Alternative Reflections on Variations of Newton`s Universal Gravitational Constant

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Abstract

As early as 1687, Isaac Newton published the law of gravitation named after him. This law includes the so-called 'universal gravitational constant', also named after him. With the help of this law, it was possible, amongst other things, to calculate the orbital paths of the planets in our solar system with such precision that perturbations in the orbit of Uranus were detected. These perturbations led to the prediction of the existence of another planet. In 1883, the new planet Neptune was indeed discovered at the predicted position, with a deviation of barely 1 degree.
In recent decades, many new measurement results with ever-decreasing errors have been published. Unfortunately, the results often differed by more than the sum of their uncertainties. The results often do not merely represent a fixed value, but also time-varying components. Of particular interest are, for example, short-term variations, as their exact date is helpful in the search for their cause. Even more interesting, however, are periodic variations, as knowledge of the period length greatly narrows the search for the cause. One such variation with a period length of 5.9 years is well established. Based on the 'Alternative Reflections on Gravitation' (ARG), the search quickly leads to the suspected polluter: Jupiter, the largest planet in the solar system. Perhaps this planet is involved also in a non-gravitational effect, the Solar Cycle with a period of about 11 years.

1. Introduction

According to Anderson et al. [1], about a dozen measurements of Newton's gravitational constant G since 1962 have yielded values that differ by far more than their reported random

plus systematic errors. They find that these values for G are oscillatory in nature, with a period of P = 5.899 ±0.062 yr, and an amplitude of (1.619±0.103) × $10^{-14} m^3 kg^{-1} s^{-2}$.
However, the authors do not suggest that G is varying by this much, this quickly, but instead something in the measurement process varies.
This statement is somewhat surprising, as in the same paper the authors report that the length of day (LOD) also varies and does so with almost the same period and phase. And this is even though a completely different measurement process was used to determine the LOD.
However, the ARG theory paints a completely different picture: the small gravitational effect observed is not an artefact of the measurement process but has a real source. And the mutual gravitational attraction is not an intrinsic property of the two masses m1 and m2 but is the result of the mutual shielding of graviton radiation. Axions or axion-like particles (ALPs) are emitted from the hot interiors of stars. These convert into gravitons along their path, particularly when passing through magnetic fields.
When these gravitons are absorbed by the masses m1 and m2, they transfer their mechanical momentum to these masses. This leads to mutual shielding and a gravitational attraction. For further details on this, reference is made here to an earlier paper [2].
Unfortunately, in the ARG, the gravitational world loses the simplicity and elegance of Newton's law of gravitation with the 'universal gravitational constant', which has been known since 1687. Evidently, there are other influences that affect the results of gravitational measurements, which are referred to below as sources, effects and measurement processes.

2. Sources, Effects and Measurement Processes

Sources: What can cause gravitational effects? Essentially, gravity is determined by the luminous matter of all stars in the universe. But even a single brightly shining supernova can produce extremely high gravitational forces which are responsible to the creation of "Hypervelocity Stars", (HVS) [3]. A nearby cluster of stars, such as that at the center of our Milky Way, can act as a source, as demonstrated by observations of the Pioneer anomaly [4] and [2] chapter 12. Not only radiating sources are responsible for variations in gravitational changes. Absorbing matter, such as the planets, also play a role. This is precisely what this paper addresses.

Effects: A second question is: How and where does the influence of these sources manifest itself?
1): Measurements of the gravitational constant at various locations around the world yield values of varying many measurements of the so-called “universal gravitational constant” indicate that there are additional small contributions from various sources, so that the terms “universal” and “constant” are likely inappropriate.
2): Measurements at the same place vary with time.
3): Variations with different periods are obiously produced by different sources. That means that both terms “universal” and “constant” of the so-called “universal gravitational constant” are likely inappropriate.
One such contribution, with a period of 5.9 years, is discussed in this paper. Based on the ARG, the possible cause is quickly identified: the planet Jupiter. Jupiter could also be responsible for the variation in the solar cycle with a period approximately twice as long. In that case, even Venus—a planet with a mass 390 times smaller than Jupiter's —could make a detectable contribution.

Measurement Processes: Measurements of the gravitational constant are performed using various methods: string pendulums, torsion pendulums, La Coste gravimeters, superconducting gravimeters, etc. It is also important to consider whether these devices are direction-sensitive, and whether they rotate in a specific direction or are fixed relative to the fixed stars. Perhaps even the timing of the measurements and their frequency have an influence on the measurement results.

