1802. Schröter's instruments, therefore, were of the highest class of the time, and certainly adequate for the purpose for which he employed them, though it is true not comparable for accurate definition with the fine Frauenhofer refractors of later observers. For purposes of measurement Schröter was very deficient in means, and in place of a micrometer he employed a contrivance, termed by him a 'projection machine,' consisting of a white screen divided into half-inch squares carried by a bar at right angles to the telescope, at a distance generally of $32\frac{1}{2}$ inches, giving a scale of 20″ to the half-inch; and it was used by projecting the image seen by one eye on to the screen viewed with the other. By this means a practised observer can obtain fairly approximate measures, and it renders the drawing of lunar formations easier and correcter than without any guide. For the purpose of accurate measurement it is, however, open to serious objections, and errors are easily made, while it is entirely wanting in delicacy; yet its merits are certainly much under-estimated by Beer and Mädler, who considered it little better than mere guesswork after all; for though Schröter, as pointed out by Bessel, seems to have made considerable mistakes at times, it is probable that these are due less to the fault of the instrument than to pure accident, to which the best methods are equally liable.

For determining the moon's libration during his observations, Schröter employed actual measurement of the distance of some object from the limbs, a process inadequate, especially with his means, to give the actual libration with accuracy even in longitude and much less in latitude, and far inferior to the result of computation. In determining the diameter of the lunar formations, Schröter employed as usual his 'projection machine,' but the results in this case are scarcely better than a good estimation, as Beer and Mädler have observed.

In determining the height of the lunar mountains, Schröter adopted a more satisfactory method than his predecessors, employing the length of the shadows, which when the solar altitude for the given spot is known, enables the height of the object to be deduced with considerable accuracy. From the great care taken by him in measuring the lengths of the shadows he obtained very good results, which, however, were generally somewhat over-estimated; and though his separate measures are at times discordant, yet, as Beer and Mädler remark, the same holds with their own, though made with superior means, whilst some of the discrepancy between his own and their results may be owing to the difficulty of obtaining good measures; and it should be remembered that later observers give a result usually between Schröter and Beer and Mädler. Schröter was also the first to add in any way materially to the lunar nomenclature, and especially in the S.W. quadrant, where the difficulties in making good observations had led to fewer names being introduced by Riccioli, and sixty of the names added by him are still retained. He also introduced the method of distinguishing the smaller objects on the moon by the use of letters of the Greek and Roman alphabets, though without any particular system.

Schröter was a most persevering observer of the details of the lunar surface, whose appearance under different illuminations he drew roughly yet faithfully, though in places where no important detail appeared only superficially. Anxious to detect any processes of change that might be in existence on the moon, he naturally directed most of his attention to those points where such changes seemed probable, and this circumstance appreciably affects the weight to be attached to his drawings. The condition of the moon and the great influence of variation of illumination, libration, and atmospheric conditions on the apparent nature and visibility of lunar details, were not so well known at that period as now ; and from imperfectly realising the influences of such points over the minute lunar details, which he was the first systematically to observe, Schröter was led to believe he had detected processes and instances of lunar change that had no real existence, but were purely optical. Beer and Mädler in pointing this out were perfectly correct, but their strictures on Schröter's work are often far more severe than is merited, taking into consideration the conditions under which Schröter's work was performed ; whilst in condemning his bias towards the occurrence of actual lunar changes, they were probably influenced by an unconscious, though apparent, tendency against the possibility of such changes occurring.

Whatever may have been the imperfections in the results obtained by Schröter, due to deficient measuring apparatus, to his imperfect realisation of the great optical changes to which lunar objects are liable, &c., for his untiring perseverance, and faithful, if roughly drawn sketches, and for his numerous observations, Selenography is strongly indebted to him ; and it is doubtful whether but for his zealous labours, which pointed out the precautions necessary to be taken, Beer and Mädler would have been so thoroughly successful in carrying out their great work.

Between 1799 and 1805 appeared the first four volumes of Laplace's great work, the 'Mécanique Céleste,' the final or fifth volume not being published until 1825 ; and they contained a full investigation of all the discoveries that had already been made in the theories of physical astronomy.

The lunar theory, as developed by Laplace in this work, was the most complete that had up to then been accomplished. In 1798 Burg, a German astronomer, derived from a large number of observations new values for the lunar elements which, introduced into the theory as developed by Laplace, enabled him to compute new lunar tables, that were published in 1806. In 1812 Burckhardt obtaining corrections to Burg's elements from a discussion of observations, embodied them in new lunar tables, the theory employed being carried beyond the point where it was left by Laplace. In 1820 Damoiseau, and Plana and Carlini, obtained the prize of the French Institute for theories of the moon independent of observations in all except the six fundamental elements. Damoiseau employed Laplace's method of investigation, only carried to a much further extent; and the resulting tables, published in 1824, possess a very high value as derived purely from theory. Plana subsequently embodied his results in a much extended investigation into the lunar theory, published in 1832, at Turin, and constituting one of the most perfect developments of the theory of the moon. Burckhardt's tables, which contained some empiric terms and co-efficients, were, however, generally employed as in the main agreeing best with observations.

The problem of the real libration of the moon was again taken up by Poisson, who in 1818 published an investigation of the effects of some terms neglected by Lagrange on the question, with results confirmatory of those already obtained; whilst by theoretical considerations he endeavoured to ascertain the probable maximum values for the lunar real libration, which he showed must necessarily be very small. This completed the theoretical portion of the inquiry, and from the labours of Lagrange, Laplace, and Poisson it appeared, that though from the influence of the earth's attraction on the moon, owing to its elliptical form, a real libration must ensue corresponding to all the periodical terms in the true longitude of the moon, yet they might all be expected to be insensible, except perhaps in the case of those inequalities known as the annual equation and equation of the centre. Moreover, owing to the considerably longer period under which the effects due to the annual equation would be able to exert themselves, it appeared that the principal real lunar libration would correspond to the annual equation, and would be more than five times as great as that due to the equation of the centre, which would in its turn considerably exceed that due to any other cause.

Bouvard and Arago, at the desire of Laplace, undertook in 1806 the investigation of the question of lunar real libration by direct observation, to detect if possible its existence, and if sensible its amount; and made during that year eighteen observations, but were interrupted by other matters. Bouvard two years later resumed the work, and between September 1808 and October 1810 obtained a series of 124 lunar measures of the position of Manilius. Nicollet in 1816–1818 undertook the reduction of these measures as a means of confirming the theoretical results obtained with regard to the optical libration, and with a view of detecting and ascertaining the amount of the real libration, selecting that of the maximum value corresponding to the annual equation. The result of his investigation was a complete confirmation of Cassini's theory of libration, as theoretically established by Lagrange and Poisson; whilst he also detected a real lunar libration in longitude corresponding to the annual equation, and amounting to 4′ 46″, from which Poisson showed that that corresponding to the annual equation would not exceed 40″; both in selenographical longitude. With a view of still further confirming these interesting results, Nicollet made a fresh series of thirty-two new measures of Manilius during 1819–1820, and combining these with the original eighteen made by Bouvard and Arago, found his former values entirely confirmed; whence by uniting the two series he deduced from the 174 observations $4' 49''\cdot 7$ for the maximum value of the real libration in longitude corresponding to the annual equation in the moon's true longitude. From the same observations Nicollet found the inclination of the moon's equator to the ecliptic to be $1° 28' 45''$, whilst he computed the position of the spot Manilius to be in selenographical longitude $+ 8° 46' 56''$, and latitude $+ 14° 26' 54''$. These results were of the highest interest, and from them Nicollet drew the conclusion that the moon's form was not a figure of equilibrium such as it would have assumed had it originally been fluid. Poisson has pointed out that this conclusion rests on imperfect data, and must be received with caution; and that, owing to the inadequate optical means at Bouvard's disposal, it was highly desirable they should be repeated with more powerful appliances, as Nicollet himself suggested.

From Schröter's time until 1824 the study of the surface of the moon made little progress, but in that year appeared Lohrmann's 'Topographie der Sichtbaren Mondoberflache,' a first issue of four sections of what was intended when complete to be a detailed lunar map in 25 sections, on a scale of $37\frac{1}{2}$ inches to the moon's diameter. The author, Wilhelm G. Lohrmann, a surveyor of Dresden, proceeded on a scientific basis, measuring the position of the principal points on the area of the moon embraced by his sections, and finding their selenographical co-ordinates by a method devised by Encke. His principal instrument was a six-feet achromatic of $4\frac{4}{5}$-inch aperture by Frauenhofer, fitted with a micrometer and other accessories, though likewise he possessed a $3\frac{1}{4}$-inch achromatic, together with smaller instruments. In his work are given the position of twenty-one different points determined from 150 good measures; the position of only five of his selected objects resting on less than five measures; and eleven were situated on the first quadrant, three on the second quadrant, two on the third quadrant, and five on the fourth quadrant; few auxiliary positions, if any, were, however, measured by him. The diameter of the lunar formations was in some few cases measured, but no measures of the altitude of the lunar mountains were made, Lohrmann simply quoting those already made by Schröter; finally, he added six names to the lunar nomenclature, namely, those of some of the most eminent astronomers of his time, whilst, like Schröter, he distinguished the minor objects by the use of letters of the alphabet or numbers.

The four sections published of Lohrmann's map were:

I.	From	12	W. to	12 E.	long., and	12	S.	to 12	N. lat.
II.	„	„	„	37 W.	„	„	„	„	„
III.	„	13	„	40 „	„	„	N.	to 37	„
IV.	„	„	„	13 E.	„	„	„	„	„

Unfortunately, Lohrmann was never able to finish his great undertaking, as failing eyesight compelled him to relinquish all hopes of this, and prevented any further section of his map ever being issued, though several remained partially completed. In 1838, however, he published an excellent lunar map $15\frac{1}{4}$ inches in diameter, founded on his observations, but on too small a scale to show the lunar details properly.

In 1837 appeared, however, the greatest contribution to Selenography: Beer and Mädler's 'Der Mond,' with its accompanying chart, the 'Mappa Selenographica,' a complete account of the then state of knowledge of the physical condition of the moon, together with a full account of the topographical details of the lunar surface, founded on observations made during the period 1830 to 1837, thus forming the first adequate description and map of our satellite. As the foundation of the great map, Mädler, who was the principal observer, adopted the method of Encke that had been employed by Lohrmann, and made a series of 919 micrometrical measures, with a parallel wire position micrometer, of the distance from the limb of 92 prominent points on the lunar surface, to be used as positions of the first order from which to measure auxiliary objects and to lay down their map. Owing, however, to the difficulty in making such measures accurately, 104 of those made were rejected as discordant, untrustworthy, or from some uncertainty as to the position of the object, though these were nearly all included in the first 200 measures. Of those employed, thirty-one were made of seven spots that had already been chosen by Lohrmann, and the remainder were employed to fix the position of eighty-five new points generally distributed over the whole surface, and whose places were usually determined by from eight to ten measures. As in constructing their maps Beer and Mädler used their own and Lohrmann's measures conjointly, their map rests primarily on the position of 105 points of the first order (including Manilius, whose position had been very accurately determined by Bouvard and Nicollet), and divided into 28 on the N.W., 25 on the N.E., 29 on the S.E., and 23 on the S.W. quadrant, most resting on from eight to twelve separate measures, whilst only eight were based on less than seven measures, and only two on under five determinations.

Beer and Mädler consider that a single measure of the position of a point of the first order cannot be regarded as determining the place of the point to within 30′ of latitude or longitude near the centre of the moon, and proportionately greater towards the limb; a conclusion borne out by the results of the actual measures employed. The probable error of the positions of the first order may be considered as from 6′ to 8′ of selenographical latitude and longitude near the centre, and it increases as they approach the limb. By measuring the distance and position angle of the smaller detail from a point of the first order, Beer and Mädler determined the position of a considerable number of auxiliary points, or, as they are termed by Mädler, points of the second order. From the method followed, however, the positions of these objects resting on only a single measure are only approximate, and carrying the whole error of the point they were measured from, their position cannot be regarded as known with certainty within 30′ to 40′ at least.

The diameters of 148 of the principal formations were also measured micrometrically by Mädler, and generally rest on a series of ten determinations, whilst by comparison with the measured objects, the approximate diameters of the less important formations were obtained, though a few of these have been determined by rough micrometrical measures and so stand between the last two classes. To ascertain the height of the lunar mountains, like Schröter they employed the length of the shadows, using Olber's method of reducing the observations; and for this purpose Mädler made a series of 1,095 measures of the height of about 830 lunar peaks; whilst by comparing the length of the shadows of less important peaks with a measured peak under similar conditions of illumination, the approximate height of these minor points can be determined with very fair accuracy. Both Beer and Mädler and Schmidt consider this latter method to afford very trustworthy results, and many of the heights given in their descriptions were obtained in this manner.

Retaining all the names of Riccioli they could identify, as well as nearly all those of Schröter, they added considerably to the lunar nomenclature by naming nearly 150 new formations, employing principally the names of the later most distinguished astronomers, mathematicians, geographers, and philosophers, whilst remarkable mountain ranges were named, in accordance with the principle of Hevelius's nomenclature, after the chief terrestrial mountain systems. The symbolisation of the smaller objects was reduced to a regular system by adopting the principle of Schröter's plan and distinguishing the smaller detail by the addition of a letter to the name of the nearest named formation; a Greek letter being employed if an elevation and a Roman if a depression or crater: the measured points being designated by capitals, and the rest by the small letters.

The instrument employed by Beer and Mädler was a Frauenhofer refractor of $3\frac{3}{4}$ inches aperture used with a power of 300 for drawing and 140 for measuring. As far as optical means were concerned, therefore, Beer and Mädler were using a smaller aperture than Lohrmann, though probably of somewhat superior quality; whilst though in possession of far superior definition than Schröter, his largest telescope gave him considerably greater power over delicate phenomena of little brightness. These differences are of considerable importance in contrasting the results obtained by the three observers.

Upon the conclusion of Beer and Mädler's fine work the great questions in connection with the physical condition of the moon were generally regarded as finally solved, with perhaps the exception of some of the obscurer phenomena which appeared likely to baffle all explanation, such as the great ray or streak systems and the rills and clefts; but it was generally regarded as demonstrated that the moon was to all intents an airless, waterless, lifeless, unchangeable desert, with its surface broken by vast extinct volcanoes. With this opinion prevailing the natural effect of such great works as Beer and Mädler's speedily ensued, the attention of astronomers was directed to other fields, and Selenography resting on its laurels made no further progress for many years. During this period the study of the physical condition of the moon's surface rested almost entirely in the hands of Schmidt of Athens, who alone worked in an adequate manner, though some desultory work was accomplished by Mädler and two or three others.

It having been pointed out again by Beer and Mädler in their 'Der Mond' that the investigation of Nicollet with respect to the real libration of the moon required repetition, and they having suggested the advisability of employing one of the small brilliant craters near the centre instead of a spot like the centre of Manilius, this subject attracted some attention. In 1839 Bessel examined the question in connection with the real libration of the moon, and suggested the adoption of the crater Mösting A as well suited for measurement, and its position he fixed from two accurate sets of measures with the Königsberg Heliometer. The question was taken up next by Wichmann of Königsberg, who made a new attempt to determine the amount of the lunar real libration from a series of fifty most carefully executed measures with the Königsberg Heliometer during forty-four nights between Dec. 1844 and Jan. 1846, a period of fourteen months only. The results obtained were still more inconclusive than those of Nicollet, Wichmann being unable to obtain any definite result on this point, his conclusion being that the inequalities of short period in the moon's real libration were very small and could not exceed 10′ of selenographical longitude, and were probably under 7′, but that with regard to the actual amount the observations failed completely to afford any trustworthy information. This left the whole question still more in need of elucidation than before, and the discrepancies between the two researches renders any certainty as to the true conditions impracticable, whilst the different values obtained for the inclination of the lunar equator to the ecliptic still more increases the uncertainty attaching to the whole subject. Though Bouvard's separate measures are inferior to those of Wichmann, the much greater number 174 against the 44 separate results of Wichmann's and the much greater regularity and duration of the period embraced, perhaps more than counterbalances this inferiority. Wichmann considers the difficulty in measuring from the limb arises less from the irradiation than from the varying irregularities on the surface at the edge of the moon ; and among the incidental points determined were the inclination of the lunar equator to the ecliptic, which he found to be 1° 32′ 9″, or more than 3′ greater than Nicollet, and the selenographical position of the crater Mösting A.

During this period Lubbock and Pontecoulant had been engaged on the lunar theory, taking the time as the independent variable, and had obtained results entirely confirmatory of those arrived at by Plana, and given in his lunar theory, but they did not carry out the development to a further extent. In 1838 appeared Hansen's 'Fundamenta Nova,' explaining a new method of investigating the lunar theory where the perturbations were thrown upon the time, and on the basis of this method Hansen computed new lunar tables, which were published in London in 1857. In the meantime the reduction in 1846 by the Astronomer-Royal of all the lunar observations made at Greenwich between 1750 and 1830, had furnished corrections to the lunar elements and confirmed the existence of an inequality of long period unaccounted for by theory. Hansen took up the investigation of this point and discovered two inequalities in the lunar longitude due to the action of the planet Venus, which he announced in 1847. The accuracy of one of these inequalities has since been rendered doubtful, by the researches of Delaunay on the subject, though the other has received full confirmation. Hansen's lunar tables, when first introduced, were very exact and still remain the best lunar tables extant. In 1846 Delaunay undertook the investigation of the lunar theory with a view of carrying it out to a considerably greater approximation than Plana, though like him with the theoretical co-efficients; he employed, however, an entirely new method of treatment, adopting the principle of variation of the arbitrary constants, a course that had already been suggested by Poisson in 1833. In effecting this Delaunay made use of a new method of treating the disturbing function, removing one at a time all the periodical terms by a number of distinct operations; and he published the result of his labours in two volumes in 1860 and 1867, but his early death prevented the full development of his views from being carried into execution.

In 1864, when the imperfect nature of our knowledge of the physical condition of the moon's surface had become more generally recognised, the British Association appointed a committee with the primary object of devising the best method for the detailed cataloguing and mapping of the lunar surface, and in 1865 this committee in their report described at length the method that had met with their approval, and advised its being carried into effect in the best manner possible.

For the purpose of obtaining the requisite material for the completion of a detailed lunar map on the scale of 100 inches to the diameter of the moon, it was determined to construct an outline map of twice this size, so as to allow of the insertion conveniently of all detail that might be discovered. In 1866 two sections of this map, founded principally on the measures of Beer and Mädler and on lunar photographs, but containing all known formations, were issued, and embraced the area between 0° to 6° west longitude and 0° to 10° south latitude, together with a catalogue of the objects inserted. In 1868 a further section 5° square was issued with a corresponding catalogue; but as after this year the committee was not re-appointed, with the exception of one more section the work has made very slight progress. In their map and catalogue an entirely new system of symbolisation was adopted, affording means of distinguishing every feature of the moon on a systematic plan; and though for general purposes the standard nomenclature of Beer and Mädler will perhaps, from its convenience and ease of remembrance, always be retained, yet for the purpose of the detailed study of separate formations the method employed by the British Association committee will be preferable.

On the British Association system the division into four quadrants by Beer and Mädler is retained, they being numbered from I. to IV. in the following order: N.W., N.E., S.E. and S.W. Each of these quadrants is divided into sixteen grand divisions, distinguished by the capital letters from A to Q, and consisting of an area 25° square, except towards the limb, where of necessity only 15° remain on this hemisphere, and the remaining 10° extend into the further side, which is brought into view by libration. The lettering runs from the equator to the poles, so that B stands nearer the pole than A; but between the same circles of longitude, whilst the square, on the side of A, between the equator and the 25° parallel of latitude, only nearer the limb, is E. Each of these grand divisions of 25° is further subdivided into 25 areas of 5° square, lettered in the same manner as the grand divisions with the Greek letters α to ω, the last space being left blank. Finally, any object is distinguished by a number attached to the symbol denoting the small area of 5° square which it is in, and also the quadrant. Thus IAσ 40 would indicate object No. 40 in area IAσ; that is, between the limits of 10° to 15° west longitude, and 15° to 20° north latitude. As already remarked, this method as carried out by the British Association committee presents many advantages for the systematic study of special formations, and for the cataloguing of the details, the most prominent defects being the somewhat unwieldly character of the symbols, and the ease of making a mistake in referring, together with the difficulty in remembering the symbols; none, however, of any particular weight.

From the period of the conclusion of Mädler's great work, Schmidt, now of Athens, had devoted much time to observing the lunar surface, and he soon turned his attention mainly to the production of a map that should adequately represent the smaller details of the surface which he recognised that Mädler's map, from the limited power of the telescope employed, failed to satisfactorily give, though in the main very faithfully drawing what was shown. For this purpose Schmidt determined that a map 75 inches in diameter would be the smallest adequate size, or four times the area of the 'Mappa Selenographica,' though when completed it is found that the scale selected was still too small for its purpose without more crowding than is desirable. For his map, which was drawn in 1868, Schmidt made a series of over a thousand drawings, and more than three times as many height measures, though it is understood that he made no measures of the position of the principal objects, employing only Lohrmann's and Mädler's, though these are certainly too few for a map of this size.

Since 1868 many observations have been made of lunar formations, but little of importance has resulted, with the exception of a systematic reduction of a number of observations of Plato made during 1869–1871, by a committee appointed in 1870 and 1871 by the British Association, and which contained several highly interesting circumstances indicating some changes of the appearance of objects on this formation not explicable by variation in illumination or in libration. At the end of 1874 the condition of Selenography may be regarded as having reached one of its resting points, from which it may start anew on its progress, the results of the previous period of activity having been to mark out distinctly the questions to be determined.

During this period (1864–1874) much of considerable interest has been established, partly by further observations and partly by comparison of the results and drawings of the earlier observers; and it has been shown that the conclusions arrived at by Mädler require in points much modification. Schmidt and others have pointed out instances of what, there exists good reason to consider, are cases of physical change in the moon, though only in one instance have these received the attention they merit. Numerous observations have also been made indicating peculiar changes in the visibility and appearance of different formations, not dependent on variations in illumination; many new objects have been detected, now so conspicuous as to appear hardly capable of having been overlooked by the earlier selenographers had they then been as distinct; finally, considerable discrepancies have been noticed between the maps of Lohrmann and Mädler in points where peculiar accuracy seems to have been sought for, and apparently very easily obtainable. The result, in short, of the last period of selenographical activity has been to reopen nearly all the questions previously considered as settled by Beer and Mädler before the true nature of the lunar details were generally understood, and with regard to which the small aperture of their telescope placed them under a considerable disadvantage.

CHAPTER V.

VARIATIONS OF THE SURFACE.

Some very interesting questions in regard to the present condition of the moon as a planet, are connected with the subject of physical changes on its surface, a problem that from its importance has deservedly engaged the attention of all selenographers, and occasionally, when some more critical issue has been raised, received the consideration of the principal astronomers of the period.

With regard to this point, the early astronomers who had telescopically studied the surface of our satellite, were on the whole inclined to receive the view of Hevelius, that the moon might not be even uninhabited, and be well suited in its way to support life. Riccioli, indeed, whose views in this as in several other instances were juster than those of his contemporaries, maintained that this could not truly be the case, but that the moon must, from the absence of any atmosphere of considerable density or any large volumes of water, be unfitted for any condition but that of an arid desert. The former view prevailed, however, and gradually gained in force as it increased in age, until in 1781 Sir W. Herschel urged as a reason for greater attention being paid to the condition of the moon the great probability, if not absolute certainty, of the moon being inhabited. Though the existence of changes of magnitude on the lunar surface and of life in various forms was strongly urged by Schröter, and still more forcibly and extensively by Gruithuisen, the commencement of the present century witnessed a gradual change of opinion, and the great work of Beer and Mädler entirely completed this alteration.

The conclusion of these great selenographers is well known, they maintaining that, though many and material analogies exist between the nature of the surface of the earth and of its satellite, yet considering especially the absence of masses of water from the moon, it could be considered as no copy of the earth, far less a colony of the same. And this view has since been almost exclusively accepted, but as very usual under these circumstances, has been applied with more and more strictness and with gradually increasing comprehensiveness, until it has reached a point far beyond that which its authors ever contemplated or would acknowledge. With but little if any real evidence other than that of Beer and Mädler, it is generally held that the moon must be an entirely lifeless, completely arid, unalterable desert, destitute of even the slightest vestige of atmosphere, water, or physical activity, but resembling the ruins of a gigantic mass of extinct volcanic scoriæ.

For this view there is not the slightest adequate evidence, and its truth would be admitted as established by no astronomer who had devoted sufficient attention to selenography to enable him to thoroughly realise the probable present condition of the lunar surface. It is, moreover, opposed to the conclusions of the great selenographers to whose labours our present acquaintance with the real nature of the moon's surface is mainly due. All selenographers appear to have recognised instances of apparently lunar changes, and Mädler and Schmidt have pointed out several cases in which they considered it probable such changes had occurred; and to a less marked extent various other instances have been detected by most astronomers who have devoted much time to the study of the lunar surface. Yet though various indications of apparently physical changes have thus been recognised, the very great difficulty of definitely establishing these as instances of physical changes has hitherto effectually prevented this being done. So that although numerous circumstances in connection with the phenomena presented by the moon might be advanced as showing the probability of lunar changes still occurring, it cannot be questioned but that the absolute proof of this has still to be brought forward.

That physical changes of various characters must be still occurring upon the moon is rendered certain by the results obtained by Lord Rosse with regard to the variations in temperature of the lunar surface; for the alternate heating and cooling of the lunar strata, from the nature of the expansion and contraction thus brought into play, must, through numerous fractures and the resulting general disintegration, gradually ruin all the lunar formations. Thus, from the effects of the unequal expansion and contraction due to the variations in temperature, considerable changes must slowly be effected in the condition of the surface through earth falls and land slips, together with analogous effects, all leaving their mark upon the nature of the formations. Moreover, it would appear that as long as these periodical changes in temperature last, such effects must be produced until all the more striking and abrupt irregularities have disappeared from their action.

The existence of these instances of change on the surface of the moon is questioned by few if any astronomers, as it is manifest that comparatively very numerous effects of this nature must be occurring on the lunar surface; but these do not come properly within the category of physical changes on the moon in the usual meaning of the term. For though it might be urged with considerable force that at times a combination of these effects must lead to a general collapse on a great scale of some portion, or even the whole of a lunar formation, such instances must be necessarily of very rare occurrence. Still more rare must therefore be an instance of this kind on a sufficiently vast scale to enable its effects to be recognised from the earth even with the most powerful telescopic means.

The question of physical changes on the moon's surface is generally and with justice held to apply only to such instances as can be detected telescopically, such as might be expected to be the case with manifestations of volcanic activity, processes of vegetation, periodical changes in the nature of the lunar surface of marked character, &c. It is very generally maintained that no instances of such a nature are any longer possible on the moon, and, as already mentioned, many selenographers allow that no such instance has been established, though its probability may have been rendered more or less certain, whilst others, including some of the most experienced, consider that in several cases the existence of such changes has been demonstrated. Thus, as before remarked, whilst no astronomer who has devoted an adequate amount of attention to the study of the moon appears to have doubted the probability of instances of physical change on the large scale still continuing, many, like Mädler and Schmidt, have pointed out instances where such changes seem probably to have taken place.

It is a matter of extreme difficulty under most conditions to distinguish purely optical variations in appearance, due to differences in illumination and libration, from what may with any degree of probability be regarded as due to actual alteration in the form or position of the object on the lunar surface. And this circumstance, whilst rendering it necessary to employ great caution in accepting any apparent alteration in the appearance of the surface of the moon as evidence of actual changes, also renders it still more necessary not to regard the absence of any established instance of such changes as indicative of the entire permanency of the lunar formations. So little known are the minor details of the moon, that, except in a very few regions, a very considerable alteration of the present constitution of the surface might occur at any moment, without the slightest probability of its being detected as an instance of physical change on the moon. Thus, for example, if on the moon proportionately the same amount of volcanic energy were every year manifested in a similar manner to what occurs on the earth, there is no reason whatever for supposing that it would have been hitherto detected. With the present condition of our acquaintance with the topography of the lunar surface in this state, it is not in the slightest degree surprising that no definite instance of volcanic energy on the moon has hitherto unmistakably declared itself. Nor can this circumstance justify its being held that selenological volcanic activity must have long ere this entirely ceased to exist.

The variation in the appearance of the lunar surface during the course of a lunation is well known, arising as it does from the alteration in the manner in which any formation is illuminated by the sun from the apparent motion of the solar disc; it corresponds to the similar variation in the manner of illumination experienced by terrestrial objects during a day, a lunation being evidently a lunar day.

Selecting any particular formation, and watching it from the period when the earliest beams of sunlight commence to fall on its nearest and loftiest point, until the whole finally disappears in the dark shades of night, a very remarkable and interesting series of changes in its appearance will be seen, and experience of great value in studying the nature of the surface will be obtained. Choosing as a typical class of lunar formations some fine ring-plain towards the centre of the moon; first, far within the dark side of the moon, will be seen faintly glittering the summits of the loftiest walled peaks on the nearest wall, these gradually growing distinct and permitting the extreme crest of the wall to be detected. Soon after appears the exterior slope of the formation, with its short shadows and generally rugged form. Long after the exterior slope of the walls has become distinct, and when the minor detail is losing distinctness, a glittering point appears perhaps far within the darkness, and soon another and another, until, on favourable occasions, the thus early illuminated peaks of the farther wall glitter like a semicircle of brilliants rising out of the darkness. As the illumination proceeds, the wall of the ring-plain forms a bright circle of light surrounding a black chasm, the interior terraces and spurs of the farther wall standing out boldly. Suddenly a faint streak breaks across the darkness, usually followed closely by a second and a third, until, seemingly rapidly widening, the whole gradually resolves into a system of long spire-like shadows from the wall peaks. As these spires of shadow shorten, numerous ridges, mounds, and other irregularities on the floor make a transient appearance, whilst the ruggedness of the walls softens down and slowly becomes imperceptible. By the time the shadows have crept close to the border-wall, the summits of the terraces, and the smaller irregularities of the interior nearer wall and exterior farther wall appear rising through the darkness, until, usually some thirty-six hours after sunrise, the ring-plain stands out distinctly free from great masses of shadow, only a few steep peaks and the terraces and irregularities on the interior nearer slope casting shadows. But though free from shadow, the farther slopes of the irregularities and walls, less brilliantly illuminated by the sun, seem, from their comparatively grey appearance, still to possess faint shadows. Hitherto differences in brightness in the formation have been very slight; but as the details of the whole ring-plain gradually soften down and fade out of sight in the slowly increasing angle of illumination, strong differences in tint and brightness begin to manifest themselves in a striking manner. On the floor will appear grey streaks, white lines and spots, and perhaps even dark grey patches, the whole lying on a background of pure yellowish grey of different tints and intensities; whilst the walls usually assume a bright greyish white appearance, with here and there a spot or streak of grey or yellow. By the time these varieties have once come strongly into view, which is usually some three days before Full, and two after the disappearance of the shadows, all the minor details visible as irregularities on the surface have disappeared, and the whole formation takes the character of a surface-marking, except in the very finest telescopes,[1] and under atmospheric conditions of great excellence. Much, however, can often be made out under these conditions from the variations in brightness, which also when the ground is familiar will enable all the principal details of the formation to be made out. For though, as Mädler repeatedly points out, differences in tint do not always indicate differences in level, and *vice versâ*, yet any marked irregularity does usually produce a difference in brightness.

[1] In telescopes of the highest excellence of definition, under favourable conditions, even at Full, a number of the lunar formations appear distinctly as raised irregularities on the surface, this appearance arising from the difference in tint between the summits and slopes which act exactly in the same manner as the shadows in giving this aspect. This, at any rate to the observer thoroughly experienced in making out with powerful instruments, differences in tint amidst the great glare of light inseparable from lunar observations under these conditions, is often of extreme use as enabling the true form of details to be seen, that at sunrise are masked by the shadow. Several of the larger rills under these conditions appear very distinctly as canals with a bright floor and grey sloping sides. The slightest terrestrial atmospheric disturbance, want of telescopic definition, or stray light, destroys the whole, blurring all into the usual appearance during high illuminations.

Moreover, many of the more extensive but more gentle formations and surface conformations, which from the slight shadows they cast at sunrise are easily overlooked, even when not entirely masked by much smaller though more abrupt and then more striking irregularities, at Full can be made out with distinctness from their differences in brightness.

From this period to two or three days after Full, this characteristic appearance is maintained, the minor differences in the intensities and position of the light-markings being slight, though valuable as affording a clue to the real nature of the surface. Soon after the third day after Full, the differences in tint and brightness commence to fade ; grey tints put in their appearance, and faint shadows may gradually be detected. The farther interior wall commences to grow rugged, then the nearer exterior wall ; shadows at first just perceptible grow long, and numerous surface irregularities spring into view. Then follows the reversal of the phenomena of sunrise ; first, the interior of the far wall, then the exterior of the near wall, disappear into shadow, which next creeps along the interior ; long spires shoot out and widen, until soon the whole floor lies immersed in night. Slowly the shadow mounts the opposite wall, crowns the summit, and leaves far within the shade of night a few glittering peaks like stars. One by one these fade out of view, and the far wall of the ring-plain stands out in giant relief against the dark terminator. Next the plain at the foot of the formation is immersed in darkness, which now creeps up the wall of the formation, soon to cover all in the folds of night, except perhaps one or two lofty peaks, which towering aloft to an immense height, often glitter in the last rays of sunset long after the rest of the formation has been wrapped in darkness for another lunar night.

Although from the influence of these changes in illumination, all the details on the lunar surface vary in visibility, these alterations are of a nature easily understood. Similarly the slight seasonal change in the axis of illumination due to the small inclination of the lunar equator to the ecliptic, though altering slightly the visibility of the minuter details on the surface, allows of its effects to be readily recognised and accounted for.

The most important cause of the alterations in the appearance of the lunar formations is the libration of the moon, and not the variation in illumination during the course of a lunar day; for the effects of this last, though usually the most extensive, are easily realised, and periods of sufficient similarity in this character are readily selected, whereas the lunar librations introduce complications whose effects are only with difficulty to be understood.[1] The effects of the lunar libration are in fact to alter the angle from which formations are seen from the earth, so that they correspond to what would occur were the moon shifted round on a variable axis to a more or less marked extent. Thus not only is the visibility of the details of the lunar formations altered, but marked changes in their apparent form, position, and dimensions result, all of which produce changes in appearance; complicate these with the variations in the manner of illumination, and the changes in the apparent nature of the formations that result are often of the most marked character.

From the effects of the moon's libration the entire formations are shifted more or less towards or away from the apparent centre of the moon, thus altering the angle under

[1] Of course the variations in the illumination are combined with the changes of libration in producing these appearances; nor would the latter alone effect anything like the two together; what is meant is, that the variations in the lunar librations so affect the position with regard to the earth of the moon's surface, that the variations in illumination, together with the changes due to libration, produce the most marked effect.

which they are viewed from the earth, and so affecting their apparent form and dimensions. Calling, for convenience, a great circle through the poles and the apparent centre of the moon's disc, the apparent first meridian, the effect of the libration in longitude is to shift the entire formations to or from this by an amount which at its maximum may be as much as 7° 53′; so that at different periods the formations may be over 15° nearer the apparent first meridian than at another. In the same manner, calling a great circle round the moon passing through the apparent centre of the disc, the apparent equator; from the effect of the libration in latitude, the lunar formations will seem to be shifted to or from this apparent equator by an amount that at times will be as great as 6° 50′, so as to be at one period nearly 14° nearer than at another. The formations midway between the equator and the first meridian will experience, however, the full effects of these two librations combined, so that they will be shifted to or from the apparent centre of the moon by an amount reaching at times as much as 10° 26′, so as to be at one period more than 20° nearer the centre than at others. Nor will this be the extreme case, for the librations hitherto considered are geocentric and do not take into account the parallactic librations, which can easily raise the librations in longitude and latitude to as much as 8° 30′ and 7° 30′ respectively, or the combined effect to about 11° 20′. The great changes in angle under which the formations are viewed is therefore manifest, and the importance of the lunar librations in altering the appearance of the formations on the moon's surface is readily understood.

Towards the limb of the moon the effects of the moon's librations are paramount, bringing into view and carrying out of sight the entire bordering regions, and by these changes entirely altering the appearance of the formations on the surface. Thus a ring-plain within a short distance from the limb, that owing to foreshortening usually appears as a narrow ellipse, will from the effect of the libration appear wider when it is moved nearer the centre by the libration, whilst when it has approached closer the limb, it will be still narrower than usual; and to such an extent is this often carried that the entire floor disappearing, the whole looks like a valley. Towards the centre of the moon, analogous effects occur, the ellipses which most of the circular lunar formations appear to be, being alternately widened or narrowed by their apparent motion to or from the apparent centre of the moon's disc, though immediately around the central portions of the surface the effect nearly entirely disappears.

Though, as has been shown, the alterations in the position and apparent relative dimensions of the different formations from the effects of the lunar libration are very great, and though the appearance and relative visibility of different objects are affected to a considerable extent, yet the influence of the effects of the lunar librations upon the study of the surface of the moon has been very generally overestimated. And its power of producing changes, of the nature and degree of those that would alone now be accepted as indicating actual changes of moment on the surface of the moon, must be held to have been greatly overrated.

For the principal effects of the libration in altering the appearance of the lunar formations in a degree of importance in studying the lunar surface, is confined to a narrow zone round the limb not one-twentieth of the lunar diameter in width, and the formations within this area are rarely capable of being properly examined unless under favourable conditions of libration, or when the libration is sensibly the same. On the rest of the surface, though the effect of the lunar librations may be sufficiently striking in altering the apparent form and relative dimensions of the lunar formations, this does not materially interfere with the study of the surface by an experienced selenographer, who can readily take into consideration and allow for the effects of all this; and by computing the libration at any moment, its effects on the relative dimensions and forms of the objects on the surface can be successfully eliminated without any material difficulty. Thus though a long catalogue might be made of the smaller changes in the appearance of a regular formation on the moon that it might undergo in consequence of alterations in the lunar libration, a comparatively short experience and careful examination of the phenomena presented by the surface under different conditions of illumination and libration will, by rendering these familiar, almost entirely remove all trouble arising from this source.

It is only in the case of some peculiarity in the form, nature, or position of the object itself, that the variation in illumination and in the angle under which it is seen produced by alterations in the lunar librations, causes difficulty. Thus occasionally, from peculiarities in form or arrangement, changes in the lunar librations may, by shifting the position of the shadows, hide or bring into view some particular portion of the formation, and so cause its appearance to vary abnormally. This is, however, exceptional, for the mean slopes of the lunar formations are sufficiently gentle to render each independent of the neighbouring objects of a similar kind. The details on the slopes of the formations or close under the walls are of course slightly influenced by the lunar librations, which may bring them earlier or later than usual out of the shadow; but as far as changes of appearance are concerned the lunar librations exert small influence. Similarly foreshortened objects, whose shadows lie behind them, will hide more or less of their shadows according to the lunar librations, or even disappear by entirely hiding their shadows; but, as has been already observed, such variations cannot be held to be abnormal, and are periodical in nature.

Therefore the lunar librations, though of the greatest importance in mapping or drawing the surface of the moon, and necessary to be taken into consideration in studying the surface, cannot justly be held to be the great difficulty in selenographical research they are commonly supposed, nor yet can they be properly held as sufficient to account for any changes whatever in the appearance of the details of the surface. This conclusion is analogous to that of Mädler, who recognised that, except near the limb, the lunar librations would not interfere with the detection of physical changes upon the surface of the moon; and its justice will be recognised after studying well any portion of the surface, so as to become thoroughly familiar with its appearance and nature; it will then be recognised that, except in the smaller detail of the moon, where the conditions of the terrestrial atmosphere exert more influence than any change due to libration, variations in the appearance of the nature of the surface are far less extensive than is generally supposed. It is only where the region is not well known that the changes due to libration appear great or startling.

The principal instance of supposed physical change on the surface of the moon, that has been brought forward in recent times, is that of Linné in 1866–1867, and this is the only instance where any proper amount of attention has been given to the subject. The details of this case, which are described fuller elsewhere, may be briefly stated as follows:—Lohrmann described this formation as a deep crater, very distinct under every illumination, and above six miles in diameter; and Beer and Mädler as a distinct deep crater about six and a half miles in diameter, very distinct under oblique illumination. This is also Schmidt's impression of the appearance of Linné when he observed it between 1838 and 1843, and in accordance with some of his drawings of this date. In 1866 Schmidt could not find Linné at all, and announced that it had disappeared, a statement which naturally directed the attention of all astronomers to the question. In the position of Linné all that could be made out with the most powerful telescopes was a very shallow depression, perhaps five or six miles in diameter, and scarcely to be detected, so that its actual existence is very doubtful, and towards the centre other observers saw what appeared to be a very minute hill. Later Secchi, Buckingham, and others detected a very minute craterlet with an orifice scarcely a thousand yards in diameter; and later on in the year, this craterlet became not only oftener seen, but appeared of larger diameter, and from measures of Huggins, Buckingham, and Knott, its dimensions were fixed at rather under two miles in diameter. This appearance Linné has since maintained sensibly unchanged; it consists of a deep craterlet, perhaps two miles in diameter, only visible under good atmospheric conditions in powerful telescopes, and then only when very favourably placed close to the terminator. Under other conditions it appears as a white spot some eight miles across.

Are we then entitled to consider that in this instance a case of actual lunar change has occurred? for it is impossible that either Lohrmann's or Beer and Mädler's descriptions can apply to Linné as it now is, seeing that it is open to question whether either Lohrmann or Mädler could have done more with their telescopic means, than just glimpse Linné in its present condition. It is not, however, admitted that in Linné exists an instance of actual lunar change; for against the otherwise powerful evidence in favour of this, a drawing of Schröter's, whose observations are otherwise nearly always rejected in favour of Beer and Mädler's, is adduced to show that no change has probably occurred. In this drawing, one of Schröter's earliest, made with a comparatively indifferent instrument, the entire Mare Serenitatis is shown, but no Linné as a crater, although, in a position not far from where Linné ought to be, a small white spot is drawn which is considered to represent Linné. As Schröter shows with his imperfect means a small white spot near where Linné ought to be, but no crater such as Lohrmann and Beer and Mädler describe; and as in small instruments Linné now appears at times as a white spot when under similar illumination to what it was when Schröter drew this region; it is considered by astronomers in general that no change in Linné can have taken place, but that Lohrmann, Beer and Mädler, and Schmidt must have been mistaken.

Other instances of apparently physical change have in recent times been pointed out, but only one case, however, of sufficient moment to require mentioning; the others, though pointing strongly towards the existence of actual changes, yet resting for their force solely on the correctness of the observations of Mädler, though he was our most accurate selenographer, are open to the objection of being doubtful. The second instance referred to is that of Messier. On the Mare Fœcunditatis, isolated in the plain, are a pair of small ring-plains close to one another, and about eight miles in diameter. In connection with one of these two formations, Schröter had suspected some physical change, so that Beer and Mädler determined to give especial attention to them. Three hundred separate observations of these two ring-plains were made by Beer and Mädler between 1829 and 1837, for the express purpose of detecting any variation between them, with the result of establishing that during the whole of this period the two ring-plains appeared *completely alike.* In diameter, form, height, depth, colour of the interior and of the walls, position of the walled peaks, these two objects were exactly alike ; and Beer and Mädler italicise this in their way, so that no question can be raised as to their complete identity in appearance. Yet at present this entire identity in the appearance of the two ring-plains has been shown to have completely disappeared, and the smallest astronomical telescope will reveal the marked dissimilarity between the two, which cannot now therefore be questioned. For not only is the one ring-plain considerably larger than the other, but it is of different form and differently placed ; one being roughly a circle foreshortened into an ellipse, with its apparent greater diameter from north to south ; and the other being of an irregular form, foreshortened into a flattened oval, with its longest diameter nearly from east to west. Minor differences are also easily noticeable, and they cannot in any manner be considered to exactly resemble one another.

Can it be justly considered that this is an instance of lunar physical change that may be regarded as established? And there is much that has been urged in favour of this idea by experienced astronomers. Little attention has, however, been given by astronomers in general to this instance, and it is just possible that Beer and Mädler might have been wrong, and no physical change have taken place, though their failure to remark this difference in such a prolonged series as three hundred observations is very singular. This has not, therefore, been considered as establishing the existence of an instance of physical change on the moon.

In the present case there is, perhaps, good reason for this, as it does not seem possible to conceive any admissible manner in which such a change could have been produced, though perhaps a more severe examination might reveal details of the greatest importance on this point. Here, however, as elsewhere, the greatest difficulty in the way of establishing instances of unquestionable lunar changes appears in the inability to show satisfactorily what the change is, even if it be admitted. And until the probable nature of the alteration which it is claimed has occurred on the surface has been shown, and until it has been established as one that may with probability be regarded as possible, it is not to be wondered that much reluctance should exist to admit it. Thus, until it can be shown with probability how on the moon a round ring-plain some miles in diameter can be squeezed into a contorted form, the difference now existing between the two ring-plains of Messier will not in general be held to establish an instance of actual change in a formation on the surface of the moon.

Besides the classes of physical changes hitherto considered, and consisting mainly of alterations in the various formations on the moon, there are others of a different nature which seem to indicate the existence of purely surface alterations. These last are principally shown by variations in the colour or brightness of the different portions of the surface, and are in part periodical in nature, and in part continuous. And these last in particular there is much reason for supposing are truly due to some processes of weathering or tarnishing on the surface.

A critical examination of the present condition of the lunar formations will show that though the estimates by the earlier selenographers of the brightness of different portions of the moon's surface in the main still satisfactorily express the true relative brightness, yet instances of differences of peculiar character will be detected apart from those which appear due to mere accidental discrepancies. These instances referred to, consist principally in a marked diminution in the brightness of some point whose brilliancy had been especially noted by the earlier selenographers, from Schröter to Beer and Mädler; or else in the existence of a more or less brilliant object in a region where none had previously been noticed; but these latter are rare. The former class of alterations has been noticed in several instances, and mainly where indications of late disturbance can be detected. The white spot within Werner may be taken as a typical instance, and consists of a small area about five miles square on the inner north-east wall. It was described by Mädler as a star-like glittering brilliant point, fully 10° bright, and therefore probably the brightest point on the entire moon. Now it is much fainter than this, and is surpassed in brilliancy by a number of other lunar formations. Considering the general faithfulness of the estimates of Mädler in this region, there exist good reasons for supposing that the brilliancy of this point has faded. There are other instances where similar indications of the brightness of the surface having faded since Mädler's time have been noticed, and the remainder of the estimates still faithfully representing the brilliancy of the surface, good reason exists for supposing this fading to be real.

The other class of variations in the tint or brightness of the surface are more or less periodical in nature; and though opening very interesting questions, their nature has not as yet been satisfactorily established. The variations on the floor of Plato may be selected as an instance of these last. This formation is a ring-plain sixty miles in diameter, with a level interior containing a few small crater cones. At sunrise the interior appears of the usual dull tint of the surface; it then quickly increases in brightness, in the same manner as the rest of the surface, for a short time; but then, instead of maintaining this brighter appearance, commences to darken slowly, until at Full it is a dark steel-grey, and forms one of the darkest points upon the entire moon. Soon afterwards it commences to grow gradually lighter, and passes through a somewhat similar variation, except that throughout the interior is somewhat darker.

This change in brightness is not due to the effects of contrast, remaining unaffected when these are eliminated, and appears to be due to some special features on the floor.

In several other formations similar variations in brightness have been detected, and Mädler has mentioned several instances. Some of the most interesting of these are in the case of long winding valleys placed in favourable conditions, to secure a moderate temperature only. Beer and Mädler suggested that could vegetation be possible upon the moon, in the apparent absence of both any sensible atmosphere or water, then the nature of these periodical variations would perhaps indicate some process of vegetation taking place. And this view has since then been taken up by various astronomers, though it rests on the very slightest basis.

It is true that later inquiries have shown that the moon may possess an atmosphere that must be regarded as fully capable of sustaining various forms of vegetation of even an advanced type; and, moreover, it does not appear how it can justly be questioned that the lunar surface in favourable positions may yet retain a sufficiency of moisture to support vegetation of many kinds; whilst in a very considerable portion of the entire surface of the moon, the temperature would not vary sufficiently to materially affect the existence of vegetable life. But though later investigations have shown that vegetation of various kinds is not incompatible with what may with probability be considered the conditions prevailing upon the surface of the moon, yet hitherto little evidence has been found to connect in any way the periodical variations in tint with processes of vegetation. Though, in fact, some of these instances of periodical variation might be due to some surface change of the nature of vegetation, yet several of them appear to exhibit characteristics inconsistent with this view.

Much remains to be done in investigating the variations in appearance presented by different portions of the lunar surface, and it cannot be said at present that these have ever received the searching and systematic examination that they merit. For the purpose of thoroughly elucidating the present condition of the moon this must be undertaken, and it cannot be properly carried out without leading to conclusions of the greatest importance and interest—not only with regard to the moon, but to the entire solar system.

CHAPTER VI.

INTRODUCTORY.

The general method employed in the description of the details of the lunar surface is similar to that adopted by Beer and Mädler in their 'Der Mond;' commencing with an account of the principal formation, and proceeding thence to the description of the smaller lunar formations grouped around it, and distinguished by bearing its name as a general classification. This system has been maintained, however, much more strictly than in their work, with the purpose of avoiding the difficulty often experienced in finding the description of any particular object in the 'Der Mond.' This method offers several advantages over the unsystematic cataloguing inseparable from that employed by the British Association Committee, which renders the finding of any particular formation on the map a work of some time. It thus combines to a considerable extent the advantages of both plans without retaining to any material degree their corresponding disadvantages; and it markedly facilitates both the finding of the object on the map and the description in the text.

The descriptive portion is illustrated by a complete lunar map on a scale of twenty-four inches to the diameter of the moon; a size sufficiently great to enable every known object on the moon of any interest or importance to be inserted. This map is divided in a systematic manner into twenty-two sections, in the method shown by the accompanying key map; and each section is separately described in the text. To render each map entirely comprehensive and independent, the edges overlap to a considerable extent, thus obviating the inconvenience so often experienced in consulting any of the other lunar maps, whether divided into quadrants or sections, from the formations at the edges appearing only in part. Whilst the scale of the map is quite adequate for the purpose of delineating every feature of any importance or interest on the lunar surface; and indeed in almost every portion to enable every formation whose existence has been established with certainty to be shown, it has yet been found necessary in the more crowded portions of the surface to omit some of the very small and entirely unimportant details. All of these last are, moreover, open to considerable doubt, not only their place and nature, but their very existence being quite uncertain, so that their omission can be regarded as of altogether minor importance.

Very many of these minute details on the more crowded portions of the great map of Beer and Mädler are not to be considered as representing actual features existing upon the moon, but were inserted to represent the nature of the surface, and in place of the details which the instrumental means of Beer and Mädler could not properly deal with. In a number of similar cases the minuteness and crowded nature of these small formations rendered it impracticable for Mädler, with his means, either to delineate them or to insert them in the 'Mappa Selenographica;' so that Mädler was obliged to supply their place in the best manner he could, and the detail shown on their map is here entirely arbitrary and conventional. Throughout, therefore, in those portions of the great map of Beer and Mädler where the formations are most crowded, the very small detail cannot be relied on as accurately representing the real nature of the actual condition of the surface; they rest in the great majority of instances on one, or at most two, sketches during particular illuminations, and under these conditions it has been long known to selenographers that such small details are not to be implicitly trusted. Whilst, therefore, the scale of the map has enabled every formation whose existence may be regarded as established to be inserted; in some portions of the surface, the minute and in general doubtful details have been in part omitted; this step being a slightly greater extension of what Beer and Mädler found necessary in these regions.[1] In fact, for the adequate and complete delineation of these very small irregularities of the surface, a scale of one hundred inches to the moon's diameter is absolutely requisite; whilst to render these very minute features of any value, the lunar surface must be submitted to a far more searching investigation than it has ever yet received.

The general basis of the map is the great trigonometrical survey of the lunar surface of Beer and Mädler, which for the present must remain, as it hitherto has been, the foundation on which all lunar maps must be constructed. This great work requires a complete revision and extension, but cannot be touched in parts, as any alteration that may be made in one point implicitly affects the entire triangulation of the surface. For though Mädler, by giving the details of his measures of the first order, has allowed any alterations in them to be easily effected which further investigations may render requisite, yet, as in no case is any information given as to the immediate origin of the measures of the second order, no alteration can be made in one of the former points

[1] The details omitted consist almost entirely of a few low mounds, hillocks, and ridges, together with a few low hills and small peaks on the ridges and walls of the ring-plains and other formations.

without sacrificing every one of the latter near it. For it is evident that a change in the assumed position of a point of the first order involves a corresponding change in the position of the points of the second order measured from this point of the first order, and this cannot be effected as these points of the second order are unknown, no information being given as to where they are measured from. Until therefore the positions of all the points of the first order have been revised, the entire trigonometrical survey of Mädler must in the main be left intact, only a few partial alterations being possible.

On the small scale of the 'Mappa Selenographica,' and consequently on the map of this work, this is of minor importance, as the probable errors in the positions of Mädler are of comparatively small extent. The places in the present map have been therefore founded directly on Mädler without any alteration, except where absolutely requisite ; but at the same time a very considerable number of new measures have been incorporated, giving the true position of many other formations whose place was not determined by Mädler.

Though resting primarily on Beer and Mädler, the greater portion of the map has been revised by a long series of observations, including the results of several hundred drawings of the moon. Thus, though with the exceptions before noted, every formation on the map of Beer and Mädler appears, unless it has been found by later observations during the revision to have no existence, the position and form have in many instances undergone correction so as to increase the accuracy of the whole. A very considerable number of new formations and of fresh detail has been also embodied, amounting in all to several thousand fresh objects, thus rendering the map more complete, so that it contains a greater mass of detail than even the 'Mappa Selenographica' of Beer and Mädler. Many hundred new rills have been inserted, a considerable number of which are absent from even the great catalogue of Schmidt, and they include almost every rill mentioned by Schmidt, the existence of many of his doubtful rills having been confirmed.

No attempt has been made to represent the variations in brightness of the lunar surface on the map, though the positions of some of the main bright streaks have been indicated. Several well-known selenographers have shown the necessity for the complete revision of this portion of the map of Beer and Mädler, which is no longer in accordance with the condition of the lunar surface. It is known in fact that the brightness of different portions of the surface varies very materially with the illumination, so that it is impossible to delineate on any one map, the relative brightness of the different portions of the surface with any accuracy and with any generality. Later selenographers have judged it best to render the maps of the details of the surface independent of variations in brightness, and until a more satisfactory acquaintance with these has been established this course seems the best that can be adopted with regard to this point.

The scale adopted in the special drawings or maps of certain selected formations, as Gassendi and Maginius, is somewhat over four times that of the general map, or one hundred inches to the moon's diameter. They show therefore these formations on a scale similar to the proposed map of the British Association, and nearly twice the area of the great map of Schmidt; yet this, as the drawings show, is only just adequate to give the principal minor details of the surface. These special maps are the results of long series of observations, and show all the details of those formations whose existence has been established and whose nature has been distinctly made out. When compared with the great map of Beer and Mädler, which shows within, Gassendi for instance, only a group of central mountains and a few mounds, or with the special drawings of Nasmyth, or even with the great map of Schmidt, many of whose objects require revision, they show the great field open before the real nature of the lunar surface is established. On Mädler's map no rills are shown within Gassendi; subsequently, however, with the great Dorpat refractor he discovered fifteen, and by Schmidt the number was raised to twenty, though several were mere fragments. Since then the number has been raised to at least thirty-eight, whilst many of those seen only in part by Mädler or Schmidt have been traced to their full length. To delineate adequately a region like Gassendi that has been well studied, a scale of at least twice this diameter is desirable.

The general map or index is drawn to a scale of one-third the diameter of the principal map, and contains merely the chief formations together with the names of the greater number, so as to render the identification of any particular formation or region easier, as well as to show the general connection of the maps. The boundaries of the maps are shown by a dotted line, but it is to be remembered that as for the sake of convenience each map slightly overlaps, each separate section will embrace a region slightly greater than that here shown. This extension is, however, purely for convenience, and in order to prevent the division of any formation, whilst it also clearly shows the relation between the different maps; the true map therefore on which to examine the details of any region, is always that within which it lies on the key map.[1]

The nomenclature employed is based on that of Beer and Mädler, as developed in their 'Der Mond,' as any alteration in this, which must be considered as the nucleus of any more extended system, would be most unadvisable. The prin-

[1] This circumstance must be remembered in case of any slight discrepancy between the minor details of the different sections, and the proper drawing on the proper map consulted.

cipal later additions to the lunar names have been included, as well as some few of the older names omitted by Beer and Mädler from their being unable to identify them. Where it seemed advantageous new names have been added, selected from well-known astronomers and mathematicians, but in especial selenographers. In some few instances the names have been altered, either in accordance with the intentions of the original authority for the name, or where for some similar reasons the alteration seemed to be desirable. No confusion is, however, likely to arise from these changes, care having been taken to render any chance of this as small as possible. In the same manner where it seemed better a few names have been omitted.

The original authorities for the 427 names employed by Beer and Mädler in their 'Der Mond' were as follows:—Hevel. 6; Riccioli 206; Hell. 1; Schröter 60; Lohrmann 8; Gruithuisen 1; and Mädler 145. From the new names, included in the British Association Catalogue, 67 have been taken and added to Beer and Mädler's, the real authorities for these being:—Webb 1; Lecouterrier 1; Schmidt 1; Lee 4; and Birt 58; together with two of Schröter's early names not identified by Beer and Mädler. To these have been also added 19 more, consisting of 2 of Riccioli's and 3 of Schröter's restored, and 14 new names. Thus the grand total of named points on the moon is 513. After each name appears the authority on which it rests: H. indicates Hevelius; R., Riccioli; S., Schröter; L., Lohrmann; M., Mädler; B., Birt; and N., the new names. This is followed by the name or symbol by which the formation is distinguished either on the 'Mappa Selenographica,' or in the text of the 'Der Mond.'

The method of distinguishing the minor detail of the moon is essentially the same as that employed by Beer and Mädler in their 'Der Mond,' these small formations being symbolised by attaching a letter of the Greek or Roman alphabet to the name of the principal formation near. For elevations, such as mountains, ridges, peaks, &c., Greek letters are commonly employed; for depressions, as ring-plains, craters, &c., Roman letters; whilst capital letters are employed for measured objects, and small letters for the rest. Mädler has not however systematically adhered to his system, but has in instances which if comparatively few are yet numerically numerous, departed from it, principally in employing small letters for measured spots, but also in some cases using Greek letters for depressions, and Roman letters for elevations. Wherever practicable, Mädler's notation has been adhered to throughout, and no alterations have been made except where absolutely requisite so as to avoid any confusion on this point. Even where, by misadventure, Mädler has employed the same letter to designate two or even three formations, the letter has been retained as a rule, distinguishing between them by the addition of a number.

It has, however, been found necessary to add still further to these exceptions to the general method of distinguishing the smaller formations. For a considerable number of objects to which a small letter was attached in the 'Der Mond' and 'Mappa Selenographica' having been measured during the last two years, some confusion and extensive alterations in the symbols of Mädler would have been requisite to convert all these into capitals, even had not that course been rendered impracticable in some cases from Mädler having already made use of the capital for another formation.

Mädler having employed Greek letters to designate the lunar rills, though these are not properly elevations, this practice has been followed, but where possible the three letters ϕ, ξ, and ψ, scarcely ever made use of by Mädler, have been used, and where more are necessary χ, θ, and η generally employed. Additional letters have been employed in many instances to point out interesting or conspicuous objects, or to aid in the identification of localities; and where, as frequently occurs, letters are referred to in the text of the 'Der Mond' which do not appear in the 'Mappa Selenographica,' these have been supplied.

The principal instances where departures from what must be regarded as the standard nomenclature of the 'Der Mond' have been rendered necessary, are in the cases where formations have been since named. Under these conditions the new name has been substituted for the original symbol of Mädler, and in the immediate neighbourhood the new name substituted for the old name in those points that are symbolised. The designation of the 'Der Mond' for these surrounding formations can usually be obtained by replacing the new name in their symbol by the name in Mädler's symbol for the principal formation. In referring, however, merely to Beer and Mädler's map, the name to which the letter may belong is of only secondary importance. The description of the formations on the lunar surface is to all intents new, for though completely embodying in a condensed form that of the 'Der Mond,' it has in general been much extended and rearranged. The systematic description of the formations has, whenever possible, been adhered to, thus enabling the whole to be much condensed and readily found. In most instances the description has been carefully revised in accordance with careful observations of the formations with far more powerful telescopic means than were at the disposal of Beer and Mädler, whilst in many cases it has been very materially extended by new details. In its present form, the description of the formations contains the material derived from a collation with the works of Schröter and Lohrmann, and in part with those of Schmidt and the British Association, together with the results derived from the observations of a number of years, and including a series of nearly one thousand sketches, drawings, &c., of the lunar formations.

The entire results of the measures of Lohrmann, and Beer, and Mädler, are given, together with a considerable number made during the last two years, thus presenting the entire *matériel* at present existing for constructing the groundwork of any lunar map.

The measures of points of the first order given are accompanied by the name of the authority, whether Lohrmann or Mädler, those without any name being the author's; and the positions are given, as in the 'Der Mond,' in degrees, minutes, and seconds, though these last are only of any value in the standard points.[1] The places of points of the second order are given only to degrees and minutes, and must be considered doubtful to perhaps ten minutes. They are mainly Mädler's, only about one hundred and fifty new ones having been added. The measures of the diameter of the formations are also almost entirely Mädler's, as given in the 'Der Mond,' where he has incorporated with his own those of Lohrmann; those given to two decimal places being the results of careful series of micrometrical measures; those given to one decimal place depend usually on two or three measures; whilst those given to miles are founded on a single result, and merely approximate. A few fresh measures of this character have been added. The height measures given in full are those obtained by Mädler by direct and careful micrometrical measures; whilst those given to the nearest fifty feet were obtained by more approximative methods. A considerable number of measures

[1] At the end will be found catalogued the entire number of points of the first order, with their positions and co-ordinates on the orthographical projection in mean libration.

by Schmidt have been added, and rank fully equal to those of Mädler's from which they are distinguished by the letter (S). A number of Schröter's measures have also been incorporated, but always with his name added; but they can only be considered as approximate, and are therefore generally only given to the first figure, and then usually only for those spots not otherwise measured. A few new height measures have also been added, but are only provisional, and so are given to only the nearest hundred feet.

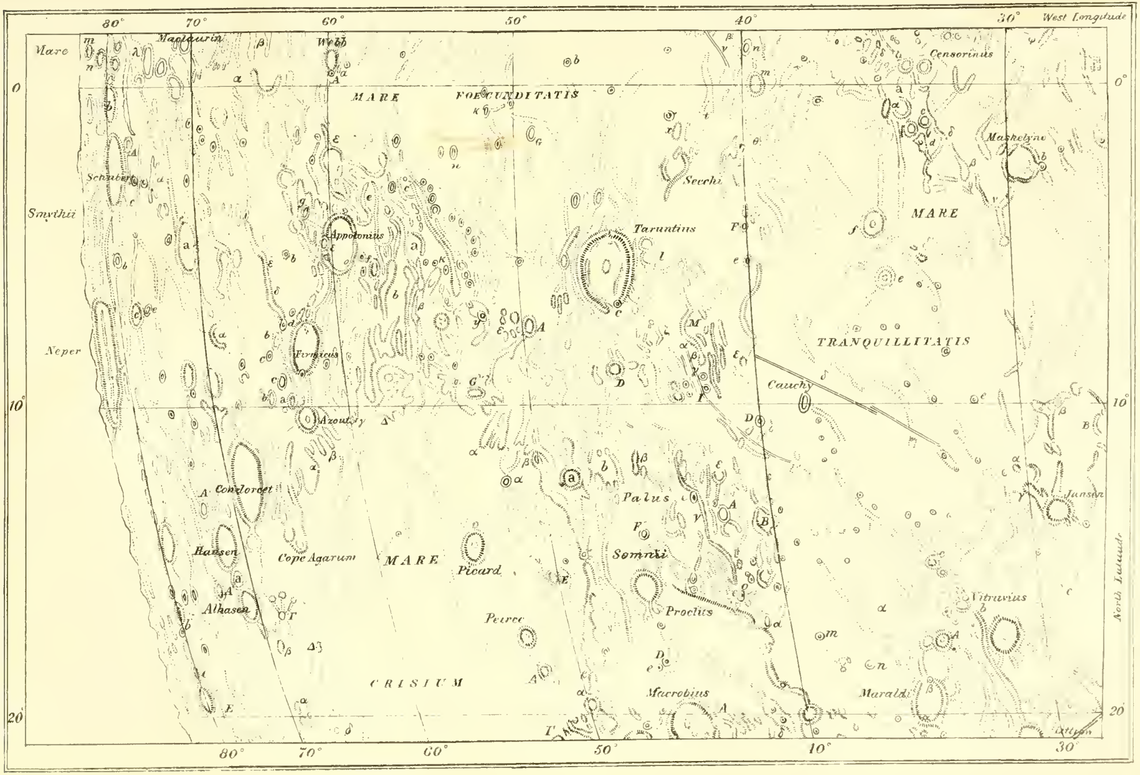
The estimates of the brightness of the surface and formations rest mainly on Mädler, being those given in the 'Der Mond,' but they have in the greater number of instances been confirmed by direct comparison with the lunar surface; and almost without exception have been found to accurately represent the real brightness of the surface. In some few cases discrepancies of moment have been found, which are usually indicated where it seemed desirable, but in other instances simply rectified. A very considerable number of new determinations of the brightness of different points of the surface have been added, both by direct estimation and by comparison with the neighbouring points whose brightness had been determined by Mädler.

It has not been considered necessary, even had it been practicable, to particularise those details in the description which rest entirely on Mädler, for it did not appear that any advantage whatsoever would result by so doing. At most it could only have enabled discrepancies between Beer and Mädler's descriptions and later observations to have been found out, in contradistinction to those between the other observers and these. But little, if any, advantage appeared in this, for slight discrepancies between Beer and Mädler and later observers cannot be held to possess any importance of their own; and serious discrepancies must, to possess any value, be compared direct with the text of the 'Der Mond.'

Any slight discrepancy between the earlier selenographers and new observations that may be made of the surface of the moon can rarely, if ever, be considered of any importance, for in no case can particular delineations of theirs of these minute features be regarded as thoroughly to be relied on. On the other hand, in the case of those discrepancies of moment where the maps and descriptions of the earlier selenographers can be regarded as trustworthy for the purpose of establishing changes, it is evident that no translation or abridgment whatsoever can be trusted; but that it is absolutely indispensable that reference must be made direct to the original work itself, and if possible to the very observation on which it is founded.

Wherever, however, it has been considered advisable for some especial purpose to indicate that a result depends on Beer and Mädler, the initial M. of Mädler's name has been employed; and in the same manner the letter S. has been employed in the descriptive portion of the work to notify that a statement rests on the authority of Schmidt of Athens. Other authorities have, where necessary, been quoted in full. The letter S followed by a number, and usually in brackets, in connection with the class of lunar formations termed rills or clefts, indicates that it is the number of the rill in Schmidt's great catalogue, 'Der Rillen auf der Mond.'

Map 1.


West Longitude
North Latitude
Mare Smythii
Neper
Schubert
Maclaurin
Webb
MARE FOECUNDITATIS
Secchi
Censorinus
Maskelyne
MARE TRANQUILLITATIS
Taruntius
Appolonius
Firmicus
Azout
Cauchy
Condorcet
Hansen
Alhasen
Cope Agarum
MARE CRISIUM
Picard
Peirce
Palus Somnii
Proclus
Macrobius
Maraldi
Vitruvius
Jansen
Ottyon

CHAPTER VII.

MAP I.

Schubert (M.)—A ring-plain, forty-six miles in diameter, with its east wall considerably higher than the west, through which arise many optical changes from variation of libration; as when by easterly libration Schubert and the neighbouring ring-plains *b* and *c* are brought more directly into view, they appear as fine formations, much detail and a small central elevation being visible; but when from westerly libration they approach the limb, Schubert and *b* appear as one long valley, whilst *c* is hardly detectable, and all beyond the + 75 meridian vanishes. At Full only Schubert A, a 7° bright crater, can be detected through its brightness, and was selected by Mädler as a point of the first order, its position from six measures being + 2° 27′ 41″ lat. and + 77° 15′ 51″ long.

Neper (S.)—A walled plain, seventy-four miles in diameter, with a west wall in points 6,000 feet high, and forming at times the limb of the moon; while the interior of Neper, possessing an area of nearly 3,800 square miles, is traversed by a mountain ridge in a meridional direction, and rising in two peaks, the southernmost being nearly central. East and north-east of Neper extends a bright table-land with a few isolated craters or minute ring-plains. In the midst of the grey plains east of this table-land lies Neper **a**, in + 5° lat. and + 71° long., a ring-plain of some size; whilst south of Neper lies the 7° bright crater *b* in + 5°½ lat. and

+ 79° long., and south of this close to Neper is *c*, from its slight depth a not easily seen ring-plain bordered on the end by a deeper crater *e*.

Hansen (M.)—A regular deep ring-plain 32·3 miles in diameter with steep walls rising on the northern half into peaks, and a 3°½ bright floor without any visible irregularities. West of Hansen is the 7° bright crater A, easily seen in Full, and from seven measures found by Mädler to be in + 13° 17′ 19″ lat. and + 74° 0′ 8″ long., standing on the border of a fine dark-grey valley 115 miles in length; and beyond which is the dark ring-plain *b*, greater than Hansen, and farther still, another dark-grey plain. South-east of Hansen and lying close under the walls of Condorcet is a 3°½ bright incomplete ring-mountain, not easily detected.

Condorcet (S.)—An extensive ring-plain 45·2 miles in diameter, in + 12°½ lat. and 68°½ long., very regular in form towards the interior, though, like all similar formations situated in a mountainous region, of irregular exterior, but without any considerable peaks on the wall, which rises on the east 8,965 feet, and on the west 8,869 feet above the grey interior, which alone can be seen in Full.

Alhazen (M.)—A small ring-plain with a grey interior north of Hansen, with which it is connected by a still smaller ring-plain a, while on its west are six small ring-plains, A on this side, and the other five beyond the grey valley west of Hansen. North of Alhazen this irregular valley expands into a broader plain, somewhat lighter in colour, whilst its sides rise in points to an altitude of 2,000 to 2,500 feet. Beyond appears a clear plain, containing some considerable peaks, and the smaller ring-plains are more irregular and fewer; but F, in + 21° 42′ lat. and + 79° 10″ long., is probably the first containing a central mountain. The peak Alhazen Γ on the Mare Crisium is remarkable for its very symmetrical branches with corresponding peaks, and is bright though small; and north of it, in + 18° 20′ lat. and + 60° 35′ long., is the small but tolerably high mountain Alhazen Δ. The two mountains β and α on the border of the Mare Crisium are also of considerable elevation, the last rising about 7,700 feet. Near this last lies the celebrated Alhazen of Schröter, who described it as a distinct and always recognisable ring-plain, about twenty-three miles in diameter, remarkable for its grey colour under every angle of illumination; and which he employed to determine the libration in longitude, though occasionally it varied in appearance. In 1825 Kunowsky asserted that it was no longer visible in any form, and Mädler was unable to detect any appearance of a ring-plain in this region, and accordingly transferred the name to the formation that now bears it. Pastorff and Harding asserted that they could still see Schröter's Alhazen, and Kohler declared that it corresponded in position with the mountain formation denoted α by Mädler, being a deep hollow between these and some ridges on the east that at times assumed the appearance of a ring. In 1862 Birt recovered what he considered to be probably Schröter's Alhazen, as a deep valley immediately west of Mädler α; and in 1867 saw in this valley a depressed ring-plain corresponding to Schröter's description of Alhazen. The discrepancy between the present rare visibility of this object and the description of Schröter still requires explanation before the question can be considered to have received a satisfactory solution.

Cape Agarum (H.)—A mass of high mountains projecting into the Mare Crisium at the end of the steep irregular mountainous south border, and rising 10,966 feet high, being steep at the base but becoming of gentler slope towards the summit. In Full it is 6° bright, but some days later becomes 8° bright, though the southern portion is not so bright nor yet so high, the peak ten miles south-west of the principal rising only 9,292 feet, and the intervening plateau only some 5,700 feet.

Auzout (S.)—A regular small ring-plain, 16·1 miles in diameter, with a dark-grey floor only 2° bright, containing a slight central elevation; and towards the south are three similar but smaller ring-plains, one, **a**, with a craterlet on its west wall. From Auzout towards the Mare Crisium extend several mountain-arms.

Firminicus (R.)—A regular ring-plain, 38·7 miles in diameter, and 4,943 feet below the summit of the west wall, connected by a strong mountain-arm with Auzout, whilst others extend in different directions, but principally towards the Mare Crisium. Towards the north-west the wall is broken by a craterlet, and on the south a spur from the wall projects on to the floor, which at Full appears of a uniform steel-grey colour. In the west is the mountain Firminicus α, with three peaks, the steepest in this region. On each side of this mountain appear broad curved and branched dark-grey streaks lying on a level country, and these undergo remarkable variations of apparently periodical nature, which Mädler considered might well be ascribed to some process of vegetation were it not that this seemed impossible in the absence of both air and moisture. Towards the limb, other streaks of a similar character appear, and must be of considerable dimensions, though they are greatly foreshortened, and are liable to much variation in shape from the effects of libration.

Apollonius (M.)—A fine ring-plain 30·4 miles in diameter, whose wall rises on the south-east 5,435 feet above the floor, and is broken in places by craters, whilst others lie close around, and from their brightness form a strong contrast to the dark floor. The crater E is in + 4° 56′ lat. and + 60° 36′ long., and is moderately bright. The regions round Apollonius are very irregular, and much disturbed, forming part of the great mass of highlands between the Mares Crisium and Fœcunditatis, the principal object being the great valley cleft *b*, situated between two massive mountain ridges, but which, however, is only visible when in shadow, from the identity in brightness of its floor with the mountains, both being 4° bright. South of it is a very irregular walled plain, a, ending in lat. + 4° 50′, and south of this a walled valley *c*. The two craters *k* and *e* are the brightest in this region, though no deeper than the rest.

The Highlands of the South Border of the Mare Crisium. In character these resemble the Palus Somnii, but are brighter, the mountains higher, the valleys and plateaus broader, while there are only small craters. Two craters, Taruntius A and Picard G, together with the high crest between them, are remarkably bright, and constitute the north-east border of this region. The peaks in this region are usually 5° bright, and the highlands 4°, only the crater Taruntius A being 7° bright; and between this and the crater Taruntius *y* rises a small plateau and a lofty peak, probably the brightest in this region. Towards the south-east border, and nearly parallel with it, is a chain of equal size, shallow depressions, and close to them a long winding rill, with very irregular high rims, steepest and highest towards its western extremity (S. 7). North of Taruntius A on the plain is a crater rill (S. 5).

Picard (S.)—This most prominent object on the Mare Crisium is a ring-plain 21·3 miles in diameter, with regular $5°\frac{1}{2}$ bright walls of considerable height, rising on the west 3,057 feet above the exterior, and 5,314 feet above the interior, which, fully 4° bright, contains a low central mountain and a number of small hillocks, and forms a strong contrast to the level only $1°\frac{1}{2}$ bright surrounding surface. Mädler determines the position of Picard to be from eight measures in + 14° 27′ 44″ lat. and + 53° 52′ 8″ long. Between Picard, Peirce, and the east wall of the Mare Crisium, are many mountains in portions high, either isolated in portions or united by low ridges. Picard E, in + 15° 35′ lat. and + 49° 42′ long. (*e* of M.), is a small ring-plain that takes the appearance of both mountain and crater; its west wall, rising 5,525 feet above the surface, entirely overshadows the more insignificant east wall at sunrise. In this region Schröter observed many apparent changes, ascribed by him to the effect of a lunar atmosphere, but regarded by Mädler as arising from changes of illumination, and in this Mädler was in the main correct; but here, as in several instances, the whole of the appearances detailed by Schröter are not thus explainable. On the east border of the Mare Crisium are the two high peaks, Picard α, rising 14,196 feet, and Picard β, rising 15,597 feet, whilst further south is Picard G, a bright crater in + 9° 40′ lat. and + 52° 37′ long.

Peirce (N.) [Picard A, M.]—A small ring-plain in + 18° 8′ lat. and + 52° 20′ long., and considerably steeper and deeper than Picard, the 5°½ bright walls on the east rising 3,210 feet above the only 1°½ bright Mare, and 6,990 feet above the interior, which is 4° bright, and contains a central peak not easily seen, and a minute craterlet discovered by Schmidt. South is the still smaller ring-plain Peirce A (Picard B, M.), which is of similar brightness to Peirce, but perhaps still deeper, and contains a very slight central mountain only just perceptible on the most favourable occasions; its position is in + 19° 9′ lat. and + 52° 23′ long. On the east wall of the Mare Crisium rise the two high peaks α and β.

Mare Crisium (R.) [*Southern and Central*].—One of the most conspicuous and completely enclosed dark plains upon the moon that have been termed Mares, extending from + 9° to + 24° lat., and from + 48° 50′ to + 69° long., being therefore 281 miles in length from north to south, and 355 miles in breadth from east to west, possessing an area of 78,000 square miles, or $\frac{1}{94}$ of the visible hemisphere. Though truly an ellipse, with its greater axis from east to west, in form it appears from the strong foreshortening to be an oval, with its longest diameter from north to south. In comparison with its border, the Mare Crisium is the darkest, as it is the smallest, of all the regularly bordered Mares; and in tint it is a grey, mixed with an unmistakable tinge of green, easiest seen by direct comparison with the pure grey floors of Condorcet, Auzout, and Firminicus; whilst its general brightness is 2° to 2°½, brightening in places to 3°, and falling around Picard and Peirce to as low as 1°½. It is only under high illumination some days before and after Full that this greenish tint is clearly visible, and it requires favourable atmospheric conditions; it does not, moreover, extend beyond Cape Agarum, from thence to the west border being a pure grey. The whole surface of the Mare is not, however, uniform, but is traversed by numerous very fine spots and delicate lines of grey and greyish white, only detectable in fine instruments and under very favourable conditions. The surface of the Mare Crisium is considerably lower than that of the neighbouring Mares Tranquillitatis and Fœcunditatis, and has been seen by Schröter, Mädler, and Webb, curiously speckled with dots and streaks of light.

The east border of the Mare is but little broken, being for the most part free from terraces or divisions, and contains some very considerable peaks, the principal being Peirce α, in + 19° 30′ lat. and + 50° 15′ long., rising 11,343 feet, and Peirce β, in + 18° 25′ lat. and + 49° 15′ long., 6,752 feet high. Near the centre of the east border it is broken by a fine pass, bordered on each side by two lofty points that have been named the *Promontorium Olivium* and *Promontorium Lavinium*, on each of which is situated a craterlet. South rise the two very lofty peaks Picard β and α. From this last, in + 12° 30′ lat. and + 53° long., to the Promontorium Agarum, in + 14° 50′ lat. and + 65° long., the border is of different character, being here on the south formed of large separate masses of steep mountains projecting into the Mare in more or less rounded capes, the steepest being the point Auzout Δ in + 10° 30′ lat. and + 57° 50′ long., and Auzout β, γ, and α. Broad deep bays, partly winding, partly delta-like, separate these projections, and penetrate deep into the southern highlands, the whole forming an indented coast-line of most interesting character, and best seen three days after new moon, when the terminator has reached Taruntius, these bays being then still partially within the shadows of the high western mountains, whilst from the Promontorium Agarum to Auzout the mountain ranges cast a broad shadow over the Mare Crisium. From the extremity of the deep bay west of the Promontorium Agarum to the north wall at Eimmart, the western border of the Mare possesses another character, being a broad, gently sloping, elevated plateau, crowned at the edge towards the Mare by a high ridge rising in places into considerable peaks, though the connecting crest is seldom of greater altitude than 1,200 feet.

The floor of the Mare Crisium is traversed by numerous and considerable ridges, much branched, ramified, and intermingled, often rising where they unite into small peaks, the whole possessing a general meridional direction and originating principally at the foot of the Cape Auzout Δ. Between Picard and the east branch are a number of low ridges, and similarly near Alhazen Γ; whilst south-east of Peirce, and between the Promontorium Agarum and Alhazen α, are a number of low peaks and hills, visible as white spots towards Full. Craterlets and crater-pits are only few in number on the Mare Crisium, the formerly especially; several have, however, been seen east of Picard and around Peirce, whilst the central portion of the Mare exhibits a very few shallow craterpits.

Proclus (R.)—After Aristarchus, this is the most brilliant crater-plain upon the moon, 18·4 miles in diameter, with steep walls rising on the east about 7,700 feet, and on the west 8,300 feet, above the only 5°–6° bright interior, whilst the crest of the wall on the south is 8°, and on the north 9° bright, the slopes being little less, though Mädler considered the floor but 4°, and the walls, excepting the west, not much brighter. From the depth and small size of Proclus it has not been definitely settled whether it possesses a central mountain, but it appears probable that it does. From nine measures Mädler found the selenographical position of Proclus to be + 16° 9′ 8″ lat. and + 46° 31′ 34″ long., and six new measures give + 16° 12′ 8″ lat. and + 46° 28′ 24″ long.; the result being from fifteen measures, + 16° 10′ 20″ lat. and + 46° 30′ 18″ long. Proclus is the nucleus of a number of light streaks requiring favourable conditions to be clearly visible; the principal, towards the north-east, passing between Macrobius and Proclus *d*, on the border of the Palus Somnii, in + 17° 43′ lat. and + 41° 8′ long., consisting of a number of very fine rays, whilst two others form angles of about 120° with this, one extending due south, and the other north and over the Mare Crisium, ending at the north border near Cleomedes F. Shorter streaks extend towards Peirce A, Peirce, and between Peirce and Picard, a faint prolongation of this last being under favourable conditions detectable as far as the Prom. Agarum; and were the surface of the high plateau mainly traversed by these streaks less brilliant, the system would form one of the most conspicuous on the moon.

Proclus **a** and *b* are two incomplete ring-plains of old date, not brighter than the surrounding surface, situated north of Proclus and not very conspicuous; but the whole region here is of some brilliancy, the mountains being fully 5° and the rest of the surface 4°½ bright. On the east lies the Palus Somnii, within which are the two imperfect ring-plains Proclus ε and B, the latter in + 13° 44′ lat. and + 44° 10′ long., both being open towards the Mare Tranquillitatis. The elevated crater A, in + 13° 31′ lat. and + 41° 54′ long., is 6° bright, and the smaller crater F, in + 14° 12′ lat. and + 44° 48′ long., is 5° bright. The fine double-peaked mountain *B* (+ 11° 50′ lat. and + 45° 45′ long.[1]) is also 5° bright, and is probably the highest peak in the Palus Somnii; and east of this extends a long mountain-ridge, the central portion γ of which, extending from Proclus *c* to *e*, is in places fully 6° bright.

A peculiar point in connection with Proclus is, that although so very brilliant in sunlight, both Schröter and Mädler were unable to detect it on the dark side of the moon, though less brilliant formations, as Menelaus and Manilius, were readily seen. Mädler ascribed this to the small extent of the area of Proclus that is of great brightness, thus rendering it easier overlooked, but it would appear to be principally ascribable to its unfavourable position. Schmidt describes two rills by Proclus, one, probably a cleft on the east wall, and the other, a crater rill described as N.E. of Proclus, but in lat. + 17°½ and long. + 48°, which would make it N.W.

Palus Somnii (R.)—This is one of the best naturally bordered portions of the lunar surface, its boundaries being marked on the west and north by the 6° bright highlands of Proclus, and on the south and east by the only 1°½ to 2° bright dark Mare Tranquillitatis, its own brightness varying between 3°½ and 4°½; consequently it is readily distinguish-

[1] Mädler gives 44° 45′ long., but it should be apparently that given, which agrees also with the map.

able in every condition of illumination, whilst it is moreover characterised by a peculiar colour, not easily defined but somewhat of a golden brown which in places is almost purple in tint. It extends from + 10° 45′ to + 17° 0′ lat. and from + 39° 40′ to + 46° 10′ long., having a meridional diameter of 117·6 miles, and one at right angles of 119·0 miles, and a surface of about 9,720 square miles; the whole extent being covered with numerous hills, mountains, and ridges, though only a few of them can be recognised towards Full from their superior brightness to the otherwise uniformly bright surface.

Taruntius (R.)—A circular ring-plain, 43·8 miles in diameter, with a low, irregular, terraced wall rising on the east 3,485 feet; surrounded on all sides by many terraces and spurs, with ridges extending from the walls far into the Mare. The floor is 3° bright, the small interior ridges 4°, the walls 4°½ to 5°; the crater C (in + 6° 25′ lat. and + 45° 16′ long.) and neighbouring wall 6°, and the central mountain 4°½ bright; this last, from eight measures by Mädler, being in + 5° 40′ 10″ lat. and + 45° 58′ 24″ long. From the north wall extends a curved ridge as far as the crater Taruntius D, in + 8° 58′ lat. and + 45° 49′ long.; and east of this are two imperfect rings, M and ζ, which are 4° bright and steep on the west, though insignificant and in portions open towards the Mare on the east. From M extends a steep mountain mass with three high peaks, α, β, and γ, towards the north. The 4° bright crater I and the 5° bright crater *e*, with the curved mountain-ridge near the last, are likewise distinct, and the peak ε is very steep. F, in + 4° 7′ lat. and + 40° 3′ long., is 5° bright and easily seen, and so are the two small 5° bright peaks west of F, though the rest of the mountains of this region are only 4° bright. South of Taruntius, and nearly twenty-five miles distant, are two 5° bright very shallow craters, only seen with considerable difficulty. On the west is A, a 7° bright crater, on the border of the Mare Crisium, and whose position is + 7° 9′ lat. and + 49° 43′ long., and between it and Taruntius are two peculiar mountains parallel to each other.

Secchi (B.) [Taruntius B, M.]—A steep ring-plain open towards the south, with 6° bright walls and a 4° bright central mountain in + 2° 27′ lat. and + 42° 11′ long. It is surrounded by a number of 4° bright mountain-ridges, and at its south stands a large and lofty mountain, ψ (Taruntius ψ. M), which, together with the masses η and θ, is 5° bright. North-east, in + 3° lat. and + 42°½ long., Lohrmann saw a rill, and Schmidt three others nearly parallel, all somewhat curved and in portions crateriform. (S. 13–16.)

Maskelyne (L.)—A circular ring-plain of the same size as Arago, with 4°½ bright walls, rising on the east side 4,470 feet above the 4° bright floor, and on the west side 1,343 feet above the Mare, whilst from the result of eight measures by Mädler, and four by Lohrmann,[1] the mountain on the interior has its south end in + 2° 38′ 31″ lat. and + 29° 35′ 58″ long. South of Maskelyne are two light spots on the Mare, whilst on the west extends a tolerably high mountain-chain from the highlands north of Censorinus as far as + 5° lat., whose highest peaks are β and γ, which are 5° bright, the remainder of the chain being only 4°. Beyond this, in the north-west, are a number of small ridges and isolated peaks; and still further the two large, shallow ring-plains Maskelyne *e* and *f*, the walls being only some 300 feet high, and soon disappear except in the west, where they appear as 5° bright ridges. These possess very low central mountains and are surrounded by small, somewhat bright hills.

[1] The result of Lohrmann's four measures gave + 29° 46′ 13″ long. and + 2° 13′ 59″ lat., and Mädler's eight + 29° 29′ 21″ long. and + 2° 40′ 28″ lat., the difference being 16′ 52″ in longitude and 26′ 29″ in latitude. A similar difference between Lohrmann's and Mädler's measures is noticeable in other cases and throughout in the same direction, being thus a fact of some interest.

East of Maskelyne are a number of crater-pits, and on the wall appears *b*, a 4° bright crater, whilst between it and Sabine are a number of ridges, but the whole surface here is drawn too bright by Mädler. Maskelyne is an irregular ring-plain with a 3°½ bright interior, and 5° bright walls, crossed by the equator; whilst on the north-west is *α*, a great 6° bright peak, 5,269 feet high.

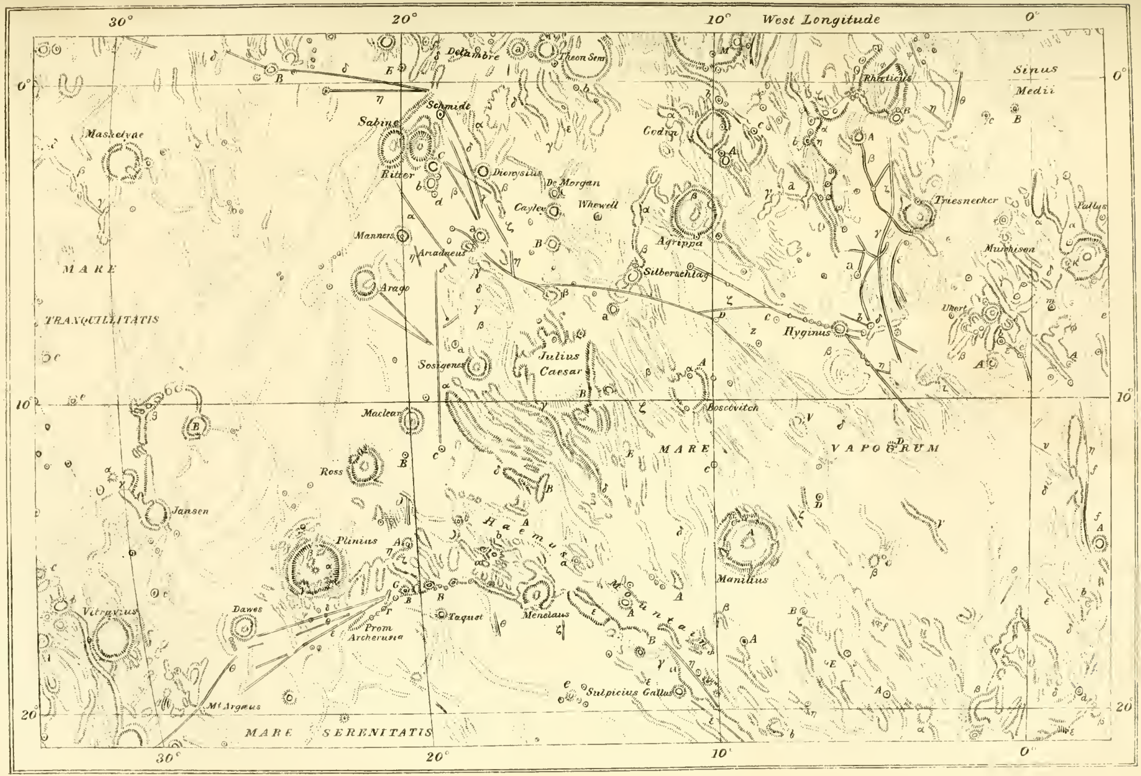
Cauchy (N.) [Jansen Δ M.]—A small crater-plain in + 10° 4′ lat. and + 38° 11′ long., very distinct in Full, and 6° bright. In the surrounding surface are a number of crater-pits, eleven extending nearly in a row as far as Vitruvius, together with a number of not inconsiderable hills, forming as it were a prolongation of the mountain system of the latter. South is a long fine rill δ (S. 18) extending from Taruntius ε to a ridge between Secchi and Jansen, first seen by Lohrmann, but perhaps really two separate rills. West is a curved rill (S. 17) first seen in part by Lohrmann and then by Mädler, but its real character is doubtful. North-west is a small 4° bright crater D (Jansen D, M.), very sharp near the terminator, in + 10° 44′ lat. and + 40° 0′ long.

CHAPTER VIII.

MAP II.

Mare Tranquillitatis (R.)—One of the darkest and largest of the great grey lunar surfaces, termed Mares by Riccioli. It is separated from the Mare Serenitatis by a gentle slope extending from the Point Mount Argæus to the Prom. Acherusia, communicates by a narrow pass north of Julius Cæsar with the Mare Vaporum, and by a broad strait and deep bay with the Mare Nectaris, and finally with the Mare Fœcunditatis, by some channels around Secchi. The Mare Tranquillitatis thus forms one of the principal connecting links in the great chain of Mares. From the Prom. Acherusia as far as Sosigenes, the border of the Mare Tranquillitatis is formed by the broad curved southern slopes of the Hæmus Mountains, and thence extends in an indented and irregular outline as far as the Equator, the line of demarcation between the dark Mare and brighter and higher plains being their difference in brightness. On the south, the border is formed by the highlands of Censorinus and the mouth of the broad strait, uniting it with the Mare Nectaris, whilst on the west it is bordered by a broad tract of irregular hill-land traversed by numerous valleys and extending to the Palus Somnii, north of which the Mare Tranquillitatis penetrates in a deep bay far into the mountainous region south of Römer, and dividing from each other the great mountain plateaus of Vitruvius and Macrobius. Its colour is throughout a clear grey, without a trace of green

Map II.



West Longitude
Sinus Medii
Delambre
Theon Sen
Rhaeticus
Schmidt
Sabine
Ritter
Maskelyne
Godin
Dionysius
De Morgan
Cayley
Whewell
Triesnecker
Pallas
Agrippa
Manners
Ariadaeus
Silberschlag
Murchison
Arago
Hyginus
Ukert
Julius Caesar
Sosigenes
Maclear
Boscovitch
MARE TRANQUILLITATIS
MARE VAPORUM
Ross
Jansen
Plinius
Haemus Mountains
Manilius
Dawes
Vitruvius
Prom Archerusia
Taquet
Menelaus
Sulpicius Gallus
Mt Argaeus
MARE SERENITATIS

or other specific tint such as appears on the Mare Crisium and Lacus Somnii, and the general brightness 2°½, rising in the northern deep bay to 3°, and in the eastern region near Ariadæus to 3°½, but falling in the south-western portion to 2°, or even in places to 1°½. A number of very delicate light streaks extend across the floor, giving it the appearance of a marbling, though it is uncertain whether this arises from the brighter colour of the more minute ridges or not.

On the interior are a great number of long curved ridges, in some portions only visible through their clearer colour, in others by the minute black lines of shadow cast near the terminator: many of the ridges are in connection with the ring-plains, or with the mountain borders. In number they are greatest towards the centre, and are smaller and harder to detect towards the west; near Arago they are highest and brightest, being there usually 4° bright, and close to Manners 1,000 feet high; in the rest of the Mare their brightness is usually 3° to 3°½. Between Maskelyne *f* and Secchi *θ* rises a low plateau a little brighter than the plain, with a number of projecting spurs from the north and south sides.

On the Mare Tranquillitatis a number of rills have been discovered, the principal being the system by Ritter and the three near Secchi.

Sabine (M.)—One of a double ring-plain of nearly equal dimensions of which Sabine is the westernmost; it is 17·84 miles in diameter, with a wall rising on the west 2,647 feet above the 4° bright interior. From a peak on its south-west wall extends a row of mountain-ridges, towards the south crossing the lunar equator.

Ritter (M.)—Forms with Sabine a double ring-plain and is 18·26 miles in diameter, with a wall rising on the west 3,965 miles above the 4° bright interior, which contains several hills and a curved rill extending from S.E. to N.W.

(S. 21). On the north-west are the two craters *c* and *b*, scarcely as bright as Ritter, and beyond *b*, on the outer slope of the wall, a third still smaller *d*.

Ritter may be regarded as the focus of a great and ramified system of rills which seemingly meet within its environs. On the north extends a long slightly curved rill α (S. 20) to the north of Ariadæus, and west of this, close N.E. of Manners, is a second (S. 25). North and east are three slightly-curved rills (S. 22–24), extending from the south of Ariadæus, the easternmost δ (S. 24) seemingly uniting the great cleft of Ariadæus with that south of Sabine. The two eastern of these appear to be crossed by another rill γ, extending from the north of Dionysius to the south of Ritter *c*, where it unites with the westernmost of the three, β (S. 22). On the south extend two long rills, the northernmost η (S. 19) appearing to be united through (S. 24) with the great cleft of Ariadæus, and the easternmost (S. 373) lying chiefly on the south-west quadrant. Owing to the difficulty with which they are seen, considerable uncertainty must attach to their position.

Schmidt (B.)—A 7° bright crater in + 0° 56′ lat. and + 18° 35′ long., nine miles in diameter, with a perhaps still brighter peak on the south-west wall.

Dionysius (R.)—One of the most distinct points on the moon, its interior 7° bright, and its walls about 4,000 feet high and 9° bright and 13·5 miles in diameter, yet not, like most other similarly bright formations, visible on the dark side of the moon, probably from its small dimensions. This formed one of the principal points in the measurements of Mayer, who from nine separate determinations fixed its position as + 2° 55′ lat. and + 17° 17′ long., its true place from eight measures by Lohrmann being + 2° 50′ 55″ lat. and + 17° 8′ 40″ long. A very intricate system of mountains and ridges, forming in portions chains and in parts plateaus, extends on the south from Dionysius to Delambre and Theon, the two principal chains enclosing a curved irregular valley, and containing the three chief peaks δ, γ, and ϵ. North of Dionysius is β, a peak on the borders of the Mare Tranquillitatis and 2,500 feet high, and south is α, a peak 4,000 feet high. Between Dionysius and Silberschlag extends a bright plain, broken only by a few small irregularities.

Ariadæus (R.)—A 7° bright deep crater on the border of the Mare, with close to it on the N.W. a second crater of similar dimensions **a**, but of less depth, and only 5° bright, north of which again is a very shallow depression, seen only with difficulty, and beyond which rises the lofty mountain mass γ. West is a curved mass of mountains, forming with γ and the crater **a** apparently the ruins of a ring-plain, the rest of the border being in places marked by low mounds.

The great Ariadæus rill (S. 31) was discovered by Schröter in 1792, and forms one of the finest examples of its class, being so broad, deep, and long as to be easily detected even with an aperture of two inches. It commences in a broad valley in the hill regions south-east of Boscovich, and is at first wide like a narrow valley, but soon contracts, and first becomes sharp and steep at the small crater Silberschlag D, in + 7° 40′ lat. and + 9° 4′ long.; crossing this it proceeds without interruption to the mountain-chain by Silberschlag, gradually narrowing and becoming deeper and having several minute crater-pits in its bed, and just before crossing a low ridge receiving a branch of the great Hyginus rill, and a short rill from the S.W. (S. 33). On reaching each branch of the mountain chain of Silberschlag it is perceptibly narrowed, expanding again in the valleys, and after traversing the enclosed plain on the north of Silberschlag it is so contracted in passing through the western branch south of **a** as to be not easily distinguishable. Emerging into the great plain on the west, it again resumes its normal width, and proceeds without interruption as far as the mountain Ariadæus β, which it traverses as a very narrow crooked cleft, easily overlooked, and either here doubles or receives a branch from this mountain mass. Further it divides, sending a branch η (S. 32) south and communicating probably with the rill ζ, which may be considered as uniting the Ariadæus rill with the system of Ritter; the main branch proceeds in a gentle curve to the south foot of the mountain Ariadæus γ, where it disappears. On the other side of the small plateau between this mountain and the two craters, a small rill has been detected, which, passing between the two, extends on to the plain, whilst Kunowsky, Gruithuisen, and Birt have seen the Ariadæus rill prolonged far over the Mare Tranquillitatis.

Cayley (B.) [Dionysius A, M.]—A 7° bright crater-plain, 9·2 miles in diameter, and very deep according to Lohrmann, who places it in + 4° 25′ lat. and + 15° 20′ long.; but by Mädler in + 4° 0′ lat. and + 15° 2′ long. In Full it appears as a bright ring from its darker floor; though the crater on its north, B (Ariadæus B, M.) in + 5° 3′ lat. and + 14° 46′ long., is then scarcely detectable.

De Morgan (B.)—A crater about 4 miles in diameter and 5°½ bright in + 3° 10′ lat. and + 14° 44′ long., appearing in Full as a clear round spot.

Whewell (B.) [Dionysius B, M.]—A craterlet about 3 miles in diameter and 6° bright on the crest of a short mountain-arm, and distinct in Full. The last three principal formations lie on the great bright plain extending from the border of the Mare between Dionysius and Sosigenes to the mountain-chain extending from the west of Agrippa to Boscovich, which though traversed by some small ridges and mounds, especially at the north-east, is comparatively level.

Silberschlag (M.)—A fine crater, 9·2 miles in diameter, 8° to 8°½ bright, with a steep and high west wall, situated on

GODIN AND AGRIPPA.

Scale 100 inches to the Moon's Diameter

Plate 33[illegible].

SUNRISE.

the western slope of a great mountain chain, which it forms the central point of. This mountain chain is traversed by numerous valleys, and extends from Boscovich to the great peak Agrippa α, and ends on the plain by Godin; its principal peaks are Silberschlag β, 6,145 feet high, and Agrippa α. North of Silberschlag these mountains divide, and reuniting further on form an enclosed plain of small dimensions, at times appearing not unlike a ring-plain, and which is traversed by the great rill of Ariadæus. The crater **a** is 7° bright, and is tolerably conspicuous in Full, and lies at the base of the western branch of the mountain chain. Schröter applied the name Silberschlag to a level space south-east of Julius Cæsar, surrounded by low ridges; and the name was transferred by Mädler to its present position, as he with justice considered the original formation too indefinite to be worthy of a special designation.

Godin (S.)—A small but very steep and 8° bright ring-plain, somewhat square in form, and 23 miles in diameter, with a central mountain, the whole being in Full more conspicuous than Agrippa. The interior and exterior are both terraced, and the wall on the west rises 7,700 feet according to Schröter, a little too great probably; and on the floor are one or two small crater-pits. From its walls strong mountain arms extend in different directions, on the principal of which stands the bright crater A, in + 2° 41′ lat. and + 9° 37′ long., and is visible in Full; and close to it, on the south, is a small craterlet not readily seen. On the great mountain arm on the south of Godin stands *b*, a distinct crater easily seen under all illuminations; on its north-east slope is a small craterlet, whilst still further north-east, on the eastern slope, is a second crater *c* that has broken the crest of the arm. West of Godin extends a mountain arm on to the plain, culminating in the high peak α, and the branches from which enclose some rounded valleys.

Agrippa (R.)—A considerable ring-plain 27·11 miles in diameter, with very steep, terraced, 5° to 6° bright walls rising on the east 7,929 feet, and on the west 6,849 feet above the interior, which is only 4° bright, but contains a considerable 7° bright central mountain whose northern peak from nine of Lohrmann's measures is in + 4° 4′ 16″ lat. and + 10° 22′ 23″ long. Several short arms project from the walls, the principal being to the south-east; but the wall is broken by a craterlet *c* on the north, and a pass on the north close to the high peak *β*. Agrippa is surrounded by a number of small mountains and short but high ridges, particularly in the north, where they are 5°½ bright, though elsewhere usually 4°, the valleys and general surface being from 3° to 3°½ bright. East of Agrippa and Godin is a mountain region of very irregular nature, full of bright craters and craterlets, only the general appearance of the larger objects having as yet been drawn. From both Godin and Agrippa a few feeble light streaks extend towards the east, visible only with difficulty.

Rhæticus (M.)—This ring-plain is one of the few formations that can have both the sun and earth in its zenith; it is composed mainly of an oval group of intersecting mountain chains 4° to 4°½ bright, surrounding a 3°½ bright region, traversed by a cleft and two ridges, but rising at one point in a central mountain. The highest point in its wall is near *γ*, and is about 5,000 feet high, whilst close under it is a fine pass. North is the crater A, in + 1° 44′ lat. and + 5° 18′ long., and 5° bright; south-west, on an arm projecting from Rhæticus, are six or eight small craterlets, and between this arm *ζ* and the great mountain arm *η* extends a long valley. On the southern central portion of *η* are three craterlets, the most conspicuous being *b*, fully 9° bright, according to Mädler, though now nearer 8°. On the east extends a group of elevations towards Murchison, south of

GODIN AND AGRIPPA.

Scale 100 inches to the Moon's Diameter

Power 450.

UNDER MERIDIANAL ILLUMINATION.

which are two clefts, η (S. 46) and θ (S. 49); and close under the east wall of Rhæticus, Schmidt mentions two short crater-rills (S. 47, 48), whilst crossing the floor is a fifth ϕ (S. 366), in portion, according to Schmidt, crateriform. South-east is a short mountain arm λ, containing three craters in its crest, whilst at its west foot on the British Association Map is drawn a rill ψ, and close to its east a short valley containing two craterlets.

Sinus Medii (M.)—A grey Mare in the centre of the moon's visible surface, and bordered by Triesnecker, Rhæticus, Réaumur, Mosting, and Pallas, comprising an area of about 13,000 square miles; the whole having, from its peculiar tint and ill-defined border, much the resemblance of a thin cloud, in the same manner as the Mare Frigoris. Towards the centre are the two craters Triesnecker *c* and B, the first 5° and the second 7° bright, the only two formations of any dimensions, the remainder consisting of low ridges, small hills, and a few crater-like depressions, together with two 4° bright light spots.

Triesnecker (L.)—A ring-plain 14·06 miles in diameter, with a regular wall rising 5,424 feet on the east, but with a pass in the south from which extends a long valley with a 3° bright floor; the wall of Triesnecker being 6°; and the interior, 4° bright, contains a small central mountain. The surrounding surface, which is of nearly uniform tint at sunrise, appears of very diverse brightness at Full, varying from 3°½ on the east to 4°½ on the south-west, and 5° to 6° on the north. Triesnecker B and *c* are two small craters near the centre of the moon, moderately distinct in Full, when they are 7° and 5° bright respectively, whilst near the first are two faint light-patches.

