CLASSICS OF SCIENCE: Huygens Explains Saturn's Ring

Astronomy

During the fifty years since Galileo had first called attention to the new beauties of the planets revealed by the telescope, the leading puzzle of the heavens was the succession of strange shapes assumed by Saturn. Huygens solved the problem with a more powerful telescope plus the exercise of his clear, common-sense imagination, to the confusion of his predecessors' wild theories illustrated below.

Cristiani Hvgenii SYSTEMA SATURNIVM, sive De causis mirandorum Satvrni Phaenomenon, Et Comite ejus Planeta Novo. Hagae-Comitis, M.DC.LIX (1659). *Translated for the* SCIENCE NEWS-LETTER *by Helen M. Davis.*

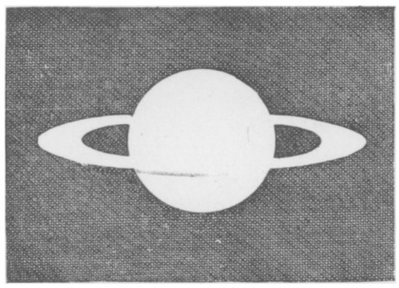
The Moon of Saturn

So on the day, according to the Gregorian Calendar the 25th of March, in the year 1655, about 8 o'clock in the evening, I saw Saturn with arms extended on both sides in a straight line; and pointing toward a little star *a* only a little distance from it toward the west, so placed that a line drawn through the extended arms would meet it, or at least would pass below it by a very small space. And on the other side, toward the east, was a little star *b*, slightly farther removed from Saturn, and much lower than the line of the arms. From this I at once suspected the star *a* of being a companion of Saturn, since it attended it closely and was almost in the same position.

Moreover the straight arms of Saturn were seen far extended, but the line at the extreme tips was a little thicker than at the place where they join the disc of Saturn, as the drawings show.

These forms persisted continuously until the setting of Saturn with the Sun. Similarly, after the other round phase of the year 1656 the arms reappeared with their form reversed, as it appeared through the 12-ft. telescope; then using the larger tube of 23 feet it was plain that this is the true figure; whence it was possible to believe that which formerly had seemed true, although through the smaller telescope it was impossible to see perfectly. But I noted, as with the 12-ft.. telescope, that faint line joining the extended arms and yet wholly separated from them below.

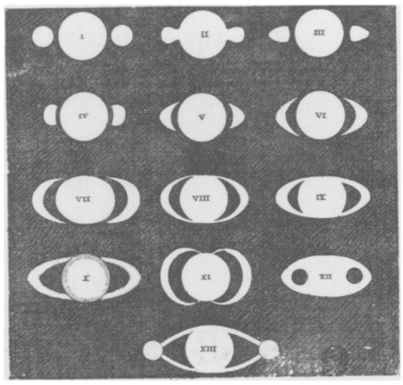
On the day following, namely the 26th of March, the star *a* in the same way as before was located a short distance from Saturn, while *b* was still further off than before. Whence, the distance between the little stars having become greater, it follows that either one or the other must be moving. And I judged this to be necessarily the star *a,* because Saturn at that time had begun to retrograde; and so it ought to be carried down in the same plane with Saturn, and ought to become much nearer it. In fact nothing opposed the belief that the other *b* was as I had judged a fixed star, on the other hand it was, as I estimated, unchanging, since Saturn had in one day withdrawn from it by so much as its motion demanded. Nor in truth have subsequent observations shown it otherwise.



