

ECLIPSE SHOWED GRAVITY VARIATION

Diversion of Light Rays Accepted as Affecting Newton's Principles.

HAILED AS EPOCHMAKING

British Scientist Calls the Discovery One of the Greatest of Human Achievements.

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LONDON, Nov. 8.—What Sir Joseph Thomson, President of the Royal Society, declared was "one of the greatest—perhaps the greatest—of achievements in the history of human thought" was discussed at a joint meeting of the Royal Society and the Royal Astronomical Society in London yesterday, when the results of the British observations of the total solar eclipse of May 29 were made known.

There was a large attendance of astronomers and physicists, and it was generally accepted that the observations were decisive in verifying the prediction of Dr. Einstein, Professor of Physics in the University of Prague, that rays of light from stars, passing close to the sun on their way to the earth, would suffer twice the deflection for which the principles enunciated by Sir Isaac Newton accounted. But there was a difference of opinion as to whether science had to face merely a new and unexplained fact or to reckon with a theory that would completely revolutionize the accepted fundamentals of physics.

The discussion was opened by the Astronomer Royal, Sir Frank Dyson, who described the work of the expeditions sent respectively to Sobral, in Northern Brazil, and the Island of Principe, off the west coast of Africa. At each of these places, if the weather were propitious on the day of the eclipse, it would be possible to take during totality a set of photographs of the obscured sun and a number of bright stars which happened to be in its immediate vicinity.

The desired object was to ascertain whether the light from these stars as it passed by the sun came as directly toward the earth as if the sun were not there, or if there was a deflection due to its presence. And if the deflection did occur the stars would appear on the photographic plates at measurable distances from their theoretical positions. Sir Frank explained in detail the apparatus that had been employed, the corrections that had to be made for various disturbing factors, and the methods by which comparison between the theoretical and observed positions had been made. He convinced the meeting that the results were definite and conclusive, that deflection did take place, and

that the measurements showed that the extent of deflection was in close accord with the theoretical degree predicted by Dr. Einstein, as opposed to half of that degree, the amount that would follow if the principles of Newton were correct.

Dr. Crommelin, one of the observers at Sobral, who spoke next, said that eight exposures of twenty-eight seconds each were made during the totality of the eclipse. Seven of these plates showed seven stars in each. One showed no stars, owing to the presence of a thin cloud, but gave well-defined images of the inner corona of the sun and of great prominence. Seven exposures of the same star field were made for comparison between July 14 and July 18 in the morning sky, the sun being then 45 degrees or more away from it. The results reduced to the sun's limb were 2.08 seconds and 1.94 seconds respectively. The combined result was 1.98 seconds, with a probable error of about 6 per cent. This was a strong confirmation of Einstein's theory, which gave a shift at the limb of 1.7 seconds. The evidence in favor of the gravitational bending of light was overwhelming, and there was a decidedly stronger case for the Einstein shift than for the Newtonian one.

Though the results were fairly conclusive, Dr. Crommelin said the question of the revision of Newton's law of gravitation was one of such fundamental importance that consideration was al-

ready being given to the next total eclipse in September, 1922, visible in the Maldive Islands and Australia.

Two of the consequences of Einstein's theory, he continued, namely, the motion of Mercury's perihelion and the bending of light by gravitation, might now be looked on as established, "at least with great probability." There was, however, a third predicted consequence, which was a shift of the lines in the spectrum toward the red in a strong gravitational field. The effect in the solar spectrum would amount to one-twentieth of the Angstrom unit, the same as that due to a motion of one-half kilometer per second away from the sun. Dr. St. John had looked for this effect without success. If this failure were taken as final it would mean that parts of Einstein's theory would need revision, but the parts already verified would remain.

The effects on practical astronomy, Dr. Crommelin said, of the verification of Einstein's theory were not very great. It was chiefly in the field of philosophic thought that the change would be felt. Space would no longer be looked on as extending indefinitely in all directions. Euclidian straight lines could not exist in Einstein's space. They would all be curved, and if they traveled far enough they would regain their starting point.

Sir Joseph Thomson, summing up the discussion, said:

"These are not isolated results that have been obtained. It is not the discovery of an outlying island, but of a whole continent of new scientific ideas of the greatest importance to some of the most fundamental questions connected with physics. It is the greatest discovery in connection with gravitation since Newton enunciated that principle."