West of Triesnecker is one of the most remarkable rill systems of the moon (S. 37–45), seen by Gruithuisen, Mädler, and Lohrmann, but not by Schröter: it embraces some of the most delicate rills that have been discovered. The three principal rills (β, γ, and ζ) are united at a small depression, where a branch ascends the slope of Triesnecker, two extending south down the slope towards Rhæticus; the third descends the other slope towards Hyginus, ending by the crater Hyginus *b*, and is probably united to the great rill of Hyginus by the short branch extending in this direction. The delicate rill δ seems to cross the rill γ, bend sharply to the east, and divide into three, two of which ascend the mountain slopes, and the third runs to the crater **a**, just north of which is a peculiar dark patch of surface, not above 1°½ bright, and at Full only 1° bright. Lohrmann mentions a rill east of Triesnecker that has never since been reobserved.

Ukert (M.)—A 7°½ bright crater-plain, 14·05 miles in diameter, remarkably distinct under all illuminations, and whose central mountain, from eleven measures, is in + 7° 48′ 24″ lat. and + 1° 9′ 10″ long., the position obtained by Mädler as a point of the second order being + 7° 33′ lat. and + 1° 26′ long. The surface around Ukert is much disturbed, and on the south side of the crater-plain is traversed by a magnificent valley δ (S. 50) of great depth, and over eighty miles long. Within this valley rises, near the north end, a shallow rill η, which extends in a curve up a broad valley deep into the plateau of the Apennines, nearly 100 miles long, but which from its position and slight depth is very difficult to distinguish. A second cleft ε (S. 51), seen only by Mädler, extends in a curve round the foot of the slope of the crater A in + 8° 45′ lat. and + 1° 0′ long., to the surface of the Mare Vaporum, commencing at the small crater *b* within a valley, and crossing the crater *e* on the summit of a gentle elevation. A third cleft ζ is mentioned by Schmidt (S. 52), but is more probably a narrow valley. North-west from Ukert extends a broad mountain arm, broken apparently by two old craters, whilst south, and close under the wall, within a broad valley, lies a fine craterlet, seldom visible owing to its position, and on the opposite side of Ukert is an imperfect crater.

Hyginus (R.)—A large crater-pit, 3·7 miles in diameter and tolerably deep, in + 8° 2′ lat. and + 6° 22′ long., from 6° to 7° bright according to Mädler, nearer 5° now. Mädler describes it as having a wall, which it appears certainly to possess; but Schröter, Lohrmann, and Webb could detect none, probably from its slight slope, and the rapid fading of its brightness. It is traversed by the great rill which is here bordered by raised banks, and cuts through the slight walls without contraction. South-east appears the crater Hyginus *b*, with some minute crater-pits; and south-west are two small dark spots, only $2°\frac{1}{2}$ bright. North are a number of complexly curved ridges, near β forming a double ring, and further west almost spiral in character.

The rill of Hyginus (S. 5) is of the true rills the most distinct of all, being readily seen with only two-inch aperture. It was discovered in part by Schröter in 1788, and completely in 1792. It begins at the foot of a low hill near D as a broad valley with gently sloping sides, and gradually contracts until at about ten miles from its commencement it attains its normal width, about 1,500 yards, and receives a short branch from the east γ; it then becomes deeper and steeper, passes over four small crater-pits, bends slightly, and receiving another short rill-branch (S. 36) first turns sharply and enters Hyginus, having traversed a distance of about sixty-five miles. From the east border of Hyginus extends a second short rill, which is not known for certain to be connected with the great rill, but probably is so, and may be regarded as uniting it with the system of Triesnecker. After traversing Hyginus, the great cleft extends in a curve to the foot of the highlands east of Agrippa, passing over five more crater-pits, and north of the crater Hyginus *c* it divides into two; the main branch, running south-west, gradually becomes broader and more irregular, ending at a craterlet at the foot of the north slope of Agrippa, a distance of nearly 150 miles from its commencement, whilst the minor and more delicate branch ζ (S. 34) extends west into the great rill of Ariadæus near Silberschlag D. Probably the supposed crater-pits are mere widenings of the rill, and Mädler has seen it appear throughout as if a confluent crater-row, scarcely a compatible condition with its nearly uniform sharpness and distinctness in powerful telescopes. Its brightness being nearly 8° in the steeper and narrower portion, and fully 6° towards the ends, it is visible under all illuminations, with the exception of the extreme ends, whose brightness scarcely exceeds that of the rest of the surface.

Mare Vaporum (R.)—Though lying so near the centre of the moon and of a general dark tint, this Mare possesses no definite border, but gradually merges into the more irregular and brighter surrounding regions, and varies in brightness from 2° near the Apennines to $3°\frac{1}{2}$ on the south-west. Throughout the whole surface extend numerous ridges, with a general direction from north-east to south-west, and these ridges being in Full brighter than the surface, are the principal reason of the great increase in brightness of the south-west portion, where they are most numerous. The highest peak on these ridges is δ, in $+ 10° 15'$ lat. and $+ 6° 0'$ long., rising 2,880 feet above the plain; the peak at β is one of the brightest, and the ridge γ the most distinct. Most of the ridges, especially towards Boscovich, are very low, seldom rising above 200 feet high, but all retaining the general south-west direction characteristic of this region. Close to Hyginus *c* is an oval dark patch of somewhat variable brightness, *z*, the two extremes being $3°\frac{1}{4}$ and $2°\frac{1}{4}$.

Manilius (R.)—A fine ring-plain, 25·50 miles in diameter, with an 8° bright wall rising on the east 7,705 feet, and on the west 7,501 feet above the 4° bright interior, which contains a 5° bright central mountain A^1, the same brightness being possessed by the terraces and short projecting arms; a small portion of the southward wall, however, being only 7° bright and pierced by a narrow pass, whilst on its summit are three minute craterlets. The central peak A^1 is one of the standard points on the moon, the position having been determined with very considerable exactness by the result of 174 measures by Bouvard and Nicollet, and found to be + 14° 26′ 54″ lat. and + 8° 46′ 56″ long. Owing to its brightness Manilius is readily detected on the dark side of the moon under favourable conditions, and under any illumination is a very conspicuous formation, and well adapted to serve as a standard point of reference for lunar measures. The surrounding regions are full of numerous low ridges rising in points into peaks of very considerable altitude, as the mountain A, which is 5,582 feet in height, and the 5° bright, tolerably steep peak β, rising 2,015 feet; but the two peaks δ and γ are only about 1,000 feet high, and most of the rest in these regions are still more inconsiderable. The two craters C in + 12° 2′ lat. and + 10° 2′ long., and D in + 13° 4′ lat. and + 6° 39′ long., are 5° bright, whilst A in + 17° 31′ lat. and + 8° 51′ long., is a not very conspicuous crater at the south slope of the Hæmus Mountains, near a steep line of cliffs. From Manilius extend some scarcely perceptible short streaks, the most conspicuous extending straight to the peak γ, whence bending back it extends to the foot of the Apennines near the crater *f*.

In the far east is a delicate rill θ (S. 53), and nearer is the short rill ζ (S. 54), whilst south, in about + 12° 40′ lat. and + 8° 30′ long., is a third (S. 55); there is a fourth (S. 56), whose position is uncertain, as, said to be west, its co-ordinates place it north; these were all discovered by Schmidt.

Boscovich (M.)—An irregular depressed plain with low and imperfect walls mostly 5° bright; the peak A in + 9° 7′ lat. and + 10° 35′ long., and the craterlet **a** are 6° bright, the south-east third of the interior, which is raised above the rest, 3°½, and the rest of the floor only 1°¼ bright; but while the darker portion of the floor is remarkably constant in tint, the south-east portion has been found by Birt to vary from 3°¾ to 2°½, the brightness decreasing as the solar altitude increases. Between Boscovich and Julius Cæsar extends a mountainous region of 5°½ brightness, the principal peak being on the arm β, whilst between the two formations runs a long valley ζ. This is not the object to which Schröter gave the name, which was a dark spot south of the peak Manilius A, but the dark plain to which Lohrmann transferred the name.

Julius Cæsar (R.)—An extensive but irregular walled-plain, with a dark interior of not uniform tint, sloping towards the north. The walls are generally 5° to 5°½ bright, and the floor varies from 3° at the south to only 1°½ at the north, but Mädler estimated it as low as 1°; the tint of the southern portion is a pure grey, and the northern a dark grey with a tinge of brown. The border on the east is in portions steep, the wall rising in high peaks, β being 5,415 feet above the interior, and α 4,773 feet above the exterior surface. North of the last is a short rill (S. 57), whilst near β stands a small craterlet from which extends a tolerably steep chain of mountains to Manilius A, the highest peak in this region being, however, the isolated point E. On the south, Julius Cæsar is bordered by a bright plateau, and west by a narrower one, with a few low peaks; whilst the northern wall is entirely broken up by a number of dark valleys extending north-east. Of these valleys the principal extends to the peak δ, and is about 2° bright. The western of these valleys extend along the north-west of Julius Cæsar, and are bordered by high ranges fully 5°½ bright, whilst the floors of the valleys are only 2°½, and within them Schmidt mentions two rills of unstated character (S. 58 and 59).

Sosigenes (R.)—A regular ring-plain 13·8 miles in diameter, on the border of the Mare Tranquillitatis, of only moderate depth, the walls and central mountain 5° bright, and the interior 4° bright. South-west is the small 4° bright crater **a**, and north-west the 5° bright peak *α*, whilst west, from a small crater-pit, extend two delicate rills towards Arago, only seen by Mädler, the northern being S. 27, and the southern S. 26. East of this crater-pit, from near Ross *c* to near Ariadæus δ, extends a very delicate rill (S. 30) very difficult to see ; whilst east again of this, south of Sosigenes **a**, a pair of short, very delicate rills cross each other, but the exact position of all these must be regarded as doubtful.

Arago (M.)—A fine ring-plain 18½ miles in diameter, with a 5° bright wall rising in the west, 5,352 feet above the interior, on which stands a central mountain in + 6° 7′ lat. and + 21° 13′ long., united to the wall by a ridge. West are some ridges in places rising to some height, and a few crater-pits, whilst south-east is a low plateau rising into a peak on one side.

Manners (B.) [Arago A, M.]—A small ring-plain, 11·5 miles in diameter, with a small central mountain in + 4° 35′ lat. and + 20° 0′ long., and with 6° bright walls, containing two peaks on the west and a higher one on the south, but an only 5° bright interior, whilst between it and Arago is a faint white shimmer. On the Mare on the north-east extends a short rill η (S. 25), only detectable with considerable trouble.

Maclear (Lee). [Ross A, M.]—A small ring-plain, 16·1 miles in diameter, with tolerably high and steep yet only 5° bright walls, rising 2,827 feet above the outer surface on the west, and not much more above the 2°½ bright interior, on which stands a feeble central mountain in + 11° 44′ lat. and 19° 52′ long.

Ross (M.)—A ring-plain, 16·13 miles in diameter, not entirely circular, nor the walls throughout of equal height, there being two slight breaks on south and east, and a depression on the south-west, but uniformly 6° bright; the interior is 4°, and the central mountain, whose position is + 11° 35′ lat. and + 21° 32′ long., 5° bright. Around it are many ridges, and east two craters, B (M. *b*), 4° bright, and in + 11° 10′ lat. and + 20° 5′ long., and *c*, 5° bright. South-west are three long parallel ridges and several crater-pits, and north-east is θ, a narrow short rill (S. 62) discovered by Schmidt.

Jansen (M.)—A ring-plain, with a wall moderately high on the west, but low and perhaps imperfect in the east, with a 2°½ bright interior but slightly depressed, and only a portion of the walls even 3°½ bright. On the south it is united to a massive mountain, much branched; and on the western arm of this rises the peculiar and steep peak γ, west of which is a very lofty peak α, erroneously given on the 'Mappa Selenographica' as a crater. The eastern arm of this mountain extends south, and unites with a great curved range of mountains rising at the peak β 4,500 feet, and ending at the ring-plain B in + 10° 36′ lat. and + 27° 16′ long., remarkable from its triangular form, and easily recognised from its brightness, being 6° bright. West of this are the two 4° bright craters, Jansen C in + 8° 51′ lat. and + 29° 1′ long., and *e*, both sharp and distinct near the terminator, but more difficult to detect in Full; and in the same region are a number of 4° bright crater-pits, seen without trouble in Full from the darkness of the Mare, here only 2° bright, whilst Mädler mentions a dark streak here, whose centre is in + 33° long. and + 10° lat., extending in a N.E.–S.W. direction, west of C and *e*.

Vitruvius (R.)—A regular distinct ring-plain, 18·76 miles in diameter, with a wall varying from 7° to 8° bright, rising on the east 4,502 feet above the only 2° bright floor, and nearly the same above the plain, but on the west scarcely at all higher than the great mountain plateau that borders it. From twelve measures Lohrmann fixed the position of the central mountain as + 17° 35′ 42″ lat. and + 31° 2′ 39″ long. The environs of Vitruvius are, from their colour and brightness, one of the most remarkable portions of the moon, some of the more elevated mountains appearing as if snow-covered, whilst others have most marked variation in brightness, a single plateau varying in different points from barely 3° to over 6°, whilst the great mass of highlands west of Vitruvius possesses some very lofty, not measurable peaks. The ring-plain A, in + 17° 38′ lat. and + 33° 24′ long., is of considerable steepness, and 6° bright, with a small central mountain, whilst still further east is a second ring-plain nearly equal in size, but with only the slightest depth, forming a remarkable contrast. South of A extends an arm of the highlands of Vitruvius, descending steeply in the east to the Mare Tranquillitatis, but gently on the west, and containing a number of craters or rounded depressions, the principal being *b* and *c*, whilst west of this is a very extensive walled plain *d*, scarcely visible owing to its low and gently sloping walls, with 4° bright walls, 2° bright interior slopes, and 3° bright centre.

Mount Argæus (Webb).—A great mountain mass in + 19° 25′ lat. and + 28° 10′ long., rising at its north end in a peak 8,377 feet above the surface, gradually sinking and widening as it approaches the south, where at its southern foot are a small ring-plain, very shallow and scarcely visible, and a 6° bright deep crater distinct in Full.

Dawes (B.) [Plinius A, M.]—A circular deep ring-plain, 13·8 miles in diameter, in + 17° 0′ lat. and + 25° 58′ long., with a wall 8° bright on the west, and 6° bright on the east, where it rises 2,168 feet above the Mare, whilst its 4°½ bright interior contains a 5° bright central mountain. Dawes is surrounded by a considerable 3°½ bright spot of pure grey tint. North of Dawes is a short rill (S. 66) difficult to see, and west of this a still shorter crater-rill (S. 67), whilst from the north to Littrow extends a fine θ, slightly curved, and passing close under the foot of Mount Argæus (S. 68).

Plinius (R.)—The largest and most distinct ring-plain of this region, 32 miles in diameter, with a 3° bright interior full of small 4° to 6° bright irregularities, and two central mountains, the principal 7° and the southern 5° bright; and with a 5° bright wall rising at the peak α, 6,392 feet above the interior, and much terraced and buttressed. Though the wall and peaks, especially α, β, and γ, rise very considerably above the interior, they are not much elevated above the exterior surface. Plinius is surrounded by a surface broken by numerous ridges, mounds, and hills, forming the western extremity of the Hæmus Mountains, the principal elevations being two 9° bright mountain peaks, Plinius ζ and η, north-west of Taquet A. From 10 measures by Lohrmann, the bright central mountain of Plinius is in + 15° 17′ 20″ lat. and + 23° 23′ 28″ long. North of Plinius are the two rills δ (S. 63) and ε (S. 65), the former 83 miles long, uniting with the last, which is slightly longer, near a mountain west of Taquet B, whilst between the two is a third, ζ, difficult to see (S. 64).

Promontorium Acherusia (H.)—A fine projecting cape rising into a lofty 6° bright peak, 4,835 feet above the plain, in + 11° 27′ lat. and + 21° 34′ long., forming the extreme western extremity of the Hæmus Mountains; whilst from its point across to the opposite Mount Argæus extends a marked but gentle slope in the plain, indicating that the Mare Serenitatis is lower than the Mare Tranquillitatis. On the north slope of the promontory is a row of four deep craterlets, whilst at its south foot extend the two rills of Plinius.

Taquet (S.)—A small 6° to 7° bright crater of moderate depth, in + 16° 29′ lat. and + 18° 56′ long., on the crest of a gentle slope from the base of the Hæmus Mountains to the Mare Serenitatis, and the principal origin of the ridge system of the Mare. Taquet B is a peak on the north edge of the Hæmus, rising 3,200 feet high, and with a small crater on each side, *c* on the west and B on the east, drawn too small by Mädler; and the last having a second small crater on its north slope. Taquet A is an 8° bright conspicuous crater in + 14° 17′ lat. and + 20° 30′ long., with an only 2° bright interior. From the north of Taquet extends a fine curved ridge to *e*, a 5° bright crater on the Mare Serenitatis. East of Taquet, on the surface, are a number of small round white spots in Full.

Menelaus (S.)—A considerable and brilliant ring-plain whose 5° bright central mountain has been ascertained to be from eleven measures in + 16° 24′ 17″ lat. and + 15° 31′ 2″ long.; Mädler's result as a point of the second order being + 16° 13′ lat. and + 15° 46′ long. The wall is broad and steep, rising on the west 6,567 feet above the 3° bright interior, and 9° bright, whilst on the east it is 8° bright. Menelaus is situated on a bright streak, very distinct when crossing the Mare Serenitatis, but scarcely perceptible when passing through the bright region on the south, and which extends probably from Tycho as far as the limb beyond Thales. South-west is a considerable shallow, nearly quadrangular depression, *b*, with a 2° bright floor, 5° bright borders, and on the north-west an 8° bright peak *α*. Further south is the 6° bright peak A, in + 13° 26′ lat. and + 16° 37′ long., on the south border of the Hæmus, and from it extend some peaks to a mountain mass, rising in a 7° bright peak at B, and a 5°½ peak at *δ*. Menelaus *ε* is a high peak on the Hæmus, rising 6,120 feet above the Mare. The crater Menelaus *c* is 6° bright with a very low wall, within a depression, with two equally bright peaks on its east; whilst further north-east is the 5° bright crater A in + 17° 19′ lat. and + 13° 8′ long., north of which is the 7° bright crater B, and a 6° bright peak *γ*. In the Mare north of Menelaus, Schmidt mentions two rills, *ζ* (S. 126) visible with difficulty, and *θ* (S. 127), probably a crater-rill.

The Hæmus Mountains (M.)—A great and bright range of mountains extending from the Prom. Acherusia to the Apennines near Aratus, and from its general brilliancy forming a strong contrast to the Mare Serenitatis. At its western extremity the principal peak is Taquet Γ, 8,767 feet high, and east of this it widens out into a broad plateau traversed by numerous mountain-ridges and rising at places into lofty peaks. After passing Menelaus the Hæmus highlands gradually contract, but still with a chain of high mountains on the north towards the Mare Serenitatis as far as the crater Menelaus B, where it is broken by three valleys and is very low; it again widens into a broad highland north of Sulpicius Gallus, and terminates at the south-western foot of the great Apennine plateau. A number of the peaks on this range are between 4,000 and 6,000 feet in height, and from 6° to 8° bright, and in two or three points 9° bright.

Sulpicius Gallus (R.)—An 8° bright and deep crater, in + 19° 29′ lat. and + 11° 18′ long., on the border of the Hæmus Mountains, which here widen out into a broad 4° bright plateau, whose principal peaks *β* and *α* are tolerably high, and on which are a number of craters and craterlets. Around Sulpicius Gallus, in Full, appear a number of bright spots, and some still more brilliant, very minute points, possibly crater-cones, for Dawes mentions having seen some very small distinct black spots here under low illumination. On the north-east, from close to Sulpicius, extends a fine rill ε (S. 104), in a broad valley as far as some mountains at the foot of the Hæmus. South-east of Sulpicius Gallus is another rill η (S. 105), seldom visible, and whose place is somewhat uncertain; and north of the western end of this, Schmidt mentions four very short curved rills of slight depth (S. 106–109).

CHAPTER IX.

MAP III.

Aratus (R.)—The most distinct of all this region at Full, being an 8° bright crater 6·9 miles in diameter, in + 23° 20′ lat. and + 4° 27′ long., near the centre of the great northern plateau of the Apennine highlands. From it extend towards the south and north strong mountain arms, whilst it is environed by exceedingly lofty peaks, α, in + 24° 10′ lat. and + 4° 30′ long., rising 10,404 feet, and β, in + 25° 25′ lat. and + 6° 25′ long., 14,320 feet in height. Close to this last are some regular craters, **a** being very bright, and the whole region is covered with ridges, hills, and other irregularities, the western border of this region being marked by the two 6° bright craters *c* and *d*. The depression *b* is probably the original Sulpicius Gallus of Riccioli, and 7° bright.

Mount Hadley (S.)—The northern cape of the Apennines, a long 7° bright point, rising 15,143 feet above the plain; whilst from its north foot a short mountain ridge connects it with the nearly isolated peak β in + 27° 25′ lat. and + 5° 30′ long., 8,530 feet above its western foot, and forming the extreme northern point of the Apennines. West of Hadley the great highlands of the Apennines extend in an irregular elevated region, and culminate in the lofty peak Γ in + 26° 7′ lat. and + 7° 7′ long., one of the highest and brightest peaks in this neighbourhood. North extends a broad arm of the Mare Serenitatis into the Palus Putredinis, and through this is united to the Mare

Map III.


West Longitude
North Latitude
Maraldi
Littrow
Mt. Argaeus
Romer
Le Monnier
Chacornac
Bond
Posidonius
Daniell
Lacus Somniorum
Maury
Cepheus
Groves
Oersted
Mason
Plana
Bessel
Sulpicius Gallus
Mare Serenitatis
Linne
Aratus
Conon
Mt. Bradley
Mt. Hadley
Palus Putredinus
Autolycus
Aristillus
Mountains
Caucasus
Calippus
Alexander
Theaetetus
Palus Nebularum
Cassini
Piton

Imbrium and great Oceanus Procellarum. East of Mount Hadley is an imperfect ring *c*, and close south-east of this Schmidt has seen four very delicate rills (S. 110–113), extending from north to south; and still further west, in + 3° long., three still lighter ones, extending meridionally, and crossed by a fourth (S. 114–117). Further south, near δ, a peak 12,500 feet high according to Schröter, in the hilly region here are four more slight rills extending south-east (S. 118–121); and south-east, west of Bradley A, are three others (S. 122–124). The position of these is uncertain, and some may prove to be narrow valleys.

Conon (R.)—A circular crater, 10·19 miles in diameter, and 6° bright, on the high Apennine plateau, from five measures by Lohrmann in + 21° 31′ 27″ lat. and + 1° 57′ 18″ long. Its depth is considerable, according to Schröter being 3,450 feet, and it contains a slight central mountain, discovered by Mädler, overlooked by both Schröter and Lohrmann. Close on the south lies a second but much shallower crater, the two being connected by a short mountain arm; and close to the two a long, fine valley winds from the Mare Vaporum. On the south extends a great mountain chain to the south border of the Apennine highlands, rising at its highest in the peak B, and brightest at the much lower mountain A, in + 20° 25′ lat. and + 3° 10′ long.

Mount Bradley (S.)—A high cape, rising, according to two measures by Mädler, 13,371 or 13,620 feet above the Mare Imbrium, whilst Schröter made it from two measures very close to 16,000 feet; the peak β is probably still higher, whilst the peak A is 7° bright, 16,000 feet high, according to Schröter, and in + 23° 33′ lat. and + 1° 40′ long. From Bradley to Huygens the Apennines are at their highest, and form a vast elevated highland, bordered by a stupendous mountain chain.

Western Apennines (H.)—This range of mountains, perhaps the greatest in the visible hemisphere of the moon, extends for 184 miles from north to south, and 166 miles from east to west, unbroken by great valleys, and with a very considerable general elevation above the Mare Imbrium. The western portion may be considered as extending from Sulpicius ε in a great concave sloping plateau to Hadley Γ, the whole sinking softly to the Mare Serenitatis, broken by broad gentle valleys and extensive depressions on the north-west, but steeper and more connected in the south-east, where the crest extends. The principal peaks here are Sulpicius ε and Sulpicius Δ, in + 21° 12′ lat. and + 9° 30′ long., the last rising 7,993 feet above the plain; whilst the average height of the plateau above the Mare Serenitatis is perhaps 6,500 feet. Towards the south-west the plateau is penetrated by a deep, only 2° bright bay of the Mare Vaporum, with on its border the peak Sulpicius η, north-east of which a number of bright valleys open into it, and end near the 6° bright crater Aratus a.

Towards the north the Apennines culminate in the high peak Hadley, and terminate at the lofty peak β, and on this portion of the Apennines are several bright craters, Aratus being the most conspicuous; and there are several small craterlets; these are, however, difficult to detect in these regions, being under high illumination masked by the brightness of the surface, and in low illumination hidden by the shadows. From Aratus to Manilius B, in + 16° 37′ lat. and + 7° 5′ long., extends a range of considerable heights, enclosing a broad bay E, equal in brightness to the plateau of the Apennines. This bay is much higher than the Mare Vaporum, from which it is divided by mountains, and with which it communicates by steeply sloping valleys close to the high peak Manilius ζ. Between Hadley and Bradley A the north border of the Apennines is formed by a great curved mass of cliffs and high peaks, from the foot of which numerous ridges and spurs project on to the plain, and the surface gradually slopes down to the Palus Putredinis; and in a wide zone along the foot of the mountain extends an irregular hilly region, traversed by valleys in all directions, and full of low peaks, which near Bradley A attain some size.

Autolycus (R.)—A circular ring-plain, 23·00 miles in diameter, and of considerable depth, rising on the east 9,017 feet, and on the west 8,358 feet above the interior, whilst at ϵ it is only 4,777 feet above the Palus Putredinis. The central mountain is low and only 3° bright, the floor is level and 2°½ bright, whilst the walls are broad, regular, and 5° bright, containing many peaks, the highest being Δ. On all sides from Autolycus radiate hill chains and short ridges on to the plains, and in Full a few faint light-streaks can be detected. South are some considerable mountains, the highest being A in + 29° 3′ lat. and + 0° 22′ long., and further the peak β forms the principal point in a steep chain; whilst west is γ, a peculiar cross-formed mass; only these three, however, being visible in Full, and Mädler could not detect either of the first two. Beyond these mountains, towards the border of the hilly region north of the Apennines, is a cleft η (S. 125), but Schmidt has described its place wrongly.

Aristillus (R.)—A fine ring-plain, 34·35 miles in diameter, from its size, depth, and favourable position one of the most distinct formations on the entire moon, and whose fine and many peaked central mountain, from ten measures by Lohrmann, is in + 33° 45′ 27″ lat. and + 1° 0′ 42″ long. The west wall rises 8,837 feet above the floor, and 5,065 above the Palus; and the still steeper eastern wall, at α 11,152 feet above the interior, which is only 3° bright, the wall being 4° to 4°½ on the lower north and south portion, and 5° bright on the east and west, whilst the central mountain and two spots on the floor are 4°. In all directions hill chains and ridges radiate from its walls to a considerable distance over the plain, being of very unequal length and $3°\frac{1}{2}$ bright; whilst in Full, Aristillus is seen as the centre of a fine system of short light-streaks $4°\frac{1}{2}$ to 5° bright, and extending over the entire surrounding surface, reaching as far as the Apennines, Alps, Caucasus, and mountains of Kirch, but most numerous towards the north, west, and east.

Palus Putredinis (R.)—A plain between Aristillus and the Caucasus and Apennine mountains, without any marked natural boundary on the east, the boundary being supposed to be a line from Cape Bradley to Archimedes, and the mountains near Kirch. The surface is about $3°\frac{1}{2}$ bright where not traversed by the streaks, nor occupied by the ridges and mountains, which are here usually 4° bright. Between the Palus Putredinis and the Mare Serenitatis, Birt has observed a step or slope extending right across from the northern point of the Apennines to the southern extremity of the Caucasus, and indicating that the Palus lies lower than the Mare. Mädler draws here a ridge, and it is probable that this step may arise from the slope on the surface, due to the Apennines being continued past the peak β towards the Caucasus which end at ψ, a low peak about 2,000 feet high.

Theætetus (R.)—A small but distinct and deep ring-plain, only perhaps for five days entirely shadow-free, owing to the steepness and height of its wall, which rises on the west 7,468 feet above the floor, and at α still higher, whilst on the east it is about 2,500 feet above the Palus. The peak α is 7° bright, the rest of the wall $6°\frac{1}{2}$, except on the south, where it is only 6° bright, and from its walls project several ridges over the plain, whilst it is united by a double ridge, perhaps nowhere more than 100 feet high, with Aristillus. Close to it is a 5° bright peak β, fairly distinct and moderately high. From this to near Calippus γ extends a broad curved rill θ (S. 102); and south-west at the foot of the Caucasus extends another rill η (S. 103) difficult to see, and interrupted in places, whose exact position is still uncertain. Schröter draws a central mountain to Theætetus.

Cassini (S.)—A very peculiar ring-plain absent from the lunar maps of both Hevelius and Riccioli, and first drawn by Dominic Cassini; it was believed therefore by Schröter to have probably arisen since the date of their observations, as he considered it little inferior in distinctness to either Autolycus or Aristillus drawn by them both. This has been regarded by Mädler as an instance where Schröter's desire to detect changes led him into conjectures, based on very insufficient grounds, and Mädler considered the classifying of Cassini as equally distinct as Autolycus and Aristillus to be unwarranted; he pointed out that Cassini's wall is narrow, and at its maximum only some 4,000 feet in height, whilst Autolycus is 9,000, and Aristillus 11,000 feet above their interior, and that consequently at the quarters, the most favourable period, the latter must be much the more distinct. Mädler considered therefore that, though of large dimensions, Cassini from its slight shadow might have been easily overlooked by Hevel and Riccioli, and that no foundation existed for Schröter's belief that it might have probably arisen since the epoch of the charts of the moon of those observers.

Though Mädler's conclusions are just, it is still strange that a ring-plain like Cassini, which though inferior in distinctness to Autolycus and Aristillus, is certainly sufficiently conspicuous, should be overlooked by Hevel and Riccioli, who saw many formations in this neighbourhood much inferior to it in visibility; but it is possible that the real origin of its omission is to be found in the very confused manner in which both these selenographers have drawn this region.

Cassini is a ring-plain thirty-six miles in diameter, with a narrow wall rising on the north-west 4,368 feet above the interior, and 4,131 feet above the outer surface, becoming lower towards the south, and in the east only 1,500 feet high. The wall of Cassini is only 4° bright and the floor $3^\circ\frac{1}{2}$ bright, and it is not visible in Full, whilst from its walls only a few ridges project on to the plain, the principal being a straight wall twenty-eight miles long projecting from the south-east wall. The most conspicuous object in Cassini is the small ring-plain A, nine miles in diameter, and 6° bright on the north and west, and 4° on the south and east, with a 3° bright interior, containing a central peak, which from ten measures Mädler finds to be in + 40° 22′ 44″ lat. and + 4° 8′ 55″ long., whilst Schröter makes its depth 2,600 feet. On the south-east of the floor is the 5° bright crater *b*, this with the north-west portion of the wall of A being alone visible in Full, and marking out the situation of Cassini; whilst close under the south wall of A is a small depression, on the south-east wall of Cassini another, and on the outer slope of the north wall a small craterlet; there being finally a small mountain on the interior, on the west of A. Toward Eudoxes are the mountain α and β, the former 6° bright with a 7° bright lofty peak rising steeply 7,379 feet above the surface; and the latter also 6° bright, but only some 4,000 feet high. North of Cassini are two lofty masses ϵ and δ, the former 4° bright and 5,000 feet high, the latter 5° bright and nearly 6,000 feet high.

Palus Nebularum (R.)—A level plain without any natural boundary on the south and east, the border being an imaginary line from Theætetus to Aristillus, thence to the mountain of Kirch, and finally to Cassini η. In tint this is darker than the Palus Putredinis, varying from $3^\circ\frac{1}{2}$ on the north of Cassini to 3° on the south, and it is tolerably level, being interrupted by only a few ridges and hills, mostly only from 50 to 100 feet in height.

Calippus (R.)—A fine ring-plain, 17·47 miles in diameter, in the centre of the Caucasian highlands, above which the 6° to 7° bright wall rises 3,000 feet, and on the west is elevated 7,705 feet above the 4° bright interior, though the steepness is much over-estimated by Mädler, who thought it 50° to 60°. Schröter considered Calippus to possess a slight central mountain, but Mädler does not draw or mention one, and if existing it must be very small. Calippus **a** is a ring-plain of little depth and steepness, on the border of the Caucasus mountains, and south of it is η, a mountain-ring on the east 7° bright, whilst still further south are θ and I, two 7° bright mountain depressions. Craters are here few in number, and probably, Mädler thought, owing to their being small and lost in the mountains. Around Calippus are a number of very lofty peaks, the principal points in the great Caucasian highlands. The mountain B is 8° bright, and rises 13,262 feet above the Palus Nebularum; the 6° bright peak α towers 18,563 feet above the plain beneath, whilst all along the east border rise lofty peaks, χ being 7° bright and over 10,000 feet high; ζ, 6,497 feet above a valley on the west, and probably fully as high as χ; and, according to Schröter, the peak θ rises 6,000 feet, a peak near ϕ over 5,500 feet, and the point ω over 11,000 feet, though Mädler makes this only 8,716 feet. Towards the west rise the two 6° bright peaks, Calippus λ, 11,829 feet, and δ, 11,782 feet above the plain, whilst the great mountain mass λ, forming the eastern apex of a chain of mountains, bordering a deep depression, is 6° bright and 6,923 feet high; the northern branch of this chain rising at μ 3,875 feet, and ending at the 6° bright peak Calippus ε, which is 4,700 feet above the depression. On the north border of the Mare Serenitatis rises the isolated peak Calippus k, 3,818 feet in height. North of Calippus is a short rill (S. 100) on the open plain, and between Calippus α and Cassini γ a second (S. 101) difficult to see; both discovered by Schmidt.

Caucasus Mountains (M.)—This great mountain mass is not very long but comparatively broad, consisting, like the principal great ranges of the moon, of a lofty mass of highlands bordered by chains of great mountain peaks that in some places are not inferior in height to the Apennines, and only surpassed, perhaps, by the stupendous Doerfel and Leibnitz ranges seen on the limb. The main mass of the Caucasus extends from the peak Calippus $\varkappa$ to Calippus I on the west, and thence to Calippus ε on the north; outlying masses extending as far as Cassini α on the north, and Theætetus ψ on the south. West of Calippus ε and k extends towards the Lacus Somniorum a low broad plateau, or hill-land, elevated perhaps from one to two thousand feet above the Mare Serenitatis, and covered with hills, mounds, and low peaks, seldom exceeding two thousand feet in height.

The main Caucasian highland is elevated very considerably, and extends from + 32° to + 41° lat. and + 7° to + 15°½ long., covering an area of about 9,600 square miles, whose highest peaks are on the east and north-west. The general brightness of the highlands is about 4°, the peaks and higher points 5°, the mountain ranges between 5° and 7°, the principal being Calippus θ and the west rim of η, which are 7° bright, the mountain β 8°, ω 6° bright, and the chain on which rises β 7° bright; whilst the high points on the chain from Calippus γ to Calippus ε are all 6° bright.

The mountains are highest on the east, but are much broken by valleys and ravines, and the general level of the highlands, though high, is very irregular. The outlying peak, Theætetus ψ, is 5,500 feet high (Schröter), but the first important mountain is Theætetus ε in + 31° 40′ lat. and + 6° 50′ long., whose height is 9,130 feet, whilst the peaks on the east border of the main mass culminate in Calippus α, which is nearly 19,000 feet high. Towards the west the mountains are lower, but north-west they rise again in points to nearly 12,000 feet high, and north-east at Cassini α to about 8,000 feet.

Alexander (B.)—A great irregular depression at the west foot of the Caucasian plateau and lower than the surrounding hill-lands, but higher than the Mare Serenitatis. The south-east portion is 3° bright and the north-west 3°½ bright, and covered with low hills, whilst a number of valleys communicate with the summits of the surrounding elevated regions. At α is a pair of tolerably elevated peaks 5° bright.

Linné (M.)—This formation was originally drawn by Riccioli as a small crater on the east part of the Mare Serenitatis, and was described by Lohrmann as the second crater on the plain, near a ridge beginning at Sulpicius Gallus, with a diameter of somewhat more than 4½ miles, very deep, and as visible under every illumination; whilst, according to Mädler, it was a 6° bright deep crater 6·4 miles, very distinct in oblique illumination, though its edge was not sharply defined in Full. Lohrmann measured it once, and Mädler seven times, deducing + 27° 47′ 13″ lat. and + 11° 32′ 28″ long. In 1866 Schmidt was entirely unable to detect any appearance of Linné as a crater, and announced that it had disappeared, a statement that at once attracted the attention of astronomers; and described the appearance of Linné according to his older observations, as a crater about seven miles in diameter, and at least 1,000 feet deep. In eleven drawings, made between 1840 and 1843, Linné is drawn as a crater in 8° and absent in 3°.

In 1867 and 1868 numerous observations of Linné were made: at first all that was detected was a white spot about the same size as the Linné of Lohrmann and Mädler, and about 5°½ bright; shortly after, Schmidt observed a mountain in the centre of the white spot, and on the 12th January, Knott, Buckingham, and Key detected a very shallow circular depression within the white spot, and about six miles in diameter; whilst next month Secchi detected a minute craterlet scarcely half a mile in diameter within the white spot. Afterwards, during 1867, the flat shallow depression was seen by several observers when Linné was near the terminator, and still more frequently the minute craterlet, which was estimated by Buckingham, Dawes, D'Arrest, and Schjellerup to be not greater than a mile and a half in diameter; and later, Huggins by a measure found its diameter to be nearly two miles: and still later, Buckingham made the exterior of the crater under three miles, and the interior under one. During 1868 more observations were obtained, and the formation appeared to retain a nearly fixed appearance, and to consist of a shallow crater-like depression, about seven miles in diameter at its base, and three miles in diameter from summit to summit of its walls, with a depth not exceeding 500 feet, and a small central aperture in the floor under half a mile in diameter, the whole shortly after sunrise taking the appearance of a white spot about 5° bright and eight miles in diameter. East of this white spot, Birt has detected on one of Rutherford's photograms a minute crater-cone with a small mountain peak very close to it on the east, and these two objects, so close to the site of Linné, he thinks may have at times during 1867–1868 been confused with Linné itself, and thus explain some of the various discrepancies between different observations during that period; and it is possible that the small cone may be within the ring of Linné, in which case it would not occupy the centre of the white spot.

Immediately it was supposed that Linné had disappeared reference was made to the 'Selenotopographische Fragmente' to ascertain what Schröter's observations indicated, and it was found that on two occasions he had drawn the Mare Serenitatis; once on November 5, 1788, when the terminator was near Autolycus; and again in 1796, on March 15, slightly earlier. In the latter drawing, the surface by Linné is not shown, and in the former, near the position that is occupied by Linné, appear three objects—a white spot on a ridge *v*, a dark-grey spot of large area on the same ridge *g*, and a white spot *y* on another ridge further east. Schmidt considered the white spot *v* to be Linné, and this view, strongly urged by Huggins, has been generally accepted, and certainly appears the most probable on glancing at the drawing of Schröter. Birt from a critical examination of the drawing, and comparing with photograms and actual observation, considers that this white spot *v* does not represent Linné, but that this last is the dark-grey depression *g*, for the following reasons. That Linné lies on the straight line drawn from the centre of Plinius through Bessel, or cannot depart far from this, and in Schröter's drawing this line falls on *g*, and a good distance north of *v*, while Bessel and all the spots towards the centre and south-west are properly placed on Schröter's sketch. Again, Schröter gives a ridge extending from *g* towards the west, which exactly corresponds to what occurs with Linné; and moreover there exists south of Linné, a white spot corresponding to Schröter's *v*, and placed exactly where it should be were *g* in reality Linné; whilst finally, if *g* be not Linné, then on the drawing appears a marked object of strongly defined character that has entirely vanished from the moon. This is a matter of considerable importance, for, from some cause, during the period of Schröter's observation, the surface of the Mare Serenitatis appears to have been badly defined, a circumstance that has often been noticed with regard to this plain, and though Schröter has not referred to this want of sharpness, it is strongly indicated in the details given by him of the appearance of the different formations he saw.

In especial Schröter mentions the existence of two grey spots on the Mare Serenitatis; one, *f*, he describes as a slightly elevated mound, and the other, *r*, as a 'very remarkable, scarcely perceptible depression,' within which was a bright very small central height; and he further declares *g* to be a very dark undefinably bordered spot 'very near' the terminator, and only 'indistinctly to be seen,' but probably a similar depression to *r*. Now, Schröter's *f* is in reality the very distinct small crater Bessel *d*, and was so seen by him later, on March 15, 1796; and his *r*, the still more distinct crater Bessel *m*; if therefore from the conditions under which the observations were made these appeared so indistinct as not to be recognisable as such, it is very probable that the dark spot *g* so near the terminator as to be only indistinctly seen may have been the crater Linné. Birt's view of the identity of *g* and Linné, and of *v* with the small white spot known to exist south of it, merits consideration, for if this be correct the weight laid upon Schröter's drawings, as showing that in his time Linné presented the same appearance as now, rests on a misconception, and with the correction of this, the entire fabric constructed to demonstrate the absence of any change in Linné crumbles into ruin.

In any case, too much reliance has been placed upon the drawing by Schröter; for though fairly accurate towards the centre it is imperfect towards the edge—a fault, as pointed out by Mädler, common to all of Schröter's sketches: and by direct comparison with the moon this appears very marked, it being especially faulty towards the north-east, where Linné is. The ridge drawn by Schröter as passing through his spots *v* and *g*, passes, it is true, through Birt's spot that he identifies with *v*, but fully a whole degree west of Linné, and bends directly towards the north-west opposite it. And it is remarkable that Schröter, when comparing this drawing with his later observations, should in no case include this region of the moon. If *g* be not Linné, it is difficult to understand what object it could have been; not the dark triangular patch, fully $2°\frac{1}{2}$ bright, close to Linné *c*, and three degrees from the ridge, for this is too far north, and too considerable. As it would be difficult to understand how Schröter could have placed only Linné so far out of its true place with regard to the other spots as to intend *v* for Linné, it would appear that possibly Schröter did not draw Linné at all, unless it be *g*. And this would not be surprising were Linné as large a crater as Bessel; for near the terminator at a period when definition must have been bad, from Schröter's own description of what he saw, and near the edge of the drawing, it being a small object not of the class he was more particularly engaged in observing, its omission from his drawing need excite little surprise, seeing that he failed to recognise some craters not so much inferior in visibility, and considering that the day before he failed to insert Littrow, a deep ring-plain, nearly ten times as large, in the centre of the region he drew and measured. From the method of drawing adopted by him such an omission was not difficult, a fact best manifest by seeing how frequently it occurred in this early portion of his work, though rare towards the end of his selenographical labours. Yet were some of these greater formations omitted by him to disappear, little satisfaction could be drawn with regard to this point from the circumstance of their absence from Schröter's special charts.

It remains manifest, however, that Schröter may have intended *v* for Linné, and as he drew this portion in some roughness, it is possible he inserted *v* more with regard to the east border of the Mare Serenitatis than with regard to the details towards the centre of the plain; and if the true position of Linné with regard to this is north of *v*, it is at the same time south of *g*; therefore Schröter's *v* may be Linné as he saw it. Consequently it is impossible to come to any certain conclusion with regard to whether any change has occurred in Linné. First, Riccioli draws Linné as a crater, and if he saw it thus it must have agreed well with the description of Lohrmann and been a deep crater, as Riccioli did not draw white spots as craters. Next, Schröter, on the sole occasion of drawing the Mare, did not see it as a deep crater if he saw it all; then Lohrmann and Mädler unite in describing it as a deep considerable crater, retaining its shadow for some time after sunrise, and in this they are confirmed by Schmidt, who so saw it when it was visible, though on three occasions it seems to have escaped his attention. Then it appears as a faint white cloudy spot about the same size as Linné; on this spot is detected a minute crater-cone, with an aperture not one-sixth of that of the Linné of Lohrmann and Mädler; and finally, a shallow crater about the size of the old Linné, but seen with great difficulty and only for a short time.[1] It would appear, therefore, that there remains but one conclusion: either some change has taken place, or else the description of Lohrmann and Mädler, with the early impressions of Schmidt, were wrong, for the great change cannot be ascribable to differences in either libration or illumination,

[1] The existence of this shallow crater is very doubtful, and it has not been seen since 1869, the appearance arising probably from some ridges here.

for since 1866 Linné has never been seen as a deep crater fully six miles in diameter, and according to Mädler, Lohrmann, and Schmidt it was so visible in what would now be termed small apertures, in Mädler's case only $3\frac{3}{4}$ inches. If Linné be still as it always was, then in their description the three selenographers above mentioned must have greatly exaggerated. But whether Linné has changed or not is a question, simple as it looks, that will not receive an answer yet; for Schröter's observation, incomplete and imperfect as it is, destroys all confidence; for though, had it not existed, a real change in Linné would have been admitted, its weight, however small, prevents any such conclusion being regarded as established, and the general view has insensibly merged into an opposite opinion. On only one basis can the fact of a real change in Linné having occurred be established, if indeed it be really a fact that a change has taken place, and that is by demonstrating that a similar alteration has occurred under similar conditions elsewhere; and if processes of actual change are still at work on the moon's surface of sufficient power to produce alterations of such magnitude as in the supposed case of Linné, then they must occur in course of time in other formations as well, where systematic series of observations will reveal their action.

It has been generally assumed that if any change in Linné has occurred, its nature must have been volcanic, and resulted in either filling up the crater, or else by producing a fixed low cloud over its site-hidden Linné. Neither of these conditions seems what is indicated by observations, and it does not appear that there exists any reason for supposing a volcanic change to have taken place; but the alteration, if any, appears to have been of a different nature. According to Lohrmann and Mädler's description, it would appear that Linné belonged to the class of deep and steeply-walled craters, and the change, if any, appears to have been simply the falling of the walls into the interior of the crater, filling this in great part up with the *débris*, a class of occurrences of which several hundred instances could be pointed out where it has happened, and in particular the north-west wall of Gassendi, which lies in ruins on the exterior plain. And all the observations seem to concur in pointing to an instance of this having occurred, and Linné to have disappeared as a conspicuous object from its steep walls tumbling into the interior. The crater-cone now visible may have been within Linné, and as in the case of Conon, have escaped attention, or else, as Birt supposes, may be a second object in the east of Linné, and altogether independent, as would appear to be indicated by one of Rutherford's photograms and by observations by Prince.

North-west of Linné is the small crater A in + 29° 0′ lat. and + 14° 5′ long., 5° bright according to Mädler, but only 3° bright according to Birt in 1867, and now fully 4° bright; and north of this is the slightly larger crater B in + 30° 37′ lat. and + 14° 1′ long., according to Mädler 6° bright, and Birt 5°½, though now nearer 5°; while east is the small craterlet *c*, perhaps 5° bright, and between this and B is a dark spot on the Mare. Linné *d* is a 5° bright crater west of A, south of which are three 4°½ bright craters, the southernmost being Linné *e*. South of A are three minute white spots, according to a drawing of Schmidt's, probably very small craterlets, and two others of the same nature lie north of the 5° bright crater *f*.

Bessel (M.)—A distinct 6° bright crater in the Mare Serenitatis 13·8 miles in diameter, whose position from seven measures is + 21° 54′ 14″ lat. and + 17° 22′ 26″ long., or, according to Mädler's determination as a point of the second order, + 21° 43′ lat. and + 17° 37′ long. The wall rises on the west 1,592 feet above the Mare and 3,958 feet above the 5° bright interior, which possesses no central mountain according to Mädler, but Webb has twice seen apparently a central peak. Schröter and Lohrmann consider a peak exists on both the south and north wall, and according to the former, about one hundred feet above the crest of the wall. Bessel A lies nearer the centre of the Mare, and is a $5°\frac{1}{2}$ bright crater in + 25° 0′ lat. and + 20° 36′ long., whose wall rises 1,125 feet above the plain. Bessel *b* is a 6° bright crater south of A, and connected to it by a ridge; west is a small crater-pit. Bessel stands on the great streak from Menelaus to Thales, which is at its maximum brightness near Bessel, and which extends, gradually becoming fainter, as far as Posidonius N; beyond this it is only to be traced on favourable occasions. From Bessel extend several mountain ridges, and close south-east is a small crater-pit C, in + 21° 26′ lat. and + 18° 0′ long.; a smaller one lies between A and *b* but nearer A, whilst further off, south-east and north-east, are two others. South-west of Bessel is a white streak, according to Birt a cleft η not given by Schmidt.

Mare Serenitatis (R.)—One of the most prominent of the lunar grey plains, extending from + $5°\frac{1}{2}$ to + $31°\frac{1}{3}$ long. and + $14°\frac{1}{2}$ to + $37°\frac{1}{2}$ lat., having a meridional length of 433 miles, and from east to west a breadth of 424 miles; it is thus nearly circular in form, and possesses therefore an area of nearly 125,000 square miles, but from foreshortening presents an elliptical appearance. It is better bordered and possesses fewer bays and gaps than any similar grey surface on the moon; of the 1,850 miles of border more than three-fourths are formed by the bright mountain ranges of the Caucasus, Apennines, Hæmus, and Taurus, but it is connected by broad arms with the Mare Tranquillitatis on the south, the Lacus Somniorum on the north, and the Palus Putredinis on the east. The Mare Serenitatis is one of the deep lunar plains, being considerably below the level of the

Mare Tranquillitatis, and somewhat below the level of the surface of the Lacus Somniorum, but it is uncertain whether it is deeper than the Palus Putredinis. The outer portion of the Mare appears a dark grey, forming a border from thirty to eighty miles broad to the lighter centre, and varies from 1°½ bright at the foot of the Taurus to 2° on the north and east, and 2°½ on the north-west. The inner portion of the surface, embracing over 80,000 square miles, appears from 3° to 3°½ bright, and in Full, of a fine clear light green tint, with a central streak of pure white 4°½ bright, together with a few 4° bright smaller streaks, and this central green portion appears not only to be lower than the exterior grey border, but to be enclosed by a system of ridges, steepest and highest towards the interior. The green tint is difficult to catch except under very favourable conditions, and is much masked by the effects of numerous small round white spots, and of the short grey ridges which appear free from this colour. The borders of the Mare Serenitatis are throughout distinctly marked, and it is well divided by natural boundaries from the neighbouring plains. On the south-east from Dawes to Hadley, the border is formed by the highlands of the Hæmus and the Apennines, forming for the most part steeply sloping indented declivities, and in places beaten lines of cliffs, well seen against the terminator in northerly libration; the bordering mountains being broken in many places by steep valleys and ravines communicating with the elevated surface above, whilst on the east deep valleys and inlets penetrate far into the mountain slopes. Towards the west, from Mount Argæus to Posidonius, the mountains form a steep wall, broken and irregular at places, but constituting a fine line of cliffs towering at places many thousand feet high, and with an immense mass of *débris* at the foot of their slopes. The northern border is gentler, being formed by the south slope of a great hill plateau rising at the edge in a row of small peaks separated by broad valleys ; except on the north-east, where the west border of the Caucasus presents a much-indented wall in place of considerable steepness and height, pierced by a number of winding deep valleys. As in the other Mares, the interior is traversed by a number of long ridges of very variable height, and in places of irregular forms. The principal system originates near Taquet, and mainly tends westwards, the chief ridge being the great serpentine ridge of Schröter, which is much branched and curved, and with its highest portion near Bessel α and Posidonius γ, but it is nowhere steep, though in places 700 or 800 feet high. The eastern portion of the system of Taquet extends towards the centre of the Mare past Bessel, but is much inferior in height, except at a few points. The north-eastern ridge system is more complex and much interlaced, and extends past Linné to near Sulpicius Gallus, but is much less well marked, and in only a few points as high. In many points on the Mare rise isolated mounds and mountain masses, occasionally possessing peaks of some height, but in general of the same brightness as the floor, and thus only visible when near the terminator. Throughout the Mare are dispersed a great number of small crater-pits, a few craters and craterlets, and several fine crater-cones, one, Posidonius γ, rising 960 feet and being 6° bright.

Posidonius (R.)—One of the largest ring-plains upon the moon, 61·74 miles in diameter, with a 5° bright, sharply marked wall of moderate height rising on the west 5,698 feet above the floor, and 3,287 feet above the plain, and broken by three passes ; one close under I, the second at *k*, and the third close to the crater *c*, this last being very rugged and steep. At B on the south rises an 8° bright lofty peak of considerable steepness, and the apex of a mountain mass of great dimensions. On the borders of Posidonius are a number of small ring-plains and some craters, the two principal ones being the 7° bright crater B on the inner slope of the north wall in + 32° 59′ lat. and + 30° 16′ long., and according to Schröter from two measures 10,000 feet deep; and the larger 6° bright crater-plain on the outer slope of the wall, I, in + 33° 41′ lat. and + 29° 52′ long., from two measures by Schröter 9,500 feet in depth. Close under the north wall is a small but deep crater *n*, and further east a peak ε, about 3,000 feet high, the north wall ending in the pass by *k*. On the east wall rises the peak *k*, nearly 3,000 feet above the plain, according to Schröter, and from here to the south the wall is double, the inner wall being highest and rising in two peaks, the principal being δ, and 3,000 feet high; whilst between the double wall is the 5° bright crater *c*, south of which the wall is traversed by a narrow pass, and then ends at the base of the peak B. On the south the wall is high and rugged, and nearly 6° bright, falling as it bends towards the west, where it branches out, and on the outer slope is a considerable depression, *d*. From the base of the peak, B, a considerable high interior ridge traverses Posidonius tolerably parallel to the wall, 5° bright, and in points 2,000 feet high, leaving a fine winding 3° bright valley between the ridge and wall; whilst the ridge, gradually sinking as it proceeds, loses itself on the floor. Opposite, parallel to the east wall, extends a shorter, straighter, and lower ridge. The principal portion of the floor is 3°½ bright, the chief exceptions being the space close under the east of the great western ridge, which is only 2° bright, and a portion of the north of the floor only 3° bright.

Towards the centre is the fine 7° bright crater A, from two measures by Schröter 3,800 feet in depth, and from ten of Lohrmann's and two of Mädler's measures in + 31° 35′ 39″ lat. and + 29° 7′ 24″ long.[1] Along the centre of

[1] The separate results are Lohrmann + 31° 33′ 34″ lat. and + 29° 11′ 29″ long., and Mädler + 30° 46′ 4″ lat. and + 28° 46′ 58″ long.

the interior, in a meridional direction, extends a fine broad valley 3° bright, and of no great depth, within which lies a fine broad rill, η (S. 80), ending on the south at the north of two narrow valleys at right angles to the rill, within the northern of which extends a broad deep valley-like rill (S. 79) discovered by Lohrmann, and considered by Schmidt to consist of confluent craters, though this is doubtful. West of the end of the first rill is a fine crater-cone, whilst on the side of the valley which contains it are three craterlets, besides the crater A, and on the west side at least one craterlet. In the north of Posidonius is a delicate rill, ξ (S. 82), and south-west of it a second rill (S. 81) at right angles has been seen by Schmidt. Another short rill, ψ, extends at right angles to the main rill, η, discovered by Gaudibert, who has also seen traces of a short rill parallel to η on the west, and a third still shorter crossing it.

Posidonius on the north-east and west is bordered by the open plain, and from it numerous ridges extend in all directions, the principal being a long serpentine ridge towards Taquet, discovered by Schröter; whilst on the south, Posidonius abuts on the great highlands of the Hæmus. In its environs are numbers of small ring-plains and craters, the chief being the deep 6° bright crater, *b*, from several measures by Schröter 6,600 feet deep; south-west of this is a 5° bright craterlet, and west a peculiar depression, figured as a crater by Mädler, and at times resembling one, but in reality a shallow depression enclosed between two curved ridges, whilst further west is a 6° bright crater, *m*, of moderate depth. In the east, on the Mare Serenitatis, are the two craters, Posidonius E, in + 30° 21′ lat. and + 19° 25′ long., and Posidonius N, in + 29° 42′ lat. and + 20° 29′ long., the latter now 5° bright, the former must be fainter; and further west is the crater *c*, 5° bright, and, according to Schröter, near 1,800 feet above the Mare, and 3,300 feet above its interior. South is the fine crater-cone

Posidonius γ, nearly 1,000 feet in height and of considerable steepness.

Daniell (B.) [Posidonius C, M.]—A small 6° to 7° bright ring-plain in + 35° 33′ lat. and + 30° 34′ long., with a 4° bright interior, 2,814 feet beneath the summit of the west wall, containing a distinct 5° bright central mountain. It is connected with Posidonius I, by three mountain ridges, whilst north on the plain are three very small crater-pits, only visible with considerable difficulty.

Grove (B.) [Posidonius D, M.]—A deep ring-plain 15 miles in diameter, whose 7° bright wall rises 7,149 feet on the east above the 3° bright interior, and on the west 2,078 feet above the exterior. On the floor is a conspicuous central mountain 4° bright. From Grove, towards the south, extend a number of considerable ridges, the principal peak being Δ in + 38° 12′ lat. and + 32° 16′ long. (Posidonius Δ of M.), rising 3,306 feet above the western surface, the remainder seldom exceeding 1,000 feet in height; whilst on the north a mountain arm connects Grove with Mason, and at Γ, in + 41° 10′ lat. and + 32° 0′ long., has a height of 2,136 feet.

Lacus Somniorum (R.)—An irregularly formed plain, with, however, fairly though slightly marked boundaries; these are on the west the mountain system of Oersted, Cepheus, and Franklin, towards the south the highlands of the Hæmus and Posidonius, towards the east the hill-land west of the Caucasus, and on the north the elevated districts of Plana, Mason, and Hercules. The surface is divided into two portions by the ridges between Posidonius and Mason, whose centres are the ring-plains Daniell and Grove; the eastern portion is lighter in colour, being 4° bright, but is covered with many ridges, mounds, &c., besides being, in places, at different levels; whilst the western, only 3°½ bright, is leveller, contains fewer ridges, but more crater-pits. The eastern portion of the Lacus Somniorum contains a number of light streaks and spots in places even 6° bright, whilst a few darker streaks and spots, only 3° bright, are not unfrequent; but on the far east, close to the highlands, the tint becomes more uniform, and the surface more undisturbed. The western portion is leveller, though containing a considerable number of ridges and many isolated hills, rising in places to a considerable altitude, the two most distinct objects being the two 5° bright craters Bond I and K; whilst dispersed over the floor are numbers of small crater-pits. The boundary of the Lacus towards the north is formed by a system of ridges, rising at points to 3,000 feet or 4,000 feet above the Lacus, though the general elevation is scarcely 1,200, and the border, although sharply marked, is steep in only a few places. In the eastern portion of the Lacus Somniorum, Kinau, in 1848, saw a long rill extending from east of Daniell to about 2° north of the small crater *d* (S. 83).

Bond (B.) [Posidonius G, M.]—A deep but small ring-plain 12 miles in diameter on the northern border of the great Hæmus highlands, and 6°½ bright, with a small peak on the west, and a small craterlet on both its south and north walls, the former not seen by Mädler. North is a portion of the Lacus Somniorum, walled in by several peaks and ridges with three bright craters on the borders; **a**, the largest, being 5° bright, but *b*, close under Bond, is only 4°½ bright; whilst the third, 6° bright, lies close under the lofty ridge, α (Posidonius ζ of M.) that at Full appears distinct and 5° bright against the darker Lacus.

North are the two fine 5° bright craters Bond K in + 35° 29′ lat. and + 33° 32′ long., and I in + 35° 38′ lat. and + 36° 32′ long. (Posidonius K and I of Mädler), whose walls rise little above the surrounding plain, though they are moderately deep. In the border of the highlands are two imperfect rings, H, whose eastern apex is 5° bright, and in + 33° 34′ lat. and + 38° 44′ long., and north is a small craterlet. South-east, well in the Hæmus highlands, is an imperfect ring-plain B (Posidonius *b* of M.), whose central mountain is in + 29° 51′ lat. and + 33° 52′ long., with four craters on its wall, and which is traversed by the fine rill Bond ε (Posidonius ε of Mädler). This is the great rill of Römer (S. 11), which, according to Schmidt in part a crater-rill, possesses a length of quite 200 miles, and commencing east of Römer ends north-west of Bond I in a small very shallow crater-pit; but the northern portion from Bond α is very difficult to see, and its place perhaps uncertain; whilst some faint appearances of its continuing as far as Maury have been detected. Schmidt's rill, No. 86, seems to have arisen from some mistake, or to involve an error.

Chacornac (B.) [Posidonius F of M.]—A deep circular ring-plain on the south of Posidonius with a 5° bright wall rising at the peak Posidonius β, 5,506 feet above the interior, and near the small crater *b*, 8,377 feet high, the mean altitude being about 4,000 feet. In the centre of the 4° bright floor is a fine crater A, 5° bright, and two small mountains. The floor is traversed by two fine rills, η and ζ (S. 77 and 78), parallel to each other, and probably crossing the wall of Chacornac near the crater *b*, whence bending they traverse the highlands of the Hæmus, but the two portions have never yet been seen actually united.

Le Monnier (L.)—A great bay on the western border of the Mare Serenitatis, forming half of a ring-plain thirty-three miles in diameter, with steep 5° bright walls and a nearly level 1°½ bright interior, the eastern half abutting on the Mare having entirely disappeared. Towards the centre of the opening of the bay is a fine peak A, from three of Lohrmann's and five of Mädler's measures in + 25° 59′ 30″ lat. and + 29° 3′ 50″ long.,[1] and 3,095 feet high; whilst

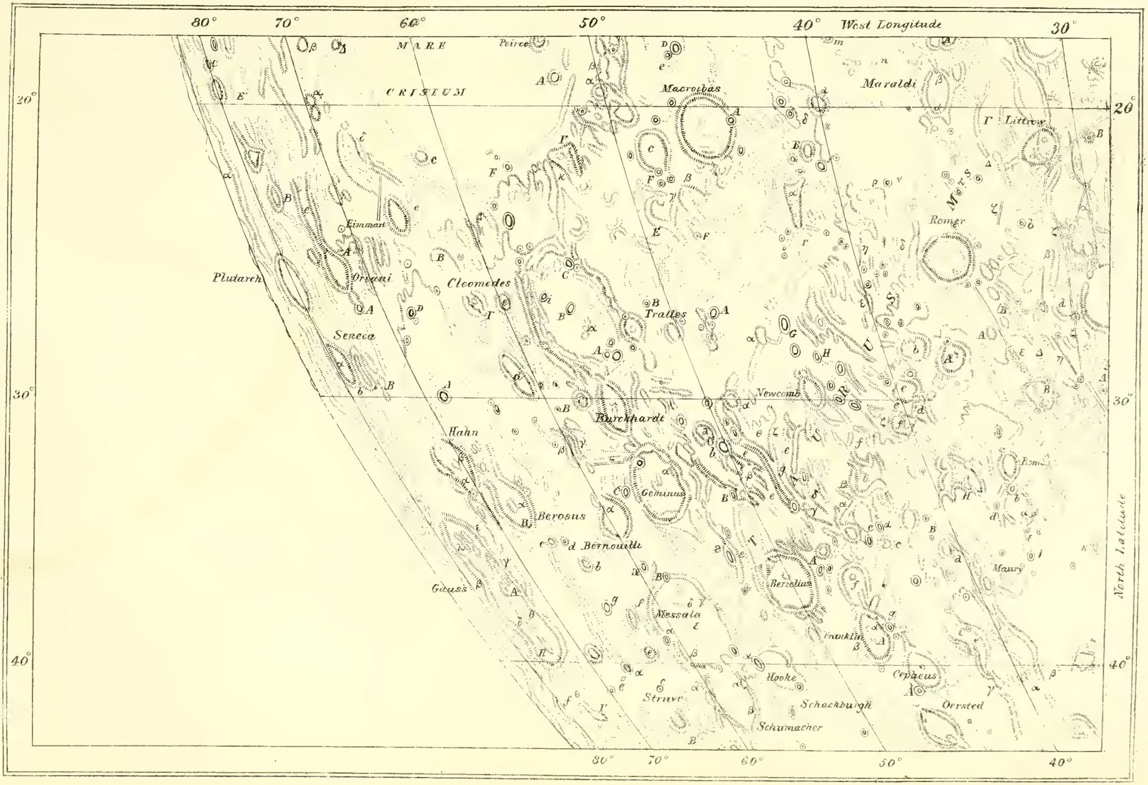
[1] The separate results are Lohrmann + 25° 47′ 32″ lat. and + 29° 24′ 24″ long., Mädler + 26° 6′ 43″ lat. and + 28° 51′ 36″ long.

the wall at Γ of the western portion of the ring-plain rises 8,140 feet. The name Le Monnier is ascribed by Mädler to Schröter, though Lohrmann seems to have been the first to use this name. The region north of Le Monnier is brighter than the rest of the highlands of the Hæmus, and forms a tolerably level plateau crossed by the two rills ζ and η. The former commences near the crater on the south wall of Chacornac, traverses the plain, crossing a curved ridge not unlike the ruins of an ancient ring, and ends at another craterlet on the wall of the small ring-plain Le Monnier **a**. Beyond this it reappears, and is distinguished as ζ (S. 76), and crossing the floor of **a** passes out at a gap in the wall and ends in the open plain, in $+ 23°\frac{1}{2}$ lat. The other rill η, which does not appear in Schmidt's catalogue, though known to him later, commences close to the last and ends west of **a**. A third rill has been described by Gaudibert as traversing the east border of the ring-plain **a**, but is probably merely a narrow deep valley between the wall of Le Monnier and a high ridge here. South and west of Le Monnier are a number of short rills, perhaps portions of one or two longer rills that have only been imperfectly seen, and from its great difficulty the whole region here is still but imperfectly mapped. Of these rills the two principal are west of the ridge B, and form part probably of the great rill of Littrow; another extends along the east of the plateau Römer β, and a fourth in the plain south of Bond B. From the peak A extend many ridges on to the Mare Serenitatis, one extending south to near Mount Argæus, being about 100 miles long and rising at the peak δ 1,113 feet above the Mare, and at γ 830 feet, though the average height is scarcely 300 feet.

Littrow (M.)—An irregularly formed ring-plain divided into two portions by a cross wall whose peaks are considerably higher than the wall of Littrow, and which though 6°

bright are only moderately high. On the only 4° bright interior are several mounds and three peaks, whilst on the walls are several small craterlets and a crater. Littrow is not given by Schröter in his drawing of this region, though a number of peaks that must have constituted part of its walls are drawn. West it is united by an intricate system of mountain-arms with a long mountain-chain rising at the points Δ and Γ in considerable peaks, visible beyond the terminator long after all the rest have disappeared, and this chain ends at the 6° bright crater Littrow *b*, west of which is the delicate rill ζ (S. 75), very difficult to detect. On the north of Littrow extend several long ridges enclosing narrow valleys, within one of which runs the great Littrow rill η; this commencing east of the crater *d* extends within the mentioned valley to a small depression close under the wall of Littrow and on an elevated ridge, this portion being Schmidt's 74, though he did not see its full length but only the northern half. Beyond the depression it reappears and crosses the Mare Serenitatis, passing close under the foot of Mount Argæus, and ends close to Dawes, being Schmidt's 68. Throughout its course, but especially near Littrow, it is a very difficult object to detect. Its length is 140 miles, or if the portions beyond its north end are added, which are very probably parts of the same, though it has not yet been seen entire, then its length will be nearly 200 miles. Towards the Mare Serenitatis the highlands possess a very marked border rising in a chain of fine peaks—that at α rises 8,140 feet above the Mare;—whilst according to Schmidt, at the foot of the border, partly in and partly off the highlands, are a set of five peculiar intersecting rills (S. 69–73). In the Mare Serenitatis here is a fine isolated 7° bright crater Littrow B, with near it on the north-east a round 6° bright light-spot 12 miles in diameter, which is not given in the 'Mappa Selenographica.'

Map IV.


West Longitude
North Latitude
MARE
CRISIUM
Peirce
Macrobius
Maraldi
Littrow
Romer
Eimmart
Plutarch
Oriani
Cleomedes
Tralles
Seneca
Newcomb
Burckhardt
Hahn
Geminus
Berosus
Bernoulli
Gauss
Messala
Berzelius
Franklin
Hooke
Struve
Schackburgh
Schumacher
Cepheus
Oersted
Maury

CHAPTER X.

MAP IV.

Maraldi (S.)—A polygonal dark ring-plain, some 3,800 feet in depth, which as its border is not well marked in Full can easily be taken for a portion of the Mare Tranquillitatis, only the two peaks α and β appearing as bright points. Near it are a number of 4° bright craters and the steep isolated 5° bright peak Γ in + 20° 25′ lat. and + 35° 12′ long., rising 2,967 feet above the western surface.

Römer (R.)—A ring-mountain 23·75 miles in diameter, with very broad 5° bright walls, terraced on the interior and in part on the exterior, rising on the west 11,574 feet above the 4° bright interior, and on the east as high. On the floor is a fine 6° bright central mountain, according to Schröter over 5,000 feet high, and north a crater not seen by him, whilst there are many smaller irregularities. This central mountain, from eight measures by Lohrmann, is in + 25° 17′ 30″ lat. and + 36° 22′ 14″ long, whilst Mädler, from three, found + 25° 33′ 25″ lat. and + 36° 10′ 49″ long., the whole eleven measures giving + 25° 18′ 51″ lat. and + 36° 19′ 6″ long. Around the outer wall of Römer are a number of craters mostly 5° bright, and on the west a deep long valley. North and north-west of Römer extends the main mass of the Hæmus Mountains, consisting of a most intricate and irregular system of intersecting mountain ranges, enclosing deep, more or less circular valleys resembling unfinished ring-plains. The ring-plain A may be considered the most perfect of these, and its 6°

bright walls rise on the east only 3,722 feet, but on the west nearly double this, and are broken at places by small craterlets and by three peaks; whilst the 4° bright floor (3° M.) contains a 5° bright central mountain. West of this are the peaks Römer A and β, the former in + 27° 18′ lat. and + 35° 2′ long., of considerable steepness and height, the latter not so steep or high, whilst in a valley, between the two, extends the great Römer rill Bond ε; on the north is the still higher peak Δ in + 28° 43′ lat. and + 33° 16′ long., 6° bright. East of the ring-plain A are four of the unfinished ring-plains referred to above, all of moderate depth, but with a scarcely visible central elevation, and 5° bright, the most regular being *c* and *b*, both containing a depression and a crater on their walls, whilst *d* and *f*, the most irregular, are the deepest and with much-peaked walls. The fine long valley *e* is very deep and with a 4° bright floor. West of Römer is a mountain highland traversed by a number of bright valleys and containing some fine peaks, the highest being ε and δ, whilst a considerable number of small craters are also to be found. In a valley south of ε Mädler saw a short rill ζ (S. 12) that has not again been seen; and west of ε Lohrmann saw another rill ζ (S. 10), likewise not again seen.

Newcomb (N.)—A great ring-plain in the centre of the Hæmus highlands with 5° bright walls, rising 11,800 feet above the 4° bright interior, which contains a nearly central mountain of some height. North are a number of intricate mountains and some fine deep valleys, the two principal being *e* and *f*; whilst south are the two 6° bright craters H and G (Römer H and G, M.) the former in + 28° 24′ lat. and + 43° 20′ long., the latter in + 27° 29′ lat. and + 44° 31′ long., with walls of considerable height, and with on the west the great mountain mass α rising 9,062 feet above the western plain. South-west of Newcomb extends a tolerably open plain of considerable brightness and elevation, from + 30° lat. and + 50° long. to the north-west of Macroibus.

Taurus Mountains (H.)—A great mass of elevated highlands extending from Geminus and Berzelius nearly to Littrow and Maraldi, bordered on the north by the Lacus Somniorum, on the east by the Mare Serenitatis, on the south by the great bay of the Mare Tranquillitatis, and on the west by a great elevated bright plain extending from near Macroibus to near Burckhardt. With the exception of some ring-plains that are darker, and some peaks and craters that are brighter, the entire highlands present a monotonous uniformity in tint, the differences being so slight as to be barely discernible. The general brightness is 4°½, rising gradually in the higher portions to about 5°, and sinking in the low regions to nearly 4°; but though formed by a mass of mountains of great irregularity in level, whose labyrinthical details present vast difficulties to being properly mapped, in Full it is difficult to pick out the place of any distinct formation, since all disappear in the sensible monotony of brightness. From Maury to Newcomb G extends a great curved row of most irregular ring-plains generally connected together by strong mountain arms and ridges, many of the ring-plains being of considerable depth, the deepest being Newcomb. Beyond these, towards Geminus and Berzelius, extend many great mountain arms in a general meridional direction, and rising at places in high peaks, which from their position are not measurable, though they are probably over 10,000 feet in height. Towards the east the highlands are not so wildly mountainous and are more open, and here a considerable number of rills have been discovered.

Macroibus (R.)—A great circular ring-plain 41·86 miles in diameter, with 6° bright walls, probably 13,000 feet high, though on the east at the 6° bright crater A in + 20°

30′ lat. and + 44° 18′ long., it is only 10,531 feet above the 4° bright interior, which contains a small central mountain and a number of irregularities. Macroibus *c* on the west is a very similar formation on a smaller scale, and of inferior brightness. South of Macroibus are the two 3° bright craters *e* and D, the latter in + 18° 20′ lat. and + 40° 1′ long., and on the west slope of a small mountain arm rising in two peaks. On the east, as on the south, extends a broad elevated little disturbed plateau, fully 4° bright in the main, and descending gently to the Mare Tranquillitatis, on the borders being some small ring-plains and craters, the principal being a and B, the last in + 20° 58′ lat. and + 40° 42′ long. North this plateau becomes more irregular and slopes gently towards the bright plain between it and the Hæmus, the brightness becoming also more variable. North of B is the peculiar plateau Macroibus α with steep sides, and rising 4,093 feet above the western plain, whilst north-west of Macroibus are a number of steep mountains, the principal being β, γ, and E, the former a peak on the end of a high plateau, and the others curved mountains enclosing a kind of ring-plain. The crater F (Mädler *f*) is a bright object easily found, and in + 22° 5′ lat. and + 47° 17′ long.

Eimmart (S.)—A ring-plain, on the north-west border of the Mare Crisium, its bright east wall rising 10,333 feet above the floor. On its south extends a broad and high plateau δ on to the Mare, between which and the west border of the Mare Crisium is a long winding valley extending on to the bright highlands north of Eimmart, where it is joined by a narrow bright valley on the east of Eimmart *e*. On the crest of the united valleys rises the great peak B in + 25° 0′ lat. and + 63° 30′ long., which is 13,500 feet high. In the plateau δ Lohrmann observed what he believed to be a short rill (S. 1), which has not been again seen, and was probably one of the many narrow valleys here.

Mare Crisium, North (R.)—The northern border of this Mare is completely opposite in character to that on the south, consisting of broad triangular plateaux, with their bases to the plain, and their points, which are more rounded, towards the surrounding higher regions. Towards the Mare Crisium these plateaux descend steeply, and are of considerable elevation, projecting at sunset far into the terminator as a row of bright points, and are probably at their chief peaks not under 12,000 feet above the grey plain beneath. In only a few cases is the border pierced by narrow valleys, leading down from the outer bright plain to the Mare, and the only one of these valleys of any magnitude is Cleomedes *k*. On the plateaux are a number of craters and depressions, some of considerable depth, but mostly shallow. Towards the north-east the border of the Mare Crisium becomes measurable, though it is here lower, and the principal peaks are Cleomedes Γ in + 21° 10′ lat. and + 52° 0′ long., rising 13,352 feet; a second, ten miles south-east, 7,168 feet high; a third, Pierce *α*, in + 19° 20′ lat. and + 50° 15′ long., rising 11,343 feet; and a fourth, *β*, 6,752 feet above the plain below. On the interior of the Mare Crisium, north of Peirce, is a long, clear, and well-marked ridge, parallel with and close to the north-east border, ending in the tolerably bright crater Cleomedes F, in + 22° 20′ lat. and + 56° 5′ long., seven miles in diameter. West is the shallow ring-plain Eimmart C, in 21° 40′ lat. and + 61° 35′ long., fourteen miles in diameter and fairly bright, but from its low walls easily overlooked. West of it Schröter draws two deep minute craterlets. East of F, in the north border of the Mare Crisium, Lohrmann saw a short rill extending from north to south (S. 2).

Oriani (M.)—An irregular walled plain of considerable depth, and 32 miles in diameter, with, on the east, a steep fine plateau, containing a peak A, in + 42° 40′ lat. and + 70° 10′ long., and opening on the south into a broad valley, *e*; whilst on the north extends a massive mountain arm, as far as the 6° bright small crater A, in + 27° 18′ lat. and + 73° 0′ long. South is a small ring-plain B.

Plutarch (R.)—A ring-plain close to the limb, with walls of some length, and on whose floor rise two central mountains; while west extend several long mountain arms, one rising at *α* to a considerable height, and the limb is often interrupted by a row of high mountains in the further hemisphere of the moon.

Seneca (R.)—A large ring-plain on the limb, with its walls highest on the west, the principal peak being *α*. Westward is a portion of the same mountain-arm that extends beyond Plutarch, and eastward an irregular ring-plain, *b*, and a bright mountain, rising in a peak at B, in + 29° 38′ lat. and + 74° 30′ long. Between Plutarch, Seneca, and Oriani is a considerable, though much foreshortened, bright plain.

Cleomedes (R.)—A large walled-plain, 78·4 miles in diameter, and in form between a circle and rectangle, with broad walls rising on the west 8,735 feet, and on the east 9,700 feet above the interior, but low, generally sloping, and much terraced on the north. On the summit of the terraced east wall are a number of depressions and craters; and at the extreme south between two craters it is broken by a deep pass communicating by the winding valley *k* with the Mare Crisium, whilst, nearly opposite, another pass in the west wall leads from the interior of Cleomedes to the bright plains above. In the centre of the floor rises the 6° bright central mountain, *α*, in three peaks, and on the darker southern portion of the interior appear three 6° bright craters, the northernmost, B, in + 26° 54′ lat. and + 55°

12′ long. ; the southernmost, C, at the foot of the wall near the eastern pass, in + 25° 33′ lat. and + 54° 26′ long., and the smaller but deeper *i* ; whilst on the northern portion of the floor appear three compactly placed craters, A, the westernmost being 8° bright, and very distinct in Full, though with an ill-defined border, its place from seven of Mädler's measures being + 28° 23′ 58″ lat. and + 54° 17′ 25″ long. Within Cleomedes, Schröter observed many variations in the appearance of the different objects in the interior, which he ascribed to actual alterations, but which have been shown by Webb and Birt to have arisen from other causes. In particular he regarded the crater A as having been formed between his earlier and later observations. Schröter and Lohrmann only saw two craters on the north of the interior. Beer and Mädler have three, but draw the eastern too small ; there are three, but the last two are more depressions than craters. On the west of the interior Gruithuisen observed nine lozenge-shaped markings that have not been seen since.

West of Cleomedes is the ring-plain *e*, 1·15 miles in diameter, connected with some high ridges, and beyond it is a round massive mountain mass, whose peak, Γ, is in + 28° 34′ lat. and + 61° 28′ long. ; whilst still further west rises a great bright plateau, falling steeply to the plain on the west, and on whose broad surface is the crater Cleomedes D, in + 27° 26′ lat. and + 66° 40′ long., five miles in diameter, with a very small craterlet on its south edge. Cleomedes *d* is a long very irregular walled plain with steep but low walls.

Tralles (M.)—A very deep, precipitous, irregular crater-plain, on the eastern wall of Cleomedes, whose interior is in shadow three days after Full, and is 13,697 feet beneath the summit of the east wall. On the wall are two craters, and on the floor a central mountain. North-east of Tralles, Schröter drew a deep depression with a crater on its east border; whilst Mädler merely gives several mountains and a depression, which correctly represent the condition of the surface, and at times assume the appearance drawn by Schröter. Tralles A is a bright crater in + 26° 47′ lat. and + 47° 25′ long., close to a mountain range on which are some minute craters. B is a small crater in + 26° 47′ lat. and + 51° 5′ long.

Burckhardt (M.)—A large irregularly formed walled plain, 34·90 miles in diameter, with bright steep walls rising at α on the east 12,674 feet, though on the south-east scarcely half as high. On the floor is a considerable central mountain. West of Burckhardt is the small ring-plain, **a**, and the bright crater, B, in + 30° 20′ lat. and + 59° 21′ long., north of which are two peculiar valleys, β and γ, in the open plain, from whose south end from west to east, towards Geminus, extends a rill, ζ (S. 8), declared by Schmidt to form part of a remarkable rill system, of which he gives no particulars.

Geminus (R.)—One of the finest ring-plains in this portion of the moon, 54·13 miles in diameter, nearly circular in form, with very rugged, much terraced, steep walls rising on the east 12,400 feet, and on the west to the immense height of 15,722 feet above the interior, which contains some low central mountains. The exterior slope of the walls of Geminus is much terraced, and on the west contains the 8° bright deep crater, C, in + 38° 45′ lat. and + 58° 9′ long.; whilst south, on the wall near a pass, is a small crater, with two others on the outer slope, beyond which extends a broad valley containing the rill Burckhardt ζ. On the east is the deep crater B, in + 33° 50′ lat. and + 51° 25′ long., beyond which is a great mass of mountains, whose principal peak, β, must rise to a very great altitude, and south of which are two deep ring-plains, **a** and *b*, whilst north the plateau, according to Schröter, rises above the valley *e* more than 10,000 feet. Beyond this valley is another high mountain range, intersected by two peculiar cleft-like ravines, θ and ζ, and at the south end of this range is the ring-plain *d*, with some smaller.

Bernouilli (S.)—A fine deep very steep ring-plain whose wall on the east rises 12,648 feet above the interior, which contains no central mountain, whilst the wall south of the peak α appears broken. Schröter seems to have much misplaced the position of Bernouilli in his drawing of this region. Between Geminus, Bernouilli, and Messala the surface has at Full a distinct bright appearance, without definite border, that includes most of the floor of Bernouilli; and it is generally to be noticed that in these regions brightness is independent of differences in level, and only some small craters appear as bright points. Two of these craters are 7° bright and lie west of Bernouilli, and are *c* and *d*; a third crater *b* resembling more a ring-plain, and a fourth **a**, disappearing at Full, though this last is about 5,000 feet deep.

Hahn (M.)—A nearly circular ring-plain, forty-six miles in diameter, with many peaks on its steep wall, which must hide a considerable portion of its floor from the earth. The peak α rises 9,690 feet above the interior, on which stands a long central mountain, while at its north end is a depression or perhaps crater. Entirely isolated in a large bright plain is the large crater Hahn A in + 30° 3′ lat. and + 68° 5′ long.; the whole surface towards Cleomedes constituting one of the bright plains of the moon, that from their colour are easily overlooked, though in the present instance embracing an area of about 40,000 square miles, or nearly the area of the Mare Vaporum, only interrupted by a few depressions and ridges.

Berosus (R.)—A very similar ring-plain to Hahn, only with a smaller central mountain, the wall rising on the west

11,427 feet high, whilst on the east wall are two peaks perhaps still higher, α and B, the latter in + 34° 42′ lat. and + 66° 55′ long., and two craterlets on the outer slope. On the south Berosus seems to be open and communicates with a short broad valley in which are two depressions.

Gauss (M.)—A great walled plain, 111 miles in diameter, nearly circular in form, though strongly foreshortened into a narrow ellipse, with an area of about 8,500 square miles. The walls are lofty, the highest peak on the west being β, though all marked are nearly as high : and particularly remarkable is the great chain of central mountains only equalled by those of Wilhelm Humboldt, which extends in a meridional direction nearly throughout the entire floor, and rises at the peak A in + 36° 46′ lat. and + 75° 30′ long. to its greatest altitude. Mädler considers it would be a grand sight to stand on the summit of this peak under favourable conditions, surrounded by a vast plain immersed in deep shadow and environed by a row of illuminated peaks on the distant horizon, and watch the sun on the one side, and the still almost Full earth on the other, slowly rise above the horizon. Between Gauss, Bernouilli, Berosus, Messala, and Struve is another large bright plain 25,000 square miles in area, or twice the size of the Sinus Medii, disturbed by only a few low ridges and craters. From the south of Messala *d* to north of Bernouilli *c*, across this plain extends a fine valley cleft with very gently sloping sides.

Messala (R.)—A circular walled plain, sixty-nine miles in diameter, with an interior apparently little deeper than the exterior surface, and a wall consisting of many parallel high ridges more or less connected, with gentler slopes than Geminus, and not above 3,000 feet high, its highest point north of γ being only 3,580 feet high. The walls are crossed by small valleys and broken by five craters, while the interior is covered with low ridges and hills which, excepting δ and ε, are only visible with great difficulty, and both these disappear soon after sunrise. Mädler points out the utter inadequacy of Schröter's first drawing of Messala, which he represents as free from almost all detail, to afford any real basis for detecting future changes by comparison with later more carefully executed observations, and that therefore Schröter's supposed instances of change were *ab initio* without a sufficient basis. Schröter in 1794 saw two or three small craterlets or crater-pits, on the south of the interior of Messala, not seen by Mädler. Messala **a** is a crater-plain, fourteen miles in diameter, within a valley east of Messala, and is 6° bright with walls 6,400 feet high, and is united to Geminus by a broad mountain arm, nearly 4,000 feet high. West of Messala are many small ring-plains, the two largest, *f* and Bernouilli *b*, being very shallow, and though given by Riccioli are omitted by Cassini, Mayer, and Schröter (M.), but the latter gives *g*. The ring-plain *e* is deeper and possesses a central mountain, and *d* is somewhat brighter than the surrounding surface.

Berzelius (M.)—A regular ring-plain with many moderate-sized peaks and projections on its walls that rise 1,000 feet above the interior, only one peak on the south-east being 1,300 feet high, while the central peak is very low and barely visible on the 3° bright interior. Berzelius is surrounded by a number of craters and depressions, the principal being A in + 36° 43′ lat. and + 47° 55′ long.; while on the west of Berzelius, on the plain, is a twin crater-pit, a nearly solitary instance here. From Berzelius to the crater Geminus B extends a long mountain-ridge 2,500 feet high, and between it and the mountain arm between Geminus and the deep crater-plain Messala **a**, is a long 3°½ to 4°½ bright nearly level valley *e*, commencing east of Geminus and opening into the hilly plain between Berzelius, Hooke and Franklin, and only separated at its south end by a short arm from a similar valley less conspicuous, but extending as far south as Burckhardt. South-east of Berzelius in the mountains are a number of very high peaks in the midst of a complex valley system, the principal, Berzelius α, β, γ, and δ, probably all nearly 10,000 feet high; and here also is the fine deep ring-plain Berzelius *b*, over twenty miles in diameter.

Franklin (M.)—A fine deep regular ring-plain, with a diameter of 33·10 miles and walls rising at α 7,782 feet, and at β 8,754 feet above the dark floor (2°), which has a not inconsiderable central elevation A in + 38° 54′ lat. and + 46° 54′ long. On the outer slope of the east wall is a shallow depression *g*, and on the south of Franklin abuts a nearly entire ring-plain *f*, tolerably steep towards the interior on the east and west, and easily seen, though the outer slopes are very gentle. Such imperfect ring-plains are not uncommon in this region and all open towards the north. South-east are a number of craters in the mountain highlands of the Taurus, the principal being *c*, *e*, and *d*, the first almost heart-shaped.

Cepheus (R.)—A regular ring-plain, 27·06 miles in diameter, with steep terraced walls rising on the east 9,150 feet above the 4° bright interior, which contains a small central elevation. Mädler fixes the inclination of the east wall at 50°, certainly overestimated. On the west wall is the nearly 9° bright crater A, from ten of Mädler's measures in + 40° 59′ 20″ lat. and + 45° 39′ 42″ long., that in Full shows the position of Cepheus. South-east is a bright crater C in + 38° 34′ lat. and + 41° 38′ long. on the east slope of a pear-shaped dark valley *e*.

Maury (B.)—A deep, very distinct crater-plain, twelve miles in diameter and 7°½ bright, on the border of the Lacus Somniorum, and from which radiate a number of mountain-arms. West are three small craters; south-west a very deep small ring-plain **a** (Franklin **a** of M.) and a bright crater B in + 35° 10′ lat. and + 41° 27′ long., whilst on the north, at the border of an elevated plateau, are three peaks of some height, α, β, and γ, with a fourth, δ, on the Lacus Somniorum.

Hooke (S.)—An irregularly shaped ring-plain, twenty-eight miles in diameter, with low walls of unequal brightness, on the south-west of which is a 6° bright crater-plain 6,535 feet deep, and visible at Full as a white spot. On the plain at the north of Hooke are dispersed a few mountains, the highest being Γ, in + 43° 30′ lat. and + 55° 2′ long.

Schumacher (M.)—An irregular ring-plain, thirty-seven miles in diameter, whose low walls are highest in the east at α and β, have a crater at the south and a break on the north, whilst the level interior is only 3°½ bright. On the north it communicates with a low light plateau γ by a stout ridge.

Struve (M.)—A walled depression not entirely enclosed and very irregular in form, the dark-grey of whose floor can be readily distinguished, even when a portion is still in shadow. The walls reach their greatest height at α, and on the outer slope on the north-west is a bright low peak, perhaps a crater-cone B, whose place from seven of Mädler's measures is + 43° 20′ 14″ lat. and + 64° 47′ 4″ long. West is a bright region traversed by a great number of low ridges, whose highest point is perhaps Γ, in + 42° 10′ lat. and + 74° 20′ long.

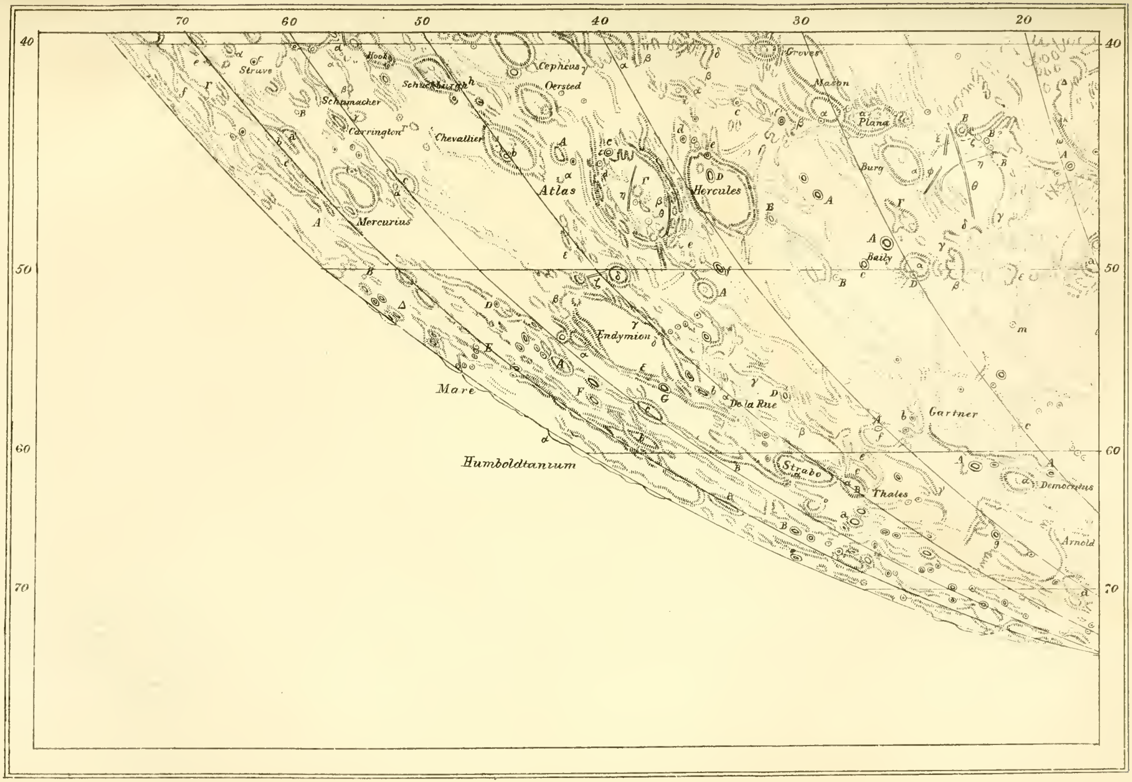
CHAPTER XI.

MAP V.

Shuckburgh (Lee.) [Hooke *b*, M.]—A very triangular slightly depressed plain, larger than Hooke, enclosed by a ring of mountains rising on the east 3,268 feet above the interior, with a small depression on the north-west wall.

Carrington (B.) [Schumacher **a**, M.]—An irregular ring-plain of small dimensions north-west of Schumacher.

Mercurius (R.)—A considerable ring-plain twenty-five miles in diameter, with a wall containing six small peaks and some projections, and rising about 7,700 feet above the floor, which is $3°\frac{1}{2}$ bright and contains a long central ridge. West of Mercurius are the remains of a large walled-plain, almost as considerable as Gauss, partially destroyed by the later formations; for though the western and southern walls can be followed from + 47° to + 41° lat., the northern and eastern are nearly entirely destroyed by the three ring-plains Struve **a**, *b*, and *c*. The whole region here is covered with numerous bright points, the most conspicuous being the brilliant small 8° bright crater, in + 41° lat. and + 71° long., Struve *e*. North-west of Mercurius is another ruined walled-plain, on favourable occasions, however, still more conspicuous than the last, with a bright peak A on the east wall in + 49° lat. and + 75° long., and north of this plain is a steep declivity in + 50° lat., that would be much more marked were it not so strongly foreshortened; whilst on the open depressed plain beyond, are two lofty peaks, Mercurius B and Δ, visible long after sunset within the night side, and


Struve
Hooke
Schumacher
Carrington
Chevallier
Mercurius
Cepheus
Oersted
Atlas
Hercules
Endymion
Groves
Mason
Plana
Burg
Baily
De la Rue
Gartner
Strabo
Thales
Democritus
Arnold
Mare
Humboldtanium

some small ring-plains; whilst from the ruggedness at times of the limb this plain is bordered probably on the further hemisphere by a considerable mountain range. East of Mercurius are some moderate mountains whose chief peak is α, and the pear-shaped small walled-plain c, from which towards Endymion extends a long row of hills and small mountains only about 2,000 feet high. North of Mercurius as far as Endymion, is for the most part a wide bright plain, bordered on the west by some regular mountains, and extending almost as far east as Cepheus, where it is more markedly bordered and somewhat darker, the plain being only interrupted by a few ridges, craters, and depressions, with some few isolated peaks and shallow ring-plains, and forming a bright plain nearly as large as the Mare Crisium, and, as pointed out by Mädler, resembling a bright Mare.

Oersted (M.)—A very regular plain north of Cepheus, surrounded by a wall only a thousand feet high, with on the north of its floor a small crater-pit and a hill about 400 feet high. Except at the terminator, the whole formation is invisible, the small hill remaining longest in view.

Chevallier (Lee).—A considerable but shallow ring-plain soon disappearing after sunrise, on the west of Oersted, with several low hills on its bright floor, and a moderately deep crater b (Atlas b of M.) visible for some time after the disappearance of Chevallier.

Atlas (R.)—A great ring-plain 54·96 miles in diameter, with a much-terraced complex broad wall broken by cavities, valleys, and passes, rising at intervals into lofty peaks, and reaching in the west an altitude of 8,895 feet, on the north 10,944 feet, and on the east at β 10,443 feet above the interior. The walls are 5° bright, the floor, some 2,000 square miles in area, generally $2°\frac{1}{2}$ bright, rising on the east to $3°\frac{1}{2}$, and sinking towards the north-west to 2° bright, whilst a small round spot on the south is still darker.

Through the centre of the floor extends a row of elevations rising at the point Γ, in + 48° 8′ lat. and + 43° 40′ long., into the highest peak, near which Schröter thought he saw a small craterlet, and on the wall at the south are two deep craters *c* and *d*, not seen by him. This craterlet of Schröter has been seen since, though Mädler could not see it; and on the floor are two very delicate rills η and θ, seen by Gaudibert and Webb, the latter having also detected a very irregular system of mounds on the floor; but θ is, perhaps, rather doubtful, as it seems to be more a deep narrow valley between two terraces than a real rill. On the north at the foot of Atlas is the small and shallow walled-plain *e*, only partially enclosed, with on its floor, which is somewhat darker on the west than on the east, some 5° bright mountains. West of Atlas is the deep crater-plain A in + 45° 3′ lat. and + 47° 5′ long., readily visible in most conditions of illumination. North is the peak α, and beyond this the peak ε, the highest in its neighbourhood, rising some 1,750 feet, whilst still further north is Atlas δ, a shallow ring-plain fourteen miles in diameter, west of which Mädler saw a short rill, Atlas ζ (S. 9), that has not been again found.

Hercules (R.)—A magnificent ring-plain forming a fit companion to its western neighbour Atlas, with a diameter of 46·34 miles, surrounded by a wall rising 10,889 feet on the west and 10,673 feet on the east above the interior, and in many places consisting of a double chain both adorned by regularly distributed peaks. In the interior is a fine very distinct crater D not centrally placed, that in Full being 8° to 9° bright forms a conspicuous and brilliant object, its position from nine of Mädler's measures being + 46° 23′ 12″ lat. and + 38° 23′ 6″ long. Schröter draws a considerable central elevation, on whose south edge he places D, and by the small crater *e* on the south wall places a considerable depression. Hercules A is a fine very deep crater-plain

5° bright, and as it is still in shadow when Atlas and Hercules are free, it is probably much deeper; its central peak is difficult to see, and in + 51° 10′ lat. and + 43° 30′ long. Beyond is the crater *f*, which, though small, is probably as deep. South of Hercules is a table-land covered with low mountain ridges on which lie three inconspicuous craterlets, of which *d* is easiest to see, whilst between Hercules and Atlas is a wide mountain plateau only 3,690 feet beneath the crest of the wall of Atlas, and perhaps 5,000 feet above the plain at the two ends. In Full, close to Hercules, appears the 7° bright crater B in + 47° 32′ lat. and + 35° 55′ long., not readily seen in low illuminations. In the far south are two peaks β and α of some height, near the last being a square-shaped enclosed plain with a central elevation, at times appearing as a ring-plain.

Mason (M.)—A deep ring-plain, 13·8 miles in diameter, with a wall rising on the east 6,081 feet above the interior, and on the north a small crater, a, of considerable depth. On the west the wall of Mason sinks steeply to a valley 3,556 feet beneath the summit. The labyrinthine mountain region on the west of Mason required, as Mädler remarked, a more powerful instrument than theirs for drawing, though in no place do the peaks much exceed 4,000 feet. The highest peak is β, from which extends a long winding valley to the Lacus Somniorum. Mason C is a 5° bright deep circular depression close west of the peak β.

Plana (M.)—A ring-plain, 23·05 miles in diameter, lying on the southern borders of the Lacus Mortis, in + 42°½ lat. and + 28° long., with very irregularly sloping but steep walls (20°–50°, according to M.) The interior is convex, and probably higher than the exterior surface, and in its centre stands a small but distinct central peak. On the wall at α is a small crater, and abutting it on the east a deep bright crater, *c*, seven miles in diameter, and far more distinct than Plana. Like Mason, Plana lies on the crest of an elevated arm, extending from the hill-land west of Eudoxes to Grove, and separating the lower Lacus Somniorum from the higher Lacus Mortis; the fall towards the south being easily seen, and several fine valleys lead from the lower level to the crest of the elevation.

Burg (M.)—A circular ring-plain, 28 miles in diameter, with a concave floor, perhaps, Mädler remarks, never free from shadow, though this shadow may not be detectable from the earth; and with a wall rising on the east 6,804 feet above the interior, and about 3,000 above the outer plain, whilst on the wall are five small peaks, α being highest. The central mountain, from nine of Mädler's measures, is in + 44° 57′ 9″ lat. and + 27° 31′ 57″ long., and is 5° bright, the walls only 4°, the floor 3°, and a small spot on the north only 2° bright. Between Burg and Hercules are two small rings of little depth or brightness, the northernmost, Burg A, being in + 46° 33′ lat. and + 32° 20′ long. Burg *B* is a high peak on the east border of the Lacus Mortis; and Burg B a feeble crater in + 43° 22′ lat. and + 23° 25′ long., but fully 6° bright. In the plain east of Burg is a fine system of very delicate rills, visible only with great difficulty; the principal, γ (S. 84), was that seen by Mädler, and extends in a curve from a ridge north of Burg to the border of the plateau north of the peak *B*, beyond which Loder has seen a continuation. The second rill, θ (S. 85), was discovered in part by Schmidt, who saw the southern half, and it is very difficult to see; the third, ζ (S. 85), and fourth, ϕ (S. 88), were also seen by Schmidt, and described as very difficult. The fifth, ξ, is perhaps a still narrower continuation of ϕ.

Lacus Mortis (R.)—A small grey plain, extending from + 43°½ to + 50° lat. and + 23°½ to + 36° lat., nearly circular in form, being 157 miles across from east to west, and 143 miles from north to south, with an area of 16,000 square miles, though from strong foreshortening elliptical in appearance. Its colour is on the whole less dark than the great grey Mares, but sufficiently so to render it clearly distinguishable in every illumination from the neighbouring surfaces. The surrounding mountain borders are nowhere Alpine in character, but towards the Lacus are tolerably steep, though furrowed and broken by many valleys and gaps. On the east the border is marked by a very steep plateau, extending from the peak Burg, γ, to B; but south of B the wall of the Lacus Mortis becomes a gentle sloping bank, rising in a few places into peaks, and with a short, steep descent at the foot, crowned by a row of minute craters as far as the shallow but bright crater B, whence the border extends as far as Plana, as a tolerably high crest rising in places into steep peaks. On the west the border is formed by a tract of hill-land, extending from Mason to Hercules, and from thence to the crater Baily B by a row of mountain ridges, whence to the ring-plain Baily no border exists, but the Lacus Mortis and Mare Frigoris are united by a broad channel; but from Baily to the east the two are separated by a wide elevated plateau, rising in high peaks at Baily β, γ, and δ. On the interior of the Lacus are a number of ridges and hill-chains, the strongest of which extends from Burg to Baily, touching the plateau Γ; and a second extends from Mason α, but is feebly connected, and only in a few points 400 or 500 feet high. In Full the great ray from Menelaus can be traced across the floor, and a number of light spots become visible.

Baily (M.)—A circular ring-plain with very irregular walls, that rise on the west nearly 2,500 feet above the floor, and 2,155 feet above the outer plain, whilst on the north a 5° bright crater, D, in + 50° 19′ lat. and + 30° 0′ long., has broken the wall. The crater, Baily B, in + 50°

27′ lat. and + 34° 31′ long., is at the north end of an elliptical plain of little depth, and 4° bright, enclosed by mountain ridges; and between B and the crater *c* the surface is only from 2°½ to 3°½ bright. Baily A, in + 48° 53′ lat. and + 30° 24′ long., is the deepest of the small formations of this region, and its 5° bright wall rises 1,778 feet above the surrounding plain. Between Baily and Burg is a small nearly triangular plateau, Baily Γ, with seven peaks united to one another, the greatest standing on the southern point, whose position is + 47° 10′ lat. and + 28° 35′ long. On the high plateau, east of Baily, rise the three steep and high peaks, Baily β, γ, and δ.

Endymion (R.)—A fine nearly circular walled-plain, 78 miles in diameter, with a much-terraced complex wall with many peaks, rising at γ 10,347 feet, at δ 9,056 feet, at ε 10,155 feet, the highest on the west wall α 15,309 feet, and at β 7,565 feet above the interior; whilst the walls are cut by a ravine south of γ, and a long pass east of G. The floor on which Mädler saw neither craterlet nor elevation appears at Full as a dark spot undergoing considerable variation in brightness according to its position, altering with the condition of the moon's libration, which moves it first towards the moon's centre, and then towards the limb, and its brightness varying from 1°½ to 2°½. It possesses, however, a border about ten miles in breadth, fully 5° bright; and these variations merit careful observation, though from the position of Endymion it is not very favourably placed for such a purpose. All round Endymion are a number of mountain ridges and other irregularities, showing that the surface must have been much disturbed. West of Endymion extends from + 53°½ to + 59° lat. a bright plain, on whose border is the 6°½ bright crater G, from eight of Mädler's measures in + 56° 28′ 30″ lat. and + 54° 18′ 26″ long., and this plain is bordered on the east by a considerable mountain chain extending as far as Strabo, and crossed by a broad valley in + 58°½ lat. On the west this plain is bordered by a greater mountain chain, interrupted by a number of small ring-plains and craters; it extends for nearly 200 miles as far north as Strabo, in Full disappearing but two days after standing out as a splendid row of peaks, visible far within the terminator, fully twenty-four hours after the sun has set on the plain beneath. On this chain are the small ring-plain, A, in + 54° 46′ lat. and + 62° 40′ long.; and the crater, D, in + 52° 25′ lat. and + 62° 4′ long.; and west on a hilly plain 5° bright, and 300 miles long by 100 broad are two ring-plains, Endymion F and *b*, the last in + 66° long. Between Endymion and Hercules A the surface is a mountainous region of very complex nature, but without either steepness or height, and soon disappearing after sunrise.

