391(2): Relation between Light Deflection and Precession with Conservation of Antisymmetry

It has been shown in note 391(1) that light deflection due to gravitation is explained exactly by the definition of relativistic velocity in ECE2 covariant physics:

$$v = \gamma v_N \quad -(1)$$

where γ is the Lorentz factor:

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

v is the experimentally observable velocity and v_N is the Newtonian velocity:

$$v_N = \dot{\underline{r}}. \quad -(3)$$

It follows that the precessing orbit must be ECE2 covariant.

Its Lagrangian is:

$$\mathcal{L} = -\frac{mc^2}{\gamma} + \frac{mMG}{r} \quad -(4)$$

and in UFT377 this was shown to give forward and retrograde precessions. In order to conserve antisymmetry correctly, the methods of UFT377 have to be extended to three dimensions.

Forward Precession

Consider the Lagrangian (4) in three dimensions:

$$\mathcal{L} = -mc^2\left(1 - \frac{\dot{X}^2 + \dot{Y}^2 + \dot{Z}^2}{c^2}\right)^{1/2} + \frac{mMG}{(X^2+Y^2+Z^2)^{1/2}} \quad -(5)$$

The proper Lagrange variables are X, Y and Z.

) The Euler Lagrange equations are:

$$\frac{\partial \mathcal{L}}{\partial X} = \frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{X}} \quad -(6)$$

$$\frac{\partial \mathcal{L}}{\partial Y} = \frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{Y}} \quad -(7)$$

$$\frac{\partial \mathcal{L}}{\partial Z} = \frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{Z}} \quad -(8)$$

These must be solved by computer algebra to give:

$$\ddot{X} = f(X, Y, Z, \dot{X}, \dot{Y}, \dot{Z}) \quad -(9)$$

$$\ddot{Y} = f(X, Y, Z, \dot{X}, \dot{Y}, \dot{Z}) \quad -(10)$$

$$\ddot{Z} = f(X, Y, Z, \dot{X}, \dot{Y}, \dot{Z}) \quad -(11)$$

and the 3-D orbits plotted as in recent work. They are precessing three dimensional orbits.

The acceleration due to gravity is:

$$\underline{g} = \ddot{X}\,\underline{i} + \ddot{Y}\,\underline{j} + \ddot{Z}\,\underline{k} \quad -(12)$$

The methodology of UFT390 may then be used to demonstrate conservation of antisymmetry, both for light deflection due to gravity and orbital precession in ECE2 physics.

Retrograde Precession

The lagrangian (4) is written as:

$$\mathcal{L} = -mc^2\left(1 - \frac{\dot{\underline{r}}\cdot\dot{\underline{r}}}{c^2}\right)^{1/2} + \frac{mMG}{|\underline{r}|} \quad -(13)$$

where

$$\underline{r} = X\,\underline{i} + Y\,\underline{j} + Z\,\underline{k} \quad -(14)$$

3) is the proper Lagrange variable. The Euler Lagrange equation is:

$$\frac{\partial \mathcal{L}}{\partial \underline{r}} = \frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{\underline{r}}} \quad -(15)$$

where

$$\underline{p} = \frac{\partial \mathcal{L}}{\partial \dot{\underline{r}}} = \gamma m \underline{v}_N = \gamma m \dot{\underline{r}} \quad -(16)$$

is the relativistic momentum. Therefore:

$$\frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{\underline{r}}} = \frac{d\underline{p}}{dt} = \gamma^3 m \ddot{\underline{r}} \quad -(17)$$

and

$$\frac{\partial \mathcal{L}}{\partial \underline{r}} = -mMG\frac{\underline{r}}{r^3} \quad -(18)$$

so

$$\underline{g} = \ddot{\underline{r}} = -\frac{MG}{\gamma^3}\frac{\underline{r}}{r^3} \quad -(19)$$

This equation gives retrograde precession, another major discovery of ECE2 theory. In Cartesian format, eq. (19) is:

$$\ddot{X} = -MG\left(1 - \frac{\dot{X}^2 + \dot{Y}^2 + \dot{Z}^2}{c^2}\right)^{3/2} \frac{X}{(X^2+Y^2+Z^2)^{3/2}} \quad -(20)$$

i.e.

$$\ddot{X} = -MG\left(\frac{c^2 - \dot{X}^2 + \dot{Y}^2 + \dot{Z}^2}{c^2(X^2+Y^2+Z^2)}\right)^{3/2} X \quad -(21)$$

$$\ddot{Y} = -MGAY \quad -(22)$$

$$\ddot{Z} = -MGAZ \quad -(23)$$

where

$$A = \left(\frac{c^2 - \dot{X}^2 + \dot{Y}^2 + \dot{Z}^2}{c^2(X^2+Y^2+Z^2)}\right)^{3/2} \quad -(24)$$

Three dimensional retrograde precession can also be plotted.

