Is the Electron Unstable?

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Abstract

The problem I shall address in this paper is concerned with the mean lifetimes of leptons (except neutrinos). Based on the hydrogen unit of time and following two simple rules I propose a formula for the lifetime of the tau particle. Then, based on the same rules I derive a formula for the lifetime of the muon. Finally, based on the two previous formulas and on the same rules, I derive the formula for the mean lifetime of the electron. The formula I found through this extrapolation process indicates that the electron is unstable and that its mean lifetime is, approximately, $(\pi/2)\times 10^{90}$ *years, which is about* 10^{80} *times the age of the universe. Thus according to this formulation the lifetime of the electron is extraordinarily long but not infinite as previously thought. This is in accordance with the author's belief that all matter is unstable.*

Keywords: *mean lifetime, fine-structure constant, tau particle, muon, electron, Planck's constant.*

1. Introduction

The electron has always been considered to be a stable particle. Or should I say that it was the case until now. In 2012 I developed this theory which, if it is correct, puts the electron in the "bag" of unstable particles. Let us consider the decays caused by weak and strong forces. The Hyperphysics web page entitled *Decays Caused by Weak and Strong Forces* [1] quotes: *"The lifetime of a decay is proportional to the inverse square of the coupling constant between the initial and final products"*

$$lifetime \propto \frac{1}{\alpha^2} \tag{1}$$

I shall generalize this law by postulating that the lifetimes of the leptons are proportional to the inverse of the *n* power of the electromagnetic coupling constant; where *n* is an integer. Mathematically I postulate that

$$mean\ lepton\ lifetime \propto \frac{1}{\alpha^n} \tag{2}$$

Based on this postulate and based on the hydrogen unit of time I shall derive the mean lifetime formulas for the tau particle, the muon and the electron, in that order. Thus, if these postulates are correct, we should get a very long mean lifetime for the electron. Since the electron is a fundamental particle with no evidence of a complex internal structure as that of the proton, we expect, assuming that these two particles are unstable, the electron to have a much longer mean lifetime than the proton. This is exactly what I have found.

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2. Nomenclature

I shall use the following nomenclature for the constants and variables used in this paper

α = fine-structure constant (atomic structure constant)
c = speed of light in vacuum
h = Planck's constant
m_e = electron rest mass
τ_τ = tau particle mean lifetime
τ_μ = muon mean lifetime
τ_e = electron mean lifetime
a_τ = numerator of the first factor for the tau particle
a_μ = numerator of the first factor for the muon
a_e = numerator of the first factor for the electron
n_τ = main part of the exponent N_τ of the formula for the tau particle mean lifetime ($N_\tau = n_\tau + 1$).
n_μ = main part of the exponent N_μ of the formula for the muon mean lifetime ($N_\mu = n_\mu + 1$).
n_e = main part of the exponent N_e of the formula for the electron mean lifetime ($N_e = n_e + 1$).
F = total number of generations of matter or families (3)
f = family quantum number or generation quantum number (1 for generation 1, 2 for generation 2 and 3 for generation 3)
a_0 = Bohr radius (hydrogen atomic radius corresponding to the quantum number n = 1)
t_H = hydrogen unit of time

3. Original Formulas for the Lifetimes of Leptons

In this section I shall introduce the original formulas for the lifetime of leptons. These formulas are based on the *hydrogen unit of time*, t_H , which is defined as follows

Hydrogen unit of time
Time taken by a photon to travel a distance equal to the diameter, $2a_0$ *, of the hydrogen atom. Where* a_0 *is the Bohr radius:* $a_0 = 0.529\ 177\ 210\ 92(17) \times 10^{-10} m$

Mathematically

$$t_H \equiv \frac{2a_0}{c} = \frac{1}{\pi\ \alpha} \frac{h}{m_e c^2} \qquad (3.1)$$

