the general science journal

The W, Z, Higgs, and top as relativistic protonium

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Milne, Sternglass, Smith, and Browne showed that there are relativistic states of positronium that Feynman and Sternglass first identified as the neutral pion. Sternglass and Browne further showed that onium states of an electron and neutral pion yield the muon and charged pion. These types of relativistic solutions also apply to relativistic protonium resonances containing one or more protons or antiprotons. A relativistic protonium compound containing a proton-antiproton pair is expected to have a mass-energy of approximately 247.8 GeV/c^2. In the case of a proton in a relativistic orbit around a negative pion, we can expect two electrically neutral relativistic resonances with mass energies of approximately 92.5 GeV/c^2 and 123.4 GeV/c^2. Those masses are close to the masses of the Z^0 and Higgs. A resonance containing a relativistic proton and a neutral pion appears to be the W^+, while a muon-like protonium resonance appears to be the top quark. These resonances have been produced in proton accelerators which is consistent with their containing one or more relativistic protons. It is, therefore, necessary to consider whether the W, Z, Higgs, and top are actually resonant states of relativistic protonium.

1. Introduction

In 1960, Earnest Sternglass was in Richard Feynman's office discussing the possibility of a relativistic proton-electron resonance as Sternglass wondered if that might explain the pion. Feynman urged Sternglass to first compute the energy of a relativistic electron-positron in a positronium state where the electric attraction is balanced by the centrifugal force. And so, Sternglass did just that with Feynman making occasional comments. When Sternglass was finished Feynman recognized that he had shown that relativistic positronium is equivalent to the neutral pion.[1]

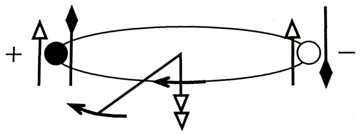

Fig. 1. A Sternglass style drawing of a neutral pion composed of a relativistic electron-positron pair. Open arrows indicate spin direction and closed arrows indicate the direction of the magnetic moment.[3]

What he did not know is that Milne had derived the relativistic solution some years earlier.[4] But when the neutral pion was discovered no one apparently made the connection. After Sternglass, Smith (1965) and Browne (1966 and 1981) also derived relativistic positronium solutions.[5][6][7]

Sternglass went on to publish his result with a few more refinements in 1961.[2] A drawing in his style is shown in Figure 1. By 1965 he had come up with models for muons (Figure 2) and charged pions (Figure 3) based on the relativistic neutral pion.[3] In both cases, he considered the combination of relativistic positronium and a non-relativistic electron from the perspective of the positronium laboratory frame. Note that it is not clear from the Sternglass style drawings that the additional electron is non-relativistic.

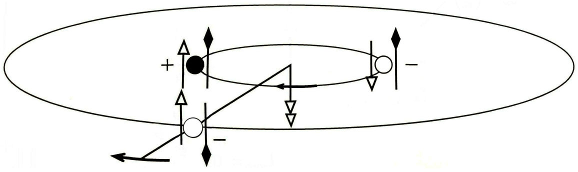

Fig. 2. A Sternglass style drawing of a negatively charged muon. An electron orbits a type of neutral pion with antiparallel spins that couples well to electrons. The outer electron is non-relativistic. [3]

Sternglass used the Bohr-Sommerfeld model to determine the mass-energy of the electron-positron resonance states. His mass calculation of the neutral pion was 263$\mathbf{m_e}$ = 134.4 MeV/c^2 where $\mathbf{m_e}$ is the electron mass.[2] This compares favorably with the presently known mass-energy of 134.9766 MeV/c^2.

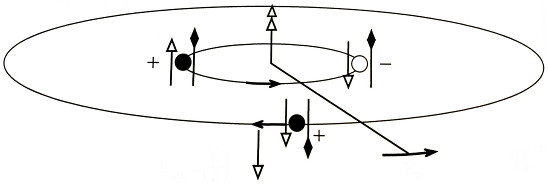

Fig. 3. A Sternglass style drawing of a positively charged pion. A positron orbits a type of neutral pion with antiparallel spins that couples well to positrons. The outer positron is non-relativistic. [3]

Sternglass' derivation of the muon mass-energy resulted in 206.7$\mathbf{m_e}$ = 105.62 MeV/c^2 which is comparable to the presently known value of 105.6583745 MeV/c^2.[3] His calculation of the charged pion mass was 273.5$\mathbf{m_e}$ = 139.76 MeV/c^2 which compares favorably with the known mass-energy of 139.57018 MeV/c^2.[3]

