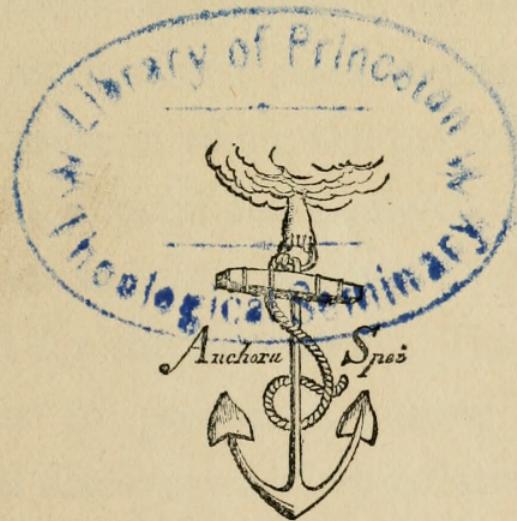


GOD'S GLORY IN THE HEAVENS

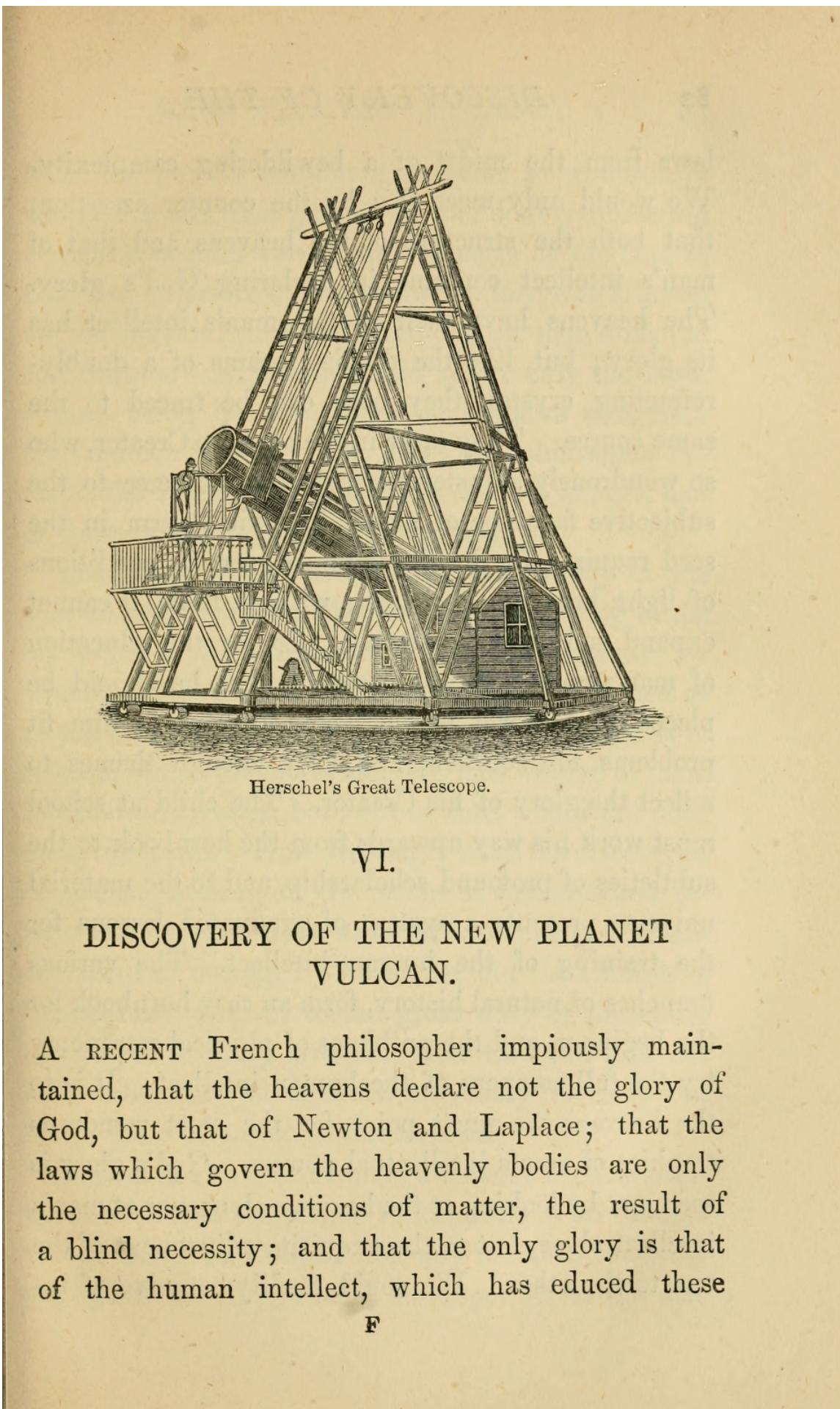
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Herschel's Great Telescope.

