Telescopic Works For Starlight Evenings

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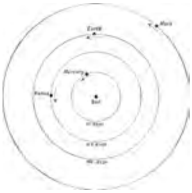

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MERCURY

Mercury is the nearest known planet to the Sun. It is true that a body, provisionally named Vulcan33, has been presumed to exist in the space interior to the orbit of Mercury; but absolute proof is lacking, and every year the idea is losing strength in the absence of any confirmation of a reliable kind. Certain planetary spots, observed in motion on the solar disk, were reported to have been transits of this intra-Mercurial orb. Some eminent astronomers were thus drawn to take an affirmative view of the question, and went so far as to compute the orbital elements and predict a few ensuing transits of the suspected planet. But nothing was seen at the important times, and some of the earlier observations have been shown to possess no significance whatever, while grave doubts are attached to many of the others. Not one of the regular and best observers of the Sun has recently detected any such body during its transits (which would be likely to occur pretty frequently), and there is other evidence of a negative character.

Visibility of Mercury

Copernicus, amid the fogs of the Vistula, looked for Mercury in vain, and complained in his last hours that he had never seen it. Tycho Brahe, in the Island of Hueen, appears to have been far more successful. The planet is extremely fugitive in his appearances, but is not nearly so difficult to find as many suppose. Whenever the horizon is very clear, and the planet well placed, a small sparkling object, looking more like a scintillating star than a planetary body, will be detected at a low altitude and may be followed to the horizon. Mercury revolves round the Sun in 87d 23h 15m 44s in an eccentric orbit, so that his distance from that luminary varies from 43,350,000 to 28,570,000 miles.

Elongations

Being situated so near to the Sun, it is obvious that to an observer on the Earth he must always remain in the same general region of the firmament as that body. His orbital motion enables him to successively assume positions to the E. and W. of the Sun, and these are known as his elongations, which vary in distance from 18° to 28°. He becomes visible at these periods either in the morning or evening twilight, and under the best circumstances may remain above the horizon two hours in the absence of the Sun. The best times to observe the planet are at his E. elongations during the first half of the year, or at his W. elongations in the last half; for his position at such times being N. of the Sun's place, he remains a long while in view. It is unfortunate that when the elongation approaches its extreme limits of 28° the planet is situated S. of the Sun, and therefore not nearly so favourably visible as at an elongation of only 18° or 20°, when his position is N. of the Sun.

I have seen Mercury on about sixty-five occasions with the naked eye. In May 1876 I noticed the planet on thirteen different evenings, and between April 22 and May 11, 1890, I succeeded on ten evenings. I believe that anyone who made it a practice to obtain naked-eye views of this object would succeed from about twelve to fifteen times in a year. In a finer climate, of course, Mercury may be distinguished more frequently. The planet is generally most conspicuous a few mornings after his W. elongations and a few evenings before his E. elongations. I have seen Mercury on about sixty-five occasions with the naked eye. In May 1876 I noticed the planet on thirteen different evenings, and later I succeeded on ten evenings.

Amateur's First View

The first view of Mercury forms quite an event in the experience of many amateurs. The evasive planet is sought for with the same keen enthusiasm as though an important discovery were involved. For a few evenings efforts are vain, until at length a clearer sky and a closer watch enables the glittering little stranger to be caught amid the vapours of the horizon. The observer is delighted, and, proud of his success, he forthwith calls out the members of his family that they, too, may have a glimpse of the fugitive orb never seen by the eye of Copernicus.

In the course of his orbital round Mercury exhibits all the phases of the Moon. Near his elongations the disk is about half illuminated, and similar in form to that of our satellite when in the first or third quarter. But the phase is not to be distinctly made out unless circumstances are propitious. Galilei's telescope failed to reveal it, and Hevelius, many years afterwards, found it difficult. The phase is sometimes noted to be less than theory indicates; for the planet has been seen crescented when he should have presented the form of a semicircle.

