FRAME ROTATION AND SPIN CONNECTION.

by

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ABSTRACT

It is shown that rotation of plane polar coordinates due to spacetime torsion leads to the inference of a spin connection and vacuum force. The frame rotation produces new physics, notably dynamics and orbit theory on the ECE2 covariant level and on the classical level. For example frame rotation produces orbital precession both on the relativistic and classical levels.

Keywords: Frame rotation and spin connection, new type of dynamics and orbit theory.

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1. INTRODUCTION

In immediately preceding papers of this series {1 - 41} it has been shown that the precession of the orbit of a mass m around a mass M is explained by rotation of the plane polar coordinate system with a given angular velocity ω_1. In general this is different from the orbital angular velocity ω and in Section 2 it is calculated without the use of any adjustables for the planets. The link between ω_1 and the spin connection of Cartan geometry is established and it is shown that frame rotation due to torsion produces a new physics on the relativistic and classical levels, and also a new quantum physics.

This paper is a short synopsis of the notes accompanying UFT412 on www.aias.us. Note 412(1) calculates the angular frequency ω_1 and precession of each planet without the use of any adjustable variable. Note 412(2) is a tabulated summary of the results of Note 412(1). Note 412(3) is a calculation of the Newtonian orbital velocity in the rotating frame. Note 412(4) is a summary of the link between the angular velocity ω_1 of frame rotation and the spin connection. Notes 412(5) and 412(6) give a summary of fundamental definitions.

In Section 3 the analytical equations are discussed with reference to graphics of the main results.

2. DYNAMICS AND ORBIT THEORY IN THE PRESENCE OF FRAME ROTATION.

Consider the rotation:

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

of the plane polar coordinate system (r, ϕ). It follows as in UFT411 that the ECE2 covariant precession is given by:

$$\Delta\phi = \frac{2\pi}{c^2}\left(v_N^2 + r^2\left(\omega_1^2 + 2\omega\omega_1\right)\right) \qquad -(2)$$

In the classical limit:

$$\Delta\phi \rightarrow \omega_1 T. \quad -(3)$$

Therefore for small precessions:

$$\frac{2\pi}{c^2}\left(v_N^2 + r^2\left(\omega_1^2 + 2\omega\omega_1\right)\right) = \omega_1 T. \quad -(4)$$

The angular velocity of frame rotation is:

$$\omega = \frac{2\pi}{T} \quad -(5)$$

where T is the time needed for completing one orbit of 2π, r is the orbital radius. and v_N is the Newtonian orbital linear velocity.

In general Eq. (4) is a quadratic in ω_1 and can be solved analytically without any approximation. However for small precessions:

$$\omega_1 << \omega \quad -(6)$$

and Eq. (4) reduces to the simple equation:

$$\omega_1 = \omega\left(\frac{v_N^2}{c^2}\right) \quad -(7)$$

as in Note 412(1). In the classical, Newtonian, limit:

$$\omega_1 \rightarrow 0 \quad -(8)$$

self consistently, Q. E. D. Note carefully that the precession (3) cannot be derived in a Newtonian theory, in which the frame is not rotating. Therefore the result (3) is a non Newtonian classical result, the classical limit of the result from ECE2 covariant theory. The theoretical result (3) for Earth:

$$\Delta \phi = \omega_1 T = 6.20 \times 10^{-8} \text{ radians per earth orbit} \quad -(9)$$

is similar to the experimental result for Earth given by Marion and Thornton {1 - 41} in the fourth edition of "Classical Dynamics":

$$\Delta \phi_{MT} = (2.424 \pm 0.058) \times 10^{-7} \text{ radians per earth orbit.} \quad -(10)$$

In the standard dogma of physics Eq. (10) is said to be a non Newtonian remnant which cannot be explained by the Newtonian effect on Earth of other planets. The actually observable precession of Earth is:

$$\Delta \phi (\mathrm{exp}) = 5.551 \times 10^{-4} \text{ radians per earth orbit} \quad -(11).$$

which is 2,290 times larger than the claim (10).

The solar system is therefore a terrible place in which to test a precession theory, because the non Newtonian precession is very tiny compared with the Newtonian precession and the situation is much worse for the outer planets. This is discussed in Note 412(1). Only one theory of precession can be applied to the planetary precessions, it is not possible to apply a Newtonian theory to one part of the precession and a non Newtonian theory to the other. Yet this is what the standard dogma perpetrates endlessly and erroneously. The S2 star system is a vastly superior system with which to test a theory of precession, because there are no complications. As soon as the Einstein theory is applied to the S2 star system it fails completely by an order of magnitude, and the Einstein theory has been abandoned in the standard literature itself. The precession of the S2 star system is described exactly in ECE2 theory by choice of ω_1 .

