THOMAS PRECESSION AND REFUTATION OF DE SITTER PRECESSION

by

M. W Evans and Horst Eckardt

Civil List and AIAS / UPITEC

(www.aias.us, www.upitec.org, www.et3m.net, www.archive.org, www.webarchive.org.uk)

ABSTRACT

It is shown that the energy levels of the Schroedinger and Bohr H atoms are due to the Thomas precession, which is also the cause of precession in the Sommerfeld H atom. This means that the well known results of non relativistic quantum mechanics are made up of relativistic structures, notably the Thomas half and the Einstein rest energy. The ECE2 spin connection of the Sommerfeld H atom is calculated and related to vacuum fluctuations. The de Sitter theory of the standard model is refuted completely by considering the H atom as a Thomas precession in the gravitational field of the erath.

Keywords: ECE2 unified field theory; Thomas precession, Bohr, Schroedinger and Sommerfeld hydrogen atoms

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1. INTRODUCTION

In the immediately preceding paper of this series (UFT406 on www.aias.us {1 - 41}) the precession theory of Einsteinian general relativity (EGR) was refuted in a very simple way by considering the accompanying de Sitter and Lense Thirring precessions. These always accompany the Einstein precession, which is due purely to the force law of EGR. Astonishingly, the standard model considers only one out of three precessions, the Einstein precession, so its claim to be a precise theory of planetary precessions is refuted completely by this fact alone. In this paper the Thomas precession is considered in an ECE2 covariant unified field theory. It is shown that the energy levels of the Schroedinger and Bohr H atoms are due to Thomas precession, so these well known atoms include remnants of a relativistic structure, notably the Thomas half, the fine structure constant and the Einstein rest energy. The precession of the elliptical orbitals of the Sommerfeld atom is shown to be due to Thomas precession. The standard model de Sitter precession is the Thomas precession in a gravitational field, and by considering an H atom in the earth's gravitational field, the standard theory of de Sitter precession is refuted completely in a very simple way.

This paper is a synopsis of detailed calculations in the notes accompanying UFT407 on www.aias.us. Note 407(1) gives the Thomas precession of planetary orbits and shows that the energy levels of the Schroedinger H atom are defined by the Thomas precession. Note 407(2) derives the Thomas half from the commutator of Lorentz boost matrices. Note 407(3) is the first version of the refutation of de Sitter precession in the standard model. Note 407(4) calculates the spin connection of the Sommerfeld atom and relates it to isotropically averaged vacuum fluctuations. Note 407(5) is the final version of the simple refutation of standard de Sitter theory. Note 407(6) shows that the fundamental structure of the Bohr and Sommerfeld H atoms is based on the Thomas precession.

2. THOMAS PRECESSION IN THE HYDROGEN ATOM.

Consider the infinitesimal line element of ECE2 covariant unified field theory:

$$ds^2 = c^2 d\tau^2 = c^2 dt^2 - dr^2 - r^2 d\phi^2 \quad -(1)$$

in plane polar coordinates r and ϕ. The Thomas precession follows from the rotation:

$$\phi' = \phi + \omega_0 t \quad -(2)$$

where the angular frequency ω_0 of rotation is defined by:

$$v = \omega_0 r \quad -(3)$$

where v is the orbital velocity of the rotation. It follows that:

$$ds'^2 = \left(1 - \frac{v^2}{c^2}\right)\left(c^2 dt^2 - 2r^2 \Omega \, d\phi \, dt\right) - dr^2 - r^2 d\phi^2 \quad -(4)$$

where the ECE2 covariant angular velocity is:

$$\Omega = \omega_0 \left(1 - \frac{v^2}{c^2}\right)^{-1} \quad -(5)$$

The same rotation produces:

$$dt'^2 = \left(1 - \frac{v^2}{c^2}\right) dt^2 \quad -(6)$$

so there is a precession:

$$\Delta \phi_T = \Omega \, dt' - \omega \, dt. \quad -(7)$$

For a rotation of 2π, the Thomas precession follows:

$$\Delta \phi_T = 2\pi(\gamma - 1) = 2\pi\left(\left(1 - \frac{v^2}{c^2}\right)^{-1/2} - 1\right). \quad -(8)$$

Note carefully that the Thomas precession takes place in a space with finite torsion and curvature. The original theory by Thomas was based on the Minkowski space in which torsion and curvature vanish.

