Alternate Models of Some of the Leptons

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It is shown here that the three leptons, the electron, the muon and the tau, appear to not be fundamental as declared by the Standard Model of Particle Physics, but are, instead, made of component particles. Electron-like particles here dubbed beta electrons and beta positron make up muons and free electrons. Muons are made of 103 beta electron-beta positron pairs plus a valence beta electron or beta positron surrounding a muon neutrino or antineutrino. The electron is beta electron orbiting an electron neutrino and the positron, a beta positron orbiting an electron antineutrino. The tau also appears to be beta electrons and beta positrons surrounding a tau neutrino or antineutrino; however, a definitive model is not offered here. Consequently, all three leptons and their antiparticles appear to be made of the beta electrons and positrons and their respective neutrinos or antineutrinos.

1. Introduction

Leptons are considered fundamental particles in the Standard Model, meaning they are not thought to be made of smaller component particles. However, the scattering analyses in reference 1 proposes that the proton is made of eight bound pions, each containing about 229 electrons and positrons.[1] Consequently, free pions appear to be made of 273 electrons and positrons.

The pion decays into a muon that appears to retain 207 of its electrons and positrons, seeming to challenge the notion that muons are fundamental particles. Unlike protons, for which probing particles have to be sent inside to determine their structure, leptons spew out an array of particles that reveal what they are made of.

2. Decay into an Electron and Neutrinos

When a free muon decays, it becomes a muon neutrino, an electron and an electron antineutrino,[2] or

$$\mu^- \rightarrow \nu_\mu + e^- + \bar{\nu}_e. \qquad (1)$$

Per the Standard Model, the electron and electron antineutrino that appear as a result of muon decay come from the decay of a W^- boson. The W^- is a gauge boson in the Standard Model responsible for carrying the weak force between particles, that has a mass of about 80 GeV. It supposedly forms with the muon neutrino when the muon decay occurs. The Feynman diagram in Fig. 1 shows the Standard Model muon decay.

Similarly, when a tau particle decays, about 18% of the time it also decays into its neutrino (a tau neutrino), an electron and an electron antineutrino,[3]

$$\tau^- \rightarrow \nu_\tau + e^- + \bar{\nu}_e. \qquad (2)$$

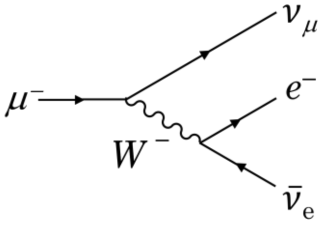

Fig. 1: **Feynman diagram of muon decay.**
The muon decays into a muon neutrino and a W^- *boson. The* W^- *then decays into an electron and an electron antineutrino.*

As with the muon decay, according to the Standard Model, the electron and electron antineutrino are the result of a W^- decaying. Fig. 2 shows the Feynman diagram of the tau decay in equation (2).

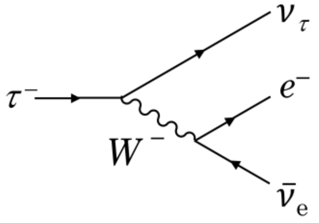

Fig. 2: **Feynman diagram of tau decay.**
The tau decays into a tau neutrino and a W^- *boson. The* W^- *then decays into an electron and an electron antineutrino.*

In both instances, the initial particle decays into its neutrino and a W^- boson, mildly suggesting that the difference between the particle and its neutrino is the W^- boson. However, the electron-proton deep inelastic scattering discussed in reference 1 indicates that the pion is made of particles the size of electrons and positrons, and it is known that pions decay into muons. Knowing these, another hypothesis of how the muon decays can be formulated.

The μ^- has a unit negative charge. Therefore, if it is made of electrons and positrons, there must be an unpaired electron that acts as the muon's valence electron. Consequently, the muon must contain $2n + 1$ particles: $n + 1$ electrons and n positrons. With a mass equivalent to 206.768 electron masses, n for the free muon could be 102, but it is more likely 103. This gives it a total of 207 particles, 103 positrons and 104 electrons.

With this muon model, a scenario for μ^- decay can be devised from three observations. First, only one electron emerges from the μ^- decay. From that, it appears that during the decay, the muon's n positrons must annihilate n of its electrons. This would leave only the muon's lone unpaired valence electron and produce about 105 MeV of annihilation energy. Most of this energy is subsequently carried off by the decay particles.

