

SATURN

IT is to be hoped that Continental observers may have been more favoured than ourselves with opportunities of scrutinising that grand display which has been for some time presented to us by this, the most wonderful of all the solar train. For more than one reason the almost unbroken persistence of that vaporous shroud which has long been investing our unfortunate sky is matter of especial regret. The broad development of that system in all its equally strange and beautiful detail;—its lofty culmination in our midnight heaven;—the probability that many who might look upon it now may never witness its return to a similar position of advantage—all find their place in the account. We can only now look for intelligence from other quarters, and hope that something more cheering may yet be in store for ourselves, before the advancing twilight steals away our opportunities; and that possibly, before these remarks meet the public eye, a change may have supervened to gladden the heart of the British observer.

Few of us, probably, would be likely to express ourselves as an individual once did, who, having for the first time seen Saturn through a good telescope, turned hastily away with a fervent aspiration that he might never see such a sight as that again! But the feeling that broke out in so grotesque a fashion is not altogether unintelligible. Many objects are more imposing in magnitude or brilliancy: none rival it in the impression of surprise. It is absolutely unique. Nothing else resembles it or approaches it in the whole visible creation. But this is not all. Our first impression of astonishment will be succeeded by the demands of a legitimate curiosity, and we shall begin to gaze upon that most charming combination of elegant outline and varied shading, not merely as a subject of admiration, but of close and careful study: we shall naturally inquire how far we understand what we are permitted to see, and how far that great mystery has been penetrated by the modern unrivalled extension of optical power. And here we may feel some disappointment when we are forced to admit that little corresponding advance in knowledge has waited on the increased means of investigation. There was an early dawn of hope and promise after the elder Herschel had shown what telescopes could do. Dawes, Lassell, Bond, De la Rue, Struve, not to mention others, at once overleaped all previous barriers, and showed how full that marvellous whole is, of not less surprising detail. But it is not encouraging to note how little progress, comparatively speaking, has been made of later years. With advantages so incontestably superior, what have we detected, on the whole, more than what passed before the attention of a previous generation? Take, for instance, the beautiful designs of De la Rue in 1852 and 1856; or the elaborate memoir of the observers at Harvard, published in 1857. What material progress have we to boast of? What further light have the same instruments, or others of greater power, thrown on the minute subdivisions of the rings, or the abnormal and inexplicable outlines of the shadow of the globe? On the contrary, with the exception of the radial streaks or notches figured by Trouvelot, the existence of which seems incompatible with the received idea as to the structure and rotation of the rings, how little can be mentioned, traces of which, to say the least, cannot be found even in very early records! The brilliant spot detected by Hall seems to have been in some measure anticipated, notwithstanding the inferiority of their instruments, by Cassini and Fatio nearly 200 years previously. The dusky markings on the ball appear in the rough designs of the elder Herschel, who also noted, for about a week in 1780, a division, possibly not since seen, near the inner edge of one ansa only of the broad ring. The curious striations of the outer ring shown, among others, by the beautiful object-glass at Nice, date back to

the $6\frac{1}{4}$ -inch reflector of Kater in 1825, if not to an earlier instrument of Short's; while their existence is now unaccountably ignored by the gigantic achromatics of Chicago, Princetown, and Washington; and other details might be specified, described in earlier days, but not corroborated or referred to now. This is certainly not what might have been expected; nor is it easy to assign its cause. Instrumental imperfection cannot be alleged: some minute dark markings might possibly be obliterated in telescopes which give large spurious disks; but this idea is incompatible with the separation of extremely close stars which the modern instruments effect. Irradiation cannot be supposed to affect perceptibly light of so little intensity as that of Saturn. As far as atmosphere is concerned, we in England might claim many an excuse for failure; yet Dawes and De la Rue and others would point to results unsurpassed elsewhere, and with no more efficient instrument than a $9\frac{3}{8}$ -inch mirror by With I have repeatedly seen Encke's division, while it is imperceptible with far superior means in the purer American sky. "Personal equation" might be credited with a share in the discrepancies—as, for instance, when on one occasion I missed Enceladus but caught Encke's hair-line at the very time when the reverse was affirmed by the well-trained eye of a friend; but this would be far from covering the whole amount of difference. It remains, therefore, to be seen whether any further advance can be made by sharper, or more widely diffused, or more persistent scrutiny. We wait for further intelligence. We have not heard how far the most remarkable investigations of Bond and his associates at Harvard have been substantiated by the same instrument in the hands of their successors. Something might be looked for at Greenwich from the ready comparison of the workmanship of Merz and Lassell. Few tidings have reached us from the acute research of Schiaparelli; no results from the splendid Roman sky. A greater mass of evidence might be brought to bear upon debatable points, and, in the present state of science, may reasonably be expected.

But even in an improved position as to information we might find a difficulty in interpreting discordant evidence, and deducing from it a consistent conclusion. At present we may incline to the idea that we must take refuge in an actual change of dimensions, or position, or brightness in some of the details. But, even if this would explain more than it will do, we are at a loss as to the possible cause of such changes.

