A FULLY RELATIVISTIC ECE THEORY OF COSMOLOGY

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ABSTRACT

A fully relativistic theory of cosmology is suggested on the concept of position tetrad. The linear velocity is defined in terms of the position tetrad and the spin connection. Using a simple antisymmetry law of ECE theory the expression for velocity is simplified into one containing one component of spin connection. The procedure of special relativity is used to define a new type of relativistic kinetic energy which is used in lagrangian theory to produce a force equation for any orbit.

Keywords: ECE theory, relativistic theory of cosmology, force law for any orbit.

UFT 196

1. INTRODUCTION

In recent papers of this series of one hundred and ninety five papers to date {1 - 10} the Einsteinian general relativity has been refuted directly in several different and very simple ways, and the refutations checked by computer for algebraic correctness. There can be no doubt that the era of twentieth century general relativity is over. Every one of its conclusions has been shown to be incorrect either by simple refutation as in UFT 194 (www.aias.us) or by astronomy. It has been known since December 1915 {11} that Einstein's theory of the perihelion precession has always been incorrect, and his theory of general relativity has been criticised repeatedly by some of the most eminent physicists and mathematicians, notably: Schwarzschild, Schroedinger, Eddington, Levi-Civita, Cartan, Dirac, Vigier and many others. The astronomical discovery of the whirlpool galaxy's velocity curve about half a century ago meant that the Einstein theory does not describe cosmology at all. It has persisted in the literature due to careless repetition of error, and has become dogmatism.

In Section 2 a new general relativity is initiated on the basis of Cartan geometry, and is based on torsion as is the whole of ECE theory {1 - 10}. The Cartan tetrad is used to define the position tetrad, from which the linear velocity is defined using the first structure equation of Cartan {12}. Simple use of an ECE antisymmetry law reduces the expression for linear velocity to one in one scalar component of the spin connection. This procedure is similar to one that uses the idea of covariant derivative, and is one that does not use any of Einstein's incorrect mathematics. The procedure of special relativity is extended to general relativity using a work integral to define the relativistic kinetic energy in terms of a characteristic evolution time t_{γ}, in terms of the spin connection and its radial derivative.

Lagrangian dynamics are used to define the force law for any orbit.

In Section 3 the non - relativistic limit of this theory is evaluated using the cylindrical polar coordinates in a plane, and the same result found as in recent papers for the force law of a precessing ellipse. The force law is not that claimed in Einsteinian theory to produce a precessing ellipse. The Einstein theory uses the same lagrangian method. A direct check by computer algebra in UFT 192 and UFT 193 shows that the claimed force law of Einsteinian theory produces a very complicated orbit that is not a precessing ellipse at all. Therefore Schwarzschild's original and severe criticism of Einstein in December 1915 {11} was correct. Einstein's theory should have been abandoned at that time. Unfortunately Eddington claimed to have verified the theory and it persisted as unscientific dogma even after the discovery of the completely non Einsteinian velocity curve of a whirlpool galaxy no less than fifty years ago.

2. TOWARDS A NEW RELATIVITY

In classical, non relativistic, dynamics the position of a particle is described by the position vector $\underline{r}$. In Cartesian coordinates {13, 14} its linear velocity ($\underline{v}$) and linear acceleration ($\underline{a}$) are described by:

$$\underline{v} = \frac{d\underline{r}}{dt}, \quad \underline{a} = \frac{d\underline{v}}{dt} \qquad -(1)$$

respectively, and the force $\underline{F}$ is defined for a particle of mass m as:

$$\underline{F} = m\underline{a}. \qquad -(2)$$

These are the familiar definitions of Newtonian dynamics. In the latter type of dynamics, the use of cylindrical polar coordinates means {13, 14} that the above definitions are changed to:

$$\underline{r} = r\,\underline{e}_r \qquad -(3)$$

$$\underline{v} = \dot{r}\,\underline{e}_r + r\dot{\theta}\,\underline{e}_\theta \qquad -(4)$$

$$\underline{a} = (\ddot{r} - r\dot{\theta}^2)\,\underline{e}_r + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\,\underline{e}_\theta \qquad -(5)$$

in the plane

$$dZ = 0. \qquad -(6)$$

The cylindrical polar coordinate system in this plane is described by (r, θ). The unit vectors of the cylindrical polar system {14} are:

$$\underline{e}_r = \underline{i}\cos\theta + \underline{j}\sin\theta \qquad -(7)$$

$$\underline{e}_\theta = -\underline{i}\sin\theta + \underline{j}\cos\theta. \qquad -(8)$$

