PHYSICS—ASTRONOMY

Roëmer Proves Velocity of Light
"A Classic of Science"

An Ancient Controversy Settled and a Prediction Fulfilled by Comparing Theory with Many Observations

HISTOIRE DE L'ACADEMIE ROYALE DES SCIENCES. Tome I. Depuis son etablissement an 1666 *jusqu'a* 1699. *A Paris*: *MDCCXXXIII. Mathematique*: *Astronomie,* 1676.

HISTORY OF THE ROYAL ACADEMY OF SCIENCES. Vol. I. From its establishment in 1666 *to* 1699. *Paris*: 1733. *Mathematics*: *Astronomy,* 1676. *This is a literal translation of an extract from the original publication. Translated for the Science News Letter by Helen M. Davis.*

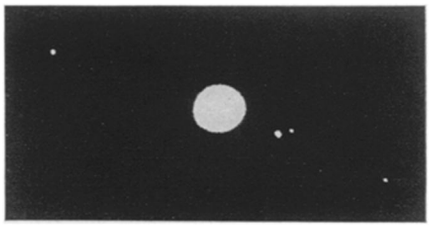
SINCE the satellites of Jupiter are extremely important, on account of the number of their eclipses, which usually amount to more than 1300 a year, M. Cassini, who is more learned than all others in the news of that world, this year notified all the astronomers of Europe that the following year, at the end of March, the system of the satellites would reverse itself; that is to say, that their superior semi-circles, which for six years have been turned to the south, would turn to the north. Thereby the hypothesis established by Galileo, the first observer of the satellites, and the calculations of those who have followed him, would be entirely destroyed.

Some other errors, where they have recurred, have already made whole hours and sometimes even days of difference to be found between their predictions and that which happens in the heavens of Jupiter, also M. Cassini no longer hesitates to declare that he retracts a certain motion which he put into his hypothesis out of a sort of deference and respect for the observations of Galileo. It is impossible that even the greatest genius should in such matters succeed to absolute precision or perfection, when he has the misfortune to be the first to work there. The glory of the discovery is counterbalanced by the mistakes attendant upon lack of experience. Anything founded upon a small number of celestial observations always contains some hidden error which does not show itself until it has accumulated with time, a third part becomes sensible only when it has become a second or a minute; and thence it extends to an infinity of other sorts of errors, which demand an ever greater mass of observations, in proportion as they are the more delicate.

It will be only through a great mass of observations that one begins to perceive a truth of Physics, ignored up to the present time by all Philosophers, and so ignored that the contrary is almost a constant principle.

The revolutions of the first satellite of Jupiter have been calculated very exactly, and a very great number of times; and consequently all its eclipses caused by the shadow of Jupiter, yet it always happens that at certain times it comes out of the shadow several minutes too late, and at other times earlier than it ought, and no one has yet recognized the principle of this variation. In comparing these times one with the other, M. Roëmer saw that the Satellite came out of the shadow later exactly when the earth by its annual movement drew away from Jupiter, and earlier when it approached it. From that, M. Roëmer began to form this ingenious conjecture; That light must take some time to diffuse Granted this, if the Satellite comes out later from the shadow when we are farther away from it, this does not mean that it actually comes out later; but the light takes more time to reach us, because, so to speak, we have been ahead of it. On the other hand, when we are going toward it, the sojourn of the Satellite in the shadow seems shorter to us.

To prove the truth of this idea, he calculated what difference in coming out of the shadow or Emersions of the Satellite, correspond to different elongations of the Earth, and he found that the light would be retarded 11′ for a difference of elongation equal to the distance of the Earth to the Sun. Upon this basis, he announced to the Academy at the beginning of September, that if his supposition were correct, an Emersion of the first Satellite which was due to arrive the 16th of the following November, would arrive 10′ later than it would be due to arrive by the ordinary calculation.



JUPITER'S FOUR SATELLITES

Discovered by Galileo in 1610 had been observed for only a little more than half a century when Roemer calculated the speed of light from the periodic variation between the theoretical and observed motions of one of them. Their positions were long observed with the idea that they would solve the pressing problem of determining longitude at sea, but this hope was not realized. These satellites can be seen by anyone with an ordinary field glass. Jupiter's other five moons, discovered since 1897, are reserved for astronomers with modern high-power telescopes.

The event corresponded to the prediction of M. Roëmer. In spite of this success, as the idea was so new, it was still not acknowledged; they were on guard against the charms of novelty. The Satellite did not have exactly for its center of motion, the center of Jupiter. Moreover, it is certain that its revolutions have more speed when Jupiter is nearer the Sun, and all this ought to produce in its movement some inequalities. But these inequalities would not by any means have been precisely regular like those in question. One even imagined another Astronomical hypothesis which would adjust everything; but this would be too different from everything which is recognized elsewhere in the Heavens. By calculation it could well satisfy all the Observations; but it would not have a certain semblance to truth which satisfies the mind.

