The Gravitational Electric Charge

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In this paper I introduce a new concept which I called: gravitational electric charge. The physical meaning of this quantity is still not clear, however, if confirmed it would indicate that gravity not only acts as a force between masses, in the Newtonian sense, but also as an extremely feeble electromagnetic force.

Keywords*: Planck's constant, Planck mass, gravitational coupling constant, electromagnetic coupling constant, Newton's gravitational constant, gravitational electric charge.*

1. Nomenclature

I shall use the following nomenclature for the constants and variables used in this paper

α_G = gravitational coupling constant for the proton
α = electro-magnetic coupling constant (fine-structure constant or atomic structure constant).
c = speed of light in vacuum
h = Planck's constant
G = Newton's gravitational constant
e = elementary charge
ϵ_0 = permittivity of vacuum
m_e = electron rest mass
m_p = proton rest mass
m = rest mass of any given particle
M_P = Planck's mass
Q_{gp} = Gravitational electric charge for the proton
Q_g = General gravitational electric charge for a particle of mass m
K_{CK} = proportionality constant

1. The New Concept

Let's consider the following quantity

$$4\pi\epsilon_o G m_p^2 \tag{1}$$

Where m_p is the mass of the proton.

The units of this quantity is C^2 , this is Coulombs square. Therefore we may define the square of the gravitational electric charge for the proton as follows

$$Q_{gp}^2 = 4\pi\,\epsilon_o\,G\,m_p^2 \tag{2}$$

Where Q_{gp} is a electric charge produced by gravity and whose physical meaning is yet to be confirmed. Thus the gravitational electric charge for the proton is

Gravitational electric charge for the proton

$$Q_{gp} = 2\,m_p\sqrt{\pi\,\epsilon_o\,G} \tag{3}$$

The value of this electric charge is

$$Q_{gp} = 1.441\ \ 335\ \ 021\ \times 10^{-37}\ C \tag{4}$$

If we calculate the absolute value of the ratio between the gravitational electric charge and the charge of the electron we find that the gravitational electric charge is much smaller than the elementary charge, e

$$\text{abs}\left(\frac{Q_{gp}}{e}\right) = \frac{1.441\ 335\ 021\times 10^{-37}\,C}{1.602\ 176\ 565\times 10^{-19}\,C} = 8.996\,106\times 10^{-19} \tag{5}$$

Therefore the gravitational electric charge is incredibly small. If this electric charge exits, then, it would explain why it was never observed.

If we square this ratio and multiply it by the electromagnetic coupling constant, α , we get

$$\alpha\left(\frac{Q_{gp}}{e}\right)^2 = \alpha\left(\frac{2\,m_p\sqrt{\pi\,\epsilon_o\,G}}{e}\right)^2 \tag{6}$$

The value of this quantity is

$$\alpha\left(\frac{Q_{gp}}{e}\right)^2 = 5.905\ 741\ 832\times 10^{-39} \tag{7}$$

We recognize this value as the gravitational coupling constant for the proton, thus, we can write

Gravitational coupling constant for the proton

$$\alpha_G = \alpha\left(\frac{Q_{gp}}{e}\right)^2 \tag{8}$$

The last equation is the formula for the gravitational coupling constant for the proton in terms of two electric charges, Q_{gp} and e, and the electromagnetic coupling constant. If we do some algebra on equation (8) we shall get to the more familiar expression

$$\alpha_G = \left(\frac{m_p}{M_P} \right)^2 \tag{9}$$

Where M_P is the Planck's mass which is defined as

Planck mass

$$M_P \equiv \sqrt{\frac{hc}{2\pi G}} \tag{10}$$

2. Conclusions

If exists, the gravitational electric charge would be an electrical charge produced by gravity. Furthermore, it would indicate that gravity is also a feeble electromagnetic force.

The questions we might ask ourselves are: What is the physical meaning of Q_{gp} ? Is Q_{gp} a real electric charge associated with the proton or is simply a mathematical illusion? Do all charge particles have also a gravitational electric charge associated with them? Do neutral particles, such as neutrons, possess gravitational electrical charges as well? In other words, do all particles in the universe possess gravitational electric charges in the manner described by the general equation

General equation for the gravitational electric charge

$$Q_g = \pm \left(2\sqrt{\pi \epsilon_o G} \right) m = \pm 2\sqrt{\pi \epsilon_o G}\, m \tag{11}$$

that we haven't been able to detect yet?

We may also define the proportionality constant, K_{CK} , that converts masses into electric charges and viceversa

$$K_{CK} \equiv \pm 2\sqrt{\pi \epsilon_o G} = 8.617\,220\,23 \times 10^{-11}\, C/Kg \tag{12}$$

Another point to consider is that according to the QCD theory, the minimum positive electrical charge in nature is *e*/3, which is the electric charge of the $\bar{d}$, $\bar{s}$ and $\bar{b}$ anti-quarks. The gravitational electric charge is, however, much smaller than the QCD limit. But we have to remember that the origin of the electric charge is unknown, so that, gravity could play an unknown and mysterious electromagnetic roll, that we should not discard at priori.

The value of Q_{gp} is so small that we do not have any chance to conduct and experiment to detect it at the present time. So how can we discard something that we may possibly detect one day? In the past the ripples of space-time were too small to detect directly but the technical difficulties were overcome by LIGO and gravitational waves were finally detect it on September 14, 2015.

Finally I want to address the following point. Equation (11) suggests that the hypothetical charge generated by gravity would have two different values: a positive and a negative one:

General equation for the gravitational electric charge

$$Q_{g1} = +2\sqrt{\pi \epsilon_o G}\, m \qquad (13\ a)$$

$$Q_{g2} = -2\sqrt{\pi \epsilon_o G}\, m \qquad (13\ b)$$

The only way of producing two identical charges of the same absolute value but opposite sign is if the process were be able to create two charged particles. Thus, a more sophisticated and advanced form of equation (11), would explain the creation of
(a) pairs of virtual particles (not observed). An example would be the spontaneous creation of a virtual negative electron and a virtual positron in empty space. Another example would be the spontaneous creation of a pair of charged virtual photons. The virtual nature of these particle, if they exist, would prevent us from measuring their charges, no matter how advanced the measurement technique is.
(b) pairs of real particles (observed). This type of creation would be, for example, the creation of a negative electron and a positive electron (positron) from the annihilation of a high energy gamma photon in the presence of matter. Of course, in this case equation (11) cannot explain the relatively high value of the elementary charge of these particles.

Finally I want to address the following point of significance. According to a new hypothetical equation, similar to equation (11), if all real and virtual particles in the universe were always produced in electrically charged pairs of opposite signs, then the *law of conservation of the electrical charge* would have an explanation from a more fundamental law. In summary, equation (11) is not the final answer as is unable to predict the observed values of electrical charges. However, the equation suggests that there should be a fundamental formulation which would include a similar square root which would explain the law of conservation of electrical charge.

With respect to the above questions, I do not have an answer to them, so maybe, one day, time will tell.