NEWTONIAN AND NON NEWTONIAN GRAVITATION IN ECE2

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ABSTRACT

The Newtonian limit of ECE2 theory is defined and the antisymmetry law used to derive the equivalence principle. The Newtonian limit is shown to be a special case of this equivalence principle. Non Newtonian effects are exemplified by light deflection due to gravitation and a new and simple explanation found for the experimental result within the context of ECE2 theory. In so doing, new estimates are made of photon mass and use is made of the Lorentz-like covariance of the gravitational field equations of ECE2. The Lorentz-like covariance is deduced from the fact that the gravitational field equations have the same structure as the Maxwell Heaviside equations of electrodynamics, but are defined in a space in which both torsion and curvature are always non-zero. ECE2 is a generally covariant unified field theory.

Keywords: ECE2 theory, Newtonian and non-Newtonian gravitation.

UFT319

1. INTRODUCTION

In recent papers of this series {1-12} the second Bianchi identity of 1902 has been corrected with torsion and extended into the Jacobi Cartan Evans (JCE) identity in UFT313. In UFT314 to UFT318 this correction has been used to develop ECE2 theory, a new phase of ECE theory which uses both torsion and curvature to define the vector field potential equations. ECE2 is a generally covariant unified field theory defined in a space in which both torsion and curvature are zero, but at the same time the ECE2 field equations have the structure of the Maxwell Heaviside (MH) field equations of electrodynamics. It is well known that the MH equations of electrodynamics are Lorentz covariant, but MH is an un-unified theory of special relativity in which the concepts of geometrical torsion and curvature do not exist. The general covariance of the ECE2 gravitational field equations have the property of being Lorentz covariant in a space with non zero torsion and curvature. The ECE2 electrodynamical equations have exactly the same structure and Lorentz covariance. The latter is referred to as Lorentz-like covariance, or quasi Lorentz covariance, a well defined limit of general covariance or general relativity.

As usual this paper should be read with its accompanying notes posted with them on www.aias.us. Note 319(1) shows that self consistency in ECE2 demands that the vector potential be always non-zero, both in gravitation and electrodynamics. Notes 319(2) and 319(3) initiate the derivation of the Newtonian limit from the ECE2 equivalence principle for gravitation, which generalizes the equivalence principles of Newton and Einstein. Note 319(3) defines the ECE2 conditions for zero gravitation and counter gravitation, while Note 319(4) explains light deflection due to gravitation using ECE2, giving a new and simple explanation for the observed deflection. Finally, Note 319(5) gives the complete Newtonian solution of ECE2.

Section 2 is a synopsis of Newtonian and non Newtonian effects in ECE2, while Section 3 is a graphical analysis of the results for photon mass from light deflection due to gravitation in ECE2.

2. NEWTONIAN LIMIT AND DEVIATIONS THEREFROM

In ECE2 theory the force is defined by:

$$\mathbf{F} = m\mathbf{g} = -\nabla U - \frac{\partial \mathbf{p}}{\partial t} - 2U\boldsymbol{\omega} + 2c\omega_0\mathbf{p} \quad -(1)$$

as part of a generally covariant unified field theory. Here U is the potential energy:

$$U = m\Phi \quad -(2)$$

where m is the mass of an object attracted by a mass M such as that of the earth. The spin connection four-vector is:

$$\omega^\mu = (\omega_0, \boldsymbol{\omega}) \quad -(3)$$

and the momentum $\mathbf{p}$ is defined by:

$$\mathbf{p} = m\mathbf{Q}. \quad -(4)$$

The gravitational four-potential is:

$$\Phi^\mu = \left(\frac{\Phi}{c}, \mathbf{Q}\right) \quad -(5)$$

where Φ is the gravitational scalar potential and $\mathbf{Q}$ the gravitational vector potential. The latter does not exist in Newtonian physics, which is a classical, non relativistic, theory.