Next, a muon neutrino appears when the μ^- decays. Since no matching antineutrino appears, it does not appear to be the product of a pair production during the decay. In fact, it will be shown that this neutrino is likely the other half of a pair produced during the pion decay that formed the muon since $\pi^- \rightarrow \mu^- + \bar{\nu}_\mu$. It is a component of the muon before the decay. The annihilation of the muon's electrons and positrons during the decay sets it free. It is the central body that the electrons and positrons forming the μ^- assemble around.

Finally, an electron antineutrino appears along with the valence electron emitted during the μ^- decay. Electrons escaping the muon appear to become free electrons, but not without the creation of an electron antineutrino. It seems unlikely that an antineutrino would form without the formation of a neutrino as a result of pair production. The neutrino must somehow pair with the electron during the decay. This hints at the electrons inside the muon and proton, call them beta electrons (β^-), being different from free electrons (e^-).

It is not unreasonable to speculate that muons are produced from charged pions, which are made of (beta) electrons and positrons that annihilate each other during its decay. The charged pions are 133 electron-positron pairs and an unpaired valence electron or positron. When the pions decay, their electrons and positrons apparently annihilate each other. It seems the electrons and positrons continue the annihilations until there are only 103 pairs left, the number of electron-positron pairs needed to form a muon. At that point, somehow the net charge of the partially decayed pion, along with its mass and energy from the annihilations produce a muon neutrino-antineutrino pair.

What is left of the pion, the 103 electron-positron pairs and either the unpaired electron captures the neutrino, or the unpaired positron captures the antineutrino. At this point, the charged pion has transformed into a muon or antimuon. The uncaptured neutrino or antineutrino becomes a decay product.

Once the muon forms, the beta electron-beta positron annihilations apparently continue, now causing the muon to decay. Similar to the pion, when all the beta electron-positron pairs of the muon have annihilated, it appears the charge of the final beta electron or beta positron plus its mass and the annihilation energy somehow produces an electron neutrino-antineutrino pair. The lone beta electron captures the neutrino to become a free electron or the beta positron captures the antineutrino to become a free positron.

This makes the muon a composite particle made of its neutrino surrounded by beta electrons and beta positrons. The electron also appears to be composite, consisting of a beta electron coupled to an electron neutrino. Since tau particles decay into muons and electrons, they, too, appear to be composite. Only beta positron, beta electron and the three neutrinos appear to be fundamental.

3. The Structure of Free Electrons

During muon decay, it appears a beta electron produces a neutrino-antineutrino pair using annihilation energy, from which it captures the neutrino to become a free electron. This conversion process does not appear to be limited to muon decay. Beta electrons seem to produce neutrino-antineutrino pairs to transform into free electrons whenever beta decays occur.

Radioactive nuclei appear to be ones that have an excess of particles. An excess of alpha particles causes alpha decay, an excess of electrons or positrons, beta decay, and an excess of electron-positron pairs causes gamma emission. In a nucleus containing an excess beta electron or positron, it seems the excess beta electron or beta positron initiates the decay by igniting the annihilation of some beta electron-positron pairs. This creates a pool of annihilation energy within the nucleus. The annihilation provides the excess charged particle with the energy it needs to spawn a neutrino-antineutrino pair.

If the excess particle is a beta electron, β^-, it captures the neutrino to become a free electron, e^-, and both it and the leftover antineutrino exit the nucleus. If the excess particle is a beta positron, β^+, it captures the antineutrino to become a free positron, e^+, and it and the neutrino exit the nucleus.

The reaction sequences below show examples of how these negative (^3H) and positive (^{13}N) beta decays likely occur. They show the internal annihilations occurring creating energy (ε) and an altered form of the isotope (X^*). The energy engulfs an excess β^- or β^+ inside the ( ) spawning a neutrino-antineutrino pair inside the { }.

If the excess beta is a β^-, it couples with the neutrino inside { }, becoming a free electron, e^-; which, along with the residual antineutrino, exit the nucleus (^3He). If the excess beta is a β^+, it couples with the antineutrino inside { } and a free positron and neutrino exit the nucleus (^{13}C). Everything inside the braces [ ] below happens inside the original nucleus. The ε^* is the energy after the pair production.

