406(4): Gravitomagnetic Theory of Geodetic Precession

This theory was introduced in UFT344 and UFT345, and is based on the interaction of the gravitomagnetic field $\underline{\Omega}$ with the gravitomagnetic dipole moment $\underline{m}_g$, producing the torque:

$$\underline{Tq} = \underline{m}_g \times \underline{\Omega} \quad -(1)$$

In analogy with the magnetic dipole moment $\underline{m}$ in electrodynamics,

$$\underline{m} = -\frac{e}{2m}\underline{L}, \quad -(2)$$

the gravitomagnetic dipole moment is defined as:

$$\underline{m}_g = \frac{1}{2}\underline{L} \quad -(3)$$

The gravitomagnetic field $\underline{\Omega}$ of an attracting object of mass M is:

$$\underline{\Omega} = \frac{G}{c^2 r^3}\left(\underline{m}_g - 3\underline{n}\,(\underline{m}_g \cdot \underline{n})\right) \quad -(4)$$

and is assumed to be a dipole field as in UFT355. So

$$\underline{\Omega} = \frac{G}{2c^2 r^3}\left(\underline{L} - 3\underline{n}\,(\underline{L} \cdot \underline{n})\right). \quad -(5)$$

The total angular momentum is the sum of an orbital and spin component:

$$\underline{L} = \underline{L}(\text{orb}) + \underline{L}(\text{spin}) \quad -(6)$$

The orbital component is responsible for the geodetic precession, and the spin component for the Lense-Thirring precession. The latter has been discussed in previous work, and in gravitomagnetic theory is defined by the Larmor precession:

$$\Delta\phi_{LT} = \frac{1}{2}|\underline{\Omega}|\,t \quad -(7)$$

assuming a gravitomagnetic g factor of unity. Here t is the time in seconds needed for one orbit of 2π. As in note 405(1) this analysis gives a Lense Thirring precession for Gravity Probe B of:

$$\Delta\phi_{LT}(ECE2) = 4.10 \times 10^{-11} \text{ radians per orbit of GPB} \quad -(8)$$

in the approximation: $\underline{L} \cdot \underline{n} = 0.$ $-(9)$

The experimental claim is:

$$\Delta\phi_{LT}(\text{exp}) = 3.25 \times 10^{-11} \text{ radians per orbit of GPB} \quad -(10)$$

(39.2 milliarcseconds per year).

The experimental claim for the geodetic precession is

$$\Delta\phi(\text{geodetic}) = 5.48 \times 10^{-9} \text{ radians per GPB orbit} \quad -(11)$$

(6,601.8 milliarcseconds per earth year). The standard model gives a geodetic precession for GPB of

$$\Delta\phi = 2\pi\left(\left(1 - \frac{1}{c^2}\left(v^2 + \frac{2MG}{r}\right)\right)^{-1/2} - 1\right) \sim \frac{3\pi MG}{c^2 a} \quad -(12)$$

$$= 5.95 \times 10^{-9} \text{ radians per GPB orbit.}$$

and contrary to the claims of NASA / Stanford the standard model does not give precise agreement with data. It is unclear how NASA / Stanford isolated the LT and geodetic precessions experimentally. The Einstein precession:

$$\Delta\phi_E = \frac{6\pi MG}{c^2 a(1-\epsilon^2)} \quad -(13)$$

is missing completely from the NASA / Stanford analysis, and is

$$\Delta\phi_E = 1.19 \times 10^{-8} \text{ radians per GPB orbit} \quad -(14)$$

but is the main contribution.

The data are summarized in the table:

Table 1: Precessions of Gravity Probe B*

Experimental geodetic	5.48×10^{-9}
Experimental Lense Thirring	3.25×10^{-11}
standard geodetic theory	5.95×10^{-9}
Gravitomagnetic LT theory	4.10×10^{-11}
Einsteinian precession	1.19×10^{-8}
Einsteinian exptl.	not given

* in radians per orbit of GPB.

The total theoretical precession is:

$$\Delta\phi(\text{theory}) = 1.19 \times 10^{-8} + 5.95 \times 10^{-9} + 3.25 \times 10^{-11} \qquad (15)$$

$$= 1.788 \times 10^{-8} \text{ radians per GPB orbit}$$

The only experimental precessions reported by Gravity Probe B are the geodetic and Lense Thirring. This gives a total of

$$\Delta\phi(\text{experiment}) = 5.48 \times 10^{-9} + 3.25 \times 10^{-11}$$

$$= 5.5125 \times 10^{-9} \text{ radians per GPB orbit} \qquad (16)$$

The only thing that could have been observed experimentally is the sum of the Einstein, geodetic and LT precessions. The main contribution, the Einsteinian precession, was not ever reported.

The complete failure of the experiment brings into question the existence of these standard model precessions, because the theory that claims their existence is incorrect. The gravitomagnetic approach is correctly ECE2 covariant, it expresses the geodetic and Lense Thirring precessions in terms of eqs. (4) to (7). The geodetic precession in gravitomagnetic theory is found from:

$$\underline{\Omega} = \frac{G}{2c^2 r^3} \underline{L}(\text{orb}) - (17)$$

here $\underline{L}$ (orb) is the orbital angular momentum defined in FT345:

$$\underline{L} = M r \underline{\omega} - (18)$$

The methods of Section 3 of UFT345 can be used to obtain agreement with the experimental claim.

However, it becomes clear that all observable precessions must be sums of $\Delta\phi_E$, $\Delta\phi_g$ and $\Delta\phi_{LT}$, and that there is no way in which these components can be separated experimentally. The only thing that can be done is to express the total as:

$$\Delta\phi = \Delta\phi_E + \Delta\phi_g + \Delta\phi_{LT} = \frac{2}{3} \frac{\langle \delta\underline{r} \cdot \delta\underline{r} \rangle}{r^2}, - (19)$$

where:

$$\Delta\phi_E = \frac{6\pi M G}{c^2 a (1-\epsilon^2)} - (20)$$

$$\Delta\phi_g = 2\pi\left(\left(1 - \frac{1}{c^2}\left(v^2 + \frac{2MG}{r}\right)\right)^{-1/2} - 1\right) - (21)$$

$$\Delta\phi_{LT} \sim \frac{2}{5} \frac{MGR^2\omega}{c^2 r^3} - (22)$$

In the standard model, but are simply expressed in terms of eq. (19) in ECE physics. In the standard model it is always assumed that:

$$\Delta\phi(\text{exptl.}) = \Delta\phi_E - (23)$$

It is worth drawing up a table for all the planets giving eqs. (20) to (22). This will show that the true theoretical result of the standard model, the sum (19), is always much greater than the experimental result.