IS EINSTEIN WRONG?--A DEBATE
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I—THE ERRORS OF EINSTEIN

CHARLES LANE POOR

A PROFESSOR of Celestial Mechanics maintains that Einstein's theory of relativity has not been proved, unless we accept on faith the special pleadings and assumptions of his followers. He calls attention to the wide divergence between stellar positions predicted by Einstein and the actual positions observed at the time of solar eclipses, and he argues that Newton's conclusions can be equally well vindicated if Newtonians permit themselves similar liberties in explaining away embarrassing facts.

SIR ISAAC NEWTON enunciated the law of gravitation, the law of universal attraction of particle for particle, of body for body and from that law developed a theory, or law of motion, of the heavenly bodies. Einstein has developed a similar law of motion, in which, however, gravitation, or attraction, plays no part, for the basic principle of the generalized relativity theory is a denial of gravitation. Einstein denies the existence of such a force: according to his theory there is no force of attraction between the earth and the moon; no force caused the fabled apple to fall upon the head of Newton.

Newton's law of gravitation can be stated in a few simple sentences, and its essentials can be made clear to the average reader. The theory of Einstein, upon which he bases his law of motion, is, on the contrary, complicated in the extreme: it cannot be expressed in words. It is impossible to read the works of Einstein and his followers and from their words and phrases to know what they really mean; the actual meaning of the relativity theory is concealed in complicated mathematical symbols and intricate formulas that are far beyond the comprehension of the

trained engineer. The Newtonian law can be expressed as simply as the Commandment, "Thou shalt not steal"; the Einstein theory is as complicated and involved as a tariff bill, with all the rulings of the Board of Appraisers and the interpretations of the officials of the Treasury Department.

In place of gravitation, in place of the attraction of one body for another, Einstein substitutes a transcendental conception of warped space and of geodesic lines along which a body freely rolls. The sun does not attract the earth, it crumples up space, twists and warps space in some mystic fourth and even fifth dimension, and the earth, carried by its own inertia, wends its way along the easiest path amid the bumps and hollows of crushed and crumpled space. And in this four-dimensional space the ordinary laws of geometry do not apply; space has become non-Euclidean and the area of a square varies as it is transported from place to place. The formulas and methods of geometry and of engineering to which we are accustomed hold only for the earth; the inhabitants of Mars, if any there be, have a different geometry and different formulas to solve their engineering problems.

From this unbelievably intricate and transcendental conception Einstein deduces a law of motion for the planets about the sun; and this law of motion apparently differs from Newton's law of motion by a single very minute term. And this little term seems to fit into a kink in Mercury's orbit, and to explain or account for certain observed motions of that planet. But, in deducing his law of motion, in traversing the complicated maze of mathematics, the relativitist meets difficulty after difficulty, and somehow surmounts them all. For each new difficulty some new mathematical device is evolved, and many of these devices are so intricate and complicated that it is extremely difficult to follow them through all their ramifications. Some of these devices seem to be ordinary approximations, but are called by Einstein substitutions, or transformations of coördinates. One such transformation, or approximation, which is used in many portions of the theory, involves the method of measuring the distance between two particles of matter. Instead of using the exact distance between the centres of such particles, the relativitist adds a small, a very small factor to this distance; and, in his formulas, uses this modified distance as if it were the true distance between the

bodies. In ordinary terms this would be called an approximation, and any result derived therefrom would be termed approximate. But to the Einsteinian such a procedure is a transformation and the result is called exact.

Further, the relativity conception of time differs from that of classical mechanics. From the earliest days of scientific thought, time has been regarded as independent of every one and everything; the same for all portions of space, for all bodies, whether in motion or at rest: a minute is a minute the world around and everywhere in space. But this identity of time is denied by Einstein: according to the relativity theory time depends upon motion, and the interval of time, known to us as a minute, varies from place to place; it is different for a person at rest and for an aviator. Thus each planet has its own particular system of relativity, or "proper" time, and even this special time changes as the planet changes its speed in different portions of its orbit.