In Cartesian coordinates in the plane (6):

$$\underline{r} = r_x\,\underline{i} + r_y\,\underline{j} \qquad -(9)$$

and:

$$\underline{v} = \dot{\underline{r}} = \frac{d\underline{r}}{dt}, \quad \underline{a} = \dot{\underline{v}} = \frac{d\underline{v}}{dt}. \qquad -(10)$$

The reason why the Cartesian and cylindrical polar systems look so different {13} is that in the latter system the coordinate axes move. In the description of orbits the cylindrical polar system is used to give very simple equations for an ellipse:

$$r = \frac{\alpha}{1 + \epsilon\cos\theta} \qquad -(11)$$

and a precessing ellipse:

$$r = \frac{\alpha}{1 + \epsilon \cos(x\theta)} \quad -(12)$$

Here 2α is known as the right latitude (latus rectum), ϵ is the eccentricity, and x the precession constant. As shown in Section 3, the force law for an elliptical orbit and for a precessing elliptical orbit can be worked out using only Eqs. (1) to (12). It is shown in Section 3 that the result is the same exactly as in the classical lagrangian dynamics of UFT 193. In seventeenth century language, "the force law of attraction" for a static ellipse is the Hooke Newton inverse square law, discovered by Robert Hooke {15} and not Isaac Newton as in the dogma. The force law of attraction for a precessing ellipse is a sum of inverse square and inverse cubed terms in r. In the incorrect dogma of Einstein theory {13} this sum is claimed to be that of an inverse square and inverse fourth power terms in r. In the Einstein method {13} an effective potential is defined and the same lagrangian method used as in UFT 193. Clearly, the Einstein dogmatists never bothered to check that their work was correct, their claimed sum of terms leads to a very complicated curve that is not a precessing ellipse at all (UFT 193 on www.aias.us). This is an astonishing illustration of how dogma can damage physics, and how useless a system of physics "administration" can be. Theories can neither be administered nor proclaimed. Section 3 shows that even in the very familiar non relativistic context, the very concept of force law of attraction is untenable, and this can be shown in a very simple way simply by working out $\underline{v}$ and $\underline{a}$ with cylindrical polar coordinates in a plane. What has been known for three hundred and fifty years as the force law of attraction is another thing altogether. Familiarity breeds contempt in natural philosophy as in other contexts. There is always a danger in the unthinking repetition of the familiar.

In UFT 143 on www.aias.us the position tetrad was introduced and defined as:

$$R^a_\mu = R\, q^a_\mu \qquad -(13)$$

where R has the units of metres and where q^a_μ is the Cartan tetrad {1 - 10}. The linear velocity was worked out in condensed differential form notation as:

$$v^a = D \wedge R^a. \qquad -(14)$$

In tensor notation this becomes:

$$v^a_{\mu\nu} = c\left(\partial_\mu R^a_\nu - \partial_\nu R^a_\mu + \omega^a_{\mu b} R^b_\nu - \omega^a_{\nu b} R^b_\mu\right) \qquad -(15)$$

and in vector notation:

$$\underline{v}^a = \frac{\partial \underline{r}^a}{\partial t} + c\underline{\nabla} R^a_0 + c\,\omega^a_{0b}\underline{R}^b - cR^b_0\,\underline{\omega}^a_b \qquad -(16)$$

where the omega symbol denotes the spin connection. The simplest type of antisymmetry law is now applied:

$$\frac{\partial \underline{R}^a}{\partial t} + c\,\omega^a_{0b}\underline{R}^b = -c\underline{\nabla} R^a_0 + cR^b_0\,\underline{\omega}^a_b \qquad -(17)$$

choosing a diagonal spin connection:

$$a = b. \qquad -(18)$$

Then for each a:

$$\underline{v} = 2\left(\frac{\partial \underline{R}}{\partial t} + c\,\omega\,\underline{R}\right). \qquad -(19)$$

