On the Anomalous Oscillation of Newton's Gravitational Constant

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Abstract: Periodic oscillations are observed in Newton's gravitational constant **G** that are contemporaneous with length of day data obtained from the International Earth Rotation and Reference System. Preliminary research has determined that the oscillatory period of **G** is ≈ 5.9 years (5.899 ± 0.062 years). In this paper, the oscillations are shown to be concomitant with the Earth's distance from the Sun and the angular frequency of its orbit. Implications for space exploration and dark matter are also discussed.

INTRODUCTION

Ground based measurements of Newton's gravitational constant **G** oscillate between 6.672×10^{-11} and 6.675×10^{-11} N·(m/kg)^2 (a difference of 10^{-4} %) with a periodicity of ≈ 5.9 years[1], [2]. The variations in **G** can be predicted from length of day (LOD) data obtained from the International Earth Rotation and Reference System[3]:

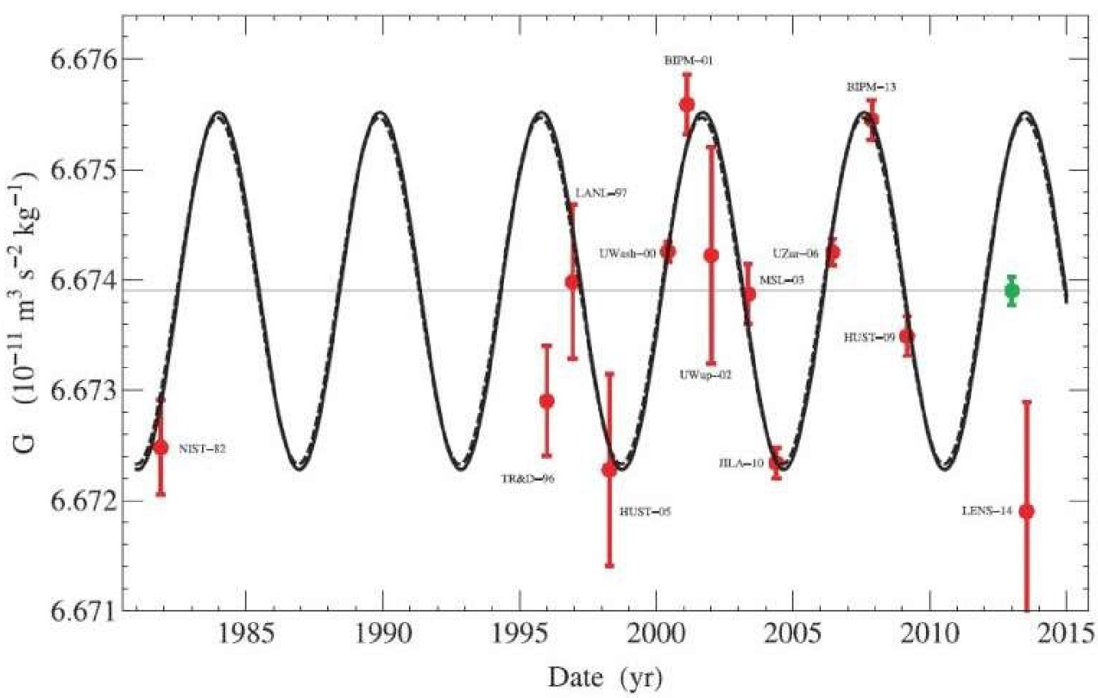

Fig. 1 G/LOD synchronicity: The solid curve is a CODATA set of G measurements and the oscillations in LOD measurements are represented by the dashed curve.