SATURN'S RING as Huygens saw it

The Ring

When therefore I discovered that the new planet revolves around Saturn in a period of 16 days, I was persuaded that Saturn itself rotates about its own axis without doubt in a less space of time. For before that I had always believed that the other primary planets agree with our Earth in this, that each rotates about itself, so that its whole surface through this alternation rejoices in the light of the Sun. Furthermore in the universe among bodies to be compared in size with the earth, when the smaller are carried around by them, those in the center rotate in less time. So indeed its spots tell us that the sun makes its revolution in 26 days: around the sun each of the planets, among which the earth is placed, according as each is further removed, takes its course more slowly. Again the Earth turns daily through this space, while the Moon goes around with a monthly motion. Moreover the four lesser moons, so to speak, of Jupiter go around the planet according to the law that those which are nearer run their course faster. Whence Jupiter which is believed to rotate in perhaps a shorter time than 24 hours, approaches that of the fastest of its little moons with less than two days. I had known this for a long time, I now judged Saturn to have a similar motion. From the swiftness of period also, the observation of its companion made me sure. The fact that it completes its orbit in 16 days proves that Saturn, placed in the center of its orbit, rotates with greater frequency. Now in truth and from this it seems credible that all the celestial material thrown out between Saturn and its companion might be subject to the same motion, on this condition that the nearer it is to Saturn the more it accelerates in its motion. Whence it follows finally that the appendices or arms of Saturn, whether joined to the globular center of the body and fixed, revolving at the same time with it, or, separate with an interval between, must necessarily have a period not much slower.



AS SATURN LOOKED to earlier observers

Furthermore the shape of the arms, while I was troubled in mind about their motion, appeared just as was seen in the former observations in the year 1655. Namely, the body of Saturn was perfectly round, with arms truly on both sides, extending in the same direction in a straight line as if the axis were stuck through the middle of the planet, whereupon I used the 12-ft. tube, by which the extreme tips were shown a little thicker and clearer, where they joined the middle of the sphere, as shown in the first appearance. But when this same spectacle presented itself daily, I thought that in no other way could it be, so short was its revolution compared to Saturn's and to that of its companion, unless the globe of Saturn be girdled around equally on every side and so have a ring which surrounds it in the middle. Hence of course it will quickly revolve, keeping the same face al- (*Turn to next page*)

Saturn—*Continued*

ways toward us, if only the axis be perpendicular to the plane of the ring.

And thus the cause of the phase which persisted at that time established itself. Therefore I immediately began to ponder those appearances offered yearly by Saturn, as to whether they could be considered rings. This indeed succeeded rapidly from study, through frequent observations, of the arms of Saturn obliquely to the ecliptic. For when I ascertained the straight line in which they extend not to follow the path of the ecliptic, but to cut it at an angle greater than 20 degrees, I determined at once that the plane of the ring which I had imagined was inclined by about such an angle to the plane of the ecliptic. At a perpetual and constant inclination, evidently, in the same way that on our Earth this is known to cut the plane of the equator. Hence it also necessarily followed that the same ring appears to us in diverse aspects, now a very broad ellipse, now the same narrower, and sometimes at last a straight line. Since also handles appear, I thought this to be due to the fact that the ring is not joined to the globe of Saturn, but is removed from it on all sides by a space. From these things so arranged and also the inclination of the ring of which I have spoken being assumed, all the remarkable appearances of Saturn can be referred to them, as will presently be shown. And this is the very hypothesis which I gave out in the year 1656 on the 25th day of March in mixed letters with the observation of the Moon of Saturn.

For the letters were a a a a a a a c c c c c d e e e e e g h i i i i i i i l l l l m m n n n n n n n n o o o o p q r r s t t t t t u u u u u; which placed in the proper place mean this, *Annulo cingitur, tenui, plano, nusquam cohaerente, ad eclipticam inclinato.* [It is girdled by a ring, thin, plane, nowhere attached, inclined to the ecliptic.] The figure of Saturn as observed by others shows indeed that the space placed between the ring and the globe of saturn equals the breadth of the ring itself or even exceeds it, and more certainly afterward the figure as seen by myself: and also the greatest diameter of the ring obtained by this calsulation is to the diameter of Saturn as 9 is to 4. Hence in truth its form must be reckoned such as I have sketched in the figure.