$$\begin{aligned}
{}^3_1H \;&\rightarrow\; {}^3_1H^*[\varepsilon] \\
&\rightarrow\; {}^3_2He^*[\varepsilon(\beta^-)] \\
&\rightarrow\; {}^3_2He^*[\varepsilon^*(\beta^- + \{\nu_e + \bar{\nu}_e\})] \\
&\rightarrow\; {}^3_2He^*[\varepsilon^*(\{\beta^- + \nu_e\} + \bar{\nu}_e)] \\
&\rightarrow\; {}^3_2He \;+\; e^- \;+\; \bar{\nu}_e \;+\; \varepsilon^*, \\
{}^{13}_7N \;&\rightarrow\; {}^{13}_7N^*[\varepsilon] \\
&\rightarrow\; {}^{13}_6C^*[\varepsilon(\beta^+)] \\
&\rightarrow\; {}^{13}_6C^*[\varepsilon^*(\beta^+ + \{\bar{\nu}_e + \nu_e\})] \\
&\rightarrow\; {}^{13}_6C^*[\varepsilon^*(\{\beta^+ + \bar{\nu}_e\} + \nu_e)] \\
&\rightarrow\; {}^{13}_6C \;+\; e^+ + \nu_e \;+\; \varepsilon^*.
\end{aligned}$$

The electron capture process appears to support this model of the electron. The nucleus pulls a free electron, e^-, in, reducing its charge and mass. At some point during the capture process, an electron neutrino appears. Based on the model offered above, that neutrino was part of the free electron.

Electron capture is equivalent to β^+ decay, which reduces the mass and charge of the nucleus by emitting a positron from the nucleus. Therefore, upon entering the nucleus, the newly acquired electron must annihilate a beta positron. To do this, the β^- part of e^- likely separates from the neutrino. This is probably why the neutrino appears during the process.

4. Leptons and their Neutrinos

The diagram in Fig. 3 shows the muon decay with the muon neutrino emerging along with a β^{*-} instead of a W^-. The β^{*-} is the sole surviving β^- of the mass annihilation of the beta electrons and beta positrons that made up the bulk of the muon. The asterisk (*) indicates that the β^- is immersed in a pool of annihilation energy. The β^{*-} essentially "decays" into a free electron and an electron antineutrino by creating a neutrino-antineutrino pair from the annihilation energy produced during the decay and capturing the neutrino.

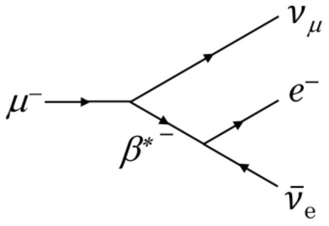

Fig. 3: **Feynman diagram of the modified muon decay**
Diagram showing the muon neutrino and the valence beta electron emerging from the initial annihilation of the 103 beta electron-beta positron pairs. The beta electron essentially decays into a free electron and an electron antineutrino.

One might propose that the muon neutrino that appears during the decay could also be the product of pair production like the electron neutrinos. There, only the electron antineutrino is visible (indirectly). However, even though the electron neutrino is not visible, it is accounted for as part of the free electron. The muon neutrino is there, but where is the muon antineutrino after the decay?

The answer is – there is not one. As with the electron in muon decay, when the muon is the product of a decay, like pion decay, a muon antineutrino also appears. In fact, when that happens in one branch of tau decay, one also appears.

When a τ^- decays, in addition to the decay branch shown in equation (2), about 17% of the time it can also decay into a tau neutrino, a muon and a muon antineutrino,[4]

$$\tau^- \rightarrow \nu_\tau + \mu^- + \bar{\nu}_\mu. \qquad (3)$$

Here, when the free muon forms, a muon antineutrino also appears like the electron antineutrino appearing when the free electron forms during muon decay. This signals that a muon neutrino-antineutrino pair formed during the tau decay, from which the muon neutrino was captured to form a free muon.

The remaining muon antineutrino is left as a decay product of the tau decay like the electron antineutrino is after free electron formation during muon decay. The Feynman diagrams of the τ^- decays in equations (2) and (3) are shown in Fig. 4. The X in the diagram on the left represents a collection (> 207) of β^- and β^+ particles.

But, in a decay event starting with a muon like in Fig. 3, the muon already exists. Therefore, the neutrino appearing during the decay does not come from a pair production ignited to form a particle. Consequently, less any other viable source, the muon neutrino that appears during muon decay must come from within the muon.

