ECE2 ANTISYMMETRY IN ORBITAL THEORY.

by

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ABSTRACT

It is shown that orbital theory in ECE2 rigorously obeys ECE2 antisymmetry laws in the limit of a vanishing gravitomagnetic field. The lagrangian and field equations of ECE2 are rigorously self consistent for Newtonian orbits in a plane and for precessing orbits in a plane.

Keywords: ECE2 theory, antisymmetry planar orbital theory, lagrangian and field equations.

UFT 384

1. INTRODUCTION

In recent papers of this series it has been shown that there is a set of equations which must be solved simultaneously in order to obtain the rich panoply of information inherent in the theory {1 - 12}. These equations originate in its antisymmetry laws, lagrangian and field equations, which unify electrodynamics, gravitation and fluid dynamics. In Section 2 it is shown that planar orbits from ECE2 theory rigorously obey its antisymmetry laws, and it is shown that ECE2 orbital theory is rigorously self consistent. A solution is given in which the relevant spin connections are calculated for Newtonian planar orbits, and precessing orbit sin forward and retrograde precession. Section 3 discusses the results with graphics and computer algebra.

This paper is a short synopsis of deatiled calculations contained in the notes accompanying UFT384 on www.aias.us. Notes 348(1) and 384(2)give the basic antisymmetry laws and field equations and approximations used, and show that the concepts are rigorously self consistent. Note 384(3) is a discussion of antisymmetry for forward precession, and it is shown that the Newtonian approximation is rigorously self consistent with the result of the calculation, an elliptical orbit. This paper is based on Notes 384(4) and 384(5), in which complete solutions are given for all types of planar orbit in the limit of vanishing gravitomagnetic field. It is shown that ECE2 lagrangian theory is rigorously self consistent with the ECE2 field equations.

2. COMPLETE SOLUTIONS.

The scalar antisymmetry law of ECE2 orbital theory gives:

$$\underline{g} = -\underline{\nabla}\Phi + \underline{\omega}\Phi = -\frac{\partial \underline{Q}}{\partial t} - \omega_0 \underline{Q} \quad -(1)$$

where $\underline{g}$ is the acceleration due to gravity, Φ is the gravitational scalar potential. $\underline{\omega}$ is the vector spin connection, ω_0 the timelike part of the spin connection, and $\underline{Q}$ is the gravitational vector potential. For gravitostatics assume that

$$\frac{\partial \underline{Q}}{\partial t} = \underline{0} \quad -(2)$$

so:

$$\underline{g} = -\underline{\nabla}\Phi + \underline{\omega}\Phi = -\omega_0 \underline{Q} \quad -(3)$$

Assume that:

$$\omega_0 = -\frac{c}{r} \quad -(4)$$

as calculated in immediately preceding papers, and in Notes 384(1) to 384(3), is the same for all types of planar orbit. This is equivalent to assuming that it is a universal property of the background spacetime, linked {1 - 12} to the existence of a vacuum particle with mass.

The vector antisymmetry laws of ECE2 link the vector spin connection and vector potential as follows:

$$\left(\frac{\partial}{\partial Y} - \omega_Y\right) Q_Z = -\left(\frac{\partial}{\partial Z} - \omega_Z\right) Q_Y \quad -(5)$$

$$\left(\frac{\partial}{\partial Z} - \omega_Z\right) Q_X = -\left(\frac{\partial}{\partial X} - \omega_X\right) Q_Z \quad -(6)$$

$$\left(\frac{\partial}{\partial X} - \omega_X\right) Q_Y = -\left(\frac{\partial}{\partial Y} - \omega_Y\right) Q_X . \quad -(7)$$

For a planar orbit they reduce to:

$$\left(\frac{\partial}{\partial X} - \omega_X\right) Q_Y = -\left(\frac{\partial}{\partial Y} - \omega_Y\right) Q_X \quad -(8)$$

and in a planar orbit Eqs. (5) and (6) each reduce to zero on both sides. The antisymmetry law for planar orbits is therefore:

$$\frac{\partial Q_Y}{\partial X} + \frac{\partial Q_X}{\partial Y} = \omega_X Q_Y + \omega_Y Q_X . \quad -(9)$$

For gravitostatics there is no gravitomagnetic field, so:

$$\underline{\Omega} = \underline{\nabla} \times \underline{Q} - \underline{\omega} \times \underline{Q} = \underline{0} . \quad -(10)$$

