REFUTATION OF GENERAL RELATIVITY : INCONSISTENCIES IN THE EINSTEINIAN THEORY OF PERIHELION PRECESSION.

by

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ABSTRACT

Perihelion precessions are calculated for nearly circular orbits for various force laws used in astronomy. It is shown that the claims of Einsteinian general relativity (EGR) are self inconsistent and are not verified by experimental data. There are also philosophical self inconsistencies within the framework of EGR, which means that it is not a satisfactory theory of natural philosophy. A simple suggestion is given for a philosophically self consistent theory within the framework of ECE theory.

Keywords: ECE theory, calculation of perihelion precessions for nearly circular orbits, refutations of Einsteinian general relativity.

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1. INTRODUCTION

During the course of development of the well known ECE unified field theory {1 - 10} many refutations emerged of Einsteinian general relativity (EGR). These refutations are simple to understand and there is no logical answer to them, so new systems of cosmology have been forged in recent papers of this series. In Section 2 a method is developed to calculate perihelion precessions for nearly circular orbits in the classical approximation to ECE theory and it is applied to potential and force laws used in astronomy and cosmology. The Newtonian approximation is adequate for most precessions but the EGR theory claims that a change in philosophy is needed to describe an anomalous precession. The latter is defined as the difference between the experimental precession and a Newtonian calculation. This claim is not only inconsistent but also untenable in view of numerous criticisms and refutations of EGR {1 - 10} made over nearly a century. The flaws in EGR become apparent with some calculations of perihelion precessions given in Section 2. It is also well known that EGR fails entirely in systems such as whirlpool galaxies, so it cannot be a precise theory inside the solar system. A theory must describe all data self consistently. In Section 3 a simple suggestion is made for the development of a philosophically self consistent relativity based on ECE theory.

2. PERIHELION PRECESSIONS FOR NEARLY CIRCULAR ORBITS IN THE NEWTONIAN APPROXIMATION.

Consider the Lagrangian in plane polar coordinates {11, 12} for orbital motion in a plane:

$$\mathcal{L} = \frac{1}{2}\mu\left(\dot{r}^2 + r^2\dot{\theta}^2\right) - V(r) \quad -(1)$$

where the reduced mass is:

$$\mu = \frac{mM}{m+M}. \quad -(2)$$

If m << M then the reduced mass is nearly the same as m. The Euler Lagrange equations are:

$$\frac{\partial \mathcal{L}}{\partial \theta} = \frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{\theta}} \quad -(3)$$

and

$$\frac{\partial \mathcal{L}}{\partial r} = \frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{r}} \quad -(4)$$

and the total angular momentum is conserved:

$$L_0 = \frac{\partial \mathcal{L}}{\partial \dot{\theta}} = mr^2\dot{\theta} = \text{constant}. \quad -(5)$$

From Eq. (4):

$$\ddot{r} - r\dot{\theta}^2 = \frac{F(r)}{m} := f(r). \quad -(6)$$

From Eq. (5):

$$h = \frac{L_0}{m} = r^2\dot{\theta} = \text{constant}. \quad -(7)$$

Consider small deviations {12} from nearly circular orbits such as the orbit of a planet in the solar system. Then from Eqs. (6) and (7):

$$\ddot{x} - \frac{h^2}{(r_{av}+x)^3} = f(r_{av}+x); \quad x := r - r_{av}. \quad -(8)$$

For small x, a Maclaurin expansion gives:

$$\ddot{x} - \frac{h^2}{r_{av}^3}\left(1 - \frac{3x}{r_{av}}\right) \sim f(r_{av}) + \frac{\partial f}{\partial r_{av}}(r_{av})\,x \quad -(9)$$

and for a nearly circular orbit:

$$\ddot{r} \sim 0 \quad -(10)$$

so Eq. (6) becomes:

$$-\frac{h^2}{r_{av}^3} \sim f(r_{av}). \quad -(11)$$

From Eqs. (9) and (11):

$$\ddot{x} - \left(\frac{3f(r_{av})}{r_{av}} + \frac{\partial f(r_{av})}{\partial r_{av}}\right)x = 0. \quad -(12)$$