3. G-Variations with 5,9 Years Period

As mentioned in the Introduction, the fitting of CODATA-Values led to variations of the Gravitational Constant G with a period of about 5,9 years. What source may produce these variations, the graviton producing stars or the graviton absorbing planets?
The enormous number of stars, which are distributed more or less homogeneously throughout space, likely account for the vast majority of the gravitational constant. However, small inhomogeneities in the distribution of stars can lead to small contributions with a period of one day when using measurement systems that rotate daily relative to the fixed stars [5], [2] chapter 17. There, however, can be found no note that the stars may be involved in a process

with a period of 5,9 years. The planets, however, may very well be assumed to be the source, due to their rotation in the sun-system with periods typically lasting some years.
Naturally, the planet that can exert the strongest influence, I, is considered to be the source. It is assumed that I is proportional to the mass M of the planet and inversely proportional to the square of the distance R between the planet and Earth: $I = M/R^2$.
The necessary data for mass, perihelion, aphelion, sidereal orbital period (SidOP), and synodic orbital period (SynOP), were obtained from de.wikipedia.org. The unit of mass is the Earth's mass; for the distance R, it is the astronomical unit.
Pluto, formerly classified as a planet but now designated a dwarf planet, was not included due to its extremely small mass and high perihelion value.

Planet	**Mass**	**Perihel.**	**Amphel.**	**SidOP**	**SynOP**
Mercury	0,0553	0.308	0,467	0,241	0,3172
Venus	0,815	0.718	0,728	0,615	1,599
Earth	1	0.983	1.017	1	
Mars	0,107	1.382	1.666	1,881	2,135
Jupiter	318	4.951	5.457	11.862	1,092
Saturn	95,16	9.054	10,092	29.45	1,035
Uranus	14,53	18.266	20,064	84.01	1,010
Neptune	17,14	29.885	30,471	164,8	1,006

Table1. Necessary data of all 8 planets.

The distance from the planet to Earth can vary between a minimum, Rmin, and a maximum, Rmax.
For the two inner planets, Rmin is calculated as the difference between Earth’s perihelion and the planet’s aphelion. Rmax is calculated as the sum of Earth’s aphelion and the planet’s aphelion. These estimates do not take into account the different inclinations.
For the outer planets, Rmin is calculated as the difference between the planet’s perihelion and Earth’s aphelion.
Rmax is calculated as the sum of the planet’s aphelion and Earth’s aphelion. This yields the following values for Rmin, Rmax, Imin, and Imax.

Planet	Rmin	Rmax	Imin	Imax
Mercury	0,516	1,484	0.0251	0,208
Venus	0,255	1,745	0,2669	12,53
Mars	0,365	2,683	0,0149	0,803
Jupiter	3,934	6,474	7.587	20,55
Saturn	8,037	11,109	0,7711	1,473
Uranus	17,25	21,08	0,0327	0.0493
Neptune	28,87	31,49	0,0173	0,021

Table 2. Minimal and maximal distances R between the planets and Earth and the related influences Imin and Imax

When fitting the Codata values to a single sine curve, the only possible cause is the planet Jupiter, with its high values of Rmin and Rmax. However, neither Jupiter's SidOP nor SynOP matches the period Psin of the fit. Nevertheless, the value of Psin (5.899) agrees with half the value of SidOP (5.932) to within 0.56%. And this deviation is only about half as large as the uncertainty of +/- 1.05% reported for Psin. Is there perhaps a possible explanation? To address this, one should consider the following scenario: A torsion pendulum with masses m1 and m2 detects, with the highest sensitivity, changes in G resulting from the directions—fixed relative to the fixed stars—of the extensions from m1 to m2. A system with a torsion pendulum rotating with its sidereal period around the pendulum system exerts its maximum effect twice during this period: first, when the attenuated graviton flux enters the pendulum system from m1 to m2, and second, when it passes through the system from m2 to m1. This explains the halving of SidOP to Psin. However, Anderson et al. [1] also present a fit of the Codata values with two sin components. For the stronger amplitude, the period P2 = 5.911 results, which differs from half of Jupiter's SidOP value by only 0.34%. The second sin component has a much smaller amplitude and a period P1 of 1,023 years. Due to its high value of 12.53 in Table 2, all evidence points to the planet Venus. However, at intervals of one synodic period of approximately 1.6 years, the I value drops to just 0.27, or about 2% of the maximum value. High I values occur only during a very small portion of the synodic period. The temporal evolution of I bears so little resemblance to a sine curve that Venus can be doubted as the source.