Thus the formula, or law of motion, as deduced by the Einsteinians, does not represent the motion of a planet about the sun in the ordinary astronomical units of distance and of time. It represents that motion in a special system, in the relativity system of time or coördinates. Now it can readily be shown that this Einstein formula of motion, this formula which has aptly been called the essence of the relativity theory, can be derived directly from the Newtonian formula by merely changing the system in which the motion is measured, by changing from the astronomical to the relativity method of measuring time. By omitting the special, or approximate systems of measurement and using the ordinary astronomical measures of time and distance, the Einstein formula becomes identical with that of Newton: on the other hand, if in the Newtonian formula the relativity system of measurement be used, then this formula becomes identical with Einstein's. The two formulas thus apparently represent the same motion of a planet, but give that motion in different units; just as a stated amount of gold may be expressed as so many francs, or so many dollars.

Yet this formula of motion, this formula which can be derived from that of Newton by a simple change in the method of measuring time or distance, is used by Einstein as proof conclusive of his theory. And this so-called proof depends upon certain minute

and little understood motions of the planet Mercury. This planet is exceedingly difficult to observe; its motions are rapid and it is never far from the glare of the sun. Its path is not a simple curve: the large planets, — Venus, the earth, and Jupiter, — pull and haul at it, and under these "pulls" Mercury writhes and squirms along a difficult and tortuous path. Leverrier calculated the effects of the various pulls of the six larger planets upon unfortunate Mercury, and found that these pulls do not fully account for all the writhings of Mercury's orbit.

He found a very slight discrepancy: he found that some other force, some other very minute pull was affecting the motions of Mercury. And this discrepancy in the motions of Mercury consists of a combination of two small "wabbles," one of which is the celebrated motion of the perihelion, or rotation of the orbit in space. But the motion detected by Leverrier is not a simple motion of the perihelion; it is a combination effect, a combination which Leverrier himself could not disentangle into its separate parts. Within limits any value could be assigned to the perihelial motion, and to each such value there would be a definite wabble of the eccentricity. Leverrier gave, however, 38 seconds of arc per century as the most probable motion of the perihelion, which corresponds to a very small change in the eccentricity. Some years later, in 1895, Simon Newcomb confirmed these general results of Leverrier; but he made the motion of the perihelion slightly larger and the change in the eccentricity correspondingly smaller, and at the same time he found several other small discrepancies, or wabbles, in the motions of Mercury and in the motions of other planets as well.

When Leverrier discovered these erratic motions of Mercury in 1859, he showed clearly that they can be explained and accounted for by the presence of an undiscovered planet, or of scattered masses of matter, between Mercury and the sun. While no large planet has ever been found in that locality, yet masses of scattered matter are now known to be in the very places that Leverrier predicted, for such matter has been seen and portions of it photographed many times. But the exact quantity of such scattered matter is not known; no method has been devised for accurately measuring it: so that it cannot be said with mathematical certainty that this matter will fully and completely

account for the slight erratic motions of Mercury and of the other planets.

Now Einstein shows that his formula apparently gives a motion of 43 seconds of arc per century to the perihelion of Mercury and he stresses the approximate coincidence of this figure with the 38 or 41 seconds of actual motion as found by Leverrier and Newcomb. But in calculating this 43 seconds Einstein uses his formula as though it gives the motions of the planets in ordinary astronomical time. He apparently overlooks the fact that his variable, hypothetical relativity time, the time to which his equations apply, differs from the ordinary time of astronomy, and that a century of mystic Mercurial time will not be one hundred years of earthly time; overlooks the fact that in these different periods of time Mercury will travel different distances in its orbit. He bases his theories and his equations upon a denial of uniform time and of constant time intervals, yet uses this very time in applying his equation to the motion of the planets. Is not the celebrated 43 seconds of Einstein a mere mathematical illusion due to the use of an approximate, or mystical system of time in the relativity equations? Have not the relativitists gone astray in the astronomical interpretation of their formulas?

Further, the Einsteinians stress this one apparent coincidence of figures and disregard everything else. Einstein claims to explain this one anomalous motion of Mercury, but he fails to account for the other discrepancies in the solar system. And to cover this failure, he disregards Leverrier's statement that the motion of the perihelion is not independent, but is bound up with a change in the eccentricity; he ignores completely Newcomb's statement that there are several other discrepancies to be explained. Einstein repeatedly asserts, in varying phrases, that "The perihelial motion of Mercury is the sole anomalous one in our planetary system, which has been sufficiently attested." And his followers and the writers of popular science repeat these assertions; they focus the attention of the world upon the one coincidence of figures and do not submit the relativity equation to any actual test.

