

How a Planet with Earth's size can have a Gravitational Field Much Stronger than the Neptune

Fran De Aquino

Professor Emeritus of Physics, Maranhao State University, UEMA.
Titular Researcher (R) of National Institute for Space Research, INPE
Copyright © 2015 by Fran De Aquino. All Rights Reserved.

In this paper we show how the gravitational field can be amplified under certain circumstances, and how a planet with Earth's size can have a gravitational field much stronger than the Neptune.

Key words: Amplified Gravitational Fields, Gravitation, Gravity, TNOs.

1. Introduction

Recent numerical calculations have revealed that there could be at least two unknown planets hidden well beyond Pluto, whose gravitational influence determines the orbits and strange distribution of objects observed beyond Neptune [1, 2]. The authors believe that some invisible forces are altering the distribution of the orbital elements of the extreme trans-Neptunian objects (ETNO) and consider that the most probable explanation is that other unknown planets exist beyond Neptune and Pluto. The calculation shows that these planets need to have more mass than Neptune. Planets of this kind, even with the size of Neptune, at the predicted distance, would be very difficult to be detected in visible light - but not impossible. They could still be detected by the infrared that they emit. However, a study published last year, using data obtained by the NASA infrared satellite WISE [3], showed that there are no planets with size of Saturn up to the limit of 10 000 AU, or with size of Jupiter up to the limit of 26 000 AU. Then, the only possibility is that the planets must be much smaller than Jupiter or Saturn, or even smaller than Neptune. But as a planet smaller than Neptune can have a gravitational field much stronger than the Neptune?

The correlation between gravitational mass and inertial mass, recently discovered, associated to the gravitational shielding effect, which results of the mentioned correlation [4], show that the gravitational field can be amplified under certain circumstances.

In this paper we show how a planet with Earth's size can have a gravitational field much stronger than the Neptune.

2. Theory

The quantization of gravity shows that the *gravitational mass* m_g and *inertial mass* m_i are not equivalents, but correlated by means of a factor χ , i.e.,

$$m_g = \chi m_{i0} \quad (1)$$

where m_{i0} is the *rest* inertial mass of the particle. The expression of χ can be put in the following forms [4]:

$$\chi = \frac{m_g}{m_{i0}} = \left\{ 1 - 2 \left[\sqrt{1 + \left(\frac{U}{m_{i0} c^2} n_r \right)^2} - 1 \right] \right\} \quad (2)$$

$$\chi = \frac{m_g}{m_{i0}} = \left\{ 1 - 2 \left[\sqrt{1 + \left(\frac{W}{\rho c^2} n_r \right)^2} - 1 \right] \right\} \quad (3)$$

where U is the electromagnetic energy absorbed by the particle and n_r is its index of refraction; W is the density of electromagnetic energy on the particle (J/m^3); ρ is the matter density of the particle; c is the speed of light.

If the particle is *also* rotating, with an angular speed ω around its central axis, then it acquires an additional energy equal to its rotational energy $E_k = \frac{1}{2} I \omega^2$ (I is the moment of inertia of the particle). Since this is an increase in the internal energy of the body, and this energy is basically electromagnetic, we can assume that E_k , such as U , corresponds to an amount of electromagnetic energy absorbed by the body.

Thus, we can consider E_k as an increase $\Delta U = E_k$ in the electromagnetic energy U absorbed by the body. Consequently, in this case, we must replace U in Eq. (2) for $(U + \Delta U)$. If $U \ll \Delta U$, the Eq. (2) reduces to

$$m_g \cong \left\{ 1 - 2 \left[\sqrt{1 + \left(\frac{I\omega^2 n_r}{2m_{i0}c^2} \right)^2} - 1 \right] \right\} m_{i0} \quad (4)$$

Note that the contribution of the electromagnetic radiation applied upon the particle is highly relevant, because in the absence of this radiation the index of refraction in Eq.(4), becomes equal to 1.