$t_H \approx 3.530\ 290\ 351 \times 10^{-19} S$

The original formulas are shown below

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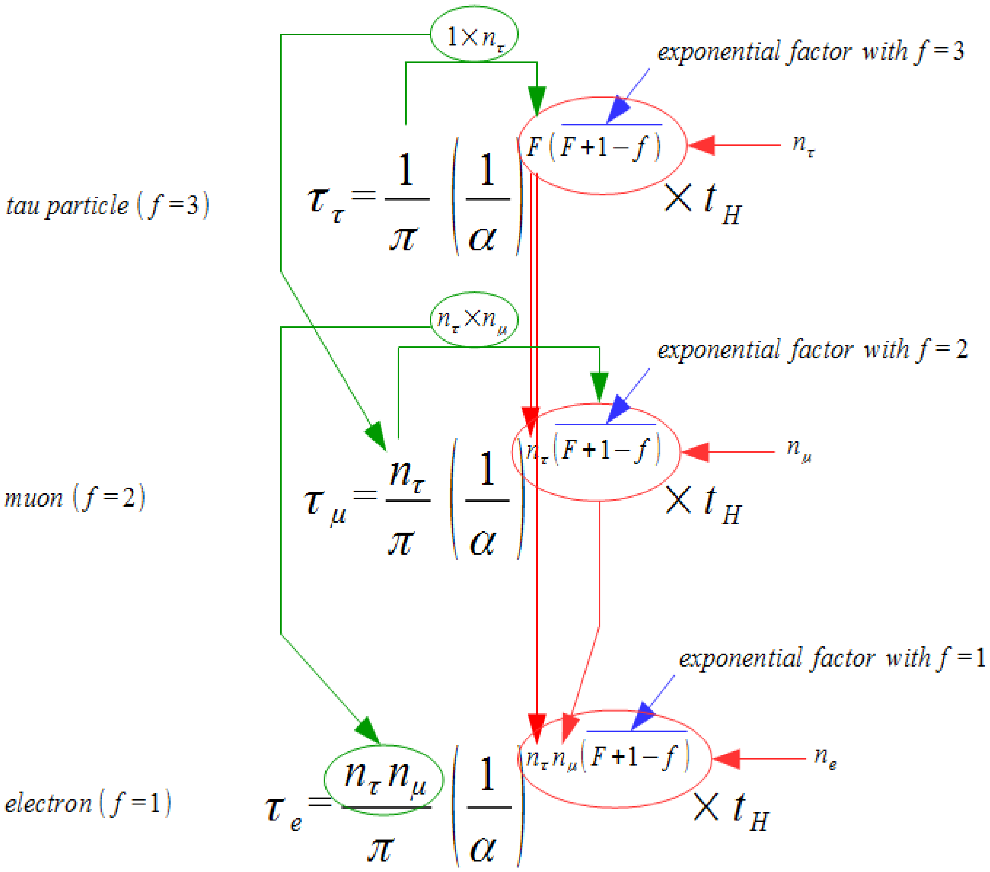

The formulas shown on Table 1 were derived from the corresponding formulas shown in the above picture by substituting t_H with the second side of equation (3.1). The rules are shown in green, red and blue. The additional number 1 in the exponent of the final formulas shown on Table 1 is due to the fact that the hydrogen unit of time contains an extra $1/\alpha$ factor. In summary, the exponent rule for the original formulas is

Exponent rule

Exponent for the tau particle = $F(F+1-f)=n_\tau$ (where F = 3 and f = 3)
Exponent for the muon = $n_\tau(F+1-f)=n_\mu$ (where F = 3 and f = 2)
Exponent for the electron = $n_\tau n_\mu(F+1-f)=n_e$ (where F = 3 and f = 1)

Note that F is a constant while f is a variable.

4. The Leptons' Final Mean Lifetime Formulas

Leptons (and quarks) are divided into three generations: the lepton generation 1 comprising the electron and the electron neutrino, the lepton generation 2 comprising the muon and the muon neutrino and the lepton generation 3 comprising the tau particle and the tau neutrino. In this article I shall only deal with the electron, the muon and the tau particle. Neutrinos lifetimes will not be addressed. Starting from the tau particle and taking into consideration the generalized lifetime formula (2), I shall, firstly, build the formula for the mean lifetime of the tau particle, secondly, the formula for the mean lifetime of the muon and, lastly, the formula for the mean lifetime of the electron.

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4.1 The Tau Particle Mean Lifetime Formula

The formula for the lifetime of the tau particle is

$$\tau_\tau = \frac{a_\tau}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha} \right)^{n_\tau + 1} \tag{4.1-1}$$

$$n_\tau = F \tag{4.1-2}$$

$$a_\tau = 1 \tag{4.1-3}$$

Where F is the total number of known families or generations of matter, which is 3, and a_τ is the numerator of the first factor, which is 1. Therefore we can build up the formula as follows

$$n_\tau = 3$$

The exponent for the tau particle lifetime formula is simply n_τ plus 1

$$n_\tau + 1 = 3 + 1 = 4 \tag{4.1-4}$$

Thus, the final formula for the tau particle is

$$\tau_\tau = \frac{1}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha} \right)^4 \tag{4.1-5}$$

It is worthy to observe that we have used the electron rest mass and not the tau particle mass. This has been done to be able to apply the same rules twice. These rules will be explained in subsection 3.3.