The second astronomical test of the relativity theory as set forth by Einstein is the bending of light rays as they pass near the edge of the sun. And in regard to this test there is much popu-

lar misconception, — misconception based upon the assertions of the too ardent supporters of the theory. Einstein has been credited as being the first to conceive the idea that light may be deflected, or bent from its straight path by the action of the sun, — has been eulogized as having predicted the existence of a hitherto undreamt of phenomenon. Yet Sir Isaac Newton certainly suspected that bodies might act upon light at a distance, and by their action bend its rays. And in 1801 von Soldner computed, upon the corpuscular theory of light, the path of a ray about the sun and the apparent bending, or deflection, in such a ray as seen from the earth. Under this corpuscular theory a ray of light consists of a group, or swarm of infinitely small particles of matter shot forth from the luminous source, particles which would be attracted by the sun, the earth, and the planets in identically the same way as the sun and the planets attract one another. This bending, as calculated by von Soldner, is what is now known as the "Newtonian" deflection. If the Newtonian, or corpuscular, theory of light be true, then all rays of light, grazing the edge of the sun, will appear to be bent, or deflected, from their straight paths by 0.87 seconds of arc.

But with the passing of the years experiments were made which could not be explained or accounted for by this materialistic theory, and it was finally and definitely supplanted by the wave, or undulatory, theory of light. This latter theory has become firmly established as one of the fundamental theories, or concepts of modern science. While light is known to be an electromagnetic phenomenon and to be propagated through space in the form of waves, it is not definitely known what effect the presence of a great mass of gravitating luminous and magnetic matter would have upon the path of a ray. Whether, under the modern theories, a ray would or would not be bent in passing close to the sun is not definitely known.

So there is really little that is new in Einstein's prediction. It appears to be a revival of a century-old idea, dressed in a somewhat novel form. The principle of equivalence is used to reconcile differences between the corpuscular and wave theories of light. The wave theory is apparently accepted, but, under the principle of equivalence, the track of a ray "agrees with that of a material particle moving with the speed of light." And in this way the

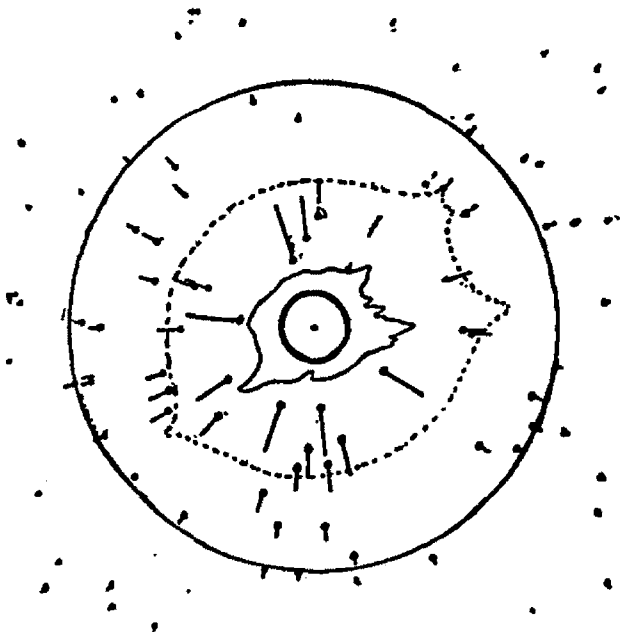
effects of both theories are obtained: the experiments, which cannot be accounted for by the corpuscular theory, are deftly explained by the fact that light is a progression of waves, and the bending, or deflection of the rays is computed by the corpuscular theory. Somewhere, however, in the computations under the principle of equivalence, Einstein introduces a factor 2 and makes the deflection 1.75 seconds instead of the 0.87 seconds of the simple corpuscular theory.

What is new in the Einstein prediction, therefore, is the figure 1.75 seconds of arc. But recent investigations seem to throw some doubt upon the validity of Einstein's calculations, and indicate that, even under his own fundamental formulas and statements, the figure should be 0.87. There are certainly contradictions and discrepancies in the methods used by the relativitists to arrive at the figure 1.75 seconds; but they cling to this figure, and claim that, if such a deflection be observed, it will completely prove the entire relativity theory and the correctness of all the mathematical processes.