Similarly in electrostatics there is no magnetic field. In components format, Eq. (10)

gives three equations as follows:

$$\frac{\partial Q_Z}{\partial Y} - \frac{\partial Q_Y}{\partial Z} = \omega_Y Q_Z - \omega_Z Q_Y \quad -(11)$$

$$\frac{\partial Q_X}{\partial Z} - \frac{\partial Q_Z}{\partial X} = \omega_Z Q_X - \omega_X Q_Z \quad -(12)$$

$$\frac{\partial Q_Y}{\partial X} - \frac{\partial Q_X}{\partial Y} = \omega_X Q_Y - \omega_Y Q_X . \quad -(13)$$

In a planar orbit, both sides of Eqs. (11) and (12) reduces to zero, and so there is only

one equation:

$$\frac{\partial Q_Y}{\partial X} - \frac{\partial Q_X}{\partial Y} = \omega_X Q_Y - \omega_Y Q_X . \quad -(14)$$

From Eqs. (9) and (14):

$$\frac{\partial Q_Y}{\partial X} = \omega_X Q_Y , \quad \frac{\partial Q_X}{\partial Y} = \omega_Y Q_X \quad -(15)$$

so the spin connection for any planar orbit can be calculated from the gravitational vector

potential.

In the Newtonian limit:

$$\underline{g} = -mG \frac{\underline{r}}{r^3} \quad -(16)$$

so the vector potential from Eqs. (3) and (4) is:

$$\underline{Q} = -\frac{mG}{c}\frac{\underline{r}}{r^2} \quad -(17)$$

with Cartesian components:

$$Q_X = -\frac{mG}{c}\frac{X}{X^2+Y^2} \quad -(18)$$

and

$$Q_Y = -\frac{mG}{c}\frac{Y}{X^2+Y^2}. \quad -(19)$$

It follows that:

$$\frac{\partial Q_Y}{\partial X} = \frac{mG}{c}\cdot\frac{2XY}{(X^2+Y^2)^2} \quad -(20)$$

and

$$\frac{\partial Q_X}{\partial Y} = \frac{mG}{c}\cdot\frac{2YX}{(X^2+Y^2)^2} \quad -(21)$$

and that the spin connection components are:

$$\omega_X = -\frac{2X}{X^2+Y^2} \quad -(22)$$

and

$$\omega_Y = \frac{-2Y}{X^2+Y^2}. \quad -(23)$$

In vector format:

$$\underline{\omega} = -\frac{2\underline{r}}{r^2} \quad -(24)$$

and the complete spin connection four vector is:

$$\omega^{\mu} = \left(\frac{\omega_0}{c}, \underline{\omega} \right) = -\left(\frac{1}{r}, \frac{2\underline{r}}{r^2} \right). \quad -(25)$$

The gravitational scalar potential is calculated from:

$$\underline{g} = -\underline{\nabla}\,\underline{\Phi} + \underline{\omega}\,\Phi = -\underline{\nabla}\,\Phi - 2\Phi\frac{\underline{r}}{r^2} = -mG\frac{\underline{r}}{r^3} \quad -(26)$$

so:

$$\underline{\Phi} = \frac{mG}{r}. \quad -(27)$$

This solution obeys the antisymmetry laws (1) and (9).

Note carefully that the sign of the scalar potential $\underline{\Phi}$ is opposite to that used in the standard model of gravitation, in which there is no spin connection. The space of the standard Newtonian theory is Galilean. In ECE2 gravitation there is always a spin connection present, Eq (25), and the geometrical space is one with finite torsion and curvature. Newtonian theory becomes part of a generally covariant unified field theory based on Cartan geometry.

The gravitostatic ECE2 field equations must also be obeyed in the Newtonian limit, and are

$$\underline{\nabla} \times \underline{g} = \underline{0} \quad -(28)$$

$$\underline{\nabla} \cdot \underline{g} = 4\pi G \rho_m \quad -(29)$$

$$\partial \underline{g} / \partial t = \underline{0} \quad -(30)$$

$$\underline{\Omega} = \underline{\nabla} \times \underline{Q} - \underline{\omega} \times \underline{Q} = \underline{0} \quad -(31)$$

where G is Newton's constant and ρ_m the source mass density. From Eqs. (28) and (31):

$$\frac{\partial}{\partial t}\left(\underline{\nabla}\times\underline{Q}\right)+\underline{\nabla}\times\left(\omega_0\underline{Q}\right)=\underline{0} \quad -(32)$$

and from Eq. (2):

$$\underline{\nabla}\times\left(\omega_0\underline{Q}\right)=\underline{0}. \quad -(33)$$

For retrograde precession {1 - 12}, ECE2 lagrangian theory gives:

$$\underline{g}=-\frac{mG}{\gamma^3}\frac{\underline{r}}{r^3} \quad -(34)$$

so the gravitational vector potential for retrograde precession is:

$$\underline{Q}=-\frac{mG}{\gamma^3 c}\frac{\underline{r}}{r^2} \quad -(35)$$

The antisymmetry laws (1) and (9) are obeyed provided that the spin connections are defined by Eqs. (22) and (23). So retrograde precession obeys antisymmetry.