The method just described for Earth is applied to the other planets in Note 412(2) and the tables of Note 412(2) are reproduced in Section 3. The observed precessions of the planets are given in these tables. In the standard physics these are computed as an N body Newtonian problem, using supercomputers. This method should be modified to include the effect of spin connections, making it an even more difficult computational task. Therefore it is much simpler to test a precessional theory with data that are uncomplicated by extraneous influences, for example data from the S2 star system. In Note 412(3) and subsequent notes it is shown that all aspects of orbital theory are affected by frame rotation. By hypothesis, frame rotation is ubiquitous and ever present, because it is due to spacetime torsion, which is part of the fundamental geometry of the universe.

The rotating frame orbit theory is exemplified by results such as the following. The Newtonian or orbital linear velocity is given by:

$$v_N'^2 = MG\left(\frac{2}{r} - \frac{1}{a'}\right) \quad -(12)$$

where primed quantities indicate the observable quantities in the rotating frame. Here a' is the semi major axis in the rotating frame. By hypothesis the frame rotation leaves r unchanged. The semi major axis is defined by

$$a' = \frac{\alpha'}{1-\epsilon'^2} \quad -(13)$$

where α' is the half right latitude and ϵ' is the eccentricity. These are constants of motion because they are defined in terms of the hamiltonian H' and the angular momentum L', which are constants of motion in the rotating frame. The half right latitude is defined by:

$$\alpha' = \frac{L'^2}{m^2 MG} \quad -(14)$$

where the angular momentum in the rotating frame is defined from lagrangian theory as follows:

$$L' = mr^2\omega'$$
$$= mr^2 \frac{d\phi'}{dt} = mr^2 \frac{d}{dt}(\phi + \omega_1 t)$$
$$= mr^2\left(\omega + \omega_1 + t\frac{d\omega_1}{dt}\right). \quad -(15)$$

For one complete orbit:

$$t = T \quad -(16)$$

so for a finite angular acceleration the orbit shrinks as in UFT411 as time increases, in order to keep L' constant. The eccentricity in the rotating frame is defined by:

$$\epsilon'^2 = 1 + \frac{2H'L'^2}{m^3 M^2 G^2} \quad -(17)$$

where H' is the hamiltonian in the rotating frame:

$$H' = \frac{1}{2}m\left(\frac{dr}{dt}\right)^2 + \frac{1}{2}\frac{L'}{mr^2} - \frac{mMG}{r}. \quad -(18)$$

The hamiltonian H' is related to a' as follows:

$$H' = \frac{1}{2}mv'^2 - \frac{mMG}{r} = \frac{1}{2}mMG\left(\frac{2}{r} - \frac{1}{a'}\right) - \frac{mMG}{r}$$
$$= -mMG/(2a'). \quad -(19)$$

The hamiltonian is computed from the orbit:

$$r = \frac{\alpha'}{1+\epsilon'\cos\phi'}, \quad -(20)$$

using

$$\frac{dr}{dt} = \frac{\epsilon'\alpha'\sin\phi'}{(1+\epsilon'\cos\phi')^2}\frac{d\phi'}{dt}. \quad -(21)$$

The link between ω_1 and the spin connection $\underline{\Omega}'$ is established from the fundamentals of kinematics, the linear velocity in the rotating frame:

$$\underline{v}' = \dot{r}\,\underline{e}_r' + r\dot{\phi}'\,\underline{e}_\phi' \quad -(22)$$

and the acceleration in the rotating frame:

$$\underline{a}' = \left(\ddot{r} - r\dot{\phi}'^2\right)\underline{e}_r' + \left(r\ddot{\phi}' + 2\dot{r}\dot{\phi}'\right)\underline{e}_\phi' \quad -(23)$$

(Note 412(4)). The unit vectors in the rotating frame are:

$$\underline{e}_r' = \underline{i}\cos(\phi + \omega_1 t) + \underline{j}\sin(\phi + \omega_1 t) \quad -(24)$$

and

$$\underline{e}_\phi' = -\underline{i}\sin(\phi + \omega_1 t) + \underline{j}\cos(\phi + \omega_1 t). \quad -(25)$$