Atmosphere

The atmosphere of Mercury is probably far less dense than that of Venus. The latter being farthest from the 14° Sun might be expected to shine relatively more faintly than the former, but the reverse is the case. Mercury has a dingy aspect in comparison with the bright white lustre of Venus. On May 12, 1890, when the two planets were visible as evening stars, and separated from each other by a distance of only 2°, I examined them in a 10-inch reflector, power 145. The disk of Venus looked like newly-polished silver, while that of Mercury appeared of a dull leaden hue. A similar observation was made by Mr. Nasmyth on September 28, 1878. The explanation appears to be that the atmosphere of Mercury is of great rarity, and incapable of reflection in the same high degree as the dense atmosphere of Venus.

Satisfactory Conditions

It is scarcely surprising that our knowledge of his appearance is very meagre, or that amateurs consider the planet an object practically inaccessible as regards the observation of physical peculiarities, and one upon which it is utterly useless to apply the telescope in the hope of effecting new discoveries. Former attempts have proved the extreme difficulty of obtaining good images of this planet. The smallness of the disk, and the fact that it is usually so much affected by the waves of vapour passing along the horizon as to be constantly flaring and moulding in a manner which scarcely enables the phase to be made out, are great drawbacks, which render it impossible to distinguish any delicate features that may be presented on the surface.

These circumstances are well calculated to lead observers to abandon this object as one too unpromising for further study; but I think the view is partly induced by a misconception. The planet's diminutive size is a hindrance which cannot be overcome; but the bad definition, resulting from low altitude, may be obviated by those who will select more suitable times for their observations and not be dismayed if their initiatory efforts prove futile. As a naked-eye object, Mercury must necessarily be looked for when near the horizon; but there is no such need in regard to telescopic observation, which ought to be only attempted when the planet surmounts the dense lower vapours and is placed at a sufficient elevation to give141 the instrument a fair chance of producing a steady image. The presence of sunshine need not seriously impair the definition or make the disk too faint for detail.

I have occasionally seen Mercury, about two or three hours after his rising, with outlines of extreme sharpness and quite comparable with the excellent views obtained of Venus at the time of sunrise or sunset. Those who possess equatoreals should pick up the planet in the afternoon and follow him until after sunset, when the horizontal vapours will interfere. Others who work with ordinary alt-azimuth stands will find it best to examine the planet at his western elongations during the last half of the year.

Schiaparelli's Results

Mercury was displayed under several advantages in the morning twilight of November 1882, and I made a series of observations with a 10-inch reflector, power 212. Several dark markings were perceived, and a conspicuous white spot. The general appearance of the disk was similar to that of Mars, and I forwarded a summary of my results to Prof. Schiaparelli, of Milan, who favoured me with the following interesting reply:

> *"I have myself been occupied with this planet during the past year (1882). You are right in saying that Mercury is much easier to observe than Venus, and that his aspect resembles Mars more than any other of the planets of the solar system. It has some spots which become partially obscured and sometimes completely so; it has also some brilliant white spots in a variable*

position. As I observe the planet entirely by day and near the meridian I have been able to see its spots many times, but not always with the necessary distinctness to make drawings sufficiently reliable to serve as a base for a rigorous investigation. It is remarkable that the views taken near superior conjunction have been more instructive for me than those taken when the disk is near dichotomy, the defect in diameter being compensated by the possibility of seeing nearly all the disk, which, under those conditions, is more strongly illuminated. I believe that by instrumental means, such as our 8-inch refractor at Milan gives, it is possible to prove the rotation-period of Mercury and to gain a knowledge of the principal spots as regards the generality of their forms. But these spots are really very complicated, for, besides the difficulties attending their observation, they are extremely variable."

JUPITER

Of all the planets, Jupiter is the most interesting for study by the amateur. It is true that Saturn forms an exquisite object, and that his wonderful ring-system is well calculated to incite admiration as a feature unique in the solar system. But when the two planets come to be repeatedly observed, and the charm of first impressions has worn away, the observer must admit that Jupiter, with his broad disk and constantly changing markings, affords the materials for prolonged study and sustained interest. With Saturn the case is different. His features are apparently quiescent; usually there are no definite spots upon the belts or rings. There is a sameness in the telescopic views, as presented in my findings that follow, which causes the object to be neglected in favour of another where active changes are in visible progress. First we will start with the brightness and position of Jupiter.