VI.

DISCOVERY OF THE NEW PLANET VULCAN.

A RECENT French philosopher impiously maintained, that the heavens declare not the glory of God, but that of Newton and Laplace; that the laws which govern the heavenly bodies are only the necessary conditions of matter, the result of a blind necessity; and that the only glory is that of the human intellect, which has educed these

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laws from the midst of a bewildering complexity. We would only meet this by the counter assertion, that both the structure of the heavens and that of man's intellect combine in declaring God's glory. The heavens have their glory—man's intellect has its glory; but, like the divided beams of a doubly-refracting crystal, they both can be traced to the same source. They meet in the all-wise Creator, who so wondrously adjusted the objective universe to the subjective faculties of man. The vital germ in the seed requires, for its development, certain conditions of light, heat, and moisture; without these, it cannot expand and fulfil its destiny. So, for the education of man's powers, it was necessary that he should be placed in a world which would present to him fit problems for solution, and lofty enough themes to reflect the glory of his Creator. The child at school must work his way upwards from the hornbook to the subtleties of profound scholarship, and so the material universe presents a system of graduated lessons for the training of the human intellect. The various branches of natural history, form an easy hornbook for the beginner, and the problems of physical astronomy try the full compass of the human intellect. It is to the heavens we must point for the most wondrous trophies of man's intellectual powers. God's glory is seen, not by looking at the heavens alone, nor at man's intellect alone, but to the exquisite adjustment of the one to the other. We could readily conceive of in-

tellectual powers without a universe so wondrously adapted to test their grasp. As the doubly-refracting crystal transmits two distinct images of the sun, so God has, in creation, impressed one image of Himself on the inmaterial universe, and one on man's mental constitution. M. Comte would admit only the latter —man being his own God—and ignore altogether the common source. But logic and philosophy demand the recognition of the two distinct images, and of their synthesis in the Divine glory.

The glory of God is declared, not merely in the adaptation of man's intellect to the unravelling of the mysteries of the universe, but also in the manner by which, in His providence, discoveries are so timed as to tell most powerfully, not only on the progress of science, but on the moral and religious welfare of man. Isolated discoveries, born out of date, would fall dead upon the world. How strikingly have the discoveries of science, bearing on the means of international intercourse; been timed so as to meet the rising missionary spirit of our age! No sooner did the Church of Christ fully awaken to the great duty of preaching the gospel to every creature, than God put into her hands the material agencies necessary to carry out the projects of missionary enterprise.