Mare Humboldtianum (M.)—A great enclosed plain on the north-west limb of the moon, extending from the high peak E in + 54° 4′ lat. and + 75° 30′ long. to a deep ring-plain in + 64° 15′ lat. and + 78° 0′ long., and from + 71° long. to the moon's limb, and probably beyond to + 96° long., a length of 191 miles and a breadth of 254 miles, though in a great bay on the far west it extends perhaps 300 miles or further, thus possessing an area of some 40,000 square miles, a little less than the Mare Humorum, but greater than the Mare Vaporum. The brightness of the floor is very variable, and so is the tint, which, perhaps naturally of a dark-grey, is much influenced by libration. The border on the east is formed by high mountain ranges very steep and containing numerous peaks, whilst it is in portions broken by valleys and a few crater-like formations. These last are more numerous and considerable on the outer slope of the border of the Mare, and the principal are, Strabo **a** and Endymion *b*, both very deep ring-plains, about thirty-two miles in diameter. The western border is probably still higher, and in portion only is visible, except with strong easterly libration of the moon, when it appears in profile on the limb; a peak α on the border here, in $+ 58° 35'$ lat., rises over 16,000 feet, and fully 8,000 feet above the crest of the wall; and other peaks on the western border must be over 13,000 feet high. Towards the north the walls decrease in height, and become only about 5,000 feet above the surface. The interior is traversed by a considerable number of long mountain-ridges, and low hills are common, but no craters have as yet been detected; yet, as Mädler remarks, standing in its centre or even on one of these central elevations, the whole of the vast enclosing wall with its stupendous peaks would be invisible, and all would appear as a comparatively level plain. Between this region and the equator in certain states of libration two singular flattenings of the limb were discovered by Key in 1863; they are principally optical, and seem due to a curved mountain-arm extending between two peaks.

De la Rue (B.)—A great, very irregular, shallow walled-plain, enclosed by intersecting mountain-chains, the principal being that extending from Endymion to Strabo on the west, where the small ring-plain *b* (Endymion *b*, the second of M.) lies on the border, and on the east the wall is formed by a system of interlacing ridges extending from Endymion to Strabo D, having its greatest elevation at γ, and from D unites with the west wall south-east of Strabo. Towards the centre rises the peak De la Rue α, which is united to the south wall by series of ridges, whilst a short arm projects from the east wall near β to the same point. The naming of this formation, considering its indefinite character, is perhaps a doubtful advantage, as Mädler's system of only including well-defined marked formations in the system of nomenclature should always be adhered to where practicable.

Strabo (M.)—An irregular walled-plain, thirty-two miles in diameter, with some high peaks on its western wall, and whose floor with the surrounding surface is only 3°½ bright. From its north-west wall extends south a great mountain chain culminating at the high peak B, which rises 10,743 feet above the east, and then divides into two branches, extending to Endymion and Endymion D, respectively, and have been already referred to. Strabo B in + 65° 35′ lat. and + 65° 30′ long., is on the border of a level plain west of Strabo, which is traversed by some mountain ridges; and Strabo D is a small bright ring-plain on the border of De la Rue, and in + 57° 35′ lat. and + 45° 25′ long.

Thales (R.)—A regular deep steep crater-plain, 6° bright, with points on the north-west wall 8° bright, the highest peaks being α and B, and from nine measures of Mädler's the position of Thales is + 61° 58′ 24″ lat. and + 49° 12′ 23″ long. North are many small ring-plains, three close to each other and 7° bright, forming a regular row, the central one being Thales **a**. The general brightness of this western region is fully 4°½, and it is traversed by some 6° bright streaks, one 7° bright streak being also visible, extending from Thales towards Democritus, crossing the peak Thales γ. East of Thales are some small ring-plains of no depth, with dark interiors, the principal being Thales *c*, *e*, and *f*, on the borders of the last rising Thales A, a bright craterlet in + 58° 24′ lat. and + 40° 21′ long.

Gärtner (S.)—A very large irregular walled-plain, with a tolerably high-peaked mountain chain as a north border, with gentle exterior but steep interior slope, whose highest point A is in + 59° 50′ lat. and + 35° 12′ long. The border on the east though low can be clearly followed, but on the south it has entirely disappeared, for the numerous hill-rows here cannot be regarded as a continuation of the wall, but are probably only ridges from the neighbouring

Mare Frigoris, which is of similar brightness to Gärtner. North on a bright elevated plateau, extending as far as Thales, is Gartner A, a deep crater with a high peak on the south; farther south is the shallow depression *b*, and east on the wall is a craterlet *c*, drawn by Schröter but omitted by Mädler.

Map VI.


West Longitude
East Longitude
North Latitude
MARE IMBRIUM
MARE FRIGORIS
MARE
Cassini
Piton
Piazzi
Smyth
Mont Blanc
Pico
Teneriffe Mts
Straight Range
Leverrier
Plato
Eudoxes
Egede
Aristoteles
Archytas
Gartner
Democritus
Chr. Mayer
W C Bond
Timaeus
Birmingham
Fontenelle
F Herschel
Condamine
Arnold
Moigno
Tyler
Meton
Euctemon
Barrow
Scoresby
Challis
Main
Gioja
Goldschmidt
Anaxagoras
Epigenes
Philolaus
Anaximenes

CHAPTER XII.

MAP VI.

Democritus (R.)—A deep ring-plain, whose wall rises on the west 5,653 feet above the interior, and on the east, at α, must be considerably higher. The northern portion of the wall and the central mountain are 6° bright, but of little intensity, and not readily seen in Full; and, from eight measures of Mädler's, the centre of Democritus is in + 62° 8′ 21″ lat. and + 33° 30′ 21″ long. Democritus is surrounded by a number of small mountains with gently sloping sides, and towards the Mare are some small craters, or probably crater-pits, the chief being Democritus A, B, and *c*.

In this region commences a particularly remarkable net-like formation, formed by the intersection of branching mountain ridges and chains, that enclose isolated spaces of very different yet in the main rectangular form, and appear to be all on the same level, and near the terminator of a uniform grey tint; while intermingled are some formations which seem to be ring-plains, but partake much of the same character.

Arnold (S.)—Mädler considered that Schröter's Arnold was probably the surface enclosed by three mountain ridges extending parallel to the meridian, and applied the name to the central of the three enclosures thus formed, marking the others as a and *b*; it would seem probable, however, that though Schröter's and Mädler's Arnolds are identical, yet the third ring-plain F of Schröter is a portion of the enclosed plain beyond **a** and not *b*. Arnold is a large walled-plain of somewhat rectangular form, whose walls are of considerable height on the north and east, and possess a steep peak at A; while on the floor, besides some hills, is a small craterlet or crater-pit. The walled-plain, Arnold **a**, is smaller than the last, with higher walls, and a very steep bright peak, β, on the west wall. Arnold *b* is only well bordered on the east, having elsewhere low and imperfect walls. West of Arnold is a wide bright plain, bordered by mountains, and containing a number of small craters. Arnold *e* is a great and deep crater-plain, from which extends as far as Meton nearly, a deep wide valley cleft; whilst south of this is the steep high peak, Γ, in + 69°½ lat. and + 36° long.

Moigno (B.)—A considerable ring-plain with tolerably high walls, and a level but dark interior, on which is the small but very distinct crater *c* (Arnold *c* of M), in + 67° 52′ lat. and + 29° 0′ long. East of it are a number of dark plains enclosed by mountain ridges, and rising at Γ into a small peak.

Peters (B.) [Arnold *d* of M.]—A small ring-plain of small depth, and about 5° brightness, on the east of a bright level plain.

Mare Frigoris Western (R.)—This Mare appears in Full with a pale yellowish, or perhaps greenish yellow, glimmer, first perceptible between Endymion and Hercules, but whose greatest intensity is between Aristoteles and Plato. Its length from east to west is very considerable, and so is its breadth, though this is optically foreshortened to only one half. The whole, especially in not entirely favourable atmospheric conditions, appears as a streak of thin cloud, fog, or mist, stretching across the northern portion of the moon; and when a thin misty cloud is seen extended as a belt across the moon, the similarity between this and the Mare

Frigoris is so great that one unfamiliar with the last would take it likewise for a cloud. In low illuminations the contrast in colour is very faint, and it is only distinguished from the surrounding regions by its more level character; but in the night side of the moon, when seen by the light reflected from the earth, it is found with tolerable certainty by the contrast between it and the bright environing mountain regions. The western portion is bordered on the north by the systems of Gärtner, Democritus, Moigno, Chr. Mayer, and Archytas; and by Hercules, Baily, Aristoteles, and Egede, on the south; and is traversed in all directions by many ridges, though the most distinct and greatest have a general south or south-west direction. The plane contains also isolated hills, crater-pits, and one or two craters, together with some small ring-plains, the principal being Aristoteles B, Chr. Mayer A, and Archytas A. Between Aristoteles C and Archytas the ridges become few, low, and scarcely detectable, and the yellowish colour of the Mare becomes very marked; and east of Chr. Mayer are a number of high peaks on the surface, with some mounds and short ridges, and here the Mare is traversed by several light streaks or rays from Anaxagoras, the principal touching the mountain Archytas γ.

Aristoteles (R.)—A magnificent ring-plain, 50·7 miles in diameter, with very lofty complex walls, consisting of parallel chains, much terraced, and rising in high peaks, the two principal being α on the east, 10,692 feet, and β on the west, 10,500 feet above the interior. The walls are 4° bright, the peaks 5° bright, and the floor 4° bright, with, however, two small grey spots 2° bright on the north, whilst a row of 4° bright hills cross the floor. From this uniformity in brightness Aristoteles, despite its great size and depth, is only to be detected with some trouble in Full. West of Aristoteles is a smaller, somewhat irregular, but fully as deep ring-plain, **a**, with a steep, fine, central mountain at the end of a short ridge; and north of the point where Aristoteles and **a** are united, is a small depression, whilst a similar lies close under the peak α. What distinguishes Aristoteles from all other ring-plains, is the hill-rows extending on all sides in the very definite direction of N.E., N.W., and S.W., these chains of hills being closely parallel to each other; and though other systems of radiating hill-rows are known, the regularity and marked direction of those of Aristoteles render them unique. The hills are small, and not particularly steep; those extending N.E. being largest, and the chains longest and most distinct. The valleys between these hill-chains are very gentle, being of little depth and of the same colour as the hills, whence, owing to the slight height and steepness of these, the whole appearance disappears very shortly after sunrise. Around Aristoteles, but principally in the north-west, are a large number of very minute crater-pits, only visible with considerable difficulty, and only a few of which are shown. Four of these minute craters lie in a row within the ring-plain at η, forming a very delicate object, first seen by Webb. West of Aristoteles is an elevated hill-land, bordered towards the Mare Frigoris by a gentle slope, crowned by a row of small peaks on the east, 4° bright, and on the west 5° bright, and culminating at ϵ, in a peak 780 feet high. South of this, on the bright hill-land, is the crater Aristoteles, *e*, on a long winding ridge. On the Mare Frigoris, north of Aristoteles, is the small ring-plain, B, in + 55° 36′ lat. and + 26° 10′ long.; according to Schröter, 8,200 feet deep; within it Webb has detected a smaller crater; and north of it is the bright and conspicuous crater Aristoteles C, from ten measures of Mädler's, in + 57° 26′ 3″ lat. and + 23° 33′ 42″ long. North of Aristoteles is the double peak, **Γ**, on the western peak being a very small craterlet; and between this and B, extending as far north-east as Chr. Mayer, C, Mädler observed a long fine rill, Aristoteles, θ (S. 89), that has not been again seen. North-east of Aristoteles, Webb has seen a small furrow or valley cleft, ψ.

Eudoxes (R.)—A very fine deep irregular ring-plain, forming a noble companion to Aristoteles, with a 5° bright wall enclosing a 3° bright interior, on which are only two or three 4° bright elevations, the rest of the numerous irregularities in the interior being of the same brightness as the floor. On the south-east the wall is in part double and crossed by a rugged pass, south is a fine though not measurable peak, and opposite it a difficultly visible crater, whilst the whole wall is much terraced, has numerous buttresses and projections, and is crowned by innumerable peaks. The crest of the wall at β rises 9,816 feet, at γ 7,194 feet, and near α 11,299 feet above the interior; Schröter obtaining for this last 12,500 feet, while on another occasion Mädler found for the height of the summit of two peaks near α an altitude of nearly 15,000 feet, which he considers in some way doubtful, as they have not the appearance of rising over 3,000 feet above the crest of the wall. Of the numerous hills within Eudoxes none appear to be of any particular importance, and are only visible for a short period.

On the north-west slope of Eudoxes is a small but bright crater B in +45° 23′ lat. and + 16° 43′ long. in high illumination, the most conspicuous object near Eudoxes. North-east, beyond a strong mountain arm ε is an area of about 1,400 square miles, covered with a great number of low hills, over one hundred in number being readily seen, and north of this is an irregularly formed, nearly rhomboidal walled plain *f* with a level floor and wall not clearly united and containing eight peaks. Further east is a low-lying level plain of dark colour only 2°½ bright, bordered by mountains in some places high and with a peak ε according to Schröter nearly 5,000 feet high. In a small plain south of this Mädler discovered a short rill θ (S. 97), visible only with difficulty, but since then it has been often seen. Crossing this, Schmidt has discovered another ξ (S. 98), a difficult object, and south of the two a third ϕ (S. 99) which seems to join the first, whilst north in the borders of the dark plain mentioned above he mentions two very difficultly visible crater rills η (S. 95), and ζ (S. 96). On the 5th Jan. 1873 a new rill ω was seen extremely delicate and in portion perhaps broken, extending from the dark plain in a broad shallow much-branched valley in a gentle curve to the bright open plain beyond the high plateau κ. Eudoxes *c* is a 5° bright, not entirely enclosed small ring-plain, and north is a $5°\frac{1}{2}$ bright deep crater D in + 42° 55′ lat. and + 12° 34′ long. and environing the two are a number of isolated mountains in points of some heighth. West of Eudoxes stretches a great elevated bright hill region rising in two places in high plateaux, on the northern of which is situated the great 7° bright crater Eudoxes Λ in + 45° 31′ lat. and + 19° 37′ long. between which and Eudoxes is the 6° bright crater *g*, whilst the southern and largest of the two plateaux rises in two peaks at κ and Δ, the last in + 40° 33′ lat. and + 18° 0′ long. This wide hill-land, with an area of about 40,000 square miles, with its long winding and much-branched shallow valleys, together with its numerous gently sloping hills and other irregularities, brings forcibly to mind many analogous terrestrial regions and deserves to be more carefully and completely drawn than has hitherto been done. Mädler found his instrument far too small to enable him to successfully deal with it and accordingly only drew the principal features, and to adequately represent the true condition of the surface a very powerful telescope must be employed.

Egede (M.)—A peculiar rhomboidal ring-plain with extremely low and narrow walls, nowhere above 400 feet high, steep only towards the interior, which is at the same level as the outer surface but darker. Egede is only visible when less than 15° to 20° from the terminator and is on the south border of the great bay of the Mare Frigoris. Schröter on the 15th Feb. 1796 observed south-east of Aristillus a dark grey ring-plain that he had on no other occasion seen, and though drawn too near Aristillus this appears to have been Egede, though Mädler makes no mention of Schröter's observation. On the east of Egede extends a sharp curved slope of the Alps as far as the small crater Egede D in + 49° 19′ lat. and + 5° 22′ long. considered by Mädler a ridge, and in the open bay is the small ring-plain Egede A, in + 51° 39′ lat. and + 9° 40′ long., with at about equal distances on either side the small craters Egede *c* and *b*.

The Great Alpine Valley.—A very remarkable deep valley eighty-three miles long, from three and a half to six miles broad, traversing the whole breadth of the lofty Alpine highlands, and uniting the high Mare Frigoris with the low Mare Imbrium, and resembling a vast cleft. First figured by Bianchini, a fact unnoticed by Schröter, Beer and Mädler, and Schmidt; it was drawn on several occasions by Schröter, though imperfectly. Beer and Mädler, and others, have drawn it more carefully, but still all the representations that have hitherto been given only imperfectly show the real character and details of this immense valley-cleft, which is included by Schmidt in his rills as No. 94. It commences at the south border of the Mare Frigoris as a gently sloping valley, scarcely a mile wide, and gradually widens and deepens as it descends, becoming more and more rugged, until after bursting through the main range of the Alps it debouches on to the Mare Imbrium in a wide mouth. On all sides from the high plateau of the Alps, branch valleys and ravines open into the principal valley, but all these are far inferior in size and steepness, and apparently after-formations. The sides of the valley are steepest on the east, and its bottom, near the peak π, lies nearly 12,000 feet beneath the main level of the crest of the Alps here, whilst in front of its mouth are a number of elevations and mountain masses dividing it into two or more openings on to the Mare.

Alps, Western (H.)—These mountains extend from the high peak Cassini η in $+ 42° 12'$ lat. and $+ 1° 0'$ long. to Plato, in a great curve, forming a high crest to the steep descent towards the Mare Imbrium of the lofty Alpine highlands. At Cassini η, a very peculiar mountain surrounded by the dark plain below, the Alps rise in a high peak, 7,639 feet, with a projecting buttress terminating in a point 1,300 feet above the Mare. From here, gradually increasing in height from 3,000 to 4,000 feet high, they extend to the massive mountain Cassini Z, that possesses three lofty peaks, the southernmost rising 8,518 feet above the Mare, and casting a long shadow across the Mare Imbrium. After this the main crest of the Alps reaches a very considerable altitude, and the peaks become more massive and loftier, k being 8,297 feet high. Next comes the great mountain mass, termed Mount Blanc by Schröter, its southern peak γ, 6,299 feet high, the chief peak α, 11,868 feet high according to Mädler and from three measures of Schröter's nearly 14,000 feet, and east β (Plato η of M.) 6,299 feet high. The western portion of the Alps ends at Mount Blanc δ, a peak detached somewhat from the rest, and perhaps 8,000 feet high. At the foot of these mountains are only few branches, buttresses or ridges, and the Mare Imbrium appears here particularly dark; the white alpine crest accordingly stands out conspicuously under all illuminations. Close beneath the peak Cassini Z, probably, Schröter on September 26, 1788, saw on the night side of the moon a brilliant white spot, resembling a fifth mag. star as seen with the naked eye, which after being visible for fully 15^{m} disappeared. A similar phenomenon has been since seen in the same neighbourhood. West of the high crest of the Alps extend the great Alpine highlands, with perhaps an average height of 6,000 feet above the Mare Imbrium, and with peaks, in places perhaps surpassing even those of the great eastern border-chain. This plateau, which slopes gently towards the west, arises insensibly in the wide hill region south of Egede. On the south-west border rises the 5° high mountain Cassini δ, over 5,000 feet high, and north of this is the 5° bright crater Cassini G, in + 44° 44′ lat. and + 40° 41′ long., of little depth; and east is a wide triangular 5°½ bright plateau, rising at θ into a 7° bright peak, and with still farther east a second, ϕ, only 6° bright. North is the 6° bright peak Cassini ι, near which are to be seen some dark spots at Full, and west is the 5° bright peak Egede β, of no particular height. Within the hill-land west of the Alpine highland, which elevated perhaps 1,000 feet above the Mare Frigoris, and sloping gently south-west, forms a connection between the Alps and Caucasus; towards the south border, here only 3° bright, is the small ring-plain Cassini E in + 42° 52′ lat. and + 6° 25′ long., 4° bright, and south-west the 7° bright crater Cassini C in + 41° 35′ lat. and + 7° 12′ long. of great depth, with close to it some mountains of no great altitude and a small 6° bright crater Cassini *f*. North of the great Alpine valley, the highlands of the Alps present exactly the same characteristics as on the south, the border towards the Mare Frigoris being more marked, and consisting of a much curved somewhat steep slope broken by many projections and mountains, the principal being Archytas ϵ and ζ, both bright and steep, though not high, the mountain mass Archytas η being alone here of any considerable height on the west of the selenographical first meridian. On the border of the great valley is Archytas *d*, an enclosure, according to Mädler, resembling a crater, and bearing some resemblance to the remains of a small ring-plain, to some degree completed by a curved mountain arm.

Archytas (R.)—A conspicuous ring-plain, 20·79 miles in diameter, with a wall 7° bright on the north and west, where it is 5,400 feet high, and 6° bright on the south and east, where it rises only 3,945 feet above the 4° bright floor, on whose centre rises a fine 6° bright central mountain occasionally lost in the shadow of the wall, and whose position from eight measures of Mädler's is + 58° 24′ 1″ lat. and + 4° 13′ 13″ long. From Archytas low hill-chains extend in all directions only visible under favourable conditions; and in the Mare Frigoris on the south-west is the very similar, slightly smaller ring-plain Archytas A in + 55° 20′ lat. and + 6° 38′ long., whose west wall rises, according to Schröter 4,000 feet, and on the east must be fully 5,000 feet deep. South-east is a fine delicate rill, Archytas *θ* (S. 93), discovered by Lohrmann, seen after an interval of forty years by Schmidt, and a rather difficult object unless under favourable conditions. North of Archytas, Schröter thought he saw a rill extending from the north wall of Archytas along the west foot of the mountain chain, whose principal peaks are γ and ϵ, as far as the latter; but Schmidt thinks this was an error on his part, though he has included it as No. 92 in his catalogue; it may, however, be one of the long valleys here that at times take the appearance of broad rills. Archytas C is the principal of these valleys, and towards its centre is a small peak in + 63° 30′ lat. and + 8° 20′ long. From the peak γ extends north-east a ridge crowned by five peaks apparently all of equal height, δ being the end one, but in Full all disappear, except γ and x, both 6° bright. West is the considerable ring-plain Archytas *d*, enclosed by long mountain chains rising at α and β into high 4°½ bright peaks, though the general brightness of the mountains is only 3°½, and forming the westernmost of the three named Chr. Mayer by Schröter. Riccioli's Archytas was in a region where no ring-plains exist, and Schröter transferred the name to the two ring-plains, Archytas and A, and Mädler restricted the name to the larger of the two, a similar course to that he has followed under analogous conditions elsewhere, and with some advantage.

W. C. Bond (B.)—An extensive walled-plain traversed by the selenographical first meridian and north of Archytas, whose very irregular walls are in some points of a considerable altitude, especially on the east, and owing to its interior being slightly darker than the walls it can be seen, though with some difficulty, in Full. On its interior, which is crossed by several light streaks from Anaxagoras, is a deep crater B (Archytas B, of M.), with 6° bright walls, in + 64° 44′ lat. and + 6° 8′ long.

Christian Mayer (S.)—A ring-plain 18·4 miles in diameter, and of considerable depth with broad walls, whose northern slope is 4° bright and southern 6° bright, whilst the 3° bright interior contains a 4° bright central peak. North-west of Chr. Mayer extends a broad short mountain arm, at whose east foot is a delicate curved rill θ (S. 91), fourteen miles long, seen only by Mädler, and on the following evening a second still more difficult rill, ζ (S. 90), was discovered by Mädler, extending from the south-west wall of Mayer to a small crater at a gap in the ring-plain *b*. This last is an irregular formation, highest on the east, where is a small peak β, and beneath this an opening, on each side of which is a small 5° bright crater, with a larger one farther north. South-west of *b* is the fine ring-plain Chr. Mayer A, still deeper than Chr. Mayer, with a 3°½ bright interior, a 5° bright wall, and a 7° bright peak δ, thus distinctly visible under every illumination, but without a central mountain. South is the 5° bright crater C, in + 57° 30′ lat. and + 23° 54′ long., and near it the double peak mountain E. From Mayer on the west, extends a curved mountain ridge rising into a tolerably high peak at Chr. Mayer α, which unites with a second γ, north of *b*, thus enclosing a level plain on whose floor are two small crater-pits, and at times appearing like a walled-plain. Mädler observes, that from the similarity in the position, dimensions, and depths of the ring-plains Chr. Mayer, Chr. Mayer A, Archytas, Archytas A, and Timaus, when all are not distinctly visible, by one unacquainted with the region, it is easy to make mistakes through confounding them.

Meton (R.)—This is one of the largest walled-plains in this portion of the surface, with a border consisting of a chain of peaks and craters connected together by a low crest, rising at the 5° bright peak α 5,207 feet, and at the wider south border only 2,950 feet above the interior; which traversed by four light streaks from Anaxagoras, while a fifth touches the south wall, contains a distinct 5° bright crater B, in + 70° 24′ lat. and + 15° 35′ long. The most conspicuous crater on the wall is **a**, west of which the wall is crossed by three narrow hardly perceptible passes near γ, and two more passes lie on the south wall near a low peak δ, whilst the central elevation ε is very low.

Euctemon (R.)—A smaller and more regular walled-plain than its neighbour Meton, with its highest peaks at α and β, which are of considerable steepness, and the latter is 11,000 feet high, but owing to the uniform brightness of the region it is not easy to find Euctemon towards Full. A fine straight ravine or pass Γ unites the two formations Euctemon and Meton, cutting through both walls almost down to the level of their floors. West of Euctemon is another walled-plain of somewhat larger dimensions **a** with a bright crater B, in + 73° 10′ lat. and + 33° 5′ long., on its wall, and three smaller ones towards the north of the floor. North and north-west of this are a number of ring and walled plains only distinctly to be seen under favourable conditions of libration and illumination, though in places their walls reach a considerable altitude, the peak γ rising 8,500 feet. Euctemon δ is a mountain in + 83° 16′ 27″ lat. and + 118° 0′ 40″ long., and Euctemon ϵ, another peak, in + 78° 1′ 46″ lat. and + 126° 37′ 35″ long., both on the farther hemisphere.

Scoresby (M.)—A well-marked deep ring-plain 35·87 miles in diameter with steep walls, containing some slight peaks, and according to two measures of Mädler's rising 8,581 and 11,063 feet above the floor or from the mean 10,000 feet above the interior; it possesses a central crater and two small peaks, all difficult to detect, while from the uniform brightness of 7° of Scoresby, it is very conspicuous in Full. North-west is a smaller ring-plain A.

Challis (B.) [Scoresby *b*, M.]—A ring-plain larger than Scoresby, but only one-third as deep and not nearly so distinct, lying closer to the North Pole.

Main (B.) [Scoresby *c*, M.]—A large ring-plain on the north of Challis, but scarcely 4,000 feet deep and only 5° bright. A broad mountain arm extends from it to Gioja; north-west is a high peak α.

Gioja (M.)—A ring-plain very close to the lunar North Pole, being in latitude + 85°, and thus seldom well seen, though it is 25·73 miles in diameter and of considerable depth, with a small central mountain on the floor. North in + 87° lat. and + 4° long. is a small crater, probably the nearest of all formations of this class to the pole, that can be seen. Gioja γ is a lofty peak, from measures of Mädler's in + 86° 44′ 33″ lat. and + 174° 46′ 33″ long., or in the farther hemisphere of the moon; and Gioja α is, from similar measures of Mädler, in + 88° 4′ 41″ lat. and − 7° 2′ 9″ long.

North Pole.—The north pole of the moon falls between two high mountain chains in a wide plain close to two high mountains, Gioja α and β, the former on the east and 9,500 feet high, the latter on the west and still higher perhaps, whilst the nearest chain rises in the west at the peak δ 8,250 feet, and the chain beyond the pole rises in the east at the peak γ over 7,000 feet. The northern polar regions therefore are marked by lofty mountain masses, though not towering aloft to the stupendous altitude of those of the opposite pole, and the summits of the two mountain peaks close to the pole must, from their height, be always illuminated and enjoy perpetual day, whilst some of the portions of the polar plain must, owing to the mountain shadow, be immersed in a continual twilight, for night would not be possible with the reflection from the always illuminated peaks.

Barrow (M.)—A nearly square-shaped walled-plain with moderately high walls, only on the east do lofty peaks appear; where A in + 72° 10′ lat. and + 1° 50′ long. rises 9,419 feet, the only high peak on the west being β, which is 7,910 feet high. On the wall is the crater B, west of which is a pass, and further east is a somewhat deep ring-plain **a**; whilst the floor, though under low illumination, appearing dark, towards Full is seen to be traversed by numerous light streaks from Anaxagoras, rendering it fully 5° bright. Mädler has remarked that from the height of the east walls of Barrow at sunset, the ring-plain **a** vanishes completely. North of Barrow is a very similar walled-plain *b*, containing a small crater Barrow *c*, on the west.

Goldschmidt (B.)—An extensive walled-plain east of Barrow, with tolerably high walls on the west and east, being near α 7,000 feet high, and with two small crater-pits on the floor, which is almost covered by the streaks from Anaxagoras.

Anaxagoras (R.)—A fine ring-plain 31·44 miles in diameter, and fully 7° bright in both wall and interior, and though not so much in the intensity as in the marked purity of its whiteness, it rises considerably above its environs, while isolated spots and peaks on the wall and interior rise to fully 8° brightness, and the central mountain is perhaps still brighter. The wall, though gently sloping and terraced on the exterior, is steep towards the interior, and rises at the peak α (η of M.) 9,529 feet, and at β perhaps 10,000 feet. Anaxagoras is surrounded by a somewhat darker ring, beyond which appear a great number of fully 5° bright light streaks radiating to a considerable distance on all sides. South-west on the border of Goldschmidt rises a high steep plateau ζ, on which is a small crater, or ring-plain **a**, and west is a still higher plateau γ, triangular in form and crowned by three lofty peaks, that on the west rising 8,729 feet, while those on the east are 7,328 and 5,480 feet high. From this plateau long mountain arms extend on all sides, the principal rising at Δ into a steep peak 3,200 feet high, whose position is + 71° 40′ lat. and – 17° 24′ long. On the west of Anaxagoras are two small craterlets fully 8° bright, from which extends a curved 7° bright light streak as far as Gioja, but owing to the brightness of the north polar regions being fully 6°, it is not particularly distinct. A branch of the same streak crosses the high peak Anaxagoras E, in + 77° 0′ lat. and – 0° 43′ long. North extends a long mountain chain of variable height, the principal peak being Anaxagoras A in + 80° 14′ lat. and -- 16° 30′ long., close to which is a small depression; and near the steep peak B in + 80° 0′ lat. and – 27° 0′ long., it bends east and forms the south border of a long valley *e*, which on the south is bordered by a similar chain whose highest point is Z, in + 80° 56′ lat. and – 49° 0′ long. Beyond the limb is a lofty peak i, from measures of Mädler's, in $+\ 85^\circ\ 24'\ 0''$ lat. and $-\ 108^\circ\ 14'\ 35''$ long.

Epigenes (R.)—A great but not very bright ring-plain with two high peaks α and β, and two craters or depressions on its walls, one on the outer slope, and the other, β, on the inner slope, in $+\ 68^\circ\ 42'$ lat. and $-\ 5^\circ\ 0'$ long.; but as the eastern wall of this last is considerably brighter than the western, the crater is often not detectable as such. West of Epigenes are two 7° bright craters of great depth, the larger **a** having a still smaller on its wall, but b lying on the open plain. A mountain chain γ unites Epigenes with Barrow, and is of moderate height; while in the south-west a similar but higher, more irregular, and very rugged chain extends to Timaus, and rises at δ 4,000 feet high. South-east extends the steep chain ζ as far as Fontenelle, traversed in several places by deep passes, whilst branches of which ϵ is the strongest, extend south to the highlands east of Timaus; the environs of Epigenes being thus a mass of mountains, except on the north-east, where it is more open. The high peak H on the end of a steep-curved mountain east of Timaus, according to four measures of Mädler's, is in $+\ 67^\circ\ 51'\ 30''$ lat. and $-\ 10^\circ\ 31'\ 0''$ long. Birt has called attention to the utter discrepancy between the nomenclature of Schröter and Mädler on this part of the moon, arising in part, however, from the somewhat indefinite character of some of Schröter's formations. Epigenes is Schröter's Philolaus, and Beer and Mädler's Anaximenes is Schröter's Lexell. Beer and Mädler being unable to identify it, removed it to the north of Tycho; whilst the names of Philolaus and Anaxagoras have been transferred to other formations than those to which Schröter thought Riccioli applied them. 'No wonder,' according to Birt, 'that in the midst of all this confusion Beer and Mädler could not find the valley J. J. Cassini, recovered by Webb some time back.'

An impartial examination will show, however, that Mädler has considerably improved the nomenclature of this district, and his nomenclature has been retained as most convenient.

Birmingham (B.)—A walled-plain of square form between Fontenelle and Epigenes, bordered by steep mountain chains and rising on the south at the peak α to a considerable height, whilst the interior is traversed by four parallel chains in a northerly direction, the two western ones being brighter than the others. As this formation is simply an irregular space enclosed within four ridges, it is a member of a class which, according to Mädler's system, would not have been named, and this system should always, if possible, be adhered to.

Timaus (R.)—A fine ring-plain on the border of the Mare Frigoris, with 8° bright walls, fully 4,500 feet high, and still higher at the peak α on the selenographical first meridian, while the central peak is in + 62° 27′ lat. and − 1° 0′ long. Timaus is surrounded by a number of short light streaks, and on the east lies a wild labyrinthical mass of mountains rising at the peak β and γ to a considerable height and enclosing two small rounded valleys *e* and *f* close to Timaus. In the far east of this mountain region is a small valley η (S. 140), resembling a rill, and west is a tolerably high peak δ.

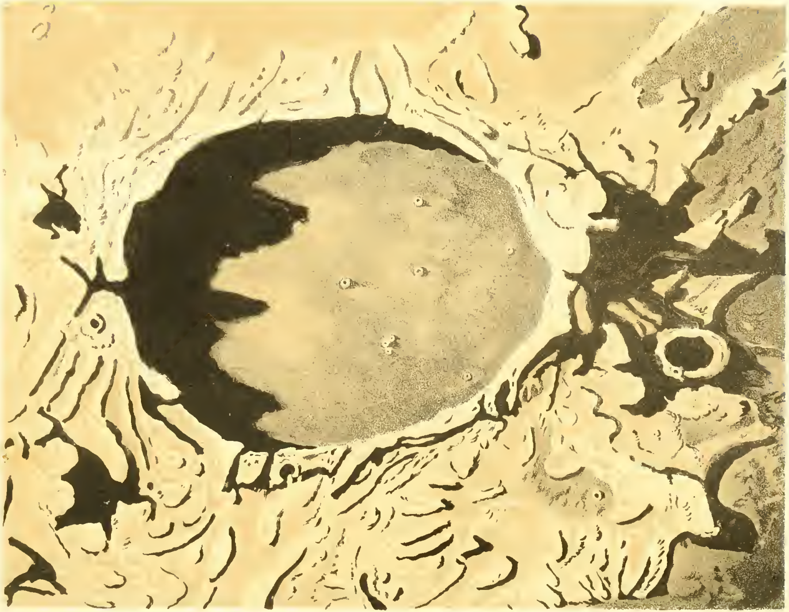
Alps, Eastern (H.)—The Alps east of the great cross valley rapidly lose in height and become broken, the border range being at its highest at Plato λ, where an altitude of 12,021 feet is reached; it ends finally at the peak ξ, according to Schröter, 8,500 feet high, which at its east encloses a crateriform depression μ. The Alpine highlands lose little in height or massiveness, the slope towards the Mare Frigoris becoming still steeper, though that towards the Mare Imbrium becomes a long gently sloping incline, broken at places by peaks. The peak ω rises 8,749 feet, and is at the summit of this southern slope, whilst farther towards the interior of the highlands, which are probably elevated several thousand feet above the Mare Imbrium, rise a considerable number of lofty peaks whose altitude would seem still greater were they near the edge of the highlands, $\varkappa$ being 7,700, and ψ over 10,000 feet, above the surrounding highlands according to Schröter.

Plato (R.)—A great walled-plain 60·12 miles in diameter with 6° bright walls, much terraced on the exterior, rising in lofty steep peaks on the west and north, where γ is 7,258 feet high, δ 6,369 feet, and ϵ 5,128 feet high; whilst on the east the massive mountain ζ rises 7,418 feet above the interior, though the height of the crest of the wall is only about 3,200 feet on the west and north, 3,800 on the east, and some 3,000 on the south, where there is a break in the wall. According to Mädler the floor of Plato is a dark steel grey, crossed in high illumination by four light streaks from north to south, paler than those of Archimedes, and containing some small craterlets or probably only light spots, which belong to the most delicate objects on the Moon, whilst the interior is free from ridges. In the second edition of the 'Mappa Selenographica' these four light streaks no longer appear, the whole floor being given as of one uniform dark steel grey colour.

The surface of Plato contains a number of light grey streaks and small white round spots that, during the period 1869–1872, were subject to a long series of observations by a number of independent observers; their observations carefully discussed by Birt, form the basis of two elaborate reports on the phenomena exhibited by the floor of Plato, communicated to the British Association by a committee in 1871 and 1872. Ten of these spots have been discovered to be minute crater cones with bright steep exterior walls,

PLATO.

Scale, 100 inches to the Moon's Diameter



Power, 450

SOON AFTER SUNRISE.

and a minute central crater on the summit, and are Nos. 1, 3, 4, 7, 9, 11, 17, 30, 31 and 32; whilst six others, Nos. 5, 13, 14, 16, 19 and 22, though doubtful, probably belong to the same class; the remaining twenty not having presented themselves as craters. During the period of observation many remarkable instances of gradual variation in visibility of these spots were noticed, to all appearance entirely independent of difference of illumination and libration, and too marked and striking in character to be either accidental or illusive. The four principal crater cones, 1, 3, 4, and 17, are generally always visible either as craters under very oblique illumination, or as white spots with a higher solar altitude, the others from their small size being far less easily observed. Besides the thirty-six crater cones and light-spots, twenty-seven light streaks have been observed on the floor of Plato, crossing each other in an involved and complex manner, and like the spots exhibiting strange variations in brightness and visibility, independent, seemingly, of the angle of illumination. These streaks, which are brighter near the border and close to the white spots, appear to stand in intimate relation to the spots, and the variations observed in the two, though by no means simultaneous, appear to stand in close connection with one another.

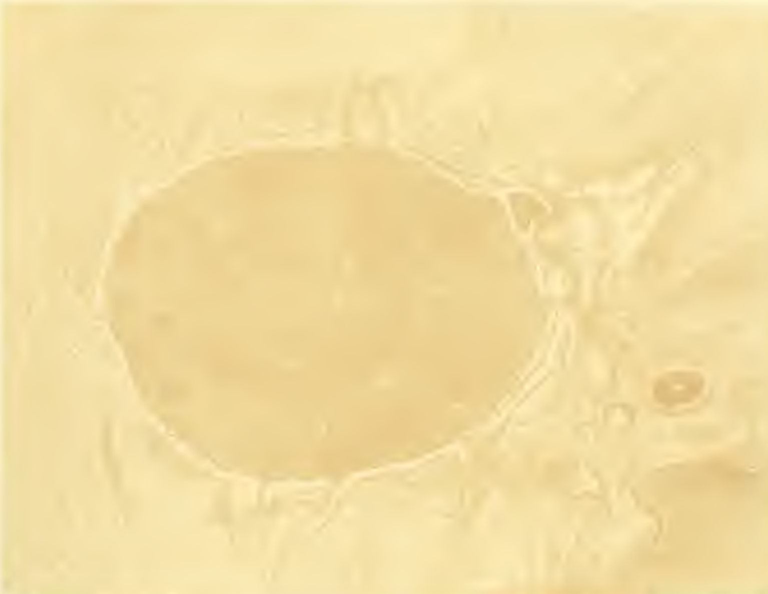
These streaks are with most of the white spots invisible near the terminator only, the comparatively lofty crater cones being then to be distinguished, but they rapidly come into view when the sun's altitude is about 15°. The tint of the floor of Plato has also been observed to undergo a regular change, which in amount is quite unparalleled, as far as is at present known, and in direction is only followed by one or two other portions of the surface. At sunrise a pure grey in colour ($2°\frac{1}{2}$); as the solar altitude increases so does the brightness of the floor, thus following the generally observed variation, but after the solar altitude reaches about 20°, the floor gradually commences to darken and falls from its cold light yellow grey ($3°\frac{1}{2}$), to shortly after Full when it appears a dark steel grey, almost black, and from only $1°\frac{1}{4}$ to 1° bright. This great change in apparent tint is extremely marked and seems entirely unparalleled by any other portion of the lunar surface.

It appears difficult to explain this gradual darkening of the floor of Plato, without ascribing it to an actual variation in the brightness of the surface ; for although attempts have been made to explain the appearance by referring it to the effects of contrast, or to a peculiar conformation of the surface, they are without exception very unsatisfactory. By entirely eliminating the effects of contrast, or even by directly reversing its effects, through employing a small telescopic field of view, or else an annular ring, whose central aperture is scarcely as large as Plato, the floor preserves almost unchanged its usual appearance and goes through the same systematic change. And it is not difficult to find similar formations to Plato, that at sunrise, and for three days after, present almost the same appearance, but yet do not in the slightest degree exhibit the remarkable darkening which then commences to occur.

The environs of Plato being the central portion of the great belt of highlands extending from Mairan almost to Posidonius, present all the disturbed and irregular characteristics of these regions, being covered by numerous hills, ridges, mountains, and craters of all kinds and dimensions. South-west, some parallel chains of mountains extend down the slope to the Mare Imbrium, their principal point being the mountain *k*, in + 48° 49′ lat. and − 7° 11′ long., and about 4000, feet high. North-west is a labyrinthical mass of mountains, the most conspicuous points amongst which are the $5°\frac{1}{2}$ bright crater G in + 51° 42′ lat. and − 6° 47′ long. on the outer slope of the wall and the 5° bright high mountain

PLATO.

Scale 100 inches to the Moon's Diameter



Power 600.

TWO DAYS BEFORE FULL.

masses Plato ν, π, and σ, the two first probably nearly 6,000 feet high. Between σ and ν extends a fine narrow valley *e*, at times much like a broad cleft, and west of the mountain mass is a still larger winding valley *f*, probably Schmidt's great curved rill No. 137, which commencing at Plato H, in + 54° 40′ lat. and − 2° 35′ long., ends in the 6° bright mountain west of the peak δ; and north-east of which is a second, probably Schmidt, No. 138, whilst close under the west foot of Plato G is a third (S. 139). In the elevated plain beyond are several small crater-pits or craterlets, and further west on the Eastern Alpine highlands is the fine crater Plato A′, close to which is the great peak α, 11,100 feet high above the plateau, and probably fully 15,000 feet above the Mare Imbrium, both this peak and A′ being fully 7° bright, and the latter in + 50° 52′ lat. and − 0° 51′ long. *l* is a peculiar ringed depression, surrounded by high mountains rising in the east 7,014 feet, and *d* is a second very similar though smaller, often taken for a crater.

North of Plato the highlands assume the form of a mass of valleys, separated by low broken ridges rising in low peaks at places, the whole surface sloping down gently towards the Mare Frigoris, where this plateau of Plato possesses in many points a steep descent, especially between Plato H and the cape ϕ. At the ring-plain Plato A, the highlands of Plato contract very much, and consist in the main of a narrow elevated plateau with a comparatively level summit, broken by only a few depressions. The ring-plain A is deeper than Plato, and perhaps never entirely free from shadow, its wall rising 3,200 feet above the outer surface, and on the north-west contains a small craterlet, whilst the position of its small central peak is + 52° 17′ lat. and + 14° 5′ long. Towards the south of Plato extend from the east wall a number of short projections on the Mare Imbrium, and between two of these Lohrmann saw a rill η (S. 142) of perhaps doubtful nature. On the Mare Imbrium here are the two 6° bright craters Plato D in + 48° 57′ lat. and – 15° 10′ long., and E in + 49° 10′ lat. and – 16° 30′ long., and west of these is the double-peak mountain *e*, that on the north being 4,604 and that on the south 3,837 feet high. On the south slope of Plato is a small round depression, west of which is a long narrow ravine not unlike a rill in appearance, and beyond this the double crater *i* and the 5° bright crater *k*, in + 46° 32′ lat. and – 3° 42′ long., with a 4° bright smaller near it. The narrow elevated plateau east of Plato A falls with some steepness on both sides, and at its edge at *o* is a steep peak of no height, and farther the 8° bright crater Plato B, in + 52° 37′ lat. and – 17° 55′ long., and on the plateau are two crater-rows, each composed of three craters, or rather perhaps crater-pits, as they possess little depth, one being *h*, and the other west of Laplace *b*. Near Plato *c*, in the hill-land east of this plateau, Mädler discovered a rill θ, extending towards the Mare Frigoris in a shallow valley, and which Schmidt saw as far prolonged south of *c* as it extended north, and describes it as a crater-rill (S. 143).

Pico (S.)—A steep, high, completely isolated peak, upon the dark grey Mare, and being 8° bright, very distinctly visible under all illuminations, whilst rising from three measures of Mädler's 7,060 feet above the plain; though Schröter, from three fairly accordant results, makes it 9,600 feet, and Schmidt thinks 8,000 nearer than 7,000 feet. Its position from ten measures of Mädler's is + 45° 28′ 7″ lat. and – 9° 12′ 21″ long. South of Pico is a long three-peaked mountain *B*, 7° bright, whose northern and steepest point is in + 43° 8′ lat. and – 8° 32′ long., and 3,939 feet above the Mare, though according to Schröter, over 6,000 feet. South and east of Pico on the plain, are many craters and crater-pits, the former mostly 6° bright, and the latter, the same brightness as the surface. Pico B, in + 46° 7′ lat. and − 15° 30′ long., is north of an elliptical 5° bright spot, apparently now fainter than in Mädler's time; Pico D, in + 42° 54′ lat. and − 11° 34′ long., is in a faint light streak, and west is Pico *e*, a small but equally 6° bright crater, also in a faint light streak. West of Pico are a number of ridges in points nearly 1,000 feet high, that curve round towards Plato *i* and *k*, one of the principal being Pico *ω*; and these with the arms from Plato near *e*, and a short eastern ridge from Pico, enclose a circular space about equal in dimensions to Plato; this Schröter called Newton, but Mädler thought it unworthy of the name, which he transferred to one of the greatest and deepest walled-plains towards the south pole of the moon. Schröter noticed several peculiarities in Newton, whose floor he described as being as dark as Plato's under high illumination; and Mädler points out that if this portion of the Mare Imbrium was as Schröter says, as dark as Plato towards Full, then an actual change here has certainly occurred; and at present, though the interior of Plato is only about 1°½ bright, this portion of the Mare Imbrium is fully 3°½ bright, one appearing a dark steel-grey almost black, and the other a pale yellowish grey.

Teneriffe Mountains (B.)—A fine mountain group extending for sixty miles, and composed of a number of 7° bright mountain masses, separated by only 4° bright valleys rising at Pico *δ* 2,400 feet, and at Pico *ε*, as the mean of two measures, nearly 8,000 feet, both according to Schröter.

Straight Range (B.)—A fine distinct line of mountains separated by a few valleys, 5° to 6° bright, the peaks being 7° bright, and the highest, Laplace *ε*, is very steep, rising 6,254 feet above the plain.

Mare Frigoris Eastern (R.)—This portion of the most northern lunar grey plain appears like the western of a pale grey tinged with yellow, or perhaps yellowish green, mixed with numerous streaks and spots of brighter and darker shades of grey. Between Timaus and Plato H, where it is darkest, its breadth is about 130 miles, rapidly narrowing throughout until at the cape Timaus γ, where it is crossed by a broad light streak, and is only 55 miles across, whence, as the apex of the cape is nearly 4,500 feet high, and the cliffs of the highlands opposite between 1,500 to 2,000 feet, the two are in sight from each other. As Mädler remarks, standing on the summit of γ, one would distinctly see on the southern horizon the white border mountains of the highlands of Plato; and beyond, rising in the far distance, the border peaks of the walled-plain might perhaps be just detectable towards the south-west, the cliffs opposite disappearing in the distance, and on the east ending in the bold cape of Plato ϕ, whilst nearer on the broad Mare are two lofty nearly straight ridges losing themselves in the far western horizon; the foreground being occupied by the diversely tinted nearly level Mare, crossed by the broad bright streak starting from the pyramidally rising peak Timaus γ, and losing itself in the southern horizon. Towards the north-west extends the steep mountain northern border of the Mare Frigoris in a straight line to Timaus, and towering aloft in an immense peak at β; but towards the north the view is obstructed by the mountains here, only the summits of δ and ζ rising above the rest in tall white spires; whilst on the east, beyond a deep dark bay, rises in the far distance a great round mountain, whose lofty peak reflects the sun's rays when it has already set for six hours on the summit of γ, and the valleys for long lain in deep night.

The light streaks extending across the Mare Frigoris, usually in a meridional direction, are particularly numerous between Plato and Fontenelle, and especial remarkable is an extensive round 6° bright spot in + 58° lat. and − 16°$\frac{1}{2}$

long., arising from no surface conformation. Numerous hills are to be found between Fontenelle and Condamine, forming at the terminator highly picturesque groups of light islands, and here a few craters are again to be found, though they are entirely absent from the central portion. In the far east, by Horrebow, the Mare Frigoris again widens, and contains a number of delicate difficultly visible hills, between Bouger, Horrebow, and Horrebow *f*, some not inconsiderable in height and 5° bright being indistinguishable in Full from the neighbouring 5° bright craterlets. The eastern end of the Mare Frigoris may be taken to be a scarcely perceptible ridge extending from Harpalus to Harpalus D, which serves to separate it from the Sinus Roris. The dark surface between Philolaus and Anaximander appears, particularly when the north pole of the moon is towards the earth, like a great bay of the Mare Frigoris, extending thus as far as + 70° lat.; and were the Mare seen directly, and not foreshortened, it would seem greater than the Mare Serenitatis, it possessing an extreme length of 920 miles, and a breadth from 50 to over 200 miles.

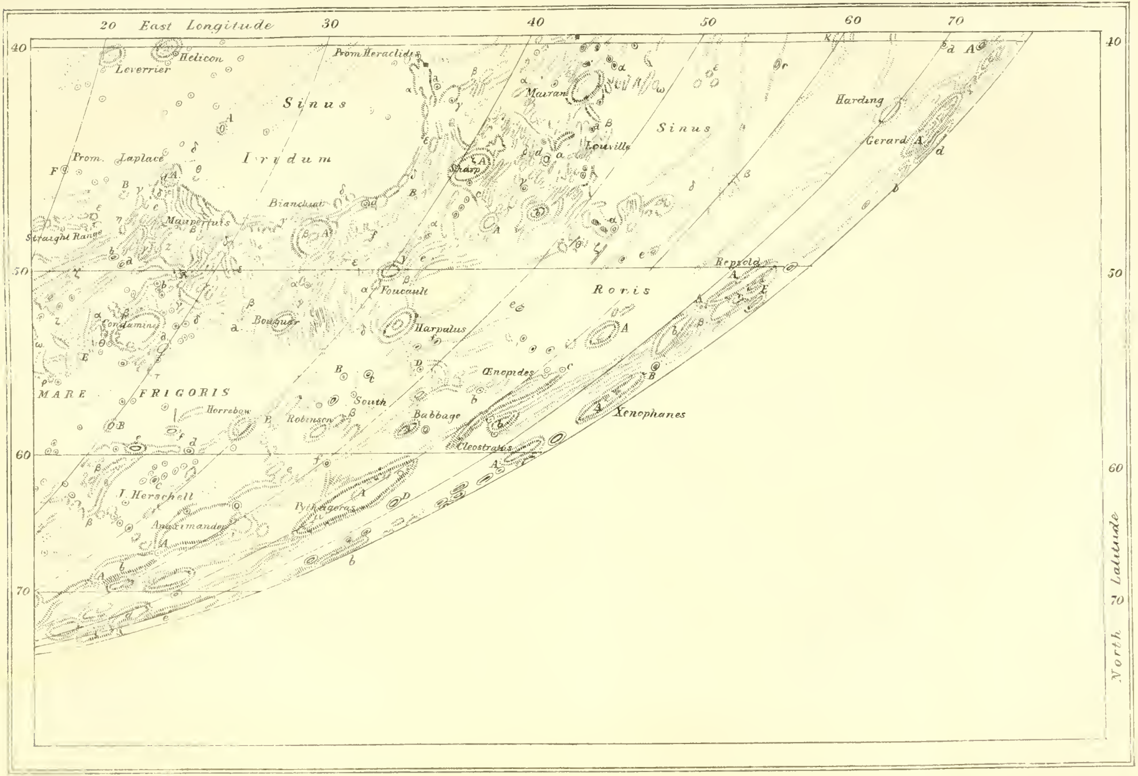
Fontenelle (S.)—A fine ring-plain 22·73 miles in diameter, with an east wall rising 6,069 feet above the interior, which contains a small central peak; but as the walls and floor are not distinguished by any marked difference in brightness from its environs, in Full it is not easily found unless its locality is known with certainty. South on the Mare Frigoris is the mountain Fontenelle A from a measure of Schröter's 3,300 feet high; whilst north extend some mountain ridges towards a great broad triangular-shaped plateau, γ, rising in steep peaks with a steep fall towards the east and north-east, and whose highest peak is E in + 67° 30′ lat. and − 18° 0′ long., and next ε, which is 5,334 feet high, whilst the general elevation of the plateau is about 2,600 feet. Fontenelle B, in + 62° 48′ lat. and − 19° 44′

long., is likewise steep and high, and so are several of the peaks on the group *e*. The ring-plain Fontenelle A, in + 65° 32′ lat. and − 15° 39′ long., is moderately distinct though not particularly bright; and C, in + 61° 45′ lat. and − 25° 37′ long., is one of a pair of very small ring-plains. West of Fontenelle, Mädler discovered a very peculiar formation, from its regularity and perfect form one of those strange objects that seem as if they were the work of Selenites, though from its vastness alone seen to be of necessity natural and not artificial, but resembling the numerous similar objects on the earth. This formation consists of a perfect square, enclosed by long straight walls about 65 miles in length, 1 in breadth, and from 250 to 3,000 feet in height. The highest side is the north-west, where Mädler estimates the walls as being 40° steep (nearer 20°), with two projecting peaks at the two ends, and between them a row of smaller peaks like towers on a wall. This side of the quadrangle, μ, is divided by a short rill-like valley (S. 141), extending to the crater *b*, with at its mouth a round small steep peak some 600 feet high: and before the chief wall at ζ is a very regular cross. The north-east side is lower, and in one or two places somewhat interrupted, and its height more irregular, at the small peak, δ, being 1,300 feet. The south-east wall is a very regular uniform straight wall, ε, of considerable steepness; and finally, the south-west border is described by Mädler as a broad light streak, but under very favourable conditions a long, nearly straight ridge very gently sloping on the south, and slightly steeper on the north, where it may be 200 feet high, can be seen. Within the quadrangle are two rows of low peaks, and besides the cross ζ, south is a smaller one not mentioned by Mädler.

J. J. Cassini (S.)—This formation was drawn by Schröter as an extensive fine valley of very remarkable appearance, but was not recognised by Beer and Mädler, though given somewhat imperfectly on their great map, and was first recovered by Webb. Neither Schröter's nor Mädler's delineation of this formation is accurate, which arises in great part from the very indefinite character it possesses, being not a true valley, but simply a space enclosed by several mountain chains and ridges, varying in its aspect most markedly with every trifling variation in illumination, and belonging to a class of formations not suited to receive special names. On its floor lie the three craters or minute ring-plains, Philolaus, **a**, *e*, and *f*.

Philolaus (R.)—A very considerable ring-plain, 45·74 miles in diameter, with a much-terraced wall rising on the west 11,721 feet above the floor, which together with the central mountain and wall is 7° bright. On the south are some long mountain chains, whose highest peaks are γ and δ, and at λ form a wide 6° bright plateau that projects into the Mare Frigoris, and is crossed by a light streak from Anaxagoras. North-west are several extensive walled-plains of irregular form, the chief being Philolaus *d*, whose wall much broken in places rises at E, in + 75° 30′ lat. and − 31° 11′ long., and *B*, in + 70° 34′ lat. and − 22° 40′ long., into steep and lofty peaks. On both the south and north of the mountain arm, on which rises the peak δ, is a long, winding, narrow valley, appearing much like rills under low illumination, that on the north being the most difficult to detect.

Anaximenes (R.)—A great ring-plain 65·65 miles in diameter, with a peak β on the east 7,980 feet high, though the rest of the wall rises only about 3,200 feet above the floor, which Mädler considered drawn too dark on the 'Mappa Selenographica,' though darker than the neighbouring formations. The floor is traversed by a light streak, which extends across the great bay of the Mare Frigoris on the south, where are the two small but nearly 6° bright craters, Anaximenes C and B. North is the peak A, and close on the limb, in + 79° lat., two small ring-plains of some depth, the southernmost being Anaximenes **a**.


East Longitude
North Latitude
Sinus Iridum
Sinus Roris
Mare Frigoris
Leverrier
Helicon
Prom. Heraclides
Prom. Laplace
Straight Range
Maupertuis
Bianchini
Condamine
Bouguer
Foucault
Harpalus
Sharp
Mairan
Louville
Harding
Gerard
Repsold
Œnopides
South
Babbage
Horrebow
Robinson
Cleostratus
Xenophanes
J. Herschell
Pythagoras
Anaximander

CHAPTER XIII.

MAP VII.

Anaximander (R.)—A ring-plain 39·14 miles in diameter, with a very similar ring-plain *b* on its north, both of irregular form, and between the two, in + 67° 20′ lat. and − 47° 50′ long., is the 7° bright crater Anaximander A bordered by two mountains, but from its depth more distinctly visible than either of the great ring-plains. The wall of Anaximander rises on the west 6,414 feet and on the south-west near α, 9,714 feet above the interior, which is on the same level as the outer surface, and on the north the wall is completely broken through. On the north are a number of great and deep ring-plains, of which the floor of Anaximander *c* is 8,224 feet beneath the summit of the south-west peak, and others perhaps 10,000 feet deep.

J. Herschel (B.)—A considerable depression on the surface of the moon between Anaximander and Horrebow, bordered on the south and west by a long mountain plateau, extending from Horrebow to the north ; bordered on the east by Anaximander, and on the south by the high tableland of Robinson ; but no true formation, merely a portion of the surface surrounded by elevated regions, and hardly one of those objects that can be named with advantage. The steepest part of the border is the south-west and west, where rises the high peak Anaximander β, 6,439 feet above the interior, whilst near Horrebow *e* the plateau falls steeply from a height of 5,333 feet to the floor. The principal object within Herschel is the 6° bright crater Horrebow *e*, which is surrounded by a number of smaller craters, some 5° bright, whilst the floor contains a few mountains.

Horrebow (S.)—A circular ring-plain 13·8 miles in diameter and 6° bright, without a central mountain or wall peaks; but Gaudibert has discovered a small depression on the north-west of the interior and a small gap on the west wall. West is the great plateau β already mentioned; in places it is very steep and contains several peaks, whilst the summit of the plateau is of very irregular level, being broken by a number of branching valleys and some crater-pits, besides peaks and craters. On its south border is the steep though small ring-plain *e*, and on its north-east border is the small 6° bright crater *d*, and on the Mare south of these, the 6° bright ring-plain *f*. Horrebow B is a small 6° bright crater of considerable depth on the south border of the table-land of Robinson, and whose position is + 58° 9′ lat. and − 42° 0′ long.

Robinson (B.) [Horrebow A, M.]—A small ring-plain 12·31 miles in diameter, but very deep and nearly 7° bright, being one of the most distinct objects in this region, and situated near the centre of a great elevated table-land that extends from Horrebow to near Pythagoras, its northern border passing through the two craters Pythagoras *e* and *f*. The name Robinson was originally applied to the whole table-land, but as this is scarcely a true formation and is of very indefinite character, it has been restricted to the principal and conspicuous ring-plain near the centre, with considerable advantage and without introducing sensibly any confusion. This table-land on the west forms the border of J. Herschel, and is broken here by a number of shallow valleys and is but little steep; towards the south it sinks very gently into the Mare Frigoris, without any definite end; on the north the border is almost as indefinite, being merely marked by a gentle slope towards a shallow valley, and only on a portion of the east border does the plateau fall with any steepness; and here rise three great mountains β, of considerable steepness and height, the southernmost being 5,877 feet, all three being remarkable for their very dark colour.

Pythagoras (R.)—A great walled-plain, 95 miles in diameter, whose walls are perhaps the highest of any on the north-east quadrant, rising at α 16,940 feet above the interior, on which, besides many hills and buttresses from the walls, rises a high very distinct 6° bright central mountain A, from nine measures of Mädler, in + 63° 3′ 44″ lat. and − 61° 36′ 45″ long. Around Pythagoras are a number of ridges and low hills, and towards the limb are some considerable ring-plains, the chief being *b*, which is very steep, and between this and Pythagoras is D, a deep crater (*d* of M.) in + 64° lat. and − 69° long.

Babbage (B.)—A very extensive walled-plain enclosed by very low and irregular walls, and seldom very distinct, though possessing an area of nearly 10,000 square miles. The only distinct object within it is the deep ring-plain A (Pythagoras A of M.) in + 58° 34′ lat. and − 54° 26′ long., and 22·18 miles in diameter, on whose east is a smaller craterlet. In favourable conditions a number of long nearly parallel ridges can be detected traversing Babbage in a meridional direction. On the south the wall is broken by a crater *b*, near which some long valleys open into Babbage.

South (B.)—An extensive tract of surface, bordered on the north-west by the table-land of Robinson, on the north-east by Babbage, on the south-east by some ridges and a small plateau near Harpalus D, and on the south-west without any real border, though at times a ridge near Harpalus C seems in some way to be one. Within these limits are some mounds, ridges, and crater-pits without any distinctness and importance, whilst the whole formation is simply a portion of the eastern extremity of the Mare Frigoris, and deserves and requires no special name. There are on the moon a number of such regions, which under particular illuminations appear as a connected whole, the shadow filling up gaps, &c., but which are in reality no true formations, but merely spaces bordered by ridges, ring-plains, &c., without any connection. Such objects do not seem well suited to be included within the lunar nomenclature, and most of Riccioli's and Schröter's names of objects of this class have with advantage been disregarded.

Bouguer (S.)—A ring-plain of moderate size, but 6° bright and tolerably deep, on the north border of the highlands of the Sinus Iridum, in + 52° 30′ lat. and − 35° 35′ long. It is environed by numerous valleys and ridges, extending from the highlands on to the Mare Frigoris, the whole surface here sloping very gently from the southern high crest down to the Mare on the north. West of Bouguer is a crater **a**, and south of it a peak β, of some height; but α in the south-west of a smaller depression is the brightest peak. East of Bouguer two short rills (S. 146–147) were seen by Schmidt, who himself thinks they are doubtful, and they were probably merely two of the numerous valleys here.

Condamine (S.)—A ring-plain, 22·96 miles in diameter, on the north border of the highlands of the Sinus Iridum; its 4°½ bright walls are broken by a number of crater-like depressions, and rise on the west 2,654 feet and on the east 4,259 feet above the interior, which contain several small hills and a crater-pit. On the Mare Frigoris on the north is the fine crater Condamine B, in + 57° 53′ lat. and − 29° 51′ long., fully 6° bright and very deep, the wall rising on the east 2,046 feet above the Mare; a light streak from Anaxagoras ends at it, and close to it are several crater-pits and a number of hills. Condamine η is the principal peak in a fine group of mountains at the extreme north-west point of the highlands of the Sinus Iridum, that are 5° bright. Close to them on the highlands are the two steep mountains Condamine ζ and E, the last in + 53° 44′ lat. and − 24° 0′ long., both nearly 6° bright. Condamine α, west of Condamine, appears to be the highest peak, however, in this region, while γ and δ on the south-east are two of the brightest. Around Condamine are very many crater-pits and craters, and these are partly single and partly in rows, whilst **a** is a 7° bright crater of some depth.

Maupertuis (S.)—A walled-plain enclosed between mountains, and perhaps 2,800 feet beneath the level of the highlands of the Sinus Iridum at this point, with six small mountains on its 3°½ bright surface, the highest of which Z, in + 48° 51′ lat. and − 27° 13′ long., is about 1,150 feet high. West are two fine craters, Maupertuis *b* 5° bright, and **a** 7° bright very conspicuous and of some considerable depth, both situated at the head of a dark valley, or perhaps inlet, extending between the highlands of Plato and the Sinus Iridum on to the Mare Frigoris, with a length of 110 miles and a breadth of 35 miles, its interior containing a number of craters and mountains. South of these two craters are a number of deep valleys between high mountain ridges, and here, near Maupertuis ϵ, Schmidt has seen a feeble rill (S. 144), perhaps one of the narrowest of these valleys, and whose position he puts at + 48° lat. and − 24° long. Lohrmann saw also a short rill (S. 145), perhaps the valley near Maupertuis γ.

Cape Laplace (M.)—The south-west projection of the great Sinus Iridum, rising in a fine peak at *A* in + 45° 26′ lat. and − 25° 16′ long., whose height from four measures Mädler gave as 6,580 and 7,282 feet above the Mare Imbrium, and 9,611 and 8,965 above the Sinus Iridum;

whilst Schröter from two measures found 6,900 and 7,300 for its height. Two small craterlets (of which only one is given in the 'Mappa Selenographica') lie on the summit of the cape, together with some high peaks besides those measured. Laplace e is a dark depression surrounded by high peaks, the principal being Laplace δ and γ, both about 6,000 feet high; whilst B is a peak not so high on a ridge on the Mare Imbrium, in $+ 46° 53'$ lat. and $- 22° 27'$ long. In the Mare are two conspicuous craters, one Laplace F, in $+ 45° 11'$ lat. and $- 19° 55'$ long.; and the other Laplace A, from ten measures of Mädler, in $+ 43° 16' 21''$ lat. and $- 26° 33' 33''$ long. East on the Sinus Iridum rises the steep peak θ to a height of 1,631 feet, and near it are some others.

Sinus Iridum (R.)—This splendid bay of the Mare Imbrium has been well called by Mädler the most gorgeous and magnificent of the lunar formations, the dark level semicircular bay being bordered by the stupendous cliffs of one of the loftiest of the great mountain highlands of the moon, whose elevated crest rises at points into noble peaks towering fifteen to twenty thousand feet above the still dark plain at their base. And in its position the Sinus Iridum is well placed to be seen, as the level foreground throws the peaks on the border well into relief, they being seen under favourable conditions almost as if it were in profile, the bright line of cliffs with the still more brilliant peaks showing well by contrast with the dark surface of the Sinus Iridum, and the sombre background of the still scarcely illuminated highlands.

The great bay, measured across from the two noble capes, the Prom., Laplace, and Heraclides, is 134·6 miles in breadth and 83·9 miles in depth, though it is so much foreshortened as to appear not two-thirds of this, whilst its area is 92,000 square miles. Mädler considered the tint to differ little from that of the rest of the Mare Imbrium, or as 2° bright in the middle, and the eastern brighter portion 3°. The western portion is covered with grey streaks and has a kind of greenish glimmer. The Sinus, however, seems to be throughout perceptibly darker than the Mare Imbrium near it, though the two shades merge insensibly into one another, the general brightness of the Mare being about 2°$\frac{3}{4}$, and the Sinus about 2°$\frac{1}{4}$. The irregularities on the surface of the Sinus Iridum are not numerous, and never very distinctly to be seen. From Cape Laplace there extend a number of low ridges and hills, nowhere much above 100 feet high, and near the centre is a very slightly elevated, very gently sloping plateau, close to which are some ridges extending from Bianchini δ, that are however chiefly parallel to the south-east border, and slightly brighter than the surface.

The Sinus Iridum Highlands.—These form the easternmost portion of the great mountain girdle extending from Posidonius to Mairan, and are one of the loftiest portions of the whole, the general elevation being several thousand feet above the Mare Imbrium, and nearly as much above the Mare Frigoris and Sinus Roris. Under favourable illumination they appear one intricate and vast network of valleys, ravines, and depressions of all kinds, intermixed with mountains of all dimensions and forms; and not even in the Apennines are a greater number of such irregularities crowded into the same space. The main crest of the highlands, as in most other cases, is towards the border, and lies in the long range of mountains from Cape Heraclides to west of Bianchini. It consists of a great chain of peaks broken only by two small craters, Bianchini *d* and Heraclides a, the peaks being loftiest between Bianchini and Sharp. The two principal peaks that have been measured on this great mountain wall to the Sinus Iridum are, Sharp δ rising 12,367 feet, and Sharp ε rising 14,938 feet above the Mare, though there are yet higher peaks in the chain, not however measurable, and many peaks over 10,000 feet high. From Bianchini γ to Cape Laplace, the mountain border of the Sinus Iridum is more broken, being pierced by several valleys, and only one peak, Bianchini γ, rises above 9,000 feet, though many are between 6,000 and 7,000 feet high. On the interior a few peaks, as Maupertuis α, δ, and ϵ, are probably nearly double this height, but not measurable owing to their position.

The highlands are united to those of Plato only between Maupertuis **a** and ϵ, where four nearly parallel mountain ridges connect the two, and enclose a fine long valley reaching from Plato *c* to Laplace γ nearly, and in places scarcely five miles wide; and within the northern portion of this lies the rill discovered by Mädler. Another dark valley, only very winding, extends from the high mountain Maupertuis α to δ, where it receives a branch from the north and opens into the Sinus Iridum near Bianchini γ; while west of it another valley, likewise winding in and out, commences also near Maupertuis, and opens into the Sinus Iridum opposite Laplace θ. A fourth dark valley, Bianchini *f*, commences near Bianchini ϵ, runs parallel to the border of the Sinus Iridum and is of considerable width, with many branching side valleys lighter in colour.

The wildest portion of the highlands is in the far east, between Sharp, Louville, and Mairan, and here are probably the very highest peaks, in some cases perhaps over twenty thousand feet above the low Mare and Sinus Iridum; and a number of craters are also to be found in this portion of the highlands, though almost absent from the region near Bianchini. From Louville, north-east to the isolated peaks near γ, and from Mairan to the Cape Mairan ω on the east, are the two last portions of the steep mountains. South of Mairan, the great highlands gradually sink into the Oceanus Procellarum in a gentle slope, and extend as a wide low plateau deep into the plain, and contain many craterlets and crater-pits.

Cape Heraclides (R.)—A fine projecting promontory on the eastern border of the Sinus Iridum, with a peak rising, according to Mädler, 3,924 feet above the bay, with a still higher peak at α, and a small craterlet at **a**; whilst the two peaks β and γ are both of some height, and close under the west foot of the last lies a small crater, seldom to be seen. From eight measures of Mädler, Heraclides is in + 41° 7′ 46″ lat. and − 34° 1′ 25″ long.

Mairan (S.)—A very fine ring-plain, 25·22 miles in diameter, with broad, 6° bright, much-terraced walls which rise, from two measures of Mädler, 3,440 and 5,211 feet above the highlands, and on the west 8,012 and 15,156 feet above the interior; this contains no central mountain, but one particularly broad terrace. The measure of the altitude of the walls appears therefore very uncertain, and the ring-plain is very unfavourably placed for measurement: Schröter moreover says that Mairan possesses a very small central mountain, which Mädler could not see. South-west on the extreme border of the highlands, is the ring-plain Mairan A, in + 38° 30′ lat. and − 39° 31′ long., neither particularly deep nor clear but very distinct, owing to the Mare here being only 2°½ bright. Near to it is the brilliant little crater *e*, close to some ridges and fully 8° bright, and on the east the peak β. Around Mairan are a great number of mixed craters and crater-pits, and towards the east is a fine projecting cape, Mairan ω.

Louville (S.)—A small depression more triangular than round, enclosed by a number of mountains, but without any connected wall; and only when the shadow of the western mountain mass α, some 5,000 feet high, throws the entire interior into darkness does Louville appear as a connected whole, and at other times it is only to be distinguished by its dark interior. Around it are some craters, of which a is the brightest and *d* the largest, together with some high peaks, the principal being δ, γ, and β.

Sharp (Hell.)—A ring-plain 23·70 miles in diameter, with a 3° bright interior and 5° bright central mountain and wall, this last being broad, rugged, and steep, with many projections on the exterior; it rises on the west 9,624 feet above the interior, whilst on the north wall is a minute craterlet. North-east is the very distinct 7° bright small ring-plain Sharp A, in + 47° 34′ lat. and − 44° 8′ long., united by a fine valley, *c*, with the foot of Sharp, and north of this valley is a broad plateau with a row of three small craters in the centre. South-east of A is Sharp *b*, a crater probably 7° bright, and very deep, and whose walls are 4,500 feet above the exterior plain; whilst west is the peak γ, on the border of a dark valley. Sharp *B* is a high peak, in + 46° 9′ lat. and − 38° 3′ long., near the border of the Sinus Iridum, and close to it are a number of very lofty peaks, two of which, ϵ and δ, have been measured.

Schmidt has discovered two short rills east of Sharp *b* and close to the mountains; one, θ, on the extreme border of the highlands (S. 149), and the other, ζ, in the Sinus Roris, north of Repsold *d* (S. 150).

Foucault (B.) [Harpalus, A. M.]—A small ring-plain, very similar to Bouguer, on the north border of the highlands of the Sinus Iridum, in + 50° 5′ lat. and − 40° 7′ long., 7° bright, and of considerable depth, with a distinct central mountain on the interior. On its north border rises the lofty peak α, whose shadow at times renders the ring-plain almost unrecognisable. Near Foucault are a number of long valleys enclosed between high ridges, the principal being *e*, whose border rises at β, 2,878 feet above the Sinus Roris.

Bianchini (S.)—A considerable ring-plain with a wall of very unequal height, rising at A in + 48° 0′ lat. and − 34° 51′ long., 7,398 feet, and on the west 8,460 feet above the interior, but much lower towards the south, where it is broken, and with a distinct pass on the north. The central peak β is very distinct, and connected with the wall by a low ridge. South, on the borders of the Sinus Iridum, are the two high peaks γ and δ; and on the east the peak ϵ, near the end of a long wide dark valley. Between Bianchini, Bouguer, and Harpalus, is the least disturbed portion of the highlands of the Sinus Iridum, consisting principally of broad shallow valleys, with a few low peaks and a great number of hills; but the plateau on which these are situated, and which slopes gently towards the Mare Frigoris, is of considerable elevation, being near Bianchini, perhaps 6,000 feet above the Sinus Iridum, and about one half as much above the Mare Frigoris. West of Bianchini ϵ is a short rill, ζ (S. 148).

Harpalus (R.)—An isolated very considerable ring-plain, with a 3° bright interior and 5° bright walls which rise on the east 2,801 feet above the Mare Frigoris, and sink 15,853 feet to the floor beneath them, it being one of the very deepest formations on the whole moon, and after Pythagoras perhaps the deepest on the two northern quadrants of the moon. The position of the 5° bright central mountain was found by Mädler from ten measures to be + 52° 28′ 11″ lat. and − 43° 36′ 20″ long. From Harpalus to the crater D in + 55° 15′ lat. and − 49° 20′ long. are two or three ridges with very gently sloping sides; and the whole of this region is elevated above the Mare Frigoris about 500 feet, with a very gentle fall towards the west, ending only by the crater Harpalus B, and with a slightly quicker fall towards the Sinus Roris, which lies perhaps twice as far below. The small crater *f* lies on the eastern slope, which ends beyond the crater Harpalus *e*, and is only faintly visible even under the most favourable conditions.

Œnopides (R.)—A considerable walled-plain 42·97 miles in diameter, and with tolerably high walls united to Babbage and Pythagoras by mountain ridges. South of Œnopides is the considerable very deep ring-plain A, with a distinct central mountain in + 53° 4′ lat. and − 63° 0′ long. In the environs appear only a few ridges and some crater-pits.

Cleostratus (R.)—A ring-plain without a central mountain, close to the limb, the northern end of its steep walls, A, being in + 61° 15′ lat. and − 77° 0′ long. At least six great ring-plains lie between Cleostratus and the limb, besides many smaller ones; but being hardly visible they cannot well be mapped. Between Cleostratus, Pythagoras, and Œnopides, lies a great bright plain, interrupted by only a few ridges and mounds; it is about 160 miles long and 140 miles broad, or has an area of 18,000 square miles, and is thus much larger than the Sinus Medii or Lacus Mortis.

Xenophanes (R.)—A great deep walled-plain, 185 miles in diameter, and probably as deep as Pythagoras, with a massive central mountain A, whose northern end is in + 57° 2′ lat. and − 77° 10′ long., whilst the southern end B of the wall of the plain is in + 55° 18′ lat. and − 79° 0′ long., and appears to be the highest point of Xenophanes. South-west are a number of long ridges, enclosing broad bright valleys, and extending as far as Repsold.

Repsold (M.)—An extensive but very irregular ring-plain, with a bright peak A on the west wall. North is the crater Repsold A, and a peak β on the east wall of a small ring-plain *b*. West is the 7° bright crater Repsold *d*, close to the east point of the highlands of the Sinus Iridum, and south-east a gently sloping little elevated extensive plateau Repsold δ.

Sinus Roris (R.)—The great northern bay of the Oceanus Procellarum, bordered on the west by the highlands of the Sinus Iridum, on the north by the elevated region between Harpalus and Œnopides, and on the east by the bright ridge extending between Œnopides and Gérard. The northern portion of the floor is the brightest, and is traversed by a number of grey ridges.

Gérard (M.)—A ring-plain on the edge of the Oceanus Procellarum with a central elevation, consisting of a peculiar long chain of tolerably high peaks. Between it and the limb are a number of ring-plains.

Harding (M.)—A ring-plain of moderate size and depth, near the north boundary of the Oceanus Procellarum, but being 5° bright in a darker level region, it is tolerably distinct, and from eleven measures of Mädler's in + 43° 8′ 41″ lat. and − 70° 52′ 10″ long. Westward between the 5° bright crater C, in + 40° 57′ lat. and − 56° 50′ long., and B, in + 36° 42′ lat. and − 59° 35′ long., rises a kind of low plateau *k* from the union of a number of ridges, and some points on the east rim of this plateau are 1,300 feet high. Close to the 60° meridian extends from + 30° to + 50° lat. a chain of ridges over 370 miles long, appearing in this level region a conspicuous object, and by Harding β reaches a tolerable height. The three steep small peaks on the west of Harding C are very distinct near the terminator, and ε, the central one, rises 838 feet, and is the highest point in this region. Harding A is a 6° bright crater, in + 40° 7′ lat. and − 76° 10′ long., with some 6° bright mountain peaks near it.

CHAPTER XIV.

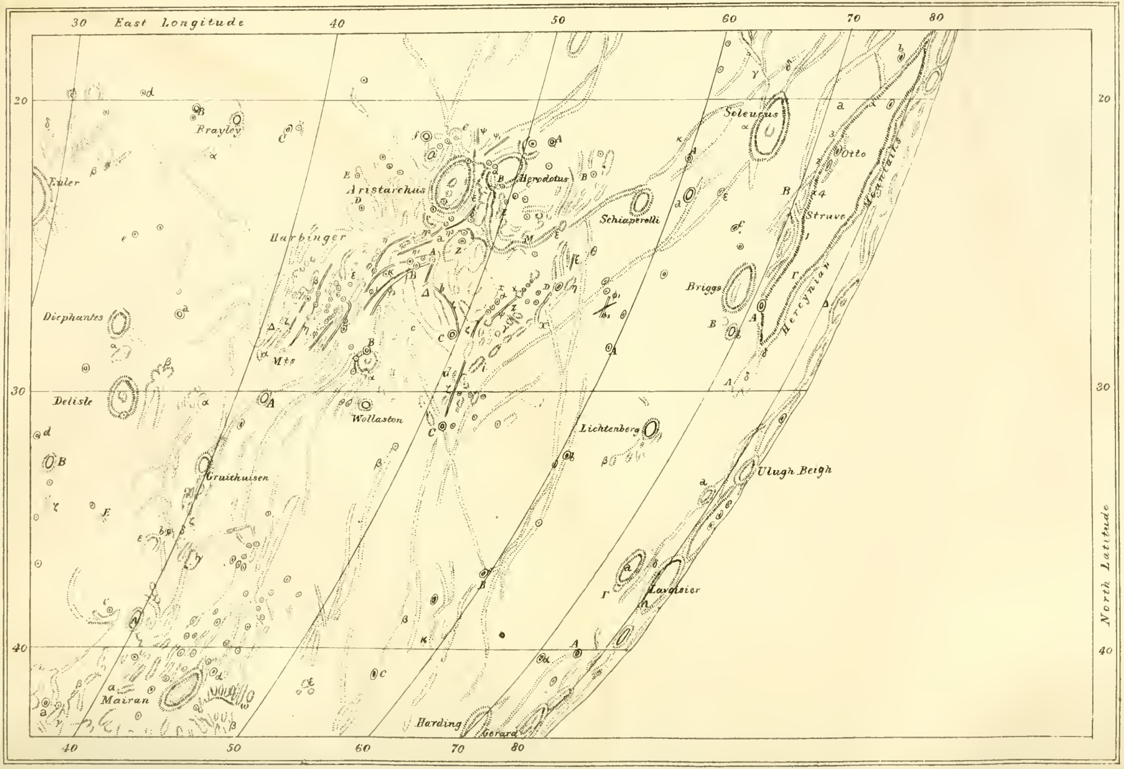
MAP VIII.

Lavoisier (M.)—A considerable walled-plain on the east border of the Oceanus Procellarum, very near the moon's limb, with 5° bright walls and environs. The limb between Lavoisier and Gérard is remarkably uneven, though all that can be seen on this side are insignificant hills and ridges, only visible through their brighter colour. West is the small ring-plain **a** with a steep peak Γ at its northern end.

Ulugh Beigh (M.)—A ring-plain on the eastern border of the Oceanus Procellarum which here extends almost to the limb, and with a low 5° bright wall. North-west is the smaller ring-plain **a**, from which extends a long ridge, reaching a considerable height at Lavoisier δ.

Lichtenberg (M.)—A small ring-plain, with a 6° bright wall and a 3° bright floor, whose centre, from eight measures of Mädler's, is in + 31° 25′ 20″ lat. and − 67° 5′ 3″ long. A somewhat ill-defined light glimmer appears on the east and north-east, whilst on the west the dark plain extends right up to the wall, and here Mädler recognised, under particularly favourable atmospheric conditions, a pale-reddish tint which appears to have since faded. Near Lichtenberg are a number of 5° bright craters and long ridges, with a somewhat high mountain at β. This is not Schröter's Lichtenberg, which was the great tract of surface between the Hercynian mountains and the nearly parallel chain, but Mädler's change is for the better.

Map VIII.



East Longitude
North Latitude
Euler
Brayley
Aristarchus
Herodotus
Harbinger
Schiaperelli
Seleucus
Otto
Struve
Briggs
Hercynian
Mountains
Diophantes
Mts
Delisle
Wollaston
Lichtenberg
Ulugh Beigh
Gruithuisen
Lavoisier
Mairan
Harding
Gerard

Briggs (S.)—A great ring-plain 33·24 miles in diameter, with a 6° bright moderately high wall and a considerable central elevation, whose principal peak is in + 26° 9′ lat. and − 67° 56′ long. Close to it lies a bright mountain peak B, in + 27° 15′ lat. and − 67° 27′ long., and north-east are the two deep small ring-plains both 5° bright, *b* and A, the last in + 26° 49′ lat. and − 71° 30′ long., whilst south-west are two small craters, the southernmost C in + 24° 9′ lat. and − 66° 22′ long, and 4° bright.

Hercynian Mountains (M.)—A great mountain range, extending from + 18° to + 29° lat., richly adorned with rounded massive peaks that at sunrise can be clearly seen and finely drawn, particularly when the moon has a high northern latitude, so that the sun illuminates the whole range almost at the same time. The average height of the crest of the mountain range is perhaps 3,800 feet, but some of the peaks must be nearly double this, and at Briggs Γ appear to be highest.

Otto Struve (B.)—This name has been applied to the great plain enclosed between the Hercynian mountains on the east, and an opposite slightly smaller range on the west, its area being very considerable, or over 26,000 square miles. The western border separates from the Hercynian mountain near Kraft **a**, and reunites with it near the peak Briggs δ, and the enclosed plain Otto Struve, has a length of 200 miles and a breadth of 100 miles. On the west, the border possesses probably a still greater height than the Hercynian mountains, especially between + 20° and + 23° lat., where, however, Schröter makes the height 3,500 feet, but it has few peaks. By Seleucus B, it expands into a mass of mountains, and sends many branches in all directions on to the grey exterior plain, and one of the most considerable bending round by Kraft β, encloses a second great plain Otto Struve **a**. On the interior of Otto Struve are some deep craters and some low ridges, together with much diversity of tint, from the surface being crossed by broad well-defined light streaks, and as at Full, Otto Struve is only marked by the difference in brightness, it is then marked by the outer of these light streaks, and so possesses a very different outline to what it has under low illumination. The very similar but much less marked bordered plain **a** on the south-west, possesses an area of about 8,500 square miles, and is of exactly the same tint as the outer surface, from which it is only with difficulty distinguished except at sunrise. At Kraft β its west wall is highest.

On the north by Lichtenberg A, rises beyond the point of union of the two borders of Otto Struve, a 5° bright long plateau Lichtenberg δ, whose highest point is Lichtenberg A. Schröter's Lichtenberg is the same as the present Otto Struve, and he draws on the summit of the wall three craters at 1, 2, and 3, not given by Mädler, and another on the floor at 4.

Seleucus (R.)—A great ring-plain, 32·00 miles in diameter, with high 5° bright walls, rising from 9,400 to 10,200 feet above the 3° bright interior, whose 5° bright central mountain, from nine measures of Mädler's, is in + 20° 54′ 21″ lat. and − 65° 48′ 19″ long. After Full, Seleucus appears as a very distinct white spot brightest towards the edge, where the peak α is 5°½ bright, and gradually diminishing in intensity towards the centre. From it in all directions extend long, mostly 3°½ bright ridges, with a few 4° bright peaks, the principal being δ towards the south and ε towards the north, with γ towards the south-west; and at a peak ε is a small crater, both very rarely to be seen at once, but generally either only the peak or only the crater. The two brightest of the ridges from Seleucus are ε and k, both 4° bright.

Schiaperelli (B.) [Herodotus, C. M.]—A ring-plain 16·37 miles in diameter, in + 23° 11′ lat. and − 58° 27′

long., whose wall rises on the east 1,899 feet above the plain, and on the west 2,878 feet above the interior. The wall possessing a very gentle slope, the whole formation is little visible according to Mädler, who draws it on the 'Mappa Selenographica' as hardly perceptible. Birt remarks that Schiaperelli wears a very different aspect now, and at the terminator appears as a very distinct ring-plain, one of the most conspicuous in this region. Schröter draws Schiaperelli thus, and measured its height, which he makes to be 2,200 feet. But towards Full Schiaperelli becomes very indistinct, and Mädler's remarks applied to it under this condition. Mädler, however (on p. 280), gives 1,138 feet as the height of the east wall above the Mare, but this is a mistake, and probably another formation was meant. East is **a**, probably Schröter's crater, which on measuring he found to be 2,700 feet high, but some uncertainty is attached to the crater intended by him.

Herodotus (R.)—A great ring-plain, nearly circular in form, and 23·51 miles in diameter, with two high peaks α and β on its wall, rising 4,349 feet above the dark grey interior, but while α is 7°, β is scarcely 3° bright. On the wall is a small crater east of the opening on the north, not seen by Beer and Mädler, and opposite on the south-west wall near a pass two others; but on the floor, though a small ridge lies under the west wall, neither craterlets nor central mountain are visible. South-east abutting on the wall is half a ring-plain with a small central crater, but whose southern portion has entirely disappeared, and close to this on the east is the 5° bright crater Herodotus A, in + 21° 10′ lat. and − 51° 55′ long. The most remarkable object near Herodotus is the great winding valley discovered by Schröter, and included by Schmidt as a rill in his catalogue (S. 151). It commences near the mountain Herodotus ε in a hilly region of the surface, and is connected with several branching very shallow valleys, and possesses at first little breadth or steepness, though it is 5° bright. By the mountain M, in + 25° 34′ lat. and − 50° 58′ long., it curves strongly, becomes broader and much deeper, and winding between a number of low mounds reaches the foot of the high plateau of Aristarchus, where it bends south and becomes very deep (according to Schmidt 1,663 feet) and steep ; it then extends to the foot of the wall of Herodotus, passes through in a gap and ends in a broad mouth in the interior. East of the valley are a number of mounds and some crater-pits, only the peak E in + 24° 6′ lat. and − 49° 6′ long. being either high or steep. The crater B, 5° bright, is the most distinct object here and is in + 22° 13′ lat. and − 54° 8′ long. The ridges in this region though very numerous are usually very low, and in few places brighter than the rest of the surface ; near θ is one of the principal peaks, its height being 1,612 feet, and it forms part of a high ridge extending past the crater Herodotus D in + 26° 27′ lat. and − 54° 57′ long., rising here in a peak η and ending near i. Near here are a great number of peaks appearing as white points in Full, and some of considerable height. The principal mountains are γ, 5° bright and 2,328 feet high, ν about the same height but 4° bright, and χ, which though only 1,030 feet high, is very steep, conical in form, and 8° bright, and probably a true crater cone. South of D is a short rill ξ (S. 154) discovered by Schmidt, and difficult to detect ; and north-east Schmidt mentions two others, ϕ_1 (S. 164) and ϕ_2 (S. 165) that have only been seen by him. From Wollaston C, as far as the peak x, extends a long rill ζ (S. 167), in portion broken and in portion crater-rill. East of this is another, only short (S. 168) ψ, and between Herodotus γ and ν, a third (S. 169), according to Schmidt a crater-rill. Schmidt's drawing of Aristarchus and Herodotus with their rills, in his catalogue, is imperfect in several respects, and here as elsewhere some uncertainty attaches to the position of the rills that rest on his authority only.

Aristarchus (R.)—A great ring-plain, lying with Herodotus towards the centre of the great grey plain, without any connection with other formations, except by a few very insignificant ridges; and from its extreme brilliancy dazzling the eye so much, as to seriously interfere in a large telescope with its being observed. The ring-plain is 28·17 miles in diameter, with broad terraced walls rising at α 2,447 feet above the outer surface and 7,520 feet above the interior, according to Mädler, though Schröter from two measures makes this last 5,600 feet, and Schmidt from seven measures 6,139 feet; but the concave nature of the interior may account for these differences, especially that between Mädler and Schmidt. The brilliant central mountain, according to Schmidt only 1,280 feet high, was found from nine measures of Mädler to be in + 23° 17′ 7″ lat. and − 47° 12′ 9″ long., and on the interior is also a second peak and a small craterlet, both 9°½ bright. The interior of Aristarchus is fully 9°½, the west wall 6° to 8° bright, the south wall 8°, the east wall 9°, the north wall 9°½, and the central mountain 10° bright, this last being the brightest on the whole moon. The eastern wall widens into a broad plateau, 5° to 6° bright towards the south, and falling to 4° towards the north, with a high crest towards Herodotus, whose interior is 2,000 feet at least above the level of the floor of Aristarchus; and on the crest of this ridge are two high peaks Aristarchus δ and ϵ, both nearly 5,000 feet above the plain on the east. South of Aristarchus are two shallow ring-plains, *e* and *f*, the latter on a small plateau, so that though its west wall rises above the outer plain 1,125 feet, towards the interior it falls only 403 feet. Under low illumination a great number of very delicate ridges are seen traversing this region, and in Full a considerable number of light streaks are seen extending in the same direction, but as both are never visible together it is impossible to say whether the two are independent of each other or not. At times these streaks enclose a dark surface, which is not however a ring-plain or any visible surface configuration. South of Aristarchus are two delicate rills ψ (S. 152) and ψ_1 (S. 153) both discovered by Schmidt, and west are two craterlets and a very shallow ring-plain. North of Aristarchus is a mountain region, extremely rich in various formations, and containing a great number of very delicate rills, but owing to its complexity this portion of the surface still requires accurate mapping. The principal formation is a great plateau Z, descending very steeply towards the east, where according to six measures of Mädler, and Schmidt, it is 3,811 feet high, and farther north-east, it is 4,500 feet high according to Mädler. On the summit of this plateau are a number of mountains, several small craterlets, and one crater. West is a lower but more extensive triangular plateau Δ, rising nowhere more than 1,000 feet, with at its corners three considerable craters, Aristarchus A in $+ 25° 30'$ lat. and $- 47° 38'$ long., B in $+ 25° 53'$ lat. and $- 46° 39'$ long., and C in $+ 27° 33'$ lat. and $- 49° 32'$ long., together with a number of mounds and some craterlets, whilst down its centre runs a shallow broad valley. Still west the ground rises in a gentle slope towards the Harbinger Mountains and Wollaston, into a third still lower plateau. From this conformation of the surface three great valleys are formed, one a, extending from off the plateau between Aristarchus and Herodotus; a second, *b*, leading from this between the plateau Z and Δ; and a third, *c*, between Δ and the rising ground west, and both these last again opening into a very shallow valley *d* north of them. Of the craters in this region A is 7°–8° bright and very deep; B 6° bright and also deep; C and k, 5°½ bright, and nearly all the rest 5° bright.

In this region Mädler saw no rills, and Lohrmann only one, whilst Schmidt discovered nearly twenty, and others have increased the number to over thirty; but considerable uncertainty attaches to many of these, and owing to their indefinite position it is impossible to either insert or catalogue all, but only the best known. Within the valley a appear four rills, η, η_1, η_2, η_3, and of these η and η_2 appear to form parts of what was seen by Schmidt as a horse-shoe rill (S. 155), but which does not appear to possess this form, and the other two east were discovered by Gaudibert, and are very delicate rills; whilst η and η_3 may be portions of the same rill. On the east border of the valley is a small craterlet, and on the summit of the peak δ, Gaudibert has seen a small crater opening; and it is remarkable that this mountain has been seen as a misty bluish tinted mass at a time when every surrounding object stood out as sharp and distinct as possible without a trace of colour, while this bluish tint remained visible, becoming gradually fainter, for over twenty-four hours. From Aristarchus B, west extend three curved rills, ϕ (S. 160), ϕ_1 (S. 161), and ϕ_2 (S. 162), all discovered by Schmidt, who describes the portions near B to be crater rills, though they appear certainly equally distinct and sharply bordered throughout, and are not very difficult; and between Aristarchus A and B is a fourth (S. 163), whilst a fifth extends north of A. In the valley b is a sixth rill ζ, seen in portion only by Schmidt (S. 166). Schmidt draws but does not catalogue a seventh rill on the low north prolongation of the plateau Z east of ζ, which appears however to be a valley. West of Aristarchus is a hill region whose only conspicuous objects are the small craterlets D and E, the former in + 23°.27′ lat. and − 42° 45′ long., and the latter, omitted in the 'Mappa Selenographica,' in + 22° 24′ lat. and − 42° 59′ long., both, despite their brightness, delicate objects on account of their small dimensions.

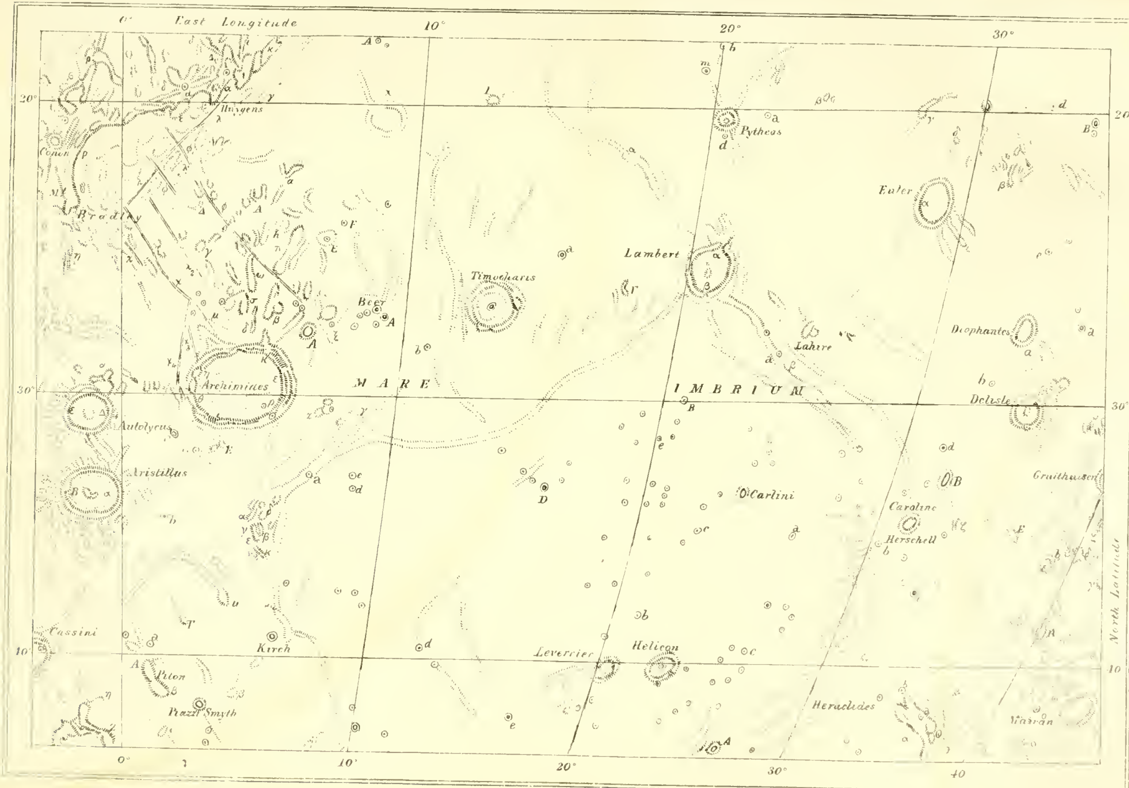
Wollaston (M.)—A 6° bright crater on the open grey plain north of Aristarchus; from nine measures of Mädler in + 30° 17′ 15″ lat. and − 46° 54′ 14″ long. East is Wollaston C, in + 31° 12′ lat. and − 51° 24′ long., a very similar crater also 6° bright, with a wall rising in the east 748 feet above the plain, and surrounded by a considerable number of low ridges, but lying in a shallow valley, in which is the delicate rill Herodotus ζ. South is Wollaston B, a small 5° bright crater in + 28° 26′ lat. and − 45° 41′ long., which according to Mädler forms, in combination with three small peaks and some ridges, a small enclosed plain, in whose centre rises an insignificant central elevation. The western peak is, according to Mädler, 4° bright and 1,963 feet high; the northern peak, α, is 5° bright and 2,740 feet high; the eastern peak 6° bright; and the crater B 5° bright, and with its east wall 2,666 feet above the plain. Schmidt draws this formation as a circular ring-plain with a craterlet on the wall near the peak α, and two others west; but Mädler's description appears correct, though the small interior craters and the two exterior shallow depressions exist. Wollaston A is a 6° bright small ring-plain in + 30° 3′ lat. and + 41° 20′ long.

Gruithuisen (N.) [Delisle A., M.]—A small 4° bright ring-plain 10 miles in diameter, in + 32° 53′ lat. and − 39° 51′ long., which is not mentioned by Beer and Mädler, though fairly distinct. From Gruithuisen extends a long ridge to Wollaston A, and on the north another to a collection of small bright peaks near ζ, this last being $5\frac{1}{2}$° bright, and 3,376 feet high. Beyond these is the very brilliant 9° bright craterlet Gruithuisen *b*; and on its east rises the massive mountain δ 5°$\frac{1}{2}$ bright, and 5,851 feet high, and the high flat plateau, Gruithuisen γ, 5° bright, and 5,211 feet high, both on the extreme border of the long projecting extremity of the highlands of the Sinus Iridum ; whilst north of b is the peculiar mountain Gruithuisen ϵ, fully 8° bright, semicircular in form, and of very unequal height. (These are Mairan ζ, b, δ, γ, and ϵ of M.)

Harbinger Mountains (B.)—A small mountain system nearly 50 miles north-west of Aristarchus, composed of a number of short broad ridges mixed with some steep round peaks, and surrounded by a number of low hills and long gently sloping ridges only from 30 to 120 feet high. The principal peaks are β, 3,140 feet high, according to Mädler, but only 2,290 according to Schmidt ; γ, which Mädler makes 4,182 feet, and Schmidt 4,355 feet high ; Δ, in $+ 27° 52'$ lat. and $- 40° 28'$ long., rising above the surface 5,595 feet from Mädler's measures, and 5,621 from those of Schmidt ; and ϵ, with a height of 6,280 feet according to Mädler, and 6,133 feet according to Schmidt ; whilst the latter makes α nearly 7,800 feet above the plain. (These are Aristarchus β, γ, Δ, and ϵ of Mädler, who has in § 268 interchanged ϵ and γ by mistake.) The peak ϵ is on a curved ridge, enclosing a kind of ring-plain open on the south, and close to the peak ϵ Schmidt draws five crater-pits, of which only two were seen by Mädler. Between the mountains extend broad shallow valleys, within which are a number of very delicate rills, principally discovered by Schmidt. The two principal are ζ (S. 150), and η (S. 157), both interrupted in portions, and within the valley east of γ, the last being longest ; and east of this valley extend two curved rills ϕ (S. 158) and ϕ_1 (S. 159), both difficult to see. Schmidt has seen here a number of crater-pits, and one or two more rills have been suspected.

Brayley (B.) [Euler A of M.]—A fine 7° bright small ring-plain west of Aristarchus on the dark grey plain, very conspicuous under every illumination, and from five measures in + 20° 53′ 52″ lat. and − 36° 25′ 10″ long., its position as a point of the second order of Mädler being + 20° 46′ lat. and − 36° 36′ long. East is the similar 6° bright formation Brayley C, in + 21° lat. and − 39° 3′ long., with, close to it on the east, a small craterlet on the west slope of a long mountain peak, and from which extends a streak to Mayer. West is the 6° bright small ring-plain Brayley B, in + 20° 23′ lat. and − 34° 18′ long., whose east wall rises 1,407 feet above the plain, and with a small craterlet on its north; and beyond is *d*, a 6° bright crater. (These are Euler C, B, and *d* of M.) The peak Brayley α is 4° bright, and 1,765 feet high.

Map IX.


East Longitude
North Latitude
MARE IMBRIUM
Huygens
Conon
Bradley
Archimedes
Autolycus
Aristillus
Cassini
Kirch
Piton
Piazzi Smyth
Beer
Timocharis
Lambert
Pytheas
Euler
Lahire
Diophantes
Delisle
Carlini
Caroline
Herschell
Gruithuisen
Leverrier
Helicon
Heraclides

CHAPTER XV.

MAP IX.

Euler (S.)—A considerable ring-plain 18·95 miles in diameter, with 5° bright broad walls terraced on the exterior, and rising on the east 1,132 feet above the Mare, and at α, 2,405 feet above the outer surface, but 5,953 feet above the 4° bright interior; whilst on the north is a pass in the wall. The 5° bright fine central mountain, from ten of Mädler's measures, is in + 22° 57′ 51″ lat. and − 28° 58′ 29″ long. East is the mountain Euler β, 6° bright, and 3,639 feet high; whilst Schröter makes the south-east peak 2,400 feet, and the north-east peak 3,100 feet above the plain. North of these is the small crater *e*, 5° bright, at the end of a light streak. South of Euler are some moderately high peaks, forming a rough circle; and of these Euler γ rises 2,100 feet, and δ 2,400 feet above the plain, according to Schröter. Euler is surrounded by a system of light streaks, the longest extending towards Mayer.

Pytheas (R.)—A ring-plain 11·58 miles in diameter, with a wall rising 2,475 feet above the Mare Imbrium on the east, and 2,455 feet on the west, though rising probably 5,000 feet above the interior; the whole forms in Full a 7°½ bright, very distinct, round white spot. On the wall is a small craterlet *d*, that Schröter considered to be a new formation of his time; and the 8° bright central peak, from ten of Mädler's measures, is in + 20° 14′ 3″ lat. and − 20° 34′ 13″ long. South of Pytheas extends a row of mountains towards the Carpathians, and here are three small craters, a, *b*, and *c*, none of them particularly distinct. North-east is the bright peak Pytheas α, on the summit of a ridge, and 825 feet high; whilst south-east is the isolated peak β in a light streak, and about 900 feet above the plain.

A singular circumstance in connection with Pytheas is that Tobias Mayer refers to two formations under the names of Pytheas; one that he identifies with Riccioli's in + 20° 43′ lat. and − 20° 30′ long., which is the same as the present ring-plain, and the second from two other measures he places in + 19° 15′ lat. and − 16° 5′ long. Lichtenberg was the first to point out that no such object now exists on the moon as Tobias Mayer's second Pytheas; and neither Schröter nor Mädler could detect the slightest trace of such a formation, which certainly does not now exist. Mädler thinks that the supposed existence of this formation arose from some confusion in Mayer's notes; for it appears that the latter himself seems to have noticed the absence of any formation corresponding to his second Pytheas, and to have felt doubtful on the subject. Schröter seemed rather to fancy that the result appeared to indicate a similar phenomenon to the white cloud-like object seen by Cassini near Walter, but which afterwards likewise vanished: though Mädler thinks this last may have been a bright region near Lexell.

Lambert (S.)—A large deep ring-plain 17·61 miles in diameter, with 4° bright terraced walls rising on the east 1,752 feet, and on the west 2,411 feet above the Mare Imbrium; and on the west 5,947 feet above the 3° bright interior, on which stands a 6° bright central peak, in + 25° 21′ lat. and − 20° 51′ long. At α and β, on the wall rise low peaks with between them a high pass, the southern of which is most distinct; and from the wall extend a number of ridges; on the south-west as far as Eratosthenes, on the north-east to Caroline Herschel, and on the north-west to Kirch, Archimedes, and Plato. Owing to its curved form, the mountain Γ in + 25° 55′ lat. and − 17° 38′ long. appears at times like a crater, and it rises 3,006 feet above the plain on the west, and 3,990 feet above the plain on the east. Occasionally this peak glitters on the terminator in a very striking manner, and then appears fully 8° bright, though usually not more than 5°½, and at Full scarcely 4°½ bright.

