DERIVATION OF THE UNIVERSAL PLANETARY PRECESSION FROM THE THOMAS PRECESSION.

by

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ABSTRACT

The universal precession of the perihelion is derived straightforwardly from the Thomas precession, the rotation of the Minkowski metric. The theory is developed within a context of general relativity, a generally covariant unified field theory (ECE theory) in which the Cartan spin connection is the angular velocity. The Minkowski metric is interpreted as a metric that is capable of describing all known planetary precessions, and not as a metric of special relativity in which one frame moves with respect to another with constant velocity.

Keywords: ECE theory, planetary precession, Thomas precession.

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1. INTRODUCTION

Recently in this series of two hundred and sixty five papers to date {1 - 10} it has been proven that the Einstein field equation cannot describe the universal planetary precession defined by:

$$x = 1 + \frac{3MG}{c^2 \alpha} \quad - (1)$$

where M is the mass of an object at the focus of an ellipse, G is Newton's constant, c is the vacuum speed of light, and α the half right latitude. The reason is that the Einstein field equation was inferred incorrectly in an era when the spacetime torsion of Cartan was unknown. As in the definitive proofs one to five on www.aias.us the neglect of torsion means that curvature also vanishes, so that the curvature based Einsteinian gravitation vanishes if torsion is neglected, a disaster for the theory. It has actually been known for a century that the Einstein field equation and Einstein's methods contain errors. These were first pointed out by Schwarzschild in December 1915 in a letter to Einstein. This has been translated by Vankov {11} who adds several more criticisms of Einstein's derivation of the planetary precession in 1915. It has been known since the late fifties that the Einstein theory fails catastrophically in whirlpool galaxies, it fails completely to describe the velocity curve, because the Einstein theory results in zero orbital linear velocity for large r, the distance between the centre of the galaxy and a star of the galaxy. The observed limit of linear velocity is a constant as is well know: the velocity curve of a whirlpool gaalxy. ECE theory easily succeeds in describing the hyperbolic orbit of a star in a whirlpool galaxy as shown in immediately preceding papers.

These recent papers have also developed an entirely new method of describing the planetary phenomena usually attributed to the obsolete Einstein theory: planetary precession of the perihelion, deflection of electromagnetic radiation by gravitation, gravitational time delay, and gravitational red shift. In addition a new method has been developed to measure the relativistic photon velocity and photon mass. The R theory of recent papers is based on the definition of the turning point of the orbit, and has been shown to be rigorously equivalent to x theory, where x is defined as above and rigorously describes the precessing orbit, a precessing conical section. The conical sections of primary interest are the ellipse and hyperbola.

In section 2 the origin of the x factor is shown to be the Thomas precession, the well known rotation of the Minkowski metric at a constant angular velocity. At a turning point such as the perihelion the Thomas precession is shown straightforwardly to result in the above Eq. (1). The framework of the theory is the generally covariant unified field theory known as ECE theory, which has been developed over eleven years in these papers and other books and articles. Therefore the Minkowski metric has a total linear velocity defined by the orbit. This is no longer the constant linear velocity of one frame translated with respect to another. The distinction between special and general relativity has always been ill defined, especially when it comes to rotational motion. In a book such as that of S. M. Carroll {12} the Lorentz transform is shown to apply to a rotation as well as a Lorentz boost. The Lorentz group contains rotation generators as well as boost generators {1 - 10} and in addition the Poincaré group contains spacetime translation generators as well as boost and rotation generators. The traditional teaching of special relativity is almost always restricted to the Lorentz boost. This is wholly inadequate for orbital theory, in which the centripetal force must be used to keep an object in orbit. The centripetal force is inwardly directed towards M, and is equal and opposite to the outwardly directed centrifugal force. As soon as force enters into consideration, acceleration is present, and so the Lorentz boost concept is inadequate for orbital theory because it deals with constant velocity and zero acceleration.

The transition from this severely restricted view of special relativity to general relativity occurs quite simply by allowing $\underline{v}$ to be the total linear velocity defined by the orbit. This definition actually emerges directly from the Minkowski metric when expressed in plane polar coordinates. It has been shown in several previous UFT papers that the plane polar coordinates define a Cartan geometry in which the spin connection is the angular velocity. The Thomas angular velocity is therefore a spin connection in the context of ECE theory. The entire and obsolete Einstein era is by passed in a straightforward way by use of x theory. The precise results of contemporary astronomy now apply to x theory, which produces all these results straightforwardly. The origin of x is the Thomas precession.