In ECE there exist a gravitomagnetic field and gravitomagnetic charge current density. In electrodynamics, the equivalents are respectively the magnetic flux density and the magnetic charge current density. If it assumed that the gravitomagnetic charge current density is zero, the ECE2 field equations of gravitation are as in preceding papers:

$$\underline{\nabla} \cdot \underline{\Omega} = 0 \quad -(6)$$

$$\underline{\nabla} \times \underline{g} + \frac{\partial \underline{\Omega}}{\partial t} = \underline{0} \quad -(7)$$

$$\underline{\nabla} \cdot \underline{g} = \underline{\kappa} \cdot \underline{g} = 4\pi G \rho_m \quad -(8)$$

$$\underline{\nabla} \times \underline{\Omega} - \frac{1}{c^2}\frac{\partial \underline{g}}{\partial t} = \frac{4\pi G}{c^2}\underline{J}_M = \underline{\kappa} \times \underline{\Omega}. \quad -(9)$$

Here $\underline{g}$ is the acceleration due to gravity, $\underline{\Omega}$ is the gravitomagnetic field, G the Newton constant, ρ_m the mass density, c is the vacuum speed of light and:

$$\underline{\kappa} = \frac{1}{r^{(0)}}\underline{q} - \underline{\omega} \quad -(10)$$

where $\underline{q}$ is the tetrad vector, $\underline{\omega}$ the spin connection vector, and $r^{(0)}$ a parameter with the units of distance.

Eqs. (6) to (9) are quasi Lorentz covariant but are at the same time equations of a generally covariant unified field theory with non-zero torsion and curvature. As shown in the well known proofs on www.aias.us, both curvature and torsion must be non zero. If ether one vanishes the other vanishes too, and there is no gravitation at all. The error made by Bianchi in 1902 and Einstein in 1915 was to use a theory in which torsion is zero. This was an inevitable error because torsion was not inferred by Cartan et al. until the early twenties {1 - 10}. So the entire Einsteinian era of gravitation is obsolete and has been replaced by ECE and ECE2 theory. The inferences of the incorrect Einsteinian theory are meaningless, notably its claims to precision in the solar system, big bang, black holes and so on. Incorrect geometry cannot predict correct physics.

By antisymmetry as in preceding papers:

$$-\underline{\nabla} U - \frac{\partial \underline{p}}{\partial t} = -2U\underline{\omega} + 2c\omega_0 \underline{p} \quad -(11)$$

Eq. (11) is the ECE2 equivalence principle and generalizes the Newtonian and Einsteinian equivalence principles. From Eqs. (1) and (11):

$$\underline{F} = m\underline{g} = 2\left(-\underline{\nabla} U - \frac{\partial \underline{p}}{\partial t}\right) = 4\left(c\omega_0 \underline{p} - U\underline{\omega}\right) \quad -(12)$$

which is much more richly structured than the classical Newtonian theory:

$$\underline{F} = m\underline{g} = -m\underline{\nabla}\phi = -\frac{mMG}{r^2}\underline{e}_r \quad -(13)$$

where ϕ denotes the Newtonian scalar potential. Eq. (13) is the Newtonian equivalence principle, which has been tested experimentally with apparent accuracy in restricted conditions such as the laboratory, (for example the Eotvos type of experiments), but at the same time it is known that there are severe limitations to the Newtonian theory. Notably, it fails completely to describe the velocity curve of a whirlpool galaxy, and so does the Einstein theory (UFT281 on www.aias.us). The failure of both Newton and Einstein in whirlpool galaxies is qualitative, or complete, not just a tiny deviation. Newton also fails qualitatively to describe light deflection due to gravitation. Einstein cannot be a correct explanation because it omits torsion. On the other hand ECE and ECE2 can explain all these phenomena straightforwardly {1 - 12}.

