ORBITAL PRECESSION AND SHRINKAGE FROM FRAME ROTATION.

by

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ABSTRACT

It is shown that in its classical limit, the ECE2 covariant theory of orbits produces orbital precession straightforwardly as a direct result of de Sitter rotation. When the angular acceleration of frame rotation is non zero, the orbit can shrink and precess. Therefore the main features of the Hulse Taylor binary pulsar, precession and shrinkage, are produced in the classical limit of ECE2 theory without use of gravitational radiation. The precession of the S2 star system is produced in terms of the angular velocity of frame rotation. The Einsteinian general relativity (EGR) fails by an order of magnitude in the S2 star system.

Keywords: ECE2 theory, orbital precession and shrinkage in the classical limit.

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1 INTRODUCTION

In recent papers of this series {1 - 41} it has been shown that de Sitter frame rotation of the plane polar coordinates leads to several interesting effects, notably the definition of the spin connection and vacuum force. In Section 2 it is shown that the de Sitter rotation produces orbital precession, and orbital shrinkage when the angular acceleration of frame rotation is also zero. These are the main features of binary pulsars such as the Hulse Taylor binary pulsar. In the classical limit of ECE2 theory these features are produced without having to postulate gravitational radiation. The same rotating frame theory in its classical limit can accurately produce the precession of the S2 star system when the Einsteinian general relativity (EGR) fails completely by an order of magnitude.

This paper is a short synopsis of extensive calculations contained in the notes accompanying UFT413 on www.aias.us. Note 413(1) gives an expression for orbital shrinkage in terms of the angular acceleration of de Sitter rotation. Note 413(2) gives the vacuum force and isotropically averaged fluctuation in terms of the spin connection produced by de Sitter rotation. Note 413(3) is a simplification of the orbital shrinkage theory. Notes 413(4) and 413(5) give the hamiltonian and lagrangian theory in the observer frame. Note 413(6) gives the orbital shrinkage theory, Note 413(7) gives the Cartan torsion and force due to de Sitter rotation and Note 413(8) gives a simple transformation of coordinate proof of orbital precession and shrinkage.

Section 3 is a numerical and graphical analysis.

2. PRECESSION AND SHRINKAGE FROM DE SITTER ROTATION.

Precession and shrinkage are obtained the well known de Sitter coordinate transformation:

$$\phi' = \phi + \omega_1 t \quad -(1)$$

of the plane polar coordinates (r , ϕ), thus producing the coordinate system (r , ϕ'). Here ω_1 is the angular velocity of frame rotation and t the time. The transformation produces the hamiltonian {1 - 41}:

$$H = \frac{1}{2}\mu\left(\dot{r}^2 + r^2\dot{\phi}'^2\right) - \frac{mMG}{r} \quad -(2)$$

and the lagrangian:

$$\mathcal{L} = \frac{1}{2}\mu\left(\dot{r}^2 + r^2\dot{\phi}'^2\right) + \frac{mMG}{r} \quad -(3)$$

for an object of mass m in orbit around a mass M. Here G is Newton's constant. From Eq (2):

$$\phi'(r) = \int \frac{L}{r^2}\left(2\mu\left(H - U - \frac{L^2}{2\mu r^2}\right)\right)^{-1/2} dr \quad -(4)$$

so:

$$\cos\phi' = \left(\frac{L^2}{\mu k r} - 1\right)\left(1 + \frac{2HL^2}{\mu k^2}\right)^{-1/2} \quad -(5)$$

where L is the angular momentum:

$$L = \mu r^2 \dot{\phi}' \quad -(6)$$

There are two constants of motion, H and L, with the property:

$$\frac{dH}{dt} = 0, \quad \frac{dL}{dt} = 0. \quad -(7)$$

Here

$$\mu = \frac{mM}{m+M} \quad -(8)$$

is the reduced mass:

$$\mu \sim m \quad -(9)$$

when m << M. The constant k is defined by:

$$k := mMG. \quad -(10)$$

Eq. (5) is the conic section:

$$r = \frac{\alpha}{1+\epsilon\cos\phi'} \quad -(11)$$

which is a precessing ellipse. The precession per orbit of 2π radians is:

