Relativity: An Approximation
By Charles Lane Poor

The generalized theory of relativity has been accepted as proved; proved by the motions of Mercury and by the bending of light rays near the edge of the sun; phenomena that, according to the relativists, cannot be explained or accounted for by the ordinary methods of astronomical research. Now, how does the relativity theory explain these motions of Mercury, this deflection of light? In what way do the formulas of relativity differ from those of the old fashioned classical mathematics of Newton, La Place, and Leverrier?

The formula of relativity, upon which is based the relativist's explanations of these phenomena, is found, upon analysis, to be nothing more nor less than an approximation towards the well known formula of Newtonian mathematics. The relativity formula, as used in the astronomical portion of the theory, contains not the slightest trace of the basic postulates of relativity, of warped space, or the mythical fourth dimension. It is a formula of Newtonian gravitation, purely and simply; but an approximate formula, derived by a series of approximations.

In deriving the formulas for the transmission of light throughout space and for the motion of one particle of matter about another, the relativity mathematician encounters a serious difficulty. His formula, derived from the postulates of relativity, indicates that light travels with different speeds in different directions, that the velocity of light depends upon the direction of transmission. That such a mathematical result represents the facts of nature is highly improbable, for in free space there is no difference between right and left, between north and south, or east and west; there is no reason why a ray of light should travel faster to the north than to the south. To overcome this mathematical difficulty, or inconvenience, as he calls it, the relativist makes a substitution, or approximation. Instead of using the direct distance between the centers of two particles of matter, the relativist adds a small, a very small, factor to this distance; or, as Eddington puts it, *"we shall slightly alter our co-ordinates."* Such an approximation is very common among physicists: it is done every day to simplify troublesome formulas. The only precaution necessary in such a procedure is to remember always that the final result is necessarily approximate, and, before drawing any conclusion, to thoroughly test the effects of the approximation.

Now the quantity, *m*, which is thus added to the distance to simplify the relativity equation, represents the mass of the attracting body, expressed in linear relativity units. It is really very small indeed in all physical problems of the laboratory. For all ordinary masses of matter, such as can be handled and experimented with on the earth, this little quantity is very much less than the billionth part of an inch; for the earth itself it is only about one -sixth (1/6) of an inch. As applied to the earth as a gravitational body, the approximation really consists in adding $1/6^{th}$ of an inch to each and every distance measured from the center of the earth. As the radius of the earth is some 4,000 miles, it is easy to see that for bodies near the surface of the earth this approximation amounts to less than one part in a billion, a quantity absolutely inappreciable in any physical problem; in the case of the motion of the Moon about the earth, this little distance is less than one part in seventy-five billion.

To the physicist such a degree of approximation is amply sufficient; no laboratory methods can measure with this degree of accuracy. But it is radically different in astronomy: distance and motion are on enormous scales and time continues on interminably, and a minute approximation might become evident in the motions of the planets.

Now it must be clearly understood that this minute approximation is the *sole appreciable difference* between the so-called Einstein law of motion and the old fashioned mathematics of Newton. By omitting this approximation and using the exact distance between the centers of the two bodies the Einstein formula becomes identical with that of Newton: on the other hand, in the

Newtonian formula the approximate distance be used, then this formula becomes identical with Einstein's. There is no essential difference between the two formulas: Einstein's formula is an approximation towards Newton's; except for the approximation, it is Newton's. In the Einstein formula for the orbit of a planet there is not the slightest trace of relativity; there is no warped space, no fourth dimension; there is nothing but every-day, ordinary Newtonian gravitation, but *approximate gravitation*. The approximation is in the Einstein equation; not in the Newtonian.

When the motions of the planets about the sun are considered, it must be remembered that the sun is many thousands of times larger than the earth, and, therefore, the little quantity, *m*, becomes proportionally larger, being in fact about nine-tenths of a mile. And the relativity approximation consists, in this case, of using in their formulas, not the actual distance of a planet from the center of the sun, but that distance increased by nine-tenths (0.91) of a mile. This same distance, this 9/10ths of a mile, is added to the distance of each and every planet, to that of Mercury, to that of Venus, of Jupiter and of Saturn. In all real astronomical work the position of the center of a planet is always determined from the center of the sun; the center of the sun is the fundamental point of reference in the solar system. No other point is ever used in actual astronomical observations, calculations, or tables; the actual distance of a planet from this point is measured, or calculated, or tabulated. But the relativity approximate formula does not give this actual distance: in the case of each and every planet it gives this distance increased by 9/10th of a mile.