On the other hand, Electrodynamics tell us that

$$v = \frac{dz}{dt} = \frac{\omega}{\kappa_r} = \frac{c}{\sqrt{\frac{\epsilon_r \mu_r}{2} \left(\sqrt{1 + (\sigma/\omega\epsilon)^2} + 1 \right)}} \quad (5)$$

where k_r is the real part of the *propagation vector* \vec{k} (also called *phase constant*); $k = |\vec{k}| = k_r + ik_i$; ϵ , μ and σ , are the electromagnetic characteristics of the medium (permittivity, magnetic permeability and electrical conductivity) in which the incident radiation is propagating ($\epsilon = \epsilon_r \epsilon_0$; $\epsilon_0 = 8.854 \times 10^{-12} F/m$; $\mu = \mu_r \mu_0$, where $\mu_0 = 4\pi \times 10^{-7} H/m$).

Equation (5), shows that the *index of refraction* $n_r = c/v$, for $\sigma \gg \omega\epsilon$, is given by

$$n_r = \sqrt{\frac{\mu_r \sigma}{4\pi f \epsilon_0}} \quad (6)$$

Substitution of Eq. (6) into Eq. (4) gives

$$m_g \cong \left\{ 1 - 2 \left[\sqrt{1 + \left(\frac{I\omega^2}{2m_{i0}c^2} \sqrt{\frac{\mu_r \sigma}{4\pi f \epsilon_0}} \right)^2} - 1 \right] \right\} m_{i0} \quad (7)$$

It was shown that there is an additional effect - *Gravitational Shielding* effect - produced by a substance whose gravitational mass was reduced or made negative [4]. It was shown that, if the weight of a particle in a side of a lamina is $\vec{P} = m_g \vec{g}$ (\vec{g} perpendicular to the lamina) then the weight of the same particle, in the other side of the lamina is $\vec{P}' = \chi m_g \vec{g}$, where $\chi = m_g / m_{i0}$ (m_g and m_{i0} are respectively, the gravitational mass and the inertial mass of the

lamina). Only when $\chi = 1$, the weight is equal in both sides of the lamina. The lamina works as a Gravitational Shielding. This is the *Gravitational Shielding* effect. Since $\vec{P}' = \chi \vec{P} = (\chi m_g) \vec{g} = m_g (\chi \vec{g})$, we can consider that $m'_g = \chi m_g$ or that $\vec{g}' = \chi \vec{g}$.

If we take two parallel gravitational shieldings, with χ_1 and χ_2 respectively, then the gravitational masses become: $m_{g1} = \chi_1 m_g$, $m_{g2} = \chi_2 m_{g1} = \chi_1 \chi_2 m_g$, and the gravity will be given by $g_1 = \chi_1 g$, $g_2 = \chi_2 g_1 = \chi_1 \chi_2 g$. In the case of multiples gravitational shieldings, with $\chi_1, \chi_2, \dots, \chi_n$, we can write that, after the n^{th} gravitational shielding the gravitational mass, m_{gn} , and the gravity, g_n , will be given by

$$m_{gn} = \chi_1 \chi_2 \chi_3 \dots \chi_n m_g, \quad g_n = \chi_1 \chi_2 \chi_3 \dots \chi_n g \quad (8)$$

This means that, n superposed gravitational shieldings with different $\chi_1, \chi_2, \chi_3, \dots, \chi_n$ are equivalent to a single gravitational shielding with $\chi = \chi_1 \chi_2 \chi_3 \dots \chi_n$.

Now consider a planet or any cosmic object made of pure iron ($\mu_r = 4,000$; $\rho_{iron} = 7,800 kg.m^{-3}$; $\sigma = 1.03 \times 10^7 S.m^{-1}$), with size equal to the Earth ($r_{\oplus} = 6.371 \times 10^6 m$). If it is rotating with angular velocity ω , then the gravity g produced by its gravitational mass, according to Eq. (7), is given by

