

Original Research Article

Validating internal electron and proton energy configurations via a theoretical derivation of the mass ratio m_p/m_e

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ABSTRACT

Background: There are no particle models giving theoretical rest mass energy values for the electron or proton, and their internal energy configurations are unknown. Consequently there is no theoretical basis for the proton/electron rest mass ratio m_p/m_e . Previous articles established both electrons and protons consist of quantum loops of the same 6.8MeV base quantum energy, albeit in different relativistic states.

Methods: Prior work is extended by considering internal particle energy cross coupling factors to derive detailed theoretical expressions for the internal energy distributions of electrons and protons. These expressions consist of the base quantum energy modified by terms containing only relativistic factors of the fine structure constant, $\alpha \sim 1/137$. For m_p/m_e the base quantum energy cancels and the derived mass ratio is given by the particle's internal quantum loop relativistic states. The derived mass ratio is compared to the empirical value. Newton's gravitational constant, G , is calculated from the electron internal energy configuration.

Results: Derived particle energy configurations give proton mass and proton/electron mass ratio values fully consistent with empirical data. The common base quantum loop energy is obtained to 6ppm. Combining particle mass energy expressions gives m_p/m_e to ten digits and consistent with the 2014 CODATA value via an expression containing only the fine structure constant. A theoretical value for Newton's gravitational constant is obtained to an uncertainty of 6ppb. The Hierarchy problem is resolved, and the Planck scale of matter is adjusted.

Conclusions: The particle energy configurations are validated by providing particle mass energy values and a proton/electron mass ratio consistent with empirical data. Newton's G is shown not a natural constant, and misunderstanding its nature gave rise to the Hierarchy problem and an erroneous value for the Planck scale of matter, both now resolved.

Keywords: Proton-electron mass ratio, Proton mass energy expression, Electron mass energy expression, Gravitational constant, G . Planck scale, Hierarchy problem

INTRODUCTION

The ratio of the mass of the proton to that of the electron has long been theoretically unsupported by physical particle models, the lack of which is a long standing problem. Both particles exhibit exactly the same, although opposite, electric charge values but their 2014

CODATA rest mass energies differ greatly; for the electron $m_e c^2 = 0.5109989461(31)\text{MeV}$ and for the proton $m_p c^2 = 938.2720813(58)\text{MeV}$. The CODATA value for the proton - electron rest mass ratio is: 1,836.15267389(17). [In concise form the two digits in parentheses indicate the standard uncertainty in the prior two digits].

Recently published articles describe particle models wherein both electrons and protons are composed of the same energy quantum of about 6.8MeV in the form of relativistic quantum loops of about 35MeV.^{1,2} Each quantum loop consists of an energy quantum of nominally 6.8MeV relativistic by $\alpha^{-1/3}$, i.e. $5.15559 \times 6.8\text{MeV} = 35\text{MeV}$. On formation both particles undergo relativistic volume changes of α with loop energies relativistic by $\alpha^{\pm 1/3}$ in each dimension.

Given the above proton empirical rest mass energy, a three dimensional model with the base quantum energy relativistic by α^{-1} provides a nominal initial value for the base quantum energy as in (1), where the fine structure constant is $\alpha \sim 1/137.035999139(31)$.

$$m_p c^2 = 938.2720813\text{MeV} \sim \alpha^{-1} 6.84\text{MeV} = 937\text{MeV} \quad (1)$$

From the referenced helical-toroid electron model,¹ with the nominal base quantum energy $m_q c^2 = 6.8\text{MeV}$, the nominal electron rest mass energy in (2) is close to, but somewhat greater than, the empirical value of 0.510998946MeV,

$$m_e c^2 \sim 2\alpha^{2/3} 6.8\text{MeV} = 0.51166\text{MeV} \quad (2)$$

It is clear the 6.8MeV base energy value is insufficiently precise and both expressions (1) and (2) require adjustment by considering possible internal particle dynamics, such as energy cross coupling between quantum loops. Initial internal energy adjustment values can be obtained by analyzing the sparse set of cross-coupling values available from simple relativistic expressions containing α . The empirical particle mass ratio m_p/m_e places an additional constraint on the values within the expressions.

