
*An Extract of the Journal Des Scavans. of April 22
st. N. 1686. Giving an account of two new Satel-
lites of Saturn, discovered lately by Mr. Cassini at
the Royal Observatory at Paris.*

THe Variety of wonderful Discoveries, which have been made this Century in the Heavens, since the invention of the *Telescope*, and the great Utility that may possibly be drawn therefrom, for perfecting natural Knowledge, and the Arts necessary to the Commerce and Society of Mankind, has incited Astronomers more strictly to Examine, if there were not yet something considerable, that had not been hitherto perceived.

The diligence of those that have gon before, having left only the most difficult and obscure Objects to discover, these *Satellites* of *Saturn* which are eminently so, by reason of their Smallness and great Distance from the Sun and Earth, have fallen to the share of *Sign. Cassini*; who being furnished with *Telescopes* of an extraordinary length and goodness, has been able to see deeper into the Heavens, than those that have hitherto attempted. *Mr. Hugen*s indeed found out one of them, *viz.* the fourth and biggest about thirty Years since, and made out the Theory of the *Ring* or *Anse* of *Saturn* till then unknown; but it seems there remained yet four others to discover. The middlemost and outermost, or third and fift *Sign. Cassini* discovered in the years 1671, 72 and 73, an account whereof is to be seen at large in Number 92 of these Transactions; the two innermost were reserved to this present time for the same Observer, having now lately gotten yet better *Telescopes*. The account he gives of these Discoverys is as follows.

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The Distance and Period of the first Satellite.

The first or innermost *Satellite* of *Saturn*, by the Observations hitherto made, is never distant from his Ring, above two thirds of the apparent length of the same Ring, which we take for the measure of the distances of these *Satellites*: and it makes one Revolution about him, in one day, 21 hours and 19 minutes. Wherefore in less than two days it makes two Conjunctions with *Saturn*, the one in the upper part of his Orbe, and the other in the lower part; and the Ring taking up the greatest part of the *Diameter* of the *Circle*, wherein this *Satellite* makes its Revolution, these Conjunctions are of a long continuance, in respect of the whole Revolution, it being 8 hours and half in passing the length of the Ring, which at present hides it every day for so long time; and longer too, because it is very hard to be distinguished, when it is very near the Ring.

This happens particularly for these two or three years, when the Position of the Ring, in respect of the Earth, being very Oblique, it appears very narrow; and the *Circle* of this *Satellite's Orb* being nearly in the same plain with it, they appear very close together. In the following years when the Ring and the *Orbs* of these *Satellites* shall be more open, there will be a greater distance in *Latitude* between this *Satellite* and the Ring, and it may be seen both above and below the *Anise*, which at present cannot be.

These Conjunctions of so long duration happening often at the times most proper to observe *Saturn*, have frequently hindered the seeing of this *Satellite*; and particularly before we had found the Rules of its Motion, so as to be able to prepare to observe it, at the times when it was far from its Conjunction. And seeing one Conjunction begins 14 hours after another is finished, and that each lasts 8 hours and half; whenever we hapned to observe after the beginning of a Conjunction, and continued the following days to observe

about the same hour, there would be 9 or 10 days wherein this *Satellite* could not at all be seen, for this only reason : and if the course of the Observation were interrupted by ill Weather or any other cause, it has been above 20 or 22 days before it could be seen again : So it hapned soon after the first discovery thereof, the which has for this cause been incomparably more difficult to make, than any other hitherto made.

The Distance and Period of the second Satellite.

The second or penintime *Satellite* of *Saturn*, according to the Observations hitherto made, is but three quarters of the length of his Ring distant therefrom, and makes his Revolution about him in 2 days, 17 hours and 43 minutes.

There seldome passes a day wherein it is not joynd to *Saturn*, either in the upper or lower part of its *Orb*. The Conjunctions or times wherein it passes the whole length of the Ring, last 8 hours ; and 25 hours after one ends another begins. By reason that at first it could not be distinguished, when it was not at a good distance from the Ring, and before we had found out the Rules of its Motion, to foresee the times proper to observe it, we were several days without seeing it. Afterwards it was discovered one day to the *Eastward*, the next day to the *Westward*, and the third or fourth day at the same hour, it was again in Conjunction with *Saturn* : and so because the first for several days together could not be seen at the same hour, it often hapned that neither the one nor the other was Visible, and when one began to appear, it was uncertain which of the two it was, both of them shewing themselves alternately one day on the *East* side, and the next day on the *West* side.

This distinction was still more difficult, for that the difference of their Elongations is so little, that for the most part the second *Satellite* is found within the limits of the E-

longations of the first, which likewise made it hard to determine their Degressions. It was not without a great number of choise Observations, that it was concluded that the proportion of the digression of the second, to that of the first, counting both from the Center of *Saturn*, is as 22 to 17.

The Rule of the Proportion, that is between the Distances and the times of their Periods.

The time wherein the second *Satellite* makes its Revolution, is to the time wherein the first makes its, is as $24\frac{1}{4}$ to 17, which is a greater Proportion by half a Degree than that of the Distances, viz. 22 to 17. This is that very same Proportion which *Kepler* observes, between the Distances & Periods of the primary *Planets*, and which we have found between the other *Satellites* of *Saturn*, upon our former discovery, and is verified in the *Satellites* of *Jupiter*. There is nothing that better shews the admirable Harmony of the particular Systemes, with the great Systeme of the World.