In Full, Lambert cannot easily be detected, only its central mountain being visible; but as the whole region is covered with bright light spots and streaks, it is difficult to identify.

Lahire (M.)—A steep isolated mountain, whose position from ten of Mädler's measures is + 27° 18′ 15″ lat. and − 25° 9′ 48″ long., and whose height, according to Schröter from five measures, is 4,900 feet. This mountain was twice seen by Schröter under very different conditions of illumination so brilliant as to glitter with rays like a star, and he thought during the long period embraced by his observations that he had detected changes in its form and appearance. Gruithuisen, however, though he often examined it, never saw its radiant aspect, and considered its shape to have entirely altered, and its size to have been reduced since Schröter's time. Webb has seen it on the terminator glittering and radiating as described by Schröter; but Beer and Mädler make not the slightest allusion to the whole formation, probably by some accidental omission. The general brightness of Lahire near the terminator is 6°, but at times it is fully 7° and even 8° bright, whilst at Full only about 6° under all circumstances, while its height is 4,750 feet.

Diophantes (M.)—A small ring-plain 12·17 miles in diameter, whose east wall rises 2,551 feet above the Mare;

whilst according to Schröter it is 3,200 feet above the interior, which contains no central peak. In Full the wall is 6° bright, and the interior 4° (Mädler 3°), and the position of the centre of the ring-plain is + 27° 26′ lat. and − 33° 50′ long. East is the small crater **a**, 5° bright, with two round small 5° bright spots beyond it at Full; and north is a low 5° bright plateau, with a 7° bright low peak on it, Diophantes α; with on the west a 5° bright crater, Diophantes *b*, a streak uniting the two last.

Delisle (S.)—A ring-plain, 15·86 miles in diameter, with a 5° bright wall, rising 5,954 feet above the 3°½ bright interior (3° M.), on which is a very distinct 5° bright central peak, from ten of Mädler's measures in + 29° 59′ 20″ lat. and − 34° 47′ 37″ long. On the north wall is a small crater not seen by Schröter, and on the south wall a small pass, neither very distinct. East is a small triangular plateau on which rises the peak α, 5° bright, and 3,792 feet high, and the steeper and higher plateau nearer, at the principal peak β, is about equal in height. Delisle B, in + 32° 17′ lat. and − 32° 18′ long. (*b* of M.), is a 4°½ bright small ring-plain, whose east wall rises 1,020 feet above the Mare, and nearly 3,000 above the interior, whilst south is *d*, a small crater only 4° bright, and north Delisle ζ, a mountain, rising 1,292 feet. East of this last is the peak E in + 34° 55′ lat. and − 36° 35′ long., 5° bright.

Caroline Herschel (B.) [Delisle, C. M.]—A 4°½ bright ring-plain, about 3,000 feet deep, in + 34° 16′ lat. and − 31° 31′ long., with several 5° bright spots near it, and surrounded with a great number of small craters, the principal of which are Caroline Herschel *c* and *b*, which are perhaps 5°½ bright in Full, most of the rest being only 4°½ bright, and from their small dimensions not easily recognised.

Carlini (M.)—A small 6° bright crater, 4·6 miles in diameter, and from its position it is fairly distinct in Full;

according to Schröter, 2,000 feet deep; whilst Mädler from eleven measures, determines its position to be in + 33° 22′ 45″ lat. and − 24° 0′ 46″ long. Near Carlini are very many craters, ridges, and light streaks, the former very small and usually 4°½ to 5° bright, the ridges low and only 3° bright at most, and the light streaks slightly brighter than the surface; one extending as far as Bianchini from Carlini, a length of 300 miles, and throughout 3° bright. Carlini D, in the west, in + 33° 24′ lat. and − 15° 42′ long., much resembles Carlini, and is also 6° bright, its west wall rising 1,867 feet above the Mare and 1,800 feet above the interior, according to Schröter, but really over 2,500 feet. B in + 30° 0′ lat. and − 20° 42′ long., is also 6° bright, and about 2,000 feet deep.

Helicon (R.)—A very deep ring-plain, in + 40° 10′ lat. and − 22° 53′ long., 13·09 miles in diameter, with a wall rising above the Mare Imbrium on the west 1,445 feet and on the east 1,656 feet according to Mädler, and according to Schröter from two measures 4,500 feet deep, though an earlier measure had given him nearly 12,000 feet for the depth. Schröter observed a central mountain, Mädler did not, and Webb has seen a central crater; and there exists on the slope of Helicon a small crater, not given by Mädler, though he has drawn others more difficult to see. Near Helicon are a considerable number of craters, mostly 4° bright, the two principal, *b* and *c*, being somewhat more distinct than the others. In Full, Helicon is fairly distinct.

Leverrier (Lecouterier.) [Helicon, A. M.]—A very similar, slightly smaller ring-plain to Helicon, in + 40° 11′ lat. and − 20° 25′ long., with a diameter of ten miles, and whose wall rises nearly as high above the Mare Imbrium as that of Helicon, and, according to Schröter from two measures, it is 6,700 feet above the interior, though from an earlier measure he found 13,500 feet. According to Mädler, Leverrier disappears entirely in Full, though its very similar eastern neighbour Helicon remains distinct; but this is not quite exact, as when the region is familiar, Leverrier, though not distinct, can always be made out with a little trouble. Within it, as in Helicon, Schröter saw a central peak, though Mädler makes no mention of one; and on the outer slope is a delicate crater far easier to see than several in the neighbourhood that Mädler gives, though he did not detect it. An interesting fact is that neither Riccioli nor Hevelius draws Leverrier but only Helicon, though Hevelius observed this region near the terminator, and drew Helicon and the region near.

Kirch (S.)—A 4° bright small ring-plain, on the western border of the Mare Imbrium, in + 39° 6′ lat. and − 6° 6′ long., and according to Schröter 2,300 feet deep, whilst from it extends a strong mountain chain towards the south, and a curved ridge towards Plato.

The southern mountains consist of a fine group of peaks close to one another, but not forming one general mass, and west of the long mountain ridge, extending from Kirch to Lambert. The peak Kirch α is 3,428 feet high, its northern neighbour δ 4,329 feet, γ 5,307 feet, ϵ 5,052 feet, and k 2,494 feet above the western plain; whilst β is 5,544 feet above the eastern. South-west of these peaks on the great ridge is the small 5° bright crater Kirch **a**, and east on the plain is *c*, smaller but as bright, whilst north of this last is *d*, 4° bright. The chief high portion of the mountain ridge from Kirch to Lambert is 6° bright, the rest from 4° to 3°, and the mountain peaks 7° bright, though the peaks isolated on the plain are only 5° bright; and the entire region is traversed by the light streaks radiating from the great ring-plain Aristillus. West of Kirch is the steep small peak Γ in + 38° 25′ lat. and − 2° 8′ long., 5° bright and 703 feet high, with east of it the small broad plateau-like mountain

μ, which $4^\circ\frac{1}{2}$ bright rises 1,010 feet above its eastern and 1,394 above its western foot.

Schröter applied the name Kirch to the mountain group by α; and Mädler, in pursuance of his system of nomenclature, transferred it to the very distinct small ring-plain that now bears this name. It has been proposed to restore to these mountains the name Kirch, and call the ring-plain, that at present bears this appellation, Rumker. After consideration it has been decided to retain Mädler's nomenclature here unaltered as most advantageous, and it would seem best to keep all mountain systems, as far as possible, named after similar terrestrial formations; and were therefore the mountains south of Kirch given a separate name, it would be advisable to employ one of this class.

Piazzi Smyth (B.) [Pico, A.]—A very distinct small ring-plain, in + 41° 45′ lat and − 3° 42′ long., whose $5^\circ\frac{1}{2}$ bright wall rises on the east 2,021 feet above the Mare, and 3,500 feet above the interior. From it extends towards Plato a broad ridge, west of which are two small craters, and south extends a broad streak; whilst near it are several round white spots and some low mountains, the two principal being Piazzi Smyth α and β.

Piton (B.) [Pico, *A.* M.]—A great curved 6° bright mountain mass rising into a $6^\circ\frac{1}{2}$ bright peak β at its northern end, according to Mädler 6,836 feet above the plain, or from three measures of Schröter 7,200 feet high; whilst its lower 7° bright southern point A is in + 40° 16′ lat. and − 1° 16′ long. South of it is a small crater **a**, and some long, broad, low ridges.

Archimedes (R.)—One of the finest and most regular of the lunar ring-plains, 49·93 miles in diameter, with a much-terraced wall containing many peaks, the principal being k, 7,373 feet high; θ, 5,800 feet; ϵ, 5,429 feet; and ρ, 4,975 feet above the interior; whilst the general elevation of the east wall is 3,856 feet above the interior, and 3,325 feet above the outer surface, and of the west wall 4,598 feet above the floor, and 3,875 feet above the Mare. The wall on the exterior is much terraced and very rugged, but with on the whole a gentle slope, and it is surrounded by long, low ridges, rising in occasional peaks, and separated by valleys, and united together by short arms and buttresses. Towards the interior it appears more regular, and only moderately steep, and with scarcely any projections or low terraces even, and without a break. The interior is described by Mädler as a mirror-like plain, without any hills or ridges, though so favourably placed that were any to exist he thought they could not have escaped detection; and it is traversed by unequally bright streaks diverting it into seven zones, though the northern clear zone is particularly difficult to see. The three bright zones of the floor are $3°\frac{1}{2}$ bright; the four dark $2°\frac{1}{2}$ bright; the entire south and east chief wall 6° bright, the north about 5°, and the west 4° bright, except the peaks ε, θ, and η, which are 6° bright. The surrounding mountains are $3°\frac{1}{2}$ and $4°\frac{1}{2}$ bright, gradually sinking in the north and east to 3° bright; but on the west, and especially in the south, the brightness of the surface is fully 4°. At present the floor appears to be on an average over $3°\frac{1}{2}$ bright, the light streaks being 4° and the darker zones fully 3°, and perhaps rather over; whilst the surface, south of Archimedes, is nearly 5° bright. On the floor of Archimedes, Gruithuisen detected a small craterlet, and since then Knott has seen six or seven, all being very minute; whilst, according to Webb, the crater drawn by Mädler on the wall is truly at its foot. Mayer drew a central mountain to Archimedes, from, Mädler thinks, having seen only the central portion of the middle bright zone, and considering that this indicated a central peak.

Archimedes C is a 7° bright crater in + 31° 25′ lat. and − 1° 48′ long.; and close to it is *d*, a small 7° bright crater on the west slope of a ridge, with on its north o, a small 7° bright peak. The western peak of the mountain E is 6° bright, and the eastern 7° bright peak rises 4,470 feet, and is in + 31° 47′ lat. and − 3° 48′ long.; and from the wall past the mountain E extends a long ridge of no great height, and east a still lower one, the slightly depressed region between them being probably Schröter's valley. At its end is the small crater b, 5°½ bright, and according to Schröter 1,200 feet high, his three results being, however, very discordant, while its depth is about 1,500 feet. The mountain triangle, Archimedes Z (ζ of M) has its southern peak 5° bright, and the two northern 7°, the north-west and highest rising 2,366 feet, and is situated in + 30° 19′ lat. and − 7° 34′ long.; whilst the 5° bright peak γ is, according to Schröter, only 450 feet high. The small conspicuous ring-plain A is 6° bright, with a 4° bright interior, according to Mädler, who, as a point of the second order, made its position + 27° 56′ lat. and − 6° 31′ long.; it is now fully 7° bright, with a 5° bright interior, and a wall on the east about 400 feet high and 3,000 feet deep, and on the west 3,800 feet deep. From seventeen measures its position is + 27° 44′ 58″ lat. and − 7° 10′ 47″ long.[1]

South of Archimedes is a labyrinthine mass of mountains, 5° bright in Full, whilst the valleys between them vary from 4°½ to also 5° bright. The principal mountain mass is that on which is the 5° bright crater E, and which rises 3,958 feet; south-east is a crater F, 5°½ bright, and in + 24° 1′ lat. and − 7° 45′ long. The steep head of the curved mountain A is also 6° bright, and in + 23° 4′ lat. and − 4° 55′ long., and is 3,132 feet high; south is another curved mountain, α, 5°½ bright, and 2,000 feet high; and north is the massive mountain β, 5° bright, with three 5°½ bright peaks, and 3,500 feet high. West is δ, 5° bright, and still higher; and

[1] Some peculiar discrepancies appear in the separate measures of this spot which require elucidation.

farther west σ, not quite so high, but curved in form; whilst south of the last two, is ω about 2,000 feet high and 6° bright, and east of it π, 5° bright, whose centre peak is nearly 4,000 feet high. In this portion of the surface is the grey small ring-plain h, not given by Beer and Mädler, though well drawn by Schröter, who found its east wall to be 3,700 feet high. Archimedes γ is drawn by Mädler as a steep peak, but is only of very moderate height, and Archimedes μ, at the south point of the projecting mass of *débris* south of Archimedes is according to Schröter 3,200 feet high. In this region the 'Mappa Selenographica' is very imperfect, and Schröter's drawing is more accurate, though not complete towards the west; the heights given of the principal mountains are round numbers, being only approximations, except in those derived from Mädler; and those found by Schröter are given with his name. South-west is a fine system of rills only rarely well seen, and the most distinct is χ (S. 129), discovered by Lohrmann; west is the branch χ_3, discovered by Schmidt and very delicate; and farther south another short rill, χ_1 (S. 128), very difficult to see. East is χ_2 (S. 131), discovered by Lohrmann, and described by Schmidt as feeble, but which must be now extremely difficult to see, having been always found invisible, when most of the others of these regions are distinctly to be seen; its position is therefore doubtful. In the hills at the foot of the Apennines runs the long rill Archimedes λ. Lohrmann discovered the west portion, which is Schmidt's 134; and the latter discovered a continuation which constitutes the centre, and is Schmidt's 136. Gaudibert saw these two united, and crossed by a third rill, probably ϕ (S. 133); but the rill continues past where Schmidt traced it as far as the north slope of Cape Huygens, and is a second time crossed by a short rill, ϕ_1, both of these last being visible only with great difficulty. North of λ Schmidt discovered a short rill, λ_1 (S. 135), very difficult to detect. Near Archimedes A, in a fine shallow valley, Schmidt discovered a short rill, ξ (S. 132); and later, Gaudibert saw an extension, ξ_1. From this rill extends a remarkably fine rill, ϕ, uniting the short rill, ϕ, with ξ, which appears entirely to have escaped the attention of Schmidt, and was seen finely in May 1875, when a very delicate branch of χ_3 was also found for the first time, and forms a very fine test for telescopic excellence.

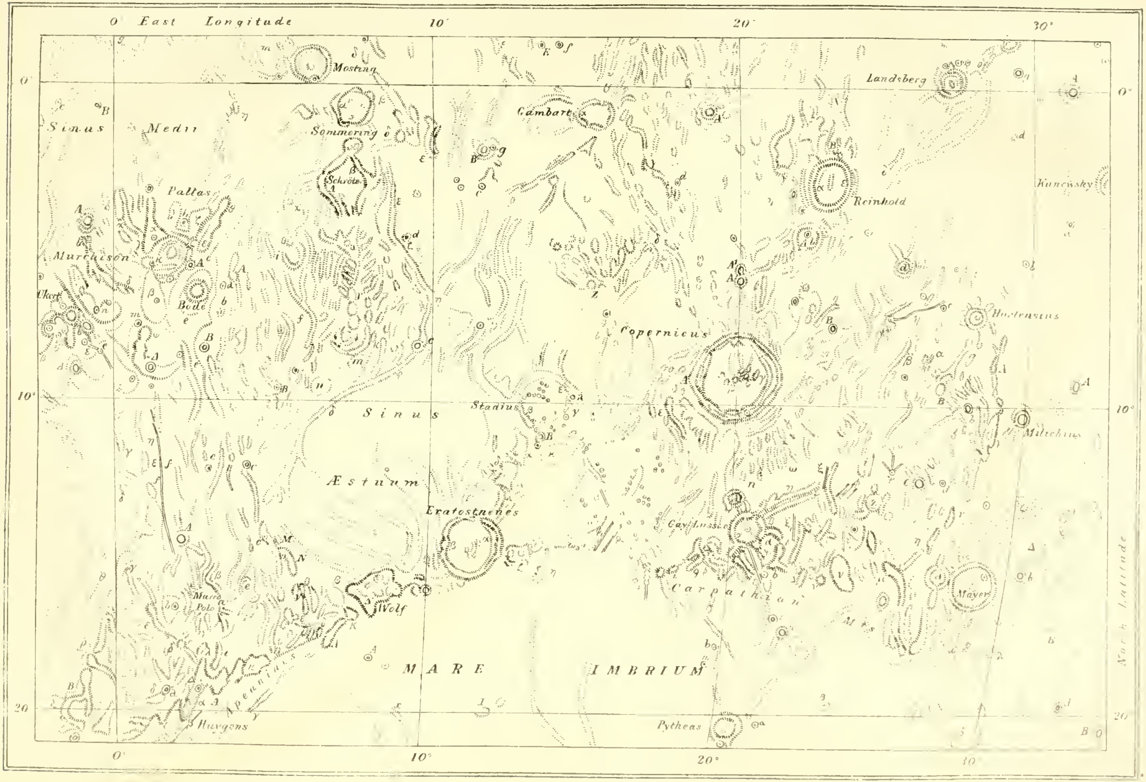
Mare Imbrium (R.)—This is the greatest of the circular dark grey plains of the moon, and is remarkably well bordered, except on the east, where it is separated from the Oceanus Procellarum by an arbitrary line drawn by Euler, Diophantes, and Delisle. On the south it is bordered by the great mountain ranges of the Carpathians and the Apennines, on the west by the Caucasus and the Alps; for the Palus Nebularum and Palus Putredinus, like the Sinus Iridum, are only portions of the great grey plain, the Mare Imbrium; while on the north rise the lofty highlands of Plato and the Sinus Iridum. Extending, therefore, from $+ 7°\frac{1}{2}$ to $- 41°\frac{1}{2}$ long. and from + 15° to + 51° lat., it has a length of 751 miles and a breadth of 678 miles, with an area of about 340,000 square miles, or three times greater than the Mare Serenitatis, and five times as large as the Mare Crisium. The surface is very variable in brightness, varying from only 2° by Helicon to over $3°\frac{1}{2}$ on the brighter portion near Archimedes, whilst containing a very great number of light streaks, mostly 4° to 5° bright. The ridges on the Mare Imbrium are very numerous, and mostly broad, low, and gently sloping.

Beer (B.)—A 6° bright, very distinct crater, whose wall rises 1,950 feet above the plain according to Schröter, and is probably over 2,000 feet above the interior. North is the crater A (Archimedes B, of M.) in + 27° 14′ lat. and − 9°

30′ long., slightly smaller, and with its wall is only 1,700 feet above the plain, according to Schröter, but it is somewhat deeper than Beer, and is perhaps nearly 3,000 feet in depth. It was proposed to call this last crater Mädler, but this name has been already applied by Schmidt to a fine ring-plain near Theophilus, and two of the same name would introduce confusion.

Timocharis (R.)—An isolated ring-plain, 22·68 miles in diameter, with a fine terraced wall which rises on the west 6,714 feet, and on the east rises 7,117 feet above the interior, and 3,652 feet above the Mare Imbrium, Schröter making these last 7,350 and 3,200 feet respectively. The walls have a slight break on the north, and are from 5° to 6° bright, the interior is 4° bright, and the central mountain 5° bright; this last, from eleven measures by Lohrmann, being in + 26° 42′ 44″ lat. and − 12° 59′ 44″ long. The surface immediately around Timocharis is 5° bright, but it gradually fades down to the brightness of the darker Mare, except on the north-west, where it extends in several light streaks for some distance. A number of flat ridges lie round the ring-plain, mostly very low and broad, and seldom more than 200 feet high, whilst craters are very few and small, the principal being Timocharis **a** and *b*.

Map X.



0 East Longitude
10°
20°
30°
Mosting
Landsberg
Gambart
Sinus
Medii
Sommering
Schröter
Pallas
Reinhold
Kunowsky
Murchison
Ukert
Bode
Hortensius
Copernicus
Sinus
Stadius
Milichius
Æstuum
Eratosthenes
Gay Lussac
Carpathian
Mts
Mayer
Marco Polo
Wolf
Apenninus
MARE IMBRIUM
Huygens
Pytheas
North Latitude

CHAPTER XVI.

MAP X.

Mt. Huygens.—A magnificent mountain mass, whose northern end projects as a bluff cape into the Mare Imbrium, and rises in a steep peak B, in + 20° 25′ lat. and − 2° 33′ long., 14,631 feet above the grey plain below; whilst the principal peak α, near the centre, towers aloft to the stupendous height of 18,046 feet, according to Mädler, or 20,900 feet, according to Schröter's four measures. Beer and Mädler think Schröter must have confused the shadows of two peaks together, as their results are 2,900 feet less than his. On the summit of the inner peak Δ, in + 19° 20′ lat. and − 3° 0′ long., is a very minute crater, hardly discernible even under very favourable conditions. West of Huygens is ϵ, a peak apparently fully 15,000 feet high; east is A, in + 19° 34′ lat. and − 3° 45′ long., 12,239 feet high; and still further east, the mountain mass *k* rises from 8,000 to 13,000 feet above the grey plain below, which contains but few hills, Huygens γ, which is perhaps 2,000 feet high, being almost alone. On the highlands south of the great crest of the Apennines are a number of lofty peaks which are not measurable; but, considering the great elevation of the entire Apennine plateau, these can be little inferior in height to the great peaks of the northern border crest. Huygens i, λ, and δ are the principal of these inland peaks, and near the last is a deep incomplete crater, Huygens **a**. Further south extends a high mountain row, whose principal peaks are Marco Polo δ and ϵ, and which ends at the peak Marco Polo γ; this, though it rises 3,677 feet above the Mare Vaporum, is far inferior in its apparent altitude to the height of the peaks δ and ϵ above the great Apennine highlands.

Marco Polo (M.)—A considerable depression within the highlands of the Apennines, scarcely ever properly visible except at the evening terminator, when shortly before sunset it is fairly distinct. It is without ring or border, but is surrounded by a number of peaks separated by fine narrow valleys, which radiate in all directions and principally lead to the summit of the highlands around, only one appearing to wind its way, becoming gradually deeper, until it opens on to the long valleys north of Ukert and communicating with the Mare Vaporum and Sinus Æstuum. The two principal peaks near Marco Polo are α and β, and around it are several minute craters, of which b is the most distinct, and is 7° bright, whilst towards the south is A, in + 14° 13′ lat. and − 2° 11′ long., a 6° bright crater.

Mt. Wolf (S.)—A great mountain mass rising at its north-west end into a lofty peak Δ, in + 16° 35′ lat. and − 7° 42′ long., and according to Mädler 11,036 feet high, or, according to two measures by Schröter, 12,100 feet above the plain beneath. The mountain mass is rectangular in form, and contains a number of rounded peaks and apparently a crater of some kind near the south. On the east towards Eratosthenes extends a chain of lower mountains, and on the west is the steep and high mountain mass Wolf A, which contains several peaks from 10,000 to 12,000 feet high, the principal being β, δ, and ϵ. At Wolf A rises a peak 10,528 feet above the plain beneath.

Apennines, Eastern (H.)—Extending from Bradley A to Huygens A, is the loftiest portion of the great Apennine mountains, rising at points nearly 20,000 feet, and with a general elevation of the highlands perhaps of not much under 10,000 feet. Between Huygens A, Wolf, and Marco Polo *c*, the Apennines assume a triangular form, with a high steep crest towards the north, an elevated but not so rugged fall towards the south-east and west, and a gentle slope between Wolf A and ε and Huygens A. This is the lowest portion of the great plateau, though even here nowhere under 6,000 feet above the Mare Imbrium. In + 16° lat. and − 4°¼ long. is Marco Polo *e*, a small 7° bright round valley, one of the most conspicuous objects, in Full, on the Apennines. The crest of the Apennine highlands between Marco Polo *e* and Wolf γ is tolerably high, and beyond it rise two peaks, Wolf M, in + 14° 20′ lat. and − 5° 5′ long., 5,538 feet high, and Wolf N, in + 14° 50′ lat. and − 5° 30′ long., 7,769 feet high.

Eratosthenes (R.)—A very fine, strongly terraced ring-plain, 37·40 miles in diameter, with rugged, broadly terraced walls, which are highest on the east, where the peak α rises 7,449 feet above the outer surface, and 15,808 feet above the interior, whilst on the west at β they are only 9,880 feet above the interior and 3,261 feet above the Mare. The interior contains three central peaks placed in a triangle; the principal, according to six measures by Lohrmann, in + 14° 26′ 35″ lat. and − 11° 26′ 22″ long., whilst from seven measures during 1874–1875 it was found to be in + 14° 23′ 58″ lat. and − 11° 41′ 19″ long., the two combined giving as the place of Eratosthenes from thirteen measures, + 14° 25′ 16″ lat. and − 11° 34′ 25″ long. In Full, this great ring-plain, which was regarded by Mädler as probably the outbreaking crater of the great Apennine highlands to which it forms a magnificent culmination, is not very distinct, and appears as an ill-bordered, badly-defined whitish spot, containing three dark-grey spots, and may easily be overlooked. On all sides Eratosthenes is surrounded by ridges and low hills, many of the former extending across the Sinus Æstuum. On the Mare Imbrium, north of Eratosthenes, appear the two mountain groups I and x, the latter at its southern point 1,790 feet high; and south of these is the small 4° bright crater Eratosthenes A, with a larger and deeper 3°½ bright neighbour. East of Eratosthenes extends a short chain of nearly isolated peaks of considerable steepness, rising at ζ 3,254 feet, and at η 3,952 feet, whilst the extreme end ω is 4,200 feet high, according to Schröter; but as Mädler has drawn this group somewhat imperfectly, it is not certain to what peaks his letters refer.

Stadius (R.)—A peculiar ring-plain, 42·79 miles in diameter, with extremely low walls only 130 feet high, except at one or two low peaks; the highest of these, β, is perhaps 700 feet, and the next, γ, 448 feet high, and with perhaps ϵ, are the only points above 150 feet high; the wall of the crater **a** rises, however, about 575 feet. The level interior is crossed by two dark streaks, and contains thirteen small craterlets or rather crater-pits, all very small and shallow, and seven forming a chain, whilst a number of low ridges can occasionally be detected. North of Stadius is the 5° bright crater B, in + 11° 26′ lat. and − 13° 24′ long.; near it are six or seven crater-pits, and a dark patch Stadius *k*. From the wall of Stadius to Eratosthenes extends a considerable mountain arm, 5° bright, and falling with some steepness towards the east: it rises at the peak Stadius α 4,470 feet above the eastern plain, and at Stadius δ 3,184 feet above the western surface; whilst, according to Schröter, near λ it rises 9,500 feet above the plain on the east. A dark plain extends from this mountain arm on the west, to the west border of the Carpathians on the east, and on the south from Stadius and a well-marked slope east of it, to the extreme outlying peak of the Carpathians and the mountain chain east of Eratosthenes, on the north; it is thus 90 miles broad and 110 miles long. The interior contains only a few elevations, the principal being a few low ridges and mounds, near the centre, but it contains a very great number of minute crater-pits. Mädler drew sixty-one of these, which he considered to be probably not one-half of the real number, and under good conditions over two hundred can be detected with great difficulty. According to Mädler, they are not generally distributed over the surface, but most are in rows, in portions close together or perhaps even confluent; these are included by Schmidt as crater-rills, in his catalogue, and are Stadius ϕ, ϕ_1, ϕ_2, and ϕ_3 (S. 171, 172, 173, 174). Many of these crater-pits, though mostly the smaller, lie dispersed over the plain without any apparent connection. Gruithuisen, who discovered them, estimated their diameter at only 500 feet, far under the truth; and Mädler considered that most of them must be at least 1,000 yards in diameter, though numbers can be detected with powerful telescopes, under exceptionally favourable conditions, that have a diameter only one-half of this. Twenty-four hours after sunrise scarcely a single crater-pit can be detected, and twelve hours later the whole plain appears as level and as free from craters as the neighbouring Sinus Æstuum.

Sinus Æstuum (R.)—A dark-grey plain, bordered on the west by the Apennines and hill-lands of Bode, on the south by the hill-lands of Schröter and a series of ridges from Stadius, on the east by the mountains between Stadius and Eratosthenes, and on the north by the Apennines and the outlying mountains; or a length of 130 miles and a breadth of 170 miles, with an area of some 14,000 square miles. The western portion is at Full about 2° bright, the eastern nearly $3°\frac{1}{2}$ bright, but at the terminator both are much darker; the general brightness seems to be due mainly to the very great number of low ridges from 3° to 3°½ bright, which traverse the surface, though they are so low and gently sloping as to be hardly well seen even under very oblique illumination. In the 'Der Mond,' Mädler draws attention to the remarkable contrast between the surface east and west of the mountains between Stadius and Eratosthenes, in the first being innumerable crater-pits, whilst on the Sinus Æstuum he could detect none. Lohrmann had, however, detected one; Mädler subsequently found several with the Dorpat refractor, and Webb finds two easy.

Bode (L.)—A very distinct ring-plain 9·40 miles in diameter, with broad 8° bright walls, and a 5° bright interior, which contains no central mountains; according to Webb the floor is crossed by a curved ridge from north to south, but this, though often looked for, has never been seen. Bode stands on the summit of a broad, elevated, gently sloping plateau of small dimensions, surrounded by two fine valleys. On the west the wall rises 4,500 feet, and on the east 5,000 feet above the interior, and about half of this above the valleys; and in Full, under high illumination, it forms, from its bright broad walls, one of the few very conspicuous points near the centre of the moon. Lohrmann from eight measures found its position to be + 6° 37′ 54″ lat. and − 2° 30′ 48″ long., and from a series of twenty-eight measures during 1874–1875, the resulting position was determined to be + 6° 37′ 55″ lat. and − 2° 39′ 21″ long., the two combined giving as the results of thirty-four measures + 6° 37′ 55″ lat. and − 2° 37′ 51″ long., rendering its position very certain. North is the still more conspicuous crater, Bode A, 8°½ bright, 4 miles in diameter, and probably 3,000 feet deep, whose position from six measures is + 8° 53′ 57″ lat. and − 1° 19′ 40″ long., Mädler's result as a point of the second order being + 8° 56′ lat. and − 1° 16′ long. Bode A stands on the crest of a fine curved plateau, with a broad gentle slope towards the north. East of it is the 7° bright crater Bode B, $3\frac{1}{2}$ miles in diameter and 1,200 feet deep, whose position from six measures is + 8° 42′ 40″ lat. and − 3° 9′ 41″ long., Mädler's result for its place as a point of the second order being + 8° 23′ lat. and − 3° 0′ long. This crater is also very distinct, though not so noticeable as A, and stands on the crest of the east border of a magnificent valley *e*, which extends from the peak ϑ to a craterlet west of Bode C, a length of 180 miles, with a breadth of from 8 to 15 miles. Bode C is a 5° bright crater in + 11° 58′ lat. and − 4° 27′ long., and is situated at the point where four great lunar regions unite, namely, the valley region of Bode, the hill-lands of Schröter, the flat plain of the Sinus Æstuum, and the great highlands of the Apennines. East of Bode, on the eastern crest of the great valley *e*, rises the 6° bright mountain peak Bode *A*, in + 6° 0′ lat. and −3° 32′ long., and near it also on the crest of the valley are two minute craters, **a** and *b*, neither given by Mädler, and both seen only at long intervals, appearing usually as white points. North, on the border of the Mare Vaporum, rise the peaks γ and δ, and east is the still higher peak ϵ on the west border of another great valley of the system of Bode. North of Bode is a very remarkable system of long broad valleys opening one into the other, with very gently sloping sides which contain many irregularities, whilst the valleys themselves wind between the steeper peaks. This region, over 20,000 square miles in area, when carefully examined presents many points of resemblance to terrestrial formations, especially from this great valley system, which extends from the Apennine highlands to the broad Sinus Medii, nearly 300 miles distant. The principal of these long valleys are *e* and *f*, both originating near Marco Polo; the former extends in a winding course as far as the south of Pallas, where it opens in a wide mouth on to the Sinus Medii; and the latter, still broader at its commencement, suddenly begins to narrow north of Bode A, and bursts through the elevated plateau between Murchison and Ukert by the great valley cleft of Ukert, and emerges on the open Sinus Medii beyond in a wide gently sloping valley. Both these receive in their course a great number of small shallow branch valleys, generally in themselves branched, but bearing a considerable general analogy to the two chief valleys. These formations, like all others of a similar nature, require an intimate acquaintance with the region they are in before they become recognisable, and from their extent they can very rarely be seen equally well throughout; moreover from their very gentle slope, and the many disturbing irregularities, they are never very easily traced unless the whole details of the region are well known. Within *f* extends the long rill Ukert η.

Murchison (B.)—A level ring-plain, enclosed by high mountain chains on the south and north, by Pallas on the east, and by Murchison A on the west, being under most illuminations even more distinct than Pallas. The highest portion of the wall is the great mountain α, and the next δ, the former being about 3,800, and the latter 3,000 feet above the interior; whilst at β it rises nearly 2,000 feet above the west, and at γ, the south wall is about the same amount above the floor. The interior of Murchison is traversed by a number of low ridges and a few mounds, and at *b* is a peculiar elliptical depression. Murchison A is a very distinct bright crater, 5 miles in diameter and 3,000 feet deep, whose position from eighteen measures is $+ 4° 3' 57''$ lat. and $+ 1° 0' 4''$ long., the results of Mädler, one of whose points of the second order it was, being $+ 3° 57'$ lat. and $+ 1° 6'$ long. Mädler estimated its brightness as 7°; it is now very nearly 9° bright, and perhaps without exception the most distinct and conspicuous object within ten degrees of the centre of the moon, and is peculiarly well adapted to serve as a standard point for the origin of lunar measures and for the investigation of the moon's real libration; its only rival is Mösting A, which, if perhaps slightly brighter, is surrounded by a bright region, and is moreover slightly larger. Murchison A stands like Bode on the summit of a high mound or rounded plateau, not unlike a mass of *débris*, and on the sides of this mound are one if not two very minute steep-crater cones, the true representatives of the terrestrial volcanic craters.

Pallas (M.)—An irregular ring-plain of elliptical form bordered by a wall, rising on the east 4,470 feet above the floor, and nearly as much above the exterior valleys; but the border consists rather of great mountain plateaus than of a wall. Pallas α is the principal of these, and has on its summit a small crater, and another at its extreme southern end; but the largest of these plateaus is β, opposite, also with a craterlet on its slope; between the two rises a steep mountain k, perhaps 3,000 feet high, with, on its east crest, a very minute crater-cone scarcely to be seen except under very favourable conditions. Two short deep ravines separate the three mountains and open a communication between Pallas and Murchison. Extending from the northern of these ravines to the east wall Mädler draws a shallow valley. On the east the wall descends into the western branch of the great valley of Bode, and on its slope are two or perhaps three craters. The northern one lies between two fine peaks on the wall, and is very deep though small. The second, Pallas A, is deep and conspicuous, and in + 5° 42′ lat. and − 2° 24′ long., whilst the third is probably imperfect, and lies on the steep north slope of a valley or ravine, separating the wall of Pallas from a fine mountain arm stretching south. On the interior of Pallas are several ridges and a steep and high central peak, in + 5° 22′ lat. and − 1° 48′ long. The mountain arm extending south from Pallas, rises in three steep high peaks, ε, at the north, being 3,696 feet, and θ, at the south, 4,067 feet above the valley on the east. Between it and α are two other mountain arms, ζ and γ, neither so high nor so steep, and between the two is a bright crater *b*. South of these extend several chains of low hills and mounds, with a few peaks at intervals, and reaching beyond the Equator, the chief mountains being near Pallas η.

Sommering (M.)—An irregular ring-plain, whose southern foot is crossed by the Equator, and with a wall which rises at the peak α on the west, 4,777 feet above the interior, and 3,498 feet above the outer plain, but on the east is so low and broken as to be only visible with difficulty. The wall is 5° bright, and the interior, which contains several small mounds, 3° bright. On the east extends a mountain chain, falling steeply towards the north-west, and rising at the peak β 2,232 feet, at δ 2,762 feet, and at ε 3,037 feet above the surface, whilst from their 6° brightness these peaks are tolerably distinct in Full.

Schröter (Gruithuisen.)—An irregular ring-plain, very imperfectly enclosed, with a wall which rises at the high peak A, in + 2° 58′ lat. and − 6° 30′ long., 5,103 feet, and at β nearly as much; but as only the three or four highest points are 5°–6° bright in high illumination, Schröter can only be found with difficulty. The breaks in the wall are very numerous, but the floor appears perfectly level and slightly below the exterior surface. North of Schröter extends one of the most peculiar regions of the moon, consisting of a somewhat elliptical low plateau, with an area of about 18,000 square miles, covered with an immense number of small hills and short ridges, which enclose a most intricate system of short shallow valleys. On the west the plateau slopes gently to the valley region of Bode; and Schröter χ, θ, and *i* are capes enclosing small bays from the Sinus Medii, though these bays are as full of hills as the elevated region above. From the peak *i* to Schröter B, a small crater, 6° bright, in + 9° 34′ lat. and − 5° 9′ long., the border consists of the east crest of a fine wide valley, Schröter *f*, extending from the Sinus Medii in a broad curve for nearly 100 miles, and separating the regions of Bode and Schröter. North of Schröter B as far as Bode C, the plateau sinks gradually and the hills become much lower and fewer, though the surface retains its dark tint; and at Bode C the west and east borders unite. Towards the east the border is a fine mountain ridge descending sharply towards the low Sinus Æstuum and at intervals rising in high peaks, the two principal being ρ (the northern ε of M.) and δ, and with an average height of 1,150 feet above the dark Sinus Æstuum. On reaching the 5°$\frac{1}{2}$ bright crater Schröter C, in + 8° 4′ lat. and − 9° 33′ long., the border of the hill-land sweeps in a bold curve round to the south-west, and possesses its brightest peaks, several, including η and ζ, rise 2,600 feet, and ε rises 2,801 feet, above the eastern plain. The interior of this hill-land is most intricate, on account of the immense number of small hills and ridges, and the slight slope and shallow character of the numerous valleys; and as Beer and Mädler confess, it is impossible to draw this region on the small scale of their map, which scarcely contains one-hundredth of the small detail that can be seen. The highest point towards the centre is the 5° bright peak Γ, which rises 2,494 feet above a valley east of it; but few of the other peaks rise above 1,000 feet, and most of them only from 50 to 200 feet. Between *k* (northern θ of M.) and B, are two dark round spots, *n* and *m*. Schröter **a** is a small depression, and from it to the peak Γ extends a mountain chain, from which extend south-west five arms. The hill-region Schröter, unlike the great majority of similar formations, is not only dark at sunrise but still darker in Full, though a great number of minute white spots can be seen; it thus presents a marked contrast to the general great increase in brightness of all disturbed regions as the solar altitude increases. Mädler could detect with certainty few craters within this hill-land, and though Lohrmann saw more, they are in number exceptionally few, considering how favourably placed the region is for detecting them. The ring-plain at present bearing this name is not the formation to which it was originally given, which was a peculiar rampart-like work, discovered by Gruithuisen in 1811, in the hill-land of Schröter, and which he described as a rampart system visible only close to the terminator. Lohrmann could not identify it; neither could Beer and Mädler, and they therefore transferred the name to the ring-plain. Mädler, subsequently with the great Dorpat refractor, succeeded in detecting a formation not unlike half this rampart system of Gruithuisen, though Schmidt and Schwabe had before detected it, and since then it has been seen more often. It extends from the peak Γ to Schröter **a**, and consists of a central wall, from which five arms extend in a south-west direction, and east of it are six peaks, which appear to form six more arms when seen just beyond the shadow of the central ridge.

Gambart (M.)—A circular ring-plain, 15·95 miles in diameter, with a narrow 4° bright wall of small height, only the peak α rising 2,302 feet above the outer plain. The interior of Gambart is level, and its centre is in + 0° 59′ lat. and − 15° 19′ long., whilst around the ring-plain, which is not easily seen in Full, are a number of long, low ridges and hills. West of Gambart are two fairly distinct craters, B in + 1° 57′ lat. and − 11° 56′ long., 8° bright, and C in + 3° 14′ lat. and − 11° 54′ long.,[1] 5°

[1] By some strange error in the 'Der Mond' the longitudes of Gambart B and C are given as 16° instead of 11°, which is correct, and so they are placed on the map.

bright, both of considerable depth; whilst near them are a number of small crater-pits, and close east of B is a 7° bright minute craterlet, *g*.

East of Gambart is the fine crater Gambart A, 8° bright, and, according to Mädler, the most distinct object in this region; it is surrounded by a 7° bright surface from which extend some streaks as far as Reinhold on the east and Gambart γ on the north-west. From nine measures by Mädler, Gambart A is in + 0° 50′ 30″ lat. and − 18° 45′ 12″ long. North of Gambart appear a great number of short ridges more or less connected, and enclosing long shallow valleys. From Gambart ε to *Z*, in + 7° 15′ lat. and + 15° 5′ long., extends a dark valley, 37 miles long, and from *z* to Gambart δ extends another of lighter colour; between the two being a number of parallel chains forming shallow valleys. The mountains near here are very dark, and Z the highest peak, only 2,500 feet high, and in Full appears here a dark spot, only this triangle and a few peaks south being 3° to 3°½ bright. The small peak Gambart ε is, however, remarkable, for at Full, 7° bright, it retains this brightness, even when on the terminator—a very exceptional instance.

Reinhold (R.)—A ring-plain, 30·72 miles in diameter, with fine broad, 3° bright, steep walls, rising at α 9,401 feet, and at ε 7,041 feet above the interior, which is 5° bright at the north and only 2°½ at the south; yet in Full the ring-plain can only be seen with difficulty, from the effects of the general brightness of its environs. The central peak of Reinhold, from ten measures during 1874–1875, is in + 23° 13′ 19″ lat. and − 22° 37′ 26″ long., Mädler's position as one of his points of the second order, being + 3° 4′ lat. and − 22° 36′ long. South of Reinhold extend mountains towards the Equator. B, the principal, is steep and 2,300 feet high, and is in + 1° 33′ lat. and − 22° 24′ long. North are two craters, A the smallest in + 4° 18′ lat. and − 21° 22′ long., lying near the centre of a second ring-plain, Reinhold *b*, far less visible than Reinhold, and with its western and highest peak only 2,660 feet above the floor. West of Reinhold are some steep peaks, γ being perhaps the highest; and extending from here Lohrmann saw a rill η, that has not been seen again (S. 192).

Copernicus (R.)—A gorgeous ring-plain, 56·02 miles in diameter, the finest on the entire northern quadrant, and whose principal central mountain, from ten measures by Mädler, is in + 9° 20′ 57″ lat. and − 19° 55′ 48″ long. The magnificent walls, not perfectly circular in form, are crowned by a row of 9° bright peaks, perhaps fifty in number, which are elevated little above the crest of the wall, and appear under favourable conditions of illumination as a circlet of pearls amidst the brilliant background. Steep and much terraced towards the interior, very rugged though not so steep towards the exterior, the walls rise at γ 10,896 feet, and at the peak A, in + 9° 4′ lat. and − 18° 29′ long., 11,279 feet above the interior. The slopes are 5° to 6° bright, the rest of the wall is 8°, and the peaks 9° bright, whilst the interior is only 4° bright (3° M.); the three chief central peaks are 6° bright, and the remaining five are barely 5° bright. On the north wall of Copernicus, Schmidt draws a short rill (S. 191), but its true character must be regarded as doubtful. Near it are two minute craterlets.

Copernicus is surrounded by a great mass of very complex mountains and ridges, all more or less radiating from it as a centre, though they are much branched; some extend direct from the base of the wall, others are separated from it by valleys. Further off the ridges become more parallel to the walls, often crossing those radiating from Copernicus. On the west these mountains are most considerable, several peaks near ε being over 2,000 feet high, but elsewhere they are only from 200 to 800 feet above the surface. Between the mountains are a complicated system of valleys, a number of these on the north-east being long, narrow, and sharply defined, not unlike rills in appearance, and five of these near ω have been included by Schmidt as rills in his catalogue (S. 185–189), three of them having at their northern end crater-rills. Beyond, Schmidt draws a crater-rill ξ (S. 181), and further has seen three short crater-rills ϕ (S. 182–184), and still further east mentions that three short rills extend from a bright crater ψ. South is the deep crater A, in + 5° 50′ lat. and − 20° 0′ long., with on its south border, though quite as deep, the smaller A_1, in + 5° 33′ lat. and − 20° 0′ long., both these being 6° bright with 3° bright interiors, and retaining their shadows longer than Copernicus. B, equally deep and nearly as bright, is in + 7° 23′ lat. and − 23° 2′ long.

The most remarkable peculiarity of Copernicus is the numerous light streaks which extend from it on all sides, forming, however, no regular ray system; the departure from this being still more marked than at Tycho or Kepler, though the real relation of the streaks to it as a centre is unmistakable. Through these streaks Copernicus is united to many other ring-plains of this region, which themselves often exhibit the same phenomena on a smaller scale, and in fact between the equator and the thirtieth parallel of latitude there are few considerable ring-plains which do not show traces of a system of bright streaks radiating from them. Near Copernicus the light streaks unite and form a kind of nimbus or light cloud around the ring-plain, which is, however, interrupted by several dark streaks and spots, one appearing even on the wall of Copernicus itself. The streaks extending south towards Reinhold and Gambart are slight and badly defined, and those that reach Reinhold appear to disperse themselves anew as if radiating from that ring-plain.

Those extending west towards the hill-land of Schröter, without, however, actually reaching so far, are more intense and considerable, and so numerous that the dark tint of the surface appears rather as dark streaks on a bright ground than as the reverse. The same appears in the region towards Eratosthenes at Full, the whole surface here, including the greater part of the Sinus Æstuum, appearing of a uniform brightness from the streaks. Towards the north, however, the streaks are most conspicuous, where after crossing the Carpathians they extend in broad, well-defined light streaks across the dark Mare Imbrium. They are here 5° to 6° bright, and five to fourteen miles broad, though gradually narrowing towards the east, where they are more broken; but, by Mayer, they regain their full breadth and intensity, and extend across the dark Oceanus Procellarum, reaching the feebler streaks of Aristarchus, and forming north of Bessarion a great light spot. On the east, between Milichius and Hortensius, are a number of bright curved light streaks extending as far as Kepler, and thus uniting the two great streak systems of the north.

Gay-Lussac (M.)—A ring-plain, 14·75 in diameter, with bright walls of some height at the peak α and β, and with a central crater on the south slope of a central peak; but owing to the uniform brightness of this region Gay-Lussac can barely be distinguished in Full. South is the 6° bright ring-plain A, steeper, deeper, and more distinct than Gay-Lussac, and in $+ 13° 7'$ lat. and $- 20° 22'$ long., with, according to Schröter's two measures, a depth of 4,800 feet: it is connected with Gay-Lussac by two arms, whilst on its south-east, at n, is a dark grey spot. From β extends a fine valley η (S. 178) south-east, with a slight curve round the base of the steep peak ζ; and from α extends a mountain arm north, which, together with the mountain arm λ, encloses a small plain d, not unlike a ring-plain open towards the north; and close to it is the 4° bright crater *b*. The arm λ on the west of this plain is of great height and completely overshadows it for some time after sunrise. Within the plain Schmidt discovered two rills, ψ (S. 176) and ψ_1 (S. 177), the last being difficult. West of the plain, at the foot of the Carpathians, is a short rill φ (S. 175), and in the mountains, east of Gay-Lussac, Schmidt mentions two others which he considers crater-rills, ξ (S. 179) and ξ_1 (S. 180), the positions of both of which are perhaps problematical.

Carpathians (M.)—These considerable mountains extend from Gay-Lussac ε to Mayer ε, a length of 125 miles, though including outlying peaks the length is much greater; and, unlike most of the other mountain systems of the moon, they form neither a long ridge nor yet the crest of a vast highland, though it is true the surface south of them gradually rises into a complex mountain region; but the Carpathians consist of great masses of mountains placed side by side, separated by great valleys, and connected by small elevations. The main chain of the Carpathians commences at Gay-Lussac *c*, which rises 2,500 feet, east of which is θ, still higher, and ε, far loftier, whilst the end of the west border of the plain Gay-Lussac *d*, rises, perhaps, 5,000 feet. Beyond rise two peaks, λ, in + 14° 20′ lat. and − 22° 5′ long., 5,356 feet, and Δ, in + 15° 15′ lat. and − 22° 03′ long., 4,053 feet high; and east of these, beyond the steep isolated peak Gay-Lussac γ, rises the lofty peak ν, 6,331 feet high and at the end of a still higher mountain mass, whilst the range finally ends at Mayer γ, nearly 7,000 feet high. Beyond these there extends a long chain of isolated peaks forming a continuation to the main chain of the Carpathians.

T. Mayer (S.)—A considerable ring-plain, 22·36 miles in diameter, with a steep 5° bright wall, rising on the west

x 2

9,726 feet above the 3° bright floor, on which is a small crater and a 5° bright central mountain, this last from ten measures of Mädler in + 15° 32′ 30″ lat. and − 28° 49′ 41″ long. Around Mayer extend a number of mountains, one chain running from Mayer ϵ to ζ, and is much curved; another, on the north, extending nearly straight for 35 miles with a bright high peak at μ. East of Mayer, towards *k* and *B*, are a great number of isolated steep peaks in part arranged in long rows, and two of the most conspicuous are B, in + 17° 0′ lat. and − 31° 53′ long.; and **Δ**, in + 14° 20′ lat. and − 30° 52′ long.; but these are not the highest, ρ, south-east of *B*, being 3,325 feet, α 3,997 feet, and λ nearly as high. The crater *b* is only 4° bright, but near the terminator is very conspicuous, and has four fine peaks on its wall. Mayer *e* is of very considerable depth, but not very distinct; whilst the small ring-plain **a**, on the south-west of Mayer, is deep and 7° bright, with two peaks of equal brightness north and south. South of Mayer extend a number of high mountains, the three principal peaks, ν, θ, and η, being all 6° bright, whilst the crater *d* is also 6° bright. Mayer C, in + 12° 24′ lat. and − 25° 58′ long., is 7° bright, and according to Schröter, its wall rises 1,700 feet above the plain, while it is over 6,000 feet deep. North-west, Mädler draws a very conspicuous small ring-plain-like crater at *z*, in + 13° lat. and − 25° long., which is probably some error, as no such formation appears to exist.

Milichius (R.)—A very fine crater-plain, 8° bright, with a wall 2,027 feet above the outer plain, and far more above the interior; surrounded by a 6° bright portion of the surface, which under exceptionally favourable conditions can be seen to be covered with a great number of small irregularities. From eleven measures the position of the centre of Milichius was found to be + 10° 0′ 15″ lat. and − 29° 40′ 1″ long.; the position, according to

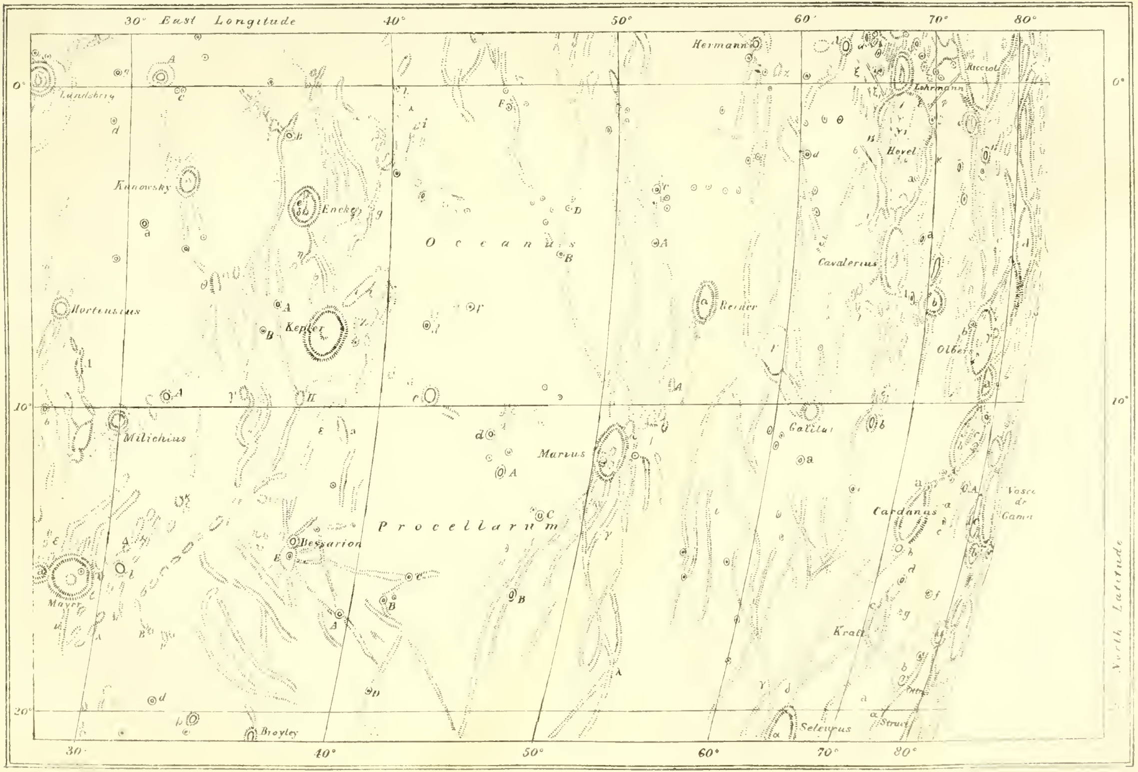
Mädler's result, as a point of the second order, being + 10° 20′ lat. and − 29° 37′ long. West appear some very considerable mountains, the main range γ extending from + 8° to + 13° lat., broken by only a few valleys; and has an average height of about 1,600 feet, rising at the principal peak γ 3,035 feet, and farther south at the 5° bright peak A, in + 9° 6′ lat. and − 28° 22′ long., 3,146 feet, according to Mädler, and 3,120 feet according to Schröter. Milichius B is a lofty peak in + 9° 22′ lat. and − 26° 47′ long., and east of it are some peculiar parallel chains of hills, or perhaps ridges. Near B is the small ring-plain b, in the mountains, not very easily seen. In the open plain east of Milichius, is the 7°½ bright crater Milichius A, in + 9° 13′ lat. and − 31° 48′ long., much resembling Milichius; and south of it three steep conical peaks on a streak from Copernicus to Kepler.

Hortensius (R.)—A fine crater-plain, in the midst of a disturbed region, with a wall rising on the west 1,400 feet above the plain, according to Schröter, and nearly as deep as Milichius. Hortensius is 7°½ bright and surrounded by a light spot, near the walls 6° bright but gradually fading, whilst in all directions extend light streaks. Its position from twelve measures is + 6° 2′ 8″ lat. and − 27° 41′ 8″ long., Mädler making its place as a point of the second order + 6° 56′ lat. and − 27° 52′ long.[1] With the exception of the crater c, the details west of Hortensius are visible with difficulty; and north-west are only some mountains by α and β, without any great height. The small ring-plain Hortensius d is drawn far too conspicuous on the 'Mappa Selenographica,' as it is very shallow and not readily seen even on the terminator. South-east are the two craters,

[1] This considerable difference appears to be owing to some error on the part of Mädler, and is not due to a misprint in the 'Der Mond,' as the place on the 'Mappa Selenographica' is in accordance with this position. This error must affect considerably the details of this region as drawn by Mädler.

Hortensius *b* and **a**, both fairly distinct. The rill η is very difficult, and was discovered by Schmidt in 1851; it is in No. 193 of his catalogue, but its place and form are very doubtful; and about one degree further north is perhaps a second still larger but still more delicate, far too faint to make sure of either its position, or even perhaps actual existence.

Map XI.



30° East Longitude
40°
50°
60°
70°
80°
0°
10°
20°
30°
North Latitude
Landsberg
Kunowsky
Encke
Hortensius
Kepler
Milichius
Mayer
Bessarion
Broyley
Oceanus
Procellarum
Marius
Reiner
Hermann
Lohrmann
Riccioli
Hevel
Cavalerius
Olbers
Galilei
Cardanus
Vasco de Gama
Krafft
Seleucus
Struve

CHAPTER XVII.

MAP XI.

Kunowsky (N.) [Encke, A. M.]—A ring-plain 14·34 miles in diameter, with low walls 5° bright on the south, 4° bright on the west, and 3°½ on the north and east, rising on the east 1,547 feet above the surrounding places, and a little more above the interior, in which is a small 4° bright central mountain in + 3° 0′ long. and − 32° 19′ lat. It is tolerably distinct under all illuminations, and can be detected without difficulty in Full, together with the two craters C, in + 0° 3′ lat. and − 31° 6′ long., and the small crater D, in + 1° 24′ lat. and − 28° 56′ long., both 4°½ bright (Encke C and *d* of M.); all the rest here then disappearing.

Encke (M.)—A considerable ring-plain, 20·33 miles in diameter, with a 5° bright wall rising at its highest point only 1,810 feet above the interior, and 770 feet above the outer plain, and possessing several peaks only visible near the terminator. The interior contains a high peak δ, united to the south wall by a ridge almost as high extending across ⅘ of the floor, leaving only a narrow gap between the peak δ and the north wall, a conformation not very rare in the south-west quadrant, but here very anomalous. The central peak, δ, from seven measures during 1874–1875, is in + 4° 18′ 14″ lat. and − 36° 35′ 35″ long., but was not measured by Mädler. Towards Kepler on the north and the equator on the south extend mountain chains, ridges, and hills. The principal chain, ζ, extends in a winding course from Kepler A to Encke B, whence dividing into two extends south of the equator; and at its steepest and highest peak, γ, rises 2,098 feet above the plain, whilst south-west rises another peak, ρ, 1,989 feet high, both on the western branch. Encke B is a 6° bright crater, from eight measures in + 1° 57′ 6″ lat. and − 36° 18′ 56″ long., but was not measured by Mädler, though one of the most conspicuous formations in Full in this region. East of Encke are a number of 4° to 5° bright mountains, *i* rising 3,556 feet, χ 2,014 feet, and β 2,903 feet above the plain, north of the last being an irregular mountain ring, *f*. Further north is a 5° bright crater *g*, with near it two high peaks; whilst on the equator itself is Kepler E, a 6° bright crater, in 0° 0′ lat. and − 40° 12′ long., and tolerably distinct.

Kepler (R.)—A considerable ring-plain 21·71 miles in diameter, with 7° bright walls, containing few peaks, rising on the west 6,618 feet, and on the east 10,021 feet above the 6° bright interior, though only slightly above the outer surface, where the slope of the wall is very gentle. The 6°½ bright, very insignificant central mountain, is from eleven measures of Mädler, in + 7° 46′ 13″ lat. and − 37° 42′ 18″ long., and from fourteen measures during 1874–1875, its position was determined to be + 7° 57′ 48″ lat. and − 37° 38′ 58″ long., the mean of the two series giving as the result of twenty-five measures + 7° 52′ 42″ lat. and − 37° 40′ 26″ long., as the place of the central peak of Kepler, rendering it thus one of the best determined points on the moon.[1]

[1] The considerable difference between the values for the latitude of Kepler obtained by Mädler, and that found from the series of measures made during 1874-75, admits of being explained; and here perhaps some modification of the value adopted by Mädler would be advantageous. Out of the eleven measures employed by him, three were made at a very early period, when from some circumstance many of the measures were found to be so discordant as to be untrustworthy, and were therefore rejected. These measures are not so satisfactory

Kepler is the centre of a great streak system, and is of all such, the one which lies on the least disturbed surface, for though Tycho is surrounded by ring and walled plains, Copernicus by numerous hills and ridges, Aristarchus by most diverse formations, and Byrgius, Olbers, and Anaxagoras in the midst of mountains; at Kepler the surface immediately round is almost absolutely level, and the streaks of Kepler, extending over the comparatively level Oceanus Procellarum, are easily seen and drawn. For a distance of from twenty to fifty miles from Kepler the surface appears to be open plain, the mountain *i* alone approaching within five miles, but beyond appear a number of mountains and ridges, few steep, however, and mostly low and inconsiderable. The most elevated formations around Kepler are the peak Z, in + 7° 15′ lat. and − 40° 24′ long., 1,100 feet high, on the north-east rim of a small plateau, and with on the north a mountain ridge, which rises 3,287 feet above the surface. The peak θ rises 2,328 feet, and from it extends a low ridge to the mountain γ, 2,098 feet high, east of which are the three mountains H in + 9° 50′ lat. and − 37° 0′ long., Δ in + 10° 54′ lat. and − 38° 55′ long., and ε, all of some height, and moreover just distinguishable at Full. The craters near Kepler are more distinct than the mountains, most of which entirely disappear shortly after sunrise. A is in + 6° 51′ lat. and − 36° 6′ long., B in + 7° 25′ lat. and − 35° 16′ long., the former 6° and the latter 5° bright, and both on the west. East is the crater E, in + 6° 58′

as the others, and there is a difference of nearly 36′ between the resulting latitude for these three early measures and the eight later and preferable measures—a considerable discordance. If, as might be preferable, these are rejected, like many made during the same period, the position of Kepler from the eight satisfactory measures of Mädler is + 7° 55′ 53″ lat. and − 37° 43′ 21″ long., agreeing very well with those obtained during 1874-75; and the resulting position of Kepler from twenty-two measures would be + 7° 57′ 6″ lat. and − 37° 40′ 34″ long.; perhaps the best value, the difference being + 4′ 24″ lat., and + 8″ long., from that obtained from the entire twenty-five measures.

lat. and $-$ 44° 0′ long., 6° bright; *d*, 5° bright; and the small ring-plain C 5°½ bright, in + 9° 48′ lat. and $-$ 41° 31′ long., with a wall rising 3,012 feet above the interior, and 1,803 feet above the plain.

Over nearly all these formations extend the nimbus or streaks of Kepler, though without destroying the visibility of the chief craters; and it is noteworthy that, unlike in other formations, Kepler is not surrounded by a darker ring, but the nimbus extends right up to the wall, and is there 6° bright. This nimbus has a greater extent than any other on the moon, stretching on the north 28 miles, and elsewhere 50 to 70 miles from Kepler, thus covering from 8,000 to 10,000 square miles, and is generally 5° bright. Beyond this extend the streaks; none towards the south, according to Mädler, though two or three feeble light streaks can perhaps be seen; on the west many light streaks unite the two systems of Copernicus and Kepler; north-west they are feeble and short; north-east a great bundle of long, thin, very intense streaks unite the two systems of Aristarchus and Kepler; and east are a very considerable number, extending as far as Marius and Reiner, the entire region here, from probably very delicate light streaks not separately distinguishable, being lighter than the rest of the plain.

Bessarion (R.)—A small 6° bright ring-plain with a very small central peak in + 14°½ lat. and $-$ 37° long., and 5° bright interior and 6° bright walls. North is the very distinct 8° bright crater Bessarion E in the centre of an elliptical 6° to 7° bright light spot and surrounded by a very irregular surface of small extent, from which extend short low ridges over the plain and slightly brighter than this. From eleven measures Bessarion E is in + 14° 58′ 48″ lat. and $-$ 37° 0′ 41″ long., its position, as one of Mädler's points of the second order, being + 14° 37′ lat.

and − 37° 5′ long. North are four 5° bright craters connected together by ridges, and which, though of very moderate depth, are at times tolerably distinct, and one of them was probably Riccioli's *Cusanus.* Bessarion A is in + 16° 36′ lat. and − 39° 43′ long.; Bessarion B in + 16° 23′ lat. and − 41° 23′ long.; C, whose wall rises on the east 661 feet above the plain, is in + 15° 36′ lat. and − 42° 20′ long.; and D, whose east wall rises 454 feet above the surrounding surface, is in + 19° 16′ lat. and − 41° 30′ long.

Marius (R.)—A considerable ring-plain, 27·43 miles in diameter, lying isolated in the Oceanus Procellarum, with a very regular uniform 5° bright wall rising on the west 4,553 feet, and on the east 4,314 feet above the 2°½ bright interior. According to Beer and Mädler, Marius possesses no central mountain, and they neither draw nor mention any objects on the interior, though they examined it to ascertain if the wall was terraced. Schröter mentions, however, a flat convex central elevation,[1] which has been since often seen, and consists of a low 3° bright mound on the summit of a slight elevation extending nearly across the interior from north to south. Webb has discovered a minute white craterlet on the north-west of the floor, which is now easily seen, and it seems strange that Mädler should have missed it were it then as distinct as now. From two measures the position of the centre of Marius has been determined to be in + 11° 58′ 44″ lat. and − 49° 57′ 5″ long. According to Mädler, one of whose points of the second order it was, its place is + 11° 27′ lat. and − 50° 27′ long. North-west of Marius is a small peak *k*, connected with the wall by a short valley; and east Schröter draws an imperfect ring-plain *f*,

[1] He also draws on the south-west wall a minute craterlet that was not seen again and has never been recovered, and probably he was mistaken in thinking it existed.

which appears though to be formed by some ridges. On the north Schröter draws the surface as forming a kind of plateau containing a crater; but though the plateau is drawn by Beer and Mädler, they give no crater. From this plateau extends a long ridge north to the distinct crater, Herodotus A, on the plain, having at λ a peak 450 feet high, and at γ is 940 feet high. On the east extend a very great number of these ridges, together with many hills, and the highest points here are Marius ε, which rises 1,042 feet above the plain, and i, which is perhaps 900 feet high. The crater e is in high illumination 4° bright, but according to Mädler in low illumination is scarcely to be seen. West of Marius are a considerable number of craterlets, together with a number of hills only visible near the terminator, though the craterlets are distinct even in Full. Marius A is 5° bright, and in + 12° 8′ lat. and − 45° 34′ long., with very steep walls rising on the east 3,444 feet above the interior, and on the west 2,040 feet above the plain; and by comparison with A, the 5° bright B on the summit of a ridge in + 15° 51′ lat. and − 47° 12′ long. appears to be 1,503 feet deep; C, also 5° bright, 1,600 feet deep, and d of the same depth. The rest of the craters here are only 4° bright, and perhaps some of them are not really craters, for while they are not distinctly to be seen at the terminator they appear in Full merely as white spots. South of Marius extend several ridges towards Reiner, one rising at β, according to Schröter, 610 feet. North of Marius, extending from + 18° lat. and − 48° 10′ long. to + 15° 30′ lat. and − 53° 0′ long, Schmidt in 1862 saw a long winding rill which he has not again detected, but considers it to be a perfectly normal rill (S. 170).

Oceanus Procellarum (R.)—This is the greatest of the grey lunar plains to which the generic term ‘Mare’ has been applied, and occupies nearly a third of the north-eastern and a considerable portion of the south-eastern quadrant, and may with its bay-like connections possess an area of two million square miles. It is united to the Mare Imbrium, the Mare Nubium, and in some degree to the Mare Humorum, and forms a very decided contrast to the highly mountainous bright south-western quadrant. The Oceanus Procellarum has no well-defined borders, and its limits are like our terrestrial oceans arbitrarily defined. The east border is tolerably well marked from Letronne to east of Galilai by the border mountains of Hansteen, Damoiseau, Hevel, and Cavalerius; and even beyond these, though extending close up to the limb, the clear mountains of Olbers, Vasco de Gama, and Otto Struve show its limits usually with some distinctness; but thence to Repsold and Harpalus, in the Sinus Roris, the eastern border is not in general well defined by natural boundaries. On the west it is separated from the Mare Imbrium by the highlands of the Sinus Iridum and the ridges extending from Gruithuisen, Delisle, Diophantes, and Euler to Mayer. Here the border becomes again more marked, and is formed by the mountain systems of Mayer, Milichius, Hortensius, and Reinhold; and then long ridges extending from south of Reinhold by Landsberg to the Riphaen mountains, separate it in some manner from the Mare Nubium; but from the southern peak of the Riphaens to Agatharchides and Letronne, ridges and isolated crater and mountain groups form its southern boundary. The surface of the Oceanus Procellarum contains very many ridges, and it is covered in part by light streaks from the systems of Aristarchus, Copernicus, and Kepler, and, as Mädler remarks, here can clearly be distinguished the difference between the ordinary ridges of the great Mares and the light streaks, and the fact demonstrated that the light streaks are not due to the ridges covering the Mares, as Schröter supposed. The general brightness of the surface is from 2° to 2°½, perhaps the same as the main portions of the Mare Imbrium and Mare Nubium, but darker than the Mare Serenitatis and Mare Humorum. The numerous ridges that cover the surface are mainly of the same brightness as the surface, though numbers are very slightly brighter, and at the peak sometimes perhaps 3° bright.

Kraft (S.)—A ring-plain, on the eastern border of the Oceanus Procellarum, with 5° bright walls, rising, according to Schröter, 4,100 feet above the floor, which contains a central peak, whilst on the south wall is a small crater *c*. Kraft *d* is a 6° bright, easily visible crater; and east of Kraft Schröter draws two other distinct craters, *g* and *f*, both absent from Mädler.

Cardanus (R.)—A distinct ring-plain, with a 5° bright wall rising on the west, 4,100 feet above the 4° bright interior according to Schröter, and the floor contains no central mountain. North is the 6° bright crater Cardanus *b*, not given by Schröter, and south a small crater **a**, drawn by him, though it is far less distinct; and east is a small crater *c* and a mountain peak *α*, neither of them drawn by Schröter.

Vasco de Gama (M.)—A very considerable ring-plain, on the extreme limb of the moon, 51 miles in diameter, and like its environs 5° bright. North are several very similar ring-plains, the most distinct being *b*; west is *c*, a ring-plain, very similar though smaller, to Vasco de Gama; and south-west is the bright deep ring-plain A; whilst south are several more smaller ring-plains and some craters. All these formations are barely visible, except under very favourable conditions of libration and illumination.

Olbers (M.)—A great ring-plain, whose central mountain, from eight measures of Mädler, is in + 7° 55′ 16″ lat. and − 77° 32′ 31″ long., and stands out, from its clearness and sharpness, distinctly from its enviorons, whilst in favourable conditions of libration it appears as the centre of a light streak system, little if any inferior in extent to those of Kepler and Copernicus. The most numerous and brightest of these streaks appear to extend east, and are thus little visible, and, like those extending north, appear perhaps to radiate from the small ring-plain Olbers **a**. The wall of Olbers seems to be of considerable steepness, especially at the two peaks γ and δ, while on the wall is a small 6° bright crater *b*. The ring-plain *c* (*b* of M., who has two *b*'s) is elliptical in form, and has a high wall, containing many peaks and some craters, while its interior is traversed by a low ridge.

From Olbers to the equator, near the limb, extends a region only well seen in extreme easterly libration. The small bright ridge ζ is tolerably distinct, and unites Riccioli with the 6° bright small ring-plain Riccioli B, in + 2° 6′ lat. and 75° 1′ long. North two long mountain ridges enclose a wide plain, Olbers C, which is crossed by numerous smaller ridges and at times appears as a great walled-plain. East extend two long mountain ranges, Olbers A and β, in places 5,000 to 6,000 feet high, and enclosing an apparently narrow valley, though solely from foreshortening, as its breadth must be over twenty miles. Beyond appear here at times peaks rising 6,000 to 8,000 feet above the limb, and therefore perhaps 10,000 above their bases, probably the northern continuation of the great D'Alembert mountains.

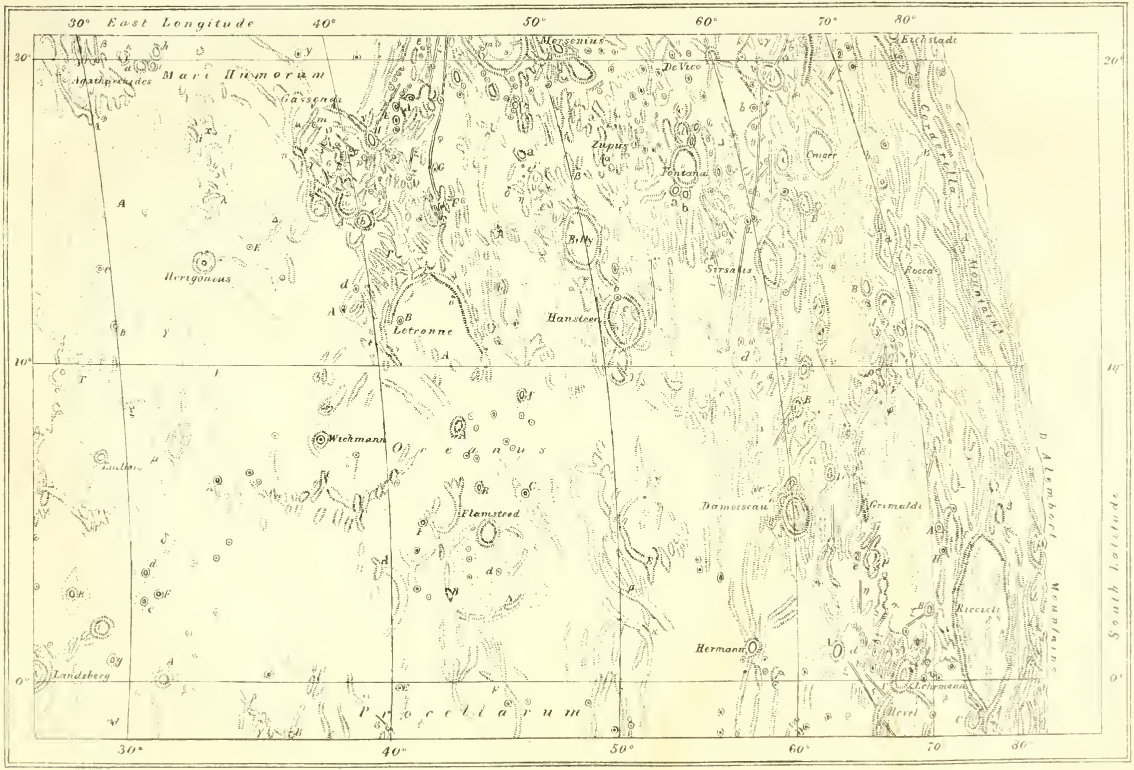
Reiner (R.)—A ring-plain, 21·02 miles in diameter, with 5° bright, broad, uniform, slightly-terraced walls, rising on the west at α 9,912 feet above the interior, which is 3° bright, and contains a small distinct central mountain, from ten measures of Mädler, in + 6° 30′ 37″ lat. and − 54° 43′ 41″ long. East of Reiner is the small plateau Γ, in + 8° 15′ lat. and − 58° 25′ long., scarcely 200 feet high, but towards Full it becomes a $6°\frac{1}{2}$ bright white spot, far more conspicuous than Reiner, which it might easily be mistaken for. Around Reiner are many ridges with a general meridional direction, but they are all only visible with difficulty. Towards the south are a considerable number of craters, mostly 4° to 5° bright and distinct in Full, and many are united together by low ridges which disappear soon after sunrise. The principal of these craters are, A, in + 4° 44′ lat. and − 51° 5′ long., with a wall rising 1,100 feet above the plain, according to Schröter; B, in + 5° 9′ lat. and − 47° 19′ long.; C, in + 3° 10′ lat. and − 51° 51′ long., with an east wall rising 500 feet above the surface, according to Schröter; D, in + 3° 30′ lat. and − 47° 36′ long., 6° bright, and at the end of a light streak from Kepler; and F, in + 0° 52′ lat. and − 44° 37′ long., with a peak on a ridge south of it rising 716 feet above the Mare.

Galilai (R.)—A small ring-plain in + 10° 14′ lat. and − 62° 16′ long., only 9·2 miles in diameter, with 4° bright walls of considerable height above the interior. From it extend several ridges to the plateau Reiner Γ, which is very distinct, appearing as a bright spot in Full, though Mädler considers the borders of this white spot and the small plateau are not coincident, and that it was probably to this spot that Riccioli gave the name Galilai. North is **a**, a very similar formation to Galilai; and east *b*, on the extreme end of the plateau of Cavalerius, with north of it the 5° bright crater Galilai *c*, and still further north is the peak α, of some considerable height.

Cavalerius (R.)—The most northern of the great ring-plain chain of the east, a very considerable ring-plain 41·13 miles in diameter, and nearly circular in form, with broad, much-terraced walls containing many peaks, and rising on the east 10,046 feet, and on the west 9,576 feet above the interior, and at A, in + 6° 10′ lat. and − 67° 0′ long., probably still higher. The walls and interior as well as the central mountain are 4° bright, almost the same as its environs, and consequently Cavalerius is scarcely to be detected in Full. North extends a fine mountain plateau, bordered on the west by a striking mountain chain, which at sunrise presents an interesting appearance, though nowhere rising more than 5,000 feet above the Oceanus Procellarum. East is the crater Cavalerius **a**, and a peculiar circular depression, *b*, with very low and gently sloping walls. Near the west wall of Cavalerius, Lohrmann discovered a rill valley (S. 200).

Hevel (R.)—A great, peculiarly formed, walled-plain, 70·86 miles in diameter, with a fine wall, on the west consisting of a long straight chain of great steepness and considerable height, rising into high peaks, B, in the centre, in + 2° 17′ lat. and – 65° 5′ long., being 5,750 feet above the interior ; whilst in the east it is a great curved ridge, not so steep, nor so high as on the west, but rising in fine peaks at ε and k ; the highest point on the entire wall being, however, Γ, in + 4° 6′ lat. and – 66° 40′ long. In high illumination the wall is not distinct, and the whole formation appears 4° bright (3° M.) ; the interior contains a considerable, low, gently rising plateau, *z*, on whose northern end is a small mountain, α. North of this is a fine crater, **a**, believed by Schröter to have been formed between his earlier and later observations, but Beer and Mädler with entire justness consider on far insufficient authority ; for, as they remark, only on the ground of a strictly systematic, thorough, detailed, and continuous examination of the moon can a properly authenticated instance of real physical change be established. West of Hevel, Mädler points out, there exists a perfect copy of the type of the greater walled-plain, only formed by small, scarcely visible ridges, instead of great mountain ranges. It contains on its floor a number of slight elevations and craters, and is traversed by two rills—Hevel, θ (S. 194), ξ_1 (S. 196), and ξ (S. 195). Two other rills, ψ (S. 198) and ψ_1 (S. 197), cross each other in the interior of Hevelius, but are both very delicate; and in the east wall is a rill valley (S. 199).

Map XII


30° East Longitude
40°
50°
60°
70°
80°
Mersenius
Eichstadt
Mari Humorum
Agatharchides
Gassendi
De Vico
Zupus
Fontana
Criiger
Cordeilla
Herigonius
Billy
Sirsalis
Rocca
Mountains
Letronne
Hansteen
Wichmann
Oceanus
Flamsteed
Damoiseau
Grimaldi
D Alembert Mountains
South Latitude
Riccioli
Hermann
Landsberg
Lohrmann
Hevel
Procellarum
20°
10°
0°
30°
40°
50°
60°
70
80

CHAPTER XVIII.

MAP XII.

Lohrmann (M.)—A ring-plain, 27·7 miles in diameter, with 5° bright broad walls, in portions steep, and with their highest peak Γ in + 0° 0′ lat. and − 61° 30′ long. East of Lohrmann, as far as Riccioli, appears a bright plain, disturbed by only a few craters, while west is a system of parallel ridges enclosing rill-like valleys, these being connected by a cross valley under the peaks α and β; and still further south-west is a remarkable row of craters. Lohrmann A is a distinct ring-plain of small dimensions; in the plain is a small shallow rill φ (S. 204) discovered by Schmidt, who has also seen a short rill which extends in a south-west direction from a crater west of Lohrmann, probably *d* (S. 203).

Riccioli (R.)—One of the largest walled-plains on the moon, extending from + 1° 9′ to − 4° 30′ lat., and from − 72° to − 78° long., or from north to south 106 miles long, and at least 100 miles from east to west, containing therefore an area of about 9,000 square miles. The interior is in part one of the darkest portions of the surface of the moon, being only from 1° to 1°½ bright, but gradually becomes brighter towards the south, where nearly two-fifths are 3° bright, whilst the small central mountain δ, and the numerous ridges on the surface, are scarcely brighter than the rest of the interior. The western wall is tolerably high but very narrow and much broken, though becoming more connected and massive towards the south, where it is united with the wall of Grimaldi by the mountain arm Riccioli ϵ. The east wall is more connected, possesses some fine peaks, and is terraced; but, as on the west wall, the peaks are no brighter than the rest, the whole being 5° bright. At a little distance from the walls appear numerous bright peaks, the principal being Riccioli ϵ, γ, Δ, and β towards the south. East of Riccioli, as far as − 82° long., is a bright plain, with, beyond it, a number of considerable ring-plains, of which **a** and *b* are the most distinct. The high mountain *k* here appears to have a very irregular profile, when on the limb. North is Riccioli B, a 6° bright ring-plain, in + 2° 6′ lat. and − 75° 0′ long., united by a bright ridge ζ to Riccioli; and west of it is the larger ring-plain C, with a fine central peak. In the north-west wall of Riccioli is a short rill, seen by Lohrmann (S. 202), and south-west of it is a long rill Φ (S. 201) extending from Hevel to Riccioli across the plain.

Grimaldi (R.)—A great wall-plain, extending from + 1° 40′ to − 9° 25′ lat. and − 64° to − 71° long., thus being 148 miles from south to north, and 129 miles from east to west, with an area of 14,000 square miles. It is, therefore, nearly as large as Clavius or Schickhard, and had it been near the centre, would have probably been included among the smaller Mares. The entire interior is apparently slightly convex, and, except a small portion on the south 2° to 2°½ bright, is a dark grey, estimated by Beer and Mädler as only 1° bright, consequently perhaps the darkest on the entire moon, and, as they say, darker than Plato and equal to Boscovich and the small dark spots within Alphonsus, Petavius, W. Humboldt, and a few other formations, but in extent surpassing all. It is not such a pure steel-grey as Plato, which now occasionally fully equals Grimaldi, a circumstance which Mädler appears never to have noticed. Grimaldi appears to have no principal wall, but to be, like the Mares, a great dark plain enclosed by mountain ranges, with its border broken by numerous valleys and ravines in all directions. Two portions of the western border near β rise considerably, and between is a break in the wall and according to Schmidt a short rill (S. 213), both perhaps identical; east of this break is ρ, 9,057 feet high, and west is β, 8,684 feet high. The entire wall on the east is without a considerable peak, and possesses a general altitude of 4,000 feet; but on the west are tolerably high mountains at α and E, and the average height of the west wall would seem to be about 5,000 feet. The dark interior is traversed by a considerable number of dark, very low, broad ridges; at its north end it is crossed by a fine rill ξ, discovered by Schmidt (S. 205), and on the south is a second ϕ (S. 214), extending from the foot of a low ridge, through a valley on the south border, to the open bright valley between Rocca *c* and *d*, a distance of about ninety miles; within this open valley is a second very short nearly parallel rill (S. 215) according to Schmidt. In the east wall of Grimaldi, Schmidt mentions another rill ψ (S. 216), but which appears to be simply a narrow ravine; and on the open plain north of Grimaldi *e* is the rill η (S. 206), which probably extends as far south as *e*, if not beyond. In Full appear close to Grimaldi a great number of brilliant white spots, some of these being craters, and others being mountain peaks. The 6° bright Grimaldi A, from ten measures by Mädler, is in $-$ 4° 54′ 27″ lat. and $-$ 70° 53′ 28″ long.; and north of it is H, equal to it in size and brightness, in $-$ 4° 17′ lat. and 71° 0′ long.; and north-west the great crater B, in $-$ 2° 22′ lat. and $-$ 69° 18′ long., 7° bright, with opposite it the steep, high 8° bright mountain α. The two craters, *c* and *e*, are also both 8° bright, and near the last is a peculiar double formation *d*, perhaps 7°½ bright, whilst on the south the two peaks by E are 7° bright;[1] all the other formations possess the general brightness common to the mountain regions here.

Hermann (S.)—Schröter gave this name to a small ring-plain, according to him in − 2°½ lat. and − 57° long., fully twelve miles in diameter, and of considerable depth; whilst its east wall rose at a peak on the south 2,400 feet, and in the centre 1,300 feet above the eastern plain. Beer and Mädler, who evidently could not identify this formation, which Schröter had twice drawn and measured, simply ignored it; but on their map, in − 1° lat. and − 57°½ long., draw a small ring-plain, six miles in diameter, which, though marked *f*, appears to belong to no formation, and is not referred to in the text. This would seem to be undoubtedly Schröter's Hermann. This small ring-plain is nearly 4° bright, and is perhaps ten miles in diameter, so it is drawn too small by Mädler, and it is fairly distinct even in Full. South of it extend two long ridges, and north two others, all under 120 feet in height, whilst the peak α rises, according to Schröter, 450 feet above the plain. Between Hermann and Lohrmann A is a white round spot on the plain.

Damoiseau (M.)—A moderately deep ring-plain, twenty-three miles in diameter, with a wall rising little above the concentrically lying bright highlands, and with its floor crossed by a long ridge from north to south, with a peak in the centre, whose position is − 5° 18′ lat. and − 59° 56′ long. South-west of it are two rounded valleys *m* and *n*, and further south a great valley plain **a**, with on its east wall the 7° bright crater Damoiseau D, in − 6° 47′ lat. and − 62° 2′ long., and forming one of the most distinct objects in this region. This valley **a** is bordered on the west by a

[1] Mädler gives the position of these peaks as − 7° 35′ lat. and − 69° long., where no such objects exist; it should be probably − 64° long.

broad plateau, containing on its surface several rounded depressions, the greatest being *c*, B, and *f*, all 7° bright and resembling craters, except in having scarcely any exterior wall. From Damoiseau B extends a great crater-rill η, seen in part by Mädler and in entire by Schmidt (S. 208). The whole region of Damoiseau seems inclined towards the Oceanus Procellarum, the ring-plain itself being on this slope; and on the grey plain at the bottom is the 8° bright crater *e*, surrounded by a 4° bright light spot, whilst the Oceanus Procellarum here contains a considerable number of long ridges, one rising in a peak at Δ, in − 7° 40′ lat. and − 58° 0′ long., over 2,724 feet above the surface. East of Damoiseau, in the bright plain, south of the dark valley Grimaldi *f*, is a rill ϕ (S. 207), in three portions, according to Schmidt, but under favourable conditions it can be seen perfect, though of very variable sharpness and depth; and south-east, Schmidt mentions another, very difficult (S. 208), and still further east a crater-rill (S. 209), this last extending from north-east to south-west, the other the reverse direction.

Rocca (R.)—A considerable depression, sixty miles in diameter, with steep ridges on the east and west, becoming gentler towards the south and north, and containing many hills on the interior; though as it is of the same brightness as the rest of the surface it is undistinguishable in Full. Entirely similar appears the very irregular formation *e*, between the two 7° bright small ring-plains Rocca B and C, the former in − 12° 24′ lat. and − 67° 0′ long., the latter in − 10° 57′ lat. and − 69° 22′ long.; north of the last are some 6° bright craters. Between Rocca and Crüger, under high illumination, appear some long dark spots with sharply defined borders, two of these being valleys springing from the south-west of the ring-plain Rocca **a**, which has tolerably steep sides and a fine central peak. West of it are the two small ring-plains *f* and *g*, both with dark interiors, and a third much smaller lies close north of *g*.

D'Alembert Mts. (S.)—A chain of considerable mountains upon the moon's limb, rising in places nearly 20,000 feet above the surface, and forming perhaps the east border of the ring-plains beyond Riccioli **a**. The principal peaks extend between $-$ 5° 20′ and $-$ 9° lat., but even as far north as + 5° lat., peaks 10,000 feet high can be detected under very favourable conditions; and in great easterly libration the mountain crest is seen extending as far south as $-$ 13° lat., though perhaps scarcely as high. The general steepness is such, that, according to Mädler, they commence to shadow on their west slopes fifty hours before New, which would indicate a steepness of perhaps 25° in parts.

Sirsalis (R.)—A very peculiar ring-plain, the deepest of a double formation, with a high steep wall 5°, 6°, and in points on the north-east 7° bright; with a 5° bright central mountain, and a 4° bright interior, that is perhaps 10,155 feet beneath the summit of the peak α. The eastern and larger ring-plain **a** is not circular, scarcely a third as deep as the principal, and has a 3° bright interior and 4° bright walls. The principal craters of this region are I, in $-$ 14° 18′ lat. and $-$ 59° 24′ long., and *f*; the former most distinct at the terminator, the latter at Full, when it is 8° bright; the two lying close together, they being placed too far apart in the 'Mappa Selenographica.' West of these are two small dark ring-plains, *g* and *h*, only 3° bright, with walls barely perceptible under the most favourable conditions. From the north wall of Sirsalis extends a broad and very considerable mountain arm, rising at β 8,556 feet above its east foot, and with a narrow valley, *z*, on its west slope, not unlike a rill. West of this extend several ridges, enclosing long shallow valleys, within one of which is a peculiar enclosed plain, *l*, not unlike a ring-plain at times. North of these ridges are the two imperfect ring-plains *d* and *e*, the former with moderately high 4° bright walls and 5° bright peaks; and west is the fine but small crater *k*. East of the mountain arm β extends a long broad plateau-like arm, containing two distinct small ring-plains, *b* and *c*, with 3° bright interiors; it rises at *b* 6,791 feet, and at *c* 5,160 feet above the bright eastern plain, though with a far less and gentler fall towards the level, nearly entirely enclosed plain on the west. Sirsalis *B* is a triangle of steep, bright, moderately high hills, the northernmost of which is in − 14° 48′ lat. and − 64° 10′ long.

West of Sirsalis extends one of the finest rills upon the entire moon, discovered in part by Lohrmann and Mädler. Schmidt detected nearly all the rest, and Knott, Birt, Knobel, and Gaudibert, fill up the remainder, except a portion on the south. This rill Φ (S. 218) extends from the crater, Sirsalis *k*, in + 10° 40′ lat., through the open plain to the two craters, Sirsalis I and *f*, and cutting through these perhaps, though this is doubtful. It then traverses the high plateau south-west of Sirsalis, though much narrowed, and emerges beyond on the open plain south of Sirsalis, sending off a short branch to the ring-plain Crüger a (S. 222). Curving slightly as it crosses this plain, it cuts through a headland near a distinct crater, De Vico *b*, not drawn by Mädler; and sweeps through a small irregular ring-plain, De Vico a, in a bold curve, cutting through both walls in a much constricted form; and ends apparently under a high ridge, De Vico γ, in a broad plain. Its total length is over 250 miles, of which 200 miles were seen by Schmidt, and 20 additional by Birt, Knott, Gaudibert, and Knobel, the remainder having been seen on June 8, 1873. Besides this portion of the great cleft, Schmidt has seen what he thinks is a southern continuation, extending through Byrgius for a length of fully 140 miles more, and the connection of a portion of this with that of Sirsalis was seen in 1875, thus rendering it probable that the full length of this great rill is from $-10° 40'$ lat. to nearly $-30°$ lat., or a length of over 400 miles; in either case it being probably the longest rill on the moon. In this region are many other rills, nearly all discovered by Schmidt. West of Sirsalis I, and north-east of Fontana, extends the short rill ψ (S. 220), in the mountains, between a number of small craters, or perhaps crater-pits; and north of this in the open plain is another rill, Sirsalis ζ; whilst south-east of Sirsalis, in the enclosed plain north of B, is a third one, η (S. 223)—according to Schmidt, curved. North of Sirsalis **a**, Gaudibert has drawn a rill θ, which may possibly be a continuation of Schmidt's (S. 223); whilst west on the open plain he shows a fine rill ζ, also new. Finally, extending north from Sirsalis C to the wall of Grimaldi, is a fine rill, ζ, with east on the wall of Grimaldi another, both discovered by Schmidt in 1862 (S. 211 and 212).

Crüger (R.)—A circular ring-plain, 30·0 miles in diameter, with a completely level, dark-grey interior, only 2° bright, surrounded by broad 5° bright walls, 1,023 feet high. It is, from its dark floor, very distinct in every illumination, and its centre Mädler, from nine measures, found to be in $-16° 45' 37''$ lat. and $-66° 40' 15''$ long. According to Beer and Mädler, in Crüger, as in Endymion, Plato, and similar dark formations near the moon's limb, the degree of darkness of the floor varies with the distance from the limb. Around Crüger the surface is tolerably level, for though traversed by numerous ridges these are all very low and with very gentle slopes, only Crüger γ, which is 2,500 feet high, and Fontana Δ, in $-17° 40'$ lat. and $+60° 0'$ long., which is 3,000 feet high, rising higher above the surface than the walls of Crüger. The ring-plain Crüger **a**, though its wall has only a gentle exterior slope, rises with some steepness, 5,000 feet above the interior on the west. East of Crüger are a number of ridges enclosing a bright plain by *b*, on which are two small craters; and south of this are two very delicate rills, Crüger ζ (S. 229) and η (S. 228), both perhaps still doubtful, discovered by Schmidt; and north-west, nearer Crüger, is a third, ϕ (S. 227). South of η, Gaudibert has seen a bent rill, probably a continuation of the same, and west of the great mountain arm, Byrgius α, draws a branch of the Sirsalis rill running towards it; and north of this is a short branch of the cleft of Sirsalis, Crüger θ, probably Schmidt's No. 226. West of Crüger **a**, Gaudibert has seen another rill, Crüger ψ.

De Vico (N.) [Fontana[1] A. M.]—A fine small ring-plain, in − 20° 22′ lat. and − 60° 10′ long., with a wall 4,500 feet above the interior; and is situated on a great bright plateau with a gentle fall towards the west, but a steep edge on the east, where the descent to the plain below is, from α to β, over 6,000 feet. On the summit of this plateau are a number of very distinct small ring-plains, the most conspicuous, De Vico *b*, *c*, *d*, and *e*, being of very considerable depth. De Vi co**a** is a ring-plain in somewhat imperfect condition, which near Full is very distinct, and is crossed by the great Sirsalis cleft; south of this on the plain are two very small crater-pits. On the southern outer slope of **a** are two craters, from the northern of which to the small crater under the east wall of the high plateau of De Vico, extends perhaps a short very delicate rill. Midway between δ and β this plateau projects close to De Vico **a**, in a fine cape, nearly 4,000 feet high, with a craterlet on its summit. West of De Vico is a great bright plain, broken by only a few ridges and craters, and an extensive low plateau; and

[1] In the 'Der Mond' it is placed under Crüger, called by mistake, perhaps, Byrgius A, though one already exists, but is meant almost for a certainty for Fontana A

it reaches as far as Mersenius without material interruption. On this plain, close to De Vico, is ϕ, a short rill, Schmidt's No. 230.

Fontana (R.)—A tolerably regular ring-plain, with a 3° bright interior, containing a small central mountain, and a 4° bright wall, neither steep nor high. South are two imperfect smaller ring-plains, Fontana *d* and *e*, and north two more, somewhat deeper, a and *b*. East of these extends a high mountain arm, Fontana α, forty-six miles long, and in places perhaps 7,000 feet high, and it is bordered on each side by a very complex mountain region. From the small ring-plain, Fontana *c*, extends the rill Sirsalis ζ, and in the valley east of Fontana, β, is perhaps Schmidt rill ψ (S. 220). East of Fontana, in the slope of the plateau of De Vico, are two distinct small ring-plains *g* and *f*, with on the plain east of them, perhaps thirty small crater-pits.

Zupus (R.)—A very irregular low depression, ascending in a very gentle slope on all sides to the surrounding bright highlands, with several low peaks close to the border, the principal α, rising 4,675 feet above the dark steel-grey interior, which at Full renders Zupus very conspicuous. Across the interior from north to south extends a low ridge, and on the eastern border are three small craterlets, whilst a narrow pass connects it with the smaller almost square depression, Zupus a, which is nearly as dark but with high mountains on all sides. West of Zupus extends a very complex mountain region, at the peaks β and γ of some height, the former rising 3,290 feet above the dark plain below. This region contains a number of short narrow valleys, principally opening into a long inlet of the level grey plain, between Sirsalis and Hansteen, and of somewhat lighter colour than the Oceanus Procellarum. Between Zupus and De Vico is another complex mountain region full of long valleys and particularly rich in craters, though this term must be held to include numerous small formations of the ring-plain class, craterlets, and crater-pits; and a few only of these can be mapped.

Billy (R.)—A fine circular ring-plain, 30·57 miles in diameter, with a narrow 5° bright wall rising on the west 3,396 feet above the interior, and from four measures 2,232 feet above the outer surface; the dark steel-grey floor being thus apparently 1,200 feet beneath the surrounding 2°½ to 3° bright surface. In Full, from its pure dark steel-grey interior, perfectly level, with the exception of a small scarcely visible hill in the south-west, Zupus is always remarkably distinct, and the position of the centre was ascertained by Mädler to be from eight measures in − 13° 59′ 45″ lat. and − 49° 57′ 40″ long. Beer and Mädler remark that this dark-grey tint is little evidence of a great depth, but rather in some way an indication of a ring-plain with an interior, but slightly depressed beneath the surrounding surface, as in Billy, Crüger, Firminicus, Apollonius, Plato, &c., the very deep formations having in general a bright interior, as in Aristarchus, Tycho, Eudoxes, &c. Beer and Mädler appeared inclined to consider that this arose from the smooth, level, almost mirror-like character of these dark interiors enabling them to reflect the sun's rays without dispersing them in all directions, and appearing, therefore, dark to any position, except where the sun's rays are directly reflected from the floor; whilst, on the other hand, they thought the extreme brightness of the interior of some of the deeper ring-plains might arise from their deep concave floors concentrating the solar rays direct on the earth. Beer and Mädler themselves saw the inadequacy of this explanation by itself to account for the phenomena, as many formations in appearance exactly like the dark ring-plains were bright, and others steep and of considerable depth dark, and neither explanation can in any way be considered as admissible.

South-west of Billy is a small bright hill-land, containing some considerable peaks, three of which, Γ, δ, and η, appear in Full as white points, together with the small ring-plain Billy a.

Hansteen (R.)—A fine ring-plain, 31·58 miles in diameter, with a steep broad wall, rising on the west 2,795 feet above the Oceanus Procellarum, and 3,754 feet above the interior. The wall on the south contains a fine 6° bright crater, *b*, whilst on the east it is 5° bright, and on the west it is 4° to 4°½ bright. The floor is on the south-west and north-east 3° bright, on the north-west only 2°½ bright, but on the south-east 4° bright, whilst it is traversed by three 5° bright ridges, and has on the east a 4°½ bright formation *c*, resembling a shallow depression; thus presenting as great a diversity in brightness as Billy, its southern neighbour, exhibits monotony. The surrounding region contains a number of mounds and short ridges, and on the west rises a fine triangular 7° bright mountain mass α, probably over 2,000 feet high, with north of it a 4° bright round white spot on the dark plain; beyond is the much-branched mountain β, 4° to 4°½ bright, forming with the 4° bright mountain γ, the end of the northern arm of the great hill-land. East of Hansteen, on the grey plain, is a delicate rill φ (S. 217).

Flamsteed (M.)—A small ring-plain, nine miles in diameter, isolated on the great Oceanus Procellarum, with a 6° bright wall rising on the east 1,407 feet above the plain, and a 3° bright interior, whose centre, from ten measures by Mädler, is in − 4° 30′ 48″ lat. and − 44° 12′ 8″ long. Flamsteed forms the south point of a great mountain ring, about sixty miles in diameter, broken in places, and formed by a number of short mountain ridges of very unequal brightness, being on the west 4° to 5° bright, and on the east only from 3° to 4° bright. Yet as this brightness is not confined to the ridges but extends apparently beyond them, the ring appears nearly perfect in Full. The interior contains several crater-pits, and a crater *d*, 4° bright, and is crossed by several ridges, all very low, like those forming the ring, and, except the peaks Δ and *B*, nowhere above 300 feet high. Flamsteed Δ, in − 2° 34′ lat. and − 45° 25′ long., is 1,145 feet high, and *B*, in − 2° 52′ lat. and − 42° 12′ long., is 5° bright. The interior of the ring is crossed by two light streaks, and contains, according to Mädler, nine crater-pits, and four more have been seen since, but only the three principal are drawn, all the rest being very minute.

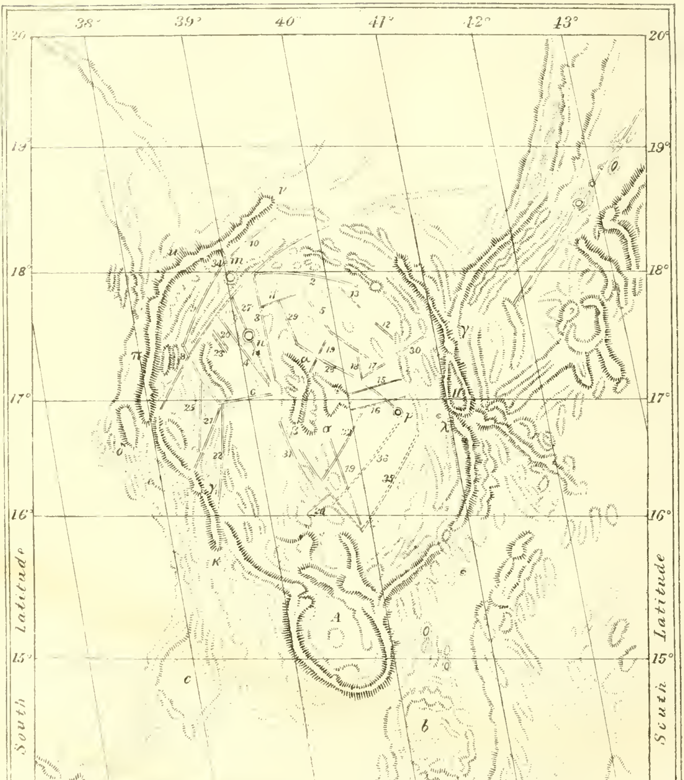
The surface around Flamsteed contains a very considerable number of low ridges, only to be detected with some trouble, and there are also some higher and steeper mountain groups. The greatest of these extends from − 7° lat. to the equator near the 50 meridian, rising highest at E, which from three measures is 3,485 feet high, though it has gentle slopes like all the mountains near. The 5° bright curved range, extending from E to Flamsteed η, is tolerably connected and high, and with a number of very small hills on the east forms a sort of mountain ring. ζ is 6° bright, but not high ; and ρ is perhaps 5° bright, and so is *k*, though neither are above 600 feet high. West of Flamsteed is a steeper mountain group, rising at *A*, in − 3° 14′ lat. and − 39° 33′ long., into a 5° bright peak, 1,298 feet high, and south is a smaller peak, 3° bright. South of Flamsteed is a small but deep ring-plain, Flamsteed A, in − 7° 51′ lat. and − 43° 0′ long., with 6° bright walls; and between it and Flamsteed is the crater B, nearly 5°½ bright, in − 5° 59′ lat. and − 43° 43′ long., and west is the 5° bright crater, F (*f* of M.) in − 4° 51′ lat. and − 41° 6′ long. The most conspicuous object in this region is the 7° bright crater, Flamsteed C, in − 5° 44′ lat. and − 45° 46° long., surrounded by a bright white spot and the centre of a disturbed region. Between C and A are a very considerable number of crater-pits, over thirty in number perhaps, and still more lie west of A; only the principal of these have been drawn, the rest being very small.

Wichmann (N.) [Euclides **a**, M.]—A very conspicuous 7° bright crater, on the Oceanus Procellarum, the centre of a slightly disturbed region, and surrounded by a small light spot. Its place, from four measures, is − 7° 41′ 15″ lat. and − 37° 56′ 13″ long.; until now, it not having been measured, though Mädler has placed it on the 'Mappa Selenographica,' in − 7° 40′ lat. and − 37° 30′ long. North of it extends a great curved 4°½ bright mountain ridge with some high peaks; Γ, in − 5° 30′ lat. and − 38° 33′ long., being tolerably steep and 5° bright; whilst θ, the highest peak, rises 2,200 feet above the surface. From ε towards the west extends a low continuation of this ridge almost to Euclides λ, but only 4° bright. (These are Flamsteed Γ, θ, and ε of M.)

Letronne (M.)—A great bay, on the border of the Oceanus Procellarum, formed by the mountains of Gassendi, with moderately high, sharply-marked walls rising on the west, north of B, 3,217 feet, and at ρ, 1899 feet above the surface. On the interior, which is slightly lighter than the rest of the surface, is the 7° bright crater B, in − 11° 10′ lat. and − 41° 16′ long., and the 6° bright mountain *A*, in − 10° 4′ lat. and − 42° 44′ long., together with a few feeble ridges. In the Oceanus Procellarum beyond the bay, is the very distinct 7° bright crater Letronne *f*, in a long-shaped light-patch, most intense on the south; and near it are a few hills and ridges, together with a number of crater-pits. On the west border of the highlands south of Letronne is the brilliant crater A, in − 11° 56′ lat. and − 39° 0′ long., fully 9° bright; and between it and the

GASSENDI.

Scale. 100 Inches to the Moon's diameter.



west wall of Letronne, the 8° bright peak ε, and the 7° bright mountain β, is a nearly quadrangular 4° bright hill-plateau, with a small 5° bright mountain λ, and a 7° bright crater *d* on its border, close to A. South of Letronne the mountains are in places of some height, and consist of a system of high ridges enclosing long valleys, all of uniform brightness. Letronne Γ, in − 13° 35′ lat. and − 42° 0′ long., is a 6° bright peak of some height, and east of it are two others equally distinct.