Particle Models: The above nominal expressions for the proton and electron mass energies are both based on conceptual models describing the energy distribution within the particles. The electron is described as two circulating electromagnetic (EM) components each of spin-1/2 and energy $m_q c^2$ propagating rectilinearly in an involute helical toroidal curved space-time path close to and just outside an event horizon as in Figure 1a. The nominal internal electron relativistic energy distribution of $2m_q c^2 (\alpha^{2/3} \cdot \alpha^{2/3} \cdot \alpha^{-1/3})$ about the x, y, z, axes was previously given,¹ where the Newtonian gravitating mass derives from the space-time curvature about the x and y axes, and the rotational energy about the z axis, (i.e. $2\alpha^{1/3} m_q c^2 \sim 70\text{MeV}$), is reduced by the coupling factor α , to energy about the x and y axes.

The proton is described as a single spin-1/2 component of energy $m_q c^2$ propagating rectilinearly just inside an event horizon in an evolute toroidal curved space-time path as in Figure 1b. Due to the toroidal propagation paths each particle evidences a magnetic dipole to the observer.

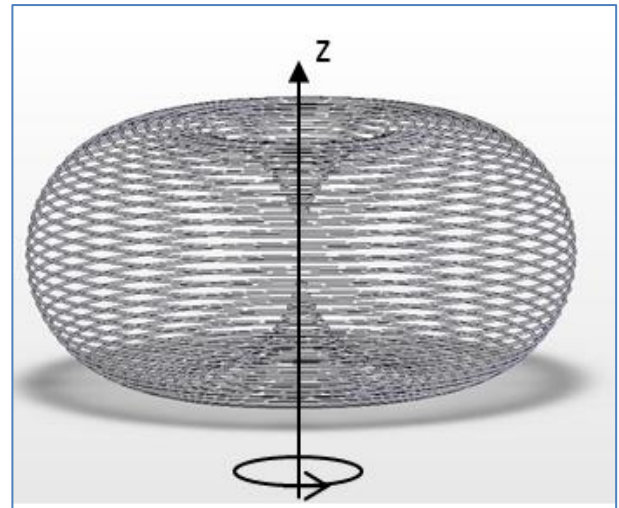


Figure 1: (a) Electron energy involute space-time path.

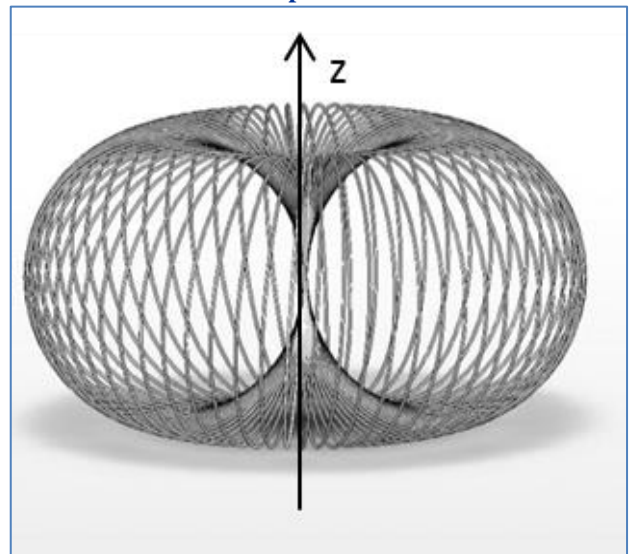


Figure 1: (b) Proton energy evolute space-time path.

The proton is considered a single spin-1/2 wave of $m_q c^2$ with two passes about the z axis overlapped to form a spin-1 wave in a quantum loop in the x, z plane, tangential to and rotating about the z axis into the y, z plane so the x and y axes energy is symmetric. As described in a previous article,² the proton's relativistic energy distribution about the x, y, z, axes relative to the observer domain is consistent with (1), the inverse of that for the electron, and resembles the quark partial charge notion,

$$m_p c^2 = m_q c^2 (\alpha^{-2/3} \cdot \alpha^{-2/3} \cdot \alpha^{1/3}) \quad (3)$$

This observer domain energy distribution derives from the inversion of the distribution in an internal particle domain very similar to that of the spin-1 electron, at $2m_q c^2 (\alpha^{2/3} \cdot \alpha^{2/3} \cdot \alpha^{-1/3})$, but with the single spin-1/2 loop wavelength passing twice around the z axis per quantum

cycle to achieve particle stability via energy phase match to mimic a spin-1 EM wave and provide unit charge.