The factor 2 can be eliminated for ease of development and without loss of generality by defining:

$$\underline{r} = \frac{1}{2}\underline{R} \quad -(20)$$

giving the simple expression:

$$\underline{v} = \left(\frac{\partial}{\partial t} + c\omega\right)\underline{r}. \quad -(21)$$

The concept of proper time τ can be defined as:

$$\frac{\partial}{\partial \tau} = \frac{\partial}{\partial t} + c\omega. \quad -(22)$$

The derivative appearing in Eq. (21) is the simplest type of covariant derivative in this theory.

There is nothing to guide this new theory in the mathematically incorrect Einstein general relativity, but the method of special relativity can still be used and developed. This was Einstein's original intention, which we seek to carry out in this paper.

The method used by Einstein to define the relativistic kinetic energy in special relativity {13} was based on classical dynamics, in which the work done is defined by:

$$W_{12} = T_2 - T_1 = \int_1^2 \underline{F} \cdot d\underline{r} \quad -(23)$$

where T denotes the kinetic energy. Using the chain rule:

$$\underline{F} \cdot d\underline{r} = m\frac{d\underline{v}}{dt} \cdot \frac{d\underline{r}}{dt}\, dt = \frac{m}{2}\frac{d}{dt}(\underline{v} \cdot \underline{v})\, dt = d\left(\frac{1}{2}mv^2\right) \quad -(24)$$

so

$$T_2 - T_1 = \int_1^2 d\left(\frac{1}{2}mv^2\right). \quad -(25)$$

If the original kinetic energy is zero the familiar expression for kinetic energy is recovered:

$$T = \frac{1}{2}mv^2. \quad -(26)$$

In special relativity {13} the law of conservation of momentum demands that the momentum be defined as the relativistic momentum:

$$\underline{p} = \gamma m \underline{v} \quad -(27)$$

where the Lorentz factor is the well known:

$$\gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1/2} \quad -(28)$$

in which $\underline{v}$ is the constant velocity of one frame with respect to the other and where c is the speed of light in the vacuum. Despite the fact that the momentum is worked out with the proper time, the force in Einstein's method {13} is worked out with the observer time t:

$$\underline{F} = d\underline{p} \,/\, dt \quad -(29)$$

and the work integral is evaluated by integration by parts to give:

$$\begin{aligned} W = T &= \int \frac{d}{dt}\left(\gamma m \underline{v}\right)\cdot \underline{v}\, dt = m \int_0^v v\, d(\gamma v) \\ &= \gamma m v^2 - m \int_0^v \frac{v\,dv}{(1 - v^2/c^2)^{1/2}} \\ &= \gamma m v^2 + mc^2 (1 - v^2/c^2)^{1/2} - mc^2. \end{aligned} \quad -(30)$$

The kinetic energy in special relativity is therefore:

$$T = (\gamma - 1) mc^2. \quad -(31)$$

The total energy in special relativity is {13}:

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

and the rest energy is:

$$E_0 = mc^2. \quad -(33)$$

So the relativistic kinetic energy is:

$$T = E - E_0. \quad -(34)$$

These ideas are consequences of the Lorentz transformation, and what is really tested experimentally is the difference between proper time and the observer time. As shown in earlier papers of this series, the ideas of the de Broglie Einstein theory of particle collisions have disintegrated completely, even within the context of special relativity. This may be due to this fundamental self inconsistency in Einstein's definition of force. These are papers published this year in ref. {1}.

