On the Anomalous Oscillation of Newton's Constant

Brent Jarvis
Jarvis.KSU@gmail.com

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

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]:

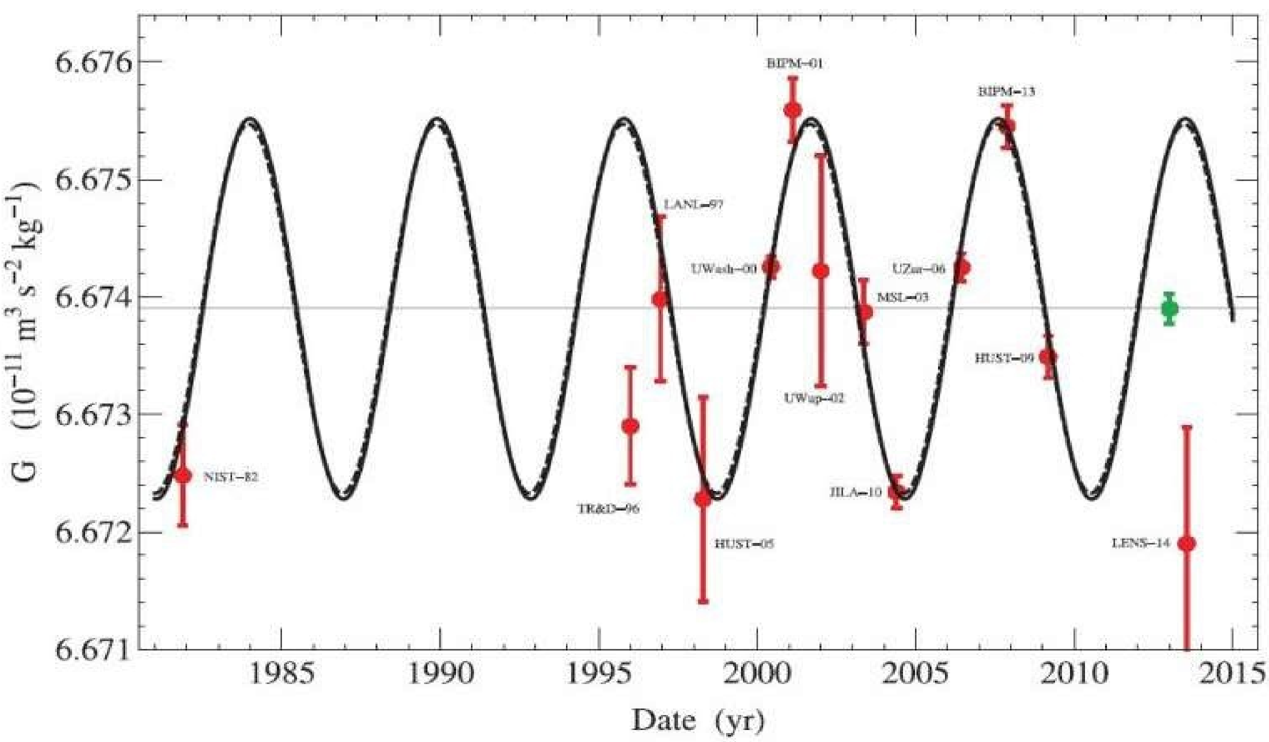

Fig. 1: G/LOD synchronicity: The solid curve is a CODATA set of G measurements and the oscillations in LOD measurements are represented by the dashed curve. The green dot, with its one−sigma error bar, is the mean value of the G measurements.

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

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

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 $\boldsymbol{a}$ is the secondary's semi-major axis. The mean motion $\boldsymbol{n}$ assumes a circular orbit where the secondary's distance from the origin remains constant and equivalent to its semi-major axis $\boldsymbol{a}$. For elliptical orbits, however, the secondary's velocity $\boldsymbol{v}$ and distance $\boldsymbol{r}$ from the primary varies according to Kepler's 2nd law,

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

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

From Kepler/Newton's laws we know

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

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

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

where $\boldsymbol{h}$ is the secondary's specific relative angular momentum. A definition for **G** can then be deduced from Eqs. (1) & (4) as

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

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

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

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

An alternative method to test if **G** oscillates proportionately with $\boldsymbol{\omega^2 r^3}$ is to measure the annual variations in **G** relative to an equation of time graph:

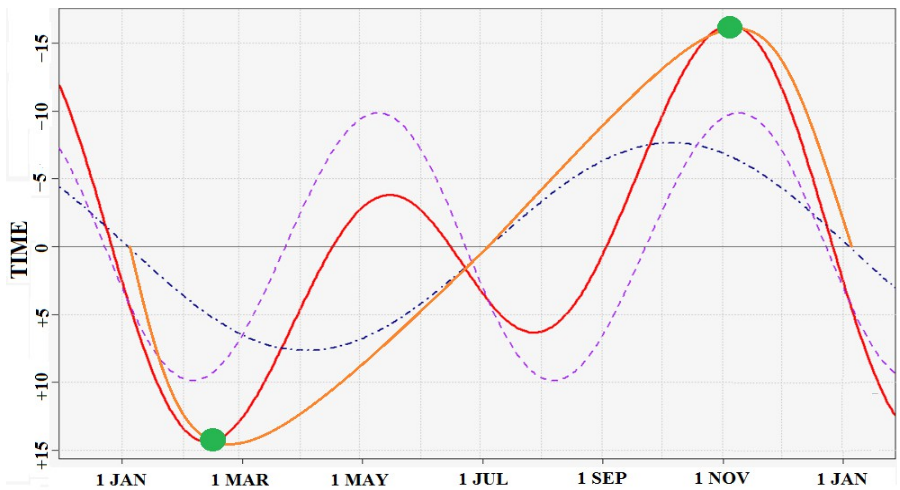

Fig. 2: An equation of time graph.

Since it is assumed that the angular frequency of the Earth's orbit varies due to spin−orbit coupling, the 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 **μ** is the reduced mass of the system (**μ ≈ m** when **M >> 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. The artificial tidal forces would be greater for contra−rotating systems since their relative angular frequencies are greater. Since the spin of Venus is retrograde from the other planets, Eq. (8) also indicates the precession rate of Venus should be less than predicted from Eq. (7) and general relativity.

According to general relativity, a spinning body produces a gravitomagnetic field[4], [5], [6]

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

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

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

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

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

The kinetic temperature of a body is

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

where ***k*** is the Boltzmann constant, **T** is temperature and $\mathbf{E_{AK}}$ is the average kinetic energy of the body. Eq. (12) highlights the possibility that $\mathbf{B_g}$ is inversely proportional to a body's temperature[7], [8]. Alternatively, since the 2nd law of thermodynamics states that a body's temperature is inversely proportional to its entropy, $\mathbf{B_g}$ would also be directly proportional to the body's entropy[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

$$\text{(14)}\quad G(M + m) = r^3\omega^2 = rv^2,$$

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

$$\text{(15)}\quad v = r\omega.$$

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. This topic will be expanded upon in a subsequent paper.

REFERENCES

[1] Zyga L. 2015 "Why do measurements of the gravitational constant vary so much?" ***Phys.org http://phys.org/news/2015-04-gravitational-constant-vary.html.***

[2] Anderson J., Schubert G., Trimble V., and M. R. Feldman 2015 "Measurements of Newton's gravitational constant and the length of day" ***EPL Europhysics Letters*** **Vol. 110, Num. 1.**

[3] Holme R. and de Viron 2013 "Characterization and implications of intradecadal variations in length of day" ***Nature*** **499 202.**

[4] Mashhoon B. 2003 “Gravitoelectromagnetism: a Brief Review”. *arXiv*: gr qc/0311030

[5] Pfister H. 2007 “On the history of the so-called Lense–Thirring effect”. *General Relativity and Gravitation* 39 (11): 1735–1748.

[6] Mashhoon B., Gronwald F., and Lichtenegger H.I.M. 1999 “Gravitomagnetism and the Clock Effect” *Lect.Notes Phys.* 562: 83–108.

[7] Bardeen J., Cooper L., Schriffer J. R. 1957 “Theory of Superconductivity”. *Physical Review* 8 (5): 1178.

[8] Tajmar M., Plesescu F., Marhold K., & de Matos C.J. 2006 “Experimental Detection of the Gravitomagnetic London Moment”. *arXiv*: *gr−qc/0603033v1*.

[9] E.P. Verlinde "On the Origin of Gravity and the Laws of Newton". *JHEP.* ArXiv:1001.0785

[10] M.R. Rampino and R.B. Stothers 1984 “Terrestrial mass extinctions, cometary impacts, and the Sun's motion perpendicular to the galactic plane,” Nature 308, 709 – 712.