To test this prediction or contention of Einstein, several expeditions have been made to observe eclipses of the sun. The most noted are that of the British astronomers in 1919 and that of the Lick Observatory party to Australia in 1922. The observation is extremely difficult, and the whole matter is complicated by the fact that there are several simple physical causes (other than relativity, or the corpuscular theory) that may cause a bending in a ray of light.

In its passage from a distant star to the telescope in Australia or Mexico, the ray of light passes through the atmosphere of the sun, it passes through the atmosphere of the earth. In the former it may be bent, in the latter it certainly is bent out of its straight path. Everyone is familar with the effects of refraction. Whenever a ray of light passes from one medium to another, from air to glass, or from air to water, it is bent out of its straight path. Upon this fact are constructed telescopes, prisms, and eye-glasses. Under ordinary conditions the amount of refraction suffered by a star ray in our atmosphere can be accurately computed and allowed for. It is usually many times greater than the minute quantity predicted by Einstein, sometimes many hundreds of times larger; and this atmospheric refraction, or bending, changes

very markedly with changes in the temperature of the air. When, in an eclipse, the sun disappears behind the moon it ceases for the moment to warm the air, and the temperature of our atmosphere drops suddenly. With this change in temperature the amount of the refraction changes, and the star appears to change its position. And no thermometer can record these sudden changes, no computation can take account of the abnormal and unknown changes in refraction caused by the eclipse shadow.



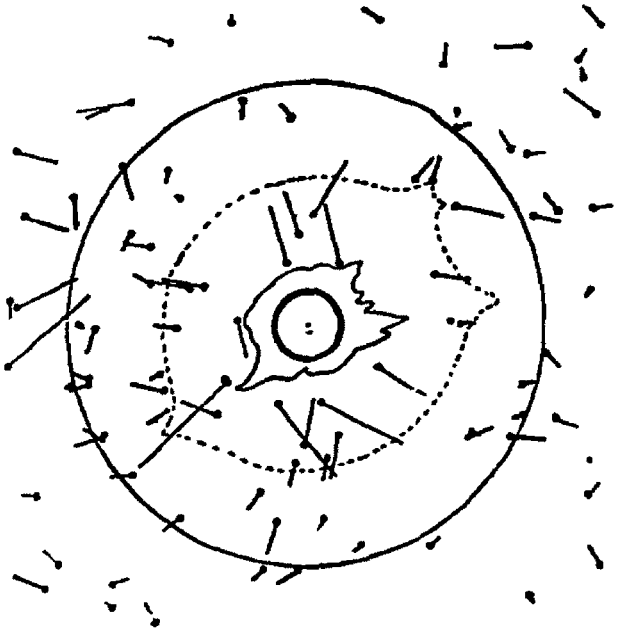
I—The Einstein Prediction

This figure shows the theoretical, or predicted Einstein displacements of 92 stars, magnified 2160 times.

These purely physical causes operate to bend a ray of light, and to bend it in a way very similar to that of the Einstein effect. So that it is really a very hard matter to disentangle one effect from another, and to say whether a definite bending, measured at an eclipse, is, in fact, due to the Einstein effect, or to one or more of the other causes. This disentanglement, however, is effected very simply by the relativitist, who denies the possibility of any such physical causes and claims that any observed deflection is conclusive proof of the Einstein theory.

In April, 1923, Professor W. W. Campbell announced that photographs, made in Australia by the Lick Observatory party at the eclipse of 1922, showed the deflection to be 1.72 seconds of

arc, agreeing almost exactly with the Einstein prediction of 1.75 seconds. This announcement was featured in the daily press and in all magazines and periodicals devoted to popular science, and was everywhere hailed as giving "the final stamp of experimental verification" to the Einstein theory. Yet less than three months later, Professor Campbell in an official publication of the Lick Observatory speaks of this as a "preliminary announcement" and gives the more probable figure as 2.05 seconds of arc,



II—The Eclipse Observations

This figure shows the displacements of 92 stars as observed at the total solar eclipse of September 21, 1922, and is from a direct tracing of the star chart and from data in Lick Observatory Bulletin, No. 346. Do these displacements bear out the assertions of the relativitists that "These results are in exact accord with the requirements of the Einstein theory"?

or some 17 per cent greater than the Einstein prediction. This excess, this difference from the predicted value of the deflection, he attributes to some kind of abnormal refraction in the earth's atmosphere.