In the low velocity limit:

$$v << c \quad -(9)$$

the Thomas precession is approximately:

$$\Delta\phi_T \sim \pi\left(\frac{v}{c}\right)^2. \quad -(10)$$

The precession rate in radians per radian is:

$$\frac{\Delta\phi_T}{2\pi} = \frac{1}{2}\left(\frac{v}{c}\right)^2. \quad -(11)$$

The factor 1 /2 in this expression is the origin of the "Thomas half" that is observed in atomic spectra. In planetary motion a mass m orbits a mass M, and in the non relativistic limit:

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

so the Thomas precession of the planet is:

$$\Delta\phi_T = \frac{\pi}{c^2} MG\left(\frac{2}{r} - \frac{1}{a}\right). \quad -(13)$$

This is correctly calculated from a theory with torsion and curvature, while all precessions calculated from EGR are incorrect, and as shown in UFT406, easily refuted. Later in this Section the standard de Sitter precession will be refuted.

The Thomas precession frequency in radians per second is:

$$\omega_T = \frac{1}{2}\frac{v^2}{c^2}\omega_0 \quad -(14)$$

where ω_0 is a fundamental frequency, notably the de Broglie rest frequency:

$$\omega_0 = \frac{mc^2}{\hbar} \quad -(15)$$

where for example m is the mass of the electron in the H atom. The Schroedinger H atom is based on the classical hamiltonian:

$$H = \frac{p^2}{2m} - \frac{e^2}{4\pi\epsilon_0 r} \quad -(16)$$

and as shown in UFT329 for example its energy levels are:

$$E = \frac{-me^4}{32\pi^2\epsilon_0^2\hbar^2n^2} = -\frac{1}{2}\left(\frac{\alpha}{n}\right)^2 mc^2 \quad -(17)$$

where n is the principal quantum number and α is the fine structure constant:

$$\alpha = \frac{e^2}{4\pi\hbar c\epsilon_0}. \quad -(18)$$

Here $\hbar$ is the reduced Planck constant and ϵ_0 is the vacuum permittivity. The individual expectation values are:

$$\left\langle \frac{p^2}{2m} \right\rangle = \frac{1}{2}m\langle v^2\rangle = \frac{1}{2}\left(\frac{\alpha}{n}\right)^2 mc^2 \quad -(18)$$

and

$$\langle U\rangle = -\left(\frac{\alpha}{n}\right)^2 mc^2. \quad -(19)$$

The angular frequencies corresponding to the energy levels of the H atom are:

$$\omega = \frac{|E|}{\hbar} = \frac{1}{2}\left(\frac{\alpha}{n}\right)^2 \frac{mc^2}{\hbar} \quad -(20)$$

so:

$$\omega = \frac{1}{2}\left(\frac{\alpha}{n}\right)^2 \omega_0 \quad -(21)$$

with

$$\frac{1}{2}\frac{v^2}{c^2} = \frac{1}{2}\frac{\alpha^2}{n^2} \quad -(22)$$

so:

$$\frac{v}{c} = \frac{\alpha}{n}. \quad -(23)$$

This result sis also true for the Bohr atom as shown in UFT266.

Therefore the Thomas half, or approximate Thomas precession in radians per radian, gives the energy levels of the H atom when multiplied by the Einstein rest energy mc^2. This is a remarkable result that shows that the Schroedinger H atom is made up of relativistic elements. The Thomas half enters into the description of the Schroedinger and Bohr H atoms as well as the Dirac atom (now developed into the ECE2 fermion equation).

