GRAVITOMAGNETICS, A SIMPLER APPRAOCH APPLIED TO ROTATING BODIES

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June 2011

ABSTRACT

In reference [1] the basics of the new approach are outlined but in this paper more details are given where the method is applied to rotating bodies. Application to single bodies is often referred to as the de Sitter effect and when applied to rotating bodies it is known as the Lense-Thirring effect. This new approach gives the same form of result as the generally accepted equations but with a different factor for the Lense-Thirring effect. This variation is discussed.

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GRAVITOMAGNETICS

The new approach, described in reference [1] and fully detailed in reference [2], is completely expressed by equation (1). When applied to two body systems the equation generated is identical to the de Sitter form and agrees with the measurement of precession of the perihelion of Mercury and of the Binary Pulsar PSR 1913+16. It also agrees with the deflection of light passing close to the Sun. The equation is equally applicable if one body is large and non-rotating.

$$\boxed{\boldsymbol{a} = -\frac{K}{r^2}\left(1-\frac{v^2}{c^2}\right)\boldsymbol{e}_r + \frac{2K}{r^2c^2}\boldsymbol{v}\times(\boldsymbol{v}\times\boldsymbol{e}_r)} \quad \ldots\ldots\ldots(1)$$

where c is the speed of light, $\boldsymbol{a}$ is relative acceleration, $\boldsymbol{v}$ is relative velocity and r is relative position. Also $\boldsymbol{e}_r$ is the unit vector from body A to body B.
$K = G(m_A + m_B)$ where G is the gravitational constant

The calculations are made easier for multi-body systems by the use of a defined force as shown in equation (2).

$$\boldsymbol{P} = \mu\boldsymbol{a} = -\frac{Gm_Am_B}{r^2}\left(1-\frac{v^2}{c^2}\right)\boldsymbol{e}_r + \frac{2Gm_Am_B}{r^2c^2}\boldsymbol{v}\times(\boldsymbol{v}\times\boldsymbol{e}_r) \quad \ldots(2)$$

μ is the reduced mass $m_Am_B/(m_A+m_B)$

PRECESSION OF THE PERICENTRE.

Consider a test body in orbit around a spherical body rotating at an angular speed of Ω. The test body is performing an elliptical orbit with a period of T in a plane that has a inclination (inc) relative to the equatorial plane of the rotating body.

The rate of precession of the pericentre, as seen from the plane of the orbit, in radians per orbit, is

$$\Delta\phi_P = \frac{6\pi GM}{c^2 a\left(1-e^2\right)} - \frac{2GI\Omega}{c^2 a^3\left(1-e^2\right)^{3/2}}\cos(inc)T \quad \text{.....(3)}$$

Where I is the moment of inertia, e is the eccentricity and a is the semi-major axis..

The first term is the de Sitter precession and has been derived algebraically from equation (1). It agrees exactly with the generally accepted answer and agrees with the measured results for the precession of the perihelion of Mercury and for the binary pulsar PSR 1913+16. However, the second term, the Lense-Thirring term, justified by numerical integration, is only half of the generally accepted value.

NODAL PRECESSION

Nodal precession is the rate of precession of the line of the intersection of the plane of the orbit and the equatorial plane, as seen from the equatorial plane. Again, in radians per orbit

$$\Delta\phi_N = \frac{GI\,\Omega}{c^2 a^3\left(1-e^2\right)}\left[1-\frac{1}{2}\left(\frac{\Omega}{\omega}\right)\cos(inc)\right]T \quad \text{...(4)}$$

Where $\omega = \frac{2\pi}{T} = \sqrt{\frac{GM}{a^3}}$ is the mean angular velocity of the test body.

Compared with the accepted result the first term is, again, only half its value. The second term does not even appear in the accepted equation.

LENSE-THIRRING EQUATIONS

The commonly accepted equations, reference [3], are.