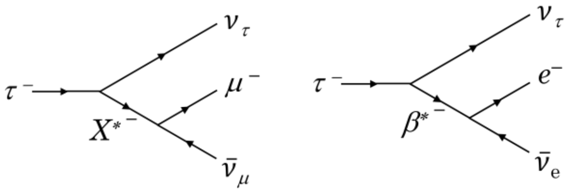

Fig. 4: **Feynman diagrams of modes of tau decay.**
In both, the tau decays into a tau neutrino and another lepton and its antineutrino. The X^{*-} *in the diagram on the left is an unknown precursor to the muon that forms.*

The tau parallel to the muon model is a τ^- made of $2n + 1$ particles: $n + 1$ electrons and n positrons, but with a mass of 3,477.15 electron masses, n must be about 1,738 for the τ^-. Like the muon, the electrons and positrons making up the τ^- apparently orbit a tau neutrino. The τ^- decay should occur in the same manner as the decay of the μ^-; and indeed, the branch of its decay shown in Fig. 2 does appear to do so. However, because of its large mass, τ^- can decay along other paths, including forming the less massive muon.

About 5.5% of the time, charged D_s mesons decay into tau leptons forming tau neutrino-antineutrino pair,[5] just as pions form muon neutrino-antineutrino pairs when they decay into muons. Consequently, when the tau decays a tau neutrino appears, just as a muon neutrino appears in Fig. 3 when the muon decays, and an electron neutrino appears when the electron disintegrates during electron capture. All three particles are leptons. The appearance of their respective neutrinos when they disintegrate seems to show that the core of a lepton is its neutrino.

The Feynman diagram in Fig. 5 shows how electron capture can be interpreted as the decay of the electron like the decay of its cousins the muon and the tau. As the electron gets pulled into the nucleus, it splits (decays) into an electron neutrino and a beta electron. Its core neutrino is freed as is its valence beta electron, just as is the case in muon decay and in one version of tau decay.

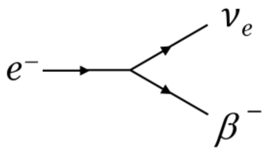

Fig. 5: **Pseudo-decay of the electron during electron capture.**
Feynman diagram of the free electron as it is pulled into the nucleus. It splits into an electron neutrino and a beta electron.

If the electron is a beta electron coupled with an electron neutrino and the muon about 207 beta electrons and positrons orbiting a muon neutrino, then is the tau, at about 3,477.15 electron masses, about 3,477 beta electrons and positrons orbiting its tau neutrino?

5. A Model of the Electron

The lepton decays discussed in section 4 suggest that the electron is made of a beta electron coupled to an electron neutrino. It can be shown that the electron magnetic moment supports an electron model with the beta electron orbiting the neutrino.

At first glance, it seems the electron magnetic moment, μ_e, should be equal to the Bohr magneton, μ_B, but it is not. The magnitude of the electron's magnetic moment, $\mu_e = -9.28476 \times 10^{-24}$ J/T, is slightly greater than the Bohr magneton, which is $\mu_B = -9.27401 \times 10^{-24}$ J/T. The actual magnetic moment is 1.0011659 times greater than the Bohr magneton or $\mu_e = 1.0011659\ \mu_B$.

In the Standard Model, this difference is attributed to quantum loop effects that cause the gyromagnetic ratio of a particle, g_p, to deviate from the Dirac equation value of $g = 2$. The loop effects are characterized by the anomalous magnetic moment of the particle, a_p, where $a_p = (g_p - 2)/2$.

For the electron, the anomalous magnetic moment is $a_e = (\mu_e/\mu_B) - 1$, or $a_e = 0.0011596$.[6] This makes the gyromagnetic ratio of the electron $g_e = 2.0023192$. However, the difference also provides a clue to the structure of the electron.

The dimensions of the magnetic moment, Joules per Tesla (J/T), reduce to Coulombs meters-squared per second (C-m^2/s). In the macroscopic world, this is usually interpreted as the product of a current (C/s) and an area (m^2). The magnetic moment is the product of a current of electricity moving through a loop of wire, times the area of the loop. This interpretation produces the Bohr magneton as the magnetic moment of the electron.

However, the units of magnetic moment can also be interpreted as a "moment of charge" (C-m^2) – similar to the moment of inertia for mass (kg-m^2) – times a frequency of revolution (s^{-1}). This interpretation seems more appropriate for determining the moment of a single particle versus the many particles flowing through a wire. Now, the magnetic moment of a charged particle becomes

$$\mu = I_q \nu, \tag{4}$$

where I_q is its moment of charge and ν is its spin frequency.