Not only does the actual size of the average deflection, as now given by Campbell, thus conflict with the Einstein prediction, but an analysis of his paper shows that the light rays were not bent in the proper directions. All of this is clearly brought out in the accompanying diagrams. In these figures the small central

circles represent the eclipsed sun as shown on the photographs; the full irregular figure just outside the sun represents the right parts of the corona, while the faint dotted lines show the outer limits of coronal light. The heavy black dots show the true positions of the various stars as photographed on the plates, and it will be at once noticed that the rays from some twenty of the stars pass through the visible portions of the corona. According to Einstein, each star should be seen at the time of the eclipse, not in its true position, but pushed slightly outward from the centre of the sun, the size of this deflection varying with the distance of the individual star from the edge of the sun. This is shown in Figure I, where the thin lines show the direction and amount of the predicted Einstein deflection for each star. As these deflections are very minute and would be invisible if drawn to scale, they have been magnified, in relation to other dimensions of the figure, somewhat over 2100 times. Figure II shows the displacements of the ninety-two stars as actually observed by Campbell, and is taken from a diagram and measurements given by Professor Campbell in the Lick Observatory Bulletin.

A comparison of these two figures shows perfectly clearly that for the great majority of the stars the observed deflections differ radically in direction and amount from those predicted by Einstein. Only fifteen stars show bendings even approximately in the directions predicted by Einstein: and twenty-six stars, or nearly one-third of the entire number, show deflections in a general direction *opposite* to that called for by the relativity theory. The average deflection, as announced by Campbell, was obtained by reducing the actual measures by formulas and methods which "presuppose the existence of the Einstein effect" and which consider all departures from the expected deflection, departures both in direction and amount, as purely accidental errors of measurement. These observations of Campbell indicate, it is true, that rays of light are bent during a total solar eclipse, but they do not show that the bending follows the Einstein prediction; they do not give any indication as to the cause, or causes of such bendings. No observations, no checks were used by Campbell to determine whether the deflections, shown in Figure II, occurred in our atmosphere, or at the sun.

Now the question as to where the bending takes place is of

vital importance. If the observed bending occurs in our own atmosphere and not at the sun, then it cannot be due to Einstein, or to any of his theories. This phase of the problem has been ignored by the relativitist, but it is beginning to receive attention. The expedition of the Sproul Observatory to observe and photograph the 1923 eclipse was equipped with special instruments to test this point, to determine whether the bending occurs in our atmosphere, or at the sun. Unfortunately clouds partially obscured the sky and greatly interferred with the success of the expedition. Some photographs were secured, beautiful pictures of the brilliant corona, but lacking many of the fainter stars, which are necessary to a complete and satisfactory test. It will take months of painstaking measurement and calculation to read the riddle of these plates and to determine whether they furnish an answer to this all important question.

The Einstein theory has been heralded to the world as self-consistent, containing no special pleadings or assumptions, and as mathematically impregnable. The astronomical tests, according to the followers of the theory, have been passed in a spectacularly successful manner and the evidence is so conclusive that we "must" accept the theory. And these statements and assertions have been taken on faith, and the theory accepted by mathematicians, physicists, and by some of the most prominent astronomers of the world. Yet the mathematical expositions of the theory are full of transformations and approximations of doubtful validity. What is the principle of equivalence but an instrument of special pleading, a handy device for selecting those portions of discordant theories which suit the special and immediate needs? The astronomical observations do not sustain the claims of the relativitists; the relativity equation of motion does not give the motions of the planets in ordinary units of time; the measured star deflections do not agree with the Einstein prediction. The Einsteinians have not worked out fully and completely the consequences of their own theory, they have gone astray in their approximations and in the astronomical interpretations of their formulas.

The second article in the debate, — "The Triumphs of Relativity" by Archibald Henderson, — will appear in the July issue.

