

ASTRONOMY

Motion of the Fixed Stars

"A Classic of Science"

This Shift of Star Images, Known as Aberration of Light, Helps Astronomers Calculate Star Motions and Velocities

A LETTER from the Reverend Mr. James Bradley, Savilian Professor of Astronomy at Oxford, and F. R. S., to Dr. Edmond Halley, Astronom. Reg. etc., giving an ACCOUNT OF A NEW DISCOVERED MOTION OF THE FIX'D STARS. In *Philosophical Transactions of the Royal Society, London, 1727.*

SIR:

You having been pleased to express your Satisfaction with what I had an Opportunity some time ago, of telling you in Conversation, concerning some Observations, that were making by our late worthy and ingenious Friend, the honorable Samuel Molyneux Esquire, and which have since been continued and repeated by myself, in order to determine the Parallax of the fixt Stars; I shall now beg leave to lay before you a more particular Account of them.

Prompted by Curiosity

Mr. Molyneux's Apparatus was completed and fitted for observing about the End of November 1725, and on the third Day of December following, the bright Star at the Head of *Draco* (marked *v* by *Bayer*) was for the first Time observed, as it passed near the Zenith, and its Situation carefully taken with the Instrument. The like Observations were made on the 5th, 11th and 12th Days of the same Month, and there appearing no material Difference in the Place of the Star, a farther Repetition of them at this Season seemed needless, it being a Part of the Year, wherein no sensible Alteration of Parallax in this Star could be expected. It was chiefly therefore Curiosity that tempted me (being then at *Kew*, where the Instrument was fixed) to prepare for observing the Star on December 17th, when having adjusted the Instrument as usual, I perceived that it passed a little more Southerly this Day than when it was observed before. Not suspecting any other Cause of this Ap-

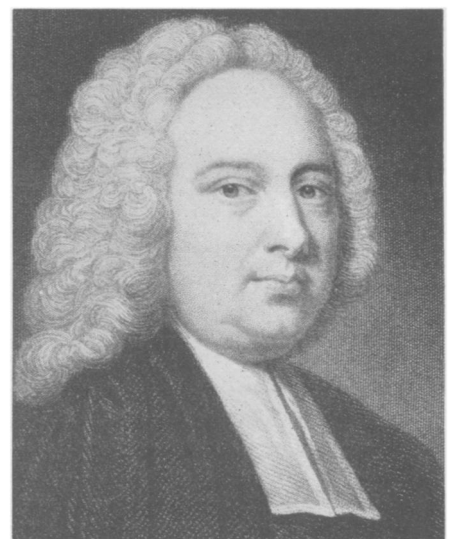
pearance, we first concluded, that it was owing to the Uncertainty of the Observations, and that either this or the foregoing were not so exact as we had before supposed; for which Reason we purposed to repeat the Observation again, in order to determine from whence this Difference proceeded; and upon doing it on December 20th, I found that the Star passed still more Southerly than in the former Observations. This sensible Alteration the more surprized us, in that it was the contrary way from what it would have been, had it proceeded from an annual Parallax of the Star: But being now pretty well satisfied, that it could not be entirely owing to the want of Exactness in the Observations; and having no Notion of anything else, that could cause such an apparent Motion as this in the Star; we began to think that some Change in the Materials, &c., of the Instrument itself, might have occasioned it. Under these Apprehensions we remained some time, but being at length fully convinced, by several Trials, of the great Exactness of the Instrument, and finding by the gradual Increase of the Star's Distance from the Pole, that there must be some regular Cause that produced it; we took care to examine nicely, at the Time of each Observation, how much it was: and about the Beginning of *March* 1725, the Star was found to be 20" more Southerly than at the Time of the first Observation. It now indeed seemed to have arrived at its utmost Limit Southward, because in several Trials made about this Time, no sensible Difference was observed in its Situation. By the Middle of *April*, it appeared to be returning back again towards the North; and about the beginning of *June*, it passed at the same Distance from the Zenith as it had done in *December* when it was first observed.

From the quick Alteration of this Star's Declination about this Time (it increasing a Second in three Days) it was concluded, that it would now pro-

ceed Northward, as it before had done Southward of its present Situation; and it happened as was conjectured: for the Star continued to move Northward till *September* following, when it again became stationary, being then near 20" more Northerly than in *June*, and no less than 39" more Northerly than it was in *March*. From *September* the Star returned towards the South, till it arrived in *December* to the same Situation it was in at that time twelve Months, allowing for the Difference of Declination on account of the Precession of the Equinox.