$$\begin{aligned} g &= -\frac{Gm_g}{r^2} = -\frac{Gm_{i0}}{r^2} \left\{ 1 - 2 \left[\sqrt{1 + \left(\frac{I\omega^2}{2m_{i0}c^2} \sqrt{\frac{\mu_r \sigma}{4\pi f \epsilon_0}} \right)^2} - 1 \right] \right\} = \\ &= -\frac{Gm_{i0}}{r^2} \left\{ 1 - 2 \left[\sqrt{1 + \left(\frac{(\frac{1}{2})m_{i0}^2 \omega^2}{2m_{i0}c^2} \sqrt{\frac{\mu_r \sigma}{4\pi f \epsilon_0}} \right)^2} - 1 \right] \right\} = \\ &= -\frac{Gm_{i0}}{r^2} \left\{ 1 - 2 \left[\sqrt{1 + \left(\frac{r_{\oplus}^2 \omega^2}{4c^2} \sqrt{\frac{\mu_r \sigma}{4\pi f \epsilon_0}} \right)^2} - 1 \right] \right\} = \\ &= -\frac{Gm_{i0}}{r^2} \left\{ 1 - 2 \left[\sqrt{1 + 4.71 \times 10^{12} \frac{\omega^4}{f}} - 1 \right] \right\} \quad (9) \end{aligned}$$

Data from radioastronomy point to the existence of an *extragalactic radio background spectrum* between 0.5 MHz and 400MHz [5].

Thus, if the considered object is in the interplanetary medium of the solar system, then this radiation incides on it. However, according to Eq. (9), the more significant contribution is due to the lower frequency radiation, i.e. $f = 0.5\text{MHz}$. In this case, Eq. (9) reduces to

$$g = -\frac{Gm_{i0}}{r^2} \left\{ 1 - 2 \left[\sqrt{1 + 9.42 \times 10^6 \omega^4} - 1 \right] \right\} \quad (10)$$

Note that the gravity becomes *repulsive* and greater than $+Gm_{i0}/r^2$ for $\omega > 0.0238\text{rad.s}^{-1}$. (Compare with the average angular velocity of Earth: $\bar{\omega}_{\oplus} = 7.29 \times 10^{-5}\text{rad.s}^{-1}$).

This repulsive gravity repels the atoms around the iron object, causing a significant decreasing in the number of atoms close to the object, and reducing consequently, the density at this region, which is initially equal to the density of the *interplanetary density* ($\rho_{ipm} \approx 10^{-20}\text{kg.m}^{-3}$). Thus, the density, ρ , at the mentioned region can becomes of the order of 10^{-21}kg.m^{-3} , i.e., very close to the density of the interstellar medium, ρ_{ism} , (*one hydrogen atom per cubic centimeter* $\cong 1.67 \times 10^{-21}\text{kg.m}^{-3}$ [6]).

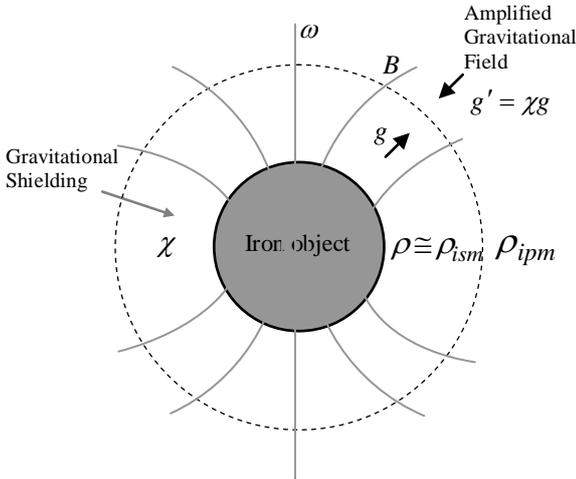


Fig. 1 – *Inversion and Amplification of the Gravitational Field*. The gravitational field produced by the rotating iron object, g (repulsive), is inverted and amplified by the *gravitational shielding* (region with density $\rho \cong \rho_{ism}$, between the iron object and the dotted circle). Thus, out of the gravitational shielding the gravity acceleration becomes attractive, with intensity: $g' = \chi g$.

