CHAPTER VIII

SCENES ON THE PLANETS

> "These starry globes far surpassed the earth in grandeur, and the latter looked so diminutive that our empire, which appeared only as a point on its surface, awoke my pity."--CICERO, THE DREAM OF SCIPIO.

Although amateurs have played a conspicuous part in telescopic discovery among the heavenly bodies, yet every owner of a small telescope should not expect to attach his name to a star. But he certainly can do something perhaps more useful to himself and his friends; he can follow the discoveries that others, with better appliances and opportunities, have made, and can thus impart to those discoveries that sense of reality which only comes from seeing things with one's own eyes. There are hundreds of things continually referred to in books and writings on astronomy which have but a misty and uncertain significance for the mere reader, but which he can easily verify for himself with the aid of a telescope of four or five inches aperture, and which, when actually confronted by the senses, assume a meaning, a beauty, and an importance that would otherwise entirely have escaped him. Henceforth every allusion to the objects he has seen is eloquent with intelligence and suggestion.

Take, for instance, the planets that have been the subject of so many observations and speculations of late years--Mars, Jupiter, Saturn, Venus. For the ordinary reader much that is said about them makes very little impression upon his mind, and is almost unintelligible. He reads of the "snow patches" on Mars, but unless he has actually seen the whitened poles of that planet he can form no clear image in his mind of what is meant. So the "belts of Jupiter" is a confusing and misleading phrase for almost everybody except the astronomer, and the rings of Saturn are beyond comprehension unless they have actually been seen.

It is true that pictures and photographs partially supply the place of observation, but by no means so successfully as many imagine. The most realistic drawings and the sharpest photographs in astronomy are those of the moon, yet I think nobody would maintain that any picture in existence is capable of imparting a really satisfactory visual impression of the appearance of the lunar globe. Nobody who has not seen the moon with a telescope--it need not be a large one--can form a correct and definite idea of what the moon is like.

The satisfaction of viewing with one's own eyes some of the things the astronomers write and talk about is very great, and the illumination that comes from such viewing is equally great. Just as in foreign travel the actual seeing of a famous city, a great gallery filled with masterpieces, or a battlefield where decisive issues have been fought out illuminates, for the traveler's mind, the events of history, the

criticisms of artists, and the occurrences of contemporary life in foreign lands, so an acquaintance with the sights of the heavens gives a grasp on astronomical problems that can not be acquired in any other way. The person who has been in Rome, though he may be no archæologist, gets a far more vivid conception of a new discovery in the Forum than does the reader who has never seen the city of the Seven Hills; and the amateur who has looked at Jupiter with a telescope, though he may be no astronomer, finds that the announcement of some change among the wonderful belts of that cloudy planet has for him a meaning and an interest in which the ordinary reader can not share.

Jupiter is perhaps the easiest of all the planets for the amateur observer. A three-inch telescope gives beautiful views of the great planet, although a four-inch or a five-inch is of course better. But there is no necessity for going beyond six inches' aperture in any case. For myself, I should care for nothing better than my Byrne five-inch of fifty-two inches' focal distance. With such a glass more details are visible in the dark belts and along the bright equatorial girdle than can be correctly represented in a sketch before the rotation of the planet has altered their aspect, while the shadows of the satellites thrown upon the broad disk, and the satellites themselves when in transit, can be seen sometimes with exquisite clearness. The contrasting colors of various parts of the disk are also easily studied with a glass of four or five inches' aperture.

There is a charm about the great planet when he rides high in a clear

evening sky, lording it over the fixed stars with his serene, unflickering luminousness, which no possessor of a telescope can resist. You turn the glass upon him and he floats into the field of view, with his cortége of satellites, like a yellow-and-red moon, attended by four miniatures of itself. You instantly comprehend Jupiter's mastery over his satellites--their allegiance is evident. No one would for an instant mistake them for stars accidentally seen in the same field of view. Although it requires a very large telescope to magnify their disks to measurable dimensions, yet the smallest glass differentiates them at once from the fixed stars. There is something almost startling in their appearance of companionship with the huge planet--this sudden verification to your eyes of the laws of gravitation and of central forces. It is easy, while looking at Jupiter amid his family, to understand the consternation of the churchmen when Galileo's telescope revealed that miniature of the solar system, and it is gratifying to gaze upon one of the first battle grounds whereon science gained a decisive victory for truth.