Instrument Not Cause

This was a sufficient Proof, that the Instrument had not been the Cause of this apparent Motion of the Star, and to find one adequate to such an Effect seemed a Difficulty. A Nutation of the Earth's Axis was one of the first things that offered itself upon this Occasion, but it was soon found to be insufficient; for though it might have accounted for the change of Declination in *v Draconis* yet it would not at the same time agree with the Phaenomena in other Stars; particularly in a small one almost opposite in right Ascension to *v Draconis*, at about the same Distance from the North Pole of the Equator: For, though



JAMES BRADLEY

Who discovered aberration of Star images. He succeeded Halley as Astronomer Royal.

this Star seemed to move the same way, as a Nutation of the Earth's Axis would have made it, yet it changing its Declination but about half as much as *v Draconis* in the same time (as appeared upon comparing the Observations of both made upon the same Days, at different Seasons of the Year) this plainly proved, that the apparent Motion of the Stars was not occasioned by a real Nutation, since if that had been the Cause, the Alteration in both Stars would have been near equal. . . .

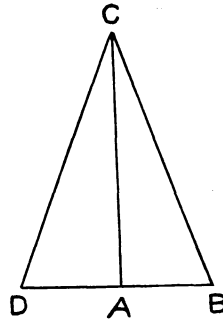
Discovers General Law

My instrument being fixed, I immediately began to observe such Stars as I judged most proper to give me light into the Cause of the Motion already mentioned. There was Variety enough of small ones; and not less than twelve, that I could observe through all the Seasons of the Year; they being bright enough to be seen in the Day-time, when nearest the Sun. I had not been long observing, before I perceived, that the Notion we had before entertained of the Stars being farthest North and South, when the Sun was about the Equinoxes, was only true of those that were near the solstitial Colure: And after I had continued my Observations a few Months, I discovered, what I then apprehended to be a general Law, observed by all the Stars, viz. That each of them became stationary, or was farthest North or South, when they passed over my Zenith at six of the Clock, either in the Morning or Evening. I perceived likewise, that whatever Situation the Stars were in with respect to the cardinal Points of the Ecliptick, the apparent motion of every one tended the same Way, when they passed my instrument about the same Hour of the Day or Night; for they all moved Southward, while they passed in the Day, and Northward in the Night; so that each was farthest North, when it came about Six of the Clock in the Evening, and farther South, when it came about Six in the Morning. . . .

When the Year was completed, I began to examine and compare my Observations, and having pretty well satisfied myself as to the general Laws of the Phaenomena, I then endeavoured to find out the Cause, of them. I was already convinced, that the apparent Motion of the Stars, was not owing to a Nutation of the Earth's Axis. The next Thing that offered itself, was an Alteration in the Direction of the Plumb-line, with which the Instrument

was constantly rectified; but this upon Trial proved insufficient. Then I considered what Refraction might do, but here also nothing satisfactory occurred. At last I conjectured, that all the Phaenomena hitherto mentioned, proceeded from the progressive Motion of Light and the Earth's annual Motion in its Orbit. For I perceived, that, if Light was propagated in Time, the apparent Place of a fixt Object would not be the same when the Eye is at Rest, as when it is moving in any other Direction, than that of the Line passing through the Eye and Object; and that, when the Eye is moving in different Directions, the apparent Place of the Object would be different.

I considered this Matter in the following Manner. I imagined CA to be a Ray of Light, falling perpendicularly upon the Line BD; then if the Eye is at rest at A, the Object must appear in the Direction AC, whether Light be propagated in Time or in an Instant. But if the Eye is moving from B towards A, and



Light is propagated in Time, with a Velocity that is to the Velocity of the Eye, as CA to BA; then Light moving from C to A, whilst the Eye moves from B to A, that Particle of it, by which the Object will be discerned, when the Eye in its Motion comes to A, is at C when the Eye is at B. Joining the Points B, C, I supposed the Line CB, to be a Tube (inclined to the Line BD in the Angle DBC) of such a Diameter, as to admit of but one Particle of Light; then it was easy to conceive, that the Particle of Light at C (by which the object must be seen when the Eye, as it moves along, arrives at A) would pass through the Tube BC, if it is inclined to BD in the Angle DBC, and accompanies the Eye in its Motion from B to A; and that it could not come to the Eye, placed behind such a Tube, if it had any other Inclination to the Line BD. If instead of supposing CB so small a Tube, we imagine it to be the Axis of a larger; then for the same Reason, the Particle of Light at C, could not pass through that Axis, unless it is inclined to BD, in the Angle CBD. In like manner, if the Eye moved the contrary way, from D towards A, with the same Velocity;

then the Tube must be inclined in the Angle BDC. Although therefore the true or real Place of an Object is perpendicular to the Line in which the Eye is moving, yet the visible Place will not be so, since that, no doubt, must be in the Direction of the Tube; but the Difference between the true and apparent Place will be (*caeteris paribus*) greater or less, according to the different Proportion between the Velocity of Light and that of the Eye. So that if we could suppose that Light was propagated in an instant, then there would be no Difference between the real and visible Place of an Object, although the Eye were in Motion, for in that case, AC being infinite with Respect to AB, the Angle ACB (the Difference between the true and visible Place) vanishes. But if Light be propagated in Time (which I presume will readily be allowed by most of the Philosophers of this Age) then it is evident from the foregoing Considerations, that there will be always a Difference between the real and visible Place of an Object, unless the Eye is moving either directly towards or from the Object. And in all Cases, the Sine of the Difference between the real and visible Place of the Object, will be to the Sine of the visible Inclination of the Object to the Line in which the Eye is moving as the Velocity of the Eye to the Velocity of Light.