Brightness and Position

Jupiter is a brilliant object in the heavens, his lustre exceeding that of Mars or Saturn, though not equal to that of Venus. I have occasionally seen the planet with the naked eye in the daytime, about half an hour after 171 sunrise; and it has been frequently observed by Bond, in America, with the Sun at a considerable altitude. Humboldt and Bonpland, at Cumana, 10° N. lat., saw Jupiter distinctly with the naked eye, 18 minutes after the Sun had appeared in the horizon, on Sept. 26, 1830. The planet is favourably visible for a considerable time every year, and is only beyond reach near the times of his conjunctions with the Sun, when he usually evades observation for about three months. As regards his altitude, Jupiter becomes exceptionally well placed at intervals of 12 years; thus in 1859, 1870-1, and 1882 his declination was 22° or ic3° N., and his height therefore very great when passing the meridian. In 1894 he will occupy a similarly auspicious region to observers in the N. hemisphere. In 1865, 1877, and 1889 his declination was 23° S., and he was favourably presented to southern astronomers.

Telescope

The image of Jupiter as seen in a telescope is involved in a slight yellow tinge, and with the naked eye the same colour is often apparent. But when observed through a very pure transparent atmosphere, his light nearly approaches the silvery lustre of Venus or the Moon. The planet shines with unusual splendour, considering his great distance from the Sun, and his atmosphere must be highly reflective and possibly intensified by inherent light from the planet himself. The central parts of Jupiter's disk are usually the brightest, as there is a faint shading-off and indefiniteness at the limbs. These and other facts support the view that Jupiter is still incalescent and sufficiently self-luminous to emit a small amount of light.

This planet revolves round the Sun in 4332d 14h 2m, which is equal to more than 11-3/4 years. His orbit is somewhat eccentric, so that his distance from the Sun varies from 506,500,000 to 460,000,000 miles, and the mean is 483,300,000 miles. His apparent diameter ranges from a max. of 50° at a good opposition to 30°·4 in conjunction. The planet's diameter measured along the equator is 88,000 miles, and the polar compression is very marked, amounting to 1/16, or, more exactly, to 1/15·82, according to Engelmann, from a mean derived from eleven observers. When Jupiter is in172 quadrature there is a slight phase evident in the shading-off of the limb furthest from the Sun.

Belts and Spots on the Planet

From the time that the telescope became available as a means of astronomical research, it may be readily surmised that an object coming so well within the reach of ordinary appliances, and one displaying so many prominent and variable features, should absorb a large share of attention, and that many facts of interest should have been gleaned as to his physical peculiarities. But it must be confessed that, though something has been learned as to the visible behaviour of the markings, there is much that is perplexing in their curious vagaries. No doubt the vast changes affecting the Jovian envelope, the diversity of the markings, and their proper motions result from the operations of a peculiarly variable atmosphere, affected probably by a heated and active globe beneath it, and by the very rapid movement of rotation to which it is subject.

The telescope, on being turned towards Jupiter, reveals at once an array of dark and light stripes or belts stretching across the disk in a direction parallel to one another and to the equator of the planet. These belts are supposed to have been first detected by Zucchi in 1630. Usually there are two broad and prominent dark belts, one on either side of the equator; while towards the poles other belts appear, some of them very narrow, partly by the effects of foreshortening. The equatoreal zone of the planet is of a lighter tint, and variegated with white and dark spots and streaks, liable to rapid changes, and indicating that this region is in a highly disturbed condition.

Observations of Hooke, Cassini, and others

Hooke and Cassini were amongst the first to find definite spots on the surface of Jupiter. From 1664 to 1667 a particularly large and distinct spot was frequently seen in the planet's S. hemisphere. This object disappeared in the latter year, but returned in 1672, and was seen until the close of 1674, when it again temporarily vanished, to reappear at subsequent epochs. Cassini was enabled to determine the rotation-period from this spot. He found that the markings in the immediate vicinity of the equator moved with greater

173 celerity than those in higher latitudes, the difference in their rotation-periods being nearly 6 minutes. He watched a bright object near the equator which had a period more than 5 minutes less than some dark spots. In later years Mädler and others followed up the investigation of these markings, and with nearly similar results. The various spots were undoubtedly affected by proper motions, enabling them to yield discordant rotation-periods. Bright forms near the equator moved with great rapidity and effected a rotation in about 9h 50m, while dark spots on either side of it occupied between 9h 55m and 9h 56m. The markings were evidently controlled by currents of different velocities in the planet's atmosphere, as described:

> *Dawes, in 1849 and following years, noted luminous spots, like satellites in transit, on a belt in the planet's S. hemisphere. In October 1857 he observed a group of eleven of these objects; and in 1858 Lassell saw many similar appearances in a bright belt near the equator.*

The Red Spot

In July 1878 a large spot, of oval form and intense red colour, appeared in about the same latitude as the ellipse seen by Gledhill and Mayer in 1869-70. It was first announced by Dennett of Southampton, though it appears to have been seen a few weeks earlier by Prof. Pritchett, of Missouri, U.S.A. The object alluded to soon attracted general notice; and as it continued visible during174 the oppositions of 1879, 1880, and 1881 under the same striking aspect, it created a considerable stir among telescopists, and the "great red spot on Jupiter" became familiarly known both in appearance and in title.

No planetary marking in modern times[1] has enlisted half the amount of attention that has been devoted to this object. It has endured amid all the turmoils of the Jovian atmosphere for twelve years, and has preserved an integrity of form and size which prove it to have been singularly capable of withstanding disruption. But its tint has varied greatly; so that at times the oval outline of the spot could hardly be discerned amongst the contiguous belts. In the winter of 1881 the interior of the ellipse began to lose tone, and in 1882 it faded rapidly, so that the central region of the spot assumed nearly the same light tint as the outlying bright belts. Apparently the spot had either been filled up with luminous cloudy material or had been partially obscured by the interposition of matter situated higher in the Jovian atmosphere.

1 Prof. Young, who has charge of the 23-inch refractor at Princeton, has also commented on the subject of the definition of large telescopes. He says: "The greater susceptibility of large instruments to atmospheric disturbances is most sadly true; that I can almost always see with the 23-inch everything I see with the 9-inch under the same atmospheric conditions, and see it better."

Observer's Aims

Those who meditate going farther afield, and taking up observation habitually as a means of acquiring practical knowledge, and possibly of doing original work, will essentially need different means. They will require reflectors of about 8 or 10 inches aperture; and, if mounted in the open on solid ground, so much the better, as there will be a more expansive view, and a freedom from heated currents, which renders an apartment unsuited to observations, unless with small apertures where the effects are scarcely appreciable. A reflector43 of the diameter mentioned will command sufficient grasp to exhibit the more delicate features of planetary markings, and will show many other difficult objects in which the sky abounds. If the observer be specially interested in the surface configuration of Mars and Jupiter he will find a reflector a remarkably efficient instrument.

On the Moon and planets it is admitted that its performance is, if not superior, equal to that of refractors. If, however, the inclination of the observer leads him in the direction of double stars, their discovery and measurement, he will perhaps find a refractor more to be depended upon, though there is no reason why a well-mounted reflector should not be successfully employed in this branch; and the cost of a refractor of the size to be really useful as an instrument of discovery must be something very considerable.

M A R S

Mars is the fourth planet in the order of distance from the Sun. He revolves in an orbit outside that of the Earth, and is the smallest of the superior planets. His brilliancy is sometimes considerable when he occupies a position near to the Earth, and he emits an intense red light36, which renders his appearance all the more striking. Ordinarily his lustre does not equal that of Jupiter, though when favourably placed he becomes a worthy rival of that orb. In 1719 he shone so brightly and with such a fiery aspect as to cause a panic. The superstitious notions and belief in astrological influences prevailing at that time no doubt gave rise to the popular apprehension that the ruddy star was an omen of disaster, and thus it was regarded with feelings of terror. Fortunately the light of science has long since removed such ideas from amongst us, and celestial objects, in all their various forms, are contemplated without misgiving. They are rather welcomed as affording the means of advancing our knowledge of God's wonderful works.

Mars revolves round the Sun in 686d 23h 30m 41s, and his mean distance from that luminary is 141,500,000 miles. The orbit is one of considerable eccentricity, the distance156 varying between 154,700,000 and 128,360,000 miles. The apparent diameter of the planet when in conjunction with the Sun is only 4"; but this may augment to 30"·4 at an opposition, when the Earth and Mars occupy the least distant parts of their orbits. The real diameter of Mars is nearly 5000 miles.