In the Newtonian limit the acceleration due to gravity is:

$$\underline{g} = -\frac{MG}{r^2}\underline{e}_r \quad -(14)$$

From Eq. (8):

$$\underline{\nabla} \cdot \underline{g} = \underline{\kappa} \cdot \underline{g} \quad -(15)$$

where the tetrad four-vector is defined by:

$$q^{\mu} = (q_0, \underline{q}). \quad -(16)$$

From Eqs. (14) and (15):

$$\kappa_r = \frac{1}{r^{(0)}} q_r - \omega_r = -\frac{2}{r} \quad -(17)$$

where the radial components of the tetrad and spin connection vectors are defined by:

$$\underline{\kappa} = \kappa_r \underline{e}_r, \quad \underline{\omega} = \omega_r \underline{e}_r. \quad -(18)$$

Eqs. (15) and (17) are interpreted as the reason for gravitation. Gravitation is geometry with torsion and curvature. Newton did not give a reason for gravitation. Einstein correctly pointed out that it is geometry, but was inevitably incorrect because in his era, torsion was not known. The inverse square law was discovered by Robert Hooke, who made Newton aware of the solution. Newton's contribution was to deduce the elliptical orbit known to him from the Hooke inverse square law.

In order to reduce ECE2 to its Newtonian limit use:

$$\underline{\nabla} U = \frac{\partial \underline{p}}{\partial t} \quad -(19)$$

and

$$c\omega_0 \underline{p} = -U\underline{\omega}. \quad -(20)$$

Eqs. (19) and (20) are equivalent to the Newtonian equivalence principle (13).
Using Eqs. (19) and (20) in Eq. (11):

$$\underline{F} = m\underline{g} = -4\underline{\nabla}\Phi = -8\Phi\underline{\omega} = -\frac{mMG}{r^2}\underline{e}_r \quad -(21)$$

so:

$$\Phi = -\frac{mMG}{4r} \quad -(22)$$

and it follows as in Note 319(5) that the spin connection vector is

$$\underline{\omega} = \frac{1}{2r}\underline{e}_r. \quad -(23)$$

From Eqs. (17) and (23):

$$\underline{\kappa} = \frac{1}{r^{(0)}}\underline{q} - \underline{\omega} = -\frac{2}{r}\underline{e}_r \quad -(24)$$

so the tetrad vector is:

$$\underline{q} = -\frac{3}{2}\frac{r^{(0)}}{r}\underline{e}_r. \quad -(25)$$

Using:

$$\omega_0 c\underline{p} = -\Phi\underline{\omega} = \frac{mMG}{8r^2}\underline{e}_r \quad -(26)$$

it follows that the momentum vector is:

$$\underline{p} = p_r\underline{e}_r = -\int_0^{\tau}\frac{mMG}{8r^2}\underline{e}_r\,dt \quad -(27)$$

and so the scalar part of the spin connection is defined in the Newtonian limit by:

$$\omega_0 = -\frac{1}{cr^2}\left(\int_0^{\tau}\frac{1}{r^2}\,dt\right)^{-1} \quad -(28)$$

In these calculations the Newtonian potential ϕ and the ECE2 scalar potential Φ

are related by

$$\phi = 4\Phi . \quad -(29)$$

The force is therefore defined in the Newtonian limit of ECE2 as:

$$\underline{F} = m\underline{g} = -4\underline{\nabla}U = -8U\underline{\omega} = -4\frac{\partial \underline{p}}{\partial t} = 8c\omega_0\underline{p} . \quad -(30)$$

Finally in the absence of gravitomagnetic charge current density:

$$q_0 = r^{(0)}\omega_0 \quad -(31)$$

as in immediately preceding papers.

