239(7): Calculation of the Precession Constant x from the Minkowski Method.

Consider the non-relativistic angular momentum for orbital motion in a plane:

$$L_0 = mr^2 \frac{d\theta}{dt}, \quad -(1)$$

it follows that:

$$\frac{d\theta}{dt} = \frac{L_0}{mr^2}. \quad -(2)$$

The relativistic angular momentum is:

$$L = mr^2 \frac{d\theta}{d\tau} \quad -(3)$$

$$= \gamma L_0$$

where τ is the proper time and γ the Lorentz factor:

$$\gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1/2} = \frac{dt}{d\tau}. \quad -(4)$$

It follows that

$$dt = \frac{mr^2}{L_0} d\theta, \quad -(5)$$

$$d\tau = \frac{mr^2}{\gamma L_0} d\theta. \quad -(6)$$

Now rewrite eq. (6) as:

$$d\tau = \frac{mr^2}{L_0}\left(\frac{d\theta}{\gamma}\right). \quad -(7)$$

It follows that the change:

2)

$$dt \rightarrow d\tau \quad -(8)$$

is produced by:

$$d\theta \rightarrow \frac{d\theta}{\gamma} \quad -(9)$$

$$= \left(1 - \frac{v^2}{c^2}\right)^{1/2} d\theta$$

For an orbital revolution of 2π radians:

$$\int_0^{2\pi} d\theta \rightarrow \int_0^{2\pi} \left(1 - \frac{v^2}{c^2}\right)^{1/2} d\theta \quad -(10)$$

i.e.

$$\boxed{2\pi \rightarrow \int_0^{2\pi} \left(1 - \frac{v^2}{c^2}\right)^{1/2} d\theta} \quad -(11)$$

If the orbit is an ellipse, then from note 238(4):

$$v^2 = \left(\frac{L_0}{m\alpha}\right)^2 \left(1 + \epsilon^2 + 2\epsilon\cos\theta\right) \quad -(12)$$

where:

$$\alpha = (1+\epsilon)\, r_{min} = (1-\epsilon)\, r_{max} \quad -(13)$$

$$= (1-\epsilon^2)\, a = (1-\epsilon^2)^{1/2}\, b.$$

where a is the semimajor axis and b the semiminor axis of the ellipse, and ϵ the eccentricity. Here r_{max} and r_{min} are the maximum and minimum distances of an orbiting mass m from a mass M at one focus of the ellipse.

The relativistic effect of eq. (8) therefore produces a change of angle:

$$\Delta\theta = 2\pi(1 - x) \quad -(14)$$

where

$$\boxed{x = \frac{1}{2\pi}\int_0^{2\pi}\left(1 - \left(\frac{L_0}{cm\alpha}\right)^2\left(1 + \epsilon^2 + 2\epsilon\cos\theta\right)\right)^{1/2} d\theta}$$

$-(15)$

and the ellipse becomes the <u>precessing ellipse</u>:

$$r = \frac{\alpha}{1 + \epsilon\cos(x\theta)} \quad -(16)$$

as observed experimentally.

In the Newtonian theory:

$$L_0^2 = m^2 M G \alpha \quad -(17)$$

4)

So

$$\frac{L_0}{m\alpha c} = \frac{m\left(MG\alpha\right)^{1/2}}{m\alpha c} = \frac{\left(MG\right)^{1/2}}{\alpha^{1/2}c} \quad -(18)$$

From eqs. (15) and (18):

$$x = \frac{1}{2\pi}\int_0^{2\pi}\left(1 - \frac{MG}{\alpha c^2}\left(1+\epsilon^2+2\epsilon\cos\theta\right)\right)^{1/2} d\theta \quad -(19)$$

In general relativity of the Einstein type, the so called "Schwarzschild" radius is:

$$r_0 = \frac{2MG}{c^2} \quad -(20)$$

So:

$$x = \frac{1}{2\pi}\int_0^{2\pi}\left(1 - \frac{r_0}{2\alpha}\left(1+\epsilon^2+2\epsilon\cos\theta\right)\right)^{1/2} d\theta \quad -(21)$$

Since:

$$\frac{r_0}{2\alpha} \ll 1 \quad -(22)$$

then

$$x \sim \frac{1}{2\pi}\int_0^{2\pi}\left(1 - \frac{r_0}{4\alpha}\left(1+\epsilon^2+2\epsilon\cos\theta\right)\right) d\theta \quad -(23)$$