The Motion of the Perihelion of Mercury

It is this approximation, which gives rise to the apparent, or so-called, Einstein motion of an elliptic orbit. According to the Newtonian formula the elliptic orbit of a planet (when the interaction of the other planets is omitted) is fixed in space; according to the Einstein formula the elliptic orbit is in slow motion, so that the perihelion appears to advance. But the Newtonian formula is mathematically exact; the Einstein formula contains an approximation, and the apparent theoretical Einstein rotation of an orbit, the theoretical Einstein advance of the perihelion is due, entirely, to the approximation so contained in his formula. The theoretical orbit of a planet is fixed in space, as shown by the mathematically exact Newtonian formula; there is no Einstein motion of the perihelion; the so-called Einstein rotation of an orbit is a mathematical illusion, caused by using an approximate formula.

But, while the Einstein motion is pure illusion, there is an actual motion of the perihelia of all the planets. When the mutual interactions of the planets, one upon another, are taken into account, then it is found that the orbits of all of them are in motion; the simple elliptic orbits writhe and squirm, so to speak, under the additional forces of the planets themselves. Not a single orbit is at rest, not a single orbit is a true ellipse. The orbit of Mercury, for example, swings around at the rate of 576 seconds of arc per century; that of Mars at the rate of 1606 seconds per century. Leverrier in 1859 computed the action of each and every planet upon the orbit of Mercury, and found that these attractions would account for only 538 seconds or arc, thus leaving an unexplained 38 seconds in the centennial advance of Mercury's perihelion. This is the celebrated discordance, which has been so stressed by Einstein and his followers. Leverrier explained it by the action of an unknown planet, or of masses of matter, between Mercury and the sun. While it is now known that no large planet is there, yet observations and photographs, without number, show clearly the presence of great masses of scattered matter in the very places that Leverrier indicated as necessary to explain this motion of Mercury.

But the relativity approximate formula gives rise to an apparent, or fictitious, motion of the orbit of Mercury of some 43 seconds of arc per century. And it is this approximate coincidence of figures, 43 seconds of illusion as against 38 seconds of actuality, which has been used by Einstein and his followers as proof, conclusive, of the relativity theory. As the relativity advance, as this 43 seconds, is a mere mathematical illusion, as there is, in reality, no such thing as the Einstein rotation of an orbit, this approximate coincidence of figures has no bearing, whatsoever, upon the truth or falsity of the relativity postulates.

The Deflection of light

There is nothing new in the idea that light may be bent, or deflected, from its course by the action of gravitation. Sir Isaac Newton certainly suspected that bodies might act upon light at a distance, and by their action bend its rays. Such action and such bending, of course, was predicated upon the theory that light consists of material particles of matter, shot forth from the luminous source. Such a material particle, or corpuscle, passing near the sun or other large gravitational mass would naturally describe a planetary orbit about such body, and the bending of the ray would be the amount of curvature in such orbit. The character of the orbit and the amount of curvature, or bending, of the orbit depends entirely upon the velocity with which the particle passes the attracting body. At a certain rather low velocity, the path of the particle is a circle about the gravitating centre: as the velocity increases the circle becomes an ellipse, a parabola, and finally a hyperbola. With each further increase in speed the arms of the hyperbola open out more and more and the path approaches nearer to a straight line.

The velocity of light is so great that the path of a particle, traveling about the sun with that speed, will be an hyperbola, the arms of which are so widely separated as to make the path almost, but not quite, a straight line.

The corpuscular theory of light, as held by Sir Isaac Newton, explained all the optical phenomena known to him. But, during the years which elapsed after his death, new facts were learned and new experiments made. Facts and experiments, which could not be explained or accounted for on this theory, gradually led to the acceptance of the then rival, wave or undulatory, theory of light. With the passing of years, with each new experiment, the wave theory of light became more and more firmly established, until it became one of the fundamental theories, or concepts, of modern science.