The first step towards a new relativity is to define the kinetic energy from Eqs. (21), (23) and (29). In the first instance the method used by Einstein is followed for the sake of argument only. The fully consistent method would define the acceleration from the velocity using the spin connection. As in UFT 143 (www.aias.us) this method produces new types of acceleration and force in dynamics. Therefore, accepting Eq. (29) for the sake of argument, the kinetic energy in this new theory is:

$$\begin{aligned} T &= \frac{1}{2}mv^2 + mc\int \omega \underline{v} \cdot d\underline{r} \\ &= \frac{1}{2}mv^2 + mc\int \omega \frac{d\underline{v}}{dt} \cdot d\underline{r}\, dt \\ &= \frac{1}{2}mv^2 + mc\iint \omega \frac{d\underline{v}}{dt} \cdot \frac{d\underline{r}}{dt}\, dt\, dt \\ &= \frac{1}{2}mv^2 + c\iint \omega\, d\left(\frac{1}{2}mv^2\right) dt \\ &= \frac{1}{2}mv^2\left(1 + c\int \omega\, dt\right) \quad -(35) \end{aligned}$$

Assume that the integral in Eq. (35) can be carried out from an initial time:

$$t = 0 \quad -(36)$$

to a final time defined by t_f. The time t_f is a constant for a given cosmological system, and characteristic of that system. So the kinetic energy is:

$$T = \frac{1}{2} m v^2 \left(1 + c\omega t_f\right). \quad -(37)$$

The lagrangian of the system is:

$$\mathcal{L} = T - V = \frac{1}{2} m v^2 \left(1 + \omega c t_f\right) - V \quad -(38)$$

and its hamiltonian is:

$$H = T + V = \frac{1}{2} m v^2 \left(1 + \omega c t_f\right) + V \quad -(39)$$

where V is the potential energy of the system.

In cylindrical polar coordinates the relativistic lagrangian is:

$$\mathcal{L} = \frac{1}{2} m \left(\dot{r}^2 + r^2 \dot{\theta}^2\right)\left(1 + \omega c t_f\right) - V(r) \quad -(40)$$

The two Euler Lagrange equations are {13}:

$$\frac{\partial \mathcal{L}}{\partial r} = \frac{d}{dt} \frac{\partial \mathcal{L}}{\partial \dot{r}}, \quad -(41)$$

and

$$\frac{\partial \mathcal{L}}{\partial \theta} = \frac{d}{dt} \frac{\partial \mathcal{L}}{\partial \dot{\theta}}. \quad -(42)$$

The radial tetrad (13) is expressed in the frame of the observer, and so is the velocity vector (21) and kinetic energy (35). The potential energy (V) is also expressed in the frame of the observer. Therefore the Euler Lagrange equations (41) and (42) are also expressed in the observer frame. The spin connection term in the kinetic energy changes the theory into a relativistic theory on the basic assumption that physics is geometry, and that a spacetime with a connection is needed for relativity in general, i.e. general relativity with accelerations and forces.

Physics is currently entering an era of deep uncertainty after the complete collapse of Einstein general relativity, Einstein de Broglie theory in special relativity, Higgs boson theory and string theory, so all assumptions must be questioned.

From Eq. (41), the force is:

$$F(r) = \left(m\ddot{r} - mr\dot{\theta}^2\right)\left(1 + \omega c t_f\right) - \frac{1}{2} m c t_f \frac{\partial \omega}{\partial r}\left(\dot{\theta}^2 r^2 + \dot{r}^2\right) \quad -(43)$$

and as the spin connection vanishes it reduces to the Newtonian result {13}:

$$F(r) = m\ddot{r} - mr\dot{\theta}^2. \quad -(44)$$

Eq. (43) is the required force law for any orbit. From Eq. (42) the constant total angular momentum is:

$$L = \frac{\partial \mathcal{L}}{\partial \dot{\theta}} = mr^2\left(1 + \omega c t_f\right)\dot{\theta}. \quad -(45)$$