For the nodal precession per unit time referred to the equatorial plane

$$\dot{\phi}_N = \left(\frac{G}{c^2}\right)\frac{2J}{a^3\left(1-e^2\right)^{3/2}} \quad \text{...(5)}$$

For the precession of the pericentre,

$$\dot{\vec{\phi}}_P = \left(\frac{G}{c^2}\right)\frac{2J\left(\hat{\boldsymbol{J}} - 3\cos(I)\hat{\boldsymbol{I}}\right)}{a^3\left(1-e^2\right)^{3/2}} \qquad \ldots(6a)$$

$$= \left(\frac{G}{c^2}\right)\frac{2J\hat{\boldsymbol{J}}}{a^3\left(1-e^2\right)^{3/2}} - \left(\frac{G}{c^2}\right)\frac{6J\cos(I)\hat{\boldsymbol{I}}}{a^3\left(1-e^2\right)^{3/2}} \qquad \ldots.(6b)$$

Where J is the moment of momentum and I is the inclination. The ^ indicates a unit vector.

In reference [9] there is the suggestion that only the second term is needed.

If equation (6a) is referred to the plane of the orbit, assumed to be $\dot{\vec{\phi}}_P \bullet \boldsymbol{I}$, then

$$\dot{\phi}_P = -\left(\frac{G}{c^2}\right)\frac{4J\cos(I)}{a^3\left(1-e^2\right)^{3/2}} \qquad \ldots.(7)$$

This term is the same form but twice the magnitude of the second term of equation (3).

THE DE SITTER EQUATION

The de Sitter term is identical to the first term of equation (3) when it is referred to precession per unit time. It has been verified by application to the precession of the perihelion of Mercury and the periastron precession of the binary pulsar PSR 1913+16.

DISCUSSION

The de Sitter effect agrees with the accepted results of analysis whether algebraically or by numerical integration for two body systems or large non-rotating bodies. This is true whether using equation (1) or equation (2).

However, for the Lense-Thirring terms there is an unresolved factor of two which affects both nodal and pericentre precession. Also an extra term appears in the expression for the nodal precession which is not in the accepted result.

The published test on the Earth satellites LAGEOS I & II, see reference [8], appear to agree with the accepted theory. The inclination of the satellites is approximately 90^0 +/- 20^0 . The reason for this is that the accepted Lense-Thirring term does not depend on the inclination but all other effects do and therefore can be cancelled out. See also references [3] and [9]. The extra term in the present theory also depends on the inclination and therefore cancels out as well. In this configuration it is small compared to the main term.

The Gravity Probe B experiment testing the precession of gyroscopes in Earth orbit displays two equations, one for the geodesic term and one for the frame-dragging effect. The geodesic term does not involve the rotation of the Earth but the frame-dragging term does. The same form of equations have been generated algebraically using equation (2) but the frame-dragging term is half of the published value. However, the geodesic term is two thirds of the published value.

It has proved to be impossible, so far, to find any modification to equation (1) such that it gives the generally accepted value for the Lense-Thirring effect without changing the de Sitter effect applications. The de Sitter results have been obtained by several observations but the Lense-Thirring effect is very small compared to other effects. In the LAGEOS experiments for the precession of the pericentre the Lense-Thirring effect is less than 1% of the de Sitter effect, which makes it more difficult to evaluate. The GP-B test results have recently been published, reference [7]. There are four gyroscopes, two of which have frame-dragging results which are close to that predicted by the new theory. The geodesic results are, on average, close to the that of the accepted value. Nevertheless, over a one month period two of the gyroscopes precess at a rate close to the new theory predictions.

It is extremely hard to believe that so many experts in this field have made an error. Errors, however, have been made in this type of problem, see reference [4] for comments on binary decay. When general relativity is applied to multiple body systems several authors have produced slightly different results. Some results even do not return to the Newtonian form when the velocities are zero but only if the speed of light is taken to be infinite. There are also comments made that the frame dragging effect has been verified by the binary pulsar mentioned above when, in fact, it is a verification of the de Sitter effect.

This new approach does not undermine the General Theory of Relativity but because it is a simpler method it leaves less room for misinterpretation. Many of the extensions of GR are very complex mathematically making errors more likely.

REFERENCES

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