The Mass of the Electron – Part III

This paper introduces a new quantum gravitational formula for the mass of the electron. The formula is based on the mass of the proton, the Planck mass and other fundamental physical constants. When we calibrate the value of Newton's gravitational constant to $G_{calibrated} = 6.67265565 \times 10^{-11} \, N \, m^2 / Kg^2$ *, we obtain the observed value for the mass of the electron. The fact that the calibrated value is very close to the value published by NIST in 1986:* $G_{NIST\,1986} = 6.67259 \times 10^{-11} \, N \, m^2 / Kg^2$ *, suggests that the formula presented in this paper is a true law of nature.*

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1. The Formula for the Mass of the Electron (The Quantum Gravitational Formula "Alpha-23" or the "Alpha-23" Formula)

The formula for the rest mass of the electron is:

$$m_e = \frac{m_p^2}{4 \alpha^6 M_P} \left(\sqrt{1 + \frac{4 e^2 \alpha^{23} M_P}{\pi \epsilon_0 G m_p^3}} - 1 \right) \tag{1.1}$$

where

$$M_P \equiv \sqrt{\frac{h c}{2 \pi G}} \tag{1.2}$$

Note that the parenthesis is a dimensionless factor that I shall denote by $f_{\alpha 23}$

$$f_{\alpha 23} \equiv \sqrt{1 + \frac{4 e^2 \alpha^{23} M_P}{\pi \epsilon_0 G m_p^3}} - 1 \tag{1.3}$$

In virtue of equation (1.3), formula (1.1) can be rewritten as:

$$m_e = \frac{f_{\alpha 23}}{4\alpha^6} \frac{m_p^2}{M_P} \tag{1.4}$$

I shall denote the dimensionless factor of this formula by $S_{electron}$:

$$S_{electron} \equiv \frac{f_{\alpha 23}}{4\alpha^6} \tag{1.5}$$

Then from equations (1.4) and (1.5) we get

$$m_e = S_{electron} \frac{m_p^2}{M_P} \tag{1.6}$$

This formula can be written in the form of the scale law [1] as follows:

$$\frac{m_e}{m_p} = S_{electron} \frac{m_p}{M_P} \tag{1.7}$$

Where $S_{electron}$ is the scale factor (or scaling factor). This formula yields the following value for the mass of the electron:

$$m_e \approx 9.108\,978\,46 \times 10^{-31} Kg \qquad (\text{for } G_{NIST\,2010} = 6.67384 \times 10^{-11} N\, m^2/Kg^2 \;)$$

If we calibrate the value of G slightly, as shown in the third row, first column of **Table 1** (see $G_{calibrated}$), we get the observed value for the rest mass of the electron [2]. The third column of the table shows the relative error (See **Appendix 2**), with respect to the calibrated value, as a percentage. The relative error of the calibrated gravitational constant with respect to the value of the gravitational constant adopted by NIST in 1986 is:

$$E_{\mathrm{rel\_1986}}(\%) = \frac{G_{calibrated} - G_{NIST\,1986}}{G_{NIST\,1986}} \times 100 \approx 0.000\,983\,876\,\%$$

The relative error of the calibrated gravitational constant with respect to the value of the gravitational constant published by NIST in 2010 is:

$$E_{\mathrm{rel\_2010}}(\%) = \frac{G_{calibrated} - G_{NIST\,2010}}{G_{NIST\,2010}} \times 100 \approx -0.017\,746\ \%$$

These figures indicate that the relative error of the calibrated gravitational constant with respect to the corresponding value published by NIST in 1986 is only $0.000\,98\,\%$ approximately. This is an exceptionally close match between experimental and theoretical values. Consequently, I propose that the following calibrated value

$$G_{calibrated} = 6.672\,655\,65 \times 10^{-11} N\, m^2/Kg^2$$

is the most accurate value so far.

Value of G (N . m^2 / Kg^2)	Mass of the electron computed with formula (1.1) (Kg)	Relative error with respect to $G_{calibrated}$ (%)
$G_{NIST\,1986} = 6.672\ 59 \times 10^{-11}$ (quite accurate!)	$9.109\ 401\ 88 \times 10^{-31}$	0.000 984
$G_{NIST\,2010} = 6.673\ 84 \times 10^{-11}$ (quite inaccurate)	$9.108\ 978\ 46 \times 10^{-31}$	−0.017 746
$G_{calibrated} = 6.672\ 655\ 65 \times 10^{-11}$ (calibrated value)	$9.109\ 382\ 911\ 379 \times 10^{-31}$	--

Table 1: The mass of the electron computed with formula (1.1) using three different values for the Newton's gravitational constant *G*.

Appendix 1 contains the nomenclature used in this paper.

2. Conclusions

The result seems to indicate that, if the calibrated value of *G* is correct, then the quantum gravitational formula presented in this paper (equation 1.1) would turn out to be a true law of nature, and that the value for the Newton's gravitational constant published by NIST in 1986 would be much more accurate than the value published in 2010. Therefore I propose, the calibrated value of *G* of this formulation, as the "least incorrect value" of Newton's gravitational constant, at least for the microscopic scale of quantum physics. Finally I want to point out that *G* might be a scale dependent "constant", a material dependent "constant", a velocity dependent "constant", an acceleration dependent "constant", a time dependent "constant" (e.g. secular variations), etc. What could add even more complexity to the panorama is that gravity could obey to a different and more complex law than that described by Einstein's General Relativity's field equations. This hypothetical unknown law could be characterized by an either slightly or by an entirely different "gravitational constant" or a set of "gravitational constants". This means that the "constant" *G* we observe through different measurement methods would be, in fact, a very rough approximation of a completely different gravitational reality. These unknown factors would explain the relatively large discrepancies amongst the values of *G* obtained through different experimental measurement methods [3, 4, 5, 6, 7, 8, 9, 10, 11]. After all, the force of gravity could be the least known force of known physics.

Appendix 1
Nomenclature

The following are the symbols used in this paper

$m_e =$ electron rest mass
$\alpha =$ fine-structure constant, electromagnetic coupling constant, atomic structure constant.
M_p = Planck mass
$m_p =$ proton rest mass
e = elementary electric charge
ϵ_0 = permittivity of vacuum
$h =$ Planck's constant
$c =$ speed of light in vacuum
G = Newton's gravitational constant
$S_{electron}$ = scale factor for the quantum gravitational formula “alpha-23” for the mass of the electron.
$X_m =$ measured value
$X_t =$ true value, standard value, or the value thought to be the true value (for example a NIST standard value)
$E_{\mathrm{abs}} =$ absolute error
$E_{rel} =$ relative error
$E_{rel}\% =$ relative error as percentage
$E_{rel}(\%) =$ relative error as percentage

Appendix 2
Absolute and Relative Errors

Absolute Error
The absolute error is the difference between the measured value and the true value

$$E_{\mathrm{abs}} = X_m - X_t$$

Relative Error
The relative error is the absolute error expressed in parts of the true value

$$E_{rel} = \frac{X_m - X_t}{X_t}$$

Relative Error as a Percentage

$$E_{rel}\% = \frac{X_m - X_t}{X_t} \times 100$$

$X_m =$ measured value

$X_t =$ true value, standard value, or the value thought to be the true value (for example a NIST standard value)

Version Notes

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