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A LEPTON MODEL THAT CAN SUPPLY PREVISIONS FOR DETECTING THE τ-NEUTRINO†

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ABSTRACT

Two flavours of quarks with leptonic number (the electronic and the muonic) are proposed, with zero[*] spin, and incorporated to quark theory, with a relative harmony with the vision of Weinberg-Salam theory.

The masses of leptons have difficulties (may be indications of a new interaction).

It is supplied a method for detecting the τ-neutrino by direct reactions. This effect can be the experimental test of the model. Others more general effects can test the model.

Key-words: Lepton model; Detecting T-neutrino.

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[*] The scalar[1] quarks naturally appear in the supersymetric version of Q.C.D. The particles ê and m could be conceived as the lithtest among the whole series of other very heavier scalars brought in by supersymmetry and are introduced to justify the detection of just two leptonic flavours.

We need to explain the decay modes and interactions in which particles composed by quarks generate leptons.

The theory of weak interactions, through changes of flavour allows us to explain these phenomena. But it creates three aesthetical and phylosophical unsatisfactions to the atomist quark vision:

(1) The division of the elementary particles in two different categories: quarks and leptons;

(2) The break of flavour conservation;

(3) The existence of truly elementary particles which are unstable.

We shall try to bypass these objections by postulating two bosonic quarks: m and ê. They will be refered to as muonium an electronium, respectively.

Their relevant quantum numbers are listed below:

		m	ê
Electric charge	Q	-1/3	+2/3
Baryonic Number	B'	+1/3	+1/3
Strangeness	S	0	0
Charm	C	0	0
Bottom Number	B	0	0
Top Number	T	0	0
Leptonic Number	L	+1	-1
Muonic Number	M	+1	0
Electronic Number	E	0	-1
Spin	J	0	0
Isospin Component	I_3	-1/2	+1/2
Isospin	I	1/2	1/2

As it will become clearer later, it is reasonable to postulate m and $\hat{e}$ with almost equal masses, which then suggests an isospin doublet structure for them.

The particle $\hat{e}$ carries the electronic flavour, whereas m carries the muonic flavour.

In terms of the ordinary and bosonic quarks, the $\pi^{\pm}$ decays can be explained according to the reactions below:

$$\pi^{+} \to \mu^{+} + \nu_{u} \quad (2) \quad \longleftrightarrow \quad u\bar{d} \to u\bar{m} + \bar{d}m \quad (4)$$

$$\pi^{+} \to e^{+} + \nu_{e} \quad (3) \quad \longleftrightarrow \quad u\bar{d} \to \bar{d}\hat{e} + u\bar{\hat{e}} \quad (5)$$

This then suggests the first law of our composite model:

"The weak interactions are those in which the chromo - dynamics interactions require the creation of pairs of bosonic quarks and anti-quarks ($\hat{e} + \bar{\hat{e}}$ or $m + \bar{m}$) or, in which bosonic quarks are exchanged".

The Z^0-particle can be thought as composed

$$Z^0 = \frac{1}{\sqrt{2}} (\hat{e}\bar{\hat{e}} - m\bar{m}) \qquad (6)$$

This compositeness suggests that the masses of m and $\hat{e}$ satisfy:

$$\text{mass}(\hat{e}) \approxeq \text{mass}(m) \approxeq \text{mass}(Z)/2 \approxeq 50 \text{ GeV} \qquad (7)$$

These large masses are necessary to explain why the formation of the pairs $\hat{e}+\bar{\hat{e}}$ and $m+\bar{m}$ occurs only at energies of 80-90 GeV (which are approximately equal to the masses of Z^0 and $W^{\pm}$).

In order that weak decay modes occur in our model, it is necessary that the pairs $\hat{e}+\bar{\hat{e}}$ and $m+\bar{m}$ be created from Z^0 and $W^{\pm}$ as we shall see later on.

To exchange the bosonic quark we need produce a very heavy particle too

There is a puzzling lightness* in the leptons (may be caused by a new interaction) that permits the particles of large masses as $\hat{e}$ and m to generate electrons, positrons, muons, neutrinos, etc.

The break of the "lightness" it is necessary to the direct exchange of an $\hat{e}$ or m, from the $\bar{\nu}_e$, as in the example below:

$$p + \bar{\nu}_e \rightarrow n + e^+ \longleftrightarrow uud + \bar{u}\hat{e} \rightarrow udd + \bar{d}\hat{e} \qquad (8)$$

But it is necessary that, at 50 GeV, the following process takes place:

$$\bar{\nu}_e \rightarrow \bar{u} + \hat{e} \longleftrightarrow \bar{u}\hat{e} \rightarrow \bar{u} + \hat{e} \qquad (9)$$

Later, it will become clear that this is in agreement with

$$\bar{\nu}_e \rightarrow e^+ + W^- \qquad (10)$$

which requires an energy of 80 GeV.

