VACUUM FLUCTUATIONS AS THE ORIGIN OF ECE2 RELATIVITY AND ORBITAL PRECESSION.

by

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ABSTRACT

A rigorously self consistent ECE2 theory of orbital precession is developed drawing on concepts of recent papers. A classical gravitational acceleration due to vacuum fluctuations is defined along the lines of the well known Lamb shift calculation in quantum mechanics and the theory applied to orbital precession in a plane using a tensorial Taylor series and isotropic averaging.

Key words ECE2 theory of gravitation due to vacuum fluctuations.

4FT401

1. INTRODUCTION

In recent papers of this series {1 - 41} the well known theory of the Lamb shift has been developed in several directions, summarized in the overview paper UFT400. The theory uses a tensorial Taylor series expansion and isotropic averaging, using computer algebra at each stage of the calculation. In Section 2 these methods are developed for orbital theory, using a self consistent synthesis of concepts summarized briefly in UFT400. This paper is a short synopsis of detailed calculations in the notes for UFT401 on www.aias.us. Note 401(1) demonstrates the rigorous conservation of relativistic angular momentum for forward and retrograde precessions, Note 401(2) details the direct computation of orbits influenced by vacuum fluctuations using force component terms of the relevant tensorial Taylor expansion. Notes 401(3) to 401 (5) develop a rigorously self consistent theory of orbital precession.

Section 3 is a computational and graphical summary of key results.

2. DEVELOPMENT OF LAMB SHIFT THEORY FOR GRAVITATION.

As in Lamb shift theory consider vacuum fluctuations of the type:

$$\delta \underline{r} = \delta \underline{r}(0) \exp(-i\Omega_0 t) \quad -(1)$$

$$\delta \underline{r}^* = \delta \underline{r}(0) \exp(i\Omega_0 t) \quad -(2)$$

where $\underline{r}$ is the position vector and Ω_0 the angular frequency of the fluctuations. It follows that:

$$\frac{d^2 \delta \underline{r}}{dt^2} = -\Omega_0^2 \delta \underline{r} \quad -(3)$$

$$\frac{d^2 \delta \underline{r}^*}{dt^2} = -\Omega_0^2 \delta \underline{r}^* \quad -(4)$$

and

$$\frac{d^2 \delta \underline{r}}{dt^2} \cdot \frac{d^2 \delta \underline{r}^*}{dt^2} = \Omega_0^4 \delta \underline{r} \cdot \delta \underline{r}^* . \quad -(5)$$

The square of the vacuum acceleration due to gravity is defined by:

$$g^2(\text{vac}) = \left\langle \frac{d^2 \delta \underline{r}}{dt^2} \cdot \frac{d^2 \delta \underline{r}^*}{dt^2} \right\rangle = \Omega_0^4 \langle \delta \underline{r} \cdot \delta \underline{r}^* \rangle \quad -(6)$$

where < > denotes isotropic averaging. From previous work summarized in UFT400 the vacuum force is defined from the fundamentals of ECE2 theory as:

$$\underline{F}(\text{vac}) = \underline{\omega} \, \phi \quad -(7)$$

where $\underline{\omega}$ is the vector spin connection and ϕ is the ordinary gravitational potential .

Using the tensorial Taylor expansion the isotropically averaged magnitde of the vacuum force is:

$$\langle F(\text{vac}) \rangle = \langle F(\text{vac}) \rangle^{(2)} + \langle F(\text{vac}) \rangle^{(4)} + \ldots \quad -(8)$$

As in Lamb shift theory use the second order approximation:

$$\langle F(\text{vac}) \rangle = \langle F(\text{vac}) \rangle^{(2)} = \frac{1}{6} \langle \delta \underline{r} \cdot \delta \underline{r} \rangle \nabla^2 F. \quad -(9)$$

It follows that:

$$\underline{\omega} \, \phi = \frac{1}{6} \langle \delta \underline{r} \cdot \delta \underline{r} \rangle \nabla^2 F. \quad -(10)$$

Using the force magnitude:

$$F = \frac{mMG}{x^2 + y^2} = \frac{mMG}{r^2} \quad -(11)$$

it follows that the laplacian of F is:

$$\nabla^2 F = mMG \left(\frac{\partial^2}{\partial r^2} \left(\frac{1}{r^2} \right) + \frac{1}{r} \frac{\partial}{\partial r} \left(\frac{1}{r^2} \right) \right) = \frac{4mMG}{r^4}. \quad -(12)$$

Assembling these concepts:

$$\langle F(\text{vac}) \rangle^2 = m^2 \Omega_0^4 \langle \delta \underline{r} \cdot \delta \underline{r}^* \rangle$$

$$= \frac{1}{36} \left(\langle \underline{\delta r} \cdot \underline{\delta r} \rangle \right)^2 \left(\nabla^2 F \right)^2 \quad -(13)$$