The two particles exhibit equal but opposite charge values as energy localization in the observer domain causes the particles to undergo opposite volume changes by adopting different relativistic states. On localizing the volume the two component electron circulation expands by α , whereas on localizing the volume of the proton's single component contracts by α . This results in the space-time metric surrounding the particles having oppositely directed radial strains, producing opposite charge effects. Via space-time curvature, the observed particle gravitational rest mass depends on the propagation radius of curvature of the particle's quantum loops in their relativistic states. Reference 1 describes the electron internal mass energy of $2m_qc^2$ reduced by about $\alpha^{2/3}$ due to loop expansion, whereas the proton single internal loop mass energy of m_qc^2 is increased by α^{-1} via loop contraction. Both particles have been previously described as in dynamic equilibrium between radial (electric) and circumferential (mass) metric strains.^{1,3}

As noted in the introduction *both electron and proton consist only of components with the same base quantum energy m_qc^2 , so the empirical mass ratio m_p/m_e depends only on the relativistic state of each particle's circulating loop energy.* To a first approximation this ratio is nominally given by;

$$m_p/m_e \sim \alpha^{-1}/2\alpha^{2/3} = 1821.2 \tag{4}$$

The ratio (4) differs somewhat from the empirical 2014 CODATA rest mass ratio of 1,836.15267389(36), but essentially confirms the base energy m_qc^2 is likely the same for both particles. It also indicates the particle's basic quantum loop energy configurations are probably valid, but are only approximate as the individual particle mass energy expressions are nominal, each requiring minor but different, adjustments.

The electron energy distribution $2m_qc^2(\alpha^{2/3}.\alpha^{2/3}.\alpha^{-1/3})$ shows the primary energy circulation of $2\alpha^{-1/3}m_qc^2$ about the z axis couples about the x and y axes via the coupling constant α , and forms relativistic energy $2m_qc^2\alpha^{2/3}$ about the x and y axes. The coupled energy thereby oscillates along the z axis to form a three dimensional particle as in Figure 1a. But subsequent smaller cross axis recoupling factors are not included. The nominal proton mass energy expression (1) does not include the particle's rotation energy about the toroid z axis. For these reasons m_qc^2 must differ slightly from the 6.84MeV in (1).

METHODS

The precise value of m_qc^2 , the base quantum energy for both electrons and protons, is not a factor in the proton/electron mass ratio as evident from (4). Possible cross axis energy coupling factors for the electron and proton mass energies are deduced as follows.

The electron

As above, the first coupling by α reduces the z axis energy and forms energy about the x, y axes of $2\alpha^{2/3}m_qc^2$. A second order coupling must exist with energy recoupling back from about the x, y axes to about the z axis, postulated as occurring via a second coupling factor $\alpha^{2/3}$, reduced by half due to a $\pi/2$ phase change. This energy then recouples again about the x and y axes by α and is thus $\alpha^{5/3}/2$ of the initial energy about the x, and y axes). The energy about the x, and y axes is thereby $2\alpha^{2/3}m_qc^2/(1 + \alpha^{5/3}/2)$. This coupling-recoupling cycle repeats with the coupling reduced by $\alpha^{5/3}/2$ at each cycle giving (5). The sign of the coupling is reversed on alternate coupling cycles due to phase effects, giving the electron rest mass energy expression,

$$m_e c^2 = 2m_qc^2\alpha^{2/3}/[1 + \alpha^{5/3}/2 - (\alpha^{5/3}/2)^2 + (\alpha^{5/3}/2)^3 -...] \text{ MeV} \tag{5}$$

Where $[1 + \alpha^{5/3}/2 - \alpha^{10/3}/4 + \alpha^{15/3}/8 \dots] = 1.0001372521822646 = K$ (say), and $2\alpha^{2/3} = 0.0752442900019$.

From (5), $m_e c^2 = (2\alpha^{2/3}m_qc^2/K).\text{MeV}$; $2m_qc^2 = 13.58426213\text{MeV}$; and $m_qc^2 = 6.792131067\text{MeV}$.

Thus $2m_qc^2 = \alpha^{-2/3}Km_e c^2$, and the CODATA value $m_e = 9.10938356(11) \times 10^{-31}\text{kg}$, gives $2m_q = 2.421614665 \times 10^{-29}\text{kg}$. The value m_qc^2 is uncertain by 6ppb as it derives from the empirical value $m_e c^2$.