In 1981 Browne performed his computation of the muon assuming the relativistic electron-positron pair is orbiting the electron. His computation was also derived from the perspective of the electron's laboratory frame instead of the pion's. He then assumed the pion was an onium state with the entire pion orbiting the electron. His calculations for the mass-energy of the muon and pion were 206.5$\mathbf{m_e}$ = 105.52 MeV/c^2 and 274.0$\mathbf{m_e}$ = 140.0 MeV/c^2 thus confirming Sternglass' result from the perspective of the opposite laboratory reference frame and suggesting the existence of a second type of muon.[7]

2. W, Z, Higgs, and Top

The general Bohr-Sommerfeld orbital solutions applied to positronium are, for the most part, not mass dependent. There is the difference in electron and proton g-factors which causes a change in the magnetic correction terms which leads to a small difference in the results. If we initially ignore this difference, we can use Sternglass' results as a first approximation for the masses of relativistic protonium resonances.

Name	Symbol	Mass (GeV/c^2)
W	W^+, W^-	80.379
Z	Z^0	91.1876
Higgs	H	125.18
Top quark	t	173.0

Table 1 List of the suspected protonium resonances.

We must recognize that there have been proton and proton-antiproton accelerators around for decades that are energetic enough to produce relativistic protonium resonances in the 80 to 200 GeV/c^2 energy range. That leaves us with having to determine if the particles listed in Table 1 are actually relativistic protonium resonances.

The lightest three, the W, Z, and Higgs, are not massive enough to contain a relativistic proton-antiproton pair, but they are in the correct mass-energy range for a resonance containing a single relativistic proton. If we take half of 263 from Sternglass' neutral pion mass calculation, we can approximate the mass-energy of a single relativistic proton as 131.5$\mathbf{m_p}$ = 123.4 GeV/c^2. This clearly shows that a single relativistic proton in an onium state produces a resonance near 125.18 GeV/c^2 which is the known mass-energy of the Higgs boson.

An electrically neutral onium state of this type would likely have a proton relativistically orbiting a negative pion that does not have additional relativistic mass-energy. Like the Sternglass-Browne positive pion models, the proton orbit would oppose the rotation of the negative pion. Note that these are not orbits in the purely classical sense as they must adhere to quantum theory.

This approach means there is a lower energy solution where the relativistic proton orbits in the same direction as the pion's orbit. The ratio between the muon and pion masses is approximately 3/4ths, so if we apply that correction factor, we can roughly estimate the mass-energy of the lower energy proton and negative-pion resonance as 123.4 GeV/c^2 x 3/4 = 92.5 GeV/c^2. This approximation is close to the measured mass-energy of the Z^0 boson. Clearly, a relativistic protonium model will produce a resonance with a mass similar to the Z^0.

Relativistic protonium also includes positively charged resonances that are essentially like a positive muon and pion with the positron replaced by a relativistic proton. In the simplest approximation, we would expect these positively charged resonances to have similar mass-energy to the Z^0 and Higgs. There will of course be negatively charged antimatter versions.

The W^+ is the only known resonance that can account for the lower energy state of these two proton-pion resonances. The W^+ is also so short-lived that a version of it with an even shorter mean lifetime may not be observable. Since charged pions have significantly shorter mean lifetimes than muons, that may mean that the we may never be able to observe a charged protonium resonance at or near 125 GeV/c^2. That said, it is still worth investigating.

It is interesting that the mass ratio between the W$^+$ and Higgs is approximately 2/3rds instead of the 3/4ths ratio of the muon to pion. But these are both fundamental fractions related to the inverse of the fine structure constant so there can certainly be a physical explanation for it. The reason for the W resonance's lower than expected mass-energy needs to be determined.

One of the first things to note about the top quark is that its mass is equal to the mass of the W and Z combined. This makes it clear that the underlying cause of the top quark's mass-energy is the same as the W and Z. Top quarks are also known to decay predominantly to W particles, which also indicates that their mass-energy comes about the same way.

3. Relativistic Protonium

The top quark is closest to the energy of a muon-like form of protonion which we can call a "protuon." The protuon would be the least massive of the protonions that contain only protons and antiprotons. To get a first approximation of the masses of the basic protonium resonances that are similar to the muon, neutral pion and charged pion, we can multiply the known masses of the muon and pions by the proton/electron mass ratio of 1836.153. If we do that, we get the results in Table 2.

Name	Symbol	Mass (GeV/c^2)
Protuon	M^+, M^-	196.9 or 170.9
Neutral Protion	Π^0	247.8
Charged Protion	Π^+, Π^-	256.3

Table 2 List of the hypothetical protonium resonances.

Then if the ratio of the muon-like protonium to charged pion-like protonium is 2/3rds instead of 3/4ths we have a second possible energy for the protuon of 170.9 GeV/c^2. This is very close to the mass of the top quark and is included in Table 2 for comparison.

