A tau particle model based on the Sternglass theory

By: Ray Fleming

Summary
Ernest Sternglass determined that a neutral meson, the π^0 could be modeled as a relativistic electron-positron pair, and later determined that the muon could be modeled as an electron rotating around a similar electron-positron pair. The author noticed that there is a second higher-energy orbital solution not previously published by Sternglass where the electron-positron pair orbits around the electron's center. A simple computation shows that the mass-energy of this second solution is consistent with the tau particle. Based on these models the mu and tau leptons are not fundamental particles as described in currently popular theories but are instead two excited meta-stable states of an electron and an electron-positron pair.

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Background

In 1961 Ernest Sternglass published a paper titled "*Relativistic electron-pair systems and the structure of the neutral meson*" in which he described a relativistic Bohr-Sommerfeld model of an electron-positron pair. He was able to show that when the pair was in a relativistic equilibrium condition, where the inertia pulling the two particles apart was equal to the electrostatic attraction, the pair had mass-energy and a half-life consistent with a neutral meson, the neutral pion (π^0).[1] In his book Before the Big Bang: Origins of the Universe Sternglass recounts how he performed his initial mathematical derivation in the presence of and with encouragement from Richard Feynman.[2]

Sternglass went on to extend his theory and describe all the known particles of the day.[3] One of the more interesting is the muon, as today it is considered to be a fundamental particle classified as a lepton within the scope of the standard model. The other leptons, the electron and tauon, are also considered to be fundamental, rather than composed of other particles. Sternglass, however, published a rather compelling model for the muon in 1965.[3] Given the simplicity of the model it seems likely that the muon is not fundamental.

The Muon

The Sternglass model of the muon is shown in figure 1. An electron rotates counter-clockwise around an electron-positron pair that is also rotating counterclockwise. The electron-positron pair is in the form of a Sternglass neutral pion, but is in an excited state with both particles' magnetic moments oriented in the same direction. The magnetic moments of the pion and electron are oriented in opposite directions allowing for magnetic coupling between them. He derived the mass-energy for this model as $206.7 m_o c^2$ where m_o is the mass of the electron.[3] That equals 105.6 Mev/c^2 in good agreement with the known mass. The radius is 1.41 fermi (10^{-15} meter =femtometer=fm).[3]

1)

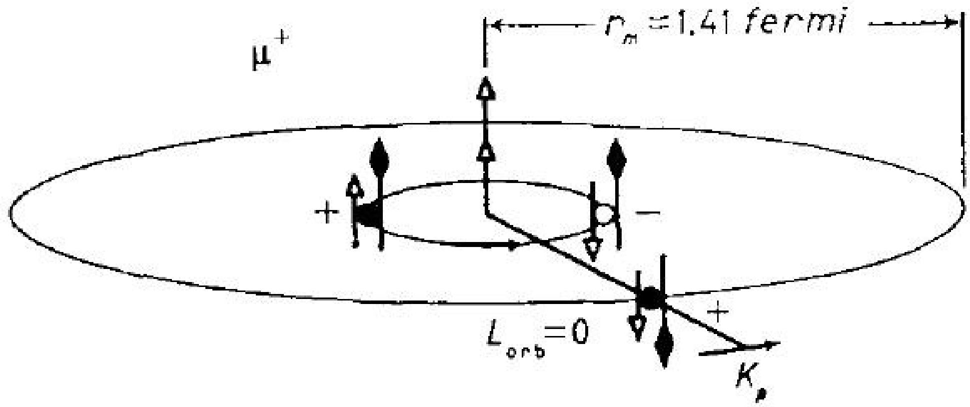

Figure 1 The Sternglass model for the Muon. The solid arrows indicate the direction of each particle's magnetic moment. The open arrows indicate the direction of the angular momenta. (Figure by Sternglass from reference 3)

The mass calculation required a sum of 6 contributions.[3] The first two contributions are the mass of the excited pion, $275m_oc^2$, and the mass of the electron, $1m_oc^2$. From that is subtracted the potential energy of the system $-274\ m_oc^2$. Next the kinetic energy of the orbiting electron, $(1/\alpha -1)\ m_oc^2 = 136m_oc^2$, is added, with α being the fine structure constant. Additionally there is relativistic precession of the system as viewed from a laboratory frame of reference, which introduces an additional $68.75m_oc^2$. Lastly he considered the wave mechanical binding energy between the electron and pion leading to a small correction term of $-.014m_oc^2$. This calculation yields the sum of $206.7m_oc^2$.

