On the Electrino Mass

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Abstract

This paper explores the exponential formula for the fine-structure constant that 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 in terms of the masses of the two lightest leptons: the electron and the electrino (new lepton); and the lightest baryons: the neutron and the proton. The electrino is a new lepton predicted by the author in a previous paper entitled: Is the Electron Unstable?. This investigation suggests that the mass of this particle, if exists, is 529.3 times lighter than that of the electron.

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

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

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 a New Lepton: The Electrino

Let us have a look at equation (1.3) again

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

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 for the fine-structure constant, taking into account the electrino rest mass, m_l, is

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

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

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

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

$$\frac{m_l}{m_e} = \frac{1.720\ 950\ 285 \times 10^{-33}\, Kg}{9.109\ 382\ 91 \times 10^{-31}\, Kg} = \frac{1}{529.322\ 839\ 1} = 0.001\ 889\ 206\ 22$$

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. Conclusions

In summary, formula (2.2) predicts the existence of a new lepton lighter than the electron. This new lepton, called electrino, should have a mass of approximately $1.720\,950 \times 10^{-33} Kg$, which is about $1/529.3$ the mass of the electron. 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) [3]. It is likely that if this new super-light lepton exists, it will be sterile. Let us take up the question of why it is that the electrino has never been observed? The answer is that the mean lifetime of the electron is extremely long, about $(\pi/2)\times 10^{90}$ 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 (assuming this particle is unstable) 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 we can postulate that the number 18 in equation (2.2) is the total number of different quarks, q. Then equation (2.2) can be rewritten as:

$$\alpha = 2^{-q\left(\frac{m_e - m_l}{m_n - m_p}\right)} \tag{3.1}$$

This is the final exponential formula for the fine-structure constant. Now this formula is complete since it is exact.

Appendix 1: Nomenclature

The following are the symbols used in this paper

$\alpha =$ fine-structure constant (atomic structure constant)
$\rho =$ mass ratio
$m_e =$ electron rest mass
$m_n =$ neutron rest mass
$m_p =$ proton rest mass
$m_l =$ electrino rest mass
m_{ν_e} = electron neutrino mass
m_{ν_μ} = muon neutrino mass
m_{ν_τ} = tau neutrino mass
$q =$ total number of different quarks (18) (also total number of different anti-quarks)
$F_{JeV} =$ conversion factor from Joules to electron-volts

REFERENCES
[1] R. A. Frino, *Exponential Formula for the Fine Structure Constant*, vixra.org: viXra 1502.0143, (2015).
[2] NIST, *Fundamental Physical Constants—Extensive Listing*, retrieved 2011 from: http: //physics.nist.gov/constants, (2010)
[3] R. A. Frino, *Is the Electron Unstable?*, vixra.org: viXra 1502.0194, (2015)