Therefore, if the iron object has an own magnetic field B , then, according to Eq.(3), the density of magnetic energy at the mentioned region will change the local value of χ , which will be given by

$$\begin{aligned} \chi &= \frac{m_g}{m_{i0}} = \left\{ 1 - 2 \left[\sqrt{1 + \left(\frac{W}{\rho_{ism} c^2} n_r \right)^2} - 1 \right] \right\} = \\ &= \left\{ 1 - 2 \left[\sqrt{1 + \left(\frac{B^2}{\mu_0 \rho_{ism} c^2} \right)^2} - 1 \right] \right\} = \\ &= \left\{ 1 - 2 \left[\sqrt{1 + 2.81 \times 10^{19} B^4} - 1 \right] \right\} \quad (11) \end{aligned}$$

Thus, the region close to the object will become a *Gravitational Shielding*, and the gravity acceleration out of it (See Fig.1), according to Eq. (8),(10) and (11), will expressed by

$$\begin{aligned} g' &= \chi g = -\frac{\chi Gm_{i0}}{r^2} \left\{ 1 - 2 \left[\sqrt{1 + 9.42 \times 10^6 \omega^4} - 1 \right] \right\} = \\ &= \left\{ 1 - 2 \left[\sqrt{1 + 2.81 \times 10^{19} B^4} - 1 \right] \right\} \times \\ &\times \left\{ 1 - 2 \left[\sqrt{1 + 9.42 \times 10^6 \omega^4} - 1 \right] \right\} \left(-\frac{Gm_{i0}}{r^2} \right) \quad (12) \end{aligned}$$

Therefore, if $\omega > 0.02\text{rad.s}^{-1}$ and $B > 10^{-4}\text{T}$, then the gravity acceleration out of the gravitational shielding is

$$g' > (-1030) \left(-1 \right) \left(-\frac{Gm_{i0}}{r^2} \right) > -103 \frac{Gm_{i0}}{r^2} = -\frac{GM_{i0}}{r^2} \quad (13)$$

where $M_{i0} = 103m_{i0}$ is the mass equivalent to the mass of an object, which would produce a similar gravity acceleration.

Since $m_{i0} = \rho_{iron} \left(\frac{4}{3} \pi r_{\oplus}^3 \right) = 8.44 \times 10^{24}\text{kg}$, then the gravity acceleration produced by the iron object would be equivalent to the one produced by an object with mass, M_{i0} , given by

$$M_{i0} = 103m_{i0} \cong 8.6 \times 10^{26}\text{kg} \cong 8.4M_{Neptune} \quad (14)$$

where $N_{Neptune} = 1.0243 \times 10^{26}\text{kg}$ is the Neptune's mass [7]. Thus, according to Eq. (13), the gravity acceleration produced by the iron object would be much stronger than the gravity of Neptune.

References

- [1] Carlos de la Fuente Marcos, Raúl de la Fuente Marcos, Sverre J. Aarseth. (2015) *Flipping minor bodies: what comet 96P/Machholz 1 can tell us about the orbital evolution of extreme trans-Neptunian objects and the production of near-Earth objects on retrograde orbits*. Monthly Notices of the Royal Astronomical Society 446(2):1867-1873.
- [2] C. de la Fuente Marcos, R. de la Fuente Marcos. (2014) *Extreme trans-Neptunian objects and the Kozai mechanism: signalling the presence of trans-Plutonian planets?* Monthly Notices of the Royal Astronomical Society Letters 443(1): L59-L63.
- [3] Luhman, K. L. (2014) *A Search for a Distant Companion to the Sun with the Wide-field Infrared Survey Explorer*, *Astrophysical Journal*, Vol. 781 4.
- [4] De Aquino, F. (2010) *Mathematical Foundations of the Relativistic Theory of Quantum Gravity*, Pacific Journal of Science and Technology, 11 (1), pp. 173-232.
- [5] Simon, A. J. B. (1977). *The origin of the extragalactic background radiation between 0.5 and 400MHz*, Mon. Not. R. astr. Soc., 180, 429-445.
- [6] Verschuur, G. L.(1989) *Interstellar Matters*. New York: Springer-Verlag; Knapp, Gillian.(1995). *The Stuff Between The Stars*. *Sky & Telescope* 89: 20-26; Bacon, D.H. and Seymour, P.(2003). *A Mechanical History of the Universe*. London: Philip Wilson Publishing, Ltd.
- [7] Williams, D. R. (2004). *Neptune Fact Sheet*. NASA. <http://nssdc.gsfc.nasa.gov/planetary/factsheet/neptunefact.html>