The force law can be put into a more convenient format by defining:

$$u = 1/r \quad -(46)$$

so:

$$\frac{du}{d\theta} = -\frac{1}{r^2}\frac{dr}{d\theta} = -\frac{1}{r^2}\frac{dr}{dt}\frac{dt}{d\theta} \quad -(47)$$

From Eq. (45):

$$\frac{dt}{d\theta} = \frac{mr^2}{L}\left(1 + \omega c t_f\right) \quad -(48)$$

so:

$$\frac{du}{d\theta} = -\frac{m}{L}\left(1+\omega c t_f\right)\frac{dr}{dt} \quad -(49)$$

and

$$\dot{r} = -\frac{L}{m\left(1+\omega c t_f\right)}\frac{du}{d\theta} \quad -(50)$$

Next evaluate:

$$\frac{d^2u}{d\theta^2} = -\left(1+\omega c t_f\right)\frac{m}{L}\frac{d}{d\theta}\left(\frac{dr}{dt}\right) \quad -(51)$$

where:

$$\frac{d}{d\theta} = \frac{dt}{d\theta}\frac{d}{dt} \quad -(52)$$

So:

$$\frac{d^2u}{d\theta^2} = -\left(1+\omega c t_f\right)\frac{m}{L}\frac{dt}{d\theta}\frac{d^2r}{dt^2} \quad -(53)$$

From Eq. (48):

$$\frac{d^2u}{d\theta^2} = -\left(1+\omega c t_f\right)^2\left(\frac{m}{L}\right)^2 r^2\frac{d^2r}{dt^2} \quad -(54)$$

so:

$$\ddot{r} = -\frac{L^2 u^2}{m^2(1+\omega c t_f)^2}\frac{d^2 u}{d\theta^2}. \quad -(55)$$

From Eq. (45):

$$r\dot{\theta}^2 = \frac{L^2 u^3}{m^2(1+\omega c t_f)^2}. \quad -(56)$$

Therefore the force law is:

$$-\frac{mF(u)}{L^2u^2} = (1+\omega c t_f)^{-1}\left(\frac{d^2u}{d\theta^2}+u\right) + \frac{1}{2}\frac{c t_f}{u^2}\frac{\partial \omega}{\partial r}(1+\omega c t_f)^{-2}\left(u^2+\left(\frac{du}{d\theta}\right)^2\right) \quad -(57)$$

The force F may be found from a parameterization of any orbit:

$$u = \frac{1}{r} = f(\theta). \quad -(58)$$

The orbit is therefore described using ω, $\partial\omega/\partial r$, and the constant t_f. In the Newtonian limit:

$$\omega \rightarrow 0 \quad -(59)$$

and Eq. (57) reduces to

$$-\frac{mF(u)}{L^2u^2} = \frac{d^2u}{d\theta^2} + u \quad -(60)$$

This equation shows that for the ellipse:

$$r = \frac{\alpha}{1 + \epsilon \cos\theta} \quad -(61)$$

the force law is the familiar:

$$F(r) = -\frac{mMG}{r^2} \, . \quad -(62)$$

It has been shown that It is possible to describe cosmology in terms of Cartan geometry and a unified field theory, ECE theory. With a given model for the spin connection, the characteristic time t_γ can be found.

3. CLASSICAL LIMIT AND CONCEPT OF FORCE.

Consider the elliptical orbit:

$$r = \frac{\alpha}{1 + \epsilon \cos\theta} \quad -(63)$$

and the unit vectors $\underline{e}_r$ and $\underline{e}_\theta$ of the cylindrical polar system. As in ref. { 13 }:

$$\dot{\underline{e}}_r = \dot{\theta}\, \underline{e}_\theta \, , \quad \dot{\underline{e}}_\theta = -\dot{\theta}\, \underline{e}_r \, . \quad -(64)$$

