Quantum Gravitational Constant

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The constant of gravitation and all electrical dimensions were devised in the 19th century without the knowledge of quantum mechanics which is the only field that could provide a framework where a direct link between electricity and gravity could be investigated. The solution is given by the relationship among three constants that Max Planck thought sufficient to create most of the other constants and quantities, namely c, h and G. Through their correlation and with the rotation of the Planck mass it is possible to calculate a theoretical value for the constant of gravitation G=6.672919533(88)$x10^{-11}$m^3 kg^{-1}s^{-2} and creating, at the same time, a connection with electric quantities such as permeability, electron charge and fine structure constant.

Keywords: constant of gravitation; fine structure constant; Planck mass; Planck charge

Introduction

In the equation below F_g and F_e are the gravitational and electric forces between two electrons. The resulting ratio is close, around 0.2%, to Planck time t_p.

$$\frac{F_g}{F_e} \approx t_p \qquad (1)$$

A peculiarity of this equation is that it does not appear to be dimensionally balanced, hence we may come to the conclusion that it is just a numeric coincidence or, as we will see, there is a hidden time dimension in the numerator on the left.

It is the detailed study of this apparent inconsistency that will allow us to find the link between electricity and gravity.

The adopted Planck time t_p is $\pi\sqrt{2}$ times larger than the value reported in the Codata listing [1]. Also the adopted Planck mass m_p that we will see later is $\sqrt{2}$ larger than the listed Planck mass. This depends on the implemented model and both the suggested Planck time t_p and Planck mass m_p seem appropriate when calculations are executed.

The small numeric difference is due to rotation: for a non rotating particle, the Planck particle, there is no difference, once rotation is accounted for, we find that both numerator and denominator change drastically, almost by the same amount, and the two sides of the equation are no longer equal and an additional factor is required.

The numbers used in all calculations are the following:

$$c = 299792458 \text{ m s}^{-1}$$
$$h = 6.62607008x10^{-34} \text{ j s}$$
$$G = 6.6729195742x10^{-11} \text{ m}^3 \text{ kg}^{-1}\text{s}^{-2}$$

c is an exact quantity, h is well within one standard deviation and G is actually a few standard deviations lower than the value reported in the Codata listing. In fact it is closer to the latest experimental value found by Rosi et al. in 2014 [2].

The Planck particle

First of all we define the Planck time $t_p = \sqrt{\pi G h / c^5}$ and the Planck mass $m_p = \sqrt{hc/\pi G}$.

If we wish to calculate the gravitational force F_{gp} of the Planck particle we would think that it is simply given by Gm_p^2, yet, we must take into account the constrain

of Planck time t_p which imposes a severe limitation on the magnitude of the resulting gravitational force, or energy, that we will be able to measure, so the actual force would be $F_{gp} = Gm_p^2 t_p$.
Dimensionally we should see it as a force, or energy, limited by time t_p.
To us and to our measuring instruments it still appears as a gravitational force because in our world we are not aware of time t_p, consequently, the gravitational force can be rewritten as $F_{gp} = Gm_0^2$ where $m_0 = m_p\sqrt{t_p}$.
We will refer to m_0 as the quantized Planck mass and this is what we see and measure.
Here we find the hidden time dimension at work, hidden to us that is, and what we measure is only the gravitational force of mass m_0 and not mass m_p.
Now it is possible to turn our attention to the electric quantities. Because of the uncertainty principle, mass m_0 can move only at speed $v_p = \sqrt{\hbar/m_0}$, this quantity may not appear to have any practical meaning but its reciprocal $Z_0 = 1/v_p$ could be seen as a "slowness", a "resistance" and defines the Planck impedance $Z_0 = \sqrt{m_0/\hbar}$.
The knowledge of Z_0 is the key for the definition of the Planck permittivity ε_p:

$$\varepsilon_p = \frac{1}{Z_p\, c} = \sqrt{\frac{m_0}{2\,\pi\, m_p}} = \sqrt[4]{\frac{t_p}{4\,\pi^2}}$$

The next step is to find a charge, the Planck charge q_p, giving the same force as the gravitational force of mass m_p:

$$q_p = m_p\sqrt{4\,\pi\,\varepsilon_p\, G}$$

Calculations show that permittivity ε_p is only 0.3% different from the known permittivity while charge q_p and the quantized mass m_0 are an order of magnitude larger that the electron charge and mass. So far no spin has been considered and this is the reason for the numerical difference. With a spinning particle there will be a perfect agreement with known quantities.
Now we are able to verify that the ratio between the gravitational force generated by m_0 and the electric force generated by q_p is exactly equal to Planck time, eq.1, both numerically and dimensionally.
The presence of a time dimension in the quantized Planck mass m_0 has a domino effect on other quantities. Its pervasive effect will be present in most electric quantities but we are not aware of it, so much so that we see the dimensions of those quantities as in the cgs system.