The mean motion $\boldsymbol{n}$ of a secondary's orbit is

$$\textbf{(1)}\quad n = \omega = \frac{2\pi}{\mathrm{P}} = \sqrt{\frac{\mathrm{G(M + m)}}{a^3}}\,,$$

where **ω** is the angular frequency of the orbit, **P** is the sidereal period, **M** is the mass of the primary, **m** is the mass of the secondary, and ***a*** is the secondary's semi-major axis. The mean motion ***n*** assumes a circular orbit where the secondary's distance from the origin remains constant and equivalent to its semi-major axis ***a***. For elliptical orbits, however, the secondary's velocity ***v*** and distance ***r*** from the primary varies according to Kepler's 2^{nd} law,

$$\textbf{(2)}\quad \frac{d\vec{A}}{dt} = \lim_{\Delta t \to 0} \frac{\vec{r}(t) \times \vec{r}(t + \Delta t)}{2\Delta t} = \frac{\vec{r}(t) \times \vec{v}(t)}{2}\,,$$

where **A** is the area swept by the secondary during its orbit.

From Kepler/Newton's laws we know

$$\textbf{(3)}\quad \mathbf{G(M + m)} = rv^2.$$

Combining Kepler's 2^{nd} law with Eq. (3) yields

$$\textbf{(4)}\quad \frac{\mathrm{G(M + m)}}{\vec{v}(t)} = 2\frac{d\vec{A}}{dt} = \vec{h},$$

where the constant ***h*** is the secondary's specific relative angular momentum. A definition for **G** can then be deduced from Eqs. (1), (2) & (4) as

$$\textbf{(5)}\quad \mathrm{G} = \frac{\omega^2 r^3}{\mathrm{(M + m)}} = 2\frac{d\vec{A}\vec{v}(t)}{dt\,\mathrm{(M + m)}} = \frac{\vec{h}\vec{v}(t)}{\mathrm{(M + m)}}\,.$$

From the laws of conservation we know the secondary's total angular momentum $\mathbf{L_T}$ is

$$\textbf{(6)}\quad \mathbf{L_T = L_S + L_O}\,,$$

where $\mathbf{L_S}$ and $\mathbf{L_O}$ are the secondary's spin and orbital angular momentum respectively. Due to spin−orbit coupling, an increase in the Earth's length of day (a decrease in the angular frequency of its spin) must result in an increase in **ω** and ***v***. Since mass is a conserved quantity, the increase of **ω** and ***v*** in Eq. (5) results in an increase in **G**, confirming the G/LOD synchronicity in Fig. 1[1], [2], [3].

An alternative method to test if the oscillation of **G** is concomitant with the angular frequency of the Earth's orbit is to measure the annual variations in **G** relative to an equation of time graph:

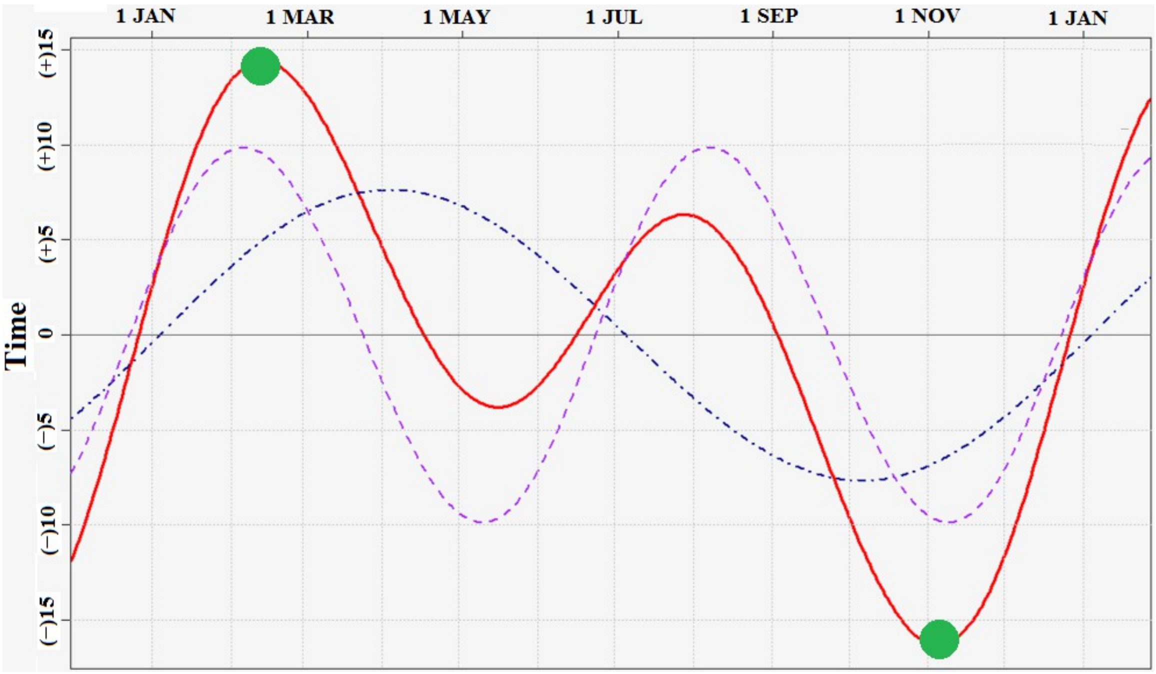

Fig. 2: An equation of time graph.

Since it is assumed that the angular frequency of the Earth's orbit varies due to spin–orbit coupling, the miniscule changes in the annual value of **G** should oscillate proportionately with the red curve graphed in Fig. 2 (assuming the measurements are taken near the Earth's equator).

IMPLICATIONS FOR SPACE EXPLORATION

Newton's gravitational force $\mathbf{F_g}$ law is

$$(7)\quad \mathbf{F_g} = \mathbf{G}\,\frac{\mathbf{Mm}}{r^2}.$$

Combining Newton's force law with the definition of **G** in Eq. (5) yields

$$(8)\quad \mathbf{F_g} = \frac{\mathbf{Mm}\,\omega^2 r^3}{(\mathbf{M}+\mathbf{m})\,r^2} = \mu r \omega^2,$$

where $\boldsymbol{\mu}$ is the reduced mass of the system ($\boldsymbol{\mu} \approx \mathbf{m}$ when $\mathbf{M} >> \mathbf{m}$). This version of Newton's force law indicates it may be possible to use spin–orbit coupling to produce artificial tidal forces that could diminish the apparent force of gravity. Increasing a body's spin angular momentum would decrease its orbital angular momentum, decreasing the angular frequency $\boldsymbol{\omega}$ of its orbit. This effect would be greater for contra–rotating systems since their relative angular frequencies are greater. Since the spin of Venus is retrograde from Sun's spin and the spin of the other planets, Eq. (8) also indicates its precession rate should be less than predicted from Eq. (7).

According to General Relativity, a spinning body produces a gravitomagnetic (GM) field[4], [5], [6]

$$(9)\quad \vec{B}_g = \frac{G}{2c^2}\frac{\vec{L}_S}{\vec{r}^3} = \frac{\vec{h}\vec{v}(t)}{2mc^2}\frac{\vec{I}\omega_S}{\vec{r}^3},$$

where $\mathbf{B_g}$ is the field measured at the body's equator, **c** is the velocity of light in a vacuum, ω_S is the angular frequency of the body's spin and ***I*** is its moment of inertia.

From Special Relativity we know

$$(10)\quad mc^2 = E\sqrt{1-(v/c)^2} = E\gamma,$$

where **E** is total energy and **γ** is the Lorentz factor. A definition for the equatorial GM field can therefore be deduced from Eqs. (5) & (10) as

$$(11)\quad \vec{B}_g = \frac{\vec{h}\vec{v}(t)}{2E\gamma}\frac{\vec{I}\omega_S}{\vec{r}^3}.$$

