Assume now that light occupies no time in travelling from the lamp to the first mirror, through the first telescope, across the space between the two telescopes, and back again after its reflection by the second mirror. Assume, in fact, that the velocity of light is infinite, then it is perfectly clear that an observer would keep on seeing that star of light whether the wheel remained at rest or were put in motion. But now assume that light does take a certain very small time to make the journey spoken of, and that the wheel can be turned with just such a velocity that when the light reaches it on its return it will meet, not an opening, but one of the cogs. Then the light would not be visible: it would find itself a cog behind, so that, if light travels very fast indeed and the wheel is made to travel with a great and known velocity and the relation existing between the velocities be known, the velocity of light can be measured in this way. That is the way in which Fizeau measured it, and he gave the velocity as being 190,000 miles per second.

It may be thought perhaps that this being the first attempt in a matter of this kind it was not very worthy of credit; but the similarity of the results which have been obtained in all such experiments proves that they are all very worthy of credit, and that this velocity must be accepted as established within narrow limits.

We come now to Foucault, the man to whose genius science owes the experimental proof of the earth's rotation, to which reference has already been made. He also attacked this question of the velocity of light. Going to work in quite a different way from Fizeau, he succeeded in enriching science with a method quite as reliable in its operation and as accurate in its results.

A pencil of light coming from a slit at (see Fig. 40, Page 224) impinges upon the plane mirror R, which is capable of turning round a vertical axis. This mirror reflects the light falling on its surface, and the action of the lens, l, causes an image to be formed on the surface of the concave mirror, M, the centre of which coincides with the axis at R. This concave mirror reflects the image backwards on its path to the slit. Foucault's arrangement, as has been said, was to have the mirror, R, made to rotate. If, therefore, R be turned about its axis while the light from the slit, S, is falling upon its surface, for so long as the light falls on the lens so long will the image of the slit be formed on the surface of the distant mirror. Similarly for so long as the reflected image falls upon the lens, so long will the image be reflected back to the slit. Now if the mirror were made to rotate rapidly, and light were infinite in its velocity, then once during each revolution of the mirror at once particular angle the light would be reflected back to the slit; but assume that light takes some very small fraction of time to travel over the space between the mirrors, it will be observed that the image will not be reflected back to the slit but will suffer a deflection in one direction or the other according as the mirror turns from left to right or from right to left, and, the velocity of the rotating mirror being known, the amount of this displacement will enable the velocity of light to be determined.

With two such different methods it might be supposed that the results obtained were very different. Not so, however; the velocity obtained by Fizeau was, as I have said, 190,000 miles per second, that by Foucault 185,000 per second.

It so happens that both these methods have been gone over quite recently, Fizeau's method by another Frenchman, M. Cornu, and Foucault's by Mr. Michelson, an officer in the American navy.

Mr. Michelson modified Foucault's method somewhat, the fault in which was that the displacement obtained was so extremely small, being but the fraction of a milimetre; and when it is remembered that the image is always more or less indistinct on account of atmospheric conditions and imperfection in the lenses and mirrors employed, it will be seen that it was difficult for Foucault to attain to any very great accuracy. Mr. Michelson therefore used an apparatus which would give him a greater deflection than that obtained by Foucault. As before, S (Fig. 41) was the slit, R the rotating mirror in the principal focus of the lens, but the distant mirror, instead of being concave, was a plane one, and the lens one of great focal length, for a reason that will appear immediately. This lens, in consequence of the smallness of its diameter in comparison with its great focal length, was not entirely convenient. In order that the displacement should be great, it is necessary that the distance between R and M, the distance from the revolving mirror to the slit, and the speed of rotation should be the greatest possible.

Unfortunately, the second condition clashes with the first, l for the distance from the revolving mirror to the slit, or the "radius" is the difference between the distance of principal and conjugate focus for the distant mirror, M, and the greater the distance the smaller the radius. Two methods were employed by Mr. Michelson in overcoming this difficulty: first, he had his lens of great focal length, 150 feet, and he placed the revolving mirror, not at the principal focus, but fifteen feet within it. He thus managed to get a distance between the mirrors of 2000 feet with a radius of thirty feet, and his mirror made 256 revolutions per second. He then obtained a deflection of 133 milimetres, that being about 200 times greater than the deflection obtained by Foucault. This deflection he measured to within three or four hundredths of a milimetre in each observation.

Mr. Michelson's experiments were made along an almost level stretch of sea wall at the Naval Academy.

We are therefore justified in saying, as the results of these experiments of Fizeau and Cornu, Foucault and Michelson, that light has a velocity of some 186,000 miles per secand.

If that be so, then, if the statement that the earth revolves about the sun be true, this must follow. In Fig. 42 *a b c d* represent the earth in different parts of its orbit around the sun; the contention is that if there be this revolution of the earth round the sun, and if light really travels with anything short of an infinite velocity, then the position of a star must change, for the reason that the telescope of the astronomer must always be pointed in advance of the star to catch its light in the same way that to catch the falling weight we had to incline the tube in the direction of its motion.

When any observation is made on any star in the heavens, the telescope of the astronomer must therefore be pointed in advance of the star to catch its light, and taking, as in the diagram, four different points in the earth's orbit, it is obvious that the telescope at these four different points must be pointed in four different directions with regard to the star. For instance, if we take a point at *c*, where the earth is travelling in the direction of the arrow, and the point at which the star would be seen if the earth were at rest, or the velocity of light were infinite, be indicated by the star in the figure *c* is the direction in which the star would be seen, and in which the astronomer's telescope must be pointed to catch its light. Similarly with the earth at *d* the telescope must be pointed to *d'*, and so with the earth at *a* we must have it pointing towards *a'*. It was this strange anomaly which puzzled Dr. Bradley in the year 1729. He noticed that the stars moved in ellipses every year round a mean point. This fact of aberration, then, is a real thing. It has been said that the angle at which the tube had to be inclined to receive the weight pepended upon their respective velocities, that the faster the tube travelled, the greater must be its inclination, and therefore the greater the angle the greater the earth's velocity with reference to the velocity of light. In the case of the majority of the stars what we get is an ellipse, an in an ellipse we have certain differences which have to be taken inio account, the last difference of all being that an infinitely elongated ellipse is a straight line, and it is found that from one particular point of the heavens where, in consequence of this aberrational motion, the orbits of the stars round their mean places are almost circular, we at last get to a point where the motion is simply an oscillation of the star backwards and forwards to and from its mean place; we are dealing, in fact, with that form of the ellipse when it is in the form of a straight line. When we deal with an ellipse we no longer talk of the radius, but of the semi-axis major, which is half the greatest length. The angle of aberration of which I have spoken only amounts to 20"·4451, but though small, it is quite enough to prove that the earth does revolve, and that consequently the sun is the centre of the system to which the earth belongs. Now in order to show the importance of physical inquiry in this matter, there is another statement which must be made. If we consider this aberration question fully, we find in it what is perhaps the most perfect way of determining the distance of the sun from the earth, and it will be seen that it is perfectly simple, so simple in fact, that the wonder is that more attention has not been given to it in our tex-books. We have first the fact that the inclination of the tube depends upon the