Seldom has an astronomical discovery been so well-timed as that of the planet Vulcan, due to an obscure village-doctor in France. At any previous time, the passage of the little, round, dark spot across the disc

of the sun would not have the same significance. Two men, unknown to one another, were at work on the same subject, and though pursuing very different methods, arrived at results, the coincidence of which forms one of the most interesting romances of science. The village-doctor humbly inquired of nature *what is*. The high priest of science had oracularly declared *what must be*. The former had no pretensions to science ; he loved to gaze upon God's handiwork, and was happy that nature should reveal spontaneously some new wonder. The other occupied a loftier position. He surveyed the celestial structure as already known, and, with the sharp eye of an architect, he declared that there was something wanting to complete the symmetry. His conclusion was, that there must be a planet between Mercury and the sun. The motion of Mercury could not otherwise be accounted for. There must be a perturbing body to explain the apparent irregularities of its path. He declared his conviction to the Academy of Science, and the fact was accepted by that learned body as one of the established facts of science, though no eye had ever been reported to have seen it. But, all the time, the village-doctor knew the planet as a fact of observation, yet hesitated to proclaim the discovery, lest it was too good a thing to be true. The interest of the story lies in the manner in which Leverrier fully established the reality of the discovery by M. Lescarbault, doctor at Orgères.

It is, however, necessary, in the first place, clearly to understand the difference between the discovery of Vulcan, and that of the small planets, which are now so numerous that the announcement of a new one has ceased to be a matter of interest. The discovery of Vulcan ranks with that of Neptune. It is not, however, likely to excite such popular interest, as there are no contending national claims. There is no Adams in this case to dispute the claim with Leverrier. It has, therefore, simply the interest of one of the greatest triumphs of the human intellect. In the case of the asteroids, the discovery implies no prophetic vision. Let a man, with proper instruments and charts, explore a certain region of the heavens, and there is a probability, almost amounting to certainty, that he will, within a few months, discover a new one, though he have few or no scientific accomplishments. From experience, it has been found that, in a certain zone, these asteroids abound, and, from the rate of discovery in the past, we naturally infer the rate of the future. This case is wholly different from that of Neptune and Vulcan, where the existence of the planets was predicted on *a-priori* grounds. The matter may be illustrated by the discovery of gold in Australia. The digger buys a claim on the banks of a river, sinks a shaft, and is fortunate enough to discover some nuggets. But there is no scientific merit in this. He was only led by an instinct, which is as strong in the inferior animals as in man. He

merely expected that what had happened before, would happen again in similar circumstances. The case is, however, different in regard to the prediction of Sir Roderick Murchison, who foretold, simply from his knowledge of the laws of the distribution of gold on the earth's surface, that gold would be found in Australia. The discovery of new asteroids, is like the discovery of nuggets by the gold-digger. The star-finder, in such a case, claims none of the prophetic genius of Leverrier and Adams.

In September 1859, Leverrier, now director of the Observatory of Paris, laid before the Academy of Science the proofs which had led him to the conclusion, that there must be a planet within the orbit of Mercury. He shewed, in his paper, that the existence of such a planet would fully explain the apparent anomalies in the motion both of Mercury and the earth. He, at the same time, warned all observers to keep a sharp look-out upon the sun's disc, as the only hope of discovering it, was by detecting its transit. Being always in the immediate vicinity of the sun, and quenched by its rays, it could manifest its existence only by appearing as a black spot on the bright background of the sun. In December 1859, Leverrier received a letter, dated from the small town of Orgères, in the department of Eure-et-Loire. This was from M. Lescarbault, announcing that he had, on the 26th of March preceding, observed a small planet cross the disc of the sun. Leverrier lost no time in sifting the

matter. Lescarbault had kept the secret to himself for several months, hoping that he might again see the planet, for he feared lest he might have deceived himself. But the results of Leverrier, reaching his ears, gave him courage to divulge it, though with some trepidation. Leverrier started for Orgères with similar feelings, hope being mingled with fear. He was sustained by the hope that he might, a second time, wear the proudest laurels that can encircle mortal brows; but he had the secret fear that he might be the victim of a delusion or a hoax.