The moment of inertia, I_m, (mass) for a solid sphere is $I_m = {}^2/_5\, mr^2$, where m is the mass of the sphere and r is its radius. Replacing the mass in the expression with charge makes the moment of charge, I_q, for a solid sphere $I_q = {}^2/_5\, qr^2$, where q is the charge of the particle. The moment of inertia for a thin-shelled hollow sphere is $I_m = {}^2/_3\, mr^2$, making the moment of charge for the hollow sphere $I_q = {}^2/_3\, qr^2$.

The classical electron radius is 2.8 x 10^{-15} m, roughly three times the proton radius of 0.9 x 10^{-15} m, but its mass is 1,836 times smaller than the proton's mass. Assuming the density of the matter forming the electron is the same as that making up the proton, then for the electron to be larger, it must not be solid. This can be the case if the mass of the electron is concentrated in a small particle that conserves the density of nuclear matter, in an orbit having the electron's classical radius.

The model proposed here is a composite electron with a beta electron in a high-frequency orbit around a neutrino. If the orbit of the beta electron precesses about an axis through the neutrino, the beta electron creates a virtual thin-shelled hollow sphere around the neutrino. This is consistent with the size difference between the electron and proton. This configuration would make the electron's moment of charge $I_e = {}^2/_3\, q_e r_e^2$; and its magnetic moment, $\mu_e = {}^2/_3\, q_e r_e^2 \nu$. A diagram of this electron model is shown in Fig. 6.

While the high-frequency, precessing orbit of the beta electron around the neutrino approximates a thin-shelled hollow sphere; in reality, it is a beta electron in a high-frequency orbit around a neutrino. It turns out that the moment of inertia for a particle whose motion approximates a thin-shelled hollow sphere is slightly greater than the moment of inertia of a hollow sphere. In addition to the moment of inertia of the hollow sphere, the moment of inertia of the particle must also be accounted for using the parallel axis theorem.[7]

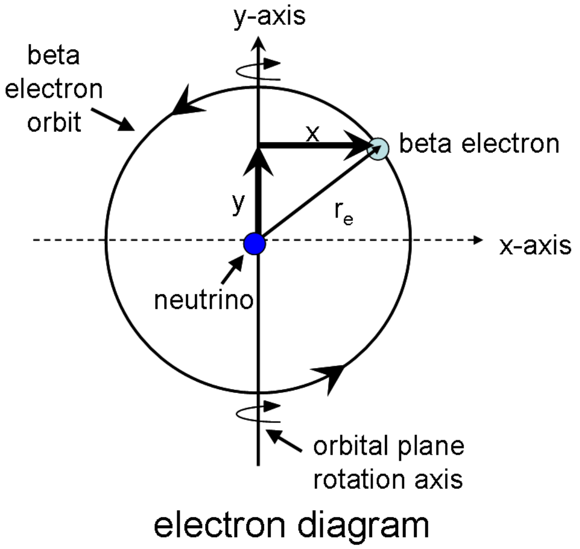

Fig. 6: Diagram of the electron model
The electron depicted as a beta electron orbiting a neutrino. As the beta electron orbits, the orbit precesses about the y-axis creating the illusion of a hollow sphere.

Briefly, the parallel axis theorem states that the moment of inertia of a body with respect to an axis not through the body, I', equals the moment of inertia of the body, plus the product of its mass and the average distance squared it is from the desired axis. That is, $I' = I + md^2$, where d^2 is the average distance squared from the axis.

Paralleling this adjustment to the moment of charge gives $I' = I + qd^2$; which, for the electron, becomes $I_e = I_{be} + q_{be}\, d^2$. Here, the subscript, "*be*", denotes the beta electron and d^2 is the average square distance the beta particle is from the rotation axis during one complete orbit.

Assuming the beta electron is a solid sphere, its moment of charge is $I_{be} = {}^2/_5\, q_{be}\, r_{be}^2$. The average distance squared that the beta particle is from the moment axis during its orbit is determined by assuming it follows a circular orbit. The equation of the orbit, if it is in an x – y plane, is $x^2 + y^2 = r_e^2$, or $x^2 = r_e^2 - y^2$. This relationship makes the average distance squared

$$d^2 = \frac{\int_0^{r_e} x^2 dy}{\int_0^{r_e} dy} = \frac{\int_0^{r_e} (r_e^2 - y^2) dy}{\int_0^{r_e} dy} = \frac{r_e^3 - \frac{1}{3} r_e^3}{r_e} = \tfrac{2}{3} r_e^2. \qquad (5)$$

