ORBITAL PRECESSION FROM THE MINKOWSKI METRIC IN ECE2 THEORY.

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ABSTRACT

The Minkowski metric produces and orbital equation which can be interpreted as a precessing ellipse. This confirms the demonstration in immediately preceding papers that the hamiltonian and lagrangian of special relativity produce a precessing ellipse using numerical methods based on computer algebra. It is shown that the claims of general relativity to produce a precessing ellipse fail qualitatively due to poor methods of approximation.

Keywords: ECE2, orbital precession from the Minkowski metric, failure of general relativity.

UFT 327

1. INTRODUCTION

In immediately preceding papers of this series (1 - 12} it has been shown that the ECE2 unified field theory is Lorentz covariant, so can be developed with the methods of special relativity, notably the hamiltonian, lagrangian and the subject of this paper, the Minkowski metric and infinitesimal line element. By using a combination of the hamiltonian and lagrangian of special relativity it has been shown numerically using a scatter plot method {1 - 12} that special relativity produces orbital precession. It has also been shown in several preceding papers of this series that the methods of Einsteinian general relativity are fundamentally incorrect. Rigorous scientometrics {1 - 12} show that this conclusion has been overwhelmingly accepted, and that ECE and ECE2 theory indicate Alwyn van der Merwe's well known description of ECE as the post Einsteinian paradigm shift. The Lorentz force law of ECE2 theory has been derived and developed into the force law of special relativity.

As usual this paper must be read with its background notes, the paper itself being a summary of the notes. The latter are posted with UFT327 on www.aias.us. Notes 327(1) and Notes 327(4) and 327(5) develop the Minkowski metrical method and give foundational detail summarized in Note 327(9) on which Section 2 of this paper is based. The other notes for this paper refute the calculation of perihelion precession from Einsteinian general relativity in several ways. Notes 327(2) and 327(3) refute the Einstein method of approximation, showing it to be incorrect using computer algebra to evaluate the integral approximated by Einstein in his paper of Nov. 1915. The results of our scholarly scrutiny of the Einstein method are given in Section 3 of this paper. Vankov {1-12} has pointed out errors in the Einstein paper of Nov. 1915. These errors were also identified by Schwarzschild in Dec. 1915 in a letter to Einstein. The computer algebraic methods available now can remove the need for the incorrect approximations of 1915, and show conclusively that the

Einstein paper of Nov. 1915 is incorrect. Furthermore, it is well known {1-12} that the Einstein theories of 1905 to 1915 were developed when spacetime torsion was unknown, so could not have been correct. It has been proven in several ways {1-12} that the omission of torsion leads to null curvature and no gravitation of the Einstein type. The scientometrics show that these proofs have also been overwhelmingly accepted internationally. Previous work {1-12} has refuted the Einstein theory in many ways. In Note 327(6) a straightforward but accurate method of approximation of the integral used by Einstein is developed and evaluated with computer algebra. This method again proves that the claim by Einstein to have produced perihelion precession is algebraically incorrect. Its results are given in Section 3. In Note 327(7) the apsidal method of reproducing the Einstein claim is shown to rely on subjective choice of approximation, so the method is scientifically meaningless. It is an example of choosing the approximation to fit the dogma, an example of Langmuir's pathological science. ECE and ECE2 set out to improve the elegant methods of Einstein and free them of algebraic errors. This is the only way in which progress can eb made in science. The dogma of any era is always made obsolete by logic and the Baconian method.

Section 2 is based on Note 327(9) and shows that the Minkowski metric produces precession in the Dirac approximation of the Einstein energy equation and the hamiltonian of special relativity. Section 3 is a summary of the numerical results of this paper using computer algebra and graphics.