The Gravitational constant G

As previously determined in reference [1] a theoretical value for Newton's gravitational constant G_N , is given by;

$$G_T = (\hbar c/\underline{c}^4)/4m_q^2 \tag{6}$$

With \underline{c} the numerical value of c in cgs units, (for reasons explained briefly in the note below), and where $\underline{c}^4 = (2.99792458 \times 10^{10})^4$, we obtain;

$$\hbar c/\underline{c}^4 = 3.913938931 \times 10^{-68} \text{ J/m} \tag{7}$$

From above $(2m_q)^2 = 5.864217632 \times 10^{-58}\text{kg}^2$, and we obtain a theoretical value G_T for Newton's constant;

$$G_T = (\hbar c/\underline{c}^4)/4m_q^2 = (3.913938931 \times 10^{-68}) / 5.864217588 \times 10^{-58}, \text{ SI units} \\ = 6.674273033 \times 10^{-11}, \text{ SI units} \tag{8}$$

This is within the standard uncertainty of the empirical value G_N , at $G_N = 6.67408(31) \times 10^{-11}$ (SI units). The uncertainty in G_T is limited by (5) to about 6ppb via the uncertainty in the derived value of m_qc^2 , following the uncertainty in the empirical value of $m_e c^2$.

Note: Reference 1 shows the historical assumption that gravity acts via force between masses in the observer domain is incorrect and inadvertently introduced a numerical factor equal to c^4 into G . Hence the dimensions of G_N , Newton's classical constant, are in error by c^4 . The real force of gravity acts on quantum energies $m_q c^2$ circulating within particles, wherein each energy propagates rectilinearly in a relativistic state close to a toroidal event horizon and is thereby dimensionally remote by c^2 from the observer domain in which mass is measured, i.e. $m = E/c^2$.

The proton

As shown previously,^{1,2} the proton energy circulation is very similar to the electron, but with the relativistic factors "inverted", i.e. $m_p c^2 = m_q c^2 (\alpha^{-2/3} \cdot \alpha^{2/3} \cdot \alpha^{1/3})$.

Using the value of $m_q c^2$ derived from (5) above we obtain

$$\alpha^{-1} m_q c^2 = 930.7664668 \text{MeV} \tag{9}$$

This differs from the empirical value $m_p c^2$ by;

$$m_p c^2 / \alpha^{-1} m_q c^2 = 938.2720813 / 930.7664668 = 1.008063907 \tag{10}$$

The proton energy circulation as shown in Figure 1b and described by $m_p c^2 = m_q c^2 (\alpha^{-2/3} \cdot \alpha^{2/3} \cdot \alpha^{1/3})$ is primarily rotationally relativistic about the x, y axes with the energy coupled about the z axis by α and the x, y circulation normally reduced by $(1-\alpha)$. However, as in reference [3], the proton energy propagates in a domain just inside a toroidal event horizon and the local space-time curvature is reversed by transiting the event horizon into the observer domain. Thus the internal energy distribution $(\alpha^{2/3} \cdot \alpha^{2/3} \cdot \alpha^{1/3})$ is evident to the observer as $(\alpha^{-2/3} \cdot \alpha^{-2/3} \cdot \alpha^{1/3})$ and the energy about the x, y axis is effectively increased by $(1 + \alpha)$, giving;

$$\alpha^{-1} (1 + \alpha) m_q c^2 = 937.5585983 \text{MeV} \tag{11}$$

This is less than the proton rest mass energy by 1.000761001. As noted above, the rotation energy about the z axis is α that about the x, y axes, and is postulated to recouple back about those axes again reduced by α , for a recoupling of α^2 , (= 0.00005325135448). This coupling factor likely repeats on subsequent cycles resulting in a recoupling of $(1 + \alpha^2 - \alpha^4)$ at 1.000053248587732, increasing (11) to give (12);

$$\alpha^{-1} (1 + \alpha) (1 + \alpha^2 - \alpha^4) m_q c^2 = 937.6085214 \text{MeV} \tag{12}$$

This energy value differs from the empirical proton rest mass energy by;

$$938.2720813 / 937.6085214 = 1.000707715 \tag{13}$$

If, similar to as in the electron, the proton internal loop energy cross couples, and considering the uncertainty in

$m_q c^2$, this factor is likely $(1 + \alpha^{4/3}/2) = 1.000707713$. Increasing (12) by this factor gives $m_p c^2 = 938.2720791 \text{MeV}$. This can be considered as the two halves of each loop energy of $\alpha^{2/3} m_q c^2$ interacting with each other for a total of $(\alpha^{2/3} m_q c^2)^2 / 2 = \alpha^{4/3} m_q c^2 / 2$. If so, presumably there would be no subsequent re-coupling.