It is rarely that science is associated with incidents of so dramatic a character. Our demonstrative neighbours have been charmed by the romantic interest of the story, and have given expression to their feelings in their own characteristic manner. The academic halls and the gay *salons* of Paris resounded for weeks with the name of the village-doctor. Leverrier, after detailing the incidents of his visit to Orgères to his brother savans in the Academy of Science, was called to repeat the story in less learned, but more fashionable parties. Others still more eloquent took up the story; and, embellished with additional incidents, it was repeated over and over again to eager audiences. We shall follow the version of the Abbé Moigno, who heard Leverrier detail the incidents to a brilliant throng in the *salon* of his father-in-law, M. Choquet.

It was on the 30th of September, that Leverrier started from Paris for the village of Orgères. He

must have had a secret conviction that the story of the discovery might be true; but, to guard himself against the laugh of Paris, he went ostensibly for the purpose of punishing the impudent attempt to hoax so high an official as the Director of the Imperial Observatory. It was not probable that the discovery could be made by a man who was never heard of in science, and about whom no one knew anything. Besides, it was unlikely that a Frenchman would, for so many months, keep the secret to himself. If true to his national instinct, he would at once have proclaimed the discovery, and reaped the glory. These reasons weighed much; still the story *might* be true, and on this possibility he acted. To preserve his dignity, and to be a check on any bias he might feel, he took with him a M. Vallée, a civil engineer, who might witness the severity with which he would treat the culprit.

They started by railway; but the station at which they stopped, was about twelve miles from Orgères. They had to trudge along this weary distance over a most miserable road. Foot-sore, and in no pleasant mood, Leverrier reached the village, and at once went up and knocked at the doctor's door. The door was opened by M. Lescarbault himself. The great man at once gave his name and titles, with an air that was meant to be very imposing. But we must now employ the very words of the Abbé Moigno. "One would require to have seen M. Lescarbault, so simple,

so modest, so timid, to comprehend the agitation with which he was seized, when the interrogator, drawing himself up to his full height, and with that *brusque* intonation, which he can assume when he pleases, said to him, with severe look, ‘Is it you, sir, who pretend to have discovered the intra-Mercurial planet, and who have committed the grave offence of keeping your observation secret for nine months? I have to tell you, that I come with the intention of exposing your pretensions, and of demonstrating your great delusion, if not your dishonesty. Tell me, at once, categorically, what you have seen?’ The lamb trembled all over at this rude summons of the lion; he tried to speak, but he only stammered out the following reply:—‘At four o’clock, on the 26th of March last, faithful to my constant habit, I looked through my telescope, and observed the disc of the sun, when, all at once, I detected, near the eastern edge, a small black point, perfectly round, and sharply defined, passing across the disc, with a very sensible motion. It gradually, though quite perceptibly, increased its distance from the edge, but’”—

Let us leave the Abbé Moigno’s account to pause on this *but*. How awkwardly and fatally are *buts* often interjected in the smooth current of life! How often, too, is the dignity of science offended, and its success marred by *contre-temps* so ludicrous, or so little, that a man would not do well to be angry at them. A whisk of Diamond’s tail, in Newton’s

study, set his papers on fire, and destroyed the labours of many years. The great philosopher shewed an equanimity worthy of his fame, when his only remark on the catastrophe was, "O Diamond, Diamond, thou little knowest the mischief thou hast done!" M. Lescarbault's *but* was nearly as fatal to the discovery he was on the brink of making. At the most interesting moment of the observation, a knock was heard on the counter of the laboratory below. He listened for a moment without moving. The knocking became more emphatic; it was a patient demanding medical relief. He would fain look on, and follow the dark spot rapidly travelling across the sun's disk. But it may not be. The call of duty must be obeyed; and no villager could say that the good doctor ever forgot his patients in his devotion to the stars. Fortunately, it was not a call to go abroad. A soothing draught was all that was needed. He scrupulously measured out the ingredients, corked and labelled the bottle; and not till then did the conscientious doctor feel at liberty to rush up to his little observatory, and eagerly apply his eye to the telescope. It is not too late; the strange planet is still upon the disc.