5) i.e. :

$$x \sim \frac{1}{2\pi}\left(1 - \frac{r_0\left(1+\epsilon^2\right)}{4\alpha}\right)\int_0^{2\pi} d\theta - \int_0^{2\pi} \frac{\epsilon r_0}{2\alpha}\cos\theta\, d\theta \qquad -(24)$$

i.e

$$\boxed{x \sim 1 - \frac{r_0\left(1+\epsilon^2\right)}{4\alpha}} \qquad -(25)$$

the precession angle is therefore:

$$\Delta\theta = 2\pi\left(1-x\right) = \frac{2\pi r_0\left(1+\epsilon^2\right)}{4\alpha} \qquad -(26)$$

i.e

$$\boxed{\Delta\theta = \frac{\pi r_0\left(1+\epsilon^2\right)}{2\alpha} \text{ radians}} \qquad -(27)$$

In terms of r_{max} and r_{min}: $\qquad -(28)$

$$\boxed{\Delta\theta = \frac{\pi r_0\left(1+\epsilon^2\right)}{2\left(1-\epsilon\right) r_{max}} = \frac{\pi r_0\left(1+\epsilon^2\right)}{2\left(1+\epsilon\right) r_{min}}}$$

For the earth - sun system:

$$r_0 = 2.95 \times 10^3 \text{ m}$$
$$\epsilon = 0.0167$$
$$r_{max} = 1.521 \times 10^{11} \text{ m}$$
$$r_{min} = 1.471 \times 10^{11} \text{ m}$$

6) So

$$d = 1.496 \times 10^{11} \text{ m}$$

Therefore

$$\Delta\theta = \frac{\pi \times 2.95 \times 1.0003 \times 10^{-8}}{2 \times 1.496}$$

$$\Delta\theta = 3.10 \times 10^{-8} \text{ radians per year.} \quad -(29)$$

Now use

$$1 \text{ radian} = 2.0626 \times 10^{5} \text{ arc seconds} \quad -(30)$$

so

$$\Delta\theta = 6.39 \times 10^{-3} \text{ arc second per year}$$

$$\boxed{\Delta\theta = 0.64 \text{ arc seconds per century}} \quad -(31).$$

The observed precession is a total of 5 arc seconds per century, which is much larger.

The precession given by the theory of this note is:

$$\alpha = 2\pi \left(1 - \int_0^{2\pi} \left(1 - \frac{v^2}{c^2} \right)^{1/2} d\theta \right) \quad -(32)$$

and is very similar to the Thomas precession calculated in UFT 110, eq. (17.13):

$$\alpha = 2\pi \left(1 - \left(1 - \frac{v^2}{c^2} \right)^{1/2} \right) \quad -(33)$$

7) So the Thomas precession of the Earth in its orbit is given by eq. (31), i.e.

$$\Delta\theta\,(\text{Thomas Precession}) = 0.64 \text{ arc seconds per century} \quad -(34)$$

assuming that v^2 is given by eq. (12). The observed mean orbital velocity of the earth is:

$$v = 2.978 \times 10^4 \ ms^{-1} \quad -(35)$$

and this is given accurately by eq. (12), which can be approximated by:

$$v^2 \sim \frac{MG}{r_{av}} \quad -(36)$$

$$= 2.98 \times 10^4 \ ms^{-1}$$

using

$$r_{av} = 1.496 \times 10^{11} \ m \quad -(37)$$

$$MG = 1.33 \times 10^{20} \ m^3 s^{-2}$$

From eq. (33):

$$\alpha \sim \frac{\pi v^2}{c^2} \quad -(38)$$

for

$$v << c \quad -(39)$$

and using eqs. (35) and (38) the earth's Thomas precession is:

$$\Delta\theta = \pi \left(\frac{2.978}{2.998}\right)^2 \times 10^{-8}$$

$$= 3.10 \times 10^{-8} \text{ radian per year} \quad — (40)$$

in excellent agreement with eq. (29).

Conclusion

The application of the Minkowski method to perihelia precession gives the Thomas precession. The latter was derived in UFT110 from a rotating Minkowski metric and is derived in this note using an independent method, giving the same result. The earth's perihelia precession is calculated to be 0.64 arc second per century. The observed perihelia precession is about 5 arc seconds per century. Replacing Newtonian time t by proper time τ produces an orbital precession. This procedure does not account for the observed total precession, indicating a failure of the theory of special relativity.

It is known that the Einstein theory is

9) mathematically incorrect for many reasons, for example those given by the AIAS group and also by Mathis, (www.milesmathis.com/merc2.html). Mathis points out that the Einstein procedure is fundamentally wrong and self inconsistent, because he applies his version of relativity only to a discrepancy of about 43 arc seconds a century for Mercury. AIAS has pointed out that Einstein neglected torsion and used the wrong connection symmetry. He also used the wrong force law, and used a classical method to calculate the force law. This is self inconsistent.

It is proposed that the precession of the perihelion be calculated from the ECE theory using the gravitomagnetic field. This was carried out in previous work using the equinoctial precession.