A TEXT-BOOK

OF

GENERAL ASTRONOMY

FOR

COLLEGES AND SCIENTIFIC SCHOOLS.

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matter which at present forms the planets was once distributed in *rings*, like the rings of Saturn. If so, this ring next outside of Mars would necessarily suffer violent perturbations from the nearness of the enormous planet Jupiter, and so would be under very different conditions from any of the other rings. This, as Peirce has shown, might account for its breaking up into many fragments.

The other view is that a planet about the size of Mars has broken to pieces. It is true, as has been often urged, that this theory in its original form, as presented by Olbers, cannot be correct. No *single* explosion of a planet could give rise to the present assemblage of orbits, nor is it possible that even the perturbations of Jupiter could have converted a set of orbits originally all crossing at one point (the point of explosion) into the present tangle. The smaller orbits are so small that however turned about they lie wholly inside the larger, and cannot be made to intersect them. If, however, we admit a *series* of explosions, this difficulty is removed; and if we grant an explosion at all, there seems to be nothing improbable in the hypothesis that the fragments formed by the bursting of the parent mass would carry away within themselves the same forces and reactions which caused the original bursting; so that they themselves would be likely enough to explode at some time in their later history.

At present opinion is divided between these two theories.

601. The number of these bodies already known is so great, and the prospect for the future is so indefinite, that astronomers are at their wits' end how to take care of this numerous family. To compute the orbit and ephemeris of one of these little rocks is more laborious (on account of the great perturbations produced by Jupiter) than to do the same for one of the major planets; and to keep track of such a minute body by observation is far more difficult. Until recently, the German Jahrbuch has been publishing the ephemerides of such as came within the range of observation each year; but this cannot be kept up much longer, and the probability is that hereafter only the larger ones, or those which present some remarkable peculiarity in their orbits, will be followed up. One little family of them, however, is "endowed." Professor Watson, at his death, left a fund to the American National Academy of Sciences to bear the expense of taking care of the twenty-two which he discovered.

INTRA-MERCURIAL PLANETS AND THE ZODIACAL LIGHT.

It is very probable, indeed almost certain, that there are masses of matter revolving around the sun within the orbit of Mercury.

602. Motion of the Perihelion of Mercury's Orbit. — Leverrier, in 1859, from a discussion of all the observed transits of Mercury, found that the perihelion of its orbit has a movement of nearly 38″ a century. This is more than can be accounted for by the action of the known planets, and, *so far as known*, could be explained only by the attraction of a planet, or ring of small planets, revolving inside this orbit nearly in its plane, with a mass about half as great as that of Mercury itself.

We say "*so far as known*," because an alternative hypothesis has been proposed, viz., that the law of gravitation, though *strictly true for bodies at rest* is not absolutely so *for bodies in motion;* that when bodies are moving towards each other the attraction is less by a minute fraction than if they were at rest. The hypothesis is known as the *electro-dynamic theory of gravitation*, but has at present very little to support it. If, however, it were true, then the peculiar motion of the apsides of Mercury's orbit would be a necessary consequence.

Subsequent investigations by a number of mathematicians have fully confirmed Leverrier's results; Mercury's orbit is beyond question affected as it would be if there were an intra-Mercurial planet, or a number of them.

603. Dr. Lescarbault's Observation: Vulcan. — A certain country physician, living some eighty miles from Paris, Dr. Lescarbault, on the publication of Leverrier's result, announced that he had actually seen this planet crossing the sun nine months before, on the 26th of March of that year, 1859. He was visited by Leverrier, who became satisfied of the genuineness of his observations, and the doctor was duly congratulated and honored as the discoverer of "Vulcan," which name was assigned to the supposed new planet. An interesting account of the matter may be found in Chambers' "Descriptive Astronomy"; and in many of the works published from twenty to twenty-five years ago, as well as in some more recent ones, "Vulcan" is assigned a place in the solar system, with a distance of about 13,000000 miles and a period of 19+ days. Lescarbault described it as having an apparent diameter of about 7″, which would make it over 2500 miles in diameter.

604. Nevertheless, it is nearly certain that Vulcan does not exist. There are various opinions which we need not here discuss as to the explanation of this pseudo-discovery. But the planet, if real, ought since 1859 to have been visible on the sun's face at certain definite times which Leverrier calculated and published; and it has never been seen, though very carefully looked for. Small, round, dark objects have from time to

time been indeed reported on the sun's disc, which in the opinion of the observers at the time were not sun spots; but most of these observations were made by amateurs with comparatively little experience, with small telescopes, and with no measuring apparatus by which they could certainly determine whether or not the spot seen moved like a planet. In most of these cases photographs or simultaneous observations made elsewhere by astronomers of established reputation, and having adequate apparatus, have proved that the problematical "dots" were really nothing but ordinary small sun spots, and the probability is that the same explanation applies to the rest.

605. Eclipse Observations. — A planet large enough to be seen distinctly on the sun by a 2½-inch telescope, such as Lescarbault used, would be a conspicuous object at the time of a solar eclipse, and most careful search has been made for the planet on such occasions; but so far, although *stars* of the third and fourth magnitudes, and even of the fifth, have been clearly seen by the observers within a few degrees of the eclipsed sun, no planet has been found.

One apparent exception occurred in 1878. During the eclipse of that year, Professor Watson observed two starlike objects (of the fourth magnitude), which he thought at the time could not be identified with any known stars consistently with his observations. Mr. Swift, also, at the same eclipse, reported the observations of two bright points very near the sun; but these from his statement could not (both) have been identical with Watson's stars. Later investigations of Dr. Peters have shown that the assumption of a very small and very likely error in Professor Watson's circle-readings (which were got in a very ingenious, but rather rough way, without the use of graduations) would enable his stars to be identified with θ and ζ Cancri, and it is almost certain that these were the stars he saw. Mr. Swift's observations remain unexplained. With this exception, the eclipse observations all give negative results, and astronomers generally are now disposed to consider the "Vulcan question" as settled definitely and adversely.

606. At the same time it is extremely probable that there are a number, and perhaps a very great number, of *intra-Mercurial asteroids*. A body two hundred miles in diameter near the sun would have an angular diameter of only about $\frac{1}{2}''$, as seen from the earth, and would not be easily visible on the sun's disc, except with very large telescopes. It would not be at all likely to be picked up accidentally. Objects with a diameter of not more than forty or fifty miles would be almost sure to escape observation, either at a transit or during a solar eclipse.