Use:

$$\langle \underline{\delta r} \cdot \underline{\delta r}^* \rangle = \langle \underline{\delta r} \cdot \underline{\delta r} \rangle \quad -(14)$$

to find the vacuum angular frequency:

$$\Omega_0^2 = \frac{2}{3} mG \frac{\langle \underline{\delta r} \cdot \underline{\delta r} \rangle^{1/2}}{r^4} . \quad -(15)$$

It also follows that:

$$\omega^2 \phi^2 = \omega^2 \frac{m^2 M^2 G^2}{r^2} = \frac{4}{9} \frac{m^2 M^2 G^2}{r^8} \langle \underline{\delta r} \cdot \underline{\delta r} \rangle^2 \quad -(16)$$

so:

$$\frac{4}{9} \frac{\langle \underline{\delta r} \cdot \underline{\delta r} \rangle^2}{r^6} = \omega^2 \quad -(17)$$

and using the positive square root:

$$\frac{2}{3} \frac{\langle \underline{\delta r} \cdot \underline{\delta r} \rangle}{r^3} = \omega \quad -(18)$$

so the mean square fluctuation can be found from the spin connection.

As described in Note 401(3) the total force in ECE2 theory is the sum:.

$$\underline{F} = -\underline{\nabla} \phi + \underline{\omega} \phi \quad -(19)$$

in which the usual Newtonian force:

$$\underline{F}_N = -\underline{\nabla} \phi \quad -(20)$$

is augmented by the vacuum force:

$$\underline{F}(\mathrm{vac}) = \underline{\omega} \phi \quad -(21)$$

The relevant spin connections can be found from a lagrangian analysis given in UFT377 and summarized in UFT400. They can be found for retrograde and forward precessions in a plane. Therefore the isotropically averaged mean square fluctuation $\langle \delta \underline{r} \cdot \delta \underline{r} \rangle$ can be found form the spin connection using Eq. (18) and the angular frequency Ω_0 found from Eq. (15).

Therefore vacuum fluctuations are the origin of orbital precession and special relativity itself. These are the same fluctuations as used in Lamb shift theory.

3. NUMERICAL DEVELOPMENT AND GRAPHICS.

(Section by Horst Eckardt)

Vacuum fluctuations as the origin of ECE2 relativity and orbital precession

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3 Numerical development and graphics

The quadratic part of the vacuum fluctuation is according to Eq. (18):

$$\langle \delta\mathbf{r} \cdot \delta\mathbf{r} \rangle = \frac{3}{2} r^3 \omega \tag{22}$$

where ω is the modulus of the vector spin connection. For a mass orbiting a centre on an elliptic orbit, we found in UFT 389 for the relativistic case with retrograde precession:

$$\boldsymbol{\omega} = -\left(1 - \frac{1}{\gamma^3}\right) \frac{\mathbf{r}}{r^2}. \tag{23}$$

The modulus of the radial component is

$$\omega = |\boldsymbol{\omega}_r| = \left(1 - \frac{1}{\gamma^3}\right) \frac{1}{r}. \tag{24}$$

Inserting this into Eq. (22) gives

$$\langle \delta\mathbf{r} \cdot \delta\mathbf{r} \rangle = 3r^2 \omega. \tag{25}$$

The vacuum angular frequency (15) then becomes

$$\Omega_0^2 = \sqrt{\frac{2}{3}\omega}\, \frac{GM}{r^{5/2}}. \tag{26}$$

Inserting (24) leads to the final result

$$\Omega_0^2 = \sqrt{\frac{2}{3}} \sqrt{1 - \frac{1}{\gamma^3}}\, \frac{GM}{r^3}. \tag{27}$$

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The total gravitational potential including vacuum is

$$\mathbf{F}(\mathbf{r}) = -m\boldsymbol{\nabla}\phi + \mathbf{F}(\text{vac}) = -\frac{mMG\mathbf{r}}{r^3} + m\boldsymbol{\omega}\phi \tag{28}$$

whose radial component is

$$\begin{aligned} F_{r1}(r) &= -\frac{mMG}{r^2} + m\omega\phi = -\frac{mMG}{r^2} - \left(1 - \frac{1}{\gamma^3}\right)\frac{mMG}{r^2} \\ &= -\left(2 - \frac{1}{\gamma^3}\right)\frac{mMG}{r^2}. \end{aligned} \tag{29}$$

The factor $\left(1 - \frac{1}{\gamma^3}\right)$ is a correction to the Newtonian gravitational force which is very small. If the negative sign of ω in (23, 24) is used, the resulting force is

$$\begin{aligned} F_{r2}(r) &= -\frac{mMG}{r^2} + m\omega\phi = -\frac{mMG}{r^2} + \left(1 - \frac{1}{\gamma^3}\right)\frac{mMG}{r^2} \\ &= -\frac{1}{\gamma^3}\frac{mMG}{r^2} \end{aligned} \tag{30}$$

and this is the original relativistic Newtonian gravitational force used in foregoing UFT papers. The equations of motion have been solved for both cases of F_r. The orbits have been graphed in Figs. 1 and 2. F_{r1} (negative spin connection) shows forward precession while F_{r2} (positive spin connection) gives retrograde precession as already found earlier. Obviously the sign of the spin connection determines the direction of precession. Although the initial conditions were the same for both calculations, the width of the ellipses is different for both types of precession, an additional effect that appears for significant precession values. While we derived the corrections of the gravitational force from vacuum fluctuation theory, we obtained results consistent with relativistic theory. This may be a hint that relativity is connected with the structure of the vacuum.

