On the Mass of the Electrino

In this paper I estimate the mass of the electrino (new lepton) through two formulas. The first formula we shall explore is the lepto-baryonic formula for the fine-structure constant which I published in a previous paper entitled: Exponential Formula for the Fine Structure Constant. Unlike the formula presented there, this paper introduces an exact formula which is given as a function of the masses of the two lightest charged leptons: the electron and the electrino; and the lightest baryons: the neutron and the proton. The second formula we shall explore is the "alpha-23" formula for the mass of the electron. Both formulas suggest the existence of a new super-light lepton which I have called: electrino. I predicted the existence of this particle in a previous paper entitled: Is the Electron Unstable?. This investigation suggests that the mass of the electrino, if this elusive particle exists, must have a value between $m_e/529.3$ *and* $m_e/517.8$ *approximately.*

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Keywords: *fine-structure constant, mass ratio, lepton, baryon, neutrino, electrino, quark, NIST, GUT.*

1. Introduction

The exponential formula for the fine-structure constant given in my previous article [1] is

$$\alpha \approx 2^{-18\rho} \tag{1.1}$$

where ρ is defined as the ratio

$$\rho \equiv \frac{m_e}{m_n - m_p} \tag{1.2}$$

(The nomenclature is included in **Appendix 1**). Combining equations (1.1) and (2.2) yields

$$\alpha \approx 2^{-18\left(\frac{m_e}{m_n - m_p}\right)} = \frac{1}{2^{18\left(\frac{m_e}{m_n - m_p}\right)}} \tag{1.3}$$

The value of the fine-structure constant given by this formula is $\alpha \approx 0.007\,229\,708\,17$ while the value of this constant according to NIST (2010) [2] is $\alpha \approx 0.007\,297\,352\,569\,8(24)$. In the next section we shall transform the approximate formula (1.3) into an exact formula, and from the new formula we shall predict the value for the mass of the electrino.

2. Predicting the Existence of the Electrino from the Lepto-baryonic Formula for the Fine-structure Constant

Let us have a look at equation (1.3) again

$$\alpha \approx 2^{-18\left(\frac{m_e}{m_n - m_p}\right)} \quad (2.1)$$

On the one hand, the denominator of the exponent in the above equation is the difference between the two lightest baryons: the neutron and the proton. On the other hand, the numerator is the mass of the lightest lepton: the electron. This suggests that the numerator should also contain the difference between two light particles (not just one). But for the numerator these particles should be leptons. Thus the numerator should be the difference between the mass of the electron and the mass of a new, yet undiscovered, lepton. This new lepton should be lighter than the electron and it should have the same electric charge as its heavier brother. Following the "convention" used by the Italian physicist Enrico Fermi, I shall call this new particle: *electrino*. The new exponential formula or lepto-barionic formula for the fine-structure constant, taking into account the electrino rest mass, m_l , is

$$\alpha = 2^{-18\left(\frac{m_e - m_l}{m_n - m_p}\right)} \quad (2.2)$$

It is worthy to observe that the approximate sign has been replaced by an equal sign. We can easily calculate the rest mass of this new particle by solving equation (2.2) for m_l . This yields

$$m_l = m_e + \frac{1}{18}\frac{\ln \alpha}{\ln 2}\left(m_n - m_p\right) \quad (2.3)$$

Thus, the value of the electrino mass turns out to be

$$m_l = 1.720\ 950\ 285 \times 10^{-33}\ Kg = 0.000\ 965\ 488\ 75\ \frac{MeV}{c^2} = 965.488\ 75\ \frac{eV}{c^2}$$

Where we used the following conversion factor: $F_{JeV} = 1.602\,176\,564 \times 10^{-19}\,\frac{J}{eV}$

To have an idea on how heavy this new particle is, we calculate the ratio between the electrino rest mass and the electron rest mass. This yields

$$\frac{m_l}{m_e} = \frac{1.720\ 950\ 285 \times 10^{-33}\ Kg}{9.109\ 382\ 91 \times 10^{-31}\ Kg} = 0.001\ 889\ 206\ 22 = \frac{1}{529.323}$$

Thus, the electrino is, approximately, 529.3 times lighter than the electron.

If we compare the electrino mass with the masses of the three known neutrinos we find that the electrino is heavier than the electron neutrino ($m_{\nu_e} < 2.2\, eV/c^2$) but it seems to be lighter than both the muon neutrino ($m_{\nu_\mu} < 170{,}000\, eV/c^2$) and the tau neutrino ($m_{\nu_\tau} < 15.5 \times 10^6\, eV/c^2$).

So, if the electrino exists, it is an extremely light particle.