4.2 The Muon Mean Lifetime Formula

The formula for the lifetime of the muon is

$$\tau_\mu = \frac{a_\mu}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha} \right)^{n_\mu + 1} \tag{4.2-1}$$

$$n_\mu = n_\tau (F + 1 - f) \tag{4.2-2}$$

Because the constant a_μ is equal to n_τ (the main part of the exponent of the tau particle – this is the rule!) we can write

$$\tau_\mu = \frac{n_\tau}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha} \right)^{n_\mu + 1} \tag{4.2-3}$$

Once again F is the total number of families or generations of matter, $F = 3$ and n_μ is main part of the exponent for the muon lifetime formula. Because the muon belongs to

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the second generation of matter, the family quantum number, f , is 2. Thus the value of n_μ turns out to be

$$n_\mu = 3(3+1-2) = 6$$

$$n_\mu + 1 = 6 + 1 = 7 \tag{4.2-4}$$

Thus the final formula for the muon is

$$\tau_\mu = \frac{3}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha}\right)^7 \tag{4.2-5}$$

It is worthy to observe that we have used the electron rest mass and not the muon mass.

4.3 The Electron Mean Lifetime Formula

The formula for the lifetime of the electron is

$$\tau_e = \frac{a_e}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha}\right)^{n_e+1} \tag{4.3-1}$$

$$n_e = n_\tau n_\mu (F + 1 - f) \tag{4.3-2}$$

Because the constant a_e is equal to $n_\tau n_\mu$ (the product of the main part of the exponent for the tau particle and the muon – this is the rule again!) we can write

$$\tau_e = \frac{n_\tau n_\mu}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha}\right)^{n_e+1} \tag{4.3-3}$$

Thus we can write down two rules - *the factor rule* and *the exponent rule*:

Factor Rule

The factor a_f for generation f, is the product of the main part of the exponents of the heavier generations. For the heaviest generation $a_f = 1$.

Thus, for the muon there is only one heavier generation: the generation that corresponds to the tau particle, as a consequence $a_\mu = 1 \times n_\tau = n_\tau$. For the electron there are two heavier generations: one that corresponds to the tau particle and another one that corresponds to the muon, consequently $a_e = 1 \times n_\tau n_\mu = n_\tau n_\mu$.

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Exponent Rule

It is easier to express this rule mathematically than in written words. Thus we shall express it as follows

$N_\tau = F(F+1-f)+1$ where $F(F+1-f) = n_\tau$ with $F = 3$ and $f = 3$
$N_\mu = n_\tau(F+1-f)+1$ where $n_\tau(F+1-f) = n_\mu$ with $F = 3$ and $f = 2$
$N_e = n_\tau n_\mu(F+1-f)+1$ where $n_\tau n_\mu(F+1-f) = n_e$ with $F = 3$ and $f = 1$

Note that F is a constant while f is a variable.

Here, as in the previous two formulas, F is the total number of generations of matter $F = 3$ and n_e is part of the exponent for the electron lifetime formula. Because the electron belongs to the first generation of matter, the generation quantum number, f, is 1. Thus the value of n_e can be computed as follows

$$n_e = 3 \times 6\,(3+1-1) = 54$$

To get the complete exponent for the formula of the electron we simply add one.

$$n_e + 1 = 55 \qquad (4.3\text{-}4)$$

The numerator, a_e, of the factor that contains the number π^2 turns out to be

$$a_e = n_\tau n_\mu = 3 \times 6 = 18 \qquad (4.3\text{-}5)$$

Thus, the final formula for the electron lifetime is

$$\tau_e = \frac{18}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha}\right)^{55} \qquad (4.3\text{-}6)$$

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5. Summary

The following table shows the mean lifetime formulas for the tree heaviest leptons (neutrinos are not included in this formulation):