Finally we make a different approach by choosing the term $\delta\mathbf{r}$ non-oscillatory. Instead of Eqs. (1, 2) we assume:

$$\delta r = \frac{a}{r} \tag{31}$$

as we did in the graphics for dipole fields in preceding papers. Then from Eq. (10) follows

$$\omega\phi = \frac{1}{6}\frac{a^2}{r^2}\nabla^2 F \tag{32}$$

and by inserting the Laplacian of F from (12):

$$\omega\phi = \frac{2}{3}a^2\frac{mMG}{r^6}, \tag{33}$$

leading to the total gravitational force

$$\begin{aligned} F_{r3}(r) &= -m\frac{\partial\phi}{\partial r} + \omega\phi = -\frac{mMG}{r^2} + \frac{2}{3}a^2\frac{mMG}{r^6} \\ &= -\frac{mMG}{r^2}\left(1 - \frac{2}{3}\frac{a^2}{r^4}\right). \end{aligned} \tag{34}$$

The solution of the field equations with this force law is graphed in Fig. 2 with a suitable a. This model gives a retrograde precession as expected, because the effective spin connection is positive.

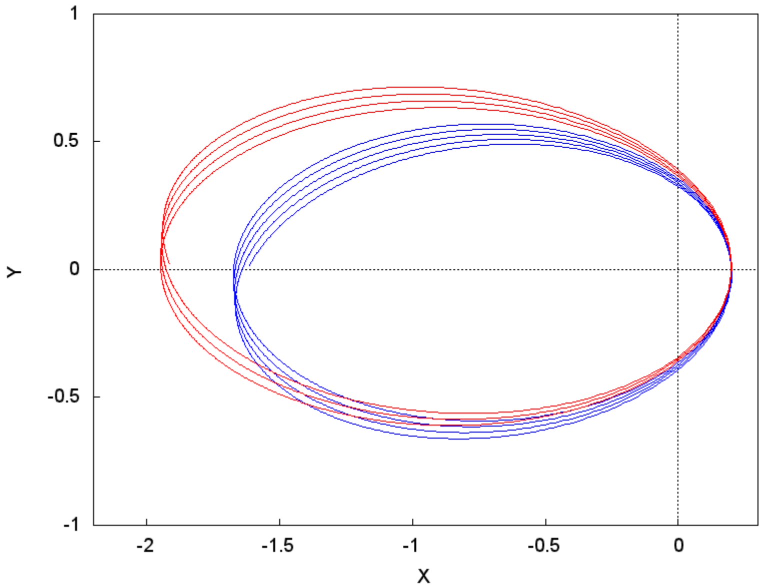

Figure 1: Orbits of forces F_{r1} (blue; forward precession) and F_{r2} (red; retrograde precession).

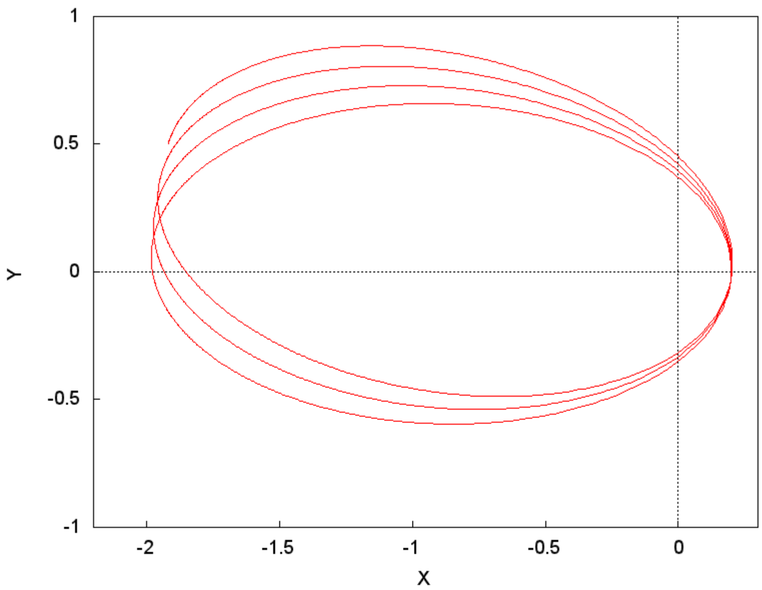

Figure 2: Orbit of force F_{r3} (retrograde precession).

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