This is a harmonic oscillator equation with oscillation period:

$$T = 2\pi\left(-\frac{3f}{r_{av}} - \frac{\partial f}{\partial r_{av}}\right)^{-1/2}. \quad -(13)$$

In the approximation (11):

$$\dot{\theta} \sim \frac{h}{r_{av}^2} = \left(-\frac{f(r_{av})}{r_{av}}\right)^{1/2}. \quad -(14)$$

The angle by which θ increases between a maximum and minimum of r is the apsidal angle {12}, and the time needed for this is T / 2. The apsidal angle for elliptical orbits for example is π. In general the apsidal angle is:

$$\phi = \frac{1}{2}T\dot{\theta} \quad -(15)$$

so:

$$\phi = \pi\left(3 + \frac{r_{av}}{f}\frac{\partial f}{\partial r_{av}}\right)^{-1/2}. \quad -(16)$$

In order for the orbit to be closed the apsidal angle has to be a rational function of ϕ. From Eqns. (15) and (16)

$$\phi = \frac{\pi}{(3+n)^{1/2}} \text{ for } f(r) = -cr^{n} \quad -(17)$$

and for the inverse square law:

$$n = -2 \quad -(18)$$

then

$$\phi = \pi. \quad -(19)$$

The EGR theory uses a metric based philosophy in which force is not defined initially {1 - 10} but self inconsistently arrives at a force law using the classical Euler Lagrange equations of this section. It uses a hugely elaborate method to calculate the perihelion precession from this force law {11}. Recently this method has been shown to be riddled with errors {1 - 10}, and also to produce unphysical singularities. The EGR method is well known and accepted to be neglect spacetime torsion and to be based on the wrong field equation and incorrect second Bianchi identity. It produces a force law of the type:

$$f(r) = -\frac{k}{r^2} - \frac{\epsilon}{r^4} \quad -(20)$$

so the apsidal angle from this force law is, from Eq. (16):

$$\phi = \pi \left(3 - 2 \left(\frac{1 + 2\epsilon / (k r_{av}^2)}{1 + \epsilon / (k r_{av}^2)} \right) \right)^{-1/2} \quad -(21)$$

If:

$$\epsilon << k r_{av}^2 \quad -(22)$$

then

$$\phi \sim \pi\left(3 - 2\left(1 + \frac{\epsilon}{k r_{av}^2}\right)\right)^{-1/2} \sim \pi\left(1 + \frac{\epsilon}{k r_{av}^2}\right) \quad -(23)$$

and the apsidal angle advances by:

$$\Delta\phi = \frac{\pi \epsilon}{k r_{av}^2}. \quad -(24)$$

In EGR:

$$k = MG, \quad \epsilon = \frac{3 L_0^2 M G}{m^2 c^2}, \quad -(25)$$

where M is the mass of the attracting object (such as the sun), G is Newton's constant and the total angular momentum in the non relativistic approximation. In the Newtonian approximation {11}

$$L_0^2 = \alpha m^2 M G \quad -(26)$$

where α is the half right latitude of an elliptical orbit. So:

$$\Delta\phi = 3\pi\left(\frac{\alpha M G}{c^2 r_{av}^2}\right). \quad -(27)$$

In one complete revolution 2π the perihelion advances by:

$$\Delta\theta = 2\Delta\phi = \frac{6\pi M G}{c^2}\frac{\alpha}{r_{av}^2}. \quad -(28)$$

Now use:

$$r_{min} = \frac{\alpha}{1+\epsilon}, \quad -(29)$$

$$r_{max} = \frac{\alpha}{1-\epsilon}, \quad -(30)$$

and so for an approximately circular orbit:

$$r_{av} \sim r_{min} \sim r_{max} \sim \alpha \sim r, \quad \epsilon \sim 0 \qquad -(31)$$

and

$$\Delta\theta = \frac{6\pi MG}{\alpha c^2}. \qquad -(32)$$

For an elliptical orbit:

$$\alpha = (1-\epsilon^2)a \qquad -(33)$$

and so:

$$\alpha \sim a. \qquad -(34)$$

This gives:

$$\Delta\theta = \frac{6\pi MG}{ac^2}. \qquad -(35)$$

The result given in reference {11} is:

$$\Delta\theta = \frac{6\pi MG}{ac^2(1-\epsilon^2)}. \qquad -(36)$$

For the Earth:

$$\epsilon^2 = 2.79 \times 10^{-4} \qquad -(37)$$

and so Eq. (35) is adequate. In previous work {1 - 10}:

$$\Delta\theta = 2\pi(1-x) \qquad (38)$$

so

$$x = 1 - \frac{2\epsilon}{k r_{av}^2} . \quad -(39)$$

However, it is known from previous work that the Einstein force law (20) does not produce the true precessing ellipse:

$$r = \frac{\alpha}{1 + \epsilon \cos(x\theta)} . \quad -(40)$$

The force law needed for Eq. (40) is the sum of terms inverse and inverse cubed in r:

$$F = -\frac{L_0^2}{m r^3}\left(1 - x^2\right) - \frac{L_0^2 x^2}{m r^2 \alpha} . \quad -(41)$$

In the approximation:

$$\epsilon \rightarrow 0, \quad r \rightarrow \alpha \quad -(42)$$

the apsidal angle from force law (41) is:

$$\psi = \pi \left(3 + \frac{r}{F}\frac{\partial F}{\partial r}\right)^{-1/2} \quad -(43)$$

which is approximately:

$$\psi = \pi \left(\frac{x^2 r}{(r-\alpha)x^2 + \alpha}\right)^{-1/2} \sim \pi\left(1 + \frac{1}{2}\frac{\alpha}{r x^2}\left(1 - x^2\right)\right) \quad -(44)$$

and the perihelion advances by:

$$\Delta\theta = \frac{\pi \alpha \left(1 - x^2\right)}{x^2 r} . \quad -(45)$$

In previous work it was shown that the perihelion advances by:

$$\Delta\theta = 2\pi(1 - x) \quad -(46)$$

so:

$$1 - x = \frac{(1 - x^2)}{2x^2}\left(\frac{\alpha}{r}\right) \quad -(47)$$

and:

$$x = \frac{1}{4}\frac{\alpha}{r}\left(1 \pm \left(1 + 8\frac{r}{\alpha}\right)^{1/2}\right) \quad -(48)$$

which has the properties:

$$\frac{\alpha}{r} \rightarrow 1 \text{ as } x \rightarrow 1. \quad -(49)$$

The equivalent result from the Einstein theory is:

$$2\pi(1 - x) = 6\pi\frac{GM}{ac^2} \quad -(50)$$

so:

$$x(\text{Einstein}) = 1 - \frac{3GM}{ac^2}. \quad -(51)$$

Taking the positive root in Eq. (48) then, using:

$$\frac{r}{\alpha} \rightarrow 1 \quad -(52)$$

and:

$$x(\text{true precessing ellipse}) \sim \frac{\alpha}{r}. \quad -(53)$$

Finally use:

$$r \sim a, \quad \alpha \sim \frac{L_0^2}{m^2 M G} \quad -(54.)$$

to find:

$$x \sim \frac{L_0^2}{m^2 \underline{M} G a} \qquad -(55)$$

which is completely different from the Einstein result:

$$x(\text{Einstein}) = 1 - \frac{3L_0^2}{2m^2c^2a} \qquad -(56)$$

Therefore EGR never gives the true precessing ellipse, QED.

Therefore it is impossible to accept the various claims that EGR is a precise theory. In addition it is possible to show as follows that the EGR result is given by a small perturbation of a Newtonian potential. Consider the general expansion {12}:

$$\left\langle \frac{1}{|\underline{r} - \underline{a}|} \right\rangle = \frac{1}{r} \sum_{n=0}^{\infty} \left(\frac{a}{r} \right)^n P_n(\cos\theta) P_n(\cos\theta'), \quad r > a \qquad -(57)$$

in terms of Legendre polynomials. In a plane:

$$\theta = \theta' = \frac{\pi}{2} \qquad -(58)$$

so:

$$\cos\theta = \cos\theta' = 0 \qquad -(59)$$

and:

$$P_0(0) = 1, \; P_1(0) = 0, \; P_2(0) = -\frac{1}{2}, \; P_3(0) = 0, \; P_4(0) = \frac{3}{8}. \qquad -(60)$$