The swift changing of place among the satellites, as well as the rapidity of Jupiter's axial rotation, give the attraction of visible movement to the Jovian spectacle. The planet rotates in four or five minutes less than ten hours--in other words, it makes two turns and four tenths of a third turn while the earth is rolling once upon its axis. A point on Jupiter's equator moves about twenty-seven thousand miles, or considerably more than the entire circumference of the earth, in a single hour. The effect of this motion is clearly perceptible to the

observer with a telescope on account of the diversified markings and colors of the moving disk, and to watch it is one of the greatest pleasures that the telescope affords.

It would be possible, when the planet is favorably situated, to witness an entire rotation of Jupiter in the course of one night, but the beginning and end of the observation would be more or less interfered with by the effects of low altitude, to say nothing of the tedium of so long a vigil. But by looking at the planet for an hour at a time in the course of a few nights every side of it will have been presented to view. Suppose the first observation is made between nine and ten o'clock on any night which may have been selected. Then on the following night between ten and eleven o'clock Jupiter will have made two and a half turns upon his axis, and the side diametrically opposite to that seen on the first night will be visible. On the third night between eleven and twelve o'clock Jupiter will have performed five complete rotations, and the side originally viewed will be visible again.

Owing to the rotundity of the planet, only the central part of the disk is sharply defined, and markings which can be easily seen when centrally located become indistinct or disappear altogether when near the limb. Approach to the edge of the disk also causes a foreshortening which sometimes entirely alters the aspect of a marking. It is advisable, therefore, to confine the attention mainly to the middle of the disk. As time passes, clearly defined markings on or between the cloudy belts will be seen to approach the western edge of the disk, gradually losing

their distinctness and altering their appearance, while from the region of indistinct definition near the eastern edge other markings slowly emerge and advance toward the center, becoming sharper in outline and more clearly defined in color as they swing into view.

Watching these changes, the observer is carried away by the reflection that he actually sees the turning of another distant world upon its axis of rotation, just as he might view the revolving earth from a standpoint on the moon. Belts of reddish clouds, many thousands of miles across, are stretched along on each side of the equator of the great planet he is watching; the equatorial belt itself, brilliantly lemon-hued, or sometimes ruddy, is diversified with white globular and balloon-shaped masses, which almost recall the appearance of summer cloud domes hanging over a terrestrial landscape, while toward the poles shadowy expanses of gradually deepening blue or blue-gray suggest the comparative coolness of those regions which lie always under a low sun.

After a few nights' observation even the veriest amateur finds himself recognizing certain shapes or appearances--a narrow dark belt running slopingly across the equator from one of the main cloud zones to the other, or a rift in one of the colored bands, or a rotund white mass apparently floating above the equator, or a broad scallop in the edge of a belt like that near the site of the celebrated "red spot," whose changes of color and aspect since its first appearance in 1878, together with the light it has thrown on the constitution of Jupiter's disk, have all but created a new Jovian literature, so thoroughly and so frequently

have they been discussed.

And, having noticed these recurring features, the observer will begin to note their relations to one another, and will thus be led to observe that some of them gradually drift apart, while others drift nearer; and after a time, without any aid from books or hints from observatories, he will discover for himself that there is a law governing the movements on Jupiter's disk. Upon the whole he will find that the swiftest motions are near the equator, and the slowest near the poles, although, if he is persistent and has a good eye and a good instrument, he will note exceptions to this rule, probably arising, as Professor Hough suggests, from differences of altitude in Jupiter's atmosphere. Finally, he will conclude that the colossal globe before him is, exteriorly at least, a vast ball of clouds and vapors, subject to tremendous vicissitudes, possibly intensely heated, and altogether different in its physical constitution, although made up of similar elements, from the earth. Then, if he chooses, he can sail off into the delightful cloud-land of astronomical speculation, and make of the striped and spotted sphere of Jove just such a world as may please his fancy--for a world of some kind it certainly is.