Gassendi (R.)—A very fine walled-plain, 55·3 miles in diameter, nearly circular in outline, with an area of 2,000 square miles, and remarkably distinct in Full, from the brightness and well-defined character of the principal details. Owing principally to this, Gassendi has long been a favourite formation for observation, and is now one of the best known portions of the lunar surface. The wall of Gassendi is in few places steep and is only of moderate breadth, whilst its height is very unequal, being at the principal peaks nearly 10,000 feet high; towards the south it rises in places, scarcely 500 feet above the surface; its interior, however, according to the measures of Mädler, is on the north fully 2,000 feet above the level of the Mare Humorum. On the east wall is a long elliptical depression H, which according to Mädler is 7° bright in Full, the general brightness of the walls being 5°; and north of it rises a lofty peak λ, fully 7°½ bright, and 9,000 feet high; beyond this the wall is very rugged, and is crossed by two deep passes near *m*, drawn by Schmidt as crater rows. On the north the wall of Gassendi has been entirely destroyed by the great ring-plain, Gassendi A, and beyond this, on the north-west, the entire wall seems to have fallen in great part outwards on to the surface, and forms a great mass of *débris*, particularly well seen under some conditions of illumination. At the great peak κ, however, the wall regains its usual character and rises, according to Schmidt, 6,382 feet above the interior; the still higher peak Δ, from a measure of the same authority, is 9,273 feet high, the wall itself being, however, according to Mädler, only 5,378 feet, and to Schmidt, 5,723 feet above the interior, and nearly 8,000 feet above the Mare Humorum on the west. Still further south rises μ, 3,677 feet according to Schröter, and 3,626 feet according to Schmidt; the high wall ending at the lofty peak ν, fully 6°½ bright, and scarcely inferior to Δ in height. Under this mountain there is a pass in the wall; this is here very low, rising in two low rounded peaks near ο, perhaps 2,000 feet high, but it gradually becomes loftier as it proceeds towards the north-east, being, probably, 5,000 feet high at the very bright peak σ, and culminating in the lofty peak γ, on the south of the depression in the wall H, which, according to Mädler, is the loftiest peak on the wall, being 9,561 feet above the floor of Gassendi. Besides the passes referred to, the wall of Gassendi is traversed by three very narrow ravine-like clefts, one under the peak λ, another near δ, and a third near μ; the first of these extends as a winding valley on to the eastern plain, this valley, like so many others, being drawn by Schmidt as a crater row. In many places extend ridges, projections, and mountain arms from the walls; and on the outer slope, moreover, a very broad peak of some height rises at δ.

The group of central mountains in the centre of Gassendi is one of the finest upon the Moon, and consists of three considerable masses divided by deep valleys, the western being the loftiest, and at sunrise completely overshadowing the rest. The principal peak β is 6° bright, and from it to α, a 6° peak little inferior in height, extends a lofty mass of mountains possessing a crest little lower than either of the two peaks; α rises 3,800 feet, and the peak β is, according to Mädler, 4,003 feet, and, according to Schmidt, 3,909 feet high. The two peaks north-west of α are nearly as lofty, being, perhaps, 3,500 feet high, but at sunrise they are not well seen against the high crest at their back, and at sunset are lost in the shadow of this crest. The central mountain-mass contains three peaks, the northernmost σ being the loftiest, and at sunrise is generally alone visible, rising out of the shadow of the western mass, in which the two southern and lower mountain peaks are lost. The easternmost central mountain is horse-shoe in shape, and resembling a broad plateau with a low peak on its western arm, and a higher one, τ, on the eastern; whilst south of this last it is broken by a delicate craterlet. On the south-western portion of the interior are two fine craters, discovered by Schröter, and most unaccountably missed by Mädler, both in the map and in his later-finished drawing with the powerful Dorpat refractor, though he draws some much smaller craterlets. The southernmost of these craters, *m*, is the smaller and deeper, whilst the northern, *n*, is higher, and stands in the centre of a triangular light spot. East of the central peaks is a third crater, *p*, smaller than the other two, and surrounded by a triangular light patch. Schmidt draws five more crateriform objects, one east of *m*, two between γ and λ, one near ω, and the other west of the central mountains; but Mädler, with the Dorpat refractor, saw none of these five, but only the craterlet on the centre peak, and a small one near λ, but not one of Schmidt's; and no other observer seems to have succeeded in finding Schmidt's craterlets. Webb succeeded in detecting a small craterlet on the rough surface outside the pass from the ring-plain A.

The interior of Gassendi contains a number of ridges and low mounds; of the two principal ridges one extends from an elevated plateau west of H to the south, and contains four peaks, perhaps over 1,000 feet in height; and the second higher ridge extends from near the pass in the wall south of δ along the edge of the crater m, to near the end of the last ridge. South of these ridges the surface of Gassendi seems considerably lower than it is on the north, and is darker in tint. West of the central peak is, however, the loftiest ridge on the interior of Gassendi, and it is bent in form, but rises near π, over 2,000 feet. The most remarkable formation in the interior of Gassendi is, however, the very numerous extremely delicate system of rills, which, entirely missed by Mädler, with his small telescope, was discovered by him later with the Dorpat telescope, when he saw no less than fifteen. Schmidt, though only cataloguing ten (S. 232–241), discovered five others. Since 1870, Webb has discovered one, Gaudibert six, Loder three, and the author eight, making a grand total of thirty-five rills ; three being joint discoveries.

These rills are all extremely delicate formations, and the difficulty in drawing them is such that a considerable amount of uncertainty still attaches to the exact position and course of all except the four or five most distinct, and on the scale of the map it has been found impossible to insert more than nine. As under similar conditions elsewhere, these are simply numbered, the distinguishing letter and name Gassendi Φ being supposed understood. Of those drawn, 1, 3, and 4, are most distinct, and were discovered by Mädler ; 5, 6, 7, and 19 are much more delicate, and likewise discovered by Mädler ; whilst 8 and 21, the most delicate of those given, were discovered in 1870 and 1871 respectively. Another rill, seen in part by Mädler, and the rest by Loder, extends between the rills 3 and 4, and is broken into two by the crater n, whilst the two chief rills discovered by Schmidt extend from the central peak τ to the east wall.

In Full, from H to the centre of Gassendi extends a row of 6° bright spots, and unite there with a similar row from the south; at the point of junction there is a 7° bright light spot. This point was taken by Mädler as one of his positions of the first order, and from nine measures was found to be in $-16° 55' 40''$ lat. and $-39° 31' 37''$ long., but according to Beer and Mädler this was not the peak β, but a small hill some $4\frac{1}{2}$ miles south; so that β must be in $-17° 12'$ lat. From a number of measures of the distance of the central peak from different points of the wall, its distance from the south wall peak ν, was found to be 0·55; from the junction of the west wall of Gassendi and the ring-plain, A = 0·46; from the north end of the depression, H = 0·45; and from the pass in the west wall, = 0·41. A similar but later series of measures of the position of the bright point forming the apex of the two light rows, gave 0·55, 0·45, 0·45, and 0·395, or placing it within 2′ of the central peak, indicating, therefore, that the two are identical.

The special map of Gassendi has been founded on a series of nearly fifty carefully-executed drawings of this fine formation, made during the last six years with powerful instruments; and it contains the entire amount of detail whose existence may be regarded as definitely established. Gassendi is especially notable for the very intricate but fine system of rills on its interior, rendering it one of the most interesting formations upon the surface of the Moon. This system comprises some thirty-eight rills, and, carefully studied, will throw much light on the real nature of these most interesting but inexplicable lunar features, so that they deserve the attention of all selenographers. Some of these rills may perhaps be doubtful, and others misplaced; for even in very powerful instruments they are most delicate and difficult features, and are rarely well seen. In this system of Gassendi, as in most others, the principal rills appear to form a united whole, thus forming a collective system; but at the same time, as is often the case, several appear entirely independent of the principal members, and though united to these, are yet probably without any true connection with the system formed by the rest.

The relation between the configuration of the surface and the position and path of the rills in this group within Gassendi, appears very definitely marked, most of them being situated within shallow valleys, this being particularly noticeable towards the south-west of the interior. The influence of hills and similar irregularities in narrowing the rills is also especially marked; and the shadows of these entirely masking these portions during low illuminations, they are readily overlooked. Some connection appears also to exist between the rill system and the peculiar passes in the walls of the formation, which, when carefully examined, may throw much light on the origin of this system of rills within Gassendi.

It has been judged advantageous to specify the discoverers of the separate members of this system, on account of the importance and interest attaching to it; for the position and existence of these rills, more especially those last discovered, must be primarily considered to rest on the authority of their discoverers. Many have, however, been since observed—particularly those first seen by Mädler—and some even independently discovered. Some of the rills included under one number consist of separate rills more or less independent.

1 = Mädler	13 = Mädler	25 = Mädler
2 = Neison	14 = Mädler	26 = Loder
3 = Mädler	15 = Schmidt	27 = Loder, Mädler
4 = Mädler	16 = Schmidt	28 = Gaudibert
5 = Mädler	17 = Neison	29 = Gaudibert
6 = Mädler	18 = Schmidt	30 = Gaudibert
7 = Mädler	19 = Mädler	31 = Gaudibert
8 = Webb, Neison	20 = Schmidt	32 = Gaudibert
9 = Loder	21 = Neison	33 = Gaudibert
10 = Mädler, Schmidt	22 = Mädler	34 = Neison
11 = Neison	23 = Mädler	35 = Neison
12 = Neison	24 = Mädler	36 = Neison

From a series of ten measures, the position of the fine central peak Gassendi β has been determined to be $-17° 0' 48''$ lat. and $-39° 30' 6''$ long. It has been already stated that Mädler, from nine measures, found $-16° 55' 40''$ lat. and $-39° 31' 37''$ long., for the bright point visible in Full, which, though considered by him to be north of the central peak, has been identified with the central peak itself. The two series of measures combined give $-16° 58' 2''$ lat. and $-39° 30' 47''$ long. as the position of the central peak Gassendi β, from nineteen measures. From an incomplete series of measures three results give as the position of the bright peak Gassendi γ $-17° 43' 27''$ lat. and $-41° 49' 2''$ long.

The ring-plain A on the north of Gassendi, well described by Phillips as spoon-shaped, is surrounded by a broad, lofty terraced wall, on the west 5° bright, and rising 13,000 feet above the 4° bright interior; on the south 7° bright; and on the east, where it is 6° bright, it is, according to Mädler, 11,000 feet, or from two measures by Schmidt, 10,036 feet high. On the south, where a small portion of the interior is only 2° bright, the wall of Gassendi A appears to have slipped down into the interior of Gassendi as if it were leaving a narrow pass on the south-west, uniting the interior of A with the floor of Gassendi; and beyond this pass, extending far into the interior of the walled-plain, is a confused mass of irregular ground, as if covered with matter ejected from the interior of the small ring-plain. East of this region extends from the south wall of Gassendi A, a strong, very broad spur, with at least three distinct crests, separated by two shallow valleys, and the western two being the highest, their successive illumination gives the appearance to the spur of having shifted.

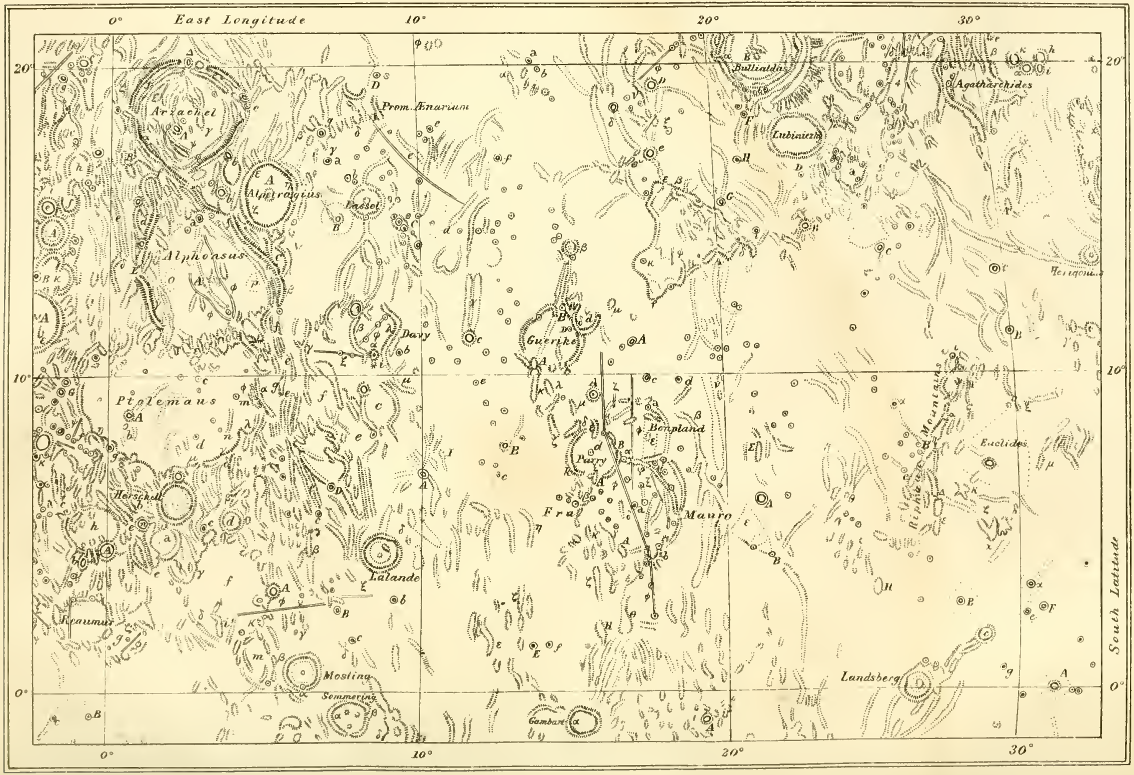
South of Gassendi extends the dark Mare Humorum, broken by only a few low ridges, except towards the west, where there is a low plateau, from which several long ridges extend across the dark Mare. The crater Gassendi I, in − 21° 20′ lat. and − 36° 54′ long., is 5° bright, and north of it is the 4° bright smaller crater *y*, whilst west is the 4°½ bright deep crater Gassendi L, in − 20° 3′ lat. and − 41° 43′ long. Towards the west is a great dark bay of the Mare Humorum, which is here separated from the darker Oceanus Procellarum by a low hill-land, nearly 6° bright in Full. On the north of Gassendi is the shallow depression Gassendi *c*, not unlike, in some illuminations, a shallow ring-plain; and north-east is the ring-plain *b*, about 13 miles in diameter, with a wall of 2,500 feet above the interior; with south, a curved ridge, enclosing a space at times very like another ring-plain, though somewhat imperfect; and on the surface here are several crater-pits and a fine curved valley *e*. East of Gassendi extends a wide bright region that may perhaps be considered a plain, though it is traversed by many high ridges, and contains a number of mountains and craters. The principal formations here are remarkable for their general brightness in full, and are the following:—Gassendi F in − 15° 9′ lat. and − 44° 34′ long.; a 6° bright crater, near which is a curve of bright hills; and towards the east rim of Gassendi *b* extends a row of 6° bright points; one, Gassendi *r*, being a crater, another, Gassendi Ω, a high mountain, in − 14° 25′ lat. and − 42° 30′ long., south of which are two others equally high, but not of similar brightness. Gassendi Z, in − 16° 5′ lat. and − 42° 31′ long., is an 8° bright mountain, according to Mädler, but by Professor Phillips is drawn as a crater, which it appears to be. Between it and the 7° bright crater Gassendi G, in − 16° 8′ lat. and − 43° 56′ long., are three small hills, scarcely perceptible near the terminator, but 5° bright in Full. The whole region between Gassendi, Letronne, and Billy, is full of small white points under high illumination, only the principal of which have been identified. Through the bright plain here extend two rills, one, ξ (S. 242), short and perhaps doubtful; the other, Φ (S. 243), extends from some narrow valleys north of G to the west wall of Mersenius, and is 150 miles long.

Herigonius (R.)—This formation, which Beer and Mädler could not identify, appears to have been very probably the 4° bright ring-plain on the Oceanus Procellarum, distinguished by them as Gassendi D; accordingly, to this the name has been restored. It is a small ring-plain, 18 miles in diameter, with moderately high 4° bright walls and a 3° bright interior, containing a very small central peak in − 13° 15′ lat. and − 33° 45′ long. South are three irregular, extensive white spots, in Full nearly 5° bright, and under low illumination their position is seen to be occupied by small mountain groups; but Mädler thinks that the white spots, especially the westernmost, occupy a greater area than these hill-regions, and that a portion of the surface seen 5° bright at Full, is near the terminator indistinguishable from the rest of the dark plain. These hill-lands are perhaps raised above the surface with very gently rising sides, and in places possess considerable peaks, χ being 3,377 feet high; Herigonius Δ, in − 14° 28′ lat. and − 36° 45′ long., rises 3,543 feet, and stands on the border between the Mare Humorum and Oceanus Procellarum; A in − 15° 15′ lat. and − 30° 40′ long., is nearly as high, and i and λ little inferior. The crater E in − 13° 40′ lat. and − 35° 20′ long. is 4° bright, most of the high peaks 6° bright; the rest like the light spot is 5° bright.

CHAPTER XIX.

MAP XIII.

Lubiniezky (S.)—A completely enclosed ring-plain, 23 miles in diameter, whose centre is in − 17° 31′ lat. and − 23° 32′ long., with very low 4° bright walls, rising at their highest point only 985 feet above the interior, while elsewhere they are scarcely 600 feet, and are consequently scarcely visible except at the terminator, only some few small 5° to 6° bright points on the north and east being visible at Full. The 3° bright interior contains, towards the west, an ill-defined dull light spot, and is perfectly level, neither Schröter, Mädler, nor Schmidt having been able to detect any irregularities on its surface. South-east of Lubiniezky appears a high plateau, not drawn on the 'Mappa Selenographica,' and rising at its highest peak μ to 3,216 feet above its eastern foot. North-east is a fine mountain ring, **a**, with 5° bright walls, which rise 2,104 feet above the 3° bright interior, and contain a small craterlet, whilst there are others on the outer slope; on the summit of the wall of **a** are two distinct craters. East of **a** is another slightly larger mountain ring *e*, and south of it another with a very imperfect east wall, the 2°½ bright interiors of these formations rendering them distinct in Full. Schmidt has drawn this region in detail, but his map of this region, though far more complete than Beer and Mädler's, is not so satisfactory. Lubiniezky C is an 8° bright, very distinct crater, in − 13° 50′ lat. and − 23° 21′ long., on the east border of a 4° to 4°½ bright low plateau, with very gently sloping sides. West of the last is the equally conspicuous


East Longitude
South Latitude
Arzachel
Alpetragius
Alphonsus
Lassel
Prom. Ænarium
Davy
Ptolemaus
Herschell
Lalande
Reaumur
Mosting
Sommering
Gambart
Guerike
Parry
Bonpland
Fra
Mauro
Bullialdus
Lubiniezki
Agatharchides
Riphæan Mountains
Euclides
Landsberg

crater B in $-14° 23'$ lat. and $-23° 21'$ long., also 8° bright, and in the centre of a highly-disturbed bright region, which contains some very considerable peaks. South of B is the small 6° bright crater D in $-16° 21'$ lat. and $-23° 12'$ long., close under the wall of Lubiniezky, west of which is a $5°\frac{1}{2}$ bright crater F in $-18° 10'$ lat. and $-21° 35'$ long., connected with the very similar $5°\frac{1}{2}$ bright crater H in $-16° 46'$ lat. and $-21° 35'$ long., by a short ridge, whilst still farther north is the 5° bright crater G, in $-15° 14'$ lat. and $-19° 37'$ long., united to the distinct 6° bright crater *i* by a broad ridge, south of which are three others parallel to it. Mädler remarks that the craters B, D, H, G, and *i* form a very regular pentagon. Beyond this is a fine broad plateau, triangular in form, like so many of these formations on the moon, and 4° bright, with a general elevation above the Mare Nubium of about 650 feet. At its north-east angle rises the steep and high peak δ, 5° bright and 2,000 feet high, with west the still steeper and higher A in $-13° 43'$ lat. and $-19° 41'$ long., the whole north border from δ to ρ being steep and tolerably high. The peak ρ at the north-west border is only low, and this angle is rounded off; whilst the 7° bright crater κ constitutes the most distinct object. The west side is curved, and with a gentler slope than on the north; but at the south-west angle rise two steep mountains, ϵ and β; and the south-eastern side from here to δ is steep, and contains some high peaks. On the summit of the plateau are a few long low ridges and some hills, together with a short distinct rill ϕ, strangely missed by Mädler, and discovered by Schmidt (S. 302).

Riphaen Mts. (M.)—This bright mountain range extends from $-3° 0'$ to $-10° 40'$ lat. and from $-23°$ to $-29°$ long., and, isolated on the grey plain, is distinct from its brightness. The chief chain is 5° bright, and is divided into three portions by two narrow passes, visible even beyond the mountains in the ridges. The southernmost of these extends from $-10^\circ 40'$ to $-7^\circ 45'$ lat., and, commencing at the peak Euclides ι, at first only slightly elevated, gradually becomes higher and steeper, rising at the two principal points Euclides Γ in $-9^\circ 2'$ lat. and $-28^\circ 24'$ long., 1,388 feet, and at α 1,579 feet above the eastern plain, but probably, Mädler thinks, considerably higher above the western plain. The second portion commences at the pass south of the peak B, in $-7^\circ 45'$ lat., and extends to the pass north of Δ, in $-5^\circ 50'$ lat., possessing a triangular form; the mountains on the western side gradually diminishing in height and those on the eastern gradually increasing; the peak Δ is 2,469 feet high. The northern portion extends from $-5^\circ 50'$ to $-4^\circ 52'$ lat. in a great curve, which culminates in the steep 6° bright mountain ϵ, and is the brightest as well as the highest mountain of the Riphaens, rising 2,750 feet above the Oceanus Procellarum, whilst west of it the Riphaens fall very rapidly into low hills. In the dark plain west of the Riphaens are a number of small crater-pits and low ridges and hills, together with a shallow 4° bright crater *d*, and a small peak θ. North is a small mountain, Euclides H, in $-3^\circ 10'$ lat. and $-24^\circ 58'$ long.

Euclides (M.)—A deep crater, seven miles in diameter, and 7° to 8° bright, with its east wall rising 1,714 feet above the plain, and its centre, from eight measurements by Mädler, in $-7^\circ 10' 21''$ lat. and $-29^\circ 15' 7''$ long. Euclides is distinguished from all the other lunar formations by being surrounded by a brilliant triangular light spot, clearest at the foot of the wall of the crater, and gradually diminishing and then fading away rapidly into the surrounding dark plain. This extent of surface is, according to Mädler, entirely level and unbroken, except by some difficultly visible hills, but it contains a number of very minute ridges radiating from

Euclides, and two, if not three, minute crater-cones beyond the range of any but very powerful telescopes. This very peculiar white nimbus or cloud appears around only a few of the lunar craters, and according to Beer and Mädler nearly all between $-7°\frac{1}{2}$ and $-46°$ long. and $-0°$ and $-15°$ lat., and they draw a marked distinction between the ray or light streak-surrounded ring-plains, and the craters with bright environs, mostly arising from surrounding terraces and other irregularities, and these light environed craters. These last consist of Euclides, the principal one in which the appearance is most marked; Wichmann, Flamsteed C, Landsberg A, B, *d*, and *e*, Alpetragius B, and Parry A, all very deep circular steep craters, over 7° bright, and in diameter from 3 to 8 miles, whilst very distinct in all illuminations. The mountain groups, Euclides ξ and μ, are only 3° bright and of moderate height, but beyond them, in the Oceanus Procellarum, is the small mountain group Euclides ν, fully 5° bright, yet of only very inconsiderable height, the principal peak Σ, in $-9° 50'$ lat. and $-33° 40'$ long., being only 940 feet high. West of these mountains are the two 5° bright deep craters, Euclides C, in $-13° 0'$ lat. and $-29° 48'$ long., and Euclides B, in $-11° 1'$ lat. and $-30° 4'$ long., near which are a number of low ridges separating the Mare Nubium from the Oceanus Procellarum. North of Euclides is a considerable mountain mass united to the Riphaens by two short ridges, whose northern point χ is in $-4° 27'$ lat. and $-28° 25'$ long., and at its high peak ζ 1,746 feet above the plain. A row of small peaks unite it to a small mountain κ, in $-6° 27'$ lat. and $-28° 14'$ long.

Landsberg (R.)—A regular ring-plain, 28·12 miles in diameter, with broad 5° bright walls, towards the interior steep and terraced, but with only a very gentle slope on the exterior, and, though rising on the west 9,662 feet, and on the east 7,060 feet above the grey floor, only 2,462 feet above the Oceanus Procellarum. The central peak, which is of considerable height, is connected by a short ridge with a lower peak, but is not united to the wall, and, from ten measures by Mädler, its position is − 0° 29′ 51″ lat. and − 26° 33′ 49″ long., whilst from nine measures during 1874–1875 its place was determined to be − 0° 25′ 58″ lat. and −26° 18′ 49″ long., the two combined giving, from nineteen measures, − 0° 28′ 9″ lat. and − 26° 27′ 6′ long.; it thus being of importance as enabling the position of the Moon's equator to be graphically found. West of Landsberg extends an open grey plain, almost perfectly level for a considerable distance; but south are a few crater-pits and east some low terraces and ridges. The small ring-plain *c* has a 5° bright wall rising on the west 1,893 feet, and on the east 2,072 feet above the surrounding plain, and its 3° bright interior appears perfectly level. North is another very similar though smaller formation, *g*, which is only detectable with difficulty in Full, though *c* is distinct enough. The 7°½ bright crater Landsberg, A, is, like Euclides, surrounded by a peculiar light spot or nimbus, though not quite so intense in tone, and from eight measures its position was determined to be + 0° 21′ 20″ lat. and − 31° 5′ 26″ long., Mädler having found its place as a point of the second order to be − 0° 5′ lat. and − 30° 43′ long. (In the map it is put in − 31° 9′.) South of it are three other craters of the same class, namely, Landsberg B, in − 2° 36′ lat. and − 28° 14′ long., Landsberg *d* of equal size, and also 7°½ bright, and the smaller Landsberg *e*, 8° bright, with a very intense surrounding glitter. East of the last is the greater crater F, 5° bright, but without a surrounding light spot, and in − 2° 30′ lat. and − 30° 40′ long. Between A and *c* are two faint light streaks extending south-east, and east of *d* are some small hills at δ, 518 feet high, and beyond extends for nearly 150 miles a wide open dark-grey plain, traversed by a very low gently-sloping ridge and land swells, and broken by a few crater-pits.

Fra Mauro (M.)—The ruins of a great walled-plain, from its very imperfect condition only visible as a whole with difficulty, and resembling a mountain ring, the walls having been entirely destroyed in parts, and broken down elsewhere, though Beer and Mädler have drawn this too markedly. The highest portion of the wall is the peak A in $-$ 4° 27′ lat. and $-$ 16° 18′ long., and the elevated points β ρ and γ appear to belong to the less imperfect portion of the old border. The interior contains, besides hills and ridges, a number of crater-pits, which, like the rills traversing the interior, entirely escaped detection by Beer and Mädler, though it is possible that here, as elsewhere, they, from the smallness of the aperture of their telescope, confused the more delicate rills with low ridges. The rill ζ appears to have been first seen by Gaudibert, and is a very delicate object. At β is an imperfect crater or small ring-plain. North of this walled-plain are several mountains and a number of low hills and ridges, the highest point being the mountain ζ, rising 6,101 feet above the western plain, but only 3,197 feet above the eastern, whilst H, in $-$ 2° 21′ lat. and $-$ 15° 34′ long., is 5° bright, but only 3,197 feet high. Fra Mauro θ, η and κ are the only other mountains in these regions of any altitude. Towards the east are a number of ridges and a tolerably high mountain, Σ, in $-$ 6° 55′ lat. and $-$ 21° 0′ long., 5° bright, and rising 2,328 feet above the surface, with near it some small peaks. North are two 6° bright distinct craters, Fra Mauro A, in $-$ 5° 30′ lat. and $-$ 20° 43′ long., and B in $-$ 4° 5′ lat. and $-$ 21° 31′ long., and between the two craters a small plateau ς, on which is a small craterlet north of a 5° bright light spot.

Bonpland (M.)—This formation, described by Beer and Mädler as a mountain ring little visible in high illumination, and crossed by a light streak from the crater **a**, is, like Fra Mauro, the ruins of a walled-plain, less completely destroyed than Fra Mauro, and smaller in dimensions. The walls, though almost entirely wrecked, can still be traced well nigh completely, and at α rise in a distinct peak nearly 3,000 feet high, whilst at their base can be traced immense masses of *débris*, visible under very favourable conditions with some distinctness as masses of broken ground. Towards the south is the crater **a**, and beyond it, on the outer slope, a smaller one; whilst on the north, close to the peak, Fra Mauro ρ, appears to be a distinct crater, *b*, though Mädler draws neither peak nor crater. The interior of Bonpland contains several low mounds and a small peak ϵ, and is crossed by a fine rill, ϕ (S. 303), which commences at the small crater α in the centre of Fra Mauro, cuts through the wall east of **a**, traverses the whole of Bonpland, and ends in the open plain south. Schmidt has also seen two short rills in the south-west wall of Bonpland, here inserted on his authority as ζ and ψ, being his 304 and 305; whilst Gaudibert draws a crater between the peak α and the wall of Parry, and it is given on his authority only. East of Bonpland is a long ridge rising at β 300 feet, and south-east are two craters *c* and *d*, 5°½ bright, near the latter of which may be a short rill extending south-east.

Parry (M.)—A walled-plain, in tolerably perfect condition, with distinct walls rising in a fine 9° bright, very distinct peak, at ϵ, and in a 5° bright peak at B, 4,866 feet high, whilst δ is 2,672 feet, A 3,462 feet, γ 2,692 feet, and *k* 2,034 feet above the plain, and all 5° bright. The interior of Parry is crossed by a 3°½ bright streak, and in the centre is a small crater, *d*, north of which is a small hill—neither seen by Mädler—whilst it is traversed by the great rill, Parry ϕ (S. 306). The rill was originally seen in part by Kinau, then all except the extreme northern end by Schmidt, and finally the northern portion by Gaudibert. It commences at a small crater north of Fra Mauro in $- 2°\frac{1}{2}$ lat., and extends as far as the imperfect small ring-plain Fra Mauro *b*, by the south wall of which it seems interrupted, then traversing the interior of Fra Mauro, breaks through the wall of Parry west of B, crosses Parry, and reaches a small crater east of the peak ε, whence, bending slightly, it ends on the open plain east of Guerike, this latter portion resting on Schmidt's authority. In the south-west wall of Parry is a narrow pass ζ, included by Schmidt as a rill (S. 307). The most distinct object in this region is the 7° bright, very deep crater Parry A, surrounded by a brilliant circle of light, amidst which under favourable conditions can be detected its small dark interior with a bright minute central peak, whilst from eight measures Mädler fixes its position at − 9° 12′ 44″ lat. and − 15° 39′ 40″ long. In the level open plain on the west of Parry is the 5° bright crater B, and the smaller but nearly as distinct crater *c*. Between Parry and Guerike extends a chain of 5° bright mountains, containing some lofty spire-like peaks, Parry λ rising 4,189 feet, and μ 3,722 feet above the surface.

Guerike (M.)—A walled-plain whose broad wall is traversed by a number of passes, particularly on the north, and is highest and most connected on the east, where it rises at the steep peak B in − 11° 36′ lat. and − 14° 20′ long. to a height of 2,194 feet above the Mare ; and north-east of this, at δ, rises 2,053 feet above the interior, though the peak A on the north, in − 9° 30′ lat. and − 13° 55′ long., is probably the highest point, being loftier than the mountain arm extending north from it, which at κ rises 3,012 feet. The interior appears little if any deeper than the Mare, and is 4° bright, the wall being 5° bright, the peak β 6° bright, and the crater D, in − 11° 32′ lat. and − 14° 28′ long., fully 7° bright. Across the floor extends a broad ridge from the peak A to the mountain B, beyond which it becomes double and encloses a narrow valley-rill extending towards Guerike B, a small deep ring-plain, with 6° bright walls open towards the south, and a small central peak. East of Guerike is the 6° bright crater A in – 10° 57′ lat. and – 17° 0′ long., with a 5° bright mountain peak μ on the south-west, and abutting on the east wall of Guerike is an imperfect ring-plain *d*.

West is the very distinct crater Guerike C, with a 6° bright interior and 9° bright wall, surrounded by a disturbed region, and from which extend south two long ridges enclosing a rill-like valley γ. From eight measures during 1875 the position of Guerike C was determined to be – 11° 48′ 53″ lat. and – 11° 43′ 37″ long., whilst, according to Mädler, one of whose points of the second order it was, its place is – 11° 13 lat. and – 11° 39′ long. Around Guerike are a great number of crater-pits, scarcely brighter than the surface, and a number of craterlets, generally from 5° to 6° bright, together with a number of light spots that seem to arise from neither craterlet nor mountain.

Davy (M.)—A fine deep ring-plain, 23·00 miles in diameter, with broad high walls cut by several deep passes, and rising on the north at α into its highest peak, whilst β is 4,500 feet high, and λ 3,473 feet above the Mare on the east. On the south is the very deep crater Davy A, with a wall 7° bright on the south and 6° bright elsewhere, rising perhaps 7,000 feet above the interior, whose centre is in – 12° 3′ lat. and – 8° 8′ long. On the south-east of the interior of Davy is a small light spot, and the floor is crossed by a short rill ϕ passing through three crater-pits. West of Davy lies a small 3°½ bright, partially-enclosed plain, bordered on the west by a 7° bright range of mountains, Davy γ, and crossed by a rill ξ, discovered by Mädler, and which, according to Schmidt, is a crater-rill (S. 317). Beyond are the three very irregular enclosed plains g, f, and e, examples of the formation intermediate between the rounded valleys or enclosed plains and the ring-plains; and east is c, a formation between the last and the more perfect ring-plains; c being a very good specimen of the more imperfect of these last, and retaining the dark colour of its interior, is distinct in Full, whilst its wall and the small crater p are fully 6° bright. Between Davy and Davy c are some high mountains, the peak ι rising 2,494 feet and μ 3,293 feet above the plain.

Lalande (L.)—A ring-plain, 13·51 miles in diameter, distinguished from all others on this portion of the Moon, except Herschel and Mösting, by its great depth and its regularity of form. The broad, terraced walls are 6° bright, and rise at least 6,000 feet above the 4° bright interior, which contains a central mountain of slight elevation, omitted by Beer and Mädler; that from six measures by Lohrmann is in $-$ 4° 20′ 3″ lat. and $-$ 8° 44′ 23″ long., whilst seventeen measures during 1875 make the position of the central peak of Lalande $-$ 4° 26′ 34″ lat. and $-$ 8° 47′ 41″ long., the result of the two series making the place of Lalande, from twenty-three measures, $-$ 4° 24′ 52″ lat. and $-$ 8° 46′ 49″ long. North of Lalande is the 6° bright crater b, with a number of hills detectable with difficulty; west, on the borders of the mountain region of Ptolemäus, rises the high peak β, over 2,800 feet above the plain; and south are a number of small irregularities on the plain, of which δ is the highest; whilst in the north-east extends a brighter region to the mountains ε and ζ on the Mare, the first being perhaps 1,500 feet high; but the most distinct object here is the crater E, 6°½ bright, and very deep; the smaller, f, being only 5° bright. Lalande A is another very deep circular crater, 7° bright, with an east wall rising 2,782 feet above the outer plain, and with its centre in $-$ 6° 26′ lat. and $-$ 10° 4′ long.

Beyond it is the peak I, in − 7° 5′ lat. and − 10° 58′ long., rising 1,695 feet above the surface.

Mösting (M.)—A fine ring-plain, 14·66 miles in diameter, with a broad 6° bright wall, which, though only elevated 1,625 feet above the outer surface in the east, rises 7,527 feet above the 4° bright interior on the east, and 5,659 feet on the west. The wall slopes gently on the exterior, but steeper towards the interior, where it is terraced and contains a 6° bright crater close to the high peak α, whilst the floor contains a dark spot on the south-east, and a small central mountain of but slightly greater brightness than the rest of the interior. From six measures during 1875 the centre of Mösting is in − 0° 36′ 26″ lat. and − 5° 53′ 2″ long., its place, according to Mädler, one of whose points of the second order it formed, being − 0° 38′ lat. and − 5° 54′ long. From the three ring-plains Herschel, Mösting, and Triesnecker, the centre of the Moon is easily ascertained, as it lies very nearly centrally between them—according to Mädler being 112 miles from Herschel and Mösting, and 103 miles from Triesnecker; whilst from the position of Mösting, Landsberg, and Landsberg A the true position of the equator can be found. The environs of Mösting consist of a tolerably bright plain, broken by some high mountains, and containing a number of low hills. The mountain γ rises 1,247 feet above the plain; δ nearly as much. North-west of Mösting is a small mountain-ring, only visible near the terminator, and south of this is another, *m*, not so regular as the last, with its highest peak at β. Towards Lalande are two craters—the larger, B, in − 2° 42′ lat. and − 7° 21′ long.; the smaller, *c*, north of it, and a very remarkable formation. Though only two miles in diameter, it is extremely bright, and is surrounded by a glittering broken surface, and appears at times like a mountain peak, being actually drawn by Lohrmann as one.

Mösting A is a great crater, with 9° bright steep high walls and a depth of 3,000 feet; it is surrounded by a much disturbed region, though only of small extent, which near the crater is 8° bright, and fades away until only 6° bright near its border. The centre of this very distinct object is perhaps the best determined spot on the Moon, its only rival in this respect being Manilius. Mädler employed it as a point of the second order, and from probably more than one measure fixed its position as – 3° 14′ lat. and – 5° 15′ long., and suggested its employment as a standard point from which to ascertain the real libration of the Moon. Bessel, in 1839, determined its place, from two very accordant careful series of measures with the great Königsberg heliometer, to be – 3° 15′ 43″ lat. and – 5° 3′ 50″ long. Wichmann, in 1844–1845, from a set of fifty such series of measures with the same instrument, found it to be in – 3° 10′ 55″ lat. and – 5° 13′ 23″ long.—a result that must be regarded as very accurate, and fully confirmed by a set of six series, comprising 24 measures, made in 1874–1875, which give – 3° 10′ 25″ lat. and – 5° 13′ 56″ long., differing thus by only 35″ and 33″ respectively. Mösting A being very distinct and sharply marked in all illuminations, it is well fitted to serve the purpose of a standard point from which others can be measured; and the position found by Wichmann seems far more accurate than necessary for this purpose, the probable error of the latitude being only 24″ and of the longitude 89″. On the north-west slope of the disturbed region round Mösting A, is a small deep crater 6° bright, and north, on the plain, a long rill, Mösting ϕ (S. 321), ending south of Mösting *b*, south-east of which is another rill, ζ (S. 322), both discovered by Schmidt in 1853.

Herschel (L.)—A fine, very distinct ring-plain, 24·39 miles in diameter, with broad, terraced, lofty walls 6° bright, and rising 9,448 feet above the 3° bright interior, which contains a small central mountain, according to six measures by Lohrmann in − 5° 37′ 6″ lat. and − 2° 9′ 7″ long. Herschel is surrounded by many mountains, ridges, and craters, the region forming the northern end of the great belt of elevated surface bordering the meridional chain of walled-plains. The 7° bright crater *c* is very distinct, and east is the shallow ring-plain *d*, with a 5° bright wall, rising 1,600 feet above the 3°½ bright interior; whilst the mountains south contain many fine long valleys with gently sloping sides. North is Herschel *f*, a great enclosed plain almost coming amongst the class designated walled-plains, with a 4° bright interior, surrounded by an irregular mass of mountain peaks, mostly 5° to 6° bright, rising at γ 3,900 feet, and near ι about 3,000 feet. West of *f* is a smaller enclosed plain, *g*, crossed by a short rill, Herschel ϕ (S. 320), and with a steep peak, ζ, on its east border. The ring-plain **a** is the most distinct of those near Herschel, possessing a well-marked connected wall, 5° bright, and a 4° bright interior, containing a small central mountain not drawn by Mädler; west is the 4° bright ring-plain *b*, of some depth, though little visible towards Full; whilst on the west extends a great deep valley cleft, *e*, resembling that south-east of Ukert, and is included by Schmidt amongst his rills as No. 319. Beyond this great valley is another enclosed plain, *h*.

Ptolemäus (R.)—The largest of the great meridional chain of walled-plains, with a greatest diameter of 114·80 miles and an area of perhaps 8,500 square miles, and having in many ways the appearance of one of the greater lunar Mares in miniature. The most conspicuous object on the 3°½ to 4° bright interior is the fine 7° bright deep crater Ptolemäus A, according to ten measures in − 0° 34′ 58″ lat. and − 0° 58′ 22″ long., the position, according to Mädler, as one of his points of the second order, being − 8° 56′ lat. and − 0° 44′ long. The crater *d* is 5° bright, and found without difficulty; but the remaining objects are all very delicate, and the ten other craters, or crater-pits, drawn by Mädler, were only seen after four years' observation of this formation. Mädler has seen the whole surface as if covered with numerous low short ridges with very gently sloping sides, and not 100 feet high, thus confirming a similar observation of Kunowsky. Schröter drew four deep craters on the interior besides A—probably *d* and *c*, with two others, *m* and *n*, in size and depth fully equal to A. Yet not only did these escape his notice during earlier observations, but they certainly do not exist, though in their position are the two very small craters *m* and *n*. These two, together with *d* and *e*, are probably the only small craters on the floor, the rest appearing to be true crater-pits; and of these Schmidt has counted at least forty-two, including twelve on the east in a chain. The walls of Ptolemäus consist of high mountains without definite connection, forming arms of great mountain masses entirely independent, and resembling the borders of the great Mares. At ε on the south opens a pass uniting the interiors of Ptolemäus and Alphonsus; and on the east is a great mountain highland, with many steep peaks, separated by long winding valleys; this highland having a moderately high crest towards Ptolemäus, and a gentle slope, falling steeply only at γ. The peak ρ rises 2,500 feet above the interior, and, according to Schröter, as much as 5,000 feet above the eastern surface; the curved mountain α rises nearly 3,000 feet above the interior and 4,300 feet above the interior of the eastern plain Davy *g*. The peak λ is nearly 4,000 feet high, and γ, which rises fully 6,000 feet above the interior, is, according to Schröter, almost 8,800 feet above the eastern region, but possibly its shadow and that of δ may have been confused; whilst finally the peak μ is 4,000 feet high. East of the peak λ Schröter draws a distinct crater not given by Mädler, and close under the west of the mountain α Schmidt has seen a long crater-row or rill, ϕ (S. 316); whilst east of λ, extending south from Lalande *c*, is a long rill-like valley, Ptolemäus *e* (S. 318), discovered by Lohrmann, which, as it extends, becomes broader and more marked, finally uniting with a corresponding valley east of Alphonsus. On the north-west the border of Ptolemäus is formed by the steep south-east fall of an elevated plateau, with two craters on its slope, the deepest being *g*, and rising at η 8,671 feet high; and then west and south-west the wall becomes lower and more broken, though at points with some tolerably high peaks. West of this peak Mädler draws a row of six craters extending as far as Ptolemäus *f*, near Albetegnius G; but later observers, as mentioned in the British Association Catalogue, have only detected five, and the easternmost of these is only a doubtful crater. Beyond them are two small depressions, not unlike craters at times.

Alphonsus (R.)—A very fine walled-plain, 83 miles in diameter, with high, very complexly-formed walls, consisting of a principal crest, much terraced, and supported by numerous projections and buttresses, rising in high peaks at places, and crossed by many passes, ravines, and long winding valleys, whilst it is backed by a number of subsidiary, mostly parallel, mountain chains and ridges enclosing long rill-like valleys. At γ the wall rises 7,034 feet above the interior, and at β 5,528 feet above the Mare Nubium, the floor being little, if at all, deeper than the Mare. On the west wall at *d* is a rounded valley enclosed by mountains not unlike a small ring-plain at times, and, according to Schröter, 2,000 feet deep, and east of this is the crater **a**. Here are three great rill-like valleys on the south-west wall of Alphonsus, included by Schmidt amongst his rills as No. 313, 314, 315, though possessing nothing of the character of rills, as they are true valleys. Alphonsus *f* is the longest valley, commencing on the west of the wall of Arzachel near the peak α, and ending on the plain close to the south end of Ptolemäus *e*. Another very similar valley, *e*, extends from the open plain west of the high peak Alphonsus E, to the more open region west of Arzachel. The wall on the north opens by many very rugged passes into Ptolemäus, and is also traversed by the more level and marked pass by Ptolemäus ε. The interior of Alphonsus contains a fine 7° bright central peak, A,—from nine measures by Mädler, in $- 12° 59' 21''$ lat. and $- 3° 14' 28''$ long., and rising 3,894 feet high, while near it are some other elevations and a long ridge, all, however, very inconsiderable. On the floor are two bright spots south of the central mountain, and on either side of A are two sharply-bordered dark-grey, almost black, spots, *o* and *p*, distinctly visible in Full, but disappearing near the terminator, when the surface they occupy appears to be perfectly free from irregularities. Across the centre of the interior extend two long winding rills, the eastern, ϕ (S. 311), being most distinct; the second, ϕ_1 (S. 312), being delicate and, according to Schmidt, thrice curved; its form and position as drawn on the map are doubtful.

Alpetragius (R.)—A magnificent ring-plain, one of the very finest towards the centre of the Moon, 26·70 miles in diameter, with a 5° bright broad regular lofty wall, which between the two peaks ε and ζ rises 12,034 feet above the 4° bright interior, whilst on the east the peak η rises over 10,000 feet above the interior and 6,011 feet above the Mare Nubium. The central peak of Alpetragius is one of the largest on the Moon, being much larger than drawn by Beer and Mädler, and, according to Schröter, 7,000 feet high—a fairly approximate result; whilst its position is $- 15° 58'$ lat. and $- 5° 19'$ long., but yet it is only with difficulty visible in Full, though 5° bright. According to Mädler, the dark Mare Nubium does not extend right up to the foot of the wall of Alpetragius, and this appears correct; and under very favourable conditions a gentle slope in the surface towards the Mare can be detected along this border.

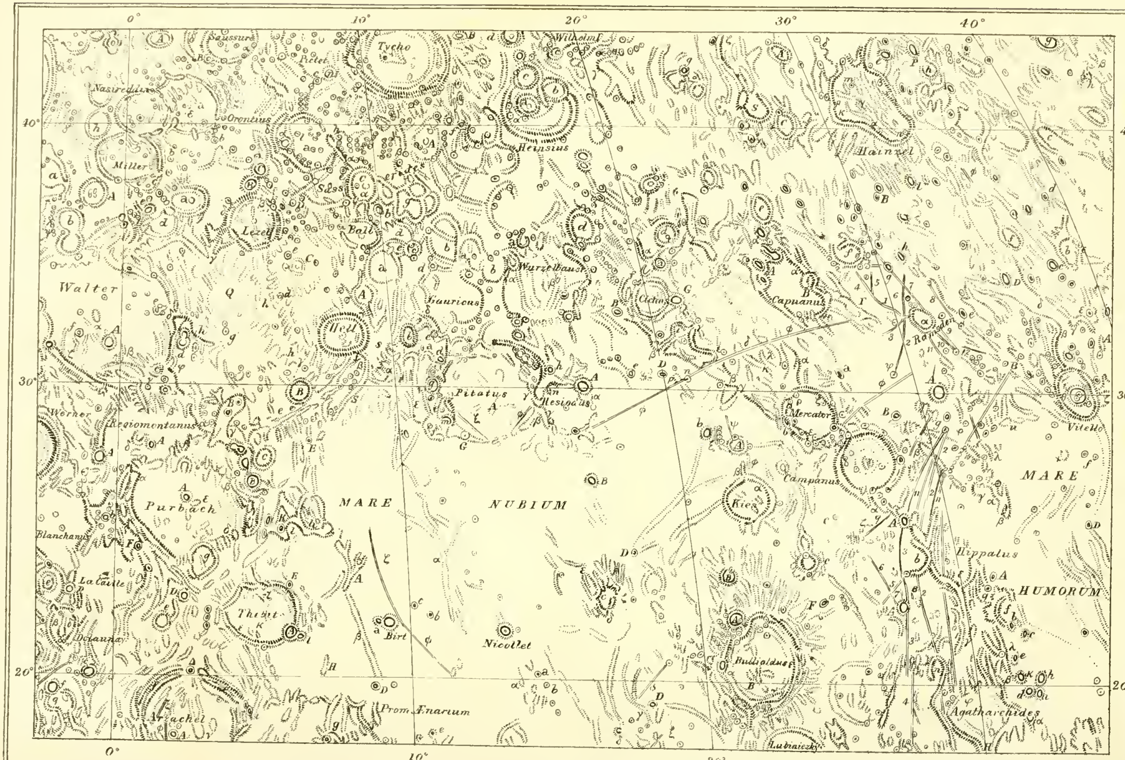
On the dark Mare Nubium glitters the very brilliant 9° bright crater B, in − 14° 55′ lat. and − 7° 27′ long., one of the few light-surrounded craters of the Moon, of which Euclides is the typical example. Beyond is the 6° bright crater C, in − 14° 24′ lat. and − 10° 7′ long., with two very similar craters south, and a mountain 1,196 feet high on the north; whilst near it are some others not so deep, first drawn by Schmidt. Still farther east of the open Mare is the remarkable formation Alpetragius *d*, which was described by Mädler as an 8° bright crater, and drawn on the 'Mappa Selenographica' as 5·0 miles in diameter, and with a much smaller one on the south-west. Schmidt in 1868 pointed out that this description is no longer true, and that the crater *d* of Mädler no longer exists; but that in its place is a small round brilliant spot, about 10 miles in diameter, with the small craterlet on the south-west very distinct and in the same relative position. At present it is a sharply-defined 7°½ bright, perfectly round spot, according to three measures 7·2 miles in diameter, and presenting many of the characteristics, in Full, of being a light-surrounded crater, about 5 miles in diameter, though no crater is visible when near the terminator. Some change, it would appear, must have occurred, unless Mädler concluded it was a crater, from its appearance in high illumination, though he has repeatedly pointed out the impossibility of doing this with any accuracy. Schröter has not drawn this region, and Lohrmann, in his imperfect results, does not probably show it at all, though near its place he draws a small hill and a great spot of light almost 40 miles in diameter, or thirty times the area of the present object.

Lassell (B.) [Alpetragius **a**, M.]—A ring-plain on the Mare Nubium, with a 4°½ bright wall with 5° bright peaks, and a small crater on the north, and a 3° bright interior, containing a small central mountain. According to Mädler, it is only to be found with trouble in Full, but is now distinct enough to be picked out very readily. South of Lassell are a number of crater-pits and two 5° bright craters, **a** and *b*, of but slight depth. In the open plain south-east are a number of long ridges, and a very delicate, extremely shallow valley, *c*, beyond which are the two 4° bright small craters Lassell *e* and *f*.

Prom. Ænarium (H.)—The projecting point of a high steep plateau, elevated, perhaps, 2,000 feet above the Mare Nubium, and crossed by short mountains, whose highest peaks are Alpetragius β and γ, and the Prom. Ænarium itself. The chief peaks of this plateau are 5° bright, and so is the small crater Alpetragius *g* near γ; the highlands themselves being from 4° to 4°½ bright. From δ stretches north-east, for a distance of 90 miles, a very gently sloping shallow valley, Lassell *c*, only visible with very great difficulty, and crossing several low ridges.

Arzachel (R.)—A great ring-plain south of Alphonsus, 65·56 miles in diameter, with 4° bright, regular, much-terraced walls, containing many valleys, peaks, and craters, and rising at α 13,589 feet, and at another peak 8,920 feet above the interior, whilst on the east it is perhaps still higher, and nowhere under 10,000 feet high, though only 6,043 feet above the outer surface. On the south-east wall, between two mountain ridges, is the fine valley *e*, discovered by Lohrmann, and very distinct; it is included by Schmidt amongst his rills (S. 304), though without any claim; whilst a second, *f*, on the west wall, is omitted by him, though just as marked. The two principal wall-craters, Δ and *b*, are not conspicuous, and the others require close examination to find them. The floor of Arzachel is of the same brightness as the walls, 4°, and consequently the whole formation disappears in Full, only a few isolated brighter points remaining visible. The central peak γ rises, according to Mädler, 4,911 feet, though Schröter makes it nearer 8,000 feet; and west of it is the deep crater A in – 18° 4′ lat. and – 2° 14′ long., both these last being 5° bright. West of the central crater A, Schmidt discovered a winding rill, ϕ (S. 309), and south a shorter and still more difficult, ξ (S. 310), neither of which had been seen by Mädler, who mentions and draws a narrow valley, ψ, which may be identical with Schmidt's ϕ, but, judging from the description, is more probably different.

Map XIV.


Saussure
Tycho
Wilhelm I
Nasireddin
Pictet
Orontius
Heinsius
Hainzel
Miller
Sasserides
Lexell
Ball
Wurzelbauer
Capuanus
Walter
Gaurious
Cichus
Hell
Ramsden
Pitatus
Hesiodus
Mercator
Vitello
Werner
Regiomontanus
Campanus
MARE
NUBIUM
Kies
Purbach
Blanchanus
Hippalus
La Caille
Thebit
HUMORUM
Delaunay
Birt
Nicollet
Bullialdus
Prom. Ænarium
Agatharchides
Arzachel
Lubiniezky

CHAPTER XX.

MAP XIV.

Thebit (R.)—A very distinct ring-plain, 32·3 miles in diameter, with an irregular $5°\frac{1}{2}$ bright wall, steep and high on the west, where it rises 8,403 feet, and the peak, ε, 9,835 feet above the 3° bright interior, though the eastern wall is much lower. The dark interior contains a number of elevations, the principal, κ, of some steepness and height, though Mädler did not consider it as constituting a central peak; and Schröter twice saw a small crater on the floor midway between ε and A.

On the north-east the wall of Thebit is broken by the very deep regular crater A, with broad steep walls 4° to 7° bright, and rising on the east 4,719 feet above the Mare Nubium, and, according to Mädler, probably 10,000 feet above the 3° bright interior. From twelve measures by Mädler the position of the centre of A is −21° 17′ 34″ lat. and − 5° 47′ 8″ long. On the north-east slope of A is the smaller and shallower crater *l*, only 4° bright. On the open plain in the east is a very remarkable straight uniform ridge or wall, β, with an average height of 450 feet according to Schröter, 1,004 feet according to Mädler, and 880 feet according to Schmidt, commencing near the small crater D in − 19° 28′ lat. and − 8° 45′ long., and ending in the mountain mass A in − 23° 41′ lat. and − 8° 8′ long., which in form, from its many branches, resembles a stag's horn, and rises, according to Schröter, 1,900 feet above the plain.

H is a small double-peaked mountain in − 20° 10′ lat. and − 6° 59′ long., 6° bright, and distinct in Full.

Birt (N.) [Thebit, B. M.]—A fine ring-plain on the Mare Nubium in − 22° 4′ lat. and − 9° 29′ long., with regular 7° bright walls, containing 8° bright peaks on the south and north, and rising on the east 2,475 feet, or, from a measurement by Schröter, 2,100 feet above the outer surface; and on the west rising, according to Schröter, 6,000 feet above the 4° bright interior. On the outer slope of the west wall is a distinct 6° bright small crater, **a**, and towards the south extend from the ring-plain a number of 4° bright light streaks. East are the two 5° bright craters *b* and *c*, neither particularly deep, and beyond is a peculiar branching mountain ridge, α, with gently sloping sides. East of the ring-plain is a fine curved rill, ϕ (S. 198), discovered by Schröter, and to which Mädler, on July 28, 1834, found a southern continuation, ζ (S. 299), which has not been seen by Schmidt or other observers since.

Nicollet (N.) [Thebit, C. M.]—A small ring-plain near the centre of the Mare Nubium, with a wall rising, according to Schröter, 4,100 feet above the interior, and, from Mädler's description, with a 6° bright wall and 3° bright interior, though now with nearer a 4°½ bright wall. Around Nicollet are a number of small crater-pits, and on the north, near some ridges, two 6° bright craters **a** and *b*, and a 5°½ bright peak, α. On the east is a regular enclosed plain, Nicollet *c*, lying between some bright mountains that are at δ and ϵ, over 2,000 feet high; the entire western portion 5°½ bright, the eastern 4° bright, and the interior plain 3° bright.[1]

Purbach (R.)—A great walled-plain, surrounded by high mountains rising north of α, 7,559 feet above the interior, and in places still higher. The border is most regular on the west, where it consists of a mountain ridge containing

[1] This formation is Bullialdus ϵ of M.

many peaks and much terraced; it is broken on its outer slope by the deep crater F in − 24° 16′ lat. and − 0° 50′ long., and at the south crossed by a fine pass, α, between two considerable mountain peaks. On the south the walls are lower and very irregular, consisting of a broad elevated mountain region crossed by a number of valleys, but on the east the walls again become rugged and high, rising in lofty peaks at β and γ, and broken by terraces and valleys; whilst north they consist, as on the south, of a wide mountain region, containing some high peaks and forming a small ring-plain, *g*. The wide bright highland on the north contains the smaller but more regular ring-plain *e*, 10 miles in diameter, 1,200 feet deep, and with a small central peak; whilst south is the smaller and deeper formation D, in − 22° 24′ lat. and −2° 16′ long., with, east of it, three circular depressions in a row. The mountain region south-east of Purbach is still more rugged and irregular, the principal objects being the deep small ring-plain B in − 26° 33′ lat. and − 4° 53′ long., 9 miles in diameter, the more irregular *c* south of it, with two smaller and more imperfect on the west, and the deep crater K, only 2½ miles in diameter, in − 24° 32′ lat. and − 5° 25′ long. West of K are two small depressions, and east, at *h* and *l*, two formations at times resembling ring-plains; whilst near K the edge of the highlands fall steeply 7,175 feet to the plain beneath. Within Purbach is the distinct crater A in − 25° 32′ lat. and − 2° 39′ long., the small central peak ε, and a number of hills and crater-pits.

Regiomontanus (R.)—An irregular walled-plain, 65 miles from east to west, and 42 miles from south to north, surrounded by rugged mountains only in portions high or steep, and broken in many places by deep fissures, and traversed by valleys, ravines, and passes. On the west the wall rises 6,771 feet, and on the east, at α, the steepest portion nearly as much, and forms a broad plateau on which appears the double crater B, in − 28° 29′ lat. and − 4° 15′ long. On the interior of Regiomontanus is the central crater A, in − 27° 46′ lat. and − 1° 18′ long., but is not so distinct as the horseshoe-shaped mountain δ on the west, and the imperfect small ring-plain *f* is also at times conspicuous. On the east the mountain border becomes very wild, and encloses a number of deep irregular formations, but beyond Purbach *c* becomes less wild, and forms a number of short valleys opening into the long rill-like valley *e*; whilst at E, in − 27° 54′ lat. and − 7° 0′ long., the mountains end and the open plain commences.

Walter (R.)—Another great walled-plain, more than 100 miles in diameter, surrounded by a wall composed of an immense number of separate peaks and mountain chains, divided by valleys, ravines, and passes, and united by cross walls, buttresses, and arms, impossible, from their great number and complexity, to be adequately mapped, except on a very large scale, but all resting on a common base of considerable elevation. The peak β, in − 30° 50′ lat.[1] and − 0° 24′ long., rises 9,937 feet, and ρ east 6,676 feet above the surface, whilst ζ on the west rises 10,053 feet above the interior. The wall contains many considerable depressions as *d* and *c*, and at δ is crossed by a pass opening into the small plain *h*, which again communicates with the bright plain near *g*. The interior of Walter contains the deep crater A, the smaller but as deep *e* and *f*, the high peak α, rising 4,943 feet above the floor, and some smaller mountains and craters, besides hills and crater-pits.

Miller (B.) [Nasireddin, a. M.]—A fine ring-plain on the lunar first meridian, with its central peak, according to Mädler, in − 38° 18′ lat. and − 0° 2′ long., surrounded by a lofty, terraced wall, rising on the west 10,985 feet, and on

[1] Given as 29° 50′ in text of the 'Der Mond,' probably by mistake.

the east 10,404 feet above the interior, whilst it is broken by a number of valleys, passes, and craters. The floor contains some mountains and a few crater-pits.

Nasireddin (M.)—A fine regular ring-plain with a lofty complex wall, much terraced, and containing many peaks, whilst broken by valleys, crater-pits, &c., but rising on the east 9,600 feet above the interior, which contains a central mountain and a number of crater-pits, with, also, a central crater according to Schmidt. Nasireddin *b* is a deep though small ring-plain. The whole of the region from Maurolycus to Heinsius, of which Nasireddin is the centre, is one mass of these crater-pits, which cover nearly every formation and entirely mask the few true craters and craterlets mixed with them. No attempt has as yet been made to distinguish between the true craters and the crater-pits or circular depressions, and only in a few instances, therefore, can they be separately indicated.

Orontius (R.)—A very irregular depression, surrounded on all sides by high mountains, and full of hills, mountains, and crater-pits, but by no means a suitable formation to have retained its name. Near δ the wall on the east is 8,000 feet high, and by α perhaps still higher, though the great mountain chain *i* must nearly equal it. On the interior, besides the innumerable crater-pits, are several craters, the principal being *b*. West of Orontius is the more regular walled-plain **a**, with steep, terraced walls rising on the east nearly 8,000 feet, and a central peak ϵ; whilst on the north is the deep regular ring-plain Orontius *c*. On the eastern slope of the wall, separating Orontius from **a**, are two long crater-pit rows, forming two of Schmidt's crater-rills (S. 324 and 325).

Lexell (M.)—A regular walled plain with walls of very unequal height, rising near δ 7,712 feet, broken at β and on the north, and pierced at α by a fine narrow valley. The interior contains a number of hills and ridges and a central peak.[1] This formation is not the same as that to which the name was originally attached by Schröter, but that to which Mädler transferred it on being unable to recognise Schröter's Lexell. South lies the small ring-plain B, whose centre is in – 37° 37′ lat. and – 4° 48′ long., and west the three irregular ring-plains **a**, *e*, and *d*, the first two with central peaks, and all three with high steep walls, whilst near them are some smaller formations, the most distinct being *e*. From **a** and *d* extend long narrow valleys, which, uniting, cross the mountains in a deep cleft and open on to the plain near the peak γ.

Sasserides (R.)—A very irregular depressed plain lying between a number of ring-plains, with its western border rising near α 7,503 feet above the interior, and at β, on the east, nearly as high and quite as steep; but on the north, where it is bordered by the ring-plain C, the slope is gentler. On the interior are the two craters *e* and *h*, and a great number of small crater-pits, including at least four crater-rows or crater-rills (S. 326–329). West is the fine ring-plain Sasserides **a**, with a bright crater, *d*, on its wall, a high peak at γ, and a crater *l*, with a number of crater-pits on its floor. Towards Lexell are a number of bright craters, D, in – 36° 45′ lat. and 6° 48′ long., remaining most distinct in Full. Towards the north are a number of great ring-plains, the two principal being C and *g*.

Ball (B.) [Sasserides, B. M.]—A considerable deep ring-plain, with a fine central mountain in – 35° 29′ lat. and – 9° 4′ long., rising 2,500 feet high, whilst the wall on the west rises over 5,000 feet above the interior, and is broken by several small craters. East of Ball are several very irregular depressions or ring-plains, with walls of some

[1] On the north-east wall Schmidt has seen a short rill (S. 323) extending from the north-west to the south-east.

height and steepness, a being deeper and more regular than *b* or *d*, whilst *c* contains a high peak α.

Gauricus (R.)—A very irregular walled-plain, north-east of Ball, and the most distinct of a great number of walled-plains east of Sasserides and Hell, with its border on the east formed by a lofty cliff falling precipitously 9,305 feet from its summit, and constituting the western declivity of a great plateau extending as far as Wurzelbaur and broken by a row of deep craters. The interior of Gauricus contains only a few hills and a crater-pit or two, all very minute; and two peaks on the west border, near δ, rise 4,783 feet above the interior. South are the three considerable depressions Gauricus *b* and a, and Wurzelbaur *b*, with the more regular Gauricus *c* and *d*, and on the north is the bright crater *e*.

Hell (S.)—A fine ring-plain, 18·4 miles in diameter, in a comparatively level region, with broad, steep terraced walls, rising on the north-west 5,372 feet, according to Mädler, but 9,900 feet according to Schröter, who makes the east wall 2,700 feet above the outer surface. The interior contains several hills and a central peak from nine measures by Mädler in $- 31° 58' 59''$ lat. and $- 8° 19' 54''$ long. In Full, Hell can be found with some trouble, forming thus an exception to almost all its southern and western neighbours. Probably Schröter gave the name Hell to the entire enclosed region between Gauricus and Walter, Lexell and Purbach, but by Mädler it was restricted with much advantage to the ring-plain described South is Hell A, in $- 33° 34'$ lat. and $- 9° 4'$ long., a small ring-plain, with walls of considerable height and a level interior, connected with Ball by a strong mountain arm, but, like all the other smaller formations, invisible in high illumination. Hell B is another small ring-plain, whose centre is in $- 29° 44'$ lat. and $- 6° 30'$ long., with near it some small ridges and craters; and Hell C is a very similar ring-plain in $-34° 4'$ lat. and $-6° 50'$ long., with a wall rising on the east 900 feet above the plain and a distinct central peak. South is the small bright deep crater *e*, with a wall 900 feet high above the outer surface, whilst a number of small bright craters are near, the deepest being perhaps *d*. From Lexell towards Hell γ extends a fine wide valley, *h*, into which open many side valleys, in themselves branched, and, as Mädler points out, very analogous to terrestrial river valleys. Smaller but similar valleys are not uncommon on the Moon, as those near Bode; and a far less extensive but analogous formation is *f*, north of Hell. Hell β is an anomalous crater-row or rill (S. 293), and the valley Purbach *e* is also included by Schmidt amongst his rills as No. 294. Hell α is a high peak east of Hell, where are a number of such mountains, enclosing a most complex system of short valleys with a general uniform direction, and opening into a long wide valley, *s*, whilst the peaks themselves in places reach a considerable height, Hell E rising 4,783 feet. At Q is a great 9° bright spot, seen at low illumination to be a level plain surrounded by low hills and valleys. Near here appeared the celebrated white cloud seen by Cassini, which soon after disappeared, and in its place he saw a new formation; this is considered by Mädler to have been probably the brilliant spot Q, which Cassini afterwards confounded with one of the neighbouring ring-plains,—perhaps Hell or Hell B.

Pitatus (R.)—An extensive walled-plain, bordered on the south by the great highlands north of Tycho, which rise in points into moderately high peaks, and are very rugged; whilst on the north the wall, in places steep and high, is in general ruined and broken down, with wide gaps at intervals. The south-west portion is tolerably steep, and contains a crater, *d*, not shown by Beer and Mädler, close to two peaks, and ends at the small deep ring-plain *g*, close to which are three small craterlets, also not shown by Beer and Mädler. On the inner slope of the wall between *g* and *d* Schmidt has seen a crater-rill ψ (S. 292). North of the ring-plain *g* is another more imperfect ring-plain, *f*, communicating with the interior of Pitatus by a narrow rill-like valley, *e*, whilst another very similar valley extends south past the west wall of *g*; the floor of *f* contains a small crater-pit and some low hills. The north-west wall is tolerably high towards *g*, gradually diminishing in height, and broken on its outer slope by the imperfect crater at *m*, and ends in the deep bright crater C in − 28° 8′ lat. and − 12° 25′ long.; whilst on the plain beneath is a fine rill, ξ, in part seen by Schmidt (S. 291). Beyond the crater C the wall becomes rapidly smaller, and contains several gaps, and not until the mountain β is reached does it become again of any height; while close under this mountain is a fine deep rill, ϕ (S. 290), missed by both Mädler and Lohrmann, although so distinct. Beneath β a broad pass connects the interiors of Pitatus and Hesiodus, with on its other side the great peak γ, perhaps the highest on the wall: beyond this the wall widens into a very gently sloping irregular declivity. The deep bright crater *h* is on the crest of the wall, and beneath, on the slope, is a peculiar formation, consisting of five deep craters in a row, the two end craters perfect, but the three centre craters with the portion of their walls that should divide them, destroyed, so that they open one into the other. Mädler draws these as a row of five perfect craters. The interior of Pitatus possesses an area of about 2,500 square miles from 2° to 2°½ bright, which, by its contrast with the 4° to 5° bright walls, renders Pitatus remarkably distinct under high illuminations. The clear central peak A is in − 29° 24′ lat. and − 13° 40′ long., with near it a number of grey ridges and low mounds.

West of Pitatus is the irregular bright enclosed plain a elevated considerably above the level of the interior of Pitatus, with on its west border the elliptical ring-plain *b*, of moderate depth; both these, like all the formations south-west of Pitatus, disappearing in Full under the light streaks from Tycho.

Hesiodus (M.)—A walled-plain on the east of Pitatus, with a high western and southern wall, in places nearly 4,000 feet high, and a lower northern wall communicating by at least two passes with the outer surface. The deep bright crater A is in $-29° 50'$ lat. and $-16° 42'$ long., with near it, on the wall, a considerable peak α, beyond which is a small craterlet, whilst west at *n* appear the ruins of a smaller crater. On the outer slope of the north wall is a fine crater, *c*, with some ridges and mountains near it, forming a small mountain-ring; and on the wall west of this, near the peak γ, is a small deep crater. Mädler draws and describes the floor of Hesiodus as lighter than Pitatus, with a lighter spot towards the centre, but makes no mention of any formation or irregularity. The floor of Hesiodus now contains a very fine deep central crater, very distinct long after sunrise, which could hardly have escaped his notice had it been then as distinct as now. North of Hesiodus, on the open dark grey Mare Nubium, is the 5° bright, very distinct crater, Hesiodus B, from eight measures by Mädler in $-26° 50' 26''$ lat. and $-16° 59' 35''$ long.

Wurzelbaur (S.)—A great, nearly circular, walled-plain, bordered on the west by the high plateau extending between Gauricus, Pitatus, and Wurzelbaur, which falls steeply 5,512 feet at α; but on the north, east, and south the wall is more imperfect, and is broken by numerous craters and small ring-plains. The interior is one mass of irregularities, consisting mainly of long ridges, of which β is the greatest, enclosing deep valleys. On the south-west is the deep ring-plain *b*, south of which is the smaller and more regular **a**, and south-east the still deeper ring-plain *d*, with a nearly level interior, and a high crater broken wall rising 7,814 feet on the west above the floor.

Heinsius (S.)—A very remarkable lunar formation,[1] consisting of a nearly circular, deep walled-plain, with its south-eastern portion entirely destroyed by three great ring-plains, Heinsius **a**, *b*, and *c*, the much-terraced remaining wall rising on the west by α 8,677 feet, and on the interior are several small craters with many crater-pits. The three great ring-plains form a regular triangle, and the west wall of each, though in *b* especially it is higher than the east, that of **a** is 6,000 feet, of *c* 7,000 feet, and of *b* 4,000 feet above the interior. Heinsius **a** contains a distinct central peak, and is alone, of the whole formation, visible in Full, appearing as a bright ring round a darker interior.

Hainzel (R.)—A pear-shaped walled-plain, 55·33 miles in its longest diameter, with very steep lofty walls, rising at the peak α on the west wall 11,574 feet, and at κ 11,593 feet above the interior, and 10,635 feet above the outer surface, though measurements are difficult, owing to the irregularity of the surface. The interior is covered with numerous ridges, in places of very considerable height rising near γ from 2,000 to 2,500 feet; and two small craters or crater-pits, *m* and *n*, can also be detected. In Full, however, the whole formation is invisible, only a minute 6° bright spot near β being detectable, and serving in some way to indicate the position of the great formation. From the wall of Hainzel extend many parallel ridges, near the crater B, in − 37° 35′ lat. and − 31° 1′ long., with a general meridional direction, and between B and the deep ring-plain Hainzel C,

[1] In the 'Mappa Selenographica,' Mädler points out that the position of this formation and of Wilhelm I. is placed too far south, and he has also drawn the ring of Heinsius too small.

in – 40° 8′ lat. and – 27° 36′ long., in a north-west direction, and then around and south of C, again with a general meridional direction. Hainzel C is on the border of a great mountain circle or enclosed plain, which, particularly at the terminator, bears the aspect of a vast walled-plain. Its western border is a great curved mountain range extending south of C and rising at the point ζ 6,458 feet above the plain, and on the west, near δ, not far short of this height. Within is the distinct small ring-plain A, with regular bright walls, and whose centre is from eight measures by Mädler in – 42° 59′ 26″ lat. and – 29° 54′ 45″ long., whilst near it are several small craters or crater-pits. The border on the west of this great semi-walled plain is the mountain arm δ, rising 5,140 feet above its eastern foot and bending near the crater D in – 45° 10′ lat. and – 32° 18′ long., where it joins a very irregular mountain chain, whose highest peak is ε. The two enclose another plain, appearing at sunrise as a second great walled-plain, on whose interior are the two small sharply-marked ring-plains *e* and F, the last in – 43° 5′ lat. and – 35° 58′ long.

On the more level southern portion of this plain at *q* is a 9° bright glittering point, according to Mädler belonging neither to crater nor mountain. South of ζ is the crater N in – 44° 41′ lat. and – 26° 3′ long., and north of *h*, on the east of Hainzel, extends a wide triangular, irregular plateau, with its surface broken by many small ring-plains and craters, whilst in the far east is Hainzel *g*, a small ring-plain, surrounded by a number of craters or ringlets, on the west border of an irregular walled-plain, *u*. North of Hainzel is the small ring-plain *l*, and east, in a small open plain surrounded by mountains, is a short rill, ϕ (S. 340), discovered by Schmidt.

Capuanus (R.)—A nearly circular ring-plain, with a fine wall, which consists, on the east, of a lofty mountain range, rising 8,588 feet above the eastern plain, and broken by a crater, B; but on the north is lower, and broken by passes and crater-like depressions; and even in the west, though more regular, is narrow and low—at the centre being only 895 feet high; whilst towards the south the wall has been replaced by three great craters, or small ring-plains, with high steep walls. The dark grey interior, with its 4° bright wall rising at the peak α and the crater B, as well as the small ring-plain A, to 6° brightness, renders Capuanus very distinct in Full, and the floor is then seen to be traversed from south to north by three narrow light streaks, but otherwise appears level. From the wall, extending north, are many considerable ridges, one rising at Γ in $-$ 33° 0′ lat. and $-$ 28° 20′ long., 1,758 feet.

North of Capuanus is a fine dark-grey plain, bordered on the north by the mountains between Cichus and Capuanus, which rise near Capuanus δ about 6,500 feet; on the east by the curved mountain region between Capuanus and Vitello; on the north by the bright highlands between this last and Campanus, and on the west by the mountain arm between Cichus and Mercator. Across this plain extends the great Capuanus rill, ϕ (S. 288), which commences at the east wall of Hesiodus, crosses the plain to the ridge ρ, which it cuts through, and after crossing a small crater, Cichus n, breaks in a fine, very narrow deep cleft, through the great mountain arm between Mercator and Cichus, and after crossing several ridges south of Mercator and north of Capuanus, ends at a ridge west of Capuanus Γ. Portions were seen by Lohrmann and Mädler; most of the rest, perhaps, by Schmidt, and the whole in 1873–1875. Its total length is over 200 miles.

South of Capuanus are the two small ring-plains d and e, and east the imperfect ring-plain f, with east the smaller g and h, together with some still smaller ones, and perhaps two or three craters.

Ramsden (M.)—A small, very distinct, ring-plain, 12·4 miles in diameter, with a 5° bright wall, rising 1,835 feet on the west, above the surrounding plain, or, according to Schmidt, 1,893 feet, and with an 8° bright peak, α, on the north-east wall, from eleven measures by Mädler, in $-32°$ $25' 48''$ lat. and $-31° 41' 55''$ long. The 4° bright interior appears to be perfectly level. Ramsden lies isolated on the dark grey plain, which on the east and south-east is only $1°\frac{1}{2}$ bright, with only a small crater and two crater-pits on the exterior slope of its wall on the south, but is surrounded by one of the most peculiar rill systems on the entire Moon. These entirely escaped the examination of Schröter, Lohrmann, and Mädler, though easily visible, and were discovered by Schmidt in 1849, who has since seen and drawn 12, though only including eight in his ' Rillen auf dem Mond,' where they constitute Nos. 280 to 287.

This rill system of Ramsden, from its peculiar ramifications and mutual intersection, bears most resemblance to the system of Triesnecker, and Schmidt believes that it will be found to be still more branched, and connected probably with the systems of Campanus and the Mare Nubium. The origin of the system of rills appears to be without the ring-plain, which seems to have entirely intercepted the system, as several of the rills disappear at its walls and reappear beyond, without interfering with either the walls or the interior of Ramsden. They are numbered in the same manner as in Schmidt's 'Rillen,' but in several instances have been extended in accordance with observations made during 1872 –1875; 5, 7, and 8, in particular, which are shown by Schmidt as intercepted, having been seen complete, though 7 is broken by the small ring-plain Capuanus *g*.

North of Ramsden is the fine 8° bright steep ring-plain A, with five high peaks on its wall, and surrounded by the dark plain; and south-west is the small crater ψ, containing, according to Schmidt, a smaller crater within; whilst on the dark plain extends a short rill, Ramsden ϕ (S. 278), probably interrupted by some hills near Campanus. North of A is a bright elevated mountain region, containing many narrow valleys resembling broad rills, and a number of small crater-like depressions. East of Ramsden is a very similar region, with wider and shallower valleys, on whose west border is the distinct ring-plain Ramsden *e*, and beyond whose east edge is the larger ring-plain Ramsden D, in – 33° 39′ lat. and – 35° 42′ long., in a wide bright valley, which extends from Vitello to the grey plain east of Capuanus *h*.

Cichus (R.)—A fine circular ring-plain, with very broad massive walls, rising steeply, with scarcely a terrace, 9,395 feet on the east, and 8,460 feet on the west above the interior, and 5,167 feet above the eastern plain. On the broad eastern wall is the very deep crater C in – 33° 18′ lat. and – 21° 20′ long., drawn by Mädler as five miles in diameter, which is very close to its real dimensions, but represented by Schröter on three separate drawings as scarcely half this; and Webb thinks that there may here be a suspicion of volcanic action, considering how faithful a draughtsman Schröter was. A critical examination tends to show, however, that in the actual dimensions of the smaller craters on the walls of the ring-plain when no particular necessity for exactitude appeared, little reliance can be placed in such discrepancies between Schröter's drawings and the present condition of the Moon, for relative dimensions was a weak point with Schröter. On the outer slope of the walls of Cichus appear several terraces and two considerable ring-plains **a** on the south, and B on the west, in – 32° 42′ lat. and – 18° 40′ long. at the very foot of the slope. North from Cichus extends a broad mountain arm, almost a plateau in character, with a rounded depression, *i*, north of which is a fine deep cleft extending from the peak β to γ, and very like a rill, amongst which Schmidt has classed it (S. 289). Beyond this the mountain arm becomes narrower and higher, and is crossed by the great rill of Capuanus, ending finally at the peak Mercator β. At Cichus γ and ϵ this mountain arm must rise nearly 4,000 feet. West is the small crater D, in − 30° 21′ lat. and − 19° 49′ long.; and beyond, the ring-plain Cichus *e*, with high walls and a distinct central peak, and on the eastern slope of a broad plateau broken by a small crater and two depressions, and connected by a high mountain arm with the mountains north of Wurzelbaur. Close to D are two small craters and four hills, pointed out by Mädler as a capital test for the excellence of a telescope. South of Cichus are a number of tolerably parallel mountain ridges, enclosing long valleys, and broken by craters and crater-pits, many of these last being grouped in rows, whilst east of this region is the regular ring-plain Cichus *d*, on whose floor are two small crater-pits. In Full, except the objects on the grey-plain, few formations can be seen in this region, the principal being Cichus B, and the small shallow depression *f* on the south wall of Cichus, which, though scarcely visible towards the terminator, in Full glitters distinctly.

Mercator (R.)—A great ring-plain, 30·34 miles in diameter, united by a strong mountain arm with Campanus, and by another with the more distant Cichus. The 5° bright walls are very unequal, rising at *b*, from three measures by Mädler, 4,431 feet, and at ρ, from one by Schmidt, 6,056 feet, but is higher at ϵ, and lower on the east and north, and contains on its crest and slopes a number of crater-like depressions, some on the west wall forming one of Schmidt's crater-rills (S. 297). It has, however, a perfectly level 3° bright interior. On the south extends a broad plateau, deeply indented, and crossed by some high ridges and narrow valleys, the principal peaks being γ, δ, *k*, and λ, all perhaps 4,500 feet above the grey-plain, whilst on the far east extends a fine curved mountain arm, rising at α 6,514 feet according to Mädler, but 6,957 feet from three measures by Schmidt, and whose shadow at times entirely hides the small crater Mercator **a**.

Campanus (R.)—A very distinct ring-plain, 30·54 miles in diameter, with steep terraced walls, rising on the west 4,500 feet, and on the east 6,529 feet above the interior, though, according to Schmidt, the east wall rises only 6,075 feet above the floor. The interior is level, being broken by only a 5° bright central peak and two crater-pits, and the entire central portion is only 2° bright, the remainder being, like the walls, 5° bright, and this peculiarity renders Campanus very readily recognisable. From eleven measures by Mädler, the central mountain of Campanus is in − 27° 36′ 50″ lat. and − 27° 27′ 1″ long. North of Campanus is the lofty mountain α, 5° bright, with the 7° bright crater A beyond it, in − 25° 36′ lat. and − 28° 3′ long., from which extends a mountain arm to Hippalus, whilst on the plain on the west is a kind of mountain-ring, ζ.

Kies (S.)—A ring-plain on the Mare Nubium, 27·7 miles in diameter, with 4° bright, gently sloping walls, at their highest point, α, rising only 2,443 feet above the surrounding plain, and on the west scarcely half as high above the interior, which is 3° bright, and crossed by a low ridge. From Kies extend some projections from the walls, only β on the south being of any length, and that, according to Schröter, 1,700 feet high. South is Kies A, a smaller but deeper ring-plain, with 6° bright high walls, on the south side increasing to 8° brightness, and with a small 8° bright crater on its outer slope, not seen by Schröter, though easily visible. From the east side of Kies A extends a straight ridge towards Campanus, ending in a small peak before reaching so far. Between Kies and A is a short shallow rill, ϕ, seen by Mädler, but not mentioned by Schmidt; whilst south of Kies A, extending towards the 3° bright small ring-plain *b*, are two short rills, ξ (S. 295) and ψ (S. 296), the first drawn by Schmidt as a crater-rill. East of Kies is the small crater C, in − 25° 36′ lat. and − 25° 50′ long., whilst on the west is the very similar 5° bright crater D, in − 24° 20′ lat. and − 18° 20′ long., united to Kies by a long ridge.

Bullialdus (R.)—The greatest and deepest of the ring-plains on the Mare Nubium, 38·45 miles in diameter, with broad, very much terraced walls, surrounded by a great number of irregular buttresses and arms, and rising at α 8,966 feet, and at ε 9,273 feet above the strongly concave interior; and at ε, from two measures by Schröter, 3,100 feet above the Mare Nubium, but according to Mädler, 4,847 feet. On the walls are some long valleys and several rows of crater-like depressions, besides several craters and round depressions. The interior contains a fine central mountain, rising into four peaks at least 3,000 feet high, the highest peak, β, being 6° bright, and, from nine measures by Mädler, in − 20° 25′ 56″ lat. and − 22° 6′ 11″ long. The floor of Bullialdus is 3°½ bright, the central mountain 5° bright, and the walls 5° bright, at Full the whole appearing like a pale grey round spot on the Mare Nubium. On the outer slope of the wall is the deep small ring-plain A, whose centre is in − 21° 44′ lat. and − 21° 0′ long., with 4° bright walls rising on the west 4,144 feet; it is, according to Mädler, connected with Bullialdus by a narrow ravine, which Schmidt does not draw; and on its floor is a small crater-pit, on the walls are two or three more, and on the west are two crater-rills according to Schmidt, but which appear to be rather rugged steep valleys. South is the very similar formation B, with 5° bright walls, rising 5,779 feet above the interior, and 2,731 feet above the outer plain, with a level interior, and a small crater on the south wall. From the walls of both A and B extend many projections on to the Mare, and though Schröter and Mädler draw B as larger than A, and Schmidt as being of the same size, B is slightly smaller than A, their diameters being 14·1 and 15·2 miles respectively. Bullialdus C is a still larger ring-plain, whose centre is in $-$ 23° 56′ lat. and $-$ 24° 11′ long., with a high 5° bright wall, according to Mädler double on the east, though apparently the second wall is only a very lofty terrace, and rising on the west 6,216 feet above the 3° bright level floor, and on the east, according to Schröter, 1,300 feet above the Mare. On the outer slope of C is a small crater on the south, and a crater-pit on the north, whilst west is a mountain rising 700 feet above the Mare. On the opposite side of Bullialdus is the peculiar crater D in $-$ 19° 15′ lat. and $-$ 18° 22′ long., at times scarcely visible, and at others as distinct as the last three, this variation arising from its east wall being three times as high and proportionately steeper than the west, rendering it in the increasing Moon only visible as a mountain, whilst in the waning Moon it appears as a fine crater with a marked shadow. The crater *e* is 8° bright, near some hill-chains; others here being only 5° bright, and one of the same dimensions is scarcely 3° bright. South of *e* is a short, perhaps doubtful, rill, ξ (S. 301), and south of D a longer, ϕ (S. 300), in portion a crater-rill

Mare Nubium (R.)—This great Mare is a little darker than the neighbouring Oceanus Procellarum and Mare Imbrium, but is a pure grey of different shades, without any tint of green as in the Mare Humorum. Towards the west, south, and south-east, it is bordered by considerable mountain regions; on the north by the hill regions of Lalande and Fra Mauro, forming two great bays, separated by the regions of Parry and Guerike, and on the east by the Riphaen mountains and the ridges from the southern extremity to the system of Agatharchides. A considerable portion of the surface is covered by isolated mountains and ring-plains, generally from 4° to 5° bright, the Mare itself being usually from 2°½ to 3° bright, only some portions in the west and east being as dark as 2°. The surface contains many long ridges, though they are not so numerous nor so considerable as on the western Mares, whilst in many places it is crossed by long light streaks, the two most considerable crossing Bullialdus, and Kies and Bullialdus C.

Hippalus (M.)—A great bay in the Mare Humorum, forming, with a similar one on the south, two-thirds of a great walled-plain, whose interior is full of small hills and mountains, usually 3° to 4° bright, the interior being only 2°½ and the wall 5° bright. The walls fall steeply, and contain many peaks, one of the highest being ε. West of Hippalus is one of the most remarkable rill systems of the Moon, comprising some of the finest lunar rills. In part discovered independently by Lohrmann and Mädler, the number of known rills here was increased greatly by Schmidt, and still later by other observers. Mädler denoted the position of the rill system he discovered by the Greek letters, but his nomenclature is now inconvenient, as different portions of what is now known to be the same rill were designated by different letters. Accordingly, for convenience the rills may be numbered from 1 onwards, with the distinguishing symbol Hippalus φ. The principal rill, 1 (S. 268), extends from the mountain region north of Ramsden A, near a mountain close to Vitello B, in a fine curve without interruption to the north border of Hippalus, a distance of 140 miles, and, reappearing beyond the border, extends in a fine valley to the peak ρ, on the border of Agatharchides. Its central portion is Mädler's Hippalus δ, and, according to Schmidt, it is in places a crater rill, and is interrupted by the mountain ridge Campanus ρ. The next important rill is 2 (S. 269), which commences at the crater Campanus g, crosses the ridge Campanus β, as two craters with a valley between, and disappears at the mountain south-west of Hippalus ϵ—this portion forming Mädler's Campanus ϵ—but reappears beyond, and after crossing several ridges ends on the south border of the imperfect walled depression Agatharchides n. The third chief rill, 3 (S. 173), commences at the same crater, Campanus g; breaks through the ridges Campanus ρ and β, being in this portion a crater-rill, and disappears at the east border of Campanus A, the rest of β being Mädler's Campanus γ. Mädler, Schmidt, and Gaudibert make it interrupted by A, but it appears to cross it much narrowed in form. Beyond A it again extends as a broad fine rill as far as the small ring-plain Agatharchides A, this portion forming Mädler's Hippalus ϵ; and at A, though drawn by Schmidt, Mädler, and Gaudibert as interrupted by the ring-plain, it appears to cross it also, though so very much narrowed as to be hardly perceptible. Beyond Agatharchides A the rill is deep and very distinct, ending apparently in a narrow valley east of the great mountain Agatharchides δ, its total length being 190 miles, and this last portion forming Agatharchides ζ. Schmidt makes it end here, but Mädler draws a rill, 4 (Agatharchides ϵ of M), which he considers a continuation, but which Schmidt regards as a separate rill, commencing in a valley east of that where 3 ends, and draws it as only short (S. 271), and considers Mädler's position misplaced. Lying in the shadow of δ it is difficult to make sure on this point; but Mädler's position seems to agree better than Schmidt's with the actual place of 4, which has a short branch about the centre, and is 40 miles long. The smaller rills in this system are more difficult, and some uncertainty attaches to their position. South-west of Agatharchides two cross each other—5 and 6; and on either side of 3 Schmidt has seen two short rills, 7 (S. 275) and 8 (S. 274). The very delicate rill, 9, only seen once, is perhaps doubtful, but Schmidt has drawn a rill near Campanus ζ, which may be a portion of it. Between 3 and 2, north of Campanus, is the very feeble rill 10 (S. 276)—Mädler's δ—and between 2 and 1 a still feebler, 11 (S. 270), whilst south of 3 is the deep well-marked rill 12 (S. 277). In his catalogue Schmidt mentions a rill (No. 272) whose assigned place and description are irreconcilable; for, stated to be west of 11, yet its position is put five degrees south, where no such rill appears.

Agatharchides (M.)—A considerable but very irregular walled-plain, with steep walls rising at H, ρ, and α to a considerable height, being at the peak ρ 3,683 feet, at α 4,495 feet, and at H probably still higher above the surface on the east, whilst at the south the wall appears more like an elevated plateau crossed by many deep valleys. Between Agatharchides and Hippalus is an elevated region containing many very considerable peaks, and falling on the east steeply to the dark Mare Humorum, the mountain β rising 3,700 feet, and λ 3,683 feet above the plain below. West of Agatharchides is a great irregular mountain ring, bordered on the west by the high mountain ridge δ, rising 2,826 feet above the surface, and appearing at times like a true walled-plain. East on the Mare Humorum are a number of small ring-plains, Agatharchides *d*, *i*, *h*, *k*, *e*, and *c*, mostly shallow.


40° East Longitude
South Latitude
Schickard
Drebbel
Lehmann
Lacroix
Bouvard
Clausius
Piazzi
Lagrange
Rook
Mountains
Lee
Vitello
Doppelmayer
Fourier
Vieta
Cavendish
Byrgius
MARE
HUMORUM
Hippalus
Mersenius
Eichstadt
De Vico
Agatharchides
Gassendi

CHAPTER XXI.

MAP XV.

Vitello (R.)—A very peculiarly formed ring-plain, with a 6° bright wall rising steeply on the east 5,100 feet above the Mare Humorum, and on the north-east 4,350 feet according to Schröter, and 4,642 feet according to Schmidt, whilst according to Mädler only from 2,000 to 2,500 feet above the floor, which must consequently be elevated considerably above the Mare Humorum. The interior, which is 3° bright on the south east and 4° bright on the north-west, is occupied by a 7° bright ring-plain, with a gently sloping wall, and a 7° bright mountain in the centre, according to Schröter, 1,700 feet high, and far surpassing the walls of the interior ring-plain in height, whilst from eleven measures by Mädler its position is $-$ 30° 0′ 26″ lat. and $-$ 37° 7′ 26″ long. Schmidt draws a small crater-pit on the inner north-east wall and another on the central peak itself. South of Vitello extends a broad only $2°\frac{1}{2}$ bright valley, with a small double ring-plain on the interior, and bordered by high mountains. Towards the south it is narrowed by the two mountain masses β and γ, the surface of the valley being here only 2° bright, but then becoming gradually brighter, and after passing the ring-plain Ramsden D, opens into a grey plain south of this. The border on the west consists of a great plateau crossed by several deep valleys and containing a number of crater-like depressions arranged in rows and groups, but the only formation of any depth is the small ring-plain B in $-$ 30° 54′ lat. and $-$ 35° 6′ long., from which extends a deep dark valley to the Mare Humorum. On the east side the border of the dark valley south of Vitello consists of a much lower plateau with a steep crest on the west and north, and a high peak at A in $-31° 59'$ lat. and $-38° 39'$ long., and a still higher at ϵ, whilst beyond are the two ring-plains Vitello *d* and A, with north the two similar *c* and *h*. North of Vitello, on the grey Mare Humorum, is the 5° bright crater F in $-27° 59'$ lat. and $-36° 23'$ long., and the $5°\frac{1}{2}$ bright crater E in $-28° 54'$ lat. and $-35° 27'$ long. On the border of the Mare Humorum rises the peak λ, projecting as a cape into the Mare, and 4,860 feet above the grey plain, with south-east of it μ, equally steep, and 2,916 feet high, east of which is a wide dark valley, ι, penetrating deep into the southern bright highlands.

Lee (B.)—A walled-plain on the south-east border of the Mare Humorum, lying between Vitello and Dopple-mayer, with, on its south and east, the steep high crest of the plateau east of Vitello for a wall, rising at ζ and η into high peaks, whilst on the west and north the wall is low and in places broken down. The dark interior contains many hills and a small central peak. East of Lee is a highland crossed by many deep rill-like valleys, the principal, Lee *e*, opening into the dark-grey plain beneath the steep peak Lee γ.

Doppelmayer (S.)—A great walled-plain with a wall of very unequal height and brightness, being on the south-west low and 4° bright; on the south-east higher and 6° bright; on the east still higher but not so bright; towards the north dwindling down to a few isolated hills, while on the west it seems to have quite disappeared; but close examination shows a slight fall from the level of the Mare, whilst there are indications of the existence of a very gentle slope from the crest of this fall towards the Mare Humorum. The western half of the interior of Doppelmayer is only 2° bright, but the eastern is 4° bright, and in the centre is a fine central peak, A, in – 28° 0′ lat. and – 41° 9′ long., and 2,437 feet high. West of Doppelmayer is the very shallow ring-plain *c*, about 9 miles in diameter, with a 4° bright wall and 3° bright interior, but only visible with considerable difficulty, being far less distinct than the surrounding small crater-pits. Beyond, on a ridge crossing the Mare Humorum, is the fine 7° bright crater Doppelmayer D, $2\frac{1}{2}$ miles in diameter and with steep walls that on the east rise 678 feet above the Mare ; and north of it is the small 6° bright crater Doppelmayer E, near the centre of the Mare Humorum, and in – 24° 25′ lat. and – 37° 41′ long. ; with still further north Dopplemayer F, in – 23° 6′ lat. and – 38° 29′ long., only $5°\frac{1}{2}$ bright. Doppelmayer has on its east several small ring-plains, the deepest being, perhaps, **a** ; and on the border of the Mare Humorum, north of this, extends a fine rill, Doppelmayer ϕ (S. 250), interrupted by a small ridge, and towards the north crateriform in character, its entire length being 80 miles. Beyond **a** is the fine steep 8° bright crater Doppelmayer G, in – 27° 56′ lat. and – 44° 54′ long., whilst north-east is the great 6° bright mountain peak Doppelmayer α, towering 10,014 feet above its eastern foot, though not very steep.

Mare Humorum (R.)—One of the smaller Mares of the Moon, extending from – 17° to – 31° lat. and from – 28° to – $45°\frac{1}{2}$ long., or a distance of 263 miles from north to south and 286 miles from east to west, with an area of 50,000 square miles, but though thus nearly circular it appears strongly elliptical from the great foreshortening. Although not equally well bordered throughout, the Mare Humorum appears one of the sharpest and most distinctly bordered of the dark-grey plains, and is easily found under all illuminations, whilst to the naked eye it is only surpassed in distinctness by the somewhat larger and darker Mare Crisium. Like the other grey plains, it is traversed by a considerable number of ridges, but all, without exception, are feeble and difficult to see, from their very gentle slopes and small height; and similarly with the craters, which are shallow and scarcely visible, and easily distinguished from the still smaller though deeper craterlets, which in Full appear as from 5° to 6° bright minute white spots. The greater portion of the interior of the Mare Humorum was discovered by Mädler to be distinctly tinged with a dusky green, and under favourable conditions this is very marked, affording a strong contrast with the purer grey of the borders and high ridges. The general brightness of this green portion of the Mare is 3°, and on the west it extends nearly to the border of the Mare, but elsewhere, as in the Mare Serenitatis, is separated from the border by a narrow darker grey fringe, though towards the north-west the two merge insensibly one into the other. Mädler considered it doubtful whether the ridges possessed this greenish tint, as very few were distinctly visible in high illumination, and the tint is too dim to enable a decision to be arrived at satisfactorily in small spaces; but he considered it certain that the white craterlets were quite free from it, and it would appear that so are the few high grey ridges which can be distinctly seen. The ridge extending from Vitello to Dopplemayer D is the highest on the Mare, rising at δ 716 feet, though the average height is scarcely 300 feet, whilst the branches from D to Gassendi and I, are perhaps barely half this height. The ridges west of these are still lower, and only visible with considerable difficulty, and on the eastern portion of the Mare are even more inconsiderable, though by no means absent. Towards the centre of the Mare Humorum are very considerable numbers of minute crater-pits, and a number of smaller but brighter and deeper craters, though from their minuteness it is often difficult to distinguish between the two, and this is seldom possible near the terminator. North of Vitello is a very small 4° bright mountain peak, χ, entirely isolated, and still farther north a fine 4° bright triangular plateau, with steep high sides and crowned by three fine peaks, 5° to 6° bright, while its south side is indented by a deep bay containing a crater-like formation. Of the peaks on this plateau Hippalus α rises 6,075 feet above the western plain; Hippalus μ 6,209 feet above the eastern plain, whilst the still steeper peak Hippalus B, in − 25° 47′ lat. and − 32° 30′ long., though the brightest of all, is only some 4,000 feet high.

Mersenius (R.)—A great ring-plain, 41·5 miles in diameter, with broad terraced walls, not so steep as usual in similar formations, and rising on the south-west 5,806 feet according to Mädler, but 7,386 feet from six measures by Schmidt, above the interior, and on the north-east 7,699 feet above the interior according to Mädler, and, from two measures by Schmidt, 4,253 feet above the eastern surface; thus making the floor of Mersenius 3,000 feet below the plain on the east, but probably from the known height of this, as high above the Mare Humorum. On the walls are a number of craters, and a small ring-plain on the south-east; and the strongly-convex 3°½ bright floor in the centre is perhaps 1,500 feet higher than at the foot of the walls. Schröter saw several minute craterlets on the interior, and three hills, but gives no drawing. Lohrmann drew one crater, Mädler another—at the foot of the west wall; Schmidt draws twelve, and two very short rills (S. 266 and 267) extending from the east wall, and described as very difficult; but Webb regards this drawing as unsatisfactory, and the craters drawn were those seen during 1874-1875. The crater *n* is the most distinct, and *m* next; ρ is a small mound, and between ρ and *n* extends a shallow rill-like valley, first seen by Gaudibert, who has also observed some mounds along the west of the interior.

North of Mersenius are the two great 9° bright crater-plains, B, in $-20° 25'$ lat. and $-50° 56'$ long., and C in $-19° 19'$ lat. and $-45° 42'$ long., and the two most conspicuous objects in this region in Full, Mersenius itself being then scarcely distinguishable. North-west towards Gassendi extends a broad high plateau, descending steeply towards the Mare Humorum; it is much branched towards the north-east, and contains some very lofty peaks, the highest, Mersenius α, rising 10,014 feet above its east foot, whilst beyond is the 9° bright peak Gassendi A, in $-18° 7'$ lat. and $-43° 21'$ long., and west of this are three crater-like depressions not seen by Mädler, whilst east of A rises the peak Mersenius χ, 5,371 feet above the plain on the east. West of Mersenius extends a long line of high mountains, rising, according to Schmidt, at *z* 6,561 feet, ten miles south 6,650 feet, and fifteen miles farther south 5,329 feet above the plain on the west, which, according to his measures, is elevated fully 2,000 feet above the Mare Humorum. Along this broad terrace or highland extend some remarkable rills, the most distinct being Mersenius ε, extending from Mersenius α to the ring-plain Mersenius *d*, which it crosses, according to Schmidt, though interrupted by the wall. Next is Mersenius β (S. 245), in reality only the continuation of the great rill Gassendi ϕ, whilst between the two is the small rill ζ, in its southern portion a crater-rill (S. 246), whilst west of ε is the short crater-rill η (S. 247), discovered by Schmidt. On the border of this terrace is a very anomalous rill, ϕ (S. 248), that often appears not entirely as a rill but as a ridge (which Schmidt thinks it is in part), and, commencing near Gassendi, ends near Mersenius *g*; but its true character must be considered doubtful. East of it is the very delicate rill ξ, crossing four crater-pits, and between it and ϕ Schmidt draws a winding rill, which is of very doubtful character, whilst west of Mersenius *d* is another short rill, probably the continuation of η, and east of the southern end of ϕ Schmidt has seen another (S. 249). South, the immediate eastern border to the Mare Humorum is formed by the small ring-plain *g*, and two ridges, perhaps 1,500 feet high, on the north and south of it; on the former being the deep crater Mersenius F, 6° bright, in − 24° 23′ lat. and − 45° 35′ long., and it forms the border to the broad terrace-like plateau already mentioned, on which here rises the small ring-plain *d*, whose west wall rises 6,702 feet above this plateau, and the east wall 3,165 feet above the interior, and is united by a mountain arm to Mersenius. Beyond these, however, on the east, rises a magnificent mountain mass, whose broad summit is broken by two small ring-plains, and abuts at its end on the fine ring-plain Mersenius **a**. The steep walls of **a** rise on the west 7,654 feet according to Mädler, but 6,746 feet according to Schmidt, above the interior, and the east wall 4,336 feet according to Mädler, but 6,113 feet from four measures by Schmidt, above the bright eastern plain, whilst on the west the wall towers, according to Schröter, 13,600 feet, and according to Schmidt, 13,876 feet above the Mare Humorum. The interior of **a** from these measures must be therefore 6,000 feet higher than the Mare Humorum, and the bright plain between Cavendish and Mersenius over 7,500 feet higher than the grey Mare Humorum. Farther south the mountain arm extending from Mersenius **a** is also very lofty, rising at λ, from Mädler's measures, 9,707 feet above the east plain, and from three of Schmidt's, 9,312 feet, though, according to the last, from two measures, it is only 11,708 feet above the Mare Humorum, whilst at Mersenius μ it rises, from seven measures by Schmidt, 10,966 feet above the eastern surface, and according to Schröter, 16,127 feet above the Mare Humorum. In the bright plain east of Mersenius **a**

Mädler discovered a delicate rill, ψ (S. 264), and Schmidt has seen two short rills extending from the north-west wall of Mersenius **a**, the southernmost a rill (S. 260), the northern one is perhaps merely a valley.

Cavendish (M.)—A fine ring-plain, 32·2 miles in diameter, with a high wall broken by deep passes rising on the east 7,181 feet, on the west at β 4,675 feet, and on the south at α at least 6,000 feet above the interior. Beneath the peak α is a small ring-plain, *e*, remaining partially visible in Full, though Cavendish is not; only the small crater A in − 23° 50′ lat. and − 52° 0′ long. being then visible. The interior of Cavendish is nearly level, though crossed towards the east by a low curved ridge. South-west is the ring-plain Cavendish *d*, with a narrow wall not 1,000 feet high, and crossed by at least one distinct rill. This rill, ϕ (S. 262), commences at the east wall of Mersenius **a**, and though interrupted by both walls, can be seen crossing the interior of *d*; and, emerging on the other side, ends at the mountain arm, Cavendish γ. North of ϕ is the more delicate curved rill ζ (S. 263), crossing the rill Mersenius ψ, and ending at the east border of *d*, whilst south is the deeper rill ξ (S. 261), generally easily seen. Schmidt has suspected a short rill crossing the southern portion of the floor of Cavendish *d*, and east has seen a very delicate rill, η, crossed both by ϕ and by another rill, θ—perhaps the continuation of ξ. North-east of Cavendish is the great ring-plain B, 22·1 miles in diameter, with a bright wall rising on the west 6,893 feet above the interior, which contains a broad ridge. Beyond is Cavendish C, after Vieta the deepest ring-plain in this region, its west wall rising 10,123 feet above the 4° bright interior, which contains a small central mountain. Both B and C can be seen in Full, their walls being 5° bright and visible in the 4° bright region they are situated in.

North-west of C is a broad, very difficultly visible, plateau, δ, with very gently sloping sides.

