Physics Notes

Note 23

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Additional Properties of the Ilectron

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Abstract

In an earlier Note [2] we had hypothesized a new particle that we called the ilectron. Starting with the electron, we had considered a complex combination of charge and mass which leads to the possibility of the 5th force and a new particle, which we called the ilectron. The ilectron has derived properties that make it a contender as a WIMP (Weakly Interacting Massive Particle). In this note we extend the earlier work and find some additional properties of the ilectron.

1. Introduction

The known properties of the electron and the derived properties of the ilectron are considered in Table 1.The classical radius of the electron is given in Table1, though quantum physicists regard the electron both as a point particle and a wave, but a point particle conflicts with relativity. If the electron had zero radius, a free electron would have infinite electrostatic energy. Dirac's equation [2] confirmed that the electron has angular momentum, $\hbar / 2$, but it also predicted that the electron rotated in space (zitterbewegung) with a velocity c and a radius of $\lambda\!\!\!^{-} / 2$ (reduced Compton wavelength), this being in conflict with special relativity.. The ilectron is modelled on the electron model developed by one of us [1] where the electron rotates around a circle with a radius ~5% greater than and a velocity ~5% less than c obtained by using a relativistic equation of motion. Because Dirac's equation [3] resulted in the above conflict, he described it as *"a purely quantum mechanical effect"*.

In Table 1, we have assumed the angular momentum of the ilectron to be the same as for the electron.

Attribute	Fundamental "Particle" – the electron	Hypothesized "Particle" – the ilectron
rest mass	$m_{oE} = 9.10938188 \times 10^{-31}$ kg	$m_{oi} = q_E \sqrt{\dfrac{g}{\varepsilon_o}}$ = 1.86 x 10^{-9} kg = 1.86 μg (Very heavy !)
charge	$q_E = 1.602176462 \times 10^{-19}$ C	$q_I = m_{iE}\sqrt{\dfrac{\varepsilon_0}{g}} = \dfrac{m_{0E}}{3.2635}\sqrt{\dfrac{\varepsilon_0}{g}}$ = 2.17 x 10^{-41} C with m_{iE} as the electron's intrinsic mass
classical radius	$r_E = 2.81795518 \times 10^{-15}$ m	Not calculated
quantum mechanical radius	0	Assumed zero
angular momentum	$\Omega = \hbar/2 = 5.27285 \times 10^{-35}$ kg m^2/s	$\Omega = \hbar/2 = 5.27285 \times 10^{-35}$ kg m^2/s (an assumption)
magnetic moment	1.001159652 μ_B μ_B is the Bohr Magneton, $= 9.27400899 \times 10^{-24}$ J/T	1.48 x 10^{-27} μ_B based on the assumption above μ_B is the Bohr Magneton, $= 9.27400899 \times 10^{-24}$ J/T
Fine structure constant FSC	$\alpha_E = \dfrac{q_E^2}{4\pi\varepsilon_0\hbar c}$ = 7.29735x10^{-3} $\simeq$ (1/137)	$\alpha_I = \dfrac{q_I^2}{4\pi\varepsilon_0\hbar c}$ = 1.3387 x 10^{-46}
Spin velocity	$\dfrac{v_{sE}}{c} = \dfrac{\sqrt{1+\dfrac{3}{\alpha_E}}-1}{\sqrt{\dfrac{3}{\alpha_E}}}$ 0.9518967	$\dfrac{v_{sI}}{c} = \dfrac{\sqrt{1+\dfrac{3}{\alpha_I}}-1}{\sqrt{\dfrac{3}{\alpha_I}}}$. = 1 - 6.68 x 10^{-24} almost 1, but not quite!

Table 1. Attributes of the electron and the ilectron

The spin velocity for the ilectron being so close to c means that the spin radius is very close to the maximum value. Designating this radius as r_∞ it can be shown that

$$r_{sE} = \frac{\lambda\!\!\!^{-}}{2\sigma} = 2.02838 \times 10^{-13} \qquad r_{sI} \sim r_\infty = \frac{r_{sE}}{\sigma} = \frac{\lambda\!\!\!^{-}}{2\sigma^2} = 2.13087 \times 10^{-13} m \qquad (1)$$

where
$$\sigma = \frac{v_{sE}}{c} \qquad (2)$$

Spin of the electron is a quantum mechanical property and is an intrinsic form of angular momentum. Some physicists think of this as the earth rotating on its own axis in 24 hours – a spinning top. This view, however, is not mathematically justifiable.