Yet it was necessary to admit the Retardation of Light, seemingly so truthful according to Physics, even if it was not proved by Astronomy. Why could Light traverse space in an instant, any more than sound, or to speak still more philosophically, any more than a block

of marble? For the motion of the most subtile body can only be quicker; it cannot be instantaneous, any more than that of the heaviest and most massive bodies. A prejudice too favorable to the Heavens and their celestial bodies has in fact given them prerogatives which they are beginning to lose. The Heavens have been thought incapable of change and alteration; we have recently been disabused of that by experience; but if we are logical, there ought to be now of all times a great prejudice against alterations and change of sublunary bodies. The same Laws of Nature hold throughout everything, and the Heavens should in no wise be privileged. The motion of a block of marble proves the necessity of some duration for that of light. The motion of sound which travels so quickly is in effect, compared to that of light, only the motion of a block of marble raised without much difficulty by a crane.

It follows from Observations by M. Roëmer, that light in one second of time travels 48203 common French leagues, and $\frac{337}{1141}$ parts of a league, a fraction which might well be neglected. Sound in the same times travels only 180 toises, that is to say, a part of one league more than four times smaller than the fraction $\frac{337}{1141}$, which is negligible in the motion of light. If we compute from that the path which it [light] travels in one minute, and that which it must travel to be retarded ten minutes to our perception, we will be frightened, alike at the immensity of space, and at the swiftness of light, and at the subtilty proportional to this swiftness, and at human understanding.

Science News Letter, May 20, 1933

ASTRONOMY

Mt. Locke Selected For Second Largest Telescope

THE SECOND largest telescope in the world will be located on Mt. Locke, the 6,790 foot peak in the Davis Mountains of southwestern Texas, which has just been selected as the site of the new McDonald Observatory, a cooperative enterprise between the University of Texas and the University of Chicago.

A bequest by the late W. J. McDonald of Paris, Texas, to the University of Texas will provide the eighty-inch telescope and buildings, while the University of Chicago will provide a staff under the direction of Dr. Otto Struve, director of the Yerkes Observatory.

Science News Letter, May 20, 1933

TEXTILES

Moth Repellent Dye Being Sought For Clothes

THE RAVAGES of clothes moths amount to about $100,000,000 a year in this country. Some six hundred mothproofing materials have been patented, not including fumigants. Thus the clothes moth, seldom seen and preferring dark places, may well be listed as a "public enemy" and put on the spot if we can.

The latest idea in protection against moths is the development of a dye for wool that makes clothes as distasteful to moths as they are beautiful to human eyes.

At the University of Illinois under the direction of Dr. L. R. Shriner, this problem is being tackled by a Textile Foundation fellow, H. E Ritchey.

At present only one dye on the market is moth repellent, preliminary tests show. This was of course accidental. Mr. Ritchey is now at work to determine whether moth repellents will retain properties when combined with dyes. If they do, whether the anti-moth material will interfere with the coloring by the dyes must then be investigated.

He believes that there is a good chance of developing an ideal moth-proofing material in the form of a moth-repellent dyestuff. The ideal material would first be effective, have no objectionable odor, should adhere evenly to the fabric treated, be unrecognizable on the material, not dust off, not be toxic to humans, and be reasonably priced.

"Some of the multitude of patented mothproofs are ineffective, but the chief loophole for moth attacks probably lies in defective conditions of application," said Mr. Ritchey in discussing the need of better moth protecting. "Sprays, for instance, are not applied thoroughly, or fumigants are allowed to escape through lack of air-tight chests or wardrobes. The habits of moths are their greatest protection. They prefer dark places and are seldom seen in the light. The moth that seeks the bright lights and incites the housewife to frantic efforts is usually a harmless variety. His destructive brother works under cover and frequently goes undetected until the damage is discovered.

"Some of the most commonly used substances are paradichlorobenzene, naphthalene, carbon bisulfide and carbon tetrachloride. Of the many materials, some seek to kill the moth, others endeavor to nauseate him and thus divert his presence or his appetite. Some methods probably only lighten the moth's daily routine.

"The great number of 'proofs' attests to the serious need for protection against moth ravages, and would seem to assure adequate defense. In actual practice, however, few of the materials prove entirely satisfactory. Some are inflammable, others poisonous to humans, some malodorous, others difficult to apply, and still others are unsatisfactory because of their expensiveness."

Science News Letter, May 20, 1933

ETHNOLOGY

Indians Branded Selves With Bonfires

STOIC INDIANS of the West branded designs on their skin by literally lighting small bonfires on themselves, it appears from new information about ancient practices obtained from living Indians.

Mission Indians of California used both branding and tattooing to adorn their bodies, J. P. Harrington of the Bureau of American Ethnology has learned. For the branding, the Indians took leaves of California mugwort which were dry and shriveled in early summer. These dried leaves were pounded on an anvil stone to make a spongy fuzzlike material. The stuff was then laid out on the bare skin of the Indian to form the desired pattern and the dried leaves were lighted.

"The pain was intense as the burning reached the skin," writes Mr. Harrington in a report of Smithsonian Institution explorations, "but it was borne without a wince or murmur. The brand resembled a cattle brand and adorned the person for life."

Mission Indians tattooed themselves by pricking a pattern with a cactus or other thorn, or a bit of sharp flint, and then rubbing a bluish-black dye, made of black nightshade, into the bleeding wound.

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