Therefore, the product of the beta electron charge and its average distance squared from the moment axis during one complete orbit is

$$q_{be}\, d^2 = {}^2/_3\, q_{be}\, r_e^2 = {}^2/_3\, q_e\, r_e^2,$$

since $q_{be} = q_e$. This is equal to the hollow-sphere electron moment of charge. Using it and the beta electron moment of charge, the actual moment of charge for the electron, $I_e = I_{be} + q_{be}\, d^2$, becomes

$$I_e = {}^2/_5\, q_{be}\, r_{be}^2 + {}^2/_3\, q_e\, r_e^2,$$

or

$$I_e = (\tfrac{3}{5}\frac{r_{be}^2}{r_e^2} + 1)(\tfrac{2}{3} q_e r_e^2). \qquad (6)$$

If the hollow sphere moment of charge corresponds to that of the Bohr magneton, then the expression in the first set of parentheses in Eq. (6) appears to correct it to the actual electron moment of charge. Assuming the frequency used to calculate the magnetic moment is the same for both the electron and the Bohr magneton, the expression in the first set of parentheses is the 1.0011596 factor that corrects the Bohr magneton to the actual electron magnetic moment. This makes the anomalous magnetic moment of the electron

$$a_e = \tfrac{3}{5}\frac{r_{be}^2}{r_e^2}, \qquad (7)$$

or

$$0.0011596 = \tfrac{3}{5}\frac{r_{be}^2}{r_e^2}, \qquad (8)$$

which makes

$$r_e = 22.75 r_{be}. \qquad (9)$$

This says that the radius of the free electron, which is a composite made of the beta electron and a neutrino, is about 23 times the radius of the beta electrons and beta positrons that reside within the proton. It also suggests that the *g*-factor that adjusts the Bohr magneton to the electron magnetic moment is due to the presence of the small beta electron in the free electron.

6. A Model of the Muon

Muon decay indicates that, like the electron, the muon has one of its neutrinos as a component. Its mass of 206.768 free electron masses and unit negative charge suggests a muon model containing 207 particles – 104 beta electrons and 103 beta positrons. Assuming they configure themselves in orbits around the muon neutrino at the center of the muon, the muon takes the form of a large electron. It is an electron with 207 beta particles orbiting its neutrino instead of one.

As with the electron, the magnetic moment of the muon can give some insight into how the beta electrons and beta positrons configure themselves within the muon. Since the muon and the electron have the same charge, the muon equivalent of the Bohr magneton is the Bohr magneton equation with the muon mass replacing the electron mass. Therefore, the "muon" magneton, μ_M, is the Bohr magneton times m_e/m_μ.

The muon magnetic moment is $1.0011659\mu_M$, which means that its anomalous magnetic moment is $a_\mu = 0.0011659$ compared to $a_e = 0.0011596$ for the electron. Having an anomalous magnetic moment nearly identical to that of the electron is a strong indication that the beta particles inside the muon are in orbits similar to that of the single beta electron in the free electron in Fig. 6. By replacing 0.0011596 in equation (8) with 0.0011659, the muon equivalent to equation (9) becomes

$$r_\mu = 22.65 r_{be}. \qquad (10)$$

All the beta electrons and beta positrons must be orbiting the central muon neutrino at that radius, and their orbital planes must rotate about an axis similar to Fig. 6. This would produce a much denser version of the free electron. A particle that is essentially the same size as a free electron, but about 207 times more massive.

If the muon is made of 207 beta particles, then the simplest model of it is a sphere containing 207 beta particles, each scribing out an orbit like the beta particle orbit in the electron. This would form 207 meridians around the central neutrino.

The problem with this model is that each beta particle orbit takes up two spaces on the muon equator because it passes through the equator twice. Therefore, 207 orbiting particles, side-by-side along the equator of the muon makes the circumference of the muon equator 414 beta particle diameters, or 828 beta particle radii. Since the circumference of the muon is 2π times its radius, the relationship between the beta electron radius and the muon radius becomes

$$2\pi r_\mu = 828 r_{be},$$

$$r_\mu = 131.78 r_{be}. \quad (11)$$

This muon radius is much greater than the muon radius required to produce the anomalous magnetic moment of 0.0011695 determined in equation (10), which means the model is not right.

One way to modify the muon model to align better with the electron is to put six beta particles, three beta electrons and three beta positrons, in each orbital around the muon neutrino. This would reduce the number of orbitals around the neutrino by a factor of six, from 207, to 34, with three betas left over. It now makes the muon equator 136 beta-electron radii, instead of 828.