2)

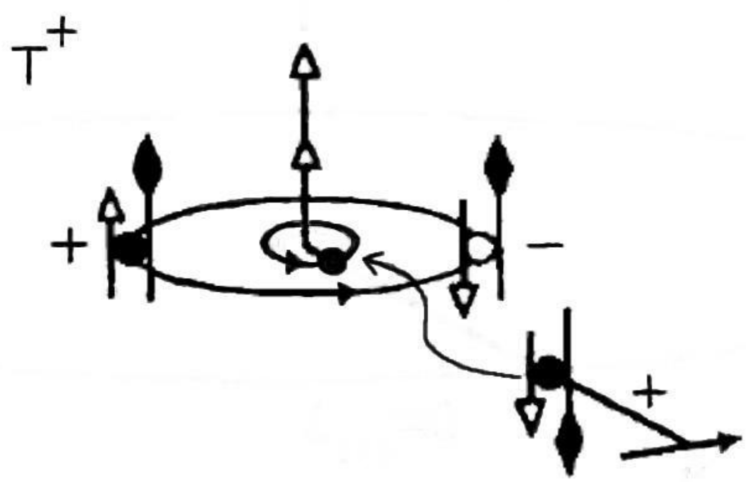

Figure 2 A Sternglass type model for the tau particle. The solid arrows indicate the direction of each particle's magnetic moment. The open arrows indicate the direction of the angular momenta.

The Tau Particle

In the muon model the electron orbits the electron-positron pair. There is, however another orbital solution where the electron-positron pair orbits the electron's center. This is shown in figure 2. Note that the electron is not located at the origin because the positron is attracted to it while the other electron is repelled. There is an additional constraint on the electron radius due to the magnetic coupling.

In order to calculate the change in kinetic energy for the electron we need to know the change in the radius. Sternglass' calculation of the muon radius was based on the equation in figure 3. Note that the radius cubed is inversely proportional to the magnetic moments of the pion and electron.

3)

$$E_{\sigma,\sigma}\big|_{\max} = -\frac{\mu_{\pi_1^0}\cdot\mu_B}{r_m^3} = (2/\alpha)m_0c^2$$

Figure 3 The energy equation as it applies to the Sternglass model for the muon. (Equation from Sternglass reference 3)

Sternglass additionally noted in the muon model that the reduced magnetic moment for the electron in the laboratory rest frame is $\alpha\mu_B$ but the relativistic motion of the electron increases the field at the pion by $1/\alpha$ thus effectively canceling those contributions. In the tauon model the electron magnetic moment is still reduced while the field at the pion is no longer increased. Thus the radius cubed is decreased by a factor of $1/\alpha$. The radius r is then equal to 0.273fm being reduced by a factor of 5.156.

Tau Particle Mass

The first two components for the tau particle mass remain the same as the mu particle. The mass of the excited pion is $275m_oc^2$ and the mass of the electron is $1m_oc^2$. The potential energy of the system -274 m_oc^2 is also unchanged.

The next mass contribution to consider is the kinetic energy of the electron. Since the kinetic energy of the system is inversely proportional to the radius squared we can calculate the change in kinetic energy by multiplying 136 m_oc^2 by $(5.156)^2$ giving us a resulting kinetic energy of 3615 m_oc^2.