2. PRECESSION FROM THE MINKOWSKI METRIC

Consider the Minkowski infinitesimal line element:

$$c^2 d\tau^2 = (c^2 - v_0^2)\, dt^2 \quad -(1)$$

where $d\tau$ is the infinitesimal of proper time, dt the infinitesimal of time in the observer frame, and v_0 the velocity in the observer frame, defined by:

$$v_0^2 = \left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\theta}{dt}\right)^2. \quad -(2)$$

Therefore:

$$mc^2 = mc^2\left(\frac{dt}{d\tau}\right)^2 - m\left(\frac{dr}{d\tau}\right)^2 - mr^2\left(\frac{d\theta}{d\tau}\right)^2 \quad -(3)$$

is the rest energy and a constant of motion. In Eq. (3), the Lorentz factor is:

$$\gamma = \frac{dt}{d\tau} = \left(1 - \frac{v_0^2}{c^2}\right)^{-1/2}. \quad -(4)$$

The relativistic total energy is:

$$E = \gamma mc^2 \quad -(5)$$

and the relativistic angular momentum is:

$$L = \gamma mr^2 \frac{d\theta}{dt}. \quad -(6)$$

The relativistic linear momentum is:

$$\underline{p} = \gamma m \underline{v}_0 = \gamma \underline{p}_0, \quad -(7)$$

so

$$p^2 = \gamma^2 m^2 v_0^2. \quad -(8)$$

It follows that:

$$\frac{p^2}{m} = m\left(\left(\frac{dr}{d\tau}\right)^2 + r^2\left(\frac{d\theta}{d\tau}\right)^2\right). \quad -(9)$$

Therefore Eq. (3) is the Einstein energy equation:

$$E^2 = p^2c^2 + m^2c^4 \quad -(10)$$

As shown in Note 327(1) and in previous UFT papers {1 -12}, the orbit is given by:

$$\left(\frac{dr}{d\theta}\right)^2 = r^4\left(\frac{E^2 - m^2c^4}{c^2L^2} - \frac{1}{r^2}\right) = r^4\left(\left(\frac{p}{L}\right)^2 - \frac{1}{r^2}\right). \quad -(11)$$

The right hand side of Eq. (11) contains the ratio p / L of the relativistic linear momentum to the relativistic angular momentum:

$$\frac{p}{L} = \frac{\gamma p_0}{\gamma L_0} = \frac{p_0}{L_0}. \quad -(12)$$

Therefore in the Newtonian limit the orbit becomes:

$$\left(\frac{dr}{d\theta}\right)^2 = r^4\left(\frac{p_0^2}{L_0^2} - \frac{1}{r^2}\right) \quad -(13)$$

in which p_0 is defined by the classical hamiltonian:

$$H_0 = \frac{p_0^2}{2m} + U. \quad -(14)$$

From Eqs. (13) and (14):

$$\left(\frac{dr}{d\theta}\right)^2 = \frac{r^4}{L_0^2}\left(2m\left((H_0 - U) - \frac{L_0^2}{2mr^2}\right)\right). \quad -(15)$$

It is well known {1 - 12} that the orbit from Eq. (15) is the conic section:

$$r = \frac{\alpha}{1 + \epsilon\cos\theta} \quad -(16)$$

where α is the half right latitude and ϵ the eccentricity. These observables of an orbit are described in terms of the planar orbital constants of motion, the classical hamiltonian and the classical angular momentum {1 - 12}. The classical conic section (16) does not precess. The self consistency of the classical analysis follows from the fact that:

$$\left(\frac{dr}{d\theta}\right)^2 = \frac{\epsilon^2}{\alpha^2} r^4 \sin^2\theta = r^4\left(\left(\frac{p_0}{L_0}\right)^2 - \frac{1}{r^2}\right) \quad -(17)$$

where:

$$\sin^2\theta = 1 - \cos^2\theta = 1 - \frac{1}{\epsilon^2}\left(\frac{\alpha}{r} - 1\right)^2. \quad -(18)$$

It follows that:

$$\left(\frac{p_0}{L_0}\right)^2 = \frac{1}{\alpha}\left(\frac{2}{r} - \frac{1}{a}\right) \quad -(19)$$

where the semi major axis of an elliptical orbit is:

$$a = \frac{\alpha}{1-\epsilon^2}. \quad -(20)$$

It is well known {1 -12} that the Newtonian orbital velocity is:

$$v_0^2 = MG\left(\frac{2}{r} - \frac{1}{a}\right) \quad -(21)$$

and that the classical angular momentum is defined by:

$$L_0^2 = m^2 MG\alpha. \quad -(22)$$

So it follows that:

$$\left(\frac{p_0}{L_0}\right)^2 = \left(\frac{mv_0}{L_0}\right)^2 \quad -(23)$$

and that

$$p_0 = mv_0 \quad -(24)$$

Q.E.D. In this analysis the Newtonian potential energy is:

$$U = -\frac{mMG}{r}. \quad -(25)$$

The infinitesimal line element (1) is derived from the invariant of the Lorentz transform:

$$x^{\mu} x_{\mu} = x^{\mu '} x_{\mu}' \quad -(26)$$

and does not use the idea of force or potential. The orbit is described entirely by geometry manifested through the infinitesimal line element. It is transformed into the familiar Newtonian analysis by expressing $\underline{p_0}$ through Eq. (14).

In the fully relativistic interpretation of Eq. (11) the relativistic angular momentum is the constant of motion {1 - 12}:

$$\frac{d\underline{L}}{dt} = 0 \quad -(27)$$

and not the classical angular momentum L_0 defined by:

$$\underline{L} = \gamma \underline{L}_0. \quad -(28)$$

Therefore the relativistic orbit can be expressed as:

$$\left(\frac{dr}{d\theta}\right)^2 = r^4 \left(\frac{\gamma^2 p_0^2}{L^2} - \frac{1}{r^2}\right) \quad -(29)$$

where the square of the Lorentz factor is defined by:

$$\gamma^2 = \left(1 - \frac{p_0^2}{m^2 c^2}\right)^{-1} \quad -(30)$$

The nature of the orbit depends on the interpretation of the term $E^2 - m^2 c^4$. The Newtonian interpretation emerges through the well known limit of the relativistic kinetic energy:

-11-

$$T = (\gamma - 1) mc^2 \xrightarrow[v_0 \ll c]{} \frac{1}{2} m v_0^2 = \frac{p_0^2}{2m} \quad -(31)$$

where:

$$T = E - mc^2 \quad -(32)$$

and where E is the total relativistic energy defined by Eq. (5).

In UFT324 and UFT325 it was shown that the relativistic hamiltonian:

$$H = \gamma mc^2 + U \quad -(33)$$

and relativistic lagrangian:

$$\mathcal{L} = -\frac{mc^2}{\gamma} - U \quad -(34)$$

give a precessing orbit when used with the Euler Lagrange equations. This result was demonstrated using a numerical scatter plot method. The infinitesimal line element corresponding to Eqs. (33) and (34) is Eq. (1), whose orbit is defined by Eq. (11). Therefore Eq. (11) must give a precessing orbit in order to be consistent with Eqs. (34) and (35). In the Newtonian limit Eqs. (33) and (34) reduce to:

$$H_0 = \frac{p_0^2}{2m} + U \quad -(35)$$

and

$$\mathcal{L} = \frac{p_0^2}{2m} - U \quad -(36)$$

respectively. The relativistic hamiltonian is:

$$H = \left(c^2 p^2 + m^2 c^4 \right)^{1/2} + U \quad -(37)$$

so the relativistic momentum:

$$\underline{p} = \gamma \underline{p_0} = \gamma m \underline{v}_0 \quad -(38)$$

can be defined from

$$c^2 p^2 + m^2 c^4 = (H - U)^2. \quad -(39)$$

As in UFT326, various approximations for $\underline{p}$ can be developed by use of factorization:

$$c^2 p^2 = \left(H - U - mc^2\right)\left(H - U + mc^2\right) \quad -(40)$$

so that:

$$H - U - mc^2 = \frac{c^2 p^2}{H - U + mc^2} \quad -(41)$$

Eq. (41) resembles the classical hamiltonian:

$$H_0 = \frac{p_0^2}{2m} + U \quad -(42)$$

Eq. (41) must reduce to Eq. (42) in the non relativistic limit:

$$v_0 \ll c. \quad -(43)$$

In the Dirac approximation (see UFT326 and previous papers)

$$U \ll H \sim mc^2. \quad -(44)$$

This is a very rough approximation which is accepted becasue it leads to a description of the