2. CALCULATION OF x FROM THE THOMAS PRECESSION

Consider the infinitesimal line element:

$$ds^2 = c^2 d\tau^2 = c^2 dt^2 - dr^2 - r^2 d\theta^2 \quad -(2)$$

in plane polar coordinates, where τ is the proper time. The Thomas precession {1 - 10} is defined by:

$$\theta' = \theta + \omega t, \quad -(3)$$

$$d\theta' = d\theta + \omega dt, \quad -(4)$$

where ω as a constant angular velocity and t the time in the observer frame. The proper time τ is the time in the frame that is moving with a mass m in orbit around a mass M. In other words the proper time is the time in the frame at which the mass m is at rest. For example in an aircraft the proper time is measured in the aircraft, and is different from the time measured on the ground. The concept of proper time was introduced by Fitzgerald and developed by Lorentz and Heaviside in the late nineteenth century. In 1905 it was used by Einstein to infer relativistic momentum:

$$\underline{p} = \gamma m \underline{v} \quad -(5)$$

from which the Einstein energy equation can be derived {1 - 10}.

From Eq. (4):

$$(d\theta')^2 = (d\theta + \omega dt)^2 = d\theta^2 + 2\omega d\theta dt + \omega^2 dt^2 \quad -(6)$$

It follows that under the Thomas precession the infinitesimal line element (2) becomes:

$$ds^2 = c^2 d\tau^2 = (c^2 - r^2\omega^2) dt^2 - dr^2 - r^2 d\theta^2 - 2\omega r^2 d\theta dt. \quad -(7)$$

The Thomas velocity is the orbital linear velocity defined by:

$$v_\theta = |\underline{\omega} \times \underline{r}| = \omega r \quad -(8)$$

and in ECE theory this becomes the orbital linear velocity produced by the spin connection of spacetime in a theory of general relativity (ECE theory). So the infinitesimal line element becomes:

$$ds^2 = \left(1 - \frac{v_\theta^2}{c^2}\right) c^2 dt^2 - dr^2 - r^2 d\theta^2 - 2\omega r^2 d\theta dt. \quad -(9)$$

Now use:

$$\omega = \frac{d\theta}{dt}, \quad v_\theta = \omega r \quad -(10)$$

so:

$$d\theta = \omega dt = \frac{v_\theta}{r} dt. \quad -(11)$$

It follows that the Thomas precession produces the result:

$$ds^2 = c^2 d\tau^2 = \left(1 - \frac{3v_\theta^2}{c^2}\right) c^2 dt^2 - v^2 dt^2. \quad -(12)$$

The total orbital velocity is defined by:

$$v^2 = v_r^2 + v_\theta^2 = \left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\theta}{dt}\right)^2 \quad -(13)$$

where v_r is the radial velocity and v_θ the orbital linear velocity:

$$\underline{v}_\theta = \underline{\omega} \times \underline{r}. \quad -(14)$$

Therefore:

$$\left(\frac{d\tau}{dt}\right)^2 = 1 - \frac{3v_\theta^2}{c^2} - \frac{v^2}{c^2} \quad -(15)$$

and:

$$\frac{d\tau}{dt} = \left(1 - \frac{v^2}{c^2}\right)^{1/2} \longrightarrow \left(1 - \frac{3v_\theta^2}{c^2} - \frac{v^2}{c^2}\right)^{1/2}. \quad -(16)$$

The Lorentz factor is therefore modified by the Thomas precession to:

$$\gamma = \frac{dt}{d\tau} = \left(1 - \frac{3v_\theta^2}{c^2} - \frac{v^2}{c^2}\right)^{-1/2} \quad -(17)$$

if

$$v \lll c, \; v_\theta \lll c, \quad \gamma \sim 1 + \frac{v^2}{c^2} + \frac{3v_\theta^2}{c^2}. \quad -(18)$$

