409(1): Thomas Precession, Planetary Precession and Light Deflection due to Gravitation

In ECE2 theory, a generally covariant unified field theory, planetary precession is due to the force equation:

$$\underline{F} = -\underline{\nabla}\,\phi_g + \underline{\omega}\,\phi_g \quad -(1)$$

where $\underline{\omega}$ is the spin connection and ϕ_g is the gravitational potential:

$$\phi_g = -\frac{mMG}{r} \quad -(2)$$

In UFT405 it was shown that eq. (1) produces the orbital precession:

$$\Delta\phi = \frac{r^2}{2}\left(\frac{\omega}{r} - \frac{\partial\omega}{\partial r}\right) \quad -(3)$$

$$= \frac{4}{3}\frac{\langle\delta\underline{r}\cdot\delta\underline{r}\rangle}{r^2} - \frac{1}{3r}\frac{\partial}{\partial r}\langle\delta\underline{r}\cdot\delta\underline{r}\rangle$$

using the apsidal method in the near circular approximation. Here $\langle\delta\underline{r}\cdot\delta\underline{r}\rangle$ is the isotropically averaged vacuum fluctuation. The vacuum force is:

$$\underline{F}(\text{vac}) = \phi_g\,\underline{\omega} \quad -(4)$$

Integrating eq. (3) produces:

$$\Delta\phi = \frac{2}{3}\frac{\langle\delta\underline{r}\cdot\delta\underline{r}\rangle}{r^2} \quad -(5)$$

So planetary precession is due to $\langle\delta\underline{r}\cdot\delta\underline{r}\rangle$.

The only valid theory of planetary precession is the theory of Thomas precession, because all the precessional theories of Einsteinian general relativity (EGR) have been comprehensively refuted in a series of papers. The theory of Thomas precession produces:

$$\Delta\phi = 2\pi\beta \quad -(6)$$

where
$$\beta = \gamma - 1 = \left(1 - \frac{v^2}{c^2}\right)^{-1/2} - 1 \quad -(7)$$
where v is the Thomas velocity:
$$v = \omega r. \quad -(8)$$
From eqs. (5) and (6)
$$\boxed{\beta = \frac{1}{3\pi} \frac{\langle \delta \underline{r} \cdot \delta \underline{r} \rangle}{r^2}} \quad -(9)$$
In the low velocity limit:
$$\beta \xrightarrow[v \ll c]{} \beta_0 = \frac{1}{2} \frac{v^2}{c^2} \quad -(10)$$
where β_0 is the Thomas half. In the limit (10):
$$\beta_0 = \frac{1}{3\pi} \frac{\langle \delta \underline{r} \cdot \delta \underline{r} \rangle}{r^2} \quad -(11)$$
so the Thomas half can be related to $\langle \delta \underline{r} \cdot \delta \underline{r} \rangle$ of the vacuum.

In the Newtonian theory:
$$\Delta \phi = 0 \quad -(12)$$
$$\langle \delta \underline{r} \cdot \delta \underline{r} \rangle = 0 \quad -(13)$$
$$\beta_0 = 0 \quad -(14)$$
The spin connection from Eq. (3) is:
$$\omega = \frac{2}{3} \frac{\langle \delta \underline{r} \cdot \delta \underline{r} \rangle}{r^3} \quad -(15)$$
so from eqs. (5) and (15):
$$\boxed{\Delta \phi = \omega r} \quad -(16)$$
In the Newtonian theory:
$$\omega = 0 \quad -(17)$$

) From eqs. (6) and (11):

$$\beta = \frac{\omega r}{2\pi} \quad -(18)$$

The magnitude of the spin connection is:

$$\omega = 2\pi \frac{\beta}{r} = \frac{2\pi}{r}(\gamma - 1) \quad -(19)$$

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

$$\xrightarrow[v \ll c]{} \frac{2\pi}{r}\beta_0 .$$

So the spin connection ω can be calculated from β, or in the low velocity limit, β_0, the Thomas half:

$$\beta_0 = \frac{1}{2}\frac{v^2}{c^2} \quad -(19)$$

In the solar system:

$$\beta \sim \beta_0 \quad -(20)$$

to an excellent approximation.