Saturn can be considered another highly suspicious candidate. Its Imin value is almost three times as high as that of Venus and the highest after Jupiter's. A look at the SynOP values in Table 3 confirms this assumption, since Saturn's value of 1,035 matches Anderson's [1] P1 value of 1,023 to within 1,2%.

Why SynOP and not SidOP? The measurement results for G depend on the measurement methods used. If the measuring apparatus is sensitive to one or two fixed directions, then the full or half sidereal period is obtained. However, if the measuring apparatus is equally sensitive in all directions, then it is not the position of the planet that matters, but rather the variation of Imin and Imax with the synodic period SidOP. However, the G values determined by Anderson [1] are not derived from a single set of measurements, but from a fit of CODATA values obtained by different teams using different measuring instruments.

4. Periodic Variations of the Solar Cycle

In addition to the variations in the gravitational constant discussed here, the planets may also be responsible for another effect: variations in the solar cycle.

Regarding the term "solar cycle," en.wikipedia [6] features the figure "400 Years of Sunspot History." There, one can see that the number of sunspots varies periodically. Between the maximum around 1750 and the maximum in 2001, there are 23 periods. This results in a period length PL1 of 10.91 years.

This variation is evidently superimposed by another, shorter periodicity, PL2, as shown in Fig. 3 of the paper by Anderson [1]. From early 1996 to early 2001, approximately 8 periods are discernible, which corresponds to a period length PL2 of 0.625 years.

However, the amplitude of PL2 is considerably smaller than that of PL1. What can be expected based on the ARG?

If also here the influence I of the planets is calculated as I = M/R^2, R should be taken as the distance from the planet to the Sun. Rmin corresponds to the planet's perihelion and Rmax to its aphelion.

Planet	Mass	Perihel.	Amphel.	I_{MIN}	I_{MAX}
Mercury	0,0553	0.308	0,467	0,253	0,583
Venus	0,815	0.718	0,728	1,538	1,581
Earth	1	0.983	1.017	0,967	1,035
Mars	0,107	1.382	1.666	0,038	0,056
Jupiter	318	4.951	5.457	10,68	12,9
Saturn	95	9.054	10,092	0,933	1,159
Uranus	14,53	18.266	20,064	0,036	0,043
Neptune	17,14	29.885	30,471	0,018	0,019

Table 3. Minimal and maximal distances R between the planets and the Sun and the related influences I_{MIN} and I_{MAX}

The two planets with the highest values for Imin and Imax are Jupiter and Venus. Jupiter: 10.68 and 12.98; Venus: 1.538 and 1.581.

However, Jupiter’s sidereal orbital period (SidOP) and the period length (PL1) differ by 0.95 years—roughly equal to Earth’s orbital period of one year.

There is no obvious simple explanation for this. However, the following should be noted:

When observing sunspots from a direction fixed relative to the fixed stars, PL1 should coincide with Jupiter’s SidOP.

The measurements, however, are made by an observer who is himself orbiting the Sun with an orbital period of one year.

The smaller variation with a period length of PL1 = 0.625 corresponds, as expected, very well to Venus with a sidereal period of 0.615 years. The fluctuations in amplitude and period length of this variation can also be expected, caused by Mercury and Earth, which have orbital periods close to one year.

5. Conclusions

Newton's law of gravitation, formulated over three centuries ago, was a significant scientific advance that remains relevant to this day. Even today, it is still successfully used to calculate gravity-related effects, such as the trajectories of projectiles and rockets, as well as the orbits of satellites and even planets. And yet, based on the "Alternative Reflections on Gravitation" (ARG), this paper challenges Newton's assumption regarding the cause of the mutual attraction between two masses: If there were only the two masses m1 and m2 in the universe, then there would be no mutual attraction, since this is not an intrinsic property of the two masses. According to ARG, the attraction results from the mutual shielding of repulsive radiation from space. And this radiation originates predominantly from the hot interiors of all stars in the universe. And since these are distributed relatively homogeneously throughout the universe, the result is a relatively constant and direction-independent attraction between the two masses.

Many measurements of the so-called "universal gravitational constant" indicate that there are additional small contributions from various sources, so that the terms "universal" and "constant" are likely inappropriate. One such contribution, with a period of 5.9 years, is discussed in this paper. Based on the ARG the possible cause is quickly identified: the planet Jupiter. Jupiter may also be responsible for the variation in the solar cycle with a period approximately twice as long. In that case, even the planet Venus, 403 times lower in weight, may make a detectable contribution.

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