Therefore:

$$\left\langle \frac{1}{|\underline{r} - \underline{a}|} \right\rangle = \frac{1}{r} \left(1 + \frac{1}{4} \left(\frac{a}{r} \right)^2 + \frac{9}{64} \left(\frac{a}{r} \right)^4 + \dots \right), \quad r > a, \qquad -(61)$$

a general result of mathematics which can be applied to calculate the average potential:

$$\phi = -MG \left\langle \frac{1}{|\underline{r} - \underline{a}|} \right\rangle \quad -(62)$$

in the Newtonian theory. Here M is a mass at the origin and m a mass separated from M by $|\underline{r} - \underline{a}|$, a modulus or magnitude with mean distance vector $\underline{r}$ and fluctuations $\underline{a}$. The potential is:

$$\phi = -\frac{MG}{r}\left(1 + \frac{1}{4}\left(\frac{a}{r}\right)^2 + \frac{9}{64}\left(\frac{a}{r}\right)^4 + \cdots\right) \quad -(63)$$

and the force per unit mass is:

$$\frac{F}{m} = -\frac{d\phi}{dr} = -\frac{MG}{r^2}\left(1 + \frac{3}{4}\left(\frac{a}{r}\right)^2 + \frac{45}{64}\left(\frac{a}{r}\right)^4 + \cdots\right) \quad -(64)$$

If:

$$a << r \quad -(65)$$

the force is:

$$F \sim -\frac{mMG}{r^2}\left(1 + \frac{3}{4}\left(\frac{a}{r}\right)^2\right) \quad -(66)$$

which is the type of potential encountered in EGR in which:

$$F = -\frac{mMG}{r^2}\left(1 + \frac{3L_0^2}{(mcr)^2}\right) \quad -(67)$$

Eqs. (66) and (67) are the same if:

$$a = \frac{2L_0}{mc} \quad -(68)$$

Using:

$$L_0^2 = d m^2 MG \quad -(69)$$

and defining the obsolete Schwarzschild radius as:

$$r_0 = \frac{2MG}{c^2} \quad -(70)$$

then Eq. (68) becomes:

$$a^2 = 2\alpha r_0. \quad -(71)$$

A small perturbation (71) of a Newtonian orbit will produce the same precession as EGR.

If the orbit is nearly circular the apsidal angle is:

$$\phi = \pi \left(3 + \frac{r}{F}\frac{dF}{dr} \right)^{-1/2} \quad -(72)$$

and for an EGR force of type (67) produces the perihelion precession

$$\Delta\theta = \frac{6\pi M G \alpha}{c^2 r^2} = \frac{2\pi r_0 \alpha}{r^2} = \pi \left(\frac{a}{r} \right)^2. \quad -(73)$$

This result means that a perihelion precession of any kind can always be thought of as a perturbation of a Newtonian result, without the need for EGR. In Section 3 it will be shown that a perihelion precession of any kind can always be attributed to a Cartan spin connection, without the need for EGR.

In note 240(6) accompanying this paper on www.aias.us an example of this type of perturbation theory is given by considering the sun of mass M, the planet Mercury of mass m, and the planet Venus of mass m_1. The total potential is:

$$V = -\frac{mMG}{|\underline{r}|} - \frac{m m_1 G}{|\underline{a}_1 - \underline{r}|} \quad -(74)$$

where:

$$a_1 > r. \quad -(75)$$

Expanding Eq. (74) in terms of Legendre polynomials:

$$V(r) = -\frac{mMG}{r} - \frac{mm_1 G}{a_1}\left(1 + \frac{1}{4}\left(\frac{r}{a_1}\right)^2 + \frac{9}{64}\left(\frac{r}{a_1}\right)^4 + \ldots\right) \quad -(76)$$

