ASTRONOMY:

A SIMPLE INTRODUCTION TO A NOBLE SCIENCE.

BY

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already described, and at present they present few features of interest except in regard to what further information may be learnt about the solar corona ; and it is doubtful whether this appendage to the sun should not be properly dealt with in the section of Intra-Mercurial Planets, under which head of course comes the search for these bodies, which can only be satisfactorily pursued during the course of a total solar eclipse. During every year there are at least two eclipses of the sun, and there may be as many as five in the one year ; but the number visible from any one place on the earth is much smaller, and many years may elapse before a second total eclipse is visible at any given place. This is from the fact that a solar eclipse is never total over an entire hemisphere of the earth, but as a rule is only total over a narrow belt about one hundred miles in width, although it may be visible as a partial eclipse over a far wider area. It will not be for very many years that another total solar eclipse will be visible in England, or even an annular eclipse.

Eclipses.

CHAPTER XIII.

INTRA-MERCURIAL PLANETS.

Suspected Existence of Intra-Mercurial Planets—Their probable Nature—Supposed Observations of Intra-Mercurial Planets—Certainly not such Planets—Vulcan—Probable Nature—Zone of Intra-Mercurial Planets—Supposed Observations of these Planets.

WHEN Leverrier, the famous French astronomer, had completed the first portion of his investigation of the motion of the planets, he found that he could not account for the observed motion of the perihelion of the planet **Mercury** unless he assumed the existence within its orbit of some unknown body or bodies having a mass amounting in the aggregate to nearly that of Mercury itself. Leverrier considered, therefore, that it was certain that there existed within the orbit of Mercury yet another planet or planets, or else a ring of small minor planets similar in size and character to the great belt of such bodies which exists between Jupiter and Mars.

Suspected existence of intra-Mercurial planets.

Which of these is the more probable? The question can now be answered with much greater certainty than it could be a quarter of a century ago, when it was first propounded.

If there be such a planet or planets, there are three ways in which it might be detected. Firstly, in the same way as the planet Mercury itself can be found—by watching the neighbourhood of the sun; when, if the planet were anything like half the size of Mercury, it could be detected, as it would shine with much greater intrinsic brightness, owing to its nearer proximity to the sun. Secondly, even if too small to be thus seen, during a solar eclipse the solar glare disappears, and stars of even the second magnitude can be seen quite close to the sun, whilst the planet Mercury shines forth most conspicuously even to the

Their probable nature.

naked eye. Any intra-Mercurial planet large enough to shine like a first or even second magnitude star might be at once detected in this manner. Thirdly, it might be seen when in transit across the solar disc, and as the planet would be much closer to the sun than Mercury, it would be far oftener observed in transit—probably at least once in every other year. Owing to the irradiation or the encroachment of the bright light of the sun upon the dark body of the planet, when seen in transit across the sun a planet is diminished in apparent diameter by over 2″ of arc, so that it would look smaller than its real dimensions, and so much less conspicuous than might otherwise be anticipated. If, however, the planet were 2000 miles in diameter when it crossed the solar disc, its real diameter would be about 5″, so that it would appear like a small circular black spot some 3″ in diameter. It is not likely that such a spot could repeatedly cross the sun without being detected in transit.

If there were one such planet, it could not have a mass even half as great as that required by Leverrier's theory unless its diameter was equal to 2500 miles. Such a body would shine like a star of the first magnitude, and when it crossed the solar disc would appear like a spot over 4″ in diameter, whilst it would be visible at elongation as a beautiful exceedingly brilliant crescent some 7″ in greatest diameter. A planet of this kind could not have escaped detection, and a very careful search has been made for it without result.

Here, however, it is necessary to notice some remarkable observations which have been made, and which have led to the frequent suspicion of the existence of such an intra-Mercurial planet. These observations consist of a number of instances, more or less well authenticated, where small dark circular spots have been seen to cross the whole or part of the solar disc, as if they were intra-Mercurial planets in transit.

Supposed observations of intra-Mercurial planets.

On November 19th, 1762, Lichtenberg, a young German astronomer, observed a large round spot upon the sun, and noticed its egress after having traversed a chord of some 70°. On March 29th, 1800, and February 7th and October 10th, 1802, Fritsch, another German astronomer, observed spots on the solar surface which moved in so exceptional a manner that it was supposed that they might be planets *in transitu*. On January 6th, 1818, a Mr. Capel Lofft and two others saw a small black spot move regularly across the sun, it disappearing shortly before sunrise. On July 12th, 1837, De Vico at Rome made a similar observation; and on October 2nd, 1839, Decuppio at the same observatory yet another. Similar observations were made by Scott and Wray in the summer of 1847; by Sidebotham and Lowe on March 12th, 1849; by Ohrt on September 12th, 1857; by Russell and others on January 29th, 1860; and by Lummis on March 20th, 1862.