$$\Delta\phi = \omega_1 T. \quad -(12)$$

The half right latitude of the ellipse is the constant of motion:

$$\alpha = \frac{L^2}{\mu k} \quad -(13)$$

and its ellipticity is the constant of motion:

$$\epsilon = \left(1 + \frac{2HL^2}{\mu k^2}\right)^{1/2}. \quad -(14)$$

The theory explains the precession of the S2 star in terms of the simple equation (12), in terms of the angular velocity ω_1 of de Sitter rotation and the time T taken for one orbit of 2π radians. The Einsteinian general relativity (EGR) fails completely to describe the precession of the S2 star. EGR fails by a factor ten, so the Einstein theory is refuted experimentally, to be replaced by ECE and ECE2.

The semi major axis of the orbit is {1 - 41}:

$$a = \frac{\alpha}{1-\epsilon^2} = \frac{k}{2|H|} \quad -(15)$$

and the semi minor axis is:

$$b = (\alpha a)^{1/2} = \frac{\alpha}{(1-\epsilon^2)^{1/2}} = \frac{L}{(2\mu|H|)^{1/2}} \quad -(16)$$

From Eqs. (1) and (2);

$$\phi' \xrightarrow[t \to \infty]{} \infty \quad -(17)$$

so:

$$H \xrightarrow[t \to \infty]{} \infty. \quad -(18)$$

In consequence the semi major axis shrinks to zero:

$$a \xrightarrow[t \to \infty]{} 0. \quad -(19)$$

The time taken for one orbit of 2π radians for example is T, so after one orbit:

$$\phi' = \phi + \omega_1 T \quad -(20)$$

and the hamiltonian has increased to:

$$H = \frac{1}{2}\mu\left(\dot{r}^2 + r^2\left(\dot{\phi} + T\frac{d\omega_1}{dt}\right)^2\right) - \frac{mMG}{r} \quad -(21)$$

and is a constant of motion:

$$\frac{dH}{dt} = 0. \quad -(22)$$

After an infinite number of orbits the hamiltonian is infinite and the orbit has shrunk to a point.

Kepler's second law is:

$$\frac{dA}{dt} = \frac{1}{2} r^2 \dot{\phi}' = \frac{L}{2\mu} = \text{constant} \quad -(23)$$

where A is area, so the areal velocity is constant. It follows that:

$$r \xrightarrow[\dot{\phi}' \to \infty]{} 0. \quad -(24)$$

The de Sitter rotation is enough to explain the shrinking of an orbit without any use of EGR and gravitational radiation, Q. E. D. Kepler's first law is Eq. (11) and Kepler's third law is the direct result of:

$$dt = \frac{2\mu}{L} dA \quad -(25)$$

so:

$$T = \int_0^t dt = \frac{2\mu}{L} \int_0^A dA = \frac{2\mu}{L} A. \quad -(26)$$

The area of the ellipse is:

$$A = \pi a b \quad -(27)$$

and the semi minor axis is:

$$b = (\alpha a)^{1/2}. \quad -(28)$$

Here α is a constant of motion so as a shrinks to zero so does b. Kepler's third law from Eqs. (13), (15) and (16) is:

$$T^2 = \frac{4\pi^2 \mu}{k} a^3 \quad -(29)$$

so

$$T \xrightarrow[\dot{\phi}' \to \infty]{} 0. \quad -(30)$$

The time T taken for one orbit is zero when the orbit has shrunk to a point.

In the coordinate system (r, ϕ') the Euler Lagrange equations are:

$$\frac{\partial \mathcal{L}}{\partial r} = \frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{r}} \quad -(31)$$

and

$$\frac{\partial \mathcal{L}}{\partial \phi'} = \frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{\phi}'}. \quad -(32)$$

Eq. (31) gives the Leibnitz equation modified by frame rotation:

$$m\ddot{r} - mr\dot{\phi}'^2 = -\frac{mMG}{r^2} \quad -(33)$$

and Eq. (32) gives:

$$\frac{dL}{dt} = 0 \quad -(34)$$

where the angular momentum is

$$L = mr^2\dot{\phi}'. \quad -(35)$$

The hamiltonian is also a constant of motion so

$$\frac{dH}{dt} = 0 = \frac{1}{2}\left(2\dot{r}\ddot{r} + \frac{dr^2}{dt}\dot{\phi}'^2 + r^2\frac{d\dot{\phi}'^2}{dt}\right) + \frac{MG}{r^2}\dot{r} \quad -(36)$$