For forward precession, ECE2 lagrangian theory gives:

$$\underline{g}=-\omega_0\underline{Q}=\frac{mG}{\gamma r^3}\left(\frac{\underline{\dot{r}}\left(\underline{\dot{r}}\cdot\underline{r}\right)}{c^2}-\underline{r}\right). \quad -(36)$$

Assuming that the timelike part of the spin connection is universal, and the same for all three types of orbit: Newtonian, retrograde precessing and forward precessing, then the gravitational vector potential for forward precession is:

$$\underline{Q}=\frac{mG}{\gamma c r^2}\left(\frac{\underline{\dot{r}}\left(\underline{r}\cdot\underline{r}\right)}{c^2}-\underline{r}\right). \quad -(37)$$

A fundamental angular frequency of spacetime or vacuum or aether can be defined by:

$$\Omega_0 := 2\pi\left|\omega_0\right| = 2\pi\frac{c}{r} \quad -(38)$$

and is associated with a relativistic vacuum particle energy:

$$E=\hbar\Omega_0=\gamma mc^2 \quad -(39)$$

$$\gamma=\left(1-\frac{\dot{x}^2+\dot{y}^2}{c^2}\right)^{-1/2} \quad -(39a)$$

where m is the mass of the vacuum particle.

From Eq. (37): the Cartesian components of the vector potential for forward precession are:

$$Q_X = \frac{mG}{\gamma c(X^2+Y^2)}\left(\frac{\dot{X}\dot{Y}Y + X\dot{X}^2}{c^2} - X\right) \quad -(40)$$

and:

$$Q_Y = \frac{mG}{\gamma c(X^2+Y^2)}\left(\frac{\dot{Y}\dot{X}X + Y\dot{Y}^2}{c^2} - Y\right) \quad -(41)$$

in which γ is defined by Eq. (39a) and has no dependence on X and Y. It follows that:

$$\frac{\partial Q_X}{\partial Y} = \frac{mG}{\gamma c^3(X^2+Y^2)}\left(\dot{X}\dot{Y} - 2Y\frac{\left(\dot{X}(Y\dot{Y}+X\dot{X}) - c^2X\right)}{(X^2+Y^2)^2}\right) \quad -(42)$$

and:

$$\frac{\partial Q_Y}{\partial X} = \frac{mG}{\gamma c^3(X^2+Y^2)}\left(\dot{X}\dot{Y} - 2X\frac{\left(\dot{Y}(Y\dot{Y}+X\dot{X}) - c^2Y\right)}{(X^2+Y^2)^2}\right) \quad -(43)$$

The spin connection components for forward precession are therefore:

$$\omega_X = \frac{\dot{X}\dot{Y} - 2Y\dfrac{\left(\dot{X}(Y\dot{Y}+X\dot{X}) - c^2X\right)}{(X^2+Y^2)^2}}{\dot{X}\dot{Y}Y + X\dot{X}^2 - c^2X} \quad -(43)$$

and

$$\omega_Y = \frac{\dot{X}\dot{Y} - 2X\dfrac{\left(\dot{Y}(Y\dot{Y}+X\dot{X}) - c^2Y\right)}{(X^2+Y^2)^2}}{X\dot{X}\dot{Y} + Y\dot{Y}^2 - c^2Y} \quad -(44)$$

The complete spin connection vector is:

$$\underline{\omega} = \omega_X \underline{i} + \omega_Y \underline{j}, \quad -(45)$$

$$\omega^\mu = (\omega_0, \underline{\omega}) \quad -(45a)$$

and obeys the antisymmetry laws (1) and (9), Q. E. D. The lagrangian theory of ECE2 and its gravitostatic field equations are rigorously self consistent, Q. E. D.

3. GRAPHICAL AND NUMERICAL ANALYSIS

Section by Horst Eckardt

ECE2 antisymmetry in orbital analysis

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3 Graphical and numerical analysis

The spin connections of Eqs. (43,44) for forward precession can be written in the form

$$\omega_X = -\frac{2XY\,c^2 - \dot{X}\,Y^2\,\dot{Y} + X^2\,\dot{X}\,\dot{Y} - 2X\,\dot{X}^2 Y}{(Y^2+X^2)\left(Y\,c^2 - Y\,\dot{Y}^2 - X\,\dot{X}\,\dot{Y}\right)}, \tag{46}$$

$$\omega_Y = -\frac{2XY\,c^2 - 2XY\,\dot{Y}^2 + \dot{X}\,Y^2\,\dot{Y} - X^2\,\dot{X}\,\dot{Y}}{(Y^2+X^2)\left(X\,c^2 - \dot{X}Y\,\dot{Y} - X\,\dot{X}^2\right)}. \tag{47}$$