Rotating Planck particle

The most suitable physical model that best fits this theory is a rotating ring, a torus in fact. It was occasionally proposed in the past [3,4] but the determination of its rotating speed was problematic. What we will find now is the initial state of this particle, that is, a set of parameters denoting the rotating elementary Planck particle that will be used later as a reference when defining the electron.
The initial rotational speed u_0, meant as the torus speed, is a parameter obtained from a modified equation originally proposed by Sutton et al. [5]. A relativistic connection is established with what we would call the initial fine structure constant α_0:

$$\alpha_0 = 2\left(1 - \frac{u_0^2}{c^2}\right) \qquad (2)$$

In order to calculate u_0 we try to relate α_0 to some electrical properties of the particle and specifically how Planck charge q_p compares with a torus of unitary charge q_u in the unitary time t_u. Due to the torus geometry we define a new constant w_u as follows:

$$w_u = 16\pi^4 \frac{q_u^2}{t_u} \qquad (3)$$

This exact quantity is very important as it will recur in many expressions. We are now able to define the initial fine structure constant α_0 and then the rotational speed u_0 in eq. 2:

$$\alpha_0 = \frac{1}{q_p}\sqrt{w_u\, t_p} \qquad (4)$$

We have an initial electron charge e_0 as the resulting interaction of electric and magnetic forces within a charged particle [6]:

$$e_0 = \sqrt{\frac{w_u\, t_p}{\alpha_0\,(2-\alpha_0)}} = q_p\sqrt{\frac{\alpha_0}{2-\alpha_0}} \qquad (5)$$

There is also an initial permeability μ_i applicable to a rotating Planck particle:

$$\mu_i = \frac{2\,h\,(2-\alpha_0)}{q_p^2\, c} \qquad (6)$$

The combination of the last 4 equations leads us to a cubic expression written in its canonical form:

$$\alpha_0^3 - 2\alpha_0^2 + \frac{w_u\, t_p\, \mu_i\, c}{2\,h} = 0 \qquad (7)$$

It is possible to have a simplified version by using the initial electron charge e_0:

$$\alpha_0^2 - 2\alpha_0 + \frac{w_u\, t_p}{e_0^2} = 0 \qquad (8)$$

Both eq. 7 and 8 show the link between the basic constants c, h, and G with the initial fine structure constant α_0. These initial data are a fraction of a percent off from the known values and if we would be able to slow down the rotational speed u_0 by a tiny amount we would get to a point where we have all data as we know them. This is possible if in eq. 7 and 8, we substitute μ_i and e_0 with the known value of permeability μ_0 and electron charge e. In this way, from eq. 7, we obtain 3 solutions applicable to vacuum: one of them is the known fine structure α, the second solution is a negative fine structure α_n, hinting at the possibility of a speed faster than light and the third solution is a strong fine structure α_{sv}, very close to 2. If matter is present as in eq. 8 we have two solutions: the known fine structure α and a strong fine structure α_s, also this one close to 2.

It is interesting to see how permeability μ_0 is related to the fine structure α:

$$\frac{\alpha^2(2-\alpha)}{\mu_0} = \frac{c\, t_p\, w_u}{2\,h} \qquad (9)$$

The term on the left is really a constant and a strict relation is established between α and μ_0. For any fine structure there is a specific permeability and vice-versa.

Constant of gravitation

Elaboration of eq. 7 or eq. 9 gives us the possibility to extract the constant of gravitation G in terms of know constants:

$$G = 8\,\hbar\, c^3 \left(\frac{\alpha^2(2-\alpha)}{w_u\, \mu_0}\right)^2 \qquad (10)$$

It is worth reminding that we defined, in eq. 3, w_u=1558.54546 C^2s^{-1} rendering the above expression dimensionally correct.

When G was first devised there was no idea what permeability was, let alone the fine structure constant but now is possible to have an equation connecting all of them and future experiments should be able to confirm the value found for G.