The Newtonian force is:

$$F(r) = -\frac{\partial V}{\partial r} = -\frac{mMG}{r} + \frac{mm_1 G}{a_1^2}\left(\frac{1}{2}\left(\frac{r}{a_1}\right) + \frac{9}{16}\left(\frac{r}{a_1}\right)^3\right) \quad -(77)$$

and in the approximations of note 240(6) produces the apsidal angle:

$$\psi \sim \pi\left(1 + \frac{m_1}{M}\left(\frac{r}{a_1}\right)^3\left(\frac{3}{4} + \frac{45}{32}\left(\frac{r}{a_1}\right)^2\right)\right) \quad -(78)$$

The precession of the perihelion of Mercury due to the influence of Venus is therefore:

$$\Delta\theta \sim 2\pi\frac{m_1}{M}\left(\frac{r}{a_1}\right)^3\left(\frac{3}{4} + \frac{45}{32}\left(\frac{r}{a_1}\right)^2\right) \quad -(79)$$

where r and a_1 are the distances respectively of Mercury and Venus from the sun. Eq. (79) is the same as that derived by Fitzpatrick {12}, a check on the method and approximations used.

Using Eq. (79) and the data for the solar system given by Fitzpatrick himself in ref {12}, a table of perihelion advances can be drawn up for the various planets. These results are given in Table 1. The results in Table 1 are completely different form those claimed by Fitzpatrick, even though the same equation and same data are being used. This does not give much confidence in the methods used in calculating these perihelion advances. It is claimed in standard physics that these Newtonian perihelion advances can be calculated with great accuracy, and lead to a shortfall or anomaly when compared with the observed perihelion advance. This assumed anomaly is calculated with EGR and it is claimed that EGR produces the anomaly with great accuracy. However, a slight perturbation in the distance of a planet from the sun would change the anomaly. The same philosophy should be used throughout, in standard physics the Newtonian philosophy is used for the planetary perturbations and also for the main equinoctial precession, and EGR is used for the anomaly. This is a nonsense.

Table 1, Planetary Precessions from Eq. (79) in Arc Seconds a Century.

Planet	m / M	T	R (au)	$\Delta\theta(T=1)$	$\Delta\theta(T=0.241)$
Mercury	1.66×10^{-7}	0.241	0.387	–	–
Venus	2.45×10^{-6}	0.615	0.723	36.5	151.5
Earth	3.04×10^{-6}	1.000	1.000	17.1	71.0
Mars	3.23×10^{-7}	1.881	1.52	0.5	2.2
Jupiter	9.55×10^{-4}	11.86	5.20	38.3	158.8
Saturn	2.86×10^{-4}	29.46	9.54	1.9	7.7
Uranus	4.36×10^{-5}	84.01	19.19	0.003	0.01
Neptune	5.18×10^{-5}	164.8	30.07	negligible	negligible

If EGR were applied self consistently, Eq. (74) would change to:

$$V = -\frac{mMG}{r} - \frac{MGL_0^2}{mc^2r^3} - \frac{mm_1G}{|\underline{a}_1-\underline{r}|} - \frac{m_1GL_0^2}{mc^2|\underline{a}_1-\underline{r}|^3} \quad -(80)$$

for the equinoctial precession and every planetary perturbation. However Eq. (80) is not applied correctly in standard physics. The only EGR equation used is, for a given planet:

$$V = -\frac{mMG}{r} - \frac{MGL_0^2}{mc^2r^3} \quad -(81)$$

and all other calculations are Newtonian. This is not self consistent. For the sake of argument however, assume that the last term in Eq. (80) is small. Then the force is:

$$F = -\frac{mMG}{r^2} - \frac{3MGL_0^2}{mc^2r^4} - \frac{mm_1G}{a_1^2}\left(\frac{1}{2}\left(\frac{r}{a_1}\right) + \frac{9}{16}\left(\frac{r}{a_1}\right)^3\right) \quad -(82)$$

and as in note 240(7) the total precession for a given planet is:

$$\Delta\theta = \frac{3\pi}{2}\frac{m_1}{M}\left(\frac{r}{a_1}\right)^2 + \frac{6\pi MG}{c^2r}. \quad -(83)$$

For Mercury the second term from EGR is the anomaly, and is the well known 43 arcseconds a century. In standard physics this is simply added to the precession due to the effect of the gravity of Venus on Mercury. So an EGR term is added to a Newtonian term, whereas both terms should be either EGR or Newtonian. Also the shape of the sun produces a precession, and small changes in the shape of the sun may completely change the experimental anomaly, so EGR would be compared with the wrong experimental data.