In order to develop a clear naming and symbol convention that relates to the muon and pion, the pion-like protonions can be called "protions" and we can use the capitol pi symbols (Π^0, $\Pi^\pm$) for them, while we can use capital mu ($M^\pm$) as the symbol for the protuon. Resonances with a single relativistic proton can generically be called "pruons."

It is clear that if the protuon mass-energy is 2/3rds the charged protion mass-energy, it corresponds to the top quark. Existing experimental equipment should have been capable of producing and detecting a protuon whether it has a mass-energy near 170 GeV/c^2 or between 190 and 200 GeV/c^2. So, assuming a relativistic protuon equivalent to a muon exists, it is most likely the resonance presently identified as the top quark. The reason for the lower than expected mass of the protuon (top) needs to be determined.

Existing equipment might also be powerful enough to produce and detect the ~250 GeV/c^2 neutral and charged protion resonances. If not, then it is possible they can be detected in the future with additional increases in collider energies, assuming the resonances are stable enough to be observable.

If we look at mesons as a guide, the next more massive resonances would be kaon-like resonances at ~900 GeV/c^2 and an eta-like resonance at ~1000 GeV/c^2. It may take a next generation collider to see those, assuming they are even long-lived enough to be observable. From there we can consider that all mesons will have a protonium analog if they are stable enough to be observed. That said, such an exercise may not be worth tens of billions of euros.

4. Discussion

The relativistic protonium model is part of a more general particle/resonance model where all known unstable "particles" can be accounted for as onium state resonances containing only electrons and/or protons. The complete model is described in greater detail in a companion paper titled "An onium model of particles with only electrons and protons."[8]

The idea that there are relativistic onium resonance states has been controversial since the 1960s.[9] The mainstream view is to deny that such states exist. On the other hand, the standard model contains quarkonium states including strangeonium, charmonium and bottomonium, and the increase in mass-energy of higher energy excitation states can only be attributed to relativistic mass-energy. Therefore, the popular stance on relativistic resonances is contradictory.

If we accept that relativistic orbital states exist, then all the unstable resonances (particles) can be accounted for as combinations of non-relativistic and relativistic onium states containing only electrons and/or protons. And all the mass of the unstable resonances can be accounted for as relativistic mass-energy due to the velocity of those electrons and protons. Some additional resonance states form with neutrons which can be treated as a combination of a proton and an electron; however, the most stable onium states usually contain electrically charged particles and resonances.

While in pions each electron or positron contributes a factor of $\mathbf{m_e}/\boldsymbol{\alpha}$ to the relativistic mass energy. But when two pions are in a relativistic orbit they can contribute energy in steps of $\mathbf{m_e}/2\boldsymbol{\alpha}$ or $\mathbf{m_e}/\boldsymbol{\alpha}$ per particle. For example, two oppositely charge pions with a $\mathbf{m_e}/2\boldsymbol{\alpha}$ per particle orbit form a kaon, two oppositely charged kaons with $\mathbf{m_e}/\boldsymbol{\alpha}$ per particle orbit form a D meson, and two oppositely charged D mesons with a $\mathbf{m_e}/\boldsymbol{\alpha}$ per particle orbit form a B meson.

So, while the relativistic orbital energy is a factor of $\mathbf{m_p}/\boldsymbol{\alpha}$ per particle in the pion-like protonium resonances, when a proton orbits a pion relativistically there can lower energy relativistic mass-energy in steps of $\mathbf{m_p}/2\boldsymbol{\alpha}$. That should allow us to compute the mass of the muon-like protion as the same mass as the W. It could also allow for better calculations of the Z^0 and Higgs masses and possibly even the top's mass.

5. Conclusion

Given the existence of metastable onium resonances containing one or more relativistic protons and/or antiprotons, it is clear that such resonances can account for the masses of the known resonances presently called the Z and Higgs and likely account for the W and top as well. There will also be additional resonances near 250 GeV/c^2 assuming they exist long enough to be observed. There are possibly others at even greater energies following the pattern we observe with the mesons, again, if they exist long enough to be observed.

The general success of the onium model in explaining all known meson and baryon resonances, as described in a companion paper, shows that the relativistic onium model allows for a complete simplified particle model. All known resonances are accounted for as non-relativistic and relativistic onium compounds containing only electrons and/or protons. And all mass-energy beyond the rest masses of the electron, proton, and neutron are relativistic in origin.

This model is superior to the quark model in most respects, particularly in accounting for resonances that do not fit the standard 2-quark and 3-quark states. Given its superiority, the onium model is likely to be correct and allow us to have a far simpler theory of unstable resonances including the W, Z, Higgs, and top. The model's success also confirms the existence of relativistic onium compounds.

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