Thomas factor and spin orbit coupling in atomic spectra as is well known, and many other well known results which led to ESR, NMR and MRI. In the Dirac approximation the classical hamiltonian is defined as:

$$H_0 = H - mc^2 \quad -(45)$$

From Eqs. (44) and (45):

$$H_0 = \frac{p^2}{2m}\left(1 - \frac{U}{2mc^2}\right)^{-1} + U \quad -(46)$$

and since:

$$U \ll 2mc^2 \quad -(47)$$

the classical hamiltonian becomes:

$$H_0 \sim \frac{p^2}{2m}\left(1 + \frac{U}{2mc^2}\right) + U \quad -(48)$$

The factor two in the brackets on the right hand side of this equation is the Thomas factor. Therefore in the Dirac approximation the relativistic momentum is defined by:

$$p^2 = \left(1 - \frac{U}{2mc^2}\right) p_0^2 \quad -(49)$$

and the orbit is given from Eqs. (11) and (49) as:

$$\left(\frac{dr}{d\theta}\right)^2 = r^4\left(\frac{1}{L^2}\left(1 + \frac{MG}{2c^2 r}\right)p_0^2 + \frac{1}{r^2}\right). \quad -(50)$$

Eq. (50) is a small correction of the Newtonian orbit. Experimentally, the latter is observed to precess as is well known. If it is assumed as in previous UFT papers that the precessing orbit is given by:

$$r = \frac{\alpha}{1+\epsilon\cos(x\theta)} \quad -(51)$$

it follows that:

$$\left(\frac{dr}{d\theta}\right)^2 = \frac{x^2\epsilon^2}{\alpha^2} r^4 \sin^2(x\theta) = r^4\left(\left(\frac{\rho_0^2}{L^2}+\frac{1}{r^2}\right)+\left(\frac{mG}{2c^2r}\right)\frac{\rho_0^2}{L^2}\right) \quad -(52)$$

in which:

$$\sin^2(x\theta) = 1 - \cos^2(x\theta) \quad -(53)$$

so:

$$x^2 = \frac{\alpha^2}{\epsilon^2}\,\frac{\left(\frac{\rho_0^2}{L^2}+\frac{1}{r^2}+\left(\frac{mG}{2c^2r}\right)\frac{\rho_0^2}{L^2}\right)}{1-\frac{1}{\epsilon^2}\left(\frac{\alpha}{r}-1\right)^2} \quad -(54)$$

For a non precessing ellipse:

$$\left(\frac{dr}{d\theta}\right)^2 = r^4\left(\frac{\rho_0^2}{L^2}+\frac{1}{r^2}\right) = \frac{\epsilon^2 r^4}{\alpha^2}\sin^2\theta \quad -(54)$$

so to an excellent approximation:

$$x^2 = 1 + \frac{\frac{\alpha^2}{\epsilon^2}\left(\frac{mG}{2c^2r}\right)\frac{\rho_0^2}{L^2}}{1-\frac{1}{\epsilon^2}\left(\frac{\alpha}{r}-1\right)^2} \quad -(55)$$

This gives an order of magnitude for the precession angle which is the same order of magnitude as given by Einsteinian general relativity, in which:

$$x = 1 + \frac{3mG}{\alpha c^2}. \quad -(56)$$

Since Einsteinian general relativity is meaningless due to numerous errors, this rough approximation based on the Dirac approximation is all that can be claimed theoretically.

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3 Additional analysis

In Einsteinian theory the orbit $\theta(u)$ with $u = 1/r$ has to be computed from solving the integral

$$\theta(u) = \int \frac{L_0\, du}{\sqrt{2m(H + ku - \frac{L_0^2}{2m}u^2 + \frac{L_0^2}{2m}r_0 u^3)}} \tag{57}$$

with non-relativistic angular momentum L_0, total energy H, $k = mMG$ and "Schwarzschild radius" r_0. The term in the square root is a polynomial of third order in u and can be written as

$$\frac{1}{\alpha}(u - u_1)(u - u_2)(u - u_3) \tag{58}$$

where $u_1 = 1/r_1$ etc. are characteristic inverse radii. The constants u_1, u_2, u_3 are defined by Eq.(57), and

$$\frac{1}{\alpha} = u_1 + u_2 + u_3. \tag{59}$$

Einstein argued by the roots of Eq.(58). The physical range of u is between two values of u where the denominator vanishes, i.e. one has to find the roots of (58) to find the integration interval. In his terminology Einstein wrote the terms in the denominator in form of