By hypothesis, the rotation of the frame produces the force:

$$\underline{F}' = m\underline{a}' = -\frac{\partial U}{\partial r}\underline{e}_r' + \underline{\Omega}' U \quad -(26)$$

where $\underline{\Omega}'$ is the spin connection vector in the rotating frame. The gravitational potential energy is:

$$U = -\frac{mMG}{r}. \quad -(27)$$

In general:

$$\underline{\Omega}' = \Omega_r'\,\underline{e}_r' + \Omega_\phi'\,\underline{e}_\phi'. \quad -(28)$$

If it is assumed for simplicity that:

$$\Omega_{\phi}' = 0 \quad -(29)$$

then:

$$\ddot{r} - r\dot{\phi}'^2 = -mG\left(\frac{1}{r^2} - \frac{\Omega_r'}{r}\right) \quad -(30)$$

i.e.

$$\ddot{r} - r\left(\omega + \omega_1 + t\frac{d\omega_1}{dt}\right)^2 = -mG\left(\frac{1}{r^2} - \frac{\Omega_r'}{r}\right) \quad -(31)$$

This is an equation that links the frame angular velocity ω_1 and the radial component of the spin connection in the rotating frame, Ω_r'.

An expression for time can be obtained from:

$$\frac{d\phi'}{dt} = \frac{L'}{mr^2} = \frac{L'}{m\alpha'^2}\left(1+\epsilon'\cos\phi'\right)^2 \quad -(32)$$

so:

$$t = \frac{m\alpha'^2}{L'^2}\int\frac{d\phi'}{(1+\epsilon'\cos\phi')^2} \quad -(33)$$

as in Note 412(5). From Kepler's third law in the rotating frame:

$$T'^2 = \frac{4\pi^2}{mG}\,a'^3 \quad -(34)$$

where T' is defined by:

$$T' = \frac{m\alpha'^2}{L'}\int_0^{2\pi}\frac{d\phi'}{(1+\epsilon'\cos\phi')^2} \quad -(35)$$

Finally consider the hamiltonian H

$$H = \frac{1}{2} m v^2 + U \quad -(36)$$

in the static frame. This is a constant of motion so:

$$\frac{dH}{dt} = 0 \quad -(37)$$

i.e.

$$\frac{d}{dt}\left(\frac{1}{2} m v^2 + U\right) = 0 \quad -(38)$$

which implies:

$$m v \frac{dv}{dt} + \frac{dU}{dt} = 0. \quad -(39)$$

Now use:

$$\frac{dU}{dt} = \frac{dU}{dr}\frac{dr}{dt} = v \frac{dU}{dr} \quad -(40)$$

to find that

$$F = m \frac{dv}{dt} = -\frac{dU}{dr} = -\frac{\partial U}{\partial r}. \quad -(41)$$

Therefore the force equation (41) follows as a direct consequence of the fact that H is a constant of motion. Eq. (41) is also the Newtonian equivalence principle of gravitational mass and inertial mass.

In the rotating frame:

$$H' = \frac{1}{2} m v'^2 + U \quad -(42)$$

so

$$m \frac{d\underline{v}'}{dt} = -\frac{\partial U}{\partial r} . \quad -(43)$$

However the total force in the rotating frame is defined by Cartan geometry as the covariant derivative:

$$F' = -\left(\frac{\partial}{\partial r} - \Omega'\right) U \quad -(44)$$

so in vector notation:

$$\underline{F}' = -\underline{\nabla} U + \underline{\Omega}' U \quad -(45)$$
$$= -\underline{\nabla} U + \underline{F}'(\text{vacuum})$$

For a central force, as in Note 412(6):

$$\underline{F}' = m\underline{a}' = m\left(\ddot{r} - r\dot{\phi}'^2\right)\underline{e}_r' \quad -(46)$$
$$= -\frac{mMG}{r^2}\underline{e}_r' + \underline{\Omega}' U$$

It follows that:

$$\ddot{r} - r\dot{\phi}'^2 = -MG\left(\frac{1}{r^2} - \frac{\Omega_r}{r}\right) \quad -(47)$$

which is the rotating frame Leibniz equation.