The non relativistic kinetic energy is the familiar:

$$T = \frac{1}{2}mv^2 \quad -(24)$$

where m is particle mass and $\underline{v}$ is the particle's linear velocity. Note carefully that this result can be written as:

$$T = \frac{1}{2}\frac{v^2}{c^2}mc^2 \quad -(25)$$

which is the Thomas half multiplied by the rest energy. This is another simple yet profound result, implying that the whole of classical dynamics has "a hidden relativistic structure". The de Sitter theory implies that the classical kinetic energy in the presence of gravitation becomes:

$$T = \frac{1}{2}m\left(v^2 + \frac{2MG}{r}\right) = \frac{1}{2}mv^2 + \frac{mMG}{r}. \quad -(26)$$

The classical, non relativistic, hamiltonian in the presence of gravitation is the well known:

$$H = \frac{1}{2}mv^2 - \frac{mMG}{r} \quad -(27)$$

Therefore the Sitter theory produces an absurd result:

$$H = ?\ \frac{1}{2} m v^2 \qquad -(28)$$

and is completely refuted in a very clear and simple way. As soon as it is realized that classical dynamics can be developed with the Thomas precession, essentially all of the solutions of the Einstein field equation are refuted. So EGR should be discarded in favour of ECE / ECE2.

The Thomas precession in radians in each orbital of the H atom is:

$$\Delta \phi_T = \pi \frac{v^2}{c^2} = \pi \frac{\alpha^2}{n^2} \qquad -(29)$$

and for n = 1 for example:

$$\Delta \phi_T = \pi \alpha^2 = 1.67 \times 10^{-4} \text{ rad}. \qquad -(30)$$

This is much larger than in planetary precession. Without the Thomas half the energy levels of the H atom would not match the spectral data, so Thomas precession is a very fundamental feature of physics from microscopic to macroscopic scales.

As shown in Note 407(2) a commutator of Lorentz boost matrices can be expressed entirely in terms of the Thomas half, and in general:

$$\Delta \phi_T = 2\pi (\gamma - 1). \qquad -(31)$$

The factor $\gamma - 1$ appears in the lagrangian of ECE2 theory and also defines its relativistic kinetic energy. Therefore the Thomas precession per radian defines the fundamentals of ECE2 theory, and vice versa.

On the fundamental level in classical dynamics, the non relativistic kinetic energy is:

$$T = \frac{1}{2} m v^2 = \frac{1}{2} \frac{v^2}{c^2} mc^2 \quad -(32)$$

and is the Thomas half $\frac{1}{2}\frac{v^2}{c^2}$ multiplied by the rest energy mc^2. It follows that the relativistic kinetic energy is:

$$T = (\gamma - 1) mc^2 = \left(\frac{\Delta \phi_T}{2\pi} \right) mc^2 \quad -(33)$$

and is the Thomas precession per radian multiplied by the rest energy. The relativistic kinetic energy corresponds to the hamiltonian:

$$H = \gamma mc^2 + U \quad -(34)$$

and the lagrangian:

$$\mathcal{L} = -\frac{mc^2}{\gamma} - U \quad -(35)$$

which describe the Sommerfeld H atom. The latter has precessing elliptical orbitals, the precession being a Thomas precession.

In these equations the Coulomb potential is:

$$U = -\frac{e^2}{4\pi \epsilon_0 r} = -\frac{\alpha \hbar c}{r} \quad -(36)$$

and its expectation value in the Schroedinger H atom is:

$$\langle U \rangle = -mc^2 \left(\frac{\alpha}{n} \right)^2 = -m \langle v^2 \rangle. \quad -(37)$$

Therefore the energy levels of the Schroedinger H atom can be expressed as:

$$E = \frac{1}{2} m \langle v^2 \rangle + \langle U \rangle = -\frac{1}{2} m \langle v^2 \rangle = -\frac{1}{2} \left(\frac{\alpha}{n} \right)^2 mc^2 \quad -(38)$$

The hamiltonian, lagrangian, force equation and spin connection of the Sommerfeld atom are discussed in Note 407(4).