Particle	f	Mean lifetime formula (algebraic factors and exponents)	Mean lifetime formula (numeric factors and exponents)	Predicted value of the mean lifetime
τ (tauon)	3	$\tau_\tau = \frac{a_\tau}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha}\right)^{n_\tau+1}$ $a_\tau = 1$ $n_\tau = F(F+1-f)$ Then eliminating a_τ : $\tau_\tau = \frac{1}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha}\right)^{n_\tau+1}$	$\tau_\tau = \frac{1}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha}\right)^4$ (4.1-5)	$2.89 \times 10^{-13} S$
μ (muon)	2	$\tau_\mu = \frac{a_\mu}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha}\right)^{n_\mu+1}$ $a_\mu = n_\tau$ $n_\mu = n_\tau(F+1-f)$ Then eliminating a_μ : $\tau_\mu = \frac{n_\tau}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha}\right)^{n_\mu+1}$	$\tau_\mu = \frac{3}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha}\right)^7$ (4.2-5)	$2.23\, \mu S$
e (electron)	1	$\tau_e = \frac{a_e}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha}\right)^{n_e+1}$ $a_e = n_\tau n_\mu$ $n_e = n_\tau n_\mu (F+1-f)$ Then eliminating a_e : $\tau_e = \frac{n_\tau n_\mu}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha}\right)^{n_e+1}$	$\tau_e = \frac{18}{\pi^2} \frac{h}{m_e c^2} \left(\frac{1}{\alpha}\right)^{55}$ (4.3-6)	$4.96 \times 10^{97} S =$ 1.57×10^{90} *years* $=$ $\frac{\pi}{2} \times 10^{90}$ *years*

Table 1: Mean lifetime formulas for the tau particle, the muon and the electron. It is worthy to emphasize that the formulas were built from the tau particle (generation 3); this is from the heaviest particle up. Note that the generation or family quantum number *f* is different for each generation while *F* remains constant and equal to 3 throughout the three families. The mass of the electron is common to all formulas because these are based on the hydrogen unit of time.

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6. Experimental Values

The following table shows the observed values for the lifetimes of the tau particle and the muon

Particle	Experimental value of the mean lifetime	Reference
τ (tauon)	$(2.97 \pm 0.09(stat.) \pm 0.05(syst.)) \times 10^{-13} S$	[2]
μ (muon)	$(2.22 \pm 0.03)\,\mu S$	[3]
	$(2.19703 \pm 0.00004)\,\mu S$	[4]
	$(2.14 \pm 0.03)\,\mu S$	[5]
e (electron)	Is it really infinite?	-

Table 2: Measured values for the lifetimes of the tau particle and the muon.

7. Conclusions

From these three formulas we can draw the following conclusions:

(1) The predicted lifetimes for both the tau particle and the muon are in excellent agreement with the observed values.

(2) The predicted lifetime for the electron: $\frac{\pi}{2} \times 10^{90}$ years, is extraordinarily long but not infinite. This is agreement with the author's belief that there are no stable particles in the Universe (as a Meta-transformation [6]).

(3) The Universe as we know it, should have a finite lifetime.

(4) The decay products of the electron could comprise, amongst other particles, a negatively charged particle that I shall call: **electrino**. This hypothetical particle must be lighter than the electron. If the electrino exists, then there is either another generation of matter or this particle is sterile. Another probably less likely possibility is that the conservation laws do not apply for the electron decay, therefore the electron will decay into pure energy.

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(5) The exponent rules shown in section 3 suggest that there could be 4 generations of matter. If, for example, we rewrite the exponent for the tau particle:

$n_\tau = F(F+1-f)$ as $n_\tau = (G-1)(G-f)$ with $G = 4$ and $f = 3$

we could interpret G as the total number of generations of matter, this is 4 instead of 3.

(6) The hydrogen unit of time is an extremely important physical quantity which relates not only to the atomic structure and the lifetimes of leptons, but also to the entire Universe.

(7) The formulas presented in this paper suggest that a) the structure of the electron is, somehow, connected to the structures of the tau particle and the muon; and that b) the electron incorporates the parameters that make up the lifetime formulas of the other two heavy leptons. It seems that Nature needs at least three stages (the three generations of matter) to build a family with extremely long lifetimes. If this were the case, then we can ask the following question: Why didn't nature build the first generation of matter directly without using three stages? The answer so far is: We don't know. We are before a mysterious quantum mechanical phenomenon for which we have no explanation.

(8) It seems that the tau particle and the muon are simply heavy “ancestors” of the electron. These “ancestors”, however, have the particular property of coming back for a short period of time during decay processes. Thus we can say that these “ancestors” are in fact “alive ancestors” that “like to show up” from time to time when the “conditions are right”. If this is the case then both the tau particle and the muon should have been created just before the electron. The reason is simply because the electron came to exist through them. This is supported by the fact that the tau particle is the lepton with the simplest lifetime formula and with the shortest lifetime. In contrast, the electron is the lepton with the most complex formula and with the longest lifetime. This is in accordance with the fact that the complexity of the Universe increases with time (I mean as the universal time increases).

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