The linear velocity is:

$$\underline{v} = \dot{\underline{r}} = \frac{d\underline{r}}{dt} = \frac{d}{dt}\left(r\, \underline{e}_r\right) = \dot{r}\, \underline{e}_r + r\, \dot{\underline{e}}_r \quad -(65)$$

and the linear acceleration is:

$$\underline{a} = \frac{d\underline{v}}{dt} = \left(\ddot{r} - r\dot{\theta}^2\right)\underline{e}_r + \left(r\ddot{\theta} + 2\dot{r}\dot{\theta}\right)\underline{e}_\theta \quad -(66)$$

The calculation takes place in the frame of the observer so the time t is used. The elliptical orbit is observed in this frame. The force on an object of mass m is:

$$\underline{F} = m\,\underline{a}\,. \qquad -(67)$$

This object orbits an object of mass M, which in the solar system is the sun. The unit vectors of the cylindrical polar coordinates in the plane of the orbit are related to the Cartesian unit vectors by { 14 }:

$$\underline{e}_r = \underline{i}\cos\theta + \underline{j}\sin\theta \qquad -(68)$$

$$\underline{e}_\theta = -\underline{i}\sin\theta + \underline{j}\cos\theta. \qquad -(69)$$

Using the lagrangian method { 13 } the total angular momentum of the system is:

$$L = mr^2\dot{\theta} = mr^2\frac{d\theta}{dt} \qquad -(70)$$

and is a constant of motion. From Eq. (63):

$$\frac{dr}{d\theta} = \frac{\epsilon}{\alpha}r^2\sin\theta \qquad -(71)$$

so:

$$\frac{dr}{dt} = \frac{dr}{d\theta}\frac{d\theta}{dt} = \left(\frac{L\epsilon}{m\alpha}\right)\sin\theta \qquad -(72)$$

i.e.:

$$\dot{r} = \left(\frac{L\epsilon}{m\alpha}\right)\sin\theta, \quad \dot{\theta} = \frac{L}{mr^2}. \qquad -(73)$$

Therefore:

$$\ddot{r} = \left(\frac{L\epsilon}{m\alpha}\right)\frac{d}{dt}\left(\sin\theta\right), \quad \ddot{\theta} = \frac{L}{m}\frac{d}{dt}\left(\frac{1}{r^2}\right). \qquad -(74)$$

Now use the chain rules:

$$\frac{df(r)}{d\theta} = \frac{df(r)}{dr}\frac{dr}{d\theta}, \quad -(75)$$

$$\frac{df(\theta)}{dr} = \frac{df(\theta)}{d\theta}\frac{d\theta}{dr}, \quad -(76)$$

to find:

$$\frac{d}{dt}\left(\frac{1}{r^2}\right) = -\frac{2}{r^3}\frac{dr}{dt}, \quad \frac{d}{dt}\left(\sin\theta\right) = \cos\theta\frac{d\theta}{dt}. \quad -(77)$$

Therefore:

$$\ddot{r} = \left(\frac{\epsilon L^2}{m^2 \alpha}\right)\frac{1}{r^2}\cos\theta, \quad \ddot{\theta} = -\left(\frac{2L^2\epsilon}{m^2\alpha}\right)\frac{\sin\theta}{r^3}. \quad -(78)$$

It follows that:

$$\ddot{r} - r\dot{\theta}^2 = \frac{\epsilon M G}{r^2}\cos\theta - \frac{L^2}{m^2 r^3} \quad -(79)$$

where G is Newton's constant. We have used { 13 }:

$$\alpha = \frac{L^2}{m^2 \underline{M} G}. \quad -(80)$$

Similarly:

$$r\ddot{\theta} + 2\dot{r}\dot{\theta} = 0. \quad -(81)$$

So the force is:

$$\underline{F} = m\left(\frac{\epsilon M G}{r^2}\cos\theta - \frac{L^2}{m^2 r^3}\right)\underline{e}_r \quad -(82)$$

and is radially directed.