In addition to these criticisms the standard physics assumes that the total force due to N planets is:

$$F = -\frac{mMG}{r^2} - \frac{mm_1G}{|\underline{a}_1 - \underline{r}|^2} - \frac{mm_2G}{|\underline{a}_2 - \underline{r}|^2} - \ldots \quad (84)$$

This force is assumed to account for the perturbations of planets m_1, m_2, ... on m. The force between m and the sun M is counted only once, and the EGR effect is also counted only once, to give:

$$\Delta\theta = \frac{3\pi}{2}\left(\frac{m_1}{M}\left(\frac{r}{a_1}\right)^2 + \frac{m_2}{M}\left(\frac{r}{a_2}\right)^2 + \ldots\right) + \frac{6\pi MG}{c^2r} \quad -(85)$$

so the EGR correction is applied to many Newtonian corrections. It is by no means clear that these fundamental assumptions are logical. The reasons are given in detail in note 240(7).

It is easily seen that the problems with EGR multiply if the EGR correction is applied to some standard calculations in astronomy {12}. For example the nutation of the earth is claimed in the standard physics to be due to a Newtonian potential of the type:

$$V = -\frac{mMG}{r} + \frac{MG(I_{\parallel} - I_{\perp})}{2r^3}\left(\frac{3}{2}\sin^2\theta - 1\right) \quad -(86)$$

where m is the mass of the earth, M the mass of the sun, r the mean distance between the earth and sun, and

$$\theta = 23.44^\circ. \quad -(87)$$

The relevant moments of inertia of the earth in this calculation are:

$$I_{\parallel} = 8.034 \times 10^{37}\ \text{kg m}^2 \quad -(88)$$

$$I_{\perp} = 8.008 \times 10^{37}\ \text{kg m}^2 \quad -(89)$$

because the earth is a symmetric top. The force from Eq. (86) is:

$$F = -\frac{\partial V}{\partial r} = -\frac{k}{r^2} - \frac{\epsilon}{r^4} \quad -(90)$$

where:

$$k = MG, \quad \epsilon = -\frac{3MG}{2}\left(I_{\parallel} - I_{\perp}\right)\left(\frac{3}{2}\cos^2\theta - 1\right) \quad -(91)$$

so from Eq. (24) the perihelion precession due to nutation is:

$$\Delta\theta = -\frac{6\pi(I_{\parallel} - I_{\perp})}{mr^2}\left(\frac{3}{2}\cos^2\theta - 1\right). \quad -(92)$$

Every century the earth's orbit moves backwards by -2.0×10^{-4} arc seconds because it is a symmetric top and nutates in its orbit. Note carefully that this result is entirely standard.

However, it is Newtonian, and if EGR were valid the potential (86) should be

$$V = -\frac{mMG}{r} - \frac{L_0^2 MG}{mc^2 r^3} + \frac{MG(I_{\parallel} - I_{\perp})}{2r^3}\left(\frac{3}{2}\sin^2\theta - 1\right). \quad -(93)$$

If it is assumed that the relativistic correction to the quadrupole term is small, then the force is:

$$F = -\frac{mMG}{r^2} - \frac{3L_0^2 MG}{mc^2 r^4} - \frac{3MG}{2}\left(I_{\parallel} - I_{\perp}\right)\left(\frac{3}{2}\sin^2\theta - 1\right) \quad -(94)$$

so the perihelion precession becomes:

$$\Delta\theta = 6\pi\left(\frac{\alpha MG}{c^2 r^2} - \frac{1}{2}\frac{\left(I_{\parallel} - I_{\perp}\right)}{mr^2}\left(\frac{3}{2}\cos^2\theta - 1\right)\right). \quad -(95)$$

The earth's orbit is nearly circular so

$$\alpha \sim r \quad -(96)$$

and the perihelion precession of the earth due to EGR is:

$$\Delta\theta = 3.86 \text{ arc seconds per century}. \quad -(97)$$

This is about four orders of magnitude greater than the Newtonian effect due to the quadrupole term and in the opposite direction. This is obviously not observed in astronomy, the precession due to nutation being known accurately. What happens in the standard model is that the EGR effect is considered to be a completely different phenomenon and is never associated with nutation. This is illogical and self inconsistent. EGR cannot be reserved for one phenomenon isolated from all others, and as soon as it is used with all phenomena it produces absurd results.