With this model

$$2\pi r_\mu = 136 r_{be}, \text{ or } \quad r_\mu = 21.65 r_{be}, \quad (12)$$

much closer to equation (10). Realizing that equation (12) represents a 207-electron muon, one more orbital, which contains only three beta particles, must be added to the model. It must contain either two electrons and one positron or two positrons and one electron. This adds two beta electron diameters or four beta electron radii to the circumference of the muon equator. It makes equation (12)

$$2\pi r_\mu = 140 r_{be}, \text{ or } \quad r_\mu = 22.28 r_{be}, \quad (9)$$

even closer to equation (10).

Fig. 7 shows what the muon might look like. The hemisphere shown in the figure contains about half of the beta electrons and beta positrons making up the muon. The other half is on the hidden hemisphere on the other side of the muon. The beta particles orbiting the central muon neutrino are all moving from bottom to top in the hemisphere shown, and top to bottom in the hidden hemisphere.

Alternating beta electrons (black dots) and beta positrons (white dots) orbit a muon neutrino (star) to form the muon. The figure shows 53 of the 104 beta electrons and 52 of the 103 beta positrons in orbit around the muon neutrino, the gray star at the center. The diagram also shows the axis of rotation of the muon, about which, the orbital planes of the beta particles in a free muon precess.

From equations (9) and (10), the radius of the electron is essentially the same as the radius of the muon. Reference 1 showed that if the charge is evenly distributed throughout the proton, then the radius of the pions in it is about 0.33 x 10^{-15}m. With some analysis, it can be shown that when pions decay into muons, the muons are the same size (radius) as pions. Therefore, the radius of the electron would also be the same as that of the pion, which is about 0.33 x 10^{-15}m.

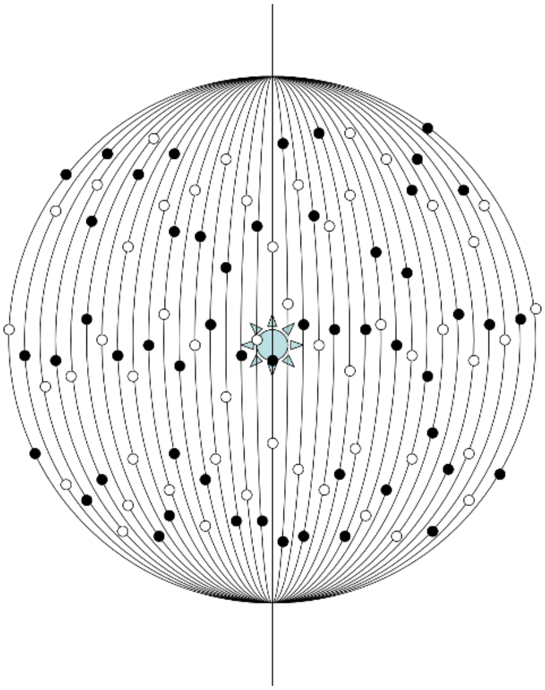

Fig. 7: Diagram of the muon model
The muon depicted as 207 beta electrons (black dots) and positrons (white dots) orbiting a muon neutrino (star) in 35 orbits. As the beta particles orbit, the orbits precess about the axis creating the illusion of a hollow sphere.

This model of the muon shows why muons and electrons are sometimes interchangeable in physical situations. A muon is truly just a heavy unstable electron. Beta particles inside the muon orbiting the muon neutrino explain why the free electrons do not retain their electron neutrinos while in the proton. They no longer need them because they have the pion's orbits. This also is why the free electrons lose their electron neutrinos upon entering the nucleus during electron capture.

An electron radius of 0.33×10^{-15}m means that the proton radius appears to be about 2.65 times the radius of the electron. This electron radius is nearly an order of magnitude smaller than the classical electron radius of 2.8×10^{-15}m.

7. A Model of the Tau

The Standard Model predicts the anomalous magnetic moment of the tau (0.0011772) to be slightly greater than the anomalous magnetic moment of the muon (0.0011695), which is slightly greater than that of the electron (0.0011596). This suggest that, in the Standard Model, the tau is just an extension of the muon and electron.

If the tau is just a heavy muon, then one might expect it to be similar in structure to the muon. This is not an unreasonable expectation since it can decay into a muon. Given the distinctive structure of the muon, the tau likely shares the major features of it. Consequently, one model of the tau could be a tau neutrino inside a shell of 3,477 beta particles, 1,738 beta electron pairs and a valence beta electron or positron.