He marked precisely the time when he saw it near the eastern edge. He must now carefully watch the moment when it leaves the disc. Having noted these times, and measured the size and position of the segment of the sun's disc cut off by the path of

the planet, he has branded the object, so that it can ever afterwards be identified. Had he been only able to report that he had seen a black point, his observation would have been of little value, and no one would know where to look for it again. By simply ascertaining how long it took to cross an ascertained portion of the sun's disc, its distance from the sun and its period of revolution could at once be deduced, and thus the chief elements of identity would be determined. These essential points were not observed when the knock was heard, and we can well conceive the painful suspense of the observer, till his eye was once more applied to the tube.

This reminds one of the interruptions of Sir William Herschel, when pursuing his musical avocations in the pump-room at Bath. He had a small workshop close at hand, and when the exacting loungers in the pump-room admitted of a pause in the music, he slipped off to complete the polishing of a speculum, or the grinding of a lens. But he was always ready, when he heard the signal, to snatch up his instrument, and be the first in the orchestra. He did not permit his astronomical tastes to interfere with the duties of his calling. He was allowed to be one of the best drummers in the Hanoverian army, and few in Bath could match him on the fiddle, the flute, or the cornet-à-piston. While his fellow-musicians spent their pauses in drinking and gossiping, he

gathered up the fragments of time, and it was these fragments that made him the friend of monarchs, and the first of astronomers.

Let us now return to the cross-questioning of the Imperial astronomer. In order to be convinced that the story is not a fabrication, he must have proof that the observer had proper instrumental means for making the observation. The astronomer must be so exact in his observation, that seconds and fractions of seconds must be taken into account. He must be able, for example, to tell the precise second when Vulcan, in his progress across the sun's disc, touches the border. He listens to the beats of a pendulum, counting them all the time, and he must be able to note the second that coincides with the instant of contact; nay, more, it may happen that the contact takes place between two successive beats; and, in that case, he must be able to estimate to the tenth of a second. Leverrier interrogates, still maintaining the grand attitude of the lion, "Where is your chronometer, sir?" "My chronometer! I have only this minute watch, the faithful companion of all my professional visits." "What! with that old watch, marking only minutes, do you dare to speak of estimating seconds? I fear my suspicions are too well founded." The doctor shewed to his satisfaction how he accomplished the object. With the aid of a ball hung by a silk thread, and swinging seconds, combined with the counting of his

pulse while observing, he attained the requisite accuracy. It is the mark of genius to obtain valuable results by imperfect instruments. We know what good service has been rendered to chemical science by blacking pots in the hands of a Priestly.

The next point was the telescope. Was it good enough to see the small black point? Here Lescarbault spoke with more confidence. He had, after great privation and suffering, saved enough to buy a lens. The optician, seeing his enthusiasm and poverty, gave it cheap. He made the tube himself, and all the fittings necessary to mount it properly. He, then, went into some technical details, to explain how, by means of threads stretched across the focus of the telescope, he was able to measure distances on the sun's disc.

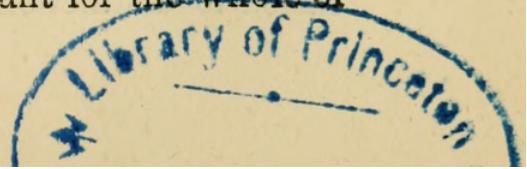
Leverrier being thoroughly satisfied as to the means of making the observation, next turned to the observation itself. It might be, after all, a fabrication, such things being known in the history of astronomy. He, therefore, demanded the original jotting of the observation, to see if it tallied with the deduced statement. Lescarbault now got somewhat alarmed, as he was in the habit of burning the scraps of paper on which he had jotted down his observations, after he had fairly entered them. He, however, rummaged every corner, and at last found the scrap in his nautical almanac, serving as a book-mark. Leverrier seized it eagerly. It was a square powder-paper,

which had seen some service in the shop, being spotted with grease and laudanum. An apparent discrepancy was at once detected. The figures did not quite coincide with the deduced observation which had been transmitted to him. Lescarbault met this difficulty with ease, as he shewed that, in the reduced observation, there was an allowance made for the clock error.

