On the Anomalous Oscillation of Newton's 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 radial distance from the Sun and the angular frequency of its orbit. Implications for space exploration and dark matter are discussed.

INTRODUCTION

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]:

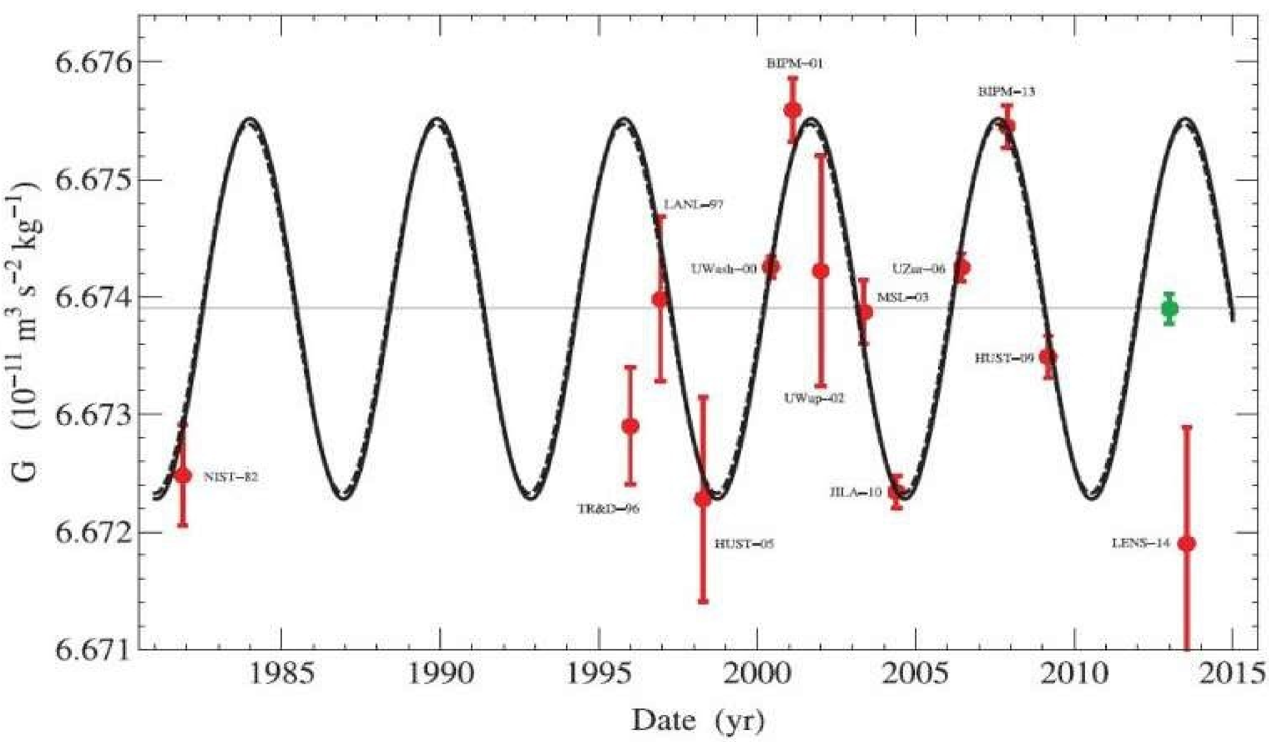

Fig. 1: G/LOD synchronicity: The solid curve is a CODATA set of G measurements and the oscillations in LOD measurements are represented by the dashed curve. The green dot, with its one−sigma error bar, is the mean value of the G measurements.

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 a 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, the secondary's radial distance ***r*** from the center of mass varies in accordance with Kepler's 2nd law,

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

where **A** is the area swept by the secondary during its orbit, ***v*** is its velocity and ***t*** is time.

From Kepler/Newton's laws we know

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

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

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

We can see from Eq. (4) that the ratio between the sum of the standard gravitational parameters and the secondary's instantaneous velocity is equal to the secondary's specific angular momentum ***h***.

A definition for **G** can be deduced from Eqs. (1) & (4) as

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

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

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

where $\mathbf{L_S}$ and $\mathbf{L_O}$ are the secondary's spin and orbital angular momentum respectively. Due to spin−orbit resonance (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 the angular frequency of its orbit. From the definition of **G** in Eq. (5) we can see that the increase in the Earth's LOD results in an increase in **G**, confirming the G/LOD synchronicity in Fig. 1[1], [2], [3].