Therefore:

$$r\ddot{r} + r\dot{\phi}'^{2}\dot{r} + r^{2}\dot{\phi}'\ddot{\phi}' + \frac{MG}{r^{2}}\dot{r} = 0 \qquad -(37)$$

which can be written as:

$$r\ddot{r} - r\dot{\phi}'^{2}\dot{r} + 2r\dot{\phi}'^{2}\dot{r} + r^{2}\dot{\phi}'\ddot{\phi}' = -\frac{MG}{r^{2}}\dot{r} \qquad -(38)$$

which implies the two equations:

$$\ddot{r} - r\dot{\phi}'^{2} = -\frac{MG}{r^{2}} \qquad -(39)$$

and

$$2\dot{\phi}'\dot{r} + r\ddot{\phi}' = 0. \qquad -(40)$$

Eq. (39) is the Leibnitz equation (33) derived self consistently from the hamiltonian and lagrangian in the (r, ϕ') system. Eq. (40) is the direct consequence of the conservation of angular momentum in the coordinate system (r , ϕ'):

$$\frac{dL}{dt} = 0 = m\frac{d}{dt}\left(r^{2}\dot{\phi}'\right) = m\left(2\dot{\phi}'\dot{r} + r\ddot{\phi}'\right). \qquad -(41)$$

The angular momentum in frame (r, ϕ') is defined by:

$$L = mr^{2}\dot{\phi}' = mr^{2}\left(\dot{\phi} + \frac{d}{dt}(\omega_1 t)\right) = mr^{2}\left(\omega + \omega_1 + t\frac{d\omega_1}{dt}\right) \qquad -(42)$$

and in general the angular acceleration is not zero. Therefore:

$$r^{2} = \frac{L}{m\left(\omega + \omega_1 + t\frac{d\omega_1}{dt}\right)}. \qquad -(43)$$

Since L is a constant of motion the radius r must decrease as t increases as shown earlier in this section using a different argument. As described in detail in Note 413(1) the rate of shrinkage can be calculated from:

$$\frac{dL}{dt} = 0 \quad -(44)$$

giving:

$$\frac{dr}{dt} = -\frac{r}{2}\frac{d}{dt}\left(\omega + \omega_1 + t\frac{d\omega_1}{dt}\right) \Big/ \left(\omega + \omega_1 + t\frac{d\omega_1}{dt}\right). \quad -(45)$$

Various models can be used for the angular velocity of frame rotation as in Note 413(1).

The fundamental kinematics of the frame (r , ϕ') are developed in Note 413(2), which defines the unit vectors of frame (r , ϕ') as:

$$\underline{e}_r = \underline{i}\cos\phi' + \underline{j}\sin\phi' \quad -(46)$$

and

$$\underline{e}_\phi = -\underline{i}\sin\phi' + \underline{j}\cos\phi'. \quad -(47)$$

The linear velocity in frame (r , ϕ') is:

$$\underline{v} = \dot{r}\,\underline{e}_r + r\dot{\phi}'\,\underline{e}_\phi \quad -(48)$$

and the linear acceleration is:

$$\underline{a} = \left(\ddot{r} - r\dot{\phi}'^2\right)\underline{e}_r + \left(r\ddot{\phi}' + 2\dot{r}\dot{\phi}'\right)\underline{e}_\phi \quad -(49)$$

As shown earlier in this section the constancy of the hamiltonian:

$$\frac{dH}{dt} = 0 \quad -(50)$$

produces

$$m\ddot{r} - mr\dot{\phi}'^2 = -\frac{mMG}{r^2} \quad -(51)$$

and

$$2\dot{\phi}'\dot{r} + r\ddot{\phi}' = 0 \quad -(52)$$

in frame (r , ϕ'). In the Leibnitz equation (51):

$$\dot{\phi}'^2 = \left(\omega + \omega_1 + t\frac{d\omega_1}{dt}\right)^2 \quad -(53)$$