He was next asked, if he had made any attempt to calculate the distance of the planet from the sun. His answer was that he was no mathematician, that he had been long trying to come to a definite result, and that one motive in delaying his discovery, was his wish to be able to announce the distance and the period of revolution, at the same time that he announced the discovery. "You must send me the rough draught of these calculations." "My rough draught! Your request embarrasses me much. Paper is a scarce article with me. I am somewhat of a carpenter as well as astronomer, and I make all my calculations in my workshop. I write with chalk upon the boards which I am using, and I have to plane the boards over again, when I wish to use the surface for new calculations. I fear that I have obliterated the calculations in question; but come and see." They descended to the ground-floor, and, happily, the calculations were still traceable. The carpenter's board formed the climax of the investigation. Leverrier could no longer resist the evidence.

"The time had now come," says the Abbé Moigno, "for the lion to soften down, and to give heart to the trembling lamb. Leverrier did this with perfect grace—with a dignity full of kindness. M. Lescarbault felt the blood rushing to his heart; he breathed with difficulty when the Director of the Imperial Observatory expressed his perfect satisfaction, and gave him the most cordial congratulations." Leverrier, as he meditated something generous, was anxious to obtain some information about the general character of the discoverer. He therefore called on the village authorities, who all united in describing him as a skilful and laborious practitioner, and a most benevolent and pious man. He lost no time in publishing the discovery to the world, and representing his claims to the Emperor. The result is, that the village-doctor is now decorated with the order of the Legion of Honour.

From the observations of Lescarbault, it follows that the distance of Vulcan from the sun is about half that of Mercury. The time of revolution is 19 days 17 hours, which is about four times less than Mercury's period of revolution. M. Lescarbault saw Mercury pass across the disc of the sun in 1845, and, from his recollection, he would estimate the apparent diameter of Vulcan as four times less than that of Mercury. This would make Mercury seventeen times larger than Vulcan. A planet of this size, unless the density is excessive, does not account for the whole of



the observed perturbation, so that it is likely other planets will yet be discovered on the sun's disc.

The black spot, produced by a planet coming between us and the sun, can readily be distinguished from the dark spots on the sun itself, which can often be seen by the naked eye. The planet's motion is much more rapid. Vulcan's time of passage was only 1 hour 17 minutes. As the sun takes twenty-five days to rotate on his axis, the solar spots are seen usually for days together before they disappear. The planetary spot is perfectly round and sharp; the solar, is usually of an irregular form, and shaded. The planetary spot does not change its form in passing across the disc; it is otherwise with the solar spots. In the case of the latter, the black central spot is the bottom of a deep pit, and the shaded parts are the shelving sides. When the spot is in the centre of the disc, you are looking straight down, and if it is circular you see it perfectly round; but when it moves to the side, the circle, from the change of perspective, becomes an oval. Solar spots are usually near the equator of the sun; planets may be seen at any distance from it. Besides these, there are other points of difference which render it impossible to mistake a solar spot for a planet.

The last news from Paris, is that the medical practitioners, there, have been attempting to spoil their unassuming brother, who has been thus suddenly raised to distinction. They invited him to a grand

banquet in the Hotel du Louvre. His reply shews that he is a man of great good sense, as well as an enthusiastic astronomer:—"I beg to express my most grateful acknowledgment for the flattering invitation which you have sent to me. I am far from being worthy of such a testimony. I am not a savant, as you appear to believe. The honourable offer of a banquet, which you have made me, does not accord with the habits of my simple and retired life; besides, I have received similar offers from our brethren of Chartres and Blois, which I have declined. The duties of our profession do not admit of such frequent absences; and I have not the facilities which you enjoy of securing a substitute to wait on my dear patients. I earnestly hope that you may take no offence by my thus declining the invitation."

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