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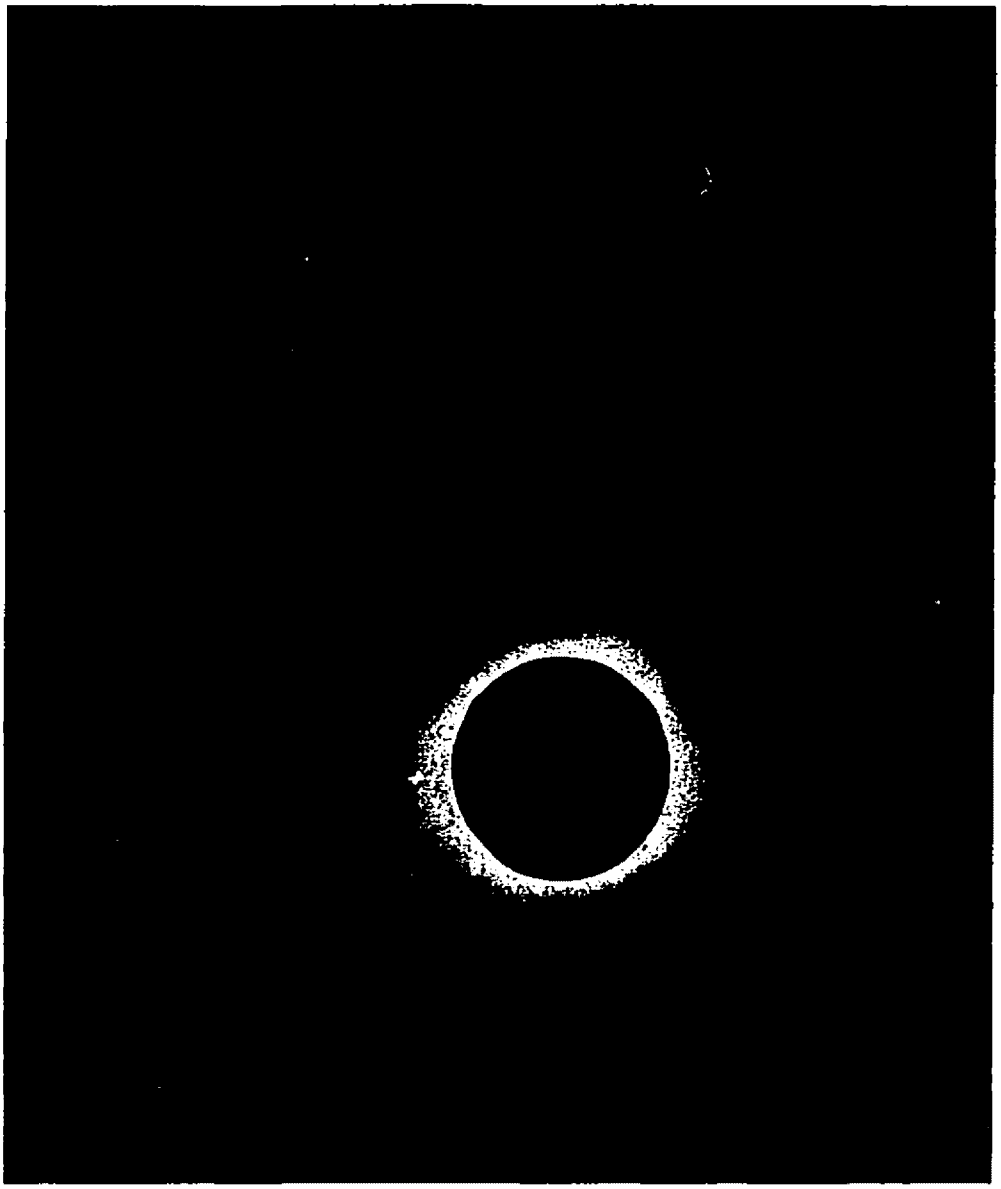

ECLIPSE OF THE SUN

An untouched reproduction of a photograph taken with the Einstein camera at Yerbaniz, Mexico, September 10, 1923. Venus is shown in the upper left hand portion of the plate, but the images of the fainter stars, which show in the negative, are lost in the reproduction. The corona, which consists of very tenuous matter, is shown surrounding the sun. Professor Poor states that Einstein neglects this matter in all his theories, that he asserts that this and similar matter can have no refractive effect upon the light which passes through it, and no gravitational effect upon Mercury