Byrgius (R.)—A walled-plain with a very unconnected border, rising on the east 6,945 feet above the interior, and probably as high on the west, though nearly open on the south and north, whilst through the interior extends a low ridge. On the west border is the deep crater-plain Byrgius A, with high steep walls 9° bright, and, from ten measures by Mädler, in $-$ 24° 23′ 43″ lat. and $-$ 63° 30′ 5″ long. Byrgius A is surrounded by a brilliant nimbus formed by the union of a great number of bright light streaks radiating from the crater-plain, the distinctness and visibility of which light streaks is greatly influenced by variations in libration, the more so from the fact that their general direction is eastwards. Towards the west extend only two 5° bright streaks through a 4° bright region—one towards Cavendish and the other extending in a bold curve through Cavendish C to Mersenius, where it ends. The streaks towards the north-east and east are very numerous, and from 6° to 7° bright. The principal portion of the interior of Byrgius falls within the nimbus of Byrgius A, and is consequently invisible. West is the small ring-plain B, with a small craterlet on its east wall, and a very slight central peak in $-$ 24° 3′ lat. and $-$ 60° 22′ long., but not to be seen in Full. Byrgius *e* is an 8° bright crater on a broad plateau north of Byrgius, and *d* is a small ring-plain only distinct near the terminator, whilst *c* is a deeper ring-plain, also invisible under high illumination. North of *d* extends one of the finest mountain arms on the Moon, with a broad summit containing several peaks and with steep slopes, and whose general elevation of about 10,000 feet culminates in the great peak α, over 13,000 feet high. East is the triangular depression *b*, and from the steep peak ζ extend some mountain arms towards the north, enclosing with the great arm α a considerable plain, appearing at sunrise like a vast walled-plain. Extending through Byrgius as far as Lagrange *c*, Schmidt thought he had discovered a continuation of the great rill of Sirsalis. The southern portion, with its union with the end of the great rill of Sirsalis, however, was distinctly seen in 1875, though it is a very delicate object, and may be considered as Byrgius ϕ (S. 219). The great mountain arm by Byrgius α appears to have interrupted a very delicate rill, η, which, extending at nearly right angles from the rill Sirsalis ϕ, disappears on the west side and reappears on the east side of the arm, and turning, sharply at a ridge, runs south. North of this branch extends a short rill from Sirsalis ϕ, both these having been discovered by Gaudibert; whilst farther north extends another delicate rill to the mountain arm by Byrgius α—probably Schmidt's No. 225; and farther north still, in the open plain east of De Vico **a**, is a sharply marked rill, Byrgius ψ (S. 224). Crossing the southern foot of the great mountain arm north of Byrgius *d*, Schmidt has seen a short rill, ζ (S. 231), but this is more like a deep valley.

Eichstädt (R.)—A regular ring-plain, 32 miles in diameter, whose centre, from three measures by Mädler, is in $-$ 21° 39′ 1″ lat. and $-$ 77° 17′ 7″ long.,[1] with, like the smaller ring-plains, a nearly level interior and gently sloping walls. West of Eichstädt, in the centre of what appears to be the walled-plain east of Byrgius α, rises the considerable peak Eichstädt *B*, from seven measures by Mädler, in $-$ 20° 31′ 15″ lat. and $-$ 70° 27′ 9″ long., east of which is the higher peak δ, and three small ring-plains, Eichstädt *c* being the deepest, two of these being on the western slope of the considerable mountain ridge extending from the east of

[1] In the catalogue of measures and list of results the position here given to Eichstädt and Eichstädt *B* are reversed, but in the text and map they correspond with those above.

Byrgius to Crüger A. South of Eichstädt is the mountain α, at least 6,000 feet high.

Rook Mountains (S.)—A great range of mountains upon the limb, extending at least from $-18°$ to $-35°$ lat., and, united in some degree with the Corderillas and D'Alembert mountains, form part of a great range, in size and height rivalling the highest mountains of the earth; rising in places, according to Schröter, 16,000 to 25,000 feet above the surface.

Lagrange (M.)—A very extensive walled-plain, nearly 100 miles in diameter, bordered on the west and east by tolerably steep and high mountains, but on the north and south enclosed by low ridges and peaks. On the west wall is a small but distinct crater, A, in $-31° 34'$ lat. and $-67° 40'$ long., south of which is a distinct pass in the wall; whilst at *k* is a wider gap in the walls. *B*, in $-34° 39'$ lat. and $-69° 41'$ long., and α on the east wall, are probably the two highest peaks,and are both over 6,000 feet in height. The entire interior has a uniform brightness of $3°\frac{1}{2}$, but is covered with a considerable number of long ridges, containing some high peaks, as at δ and ε; whilst there are also several small crateriform objects, *d* being the most distinct. North of Lagrange is the small walled-plain *e*, with high walls and a level interior, west of which is the small ring-plain *c*, surrounded by still smaller ones, and south-west the 7° bright crater Lagrange *b*. South and east of Lagrange are a considerable number of high mountain ridges, having at γ a lofty peak, and forming at **a** a very irregular walled-plain, north of which is the steep bright mountain *f*.

Bouvard (M.)—A walled plain, in size nearly equal to Lagrange, but resembling Schickard in the great complexity of its wall, though the details of its constitution can only be seen with difficulty, from its being situated in $-80°$ long. The walls at times appear almost in profile, and are at least 6,000 feet high, rising at the points δ and β from 8,000 to 10,000 feet, whilst the central peak must also be of very considerable height. Bouvard is surrounded by numerous mountain ridges, containing some high peaks—as Bouvard α; and on the south is Bouvard *b*, a smaller but similar walled-plain to Bouvard, with several craters on its wall; whilst close to *b* is the deep, but small, ring-plain Bouvard *e*.

Piazzi (M.)—A walled-plain, smaller than Lagrange, but better enclosed, and, like it, with a $3°\frac{1}{2}$ bright interior, containing some long ridges, whilst the terraced walls rise from 6,000 to 7,000 feet, and are $4°\frac{1}{2}$ bright. The central peak, Γ, is in $-34° 40'$ lat. and $-65° 25'$ long., and, like the two peaks α and β, is of some steepness. Around Piazzi are a number of ridges, steepest and highest in the east; and south is the deep 7° bright ring-plain *c*, with three considerable 5° bright mountain arms extending from it. Piazzi δ is a 6° bright high mountain, from which extend several mountain ridges, one reaching the 6° bright crater *f*, north of which is another ridge. The two craters A and *b* are both 5° bright, with steep walls, and easily visible, except under very high illumination.

Vieta (R.)—A magnificent ring-plain, 51 miles in diameter, surrounded by steep, broad walls, in most portions with a double crest, rising on the west 8,805 feet above the interior, but containing, at ε, a fine lofty peak 10,705 feet high, and forming at δ a magnificent mountain peak, towering fully 14,625 feet above the plain below, and highly illuminated long after the rest of the great ring-plain has disappeared in the shades of night. The east wall, though without the great peaks of the western wall, is lofty and steep, and with broad terraces, while the crest of the wall is fully 9,000 feet above the interior. The floor of Vieta is comparatively level, containing only a moderate-sized central peak, with a small hill on each side, and a craterlet on the east, with, south-west of the central peak, three valleys or rills, discovered by Schmidt, the central one being easy (S. 257–259). Vieta A and B form a double ring-plain of the same description as Sirsalis and Steinheil, the westernmost, A, being the principal and deepest, its wall rising in a fine peak at γ, whilst B has a lower wall, and its interior lies at a higher level than that of A, and neither appear to contain any marked irregularities. North of Vieta is a bright region, comparatively level, and forming one of the class of bright lunar plains; for though it contains a number of considerable mountains, and still more small hills and ridges, the surface is scarcely more disturbed than in many portions of the lunar dark-grey plains or Mares. From Fourier *c* to Cavendish extend several broad plateau-like elevations, scarcely 650 feet high at the highest point. A wider plateau, μ, lies north-east of Vieta, connected with it by several ridges, and from which, on the north, extend a series of ridges and low mountains to Cavendish C. A similar system of mountain ridges extends from Vieta B to Byrgius B, in a bold curve, and are united to a branch of the plateau μ by the fine mountain Vieta β, which, rising 4,500 feet above the surface, is the highest in this region. South of Vieta the mountains are higher, steeper, and better connected, one great mountain ridge extending from Vieta as far as Lehmann, a distance of 190 miles, and by Fourier γ, rises 7,341 feet above the eastern plain. East is the broad high mountain plateau, Vieta λ, with an irregular summit and some lofty peaks.

Fourier (M.)—A considerable ring-plain, 30·4 miles in diameter, with a terraced wall rising, on the east, 6,030 feet above the interior, and 5,096 feet above the outer surface, whilst, on the west, the peak α is 9,465 feet high. Fourier is surrounded by a level region, and on the south is a short rill, ϕ (S. 255), with the exception of a few low mounds, the only irregularity. North, towards Vieta, is a double crater, and north-west, towards Cavendish, is a group of seven great craters, the principal, *d*, being 8° bright, *e*, 6° bright, *c* and the two south 5° bright, and the other two only 4° bright, far less deep, and apparently ruined. North-west of this group are two other groups of smaller craters, connected by sharply-marked mountain plateaus. West is the great ring-plain Fourier a, with low walls, but remarkable for its only 2° bright interior—an anomaly here—which is crossed by a very delicate, almost doubtful, rill, once seen by Schmidt. North-west of it is the still larger ring-plain Fourier *b*, with a steep wall, and a 7° bright crater on its south-east exterior slope. The interior of Fourier is crossed by a rill, Fourier ξ, commencing at the inner south-east wall, breaking through the opposite west wall, and ending by the small plateau Fourier δ, and was in portion seen by Schmidt (S. 253); whilst near the centre of the floor is, according to Schmidt, a second rill, ψ (S. 254), perhaps doubtful, however ; lastly (S. 256) is only a portion of ξ. West of Fourier *b* are two short rills, both discovered and seen only by Schmidt (S. 251–252). South of a is Fourier *d*, a small ring-plain, with a central peak, with some still smaller ones near ; whilst beyond is Fourier A, a slightly larger and deeper ring-plain, in $-$ 31° 47′ lat. and $-$ 47° 42′ long. East of A is the great plateau ε, with steep sides, much indented, connected by a broad mountain arm with *d*, and by a long ridge with the plateau containing Lehmann α. South of ε, is a fine, almost absolutely level, bright plain.

East of Fourier is the great mountain ridge extending from Vieta to Schickard, and rising at Fourier γ 7,341 feet ; and beyond the second arm of this ridge is the very marked curved mountain Fourier B, 7° bright, from ten measures by Mädler, in $-$ 32° 40′ 50″ lat. and $-$ 56° 49′ 40″

long., and surrounded by a dark-grey plain, which, close to B, on the east, is only 1° bright, thus rendering the mountain very distinct in Full. Beyond B extend several branched mountain ridges, commencing at the great mountain mass Vieta λ, and ended by Lacroix.

Lacroix (N.) [Lehmann *b*, M.]—A regular ring-plain, 20 miles in diameter, on the west border of the bright plain extending from Piazzi to Inghirami, with steep, moderately high walls, and a strong central peak. West of Lacroix is a high mountain arm, rising at α into a lofty peak, and with another peak almost as high at β. West is the peak γ, and north a small, moderately bright crater, Lacroix A; west of which is the lofty rounded mountain δ, these four peaks being all perhaps over 7,000 feet high. East of Lacroix is the small double ring-plain *f*, and the larger and deeper *e*, on the bright plain south of Piazzi.[1]

Lehmann (M.)—A considerable, deeply-depressed plain, surrounded by an imperfect wall, formed of groups of steep and high mountains, the two most distinct of which are γ and β. The interior is level, and communicates by two deep valleys with Schickard. West is the great mountain δ, steep and high, forming the southern point of a lofty broad plateau, rising at the peak Lehmann α, 13,179 feet above the low dark-grey valley *e*, on its east, which, through the southern rounded valley *f*, opens into the interior of Lehmann. West of the plateau containing the lofty peak α, is the bright small ring-plain *c*, on the border of the level bright plain south of Fourier ϵ.

Clausius (N.) [Drebbel, A. M.]—A fine ring-plain of small dimensions, with 5° bright steep walls, of some height, broken on the south by a crater, and on the north by a

[1] These formations are not referred to by Beer and Mädler in the 'Der Mond,' though some are lettered in their map, but probably come under the general designation of Lehmann.

still smaller one, both 6° bright; whilst the 4° bright interior contains a very delicate central peak. West and north of Clausius is a fine open dark-grey plain, only broken by a few low peaks and crater-pits; beyond this is the 6° bright mountain α, containing a dark crater-like depression on its summit; and on the west border of the dark plain are the three ring-plains Clausius *f*, *c*, and *b*—the first of little depth, but with a 6° bright crater east of it; the second deeper, and 5° bright; and the third of irregular form, containing a 5° bright peak, ϵ, and two small craters on the wall, that south of ϵ being 6°½ bright. West of Clausius are three steep mountains, α, γ, and β. (On the 'Mappa Selenographica' these formations are lettered, but no reference is made to them in the 'Der Mond;' probably those on the west are Ramsden *f*, *c*, and *b*, and those on the east Drebbel β, γ, and α.)


East Longitude
South Latitude
Doerfel
Mountains
Bailly
Wilson
Kircher
Bettinus
Zuchius
Hausen
Scheiner
Segner
Weigel
Rost
Pingré
Phocylides
Schiller
Bayer
Longomontanus
Wargentin
Inghirami
Wilhelm I.
Schickhard
Hainzel
Drebbel
Lehmann
Heinsius
Bouvard
70°
60°
50°
40°
20°
30°

CHAPTER XXII.

MAP XVI.

Drebbel (M.)—A very distinct ring-plain, 18 miles in diameter, with 6° bright walls of considerable height, surrounding a 4° bright interior, whose centre, from ten measures by Mädler, is in $-40° 47' 21''$ lat. and $-48° 12' 59''$ long. Between Drebbel and Schickard is a narrow 4° bright plain, gradually darkening in tint towards the south, and east of it rises the steep peak Drebbel ε, 6° bright, and 4,310 feet high. West of Drebbel is δ, a very lofty peak, which overshadows Drebbel for some time after sunrise. On the north extend low arms to some moderately high peaks, one, α, being over 2,000 feet high, whilst another peak of nearly equal height is south of Drebbel *d*, on the easternmost ridge; north of *d* the ridge becomes a chain of depressions, extending nearly as far as Lehmann *c*, with, on the west, a circular dark spot, *e*, like the interior of a ring-plain, but without a perceptible wall on the east and north. West of Drebbel the bright plain contains a number of short ridges and low mountains, β being the highest, and west of which are three craters in a row, *h*; whilst farther south are the two small ring-plains, Drebbel *f* and *g*. East of the last is another mountain, γ, nearly as high as β, with a difficultly visible crater-like formation on its slope; whilst north of *f* is the deep bay or imperfect ring-plain, *c*, with a small peak close to it on the south.

Schickard (R.)—A magnificent walled-plain, one of the largest on the Moon, having a length from north to south of

134 miles, and a breadth of nearly as much, and though tolerably circular in general outline, has in places considerable irregularities in form. The wall is very complex, consisting of numerous peaks, terraces, plateau-like arms, isolated mountains, and deep crater-like depressions, separated by long valleys, and crossed by a great number of ravines and passes, rendering the whole formation so complicated as to make its drawing a work of very great difficulty. The peak α is steep, and, with nine others, encloses a rounded valley, connected by a narrow ravine with the interior of Schickard; but this formation must not be confounded with the crateriform depression close south of it. By the high peak β the mountains and ridges are arranged in rows, and somewhat regular groups, and, south, a branch from the peak γ encloses the dark depression *e*, whose interior is only $1^\circ\frac{1}{2}$ bright. East is a broad plateau, crowned by two craters—*f*, on the north, being deepest; and, separated from this by a fine winding valley, is the similar plateau, δ, uniting the walls of Schickard and Phocylides *b*. On the east wall is the distinct peak, ε, from which, across the floor, extends an easily visible ridge towards δ, and north of ε the wall becomes more closely united towards the interior, though its outer slope is crossed by some fine rill-like valleys, the principal being ζ, η, and θ. Two valleys on the north connect the interior of Schickard and Lehmann, and south, at *i*, are a number of rounded peaks on a level plateau. The general elevation of the wall of Schickard is not considerable, being only about 4,000 feet on the west, and slightly more on the east, but at some points on the wall rise lofty peaks, α having a height of 9,516 feet, β of 8,371 feet, and γ of 5,947 feet above the interior.

Mädler drew twenty-three craters and crateriform objects on the walls of Schickard, and considered these scarcely one-half of those which would be visible were its position more favourable; but the greater number of these belong to the class of miniature ring-plains, and the rest are rounded valleys.

The interior of Schickard is remarkable for its peculiar variations in shade, the entire area of 13,000 square miles being divided into equal areas—dark grey near *b*, only 1°½ bright, and in general only 2° bright, whilst the other half is a light grey, fully 4° bright near the centre, and only becoming as little as 3° bright near *c*. The border between light and dark appears sharply marked, but is free from any perceptible differences in level, and the brighter portion extends in long arms deep into the darker portion on the north. On the floor of Schickard Mädler draws four small ring-plains; a and *d*, only 4° bright, are scarcely visible in Full, and *b* and *c*, both 6° bright, and fairly distinct, whilst, from the steepness of their walls, they approach nearer the class of craters; the only other formations drawn, besides a few ridges, being the small crater or crater-pit *m*. Schröter saw, however, two other distinct craters, of the same class as *m*, on the northern portion of the interior, *n* and *p*, with, south of the last, an irregular depression, and south of what was probably Mädler's formation, a small mountain peak.

Inghirami (M.)—A ring-plain, 60 miles in diameter, with walls 4° bright, and clearly terraced towards the interior, rising, at β, 12,213 feet, and at α probably still higher, above the floor, which contains two craters and some ridges, besides a small central peak. From the entire uniformity of its walls and interior with the brightness of its environs, Inghirami, though one of the deepest ring-plains of this region, is invisible in Full. Surrounding Inghirami are a considerable number of small ring-plains, and northwards extend some considerable mountain ridges towards Lagrange, enclosing the ring-plain *c*, whilst east of this are some others, formed probably in the same way, *d* being the deepest. On the west is the ring-plain a, with a considerable central peak, and south-west of Inghirami is the very extensive walled-plain *b*, with a nearly perfectly-level interior, and very low walls.

Wargentin (S.)—A very peculiar formation, consisting of a high, nearly circular, plateau, 54·27 miles in diameter, with a gently sloping side, and scarcely any fall towards the interior, as it possesses only a very narrow and low rim all round, which soon disappears after sunrise; and then the whole appears like a round pedestal, or, according to Webb, like a large thin cheese. On the north-east Wargentin rises 1,484 feet above the level plain beyond, and on the surface both Schröter and Mädler succeeded in detecting some very delicate ridges, only visible for a very short time.

Wargentin being only of the same brightness as its environs, 4°, is quite imperceptible in high illuminations. East of Wargentin Mädler draws a long valley, δ, which, according to Schmidt, is a crater-rill (S. 341); and north of this is another crater-rill, ψ (S. 342), with, north of Wargentin *b*, a short rill, ϕ (S. 343).

Phocylides (M.)—A walled-plain of considerable size, only indistinctly visible in Full, with 4° bright walls—in portion double—containing many terraces, buttresses, and peaks, rising at α 8,793 feet above the interior, and at γ, from three measures, 6,005 feet. The interior is almost completely level, being only broken by the small ring-plain N, and is divided by a cross wall into two portions, the northern portion, *b*, being about 1,500 feet higher than the southern. The northern portion, *b*, is $3°\frac{1}{2}$ bright; the southern portion varies from 4° on the north to $3°\frac{1}{2}$ on the south, whilst the walls, the interior of the walled-plain *c*, and the entire environs, are 4° bright, so that in Full little trace of Phocylides appears. The ring-plain E is 5° bright, the ring-plain *f* 6° bright, and they are seldom both distinctly visible at the same time; possessing, moreover, an apparent difference in constitution, *f* being a regular ring-plain, and E seeming to be a rounded valley with walls much higher than those of *f*. From five measures by Mädler, the centre of E is in − 54° 34′ 48″ lat. and − 55° 34′ 35″ long. The western plain is broken by a group of distinct ring-plains, *d* being the largest and G perhaps the deepest, whilst *i* is merely shallow, and *h* and its neighbour small. South of Phocylides is the deep distinct crater-plain A, in − 53° 40′ lat. and − 48° 28′ long., surrounded by an irregular surface containing several craters, and with, west on the plain, a number of crater-pits. Between Phocylides, Schiller, and Segner, there are many small hills, often grouped into chains, but seldom 300 feet high, and only visible in powerful telescopes. East of Phocylides are a number of low ridges and small ring-plains, seldom to be seen distinctly.

Schiller (R.)—An elliptical ring-plain, whose longer axis from north-east to south-west is 112·64 miles in length, though the breadth never exceeds 65 miles; with very steep, well-connected walls, of very unequal height, containing many peaks and some craters and rising at α, where some terraces exist, 12,635 feet above the interior and 8,563 feet above the outer surface, and at β 6,004 feet above the eastern plain; whilst on the west the wall is probably as high, if not higher, than at α. The interior is nearly level, as only towards the north are there some low hills and a long mountain ridge with three peaks, γ. On the south-eastern side of Schiller are a great number of low hills and some minute ring-plains. Schiller A is a small ring-plain in − 46° 40′ lat. and − 36° 30′ long., near some ridges and mountains; and between it and Schiller is *b*, a similar but shallower formation. Schiller C is a ring-plain on the open plain south-east of Schiller, with two high steep peaks on the south-east and north-east, and on the south the wall widens into a low plateau containing some low peaks, whilst the interior contains four hills in a row.

Bayer (R.) —A nearly circular ring-plain, 29·32 miles in diameter, with broad walls, containing two craters, and rising on the west 8,070 feet above the interior, which contains a small crater, G, in – 51° 36′ lat. and – 34° 40′ long. Around Bayer are a great number of mountains and ring-plains, separated by the bright open plain. North extends a long ridge to Schiller A, rising at the peak Bayer α to a considerable height—perhaps 7,000 feet; and west of this is the plateau Bayer η. The two deepest and most distinct ring-plains west of Bayer are *f* and A, in – 51° 6′ lat. and – 29° 11′ long., the two being connected by a long mountain ridge commencing near the irregular ring-plain *e*, passing by *f*, and the larger but shallower *h*, round to A, whence, extending in a long curve past the irregular-shaped ring-plain C, it rises by γ to a height of 1,300 feet, and ends at the small ring-plain κ, enclosing twenty-two craters in the irregular space, according to Mädler. Beyond, in the far west, is the deep small ring-plain B, in – 48° 32′ lat. and – 27° 27′ long., with near it the imperfect ring-plain *d*, open towards the north.

Weigel (S.)—A small, deep ring-plain, with steep high walls and a level interior, surrounded on all sides by numerous craters and some crater-pits, with north-west the very small ring-plain A, east the far deeper *b*, and north-east the imperfect rounded valley *d*. From the north of Weigel extends a mountain arm to Schiller, rising at the peak Weigel α 6,229 feet above the plain on the east, and at β 4,202 feet high.

Segner (S.)—A circular ring-plain, 46 miles in diameter, with a narrow wall of an average height of about 4,000 to 5,000 feet above the interior, but rising at the peak α 6,401 feet above the outer surface, and at β 8,115 feet above the floor, which contains an easily-found crater and a difficultly visible mountain and ridge. North are the two small ring-plains A and C, the last with a steep peak, γ, on the south, and a shallow ring-plain on the north ; whilst beyond, on the open plain, appear a considerable number of low hills, only visible near the terminator, when the plain appears darker than at Full. This bright plain forms one of the number of its kind on the Moon, and though all of only moderate dimensions, are yet as large as some of the smaller dark-grey plains, though very easily overlooked. Segner B is a deep ring-plain, darker than its environs, and united to Segner by a ridge.

Hausen (S.)—A considerable ring-plain of great depth, very seldom visible, with high peaks at α and β on the wall, and, according to Schröter, with two lofty central peaks. Beyond Hausen are three ring-plains, drawn by Mädler on the 'Mappa Selenographica,' though he considered that they were probably on the further hemisphere, and they are hidden by the wall of Hausen at mean libration. North-west of Hausen, Schmidt has seen two crater-rills, one (S. 338) in – 58° lat. and – 67° long., with a south-east direction, and the other (S. 339) in a meridional direction a degree farther east. Near these are the two ring-plains Hausen a and *f*, and farther the larger and more regular ring-plain Hausen *b*, east of which is a row of five small ring-plains, the two on the north, Hausen *c* and *g*, being largest and deepest. North are the two small ring-plains Hausen *d* and *e*, with a smaller one between them, and three crater-like depressions in a row on the south.

Pingre (S.)—Schröter gave this name to a formation like the southern Bailly—a great region surrounded by mountain ridges, and containing some deep ring-plains, and which Mädler, unable to identify, thought must lie on the further hemisphere. It appears to be the wide open plain close to the Moon's limb east of Phocylides, and as it is not well suited for a name, this has, in accordance with Beer and Mädler's principle, been retained for the principal ring-plain, Schröter's A. It is a ring-plain, with moderately high walls, but from its position near the limb is rarely to be seen with distinctness.

Bailly (S.)—This formation, as Mädler remarks, is not truly a single formation, but a completely, though very unequally, enclosed system of ring-plains and mountains, 148·7 miles in length and probably as broad, but from its position very seldom clearly visible. It cannot be properly drawn—as Beer and Mädler found, under conditions of mean libration, owing to its neighbourhood to the Moon's limb; but to show its features distinctly, must be represented as if under the most favourable conditions of libration. The brightness of its colour excepted, it is not unlike a small Mare, and its interior is depressed considerably beneath the surrounding surface, and the border consists in part of the walls of considerable ring-plains, and in part of lofty mountain ranges, rising on the west, near α and ϵ, perhaps 10,000 to 13,000 feet, and on the east is at β and γ not under 13,000 feet, and at δ 14,800 feet above the interior. The steep eastern border is broken by ring-plains of all dimensions, a number being at β, but they are usually not visible as such, only their western walls appearing. The most distinct formation on the interior is Bailly **a**—perhaps Riccioli's *Bartolus*—which has 6°½ bright walls, rising steeply, from two measures, 14,382 feet above the interior, and consequently one-third of its diameter must be in perpetual shadow and only illuminated by the reflection from the bright enlightened wall opposite. The small ring-plain *b* has walls elevated little above the outer surface, and not much more above the interior, and is therefore only little visible; but *c* and *d*, though also of small dimensions, are of great depth.

Doerfel Mountains[1] (S.)—A magnificent range of immense mountains on the further hemisphere of the Moon, visible in profile on the limb, extending from − 60° to − 80° lat., with a lofty crest fully 12,000 feet high, and culminating in the three tremendous peaks α, β, and γ, towering, according to Schröter, over 26,000 feet above the level of the limb,—a height that Beer and Mädler think is not over-estimated, whilst many peaks range between 15,000 to 20,000 feet high, but are scarcely visible except under favourable conditions of libration. From their appearance, it is probable that these mountains consist of either a great highland like the Alps, or else extend in several approximately parallel chains like the Cordilleras.

Zuchius (R.)—A considerable ring-plain on the south-east of Segner, with broad walls, containing many peaks, and rising at α 10,794 feet above the interior, which contains a distinct central peak, together with some small hills and ridges; whilst from the west wall, being 5°½ bright and the east 6° bright, it can be found in Full with a little trouble. From its walls extend many projecting branches, and on the east is a row of four distinct ring-plains with their broad walls united to each other, **a** and *d* being largest, and *b* and *e* deepest, and from the last extend some ridges to Hausen *b* and Phocylides.

Bettinus (R.)—A fine ring-plain, with a steep, very lofty, wall, rising on the east 12,380 feet, and on the west 13,301 feet above the interior, while α is probably still loftier; and on the floor is a massive double-peaked central mountain,

[1] Beer and Mädler term these the Leibnitz Mountains, having probably accidentally interchanged Schröter's names of the Leibnitz and Doerfels. Here, following Webb's example, Schröter's nomenclature has been restored.

together with a lower ridge. East are the two distinct small ring-plains a and *b*, the last on a wide plain extending as far as the west wall of Bailly, and crossed by only a few ridges, Bettinus ζ being highest and longest. North, between Bettinus, Zuchius, Segner, and Weigel, extends another open bright plain of considerable size, bordered on the west by the mountain Weigel α, on the south of which rises Bettinus ϵ, 11,542 feet above the plain, the general elevation of the rest of the lofty border being 9,500 feet. The whole plain appears like a great depression, and near the terminator it is darker than the rest of the surface, but under high illumination, of the same brightness.

Kircher (R.)—A very deep ring-plain, with a broad, massive, extremely lofty wall, rising on the west, at α, 14,746 feet, and on the south-east, near ϵ, towering to the immense height of 17,839 feet above the nearly level floor, which appears to be broken by only a low hill on the south. On the east and west are the two great ring-plains a and *d*, both very deep, and the last, from its 7° bright wall, very distinct in Full. Schröter draws them at a distance from the wall, and much smaller than Beer and Mädler have represented them to be. In the neighbourhood of Kircher are many small ring-plains, the two principal being *f* and *b*, and there are also many crateriform objects, which must be classed indifferently under the head of craters, it being in these high latitudes not easy to distinguish between craters, small members of the ring-plain class, and depressions.

Röst (S.)—A ring-plain, 30·0 miles in diameter, with fine broad walls, particularly steep on the north, where there are some craters, and rising on the west 7,891 feet above the interior, but on the south and east are lower and broken by two passes. The interior of Röst contains a very shallow depression, like a small ring-plain, and two low hills. South is the irregular ring-plain *c*, with, on its west, a group of mountains at times appearing like another ring-plain, and on the east is the ring-plain **a**, as large as Röst, but not so deep. North of Röst are several ring-plains of moderate depth, two or three craters, and numerous, mostly very minute, crater-pits, together with some high mountains, ε being the principal. The small ring-plain *b*, north of **a**, is for its diameter deep, and on its west appear the ruins of an older formation.

CHAPTER XXIII.

MAP XVII.

Longomontanus (R.)—A great walled-plain, 90·64 miles in diameter, and of very considerable depth beneath the walls, though their breadth and many terraces, as in Maginus, render this far less marked than it would otherwise be. The highest peak on the east border is δ, on the broad wall plateau, rising 13,314 feet above the interior and overshadowing the whole region around *f*; whilst on the west wall the two principal peaks are α, towering 14,542 feet above the interior, and for some time entirely overshadowing a great group of craters; and the steep peak β, only 11,318 feet high, south of which the broad wall is crossed by two deep ravines, considered correctly by Mädler as rill-like valleys, though Schmidt, as elsewhere, calls them rills (S. 337). The interior of Longomontanus contains several ring-plains, *f* being the largest; a number of craters, and thirty very small crater-pits, too minute to be drawn except on a larger scale. Around Longomontanus is a wild chaos of mountains, ring-plains, and craters, with innumerable crater-pits and crater-like depressions, many of the formations being due to the intersection of great ranges of mountains, and are, therefore, perhaps, rather deep valleys than actual formations. South of Longomontanus are the three small walled-plains *b*, *d*, and *c*, and the deep regular ring-plain A.

According to Beer and Mädler, Longomontanus is drawn too small on their map; from Wilhelm I. being placed too far

Map XVII.

West Longitude
East Longitude
Leibnitz
Mountains
Malapert
Cabeus
Boguslawsky
Boussingault
Schomberger
Simpelius
Short
Newton
Legentil
Casatus
Moretus
Klaproth
Wilson
Manzinus
Curtius
Cysatus
Kircher
Gruemberger
Pentland
Mutus
Blancanus
Bettinus
Kinau
Zach
Scheiner
Clavius
Pitiscus
Jacobi
Lilius
Leluc
Rost
Bacon
Maginus
Longomontanus
Cuvier
Clairaut
Licetus
Barocius
Street
Wilhelm I.
Pictet
Saussure
Tycho
Faraday
Maurolycus
Stofler
Nasireddin
Heinsius
South Latitude

south, and too large; but it is at present impossible to rectify this materially, without entirely disturbing the whole, until the principal points have been re-measured, as Beer and Mädler do not state what points of the second order were affected by the error they discovered; and until, therefore, this whole region is re-measured, any great correction, being purely arbitrary, is worse than none at all.

Wilhelm I. (R.)—A considerable walled-plain, 46·00 miles in diameter,[1] with a steep lofty wall, more regular than most of these great southern walled-plains, and rising on the east at δ 11,068 feet above the interior, but on the west only 6,682 feet above the floor, which presents, however, considerable differences in level. On the walls, besides very numerous small crater-like formations, are the three circular ring-plains A, B, and C, with steeply-rising walls and very deep interiors, retaining their shadows long after they have disappeared from Wilhelm, whilst remaining visible under high illumination as bright rings; resembling, therefore, in certain respects, gigantic craters. On the north-east wall are a number of rows of crater-pits—one especially, by the ring-plain-like formation west of the peak γ, being well marked. In the north-east is the small deep ring-plain *g*, close to some more irregular formations, at sunrise resembling small walled-plains; and south of these is the triangular-shaped ring-plain *f*, with lofty walls, in the west, 6,000 feet high. East of Wilhelm there is a comparatively level elevated plain, *h*, enclosed by the great curved mountain range β, lowest towards the south, and beyond this is the deep ring-plain *i*, drawn by Mädler as a small depression. West of Wilhelm is the small terraced ring-plain *d*, one of the few formations in this region visible in Full, and the deep small ring-plain E, together with a good number of ring-plains, craters, and crater-pits.

[1] From an error, drawn too large on the 'Mappa Selenographica.'

Tycho (R.)—A magnificent ring-plain, 54·28 miles in diameter, well termed by Webb the metropolitan formation of the Moon, and one of the vast formations resembling gigantic crater-plains, of which Copernicus, Eratosthenes, Piccolomini, and Theophilus are the rest. The circular broad wall, which contains many terraces on the interior and is a mass of terraces and buttresses on the exterior, rises, according to Mädler, on the west, 17,113 feet above the interior, and 12,539 feet above the terraces; the height of the east wall being 16,044 feet, and the central mountain 4,953 feet, though Schmidt makes this last nearly 6,000 feet. The terraces on the interior form a quintuple row, and are of some breadth and divided by deep narrow clefts resembling rills, whilst Schmidt draws several crater-rows on the terraces. The interior contains a fine lofty central peak, A, from nine measures by Mädler, in – 42° 52′ 19″ lat. and – 11° 52′ 25″ long., forming, however, only the principal peak of a less elevated mountain mass that escaped Beer and Mädler, and on which Schmidt draws a small crater. On the interior, besides the central peak, Mädler draws two small hills, Schmidt four or five, and other observers have seen still more, but all very low and scarcely visible. The outer walls of Tycho towards their base lose all regularity and steepness, and become an inextricably involved mass of mountains, peaks, ridges, mounds, crater-like depressions, and crater-pits, in which it is only with difficulty any complete object can be clearly traced. Around Tycho is a mass of formations in part of the nature of irregular formations, and in part that of great walled-plains enclosed by the mountains uniting the smaller formation. Both ring-plain and walled-plain, and the intervening regions, are here one mass of crater-like depressions and crater-pits. Though almost innumerable as these last are, according to Schmidt, they do not occupy a fiftieth of the actual surface, even if at first sight almost covering it. The whole of this southern portion of the Moon within the 45th parallel of latitude contains a great number of these crater-pits, as well as numerous formations of a crater-like appearance, whose character, especially in the higher latitudes, it is difficult to ascertain ; for here the older craters and craterlets, the small ring-plains and the crater-like depressions and valleys, present almost the same appearance, and require careful observation under different illuminations to distinguish one from the other, a course to which they have never yet been submitted.

The principal formations classed under Tycho are on the east and north, the most distinct being the polygonal ring-plain A, whose central mountain is in – 39° 18′ lat. and – 12° 2′ long., and whose wall rises on the west 5,340 feet above the interior. West of it is the round depression F, and on the east a row of three deep small ring-plains, the central one, *f*, being deepest and largest, whilst around them Schmidt draws a mass of crater-pits. South is the small ring-plain B, and the larger *d*, both deep, and west of the last the bright crater C, whilst the whole surface east of Tycho is a mass of rounded depressions, only a few being in any way deep. In this region, between Tycho and Heinsius, was Schröter's *Wing*, which Mädler could not identify, but it appears to have been one of the largest of these depressions.

Tycho is the centre of the principal streak-system of the Moon, the light streaks radiating from it in all directions extending over one-fourth of the entire visible lunar surface. South they reach the limb ; east, they reach as far as Capuanus and Hainzel ; north-east, they extend beyond Bullialdus, and are lost in the Mare Nubium ; north, though abruptly stopped by Hesiodus, they extend west of it as far north as Thebit and Alphonsus ; and north-west they reach their greatest distance, extending as far as the regions beyond Piccolomini, the Altaï Mountains, and Theophilus; and one even extends past Menelaus, across the Mare Serenitatis to the region beyond Thales, or nearly across the Moon; whilst, finally, on the west, where they are closest, the streaks almost reach the limb. These great light streaks become visible when the solar altitude is greater than 25°, and disappear when it falls below that height; a few only of the most intense remaining longer visible, and these can be seen even in the dark portion of the Moon illuminated by the earth-light; but none are visible near the terminator. In the mountain regions the streaks commence to appear when the shadows disappear, and when the streaks have disappeared the shadows become perceptible. Under the uniform monotony of brightness possessed by the light streaks, some of the most magnificent and tremendous lunar formations entirely disappear, as in the case of Clavius, Longomontanus, Wilhelm I., Heinsius, Sasserides, Gauricus, Lexell, Orontius, Walter, Nasireddin, Stöfler, Maginus, Maurolycus, and Moretus. Of these great walled-plains, with their extremely lofty and massive walls, not the slightest trace can be detected in Full. Some of the smaller formations lying either within or on the walls of these fine walled-plains can be detected under high illumination, owing to their brightness being superior to that of the streaks of Tycho. From the disappearance of the great surrounding walled-plains, and, with rare exceptions, of all the small objects, the environs of Tycho present towards Full a very different aspect to that when near the terminator. Tycho itself appears with a 5° bright interior, containing a distinct 8° bright central peak, surrounded by a wall with a 5° bright outer slope and an 8° bright crest, with, in places, only 3° bright interior terraces, whilst on the south is the 8° bright crater C, and a similar 8° bright point on the south-west. The base of the exterior slope of Tycho is only 3° bright, and this grey tint extends all round Tycho for a distance of about 25 miles, and is only broken by the brighter ring of Tycho B; but beyond this dark ring commences the great streak or ray-system of Tycho, which extends 90 miles before separating into light streaks. In the east these streaks are short, and Pitatus, Capuanus, and Capuanus C are easily seen, whilst with more trouble Hainzel, Röst, and Scheiner can be found. The brighter formations, as Wilhelm *d*, C, E, A, *f*, and B, Longomontanus A, and some other similar formations near Hainzel, Scheiner and Wurzelbaur, being from 6° to 7° bright, are easily seen, and there are also a number of still brighter points which have been only partially identified. The streak system of Tycho is here 5° bright, only a few 6° and one 7° bright streaks being visible, and they are wider apart than elsewhere. On the north the streaks are brighter, and only Hell, with its central peak, Gauricus **a**, Ball, and Lexell *c* and *d*, are to be seen, except with great difficulty. West, Saussure stands out distinctly, almost the solitary large formation that has overpowered the rays with any marked success; and Pictet **a**, with some bright mountain peaks, can also be seen. Maginus disappears completely, only the 3° bright grey interiors of Maginus *i* and *k* remaining visible in this region. Around Maurolycus and Stöfler, except Maurolycus A, only a few 7° bright craters can be seen; but Lindenau, Piccolomini, and some others near, are the first ring-plains of any size that remain distinctly perceptible. Towards the south the streaks are much foreshortened, but they completely hide the walls of Clavius, though the small ring-plains D and C, the crater *i*, and the larger ring-plain **a**, are distinct. A very remarkable feature in connection with the streaks of Tycho, as well in a less marked degree with those of Copernicus and Kepler, is the fact that more can be distinctly seen on the photograms than can be found with considerable trouble on the Moon during Full; so much so as to indicate that the power of masking the various formations possessed by the streaks to such a great extent, is far less powerful photographically than optically.

Pictet (M.)—A very irregular walled-plain, surrounded by walls of unequal height, and broken by small ring-plains, the average height of the border being perhaps 3,000 feet. The most considerable of these smaller ring-plains is C, in $-41° 33'$ lat. and $-8° 0'$ long. South is the ring-plain Pictet **a**, smaller than Pictet, but far more distinct, and with a tolerably high wall, rising on the north-east 8,000 feet, and on the west 5,685 feet above the interior. Mädler could not see any craters on the wall, but Schmidt, who draws, however, this ring-plain too small, has seen a row of five crater-pits on the south wall. East is Pictet *d*, not drawn by Mädler as a ring-plain, but appearing as one on Schmidt's map, with high regular walls.

Saussure (M.)—A ring-plain, regular in form, and 27·7 miles in diameter, with a wall highest at the peaks α and β, on the east, where it rises nearly 8,000 feet, and is terraced; but lower on the west, and with a nearly level 3° bright interior, containing only a small crater, *f*, and a number of small crater-pits, four of these being in a row at the foot of the south-east wall. The wall of Saussure, though of the same brightness as the streaks of Tycho, has bent the great streak passing along the base of its southern wall into a curve, which affords almost the only instance of this occurring in a ring-plain of such dimensions. On the border of Saussure is B, a deep crater, in $-42° 25'$ lat. and $-5° 36'$ long., and further south is *g*—according to Schmidt, a crater-like formation, but, according to Mädler, a depression, whilst the wall contains several other small craters, besides crater-pits. On the west extends a strong mountain arm, parallel with the border of Saussure, and distant about twelve miles, which, rising considerably higher than the west wall of Saussure, gives, under low illumination, a very peculiar aspect to the formation, and at sunset may very easily be mistaken for the real wall of Saussure. Between this mountain arm, ε, and the west wall of Saussure is a fine valley. Schmidt has apparently drawn this arm as a row of small ring-plains and crater-pits, though it is over 7,000 feet high. On the outer slope of Saussure, commencing at β, and extending south, Mädler discovered a small rill, and west, by γ, he had on a previous occasion seen two others; these, by error, were drawn on the 'Mappa Selenographica' as two ridges. Schmidt, who includes them in his catalogue as Nos. 331 and 332, has not been able to find them, nor does any other observer seem to have been more successful.

Saussure A is a ring-plain west of the high chain ε, with its centre in − 43° 20′ lat. and − 1° 14′ long., in a bright, comparatively level, region; and south is the double formation, *e*, like two adjoining ring-plains, with the wall dividing them broken down; whilst, on the west, is a similar, but much smaller, formation. As Mädler remarks, this region contains a very great number of small crater-pits, visible only under exceptionally fine atmospheric conditions, and for only a very short period, from their being extremely shallow; whilst, between them are a great number of small, gently-sloping hills, scarcely any being more than 300 feet high. Even in this region the crater-pits, when they are counted, and their small diameter considered, cannot be regarded as occupying more than one-twentieth of the surface.

Street (S.)—A walled-plain, enclosed by irregular mountain ridges, which are, at their highest point, a peak on the south-west, only 4,464 feet high, whilst the interior is crossed by numerous ridges, and contains some crater-pits. Around Street are a number of deep craters, the three principal being A, in $-$ 46° 44′ lat. and $-$ 9° 39′ long., B, and E; the last two being close together on the east; whilst south and south-west are several very imperfect walled-plains, on the border of one of the most distinct being the crater Street *d*. East of Street are some other similar walled-plains, together with a great number of smaller shallow ring-plains, and a few deeper formations resembling craters; the most distinct of these walled-plains being Street *h*, which is probably Schröter's *Robert Smith*; and on its wall is the bright crater Street *d*.

Maginus (R.)—This formation is aptly described by Beer and Mädler as presenting the appearance of being the ruins of a magnificent, well-connected walled-plain, and at sunrise, when the floor is deeply immersed in shadow from the remains of its west wall, still rising 14,426 feet above the interior, it yet presents much of the appearance of the more regular walled-plains. It is only, however, in a few places, where the border remains perfect, or steep, and no general wall remains; but on the broad elevated base appear numerous ranges, terraces, and groups of peaks, uniting to form one of the most complex borders possessed by any formation; with, at intervals, great craters, and in many places enclosing deep plains, which present all the characteristics of the lunar ring-plains. The central peak, A, is a small, sharply-marked hill—according to Schröter, 2,000 feet high, and, from nine measures by Mädler, in $-$ 49° 37′ 17″ lat. and $-$ 7° 5′ 50″ long.; near it is a small crater-like depression, and some small hills and ridges. Besides the small deep crater A, in $-$ 48° 51′ lat. and $-$ 5° 14′ long., the interior contains several small hills, and a number of crater-pits,—all very delicate objects. In the north border is the long rill-like valley δ (S. 330), discovered by Mädler, which, after crossing five depressions, opens into the ring-plain Maginus *i*; and parallel with it are some coarser valleys of

MAGINUS.

Scale . 100 Inches to the Moon's diameter.

very similar character; whilst a similar system of narrow rill-like valleys exists in the wall west of Maginus A. Towards the north-east the wall of Maginus is more connected, and forms a broad, gently-rising plateau, falling steeply on the exterior, and the great height above the interior is only shown by the mass of shadow at sunset. This broad portion of the wall is broken by three small, but very deep, ring-plains—*g*, *f* and *h*—together with some shallower depressions and ring-plains, and the usual number of crater-like formations, one of these, L, being in $-49° 20'$ lat. and $-9° 38'$ long. Towards the east, the broad, plateau-like wall is bordered by a sharp, steep crest, rising considerably above the plain below; but the broad summit of the wall west of it is broken by the same class of depressions as further west. South-east is the deep ring-plain Maginus *c*, with its high walls broken by crater-like formations, H, in $-53° 10'$ lat. and $-10° 57'$ long., being the most conspicuous. Beyond, the south and south-west wall consists of a complicated mass of mountains and mountain ridges, enclosing narrow valleys, and broken by small ring-plains, the principal of these being B, in $-51° 56'$ lat. and $-7° 18'$ long. Schmidt draws many of Mädler's rounded valleys as if they were ring-plains, but the configuration of this portion of the wall, as drawn by Mädler, seems very accurately to represent the real condition. West, the border of Maginus retains more perfectly the appearance of being the crest to the wall of a grand ring-plain, and is in places steep, though broken by several broad terraces and crater-like formations. North-west, the wall of Maginus abuts on the three, somewhat square, small walled-plains *e*, *d*, and *k*, and the ring-plain *i*, the last containing several ridges.

In high illumination Maginus, as a grand lunar formation, does not appear, only a few isolated points being detectable, and, in Mädler's brief but forcible expression, 'the Full Moon knows no Maginus.'

The special drawing, or rather map, of this magnificent formation, Maginus, by permitting its details to be drawn, shows the real nature of its constitution and its entire dissimilarity to the volcanic craters. Founded on a series of nearly twenty special drawings, made at intervals during five years, it is the most complete map of this portion of the surface extant; and, based on independent measures, its outline and general relation will be found entirely trustworthy, although not quite accordant with Madler's. With few exceptions every feature delineated may be considered to have had its existence well established, though the difficulties in effecting this are, in this portion of the Moon, far more formidable than in the more undisturbed regions towards the north. An especial feature to be noticed is the comparatively few crater-pits found within this grand walled-plain, though the surrounding regions contain very numerous members of this class.

Deluc (M.)—A circular ring-plain, 27·7 miles in diameter, with a lofty regular wall, rising on the west 7,000 feet, and on the east about 6,000 feet, above the level interior, broken, according to Mädler, by only a central peak; but Schmidt draws only a conspicuous crater. On the north is the strongly-marked smaller ring-plain H, which, as Schmidt shows correctly, pushes back the wall of Deluc, and is situated on a strong slope towards the west: so that whilst losing its shadow sooner, it obtains it before the deeper formation Deluc. At times its central peak breaks entirely through the shadow as a light island in a dark floor; the position of this central peak being $-$ 54° 8′ lat. and $-$ 2° 32′ long. South, is the somewhat larger ring-plain *d*, almost as deep as Deluc, but without a central peak; and east of where its wall and that of Deluc joins is a smaller and shallower ring-plain, or rounded depression. North-east are some ring-plain-like formations, due to the intersection of systems of mountain ridges, as ι and k—this last remarkable as the solitary dark plain on this southern portion of the Moon visible in Full. On the north-west are the three ring-plains a, b, and c, all probably of similar origin to ι and k, being formed by intersecting mountain ridges. Between these and Maginus are a number of craters or minute ring-plains, and some crater-pits. South of Deluc is the regular ring-plain g, of very considerable depth, and the smaller and not so deep ring-plain E, in $-$ 60° 20′ lat. and $-$ 5° 31′ long.; whilst between the two the mountains enclose the considerable ring-plain f and the very small ring-plain n, neither in any way deep or steep; on the south wall of f, however, Schmidt has seen several craters.

Clavius (R.)—One of the most magnificent walled-plains upon the lunar surface, with a diameter of 142·6 miles, and an area of 16,000 square miles, forming, at sunrise and sunset, one of the finest lunar landscapes, the view at sunset being aptly described by Beer and Mädler as gorgeous in the extreme. The sunrise on Clavius commences with the illumination of a few peaks on the western wall, but soon rapidly extends along the whole wall of Clavius, which then presents the appearance of a great double bay of the dark night side of the Moon, penetrating so deep into the illuminated portion as to perceptibly blunt the southern horn to the naked eye. Within the dark bay some small bright points soon appear—the summits of the great ring-plains within—followed shortly by similar light points near the centre, due to peaks on the walls of the smaller ring-plains, these light islands gradually widening and forming delicate rings of light in the dark mass of shadow still enveloping the floor of Clavius. Far in the east then dimly appear a few scarcely perceptible points, rapidly widening into a thin bright line, the crest of the great south-eastern wall of Clavius, the end being still lost far within the night side of the Moon. By the period the extreme summit of the lofty wall of Clavius on the east becomes distinct, fine streaks of light begin to extend across the dark mass of shadow on the interior of Clavius, from the light breaking through some passes on the west wall and illuminating the interior; and these streaks widen near the centre and form illuminated spots on the floor, when both east and west it still lies deeply immersed in shadow, strongly contrasting with the now brightly-illuminated crest of the lofty east wall and the great circular broad rings of light formed by the small ring-plains within Clavius. The illumination of the interior of Clavius now proceeds rapidly and forms a magnificent spectacle: the great brightly-illuminated ring-plains on the interior, with their floors still totally immersed in shadow; the immense steep line of cliffs on the east and south-east, are now brilliantly illuminated, though the entire surface at their base is still immersed in the shades of night; and the great peaks on the west towering above the floor are thrown strongly into relief against the dark shadow beyond them. Yet, as Beer and Mädler remark, the portion of the floor of Clavius that, even long after sunrise, remains in the shadow of the west wall, cannot be in total darkness with the reflection of the sun's rays from the line of brilliantly illuminated lofty eastern cliffs. The western wall of Clavius rises with a very gentle slope from the bright, elevated regions west, and falls with some steepness in a broadly-terraced declivity to the interior of Clavius, the general elevation of the crest of the wall being nearly 12,000 feet. At α the wall rises in a grand mountain, whose loftiest peak towers, from five measures, 16,812 feet above the interior; whilst λ, farther north, rises from two measures, 12,495 feet; μ, at the projecting point of the wall, according to Schröter, 10,800;

and ν, from the measures of Schröter, 17,300 feet above the interior; both α and ν, from their great height, throwing at times into shadow, long after sunrise, the entire walls towards the interior of Clavius of the two great ring-plains **a** and *b*. The wall of the ring-plain **a** rises on the west 8,358 feet above the interior, and the west wall of *b* 11,727 feet above the floor, whilst the east wall of *b* rises, according to Schröter, 7,500 feet above the interior of Clavius. The eastern wall of Clavius rises from the interior in a fine, somewhat steep, ring of cliffs, broken towards their base by a great number of terraces, spurs, and short projections, and at ϵ possesses the immense height above the interior of 16,837 feet, whilst the general elevation along the south-east is from 10,000 to 13,000 feet, rising in peaks still higher, though on the north-eastern, where it forms a mass of mountain valleys, the crest is only from 8,000 to 9,000 feet high, and possesses few peaks much loftier, γ and δ being the highest. Within the two ring-plains **a** and *b* are a number of long ridges and some mountains, together with several craters, R in **a** being in $-$ 60° 12′ lat. and $-$ 12° 41′ long.; and in **a** a crater-chain extends from the south-west wall towards the centre, whilst from its wall extend many short mountain arms on to the interior of Clavius, one of these, *s*, containing a row of crater-pits. The largest and finest of the smaller ring-plains towards the centre of Clavius is D, whose central mountain is in $-$ 57° 56′ lat. and $-$ 12° 18′ long., and its diameter is 16·01 miles, whilst its terraced walls, rising only 2,910 feet above the interior of Clavius, are 9,362 feet above its floor, which must consequently lie 23,264 feet beneath the summit of the great peak α, or nearly 24,000 feet beneath ν. The smaller but more regular ring-plain Clavius C, with walls rising only 6,200 feet above the completely level interior, has its centre, from eight measures by Mädler, in $-$ 57° 16′ 47″

lat. and $-$ 14° 40′ 26″ long. The small ring-plain *n* is 5·63 miles in diameter, but is drawn too small on the 'Mappa Selenographica;' and *i* is 4·8 miles in diameter, both being shallow, their walls rising scarcely 2,000 feet above the interior. Between C, *i*, and the small ring-plain *k*, on the east wall, the interior of Clavius contains five craters and probably over forty crater-pits, some being arranged in chains, and some—especially two south-east of C—appearing like ruined ring-plains, of dimensions nearly equal to *i*. East of **a** are over twenty other crater-pits, principally near the small ring-plain *t*, about four miles in diameter, but drawn too small by Mädler; whilst west of this last is a short rill, Clavius Φ, seen distinctly on several occasions, but drawn by Schmidt as a crater-row. On other portions of the interior of Clavius are many more crater-pits and a number of small mountains and short ridges, all only visible with considerable difficulty.

From Clavius to Tycho extends a gently-sloping decline, containing many short ridges, and broken by numerous depressions and crater-like formations, the principal being Clavius G,—a small ring-plain, distinctly visible in Full; and west of this is the larger ring-plain-like depression, Clavius *h*. West of Clavius, on the gently-sloping exterior wall, is the bright deep ring-plain Clavius K, in $-$ 56° 11′ lat. and $-$ 8° 24′ long.

Scheiner (R.)—A considerable walled-plain, of very regular form, 69·71 miles in diameter, surrounded by a very lofty steep wall, broken by high terraces and small craters, and rising into its highest peaks at *α* and *β*. The interior contains the very distinct central crater A, 7° bright, and of considerable depth, whose position, from nine measures by Mädler, is in $-$ 59° 58′ 26″ lat. and $-$ 26° 36′ 13″ long. On the floor are also eighteen craters or crater-pits, mostly of little depth and small dimensions, and nine of which were seen by Mädler; whilst the interior is crossed by a low mountain arm, ϵ, as well as by a number of short ridges. The environs of Scheiner are as wildly mountainous as any in this region, and the portion between Scheiner, Wilson, and Bettinus is, perhaps, according to Mädler, the most difficult portion of the surface of the Moon to draw, from its consisting of a labyrinthical mass of mountains, ridges, hills, and crateriform objects of all descriptions, which never long retain the same appearance. The most conspicuous formation in this region is the deep, irregular, small ring-plain Scheiner C, north of which is the peak δ, perhaps the highest mountain here; and in the west, near the peak Wilson γ, Mädler discovered a short rill, Scheiner ϵ (S. 333), of considerable depth towards the centre, but which Schmidt could not find. Near Scheiner, on the south, is the irregular depression *e*, with some craters on its walls, and east the deep ring-plain Scheiner B, in $-$ 59° 0′ lat. and $-$ 30° 42′ long., with high terraced walls. Scheiner *d* is a small ring-plain of considerable depth, but the formation *f*, drawn by Mädler as a similar ring-plain, appears to be but a rounded valley in the east wall of Scheiner.

Blancanus (R.)—This formation is one of the finest ring-plains upon the Moon, with a diameter of 50·7 miles, and surrounded by a very lofty, broad, much-terraced wall, crowned by fine peaks, towering at α 13,307 feet, and at β 18,008 feet above the interior, the general height of the crest of the wall being fully 12,000 feet. The interior of Blancanus is level, being only broken by the bright crater A, in $-$ 63° 20′ lat. and $-$ 20° 11′ long., which has east of it a small mound and crater-pit, and west a small crater, near which, close under the wall, are nine minute crater-pits arranged in two rows. On the north-west, the walls of Clavius and Blancanus are united by a lofty narrow plateau, forming a kind of shallow valley between the two, broken in places by low ridges and crater-like depressions; whilst on the south and west extend from the walls long mountain arms and numerous projections. Between Gruemberger, Blancanus, and Klaproth is a wide, open, elevated plain, broken by only a few low hills, short ridges, and shallow crater-pits; with, north of it, as far as the border of Clavius, a very similar region, traversed by some long ridges, enclosing leveller portions of the surface resembling shallow ring-plains, and containing the small but deep ring-plain Blancanus *d*. On the south of Blancanus is *c*, a considerable deep ring-plain; south of which is *b*, as large, but not so well enclosed, nor so deep; and west of these the rounded deep valley, *e*, with two crater-like depressions on its borders.

Wilson (S.)—An irregularly-formed, incompletely-bordered walled-plain, in a wildly mountainous region, with a lofty wall, rising at α 13,742 feet above the floor, though lower elsewhere, the whole appearing complete only near the terminator. Mädler draws the interior completely level, but it appears to contain at least two small crater-like depressions, and a low ridge. North of Wilson is a group of three ring-plains, one of some depth, and near it a peak, Wilson γ; and south is the deep ring-plain *c*, whilst in its environs are many other small ring-plains, the principal being Wilson *e* and A; but this region is only drawn with great difficulty.

Legentil (S.)—A considerable walled-plain, very close to the limb on the south of Bailly, which Mädler could not identify, and thought must lie beyond the limb under mean libration, probably because, from its high west wall, Legentil usually appears like a mountain range. It is, from its position, very difficult to draw, and may be placed a little too far south, and is, perhaps, the same as Mädler's Wilson *d*. On the west is the deep ring-plain Legentil **a**. Between

Legentil and Bailly, in $-72°\frac{1}{2}$ lat. and $-57°$ long., Schmidt has seen what he thinks is a great curved rill (S. 336).

Casatus (R.)—A great walled-plain, with an extremely high border, which, on the west, possesses a grand mountain peak, α, rising to the immense height of 22,285 feet above the interior; a second, on the north, γ, towering 18,576 feet; and a third, δ, on the south, reaching the great height of 20,060 feet above the interior, the general height of the crest of the west wall being above 17,586 feet. The fall towards the outside is very much less, and the inclination gentle, the average height of the crest of the wall being scarcely 6,000 feet, or, according to Beer and Mädler, only from 4,000 to 5,000 feet, so that the interior of Casatus must be very deep beneath the level of the surrounding surface. Similar great walled-plains extend from here to the limb, apparently not inferior in depth, and not much less in size, forming a magnificent group, scarcely visible, however, except under particularly favourable conditions of libration, when, under suitable illumination, and backed by the southern extremity of the stupendous Doerfel mountains, they form a grand sight. The principal of these great walled-plains is A, in Full distinctly visible, as well as the mountain β; and one of those near the limb was probably the great walled-plain, considered by Schröter to be Casatus. The interior of Casatus contains the small deep ring-plain *c*, and three or four small crater-pits, together with several low ridges. In the open plain far south of Casatus, Schmidt has seen a short rill, ϕ (S. 335), of doubtful character, perhaps, as some of the valleys here appear much like rills at times.

Klaproth (M.)—Another great walled-plain, of even greater dimensions than Casatus, and drawn somewhat too small by Mädler, but with far lower walls, rising at their highest point, α, only 8,678 feet, the general height in the west being about 6,000 feet, and on the east, near γ, 7,800 feet above the interior, which was drawn by Mädler as completely level—as he remarks, the single example of the kind in this region. The interior does contain, however, three small ridges and a crater-pit; besides which Schmidt draws another crater-pit on the south, and several low mounds—all, however, very insignificant objects. North is the ring-plain **a**, of very considerable depth—deeper, probably, than Klaproth.

Gruemberger (S.)—A great ring-plain, 39·2 miles in diameter, with broad, much-terraced, very rugged walls, rising at α 13,883 feet above the interior, which, though described by Beer and Mädler as level, contains many low ridges and chains of crater-pits, together with a very deep ring-plain, A, whose wall, scarcely elevated above the interior of Gruemberger, rises at least 7,000 feet above the floor, which is 20,000 feet beneath the crest of the peak at α. The centre of the ring-plain A is in $-$ 66° 15′ lat.[1] and $-$ 12° 30′ long, and close around it are several crater-pits, and on the walls of Gruemberger, as well as on the interior, are short crater chains.

Cysatus (R.)—A walled-plain, west of Gruemberger, of only moderate dimensions, though with broad, much-terraced walls, rising on the west, from two measures, 12,687 feet above the interior, which appears to be completely level. West of Cysatus is the more irregular walled-plain *e*, with in general far lower but more rugged walls, only at the point ε rising 9,000 feet high; and north of this are the two more distinct small ring-plains **a** and *b*, whilst east, on the wall of Cysatus, is the deep crater D. A considerable mountain range extends from Deluc E to Cysatus, rising at the two steep but rounded peaks Cysatus α and β to some height; and on the plain west of these are a number of small crater-pits, only the principal of which were drawn by Beer and Mädler.

[1] Given, probably by error, as 61° 15′ lat. in the 'Der Mond.'

Moretus (R.)—A nearly circular great walled-plain, 78·24 miles in diameter, with very rugged walls, in places consisting of double and triple chains, all much terraced, and culminating in lofty peaks, the principal of which on the west, α, rises 15,200 feet above the interior, though on the east the peaks are very low and the wall only 9,222 feet high. The interior contains a magnificent central mountain, whose principal peak, B, is 7° bright, and 6,842 feet high, and according to Beer and Mädler, is the loftiest central mountain on the entire Moon; its position, from ten measures by Mädler, is $- 69° 45' 52''$ lat. and $- 7° 8' 38''$ long. The remainder of the floor of Moretus is almost level, being broken by only a few small mounds; it seems to be almost free from crater-pits — a great anomaly here, only two extremely minute crater-pits being visible, one discovered by Webb, and the other, close to the central peak, being very probably a rounded valley.

The walls of Moretus are traversed by long, narrow valleys, often assuming the appearance of rills, and so rugged as to give them the appearance of crater-rows, as which, indeed, Schmidt has drawn several, though rows of crater-pits are not uncommon here. In the environs are also some rounded valleys, or semi-ring-plains, of considerable depth, the principal being **a**, *b*, and *c*, whilst in most of the leveller portions of the surface numbers of crater-pits can be detected.

Short (S.)—A fine walled-plain, with a steep, lofty wall on the south-east, forming the common wall of Short and Newton, and rising at α 16,748 feet above the floor of Short, but elsewhere scarcely so high; it is of slight steepness, and nearly free from terraces, whilst the interior is level and broken by only a small central peak, some ridges, and a crater-pit. West is the shallower ring-plain Short *d*, and south of this the two deep ring-plains Short *b*, **a**, and *c*, the central one being deep, whilst the interior of *d* contains a number of small crater-pits and a small rill, Short ϕ.

Newton (M.)—This magnificent formation is probably the deepest walled-plain upon the entire visible surface of the Moon, and is elliptical in shape, being from SSE. to NNW. 143 miles in length and only about 69 miles broad. The walls are much terraced and exceedingly lofty, rising at the great peak α, in $-78° 40'$ lat. and $-12° 20'$ long., to the immense height of 23,833 feet above the interior, an altitude only approached by the great wall-peaks of the walled-plains Casatus and Curtius, and only surpassed by the stupendous peaks of the immense mountain ranges of the Rook and D'Alembert mountains on the east, and the Doerfel and Leibnitz mountains on the south. The interior contains some long mountain arms and small craters, and from the immense height of the wall a great part of the floor is entirely lost in shadow, neither earth nor sun being ever visible from it. The wall on the east is not so high as on the west, and Newton is here bordered by the two great ring-plains **a** and *b*, whilst north is the shallower depression *c*. This is not Schröter's Newton, which was a portion of the surface south of Plato; but Beer and Mädler, regarding this as entirely unworthy of the great name, rejected it, and transferred the name to the grandest walled-plain towards the south of the Moon that they found unoccupied. South of Newton, in $-83°$ lat. and $-22°$ long., Schmidt has seen a formation, regarded by him as constituting a great crater-rill (S. 334).

Cabeus (R.)—A walled-plain in $-84°$ lat., too near the limb to be seen in any detail, and usually only just visible; but, from the length of time its wall retains a strong shadow, Beer and Mädler think it can be scarcely inferior in depth to Newton. The interior contains a fine central peak and two small craters, all three only visible under exceptionally favourable conditions of libration. North-west are the two considerable and deep ring-plains Cabeus **a** and *b*, and beyond is the steep peak Cabeus A, east of which are some more deep formations.

Malapert (R.)—The southernmost ring-plain on the Moon, its centre being in − 86° lat., with a lofty wall, broken by a deep broad pass in − 87°½ lat. On the north Malapert is bordered by an elliptical ring-plain, A, not unlike Newton in form, and farther north the deep ring-plain *b*, with a long central ridge, whilst east is Malapert α, a lofty wedge-shaped mountain.

South Pole.—As on the north, the pole of the Moon on the south is surrounded by lofty peaks, but is not marked by any peculiarity of form or colour, and is usually hidden by the lofty south wall of Malapert, though, under great easterly libration, it is occasionally visible through the deep pass in this, and under high southerly libration it can be seen over the wall.

Leibnitz Mountains (S.)—This magnificent range of mountains was discovered and measured by Cassini in 1724, and named by Schröter, who drew and measured them on several occasions, but was unacquainted with Cassini's earlier discovery. Situated on the further hemisphere of the Moon, favourable conditions of libration bring them on to the limb, so as to be seen in profile, and under these conditions they are seen to extend in a great range, or more probably series of ranges, from − 78° lat. on the west to − 80° lat. on the east. The principal peaks of these immense mountains rise to stupendous heights, four being, according to Schröter, not under 26,000 feet and probably nearly 30,000 feet high ; a result confirmed by Mädler, who found for one peak a height of at least 27,000 feet. They are, therefore, probably the highest peaks of the entire visible portion of the Moon.

Four of the greatest mountain peaks are α, β, γ, and δ, all four probably over 25,000 feet high, whilst ε and $\varkappa$ are apparently on a range beyond that containing the principal peaks; but the former may with some reason be considered as perhaps the loftiest mountain of the Moon, and 30,000 feet in height. By Beer and Mädler, through some mistake, these mountains are called the Doerfels, but here Schröter's nomenclature has been restored.

Schömberger (R.)—A considerable ring-plain with uniform high walls, much terraced, and somewhat rugged, and with a nearly level interior, containing two small central mountains, A. Towards the south pole are some considerable depressions resembling walled-plains, and some more regular ring-plains; B being the most considerable of the former, and extending from $-78°\frac{3}{4}$ to $-82°\frac{1}{4}$ lat., whilst **a** and *c* are the most distinct of the latter. Beyond *c*, extending between two small ring-plains, Mädler discovered a short rill in $-84°$ lat. and $+4°$ long., which, though over twenty miles long, appears scarcely three, from its being greatly foreshortened; but Schmidt has never been able to find it (S. 344). The whole of this region is only visible with any distinctness when the Moon possesses great southerly libration, and in high illumination has a general brightness of $5°$ to $5°\frac{1}{2}$.

Simpelius (R.)—A ring-plain, surrounded by lofty walls, rising in many fine peaks, β being 12,552 feet high, and α nearly as much, the level interior containing a small central peak and two or three craters towards the south, whilst Schmidt draws a crater-row on the south wall. North is the very regular ring-plain Simpelius **a**, with distinct walls, only terraced on the east, and rising at γ 8,230 feet above the floor, which is tolerably level, containing only some low mountains, two craters, and four crater-pits. On the north-west it communicates by a pass with the small ring-plain *f*, beyond which is the deep and finer *h*. East of Simpelius are three other ring-plains with more rugged walls, *e*, *d*, and *c*, whose walls, like those of nearly every other formation in this region, are broken by crateriform depressions. South is the walled-plain *b*, bordered on the east by some small ring-plains, and west is the great 7° bright crater *g*.

Curtius (R.)—A great walled-plain with a complex wall of very unequal height, and in places formed of four or five distinct ranges separated by very rugged valleys, containing, according to Schmidt, many crateriform depressions, and generally with many terraces. On the north is a chain of exceedingly lofty peaks, separated by deep passes, and rising at δ to the immense height of 22,219 feet above the interior, the wall near this grand peak being fully 16,447 feet high. The rest of this wall is scarcely so high, being on the east only 10,379 feet above the interior. On the slope of the broad south-eastern and lowest portion of the wall is the crater A, together with some smaller ones, and on the interior are several small peaks, one or two craters, and some shallow crater-pits. North of Curtius is a small depression, and beyond, the deep ring-plain Curtius B, with high terraced walls and a level interior, containing a small central mountain in $-$ 63° 0′ lat. and + 2° 55′ long.

Zach (M.)—A great ring-plain, 46 miles in diameter, with lofty walls, containing high terraces on the east, where it rises 13,096 feet above the interior, and on the west falling towards the interior in a succession of broad terraces, whilst the floor is nearly level, being only interrupted by some low ridges, a small central peak in $-$ 59° 5′ lat. and + 4° 43′ long., and a nearly central crater. Around Zach are four ring-plains, **a**, *d*, *e*, *f*; the first being largest and deepest, its wall rising 6,000 feet above the interior; but *d* and *e* contain conspicuous central mountains, *B*, the central peak of *d*, being in $-$ 60° 17′ lat. and + 7° 0′ long., and Δ in $-$ 57° 12′ lat. and + 5° 16′ long., though given by some error in the 'Der Mond' as in − 62° 12′ lat. North-east is the irregular walled-plain Zach *b*, and beyond the deep crater Zach *c*, with some small gently-sloping depressions.

Lilius (R.)—A well-enclosed ring-plain, 38·73 miles in diameter, with regular walls rising with a very gentle slope from the exterior, but falling with some steepness to the floor, and at γ rising 9,899 feet, and at β 7,245 feet above the interior, which contains a fine central peak, A, in − 54° 20′ lat. and + 5° 17′ long., absent, by a mistake, from Beer and Mädler's map. Lilius **a**, *b*, and *c* are three similarly formed but shallower ring-plains around Lilius, and united to it by ridges, their walls, like those of the chief formation, being broken by crater-like depressions. Farther north are the three irregular depressions Lilius *d*, *e*, and *f*, with their walls broken by crater-like depressions, but, except *f*, with perfectly level interiors, only the last containing some small crater-pits. Around Lilius the mountains enclose other shallow depressions, looking like ring-plains, near the terminator.

Licetus (R.)—A walled-plain of very irregular form, consisting of a group of ring-plains united into one, from the walls separating them having been partially destroyed, and only near the terminator appearing as a connected whole. The portion **a**, in the north, is the principal formation, and is the deepest, the nearly circular walls rising at β 10,902 feet, and at α 12,706 feet above the interior, which contains a number of ridges and some craters, besides crater-pits, and is crossed by a broad light streak from Tycho, which extends as far as Clairaut. The two portions *b* and *c* of Licetus form the central part, and are separated by the low wall γ, with crateriform depressions on both slopes, and the interiors of each contain some low ridges and deep craters. The southern, or fourth, portion of Licetus, according to Mädler, is *d*, which is completely divided from the other three by a wall, and properly should scarcely form a portion of

Licetus; its walls are steep, high, and much terraced, whilst the interior contains some considerable mountain ridges. In Full, Licetus, like most other formations in this region, is completely lost under the light streaks of Tycho. East is a comparatively open region, containing some mountains, in few points more than 1,000 feet high, though a number of small crater-pits can be seen; and the two principal objects are the deep ring-plain Licetus *f*, and the 6° bright crater Licetus H, in – 45° 5′ lat. and + 2° 10′ long. North of this region extends from Licetus to Nasireddin a broad plateau, with very rugged summit and sides, separated from Stöfler by two deep depressions, and broken by the deep crater *i*, and the still deeper ring-plain Licetus G, in – 43° 21′ lat. and + 1° 11′ long., east of which is the peculiar depression *o*, and south the deep valley *e*, the whole containing, moreover, many crater-like depressions. North of H is a small crater-rill, ξ (S. 346), and south a longer, ϕ (S. 345).

Clairaut (M.)—A great irregular formation resembling Heinsius in character, according to Mädler, consisting of a circular ring-plain, broken by the two deep ring-plains a and *b*, the last being in turn broken by the smaller, *c*, whilst a deep double ring-plain, D, is on the floor. Schmidt draws Clairaut as a circular ring-plain, with *c* on its wall, and a and *b* beyond the border; but Mädler's drawing certainly seems to represent faithfully the appearance of this peculiar formation. The centre of the ring-plain C is in – 47° 46′ lat. and + 13° 31′ long., and the centre of the southern of the double ring-plain D, in – 47° 16′ lat. and + 14° 3′ long. North of Clairaut are two irregular depressions, *f* and *e*, and north-east is the steep, deep crater Clairaut G, in – 46° 20′ lat. and – 10° 57′ long., and 6°½ bright in Full. East of Clairaut is a rill between numerous crater-pits, according to Schmidt (S. 349) extending from SE. to NW.; but though a great number of crater-pits appear here—many in chains—

and a number of shallow valleys, this rill has not been found.

Cuvier (M.)—A fine walled-plain on the west of Licetus, with lofty, steep, terraced walls, rising at α, on the east, 11,951 feet, and at β, on the west, 8,710 feet above the interior, but on the north it is broken into a very irregular condition; whilst throughout the exterior slope of the wall is very gentle, and both the inner and outer slopes are broken by crateriform depressions. Excepting some short wall-projections, the interior appears to be perfectly level, and is so drawn by Mädler and Schmidt, but it contains a small mound near the centre, and a minute craterlet west of it, both extremely delicate objects. Around Cuvier are great numbers of small ring-plains and depressions of various natures, the principal being the deep craters C and D, and the four ring-plains **a**, *b*, *e*, and *f*.

Barocius (R.)—An elliptical ring-plain on the south-west of Maurolycus, surrounded by a lofty, much-terraced wall, rising at β 9,924 feet, and at α 12,111 feet above the interior, which contains a number of considerable ridges and two craters, whilst on the walls are many crater-like depressions. South is the great ring-plain Barocius **a**, 27·7 miles in diameter, with a lofty, in portion terraced, wall, rising at β 7,700 feet above the interior, which is almost level, whilst in the environs are a great number of crater-pits, in places arranged in crater-chains. The north wall of Barocius is broken by the deep ring-plain *b* with lofty walls, and on the floor are two craters and some crater-pits, whilst north of this is the smaller ring-plain Barocius *c*, united by a pass with *b*. West of the principal formation is a wide plain, only broken by ring-plains and shallow depressions, besides the, in this region, ubiquitous crater-pits, the hills and ridges being very insignificant. Barocius *e* is a pear-shaped ring-plain, of only slight depth, however;

and *f*, north of it, is steep and more distinct; whilst still farther is the shallow ring-plain *i*, between which and Barocius *b* is a dark portion of the surface, the most southern within a great distance. North of this is Barocius *g*, a small walled-plain enclosed by low ridges and small walled depressions, with on its west border the ring-plain *h*.

Baco (M.)—A great ring-plain with lofty terraced walls, rising at the great peak β 13,755 feet, and at γ 8,057 feet above the level interior. On the crest of the south wall is a row of fine craters, and on the east wall a row of five small crater-pits. East is the considerable ring-plain Baco *b*, with low walls surrounding a flat floor containing two craters and two small crater-pits, whilst south of Baco is the smaller but finer ring-plain **a**, with a strong central peak and steep terraced walls, rising 8,767 feet above the interior. Baco *e* is a small ring-plain with a central peak, and beyond, as far as Jacobi, extends a bright plain, broken by a few ring-plains and a considerable number of small shallow crater-pits.

Jacobi (M.)—A considerable ring-plain, with many crater-like depressions and peaks on its walls, which rise on the east 9,688 feet, and on the west nearly as much above the floor, and contains many hills, two single craters, a double crater-like formation of but slight depth, and two crater-pits. South, are many irregular ring-plain-like depressions, containing some smaller ring-plains, the principal of the former being Jacobi *b*, *e*, and *f*, whilst the three chief small ring-plains are Jacobi **a**, B, and C. In the north wall of Jacobi is ϕ, a short crater-rill, according to Schmidt (S. 348), though much like a narrow, rugged valley.

Pentland (M.)—A ring-plain, 50 miles in diameter, with a steep terraced wall rising about 10,000 feet above the interior, and highest at the peak, β, whilst the interior contains a fine central peak, A, in $-$ 63° 40′ lat. and $+$ 10° 47′ long. The wall possesses a very gentle exterior slope, giving the formation the appearance of a great hole in the surface; but it is much branched, and the wall-projections enclose numerous ring-plain-like depressions. Pentland **a** is a ring-plain nearly as deep and large as Pentland, and west of it are the two smaller but almost as deep ring-plains *c* and *b*, whilst on the north is Pentland *d*, the most distinct portion of a formation resembling Heinsius.

Kinau (N.) [Jacobi, D. M.]—A considerable ring-plain, at the point where two great chains of walled depressions and ring-plains intersect, one chain extending from Jacobi to Simpelius, and the other from Zach to Mutus. West are the four considerable ring-plains **a**, *b*, *c*, and *d*, all of some depth, and the last two with central peaks.

Tannerus (R.) [Mutus, B. M.]—A regular ring-plain, with steep walls of moderate height and a nearly level interior, only broken by a sharply-marked central peak. North is a broad plateau containing four considerable depressions resembling ring-plains and a fine peak, the deepest depression being Tannerus *c*, and the largest *f*. East is the deep ring-plain D, containing a central peak and a small crater, and west of it is the smaller but very similar *e*, whilst on the south are some small hills and crater-rows. South and west of Tannerus are some groups and rows of very small ring-plains. Mädler could not identify this name, and considered it very uncertain to which formation it properly belonged, but as this ring-plain is by far the most distinct, it most probably represents Riccioli's Tannerus.

Mutus (R.)—A great walled-plain, 50·86 miles in diameter, one of the most distinct in this region, with a fine steep wall, rising at α 7,769 feet above the wall of the small ring-plain *b*, and 12,284 feet above the interior, whilst the west wall at δ rises 13,659 feet above the interior. On the interior are the two small ring-plains **a** and *b*, together with some small hills and crater-pits, whilst the centre of the floor, from nine measures by Mädler, lies in $-63° 6' 5''$ lat. and $+29° 21' 50''$ long. East of Mutus extends a great chain of ring-plains to Zach, commencing at Mutus *c*, a deep ring-plain containing a small crater and a central peak. West of Mutus is a high plateau, broken by three circular deep depressions, the central one, *e*, being, though smallest, the most distinct; and branches of this plateau enclose a kind of ring-plain *f*, with a lofty peak at β on its east border.

Manzinus (R.)—A considerable walled-plain, 61·97 miles in diameter, with steep, lofty walls, rising on the east 10,647 feet above the interior, but towering at the great peak β 14,548 feet above the level of the floor, whilst on all sides the walls are broken by deep crater-like depressions. On the otherwise level interior are two very delicate craters and a small central peak, only to be seen with powerful telescopes. The small ring-plain A, on the south wall, and the somewhat larger ring-plain C, on the south-east, are the two principal formations near Manzinus, whilst on the west are three short crater-chains near the wall, a number of crater-pits, and a short rill, ϕ.

Boguslawsky (M.)—A great walled-plain, bordered by a labyrinthical mass of mountain chains, broken by deep crater-like depressions and small ring-plains, the whole rising in lofty peaks in places, one at α being 11,369 feet above the floor. On the interior slope of the walls are several terraces and some small ring-plains, those on the east being rarely visible; but the interior itself seems to contain only a short, nearly central ridge, and some wall projections. The environs of Boguslawsky appear to be some of the wildest on the Moon, but from their position can scarcely ever be seen with distinctness. East are some irregular depressions, apparently without walls; south is the ring-plain *e*, and west the irregular depression *b*, with two central peaks.

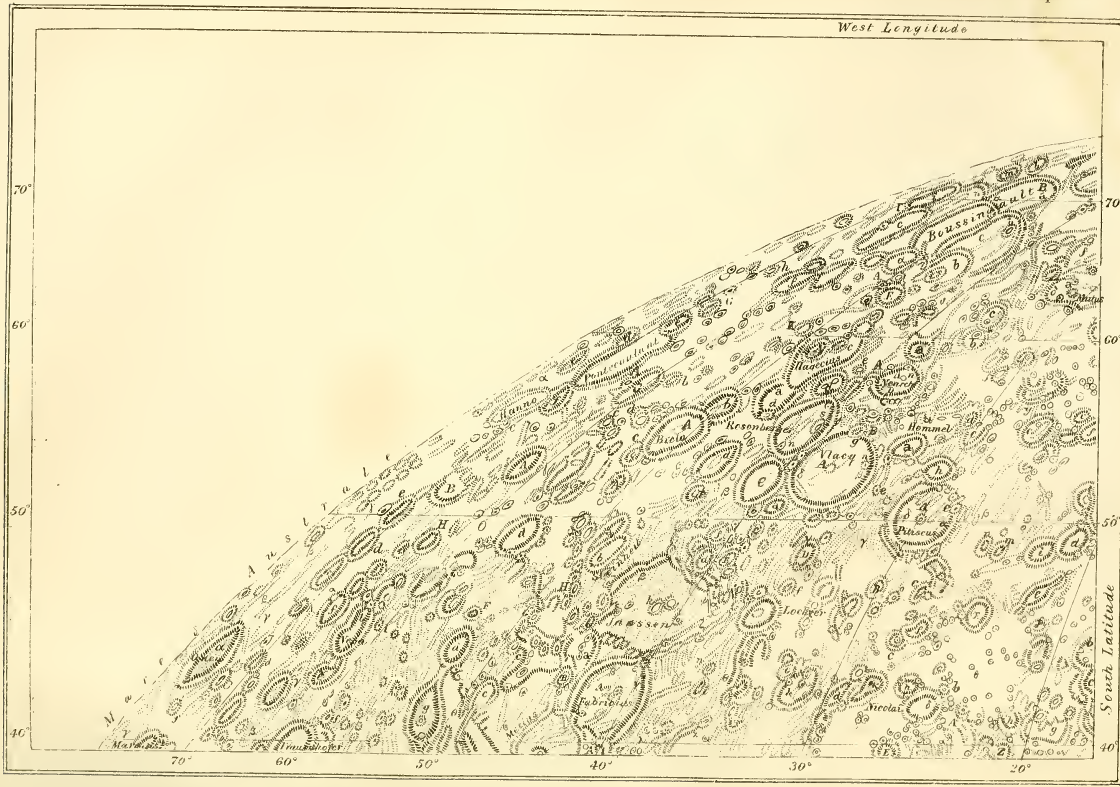
CHAPTER XXIV.

MAP XVIII.

Boussingault (M.)—A colossal ring-plain, 92 miles in diameter, like Phocylides divided by a curved cross-wall, α, into two parts, one deeper than the other, but, with the exception of a few wall-projections, with a nearly entirely level interior. On all sides Boussingault is surrounded by great ring-plains, though *f* and those near it look more like great clefts than ring-plains, whilst on the walls of *c*, *i*, and **a** are great peaks, *B* and Γ being brightest and most distinct. Boussingault G, in $-61° 55'$ lat. and $+67° 40'$ long., appears in Full distinct, and is on the border of Pontécoulant *e*, the southernmost of the dark ring-plains of the Moon.

Hagecius (R.)—A very peculiar formation, presenting anomalous features as seen in every illumination, appearing heart-shaped, and with many crater-like depressions on its borders. On the interior are the two small but regular ring-plains, containing distinct central peaks, and on the north Hagecius breaks into the wall of the deep ring-plain **a**, though elsewhere, almost without exception, the smaller formation disturbs the larger. South of Hagecius the surface contains many, mostly shallow, depressions and ring-plains, the principal being E, whose centre is in $-62° 29'$ lat. and $+47° 50'$ long., whilst on the west the most conspicuous formation is the small but deep depression K, in $-60° 37'$ lat. and $+52° 2'$ long., beyond which is a wide open plain containing a few ridges and a number of the smallest kinds of ring-plains.

Map XVIII.



West Longitude
South Latitude
Mare Australe
Boussingault
Pontecoulant
Hanno
Hagecius
Biela
Rosenberger
Nearch
Hommel
Vlacq
Pitiscus
Steinheil
Janssen
Lockyer
Fabricius
Nicolai
Fraunhofer
Metius
70°
60°
50°
40°
30°
20°

Nearch (M.)—A fine circular ring-plain, with a wall containing a lofty peak A, in − 58° 20′ lat. and + 40° 0′ long., and some small craters, D being the principal, together with many branches and projections, whilst the interior is only broken by the deep crater *n*, and a long ridge extending south from it. A chain of considerable ring-plains, a, *b*, and *c*, extends from Nearch to Mutus, with rugged walls, and surrounded by small crater-like depressions.

Rosenberger (M.)—A ring-plain with a moderately high wall, in part, on the east, common with Vlacq, and rising about 5,000 feet above the interior, whilst it contains several, in places broad, terraces. The interior contains a fine central peak and a small crater, *n*, together with a shallow depression, *s*, and some low ridges. South of Rosenberger is a sharply walled ring-plain *d*, with two deep craters on the floor, and south a shallow valley *e*, whilst north of Rosenberger is the fine ring-plain C, with steep lofty walls but a perfectly level interior. On the west is the ring-plain a, with some steep peaks and two craters on its wall, and a central ridge on the floor, with, on the north, the deeper B, whose central peak is in − 51° 40′ lat. and + 45° 23′ long., whilst farther north extends a wild hill-land, on whose southern border is the peak β.

Vlacq (M.)—The greatest and deepest of the ring-plains of this group, 57·30 miles in diameter, with very unequal though steep and rugged walls, terraced only on the east, and rising at δ 8,582 feet, and at β 10,168 feet above the interior. The floor of Vlacq contains a fine central peak A, in − 52° 0′ lat. and + 36° 44′ long., though only 1,000 feet high, together with a small crater *n*, and some small with difficulty visible hills and ridges, scarcely 150 feet high. Vlacq is surrounded by a wide hilly highland, broken by a number of ring-plains and walled depressions, but none of particular depth, and **a**, D, and *c* are the most important; whilst on the east, in a valley, near the two small depressions south of Vlacq *e*, Lohrmann saw a small rill that has not been seen again (S. 425).

Hommel (R.)—A considerable, strongly elliptical, walled plain of irregular form, originating in the union of the five small ring-plains Hommel **a**, B, *d*, *c*, and *h*, by cross-walls and a broad plateau, consequently neither a true lunar formation, though near the terminator, appearing as much so as Licetus, nor a suitable formation to receive a name, so that advantage would have accrued had Mädler transformed the name to the ring-plain **a**. The border reaches its maximum height at the crest of the elevated rugged plateau α, the projections from which occupy fully a third of the interior, and another third is taken up by the ring-plains **a**, *c*, and *d*, the remainder being, however, more level. The ring-plains around and within Hommel are of the character usual in this district, with rugged, moderately high walls and tolerably level interiors, and the small crater within B is in $-$ 55° 28′ lat. and + 36° 40′ long. South-east of Hommel the surface is leveller than farther west, and contains, besides the ring-plains, only a few low ridges and the usual number of crater-pits, the principal formations being the regular ring-plain *e*, with three crater-like depressions on its walls, and a ridge and two craters on its floor; *g*, an irregular formation of the same character as Hommel, only smaller; and *f*, a fine very deep ring-plain with some shallower ones near it.

Pitiscus (R.)—A fine regular ring-plain, 52·20 miles in diameter, with a moderately steep wall, broken by some craters, and the small ring-plain *e* in the south, but rising on the east at α 6,529 feet, and on the west, at δ, 10,085 feet above the floor. The interior contains some short ridges, and three crater-pits, together with a central peak of small height, and the fine deep 7° bright crater A, from eight measures by Mädler, in − 49° 58′ 43″ lat. and + 29° 32′ 49″ long. A small chain of irregular, shallow ring-plains extends from the north wall of Pitiscus to the peculiar depression *c*, whilst on the east is the small but distinct peak *β*, some 2,500 feet high; and on the west, between Pitiscus, Vlacq, and Hommel, is an elevated plateau, full of small hills, and containing some craters.

Nicolai (M.)—A ring-plain, 18 miles in diameter, with broad walls, very steep towards the interior, falling very gradually, however, to the surrounding surface, and rising at *δ* 6,261 feet above the interior, which contains two very minute craters, one of which was seen by Mädler. Nicolai is the centre of what must be considered to be a great bright plain, bordered by Pitiscus, Baco, Barocius, Büsching, Riccius, and Fabricius, containing a number of large and small ring-plains, a few craters, and a considerable number of small crater-pits, ridges, and hills, whilst at Full it is crossed by many bright light streaks. The craters A, in − 42° 2′ lat. and + 22° 57′ long., and *b*, are very distinct, the first being 9° bright, and the last 7°½ bright in Full, both being crossed by light streaks, whilst one between the two crosses Nicolai.

North of Nicolai, the mountains form a kind of walled-plain, whose border rises at *α*, nearly 4,000 feet high, and east of this the mountains are somewhat numerous, and rise at points 5,000 feet high, enclosing at *z* a rough ring-plain, with steep borders and a small central peak. South, is the ring-plain Nicolai E, in − 45° 19′ lat. and + 23° 51′ long., near which are many shallow crater-pits of some size, and at Full appear here a number of short light streaks, radiating from Barocius, but forming a portion of the great system of Tycho. West of E is the shallow ring-plain *f*, of somewhat square shape, and north of this is the deep ring-plain *c*, and the very shallow *d* and *k*, separated by a steep mountain arm north of *c*.

Lockyer (B.) [*Fabricius*, C.]—A very considerable ring-plain, 32 miles in diameter, with very steep uniform walls, nearly 9,000 feet high, and a level interior, broken only by a distinct central peak, in $-$ 45° 55′ lat. and + 35° 37′ long. South is the much smaller but very similar formation *f* (probably Vlacq *f* of M.), and east are some of the peculiar depressions, resembling ring-plains, common in this region, and beyond is Lockyer G, a small deep ring-plain, on the borders of the peculiarly irregular formation *h*.

Fabricius (R.)—A fine ring-plain, 55·51 miles in diameter, with a rugged, much terraced wall, open on the south at ε, but rising at δ 7,499 feet, at γ 8,339 feet, and at β nearly 10,000 feet above the interior. The floor of Fabricius contains three fine central peaks, two craters, two craterlets, and some ridges and hill chains, and the principal central peak A, from nine measures by Mädler, is in $-$ 42° 8′ 0″ lat. and + 40° 46′ 0″ long. West is the smaller but as rugged ring-plain Fabricius **a**, with walls scarcely as lofty as those of the larger formation, to which it is united by a small narrow plateau lying between the crests of the two walls, and appearing as a fine valley at times, broadening out on the south, where it terminates in a steep slope, crowned by a row of nine peaks, whilst on the north it opens into a lower but wider plateau, containing the very deep but small ring-plain Fabricius B.

Janssen (B.)—A great walled-plain, enclosed by very irregular mountain chains, and enclosing a space of about 10,000 square miles, and though more irregular than most of the walled-plains, this is not apparent near the terminator, when alone the details can be well seen. Janssen is tolerably circular in outline, except where Fabricius occupies the north-western region, and in places its very complex wall rises in considerable peaks, though it is everywhere crossed and broken by numerous valleys and small ring-plains. It is highest on the south-west near β,[1] and at α on the south; the wall in the east being highest near θ, and on the north at the two peaks χ and λ, though near the last it is almost destroyed by long cross valleys. The interior of Janssen is one mass of mountain ridges and short valleys, broken in places by ring-plains of various dimensions, the largest being *i* on the north-east, and the deepest *K* in − 45° 59′ lat. and + 41′ 16″ long. on the south-west, the rest being much smaller, and most of them appear like shallow depressions. Across Janssen extends a great valley, ζ, with several smaller valleys opening into it, commencing at Fabricius ε, and ending on the open plain east of Janssen E. It is Schmidt's 421, he regarding it as a rill valley, though it is in every way apparently quite distinct from the rills, except in being narrow, and is distinctly visible for some time after sunrise, with very small telescopes, a two-inch aperture rendering it an easy object, though Mädler did not see it until 1834. Extending from the mountain α to the valley is a fine rill, ϕ, discovered by Mädler in 1837, though Schmidt, whose 424 it is, was unaware of this; and, south, Schmidt has seen two short crater rills (S. 423 – 422). In the east is θ, a very similar valley to ξ, only being broader it does not show the rill-like appearance of ξ, and between the two is the still broader η, but all belong probably to the same class of formation, the true lunar valleys resembling those of Bode and Lexell. South of Janssen is an elevated hill region, broken by some ring-plain-like depressions, the principal of which are Janssen E, *f*, and *d*, the last with a central peak.

Steinheil (M.)—A double ring-plain, similar to Sirsalis, and some other formations of a like nature, but probably the

[1] The entire letters employed are attached to Fabricius in the 'Der Mond,' with the exception of α and ξ.

deepest of the class on the Moon, and can for long after sunrise be distinguished with ease from all other ring-plains in this region, though becoming visible only shortly before sunset. The ring-plain *b*, on the east, is the principal of the two, and is 27·7 miles in diameter, with a depth of 11,772 feet beneath the west wall, and 11,887 feet beneath the east wall, and its interior, with the exception of some wall-terraces, is perfectly level, whilst the interior of **a**, which is 11,079 feet beneath its east wall, contains some low ridges. North and north-west of Steinheil are a great number of the peculiar ring-plain-like formations of this region, together with some deep craters, the two principal being F, in − 45° 20′ lat. and + 52° 41′ long.; and G, in − 46° 21′ lat. and + 50° 41′ long., whilst H, in − 46° 24′ lat. and + 47° 22′ long., and *c*, are rather deep ring-plains than craters. In the west, extending from Vega to Biela, is a fine row of irregular ring-plains, in some places of considerable depth, especially the four from Steinheil *e* to *d*; and when the lower cross-walls are immersed in the shadow of the higher western or eastern wall, the whole assumes the appearance of a gigantic cleft.

Biela (M.)—A fine distinct ring-plain, with broad, regular walls of considerable height on the east and south-west, where the peaks are about 9,000 feet high; but on the north it is lower, and is here bordered by a small ring-plain *c*. The interior of Biela is nearly level, being only broken by a small central peak *A*, in − 54° 23′ lat. and + 51° 0′ long, and some small ridges. South is the deep but small ring-plain *b*, with an almost level interior, and on the west *d*, a similar formation on a reduced scale to Steinheil, whilst north is the small ring-plain A.

Pontécoulant (M.)—A great ring-plain near the Moon's limb, with 5° bright, somewhat irregular, walls, rising in places about 6,000 feet above the interior, which is level and only 2° bright. South is the smaller, very similar formation *e*, and north the still smaller *f*, both with only 2° bright interiors, whilst east is the large ring-plain *G*, and the two smaller *c* and *b*, the first two with central peaks. The small crater A is 6° bright, and is easily seen under even high illumination, whilst on the west of Pontécoulant extends one of the bright lunar plains, nearly two hundred miles long and one hundred and fifty broad, broken by only small ring-plain-like depressions and low hills and ridges.

Hanno (M.)—A ring-plain close to the limb of the Moon, with 5° bright walls and a 2° bright level interior; with west of it a fine mountain *α* on the north of a considerable ring-plain Hanno *e*, south-east of which is the deeper ring-plain Hanno *d*. On the north-east border of Hanno is *c*, a small ring-plain, and beyond are the two considerable ring-plains Hanno A and B, both with high steep walls and bright level interiors.

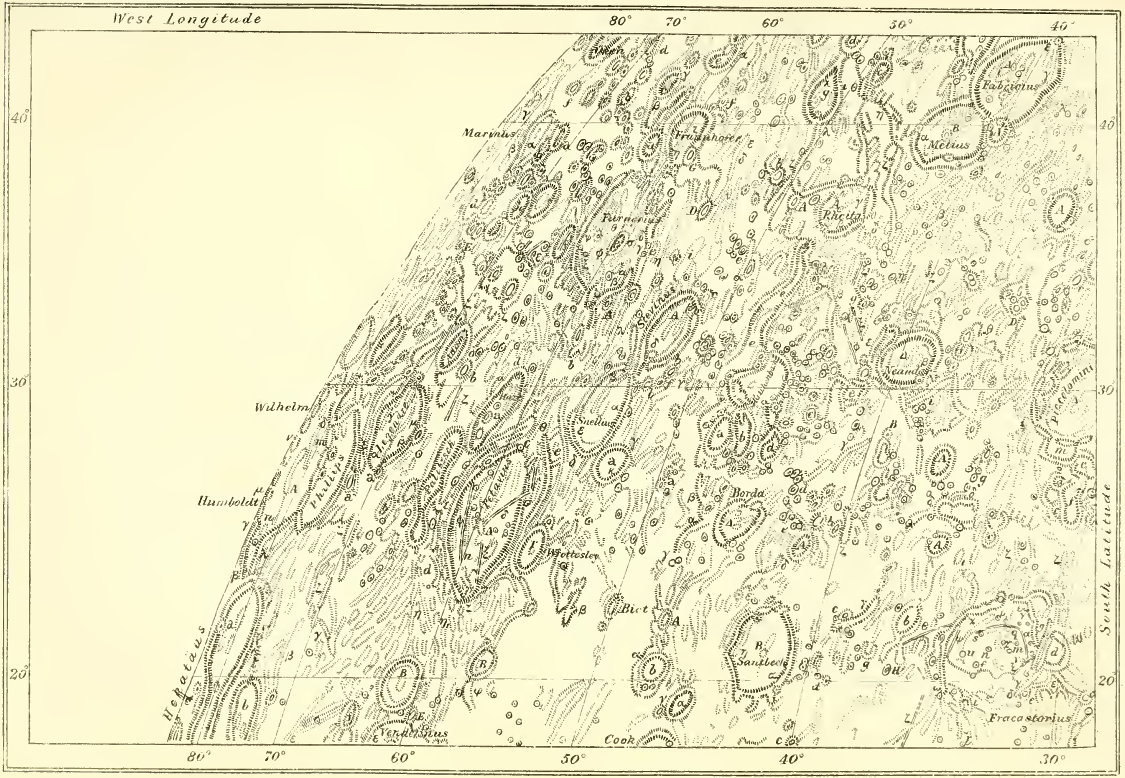
Vega (M.)—A very peculiar formation that only appears as a ring-plain under certain conditions of libration and illumination, generally only the lofty east wall appearing, the rest being more or less hidden. The southern portion, *b*, of the floor is depressed below the remainder, and on the north the wall appears to be only the border of a highland. The same irregularity of form appears in the environs of Vega, well-enclosed circular formations being few, most of them exhibiting some irregularity or anomaly in formation, whilst from the high peaks on their walls, hiding portions of the walls, the true character of the object is often difficult to ascertain. The two principal formations are Vega *f*, with the great peak *α* on its wall; and H, of some depth, and in − 48° 13′ lat. and + 61° 55′ long. In the west, on the border of the Mare Australe, is the great crater-plain Vega A, 9° bright, with a very distinct northern end, from eight measures by Mädler, in − 44° 56′ 54″ lat. and + 68°

44′ 0″ long. South is a row of three considerable ring-plains—Vega *c* with 5° bright walls and a 3° bright interior, Vega *d* with also 5° bright walls and a 2° bright interior, and Vega *e* with 4°½ bright walls and a 2° bright interior, forming a portion of the east border of the Mare Australe. East of Vega is a wide very complex hill-land, crossed by numerous valleys and containing a few small ring-plains, Vega I, in − 45° 0′ lat. and + 60° 33′ long. being the most distinct from its fully 6°½ brightness.

Oken (M.)—A considerable ring-plain, from its great west longitude only very seldom visible, with moderately high 4° bright walls rising at α about 6,000 feet, and a 2° bright interior, crossed by two delicate 4° bright ridges, enclosing a narrow rill-like valley. West of Oken only a few craters and the peak δ can be distinctly seen, and the valleys here appear dark and the mountain bright. South of Oken are some high ridges, the two chief being Oken β and γ.

Mare Australe (M.)—A dark Mare on the extreme limb of the Moon, requiring favourable conditions of illumination and libration to be well seen, and it then appears to stretch from − 36° lat. to − 54° lat., a distance of 360 miles, and after being in − 54° lat. broken by a twenty miles broad bright portion, can be seen from near −55 ° lat. to extend as far as − 61° lat. or over 120 miles more; but were it more favourably placed it is possible that it might appear entirely connected, and the various interruptions seen to be due to numerous bright ridges on the surface which would hide the dark interior between them. The breadth is very variable, being, however, in the region of Oken, about 190 miles. The Mare Australe is far from level, being crossed by a great number of low ridges, some scarcely brighter than the 2° bright Mare, whilst on the surface are a number of ring-plains, some being of considerable dimensions.

Map XIX.



West Longitude
South Latitude
Hepatäus
Humboldt
Wilhelm
Philips
Legentil
Marinus
Fraunhofer
Furnerius
Stevinus
Petavius
Snellius
Wrottesley
Biot
Borda
Santbech
Rheita
Metius
Fabricius
Neander
Piccolomini
Fracastorius
Vendelinus
Cook

CHAPTER XXV.

MAP XIX.

Marinus (M.)—A ring-plain on the north-east border of the Mare Australe, ordinarily appearing as a dark spot, its 5° bright narrow wall being seldom distinctly to be seen, though rising at points considerably above the interior, α being some 7,700 feet high, whilst on the south the wall appears still higher. West of Marinus only the two lofty peaks β and γ can be well distinguished, and form the principal points of a long 4° bright chain surrounded by the dark Mare. North is the small ring-plain Marinus *d*, with a steel-grey, only $1°\frac{1}{2}$ bright interior, and a 6° bright wall, so low on the south as to be hardly perceptible, and which escaped Mädler's notice. The other formations, near *d*, are merely shallow depressions, in no way noteworthy, except the 8° bright crater E in − 35° 5′ lat. and + 75° 0′ long., which, with the 7° bright crater *f*, and the small ring-plain **a**, with its 2° bright interior and 5° bright broad wall, alone appear distinct under high illumination.

Frauenhofer (M.)—A considerable ring-plain with a moderately high wall, rising generally 5,500 feet above the interior, though at η and ζ higher, and towards the north lower; and a nearly level interior crossed by a gently sloping valley. On the wall is the considerable crater-like formation G, in − 38° 43′ lat. and + 58° 0′ long., that alone of the whole of Frauenhofer can be distinctly seen in Full. East of Frauenhofer is a bright region crossed by very numerous ridges, and rising at δ and ε into fine peaks.

West of Frauenhofer is a fine valley, running in portion close under the wall, and extending from the small open plain west of Frauenhofer *f* to the south wall of Furnerius, where it joins the great valley that crosses Furnerius and extends as far as Haze *b*. Beyond the valley west of Frauenhofer are a number of ring-plain-like formations, the principal, a, *b*, and *c*, being deep, the interior of *b* being, moreover, only 3° bright, so that it can be seen in Full, its environs being 4° to 5° bright. Other ring-plain-like formations are enclosed by the mountain ridges β and γ, and on the wall of one of these, Frauenhofer *e*, rises a very considerable peak, Frauenhofer α.

Metius (R.)—A ring-plain of irregular form, with slightly terraced, very lofty walls, rising at α 13,086 feet above the interior, and with many other peaks 3,000 feet above the crest of the wall, whilst at various points small bright craters have broken the wall, including two on the gentle interior north-east slope. On the floor is the deep crater B, in − 39° 42′ lat. and + 43° 38′ long., together with a number of flat ridges and two small crater-pits. East of Metius is the great bright crater-plain A, with very steep walls, and the surrounding irregular surface broken by several small craterlets, whilst on the walls of A itself is a very delicate crater and twelve peaks. North-east of Metius is a great hill-region, crossed by a great number of valleys, and containing both small craters and ring-plains, and with the highest point at the peak Metius β.

Rheita (R.)—A circular ring-plain with steep, lofty, much-terraced walls, rising at the long peak β 14,350 feet, and at γ 10,033 feet, above the interior, which contains a small crater and a long ridge, rising into a central peak A in − 36° 32′ lat. and + 46° 22′ long. South of Rheita is a colossal valley commencing in a steep decline from the small highland δ, east of Rheita, and ending at the north end of the fine ring-plain Rheita *d*, a length of 187 miles with a breadth of from 10 to 25 miles; it is bordered on the south by a great frowning line of cliffs, the northern end of the elevated highland west of Metius, and rising at θ 9,452 feet, whilst on the north the border is a broad, very rugged mountain arm, much lower than on the south. East of θ the valley is crossed by two low projections, opposite which is an opening in the south wall uniting the valley with the level plain south-west of Rheita. Rheita *g* is a pear-shaped rounded valley, enclosed between the two lofty mountain arms χ and ι, and containing some low ridges and a craterlet, whilst on the north it communicates with a shallow valley west of the great elevated ridge extending from λ to μ. Between Rheita and Furnerius is the hill-land east of Frauenhofer already mentioned, and on this are the two considerable craters Rheita A and *b*. Near the peak Rheita ζ, on the border of the great valley, Schmidt has often seen a rill (S. 416), in $-$ 39° lat. and $+$ 46° long., which has not been identified, though east of the position given by him, in the great southern cliff east of ζ, is a fine narrow valley, at times very like a rill.