For many observers the satellites of Jupiter possess even greater attractions than the gigantic ball itself. As I have already remarked, their movements are very noticeable and lend a wonderful animation to the scene. Although they bear classical names, they are almost universally referred to by their Roman numbers, beginning with the

innermost, whose symbol is I, and running outward in regular order II, III, and IV.[5] The minute satellite much nearer to the planet than any of the others, which Mr. Barnard discovered with the Lick telescope in 1892, is called the fifth, although in the order of distance it would be the first. In size and importance, however, it can not rank with its comparatively gigantic brothers. Of course, no amateur's telescope can afford the faintest glimpse of it.

[5] Their names, in the same order as their numbers, are Io, Europa, Ganymede, and Callisto.

Satellite I, situated at a mean distance of 261,000 miles from Jupiter's center--about 22,000 miles farther than the moon is from the earth--is urged by its master's overpowering attraction to a speed of 320 miles per minute, so that it performs a complete revolution in about forty-two hours and a half. The others, of course, move more slowly, but even the most distant performs its revolution in several hours less than sixteen days. The plane of their orbits is presented edgewise toward the earth, from which it follows that they appear to move back and forth nearly in straight lines, some apparently approaching the planet, while others are receding from it. The changes in their relative positions, which can be detected from hour to hour, are very striking night after night, and lead to a great variety of arrangements always pleasing to the eye.

The most interesting phenomena that they present are their transits and those of their round, black shadows across the face of the planet; their

eclipses by the planet's shadow, when they disappear and afterward reappear with astonishing suddenness; and their occultations by the globe of Jupiter. Upon the whole, the most interesting thing for the amateur to watch is the passage of the shadows across Jupiter. The distinctness with which they can be seen when the air is steady is likely to surprise, as it is certain to delight, the observer. When it falls upon a light part of the disk the shadow of a satellite is as black and sharply outlined as a drop of ink; on a dark-colored belt it can not so easily be seen.

It is more difficult to see the satellites themselves in transit. There appears to be some difference among them as to visibility in such circumstances. Owing to their luminosity they are best seen when they have a dark belt for a background, and are least easily visible when they appear against a bright portion of the planet. Every observer should provide himself with a copy of the American Ephemeris for the current year, wherein he will find all the information needed to enable him to identify the various satellites and to predict, by turning Washington mean time into his own local time, the various phenomena of the transits and eclipses.

While a faithful study of the phenomena of Jupiter is likely to lead the student to the conclusion that the greatest planet in our system is not a suitable abode for life, yet the problem of its future, always fascinating to the imagination, is open; and whosoever may be disposed to record his observations in a systematic manner may at least hope to

render aid in the solution of that problem.

Saturn ranks next to Jupiter in attractiveness for the observer with a telescope. The rings are almost as mystifying to-day as they were in the time of Herschel. There is probably no single telescopic view that can compare in the power to excite wonder with that of Saturn when the ring system is not so widely opened but that both poles of the planet project beyond it. One returns to it again and again with unflagging interest, and the beauty of the spectacle quite matches its singularity. When Saturn is in view the owner of a telescope may become a recruiting officer for astronomy by simply inviting his friends to gaze at the wonderful planet. The silvery color of the ball, delicately chased with half-visible shadings, merging one into another from the bright equatorial band to the bluish polar caps; the grand arch of the rings, sweeping across the planet with a perceptible edging of shadow; their sudden disappearance close to the margin of the ball, where they go behind it and fall straightway into night; the manifest contrast of brightness, if not of color, between the two principal rings; the fine curve of the black line marking the 1,600-mile gap between their edges--these are some of the elements of a picture that can never fade from the memory of any one who has once beheld it in its full glory.

Saturn's moons are by no means so interesting to watch as are those of Jupiter. Even the effect of their surprising number (raised to nine by Professor Pickering's discovery in 1899 of a new one which is almost at the limit of visibility, and was found only with the aid of photography)

is lost, because most of them are too faint to be seen with ordinary telescopes, or, if seen, to make any notable impression upon the eye. The two largest--Titan and Japetus--are easily found, and Titan is conspicuous, but they give none of that sense of companionship and obedience to a central authority which strikes even the careless observer of Jupiter's system. This is owing partly to their more deliberate movements and partly to the inclination of the plane of their orbits, which seldom lies edgewise toward the earth.