The total linear velocity of the mass m in orbit around the mass M is:

$$\underline{v} = \underline{v}_r + \underline{\omega} \times \underline{r} \quad -(19)$$

where:

$$\underline{v}_r = \frac{dr}{dt} \underline{e}_r . \quad -(20)$$

So the total kinetic energy is:

$$T = \frac{1}{2} m \left(v_r^2 + \underline{\omega} \times \underline{r} \cdot \underline{\omega} \times \underline{r} \right)$$
$$= \frac{1}{2} m \left(v_r^2 + \omega^2 r^2 \right) \quad -(21)$$

if:

$$\underline{\omega} \perp \underline{r} . \quad -(22)$$

The radial kinetic energy is:

$$T_r = \frac{1}{2} m v_r^2 \quad -(23)$$

and the angular kinetic energy is:

$$T_\theta = \frac{1}{2} m \omega^2 r^2 = \frac{1}{2} I \omega^2 \quad -(24)$$

where the moment of inertia is:

$$\underline{I} = m r^2 . \quad -(25)$$

For a constant ω :

$$T_\theta = \frac{1}{2} m \omega^2 r^2 = m \int \omega^2 r \, dr \quad -(26)$$

which is the rotational work integral. The integral over the centrifugal force produces the rotational kinetic energy. The integral over the radial force produces the translational kinetic energy.

In generating the Thomas precession the only velocity considered is the orbital linear velocity:

$$\underline{v}_\theta = \underline{\omega} \times \underline{r} = \omega r \, \underline{e}_\theta \quad -(27)$$

whose magnitude is:

$$v_\theta = \omega r. \quad -(28)$$

The equivalence principle means therefore that in the case of the Thomas precession:

$$\underline{F} = m \omega^2 r \, \underline{e}_r = -\frac{\partial U}{\partial r} = -\frac{mMG}{r^2} \quad -(29)$$

where U is the gravitational potential energy. It follows that:

$$\int F \, dr = \frac{1}{2} m v_\theta^2 = \frac{mMG}{r} \quad -(30)$$

so:

$$v_\theta^2 = \frac{2MG}{r}. \quad -(31)$$

The infinitesimal line element (2) becomes:

$$ds^2 = c^2 d\tau^2 = \left(1 - \frac{6MG}{c^2 r}\right) c^2 dt^2 - v^2 dt^2 \quad -(32)$$

The additional Lorentz factor due to the Thomas precession is:

$$\frac{dt}{d\tau} = \left(1 - \frac{6MG}{c^2 r}\right)^{-1/2} \sim 1 + \frac{3MG}{c^2 r} \quad -(33)$$

if:

$$\frac{MG}{c^2} << r. \quad -(34)$$

The definition (27) used in the Thomas precession corresponds to a turning point of the orbit. At the turning point the radial part of the velocity vanishes:

$$\underline{v}_r = \underline{0} \quad -(35)$$

and the perihelion of an orbit, the distance of closest approach, is a turning point. Consider the effect of Thomas precession on an orbit defined by the conical section {1 - 10}:

$$r = \frac{\alpha}{1 + \epsilon \cos\theta} \quad -(36)$$

notably an ellipse or hyperbola. In immediately preceding papers it has been shown that the turning point of an ellipse occurs at:

$$r = \alpha = a(1 - \epsilon^2) \quad -(37)$$

where a is the semi major axis and ϵ the eccentricity. The perihelion turning point is the minimum value of r in Eq. (36), the point at which m is closest to M, corresponding to the angle defined by:

$$\cos\theta = 1, \quad \theta = 0. \qquad -(38)$$

So the perihelion of an ellipse is on the major axis.

At the perihelion therefore:

$$x = \frac{dt}{d\tau} = 1 + \frac{3MG}{c^2\alpha} = 1 + \frac{3MG}{c^2 a(1-\epsilon^2)} \qquad -(39)$$

which is the universal planetary precession per radian of the perihelion, Q. E. D.

The precession of the perihelion is therefore the Thomas precession. Its effect is:

$$\theta \rightarrow x\theta \qquad -(40)$$

where:

$$x = \gamma_T = \frac{dt}{d\tau} = 1 + \frac{3MG}{c^2\alpha}. \qquad -(41)$$

Therefore:

$$dt = \left(1 + \frac{3MG}{c^2\alpha}\right) d\tau \qquad -(42)$$

and the precession changes the spin connection or angular velocity to:

$$\Omega = \frac{d\theta}{d\tau} = \left(1 + \frac{3MG}{c^2\alpha}\right)\frac{d\theta}{dt} \qquad -(43)$$

which can be used as a definition of the relativistic angular velocity and angular momentum akin to the definition of the relativistic linear momentum in Eq. (5), Q. E. D. It is concluded that the precession of the perihelion is due to the rotation of the Minkowski metric and is not due to the Einstein field equation at all.

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