The Principle of Orbits.

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Abstract

The principle of orbits is that all orbits in cosmology are described by a Minkowski metric with a given functional dependence of metric parameters determined experimentally. For example, a precessing elliptical orbit is described by a Minkowski metric with r being given as a function of φ of the cylindrical polar system of coordinates (r, φ , Z). This function is given by the equation of the precessing ellipse. Similarly the logarithmic spiral orbit of a whirlpool galaxy is described by a Minkowski metric with the equation of the logarithmic spiral. In this way all known orbits are described in the same way, based on the ECE Orbital Theorem without use of the Einstein field equation.

Keywords: Einstein Cartan Evans (ECE) field theory, the Principle of Orbits, Orbital Theorem.

1. Introduction

In UFT 111 of this series of papers [1 – 10] on the applications of Einstein Cartan Evans (ECE) theory, the Orbital Theorem was introduced in order to devise metrics without use of the incorrect Einstein field equation. The Orbital Theorem is based on spherically symmetric spacetime, and its simplest solution is the Minkowski metric. In this paper the ECE Principle of Orbits is introduced, a principle which asserts that all known orbits can be described by the Minkowski metric, given the observationally derived functional dependence between coordinates. In Section 2 examples of this principle are given, for example the orbit of a precessing ellipse is described by a Minkowski metric with the functional dependence of r upon φ of the cylindrical polar system of coordinates (r, φ, Z) given by the equation of the precessing ellipse. The orbit of stars in a whirlpool galaxy is described by the Minkowski metric with the equation of the logarithmic spiral. In Section 3 it is shown that the description of the precessing ellipse given in Section 2 is equivalent to its description in terms of the gravitational metric, another solution of the ECE Orbital Theorem. The gravitational metric is wrongly attributed to Schwarzschild in the received opinion and is of limited applicability to the solar system only. The gravitational metric is unable completely to describe the orbits of stars in whirlpool galaxies, while the Principle of Orbits does so straightforwardly in terms of the Minkowski metric.

2. Precessing elliptical orbit

It is well known that the orbits of planets in the solar system are precessing ellipses in which the perihelion advances. The equation of the precessing ellipse is [11, 12]:

$$\frac{1}{r} = \frac{1}{\alpha} (1 + \epsilon \cos(y\varphi)) \tag{1}$$

where r is the radius of the orbit, ϵ is its eccentricity, and where α and y are determined experimentally. In the received opinion the description of the precessing ellipse is given in terms of the Einstein field equation of general relativity. However it is accepted that the Einstein field equation is incorrect (UFT 139) mathematically [1 – 10] and the equation has been criticised since inception in 1915 by some of the best minds in physics and mathematics. So its continued acceptance in the received opinion is obsolete and non-Baconian. In this section the geometrical equation (1) of the precessing ellipse in the XY plane is used with the Minkowski metric of four dimensional spacetime. In cylindrical polar coordinates this metric is:

$$ds^2 = c^2 d\tau^2 = c^2 dt^2 - d r^2 - r^2 d\varphi^2 - dZ^2 \quad . \tag{2}$$

In the XY plane:

$$dZ = 0 \quad . \tag{3}$$

From Eq. (1):

$$\frac{dr}{d\varphi} = ar \tag{4}$$

where

$$a = \frac{y\epsilon}{\alpha}\ r\ \sin(y\varphi) \quad . \tag{5}$$

Therefore the metric of the precessing ellipse in XY is:

$$d\tau^2 = dt^2 - (1 + a^2)\left(\frac{r}{c}\right)^2 d\varphi^2 \tag{6}$$

which can be rewritten as:

$$c^2(dt^2 - d\tau^2) = (1 + a^2)\left(\frac{r}{c}\right)^2 d\varphi \quad . \tag{7}$$

However, in the Minkowski metric, by definition {12}:

$$\boldsymbol{v} = \frac{d\boldsymbol{r}}{dt} \tag{8}$$

where $\boldsymbol{v}$ is the linear velocity. In Eq. (2):

$$d\tau^2 = dt^2 - \frac{1}{c^2}\, d\boldsymbol{r}.\, d\boldsymbol{r} \tag{9}$$

so:

$$d\tau^2 = dt^2\left(1 - \frac{v^2}{c^2}\right) \quad . \tag{10}$$

Comparing Eqs. (6) and (10) gives the angular velocity:

$$\omega = \frac{d\varphi}{dt} = \frac{v}{r}\left(1 + a^2\right)^{-1/2} \quad . \tag{11}$$

In the limit:

$$\epsilon \longrightarrow 0 \tag{12}$$

then

$$\omega \longrightarrow \frac{v}{r} \tag{13}$$

for a circular orbit.

The precessing elliptical orbit (relativistic Kepler problem) is described completely by Eqs. (2), (4) and (11).