But the charm of the peerless rings is abiding, and the interest of the spectator is heightened by recalling what science has recently established as to their composition. It is marvelous to think, while looking upon their broad, level surfaces--as smooth, apparently, as polished steel, though thirty thousand miles across--that they are in reality vast circling currents of meteoritic particles or dust, through which run immense waves, condensation and rarefaction succeeding one another as in the undulations of sound. Yet, with all their inferential tumult, they may actually be as soundless as the depths of interstellar space, for Struve has shown that those spectacular rings possess no appreciable mass, and, viewed from Saturn itself, their (to us) gorgeous seeming bow may appear only as a wreath of shimmering vapor spanning the sky and paled by the rivalry of the brighter stars.

In view of the theory of tidal action disrupting a satellite within a critical distance from the center of its primary, the thoughtful observer of Saturn will find himself wondering what may have been the

origin of the rings. The critical distance referred to, and which is known as Roche's limit, lies, according to the most trustworthy estimates, just outside the outermost edge of the rings. It follows that if the matter composing the rings were collected into a single body that body would inevitably be torn to pieces and scattered into rings; and so, too, if instead of one there were several or many bodies of considerable size occupying the place of the rings, all of these bodies would be disrupted and scattered. If one of the present moons of Saturn--for instance, Mimas, the innermost hitherto discovered--should wander within the magic circle of Roche's limit it would suffer a similar fate, and its particles would be disseminated among the rings. One can hardly help wondering whether the rings have originated from the demolition of satellites--Saturn devouring his children, as the ancient myths represent, and encircling himself, amid the fury of destruction, with the dust of his disintegrated victims. At any rate, the amateur student of Saturn will find in the revelations of his telescope the inspirations of poetry as well as those of science, and the bent of his mind will determine which he shall follow.

Professor Pickering's discovery of a ninth satellite of Saturn, situated at the great distance of nearly eight million miles from the planet, serves to call attention to the vastness of the "sphere of activity" over which the ringed planet reigns. Surprising as the distance of the new satellite appears when compared with that of our moon, it is yet far from the limit where Saturn's control ceases and that of the sun becomes predominant. That limit, according to Prof. Asaph Hall's calculation, is

nearly 30,000,000 miles from Saturn's center, while if our moon were removed to a distance a little exceeding 500,000 miles the earth would be in danger of losing its satellite through the elopement of Artemis with Apollo.

Although, as already remarked, the satellites of Saturn are not especially interesting to the amateur telescopist, yet it may be well to mention that, in addition to Titan and Japetus, the satellite named Rhea, the fifth in order of distance from the planet, is not a difficult object for a three-or four-inch telescope, and two others considerably fainter than Rhea--Dione (the fourth) and Tethys (the third)--may be seen in favorable circumstances. The others--Mimas (the first), Enceladus (the second), and Hyperion (the seventh)--are beyond the reach of all but large telescopes. The ninth satellite, which has received the name of Ph[oe]be, is much fainter than any of the others, its stellar magnitude being reckoned by its discoverer at about 15.5.

Mars, the best advertised of all the planets, is nearly the least satisfactory to look at except during a favorable opposition, like those of 1877 and 1892, when its comparative nearness to the earth renders some of its characteristic features visible in a small telescope. The next favorable opposition will occur in 1907.

When well seen with an ordinary telescope, say a four-or five-inch glass, Mars shows three peculiarities that may be called fairly conspicuous--viz., its white polar cap, its general reddish, or

orange-yellow, hue, and its dark markings, one of the clearest of which is the so-called Syrtis Major, or, as it was once named on account of its shape, "Hourglass Sea." Other dark expanses in the southern hemisphere are not difficult to be seen, although their outlines are more or less misty and indistinct. The gradual diminution of the polar cap, which certainly behaves in this respect as a mass of snow and ice would do, is a most interesting spectacle. As summer advances in the southern hemisphere of Mars, the white circular patch surrounding the pole becomes smaller, night after night, until it sometimes disappears entirely even from the ken of the largest telescopes. At the same time the dark expanses become more distinct, as if the melting of the polar snows had supplied them with a greater depth of water, or the advance of the season had darkened them with a heavier growth of vegetation.