By using the nominal data for h and α, all others are exact quantities, we get G=6.672919533x10^{-11}m^{3}kg^{-1}s^{-2}.A slightly modified number, as reported in the introduction, is used in the calculations in order to get the best match among all constants.

There is a linear relationship between numerator and denominator in the term between parentheses in eq. 10, the ratio $\alpha^2(2-\alpha)/\mu_0$ is a constant. This means that we can take any arbitrary fine structure constant, within a certain range anyway, then find, with eq. 9, the corresponding permeability and discover that the ratio is always the same, hence there is really no need to know a specific fine structure constant and permeability, in fact eq. 10 is only a particular case, useful to show the link among known constants but we could just as well have used the initial μ_i and α_0 with the same result.

Electron mass and charge

The electron charge e is obtained by elaborating eq. 5 and substituting α_0 with α where necessary:

$$e = \sqrt{\frac{w_u\, t_p}{\alpha(2-\alpha)}} = m_p \sqrt{2\,\pi\,\varepsilon_0\,\alpha\,G}$$

The electron mass m_e requires a more detailed study of its complex toroid structure [6]; the rotational speed, initial and final, is represented by the initial and known fine structure constants α_0 and α respectively. Their relationship seems to be adequate to describe the electron mass m_e:

$$m_e = m_0 \left(\frac{\alpha}{2}\right)^{\frac{1}{2}} \left(\frac{\alpha}{\alpha_0}\right)^{12} \left(\frac{(2-\alpha)^2}{2(2-\alpha_0)}\right)^{\frac{3}{8}}$$

We see here the effect of the quantized mass m_0 with the attached time dimension.

In reality, the electron gravitational force F_g can be expressed in terms of basic constants only, with no need at all to call for the electron mass:

$$F_g = G m_e^2 = t_p\,\hbar\,c\,\alpha \left(\frac{\alpha}{\alpha_0}\right)^{24} \left(\frac{(2-\alpha)^2}{2(2-\alpha_0)}\right)^{\frac{3}{4}}$$

For the electric force F_e we have many expressions leading to the same result:

$$F_e = \frac{e^2}{4\,\pi\,\varepsilon_0} = \frac{\alpha\, q_p^2}{8\,\pi\,\varepsilon_p} = G m_p^2 \frac{\alpha}{2}$$

This means that the forces we experience have just a single origin: the Planck mass. It is an electric force when the Planck time is not involved but becomes a gravitational force when subjected to Planck time t_p.

Conclusion

We started with eq. 1 and we end up with the same equation. It is now possible to account for the numerical difference because there is a factor which takes care of the discrepancy. This factor, with only the initial and known fine structure constants, is the missing element to make eq. 1 numerically correct:

$$\frac{F_g}{F_e} = \frac{2}{\alpha}\left(\frac{m_e}{m_p}\right)^2 = t_p \left(\frac{\alpha}{\alpha_0}\right)^{24} \left(\frac{(2-\alpha)^2}{2(2-\alpha_0)}\right)^{\frac{3}{4}}$$

This is also dimensionally balanced because, as we have seen, the electron gravitational force has an additional time dimension.

An accurate quantum constant of gravitation G comes out as a natural consequence once a connection is established among basic constants.

All this was possible by first considering the Planck particle and then its rotation. The result from this toroidal shaped particle was a set of quantities very close to known ones. A small adjustment to its rotational speed was possible through the knowledge of permeability μ_0 yielding eventually all data as we know them.

The calculated numeric values of some quantities, including all the fine structure constants, are reported below. All of them are obtained from three basic constants: c, h and G although we should also add permeability μ_0 necessary for the calculation of the known fine structure constant with eq. 7.

Constant of gravitation $G = 6.672919533(88)x10^{-11}$
Fine structure constant $\alpha = 7.2973525665x10^{-3}$
Initial fine structure $\alpha_0 = 7.295873083x10^{-3}$
Negative fine structure (vacuum) $\alpha_n = -7.270823334x10^{-3}$
Strong fine structure (vacuum) $\alpha_{sv} = 1.99997347077$
Strong fine structure (electron) $\alpha_s = 1.9927026474$
Electron charge $e = 1.6021766257x10^{-19}$
Electron mass $m_e = 9.10938361x10^{-31}$
Rydberg constant $R_\infty = 10973731.568496$
Compton wavelength $\lambda_c = 2.4263102368x10^{-12}$
Classical electron radius $r_e = 2.8179403229x10^{-15}$
Bohr magneton $\mu_B = 927.4010023x10^{-26}$

References

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