In Note 407(6) it is shown that the Bohr atom produces the same energy levels as the Schroedinger atom and also gives:

$$\frac{v}{c} = \frac{\alpha}{n} \quad -(39)$$

(UFT266, Eq. (35)). Therefore the Thomas half:

$$\frac{\Delta\phi_T}{2\pi} = \gamma - 1 \xrightarrow[v \ll c]{} \frac{1}{2}\frac{v^2}{c^2} = \frac{1}{2}\left(\frac{\alpha}{n}\right)^2 \quad -(40)$$

is responsible for the energy levels both of the Schroedinger and Bohr atoms, another remarkable result. The Thomas half:

$$\frac{\Delta\phi_T}{2\pi} = \frac{1}{2}\left(\frac{v}{c}\right)^2 = \frac{1}{2}\left(\frac{\alpha}{n}\right)^2 \quad -(41)$$

appears in both atoms despite the fact that the scheme of quantization in the two atoms is completely different as is well known. The energy levels of both atoms are:

$$E = -\frac{1}{2}m\langle v^2\rangle \quad -(42)$$

where the expectation value of the orbital velocity is:

$$\langle v\rangle = v = \frac{c\alpha}{n} \quad -(43)$$

in both atoms. Both atoms therefore have relativistic elements in their structure. This relativistic nature manifests itself in the Sommerfeld atom, which is based on the hamiltonian:

$$H = \gamma mc^2 - \frac{e^2}{4\pi\epsilon_0 r} = (\gamma - 1)mc^2 + mc^2 - \frac{e^2}{4\pi\epsilon_0 r} \quad -(44)$$

So the Sommerfeld atom is the quantization of:

$$\frac{H_0}{mc^2} = \gamma - 1 - \alpha \frac{\lambda_c}{2\pi} \frac{1}{r} \quad -(45)$$

where

$$\lambda_c = 2\pi \frac{\hbar}{mc}. \quad -(46)$$

is the Compton wavelength. The Sommerfeld atom therefore contains the Thomas precession:

$$\Delta\phi_T = 2\pi(\gamma - 1) \quad -(47)$$

and this is the precession of the elliptical orbitals. Note carefully that in previous work it has been shown that the relativistic lagrangian of ECE2 gives a precessing elliptical orbit in a gravitational context. Therefore the same type of lagrangian will give precessing elliptical orbitals of the H atom, Q. E. D. These are the famous rosette orbitals sketched in a letter from Sommerfeld to Einstein. In Eq. (46):

$$\gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1/2} = \left(1 - \frac{\alpha^2}{n^2}\right)^{-1/2}. \quad -(48)$$

Sommerfeld introduced the well known quantization condition:

$$n = n_r + n_\phi \quad -(49)$$

where

$$n_r = 0, 1, 2, 3 \ldots \quad -(50)$$

$$n_\phi = 1, 2, 3, 4 \ldots \quad -(51)$$

so the energy levels of the atom are:

$$E = H - mc^2 = \left(1 - \frac{\alpha^2}{(n_r + n_\phi)^2}\right)^{-1/2} mc^2 - \frac{\hbar c \alpha}{r} \quad -(52)$$

in which the velocity is given by:

$$\frac{v}{c} \doteq \frac{\alpha}{n_r + n_\phi} . \quad -(53)$$

In the non relativistic approximation:

$$v^2 \sim \frac{e}{4\pi\epsilon_0}\left(\frac{2}{r} - \frac{1}{a}\right) \quad -(54)$$

in analogy with the Newtonian:

$$v^2 = MG\left(\frac{2}{r} - \frac{1}{a}\right) \quad -(55)$$

3. NUMERICAL AND GRAPHICAL ANALYSIS.

(Section by Dr. Horst Eckardt)