3. Predicting the Existence of the Electrino from the "Alpha-23" Formula for the Mass of the Electron

In this section we shall examine the second formula from which we shall also predict the existence of the electrino. This formula, which I have called the "alpha-23" formula [3], gives the rest mass of the electron as a function of the proton rest mass, the Planck mass and other fundamental physical constants. The formula is:

$$m_e = \frac{m_p^2}{4\alpha^6 M_P}\left(\sqrt{1+\frac{4e^2\alpha^{23}M_P}{\pi\,\epsilon_0 G\,m_p^3}}-1\right) \qquad (3.1)$$

This formula yields the following value for the mass of the electron

$$m_e \approx 9.108\,978\,46\times10^{-31}\,Kg \quad (\text{for} \quad M_P \approx 2.176\,509\,252\times10^{-8}\,Kg \quad)$$

We observe the value of the mass: m_y , defined as

$$m_y \equiv \sqrt{\frac{e^2\alpha^{23}}{\epsilon_0 G}} = e\sqrt{\frac{\alpha^{23}}{\epsilon_0 G}} \qquad (3.2)$$

turns out to be

$$m_y = 1.759\,338\,5\times10^{-33}\,Kg$$

If we consider the ratio between m_y and the mass of the electron we get

$$\frac{m_y}{m_e} = \frac{1.759\,338\,5\times10^{-33}\,Kg}{9.109\,382\,91\times10^{-31}\,Kg} = 0.001\,931\,35 \approx \frac{1}{517.773}$$

Thus comparing this result with the result from the previous section: $1/529.323$, we draw the conclusion that the mass m_y corresponds to the same particle: the electrino. Thus, according to formula (3.1) the electrino is, approximately, 517.8 times lighter than the electron. Therefore we have found another formula for the mass of the electrino. This formula is:

$$m_l = e\sqrt{\frac{\alpha^{23}}{\epsilon_0 G}} \qquad (3.3)$$

Now equation (3.1) can be written in terms of the mass of the electrino as follows

$$m_e \approx \frac{m_p^2}{4\alpha^6 M_P}\left(\sqrt{1+\frac{4M_P m_l^2}{\pi\, mp^3}}-1\right) \qquad (3.4)$$

4. Conclusions

In summary, formula (2.2) and formula (3.1) predict the existence of a new lepton lighter than the electron. This new lepton, called electrino, should have a mass between: $1.721\times10^{-33}\,Kg$ and $1.759\times10^{-33}\,Kg$. In other words the mass of the electrino must be between $m_e/529.3$ and $m_e/517.8$. This posssible range can be expressed mathematically as follows

$$\frac{m_e}{529.3}\leq m_l\leq\frac{m_e}{517.8}$$

This finding is in agreement with the finite lifetime of the electron proposed by the author in his article published in February this year (2015) [4]. It is likely that if this new super-light lepton exists, it will be sterile. Let us take up the question of: Why is it that the electrino has never been observed? The answer is that the mean lifetime of the electron is extremely long, about $(\pi/2)\times10^{90}$ years. So far we were unable to observe the decay of the proton (assuming this particle is unstable), which according to the GUTs theories, is in the order of 10^{33} years. This lifetime is many orders of magnitude smaller than that of the electron. Therefore it is extremely unlikely that an experiment can detect the electron decay in the foreseeable future.

In addition we observe that the exponent contains the number 18. We also know that there are 18 different quarks and 18 different anti-quarks. Thus there could be a relationship between these numbers.

There is something remarkable to mention about the formula for the mass of the electrino (eq. 3.3):

$$m_l=e\sqrt{\frac{\alpha^{23}}{\epsilon_0 G}}$$

since the formula for the fine-structure constant, α , is

$$\alpha=\frac{e^2}{2\epsilon_0 h\,c}$$

is clear that formula (3.3) does not depend on any other mass. It is a function of 5 fundamental constants only:

(1) the elementary charge, *e*,
(2) permittivity of vacuum, ϵ_0 ,
(3) the Planck's constant, *h,*
(4) the speed of light in vacuum, *c,* and
(5) the Newton's gravitational constant, *G*

This means that formula (3.3) must be one of the most fundamental formulas in physics and perhaps it also relates to a unit of mass in the universe.

Appendix 1: Nomenclature

The following are the symbols used in this paper

α = fine-structure constant (atomic structure constant)
ρ = mass ratio
m_e = electron rest mass
m_n = neutron rest mass
m_p = proton rest mass
m_y = unknown rest mass (turned out to be the electrino mass)
m_l = electrino rest mass
m_{ν_e} = electron neutrino mass
m_{ν_μ} = muon neutrino mass
m_{ν_τ} = tau neutrino mass
M_p = Planck mass
e = elementary electric charge
G = Newton's gravitational constant
ϵ_0 = permittivity of vacuum

REFERENCES

[1] R. A. Frino, *Exponential Formula for the Fine Structure Constant*, viXra.org: 1502.0143, (2015).

[2] NIST, *Fundamental Physical Constants—Extensive Listing*, retrieved 2011 from: http://physics.nist.gov/constants, (2010)

[3] R. A. Frino, *The Mass of the Electron – Part III*, viXra.org: pending, (2015).

[4] R. A. Frino, *Is the Electron Unstable?*, viXra.org: 1502.0194, (2015)