Now use Eq. (63) again to find:

$$\epsilon\cos\theta = \frac{\alpha}{r} - 1 \quad -(83)$$

so the force is:

$$\underline{F} = \left(-\frac{mMG}{r^2} + \frac{L^2}{mr^3} - \frac{L^2}{mr^3}\right)\underline{e}_r \quad (84)$$

and is the familiar inverse square law of Robert Hooke { 15 } attributed to Isaac Newton by physicists. The latter define the traditionally named "centrifugal force" as:

$$\underline{F}_c = \frac{L^2}{mr^3}\underline{e}_r \quad -(85)$$

so the force in Eq. (84) is:

$$\underline{F} = \left(-\frac{mMG}{r^2} + F_c - F_c\right)\underline{e}_r \quad -(86)$$

and is due to a precise cancellation of the traditionally named centrifugal force. The only thing that has been used in this calculation is the definition of the cylindrical polar coordinate system in a plane { 13 }. For a circular orbit:

$$\epsilon = 0 \quad -(87)$$

and

$$r = \alpha. \quad -(88)$$

In this case the force is an inverse cube in r:

$$\underline{F} = -\frac{L^2}{mr^3}\underline{e}_r \quad -(89)$$

and agrees precisely with that obtained in UFT 193 (www.aias.us) by the lagrangian method. It is seen that the force for a circular orbit is exactly the negative of the traditionally named centrifugal force.

In an orbit the net force on m is zero in traditional understanding or received opinion. In the latter, the force is defined by the potential energy of the hamiltonian:

$$H = T + V \quad -(90)$$

i.e.

$$F = -\frac{\partial V}{\partial r} \quad -(91)$$

The potential energy V is defined as m multiplied by the gravitational potential:

$$V = m\Phi . \quad -(92)$$

In order to obtain an inverse square law (84) the potential must be:

$$V = -\frac{mMG}{r} \quad -(93)$$

in the received opinion. However, from Eq. (84), the complete potential must be:

$$V = -\frac{mMG}{r} + \frac{L^2}{2mr^2} - \frac{L^2}{2mr^2} . \quad -(94)$$

The received opinion gives an incomplete view of an orbit and force law.

What is observed experimentally in the solar system is the precessing ellipse:

$$r = \frac{\alpha}{1+\epsilon\cos(x\theta)} \quad -(95)$$

where x is the precession constant. In the received opinion of physicists the precession is due to the incorrect Einstein general relativity, but in Section 2 this view has been corrected and a new definition introduced of relativistic kinetic energy using the spin connection of Cartan. In the solar system x differs from unity only in the fifth or sixth decimal place, so the planetary precession is tiny, a few arc seconds per century. To an excellent approximation therefore the kinetic energy of Section 2 reduces to:

$$T = \frac{1}{2} m v^2 \quad -(96)$$

The lagrangian is:

$$\mathcal{L} = T - V \quad -(97)$$

and the total angular momentum is { 13 }:

$$L = \frac{\partial \mathcal{L}}{\partial \dot{\theta}} = m r^2 \dot{\theta} . \quad -(98)$$

This angular momentum is a constant of motion and can also be obtained from:

$$\underline{L} = \underline{r} \times \underline{p} . \quad -(99)$$

In this approximation:

$$\dot{r} = \left(\frac{x L \epsilon}{m \alpha} \right) \sin(x\theta), \quad \dot{\theta} = \frac{L}{m r^2} \quad -(100)$$

and it follows that:

$$\ddot{r} = \frac{x L \epsilon}{m \alpha} \frac{d}{dt} \left(\sin(x\theta) \right) = \frac{x L \epsilon}{m \alpha} \frac{d}{d\theta} \left(\sin(x\theta) \right) \frac{d\theta}{dt} = \frac{x^2 L \epsilon}{m \alpha r^2} \cos(x\theta) \quad -(101)$$

and

$$\ddot{\theta} = - \frac{2 L^2 x \epsilon}{m^2 \alpha} \frac{\sin(x\theta)}{r^3} . \quad -(102)$$

