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ECE Theory of the Orbit of Binary Pulsars

by

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Abstract

Recently in this series of papers on Einstein Cartan Evans (ECE) unified field theory it has been shown that the Einstein Hilbert (EH) field equation is incompatible with the fundamental Bianchi identity of Cartan geometry. This means that new explanations must be sought for the experimental tests of gravitational relativity theory now available. One of these is the 3 millimeter decrease per revolution in the orbit of the Hulse Taylor binary pulsar. It is no longer valid to attempt to explain this with EH theory and a straightforward qualitative explanation is given in terms of ECE theory without using the flawed EH postulate of gravitational radiation. The explanation is based on the experimentally observed r dependent ratio of torsion (T) to curvature (R). If this ratio is not precisely constant, but increases with the radial co-ordinate r, the orbit decays as observed.

Keywords: ECE theory of the Hulse Taylor binary pulsar, r dependent ratio of torsion to curvature.

13.1 Introduction

Recently it has been demonstrated in this series of papers [1–10] that the Einstein Hilbert (EH) field equation is incompatible with the fundamental Bianchi identity of Cartan geometry, the incompatibility was first observed by computer algebra in paper 93 of the ECE series on www.aias.us. and shows up in the Hodge dual of the Bianchi identity. The latter has been proven in several ways during the course of development of the ECE series of papers, of which this is paper 106. This means that the EH field equation must be rejected, because it is based on a torsion-less geometry. Cartan showed in 1922 that there are two structure equations that determine the geometry of a four-dimensional space-time such as that used in general relativity. The first defines torsion in terms of the spin connection and tetrad, and the second defines curvature in terms of the spin connection. The Bianchi identity due to Cartan ineluctably relates torsion to curvature. The Hodge dual of this identity was proven in this series of papers, and leads to a tensor equation in which the covariant derivative of the three index torsion tensor $T^{\kappa\mu\nu}$ is equated to a curvature tensor $R^{\kappa}{}_{\mu}{}^{\mu\nu}$

$$D_\mu T^{\kappa\mu\nu} = R^{\kappa}{}_{\mu}{}^{\mu\nu}. \tag{13.1}$$

The curvature tensor was evaluated by computer algebra in paper 93 for several well used line elements, all based on the Christoffel connection. It was found by computer algebra that in general the tensor $R^{\kappa}{}_{\mu}{}^{\mu\nu}$ is non zero. However, for the same Christoffel connection the torsion tensor is always zero by definition so the covariant derivative of the torsion is also zero. Therefore the use of a Christoffel connection is incompatible with Cartan geometry and there is no way out of this "ECE Paradox" for the EH equation. The latter is always based on a Christoffel connection.

Therefore all inferences based on the EH equation must be re-evaluated and made consistent with the Bianchi identity and its newly inferred Hodge dual. In paper 103 a new field equation was suggested-one that includes torsion and curvature self consistently, in paper 104 the Hodge dual of the Bianchi identity was proven for any metric and spin connection, and in paper 105 a new explanation of the precision tests of general relativity was given in terms of the ratio of a well defined scalar torsion T to a well defined scalar curvature R. In this paper the theory of paper 105 is applied to the Hulse Taylor binary pulsar [11] in which a decrease in orbit of about 3 millimeters per revolution is observed. In the standard model the now obsolete Einstein Hilbert (EH) field equation is used in an attempt to explain this decrease in terms of quadrupole gravitational radiation [12] in the weak field limit. However, no direct observation of gravitational radiation has been made. In Section 13.2 a much simpler explanation of this decrease in orbit is given. When the ratio of T/R is not exactly constant, but increases with the radial coordinate r, the orbit spirals inwards as observed. Therefore the data of the Hulse Taylor binary pulsar and another binary pulsar recently discovered by Joddrell Bank [13] must be used to determine the precise dependence of T/R upon r. No postulate of gravitational radiation is needed. The correct method of developing gravitational radiation is based on the well known ECE wave equation:

$$(\Box + kT)q^a_\mu = 0 \tag{13.2}$$

where the gravitational wave is the tetrad q^a_μ. The eigenvalues of this gravitational wave equation are kT, where k is Einstein's constant and T in this context is a well defined scalar canonical energy momentum density, not to be confused with the symbol T for scalar torsion. The eigenvalues are related to a well defined scalar curvature by a generalization of the Einstein postulate to all fields [1–10]:

$$R = -kT. \tag{13.3}$$

Therefore if gravitational radiation is ever detected, it is due to Eq. (13.2), and not due to the EH field equation. The latter is geometrically incorrect, so no physical inference can be based upon it. There are no black holes, no Big Bang, and no dark matter. These are all based on the incorrect EH field equation. Additionally, the so called Schwarzschild metric was not inferred [14] by Schwarzschild in 1916. The so called Schwarzschild radius is not due to Schwarzschild. The latter published two papers in 1916, one of which gave a vacuum solution of the EH equation in terms of a parameter α. The mass M of the gravitating source was not used by Schwarzschild. In paper 105 we redefined the so called Schwarszchild radius r_s as:

$$r_s = -\frac{T}{R} = \frac{2mG}{c^2} \tag{13.4}$$

where G is Newton's constant and c the vacuum speed of light. Therefore the standard model approach to gravitational relativity must be finally discarded. It is already highly controversial and effectively obsolete, and is being replaced by the internationally accepted ECE theory. In these papers we are applying ECE to the experimental data directly, without being influenced by the EH equation or by flawed dogma, however oft repeated. A theory is accepted or rejected upon logic and the Ockham/Bacon scientific method, not upon the transient subjective opinion of any era.