Therefore von Soldner's paper on the bending of light rays, which was published in 1801, attracted very little attention. For in this paper he assumed the corpuscular theory of light and calculated the amount that a ray should be bent in passing near the sun. He treated light as being material, a particle of light being attracted by the sun in the same way as a planet, and obeying the same laws of motion. He treated the problem of finding the light deflection in exactly the manner one would treat the path of a minute planet, which travels about the sun with the speed of light. He applied to the problem the ordinary, every-day, formulas of Newtonian gravitation.

It can be readily shown that, under the Newtonian laws of motion, a minute planet, traveling about the sun with the speed of light in a path which just grazes the surface of that luminary, will travel in an hyperbolic orbit; in a curve which is almost, but not quite a straight line. A very simple calculation shows that the total amount of bending in such path amounts to only 0.87 seconds or arc. This is the so-called "Newtonian" deflection. If the Newtonian, or corpuscular theory of light be true then all rays of light, grazing the edge of the sun, will be bent, or deflected from their straight paths by this amount, by 0.87 seconds of arc.

Now Einstein, in his generalized theory of relativity, introduces a factor two (2) into the formula for the bending of light rays, and gives the total deflection of a ray, passing the sun, as double the above amount, as 1.75 seconds of arc. This theoretical Einstein bending of a light ray is found, by Eddington and others, from the relativity equations by the use of the celebrated principle of equivalence. Under this principle of relativity, the track of a ray of light *"agrees with that of a* *material particle moving with the speed of light."* The principle of equivalence, so stated, appears to be nothing more nor less than an assumption of the truth of the corpuscular theory of light; yet the relativist never distinctly acknowledges this assumption, never distinctly states which theory of light is to be accepted. To explain certain phenomena the wave theory seems to be used by the relativists; other phenomena, under the principle of equivalence, by the corpuscular theory. Is not the principle of equivalence, so used, a handy device for passing readily from one theory to another as necessity drives?

But let us assume, with the relativist, the validity of the principle of equivalence, and from this principle find from the relativist's own formulas the track of a ray light. The fundamental formula of relativity dynamics is given by Eddington and it differs from that of Newtonian mathematics by a single small term (which has been shown to be the result of an approximation). From this fundamental differential formula the relativist finds the path of a planet, and the track of a ray of light; finds the motion of the perihelion of Mercury, and the deflections of the rays from distant stars as they pass near the eclipsed sun. According to the principle of equivalence there is no essential difference between these two cases: Mercury travels about the sun at the distance of many millions of miles and at a comparatively slow speed; the ray of light grazes the edge of the sun and travels at a terrific velocity. But the same formula applies to both cases; substitute in it the speed and distance of Mercury for the motions of Mercury; substitute in it the speed and distance of the ray of light and obtain the track of such ray.

Now Eddington integrates this fundamental equation of relativity dynamics and finds the complete path of any body, Mercury, Jupiter, or a material particle travelling with the speed of light. This complete and general orbit of any body, of Mercury or of a ray of light, is given by Eddington in his discussion of the motion of the perihelion of Mercury, and this orbital equation of relativity, so given by Eddington, differs from the ordinary equation of celestial mechanics by a single small term, by the term which gives rise to the so-called relativity motion of the perihelion. According to repeated statements of Einstein, of Eddington and of other relativists, according to the printed formulas of relativity, the relativity orbit, or path of a body is identical with that of Newtonian mathematics, with the single exception of this perihelial motion. This complete formula for the orbit of a body is used by the relativists to find the so-called motion of the perihelion of Mercury, to find the celebrated 43 seconds of arc, upon which is based the Mercurial proof of the Einstein theory.

But, upon the equivalence principle, this same orbital equation should give the track of a ray of light, passing near the sun. Substituting in this equation the distance of the ray from the sun's centre and its speed, the resulting orbit, or track of a ray is a hyperbola, and the total deflection, or bending is easily shown to be 0.87 seconds of arc, agreeing identically with that found from the Newtonian equation. This is necessarily so, for the two equations are the same, with the exception of the small term, which gives rise to the motion of the perihelion. In the case of Mercury, this minute term appears to give a motion of the perihelion of 0.103 seconds of arc in one revolution of the planet in its orbit (42.7 seconds per century): in the case of any of light, the same term amounts to about only *thirty-five millionths* (0.000,035) of a second of arc, a quantity absolutely negligible.