If the tau retains the 35 orbitals of the muon, each orbital would contain about 100 beta particles. Since equation (13) puts the muon radius at about 22 times that of a beta electron, a muon orbital can hold a maximum of about 70 beta particles. To hold 100 beta particles, the circumference of the orbital must be increased by about 43% to 31.8 beta electron radii. However, at this radius, the betas would be crammed into the tau; so, for this model, it is likely even greater.

This model could facilitate the decay of a tau into a muon or electron. For a muon, it need only burn off the appropriate number of electron-positron pairs (1,635) through annihilation and produce a muon neutrino-antineutrino pair in the process. For the electron, all the beta electron-positron pairs must get annihilated and an electron neutrino-antineutrino pair created.

Because a specific number of beta electron-positron pairs must be annihilated to form the muon, it seems more likely that a second shell of beta pairs surround the shell containing the 207 beta particles that will form the muon. That shell contains the 1,635 pairs that must annihilate to form the muon. Now, the particle starts out as a tau, then quickly burns off its outer shell, becoming a muon.

It turns out that, because of its short lifetime, the tau's magnetic moment cannot be determined by the conventional means used to measure the magnetic moments of the muon and the electron. Consequently, to date, no experimental value of the tau particle anomalous magnetic moment, a_τ, has been measured. However, a number of indirect techniques have been employed in an attempt to place limits on the value of a_τ. The latest range is $0.013 < a_\tau < -0.056$.[8]

In most cases, the limits indicate that the actual anomalous magnetic moment of the tau is significantly greater than the Standard Model prediction. This suggests that the Standard Model does not provide a good model of the tau. It also suggests that, contrary to the Standard Model implication, the tau is not an extrapolation of the muon and electron. Its structure is far more complex than theirs, and its magnetic moment is not determined by the same parameters.

The uncertain anomalous magnetic moment could support the shell-in-shell model of the tau mentioned earlier. The outer shell would have a radius greater than the inner shell radius, which is apparently what produces the anomalous magnetic moment predicted by the Standard Model. The larger radius of the outer shell would cause the tau particle to have an anomalous magnetic moment greater than the Standard Model prediction.

A review of the tau decay modes reveals that the tau can decay into either multiple mesons (π's and K's) or lepton pairs (μ^+-ν_μ, μ^--$\bar{\nu}_\mu$, e+-ν_e or e^--$\bar{\nu}_e$), but not both simultaneously. This suggests that the particles being called taus may actually be a mixture of two different particles. One of the particles is like the leptons e and μ, call it τ_L, and the other is like the mesons K and D, τ_M. In fact, D_s mesons decay into tau leptons about 5.5% of the time, and even B mesons can decay into taus, although rarely (< 0.06%). The lifetime of the D, 5.0×10^{-13} seconds, is also suspiciously close to that of the τ, 2.9×10^{-13} seconds.

Particles thought to be taus decay into lepton pairs about 37% of the time, probably the τ_L's and into mesons the remaining 63%, the τ_M's. It may be that the ones that decay into leptons are real taus and the others, a meson whose mass is close to that of the tau. In many instances, the τ^- is thought to decay into a tau neutrino and a collection of up to seven pions,[9] some charged and some uncharged.

Of course, the tau neutrinos cannot be seen by detectors and only are implied through missing mass. Likewise, particles like neutral pions are also invisible to the detectors. In instances where they are also part of the decay, the neutral pions may be carrying the missing mass attributed to the tau neutrino. There may be no tau neutrino involved in those decays at all.

Given its mass, the tau could be a collection of pions, similar to the proton. With 3,477 electrons and positrons, the tau could contain as many as 12 pions, one and one half as many as the proton. Charged pions have a mass of 139.6 MeV. If they are made of just beta electrons and beta positrons, they contain about 273 betas – 136 positrons and 137 electrons. The mass of a neutral pion is 135 MeV or about 264 electron masses, making a model of it 132 electrons and 132 positrons.

A τ^- made of 3,477 particles could be made of 12 charged pions – six positive and six negative – with 201 electrons and positrons left over. Some of the pions in the tau model could be neutral, making it likely that the model contains 13 or more pions. The 12 pions allow for virtually no mass defect to produce binding. An extra pion could produce about 15 - 20 MeV/particle binding energy.

8. References

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