An alternative method to test if **G** varies with $\omega^2 r^3$ is to measure the annual variations in **G** relative to the temporal waves of an equation of time graph:

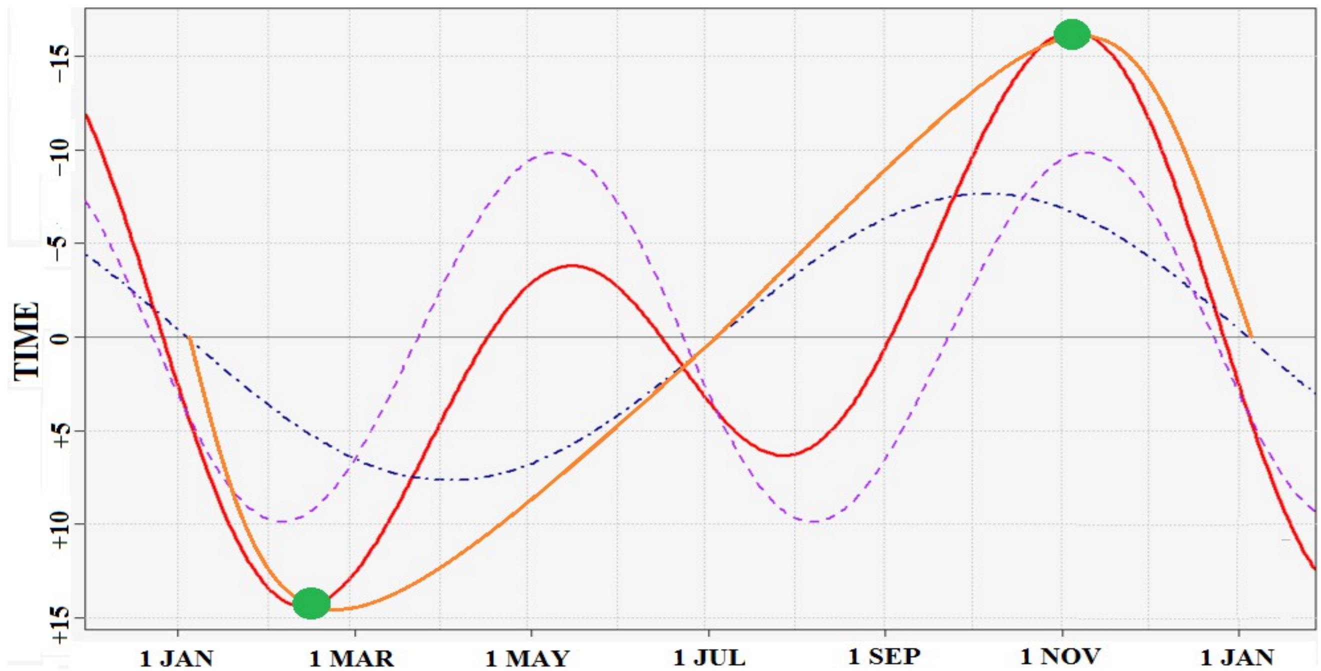

Fig. 2: An equation of time graph.

Since it is assumed that the Earth's angular frequency varies due to spin−orbit coupling, the 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 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 μ is the reduced mass of the system ($\mu \approx \mathbf{m}$ when $\mathbf{M} >> \mathbf{m}$). This modified version of Newton's force law indicates it may be possible to utilize spin−orbit coupling to produce artificial tidal forces that negate the apparent force of gravity. Increasing a body's spin angular momentum would decrease its orbital angular momentum, decreasing the angular frequency ω of its orbit. According to general relativity, a rapidly spinning body also produces a gravitomagnetic field[4], [5], [6]

$$(9)\quad \mathbf{B_g} = \frac{\mathbf{G}}{2\mathbf{c}^2}\,\frac{\mathbf{L_S}}{r^3} = \frac{\omega^2 r^3}{2\mathbf{mc}^2}\,\frac{I\omega}{r^3} = \frac{I\omega^3}{2\mathbf{mc}^2},$$

where $\mathbf{B_g}$ is the field measured at the body's equator, **c** is the velocity of light in a vacuum, and ***I*** is the body's moment of inertia. We know from special relativity that

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

where **E** is total energy and **γ** is the Lorentz factor. A definition for the equatorial gravitomagnetic field can therefore be given as

$$\textbf{(11)}\quad B_g = \frac{I\omega^3}{2E\gamma}.$$

The kinetic temperature of a body is

$$\textbf{(12)}\quad \frac{3}{2}kT = E_{AK},$$

where ***k*** is the Boltzmann constant, **T** is temperature and $\mathbf{E_{AK}}$ is the average kinetic energy, suggesting that the equatorial gravitomagnetic field is inversely proportional to a body's temperature[7], [8], [9].

IMPLICATIONS FOR DARK MATTER

Geological evidence[10] 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, there is a large difference between the Sun's mean motion and its angular frequency. It was shown previously in Eqs. (3) & (5) that

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

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

$$\textbf{(14)}\quad v = r\omega.$$

It is hypothesized that the gravitational lensing effect is caused by the warping of light and gasses near the center of mass (COM) points between interstellar *n*−body systems. It may be possible to utilize these COM points as "virtual mass" portals to increase the efficiency of deep space exploration.

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