We solve the equation of an elliptic orbit numerically in the Newtonian limit. Then we insert the orbital and velocity coordinates $X(t), Y(t), \dot{X}(t), \dot{Y}(t)$ into the above equations. The results are expressions for a forward precession orbit. By taking the limit $c \to \infty$ (using computer algebra) the spin connections of the Newtonian limit appear again:

$$\omega_X \to -\frac{2X}{X^2+Y^2}, \tag{48}$$

$$\omega_Y \to -\frac{2Y}{X^2+Y^2}. \tag{49}$$

The vector spin connection is not defined for the whole space but only for the orbit. Therefore the arrows have been applied at the respective orbital points. The spin connection is graphed for the Newtonian case (by arbitrarily setting c to a high value) in Fig. 1. Its direction is oblique to the orbit and smaller in the region of high orbital velocity (periastron). In the relativistic case (c set to a small value), direction changes near to the periastron, the arrows are pulled more to the periastron, and when going to the right side of the focal point, more pulled to the apastron. Directly at the apastron, orbital velocity is low and therefore no significant difference to the Newtonian case visible.

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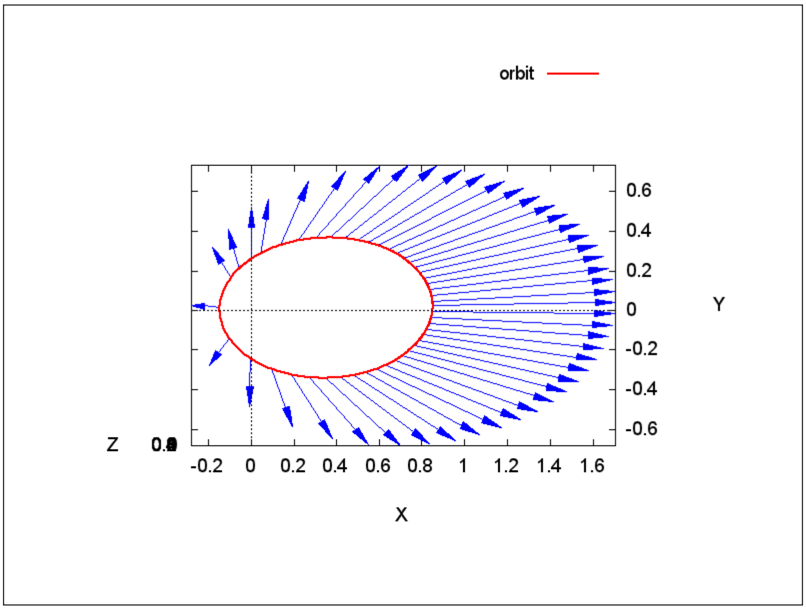

Figure 1: Path and vector spin connection $\boldsymbol{\omega}$ of a Newtonian 2D elliptic orbit.

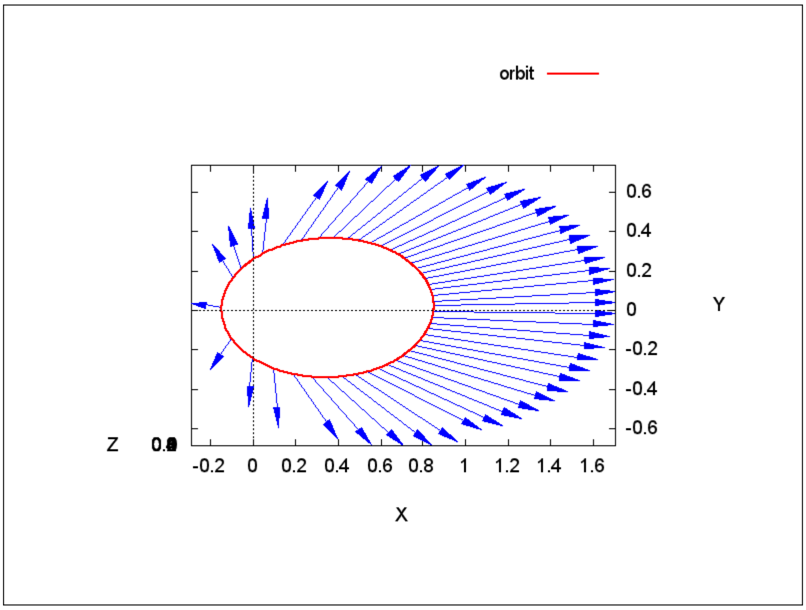

Figure 2: Path and vector spin connection $\boldsymbol{\omega}$ of a relativistic 2D orbit (forward precession).

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