We then must consider the contribution due to the precession. After some consideration we can determine that the muon value of 68.75 m_oc^2 still applies, as the electron's zero-point angular momentum is the same, as is the spin of the pion. But, since the pion is now rotating around the center of orbit, both particles in the pion particle pair contribute to the rate of precession and the effect on the precession and mass is opposite since the electron's center is now inside. This leads to a mass reduction by a factor of twice the value for the muon, $-137.5m_oc^2$.

The last contribution is the wave mechanical binding energy. Sternglass calculated this on the basis of it being proportional to the inverse of the electron radius. This leads to a somewhat larger but still small additional correction factor of -0.072 $m_o c^2$

We can then sum the individual mass contributions and get a result of $3479 m_o c^2$. This is equal to 1778MeV/c^2, which, within the number of significant figures used in the calculation, compares favorably to recent mass measurements of the tau particle of 1776.82 MeV/c^2.[4] Due to the uniqueness of the properties of the tau particle this physical model can only be a tau particle.

Discussion

Using a different approach to the electron-positron two body problem, a half retarded half advanced method, Schild showed that the magnetic effects essentially cancel and do not lead to any additional mass, thus setting an upper mass limit for the system of the two particle's rest masses, $2m_o c^2$.[5] His derivation has long been the basis for many physicists to dismiss the Sternglass model out of hand. The difficulty is that we do not have a methodology to mathematically model an excited virtual electron-positron pair in an exact way. This makes it necessary to use methods that approximate this model, and depending on what method is chosen, a different result can be found. Thus a physicist can favor whatever method suits their theoretical bias.

It is important to note as well that the favored quark model for the π^0 shown in figure 4 is not without its own problems. The quark model has such irrationalities as matter-antimatter particle pairs that do not annihilate, fundamental particles that can be subtracted from one another, and fundamental particles that are divisible by the square root of two. As Paul Dirac said, "square roots do not occur in basic equations."[6] It is little wonder that the Sternglass model keeps resurfacing.

4)

$$\pi^0 = \frac{u\bar{u} - d\bar{d}}{\sqrt{2}}$$

Figure 4 The formula for the neutral pion.[6]

We are presently in a situation where there is no generally accepted rational and physical model for the neutral pion, muon or tauon, and due to the mathematically simple relationship between their masses and other properties there should be a simple physical model for them. Once we find such a model we can then proceed to model more complicated particles in a manner consistent with that theory. The Sternglass theory appears to offer a simple way to model all three along with many other classically known particles, but additional work will be necessary to develop it further and achieve general acceptance.

Conclusion

This paper shows that it is simple to model the tau particle using the Sternglass theory, and the mass calculated from this model is very close to the accepted value. The Sternglass theory can now account for both the mu and tau particles, so it seems that the standard model, in which they are both fundamental particles, is incorrect. The Sternglass theory also provides a simple physical model for the neutral pion, which is favorable when compared to the irrational quark π^0 model. Based on this result there should be more in-depth investigations made of the Sternglass theory.

[1] Sternglass, E. J., Relativistic electron-pair systems and the structure of the neutral meson, Phys. Rev., 123, 391 (1961).

[2] Sternglass,E.J., Before the Big Bang: Origins of the Universe, 1993, Four Walls Eight Windows Publishing (1993)

[2] Sternglass, E. J., Electron-positron model for the charged mesons and pion resonances, Il Nuovo Cimento, 1 Gennaio, Volume 35, Issue 1, pp 227-260 (1965)

[4] Beringer, J., et al. (Particle Data Group) (2012). Leptons. "Review of Particle Physics". Journal of Physics G 86 (1): 581–651. Bibcode:2012PhRvD..86a0001B. doi:10.1103/PhysRevD.86.010001.

[5] Schild, A., Electromagnetic two-body problem, Phys. Rev., 131, 2762 (1963)

[6] Dirac, P., The evolution of the physicist's picture of nature, American Scientific 5 (1963)

[7] Amsler, C., et al., Physics Letters B667, 1 (2008) http://pdg.lbl.gov/2008/reviews/quarkmodrpp.pdf