$$\frac{2A}{B^2} + \frac{\alpha}{B^2}u - u^2 + \alpha u^3 \tag{60}$$

and additionally omitted the cubic term. This seems to be arbitrary but guarantees that only two roots exist which then are

$$u^{(1,2)} = \frac{\pm\sqrt{8\,A\,B^2 + \alpha^2} + \alpha}{2\,B^2}. \tag{61}$$

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The correct method, however, would be finding the roots of the cubic equation (58). By computer algebra this is possible. Quite complicated solutions follow from which two are complex-valued. This problem of the "true" solution of (58) have never been addressed in literature.

With modern computer algebra, it is possible to solve Eq.(57) analytically. Writing it in the form

$$\theta(u) = \int \frac{du}{\sqrt{\alpha(u-u_1)(u-u_2)(u-u_3)}} \tag{62}$$

leads to a solution which, after some simplifications, reads

$$\theta(u) = \frac{2}{\sqrt{\alpha(u_2-u_1)}}\,\mathrm{F}\left(\mathrm{asin}\left(\sqrt{\frac{u_1-u_2}{u_1-u}}\right),\ \frac{u_3-u_1}{u_2-u_1}\right) \tag{63}$$

with the elliptic integral of first kind $\mathrm{F}(x, y)$. It has to be noted that this integral is complex-valued. The real value has to be taken as physical value.

Having found this solution, the result can be plotted and computer graphics gives an impression of the solution immediately. First we have graphed the integrand of (62) as a function $f(u)$ with parameters $u_1 = 3,\ u_2 = 2,\ \alpha = 0.1$ from which follows $u_3 = 5$. Fig. 1 shows that the integrand has strong infinite asymptotes as was already known from corresponding plots in UFT papers 150 and 155. u_1 and u_2 are the physical inverse radii, above u_3 an unlimited unphysical range appears. The real part of solution (63) (Fig. 2) is dominated by the inverse sine function which is defined between u_1 and u_2 correctly. The imaginary part pertains to an unphysical range. Choosing parameters differently with $u_1 < u_2$ (not shown) gives similar results with positive $\theta(u)$. We conclude that there is no multiplicity of solution for θ, i.e. there is no room for any precession effects from this Einsteinian solution which probably was analysed in these details for the first time.

The last example is an assessment of relativistic effects for a non-relativistic elliptic orbit. The latter is given by

$$r = \frac{\alpha}{1+\epsilon\cos(\theta)}. \tag{64}$$

We assume that the half-right latitude α is affected by relativistic effects:

$$\alpha = \gamma\ \alpha_0 = \frac{1}{1-v_0^2/c^2}\,\alpha_0 \tag{65}$$

for a non-relativistic α_0. Using the well-known solution

$$v_0^2 = \left(\frac{2}{r} - \frac{1}{a}\right) MG \tag{66}$$

and inserting this into (64), we obtain an equation for the orbit $r(\theta)$ with relativistic correction:

$$r = \frac{(2\,a\,\epsilon\cos(\theta) + 2\,a)\ M\,G + a\,\alpha_0\,c^2}{(\epsilon\cos(\theta)+1)\ M\,G + a\,c^2\,\epsilon\cos(\theta) + a\,c^2}. \tag{67}$$

The graph (Fig. 3) shows what is to be expected from (65): the effective alpha is enlarged by relativistic effects (here obtained by varying c and keeping all other parameters to unity). The enlargement is not constant, but there is no crossing of the curves, that means that the constants of motion are different. This is plausible because the angular momentum L_0 is increased by the gamma factor. A smaller c here means stronger relativistic effects.

