CLASSICS OF SCIENCE: The Moons of Jupiter

Astronomy

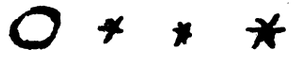
Sidereus Nuncius (The Sidereal Messenger), by Galileo Galilei, Venice, 1610; *Tr. by Edward Stafford Carlos, London,* 1880.

Jupiter's Satellites

On the 7th day of January in the present year, 1610, in the first hour of the following night, when I was viewing the constellations of the heavens through a telescope, the planet Jupiter presented itself to my view, and as I had prepared for myself a very excellent instrument, I noticed a circumstance which I had never been able to notice before, owing to want of power in my other telescope, namely, that three little stars, small but very bright, were near the planet; and although I believed them to belong to the number of the fixed stars, yet they made me somewhat wonder, because they seemed to be arranged exactly in a straight line, parallel to the ecliptic, and to be brighter than the rest of the stars, equal to them in magnitude. The position of them with reference to one another and to Jupiter was as follows:

On the east side there were two stars, and a single one towards the west. The star which was furthest towards the east, and the western star, appeared rather larger than the third.

I scarcely troubled at all about the distance between them and Jupiter, for, as I have already said, at first I believed them to be fixed stars; but when on January 8th, led by some fatality, I turned again to look at the same part of the heavens, I found a very different state of things, for there were three little stars, all west of Jupiter and nearer together than on the previous night, and they were separated from one another by equal intervals, as the accompanying illustration shows.



At this point, although I had not turned my thoughts at all upon the approximation of the stars to one another, yet my surprise began to be excited, how Jupiter could one day be found to the east of all the aforesaid fixed stars when the day before it had been west of two of them; and forthwith I became afraid lest the planet might have moved differently from the calculation of astronomers, and so had passed those stars by its own proper motion. I therefore waited for the next night with the most intense longing, but I was disappointed of my hope, for the sky was covered with clouds in every direction.

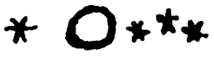
But on January 10th the stars appeared in the following position with regard to Jupiter; there were two only, and both on the east side of Jupiter, the third, as I thought, being hidden by the planet. They were situated just as before, exactly in the same straight line with Jupiter, and along the Zodiac.

When I had seen these phenomena, as I knew that corresponding changes of position could not by any means belong to Jupiter, and as, moreover, I perceived that the stars which I saw had always been the same, for there were no others either in front or behind, within a great distance, along the Zodiac—at length, changing from doubt into surprise, I discovered that the interchange of position which I saw belonged not to Jupiter, but to the stars to which my attention had been drawn, and I thought therefore that they ought to be observed henceforth with more attention and precision.

Accordingly, on January 11th I saw an arrangement of the following kind, namely, only two stars to the east of Jupiter, the nearer of which was distant from Jupiter three times as far as from the star further to the east; and the star furthest to the east was nearly twice as large as the other one; whereas on the previous night they had appeared nearly of equal magnitude. I therefore concluded, and decided unhesitatingly, that there are three stars in the heavens moving about Jupiter, as Venus and Mercury round the Sun; which at length was established as clear as daylight by numerous other subsequent observations. These observations also established that there are not only three, but four, erratic sidereal bodies performing their revolutions round Jupiter, observations of whose changes of position made with more exactness on succeeding nights the following account will supply. I have measured also the intervals between them with the telescope in the manner already explained. Besides this, I have given the times of observation, especially when several were made in the same night, for the revolutions of these planets are so swift that an observer may generally get differences of position every hour.

January 12.—At the first hour of the next night I saw these heavenly bodies arranged in this manner. The satellite furthest to the east was greater than the satellite furthest to the west, but both were very conspicuous and bright; the distance of each one from Jupiter was two minutes. A third satellite, certainly not in view before, began to appear at the third hour; it nearly touched Jupiter on the east side, and was exceedingly small. They were all arranged in the same straight line, along the ecliptic.

January 13.—For the first time four satellites were in view in the following positions with regard to Jupiter.



There were three to the west, and one to the east; they made a straight line nearly, but the middle satellite of those to the west deviated a little from the straight line towards the north. The satellite furthest to the east was at a distance of 2′ from Jupiter; there were intervals of 1′ only between Jupiter and the nearest satellite, and between the satellites themselves, west of Jupiter. All the satellites appeared of the same size, and though small they were very brilliant, and far outshone the fixed stars of the same magnitude.

. . . . . .

These are my observations upon the four Medicean planets, recently discovered for the first time by me; and, although it is not yet permitted me to deduce by calculation from these observations the orbits of these bodies, yet I may be allowed to make some statements, based upon them, well worthy of attention.