It is therefore postulated;

$$m_p c^2 = \alpha^{-1} (1 + \alpha) (1 + \alpha^{4/3}/2) (1 + \alpha^2 - \alpha^4) m_q c^2 = 938.2720791 \text{MeV} \tag{14}$$

The above calculation gives essentially the same value as the proton empirical rest mass, both having an uncertainty of about 6ppb. These calculations employed ten digit numbers so rounding off during multiple calculation steps may significantly affect the last two digits.

Proton / electron mass ratio: In calculating the electron / proton mass ratio from (5) and (14), the $m_q c^2$ terms cancel and we obtain (15), a mass ratio containing only terms of α and thus independent of individual particle masses. The standard uncertainty in the empirical value of α is only 0.32ppb, which requires a calculation to 15 significant digits to minimize computational round-off errors. Thus,

$$m_p / m_e = \alpha^{-5/3} (1 + \alpha) (1 + \alpha^{4/3}/2) (1 + \alpha^2 - \alpha^4) [1 + \alpha^{5/3}/2 - (\alpha^{5/3}/2)^2 + (\alpha^{5/3}/2)^3 - \dots] / 2 = 1836.1526772749. \tag{15}$$

RESULTS

This mass ratio result closely matches the empirical mass ratio (1836.152 673 89(17), over nine orders of magnitude, differing by only 2.09ppb. Much if not all of this difference may be due to the small uncertainty in the value of α .

The electron and proton internal energy distributions described above via relativistic quantum loop concepts give the particle masses to a few parts per billion, fully consistent with empirical data.

The base quantum loop energy common to both particles is; $m_q c^2 = 6.792131067 \text{MeV}$, and is derived via the electron rest mass energy with an uncertainty of 6ppb. Note $\alpha^{-1/3} m_q c^2 = 35.0174 \text{MeV}$.

A theoretical value for Newton's classical gravitational constant G_N is obtained matching and surpassing empirical data with increased precision, providing an uncertainty of 6ppb due to the uncertainty in $m_q c^2$.

DISCUSSION

The impact of this analysis is far reaching with one major consequence being resolution of the Hierarchy problem. This problem is the lack of an explanation for the dearth of particles with masses much greater than the proton at

about 1 GeV, but less than the traditional Planck mass at about 1.22×10^{19} GeV, a huge gap of about 19 orders of magnitude!

The Planck mass has been historically obtained by equating the strong force with the gravitational force due to an assumed mass M , i.e. $\hbar c/r^2 = G_N M^2/r^2$, leading to $M = (\hbar c/G_N)^{1/2}$. However, as shown herein Newton's G_N contains a hereto unrecognized factor of ζ^4 , essentially a numerical value of about $(3 \times 10^{10})^4$, which places the historical Planck mass too high by about 10^{20} .

The Planck scale has been described as where the strong force, the electromagnetic force, and gravity are all equal. But the described electron model shows these are all equal in the frame in which the electron energy rotates. This equality is clearly necessary for particle stability. Replacing G_N in the Planck mass derivation with G_T as in (6) shows the "Planck mass" is $2m_q^2$, thereby resolving the Hierarchy problem.

CONCLUSION

The conceptual particle models provide a basic energy configuration by which the localization of electromagnetic energy as quantum loops gives rise to the observed attributes of mass and charge. A detailed mathematical description of the particles is not intended, but the above analysis strongly supports the conceptual electron and proton models as composed of similar quantum loops by producing the proton rest mass and the proton / electron rest mass ratio with uncertainties essentially matching the CODATA 2014 empirical data. Obtaining a theoretical value for the proton - electron mass ration to within 2.1ppb of the empirical value substantiates the particle concepts.

The base quantum loop energy $m_q c^2$ is the same for both particles, but the basis for this particular value remains unknown. The derivation of G_N via the electromagnetic quantum loop electron model emphasizes Newton's original concept that "mass is a notion enabling quantification of the gravitational effect", and is not a particle attribute at a fundamental level. The gravitational 'constant' G is the same for both electron and proton and the long standing Hierarchy problem is resolved.

With the introduction of $m_q c^2$, the electron and proton rest mass energies and the gravitational constant G are now given via $m_q c^2$, and the number of basic unknown parameters in the Universe is reduced by two.

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Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Oakley, W. S. Analyzing the large number problem and Newton's G via a relativistic quantum loop model of the electron. *Int J Sci Rep.* 2015;1(4):201-5.
2. Oakley WS. Deducing the proton energy configuration. *Int J Sci Rep.* 2016: 284-7.
3. Oakley WS. Resolving the Electron - Positron mass annihilation mystery. *Int J Sci Rep.* 2015;1(6):250-2.

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