Summary

1) Planetary precession,

$$\Delta\phi = 2\pi\beta_0 = \frac{2}{3}\frac{\langle \delta \underline{r} \cdot \delta \underline{r} \rangle}{r^2} \quad -(21)$$

$$= \omega r$$

2) Spin Connection:

$$\omega = 2\pi \frac{\beta_0}{r} \quad -(22)$$

3) Thomas Half

$$\beta_0 = \frac{1}{2}\frac{v^2}{c^2} \quad -(23)$$

$$= \frac{1}{3\pi}\frac{\langle \delta \underline{r} \cdot \delta \underline{r} \rangle}{r^2} \quad -(24)$$

$^{+)}$ Any planetary precession can be described by fitting the Thomas velocity v from the experimental data. Any precession in the solar system can be described using this method, given that the orbit is approximately circular. This approximation can be removed in more accurate calculations, for example numerical methods based on the relevant lagrangian:

$$\mathcal{L} = -\frac{mc^2}{1+\beta} - U \quad -(25)$$

and hamiltonian:

$$H = (1+\beta)mc^2 + U \quad -(26)$$

The force equation (1) is:

$$\underline{F} = (1+\beta)^3 m\ddot{\underline{r}} = -mMG\frac{\underline{r}}{r^3} + m\phi_g \underline{\omega}. \quad -(27)$$

The result (22) can be expressed as:

$$\Delta\phi = \Omega r \quad -(28)$$

where:

$$\Omega := \omega. \quad -(29)$$

This notation is used to avoid confusion with the angular velocity ω defined by the Thomas velocity:

$$v = \omega r \quad -(30)$$

From eqs. (28) and (30):

$$\boxed{\Delta\phi = \frac{\Omega}{\omega} v} \quad -(31)$$

In UFT406 it was shown that the observed light deflection due to gravitation is given

5) by the definition of ECE2 covariant relativistic velocity:

$$v^2 = \gamma^2 v_N^2 = (1+\beta)^2 v_N^2 \quad -(32)$$

where v_N^2 is the Newtonian velocity. So:

$$v^2 = \frac{v_N^2}{1 - \frac{v_N^2}{c^2}} \quad -(33)$$

and

$$v_N^2 = \frac{v^2}{1 + \frac{v^2}{c^2}} \quad -(34)$$

The observed velocity is the relativistic velocity of magnitude v. In light deflection by gravitation:

$$v \rightarrow c \quad -(35)$$

So from eqs. (34) and (35):

$$v_N^2 \rightarrow \frac{c^2}{2} \quad -(36)$$

The Newtonian theory of light deflection due to gravitation gives a deflection angle of:

$$\Delta\phi = \frac{2MG}{R_0 v_N^2} \quad -(37)$$

From eqs. (36) and (37), the ECE2 theory of light deflection due to gravitation gives:

$$\Delta\phi\,(\text{ECE2}) = \frac{4MG}{R_0 c^2} \quad -(38)$$

which is precisely the experimental result.

Note carefully that v_N^2 in eq. (36) is not an observable, the observable is v^2.

Eq. (36) means that:

$$\gamma = \left(1 - \frac{v_N^2}{c^2}\right)^{-1/2} \rightarrow \sqrt{2} \quad -(39)$$

So

$$\beta = \gamma - 1 \rightarrow \sqrt{2} - 1 \quad - (40)$$
$$= 0.4142$$

The Thomas precession under the condition (40) is

$$\Delta \phi = 2\pi\beta = 2\pi\left(\sqrt{2} - 1\right) \quad - (41)$$

and the Thomas velocity is v_N. Therefore the Thomas half is:

$$\beta_0 = \frac{1}{2}\left(\frac{v_N^2}{c^2}\right) = \frac{1}{4} \quad - (42)$$

under the condition (42),

$$v \rightarrow c. \quad - (43)$$

Therefore light deflection due to gravitation is explained by the maximum attainable value of the Thomas half, eq. (42).