The great difficulty which confronts us is our entire ignorance of the real nature of our object. A certain degree of previous acquaintance with what is before us may in some cases tend to preoccupy the judgment, but in others it assists in clearing the way. We are seldom puzzled in interpreting the aspect of the moon, because we are persuaded of its general solidity and fixity. But what is it that we gaze upon in Saturn? Analogy, often so valuable an assistant, breaks down here. A magnificent globe is set before us, but how little can we guess its constitution! One step would be gained if its density at all resembled our own; but there we are thrown out at once. We simply cannot imagine a state of things so utterly unlike our own experience, or draw any reliable conclusions from what we see. We may safely infer that the surface of the globe is chiefly shrouded in vapour in which currents ascend or descend according to their temperature, and are swept by different times of rotation into longitudinal streaks. And we may further suppose that the atmosphere is of no great comparative depth from the occasional presence of less uniform variations in form and shading, such as would not be compatible with any great difference of velocity between the highest and lowest strata. But as to what may lie beneath, not a conjecture is available; nor do we know that it is ever exposed to the eye. We may assume that the globe is warmer than surrounding space or such alternating currents would not

be generated. And, further, since we are favoured with such a view of the polar regions as we can never obtain on Jupiter, we may conjecture that the internal heat is not great, or it would tend, by equalising the temperature of the whole globe, to remove that difference of tint which has been often remarked between the polar and more temperate zones. But these are but guesses, and as such they must remain.

Then, as to the complex ring. Its constitution may be deduced, within certain limits, from theoretical considerations; but it is beyond the power of observation to confirm it. Especially as to the aspect of the dusky veil, if we

accept the varied tints that have been ascribed to it in opposite ansæ, it can hardly be said to correspond with the idea of a thinly scattered stream of separate luminous masses, and is still less capable—some would say incapable—of such an explanation where it is projected upon the ball. The brighter ring gives no indication of its structure, while showing from time to time marked variations in the relative light of its parts; and of the period of its rotation—*pace* Sir W. Herschel—there is no evidence at all. Some observers have thought the great division dusky, rather than black as it shows itself to others, and the whole system of markings is stated to be occasionally

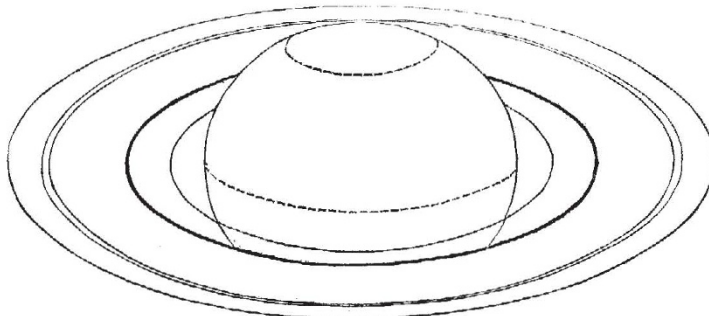


FIG. 1.

unsymmetrical on the opposite sides of the planet—a very perplexing anomaly; for the only conceivable cause—a perturbing influence of the satellites—must be too feeble to have any perceptible effect, even were they not all drawing in different directions.

This claims to be nothing more than a hasty and incomplete notice of a subject of admitted difficulty. Questions like these might easily be multiplied, especially if we took into account such as arise at the time of the edgewise presentation of the ring, its irregularity of illumination, the probable want of parallelism between the axis of the ring-system and that of the globe, the alleged

“square-shouldered” outline, and similar peculiarities. Nor has allusion been made to spectroscopic examination, which is stated to have detected the presence of atmospheric bands and those of aqueous vapour, and may possibly, as in the case of the sun, lead to results beyond the bounds of telescopic research. If what has now been said may serve to stimulate further and closer and more systematic inquiry into this wonderful exhibition of creative power, its purpose will have been attained.

T. W. WEBB

P.S.—May I be allowed to add that since the foregoing paper has been in the printer's hands, the kindness

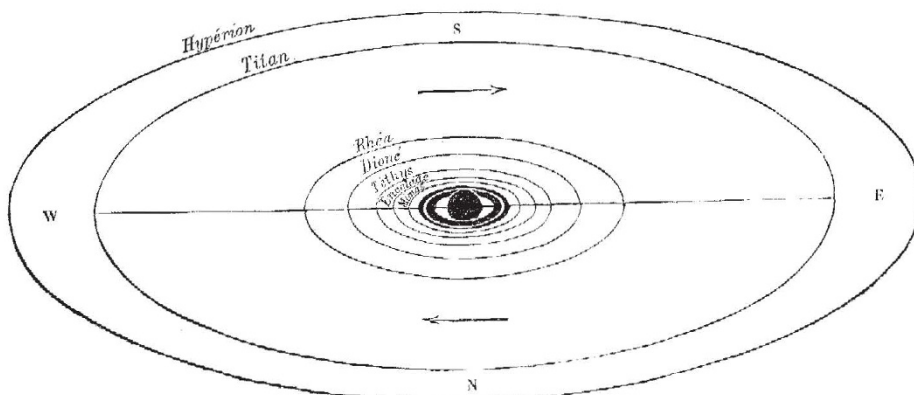


FIG. 2.

of M. Trouvelot has put me in possession of his very important observations of a recent date, proving that, as far as he is personally concerned, there is no foundation for the remarks which I have ventured to make as to our comparative deficiency in progress. His careful and multiplied observations from 1877 to 1884 have led him to the conclusion that many anomalies, not otherwise to be accounted for, must be due to actual variations in the physical structure of the system. It would be a great satisfaction to find that other observatories are likely to prove as fruitful in valuable results as that of Meudon.

I am permitted by the kindness of M. Flammarion to illustrate the present article by two very effective woodcuts, which have appeared in his valuable and interesting periodical, *L'Astronomie*, of which he is now publishing an improved continuation. The first exhibits the existing presentation of the ring system in its fullest possible development; the second, the corresponding projection of the paths of the satellites, in which, however, on account of its great extent, the orbit of the outermost, Japetus, is unavoidably omitted.

T. W. W.