4) The following Hamiltonian method gives a simple method of calculating precession.

First consider the classical Hamiltonian:

$$H = \frac{1}{2} m v_N^2 - \frac{mMG}{r} \quad -(25)$$

For a planar orbit this gives:

$$r = \frac{\alpha}{1+\epsilon\cos\phi} \quad -(26)$$

i.e. a conic section in which α is the half right latitude and ϵ the eccentricity. Plane polar coordinates r and ϕ are used in eq. (26).

From eqs. (25) and (26):

$$H = \frac{1}{2} m v_N^2 - \frac{mMG}{\alpha}\left(1+\epsilon\cos\phi\right) \quad -(27)$$

so

$$\cos\phi = \frac{1}{B}\left(\frac{1}{2} m v_N^2 - A\right) \quad -(28)$$

where

$$A = H + \frac{mMG}{\alpha} \quad -(29)$$

and

$$B = \frac{mMG\epsilon}{\alpha} \quad -(30)$$

are constants.

The transition from classical to relativistic motion is defined by:

$$\frac{1}{2} m v_N^2 \longrightarrow mc^2\left(1 - \frac{v_N^2}{c^2}\right)^{-1/2} \quad -(31)$$

i.e.:

5)

$$\cos\phi \rightarrow \frac{1}{B}\left(mc^2\left(1-\frac{v_N^2}{c^2}\right)^{-1/2} - A\right) \quad -(32)$$

In these equations:

$$v_N^2 = mG\left(\frac{2}{r} - \frac{1}{a}\right) \quad -(33)$$

where a is the semi major axis:

$$a = \frac{\alpha}{1-\epsilon^2} \quad -(34)$$

Eqs. (33) and (34) can be used because v_N is the Newtonian orbital velocity. In eq. (33):

$$\frac{1}{r} = \frac{1}{\alpha}(1+\epsilon\cos\phi) \quad -(35)$$

The precessing orbit is given by eqs. (33) to (35) in this simple theory. ~~The experimentally~~ The observed precession is:

$$\Delta\phi = \frac{3mG}{c^2\alpha} \quad -(36)$$

to high precision.

Using:

$$\cos\phi = \frac{1}{B}\left(\frac{1}{2}mv_N^2 - A\right) \quad -(37)$$

$$\cos(\phi+\Delta\phi) = \frac{1}{B}\left(mc^2\left(1-\frac{v_N^2}{c^2}\right)^{-1/2} - A\right) \quad -(38)$$

The precession $\Delta\phi$ can be found from the cosine addition formula:

$$\cos(\phi + \Delta\phi) = \cos\phi \cos\Delta\phi - \sin\phi \sin\Delta\phi \quad -(39)$$

in which $\cos\phi$ is given by eq. (37) and:

$$\sin\phi = \left(1 - \cos^2\phi\right)^{1/2} \quad -(40)$$

$$\sin\Delta\phi = \left(1 - \cos^2\Delta\phi\right)^{1/2} \quad -(41)$$

The precession (36) is usually measured at the point:

$$\phi = 2\pi \quad -(42)$$

so eq. (39) becomes:

$$\cos(2\pi + \Delta\phi) = \cos\Delta\phi \quad -(43)$$

So

$$\Delta\phi = \cos^{-1}(2\pi + \Delta\phi) \quad -(44)$$

and

$$\cos(\Delta\phi) = \frac{1}{B}\left(mc^2\left(1 - \frac{v_N^2}{c^2}\right)^{-1/2} - A\right) \quad -(45)$$

At the point:

$$\phi = 2\pi \quad -(46)$$

eq. (26) gives:

$$r = \frac{\alpha}{1+\epsilon} \quad -(47)$$

So

$$v_N^2 = mG\left(\frac{2}{\alpha}(1+\epsilon) - \frac{(1-\epsilon^2)}{\alpha}\right)$$

$$= \frac{mG}{\alpha}\left(\epsilon^2 + 2\epsilon + 1\right) \quad -(48)$$

Therefore $\Delta\phi$ can be calculated from eqs. (45) and (48) and compared with the experimental eq. (36)