The Number of the Conjunctions, of these Satellites with Saturn.

Of all the *Satellites* that are, there are no two so near placed to their primary *Planet*, as these two *Satellites* of *Saturn*, and which taken both together make so great a number of Conjunctions with their *Planet* in the same space of time ; for there are in all no less than 653 in a year, whereas the two first *Satellites* of *Jupiter* make, one with another, but 617 ; the first of *Saturn's*, makes its Revolution in 3 hours longer time than the first of *Jupiter's*, but *Saturn's* second has its Period 9 hours and half shorter than *Jupiter's* second *Satellite*.

The Glasses used to make these Discoveries.

The Distance of these two *Planets*, which is almost Infinite in respect of their Magnitude, had kept them yet much longer concealed, if we had not for this purpose made use of Glasses of extraordinary Force. They were first of all seen in *March Anno 1684*, by two excellent Object Glasses of 100 and 136 *feet*, and afterwards by two others of 90 and 70 *feet*, all made by Sigr. *Campani* and sent from *Rome* to the Royal Observatory by the Kings order, after the discovery of the third and fifth *Satellites*, which had been made by others of his Glasses of 47 and 34 *feet*. We made use of them without *Tubes*, by a more simple contrivance than those proposed either before or since. We have since seen all these *Satellites* with that of 34 *feet*, and continued to observe them with Glasses of Mr. *Borelli* of 40 and 70 *feet*, and by those which Mr. *Artouquel* hath lately made, of 80, 155 and 220 *feet*. It was easy for us to see these two *Satellites* by these different sorts of Glasses, after having found the Rules of their Motion, whereby we might with more particular attention look upon the places where they ought to be.

We placed these great Glasses sometimes upon the Observatory, sometimes upon great Masts, sometimes upon the Tower of Wood, which his Majesty has caused to be brought for this purpose from *Marly*, upon the Terrass of the Observatory. Lastly we put them in a *Tube* raised upon a support made like a Ladder with three legs, which had all the success we desired.

After having distinguished these 2 *Satellites* from the fixt Stars, from the other *Satellites* of *Saturn*, and from each other, and found the periods of their Motion, we have established *Epochæ* from Observations, as near as we could to the Conjunctions.

Radices or Epochæ of their Motions.

The first *Satellite* was observed 45 *degrees* distant from its *Perigee*, moving towards the *West*, *March 11th 1686* ft. N. at 10 *h. 40 min.* at night, and returned to the same position on the 14th of *April* at the same *hour*.

The second was 36 *degrees* distant from the *Perigee* to the *West*, the 30th of *March 1686* ft. N. at 8 of the clock in the evening.

A Comparison of the Revolutions of Saturns Satellites with Jupiters.

It were too much at this time, to give all we have observed of the other *Satellites*, but we cannot miss comparing the *Periods* of the *Satellites* of *Saturn* with those of *Jupiter*, after the following manner, by which it appears that the *Satellites* of *Saturn* in the same order, performe their *Revolutions* in less time, than those of *Jupiter*, that answer to them, except the first, as may be seen in this *Table*.

	day	hour	min.
<i>The first Satellite of Jupiter revolves in</i> —	1	18	29
<i>The first Satellite of Saturn in</i> —	1	21	19
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<i>The second of Saturn in</i> —	2	17	43
<i>The second of Jupiter in</i> —	3	13	19
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<i>The third of Saturn in</i> —	4	12	27
<i>The third of Jupiter in</i> —	7	4	0
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<i>The fourth of Saturn in</i> —	15	23	15
<i>The fourth of Jupiter in</i> —	16	18	5
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<i>The fifth of Saturn in</i> —	79	21	0

These are the particulars of the Discovery, whereby the admirable Analogy and Uniformity of the parts of the Universe are most evident, and the Infinite Wisdom and Power of the Creator is demonstrated to the Contemplative. In the Conclusion, the Discoverer considers that the Ancient Astronomers, having translated the Names of their Heroes among the Stars, those Names have continued down to us unchanged, notwithstanding the endeavour of following Ages to alter them ; and that *Galileo*, after their Example, had honoured the House of the *Medici* with the discovery of the *Satellites* of *Jupiter*, made by him under the Protection of *Cosmus II* ; which Stars will be always known by the Name of *Sidera Medicea*. Wherefore he concludes that the *Satellites* of *Saturn*, being much more exalted and more difficult to discover, are not unworthy to bear the Name of *Louis le Grand*, under whose Reign and in whose Observatory the same have been detected, which therefore he calls *Sidera Lodoicea*, not doubting but to have perpetuated the Name of that King, by a Monument much more lasting than those of Brass and Marble, which shall be erected to his Memory.

In our Figure we have omitted the Orbe of the outer *Satellite*, that so the rest might not be crowded, but its distance to that of *Hugenius's*, is as Cube Root of 25 or 2,925 to 1.

Two Astronomical Observations of the Eclipses of the Planet Jupiter, by the Moon in March and April last, made at London.

The *Lipsick Ephemerides* of Mr. *Godfrid Kirck*, giving notice of these Occultations, they were thought of too great consequence to be neglected, if the weather proved fair. The first hapned *March 31th*. at night, and was attended with a most Serene Sky, no Clouds any where appearing, wherefore Mr. *Hook* and *E. Halley* undertook the Observation in
Gresham