Visibility Altered

If Light moved but 1000 times faster than the Eye, and an Object (supposed to be at an infinite Distance) was really placed perpendicularly over the Plain in which the Eye is moving, it follows from what hath been already said, that the apparent Place of such an Object will be always inclined to that Plain, in an Angle of $89^{\circ} 56' \frac{1}{2}$; so that it will constantly appear $3' \frac{1}{2}$ from its true Place, and seem so much less inclined to the Plain, that way towards which the Eye tends. That is, if AC is to AB (or AD) as 1000 to one, the Angle ABC will be $89^{\circ} 56' \frac{1}{2}$, and $ACB = 3' \frac{1}{2}$, and $BCD = 2ACB = 7'$. So that according to this Supposition, the visible or apparent Place of the Object will be altered $7'$, if the Direction of the Eye's Motion is at one time contrary to what it is at another.

If the Earth revolve round the Sun annually, and the Velocity of Light were to the Velocity of the Earth's Motion in its Orbit (which I will at present suppose to be a Circle) as 1000 to one; then tis easy to conceive, that a Star

"The Edison Effect"

the principle of the electron tube, is an example of the indirect influence of America's Greatest Inventor

THOMAS A. EDISON

Descriptions of the first studies of this phenomenon will be published as
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really placed in the very Pole of the Ecliptick, would, to an Eye carried along with the Earth, seem to change its Place continually, and (neglecting the small Difference on the Account of the Earth's diurnal Revolution on its Axis) would seem to describe a Circle round that Pole, every Way distant therefrom $3\frac{1}{2}$. So that its Longitude would be varied through all the Points of the Ecliptick every Year; but

its Latitude would always remain the same. Its right Ascension would also change, and its Declination, according to the different Situation of the Sun in respect to the equinoctial Points; and its apparent Distance from the North Pole of the Equator would be 7' less at the Autumnal, than at the vernal Equinox.

The greatest Alteration of the Place of a Star in the Pole of the Ecliptick (or which in Effect amounts to the same, the Proportion between the Velocity of Light and the Earth's Motion in its Orbit) being known; it will not be difficult to find what would be the Difference upon this Account, the Difference between the true and apparent Place of any other Star at any time; and on the contrary, the Difference between the true and apparent Place being given; the Proportion between the Velocity of Light and the Earth's Motion in its Orbit may be found.

Science News Letter, October 17, 1931

EVOLUTION

Gibbon-Like Animal Declared Ancestor of Both Man and Ape

Human Evolution Can be Traced Back to this Creature Of Prehistoric Egypt, Scientist Tells British Meeting

PROPLIOPITHECUS is proclaimed the common ancestor of man and apes, acceptable to all students of human evolution as "the starting point from which to derive evolutionary history of man and ape," by Sir Arthur Keith, eminent British anthropologist and anatomist.

Propliopithecus was a primitive small form of gibbon which lived in Egypt at the beginning of the Oligocene period, some thirty-five million years ago. It is known from teeth and jaws discovered by Prof. Max Schlosser in 1910. This earliest gibbonish form, known to have been very similar to living gibbons, was then ortho-grade in posture, habitually walking on all fours; and although of small size was ancestor of the higher primates to whom erect posture is peculiar. Human lineage can be traced backward to this creature regardless whether, as Dr. W. K. Gregory and Prof. Elliot Smith believe, humans broke away from apes in Miocene times, or as Sir Arthur Keith believes, earlier in evolution, or as Dr. Henry

Fairfield Osborn believes, still earlier.

"Paleontological evidence favors the theory formulated by Darwin in 1870, that man and anthropoid apes are descendants from a common stock," Sir Arthur said, discussing more recent fossil human remains. He believes that Rhodesian man, found in Africa, will prove to be an early form of Negro, although he is not positive.

"*Homo-rhodensis* is the only extinct type so far discovered whose crude features certainly foreshadow those of modern man," he said.

It is extremely probable that Heidelberg man was ancestral to Neanderthal man, though not in direct lineage to modern man. Sir Arthur considers *Pithecanthropus* of Java, *Sinanthropus* of China, *Eoanthropus* of Piltdown and *Palaeanthropus* of Heidelberg to be the four oldest fossil human remains, dating from the earliest Pleistocene or Ice Age. But they represent four separate genera of mankind, whereas living races are all one species.

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