In Table 2, we list some fundamental physical constants.

Physical Constant	**Notation**	**Value and Units**
Planck's constant	h	6.62607 x 10^{-34} m^2 kg /s
Planck's charge	$q_P = \sqrt{4\pi\varepsilon_o (h/2\pi) c}$ $= \sqrt{2\varepsilon_o h c}$	1.8755 x 10^{-18} C
Planck's Mass	$m_P = \sqrt{\dfrac{hc}{2\pi G}}$	21.764 μg Or, in energy units 1.220910×10^{19} GeV
Planck's length	l_P	1.6 x 10^{-35} m
Speed of light in vacuum	c	3 x 10^8 m/s
Permittivity of free space	ε_o	8.85418 x 10^{-12} F/m
Gravitational constant	G	6.67030 x 10^{-13} m^3 kg^{-1} s^{-2}
Constant related to G	$g = \frac{1}{4\pi G}$ This is not acceleration of earth's gravity	1.192 x 10^9 m^{-3} kg s^2

Table 2. Some fundamental constants

2. *Ilectronic Mass and its Relation to Planck's Mass*

2.1 Planck's mass, denoted by m_P, is the unit of mass in the system of natural units known as Planck units [4]. It is approximately 0.02 milligrams. Unlike some other Planck units, such as Planck length, Planck mass is not a fundamental lower or upper bound; instead, Planck mass is a unit of mass defined using only what Plank considered fundamental and universal units.

It is defined as:

$$m_P = \sqrt{\frac{hc}{2\pi G}} \tag{3}$$

where

h is the Planck's constant = 6.6260 x 10^{-34} m^2 kg / s and

G is the gravitational constant = $\dfrac{1}{4\pi g}$ = 6.670 x 10^{-11} (Nm^2 / kg^2) or m^3 kg^{-1} s^{-2}

resulting in g = 1.192 x 10^9 m^{-3} kg s^2

Substituting these physical constants, we get

$$m_P = 21.764\ \mu g \tag{4}$$

Using the mass-energy equivalence E = m c^2, Planck mass converts to

$$m_P = 1.220910\times10^{19} \text{ GeV} \tag{5}$$

In comparison, this value is of the order of 10^{15} (a quadrillion) times larger than the highest energy available (13 TeV) in the Large Hadron Collider at CERN.

2.2 Ilectron mass

We had derived the ilectron mass [2] as

$$m_{ii} = q_E \sqrt{\frac{g}{\varepsilon_o}} \tag{6}$$

Rewriting the Planck's mass from equation (3)

$$m_P = \sqrt{\frac{hc}{2\pi G}} \tag{7}$$

Taking the ratio of two masses, we have

$$\frac{m_P}{m_{ii}} = \frac{\text{Planck's mass}}{\text{Ilectron mass}} = \frac{\sqrt{2hc\,\varepsilon_o}}{q_E} = \frac{1}{\sqrt{\alpha_E}} \simeq 11.706 \tag{8}$$

We recognize that the ratio of Planck's mass to ilectron mass is closely related to the fine structure constant of the electron α_E.

In terms of the actual masses, we have

$$m_{ii} = q_e\sqrt{\frac{g}{\varepsilon_o}} = 1.86 \text{ x } 10^{-9}\text{ kg} = 1.86\ \mu\text{g} \sim 10^{21}\text{ MeV} = 10^{15}\text{ TeV} \tag{9}$$

So

$$\frac{m_P}{m_{ii}} = \frac{\text{Planck's mass}}{\text{Ilectron mass}} = \frac{21.764\,\mu g}{1.86\,\mu g} = 11.70 \tag{10}$$

which is consistent with equation (8).

3. Ilectronic Charge and its Relation to Planck's Charge

Planck's charge is given by

$$q_P = \sqrt{4\pi\varepsilon_o (h/2\pi)c} = \sqrt{2\varepsilon_o hc} \tag{11}$$

Ilectronic charge is given by

$$q_i = m_{iE}\sqrt{\frac{\varepsilon_o}{g}} = \frac{m_{oE}}{3.2635}\sqrt{\frac{\varepsilon_o}{g}} \tag{12}$$

with m_{iE} is the electron's intrinsic mass and m_{oE} is the rest mass of the electron.