And, in the first place, since they are sometimes behind, sometimes before Jupiter, at like distances, and withdraw from this (*Turn to page* 163)

Moons of Jupiter—*Cont'd*

planet towards the east and towards the west only within narrow limits of divergence, and since they accompany this planet alike when its motion is retrograde and direct, it can be a matter of doubt to no one that they perform their revolutions about this planet, while at the same time they all accomplish together orbits of twelve years' length about the center of the world. Moreover, they revolve in unequal circles, which is evidently the conclusion to be drawn from the fact that I have never been permitted to see two satellites in conjunction when their distance from Jupiter was great, whereas near Jupiter two, three, and sometimes all (four) have been found closely packed together. Moreover, it may be detected that the revolutions of the satellites which describe the smallest circles round Jupiter are the most rapid, for the satellites nearest to Jupiter are often to be seen in the east, when the day before they have appeared in the west, and contrariwise. Also the satellite moving in the greatest orbit seems to me, after carefully weighing the occasions of its returning to positions previously noticed, to have a periodic time of half a month. Besides, we have a notable and splendid argument to remove the scruples of those who can talerate the revolution of the planets round the Sun in the Copernican system, yet are so disturbed by the motion of one Moon about the Earth, while both accomplish an orbit of a year's length about the Sun, that they consider that this theory of the constitution of the universe must be upset as impossible; for now we have not only one planet only revolving about another, while both traverse a vast orbit about the Sun, but our sense of sight presents to us four satellites circling about Jupiter, like the Moon about the Earth, while the whole system travels over a mighty orbit about the Sun in the space of twelve years.

Galileo Galilei was born in Pisa, Italy, in 1564 and died in 1642. Besides his invention of the telescope and astronomical discoveries, he constructed the first thermometer and was the first to state the law of falling bodies. When a small boy watching the lamps swinging in the cathedral, he conceived the idea of measuring time by the pendulum, thus laying the foundation for modern clocks. Galileo also first observed that the path of projectiles is a parabola. His theories brought him into conflict with the church and he was tried by the Inquisition. He was released, but lived in seclusion till the end of his life.

Science News-Letter, September 15, 1928

Foolproof Airplane Invented

Aviation

A new airplane that differs radically from previous models, that completely eliminates the possibility of stalling—the constant fear of the pilot of the ordinary plane—and that is as easy to control as an automobile, is one of the first products of the newly organized Daniel Guggenheim School of Aeronautics at the California Institute of Technology, Pasadena. It is being demonstrated at the air meet now in progress at Los Angeles, and has there proved a sensation.

The new plane was the original idea of Albert A. Merrill, who is not a professional airplane builder, although he has been connected with experimental aeronautics since his original association with Octave Chanute in 1891. Though he was told long ago that his idea was worthless, he persevered for more than 15 years, finally to prove its validity.

What first strikes one who sees the plane for the first time is its short stubby tail, which extends only for about four feet in back of the rear cockpit. There is no stabilizer, though there is a large vertical rudder. The wings are staggered, that is, the front of the lower wing is under the middle of the top one. There is a four degree positive decalage, as the aeronautic engineer calls it. This simply means that if the lower wing is horizontal, the upper one slants forward and upward at an angle of four degrees.

But most novel about the wings is the fact that they are not rigidly fastened to the fuselage. The two wings are fastened rigidly together, and pivoted to the fuselage about the rear spar of the upper wing. The result of this design is that the wings are stable in themselves, and not dependent upon the tail surfaces, as in the ordinary plane.

The angle of the wings to the fuselage is controlled by a crank handle by the pilot's side, connected to the wings by a sprocket and chain. This takes the place of the elevator of the ordinary plane. When the pilot wishes to ascend, he merely sets the wings at an angle and forgets about them until he is high enough, then he sets them level, and continues horizontally. If the engine stops, or if the pilot deliberately shuts off the power, the ship glides down along a slant line, but is always horizontal. Under such circumstances the ordinary airplane might stall and go into a tailspin, probably with disastrous results.

Associated with Mr. Merrill in the building of the plane was Dr. A. L. Klein, who did most of the fitting design, and Dr. Clark Millikan, who was responsible for the aerodynamic and primary structure design.

"The ordinary airplane is like an automobile that couldn't be steered if it was running slowly," said Dr. Millikan today to Science Service. "With the Merrill plane, however, longitudinal, or up and down, control is possible even at the lowest speeds. The control of the angle of attack, which is the angle at which the wings meet the wind, is independent of the air speed. As the pilot can always tell the angle of the wings, he can tell whether he is ascending or descending at once. A sudden gust of air, which would throw the ordinary plane out of line, and require a quick manipulation of the elevator to prevent trouble, merely lifts the entire plane without disturbing its horizontal position. Even with a heavy load in back, the stability of the ship is unaffected. These advantages might be summarized by saying that the pilot only has to control his movement in two directions—to one side or the other—instead of in three, which includes up and down as well. Only in the smoothest air, which is an exceptional condition, can this be said of the ordinary plane.

"The Merrill design also permits landing in a much shorter space than ordinarily, perhaps as short as 40 feet, as compared with the usual 200 feet or so. The take-off, however, requires as long a run as the usual type.

"For the previous model of the Merrill plane a glider was used, to which a small engine was later added. Then we built the present plane. At first this had an 80 horsepower engine, with which it was flown by an experienced pilot, who pronounced it far easier to handle than any plane he had ever flown. We have just installed a 100-horsepower engine for use in the demonstration at Los Angeles."

Science News-Letter, September 15, 1928

Egg yolks contain vitamin D, the food factor that helps to safeguard children against rickets.