The kinetic temperature of a body is

$$(12)\quad \frac{3}{2}kT = E_K,$$

where ***k*** is the Boltzmann constant, **T** is temperature and $\mathbf{E_K}$ is the average kinetic energy. Eqs. (11) & (12) highlight the possibility that $\mathbf{B_g}$ is inversely proportional to a body's temperature. Experiments conducted by M. Tajmar & C. de Matos[7] show that the GM field of low temperature superconductors are no less than one hundred million trillion times greater than predicted with General Relativity. The fact that superconductors have zero electrical resistance also suggests that the GM field is inversely proportional to a body's resistance. Alternatively, since entropy is the inverse of temperature, $\mathbf{B_g}$ would be directly proportional to a body's entropy, lending credence for E. Verlinde's entropic theory of gravity[8].

Evidence for the decay rate of radioactive materials being contemporaneous with the Earth's spin has been given by J. H. Jenkins, E. Fischbach, P. A. Sturrock & D. W. Mundy[9]. It was shown in a previous paper published by the author[10] that the square root of Newton's constant (the Gaussian gravitational constant) is directly proportional to $\mathbf{Z_0\varphi_0 f}$, where $\mathbf{Z_0}$ is the charge of an alpha particle (**2e**), φ_0 is the magnetic flux quantum and **f** is frequency (in units that are based upon the mass of a helium nucleus). Since the evidence presented in this paper suggests **G** is dependent upon a body's angular frequency, an alternative method to test this hypothesis (and a method for space propulsion) is illustrated in Fig. 3:

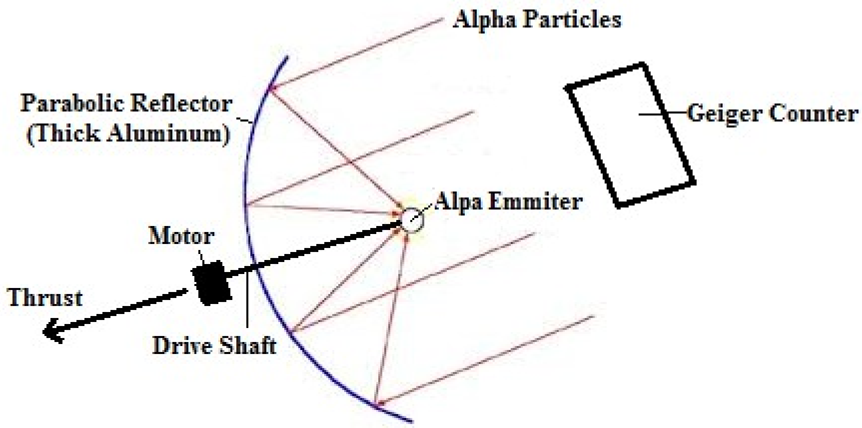

Fig. 3: If G is dependent upon a body's angular frequency then the half−life of a radioactive material may be reduced by increasing its spin rate. By using a parabolic reflector that is attached to the drive shaft of a motor, the radiation emitted from a radioactive material at the focus of the reflector could be measured with a Geiger counter to determine if there is a decrease in its half−life. For thrust applications, alpha emitters would be more efficient than beta emitters since they are more massive. Also, alpha particles require less material for shielding. Applying a positive voltage to the drive shaft may also increase the efficiency since the charge of alpha particles are positive.

IMPLICATIONS FOR DARK MATTER

Geological evidence[11] indicates our Sun oscillates vertically about the plane of our galaxy in 31 ± 1 Myr cycles during its estimated 225−250 Myr revolution. In effect, the Sun's mean motion is much less than the angular frequency of its orbit. It was shown previously in Eqs. (3) & (5) that

(13) $G(M + m) = \omega^2 r^3 = rv^2$,

so the relative consistency observed in a stellar orbital speeds may be resolved by

(14) $v = r\omega$.

It is hypothesized that the gravitational lensing effect is caused by the warping of light and gasses near the center of mass points between interstellar *n*−body systems. It may be possible to utilize these “virtual mass” points to increase the efficiency of deep space exploration. This topic will be expanded upon in a subsequent paper.

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