On a possible internal structure of the tau

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The mass of the tau is found to be three times that of a preon described in precedent articles. From this we make an hypothesis about its internal structure.

In [1] it was presented a preon model in which two preonic particles, the "mark" and the "supemark", are supposed to give rise to the known spectrum of particles described by the Standard Model other than the electron-positron, the photon and the graviton.

We recall that in this model:

- the spin of the mark is ¼ (it is a half-fermionic or semionic particle); the mass of the mark is a complex quantity, its absolute value is **me/4α = 17.5 MeV**, where me is the mass of the electron
- the spin of the supemark is ⅛ (it is a half-semionic particle); the mass of the supermark is a quaternionic quantity [2], its absolute value is **me/(4α)^2 = 586.5 MeV**

Like Lego bricks, the combinations of these two preons can explain the phenomenon of elementary particle masses as integer multiples of a mass quantum [3].
For example, the model offers an explanation of the structure of the X17 boson [4], which has a mass very near to that of a mark [1, third article].

Mass of tau

The motivation of this short note is the observation that the mass of the tau is three times the mass of the supermark, almost exactly:
m tau / m supermark = 1776.86 MeV / 586.5 MeV = 3.029

From this fact we deduce a possible structure of the tau: it could be made of 3 supermarks in ordinary state plus 1 supermark whose mass is (almost) all distributed over the 3 imaginary quaternionic units. We can call this state of the mass "hidden state".
This phenomenon can occur both for a complex mass (e.g. for the X17 boson) and for a quaternionic mass.
We recall that supermarks must group in clusters of 4 to recover fermionic or bosonic behavior: from this follows that the structure of the tau could be also of 3 supermarks in ordinary state plus 1 + 4n supermarks in "hidden state", with n that can be 1, 2, 3, ...
Furthermore, one can think that not only one realisation of the structure is possible, but for the same particle the number of components in "hidden state" can be variable.

The concept of "hidden state" could also be useful to explain why neutrinos are so light: perhaps they are clusters of supermarks, no one of them being in ordinary state, i.e. in a state with a huge prevalence of the real part of the quaternionic vector of mass [5].

Bottom and charm quarks

When one tries to apply the same numeric analysis to bottom and charm quarks, the result is not so striking:

m bottom / m supermark = 4180 MeV / 586.5 MeV = 7.127
m charm / m supermark = 1275 MeV / 586.5 MeV = 2.174

Anyway the difference between the two quantities is closer to an integer number:

7.127 – 2.174 = 4.953

This is somehow reminescent of the analysis made in [6], where it was considered pion-muon mass difference.

Koide formula and the fine structure constant

Koide mass formula for leptons is [7]:

$$\mathbf{(m_e + m_\mu + m_\tau) = 2/3(\sqrt{m_e} + \sqrt{m_\mu} + \sqrt{m_\tau})^2}$$

Since **mμ** can be expressed as **6·me/4α** and **mτ** as **3·me/(4α)^2**, it is straightforward to see that **me** can be eliminated from the Koide formula.
It follows that the validity of the Koide formula for leptons relies only on the value of the fine structure constant.

This observation agrees with the following citation from [6]:
"The recognition of the pionic mass intervals among the particles combined with the fact that ratios of life times of elementary particles scale as powers of α, the fine structue constant, indicated the **fundamental role of α in the generation of mass of elementary particles** and that its domain is not restricted to leptons only, but also extends to include hadrons".

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