13.2 Orbit of the Hulse Taylor Binary Pulsar

The first binary pulsar was found in 1974 by Hulse and Taylor [11]. It consists of a pulsar (a neutron star) with a pulsation period of 59 milliseconds, and a second neutron star in an elongated orbit of period 7.75 hours. Each neutron star is 1.4 million times the mass of the sun in the solar system. The orbit is observed to be gradually decreasing by 3.1 mm per orbit. The orbital precession is 4.2° a year. In ECE theory (paper 105) a constant orbital precession is given by a constant:

$$r_s = -\frac{T}{R}. \tag{13.5}$$

However, the orbit of the binary pulsar is a spiral inwards, so experimentally the ratio of T to R in Eq. (13.5) is not constant. Universal gravitation means a constant G for a given constant M, but more generally, G depends on T/R when the gravitational fields are enormous, such as in a binary pulsar. The well known Pioneer anomalies [15] are due in ECE theory to the same ratio of T/R. In other words gravitation is not universal in general.

It is well known that the orbit in standard model general relativity is calculated from the line element and the latter in turn is taken to be the so called Schwarzschild metric. In paper 105 an entirely new method of calculating the orbit was proposed. The result is that the line element is expressed as:

$$c^2 d\tau^2 = \left(1 + \frac{T}{Rr}\right) c^2 dt^2 - \left(1 + \frac{T}{Rr}\right)^{-1} dr^2 - r^2 d\phi^2 \tag{13.6}$$

where:

$$\frac{dr}{d\phi} = \frac{dr}{d\tau}\frac{d\tau}{d\phi}. \tag{13.7}$$

Here τ is the proper time, r is the radial coordinate and ϕ an angular coordinate of the spherical polar system. For a constant perihelion advance per orbit, the experimental data are reproduced by a constant as in Eq. (13.4). In the weak field limit this condition is the universal gravitation of Newton, in which G is a universal constant. In all field theories of relativity, including ECE theory, c is a universal constant. The constant c is taken to be exact in standard laboratories, but G is among the least precisely known of the constants of physics. Therefore Eq. (13.4) means that G is determined by T/R for a given M and given c. In the weak field limit, T/R is constant, and this is the limit of ECE that defines the universal gravitation of Newton. The Hulse Taylor binary pulsar shows that more generally, gravitation is not universal, in the huge gravitational fields of a binary pulsar G is not the same as in the solar system, where the sun's gravitational field is a millionth of that of a neutron star. In the solar system itself, the Pioneer anomaly suggests that there are also small departures from universal gravitation of the order of one part in 10^{-10}. In ECE these are small departures from the constancy of T/R.

From the line element (13.6) two constants of motion are defined [12]:

$$E = mc^2 \left(1 + \frac{T}{Rr}\right) \frac{dt}{d\tau} \tag{13.8}$$

and

$$L = mr^2 \frac{d\phi}{d\tau} \tag{13.9}$$

in S.I. units. Therefore the orbital equation is:

$$\left(\frac{dr}{d\tau}\right)^2 = \frac{E}{m^2c^2} - \left(1 + \frac{T}{Rr}\right)\left(c^2 + \frac{L^2}{m^2r^2}\right). \tag{13.10}$$

For a planet such as Mercury in the solar system the advance of the perihelion is only a few arc-seconds per century and is essentially constant. This is due to the relatively weak gravitational forces in the solar system in comparison with the Hulse Taylor binary pulsar, where the advance in the perihelion is 4.2° per year. Eq. (13.10) is for a mass m orbiting a mass M and may be written as a function of T/R as follows:

$$\begin{aligned}\frac{1}{2}m\left(\frac{dr}{d\tau}\right)^2 = \left(\frac{E^2}{2mc^2} - \frac{1}{2}mc^2\right) - \frac{c^2}{2}\frac{T}{rR}m \\ - \frac{L^2}{2mr^2} - \frac{T}{2R}\frac{L^2}{mr^3}.\end{aligned} \tag{13.11}$$

The potential energy of the orbital equation is:

$$V(r) = \frac{c^2}{2}\frac{T}{rR}m + \frac{L^2}{2mr^2} + \frac{T}{2R}\frac{L^2}{mr^3}, \tag{13.12}$$

and consists of the 1/r dependent gravitational attraction, the $1/r^2$ dependent centripetal repulsion, and the $1/r^3$ dependent relativistic attraction. It is seen that the negative attraction terms depend on T/R, but the centripetal repulsion does not. The perihelion advance is given [1–10] by:

$$\delta\phi = -\left(\frac{3\pi r}{A(1-e^2)}\right)\frac{T}{R} \tag{13.13}$$

where A is the semi-major axis and where e is the orbital eccentricity. When T/R is constant the perihelion advance is constant, as appears to be the case for Mercury within experimental precision at present.