All these observations seem to have been instances of round dark spots of nearly the apparent size of Mercury when in transit, or from 8″ to 15″ in diameter, so that they would indicate the existence of a planet from 4000 to 7000 miles in diameter. Such a planet would shine nearly as bright as Venus, and would be so distinct, especially during solar eclipses, that had it existed it must long

ere this have been detected. Either, then, these observers very much exaggerated the dimensions of the object they saw, or it was not a planet in transit. If they were not deceived in thinking the bodies actually moved as they described them, then their observations would seem most perplexing. They might be comets, they might be gigantic meteors moving quite close to the earth, and in the same direction, with nearly the same velocity; but it is certain that they were not intramercurial planets.

Certainly not such planets.

There is, however, one of these observations which stands out from the rest. Shortly after Leverrier had announced his theoretical conclusions, a Dr. Lescarbault, a French amateur observer, sent him an account of an observation of the transit across the sun of a body which he regarded as that of an intra-Mercurial planet. On March 26th, 1859, Lescarbault saw a small circular black spot, about 3″ in diameter, cross part of the solar disc, and egress from the sun at a determined time. Leverrier made an elaborate inquiry into this observation, and soon satisfied himself that it was genuine. Employing the data furnished by the Doctor's observations, he deduced the distance and elements of the orbit of the supposed new planet, which was named *Vulcan*. Arrangements were made to watch for it at the epochs of its next transits. Yet, though repeated searches have been made for it, this planet Vulcan has never been seen again. From Lescarbault's description, the real diameter of this planet must be about 1800 miles, so that it would under favourable circumstances shine like a star of the first magnitude; yet it has never been seen near the sun at the time of solar eclipses, though often looked for. It would seem, therefore, that either Lescarbault over-estimated the size of the body, or else it falls into the same category as the preceding observations.

Vulcan.

It may be regarded as certain that if such intra-Mercurial planets really exist, their actual diameter does not exceed 1500 miles, and is probably not greater than 1000 miles. Such bodies would, under favourable conditions, shine like stars of the second or third magnitude, and show bright little crescents about 3″ to 4″ in diameter, but when in transit across the sun they would be diminished by irradiation to tiny circular black points scarcely 1″ in diameter. They would thus be very difficult to detect *in transitu*, and would not be easy to discover except with a telescope even at the time of solar eclipses. Were their diameter less than 1000 miles, they would scarcely be visible in crossing the solar disc, and could only be detected with considerable trouble even during a total eclipse of the sun.

Probable nature.

If, then, there existed a ring of minor planets, in size and number resembling the great group which move round the sun in orbits lying between those of Mars and Jupiter, they would be too small to be detected when crossing the sun, and would be exceedingly hard to see even during solar eclipses, for the diameter of the largest of the minor planets does not probably exceed 500 miles, and most are much smaller. Leverrier's theoretical investigations would lead us to believe in the existence of such a belt, and if subsequent investigators confirm them,

Zone of intra-Mercurial minor planets.

this belief will be much strengthened. It is true that a portion of the mass may exist in the form of the numerous meteor streams known to move round the sun, and which for a considerable portion of their paths are within the orbit of the planet Mercury; but these cannot explain more than a small portion of the required mass, or they would disturb Venus as well as Mercury.

But of late observations have been made which, whilst tending to confirm the supposed existence of a belt of minor planets within the orbit of Mercury, would also tend to show that some members of this group are much larger than the corresponding *ultra-Martial* system. During the solar eclipse of 1878, Professor Watson, an American astronomer of considerable eminence, observed one or two brilliant star-like bodies near the sun, in places where no such stars are known to be. These bodies shone even in the glare as stars of the fourth magnitude, and appeared with rounded discs 3″ or 4″ in diameter. Their real dimensions would thus appear to be from 800 to 1000 miles in diameter, or practically twice the size of the largest known minor planet. Some uncertainty still attaches to these observations, for at some little distance away there were a pair of stars which might correspond to the objects seen by Professor Watson, if he had made some error in marking the position of the bodies seen by him, and had somewhat over-estimated their brightness.

Supposed observations of these planets.

Further opportunities must be awaited before this very interesting question can be settled.

CHAPTER XIV.

MERCURY AND VENUS.

Mercury—Size and Appearance—Transits of Mercury—Venus—Physical Condition—Markings—Transits.

MERCURY.—This planet, from its proximity to the sun, is only occasionally well placed for observation, so that the amount of information possessed by astronomers as to its appearance and physical condition is very meagre. It is a spherical planet 3000 miles in diameter, with a mass of about 1 ÷ 5,000,000 of that of the sun, so that in density it is about equal to the earth. It is surrounded by an atmosphere of considerable density and thickness, so that it is probable that astronomers never see the real surface of the planet, but only the upper cloud-layers. When carefully scrutinised with large telescopes, Mercury appears like a golden white disc, which takes all the phases of the moon, varying in appearance from a minute little disc 5″ in diameter, to a bright quadrant 7·5″ in diameter when near its greatest elongation from the sun, and thence to a brilliant little crescent nearly 12″ in diameter when approaching inferior conjunction. The real diameter of Mercury, when seen at the same distance as the sun from the earth, appears to

Size and appearance.