We also have the Fine structure constant of the ilectron given by

$$\alpha_i = \frac{q_i^2}{4\pi\varepsilon_o hc} = \frac{q_i^2}{q_P^2} \tag{13}$$

Or $$\frac{q_i}{q_P} = \sqrt{\alpha_i} = \sqrt{1.3387x10^{-46}} = 1.157x10^{-23} \tag{14}$$

We can also get this ratio in another way

$$\frac{\text{ilectron charge}}{\text{Planck's charge}} = \frac{q_i}{q_P} = \frac{2.17x10^{-41}\text{C}}{1.8755\ x10^{-18}\text{C}} = 1.157 \text{ x } 10^{-23} \tag{15}$$

Which is consistent with equation (14)

We can write the reciprocal of this ratio as

$$\frac{\text{Planck's charge}}{\text{ilectron charge}} = \frac{q_P}{q_i} = \frac{1.8755x10^{-18}\text{C}}{2.17\ x10^{-41}\text{C}} = 8.642 \text{ x } 10^{22} \tag{16}$$

4. *Mass and Energy Equivalence leading to Charge and Energy Equivalence*

Sir Isaac Newton believed mass and energy are two distinct and unrelatable quantities. In the Newtonian scheme, mass is a measure of inertia or quantity of matter that resists its motion, and mass and energy have distinct and separate identities. However, Einstein's most famous equation

$$E = mc^2 \tag{17}$$

explicitly states that mass and energy are interconvertible. Mass does not have to move to have energy. Just need to have mass. This simple equation has enjoyed profound consequences. Now that we have found an "equivalence" between mass and charge , we can rewrite equation (17) as

$$E = q\sqrt{\frac{g}{\varepsilon_o}}\,c^2 = q\,d^2 \tag{18}$$

where

$$d = \sqrt{\sqrt{\frac{g}{\varepsilon_o}}}\,c = 1.0777 \text{ x } 10^5 \text{ c} = 3.2333 \text{ x } 10^{13} \quad (\sqrt{Voltage}) \tag{19}$$

Furthermore, dimensionally speaking, Energy = Charge x Voltage, which suggests, the dimension of the constant quantity *d* in equation (18) is the square root of Voltage, and this has been verified. An alternate view is to regard equation (18) as defining charge having an effective mass of

$$M_q = q\sqrt{\frac{g}{\varepsilon_0}} \tag{20}$$

Equation (20) indicates that charge and energy are two sides of the same coin.

5. Summarizing Remarks

We have found that:

***Mass of the ilectron and Planck's mass are simply related by the fine structure constant of the electron*.**

$$\frac{m_P}{m_{ii}} = \frac{\text{Planck's mass}}{\text{Ilectron mass}} = \frac{1}{\sqrt{\alpha_E}} \simeq 11.706 \tag{21}$$

Charge of the ilectron and Planck's charge are simply related by the fine structure constant of the ilectron.

$$\frac{\text{Planck's charge}}{\text{ilectron charge}} = \frac{q_P}{q_i} = \frac{1}{\sqrt{\alpha_i}} = 8.642 \text{ x } 10^{22} \tag{22}$$

We had established an equivalence between mass and charge [2] and this leads us to the following observation. Einstein's equation firmly established the interconvertibility of mass and energy with profound consequences. This leads us to the following

$$\mathrm{E = m\ c^2} \qquad\qquad \mathrm{E = q\ d^2} \tag{23}$$

where E is energy, m is mass, c = speed of light in vacuum, q is charge and d is a physical constant simply related to the speed of light, as can be seen in equation (19). The consequences of the interconvertibility of charge and energy are yet to be determined. This equivalence between charge and energy prompts other questions.

References:

[1] I. L. Gallon Extending Classical Physics into the Quantum Domain, Physics Note 21,3rd June,2013

[2] I. L. Gallon, D. V. Giri, and C. E. Baum, "The Electron and the Ilectron", Physics Note 22, 9 December 2016, can be downloaded from: http://ece-research.unm.edu/summa/notes/Physics/physicsNote22.pdf

[3] P. A. M. Dirac, (1982) [1958]. "Principles of Quantum Mechanics" International Series of Monographs on Physics (4th ed.). Oxford University Press. p. 255. ISBN 978-0-19-852011-5

[4] https://en.wikipedia.org/wiki/Planck_mass