These equations give the complete Newtonian solution of the ECE2 gravitational field equations. Note that the gravitational vector potential is non-zero in this solution, which accepts the sixteenth or seventeenth century definition:

$$\underline{F} = m\underline{g} . \quad -(32)$$

More generally this force should be replaced by the gravitational Lorentz force, a concept that does not exist in standard physics. Note 319(2) shows that a possible operator solution of the Newtonian limit of ECE2 is:

$$(\omega_0 , \underline{\omega}) = \frac{1}{2}\left(\frac{1}{c}\frac{\partial}{\partial t} , -\underline{\nabla}\right) -(33)$$

or:

$$\omega^\mu = \frac{1}{2}\partial^\mu -(34)$$

Using the quantum condition:

$$p^\mu = i\hbar\,\partial^\mu = 2i\hbar\,\omega^\mu \quad -(35)$$

the Newtonian condition (19) becomes:

$$\underline{\nabla}\frac{\partial}{\partial t} + \frac{\partial}{\partial t}\underline{\nabla} = \underline{0} \quad -(36)$$

giving the anticommutator equation of quantum gravity:

$$\left\{ \underline{\nabla}, \frac{1}{c}\frac{\partial}{\partial t} \right\}\phi = 0. \quad -(37)$$

Non Newtonian effects can be explained by deviations from the above set of equations. For example, in Note 319(3) it is shown that the condition for zero gravitation is:

$$\omega^\mu = -\frac{1}{2}\partial^\mu \quad -(38)$$

which is the opposite of Eq. (34). In Note 319(4) it is shown that ECE2 theory gives a simple and original explanation for the well known angle of deflection of electromagnetic radiation by gravitation (the "twice Newton" effect). This calculation is based on papers such as UFT215 ff. and UFT261 and on the Lorentz like covariance of the gravitational field equations of ECE2. This means that a quasi Minkowski metric can be used:

$$c^2 d\tau^2 = (c^2 - v^2)\,dt^2 \quad -(39)$$

where the velocity $\underline{v}$ for a planar orbit is:

$$v^2 = \left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\theta}{dt}\right)^2 \quad -(40)$$

using plane polar coordinates. Here τ is the proper time. For light deflection by the sun, the orbit to an excellent approximation is the hyperbola:

$$r = \frac{\alpha}{1+\epsilon\cos\theta} \quad -(41)$$

with very large eccentricity ϵ. So the orbit is nearly a straight line. As shown in Note 319(4), the velocity from Eqs. (40) and (41) is:

$$v^2 = \frac{MG}{R_0}(1+\epsilon) \quad -(42)$$

where R_0 is the distance of closest approach. The angle of deflection is:

$$\psi = 2\phi = \frac{2}{\epsilon} \doteq \frac{2MG}{R_0 v^2} \quad -(43)$$

The experimentally observed result, known to high precision, is:

$$\psi = \frac{4MG}{R_0 c^2} \quad -(44)$$

so it follows that the velocity of Eq. (43) is:

$$v^2 = \frac{1}{2}c^2 \quad -(45)$$

and that the Lorentz factor is:

$$\gamma = \frac{dt}{d\tau} = \left(1-\frac{v^2}{c^2}\right)^{-1/2} = \frac{1}{\sqrt{2}} = 0.707. \quad -(46)$$

Therefore the quasi Lorentz covariance of ECE2 gives a simple and straightforward explanation of the well known experimental result (44). Finally, the photon mass is given by the de Broglie Einstein equation:

$$\hbar\omega = \gamma mc^2 \quad -(47)$$

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3 Plots of photon mass from ECE2

The photon mass from the de Broglie-Einstein equation (47) is

$$m = \frac{\hbar\omega}{\gamma c^2} \tag{48}$$

where γ was shown to be

$$\gamma = \frac{1}{\sqrt{2}}. \tag{49}$$

If photons are considered as oscillators with statistical energy distribution, the average energy is given by

$$\langle \hbar\omega \rangle = \frac{\hbar\omega}{\exp(\frac{\hbar\omega}{kT}) - 1} \tag{50}$$

from which follows for the photon mass:

$$m = \frac{\hbar\omega}{\gamma c^2} \cdot \frac{1}{\exp(\frac{\hbar\omega}{kT}) - 1}. \tag{51}$$

Here k is the Boltzmann constant and T the temperature of the environment. Since the temperature near to the surface of the sun is of some thousand Kelvin, we used corresponding values for the numerical evaluation of Eq.(49). The results for both equations (with and without statistics) are graphed in Fig. 1. The photon mass of a single photon grows linearly on a double-logarithmic scale while it drops to zero for finite temperatures. There is a plateau (constant limit) in the infrared.