Furnerius (R.)—A great but irregular walled-plain with a steep wall much broken by crateriform depressions and valleys, and containing many lofty peaks, the four principal ones being α 10,494 feet above the interior, and with a narrow pass on its east, β 11,490 feet high, γ 11,420 feet, and δ 10,033 feet above the interior. The floor of Furnerius is crossed by numerous ridges and the great valley σ already mentioned, together with several crater-like depressions, and the small but deep ring-plain B, whose central peak is in $-$ 35° 5′ lat. and $+$ 59° 14′ long. North of B is a peculiar bent rill ϕ, very delicate and not easily seen, and on the north-west are two crater-rills, ξ (S. 409), easily visible, and ψ (S. 410) more difficult, being shallower, both discovered by Schmidt; whilst on the north wall Lohrmann saw a rill (S. 411) which Schmidt could not find, and it may very likely have been a valley. On the outer slope of the wall of Furnerius is the small steep deep crater A, 8° bright, and a sharply marked point in Full, whose position, from nine measures by Mädler, is $-$ 33° 6′ 4″ lat., and + 57° 51′ 52″ long., whilst from it extends south for 90 miles a pale light streak, and another extends 50 miles north. East of A is the small deep ring-plain *c*, and between the two is a fine valley opening into Furnerius by the pass east of the peak α. From Furnerius A to Petavius θ and west of this extend some long ridges with some considerable peaks at λ and η; and south of these is the depression D, north of which is the long plateau *i*. From Furnerius to the limb extends a labyrinthical region, only to be drawn with very considerable trouble, and containing numerous crater-like depressions and ring-plains, the four principal formations being *f*, *g*, *h*, and *i*; and in the first Lohrmann believed he saw a short rill (S. 408) that has not been again found; whilst west of this in the plain near ϵ he drew a second rill (S. 407), likewise not again seen. At ϵ and ζ the elevated plateau-like formation is traversed by two very rugged clefts or valleys, similar to, though very much smaller, than that south of Rheita.

Adams (B.) [Legendre, C. M.]—A considerable ring-plain south of Legendre with a lofty peak δ on its wall, whilst south-west is a delicate rill-like valley ζ of the same character as Furnerius ϵ. On the east, Adams is bordered by an elevated plateau with somewhat steep and rugged slopes, whilst west is a broad flat valley somewhat brighter in tint than the surrounding elevated regions.

Legendre (M.)—A ring-plain 46 miles in diameter, with a very unequal wall broken by two craters and a peculiar depression, and rising at β 8,204 feet, at α about 11,500 feet, at λ some 9,000 feet, at μ only about 4,500 feet, and near κ 7,500 feet above the interior, which is only crossed by a small ridge. Legendre *b* is a precipitous crater plain with 8° bright walls and a 3° bright interior, situate on an elevated plateau east of Adams. West of Legendre is a narrow valley with a high peak at ε extending south to a plateau with many crater-like depressions which borders Legendre *d* on the east.

Wilhelm Humboldt (M.)—A great walled plain, extending from − 23° to − 30° lat., and from + 78° to + 85° long., possessing therefore an area of nearly 12,000 square miles,[1] and consequently, after Clavius and Schickard, the largest walled-plain visible to us. The walls are lofty, and the grand peaks can be seen with ease far within the terminator, the most distinct and highest being on the east wall, λ in − 23° 40′ lat., about 16,000 feet high, κ in − 23° 8′ lat., 10,200 feet above the interior, and δ in − 29° 5′ lat. about 9,600 feet in height; and on the west, γ in − 24° 45′ lat., about 15,000 feet, μ in − 25° 54′ lat. 11,500 feet, and two others, β and ν, perhaps 9,600 feet in height. The floor of Humboldt contains a number of ridges, two dark steel-grey spots, *n* on the south 1° bright, and *m* on the north 1°½ bright, together with a central ridge, containing some fine peaks; the principal A being 5,700 feet high, and that in − 27° 2′ lat. nearly 4,000 feet, whilst two others in − 26° 12′ lat., and − 25° 30′ lat., rise 3,200 and 2,200 feet respectively above the interior. In the south-west wall Schmidt has seen a short rill, (S. 405), which is very seldom visible, and is south of the peak ν.

Phillips (B.) [W. Humboldt, A. M.]—A fine walled-plain, east of Wilhelm Humboldt, with a wall of considerable height, and a number of ridges upon the interior, whilst on the slope of the wall on the west are two deep

[1] Mädler makes the area too great.

craters. East of Phillips is a considerable plateau, containing the 6° bright small ring-plain Phillips a and falling gently towards Palitzsch, though steeply on the north at Phillips ζ, and on the south near Legendre ε.

Palitzsch (S.)[1]—An irregular elliptical ring-plain, with a steep, much-branched, narrow wall, sending many projections into the interior, and apparently eight times as long as broad, though only in reality three times. North-west are the two ring-plains a and *b*, the former with walls rising 6,000 feet above the interior, and the latter with a central peak, and walls which are about 7,700 feet high.

Petavius (R.)—A fine walled-plain, with a steep lofty wall, in most places double, separated by long narrow valleys, and rising on the east at β 10,945 feet, and on the west at ε 6,433 feet above the interior. The convex interior contains a very considerable number of low hills and ridges, besides a fine central peak A, rising 5,595 feet above the surface on the east, and, from eleven measures by Mädler, in − 24° 38′ 58″ lat. and + 59° 15′ 53″ long. West of A is a small peak, 3,888 feet above the plain on the west, whilst the entire floor being convex in form, the interior near the central peaks is about 800 feet higher than under the walls. In the map Mädler draws two small craters south-west of A, which in his finished drawing of Petavius do not appear, but yet at times the surface near these supposed craters seems to have two small depressions. From the central peak A, to the east wall, extends a fine rill δ (S. 404), discovered by Schröter, and in places very deep and broad, so that it can easily be seen with an aperture of only two inches. Gaudi-

[1] This is not Schröter's Palitzsch, as Beer and Mädler, who seem to have been but ill-acquainted with Schröter's work, state, as this was a slightly depressed portion of the surface near Furnerius A. The alteration, however, is a very considerable improvement.

bert has seen a continuation of this rill, running south in an irregular manner, and crossed by a short branch. On the west portion of the floor of Petavius is a long rill ϕ discovered in 1870, and north of the central mountain A is another ξ, with two short rills west of it, these three having been discovered by Gaudibert. Besides the two doubtful depressions south of the central peak, the floor contains two very delicate craterlets, and three or four shallow crater-pits, the last not being drawn. In Full Petavius can no longer be found, only the 6° bright crater *c*, and two dark spots on the floor, *n*, 1°½ bright on the north, and *m*, 2° bright on the south wall, remaining visible.

The environs of Petavius are highly interesting, though only drawn with very considerable difficulty, and in most directions are covered with numerous ridges and hills radiating from Petavius, and forming narrow long valleys of little depth, but much branched. Petavius B., in − 20° 49′ lat. and + 56° 12′ long., is a deep ring-plain, with terraced walls, having on the south a small crater; and west is *d*, a small plain enclosed by mountains, whilst exactly opposite, on the other side of Petavius, is *e*, a very similar formation.

Wrottesley (B.) [Petavius, **a** M.]—A fine ring-plain on the east of Petavius, with high very steep walls, retaining their shadow nearly four days after sunrise according to Mädler, and on the east 8,837 feet high. The interior, which is nearly as bright as the walls, contains a 5° bright central peak Γ, in − 24° 35′ lat. and + 55° 30′ long, and at times a small craterlet can be seen south of the central peak.

Haze (S.)—A considerable ring-plain with a rugged wall rising about 7,500 feet above the interior, and broken by crater-like depressions, whilst on the floor are some low mountains, a crater **a**, and some smaller crater-like formations. South-west is Haze *d*, a second still deeper ring-plain of more irregular form, rising at α 11,765 feet above the nearly level floor. On the east is the short mountain-chain β, and on the west a kind of doubtful crater rill ζ (S. 406).

Snellius (R.)—A ring-plain with broad terraced walls falling gently on the west, but steeply on the east towards the interior, and rising at α 6,823 feet, whilst they are broken by several crater-like depressions; but being 5° bright and the interior only 3°, Snellius can be found with some trouble in Full. The interior contains a central mountain in − 29° 25′ lat. and + 54° 39′ long., and from it, extending towards the southern wall, which it crosses at β in a pass, is a fine rill-like valley, ending in the grey plain west of Stevinus. Snellius **a** appears not as a ring-plain, but a great steeply-sloping depression, with a smooth interior and two peaks in the west border, and one in the east, whilst near κ it is 6,695 feet below the surface. Snellius *b* is a fine deep crater and 7° bright, though drawn by Mädler merely as a depression.

Stevinus (R.)—A regularly formed ring-plain with broadly terraced walls, containing only few peaks, but with two low passes, and rising at β 11,420 feet, and at δ 10,180 feet above the 3° bright interior, which contains a 5° bright central peak in − 32° 0′ lat. and + 53° 3′ long. The environs contain a number of mountains and many crater-like depressions, together with some of what are probably true lunar craters. Stevinus **a** is 8° bright and very deep, *b* 6°½ bright, and *f* 7° bright, all on a 6° bright arm, which extends from the wall of Snellius, whilst Stevinus *e* is 6° bright and has a 4° bright interior, all these being visible in Full; and Stevinus itself is better visible then than perhaps any formation in this region of equal size, except Langrenus.

Reichenbach (M.)—An irregular ring-plain with a lofty steep wall rising at α 11,721 feet, and broken in places by deep passes, terraced on the west, and consisting on the north of a broad plateau, whilst the interior, excepting a few wall projections and three little hills, seems level. On the plateau on the north are the three considerable and deep depressions a, *b*, and *d*, and west and south is a similar highland, also broken by many crater-like depressions, *c* being apparently a small ring-plain, whilst on the west border of this highland is the great valley Reichenbach *e*, ending near the small imperfect ring-plain *f*, and with very steep sides.

Neander (R.)—A tolerably regular ring-plain, 33·80 miles in diameter, with a massive much-terraced wall rising on the east at β 7,948 feet above the interior, which contains a central peak some 2,500 feet high, in − 31° lat. and + 39° 26′ long, and a number of small hills. Between Neander, Stiborius, Metius, and Rheita is a wildly mountainous region, consisting apparently of an elevated plateau falling very gently on all sides, and traversed by an immense number of long valleys of all descriptions, separated by ridges and mountains which rise occasionally in fine peaks. Between Neander ζ and η, both perhaps 6,000 feet high, extends an irregular, much-branched valley as far as Metius β, full of small ridges and hills, and west of this by Neander *g* are three rills, two discovered by Schmidt ɸ (S. 412) being the most distinct, ξ (S. 413) being delicate, whilst south of the last Lohrmann saw a third rill, ξ_1 (S. 4,141), presumably again seen by Schmidt, who considers it probably a continuation of ξ, but which has not been seen, though often looked for. The highest mountain peak in this region appears to be ε, rising 8,966 feet above a small not very uneven plain in the west, and wrongly placed in the 'Mappa Selenographica.' North-east of Neander is a small rill-like valley, *i*, crossing a small highland and seen by Mädler in 1834, and is probably Lohrmann's rill (S. 415), which Schmidt could not identify; probably because, like several of Lohrmann's other pseudo-rills, its valley character is usually so well marked that it does not appear at all like the true rills, its rill-like appearance being only seldom visible. Beyond this plateau is the ring-plain Neander A, with a very slightly rising exterior slope and a strong central peak, with close to it some crater-like depressions, near *g* being a group, and north of the crater B are two united to each other.

Borda (M.)—A ring-plain with steep, much-terraced walls, with a narrow pass on the south, and a fine central peak Δ, in − 25° 9′ lat. and + 45° 14′ long., united by two smaller peaks to the wall, rather an anomaly here. East is a comparatively open plain, containing a few hills and crater-like depressions, whilst west are some considerable mountains. At β these mountains are very steep and lofty, and at α rises a grand mountain into a lofty peak 11,018 feet above the grey Mare below. Beyond the narrow arm of the Mare Fœcunditatis rises a fine highland, containing numerous hills and some craters, Borda **a** being the most distinct.

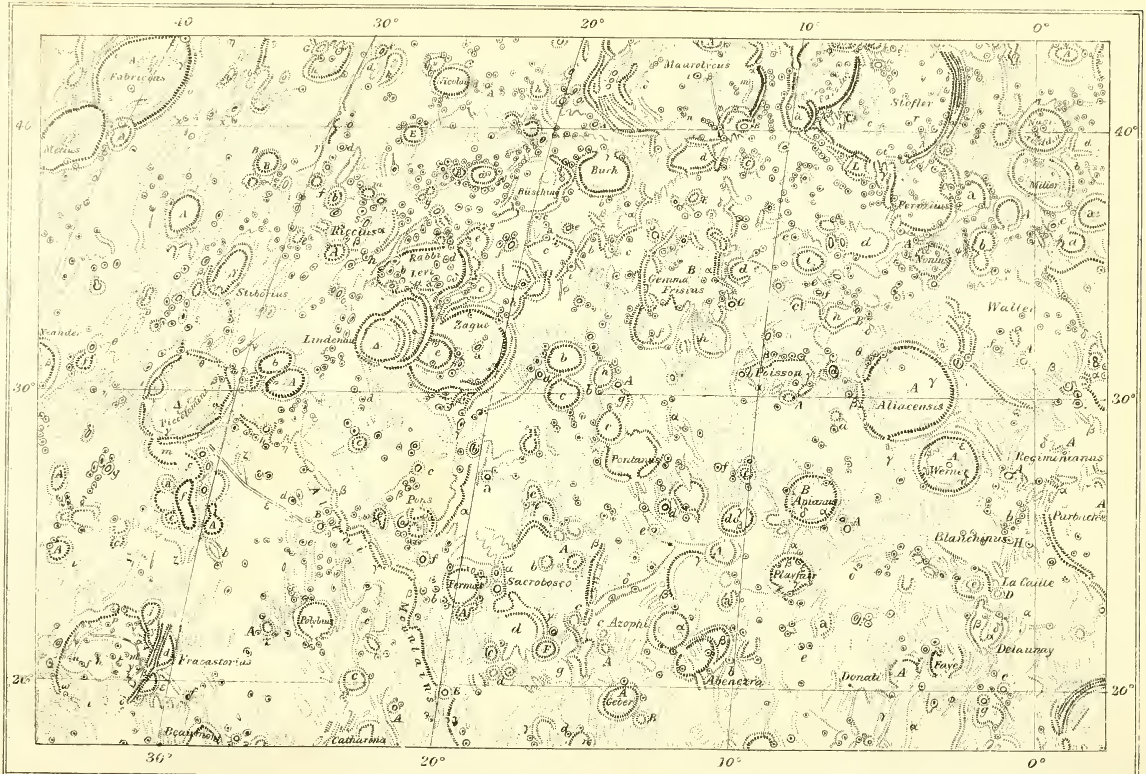
Biot (M.)—A small 8° bright ring-plain, on the south of the Mare Fœcunditatis, whose centre, from ten measures by Mädler, is in − 22° 20′ 10″ lat. and + 50° 4′ 24″ long., and near it are a great number of 5° bright conspicuous light streaks. North-east is Biot A, a very deep 6° bright crater-plain, surrounded by masses of 5° bright mountains, in points rising into lofty peaks, and the centre of A is in − 21° 38′ lat. and + 47° 41′ long. Larger than the last, but scarcely so conspicuous, is the distinct ring-plain Biot *b*, with lofty 6° bright walls around a 3° bright floor. On its north are two craters, both 6° bright, and on its west rises the peak α, 6,541 feet above the Mare Fœcunditatis, though scarcely so high above the floor of *b*; while on its east is a 5° bright light streak, which crosses Cook *d*, and ends near Colombo.

Santbech (R.)—A great ring-plain, 46 miles in diameter, with a complex, very lofty wall, containing many peaks, projections, terraces, and crater-like depressions, rising on the east 15,113 feet and on the west 9,784 feet above the interior; which contains a considerable central peak *B*, in − 20° 33′ lat. and + 42° 30′ long. Santbech is surrounded by an extensive bright plain, broken by only a few ring-plains, craters, crater-like depressions, and small mountain groups, and distinguished from the great Mares of the north by its brighter colour, though near the terminator no difference is noticeable. South is Santbech A, a small ring-plain with steep walls of considerable height and a level interior, whose centre is in − 24° 10′ lat. and + 41° 34′ long., whilst near it are some considerable mountains, rising at δ and ϵ about 6,000 feet high. Santbech *b* is still smaller, but nearly as deep, and the peak ζ, north of it, is lofty but not steep.

Fracastorius (R.)—This formation appears to be one of those great, nearly circular, walled-plains, abutting on the lunar Mares, whose wall nearest the dark grey plain has been destroyed in some manner, and except very close to the terminator, now resembles a great bay of the Mare Nectaris; but at sunrise or sunset the ruins of the northern wall can be seen as a row of hills and mounds. The southern portion of the interior is 3°$\frac{1}{2}$ bright, and elevated above the lower northern portion, which is covered with low hills, and at the same level and of the same colour as the Mare Nectaris. The wall of Fracastorius is 5° bright, and is crossed in many places by fine narrow valleys, whilst it is of very unequal height, rising on the west about 6,000 feet, and on the east, at α, 8,511 feet (three measures), at β 7,431 feet (three measures), at γ 5,199 feet (two measures), and at δ 3,200 feet.

The interior of Fracastorius on the north contains principally only a few hills and one or two small craters; but on the southern brighter portion of the interior a great number of formations have been discovered, only a few of the principal being given on the map. ϕ is a curved rill, the southern portion discovered in 1873, and the rest by Gaudibert in 1874, who also discovered the rill ξ. The small white spots as generally seen, *m*, *n*, *p*, *q*, *r*, *s*, *u*, *v*, and *z*, are very delicate craterlets; and extending between *n*, *z*, *m*, *q*, and *p*, is a peculiar double row of still more minute craterlets seen first by Ingal in part. Right under the west wall, in a position where it can be seldom well seen, is a very delicate rill, ψ, discovered in 1875. In some respects this southern portion of Fracastorius appears to resemble Plato, and of the twenty distinct small craterlets on the floor, perhaps three, *m*, *n*, and *p*, may be true crater-cones, whilst several not drawn may be only deeper crater-pits. West of Fracastorius extends the bright plain towards Santbech, and is here broken by many ridges, rising at H and ι to some height, whilst north of A extends towards the wall of Fracastorius a delicate rill θ, discovered by Gaudibert. The two ring-plains Fracastorius A and *b* are both distinct from the contrast between their 5° bright walls and 3° bright interiors. On the east, in the region close to the wall of Fracastorius, and almost forming part of the border, are a number of considerable rounded valleys, the principal being *d*; and from this extends a strong mountain arm ε to Beaumont *c*, whilst close to the peak δ lies an $8°\frac{1}{2}$ bright depression, resembling a crater-plain in a ruined condition.

Map XX.



Fabricius
Metius
Nicolai
Maurolycus
Stöfler
Buch
Büsching
Miller
Faraday
Riccius
Rabbi Levi
Stiborius
Gemma Frisius
Walter
Nonius
Neander
Lindenau
Zagut
Poisson
Aliacensis
Piccolomini
Pontanus
Werner
Regiomontanus
Apianus
Purbach
Pons
Blanchinus
Sacrobosco
Playfair
La Caille
Polybius
Azophi
Fracastorius
Delaunay
Abenezra
Donati
Faye
Geber
Catharina
Beaumont
Mountains

CHAPTER XXVI.

MAP XX.

Piccolomini (R.)—A magnificent ring-plain, 57·45 miles in diameter; from its position, size, and great depth, one of the most conspicuous formations on the lunar surface, and remaining distinctly visible even in Full. The lofty massive wall is bordered by numerous terraces, spurs, and mountains, and rises in over thirty fine peaks, whilst the height of the wall above the interior is, on the west, 9,848 feet; on the north, near γ, 9,000 feet; at β, on the east, 13,915 feet; and at the grand peak α, 15,533 feet. On the interior slope are some elevated valleys, and on the terraces are some low peaks, and the general slope, especially in the west, is very moderate, though that of the irregularities on the wall is steeper. The slightly concave dark floor of Piccolomini contains some small mounds and a fine central peak, Δ, according to twelve measures by Mädler, in $-$ 29° 10′ 50″ lat. and + 31° 35′ 22″ long. North of Piccolomini is a mountainous region, enclosing some irregular ring-plain-like formations, of which *d* and *e* are the most regular, and at times much resemble craters; *m* is the largest, and *c* is the most irregular, and alone contains a peak; whilst *f*, the deepest, resembles one of the valley-like central clefts common in the south-west. The surface also contains some of those peculiar depressions resembling small ring-plains, but with scarcely any wall, which seem one of the principal peculiarities of the south-western quadrant. The chief of these, A, is in $-$ 25° 22′ lat. and $-$ 29° 27′ long., and has a smaller opening into it on the south; and north of it is the similar but elliptically-shaped depression *b*. East of these in the mountain region is the fine distinct rill ε (S. 419), discovered by Lohrmann and Mädler independently, and described by Schmidt as a crater-rill; whilst on the south is the small branch ζ (S. 420), also discovered independently by Lohrmann and Mädler. North of the already-mentioned ring-plain-like formations, from Fracastorius ζ to Piccolomini $\varkappa$, extends a great curved mountain ridge with some fine peaks, and enclosing some ring-plain-like valleys; the principal mountain, δ, being 8,793 feet high, but the general elevation is only from 2,000 to 3,000 feet. South of Piccolomini extends the irregular mountainous region already mentioned as extending between Neander and Stiborius; and west of Piccolomini, Lohrmann mentions a rill, nearly 36 miles long, which Schmidt could not identify (S. 417), but which appears to be the narrow valley η, drawn somewhat imperfectly by Mädler; but the other rill south of Piccolomini mentioned by him (S. 418), being in an open region, is more doubtful. Schmidt could not find it, and it does not appear to exist where Lohrmann placed it, or else it must be very shallow; but it may have been one of the narrow valleys west of Lindenau *b*. It is drawn as given by Schmidt and marked ψ.

Stiborius (R.)—A small ring-plain, with a lofty steep wall and a nearly level interior, containing a massive central mountain A in $-$ 34° 20′ lat. and + 31° 52′ long. Close around Stiborius rise lofty mountains considerably higher than the wall of the ring-plain, and completely overshadowing it at times; γ on the east being 7,609 feet above the plain on the west, and β on the west 12,085 feet higher than the interior of Stiborius. South-west is Stiborius A, a fine though small ring-plain, with lofty walls broken by some craters, but with a completely level interior, and south of it is Stiborius B, a rather more irregular ring-plain with low walls on the south, and on its east a crater-chain. In high illumination the whole of this region is lost under the light streaks of Tycho; one, particularly intense streak, extends from Nicolai A over Stiborius B and A as far as the south-west of Neander.

Lindenau (M.)—A ring-plain with a wall of some height, quadruple in the east, where at α it rises 11,861 feet above the interior, though on the west only 8,582 feet, whilst at Full it appears with a 7° bright uniform single wall containing some 8° bright small points. The interior contains some low mountains; one, Δ, being fairly distinct, was taken by Mädler as a point of the first order, and its position, from eleven measures, was determined to be $-31° 52' 6''$ lat. and $+24° 29' 31''$ long. North of Lindenau is the fine but small ring-plain *c*, with craters around it; south, near some mountains, is the deep crater *d*; whilst in the west is the twin-formation *e*; south of which is an 8° bright steeply-walled deep craterlet, *f*, distinctly visible in Full. Lindenau A is a fine ring-plain with a lofty wall, terraced in the east and 6,983 feet high, but steep in the west, where it rises 8,850 feet above the interior, which contains some small hills. South is the small ring-plain *b*, with a lower wall and level interior,

Zagut (R.)—An irregular walled-plain united to Rabbi Levi and Lindenau by a small highland, with very unequal walls rising on the south-west, about 9,500 feet, and broken in places by craters and rounded depressions; the former 7° bright, the latter the same brightness as the walls. Nearly a third of the interior of Zagut is occupied by the small ring-plain *e*, with walls much lower than those of Zagut, and containing a small central peak and two crater-pits. The rest of the floor of Zagut contains some small hills, three crater-pits, and a crater, **a**, 6° bright in Full. East are some steep 6° bright mountains and some depressions, together with the 6° bright crater *d*, from which extends a considerable mountain ridge to Pons, whilst east of *d* are the two ring-plains *b* and *c*, the last possessing the steepest and highest walls.

Rabbi Levi (R.)—A very irregular walled-plain, with a wall only distinctly visible near the terminator, and which is highest at α on the west, and at δ on the east, whilst on the south it is crossed by narrow passes, and is very low. On the north the walls form a broad plateau containing some lofty peaks, and, according to Lohrmann, crossed from north-west to south-east by a crater-rill (S. 369) not found by either Mädler or Schmidt, but which is perhaps the rugged valley η. On the west the wall forms another plateau, broader but much lower than on the north, and broken by numerous crater-like depressions, *b* being the principal. The interior contains the 7° bright crater **a**, with a larger one south, and the 6° bright crater *d*, with two others equally bright near it; together with nine minute crater-pits, the three most distinct being west of **a**, and two others are east of *d*. East of Rabbi Levi are some ring-plain-like formations enclosed by the mountains, *e h* and *i* being the principal, together with the small ring-plain *f* and the crater *g*.

Riccius (R.)—A considerable but very irregular ring-plain, 51 miles in diameter, with a triple broad east wall and a low western wall. On the north it is bordered by the distinct ring-plain A, with a 6° bright wall and a 5° bright level interior, visible in all illuminations; and on the south is the peculiar depression *b*, with a level interior, and a strong fall on the south and west, but scarcely any on the north and east; whilst on the south are the two more regular depressions *m* and *n*, the last close under a high peak which often hides it. The interior of Riccius contains the fine 7° bright crater *s*, together with some small craters and low depressions, one on the west with a central hill; whilst at β is the highest peak of a number of low ridges, though this is scarcely 600 feet high. Between Riccius and Zagut is a narrow valley crossed by some light streaks. West of Riccius extends a great chain of depressions and crater-like formations from the ring-plain Nicolai *c* to Riccius *e*, the deepest and most distinct being Riccius *e*, *d*, and *f*. West of this chain is a long mountain ridge, rising at γ to some height, though drawn as too strongly marked in the 'Mappa Selenographica;' whilst between *d* and Riccius is a broad elevated highland crossed by some shallow valleys. East of Riccius, on the open plain, are a considerable number of crater-like depressions, two—*g*, which is 7° bright, and *h*, which is 6° bright—being visible in Full.

Büsching (M.)—A considerable ring-plain, with a wall about 4,000 feet high, and a nearly level interior of the same brightness as the walls and environs, rendering the entire formation invisible in Full. On the floor are some small hills and ridges, a small crater, and several crater-pits, whilst on the wall are numerous crater-like formations, in places forming chains; one, C, in − 37° 0′ lat. and + 19° 44′ long., being steep, and 6° bright, is perhaps a true crater. Büsching *d* appears to be a depression without any wall, and is, according to Mädler, surrounded by ten crater-pits, but he did not see several of the smallest; it has a nearly level interior, broken only by a small hill and crater-pit. Büsching B is a steep, extremely deep crater, 9° bright, surrounded by a disturbed region, full of crater-pits and very minute craterlets, and its centre is in − 38° 25′ lat. and + 23° 0′ long.

Buch (M.)—A regular ring-plain, 31·4 miles in diameter, with 4° bright, gently sloping walls, about 4,500 feet high, broken by 6° to 7° bright craters, besides crater-pits; and with a 3° bright interior, which would be absolutely level but for two very small crater cones, not drawn. South is the 6° bright crater Buch A, and north the nearly as bright crater *b*, close to the lofty peak Buch β.

Maurolycus (R.)—One of the most magnificent and remarkable walled-plains upon the Moon, with a much-terraced, highly complex wall, rising at α 13,838 feet above the interior, and on the west, at δ, according to Mädler, about 12,000 feet high; but Schmidt makes it 18,000 feet above the floor—a most inexplicable difference. The wall contains a number of crater-like formations, besides some ring-plains, craters, and crater-pits, as well as numerous valleys; and on the west wall, according to Schmidt, is a rill-like valley, 50 miles in length (S. 347). The principal object on the wall is the fine steep crater-plain A, of very great depth, with 8° bright walls, round a 6° bright interior, whose centre, from ten measures by Mädler, is in − 43° 23′ 20″ lat. and + 13° 40′ 47″ long. B, on the north-east wall, is a steep 7° bright crater, also of great depth, and in − 40° 4′ lat. and − 11° 26′ long., on the border of a great shallow ring-plain, *f*; and farther west is the more irregular but analogous formation *d*. The floor of Maurolycus contains a great number of low mountains, one, β, forming a central peak, and higher than the rest; together with a number of crater-pits, as well as the two formations *n* and *m*, which are more like very small ring-plains, and *i* a crater; whilst φ is probably a rill, and may be the formation drawn by Schmidt near here as a row of crater-pits. In Full the whole floor is covered, according to Mädler, by a great number of 6° to 7° fine bright streaks, radiating over the 3° to 4° bright interior, and apparently originating near α. North-east of Maurolycus is the very deep small ring-plain-like formation *c*—perhaps a crater-plain; and beyond is a region containing only few craters, but crammed with crater-pits. South of Maurolycus is a hilly plain, higher than the interior of the walled-plain, and bordered by the mountain arm γ.

Faraday (B.) [Stöfler, *b.* M.]—A considerable ring-plain on the borders of Stöfler, containing on the west and north numerous mounds, together with two craters, *b* and *c*, and two crater-pits, but on the south and east nearly level, only a small hill being visible.

Stöfler (R.)—A noble walled-plain, a fit companion to its grand neighbour Maurolycus, but, like that, being in the centre of the great western streak system of Tycho, is utterly invisible in Full, only a few bright light points being visible. On the east the wall consists of a broad plateau, crossed by numerous high ridges, and rising at λ 10,500 feet, and at α 11,670 feet, but at δ only 6,300 feet, and sinking between the two to only 4,500 feet above the interior. South, the wall is loftier, but not well measurabie, and many projections extend from it on to the floor, whilst it is broken by the two very deep small ring-plains, or perhaps craters, *f* and E, the last being in $-$ 43° 41′ lat. and + 5° 6′ long. West, the wall and that of Faraday are united, and form a very irregular triangular plateau, crossed by numerous valleys and broken by many crater-like depressions. The wall of Stöfler on the north is lower than on the east even, and falls very gently towards the north, but at points contains some lofty peaks. On this north wall of Stöfler are a number of formations resembling craters, and mostly of considerable depth; L, in $-$ 38° 46′ lat. and + 8° 5′ long., and K, in $-$ 39° 9′ lat. and + 3° 25′ long., being the most considerable, whilst on the west is the deep ring-plain **a**, with lofty walls, but a level interior, and drawn too large by Mädler. On the interior of Stöfler are some small hills, a steep central peak, β, and the two fine craters M, in $-$ 40° 37′ lat. and + 7° 24′ long., and n, together with a peculiar group of peaks at ε. Dispersed over the level eastern portion of the floor are perhaps three craters, r, s, t, and a number of crater-pits—Schmidt drawing nine, Birmingham four; and there are in all, as far as has at present been seen, sixteen, most of which are very delicate objects. South-west of Stöfler is the small ring-plain c, with moderately steep 6° bright walls and a 6° bright central peak; on the interior there are, according to Birmingham, some crateriform objects, probably crater-pits. East of this is the more irregular rounded valley p, containing a crater rill (S. 351), and perhaps a second one. Beyond c is the small but deep ring-plain D, in $-43° 41'$ lat. and $+ 9° 3'$ long., and still farther the larger ring-plain g, with a steep central peak and lying in a region full of crater-pits. East of E is a depression or valley of very considerable depth, and almost, if not quite, free from crater-pits, though two small hills can be seen.

Fernelius (R.)—A considerable walled-plain, surrounded by the steep edges of broad plateaus, which unite Fernelius with Stöfler, Nonius d, and smaller ring-plains in the east, and rise at γ 6,138 feet. The interior contains a number of minute crater-pits and some low ridges. East is Fernelius **a**, a smaller but similar formation to the walled-plain; and between the two is the deep crater c, from which extends a light streak to Nonius d.

Nonius (R.)—A considerable ring-plain with a wall much divided by numerous and deep valleys and passes, so that, though at α 7,782 feet high, it is only near the terminator that Nonius is seen as a complete formation. Half the interior of Nonius is full of small mounds, and on the floor is a small depression, whilst others lie on the outer slope of the wall. West of Nonius is the brilliant deep crater A_1 (Mädler has two), and beyond is a ring-plain, d, with a nearly level floor and a wall on the east 5,461 feet, and on the west

5,915 feet above the interior; the entire formation, except near the terminator, being far more distinct than Nonius. East is the deep ring-plain A, with four central peaks, with, north of it, *b*, a twin ring-plain, west of which is Nonius ψ, a small crater-rill discovered by Schmidt, who thinks there are others. In this region are a great number of crater-pits, very few of which can be drawn.

Gemma Frisius (R.)—A walled-plain of irregular form, with a lofty, much-terraced wall, crossed by many valleys, broken by crater-like depressions, containing numerous spurs and projections, rising at γ 13,704 feet above the interior. The interior, which is nearly level, contains some hill-chains visible with difficulty, a central peak, B, in $-$ 35° 1′ lat. and + 13° 38′ long., and two small craterlets. On the borders of Gemma Frisius are the three very considerable ring-plains *f*, *h*, and *d*, more regular than the principal formation, but with very uneven walls; *d*, though 9,500 feet deep, opens in the south into a long valley extending as far as Nonius *c*. Of the smaller formations in this region, G, in $-$ 33° 24′ lat. and + 11° 30′ long., and E, in $-$ 37° 21′ lat. and + 13° 4′ long., are the most conspicuous. West stretch the three great depressions *a*, *b*, and *c*; the first two united to one another, and all three surrounded by mountains rising about 4,000 feet above their interiors, giving them at times the appearance of ring-plains. In Full *i* appears with a 7° bright floor, with walls, whose slopes are only 3° bright towards the interior, and 6° bright towards the exterior. In this region, but especially towards the south, are a great number of crater-pits, mixed, probably, with a few craters, only distinguishable from being 6° to 8° bright in Full, but owing to the almost complete disappearance of land-marks in Full the identification of these has in only a very few cases been accomplished. Very few of these crater-pits can be drawn, owing to the small scale of the maps and the minuteness of these formations, which, to be properly represented, would require a map of five-and-twenty times the area. The same remarks apply to a considerable portion of this part of the Moon. North of *i* Lohrmann drew a short rill, Gemma Frisius Φ (S. 368), that has not been seen again.

Poisson (M.)—A long, very irregular ring-plain, united by a strong mountain arm to Gemma Frisius, and bordered by a wild mass of mountains, rising near γ 7,341 feet above the interior, which is full of small hills. The craters, A, in − 29° 50′ lat. and + 8° 53′ long., and *b*, are the two deepest here. Between Poisson and Nonius is a wide elevated plateau, broken by many irregular depressions and some craters—*c*, *d*, *h* ; *c* being the principal of the former, and *e* and *f* of the latter.

Aliacensis (R.)—A fine ring-plain, 53·30 miles in diameter, with a broad, lofty, much-terraced wall, containing many spurs and projections, and towering at β 11,964 feet, and at γ 16,537 feet above the interior, whilst other grand peaks can be little, if in any way, inferior to γ. The interior of Aliacensis contains a delicate central peak, A, in − 30° 16′ lat. and + 4° 38′ long., with a small hill north of it and a low ridge west of it, whilst on the south is a small but very minute hill, or, perhaps, craterlet. East of Aliacensis as far as Walter, extend a number of ridges enclosing ring-plain-like formations, *b* being the principal. West of Aliacensis is a lofty peak, δ, near which is a rill-like valley, θ, and south of this a deep crater, B, on the border of a small depression, whilst west is the small ring-plain **a**, connected with Aliacensis by a short, narrow plateau.

Werner (R.)—A great, nearly circular, ring-plain, 45·05 miles in diameter, with a very lofty wall having a narrow crest, but numerous and broad terraces, and rising on the east at δ 16,543 feet, and elsewhere about 13,000 feet high, though many peaks must nearly approach δ in height, rising over 1,500 feet above the crest of the wall. The interior contains a fine lofty central peak, A, 4,572 feet high, and, from eight measures by Mädler, in − 27° 45′ 42″ lat. and + 2° 58′ 10″ long.; together with some low mounds and ridges, very delicate objects, and not all to be seen under any one illumination. The wall of Werner is 6° bright in general, and the peaks 7° bright, whilst a portion of the principal wall near ε is 9° bright, and the general tint of the floor is 5° bright, a broad light streak crossing it 6° bright, and the central peak 7° bright, whilst two dark segments near λ and β are only 3° bright. By far the most brilliant, however, according to Mädler, on whose authority all the above determinations rest, is a very small spot, about 20 square miles in area, at the foot of the wall close to δ, and which, 10° bright, rivals even the central peak of Aristarchus in its intense brilliancy, and forms a very delicate glittering star-like object. With respect to this spot Webb makes the following remarks: 'I have several times readily seen it with two achromatics of $3\frac{7}{10}$ inch, and powers of 75, 80, and 144, but *never of the specified brilliancy*; and a careful study of it in 1864, with $5\frac{1}{2}$ inch, confirmed with a 9-inch mirror in 1871, induces me to believe that *it has faded since the date of* B. *and* M. The reflector has shown in it a minute black pit and a very narrow ravine.'[1] At present the entire formation answers very well in its brightness to the estimate of Beer and Mädler, except that the 9° bright crest of the wall on the south-east is scarcely $8°\frac{1}{2}$, and the bright point referred to by Webb is, as accurately as its size will allow of its determination, only from $8°\frac{1}{2}$ to 9° bright, whilst the black pit of Webb is a very delicate crater-cone, still fully 9° bright. This fading of some of the more brilliant of Beer and Mädler's bright points appears to have taken

[1] 'Celestial Objects,' p. 113.

place elsewhere, and a very noticeable peculiarity in the brightness of the small spot on Werner is the blueness of its tint.[1]

Werner A is a crater-plain, 6° bright, and very deep, in − 27° 6′ lat. and + 0° 34′ long., with south of it a strong mountain mass and a small craterlet; not so deep, but as distinct, is Werner *b*, around which is a group of craters, whilst between A and *b* is an irregular depression of some depth that can easily be confounded with A under low illumination, both being not often visible at the same time. West of Werner are some ridges and mountains, γ being the highest.

Apianus (R.)—A great ring-plain, 38·50 miles in diameter, with a much-terraced wall, rising at α 9,369 feet above the interior, which is quite level. On or close to the wall are a number of craters and crateriform depressions, the greatest of the former being B, in − 27° 0′ lat. and + 8° 23′ long.; and the principal of the latter is near δ, and has an eastern wall 8° to 9° bright. Several of the streaks from Tycho reach Apianus, but either stop at the wall or skirt it, and none cross it. Around Apianus is a mountainous region containing only few peaks of any height. West is the strong ring-plain *d*, with four fine peaks on the wall, β being about 5,000 and γ about 6,400 feet high, and south of this the small crater-like depression *c*, united to the last by some ridges. East of Apianus is A, a double crater, the northern being in − 25° 24′ lat. and + 5° 53′ long., and beyond this is a nearly triangular plain, containing some small hills, and with a steep border on the east and west, perhaps 2,500 feet high.

[1] It is of some interest to find that, though Schröter measured and drew Werner and its region, examining it particularly on account of his believing the central peak to have been formed since Cassini's time, he makes no mention of this glittering point, though it is even now distinctly visible with an aperture of only two inches.

Pontanus (R.)—A ring-plain, 27·7 miles in diameter, with an unequal wall, broadly terraced, and a dark interior, containing a considerable central mountain; its dark floor leaves still visible in Full, though most of the neighbouring formations are not to be seen. The two craters *b* and A, in − 30° 22′ lat. and + 15° 2′ long., are deep and moderately bright, but, like the three steep and deep ring-plains *c*, *g*, and *h*, are not visible in Full. Around Pontanus the numerous mountain ridges by their union form many ring-plain-like enclosures, with at times considerable peaks on their borders, the highest of which is α, and amongst these formations are the three craters *d*, *e*, and *f*, together with smaller ones.

Pons (M.)—A peculiarly-formed ring-plain, with a single wall only on the east, the rest consisting of a labyrinthical mass of craters, peaks, ridges, and mountains, dividing the interior into separate portions, of which *d* is the deepest, and some contain in Full dark interiors. Pons **a**, *b*, and *c* are three sharply-marked deep craters, with steep walls, forming a right-angled triangle, the last two being connected with Pons by ridges, rising at α and β to a considerable height. North is the crater *f*, on a plateau near a small deep depression, and west is the peculiar, almost heart-shaped, depression *e*, also of considerable depth.

Altaï Mountains (M.)—These mountains, like the Apennines and others, form the crest of a broad highland, falling steeply in a line of great frowning cliffs to the plain below, and rising in some places to a considerable altitude. Commencing at Piccolomini they extend to Tacitus A, a length of about 275 miles, and the average height of the crest from the south as far as Polybius γ is about 6,000 feet, and from thence north perhaps 4,000 feet above the plain beneath, though only the peaks seem materially elevated above the highland itself. Accordingly, in the waning moon they throw a fine shadow, but in the increasing moon they appear simply as a white line of cliffs with scarcely any shadow. The two loftiest of the peaks are Polybius β, from two measures, 13,275 feet high, and γ, perhaps 11,000 feet in height.

Polybius (M.)—A ring-plain, surrounded by hills, and with a very gentle exterior slope, though the wall within falls steeply to the level interior. Towards the south is a small highland, containing numerous ridges, and broken, according to Mädler, by eighteen craters, the deepest being Polybius B, in $-$ 25° 31′ lat. and + 25° 7′ long.; but there are over forty crateriform objects on this highland, mostly, perhaps, small crater-pits, though *e* seems to be a true crater. West, in a level region, containing principally low hills, scarcely 400 feet high, is the very deep 7° bright crater Polybius A, surrounded by some smaller craters and with some fine mountain peaks near it. East of Polybius appears a hill-land, containing a number of depressions and mountain enclosures; Polybius *c* being the principal of the last, and resembling an imperfect ring-plain; but the details of this region are only visible with difficulty.

Fermat (M.)—A ring-plain, 24·9 miles in diameter, not very regular in form, with its wall broken by valleys and rising so slightly from the surrounding highland as to give it the appearance of being a mere depression, though the interior is at least 6,000 feet above the crest of the wall. On the north a pass connects it with the smaller but very similar A, into which opens in the east a still smaller formation, and the centre of A is in $-$ 22° 5′ lat. and + 19° 30′ long. West, in the highland, is a group of four small craters by *b*, and north, beyond some depressions, is E, apparently a crater, in $-$19° 37′ lat. and +19° 28′ long.; north again of which is γ, the last steep peak of the Altaï mountains, and perhaps 7,000 feet high. South-east of E is the steep depression *c*, and the small, very delicate, ring-plain *d*, containing a central peak, so minute and yet so sharp, as to be deservedly pointed out by Mädler as a capital, though severe, test for an aperture of about four inches.

Sacrobosco (R.)—A considerable walled-plain of irregular form, with lofty steep walls, rising highest at α on the east, where it is 12,041 feet above the interior, and but little lower at β and γ, though in places the wall is much lower and gentler. On the north-west Sacrobosco is bordered by the irregular ring-plain *d* with steep lofty walls, except in the north, where they are replaced by a gentle slope and low hills. The interior of Sacrobosco in the north is full of low hills and short ridges, and contains a fine 6° bright steep crater, *c* ; a larger and not so bright nor deep formation, *b*, containing a delicate central mountain, and the great crater-plain A, with steep 6° bright walls, and a very deep 4° bright interior, whilst it is surrounded by low hills and two small craterlets. The centre of A, which is the most distinct object in this region, is, from nine measures by Mädler, in − 23° 42′ 51″ lat. and + 15° 40′ 35″ long. South-west of Sacrobosco towards Pons is an open bright plain containing only some mountains, three craters, and the depression *e*. East extends a very broad mountain arm, δ, which, uniting with others, forms some ring-plain-like enclosures ; on the summit of δ Mädler saw two minute craterlets, and it is bordered on the north-east by a bright streak from Tycho, which crosses Apianus *d*. North of Sacrobosco are the two imperfect ring-plain-like depressions F and *g* ; the first with a central peak in − 21° 2′ lat. and + 16° 35′ long., and both with 6° bright walls. Further north, in − $20°\frac{1}{2}$ lat. and + $17°\frac{1}{2}$ long., Lohrmann drew a short rill running north and south (S. 367), which Schmidt could not find, but which is very probably only one of the numerous long narrow valleys in this place.

Azophi (R.)—A ring-plain, 30·0 miles in diameter, with a 5° bright lofty wall, rising 10,928 feet above the 4° bright interior, which contains some small 6° bright mountains and a 6° bright round light spot, whilst the small craterlet *c* is 7° bright. South-west a strong mountain arm extends in a broad curve uniting with the arm δ from Sacrobosco and reaching Azophi A. This last is a considerable ring-plain, with walls of unequal height rising on the south, near γ 4,000 feet, whilst on the north scarcely 1,200 feet above the interior, which contains a central peak in − 24° 19′ lat. and + 10° 46′ long. Between it and Azophi is a considerable depression, or, perhaps, enclosed plain, at times resembling a ring-plain.

Abenezra (R.)—A fine ring-plain, 26·7 miles in diameter, with a very lofty wall, 5° bright, and rising on the west only 5,774 feet above the outer surface, but 14,547 feet above the interior, which is probably the deepest in this region. On the floor are two small craters and a central peak, besides numerous small hills and ridges. East, a strong curved mountain arm, β, encloses a portion of the outer plain, and gives the formation near the terminator the appearance of a double ring-plain. Close to this arm is *b*, a 6° bright crater, and south is a small ring-plain, **a**, both visible in Full; but all the other crateriform objects in this neighbourhood are invisible in Full.

Playfair (M.)—A fine, very distinct, ring-plain, 27·7 miles in diameter, with a broad terraced wall, containing ten craters and many peaks, and rising at β 8,326, at γ 8,000, and at ϵ 3,946 feet above the interior, which contains no central mountain, and only two small mounds near the west. Towards the east is a great plain—half mountain-ring, half walled-plain—with a border nowhere over 2,000 feet high, whilst its interior on the south is elevated slightly above the rest, and contains some low hills. Near δ are two small steep 8° bright hills, very probably crater-cones, near four small craterlets;

and on the north border are some small depressions, Playfair **a** being the largest. To Apianus, Playfair is united by the high mountain arm α.

Blanchinus (S.)—A great walled-plain, north of Werner, with a low border and an apparently level interior, crossed, however, by some very delicate ridges, and containing a minute central peak besides two small craterlets. Beer and Mädler pass over Schröter's designation, probably because, from the faulty nature of his drawings of this region, they were not sure of its identity. Birt restored Schröter's designation, and it is here retained, though the formation is not very definite or conspicuous.

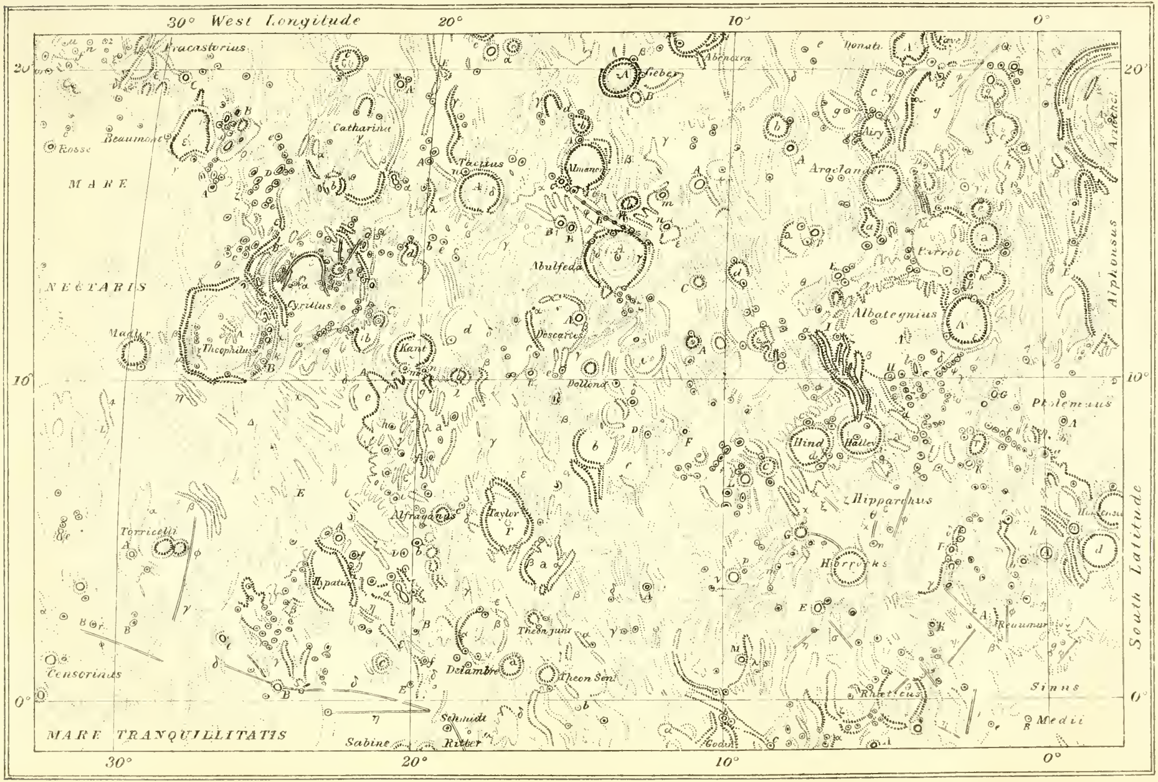
Lacaille (S.)—A small walled-plain, with a wall, crossed by many valleys in its western region, and rising at α 9,726 feet above the interior, which, though stated by Beer and Mädler to be completely level, contains three small mounds, slightly brighter than the floor and near the centre. The wall is in general 6° bright, at β only 5° bright, and north of D 7° bright, whilst the 3° bright interior is crossed by some light streaks. The two craters, Lacaille D, in − 23° 4′ lat. and + 1° 9′ long., and Lacaille H, in − 24° 45′ lat. and + 0° 44′ long., are both deep and 6° bright, though the first is steepest and most distinct. West is Lacaille *e*, a deep depression, its wall, according to Schröter, being 4,500 feet above the interior ; and from it to Blanchinus *d* extends a row of crater-like depressions. North-west of Lacaille is C, a deep, sharply-marked crater, in − 20° 57′ lat. and + 1° 5′ long., and beyond it the smaller *g*, together with some others.

Delaunay (B.) [Lacaille, *f.* M.]—A massive, very irregular ring-plain, with a wall rising on the east, at β, to the immense height of 11,600 feet above the interior, according to Schröter, and containing a long central ridge, from Schröter's measures 5,100 feet high, though at the western peak α, probably still loftier. On the wall at δ is a small crater, and another lies on the interior, south of the central ridge.

Faye (B.) [Lacaille, B. M.)—A great ring-plain, of irregular form and moderately high walls, whose central peak is in $- 21° 2'$ lat. and $+ 2° 40'$ long. South of it are some crater-like depressions and a small hill region, and near it some long narrow valleys. North is ϕ (S. 352), a rill seen by Lohrmann, but which Schmidt could not find.

Donati (B.) [Lacaille, A. M.]—A ring-plain of very similar nature to Faye, with its central peak, A, in $- 20° 28'$ lat. and $+ 3° 50'$ long.

Map XXI.


30° West Longitude
South Latitude
Fracastorius
Beaumont
Rosse
MARE
NECTARIS
Catharina
Theophilus
Cyrillus
Mädler
Tacitus
Almanon
Abulfeda
Descartes
Kant
Dollond
Alfraganus
Taylor
Torricelli
Hypatia
Delambre
Theon Jun.
Theon Sen.
Censorinus
MARE TRANQUILLITATIS
Sabine
Ritter
Schmidt
Godin
Sieber
Abenezra
Donati
Airy
Argelander
Parrot
Albategnius
Alphonsus
Arzachel
Hind
Halley
Hipparchus
Horrocks
Ptolemæus
Rhæticus
Réaumur
Sinus
Medii

CHAPTER XXVII.

MAP XXI.

Airy (M.)—A steep ring-plain with a lofty broad wall, broken by several craters and highest at β, surrounding a nearly level interior, broken only by a steep central peak. South is the more irregular Airy *c*, with a high peak at γ, and an interior without a central peak, but crossed by a long ridge. East of this rises a long mountain arm, whose height at the peak α is 3,434 feet above the level plain on the east. West of Airy is the considerable crater Airy A, in $-17°$ $18'$ lat. and $+7°$ $58'$ long., close to which is the small ring-plain *b*, with steep walls of some height, though of little steepness, and a small central peak, whilst close to it are a number of long ridges and hill chains, δ being the most distinct and longest visible. Airy *e* and *g* are two mountain-rings, with some small craters close to them, and in the interior are some low hills and minute crater-like objects, forming very delicate test objects.

Argelander (B.) [Airy, C. M.]—A fine but small ring-plain, with lofty much-terraced walls, containing some high peaks, and with a nearly level interior, only broken by a steep central peak. North is Argelander *d*,[1] a smaller but similar formation to the principal ring-plain, and united by deep broad passes to two much smaller objects of the same nature, one at each end ; the wall of all three sloping only gently to the outer surface, but very steeply towards the interior, so

[1] These are Airy *d* and F of Mädler.

that Mädler estimates that the interior is in sunlight for only seven days, and in shade for twenty-two days. West is Argelander F, a crater in − 14° 25′ lat. and + 6° 44′ long., with steep high exterior walls abutting on the west on a small plateau broken by two small crater-like formations, beyond which appears an irregular ring-plain, Argelander **a**.

Parrot (M.)—A considerable ring-plain, 41·5 miles in diameter, with a wall of moderate height, containing a number of craters, of which B, in − 13° 25′ lat. and + 1° 55′ long., is the most distinct, and a 3° bright interior full of small hills and ridges. At *α* the wall is crossed by a fine narrow valley, with steep rugged sides, which widens out towards the south, where, after a course of 37 miles, it ends near three crater-like depressions. This valley has been included by Mädler and Schmidt amongst the rills (S. 358), but it is only an example of the steeper and more marked lunar valleys common all over the surface of the Moon, and in many features distinct from the rills. Parrot D, in − 16° 52′ lat. and + 3° 42′ long., is on the border of an elevated plateau, which, extending eastward to the two peaks *β* and *γ*, passes south to Lacaille C, being indented on all sides by deep bays, and rising 4,000 feet above the northern hill-land, and 6,400 feet above the plain on the south-west. On the east, three irregular ring-plains—Parrot *c*, *h*, and *i*—border this plateau, and on the south-west is the fine dark plain *g*, containing some low mounds, scarcely 60 feet high, and broken by some very minute crater-like formations. East of Parrot are the three ring-plains **a**, *e*, and *f*, the first of some depth and regularity, possessing also a considerable central peak, the others being more imperfect; and farther north is the irregular depression *k*, with two craters on its south.

Albategnius (R.)—A true walled-plain, 64·6 miles in diameter, with a level 3° bright interior, containing only a few hills and a considerable central mountain *A*, nearly ten miles long and 4,157 feet high, its centre being, from seven measures by Lohrmann, in − 11° 28′ 20″ lat. and + 3° 58′ 13″ long. The wall of Albategnius is steep and high, but much broken by deep valleys and crater-like depressions, besides a number of small craters; the loftiest peaks are ζ, rising 11,426 feet; β, 9,280 feet; δ, 10,487 feet; and γ, 14,720 feet above the interior, whilst there may be still loftier peaks in places within the 4° bright wall, which is from 13 to 18 miles wide. Near δ, on the wall, is a row of craters, or crater-pits, according to Mädler, which Schmidt draws as a rill, φ (S. 354); and farther west, near H, where Mädler draws some crater depressions, Schmidt also draws a rill (S. 353). Albategnius H is a small crater, in − 9° 36′ lat. and + 4° 45′ long., with close to it the elliptical ring-plain *b*, containing a central peak, whilst near it are some others. West of Albategnius is the 5°½ bright crater E, in − 12° 58′ lat. and + 6° 10′ long., with some crater-like depressions near it, and a high mountain mass, θ, with a 5° bright steep eastern slope, whilst north are the two craters *d* and I, both 5° bright. On the east of Albategnius is the great ring-plain A, 27·7 miles in diameter, with a steep lofty wall rising at ε, 10,283 feet above the interior, which contains a distinct central peak, in − 11° 57′ lat. and + 2° 10′ long., besides some small ridges. North, towards Ptolemäus, the ground slopes gently, and contains a number of ridges, besides three crater-like formations: G, the centre one, being in − 9° 29′ lat. and + 1° 45′ long., according to Mädler; but Birt places it in − 9° 27′ lat. and + 1° 27′ long., whilst a measurement in 1875 gave − 9° 36′ lat. and + 1° 36′ long., the mean, therefore, being − 9° 31′ lat. and + 1° 36′ long.

Halley (B.)—A very fine ring-plain, 21 miles in diameter, with lofty but unequal 5° bright walls, rising on the east at the peak ι 3,543 feet above the outer surface, and 7,546 feet above the interior, to which it falls nearly perpendicularly, but on the west, though also lofty, it falls very gently towards the interior. The interior, which is 3° bright, though drawn perfectly level by Lohrmann and Beer and Mädler, contains a fine craterlet, discovered on Rutherford's photogram by Birt, and a second one seen by Gaudibert very distinctly on the south-east portion of the floor, when the former could scarcely be detected, indicating, in his opinion, that it has been formed since the date of Rutherford's photogram, 1865. This is one of several instances of craters now more conspicuous than others that have been drawn by earlier observers, who did not see the now more distinct formation, and these merit considerable attention as strong indications of modern lunar activity; and here, as in other cases, the differential effects of variation in libration and illumination must be extremely slight. South of Halley extends a fine serpentine valley, *f* (S. 356), included, like so many similar formations, by Schmidt as a rill, commencing at the foot of the wall of Halley, and opening on to the plain by Albategnius *d*. It receives several branches, in one of which is a short rill, Φ, seen by Schmidt (S. 357), and the principal of these branches curves round into a wide shallow valley between Hind and Halley, and within this valley are several small craters. North, extending from the wall, is the very similar but shorter valley *e*, opening on to the low-lying floor of Hipparchus, near a small craterlet, and on the east border are three very delicate craterlets, first seen by Lohrmann. East, at Halley **a**, is a small depression enclosed by mountains, the peak Halley α being highest. From six measures during 1875 the position of the centre of Halley is $-\ 8°\ 6'\ 45''$ lat. and $+\ 5°\ 37'\ 14''$ long., its place, according to Birt, being $-\ 7°\ 58'$ lat. and $+\ 5°\ 24'$ long.,[1] and by Mädler it is put in $-\ 8°\ 14'$ lat. and $+\ 5°\ 44'$ long.

[1] The measures quoted here, as made by Birt, were obtained by measurement

Hind (B.)—A fine ring-plain, 16·5 miles in diameter, on the south-west border of Hipparchus, nearly as large as Halley, with a 5° bright wall, containing a lofty 6° bright peak, χ, on the east wall, 10,033 feet in height above the interior, which appears 4° bright and perfectly level. The wall on the north contains a small crater, *d*, and another, Hind *c*, on the south, where a small valley breaks through the wall, whilst a second broader valley extends from the foot of the wall, by *d* to ζ, on the floor of Hipparchus.

Horrocks (B.)—A fine small ring-plain on the interior of Hipparchus, 18·4 miles in diameter, with a 5° bright wall, rising on the east 7,800 feet above the interior, which contains two small hills, besides a central mountain in − 4° 0′ 24″ lat. and + 5° 52′ 59″ long., according to six measures in 1875; the place, according to Birt, being − 3° 54′ lat. and + 5° 18′ long., whilst Mädler has placed it in − 4° 12′ lat. and + 6° 10′ long. From the south border, to the crater Hipparchus G, extends a short curved rill, Horrocks ϕ, discovered by Birt on Rutherford's photogram, and at times very distinct.

Hipparchus (R.)—A great walled-plain, considered by Mädler, owing to its ruinous condition, to be more like a mountain ring than anything else, its borders being irregular in form, and broken through by numerous craters, depressions, and valleys, whilst at places it appears to have crumbled into a mass of broken *débris*. Extending for 96·8 miles from north to south, and 87·6 miles from east to west, it is only under very oblique illumination that it resembles the more perfect lunar formations, and presents the appearance of a connected whole; under high illumination only isolated portions of the border can be seen, and the great outline of

on a lunar photograph, and are contained in the B. A. Reports for 1866–1868, but, considering the source, are distinctly inferior to a good micrometrical measure.

this formation is only to be found by the great ring-plains Halley and Hind, and the six bright craters Hipparchus C, G, E, F, K, and I. The interior is covered with numerous mounds and short ridges, besides three or four small craters, *n* being the principal, and the great ring-plain Horrocks, and the as large but entirely ruined formation x, a peak ε within which, serves as a central peak to Hipparchus. This small peak ε, with several between ε and ζ, and some others nearer Halley, though only of very feeble height, are so sharply marked at their base as to be clearly separated from the ridges. The wall of Hipparchus on the west is broken by a considerable number of long valleys, descending from the higher plain west of Hipparchus, and three of these valleys are included by Schmidt amongst the lunar rills (S. 358–360), these being probably the three long valleys between the peak α and the lower peak χ, the central one being shallowest. North of these three valleys is the 7° bright, very deep crater Hipparchus G, in − 5° 5′ lat. and + 7° 27′ long., with a lofty peak, β, close to its south wall, rising 4,236 feet above the interior of Hipparchus; and close to this peak Schmidt mentions a short crater-rill (S. 362), whilst north is a considerable mountain mass broken by two craterlets, and with a third on the east slope, though in the B. A. map only one is marked. This one, *m*, has exhibited some peculiar variations in appearance, resembling usually under low illumination a bright well-defined crater with a small central peak, whilst under higher illumination generally resembling a small bright spot, but at times appearing as a mountain, a shallow crater, or a mere white spot. From G to the 7° bright crater E, the border is very imperfect, and this last crater is, according to Mädler, in − 2° 50′ lat. and + 7° 2′ long., though placed by Birt, from a measurement, in − 2° 44′ lat. and + 6° 32′ long.; but a measurement made during 1875 confirms Mädler's position, putting it in − 3° 13′ lat. and + 7° 9′ long.; the mean giving − 2° 56′ lat. and + 6° 54′ long. From Hipparchus E to γ the border consists of a slightly elevated mass, containing numerous low mountains divided by irregular valleys, but by γ again begins to become loftier, rising near F perhaps 3,000 feet, and at δ nearly 5,000 feet above the interior. The crater F is moderately deep and 5° bright, and its position is fixed by Mädler as in − 4° 19′ lat. and + 2° 43′ long.; by Birt as in − 4° 25′ lat. and + 1° 54′ long., and from two measures in 1875 as being in − 4° 28′ lat. and + 2° 30′ long. (the later observations, as in most instances, again confirming Mädler); the position, from the mean of the four measures, being − 4° 25′ lat. and + 2° 24′ long. Near F are several craters, between 4°½ and 5° bright, and several crater-pits, only 3°½ bright, together with a considerable number of small hills. The south-east wall, from Hipparchus δ to Halley, is formed by the foot of a gently rising slope leading to the high region between Albategnius and Ptolemäus, and broken by a number of hills, shallow valleys, and craterlets. On this slope are the two distinct deep 6° bright craters Hipparchus K and I. Mädler places K, which alone he measured, in − 7° 53′ lat. and + 2° 1′ long., but Birt, in the B. A. map, obtained for its position from one of his measures on the photogram employed as the basis of that map, − 7° 7′ lat. and + 1° 58 long., a result confirmed by four measures during 1875, which give − 7° 10′ lat. and + 2° 10′ long. as the true position, and Mädler therefore probably reduced this measure erroneously. The crater I, not measured by Mädler, was also consequently placed too far south, its right position being, from two measures obtained in 1875, − 7° 45′ lat. and + 3° 3′ long., agreeing well with the position found by Birt, which was − 7° 39′ lat. and + 2° 57′ long. Near K is a deep elliptical depression, *r*, with bright walls and a small central peak, whilst close to it are a number of craters and a small rill, ψ, discovered by Birt, together with a peculiar furrow or shallow valley, seen by Webb. Across the interior of the ruined ring-plain in the centre of Hipparchus extends a narrow valley-rill, θ, discovered by Birt, who has also detected on Rutherford's lunar photogram two other valley-like rills; one wide and shallow, ϕ, on the east, and the other more delicate, ξ, on the west.

North of Hipparchus extends an irregular plain, forming a deep bay, of the Sinus Medii, and containing a number of small hills. The most distinct object is the fine $5^\circ\frac{1}{2}$ bright crater H, which, though very conspicuous near the terminator, is by no means so under high illumination, and its place, according to Mädler, $-2^\circ 18'$ lat. and $+3^\circ 15'$ long., questioned by Birt, who found $-2^\circ 18'$ lat. and $+2^\circ 25'$ long., was confirmed by two measures in 1875, which give $-2^\circ 31'$ lat. and $+3^\circ 12'$ long., the mean of the four being $-2^\circ 25'$ lat. and $+3^\circ 1'$ long., though this gives a value for the longitudes probably at least $5'$ too small. North of the bright crater E are two delicate valley-like rills, σ and η, both inserted by Birt in the B. A. map, without their source being stated. Beyond is a fine ancient ring-plain, with its southern portion entirely ruined, and on its walls a lofty peak, λ, 6,179 feet high, and north of this a row of five others, whilst on the interior, besides numerous ridges and a small craterlet, is the fine $7^\circ\frac{1}{2}$ bright crater Hipparchus M, in $-1^\circ 22'$ lat. and $+9^\circ 25'$ long. East of this is a narrow winding valley, *s*, and a small crater-like depression, and north is the larger crater-like depression *p*, with, close on its west, a small walled depression, *v*, from which extends a fine valley to near Hipparchus G.

On the western border of Hipparchus is the very fine $8^\circ\frac{1}{2}$ bright crater-plain Hipparchus C, with a very lofty steep wall surrounding a 5° bright interior (3° bright, Mädler), and the centre of a much-disturbed region containing several small craters. Its position, from eighteen measures, is − 7° 22′ 57″ lat. and + 8° 3′ 34″ long.; its place, according to Mädler, being − 7° 19′ lat. and + 8° 18′ long., whilst its very distinct appearance in Full renders it well qualified to form a third to Mösting A and Murchison A in an investigation of the Moon's real physical libration, for which reason its place is being determined with great care. West are a considerable number of craters and crater-like formations, of which only Hipparchus L, a 6° bright crater, with 3° bright walls, from six measures in 1875, in − 6° 49′ 45″ lat. and + 8° 49′ 31″ long., remains visible in high illumination.

Réaumur (M.)—A slightly depressed plain, surrounded by a mountain border, rising in places to a considerable height, the principal peak being *A*, on the west wall, in − 2° 44′ lat. and + 1° 24′ long., according to Mädler, but − 2° 58′ lat. and + 0° 59′ long. from a measure of Birt's, whilst a measure during 1875 gave − 3° 7′ lat. and + 1° 32′ long., the mean being − 2° 56′ lat. and + 1° 18′ long. The interior of Réaumur is 3° bright, and with the exception of a short rill seen by Schmidt, ϕ (S. 364), is perfectly level. South of Réaumur is an elevated hill-region, containing a row of small deep craters: A, the largest, being in − 4° 24′ lat. and + 0° 5′ long., the smaller, *b*, being, however, deeper; whilst beyond the small walled enclosure is the small 6° bright crater Réaumur *c*, from which to *b* extends a 5° bright mountain arm, rising in two considerable peaks. West of Réaumur, from the peak β to near Hipparchus γ, extends a fine rill, ξ (S. 363), whilst another, ψ (S. 365), extends across the plain on the north.

Theon, Senr. (R.)—A fine, 7° bright, very deep crater-plain, 11 miles in diameter, with a steep wall rising to a considerable height above the outer surface, which is only

3° to 4° bright, and a completely level interior, whose centre is in − 0° 40′ lat. and + 15° 25′ long. Close on the north of it is a 5° bright crater, **a**, visible in Full.

Delambre (L.)—A considerable ring-plain, 32 miles in diameter, with a much-terraced, lofty, 5° bright wall, rising at α 14,970 feet, and at β 7,763 feet above the $4°\frac{1}{2}$ bright interior. The central peak, from three measures by Lohrmann, is in − 2° 0′ 45″ lat. and + 17° 28′ 50″ long., whilst from seven measures by Mädler it is in − 1° 41′ 31″ lat. and + 17° 9′ 17″ long., the position from the whole ten measures being − 1° 47′ 7″ lat. and + 17° 15′ 9″ long. North of Delambre is **a**, the ruins of a small ring-plain, containing a central peak, but now scarcely visible; whilst farther west is a curved mountain arm, δ, on which is the 6° bright crater *f*. South, towards Alfraganus, are some lofty mountains, γ being highest, but ϵ being 6° bright and perhaps a crater-cone. Delambre B is a small crater in − 1° 59′ lat. and + 19° 35′ long.

Theon, Junr. (R.)—A small crater-plain, about 11 miles in diameter, with a 7° bright wall of considerable height and steepness, and a 4° bright interior, whose centre is in − 2° 22′ lat. and + 15° 42′ long. East of Theon, Junr., are a number of mountains, the most massive extending in a great curve from the 7° bright crater Theon, Senr. *b* to the lofty peak β, and rising at α in a grand 7° bright double peak, and of all these mountains is alone visible in Full, though at times it appears as if this were in reality a crater-cone, a very minute black shadow perhaps appearing on the summit, but which is too small for a certain decision to be arrived at. Near Theon, Junr. γ is a small 6° bright craterlet, and east another, though near the terminator not to be distinguished in appearance from the rest of the small crater-like formations in this region.

Taylor (M.)—An elliptical, not entirely enclosed ring-plain, with a tolerably high wall, open on the south, and crossed on the north by two deep passes, whilst on the west enclosing a narrow valley; and a 3° bright floor, containing a distinct central peak, Γ, in − 3° 15′ lat. and + 16° 20′ long. North is Taylor **a**, an irregularly-formed ring-plain, 18 miles in diameter, with lofty terraced walls, rising on the east at α 7,060 feet, and on the west, at β, 5,570 feet above the only $2°\frac{1}{2}$ bright level floor, whilst at an opening on the south are two small craters. East of Taylor are a number of delicate parallel ridges, ending by ε; west a strong mountain, δ; and south, a number of mountain ridges, extending as far as Kant, and having a lofty peak at γ. In the far east is Taylor A, a 5° bright crater in − 3° 38′ lat. and + 12° 13′ long.

Alfraganus (R.)—A considerable crater plain, 9·5 miles in diameter, in − 5° 30′ lat. and + 18° 58′ long., with 7° bright, very steep walls, and a 3° bright deep interior, whilst the environs contain a number of irregularities, some small craters, and crater-like depressions, *b* and *c* being the principal. Alfraganus is the centre of a short light-streak system, extending to Taylor, Theon (Junr.), Delambre, Hypatia, Kant, and Dollond; whilst one crosses Cyrillus and reaches Fracastorius. North of Alfraganus is a mountain mass, α, containing a long-shaped depression, **a**, and south of this is D, the deepest and brightest of five craters. West of Alfraganus, Schmidt places three rills with craters, all very bright (S. 372), though he describes them as being east.

Kant (M.)—A considerable ring-plain, 23 miles in diameter, distinctly visible in every illumination, with 6° bright, steep broad walls, surrounding a 3° bright level interior, containing a 7° bright central peak, from two measures, in − 10° 46′ lat. and + 20° 8′ long; whilst the plain on the west is only $2°\frac{1}{2}$ bright, the mountains on the east 4° bright, and the two craters, *n* and *m*, 5° bright. West of Kant is the lofty peak A, in $-$ 10° 22′ lat. and + 21° 33′ long. rising 14,292 feet above the dark plain on the west, and separating two dark bays, Kant c and e; whilst from A extends towards Alfraganus a great 4° bright broad mountain mass, containing some high peaks and small crater-like depressions, and crossed by a long, very rugged valley, Kant f. The principal point on this mountain plateau are the peaks γ, ϵ, and λ, and the craters i and h.

East of this mountain plateau extend some considerable chains towards Alfraganus, enclosing two elliptical depressed plains, Kant g and **a**, the former being 4° bright, and the latter, with a 3° bright interior and a 4° bright wall. East of **a** is another enclosed plain, l, with a 3° bright interior and a 4°½ bright wall rising into a mass of lofty 5° bright peaks near β. South of this is the imperfect walled-plain Kant d, with a wall rising at δ 6,919 feet above the interior, which, according to Lohrmann, contains a rill (S. 371), in $-$ 11°½ lat. and $-$ 18° long., with a south-westerly direction, though Schmidt was unable to find it.

Descartes (M.)—An incomplete ring-plain, with a low wall, in places only 4,000 feet high, with its chief peak at α and β, but crossed in many places by short valleys, whilst in the interior are some mountain ridges, only in part drawn by Mädler. The fine crater A, in $-$ 11° 55′ lat. and + 14° 36′ long. on the eastern portion of the floor, being 7° bright, is distinctly visible in Full, and so is the brilliant 8° bright glittering craterlet c; north of which are some 6° bright mountain peaks. East of Descartes, through the mountains, extends a nearly straight valley, 37 miles long and 2 miles wide, beginning by Descartes γ, and ending by Abulfeda ζ, into which open many wide valleys.

Dollond (L.)—A fine deep 6° bright crater, whose position, from three measures by Lohrmann, is in $-$ 10° 22′ 39″ lat. and + 14° 35′ 10″ long, but from six measures by

Mädler it is in − 10° 11′ 9″ lat. and + 14° 0′ 15″ long.; its place from the two series combined being − 10° 14′ 59″ lat. and + 14° 11′ 53″ long. West of Dollond is a fine hill region, which though in few points 600 feet high, is on the south-east 6° bright, and elsewhere 4° to 5° bright, the minute craterlet *e* being 9° bright, and the mountain β, 7° bright; the small crater by *e*, and the two ring-plain-like depressions *m* and *n* being only 5° bright. North of Dollond are the two considerable ring-plains *b* and *c*, with 4° bright walls and 3° bright level interiors, whilst north of the first is a lofty mountain mass, rising at α 9,267 feet above the plain, and at times completely overshadowing the walls of *b* and *c*. South-east of *c* is the 5° bright crater D, in − 8° 13′ lat. and + 12° 25′ long. in a mountain region, with the very similar 5° bright crater F on its east, in − 8° 13′ lat. and + 11° 12′ long. East of Dollond is the great ring-plain G, with moderately high walls and a central peak, in − 10° 31′ lat. and − 12° 19′ long.; with, farther east, the small ring-plain Dollond A, whose distinct central peak is in − 10° 59′ lat. and + 11° 24′ long.

Abulfeda (R.)—A fine ring-plain, 39·33 miles in diameter, with a lofty, broad, terraced wall, rising on the east 10,027 feet, and on the west 8,882 feet above the interior, and about 7,000 feet above the surrounding surface. The 7° bright central peak A, in − 13° 54′ lat. and + 13° 36′ long., possesses so small an elevation as to be easily overlooked near the terminator, and is surrounded at a distance of seven miles by a dull ring of lighter surface, and beyond this, close to the wall, is a portion of another ring; though this last, like the 4°½ bright wall, is only visible in favourably-placed Full Moons. A remarkable crater-rill, ϕ (S. 370), unites Abulfeda and Almanon, forming a tangent to both walls; its great brightness and depth, as well as its position, rendering it more like a true row of confluent craters than the general class of crater-pit rows called crater-rills. The principal craters forming it are 6° bright, and one at least 7° bright. West is the great 7° bright crater Abulfeda B, in − 14° 55′ lat. and + 15° 18′ long., with, on its west, the crater B, as deep but not so high, the two being surrounded by a much disturbed surface. South of Abulfeda is *b*, a somewhat elliptical crater-plain, with 8° bright walls and environed by a mountainous region in which some minute craterlets have been seen, whilst near it are the two deep 5° bright craters *m* and *n*. Farther east lies the deep crater A, in − 16° 12′ lat. and + 10° 28′ long., and beyond it an 8° bright, very delicate craterlet, *e*, surrounded by some 6° bright light streaks. North of A is the small highland ε, and still farther the small bright ring-plain C, in − 12° 43′ lat. and + 10° 41′ long., with a delicate central hill, while close east is the irregular but steep ring-plain *d*, surrounded by numerous ridges.

Almanon (R.)—A ring-plain, 35·96 miles in diameter, with a terraced wall, rising on the west 5,966 feet, and on the east 3,849 feet above the 4° bright interior, which contains no central mountain but only some low ridges and mounds. The wall is only 5°½ bright at the summit, and is broken on the south by the 7° bright crater Almanon A, in − 17° 28′ lat. and + 15° 0′ long., which connects Almanon with the small ring-plain *b*, which from its 7° bright wall and the brilliant glittering 8° bright craterlet *d*, is very distinct in Full. East of Almanon is the long, curved, broad valley β, extending from Abulfeda *b* and Geber, but with very gently sloping sides, whilst west of Almanon is a fine mountain mass, α, sinking steeply on the north-east to the plain below.

Geber (R.)—A ring-plain, 25·4 miles in diameter, with 5° to 6° bright terraced walls, rising on the west 8,767 feet above the interior, which contains a very feeble central peak A. North-east is the small ring-plain B, with very steep walls and a distinct central peak in $-$ 18° 44′ lat. and + 17° 43′ long. South and west is a region full of small hills, on the borders of which are the two sharply-marked craters A and *c*, the former in $-$ 22° 30′ lat. and + 19° 26′ long., but never both equally well visible.

Tacitus (R.)—A considerable ring-plain, 27·7 miles in diameter, with a 6° bright terraced wall, rising on the west 11,843 feet, and on the east, by δ, about 11,500 feet above the 4° bright interior, which contains besides some hills a distinct central peak A, in $-$ 15° 55′ lat. and + 18° 0′ long. Around Tacitus are only some inconsiderable ridges and hills, and the small crater *n*; but in Full, on the south, appear some 9° bright points hitherto not identified, probably crater-cones. North, however, are some considerable mountains, the principal being β, which is steep and high, and γ as lofty but less steep, whilst beyond these mountains are the three craters *b*, *e*, and *c*, the first two 6° bright, and the irregular formation *d*. West of Tacitus are some peaks near λ, of some height, and the crater A, in $-$ 17° 16′ lat. and + 20° 3′ long., together with some smaller craters.

Catharina (R.)—A great walled-plain, the largest of the grand group of Catharina, Cyrillus, and Theophilus, with an irregular wall, rising at β only 8,249 feet, but at α towering 16,441 feet above the interior, which contains numerous ridges, mounds, hills, and crater-pits. From α, on the west, extends a long, curved, shallow valley, within the wall, ending by the small ring-plain Catharina *c*, whilst a branch extends north to the small ring-plain Catharina *b*. On the east the much-terraced wall contains numerous moderately high peaks, but on the south the wall is very imperfect and formed principally by ridges. The highest of the ridges on the interior is the small central peak γ. Catharina A is a small ring-plain at the end of the east wall, with some small crater-pits near it, whilst east of the wall is the group *d*, consisting of a small craterlet and three confluent depressions.

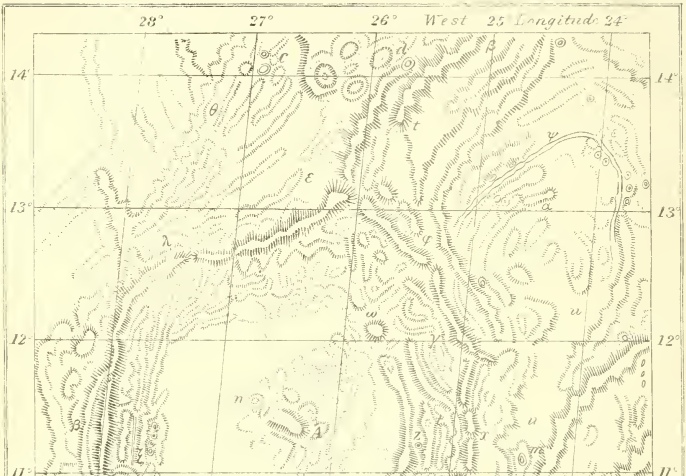
Beaumont (M.)—A ring-plain with moderately high broad walls, loftiest at β, surrounding a 4° bright interior, divided by a cross ridge ϵ into two portions, whilst around the ring-plain are a considerable number of hills and ridges, and some craters. South is Beaumont C, deep and 6° bright, with a sharply marked central peak, in − 19° 23′ lat. and + 29° 9′ long. North of Beaumont is the 7° bright crater A, with a very delicate central peak, in − 15° 50′ lat. and + 27° 30′ long., seldom visible. East are two grand groups of crater-like depressions, those by B, a very distinct 8° bright crater, in − 17° 56′ lat. and + 25° 55′ long., being the largest and placed on the summit of a triangular plateau, but the more scattered group by D is the most numerous. Near the peak Beaumont ζ, Schmidt believes he has seen a crater-rill (S. 379), but which is still doubtful; its direction is south-west, and its position − 15° lat. and + 26° long.

Cyrillus (R.)—A great walled plain, more square than circular, with a steep lofty wall rising in many broad terraces from the interior, which contains a group of central mountains and many long mountain arms. The principal object on the wall is the great 7° bright crater A, surrounded by a 4° bright region, containing numerous craters and crater-pits, whilst the centre of A, from seven measures by Mädler, is in − 13° 30′ 3″ lat. and + 22° 37′ 3″ long.[1] Gaudibert discovered two delicate rills, extending from A to the summit of the wall, ϕ and ξ, which escaped Schmidt, who draws here only some crater chains. On the east wall, both south and north of A, are a considerable number of rugged valleys

[1] By mistake Beer and Mädler, in the 'Der Mond,' obtain from their observations the value − 13° 30′ 3″ lat. and + 22° 41′ 20″ long., a value inconsistent with their measurements.

THEOPHILUS.

Scale. 100 Inches to the Moon's Diameter.



between the terraces, together with some craters and crater-pits; but towards the north Schmidt draws a number of crater-pits, arranged in rows, apparently identical with some of these valleys. The western wall, though containing numerous valleys, is quite free from a single crater or crater-pit, forming a very remarkable contrast to the east wall, especially as drawn by Schmidt. On the interior is a fine rill ψ, discovered by Schmidt, who draws it in two portions (S. 377 and 378), but which was seen by Gaudibert united. The central peak α is low, and on its west are two minute crater-pits, whilst others can be found on the floor, five west of the west branch of the rill ψ being arranged in a row. West of Cyrillus is the 7° bright crater *e*, of considerable depth, and near it is the lofty mountain ε, whilst east is the small highland δ, with five projecting arms, described by Mädler as resembling a hand, though the appearance is anything but striking; and south of this is the mountain-ring *b*, and the small ring-plain Cyrillus C, whose central peak is in − 12° 16′ lat. and + 21° 34′ long.

Theophilus (R.)—A magnificent ring-plain, 63·81 miles in diameter, with steep, lofty, much-terraced walls, rising in grand peaks to an immense height, γ being 14,326 feet, and $\varkappa$ from four measures, 15,925 feet high; whilst β towers aloft in a noble peak to the tremendous altitude of 18,238 feet above the interior, whilst μ is scarcely inferior, being 17,170 feet in height. The principal crest of the wall is 5° bright, the terraces and deep valleys on its interior slopes 4° bright, and those on the outer slope 3° bright, this last being very gently sloping at its base, though very steep at its summit, and according to Schmidt, the crest of the wall rises only some 3,200 feet above the Mare Tranquillitatis, though this seems to be far under its true altitude. The crater B on the wall, in − 10° 28′ lat. and + 25° 10′ long., is, like the one north-west, 6° bright, and near it Schmidt has seen some crater chains. The wall on the east contains, according to Schmidt, a crater-rill ψ (S. 374), but Gaudibert draws it as a valley which it appears to be, though with rugged sides, and opposite Gaudibert has seen a rill ξ, though this, as well as another close to it, appear to be also merely narrow deep valleys.

The interior of Theophilus is 3° bright, and contains a grand 6° bright central mountain, divided by valleys into several masses, the principal peak A rising, according to Mädler, 5,180 feet, but according to Schmidt, 6,400 feet above the floor; and, from ten measures by Lohrmann, is in − 11° 21′ 3″ lat. and + 26° 18′ 16″ long. Besides several hills and a small craterlet, Schmidt suspects a hooked rill on the south of the floor (S. 375), and two crater rills on the east, extending from the central mountain towards the east wall (S. 376). From the peak λ on the wall extends to Beaumont a strong ridge across the Mare; and east of this is a valley cleft θ, gradually widening and ending at *c*, a crater surrounded by four peaks. North of Theophilus extends the dark Mare Tranquillitatis, which is covered by numerous ridges and hill chains, radiating from Theophilus as a centre, and usually 3° bright in the slightly darker Mare. The principal points here are the 4° bright hill Δ, in − 8° 15′ lat. and − 25° 23′ long., and the 5° bright mountain E, in − 6° 42′ lat. and + 24° 3′ long. West of Δ, the ridges are broader than on the east, and both the ridges and the Mare are darker.

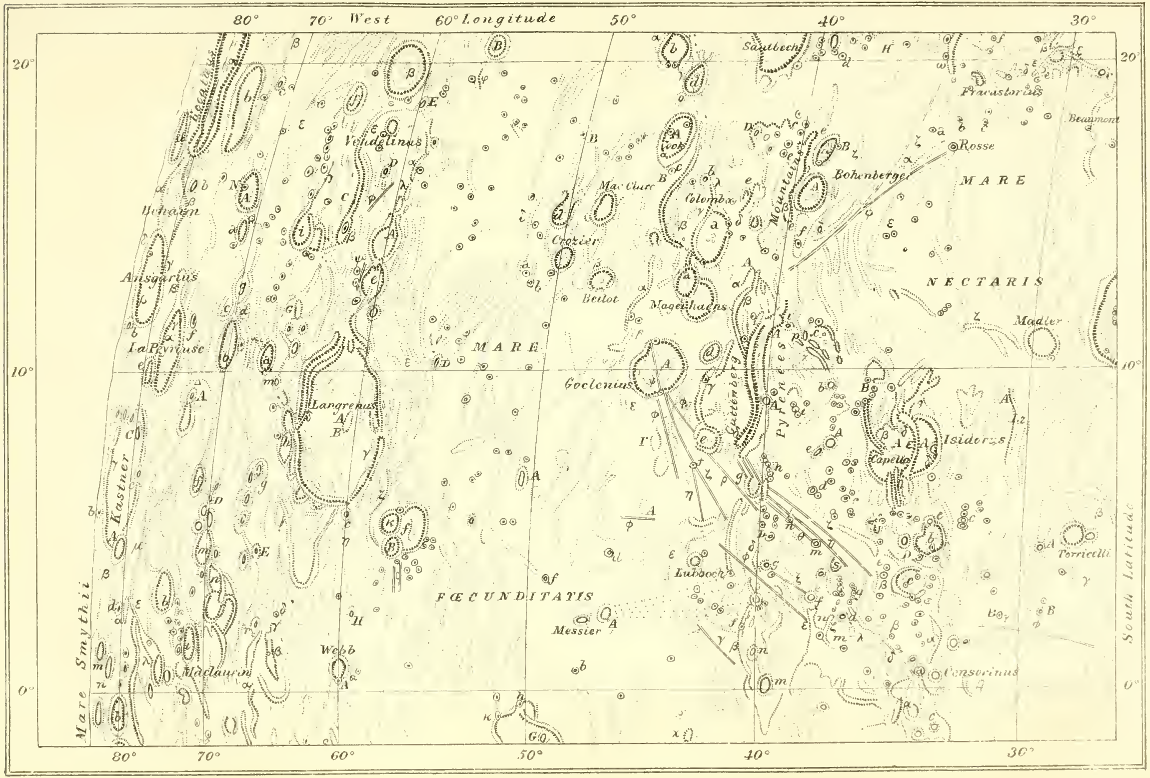
Mädler (Schmidt). [Theophilus, A.] — A fine ring-plain, very distinct in every illumination, with a broad regular wall, rising on the west 3,229 feet above the surrounding plain, and on the east 6,107 feet above the 3° bright interior, which contains a distinct central peak in − 10° 58′ lat. and + 29° 34′ long. The wall is 5° bright from south to east, 4° bright from east to north, 5° bright from north to west, 6° bright on the west, and 7° bright on the south-west, the surrounding plain being from 2°½ to 3° bright. From five measures during 1875 the position of the central peak of Mädler was found to be − 10° 55′ 59″ lat. and + 29° 11′ 58″ long.

Hypatia (R.)—An elliptical ring-plain, open towards the north, with a steep 4° bright wall, rising at α in a 5° bright peak 7,431 feet above the 3° bright interior; but from its walls being of the same brightness as the environs, Hypatia is not easily found under high illumination. The steep crater A, in − 4° 54′ lat. and + 22° 18′ long., has 6° bright walls surrounding a 3° bright interior; and with the peak α and the 5°½ bright crater *f*, can be found easily in Full. West of Hypatia is a nearly triangular highland, rising about 3,000 feet above the Mare, and containing, according to Mädler, 28 craters, which, with 6 seen since, makes 34; though the appearance of some indicates their being simply rounded valleys. Near β are some deep valleys, perhaps ½° brighter than the mountains, whilst at γ are the loftiest portions of the plateau. On the Mare north of this highland is the fine, very distinct, 6°½ bright crater Hypatia B, in − 0° 24′ lat. and + 24° 2′ long., and from this extends the southern branch of the great rill-system of Sabine and Ritter, δ (S. 373). In the small bay here are a number of craters, crater-pits, and ridges, the two principal objects being the 5°½ bright crater E, and the 5° bright crater Hypatia C. By Hypatia ζ are a number of low ridges, rising in low peaks and crossing an otherwise level bright plain, whilst farther north, near the two straight and regular ridges η and ϵ, is a small 6° bright mountain-peak.

Torricelli (M.)—A small ring-plain, easily found from being nearly equally distant from Isidorus and Hypatia, and Theophilus and Maskelyne; with a 3° bright wall, about 2,000 feet high, becoming almost 4° bright on the north, and surrounded by the only 2° bright Mare Tranquillitatis, whilst on the east it communicates by a broad pass with a smaller very similar ring-plain. On all sides of Torricelli are broad ridges and small hills; north-east is the small 4° bright crater Torricelli C, in − 2° 8′ lat. and + 25° 42′ long., with north of it the 4° bright mountain ridge δ, perhaps 1,000 feet in height. North is the small 4°½ bright crater B, in − 2° 46′ lat. and + 28° 45′ long., with another close to it only 3° bright, whilst west is the fine 6° bright crater Torricelli A, in − 4° 18′ lat. and + 29° 19′ long., with near it *f*, 4° bright, and on its south the 5° bright peak α. The crater-rill ϕ was discovered by Schmidt (S. 380), and is only visible with difficulty.

Mare Tranquillitatis (R.) *Southern.*—This portion of the great west-central dark grey Mare extends from Mädler to the equator, forming a great bay round Torricelli only 2° bright, but elsewhere 2°½ bright, and is bordered by the highlands of Hypatia and Kant on the east, by Theophilus and Mädler on the south, and by the bright region of Isidorus and Censorinus on the west, and comprises an area of 32,000 square miles. The surface is covered by innumerable ridges, hills, and mounds, but contains comparatively very few crater-pits, and scarcely any bright craters, excepting close to the very border. Mädler pointed out that although the neighbouring mountain region contained very many rills, he could not detect a single one on this Mare, where they would be so readily seen, but since then Schmidt has found two, one near Torricelli, and the other east of Censorinus.

Map XXII.


80°
70° West
60° Longitude
50°
40°
30°
20°
10°
0°
Mare Smythii
Kastner
La Pérouse
Ansgarius
Behaim
Hecataeus
Vendelinus
Langrenus
Maclaurin
Webb
MARE
FŒCUNDITATIS
Messier
Goclenius
Crozier
Bellot
Mac Clure
Colombo
Magelhaens
Guttenberg
Pyrenees
Mountains
Sauttbech
Bohenberger
Rosse
Fracastorius
Beaumont
MARE
NECTARIS
Madler
Capella
Isidorus
Lubbock
Censorinus
Torricelli
South Latitude

CHAPTER XXVIII.

MAP XXII.

Censorinus (R.)—A small, very brilliant crater, with 9° bright walls, and surrounded by irregular 8° bright environs, gradually fading into the brightness of the surrounding regions. From twelve measures by Mayer, its position was fixed at − 0° 6′ 0″ lat. and + 32° 45′ 0″ long.; and from five measures by Mädler as in − 0° 26′ 35″ lat. and + 32° 21′ 31″ long., which value is adopted in the 'Der Mond'; but as the number of measures was so small, a series of five were obtained during 1876 which give as the position of Censorinus − 0° 21′ 24″ lat. and + 32° 33′ 27″ long., giving, when united with Mädler's, − 0° 24′ 0″ lat. and + 32° 27′ 29″ long. as the true position of Censorinus.

Censorinus stands on the east edge of a small highland, crossed by the equator, and divided on the south by deep valleys into strong arms, and close on its west is **a**, a 5° bright crater, resembling in form Censorinus. East of Censorinus, in the dark grey Mare Tranquillitatis, is the 4° bright crater B, in − 2° 3′ lat. and + 31° 0′ long., with on its east the 4° bright peak γ, perhaps 3,000 feet high, and north of which extends the delicate rill Censorinus ϕ (S. 381) forming the connecting link between the great rill system of the centre of the Moon, extending from Triesnecker to Sabine, and the equally extensive western system extending from Censorinus to Guttemberg, and thence to Fracastorius. West of the crater B is the lofty mountain mass α, rising 6,229 feet above the grey plain, whose border it here forms. The ring-plain Censorinus *c* is remarkable for the variation in appearance it presents under different illuminations, containing in its interior a great number of mountain peaks and several craterlets, which, with the irregular walls, often cause it to assume very different appearances. West of *c* is the 5° bright double crater *e*, and still farther an imperfect ring-plain *s*, north of which are a number of crater-pits, arranged in rows, *g* being the longest, and near them at least two rows of very delicate hills. This entire region contains a great number of very delicate hills and small crater-pits, together with considerable numbers of small bright craters with steep walls, from 4°½ to 6° bright. Still farther west is Censorinus *f*, a bright crater, the western extremity of the group of Censorinus. The south portion of the plateau of Censorinus is here deeply indented by two great bays, *m* and *n*, forming three great capes, ε, ζ, and λ, of considerable height; and these two bays appearing at times like considerable ring-plains, are, Beer and Mädler believe, probably Riccioli's *Beda*, and *Alcuin*. From the base of the crater **a** to the end of the mountain ridge β, Mädler saw a delicate rill, δ, 37 miles long, but which Schmidt (S. 399) has not been able to find.

Isidorus (R.)—A great ring-plain, resembling an immense depression in a great mountain mass, with 4° bright, steep, much-terraced broad walls, rising at the peak Capella δ, 9,598 feet above the floor of Isidorus, and at ε, 13,314 feet above the interior, though the east border at δ rises only 5,877 feet. On the 3°½ bright interior is the fine 6° bright crater A, in − 8° 0′ lat. and + 33° 5′ long. The high plateau-like environs of Isidorus fall quickly to the lower-lying grey Mare, and forms a considerable mountain mass, whose loftiest points are on a great ridge, extending from Capella γ to Isidorus β, the last being probably the highest peak in this region. East, on the Mare, is the 5° bright mountain Isidorus

A, in − 8° 42′ lat. and + 30° 31′ long., with north the lower but equally distinct peak Z, in − 8° 11′ lat. and + 30° 17′ long. On the north is Isidorus *b*, a pear-shaped formation, with irregular walls, perhaps 4,200 feet high, and in portion 5° bright, whilst south-east are two 6° bright mountains, and the 6° bright crater *e*, with a 3° bright interior. East of this last is a crater row, *c*, consisting of four somewhat shallow crater-like depressions, the one on the north being 5° bright, and the rest 4° bright.

Capella (R.)—A considerable ring-plain, like its neighbour Isidorus, much resembling a grand depression in the midst of a mountain mass, its wall being very broad and sinking but slowly to the surrounding surface, though falling precipitously to the dark interior. The wall is broken in three places by deep rill-like valleys; that south-west at β, with the one opposite γ, constituting a rill-like valley, discovered by Schröter, and included by Schmidt amongst his rills (S. 382); but the third more delicate valley near δ is not so included. The interior contains a fine 6° bright very distinct central peak A, from ten measures by Lohrmann, in − 7° 32′ 41″ lat. and + 34° 48′ 14″ long., besides smaller irregularities. South of Capella is B, in − 9° 27′ lat. and + 35° 42′ long., a 6° bright crater on the borders of a ruined ring-plain, whilst close to it are four craters in a row.

West is the very deep crater A, in − 7° 38′ lat. and + 36° 54′ long., with its neighbour *e*, both 6° bright; and farther north-east is the 6° bright C, in − 6° 19′ lat. and + 36° 15′ long., close to which are a number of small and much less bright crater-like formations; whilst in the extreme north is the 6°½ bright very deep crater Capella D, in − 4° 22′ lat. and + 34° 3′ long.[1] North-west extend three fine rills, discovered by Mädler in 1834, and though long, very delicate. The first ζ (S. 393) extends from some hills east

[1] Some uncertainty attaches to Mädler's place for this crater.

of Guttemberg *g*, in a slight curve, to some hills near Censorinus *e*, a length of 70 miles; the second η (S. 394) reaches from the same point to the south of Censorinus *s*, and the third θ (S. 395) extends likewise from the same origin to the small crater Capella *m*, crossing a small crater *n*, and like η, a short ridge north of *n*.

Lubbock (N.) [Messier, C. M.]—A fine 5°½ bright, very deep crater, in − 4° 0′ lat. and + 41° 27′ long., in a slightly elevated 4° bright plateau on the east border of the Mare Fœcunditatis, to which it falls gently, except at the 5° bright peak ε. North, on the border of the Mare, is the small crater *f*, and near it the peak Lubbock β, whilst south-west Mädler discovered a rill, Lubbock γ (S. 383), not found by Schmidt. East are the two bright craters Lubbock D and *g*, connected by a bent mountain arm, δ. From *g* to Censorinus *f* extends a short rill, ξ (S. 398), discovered by Schmidt, and north of this is a very delicate rill, ϕ (S. 397), also discovered by Schmidt, which, commencing near Censorinus ε, ends by Lubbock λ, after having crossed several crater-like depressions.

Messier (M.)—A fine crater-plain, 9 miles in diameter, with a 7° bright wall surrounding a level 3° bright interior, and with on its east a second, described by Mädler as in every way exactly alike, in diameter, form, height, depth, colour, and position of the wall peaks, but which are now no longer thus alike, but markedly different in form and size. Gruithuisen in 1842 noticed that they were not exactly alike, but Webb was the first to point out the importance of this, and he says:—'This similarity no longer exists, and we have here strong evidence of *modern physical change*. Two curious white streaks, slightly divergent, extend from Messier A for a long distance, E forming, with the included shade, the picture of a comet's tail. Gruithuisen, who imagined them to be artificial, states that they are composed of a multitude of distinct parallel lines. In consequence of an observation by Schröter, who discovered this 'comet,' Beer and Mädler fortunately examined the spot, so peculiarly calculated to exhibit any variation, *more than* 300 *times*, between 1829 and 1837, without noticing any change. On Nov. 4, 1855, I perceived with my $3\frac{7}{10}$-inch Achromatic, that the east crater appeared the larger of the two. March 11, 1856, I found the west crater not only the lesser, but '*lengthened obviously in an E. and W. direction.* I have since noticed the dissimilarity with larger instruments, and it is, in fact, matter of very easy observation' ('Cel. Objects,' 3rd ed., p. 116). This fact has since been seen by many observers, and admits of no question, the eastern crater, A, being circular and the larger, and the western crater, Messier, elliptical and the smaller. It is noteworthy that while Mädler draws the two craters as exactly alike, Schröter draws the now smaller eastern as the larger of the two, a circumstance indicating a gradual change in its dimensions. Had the supposed similarity between the two craters rested merely on the map of Beer and Mädler, the inference which it has been proposed to draw, that here is an undoubted instance of physical change, would have no basis; for in this respect no strict reliance can be placed on the drawings and maps of Schröter, Lohrmann, Mädler, or Schmidt. Inserted by merely eye estimates, the relative dimensions of the smaller formations, as given by the principal selenographers, cannot in any way be trusted to this degree of accuracy, and numerous discrepancies on this point exist between the various authorities. But Beer and Mädler, there cannot be the slightest question, on repeated occasions paid particular attention to the relative dimensions and forms of these two craters; and the complete identity of the two in every respect they draw especial attention to, and as they themselves say, the slightest variation could not have escaped their notice. Had the two exhibited the now marked difference in form, it does not seem possible that it could have escaped the repeated and searching examinations of Beer and Mädler, so that there seems to have occurred in this formation a true modern physical change.

Messier lies, from eleven measures by Mädler, in − 1° 58′ 55″ lat. and + 47° 9′ 12″ long., and its floor is 5,602 feet beneath the east wall; whilst Messier A is in − 2° 6′ lat. and + 46° 15′ long. South of Messier is a low plateau, perhaps 60 feet high and 3° bright, with beyond it a small crater *d*; whilst east, between some ridges, are two, if not three, small crater-pits. North is the crater Messier *b*, and west Messier *f*, neither of any particular depth or brightness, whilst south is the 6° bright mountain Messier A, whose northern peak is in − 5° 49′ lat. and + 44° 51′ long., and north of this is a short rill ф.

Guttemberg (M.)—A ring-plain of considerable dimensions and pear-shaped form, surrounded by a 4° to 5° bright irregular wall, of considerable height, and with a 3° bright interior, containing a 5° central peak. On the west wall is the small ring-plain Guttemberg *e*, with 6° bright walls and a 6° bright central mountain, but with a considerable gap on the west. This ring-plain interrupts the delicate rill Guttemberg ф, which extends from Goclenius to the north of the small irregular ring-plain *g*, with 5° bright walls and a 4° bright interior. East of Guttemberg is the great 7° bright crater A, in − 9° 12′ lat. and + 39° 46′ long., with very steep walls and a great depth. Beyond this is a region containing many craters, three at *i* forming a short crater-rill, and six at *h* a longer (S. 396), whilst north of Guttemberg and west of *h*, Schmidt has seen three shallow rills (S. 390–392).

Guttemberg *c* is a very irregular depression, containing a number of small peaks and craters, with on its west a fine broad valley *b*, which branches out towards the west, where at χ are a number of parallel ridges enclosing rill-like valleys. Guttemberg *i* is a small but deep crater, and Guttemberg *b* is a very similar formation, and has around it a number of small hills and crater-pits.

Goclenius (R.)—An elliptical, not very deep, ring-plain, with a 6° to 7° bright wall, in places steep, and containing many peaks, surrounding a 3° bright interior, which has a fine 6° bright central peak, from twelve measures by Mädler, in − 9° 58′ 46″ and + 44° 27′ 2″ long., besides five 6° bright light spots, together with a short rill, ψ (S. 384). North of Goclenius extends a fine rill, ζ (S. 386), the northern portion of which, together with the branch η (S. 388), was discovered by Mädler, whilst west of these is the still more delicate rill ϕ (S. 387), discovered by Schmidt. In this region is the small, 8° bright, very conspicuous plateau Γ, whose east edge is in − 8° 41′ lat. and + 44° 29′ long., whilst nearer the crater *f* are three small 6° bright mountains. West is Goclenius ϵ, a 6° bright mountain, and close to Goclenius A [1] a small ring-plain, in − 7° 0′ lat. and + 50° 36′ long., is a 6° bright light spot on a scarcely 130 feet high plateau. South-west of Goclenius there are some glittering points in Full, one a short light streak, 6° bright, near the peak β, another a short mountain ridge with two peaks, and a third a 5° bright mountain.

Magelhaens (M.)—A ring-plain, with a 6° bright wall of moderate height, and a 3° bright interior, containing a small central mountain, perhaps 4° bright. United to it is the very similar a, slightly smaller, but with somewhat loftier walls and a brighter floor. Close to Guttemberg is the 6° bright small ring-plain Magelhaens *d*, and between the two, extend-

[1] Given in the text of the 'Der Mond' as in + 45° 36′ long.

ing from near Goclenius to east of Colombo **a**, is a perhaps doubtful rill, which being so uncertain is not drawn.

Bellot (B.) [Magelhaens, C. M.]—A small ring-plain, with a gently sloping, moderately high wall, about 6° bright, except on the south-west, where it is 8° bright. Near it are the two peaks α and β, both high, and between them the surface gently rises into a low, nearly 4° bright plateau.

Crozier (B.) [Magelhaens, B. M.]—A small ring-plain, with a 5° bright wall and a 3° bright interior, which is crossed by a low ridge, and contains a small central peak, in − 13° 27′ lat. and + 49° 31′ long. From it, towards Messier, extends a long straight light streak, with on its east a narrower and fainter, which does not reach so far. North-west are the two 5° bright craters, Crozier **a** and *b*.