Therefore:

$$\ddot{r} - r\dot{\theta}^2 = \frac{\epsilon x^2 MG}{r^2}\cos(x\theta) - \frac{L^2}{m^2 r^3}, \quad -(103)$$

$$r\ddot{\theta} + 2\dot{r}\dot{\theta} = 0. \quad -(104)$$

Using Eq. (66) for linear acceleration and Eq. (67) for the force:

$$\underline{F} = m\underline{\ddot{a}} = m\left(\frac{x^2\epsilon MG}{r^2}\cos(x\theta) - \frac{L^2}{m^2 r^3}\right)\underline{e}_r. \quad -(105)$$

Finally use Eq. (95):

$$\epsilon\cos(x\theta) = \frac{\alpha}{r} - 1 \quad -(106)$$

and Eq. (80), which is true in the solar system to an excellent approximation, to find that:

$$\underline{F} = \left(-\frac{x^2 mMG}{r^2} + \frac{L^2}{mr^3}(x^2 - 1)\right)\underline{e}_r \quad -(107)$$

which is exactly the same as the result obtained in Eq. (9) of UFT 193 (www.aias.us).

So for tiny precessions of the perihelion, the force law is a combination of an inverse square and inverse cube in r. The Einstein theory is incorrect, because using the same lagrangian method it gives a sum of inverse square and inverse fourth terms. By direct checking with computer algebra in UFT 193, the sum used by Einstein general relativity does not give a precessing ellipse. The Einstein theory is now known clearly to scientists to be incorrect for many other reasons. The fully relativistic theory of the precessing elliptical orbit is given in Section 2, using the Cartan spin connection.

The calculations in this Section 3 also have implications in the traditional classical dynamics known to physicists as Newtonian dynamics. They start with the analytical function of the ellipse in cylindrical polar coordinates and give the force (86) using the definition of derivatives in the cylindrical polar coordinates, and nothing else. No other concept is used. The force law (86) contains an exact cancellation of the term known traditionally to physicists as "the centrifugal force of repulsion". This idea has always given a lot of trouble, and by inspection of Eq. (84) it becomes clear that it appears from the orbital equation but cancels out to give the force of attraction known as the inverse square law of attraction. The use of the cylindrical polar coordinate system gives a sum of the mathematical object known as the centrifugal force. One term of the sum is positive, the other term is negative. For a static ellipse (Eq. (63)) the two terms cancel exactly, but for a precessing ellipse (Eq. (95)) they do not, and give the inverse cube term. The origin of the centrifugal term is the movement in the cylindrical polar system of the unit vectors, which are not necessarily constant in time. This fundamentally important point is discussed in chapter one of ref. { 13 } and is true independently of the Newton laws of motion as they are known traditionally in the dogma of physicists. In historical fact Newton inferred only the third law. In Newtonian dynamics the precise origin of the "centrifugal force" is the angular part of the kinetic energy in cylindrical polar coordinates:

$$T = \frac{1}{2} m r^2 \dot{\theta}^2 = \frac{L^2}{2mr^2} . \quad -(108)$$

The total energy is written as { 13 }:

$$E = \frac{1}{2} m \dot{r}^2 + \frac{L^2}{2mr^2} + V(r) \quad -(109)$$

and the received opinion asserts that the effective potential energy is { 13 }:

$$u(r) = V(r) + \frac{L^2}{2mr^2} \quad -(110)$$

giving rise to the received opinion of an orbit as the balance of an attractive, negative valued part of the "effective" potential (110) and a positive valued repulsive part, the centrifugal potential energy. This is obviously incorrect dogma, because the object known as a centrifugal potential of repulsion is in fact part of the kinetic energy. There is no potential of repulsion in Newtonian dynamics, which does not therefore describe orbits at all. It merely describes the radially directed force of attraction between two objects. It is concluded that the object known to physicists as "force" in Eq. (86) is a re-formulation of the analytical equation of an ellipse, and no more than that. It is not a "universal" force of gravitation as claimed in the dogma. It varies from orbit to orbit.

The fully correct description of orbits requires the spin connection in ECE theory, in which the centripetal force is part of the spacetime torsion in papers such as UFT 55 (www.aias.us), dealing with the non-inertial Coriolis dynamics.

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