Thus:

$$\frac{dr}{dt} = \frac{dr}{d\varphi}\frac{d\varphi}{dt} = v\left(\frac{a}{(1+a^2)^{1/2}}\right) \tag{14}$$

where v is defined by:

$$v = |\,\boldsymbol{v}\,| = \left|\frac{d\boldsymbol{r}}{dt}\right| \tag{15}$$

with:

$$\mathrm{d}\boldsymbol{r}.\,\mathrm{d}\boldsymbol{r} = \mathrm{d}\,r^2 + r^2\,\mathrm{d}\varphi^2 + \mathrm{d}Z^2 \quad . \tag{16}$$

In the limit (12) for a circle it is seen that:

$$\frac{dr}{dt} \longrightarrow 0 \tag{17}$$

i.e.

$$dr \longrightarrow 0 \tag{18}$$

meaning that the circle has constant r.

Therefore the metric of the precessing ellipse is:

$$\mathrm{ds}^2 = c^2\mathrm{d}\tau^2 = \frac{c^2}{\omega^2}\,\mathrm{d}\varphi^2 - \mathrm{d}\boldsymbol{r}.\,\mathrm{d}\boldsymbol{r} \quad . \tag{19}$$

From Eqs. (11) and (14):

$$\frac{dr}{dt} = a\omega r$$

so the metric of the precessing ellipse is also:

$$\mathrm{ds}^2 = c^2\mathrm{d}\tau^2 = \left(\frac{c}{a\omega r}\right)^2 \mathrm{d}\,r^2 - \mathrm{d}\boldsymbol{r}.\,\mathrm{d}\boldsymbol{r} \quad . \tag{20}$$

It is seen that both metrics are isotropic and have the structure of the Minkowski metric:

$$\mathrm{ds}^2 = c^2\mathrm{dt}^2 - \mathrm{d}\boldsymbol{r}.\,\mathrm{d}\boldsymbol{r} \tag{21}$$

with:

$$dt^2 = \left(\frac{d\varphi}{dt}\right)^2 = \left(\frac{dr}{a\omega r}\right)^2 \quad . \tag{22}$$

The orbit of stars in a whirlpool galaxy [1 – 10] is observed experimentally to be the logarithmic spiral:

$$r(\mathrm{t}) = r \exp(\mathrm{b}\varphi) \tag{23}$$

so

$$\frac{dr}{d\varphi} = \mathrm{b}r \quad . \tag{24}$$

Comparing Eqs. (4) and (24) it is seen that $dr \,/\, d\varphi$ has the same overall mathematical structure in the precessing ellipse and logarithmic spiral, so it may be that one type of orbit evolves into another. Using the ECE principle of orbits both types of orbit are based on a Minkowski metric. In the received opinion there is no self-consistent description, one type of orbit being described by an incorrect Einstein field equation, the other by a completely arbitrary use of dark matter, merely a non-scientific assertion. The ECE description is far simpler and more powerful.

If:

$$y = 1 \tag{25}$$

the ellipse does not precess. In this case the description in the received opinion is based [11] on the inverse square law of Newton (see notes 148(4) accompanying this paper on www.aias.us). There is a well known and fundamental problem [11] with Newton as described further in notes 148(6) and 148(7) accompanying this paper. The problem is that Newton applies only to an inertial frame, whereas orbits are non-inertial by definition. Newton gives a net attraction force [11]:

$$F = -\frac{\partial U}{\partial r} = m\,(\ddot{r} - \dot{\varphi}^2) \tag{26}$$

where U is the potential energy, yet the particle is not attracted towards the attracting mass at the centre of an orbit. In Eq. (26) m is the mass of an attracted particle. Eq. (26) may be rewritten [11] as:

$$\frac{d^2u}{d\varphi^2} + u = -\frac{mr^2}{L^2}\,F \tag{27}$$

where:

$$u = \frac{1}{r} \tag{28}$$

and where

$$L = mr^2\dot{\varphi} \tag{29}$$

is a constant of motion. If the force of attraction is assumed to be the Newton inverse square law:

$$F = -\frac{mMG}{r^2} \tag{30}$$

then the orbit from Eq. (27) is the static, non precessing, ellipse:

$$u = \frac{1}{r} = \frac{1}{\alpha}\,(\,1 + \epsilon\cos\varphi) \quad . \tag{31}$$

However, the mass m in an orbit is obviously not attracted to the mass M, it remains indefinitely in the orbit. The attractive force:

$$F = -\,m\,r\,\dot{\varphi}^2 \tag{32}$$

in Eq. (26) is the centripetal force inwards towards M. The force:

$$F = -\,m\,\ddot{r} \tag{33}$$

is also attractive, inwards towards M. Yet m does not move towards M. Therefore Newton did not explain orbits with his inverse square law (30). This point is rarely if ever made clear in the received opinion. The latter artificially changes Newton [11] by introducing the centrifugal force outwards, so the total force on m is zero:

$$\begin{aligned} F &= m\,\ddot{r} - m\,r\,\dot{\varphi}^2 + m\,r\,\dot{\varphi}^2 \\ &= -\frac{mMG}{r^2} + m\,r\,\dot{\varphi}^2 \quad . \end{aligned} \tag{34}$$

In any stable orbit on average:

$$\langle F \rangle = m \langle \ddot{r} \rangle = 0 \quad . \tag{35}$$

In a circular orbit, r does not change with time, so the result (35) is always true:

$$F = 0 \quad . \tag{36}$$

Therefore the centrifugal force outwards does not occur at all in Newtonian dynamics because the latter are inertial. Newton produces an elliptical orbit, but that orbit is not stable.