Thomas precession and refutation of de Sitter precession

M. W. Evans*, H. Eckardt†
Civil List, A.I.A.S. and UPITEC

(www.webarchive.org.uk, www.aias.us,
www.atomicprecision.com, www.upitec.org)

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3 Numerical and graphical analysis

As a numerical example the γ factor (48) has been graphed in dependence of the principal quantum number n. In order to get an impression of the ordinal number of the element, we have added an atomic number Z to the equation:

$$\gamma = \left(1 - \frac{Z\,\alpha}{n}\right)^{-1/2} . \tag{56}$$

For convenience we have considered n to be a continuous variable. The result for $Z = 1$ (Hydrogen) is graphed in Fig. 1 and the result for $Z = 92$ (Uranium) in Fig. 2. The curves are qualitatively identical as expected, only the size of γ differs by two orders of magnitude. Even for the heaviest elements, γ stays in a low range, at least in this simple model.

*email: emyrone@aol.com
†email: mail@horst-eckardt.de

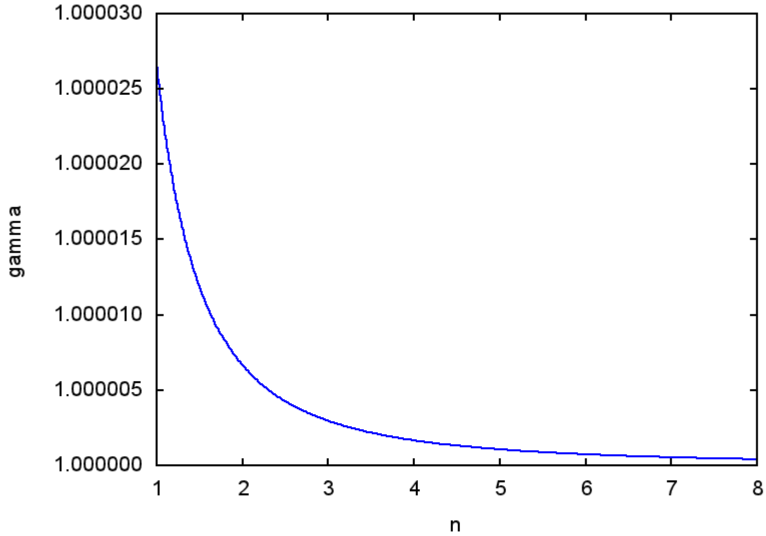

Figure 1: γ factor for $Z = 1$ in dependence of n.

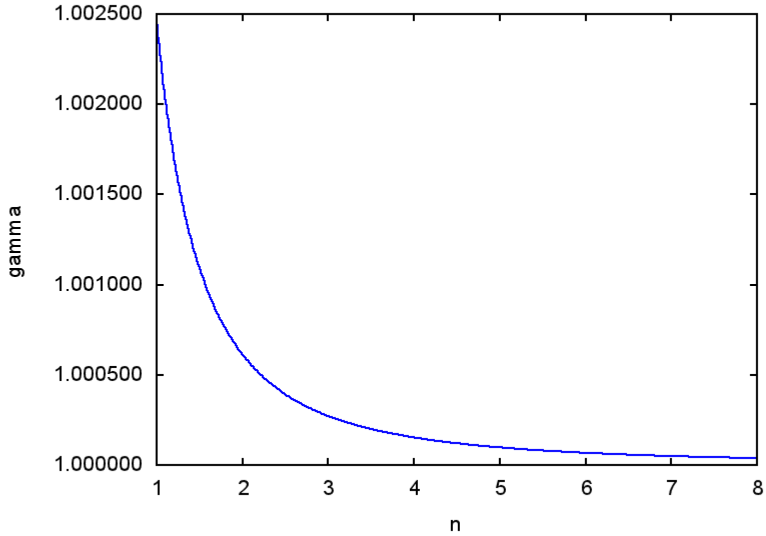

Figure 2: γ factor for $Z = 92$ in dependence of n.

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