RESEARCH

The possible existence of a ‘Gravito-electric’ Current

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ABSTRACT

The unification of gravitation and electromagnetism requires the existence of a gravito-electric current, however small, and an equation for the velocity of gravitation taking the existence of such a current into account enables us to quantify this current in amperes, and to relate the value of the Newtonian gravitational constant to the values of the magnetic and electric constants.

Key Words: *Gravitation; Electromagnetism; Velocity of gravity; Velocity of light; Electric current; Newtonian gravitational constant; Electric constant; magnetic constant.*

INTRODUCTION

The classical works on the unification of gravitation and electromagnetism are those of Nordström (1914), Kaluza (1921) and Klein (1926) [1-3]. None of these, however, make any mention of the possibility of a gravito-electric current, which would appear to be a natural concomitant of gravitational propagation, given that electric current is simply moving electric charge or charges.

Laplace attempted, using Newtonian theory (Newton, 1687), and the assumption that gravity behaves similarly to a fluid, to calculate the speed of gravity in Laplace (1776), and concluded that it travelled at a speed of 7.45 million times that of light [4,5]. Einstein, in the early part of the twentieth century, corrected this idea, demonstrating that the speed of light is universal, and that gravitation propagates, in wave form, at light speed (Einstein, 1905); (1918) [6,7].

If we combine these two ideas, we find that:

$$v_G = c = \left|\sqrt[4]{G}\mu_0 I_G{}^2\right| = \left|\left(\varepsilon_0\mu_0\right)^{-\frac{1}{2}}\right| \quad (1)$$

Here, v_G is the speed of gravitation, c that of light or electromagnetic radiation in vacuum, ε_0 and μ_0 the electric and magnetic constants, G the Newtonian gravitational constant, and I_G the purported ‘gravitoelectric’ current.

If the above is correct, then:

$$G\mu_0 I_G{}^2 = \left(\varepsilon_0\mu_0\right)^{-2} = c^4 \quad (2)$$

From this straightforward algebra, we can conclude that:

$$I_G = c^2\left(G\mu_0\right)^{-\frac{1}{2}} \quad (3)$$

and also:

$$G = c^4 / \mu_0 I_G{}^2 \quad (4)$$

A quick dimensional analysis confirms that these formulae are correct, as may readily be seen. Equation (3) enables us to obtain a value for the gravito-electric current, I_G, of 9.81372×10^{24} A, which is far from being ‘small’, in any sense!

This would seem absurd and unphysical – but is the simplest obtainable relation, nevertheless, and we find that:

$$e / t_P = 2.9718 \times 10^{24}\,\mathrm{A} \quad (5)$$

where e is the fundamental electric charge and t_P is the Planck time. $I_G \simeq 3.3\ e/t_P$. It is possible that the equation:

$$t_G = \left|\left(\sqrt[4]{G}\mu_0 e^2 / c^4\right)\right| = 1.2777279 \times 10^{-22}\,\mathrm{s} \quad (6)$$

gives what would seem a more realistic value to the fundamental, and indivisible, unit of time, in which case, e/t_G = 1,253.926 A, which is still large, obviously, but seemingly not so unfeasibly large as either of the results given above. The fundamental (smallest measurable) unit of length would then be $\ell_G = ct_G = 3.830532 \times 10^{-14}$ m.

Given the collision energies, E, of the protons at the Large Hadron Collider (LHC) at CERN (Conseil Europeen pour la Researche Nucleaire; European Council for Nuclear Research), however, which routinely reach 13.6×10^{12} eV = 2.17896×10^{-6} J, these yield measurable length distances equal to $9.1164861 \times 10^{-20}$ m by the equation:

$$\Delta x = hc / E \quad (7)$$

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Here h is Planck's constant and c is the speed of light in a vacuum, as above. Then $x/c = 3.0409 \times 10^{-28}$s. It would seem we must retain the Planck distance and time scales, and the very much larger figure for the gravito-electric current we derived earlier.

Any electric current must, however, by the terms of classical electromagnetic theory (Maxwell, 1865), produce a magnetic field, and thus a magnetic force [8]. It is thus quite easy to determine what the magnetic force between the 'gravito-electric' current, given its value in (3), and another current of – say – one ampere, running through a conductor in free space, would be:

$$F_m = \mu_0 I_G I \simeq 1.23323 \times 10^{19}\,\mathrm{N} \quad (8)$$

It is perfectly plain that no such force is experienced, and that therefore no 'gravito-electric' current of such magnitude exists. It can only be saved, as it were, with the introduction into Equation (1) and consequent equations of a dimensionless constant of such numerical value as to render I_G a considerably smaller quantity, howsoever measured.

This constant might be the square of the reciprocal of the gravitational fine-structure constant, $\alpha_G = (\mathrm{G}m_p^2\,/\hbar \mathrm{c})$, where m_p is the rest-mass of the proton and $\hbar$ is Dirac's constant$(h/2\pi)$.
It has the value 5.906149×10^{-39}, its reciprocal is 1.6931506×10^{38}, and its square, $(\hbar c/\mathrm{G}m_p^2\,)^2 = 2.866759 \times 10^{76}$, is Eddington's number, the total number of protons in the observable Universe (Eddington, 1939) [9].

If this is then inserted into (1), the value we obtain for I_G is then given by:

$$I_G = (m_p{}^2 c / \hbar).\left|(G/\mu_0)^{1/2}\right| =$$

$$(m_p{}^2 / \mu_0 \hbar).\left|(G/\varepsilon_0)^{1/2}\right| = 5.79613 \times 10^{-14}\,\mathrm{A} \quad (9)$$

This is not only a smaller value but is far more realistic and is related to the fundamental electric charge, *e*, by the relation $e/I_G = 2.76422 \times 10^{-6}$ s.

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