In the Hulse Taylor binary pulsar the perihelion advance is not constant, because the orbit decreases by 3.1 mm per revolution. Therefore r in Eq. (13.12) decreases by 3.1 mm each revolution. In consequence the attractive $1/r^3$ term begins to dominate over the other two terms as

$$r \to 0. \tag{13.14}$$

Therefore the attraction between the two objects of mass M and m will increase per revolution of orbit as observed. Using the experimental data the ratio T/R can be found for the Hulse Taylor binary pulsar, or any other binary pulsar such as the one discovered at Joddrell Bank in 2003/2004 [13].

In the solar system the data from the Pioneer anomaly can be used to find the appropriate T/R for the solar system, and in general for every system that is observed to have anomalous behavior. More generally T/R may depend on the three coordinates of the spherical polar system (r, θ, ϕ). Therefore a systematic astronomical survey may be carried out to describe each system in terms of its characteristic T/R parameter. This is precisely constant only if the perihelion advance is constant and the orbit is stable.

Similarly, light deflection due to gravity is precisely twice the Newtonian value only if the ratio T/R is precisely constant. Light deflection is calculated by eliminating the proper time as follows:

$$\left(\frac{dr}{d\phi}\right)^2 = \left(\frac{dr}{d\tau}\right)^2 \left(\frac{d\tau}{d\phi}\right)^2 = \left(\frac{dr}{d\tau}\right)^2 \left(\frac{mr^2}{L}\right)^2 \tag{13.15}$$

which implies that:

$$\left(\frac{dr}{d\phi}\right)^2 = \frac{r^4}{b^2} - \left(1 + \frac{T}{rR}\right)\left(\frac{r^4}{a^2} + r^2\right) \tag{13.16}$$

where a and b are constants [12]:

$$a := \frac{L}{mc}, \ b := \frac{cL}{E}. \tag{13.17}$$

This is the orbital equation in a form where proper time has been eliminated. It is seen that the orbital equation also depends on the ratio T/R. All orbits are defined by this ratio. From Eq. (13.16):

$$\phi = \int \left(r^2 \left(\frac{1}{b^2} - \left(1 + \frac{T}{rR}\right)\right)\left(\frac{1}{a^2} + \frac{1}{r^2}\right)\right)^{-1} dr. \tag{13.18}$$

The formula for light deflection due to gravitation is obtained as:

$$m \to 0 \tag{13.19}$$

and so:

$$\phi \to \int \left(r^2 \frac{1}{b^2} - \left(1 + \frac{T}{rR}\right)\frac{1}{r^2}\right)^{-1} dr. \tag{13.20}$$

Expanding in power of $\frac{T}{rR}$ gives:

$$\delta\phi \sim -\frac{2T}{Rb}. \tag{13.21}$$

Here b is identified with the distance of closest approach. Any deviation from twice the Newtonian value means that the ratio T/R is not precisely constant, as in the problem of the perihelion advance. In addition to light deflection, ECE theory predicts that gravitation will change all the electro-dynamical properties of light, notably polarization. This phenomenon could be looked for in the newly discovered Joddrell Bank binary pulsar or other objects with mass much greater than the sun of the solar system. The greater the mass the greater the ratio T/R from the formula:

$$-\frac{T}{R} = \frac{2mG}{c^2} \tag{13.22}$$

and the greater the angle of deflection from the formula (13.21).

In future work a search will be made for a theoretical method that may give T/R from first principles, and also modeling of T/R with various kinds of r dependence may be made with the use of computer graphics and algebra. This is a much simpler explanation than gravitational radiation, which cannot exist according to the EH equation because the latter is fundamentally flawed, i.e. is not compatible with the Bianchi identity as given by Cartan. Therfore gravitational radiation from the EH equation cannot be a precise test of gravitational relativity. Unless torsion is correctly incorporated as in ECE theory, light deflection and perihelion advance cannot be regarded as precise tests of the EH equation. It appears that the claims of the standard model in this respect are due to modeling with many parameters.

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[13] Discovered circa 2003/2004 and consisting of two pulsars whose orbit decreases by about 7 millimeters a revolution, see ref. (3) for more details.

[14] See section by S. Crothers in paper 93 of ECE theory on www.aias.us.

[15] These show a small but systematic non-Newtonian attraction towards the sun, and new anomalies are being discovered, suggesting a dependence of - T/R on all three spherical polar coordinates in general.