Another clear refutation of EGR can be argued by considering the earth as an oblate spheroid or symmetric top with a Newtonian potential energy:

$$V(r) = -\frac{mMG}{r}\left(1 + \frac{\epsilon}{r^2}\right) \quad -(98)$$

where

$$\epsilon = \frac{2}{5} R \Delta R. \quad -(99)$$

Here R is the earth's equatorial radius (about 4,000 miles) and ΔR the difference between the equatorial and polar radii (about 13 miles). The force from Eq. (98) is:

$$F(r) = -\frac{mMG}{r^2} - \frac{3mMG\epsilon}{r^4}. \quad -(100)$$

Assume that there is a satellite in equatorial orbit, then from Eqs (24) and (100) its perihelion precesses by:

$$\Delta\theta = \frac{6\pi}{r^2}\left(\frac{2}{5} R \Delta R\right) \quad -(101)$$

every orbit of the satellite, i.e. by

$$\Delta\theta = \frac{6\pi}{r^2} \times 3.35 \times 10^{7} \quad -(102)$$

radians per orbit.

However this is a Newtonian calculation and if EGR were valid it should be corrected to a potential energy:

$$V(r) = -\frac{mMG}{r}\left(1 + \frac{\epsilon}{r^2}\right) - \frac{L_0^2 MG}{mc^2 r^3} \quad -(103)$$

so the perihelion procession would be corrected to:

$$\Delta\theta = 6\pi\left(\frac{\epsilon}{r^2} + \frac{MG}{c^2}\frac{1}{r}\right). \quad -(104)$$

For the earth:

$$\frac{MG}{r^2} = 4.43 \times 10^{-3} m \quad -(105)$$

so the effect on a satellite due to EGR is:

$$\Delta\theta = 1.723 \times 10^{4} / r \quad -(106)$$

arc seconds per orbit. An orbit such as that of Gravity Probe B was 650 km above the earth's surface. This is a distance of 4,000 miles plus 650 km above the centre of the earth, i.e. 7.086×10^{6} m above the centre of the earth. This gives an EGR effect of

$$\Delta\theta = 2.43 \times 10^{-3} \quad -(107)$$

arc seconds per orbit. In one thousand orbits this would increase to 2.43 arc seconds. This is a very large effect and should have been observed by Gravity Probe B with its well known high resolution. However the only thing observed by Gravity Probe B was a Thomas precession or geodetic drift of – 6.60 arc seconds per year (many orbits of Gravity Probe B). The precession due to the shape of the earth is 2.56 arc seconds per orbit at 650 km above the surface. It is assumed that this was taken into account by Gravity Probe B. Considering all the errors being uncovered here this seems like a big assumption.

Proceeding in this way note 240(10) collects the results of some EGR corrections when applied self consistently to well known textbook {11, 12} Newtonian calculations in astronomy. For example the moon is a satellite of the earth in a nearly circular orbit and the fact that the earth is a symmetric top causes a perihelion precession of 4.27×10^{-11} radians per orbit of the moon. It is assumed that this is a well observed effect in astronomy. However this is again a Newtonian calculation and the EGR correction in this case is almost as large, 2.20×10^{-11} radians per orbit of the moon (27 days).

The largest contribution to the precession of planets around the sun is the equinoctial precession, which for the earth is 5,029.1 arc seconds per century, which is

0.0139697° per century. So 2π radians are covered in:

$$T = \frac{360}{0.0139697} = 25,770 \text{ years.} \quad -(108)$$

In UFT119 the equinoctial precession was considered to be due to the gravitomagnetic field. It can also be calculated straightforwardly by assuming that the sun is a symmetric top described by the Newtonian potential (98), which gives a perihelion precession of the earth around the sun of:

$$\Delta\theta = \frac{6\pi\epsilon}{r^2}. \quad -(109)$$

The distance from the earth to the sun is:

$$r = 1.49 \times 10^{11} \, m \quad -(110)$$

and the equatorial radius of the sun is:

$$R = 5.96 \times 10^{8} \, m \quad -(111)$$

so

$$\Delta R = 1.25 \times 10^{8} \, m \quad -(112)$$

would give a precession of 5,029.1 arc seconds per century. Compared with this the EGR precession of the earth is only 3.85 arc seconds per century, and the combined planetary perturbations are of the order of a tenth of the equinoctial precession.