It follows that the Leibnitz equation is:

$$m\ddot{r} - mr\dot{\phi}^2 = -\frac{mMG}{r^2} + 2\left(\omega_1 + t\frac{d\omega_1}{dt}\right)\dot{\phi} + \left(\omega_1 + t\frac{d\omega_1}{dt}\right)^2 \quad -(54)$$

This equation is expressed in terms of the spin connection Ω_r by using:

$$F = m\ddot{r} - mr\dot{\phi}^2 = -\frac{mMG}{r^2} + m\Omega_r\Phi \quad -(55)$$

where:

$$\Phi = -\frac{MG}{r} \quad -(56)$$

is the gravitational potential.

Therefore the spin connection has been defined by the de Sitter rotation (1).

It follows as in Note 413(5) that the spin connection is:

$$\Omega_r = \frac{-L}{mMG}\left(\omega + \omega_1 + t\frac{d\omega_1}{dt}\right)\left(\omega_1 + t\frac{d\omega_1}{dt}\right)\left(\omega_1 + t\frac{d\omega_1}{dt} + 2\omega\right) \quad -(57)$$

and that this results from the frame rotation:

$$\phi' = \phi + \omega_1 t \quad -(58)$$

As in Note 413(7) the Cartan torsion associated with the spin conenction (57) results in the acceleration due to gravity:

$$g_r = -\frac{mG}{r^2} - \frac{mG}{r}\Omega_r \quad -(59)$$

and the gravitational force:

$$F_r = m g_r . \quad -(60)$$

The vacuum force is:

$$F_r(\text{vac}) = -\frac{mMG}{r}\Omega_r$$

$$= \frac{L}{r}\left(\omega + \omega_1 + t\frac{d\omega_1}{dt}\right)\left(\omega_1 + t\frac{d\omega_1}{dt}\right)\left(\omega_1 + t\frac{d\omega_1}{dt} + 2\omega\right) \quad -(61)$$

So the complete acceleration due to gravity results in the total force

$$F_r(r + \delta r) = F_r(r) + F_r(\text{vac}) \quad -(62)$$

which can be developed as in recent UFT papers in terms of vacuum fluctuations δr. It follows that the total force is:

$$F_r(r + \delta r) = -\frac{mMG}{r^2} + F_r(\text{vac}) \quad -(63)$$

and that the ubiquitous vacuum force is:

$$F_r(\text{vac}) = \frac{1}{6}\langle \underline{\delta r} \cdot \underline{\delta r} \rangle \nabla^2 F = -\frac{2}{3} mMG \frac{\langle \underline{\delta r} \cdot \underline{\delta r} \rangle}{r^4} \quad -(64)$$

So the total force is:

$$F_r(r+\delta r) = -\frac{mMG}{r^2}\left(1+\frac{2}{3}\frac{\langle \delta \underline{r} \cdot \delta \underline{r} \rangle}{r^2}\right) \quad -(65)$$

and the spin connection is:

$$\Omega_r = \frac{2}{3}\frac{\langle \delta \underline{r} \cdot \delta \underline{r} \rangle}{r^3} \quad -(66)$$

It follows that:

$$|\Omega_r| = \frac{2}{3}\frac{\langle \delta \underline{r} \cdot \delta \underline{r} \rangle}{r^3} \quad -(67)$$

$$= \frac{L}{mMG}\left(\omega+\omega_1+t\frac{d\omega_1}{dt}\right)\left(\omega_1+t\frac{d\omega_1}{dt}\right)\left(\omega_1+t\frac{d\omega_1}{dt}+2\omega\right)$$

In the limit:

$$\omega_1 \rightarrow 0 \quad -(68)$$

it follows that

$$|\Omega_r| \rightarrow 0 \quad -(69)$$

self consistently, and

$$r = \frac{\alpha}{1+\epsilon\cos\phi} \quad -(70)$$

The vacuum force is ubiquitous and gives rise to the anomalous g factors of elementary particles, the Lamb shift and the Casimir effect. The same vacuum force gives rise to orbital precession and shrinkage.

3. NUMERICAL ANALYSIS AND COMPUTATION

(Section by Dr. Horst Eckardt)