The Lagrangian in the rotating frame is:

$$\mathcal{L}' = \frac{1}{2} m v'^2 + \frac{mMG}{r} \quad -(48)$$

and the Euler Lagrange equations are:

$$\frac{\partial \mathcal{L}'}{\partial r} = \frac{d}{dt}\frac{\partial \mathcal{L}'}{\partial \dot{r}} \quad -(49)$$

and

$$\frac{\partial \mathcal{L}'}{\partial \phi'} = \frac{d}{dt}\frac{\partial \mathcal{L}'}{\partial \dot{\phi}'}. \quad -(50)$$

In general dynamics:

$$\underline{g}' = g_r' \underline{e}_r' + g_\phi' \underline{e}_\phi' \quad -(51)$$

and

$$\underline{\Omega}' = \Omega_r' \underline{e}_r' + \Omega_\phi' \underline{e}_\phi'. \quad -(52)$$

For a central force:

$$\ddot{r} - r\dot{\phi}'^2 = -mG\left(\frac{1}{r^2} - \frac{\Omega_r'}{r}\right) \quad -(53)$$

$$r\ddot{\phi}' + 2\dot{r}\dot{\phi}' = 0 \quad -(54)$$

and these two equations must be solved simultaneously by computer as in previous work. In so doing:

$$\dot{\phi}' = \omega + \omega_1 + t\frac{d\omega_1}{dt} \quad -(55)$$

and

$$\ddot{\phi}' = \frac{d\omega}{dt} + 2\frac{d\omega_1}{dt} + t\frac{d^2\omega_1}{dt^2}. \quad -(56)$$

The Newtonian theory is recovered in the limit:

$$\omega_1 \rightarrow 0 \quad -(57)$$

3: COMPUTATION AND GRAPHICS

Section by Dr. Horst Eckardt

Frame rotation and spin connection

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3 Computation and graphics

The ECE2 covariant precession of Eq. (2) in the limit (3) is

$$\omega_1 T = \frac{2\pi}{c^2}\left({v_N}^2 + \left({\omega_1}^2 + 2\omega\omega_1\right) r^2\right) \tag{58}$$

where ω_1 is the angular frequency of frame rotation and ω is the orbital frequency. This is a quadratic equation for ω_1 and can be solved, giving:

$$\omega_1 = -\omega + \frac{1}{4\pi r^2}\left(Tc^2 \pm \sqrt{16\pi^2 r^2(\omega^2 r^2 - v_N^2) - 8\pi T c^2 \omega r^2 + T^2 c^4}\right). \tag{59}$$

In the approximation $\omega_1 \ll \omega$ Eq. (58) reduces to the linear equation

$$\omega_1 T = \frac{2\pi}{c^2}\left({v_N}^2 + 2\omega\omega_1 r^2\right), \tag{60}$$

having the solution

$$\omega_1 = -\frac{2\pi {v_N}^2}{4\pi\omega r^2 - T\,c^2} \tag{61}$$

which could be further simplified to give Eq. (7). Here we will compare solutions (59) and (61). When using

$$v_N \approx \omega r \tag{62}$$

which is valid for near-circular orbits, one can plot the functions $\omega_1(\omega)$ for the exact solution of (59) and the approximate solution (61). For parameters chosen all unity (which is quite arbitrary due to relativistic restrictions), one can see in Fig. 1 that both functions start congruently from zero. The exact solution moves into a pole while the approximated solution behaves like a parabola. This parabolic range is outside the validity of the linearized approximation (60).

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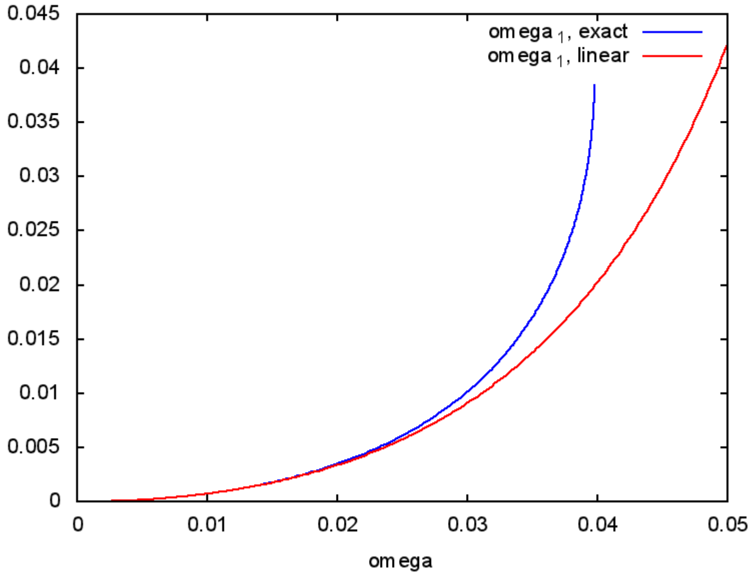

Figure 1: Exact and linearly approximated solution of $\omega_1(\omega)$.

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