The phenomena mentioned above are about all that a small telescope will reveal. Occasionally a dark streak, which large instruments show is connected with the mysterious system of "canals," can be detected, but the "canals" themselves are far beyond the reach of any telescope except a few of the giants handled by experienced observers. The conviction which seems to have forced its way into the minds even of some conservative astronomers, that on Mars the conditions, to use the expression of Professor Young, "are more nearly earthlike than on any other of the heavenly bodies which we can see with our present telescopes," is sufficient to make the planet a center of undying interest notwithstanding the difficulties with which the amateur is confronted in his endeavors to see the details of its markings.

THE ILLUMINATION OF VENUS'S ATMOSPHERE AT THE BEGINNING OF HER TRANSIT ACROSS THE SUN.

In Venus "the fatal gift of beauty" may be said, as far as our observations are concerned, to be matched by the equally fatal gift of brilliance. Whether it be due to atmospheric reflection alone or to the prevalence of clouds, Venus is so bright that considerable doubt exists as to the actual visibility of any permanent markings on her surface. The detailed representations of the disk of Venus by Mr. Percival Lowell, showing in some respects a resemblance to the stripings of Mars, can not yet be accepted as decisive. More experienced astronomers than Mr. Lowell have been unable to see at all things which he draws with a fearless and unhesitating pencil. That there are some shadowy features of the planet's surface to be seen in favourable circumstances is probable, but the time for drawing a "map of Venus" has not yet come.

The previous work of Schiaparelli lends a certain degree of probability to Mr. Lowell's observations on the rotation of Venus. This rotation, according to the original announcement of Schiaparelli, is probably performed in the same period as the revolution around the sun. In other words, Venus, if Schiaparelli and Lowell are right, always presents the same side to the sun, possessing, in consequence, a day hemisphere and a night hemisphere which never interchange places. This condition is so antagonistic to all our ideas of what constitutes habitability for a

planet that one hesitates to accept it as proved, and almost hopes that it may turn out to have no real existence. Venus, as the twin of the earth in size, is a planet which the imagination, warmed by its sunny aspect, would fain people with intelligent beings a little fairer than ourselves; but how can such ideas be reconciled with the picture of a world one half of which is subjected to the merciless rays of a never-setting sun, while the other half is buried in the fearful gloom and icy chill of unending night?

Any amateur observer who wishes to test his eyesight and his telescope in the search of shades or markings on the disk of Venus by the aid of which the question of its rotation may finally be settled should do his work while the sun is still above the horizon. Schiaparelli adopted that plan years ago, and others have followed him with advantage. The diffused light of day serves to take off the glare which is so serious an obstacle to the successful observation of Venus when seen against a dark sky. Knowing the location of Venus in the sky, which can be ascertained from the Ephemeris, the observer can find it by day. If his telescope is not permanently mounted and provided with "circles" this may not prove an easy thing to do, yet a little perseverance and ingenuity will effect it. One way is to find, with a star chart, some star whose declination is the same, or very nearly the same, as that of Venus, and which crosses the meridian say twelve hours ahead of her. Then set the telescope upon that star, when it is on the meridian at night, and leave it there, and the next day, twelve hours after the star crossed the meridian, look into your telescope and you will see Venus,

or, if not, a slight motion of the tube will bring her into view.

For many amateurs the phases of Venus will alone supply sufficient interest for telescopic observation. The changes in her form, from that of a round full moon when she is near superior conjunction to the gibbous, and finally the half-moon phase as she approaches her eastern elongation, followed by the gradually narrowing and lengthening crescent, until she is a mere silver sickle between the sun and the earth, form a succession of delightful pictures.

Not very much can be said for Mercury as a telescopic object. The little planet presents phases like those of Venus, and, according to Schiaparelli and Lowell, it resembles Venus in its rotation, keeping always the same side to the sun. In fact, Schiaparelli's discovery of this peculiarity in the case of Mercury preceded the similar discovery in the case of Venus. There are markings on Mercury which have reminded some astronomers of the moon, and there are reasons for thinking that the planet can not be a suitable abode for living beings, at least for beings resembling the inhabitants of the earth.

Uranus and Neptune are too far away to present any attraction for amateur observers.