MacClure (B.) [Colombo *c*. M.]—A small ring-plain of some depth, with 6° bright walls and a 3° bright interior, containing a scarcely perceptible central peak, in − 15° 10′ lat. and + 47° 25′ long. From it to Bellot extends a not inconsiderable ridge, and west are some 4° bright mountains from 2,000 to 2,500 feet high, together with the 5° bright ring-plain MacClure *d*, which has an only 2°½ bright floor.

Colombo (M.)—A great ring-plain of very irregular form, with a complex much-terraced 5° bright wall, double and triple on the west, and rising on the east at λ 7,079 feet and at γ 8,028 feet above the 3°½ bright interior, which contains a large 6° bright central peak, and two smaller 7° bright central peaks. On the south is a labyrinthical mountain mass, containing two crater-like depression, of which *b* is the larger and deeper. North-east is the more regular ring-plain Colombo **a**, surrounded by a 5° bright wall of moderate height, and with a 3° bright interior, containing some very delicate 4° bright central hills, whilst on the walls are some 5°½ bright craters.

Pyrenees (M.)—A fine mountain range, extending from

$-8°$ to $-18°$ lat., and consisting of two great mountain masses falling steeply on all sides, and connected by a lower central portion. On the north it rises to its highest point in the grand peak Guttemberg *A*, in $-11° 18'$ lat. and $+39° 50'$ long., towering 11,913 feet above the surface; whilst on the south the loftiest measurable peak is perhaps Bohnenberger γ, which rises 6,420 feet above the surface. The higher portions of the range are almost unbroken, but the lower, and especially the central mass, are pierced by numerous valleys and ravines. South of Guttemberg the mountains widen out into an irregular plateau, containing two crater-like depressions, and ending at the peak Colombo A, in $-12° 52'$ lat. and $+41° 5'$ long. On the south, the highest peaks are perhaps, Bohnenberger β and γ, and Colombo δ; and on this portion are a considerable number of crater-like depressions, whilst on the west, several valleys lead from the summit to the plain below, the one by δ being most marked. The southern end of the Pyrenees occurs at the two 6° bright craters D, in $-17° 48'$ lat. and $+41° 30'$ long.; and C, in $-18° 7'$ lat. and $+39° 58'$ long.

Bohnenberger (M.)—A ring-plain, with a low narrow wall, scarcely 1,500 feet high, and a nearly level $4°\frac{1}{2}$ bright interior, containing a 5° bright central peak *A*, which is little conspicuous, whilst a narrow valley, *e*, divides Bohnenberger and Bohnenberger A from the Pyrenees. Bohnenberger A is a slightly smaller ring-plain than the last, with walls barely 400 feet high, and a bright convex interior, the whole ring-plain being only found with trouble. The walls are broken by two deep craterlets, **a**, on the north, being largest and $5°\frac{1}{2}$ bright, whilst B, on the east, is 6° bright, very small, but perfectly distinct even in Full, and in $-17° 5'$ lat. and $+38° 30'$ long. From four measures during 1875, the position of the centre of Bohnenberger A was ascertained to be − 17° 3′ 8″ lat. and + 39° 24′ 10″ long., the position, according to Mädler, being about − 17° 4′ lat. and + 39° 10′ long.

Rosse (N.) [Fracastorius, E. M.] — A fine, very deep and steep crater on the Mare Nectaris, with 7° bright walls, and a 6° bright interior, forming under high illumination one of the most distinct and conspicuous objects upon the Moon. From four measures during 1875, its position was determined to be − 17° 48′ 37″ lat. and + 34° 19′ 38″ long., whilst Mädler, as one of his points of the second order, made its place − 17° 27′ lat. and + 33° 41′ long.

Rosse is at the point where two light streaks traversing the Mare Nectaris cross, and south of it are three deep craters, Rosse a, *b*, and *c*, all 5° bright, and readily found in Full, whilst from Rosse towards the north extend several broad ridges. From Rosse to the small crater Bohnenberger *f*, extends a very delicate rill ϕ, the northern portion of which, though discovered by Mädler, is not referred to in Schmidt's catalogue. Near a small plateau α, this rill is joined by a second, ξ, discovered by Gaudibert in April 1874, and extending south-east to Fracastorius. This name was originally applied to an irregular extent of surface between Zuchius, Segner, and Phocylides, but not only is this region, from its indefinite character, unworthy of being named, but no extra name is required there; accordingly the name has been transferred to one of the most distinct formations on the south-west quadrant of the Moon.

Mare Nectaris (R.) extends from Mädler to Fracastorius, and Beaumont to Bohnenberger, with, except on the north-east and south-west, a fairly-marked natural border; its tint is a light grey, with many difficultly-visible shadings, in general with a brightness of 2°½, sinking in places to 2°, and rising on its very numerous ridges and hills to 3° and 3°½. The principal of the numerous ridges of this Mare commences near Capella B, and, roughly parallel to the border, extends as far as Fracastorius, a distance of 250 miles, while its brightness, 3°½ to 4°, is as exceptional as its general height, which, while usually 1,200 feet, is at Bohnenberger δ, 1,995 feet. Another considerable ridge extends from Mädler in a bold curve, and is 5° bright, and at ζ contains a 6° bright low peak. North of this ridge the Mare is only 2° bright, whilst south it is 4° bright, gradually sinking first to 3° and then to only 2°½ bright. West of ζ is a row of three crater-pits, and farther south Mädler draws nine others, though many more would probably be found by a close examination. In the centre of the Mare Nectaris is an extensive, very gently sloping, round plateau, with a 3° bright summit, apparently free from crater-pits.

Cook (M.)—A circular ring-plain, with uniform narrow walls of moderate height, and 5°½ brightness, rising at their loftiest peak, α, only 3,146 feet above the 3° bright interior, which contains a small craterlet, A, in − 17° 33′ lat. and + 46° 41′ long., that is 5° bright and very deep. North extends a short arm, β, and on the north-east outer slope of the wall of Cook is the moderately deep crater *c*. South is the fine ring-plain *d*, with a 6° bright broad lofty wall, rising at the 7° bright peak γ 7,700 feet above the 3° bright floor. West, on the Mare, is the 5°½ bright crater Cook B, in − 17° 12′ lat. and + 49° 51′ long., on a 4° bright ridge extending from MacClure *d* to Biot α.

Mare Fœcunditatis (R.)—The greatest of the western lunar Mares, stretching from Taruntius D, in + 9°, to at least − 25° lat., a distance of 640 miles, and from + 40° to + 62° long., a distance of 415 miles; and possessing an area of 160,000 square miles. The great northern bay of the Mare near Taruntius is at least 3° bright, and would, were it not for the contrast with the bright surrounding mountain regions, hardly appear like a grey Mare, according to Mädler; but the ordinary brightness is only $2°\frac{1}{2}$, and sinks in portions, especially towards the west, to only 2°, though on the south it rises to fully $3°\frac{1}{2}$ bright. The surface, on the south especially, is crossed by numerous light streaks and bright ridges, whilst it contains numerous bright ring-plains and craters, rendering its general brightness greater than it would otherwise have been. West of Messier are a great number of low ridges and many crater-pits, together with a few 4° to 5° bright craters, whilst the ridges in a few points rise into low peaks, perhaps 1,000 feet high and $3°\frac{1}{2}$ to 4° bright. Towards the south the Mare narrows, and between the terraces of Vendelinus and the steep mountain slope by Vendelinus δ, which is 3,306 feet high, contracts to a breadth of only 132 miles; so that as the wall of Vendelinus rises 5,378 feet above the Mare, were the two on the earth, one could see the summit of one from the other; but this could not be done on the Moon, as the curvature of the surface is so much more rapid. In this portion of the Mare there are many craters and crater-pits, but scarcely any ridges. Still farther south the grey plain again becomes wider and contains several bright ridges, besides craters and crater-pits, but beyond, between Biot α and β, it narrows to only 70 miles, and farther south penetrates in deep winding bays far into the southern mountain regions.

Vendelinus (R.)—A great but irregular walled-plain, with a moderately high, but little terraced wall, broken by numerous valleys, and rising at α 5,378 feet, and at λ 4,600 feet above the interior, which, slightly convex in form, varies in brightness from only $1°\frac{1}{2}$ on the south to $3°\frac{1}{2}$ on the north, and contains many irregularities. The border on the south is formed partly by some small hills and craters, amongst which the 6° bright E, in $-18° 40'$ lat. and $+60° 24'$ long., is very distinct—the floor of Vendelinus at its north border being scarcely 1°½ bright—and partly by the considerable ring-plain Vendelinus B, in − 19° 25′ lat. and + 61° 2′ long., with a terraced wall like the almost level interior, 6° bright. On the north the border consists of a gently rising plateau, containing some hills and crater-like depressions, and crossed by a small crater-rill, ψ (S. 402), whilst on its east it is bordered by the two considerable ring-plains Vendelinus *e* and A, and on the west, in part by the high peak β. The interior of Vendelinus contains no central peak, though there are many low ridges, and the most distinct formation, according to Mädler, is the small crater D, in − 16° 15′ lat. and + 59° 45′ long.[1] Schmidt discovered a short rill, φ (S. 403), on the north of the interior, and there is probably another closer to the east wall. West of Vendelinus is the irregular but considerable ring-plain C, with a steep wall whose interior is crossed by several ridges, one broken by a small craterlet; whilst on its north are some smaller ring-plains—one, *i*, only separated from it by a low ridge, which is not visible near the terminator. South of *i* extends a row of several crater-like depressions, ending near the small ring-plain *f*.

Hekatäus (M.)—A peculiar pear-shaped walled-plain on the Moon's limb, extending from − 17° to − 23° lat., a distance of 115 miles, with irregular walls and a bright interior, containing a 6° bright crater, a, a fine central peak, α, and a number of ridges and small mountains. On its west is *d*, a great and deep ring-plain seldom very distinct; whilst east is the still larger ring-plain *b*, 46 miles in diameter, but with only moderately high walls, broken by a 6° bright crater. Beyond is the large crater *c*, also 6° bright, on the

[1] In the map Beer and Mädler neither draw this crater D nor mention a crater *h* which they have drawn, and it is probable that their D and the *h* shown are identical, though whether the position of this crater should be in + 59° 45′ long., as stated, or in + 60° 45′ as drawn, is doubtful.

edge of a dark plain of considerable area, only 3° bright, and crossed by several ridges, the principal being Hekatäus β and γ, which, uniting, form the irregular ring-plain Humboldt *b*.

Behaim (M.)—An irregular ring-plain, 65 miles in diameter, with lofty steep walls, rising at α and β into high peaks, whilst the interior, divided into two by a cross-wall, contains several ridges and mounds. In the west, along the limb, a very mountainous region appears to extend, though without the very lofty peaks of the Doerfel and Leibnitz mountains, but yet, perhaps, from 12,000 to 15,000 feet high. East of Behaim is the deep ring-plain A, with a 7° bright crater, N, on its floor, in $-$ 16° 4′ lat. and + 72° 25′ long., whilst a strong ridge, ϵ, in points perhaps 500 to 600 feet high, unites it with Vendelinus *f*. West of H the plain is from 3° to 4°½ bright, but east it is perhaps slightly lower, and is only 2°½ bright. Behaim *b* is a small deep ring-plain.

Ansgarius (M.)—A ring-plain, 50 miles in diameter, well enclosed by regular walls rising in lofty peaks at δ and β, and with a perfectly level interior. On the west is the small ring-plain *b*, and on the east, in the open plain near Behaim A, is the shallow ring-plain Ansgarius **a**, together with some small crater-like formations.

Lapeyrouse (M.)—A ring-plain, 41 miles in diameter, with uniform narrow walls, rising only at α and γ in peaks, and with a nearly level interior, containing only two ridges and perhaps a small crater. North, extends a fine low plateau, an arm of which unites it with Kästner, whilst on the south extends a short but lofty mountain arm, β (Mädler's second α). West of Lapeyrouse is the deep ring-plain *e*, and east the far shallower *f*, with a slight central peak; whilst north-east is the very brilliant 9° bright point Δ, close to the bright crater Lapeyrouse A, from nine measures by Mädler, in $-$ 9° 23′ 20″ lat. and + 73° 52′ 41″ long. Lapeyrouse *b* is a fine ring-plain, with broad lofty walls, rising 12,546 feet above the interior, which contains a long ridge and central peak, whilst south are the two imperfect ring-plains *c* and *d*, with still further the shallow *g*, of about double their size.

Langrenus (R.)—A very fine, walled-plain, remaining distinctly visible, even in Full, with a steep, complex, much-terraced 6° bright wall, surrounding a 3° bright interior, containing a fine 8° bright central peak, A, 3,344 feet high, and a 8°½ bright, somewhat lower, peak, B, from ten measures by Mädler, in − 8° 22′ 29″ lat. and + 60° 34′ 9″ long. On the east the wall rises at γ 9,611 feet, and contains a narrow valley, extending from the peak to the north, whilst on the west wall are two longer, broader, and deep valleys. Around Langrenus are a great number of mountains and low hills, enclosing peculiar depressions, in some manner resembling the formations of high south latitudes. Langrenus C is a 4° bright circular small ring-plain, in − 5° 23′ lat. and + 60 11′ long., with north of it the steep peak η. On the Mare is the small, deep, but not steep ring-plain Langrenus B, in − 4° 12′ lat. and + 57° 30′ long., containing a pair of central peaks, united by a low ridge, and close to it are two others, *f* and *k*, the former with a wall rising 5,640 feet above the interior, whilst north are two short crater-rills (S. 400–401), discovered by Schmidt, who thinks others exist here. South of B extends a fine system of broad shallow valleys, scarcely 2° bright, and extending far south, the principal one, ζ, having been noticed by Mädler. South, at Langrenus D, in − 10° 7′ lat. and + 55 °34′ long., are a number of very similar shallow valleys, only visible under favourable conditions of illumination. West of Langrenus are a considerable number of ring-plain-like formations, enclosed by mountain ridges, *h* and *g* being the most distinct. Langrenus a is a fine ring-plain, with lofty walls rising 11,490 feet above the interior, which contains a central peak visible with difficulty, whilst north-east of it is Langrenus *m*, a fine 9° bright crater, containing a central peak.

Maclaurin (M.)—The most distinct of a group of ring-plains on the west of the Mare Fœcunditatis, with a bright, moderately high wall and a strongly concave interior, containing a massive central mountain. The row of ring-plains extends south of Maclaurin to D, in − 6° 36′ lat. and + 69° 34′ long., and consists of eight principal ring-plains, besides secondary formations, and of these *m* and *n* are the most distinct. From the peak α, east of Maclaurin, extends a broad valley to the crater E, in − 3° 44′ lat. and + 66° 6′ long., whilst east of the valley are a number of steep and lofty peaks, the principal being β, γ, and δ, near the second being the 6° bright crater *r*. West of Maclaurin is the ring-plain *b*, containing a central mountain; and south, at *f*, a smaller but deeper ring-plain, whilst between the two extends a winding valley.

Webb (N.) [Maclaurin, C. M.]—A fine 7° bright, small ring-plain, 14 miles in diameter, on the dark Mare Fœcunditatis, distinct under all illuminations, marking the position of the lunar equator on the far west. The dark floor contains a small central peak, whilst the wall close to the wall-peak α is broken by a 7° bright crater A, whose position is − 0° 24′ lat. and + 59° 42′ long. South of this ring-plain is the 5° bright crater Webb H, in − 1° 59′ lat. and + 59° 25′ long., surrounded by low hills; and near it, in − $3°\frac{1}{2}$ lat. and + $57°\frac{1}{2}$ long., is a crater seldom distinctly visible.

Kästner (S.)—A great walled-plain, with low borders, highest at γ, and extending from the small ring-plain A to C, both, as well as *e* on the east wall, 5° bright. This is not Schröter's Kästner, but the formation to which Beer and Mädler transferred the name, and consists merely of a portion of the region so named by the earlier selenographer. North is the small ring-plain *d*, close to the lofty peak Kästner α, and west is the crater Kästner *b* and the isolated mountain β.

Mare Smythii (Lee.)—A great plain, extending from + 6° to − 8° lat., drawn and described by Schröter, who named it Kästner, which name was transferred by Beer and Mädler to a great walled-plain connected with it. The formation is, however, of a very indefinite character, and scarcely visible as a connected whole, even under favourable conditions of libration and illumination. On the east, its border extends by the peak Maclaurin μ, ϵ, λ, and on its surface are a number of ring-plain-like formations. Under certain conditions of libration this great plain is brought centrally on to the limb, when the lofty peaks at each end, and the generally lofty wall on the east, give a peculiar flat appearance to the limb. It forms then the principal of the great flattenings of the western limb described by Key.

CHAPTER XXIX.

SELENOGRAPHICAL FORMULÆ.

In studying the details of the lunar surface, it has been already remarked that it is necessary to take into consideration the relative positions of the Sun, Earth, and Moon, so as to be enabled to eliminate the effects produced by differences in the illumination of the surface and the lunar librations. Moreover, much yet remains to be done before the position of the principal formations can be regarded as satisfactorily established, and many measurements of the dimensions of the principal details must yet be obtained, before this important branch of selenography can be held to have received adequate attention.

A complete system of formulæ for the proper treatment of this most important branch of selenography has therefore been framed for the purpose of assisting in the prosecution of this subject; for there is much reason for believing that the principal cause of its neglect has been the absence of any simple methods of obtaining the means for reducing the observations. The following pages contain, however, all that will be necessary to obtain the various selenographical elements, not only for determining the position and dimensions of the lunar formations, but for the purpose of comparing different series of observations and drawings.

The different formulæ have been designedly broken up into different sections, so as to render the computation of any particular quantity or element easier, and processes of different degrees of accuracy have been given, so as to shorten the computation when, as is often the case, only an approximate value of the quantity is required.

THE APPARENT CO-ORDINATES OF THE MOON.

1. The Right Ascension, Declination, Semi-diameter, &c., of the Moon, given in the 'Nautical Almanac' and other ephemerides, being geocentric, or such as would be true for the centre of the earth, to render them available for any place upon the surface of the earth, it is necessary to apply certain corrections, so as to take into consideration the real position of the observer.

To effect this for any instant, so as to obtain the apparent position, &c., of the Moon as seen by an observer at the place in question, the following data must be taken from the 'Nautical Almanac' or similar ephemerides:—

Geocentric Right Ascension of the Moon	$= a$
,, Declination . . .	$= \delta$
,, Semi-diameter . .	$= s$
Equatorial Horizontal Parallax .	$= p$

2. *To Compute the Horizontal Parallax* $= p'$.

The tabular parallax being the equatorial horizontal parallax, and as, owing to the ellipticity of the earth, its radius gradually diminishes as the latitude increases at any given point, the horizontal parallax is smaller than the tabular or equatorial horizontal parallax, in the same ratio as the terrestrial radius at that point is to the equatorial radius of the earth. Putting ϕ for the geocentric[1] latitude at the

[1] The geocentric latitude, or latitude at the centre of the earth, differs slightly from the geographical or surface latitude, the difference arising from the ellipticity of the earth, and is known as the angle of the vertical. If ϕ' be the geographical latitude, then

$$\tan \phi = 0{\cdot}993325 \tan \phi'.$$

The two coincide only, therefore, at the equator and poles, but as far as this purpose is alone concerned, either might be employed without material error.

place of observation, and adopting Bessel's value for the terrestrial polar compression, then to a sufficient degree of approximation

$$p' = p\,(1 - 0{\cdot}00674 \sin^2 \phi).$$

3. *To Compute the Parallax in Right Ascension* ($= \Delta\,\alpha$) *and Declination* ($= \Delta\,\delta$).

Let h denote the Moon's hour angle at the given time, found by subtracting the sidereal time at the instant of observation from the right ascension of the Moon, and converting this result, which will be expressed in time, into arc in the usual manner.

Then putting for simplicity

$$a = \cos\phi \frac{\sin p'}{\cos\delta}$$

the resulting parallax in right ascension expressed in arc becomes

$$\Delta\,\alpha = \frac{1}{\sin 1''}\left\{a \sin h + \frac{a^2}{2}\sin 2\,h + \frac{a^3}{3}\sin 3\,h\right\}.$$

This parallax always acts so as to increase the distance of the Moon from the meridian, so that it will be positive when the Moon is east of the meridian and negative when west, possessing, therefore, the same sign as the hour angle.

Next putting also for brevity

$$\cot b = \cot\phi \frac{\cos(h + \frac{1}{2}\Delta\,\alpha)}{\cos\frac{1}{2}\Delta\,\alpha}$$

$$c = \sin\phi \frac{\sin p'}{\sin b}$$

and the expression for the Moon's parallax in declination becomes

$$\Delta\,\delta = \frac{1}{\sin 1''}\left\{c \sin(b - \delta) + \frac{c^2}{2}\sin 2\,(b - \delta) + \frac{c^3}{3}\sin 3\,(b - \delta)\right\}.$$

The parallax in declination always acting so as to increase the zenith distance of the Moon, on the northern hemisphere it will always act so as to increase the lunar north polar distance. North declinations being supposed positive, and south declinations negative, the sign of $\Delta\,\delta$ is easily ascertained; but it will be necessary to pay some attention to the signs of b and δ in ascertaining its amount.

In both the expressions for the parallax in right ascension and in declination, as the third term can never exceed half a second of arc and rarely amounts to half of this, it can usually be neglected. In the same manner since the second term cannot exceed some half a minute of arc, it may often be omitted in merely approximative calculations, thus simplifying the computation of the Moon's parallax in right ascension and declination to the first term of each expression.

For many purposes it is convenient to obtain the variation in the parallax of the Moon in right ascension and declination for any small interval of time, so as to obtain the value of the parallax for any period near to that for which they have been calculated, without having to repeat the work. Putting then $\Delta\,h$ for any small alteration in the hour angle due to the lapse of a small period of time, then the corresponding alterations in the parallax in right ascension and declination will be given by

$$\Delta\,(\Delta\,\alpha) = a,\ \cos h,\ \Delta\,h,$$

$$\Delta\,(\Delta\,\delta) = \frac{a}{2}\ \sin h,\ \sin 2\,\delta,\ \Delta\,h.$$[1]

The increment of hour angle $\Delta\,h$ is here supposed expressed in degrees, minutes, and seconds of arc, and the variations in $\Delta\,\alpha$ and $\Delta\,\delta$ are given in the same manner in arc. The sign of $\Delta\,(\Delta\,\delta)$ may be determined by the consideration

[1] Or, putting $\Delta\,h$ in circular arc, then

$$\Delta\,(\Delta\,\delta) = \frac{\Delta\,a}{2}\ \sin\,2\,\delta\,\Delta\,h,$$

generally a convenient form.

that the parallax in declination will increase and decrease inversely as the hour angle, as long as this does not exceed six hours or ninety degrees.

4. *To find the Moon's Zenith Distance* ($= z$) *and the Parallactic Angle* ($= \psi$).

The zenith distance in connection with the other elements of the position of the Moon is most readily computed by the formula

$$\cos z = \sin \phi, \sin \delta' + \cos \phi \cos \delta' \cos h',$$

and it can be easily tabulated under this form. Under other conditions, the following form may be preferable :—

$$\cos z = \sin \delta' \frac{\sin (y_1 + \phi)}{\cos y_1}$$

where

$$\tan y_1 = \cos h' \cot \delta'.$$

If the zenith distance has been already computed, the parallactic angle, or angle between the vertical and declination circles at the Moon's centre, may be obtained from the equation

$$\sin \psi = \cos \phi \frac{\sin h'}{\sin z}.$$

If the zenith distance has not been found, then putting

$$\tan q = \cot \phi \cos h'$$

we have

$$\tan \psi = \tan h' \frac{\sin q}{\cos (q + \delta')}.$$

In the above, h' is the apparent hour angle, found by adding the parallax in right ascension to the geocentric hour angle h. If the geocentric zenith distance and parallactic angle are required, throughout the above, the tabular or geocentric quantities may be employed, and for many purposes this will be quite sufficiently approximate.

Under all conditions, to obtain the apparent declination δ', it will only be necessary to add the parallax in declination $\Delta\,\delta$ to the geocentric declination δ.

The variation in the cosine of the zenith distance may be approximately found by the expression

$$\Delta\,(\cos z) = -\cos\delta'\cos\phi\sin h\,\Delta\,h.$$

The accuracy of this can be still further increased by using, instead of δ, the value of the declination at the middle of the interval for which the variation is required.

5. *To find the Effect of Refraction upon the Apparent Position of the Moon.*

It is only when some accuracy is desired that it will be necessary to consider the effects of the atmospheric refraction upon the apparent right ascension and declination of the Moon; for delicate observations of the Moon being impracticable with the lunar altitude under twenty degrees, the maximum amount of refraction will not exceed three minutes of arc. Putting $\Delta'\,(\alpha)$ for the correction to the Moon's right ascension, and $\Delta'\,(\delta)$ for that to the declination from this cause, then if R be the amount of the refraction at the known zenith distance of the Moon

$$\Delta'\,(\alpha) = \mathrm{R}\sin\psi$$
$$\Delta'\,(\delta) = \mathrm{R}\cos\psi.$$

As the atmospheric refraction, like the lunar parallax, acts along a vertical circle through the Moon, but tends to elevate it, the signs of the above will always be opposite to the signs of the parallax in right ascension and declination respectively.

The value of R must be found in the usual manner from a table of refractions for the given altitude, if accuracy is required. If recourse to a table is not convenient, a fairly approximate result may be obtained from the expression

$$R = 57''\!\cdot\!5 \tan z \left(\frac{P}{P_\circ} \cdot \frac{1 + \varepsilon\, t_\circ}{1 + \varepsilon\, t}\right),$$

where P and $P_\circ$ are the height of the barometer at the time of observation, and the standard height (= 39·6 inches = 0·752 metres), and t and $t_\circ$ the temperature at the time of observation, and the standard temperature (= 50° F. or 10° C.) respectively, whilst the value of ε will be 0·002, or 0·0037, according as the temperature is taken in Fahrenheit or Centigrade degrees, only in the former case 32 must be subtracted from both temperatures before being employed.

If an error of a few seconds of arc is not material, as will frequently be the case, the factors in brackets in the above expression for the refraction may be considered as equal to unity.

6. *To Compute the Apparent Semi-diameter of the Moon* $(= s')$.

The tabular semi-diameter being, as already remarked, geocentric, the observer being placed on the surface, must be, except when the Moon is on the horizon, closer to it, so that its apparent diameter is augmented; and in all except approximate measures made on the Moon, this increase in diameter must be taken into consideration.

If the Moon's parallax in declination has been already computed, as will generally be the case, the apparent semi-diameter can be best found from the formula

$$s' = s + s, \sin \Delta\,\delta, \cot(b - \delta) - \frac{s}{2} \sin^2 \Delta\,\delta,$$

the value of $(b - \delta)$ being given in the determination of the parallax. As the last term never exceeds one-sixth of a second of arc, it will be in general unnecessary to take it into consideration.

If the parallax in declination is not to be computed, only an approximate value for the augmentation of the Moon's semi-diameter will be required, and to within half a second of arc

$$s' = s + 0{\cdot}0000178\ s^2 \cos z.$$

From the unequal effect of the atmospheric refraction on the upper and lower limb of the Moon, the Moon's apparent semi-diameter is decreased, and when the altitude is low this diminution may become very sensible. The effects of this are usually taken into consideration by applying a small correction to the observations themselves, but occasionally it may prove advantageous to apply it direct to the Moon's semi-diameter. As the diminution acts along a vertical circle, and is inappreciable at right angles to this, the effect varies according to the position of the semi-diameter selected. If the position-angle of the semi-diameter, or the angle between the semi-diameter and the circle of declination through the Moon's centre, be denoted by Π,[1] then the correction to the Moon's semi-diameter, from the effects of refraction, will be

$$\Delta\,(s') = -\,\Delta\,\mathrm{R}\cos^3(\pi - \psi)$$

where Δ R is the difference in refraction between a point at the altitude of the centre of the Moon, and when this altitude is increased by the lunar semi-diameter.

The altitude of the Moon being supposed greater than twenty degrees,[2] the amount of the correction will seldom much exceed one second of arc, and can, therefore, except in delicate series of measures from the Moon's limb, be

[1] If the position angle is, as usual, reckoned from 0° to 360°, its cos must throughout be regarded as positive.

[2] The formulæ, however, will hold sensibly correct for much lower altitudes of the Moon.

usually disregarded. For measures upon the Moon, where distances exceeding three or four minutes are rarely necessary, it can almost always be neglected.

The variation $\Delta\, s'$ in the augmentation of the Moon's semi-diameter during any small period of time will usually be very small, but if ever required it can be computed from the formulæ

$$\begin{aligned}\Delta\, s' &= -\ 0{\cdot}0000178\ s^2 \cos\phi,\ \cos\delta,\ \sin h,\ \Delta\, h,\\ &= -\ 0{\cdot}0000178\ s^2,\ \Delta\,(\cos z),\end{aligned}$$

the last factor, $\Delta\, h$, being the increase in the hour angle in arc in the interval of time.

7. *Expressions for the Apparent Right Ascension* ($= \alpha'$) *and Declination* ($= \delta'$) *of the Moon.*

Applying to the geocentric position of the Moon the corrections already determined, its apparent place as seen from the point of observation will be

$$\begin{aligned}\alpha' &= \alpha + \Delta\,\alpha + \Delta'\,(\alpha)\\ \delta' &= \delta + \Delta\,\delta + \Delta'\,(\delta).\end{aligned}$$

If, as is very usual, the effects of refraction are taken into consideration, by applying the corrections found with the signs reversed to the observations themselves, the third term on the right-hand side of the above expressions must be omitted, and in general this will be found the preferable method.

It is very often useful to have an expression for the variation in the apparent right ascension and declination during a small interval of time, denoting these by $\Delta'\,\alpha'$ and $\Delta'\,\delta'$ respectively; and putting $\Delta'\,\alpha$, $\Delta'\,\delta$ for the motion in geocentric right ascension and declination during this period, which can be obtained from the 'Nautical Almanac;' then, as before, $\Delta\,(\Delta\,\alpha)$ and $\Delta\,(\Delta\,\delta)$ being the variations in the parallax in right ascension and declination with their proper signs—

$$\Delta' \alpha' = \Delta' \alpha + \Delta (\Delta \alpha)$$
$$\Delta' \delta' = \Delta' \delta + \Delta (\Delta \delta).$$

If the Moon's altitude be low, it may be advisable to alter the amount of refraction, if this is to be applied to the place of the Moon, by employing the new zenith distance, instead of the old, to estimate its amount.

8. *To obtain the Apparent Longitude* ($= \theta'$) *and Latitude* ($= \beta'$) *of the Moon.*

As it will be seldom that the apparent longitude and latitude will be wanted without the apparent right ascension and declination, it will usually be most expeditious to convert these last directly into the former rather than to compute the first independently.

Putting

ω = the obliquity of the ecliptic,

whose value can be taken from the 'Nautical Almanac' for any period, the usual method of effecting the conversion is by the use of the following expressions:—

$$\tan \theta' = \sin (g + \omega) \tan \alpha' \cos g$$
$$\tan \beta' = \cot (g + \omega) \sin \theta'$$

where

$$\tan g = \sin \alpha' \cot \delta'.$$

This method, when accuracy is required, is inconvenient when the longitude is near 90° or 270°, and requires an elaborate table of the functions. Where many computations, or greater accuracy, therefore, are required, the following method may be employed with advantage:—

Assume

$$\sin \gamma = \sin \omega \cos \alpha'$$
$$\tan \eta = \tan \omega \sin \alpha'$$
$$\tan \chi = \sin \omega \cos \alpha' \tan (\delta' - \eta);$$

put also

$$\tan(\alpha' + \zeta) = \frac{\tan \alpha}{\cos \omega}$$

then

$$\theta' = \alpha' + \zeta + \chi$$
$$\sin \beta' = \cos \gamma \sin (\delta' - \eta).$$ [1]

To find the variation in the longitude and latitude for any small interval of time, when the variation in the right ascension and declination are known, putting ψ' for the angle between the circles of declination and latitude and

$$\Delta \theta' = \frac{\cos \delta'}{\cos \beta'} \cos \psi' \Delta' \alpha' - \frac{\sin \psi'}{\cos \beta'} \Delta' \delta'$$
$$\Delta \beta' = \cos \delta' \sin \psi' \Delta' \alpha' + \cos \psi' \Delta' \delta'$$

where the angle ψ' is computed by the formulæ

$$\tan \psi' = \frac{\tan \gamma}{\cos(\delta' - \eta)}.$$

If it is desired, from the geocentric longitude and latitude of the Moon being known, to obtain the apparent longitude and latitude without proceeding through the apparent right ascension and declination, this can be effected by converting the parallax in right ascension and declination into the parallax in longitude and latitude by the above method, putting $\Delta \alpha$ for $\Delta' \alpha'$ and $\Delta \delta$ for $\Delta' \delta'$. The expressions for the parallax in longitude and latitude being comparatively complex, this will be found more expeditious than the direct computation by means of these.

[1] By tabulating the values of γ and η for different values of α', the labour will be materially diminished, and ζ can also be so tabulated by the formulæ

$$\zeta = \tan^2 \frac{\omega}{2} \sin 2a + \tfrac{1}{2} \tan^4 \frac{\omega}{2} \sin 4a + \tfrac{1}{3} \tan^6 \frac{\omega}{2} \sin 6a.$$

If these three quantities are tabulated, with differences for variations in ω, the conversion of right ascensions and declinations into longitudes and latitudes can be speedily effected. A very complete table of this form will be found in Hansen's 'Tables de la Lune,' pp. 494–511, where, however, ω and θ are employed to denote the angles here termed ζ and γ.

SELENOGRAPHICAL ELEMENTS.

9. *Determination of the Librations in Longitude and Latitude of the Moon.*

These being measured upon the Moon, and as a libration of one minute of selenographical longitude or latitude subtends an arc never greater than one-third of a second of arc as seen from the Earth, an error of a second or two in the Moon's librations will be quite inappreciable; accordingly the otherwise complex expressions for the lunar librations can be much simplified.

The following quantities have been obtainable from the 'Nautical Almanac' since 1867:—

$l_{\circ}$ = the Moon's mean longitude.
☊ = the mean longitude of the Moon's ascending node.

But further

I = the mean inclination of the lunar equator to the ecliptic; and
☋ = 180° + ☊ = the mean longitude of the Moon's descending node.

Then the Moon's libration in latitude ($= \lambda'$) will be given by

$$\lambda' = B' - \beta'$$

where

$$\tan B' = \tan I \sin (\theta' - ☋);$$

and the Moon's libration in longitude ($= l'$) can be found from the expression

$$l' = \theta' - l_{\circ} - D\,\lambda' + E,$$

where for convenience there has been put

$$D = \sin I \cos (\theta' - ☋)$$
$$E = \tan^2 \tfrac{1}{2} I \sin 2 (\theta' - ☋).$$

The value of the three terms B′, D, and E is easily tabulated for different values of the argument (θ′ − ☋)[1], and this has been effected and the result given at the end, so that

[1] Since 1867, their values have been given, in the 'Nautical Almanac,' with

the values of B, E, and $\frac{1}{D}$ can be taken out directly in most cases. $\frac{1}{D}$ has been substituted for D, as the most convenient for quickly finding D λ'.

The variation in the libration in latitude $\Delta\lambda$, and in longitude Δl during a short period in which the longitude of the Moon has increased by an amount $\Delta\theta'$, is given by the expressions

$$\Delta\lambda' = D\,\Delta\theta' - \Delta\beta'$$
$$\Delta l' = \Delta\theta' - \Delta l_0$$

where Δl_0 is the increase in the mean longitude of the Moon during the supposed interval of time.[1]

In general, it will only be necessary to compute the Moon's librations for intervals of one hour, and its condition at intermediate instants can be found with ease from the above variations, and for many purposes it will be only necessary to compute the libration for the most convenient instant towards the middle of the period of observation, and determine the libration at any other time, by the use of the expressions for the variations of the librations and the elements which enter into these. By this means the labour incidental to the reduction of observations of the Moon may be very much lightened.

For a very considerable number of purposes, where only an approximate value of the lunar librations is required, or, for example, in the comparison of drawings, making auxiliary measurements of the positions of points of the third order, or comparative measurements of the dimensions of formation, so as, by comparison with a measure of a neigh-

the only difference that there the letters θ', D, and E are replaced by λ, a', and $\Delta\lambda$, and the value of $\frac{1}{a'}$, given, not a'.

[1] In the above it has been assumed that I, being small, its tangent can be replaced by its sine, no sensible error being introduced by so doing. The motion of the mean longitude of the Moon in one second of time being equal to 0·54901 seconds of arc, its amount for any interval is easily computed.

bouring formation, whose exact size is known, to obtain a very approximate value of the true diameter of the former, it will be sufficient in general to know the actual libration within very wide limits.

For most of these purposes, the geocentric librations of the Moon will be sufficient, and these can be readily obtained by the following short process:—

Find for the given time the geocentric latitude ($=\beta$) and longitude ($=\theta$) of the Moon from the 'Nautical Almanac,' by taking a proportional part of the difference, and take out also the value for the same time of the Moon's mean longitude l_o, then

$$\text{Approximate libration in longitude} = \theta - l_o$$
$$\text{Approximate libration in latitude} = B' - \beta,$$

the value of β being obtained as before, only using (θ – ☊) instead of (θ' – ☊) as the argument. The resulting values for the librations will in general be within three-quarters of a degree of the true values.[1]

The resulting values of the librations in longitude and latitude will possess the same system of signs as the selenographical longitude and latitude, and denote the selenographical longitude and latitude of the portion of the surface that forms the apparent centre of the disc of the Moon. Thus when west, the libration in longitude is positive, and denotes that the apparent centre of the Moon lies west of the lunar first meridian; and similarly when the libration in latitude is positive it shows that the apparent centre of the lunar disc lies north of the Moon's equator.

[1] When the Moon is not far from the meridian these results may be rendered considerably more accurate by adding to the geocentric longitude and latitude respectively the two corrections

$$\mathbf{a} = p \sin(\phi - \delta) \cos h$$
$$\mathbf{a}' = p \sin(\phi - \delta) \sin h.$$

By this means the error may be reduced to a few minutes. The hour angle should not much exceed two hours.

10. *To Determine the Position of the Pole and Equator of the Moon.*

Suppose the three planes of the ecliptic and the equators of the Moon and Earth to cut the surface of a sphere, and put—

M = the arc from the ascending node of the lunar equator on the Earth's equator to the ascending node of the Moon's equator on the ecliptic.

N = the right ascension of the ascending node of the Moon's equator on the Earth's equator; and

i = the inclination of the lunar equator to that of the Earth's.

Then these three are computed from the equations

$$\tan \tfrac{1}{2}(M + N) = \frac{\cos \frac{1}{2}(\omega - I)}{\cos \frac{1}{2}(\omega + I)} \tan \tfrac{1}{2} \Omega$$

$$\tan \tfrac{1}{2}(M - N) = \frac{\sin \frac{1}{2}(\omega - I)}{\sin \frac{1}{2}(\omega + I)} \tan \tfrac{1}{2} \Omega$$

whence

$$M = \tfrac{1}{2}(M + N) + \tfrac{1}{2}(M - N). \qquad N = \tfrac{1}{2}(M + N) - \tfrac{1}{2}(M - N)$$

and finally

$$\sin \tfrac{1}{2} i = \sin \tfrac{1}{2}(\omega - I) \frac{\sin \frac{1}{2} \Omega}{\sin \frac{1}{2}(M - N)}.$$

In the 'Nautical Almanac,' since 1867, the values of these three quantities,[1] M, N, and i, will be found computed for every tenth day, so that they can be taken out by inspection.

Next denote by ξ the angle at the apparent centre of the Moon, between the circle of declination and the lunar axis; then the value of ξ can be found by one of the two expressions

$$\sin \xi = - \sin i \frac{\cos (\alpha' - N)}{\cos \beta'}$$

or

$$\sin \xi = - \sin i \frac{\cos (l_\circ + l' + M - N)}{\cos \delta'},$$

[1] They are given in the 'Nautical Almanac' as Δ, Ω', and i, to the nearest tenth of a minute of arc, which is ample for all purposes.

the first, from its simplicity, being always to be preferred when the right ascension is known.

The angle ξ is considered positive when the northern part of the circle of declination is to the west of the Moon's polar axis, and the same angle will obviously represent the inclination of the lunar equator to a plane or circular section parallel with the celestial equator. By changing the sign of ξ, it will be equal to the position angle of the lunar north polar axis, the negative degrees being expressed by subtracting them from 360° in the usual manner.

The variation in the value of sin ξ for a small interval of time, during which the apparent right ascension has increased by $\Delta' \alpha'$, will be approximately

$$\Delta (\sin \xi) = - \sin i \sin \alpha' \Delta' \alpha'.$$

For nearly all purposes, the value of this angle need only be computed once towards the centre of the period of observation, as its value for intermediate periods can be found with sufficient accuracy by the above expression for its variation.

Very frequently it is useful to have the value of the angle between the equator of the Moon and the apparent path of the Moon in the heavens, so as to dispense with a knowledge of the position of the circles of declination, which can only be conveniently obtained from a position micrometer on an equatorially-mounted telescope. The apparent path of the Moon being readily ascertained, by computing the angle made with it by the Moon's equator, the position of this last can be easily found.

Putting $\Delta \xi$ to denote the angle made by the apparent path of the Moon to the apparent path of a star—that is to say, a circle at right angles to the circles of declination ; then $\Delta \xi$ depends directly on the apparent motion of the Moon. Let $\Delta'_m \alpha'$ and $\Delta'_m \delta'$ denote the apparent motion in seconds of arc of the Moon in right ascension and declination in one minute of time, and then

$$\tan \Delta \xi = - \frac{\Delta'_m \delta'}{\left\{ 900{\cdot}0 - \Delta'_m \alpha' \right\} \cos \delta'}.$$

The angle between the Moon's equator and her apparent path will thus be

$$\xi' = \xi + \Delta \xi.$$

In finding the sign of $\Delta \xi$, a change of declination towards the south—that is to say, an increase in the Moon's north polar distance—must be regarded as making the sign of $\Delta'_m \delta'$ negative, and a decrease in the north polar distance as making it positive; whilst the sign of $\Delta \xi$ will obviously be the reverse to that of the change in declination.

SELENOGRAPHICAL ELEMENTS (AUXILIARY).

The foregoing methods will render it possible to determine the exact position of the Moon, as seen from the Earth at any period, and also to ascertain the position of the system of co-ordinates, by which the formations on the surface of the Moon are laid down. By determining also the exact position of the Moon with reference to the Earth, it allows of measures made at any given time to be reduced to what they would have been had the Moon been in its mean condition, and so allow measures taken at different periods to be united into one whole.

It remains therefore simply to indicate how to determine the apparent position, dimensions, &c. of the lunar formations, and to furnish formulæ for reducing them to the standard system of co-ordinates and to mean conditions.

12. *To Determine the Position at any Period of the True Equator and First Meridian of the Moon.*

Occasionally, and especially in examining lunar photographs, it is advantageous to be able to lay down the position of the true equator and first meridian. The apparent equator and first meridian being the circle of selenographical latitude, and the great circle at right angles to this through the apparent centre of the Moon, they will be always readily ascertained, being simply the lines dividing the apparent disc of the Moon into equal quadrants by connecting together the east and west, and north and south points of the Moon. The true equator and first meridian, however, will evidently appear as ellipses, being circles projected on a plane, and the semi-major axis will be always equal to the Moon's semi-diameter, and the minor axis proportional to the amount of the lunar librations in latitude and longitude respectively.

If, now, X be any distance measured along the apparent equator of the Moon, the distance Y, at right angles to this, of the true equator of the Moon will be

$$Y = \sin \lambda' \sqrt{(s'^2 - X^2)}$$

where s' is the apparent semi-diameter of the Moon, and λ' the libration in latitude.

Further, let Y denote any distance measured along the apparent first meridian of the Moon, then X the distance at right angles from the apparent to the true first meridian will be given by the equation

$$X = \sin l' \sqrt{(s'^2 - Y^2)}$$

when l' is the libration in longitude.

These will give the true distances; if the apparent distances, or such as would appear as seen from the Earth, are required, then the above values of Y and X must be corrected by adding to each respectively Y sin s' and X sin s'.

From the above formulæ the distances of the true from the apparent equator and first meridian can be computed for any point, and thus the positions of the former easily laid down.

13. *To find the Selenographical Azimuth at the mean Centre of the Lunar Surface of any formation on the Moon.*

By the term selenographical azimuth at the mean centre of the surface of the Moon is here to be understood the angle between the great circle forming the lunar first meridian and the great circle passing through the given formation and the mean centre of the surface. This angle can be measured either right round the Moon, but always from the north pole by the west, or else from the north pole on either side to the south pole, and divided into western and eastern azimuths. The former method seems preferable, and the quadrant which the azimuth lies in must be determined by the quadrant within which the formation lies.

Putting n_o for the selenographic azimuth at the mean centre of the Moon, then

$$\tan n_o = \frac{\sin l_o}{\tan \lambda_o}$$

the quantities l_o and λ_o being the longitude and latitude of the formation.

14. *To determine the Selenographical apparent Azimuth of any formation upon the Moon.*

The apparent azimuth is to be understood as representing the lunar azimuth when the apparent centre of the surface and first meridian are substituted for the mean centre and true first meridian; but in other respects is the same.

Putting n for the apparent azimuth, l_o and λ° for the longitude and latitude of the formation, and l and λ as usual for the lunar librations in longitude and latitude, and making

$$\tan m = \frac{\tan \lambda_o}{\cos (l_o - l')}$$

then

$$\tan n = \cos m \frac{\tan (l_o - l')}{\sin (m - \lambda')}.$$

As previously the quadrant n falls within must be determined primarily from the position of the formations.

From the definition of the selenographical azimuths, it will be evident that the apparent azimuth of the circle of declination through the apparent centre of the Moon will be the same as the position angle of the lunar north pole.

15. *To determine the Distance of the apparent Centre of the Moon from the Mean Centre or Origin of Selenographical Co-ordinates.*

Let ρ' be the distance in selenographical arc and ρ in seconds of arc, and put as usual l' and λ' for the librations in longitude and latitude, whilst s' is the apparent semidiameter of the Moon.

Putting, then,

$$\tan n_\circ = \frac{\sin \lambda'}{\tan l'}$$

which will give the azimuth of the apparent centre, and

$$\sin \rho' = \frac{\sin l'}{\cos n_\circ}$$

where ρ' is the true distance in selenographical arc.

To obtain the apparent distance in seconds of arc or ρ, put

$$\rho_\circ = \rho' + s' \sin \rho'$$

and

$$\rho = s' \sin \rho_\circ.$$

If this is resolved into two components $\Delta x'$ and $\Delta y'$ perpendicular to and along the apparent first meridian, then their values in seconds of arc will be

$$\Delta x' = s' \sin \rho_\circ \cos n_\circ$$
$$\Delta y' = s' \sin \rho_\circ \sin n_\circ$$

The following method will occasionally prove useful in obtaining quickly a fairly close approximation to the last two quantities :—

$$\Delta x' = s'(1 + s') \sin l'$$
$$\Delta y' = s'(1 + s') \sin \lambda' + \Delta x \sin \lambda' \cos^2 \lambda' \text{ vers } l',$$

the value of s' in brackets being expressed in arc, or as it is small, its natural sine may be taken as equal to the arc.

If in the above value for ρ' and $\rho_\circ$, instead of the lunar librations, are substituted $l_\circ$ and $\lambda_\circ$, the longitude and latitude of any lunar formation not too near the limb, the distances of these from the mean centre of the Moon will be obtained ; the effects of the lunar librations will be, however, to render the latter distance only approximate.

16. *To find the Distance of a Formation from the Apparent Centre of the Moon.*

Suppose $l_\circ$ and $\lambda_\circ$ to be the selenographical longitude and latitude of the formation ; l' and λ' being, as before, the Moon's librations ; and computing the apparent azimuth by assuming

$$\tan m = \frac{\tan \lambda_\circ}{\cos (l_\circ - l')}$$

so that

$$\tan n = \cos m \frac{\tan (l_\circ - l')}{\sin (m - \lambda')};$$

then using the same notation as before, the distance in arc ρ' of the formation from the apparent centre of the Moon will be given by

$$\tan \rho' = \frac{\tan (m - \lambda')}{\cos n}$$

and the value in seconds of arc, of ρ, will be found by pútting

$$\rho_\circ = \rho' + s' \sin \rho'$$

and making

$$\rho = s' \sin \rho_\circ$$

Resolving this, in the same manner as before, into two co-ordinates, Δx and Δy, measured perpendicular and along the apparent first meridian, then

$$\Delta y = s' \sin \rho_\circ \cos n$$
$$\Delta x = y \tan n.$$

When the formation is not near the limb the following approximate expressions may often become useful, they being easily computed :—

$$\Delta x = s' \cos \lambda_\circ \left\{ \sin (l_\circ - l') + \frac{s'}{2} \sin 2 (l_\circ - l') \right\}$$

$$\Delta y = s' \left\{ \sin (\lambda_\circ - \lambda') + \frac{s'}{2} \sin 2 (\lambda_\circ - \lambda') \right\} + A' \Delta x \sin \lambda'$$

where

$$A' = \text{vers} (l_\circ - l') \cos^2 (\lambda_\circ - \lambda').$$

The terms involving s'^2 in the above expression are always very small, so that they can easily be tabulated if many computations are required, or approximately computed if not. The second term of y, involving A, is also small, and when of little importance, except λ' or $l_\circ$, is large.

To obtain the arc measured on a lunar great circle between the given formation and the apparent centre, the following approximate process may be employed when they are not close together :—

$$\cos \rho' = \cos (l_\circ - l') \cos (\lambda_\circ - \lambda').$$

It is apparent that if the positions on the Moon be referred to polar co-ordinates, and making the circle of selenographical latitude through the apparent centre of the Moon the initial line, the selenographical azimuth will correspond to the vectoral angle and the distance from the centre to the radius vector.

The position angle of any formation on the Moon will also be readily obtained from the azimuth of the same, for the angle between the circle of declination through the apparent centre of the Moon, and the circle of selenographical latitude of the same, being denoted by ξ (§ 10), then evidently

$$\text{Pos. angle} = 360° - (n + \xi).$$

The use of several of these formulæ will be evident, and most of them will be applied presently to various selenographical purposes.

SELENOGRAPHICAL POSITIONS.

17. *The Determination of the Positions of Points upon the Surface of the Moon.*

The points whose position it is necessary to determine upon the Moon may be divided into four classes, as follows :—

Points of the First Class, or Standard Points.—Several of the most distinct and convenient small craters upon the Moon should be selected for the purpose of acting as standard points upon the surface, so that after their positions have been determined with great care by numerous series of measures from the Moon's limb, they may serve as the origin of other measures. For this purpose each point should rest upon at least eighty to one hundred and fifty carefully conducted sets of measures, so as to determine their position within one minute of selenographical arc. The method to be shortly described for the determination of points of the first order from the limb will serve to determine these standard points, but every care must be taken to secure the most minute accuracy, and special precautions and modifications will probably be found necessary in different cases. It will, however, be impossible to enter into details on the best manner of conducting these systematic measures.

At present there are only two points on the Moon whose position has been fixed with the accuracy desirable for standard points—namely Manilius, from the 174 measures of Bouvard and Nicollet, and Mösting A, from the 50 fine measures of Wichmann. Either of these points would probably give far superior results in the determination of the position of a point of the first order than eight or ten measures from the limb; and measures from both would certainly in general be more accurate, owing to the irregularities on the surface at the limb.

Points of the Second Class, or Mädler's Points of the First Order.—All the principal formations on the Moon should come under this class, from the position of the most distinct object on or near them being carefully fixed by from ten to fifteen series of independent measures. These can be made either in the manner followed by Lohrmann and Mädler, by micrometrical measures from the limb, or by similar measures from two or more standard points upon the surface. When several standard points on the Moon have been accurately determined, it appears probable that this latter method will give far more trustworthy observations than those made from the limb. And even with the present two positions of the First Class, it would in general appear preferable to measure from them rather than from the variable limb of the Moon.

Points of the Third Class, or Mädler's Points of the Second Order.—Under this class comes the great majority of the distinct and well-marked lunar formations, their positions being fixed by one of the two methods to be described. These points are measured from the neighbouring point of the First Order, and, as determined by Mädler, rest usually on only one measurement with a position micrometer; but it is desirable that they should be founded on three separate measures from three distinct points of the First Order, or, at any rate, upon two.

Points of the Fourth Class, or of the Third Order.—Little need be said of these, as they should consist of those positions on or around a formation that it may be necessary to measure to aid in drawing any formation, or to fix approximately the position of any point of interest. Any method of measuring will serve to determine these points, though a short and expeditious one will be given.

18. *Measurement of Points of the First Order from the Limb.*

This method was the one employed by Lohrmann and Mädler, and requires little preparatory reduction before the selenographical co-ordinates of the spot can be determined. The measures which are made from the limb of the Moon along and at right angles to the declination circle, should consist of three separate measures of the distance from the limb in a right ascension direction, and two along the declination circle.[1] The measures must then be converted from readings of the micrometer screw into arc, and corrected for refraction by the method already described. Putting X and Y for the resulting distances of the point from the west, or east, and north, or south limbs respectively, and putting X and Y positive when measured from the east and south respectively, that is to say in a west or north direction, and s' being the apparent semi-diameter of the moon,

Then

$$x = X - s'$$
$$y = Y - s'$$

and will be the components at right angles to, and along the

[1] Mädler made only two in the right ascension direction and one along the declination circle; but, by increasing the number to those stated, the separate measures can be considerably improved, and little more time is occupied.

declination circle of the formation from the apparent centre of the Moon. The method of converting these into selenographical co-ordinates will be described (§ 20, p. 547).

The values of X and Y will be, of course, the mean of the three determinations and two determinations in their respective directions, and the time of observation may be taken as the mean of the time of observation of the five separate readings. The method followed by Mädler was to measure several formations in a right ascension direction, rotate the micrometer, and measure the same at right angles to this; finally restoring the micrometer to its first position, and obtaining another set of measures. Limiting the number of formations to five,[1] thus grouped together, the same process may well be followed, excepting that one more series in the declination and one more in the right ascension direction must be made.

19. *Measurement of Points of the First Order from Standard Points upon the Surface of the Moon.*

This method, though the preparatory reductions are longer, will be found, from the superior accuracy of each measure, to give better determinations, and the results will be usually entirely free from errors, dependent on the exact amount of the lunar librations being known. Thus, though any error in the assumed lunar librations introduces an error of exactly similar amount in the determination of the point of the first order when measured from the limb; if measured from a standard point, it will be rarely that any possible error will introduce any sensible error in the position as determined. Seeing the uncertainty with respect to the real libration of the Moon, this is an important advantage. More-

[1] The interval between the first and last measures should not, if possible, much exceed half an hour; and if more than five objects in a series be taken, the time occupied in the measures will be found usually to exceed this period.

over, as the points whose distance is to be measured will consist of two small, bright, very distinct objects, a far greater accuracy in measuring can be secured in comparison with finding the distance from the limb, where the puzzling effects of irradiation and the spurious optical discs have to be considered; whilst irregularities on the surface at the limb will often introduce an error of several minutes of selenographical latitude or longitude into the measures.

The measurement of the position of the point from a standard point on the surface is obviously exactly analogous to that from the limb, one measure being taken along, and two at right angles to the declination circle through the standard point. It will be found that these will give as close a result as the greater number from the limb. If, instead of measuring as stated above, the measures be taken along and perpendicular to the apparent path of the Moon, the measure at right angles to this path will be found to be very easily and accurately obtained. The difficulty in measuring, introduced by the motion of the Moon in right ascension and declination, is very considerable, and, as Mädler points out, seriously affects their accuracy, the greater motion in right ascension rendering two measures in that direction little superior to one at right angles. If the effects of this motion are obviated, the resulting determinations gain much in accuracy.

Combine the two measures in the right ascension direction, and correct the result obtained for the distance in both directions, for the effects of refraction after converting into arc, and denote them by x and y. These are then to be resolved into the distances at right angles to and along the selenographical circle of latitude, through the apparent centre of the Moon, by the equations

$$x = Y \sin \xi + X \cos \xi + \Delta x$$
$$y = Y \cos \xi - X \sin \xi + \Delta y$$

The angle ξ is to be computed by the method already described (§ 10, p. 534), and the distances Δx, Δy of the standard point from the apparent centre of the Moon, by the method in § 15 (p. 539). If the measures were taken along and perpendicular to the Moon's apparent path, then the angle ξ' must be employed (§ 10, p. 536).

These distances, x and y, are then converted into the proper selenographical co-ordinates by the method to be given: with this exception, that the angle ξ having been already taken into consideration, in the equations to ν and μ, it must be considered as zero. It is evident that this method can be applied to the measurement of positions of the first order from lunar photographs, and for this purpose is well adapted; but except for very short distances only the finest photographs appear likely to be suitable for this process.[1] Were great care taken, and photographs on a moderately large scale secured, perhaps more satisfactory measures of points of the first order might be obtained from them.

20. *To reduce the Distance of a Formation from the Apparent Centre of the Moon into Selenographical Longitude and Latitude.*

Suppose x and y to denote the components of the distances of the formation from the apparent centre of the Moon, the former being measured in a direction at right angles to the circle of declination through the Moon's centre, and the latter along this last: convert these into polar co-ordinates ϕ and r by the equations

$$\tan \phi = \frac{x}{y}$$

$$r = r' - \Delta r'$$

[1] No photograph as yet tried has been found to give trustworthy measures for greater distances than three or four minutes of arc, shrinkage and distortion of the films seeming to be so irregular as to defy elimination. Photographic prints, when on an enlarged scale, seem little inferior to the negatives. This applies, of course, simply to existing lunar photographs.

where

$$\sin r' = \frac{y}{s' \cos \phi}$$

and

$$\Delta r = s' \sin r'$$

this last expressing the excess of r' above r, from different positions of the Moon's surface being at different distances from the Earth's, and, as will be seen, depends on the angle between the spot and the Moon's centre as seen from the Earth. The semi-diameter s' being in seconds of arc, the value of $\Delta r'$ will also be in seconds, but, like that of r' and r, will be in selenographical arc.

To convert ϕ and r into selenographical longitude l and latitude λ, use must be made of the angle ξ[1], expressing the position of the polar axis, together with the two auxiliary angles μ and ν, where

$$\tan \mu = \tan r \cos (\phi + \xi)$$
$$\tan \nu = \tan (\phi + \xi) \frac{\sin \mu}{\sin (\mu + \lambda')}$$

In the above angles μ will be positive when the formation is to the selenographical north, and negative when to the south of the apparent centre of the disc; whilst ν will be positive when to the selenographical west, and negative when to the east of the apparent centre.

Then

$$l = \nu + l'$$
$$\tan \lambda = \cos \nu \tan (\mu + \lambda')$$

Selenographical longitudes being considered positive when west and negative when east, and latitudes positive when north and negative when south, the signs of the above expressions will denote the quadrant on which the formation is.

[1] When the positions of points of the first order are to be computed, and these have been measured and reduced by the method of § 19, then the angle ξ must be considered as zero.

21. *Measurement of Points of the Second Order.*

The method adopted by Mädler for the purpose of determining the positions of the points of the second order was as follows:—As the origin of measures, the most convenient point of the first order close to the object whose place was to be found was chosen; and then another or auxiliary point of the first order was selected, such that the line joining this with the origin, passed close to the formation whose position was to be ascertained. The distance and position-angle of both the auxiliary point of the first order and the proposed point of the second order having been carefully determined by a position micrometer, the selenographical longitude and latitude of the formation of the second order was ascertained from this data by the following method:—

Put

L' = the measured length of the line connecting the two points of the first order.

Q' = the measured length of the line joining the point of the second order with the origin.

π = the angle between these two lines equal to the difference between the position-angles of the two lines.

Further, the selenographical position of the two points of the first order being known, let l_1 λ_1 be the longitude and latitude of the point of the first order acting as origin, and l_2 λ_2 the longitude and latitude of the auxiliary point of the first order; then the position of L′, the line connecting the two in reference to the selenographical first meridian, may be approximately determined as follows, the angle between the two being denoted by Λ:—

Then

$$\tan \Lambda = \frac{\sin l_1 \cos \lambda_1 - \sin l_2 \cos \lambda_2}{\sin \lambda_1 - \sin \lambda_2}$$

Further, the length at mean libration of the line connecting the two points of the first order being L, then we have

$$L = \frac{\sin \lambda_1 - \sin \lambda_2}{\cos \Lambda}$$

Then by increasing or diminishing the measured length of the distance of the point of the second order from the origin of measures in the same ratio as the measured length L′, differs from the computed length L, the effects of the lunar librations on the position of the point of the second order may be in great part eliminated. Putting, then, Q for the value of Q′ thus corrected,

$$Q = Q' \frac{L}{L'}$$

and the value of Q can be converted into the selenographical longitude and latitude, l_3 λ_3 of the point of the second order by the formulæ

$$\sin \lambda_3 = \sin \lambda_1 + Q \cos (\Lambda + \pi)$$
$$\sin l_3 = \sec \lambda_3 \{ \sin l_1 \cos \lambda_1 + Q \sin (\Lambda + \pi) \}$$

For the purpose of shortening this apparently long computation, Mädler united the system of points of the first order into a series of 176 triangles, the lengths of whose sides and the angles they made with the lunar first meridian he carefully computed and tabulated. From these lists, therefore, it is at once possible to take out the length L, the angle Λ, and the quantities sin λ_1 and sin l_1 cos λ_1 without any trouble, and the computation of the points of the second order be very rapidly performed.

This list of triangles, with their sides and angles, given by Mädler, is lengthy, and swelled as it would be by the incorporation of the points since determined, would be still longer. Moreover, as the number of points whose position has been determined increases, and as the positions of Mädler's are revised, it would lose its value. Instead, therefore, of reproducing the catalogue of triangles in the extended form necessary, the values of X_0 and Y_0 for the principal formations where

$$X_0 = \sin l \cos \lambda$$
$$Y_0 = \sin \lambda$$

has been appended, giving the values for each point of the first order, and then the angle Λ and the side L can be easily computed by the simple expressions

$$\tan \Lambda = \frac{X_1 - X_2}{Y_1 - Y_2}$$
$$L = \frac{Y_1 - Y_2}{\cos \Lambda}$$

where X_1 Y_1 are the values for the origin, and X_2 Y_2 for the auxiliary point.

Then otherwise with the same notation as before

$$\sin \lambda_3 = Y_1 + Q \cos (\Lambda + \pi)$$
$$\sin l_3 = \sec \lambda_3 (X_1 + Q \sin (\Lambda + \pi)$$

This method evidently requires that not only should the two points of the first order be close together, but that the point of the second order should be close to the line joining the two points and not far from the origin, if accuracy is to be obtained. The number of points of the first order in the Moon were unfortunately not sufficiently great to enable Mädler to combine these two qualities, or even to realise one properly, and yet to determine a sufficient system of points of the second order, so that he was often compelled to depart from the conditions desirable. The accuracy of the position of the second order is thus very variable.[1]

In determining the places of points of the second order by this method, as Mädler points out, the points of the second order selected should, as far as possible, be such as to make

[1] The drawing in the 'Der Mond' illustrating the method of measuring points of the second order has the letters misplaced, and is useless; and the same error also applies to the illustration in the 'Report of the British Association' for 1865, which is simply Mädler's drawing reproduced. The description is, however, sound.

the angle π and the side Q′ as small as possible, and the larger π is obliged to be made the smaller ought Q to be.

22. *Second Method of determining Points of the Second Order.*

It is often convenient to possess a method of ascertaining the positions of points of the second order with considerable accuracy, so that where any especial reason exists for desiring certainty with regard to the position of any formation, it can be easily obtained. Whenever, therefore, accuracy is desired in obtaining the position of points of the second order, the following modified form of the method of determining points of the second order may be employed:—

Let the three angles ξ (§ 10, p. 534), ρ' (§ 16, p. 540), and n (§ 14, p. 538) be computed for the point of the first order, serving as the origin of measures, and denote by Q′ the distance, and Θ the position angle of the point of the second order from the origin, measured with a position micrometer. Then assume

$$Q = Q' \, (1 - \sin s' \cos \rho')$$

and put

$$y'' = s' \sin \rho' \cos n + Q \cos (\Theta - \xi)$$
$$x'' = s' \cos \rho' \sin n + Q \sin (\Theta - \xi)$$

Then from these values of the co-ordinates y'' and x'', putting in the same manner as in § 20

$$\tan \phi = \frac{x''}{y''} \qquad\qquad \sin r = \frac{y''}{s' \cos \phi}$$

and assuming

$$\tan \mu = \tan r \cos \phi$$
$$\tan \nu = \tan \phi \, \frac{\sin \mu}{\sin (\mu + \lambda')}$$

the longitude l and latitude λ of the point of the second order are given by

$$l = \nu + l'$$
$$\tan \lambda = \cos \nu \tan (\mu + \lambda')$$

The quantity Q′ will be positive when measured towards the west, and negative when towards the east, and is supposed expressed in seconds of arc.

It will be evident that this last method, though sufficiently accurate, is but little shorter than the method of determining points of the first order. But, instead of employing the actual librations of the Moon, it will be sufficient to employ the geocentric librations, which are rapidly computed. Again the angle ξ can be either employed in merely an approximate form, or even the parallax in right ascension entirely neglected in finding it without material error, though when ξ is small it will be better to include an approximate determination of the parallax in right ascension. With these limitations, the position of points of the second order can be determined by this method without any serious increase of labour over that of Mädler.

It will, however, in general be desirable to compute approximately the true librations in longitude and latitude, and the true value of the angle between the Moon's axis and the declination circle;[1] for since a number of observations of points of the second order will usually have to be reduced each night, the extra labour of having to do this once will not be very material, whilst the practical elimination of all except errors of observation in the places of the formations will be a considerable gain.

23. *Determination of Points of the Third Order.*

The method of ascertaining these are very various, and any plan will do, for they are supposed to lie close to the point measured from, which may be either a point of the first or second order, if the place of this last is fairly well

[1] To an ordinary skilful computer the approximate determination of the apparent semi-diameter and these three elements will not require more than three-quarters of an hour, and with the aid of a few tables scarcely half as long.

known. Perhaps as short and good a method as any that can be employed will be as follows:—Let Q' be the measured distance of the point from the origin, Θ its position angle, and l_1 λ_1 the longitude and latitude of the origin; and compute an approximation to the angle ξ by the equation

$$\sin \xi = - \sin i \cos \alpha$$

where i is the inclination of the lunar equator and α the Moon's right ascension.

Then the longitude and latitude (l) (λ) of the point will be

$$(l) = l_1 + \Delta (l)$$
$$(\lambda) = \lambda_1 + \Delta (\lambda)$$

where

$$\sin \Delta (l) = \frac{Q}{s} \sec l_1 \sin (\Theta - \xi)$$

$$\sin \Delta (\lambda) = \frac{Q}{s} \sec \lambda_1 \cos (\Theta - \xi)$$

Unless the formation is close to the limb of the Moon, the above will give a sufficiently close approximation to the position of the point. If the formation be close to the limb, then it can seldom be worth while to determine points of the third order, for all methods will be complicated. Further accuracy can be obtained by replacing the latitude and longitude of the origin by the same, increased by the geocentric librations of the Moon, and then subtracting these last from the final result. Points very close to the limb are, as Mädler found, seldom to be well determined, except as points of the first order.

SELENOGRAPHICAL DIMENSIONS.

24. The early selenographers determined the height of the lunar mountains by estimating the distance within the dark side of the Moon that the tops of the peaks remained illuminated, whence it was not difficult to obtain an approximate

determination of their height. Schröter rejected this system and adopted that of measuring the length of the shadows and the distance within the illuminated portion of the surface in which was the peak. This method was far superior to the other, and was adopted by Mädler in the 'Der Mond,' he making use of a method of Olbers for reducing the observations.

Very considerable importance attaches to good measures of the height of the principal lunar mountains, as affording a decisive means of recognising instances of lunar change in many of the ring-plains and analogous formations. It is desirable, therefore, that these should be much more extensively made than has hitherto been the case.

25. *Measurement of the Height of the Lunar Mountains, with Olbers' Method of Reducing the Observations.*

This method is that followed by Mädler in the 1,095 height measures in the 'Der Mond,' and consists in measuring the length of the shadow cast by the mountain, and determining from that the height of the mountain.

Placing the cross wire of the micrometer so as to be parallel to the line joining the two cusps or horns of the Moon, the length of the shadow of the mountain is measured in the ordinary manner; next, with the micrometer in the same position, the distance of the summit of the mountain from the terminator or border of the illuminated surface is measured as accurately as possible; and then, moving the micrometer into a position at right angles to the former, the distance of the mountains from the cusp of the Moon is determined.

Converting these from micrometer revolutions into arc, and correcting for refraction when necessary, which will seldom be the case, the three resulting distances are then to be denoted by σ, τ, and $\mathbf{a}_0$, the first being the length of the shadow, the second the distance from the terminator, and the third the distance from the cusp. For the length of the shadow and the distance of the mountain from the terminator, at least three separate determinations should be made; but accuracy in the value of the distance from the cusp not being so essential, one determination will be enough.

It will be found that the length of the shadow is measurable with far greater accuracy than the distance from the terminator, owing to the indefinite nature of this latter; and this latter is where an error is easily made. Care must also be exercised in placing the cross wires parallel to the line joining the cusps or horns of the Moon, and in measuring the distance **a** to place the wire at right angles to this last, so as to have one wire of the micrometer a tangent to the cusp of the Moon.

The method of reducing these measures, as devised by Olbers, is as follows:—

The following data must be obtained for the time of observation by interpolating for the given instant from the 'Nautical Almanac' or some similar ephemeris:—

$\theta_{\circ}$ = the geocentric longitude of the Sun.
θ = the geocentric longitude of the Moon.
β = the geocentric latitude of the Moon.
$p_{\circ}$ = the horizontal parallax of the Sun.
p = the horizontal parallax of the Moon.

Then in the angle formed by the Sun, Earth, and Moon, the two angles

u = angular distance at the centre of the Earth, of the Sun and Moon;
v = angular distance at the centre of the Sun between the Earth and Moon

must be found from the equations

$$\cos u = \cos \beta \cos (\theta - \theta_{\circ})$$
$$\tan v = \sin u \tan p_{\circ} \cot p.$$

Next find the angle at the Moon's centre, between the great circle passing through the extremities of the horns or cusps of the Moon and the mean terminator of the illuminated portions of the surface of the Moon, which angle denote by ω; then

$$\omega = 90° - (u + v)$$

when the Moon is less than half illuminated, and

$$\omega = (u + v) - 90°$$

when the Moon is more than half illuminated.

Now the observations necessary to determine the height of a mountain give the three quantities,

σ = length of the shadow of the mountain.
τ = distance of the mountain from the terminator.
v = distance[1] in selenographical arc of the mountain from the illumination equator, or great circle, whose poles are the extremities of the lunar cusps, and whose plane passes through the centre of the Sun and Earth.

Then putting

ι = the angle at the Moon's centre, between the great circle, representing the Moon's mean terminator, and that passing through the same poles and the mountains measured,

and it is to be found from the expression,

$$\sin (w + \iota) = \sin w + \frac{\tau}{s' \cos v}$$

or,

$$\sin (w - \iota) = \sin w - \frac{\tau}{s' \cos v}$$

according as the Moon is less or more than half illuminated.

Computing, now, the height of the Sun above the horizon

[1] This quantity v is obtained by the equation

$$\sin v = \frac{s' - a_{\circ}}{s'}$$

where s' is the apparent diameter of the Moon and $a_{\circ}$ the distance of the mountain from the tangent to the nearest cusp of the Moon—that is to say, the distance measured along the line connecting the extremities of the cusps of the Moon.

of the position of the mountain measured; then denoting it by Φ,

$$\sin \Phi = \sin \iota \cos v.$$

Before employing the value of σ it is necessary to allow for its foreshortening; and its true length being denoted by σ', then

$$\sigma' = \frac{\sigma}{s' \cos w}$$

its value being now expressed in parts of the Moon's radius, σ and s' both being given in seconds of arc.

The height of the Sun above the horizon, Φ, and the true length of the shadow σ' being now known, the height H of the mountain in parts of the Moon's radius is easily computed, for, putting

Ψ = the angle at the Moon's centre between the summit of the mountain and the end of the shadow,

$$\sin \Psi = \sigma' \cos \Phi$$

and

$$H = \frac{\cos (\Phi - \Psi)}{\cos \Phi} - 1.$$

To obtain the height in miles, H must be multiplied by 1081·53, and to obtain it in feet multiplied by 5,710,480; whilst the height in metres will be given by multiplying by 1,740,522, and in toises by 893,017.

Under certain conditions modifications of the above method may be employed; thus, when ι is small, or the mountain is near the terminator, the angle Φ may be computed directly by the formula

$$\sin \Phi = \frac{\tau}{s' \cos w}$$

In one or two other instances the computations may be shortened; but as they are of an isolated character, they need not be specialised.

In some points the above method of Olbers involves approximations to the strict formulæ for the reduction of the observations; but it is unnecessary to attempt to carry the method to any greater approximation, for the errors of observation far exceed those incidental to the method of reduction.

Mädler made extensive use of a method of obtaining the approximate height of the lunar peaks by comparing the length of their shadows with the length of the shadow of some known peak; and he considered that tolerably accurate results could be easily obtained by an experienced observer. Schmidt, who has also used this method extensively, thinks it capable of being carried to a considerable degree of accuracy, and as being very trustworthy.

Thus carefully estimating or approximately measuring the length σ_0 of the shadow of the mountain whose height H_0 was known, and also the length, σ, of the shadow of the mountain whose height, H, was unknown, and putting τ_0 and τ for their respective distances from the terminator, either carefully estimated or approximately measured, then within some degree of accuracy

$$H = H_0 \frac{\sigma \ \tau}{\sigma_0 \ \tau_0} \cdot$$

To an experienced observer careful estimations will give the height of the mountain to a degree of accuracy not very far short of a single measure, supposing both mountains favourably placed. An approximate measure of the distances τ_0 and τ will, however, always be an improvement.

26. When the position of the mountain is known with some certainty it is possible to simplify the above method by dispensing with the measurement of the distance **a**, and computing the value of Φ and v direct from the co-ordinates of the spot.

Thus, let l_1 λ_1 be the longitude and latitude of the mountain, and put l_0 for the mean longitude of the Moon, ☊ for the mean longitude of the ascending node, and I for the inclination of the Moon's equator to the ecliptic, then the selenocentric latitude of the Sun being β_m,

$$\sin \beta_m = \sin I \sin (\theta - \Omega)$$

and the selenocentric solar hour angle being denoted by h_m, then

$$h_m = l_1 + (l_\circ - \theta_\circ + v)$$

whence by a known formula

$$\sin \Phi = \sin \beta_m \sin \lambda_1 + \cos \beta_m \cos \lambda, \cos h_m$$

and

$$v = \lambda_1 + \beta_m.$$

27. *To Determine the Solar Altitude and Azimuth at any Point on the Lunar Surface.*

This may be considered as an auxiliary to the measurement of the height of the lunar mountains, depending on the same principles, and is very useful in comparing lunar drawings made at different epochs, the appearance of which depends much on the angle of illumination.

The solar altitude at any point whose latitude is λ_1 has been already determined (§ 25, p. 558) to be given by

$$\sin \Phi = \sin \beta_m \sin \lambda_1 + \cos \beta_m \cos \lambda_1 \cos h_m$$

where β_m is the selenocentric latitude of the Sun, and h_m its hour angle.

For most purposes the following method of obtaining the solar altitude and azimuth will be found suitable :—Assume

$$\sin \beta_m = \sin I \sin (\theta - \Omega)$$
$$h_m = l_1 + (l_\circ - \theta_\circ)$$

and put

$$\tan G = \cot \beta_m \cos (l_1 + l_\circ - \theta_\circ)$$

then

$$\sin \text{altitude} = \sin \beta_m \frac{\sin (G + \lambda')}{\cos G}$$

$$\cot \text{azimuth} = \cot (l + l_\circ - \theta_\circ) \frac{\cos (G + \lambda')}{\sin G}$$

28. *Determination of the Diameters of the Formations on the Moon.*

The general method for measuring the diameters of the principal formations, which is in general confined to the measurement of those that are sensibly circular and free from marked irregularities of figure, is to measure micrometrically the maximum diameter, which, under the conditions supposed, will be at right angles to a line joining the centre of the formation and the apparent centre of the Moon.

Calling the measured diameter in seconds of arc d, s' being the Moon's apparent semi-diameter, and $l_\circ$ and $\lambda_\circ$ the approximate longitude and latitude of the formation, then the diameter $d_\circ$, in miles of the formation, can with sufficient accuracy be computed by the formulæ

$$d_\circ = 1081{\cdot}53 \frac{d}{s'} (1 - 0{\cdot}0045 \cos l_\circ \cos \lambda_\circ)$$

For very many purposes, where an error of one-hundredth of the diameter is not important—as when the formation is irregular or of small dimensions—the following modification may be employed, the error of which, unless the Moon is near the zenith and the formation is very close to the limb, cannot exceed this amount. Under these conditions it may be assumed that

$$d_\circ = 1081{\cdot}53 \frac{d}{s}$$

the geocentric semi-diameter of the Moon being employed instead of the apparent.

As this method assumes that the formations whose dia-

[1] The approximations consist in introducing the distance from the mean centre instead of the apparent centre, and the use of the numerical value of the sine of the mean semi-diameter instead of that of the variable semi-diameter. As these cannot introduce an error exceeding one-thousandth of the diameter, they are by this method within the errors of observation.

meters are to be measured are absolutely circular, strict accuracy cannot be expected by its means, for though most of the ring-plains and craters that are usually measured are for most purposes practically circular, differences of a mile or more in different diameters are very frequent. As accuracy in determining the size of formations is often desirable for special reasons, it is necessary to make use of a method which will enable the diameter in any particular direction to be measured; so that even under very different conditions of libration the exact diameter of a formation in any particular direction can be determined. As many lunar formations, and especially white spots, are somewhat elliptical in form, it is absolutely essential, to detect any variation in their dimensions, that the measures should always be of the same diameters.

It has already been stated that by measuring the diameter of a formation at right angles to the line joining it with the centre of the Moon's disc the effects of foreshortening on this particular diameter are eliminated: only from the position of the formation with regard to the apparent centre of the Moon varying from the effects of the lunar librations; at different times different diameters will occupy this position. It remains first, therefore, to compute what particular diameter of the formation occupies this position.

To determine the relative position of the diameter of the formation that at any period may occupy this position, denote by j the angle between its northern half and the northern portion of the circle of selenographical latitude passing through the centre of the formation. Then n being the apparent azimuth of the formation (§ 14, p. 538)

$$\cos j = \frac{\cos \lambda'}{\cos \lambda_0} \sin n$$

It will be convenient to possess what may be termed a standard diameter of a formation, which may with advantage be defined as the diameter measured along the circle of selenographical latitude through the centre of the formation. Then, obviously, if o be the angle this makes with the diameter at right angles to the line through the centre of the Moon's surface and the formation, measured in the same manner as j,

$$\sin o = \frac{\cos \lambda'}{\cos \lambda_o} \sin n$$

The angles j and o will be greater than a right angle when the formation is north of the apparent centre of the surface, and less when south of the same.

If it be desired to measure the diameter of the formation at an angle κ to the principal diameter, it will evidently be merely necessary that the measure be taken at an angle $(o + \kappa)$ to the line at right angles to that through the centres of the formation and Moon's surface.

To reduce the measures thus obtained to miles, the following method may be adopted:—Supposing d to be the measured distance in arc, and d_o the required distance in miles: compute by the methods already given the distance ρ' in selenographical arc of the formation from the apparent centre of the Moon, and o and κ having the meaning just stated, then

$$d_o = 1081{\cdot}53 \frac{d}{s'} (1 - \sin s' \cos \rho') \left\{ \sin^2 (o + \kappa) \sec \rho' + \cos^2 (o + \kappa) \right\}$$

Unless the formation is near the limb, the following approximation may be used without material loss of accuracy:—

$$d_o = 1081{\cdot}53 \frac{d}{s'} (1 - 0{\cdot}0045 \cos (l_o - l') \cos (\lambda_o - \lambda'))$$
$$\left\{ \frac{\sin^2 (o + \kappa)}{\cos (l_o - l') \cos (\lambda_o - \lambda')} + \cos^2 (o + \kappa) \right\}$$

where l_o λ_o are the selenographical longitude and latitude of the formation, and l' and λ' the lunar librations in longitude and latitude, which may, without sensible error, be usually the geocentric librations.

TABLE I.

Value of the Auxiliary quantities required for the Computation of the Moon's Librations.

$\theta'-\Omega$	E	$\frac{1}{D}$	B′	Diff. for 10′	$\theta-\Omega$	E	$\frac{1}{D}$	B′	Diff. for 10′
0°	+0″	+37	+0° 0′ 0″	+16″	46°	+37″	+54	+1° 6′ 19″	+11″
1°	+0″	+37	+0° 1′ 36″	+16″	47°	+37″	+55	+1° 7′ 24″	+11″
2°	+2″	+37	+0° 3′ 11″	+16″	48°	+36″	+56	+1° 8′ 29″	+11″
3°	+3″	+37	+0° 4′ 47″	+16″	49°	+36″	+57	+1° 9′ 34″	+10″
4°	+5″	+37	+0° 6′ 23″	+16″	50°	+36″	+58	+1° 10′ 38″	+10″
5°	+6″	+37	+0° 7′ 58″	+16″	51°	+36″	+59	+1° 11′ 37″	+10″
6°	+7″	+38	+0° 9′ 34″	+16″	52°	+35″	+61	+1° 12′ 36″	+10″
7°	+8″	+38	+0° 11′ 10′	+16″	53°	+35″	+62	+1° 13′ 35″	+10″
8°	+10″	+38	+0° 12′ 46″	+16″	54°	+35″	+63	+1° 14′ 34″	+ 9″
9°	+12″	+38	+0° 14′ 22″	+16″	55°	+34″	+65	+1° 15′ 32″	+ 9″
10°	+13″	+38	+0° 15′ 58″	+16″	56°	+34″	+67	+1° 16′ 24″	+ 9″
11°	+15″	+38	+0° 17′ 34″	+16″	57°	+33″	+69	+1° 17′ 17″	+ 9″
12°	+16″	+38	+0° 19′ 10″	+15″	58°	+32″	+71	+1° 18′ 10″	+ 8″
13°	+17″	+38	+0° 20′ 45″	+16″	59°	+32″	+73	+1° 19′ 2″	+ 8″
14°	+18″	+38	+0° 22′ 20″	+16″	60°	+31″	+75	+1° 19′ 50″	+ 8″
15°	+19″	+39	+0° 23′ 54″	+15″	61°	+30″	+77	+1° 20′ 30″	+ 8″
16°	+20″	+39	+0° 25′ 26″	+16″	62°	+30″	+79	+1° 21′ 22″	+ 7″
17°	+21″	+39	+0° 27′ 0″	+15″	63°	+29″	+82	+1° 22′ 9″	+ 7″
18°	+22″	+39	+0° 28′ 32″	+15″	64°	+29″	+85	+1° 22′ 59″	+ 7″
19°	+23″	+39	+0° 30′ 2″	+15″	65°	+28″	+88	+1° 23′ 30″	+ 7″
20°	+24″	+40	+0° 31′ 31″	+15″	66°	+27″	+92	+1° 24′ 10″	+ 6″
21°	+25″	+40	+0° 33′ 1″	+15″	67°	+26″	+96	+1° 24′ 49″	+ 6″
22°	+26″	+40	+0° 34′ 30″	+15″	68°	+25″	+100	+1° 25′ 25″	+ 6″
23°	+27″	+41	+0° 36′ 0″	+15″	69°	+24″	+104	+1° 26′ 0″	+ 6″
24°	+28″	+41	+0° 37′ 29″	+15″	70°	+23″	+109	+1° 26′ 35″	+ 6″
25°	+29″	+41	+0° 38′ 58″	+15″	71°	+22″	+115	+1° 27′ 10″	+ 5″
26°	+29″	+41	+0° 40′ 27″	+14″	72°	+21″	+121	+1° 27′ 42″	+ 4″
27°	+30″	+42	+0° 41′ 56″	+14″	73°	+20″	+128	+1° 28′ 6″	+ 5″
28°	+30″	+42	+0° 43′ 16″	+14″	74°	+19″	+135	+1° 28′ 38″	+ 4″
29°	+31″	+43	+0° 44′ 43″	+14″	75°	+18″	+144	+1° 29′ 0″	+ 4″
30°	+32″	+43	+0° 46′ 6″	+14″	76°	+17″	+154	+1° 29′ 23″	+ 4″
31°	+32″	+44	+0° 47′ 29″	+14″	77°	+16″	+166	+1° 29′ 46″	+ 3″
32°	+33″	+44	+0° 48′ 52″	+13″	78°	+15″	+180	+1° 30′ 8″	+ 4″
33°	+34″	+45	+0° 50′ 15″	+14″	79°	+13″	+196	+1° 30′ 30″	+ 3″
34°	+34″	+45	+0° 51′ 37″	+13″	80°	+12″	+215	+1° 30′ 47″	+ 2″
35°	+35″	+46	+0° 52′ 55″	+13″	81°	+10″	+239	+1° 31′ 2″	+ 3″
36°	+35″	+46	+0° 54′ 12″	+13″	82°	+ 8″	+268	+1° 31′ 19″	+ 2″
37°	+35″	+47	+0° 55′ 29″	+13″	83°	+ 7″	+306	+1° 31′ 30″	+ 1″
38°	+36″	+47	+0° 56′ 46″	+12″	84°	+ 6″	+357	+1° 31′ 39″	+ 2″
39°	+36″	+48	+0° 58′ 1″	+12″	85°	+ 5″	+428	+1° 31′ 48″	+ 1″
40°	+36″	+49	+0° 59′ 10″	+13″	86°	+ 3″	+535	+1° 31′ 55″	+ 1″
41°	+36″	+49	+1° 0′ 33″	+12″	87°	+ 2″	+713	+1° 32′ 1″	+ 1″
42°	+37″	+50	+1° 1′ 42″	+12″	88°	+ 1″	+1069	+1° 32′ 5″	+ 1″
43°	+37″	+51	+1° 2′ 53″	+12″	89°	+ 0″	+2138	+1° 32′ 8″	+ 1″
44°	+37″	+52	+1° 4′ 4″	+11″	90°	+ 0″	∞	+1° 32′ 9″	—
45°	+37″	+53	+1° 5′ 14″	+11″					

When the argument $\theta'-\Omega$ exceeds 90° and is less than 180°, take its supplement as the argument, and change the signs of E and $\frac{1}{D}$.

When the argument $\theta'-\Omega$ exceeds 180°, take the excess for the argument and change the signs of $\frac{1}{D}$ and B′.

TABLE II.

Points of the First Order, with their Positions and Co-ordinates.

Name	No. of Observations	Authorities	Longitude	Latitude	X	Y
Agrippa . .	12	L & N	+10° 17′ 44″	+ 4° 2′ 2″	+0·17828	+0·07034
Albategnius .	7	L	+ 3° 58′ 13″	−11° 21′ 20″	+0·06788	−0·19689
Alphonsus A .	9	M	− 3° 14′ 28″	−12° 59′ 21″	−0·25509	−0·22477
Archytas .	8	M	+ 4° 13′ 3″	+58° 24′ 1″	+0·03854	+0·85173
Archimedes A .	17	N	− 7° 10′ 47″	+27° 44′ 58″	−0·11647	+0·46559
Aristarchus .	9	M	−47° 12′ 9″	+23° 17′ 17″	−0·67397	−0·39536
Aristillus .	10	L	+ 1° 6′ 42″	+33° 45′ 27″	+0·01468	+0·55567
Aristoteles C .	10	M	+23° 33′ 42″	+57° 26′ 3″	+0·21516	+0·84277
Bessarion E .	11	N	−37° 0′ 41″	+14° 58′ 48″	−0·58137	+0·25848
Bessel . .	7	N	+17° 22′ 26″	+21° 54′ 14″	+0·27705	+0·37305
Billy . .	8	M	−49° 57′ 40″	−13° 59′ 45″	−0·74288	−0·24185
Biot . .	10	M	+50° 4′ 24″	−22° 20′ 16″	+0·70932	−0·38007
Bode . .	34	L & N	− 2° 37′ 51″	+ 6° 37′ 55″	−0·04559	+0·11550
Bode A . .	6	N	− 3° 19′ 40″	+ 8° 53′ 57″	−0·02291	+0·15470
Bode B . .	6	N	− 3° 9′ 41″	+ 8° 42′ 46″	−0·05448	+0·15145
Bohnenberger.	4	N	+39° 24′ 10″	−17° 3′ 8″	+0·60685	−0·29326
Brayley . .	5	N	−36° 25′ 10″	+20° 53′ 52″	−0·55464	+0·33289
Bullialdus .	9	M	−22° 6′ 11″	−20° 25′ 56″	−0·35260	−0·34910
Burg . .	8	M	+27° 31′ 57″	+44° 57′ 9″	+0·32714	+0·70651
Byrgius A .	10	M	−63° 30′ 5″	−24° 22′ 43″	−0·81515	−0·41277
Campanus .	11	M	−27° 27′ 1″	−27° 36′ 50″	−0·40847	−0·46351
Capella . .	10	L	+34° 48′ 14″	− 7° 32′ 41″	+0·56582	−0·13130
Carlini . .	11	M	+24° 0′ 46″	+33° 22′ 45″	−0·33982	+0·55017
Cassini A .	10	M	+ 4° 8′ 55″	+40° 22′ 44″	+0·05512	+0·64784
Censorinus .	10	M & N	+32° 27′ 29″	− 0° 24′ 0″	+0·53668	−0·00698
Cepheus A .	10	M	+45° 39′ 42″	+40° 59′ 20″	+0·53986	+0·65592
Clavius C .	8	M	−14° 40′ 26″	−57° 16′ 47″	−0·13693	−0·84132
Cleomedes A .	7	M	+54° 17′ 25″	+28° 23′ 58″	+0·71427	+0·47562
Conon . .	5	L	+ 1° 57′ 18″	+21° 31′ 27″	+0·03173	+0·36689
Copernicus .	10	M	−19° 55′ 48″	+ 9° 20′ 57″	−0·33634	+0·16245
Crüger . .	9	M	−66° 40′ 15″	−16° 45′ 37″	−0·87925	−0·28836
Cyrillus .	7	M	+22° 37′ 3″[1]	−13° 30′ 3″	+0·37395	−0·23346
Delambre .	10	M	+17° 15′ 9″	− 1° 47′ 17″	+0·29644	−0·03120
Delisle . .	10	M	−34° 47′ 57″	+29° 59′ 20″	−0·49430	+0·49984
Democritus .	8	M	+33° 30′ 21″	+62° 8′ 21″	+0·25797	+0·88406
Dionysius .	8	L	+17° 8′ 40″	+ 2° 50′ 55″	+0·29442	+0·04970
Dollond . .	9	L & M	+14° 11′ 53″	−10° 14′ 59″	+0·24136	−0·17794
Drebbel . .	10	M	−48° 12′ 39″	−40° 47′ 21″	−0·56449	−0·65328
Eichstädt .	7	M	−70° 27′ 9″	−20° 31′ 15″	−0·88255	−0·35054
Eichstadt B .	3	M	−77° 17′ 7″	−21° 39′ 1″	−0·90666	−0·36894
Encke . .	7	N	−36° 35′ 35″	+ 4° 18′ 14″	−0·59445	+0·07487
Encke B. .	8	N	−36° 18′ 56″	+ 1° 57′ 6″	−0·59190	+0·03406
Endymion G .	8	M	+54° 18′ 26″	+56° 28′ 30″	+0·44856	+0·83364
Epigenes H .	4	M	−10° 31′ 0″	+67° 53′ 30″	−0·06869	+0·92647
Eratosthenes .	13	L & N	−11° 34′ 25″	+14° 25′ 16″	−0·19430	+0·24905
Euclides. .	8	M	−29° 15′ 47″	− 7° 10′ 21″	−0·48500	−0·12485
Euler . .	10	M	−28° 56′ 59″	+22° 57′ 5″	−0·44567	+0·39016
Fabricius .	9	M	+40° 46′ 0″	−42° 8′ 0″	+0·48424	−0·67086

[1] This value is Mädler's result as amended, he giving 22° 41′ 20″, which does not agree with either his separate results or with any alteration that can appear to be allowable.

Name	No. of Obser-vations	Autho-rities	Longitude	Latitude	X	Y
Flamstead .	10	M	−44° 12′ 8″	− 4° 30′ 48″	−0·69502	−0·07864
Furnerius A .	9	M	+57° 51′ 52″	−33° 6′ 4″	+0·70937	−0·54612
Gambart A .	9	M	−18° 45′ 12″	+ 0° 50′ 30″	−0·32138	+0·01469
Gassendi .	19	M & N	−39° 30′ 47″	−16° 58′ 2″	−0·60854	−0·29182
Goclenius .	12	M	+44° 27′ 2″	− 9° 58′ 46″	+0·68970	−0·17329
Grimaldi A .	10	M	−70° 53′ 28″	− 4° 54′ 27″	−0·94141	−0·05855
Guerike C .	8	N	−11° 43′ 37″	−11° 48′ 53″	−0·19894	−0·20476
Hainzel A .	8	M	−29° 24′ 45″	−42° 59′ 26″	−0·35839	−0·68187
Halley . .	6	N	+ 5° 37′ 14″	− 8° 6′ 45″	+0·09696	−0·14112
Hansen A .	7	M	+74° 0′ 8″	+13° 17′ 19″	+0·93563	+0·22985
Harding . .	11	M	−70° 12′ 10″	+43° 8′ 41″	−0·68933	+0·68385
Harpalus .	9	M	−43° 36′ 20″	+52° 28′ 41″	−0·42005	−0·79310
Hell . .	9	M	− 8° 19′ 54″	−31° 58′ 59″	−0·12291	−0·52967
Heraclides .	8	M	−34° 1′ 25″	+41° 7′ 46″	−0·42144	+0·65776
Hercules .	9	M	+38° 23′ 26″	+46° 23′ 22″	+0·42834	+0·72405
Herschel .	6	L	− 2° 9′ 7″	− 5° 37′ 6″	−0·05737	−0·09789
Hesiodus B .	8	M	−16° 59′ 35″	−26° 50′ 26″	−0·26077	−0·45150
Hipparchus C .	18	N	+ 8° 3′ 34″	− 7° 22′ 57″	+0·13904	−0·12850
Hipparchus L.	6	N	+ 8° 49′ 31″	− 6° 49′ 45″	+0·15233	−0·10156
Horrocks .	6	N	+ 5° 52′ 59″	− 4° 0′ 24″	+0·10225	−0·06987
Hortensius .	12	N	−27° 41′ 8″	+ 6° 2′ 8″	−0·46205	+0·10514
Kepler . .	22	M & N	−37° 40′ 34″	+ 7° 57′ 6″	−0·60530	−0·13833
Lahire . .	10	M	−25° 9′ 40″	+27° 18′ 25″	−0·37777	+0·45875
Lalande . .	23	L & N	− 8° 46′ 49″	− 4° 24′ 52″	−0·15219	−0·07697
Landsberg .	19	M & N	−26° 27′ 6″	− 0° 28′ 9″	−0·44542	−0·00819
Landsberg A .	8	N	−31° 5′ 26″	+ 0° 2′ 20″	− 51639	+0·00076
Langrenus .	10	M	+60° 34′ 9″	− 8° 22′ 29″	+0·86165	−0·14561
Lapeyrouse A .	9	M	+73° 52′ 41″	− 9° 23′ 20″	+0·94779	−0·16313
Laplace A .	10	M	−26° 33′ 33″	+43° 16′ 21″	−0·32558	+0·68545
Le Monnier A .	8	L & M	+29° 3′ 50″	+25° 59′ 30″	+0·43665	+0·43824
Lichtenberg .	8	M	−67° 5′ 3″	+31° 25′ 20″	−0·78601	+0·52134
Lindenau .	11	M	+24° 29′ 31″	−31° 52′ 6″	+0·35206	−0·52797
Linné . .	8	L & M	+11° 32′ 28″	+27° 47′ 13″	+0·17697	+0·46618
Mädler . .	5	N	+29° 11′ 58″	−10° 55′ 59″	+0·47900	−0·18967
Maginus . .	11	M	− 7° 5′ 50″	−49° 57′ 17″	−0·07949	−0·76553
Manilius .	174	B	+ 8° 46′ 56″	+14° 26′ 54″	+0·14824	+0·24949
Marius . .	2	N	−49° 57′ 5″	−11° 58′ 44″	−0·74878	−0·20784
Maskelyne .	12	L & M	+29° 34′ 58″	+ 2° 31′ 38″	+0·49332	+0·04409
Maurolycus .	10	M	+13° 40′ 47″	−43° 23′ 20″	+0·17186	−0·68694
Mayer . .	10	M	−28° 49′ 41″	+15° 32′ 30″	−0·46455	+0·26794
Menelaus .	11	N	+15° 31′ 2″	+16° 24′ 17″	+0·25664	+0·28242
Messier . .	11	M	+47° 9′ 12″	− 1° 58′ 55″	+0·73274	−0·03458
Milichius .	11	N	−29° 40′ 1″	+10° 0′ 15″	−0·48744	+0·17372
Moretus . .	10	M	− 7° 8′ 38″	−69° 45′ 25″	−0·04303	−0·93823
Mösting . .	6	N	− 5° 53′ 2″	− 0° 36′ 26″	−0·10250	−0·01060
Mösting A .	50	W	− 5° 13′ 23″	− 3° 10′ 55″	−0·09089	−0·05551
Murchison A .	18	N	+ 1° 0′ 4″	− 4° 3′ 57″	+0·01743	+0·07090
Mutus . .	9	M	+29° 21′ 50″	−63° 6′ 5″	+0·22183	−0·89181
Olbers . .	8	M	−77° 32′ 31″	+ 7° 55′ 16″	−0·96729	+0·13781
Parry A . .	8	M	−15° 39′ 40″	− 9° 19′ 41″	−0·26638	−0·16210
Petavius .	11	M	+59° 15′ 48″	−24° 38′ 51″	−0·78111	−0·41733
Phocylides E .	5	M	−55° 34′ 35″	−54° 34′ 48″	−0·47807	−0·81493
Picard . .	8	M	+53° 52′ 8″	+14° 27′ 44″	+0·78208	+0·24974
Piccolomini .	12	M	+31° 35′ 22″	−29° 10′ 50″	+0·45519	−0·48756
Pico . .	10	M	− 9° 12′ 31″	+45° 28′ 7″	−0·11223	+0·71287
Pitiscus . .	8	M	+29° 32′ 49″	−49° 58′ 43″	+0·31712	−0·76581

Name	No. of Observations	Authorities	Longitude	Latitude	X	Y
Plinius . .	10	L	+23° 23′ 28″	+15° 17′ 20″	+0·38287	+0·26369
Posidonius A .	12	L & M	+29° 7′ 24″	+31° 35′ 39″	−0·41455	+0·52389
Proclus . .	15	M & N	+46° 30′ 18″	+16° 10′ 20″	+0·66105	+0·27853
Ptolemäus A .	10	N	− 0° 58′ 22″	− 8° 34′ 58″	−0·01679	−0·14924
Pythagoras .	9	M	−61° 36′ 45″	+63° 3′ 44″	−0·39854	+0·89150
Pytheas . .	10	M	−20° 34′ 13″	+20° 14′ 3″	−0·32968	+0·34586
Ramsden .	11	M	−31° 41′ 55″	−32° 25′ 48″	−0·44351	−0·53627
Reinhold .	10	N	−22° 37′ 26″	+ 3° 13′ 19″	−0·38407	+0·05621
Römer . .	11	L & M	+36° 19′ 6″	+25° 18′ 51″	+0·53540	+0·47758
Rosse . .	8	N	+34° 19′ 38″	−17° 48′ 37″	+0·53690	−0·30587
Sacrobosco .	9	M	+15° 40′ 55″	−23° 42′ 5″	+0·24749	−0·40197
Scheiner A .	9	M	−26° 36′ 13″	−59° 58′ 26″	−0·22407	−0·86580
Schubert A .	6	M	+77° 15′ 51″	+ 2° 27′ 42″	+0·97449	+0·04295
Seleucus . .	9	M	−65° 48′ 19″	+20° 54′ 21″	−0·85211	−0·35683
Struve B .	9	M	+64° 47′ 4″	+43° 20′ 14″	+0·65802	+0·68629
Taruntius .	8	M	+45° 58′ 24″	+ 5° 40′ 10″	+0·71550	+0·09879
Thales . .	9	M	+49° 12′ 23″	+61° 58′ 24″	+0·35573	+0·88273
Thebit A .	12	M	− 5° 47′ 8″	−21° 17′ 34″	−0·09392	−0·36312
Theophilus .	10	L	+26° 18′ 16″	−11° 21′ 3″	+0·43447	−0·19682
Timocharis .	11	L	−12° 59′ 44″	+26° 42′ 44″	−0·20086	+0·44951
Tycho . .	9	M	−11° 52′ 25″	−42° 52′ 19″	−0·15079	−0·68036
Ukert . .	11	N	+ 1° 9′ 10″	+ 7° 48′ 24″	+0·01993	+0·13583
Vega A . .	8	M	+68° 44′ 0″	−44° 56′ 54″	+0·65955	−0·70646
Vieta A . .	10	M	−56° 49′ 40″	−32° 40′ 50″	−0·70451	−0·53996
Vitello . .	11	M	−37° 8′ 26″	−30° 0′ 26″	−0·72264	−0·50010
Vitruvius .	13	L & M	+31° 2′ 5″	+17° 36′ 10″	+0·49165	+0·30229
Werner . .	8	M	+ 2° 58′ 10″	−27° 45′ 42″	+0·04584	−0·46580
Wichmann .	4	N	−37° 56′ 13″	− 7° 41′ 15″	−0·60927	−0·13377
Wollaston .	9	M	−46° 54′ 14″	+30° 17′ 15″	−0·63052	+0·50434

[In the column of authorities, Lohrmann is represented by L; Bouvard and Nicollet by B; Wichmann by W; Mädler by M; and the Author by N.]

TABLE III.

Lunar Elements.

Synodical Revolution	29·5305887 days 29d 12h 44m 2s·684
Sidereal Revolution	27·3216614 days 27d 7h 43m 11s·545
Tropical Revolution	27·321582 days 27d 7h 43m 4s·68
Anomalistic Revolution . . .	27·55460 days 27d 13h 18m 37s·44
Nodical Revolution	27·21222 days 27d 5h 5m 35s·81
Distance (Mean)	60·27035 of Earth's radii 238,840·25 miles
„ (Maximum)	252,972 miles
„ (Minimum)	221,614 miles

Diameter (Mean)	31′ 8″·00 2163·06 miles	
,, (Maximum)	33′ 33″·20	
,, (Minimum)	29′ 23″·65	
Mass	0·01228 $\frac{1}{81\cdot40}$	of the Earth's
Revolution of Perigee (Mean)	3232·575 days 8·8505 years	
Advance of Perigee each year (Mean)	40° 40′ 31″·1	
Revolution of Nodes (Mean)	6793·391 days 18·5997 years	
Regression of Nodes each year (Mean)	19° 21′ 18·3″	
Maximum Geocentric Libration in Longitude	7° 53′ 51″·0	
,, ,, ,, in Latitude	6° 50′ 45″·0	
,, Parallactic Libration	1° 1′ 35″·0	
,, Geocentric Libration	10° 25′ 22″·0	
,, Libration (Total)	11° 25′ 30″	
Surface of the Moon never seen	·4100	
Surface of the Moon that is visible at one time or another	·5900	
Angle subtended by one degree of Selenographical Latitude and Longitude at the Centre of the Moon's disc, when at its mean distance	16″·566	
Length in miles of the same	18·871″	
Selenographical arc at centre ofthe Moon's surface, subtending an angle of one second of arc	3′ 37″·31	
Miles at the centre of the Moon's disc, subtending an angle of one second of arc	1·139	
Surface	0·074478 $\frac{1}{13\cdot43}$	of the Earth's
Volume	0·02033 $\frac{1}{49\cdot20}$	of the Earth's
Density	0·60419 3·444	of the Earth's Water being unity
Action of Gravity at the Surface	0·16489 $\frac{1}{6\cdot065}$	of the Earth's
Horizontal Parallax (constant of)	57′ 2″·325	
Eccentricity of Orbit (Mean)	0·05490807	
Inclination of Orbit (Mean)	5° 8 39″·96	
,, of Axis to Ecliptic	87° 27′ 51″·0	
,, of Equator to Ecliptic	1° 32′ 9″·0	
Inequalities in the Moon's Longitude:		
Equation of the Centre (Maximum)	6° 17′ 19″·06	
Evection ,,	1° 16′ 27″·01	
Variation ,,	39′ 30″·70	
Annual Equation ,,	11′ 9″·00	
Parallactic Equation ,,	2′ 4″·70	
Inequalities in the Moon's Latitude:		
Evection ,, ,,	8′ 57″·37	
Variation ,, ,,	33″·44	

SYNOPSIS OF THE SELENOGRAPHICAL FORMULÆ.

APPARENT CO-ORDINATES OF THE MOON.

SELENOGRAPHICAL ELEMENTS.

SELENOGRAPHICAL ELEMENTS (*AUXILIARY*).

SELENOGRAPHICAL POSITIONS.

SELENOGRAPHICAL DIMENSIONS.

ALPHABETICAL INDEX TO FORMATIONS.

GENERAL INDEX.

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