However all these calculations are Newtonian with the exception of 3.85 arc seconds per century. If EGR were valid all the calculations should be EGR calculations. It is also clear that a change in ΔR of the sun by less than one part in a thousand would produce the so called "anomaly" on which the test of EGR is based. In standard physics the EGR effect is considered in isolation, i.e. is not associated with perihelion precession. Similarly EGR is considered in isolation of the effect of a perturbing planet on the earth's orbit. Criticisms such as these are detailed in note 240(11). The EGR potential:

$$V(r) = -\frac{mMG}{r} - \frac{MGL_0^2}{mc^2r^3} \quad -(113)$$

should be used in all the Newtonian calculations, and if this is done, the EGR correction would occur many times. In standard physics however it is applied only once, and then only to a claimed experimental anomaly.

3. SELF CONSISTENT ECE THEORY OF PRECESSION

Consider the Cartan torsion {1 - 10}

$$T^a_{\mu\nu} = \partial_\mu q^a_\nu - \partial_\nu q^a_\mu + \omega^a_{\mu b} q^b_\nu - \omega^a_{\nu b} q^b_\mu \quad -(114)$$

where q^a_μ is the Cartan tetrad and $\omega^a_{\mu b}$ the spin connection. By antisymmetry:

$$T^a_{\mu\nu} = 2\left(\partial_\mu q^a_\nu + \omega^a_{\mu b} q^b_\nu\right). \quad -(115)$$

For the sake of simplicity consider the element:

$$T^0_{1\nu} = 2\left(\partial_1 q^0_\nu + \omega^0_{1b} q^b_\nu\right) \quad -(116)$$

and the indices:

$$b = 0, \quad \nu = 0 \quad -(117)$$

so:

$$T^{0}{}_{10} = 2\left(\partial_1 q^{0}{}_{0} + \omega^{0}{}_{10}\, q^{0}{}_{0}\right). \quad -(118)$$

Define the gravitational potential as:

$$\phi = -2\,\phi^{(0)}\, q^{0}{}_{0}. \quad -(119)$$

It follows that the force is:

$$F = -\frac{\partial \phi}{\partial r} - \Omega\,\phi. \quad -(120)$$

Assume that the gravitational potential is Newtonian:

$$\phi = -\frac{mMG}{r}. \quad -(121)$$

If the spin connection is defined by:

$$\Omega = \frac{3}{r}\left(\frac{L_0}{mcr}\right)^2 \quad -(122)$$

the force is:

$$F = -\frac{mMG}{r^2} - \frac{3MGL_0^2}{mc^2 r^4} \quad -(123)$$

which is the force law of EGR. It is known that this EGR force law is incorrect, and is being used here only to show that it can be produced by a particular choice of spin connection in ECE theory. For an approximately circular orbit:

$$\Omega = \frac{3}{2}\frac{r_0}{r^2} \quad -(124)$$

where the obsolete Schwarzschild radius is defined by:

$$r_0 = \frac{2MG}{c^2}. \quad -(125)$$

The force is therefore:

$$F = -\frac{mMG}{r^2}\left(1 + \frac{\Omega}{r}\right) \quad (126)$$

which gives the perihelion precession:

$$\Delta\theta = 2\Omega r = \frac{6\pi MG}{c^2 r} \quad (127)$$

All observed precessions are produced within one self consistent philosophy in which the potential is Newtonian, but in which the force contains the spin connection. This approach will be developed in future work.

ACKNOWLEDGMENTS

The British Government is thanked for a Civil List Pension and the AIAS and others for many interesting discussions. Dave Burleigh is thanked for posting, and Alex Hill and Robert Cheshire for translation and broadcasting.

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