Phase

At opposition the disk of Mars is round, but when in quadrature he appears distinctly gibbous and resembles the Moon three days from full. The phase is so palpable that Galilei glimpsed it at the end of 1610. In delineations of Mars the disk is generally drawn circular, the compression being very slight and the phase too trivial to be regarded.

This planet being singularly variable in his position relatively to the Earth, presents at times a diameter so small that the most powerful instruments are ineffective to deal with him. But at certain epochs he becomes an excellent object, with a much expanded disk, on which are displayed a number of bright and dark markings. This happens, however, with comparative rarity; for only during two months or so near every opposition, occurring at intervals of 780 days, can the planet be well seen. Generally the apparent size of

Mars is very inconsiderable, and the disk not sharply defined, especially when the altitude is low. Reliable observations are seldom made at a time far removed from the date of opposition. When the planet was badly placed, in July 1882, an observer secured some observations of position, and published them, thinking he had seen Wells's Comet, which happened to be in the same quarter of the sky!

Mars, in nearer degree than any other member of our system, shows a configuration which may be likened to that of the Earth as regards its permanency; and in some of its outlines a general resemblance also exists, though in detail there is evidently much that is dissimilar. It is fortunate that the atmosphere of Mars is so rarefied that observers can look upon his real surface-lineaments with satisfactory perspicuity. For more than 250 years now, the telescope has been engaged in perfecting our knowledge of Martian features, and these have exhibited no mobility of form or place (apart from that due to rotation or varying inclination of the planet) so far as157 may be judged from a comparison of drawings. Plenty of differences exist in the latter, it is true, though similar objects are represented; but the explanation obviously lies in the inaccuracies of amateur artists, and has little if anything to do with physical changes on the planet.

When the spots were discovered in 1636 by Fontana they were, of course, very dimly glimpsed in the incompetent appliances available at that time. Huygens, in 1659, saw them better by means of his long telescopes, but still very imperfectly. Cassini, in 1666, effected a further advance in the same field, and gathered data from which he was able to announce the period of rotation. His value has proved remarkably correct, considering the means he employed to obtain it and the very short interval over which his inquiries were conducted. Huygens had previously, in 1659, witnessed the returns of a certain spot to the same approximate place on the planet, and was led to infer rotation in either 12h or 24h. But this was little better than a guess, and not nearly of the same precision as that which marked Cassini's subsequent determination.

Charts and Nomenclature of Mars

It is not desirable to trace with any detail the successive labours of those who have chiefly contributed to our knowledge of areographic features. Maraldi, W. Herschel, Schröter, Mädler, Schmidt, and Dawes were foremost amongst the observers of the past; while Schiaparelli and Green are the most successful observers of to-day. As telescopes improved in effectiveness the true forms and characteristics of the markings were discerned, and at the present time some thousands of delineations of this planet must be in existence. Charts of the leading and best-assured features have been formed, and the regions of light and shade (supposed to represent land and sea) have received proper names to distinguish them. Thus there is "Fontana Land," "Maraldi Sea," "Herschel Continent," and others of similar import. Schiaparelli has framed a chart in which the spots are furnished with Latin names taken from classical geography. Mädler's plan was to designate the markings by capital letters of the alphabet, and to divide these by small letters in necessary cases. But the charts of Proctor, Green, and others, in which the names of past and present astronomers are applied, seem to find most favour, though it is admitted that this method of nomenclature is not free from objections. In some instances the names have not been wisely selected.

A few years ago, when christening celestial formations was more in fashion than it is now, a man simply had to use a telescope for an evening or two on Mars or the Moon, and spice the relation of his seeings with something in the way of novelty, when his name would be pretty certainly attached to an object and hung in the heavens for all time! A writer in the 'Astronomical Register' for January 1879 humorously suggested that "the matter should be put into the hands of an advertizing agent" and "made the means of raising a revenue for astronomical purposes." Some men would not object to pay handsomely for the distinction of having their names159 applied to the seas and continents of Mars or to the craters on the Moon.