In a second plot, the ratio v/c in the gamma factor has been varied for T=293 K. Obviously the results are not very sensitive to γ. Only in the ultra-relativistic limit the photon mass drops significantly.

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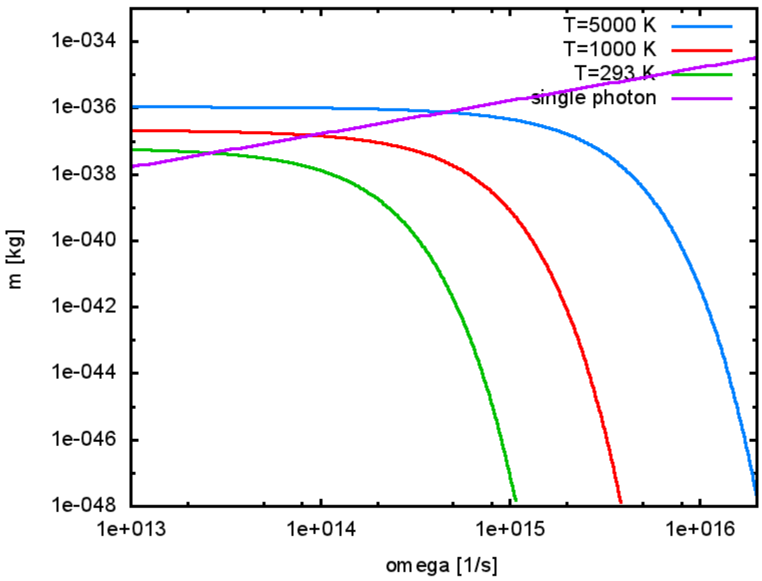

Figure 1: Photon mass in dependence of light frequency for various temperatures and the single-photon case.

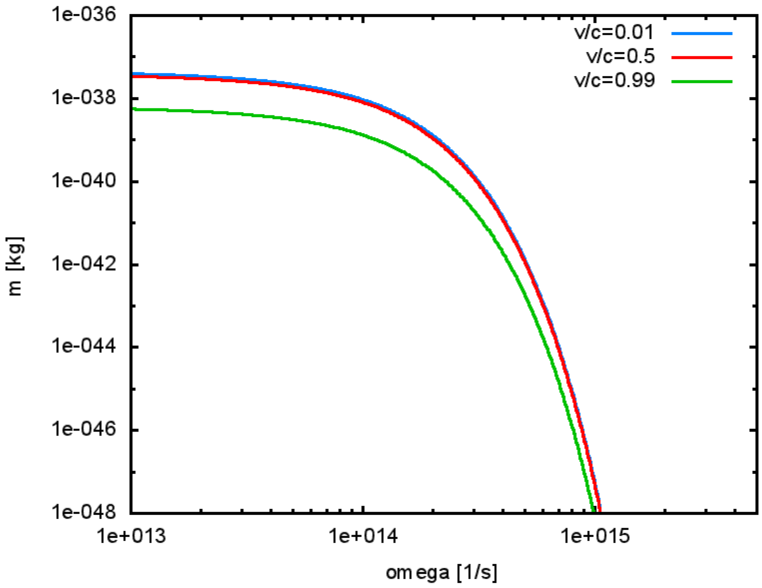

Figure 2: Photon mass for T=293K and different ratios v/c.

and is plotted and discussed in Section 3.

3. PLOTS OF PHOTON MASS FROM ECE2

Section by Dr. Horst Eckardt

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