That is, the very formula, used by the relativists to prove their theory by the motion of Mercury, disproves their computed value for the light deflection. This equation, their own equation, gives the so-called Newtonian value, 0.37 seconds of arc, for the bending of a ray of light by the gravitational action of the sun. The relativist, however, does not use this orbital equation in his calculations of the amount of the light deflection. He reverts to the fundamental differential equation and integrates it in an entirely different manner for the track of the light ray. This second method of integrating the fundamental equation is, however, frankly approximate and gives a result which applies solely to light. Before beginning the integration, Eddington discards a term from the fundamental equation as being, in the case of light, infinitely small in comparison with other terms in the equation. This simplifies the equation, and the integration of the thus mutilated equation results in a curved path, which may approximate that of a light ray, but which is clearly approximate. The total bending, resulting from the use of this approximate path, is the relativity figure of 1.75 seconds of arc.

The validity of this method depends upon the question as to whether the discarded term is really very small with respect to those retained, or not. The omitted term is a constant, while the value of the term retained varies with the movement of the light particle along the curved orbit. A very simple comparison of this rejected term with the one retained shows that, in the most favorable case, the term, *I/P*, which Eddington omits as negligibly small, is two-thirds (2/3rds) as great as the term which he retains. Two-thirds can hardly be called negligibly small in comparison with unity. Further, except for a minute portion of the curve near perihelion, the omitted term *I/P* is actually very much *larger* than the term, $3mu^2$, which is retained. Eddington, in fact, omits as negligibly small, the large, important term of the equation, and retains the insignificant term.

It would thus seem that the approximation used by Eddington to integrate the equation for the deflection of light is *invalid*, and that the resulting value for the bending of the light ray is erroneous. Both methods of integrating the fundamental relativity equation cannot be right: one or the other must be wrong. The first and more general method, as we have seen, is used by the relativist to obtain the so called relativity motion of the perihelion of Mercury, but this method gives the deflection of light only 0.87 seconds of arc; the second method is restricted to light, is frankly approximate, and gives the amount of the deflection as 1.75 seconds. The same equation is handled by the relativist in two different ways and gives two radically different results. Which result is correct?

The relativist apparently checks his invalid calculation by the use of an entirely different method, a physical method of determining the deflection. But the method is faulty and contains obvious errors, and the fundamental formula for the velocity of light, upon which the entire method is based, is in direct contradiction to the principle of equivalence, for it shows that the speed of light *decreases* as it approaches the sun, while the equivalence principle demands that such velocity should increase. It would thus seem that the calculations by which Eddington finds the deflection of light equal to 1.75 seconds of arc are invalid. The principle of equivalence, if true, shows that the total bending of a ray of light, passing near the sun, is 0.87 seconds of arc, and not the 1.75 seconds, as claimed by the relativists.

Conclusions

1. The fundamental formulas of relativity dynamics contain an approximation; the *r* of these formulas is not the direct distance between the centres of two particles of matter; it is this distance increased by a minute quantity.

2. The relativity formulas can be obtained directly from the corresponding Newtonian formulas by the introduction of the relativity approximation.

3. The relativity motion of the perihelion of an orbit is a mathematical illusion, due entirely to the use of the relativity approximation. The elliptic orbit of a particle of matter is fixed in space (when the interaction of the other planets is omitted).

4. The supposed confirmation of the Einstein theory by the motion of the perihelion of Mercury depends entirely upon the use of the approximation in the relativity formulas: when the approximation is removed from the formula, all appearances of confirmation vanish.

5. Under the generalized theory of relativity, through the principle of equivalence, a ray of light, passing near the sun, will be bent by the same amount as under the corpuscular theory of light. The theoretical bending being thus the same for these two theories, a deflection, observed at an eclipse, cannot be used to prove the truth of the relativity theory a against that of the corpuscular theory of light.

6. The figure, 1.75 seconds of arc, given by the relativists for this deflection is obtained by approximate and invalid calculations. The relativists' own formulas give, as they should under the principle of equivalence, 0.87 seconds, and not 1.75.

The amount of deflection observed at the 1922 eclipse cannot be explained, either by the Einstein theory or by the corpuscular theory of light. Such deflection, if confirmed by later eclipses, will have to be explained on other grounds, by some purely physical cause, or by a combination of causes.