The fundamental problem is that Newton is non relativistic, and uses space and time as separate entities, Newton does not use the correct rotating frame introduced later by Coriolis [11]. The ECE Orbital Principle uses spacetime, in which the orbit, the only thing observable, is parameterized by using observation. The ECE method automatically keeps orbits stable without use of the incorrect Newtonian and incorrect Einsteinian descriptions.

To emphasize the self-inconsistency of the Newtonian description (see notes 148(7) accompanying this paper on www.aias.us) some remarks are given as follows. In Newtonian dynamics the hamiltonian is:

$$H = T + U = \frac{1}{2} m\dot{r}^2 + \frac{1}{2}\frac{L^2}{mr^2} + U \tag{37}$$

in which:

$$U = -\frac{k}{r} = \frac{mMG}{r} \quad . \tag{38}$$

The lagrangian is:

$$\mathcal{L} = T - U \tag{39}$$

and the relevant Lagrange equation is:

$$\frac{\partial \mathcal{L}}{\partial r} = \frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{r}} \quad . \tag{40}$$

Use:

$$\frac{d\varphi}{dr} = \frac{d\varphi}{dt}\frac{dt}{dr} \tag{41}$$

to find that:

$$\varphi\,(r) = \int \frac{1}{r^2}\,(\,2\,m\,(H - U - \frac{L^2}{2mr^2}\,))^{-½}\,dr \tag{42}$$

whose solution is the ellipse (31) with:

$$\alpha = \frac{L^2}{mk} \quad , \qquad \epsilon = \left(1 + \frac{2\,HL^2}{mk^2}\right)^{½} \quad . \tag{43}$$

The ellipse is the result of attraction forces only, but the particle m does not fall towards M, a basic self inconsistency. The centrifugal force outwards:

$$F_c = m\,r\,\dot{\varphi}^2 \tag{44}$$

is added in a Newtonian context, in which it is not even defined. This gives the arbitrary construct:

$$U = -\frac{mMG}{r} = -\int F_c\,(r)\;dr = \frac{L^2}{2mr^2} \tag{45}$$

in which the total force on m is zero, as in an orbit, but zero merely by construction.

The only thing that Newton really says is that if two masses m and M are placed on a laboratory bench, they are attracted by:

$$F = -\frac{mMG}{r^2} \quad . \tag{46}$$

It is not easy to prove this law experimentally and without any further assumption, because in the laboratory, F is very tiny. It may be argued that the acceleration due to gravity proves the law through the equivalence principle:

$$F = mg = -\frac{mMG}{r^2} \tag{47}$$

but this only gives a number to g:

$$g := -\frac{MG}{r^2} \tag{48}$$

by simply defining.

3. Comparison with the gravitational metric

In ECE theory [1 – 10] the gravitational metric is obtained from the Orbital Theorem of UFT 111 and is not referred to as "the Schwarzschild metric" because it was not derived by him and because he based his work on the incorrect Einstein field equation. The gravitational metric is a solution of the Orbital Theorem as follows:

$$ds^2 = c^2 d\tau^2 = \left(1 - \frac{r_S}{r}\right) c^2 dt^2 - \left(1 - \frac{r_S}{r}\right)^{-1} dr^2 - r^2\, d\varphi^2 - dZ^2 \tag{49}$$

where

$$r_S = \frac{2MG}{c^2} \tag{50}$$

where G is Newton's constant. It is well known that the mathematical format (49) gives a precessing elliptical orbit. Therefore it must be equivalent to Eqs. (19) or (20), which give the same precessing elliptical orbit. To prove this is straightforward using the well known isotropic Eddington metric, which is a rewriting of Eq. (49):

$$ds^2 = c^2 d\tau^2 = b^2\, c^2\, dt^2 - d\boldsymbol{r}\cdot d\boldsymbol{r} \tag{51}$$

where

$$b = \left(1 - \frac{MG}{2r_1c^2} \right) \left(1 + \frac{MG}{2r_1c^2} \right)^{-1} \tag{52}$$

and where:

$$r = r_1\left(1 + \frac{MG}{2r_1c^2} \right)^2 \quad . \tag{53}$$

Therefore the gravitational metric changes the Minkowski metric by adjusting the time infinitesimal as follows:

$$dt \longrightarrow bdt \tag{54}$$

and the ECE Orbital Principle does the same thing as follows:

$$dt \longrightarrow \frac{d\varphi}{\omega} = \frac{dr}{a\omega r} \quad . \tag{55}$$

The great advantage of the ECE Orbital Principle is that the precessing elliptical orbit is described by a Minkowski metric which can be applied to all orbits. The hugely elaborate subject of general relativity is by passed entirely. This is very necessary after over ninety years of severe criticism of the Einstein field equation [1–10]. As we have illustrated with Newton, is very easy for an incorrect concept to become accepted in received opinion.

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