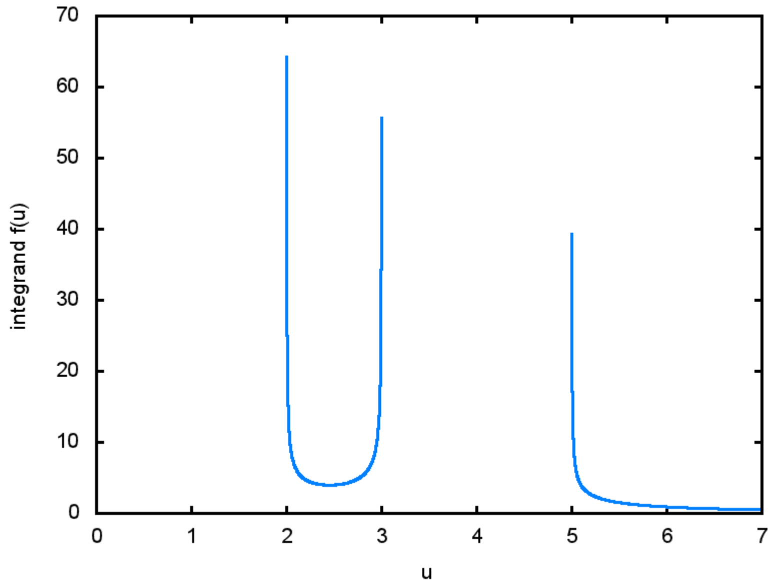

Figure 1: Integrand of Einstein integral in form of Eq.(62).

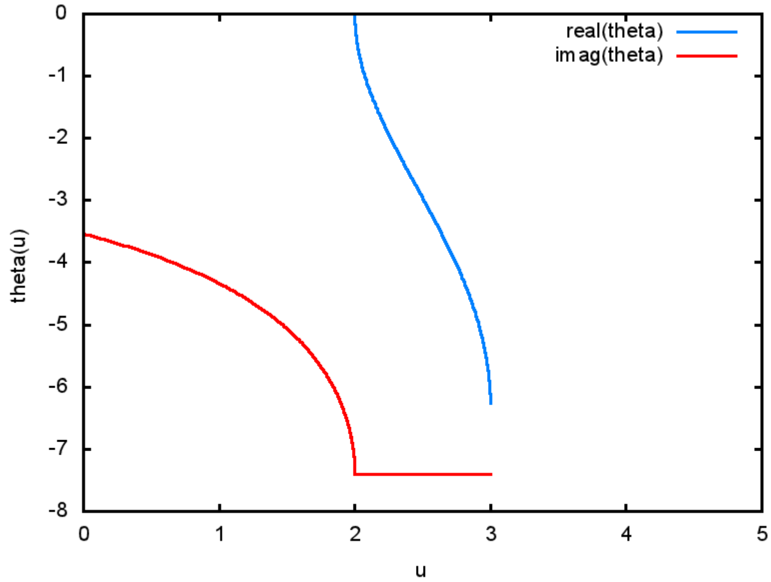

Figure 2: Analytical solution (63) of the Einstein integral.

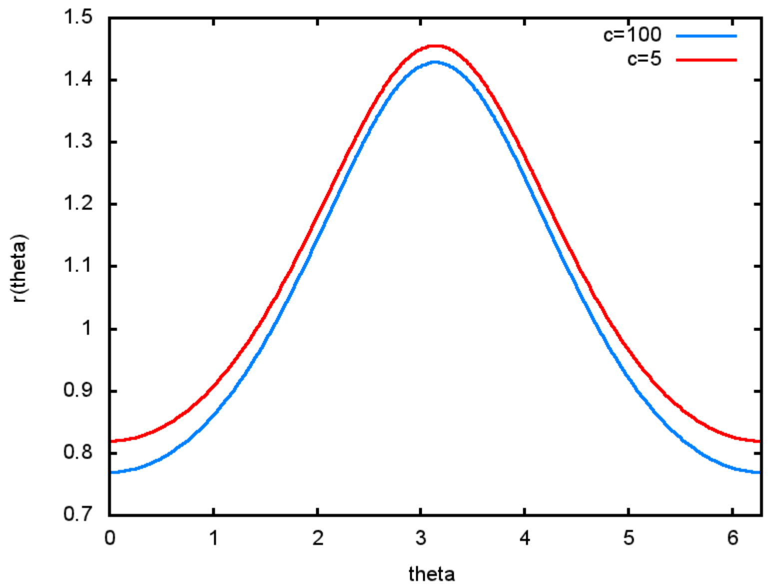

Figure 3: Radius function $r(\theta)$ for different cases of relativistic effects, characterized by c.

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