On physical grounds, it would not be sensible to propose a model of quark-composite leptons without postulating a conservation law for the quark flavours. We are therefore led to the second law of our model:

"The flavours are conserved".

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*Since we only present a quark model, and not a field theory for the scalar quarks, we cannot give here a here a model for the lepton lightness.

In all those reactions where leptons are created, annihilated or transformed, there occur the creation, annihilation and transformation of the quark flavours and vice-versa.

The "decay modes" for the flavours have to be seen, in terms of the flavour conservation, in the following way:

$$d \rightarrow u + W(\bar{u}d)^{-} \rightarrow u + \bar{\nu}_e + e \longleftrightarrow d \rightarrow u + W^{-}(\bar{u}d)$$

$$\rightarrow u + u\hat{e} + d\bar{\hat{e}}$$

where:

$$W(\bar{u}d)^{-} = \bar{u}d \text{ res } \rightleftarrows \bar{u}d + Z^0$$

Other example:

$$s \rightarrow u + W(s\bar{u})^{-}$$

where

$$W(s\bar{u})^{-} = s\bar{u} \text{ res. } \rightleftarrows s\bar{u} + Z^0$$

This then shows that the flavour conservation requires families of $W^{\pm}$ ($W(\bar{u}s)^{-}$,$W(c\bar{s})^{+}$,$W(c\bar{d})^{+}$,etc), in place of the single $W^{\pm}$ and Z^0 of the standard model.

These $W^{\pm}$ particles will explain the "decay-modes" of heavy flavour as conservations of flavour:

$$
\begin{aligned}
&s \rightarrow u + W(\bar{u}s)^{-} \quad , && \text{where: } W^{-}(\bar{u}s)^{-} = \bar{u}s \text{ res. } \rightleftarrows \bar{u}s+Z^0 \\
&c \rightarrow s + W(c\bar{s})^{+} \quad , && \text{where: } W(c\bar{s})^{+} = c\bar{s} \text{ res. } \rightleftarrows c\bar{s}+Z^0 \\
&c \rightarrow d + W(c\bar{d})^{+} \quad , && \text{where: } W(c\bar{d})^{+} = c\bar{d} \text{ res. } \rightleftarrows c\bar{d}+Z^0 \qquad (12) \\
&b \rightarrow c + W(\bar{c}b)^{-} \quad , && \text{where: } W(\bar{c}b)^{-} = \bar{c}b \text{ res. } \rightleftarrows \bar{c}b+Z^0 \\
&b \rightarrow u + W(\bar{u}b)^{-} \quad , && \text{where: } W(\bar{u}b)^{-} = \bar{u}b \text{ res. } \rightleftarrows \bar{u}b+Z^0
\end{aligned}
$$

Reminding the electronic (E) and muonic number (M) attributions, it follows that:

$$E(m\bar{q}) = 0$$

$$M(m\bar{q}) = 1 \quad ,$$

where q are the usual fermionic quarks,

$$M(\bar{\bar{e}}q) = 1$$

$$M(\bar{\bar{e}}q) = 0 \quad ,$$

the $m\bar{q}$'s are the usual muonic leptons, and the $\bar{\bar{e}}q$'s are the usual electronic leptons.

The following series will appear:

(charge)	Fermionic Quarks	Leptons of Charge	Neutrinos
-1/3	d	$d\bar{\bar{e}} = e^-$	$\bar{d}m = \nu_\mu$
+2/3	u	$\bar{u}m = \mu^-$	$u\bar{\bar{e}} = \nu_e$
-1/3	s	$s\bar{\bar{e}} = \tau^-$	$\bar{s}m = \nu_\tau$
+2/3	c	$\bar{c}m = \ell_c^-$	$c\bar{\bar{e}} = \nu_c$
-1/3	b	$b\bar{\bar{e}} = \ell_b^-$	$\bar{b}m = \nu_b$
+2/3	t	$\bar{t}m = \ell_t^-$	$t\bar{\bar{e}} = \nu_t$

The charges of the quarks u and d induce this order in this series.

The reasons to elect $d\bar{\hat{e}}$ to be e^- (and therefore to elect $\bar{u}m$ to be μ^-, and not the inverse model) are the following decay modes[2]:

$$K^- \to \mu^- + \bar{\mu} \quad (63\%) \longleftrightarrow \quad \bar{u}s \to \bar{u}m + s\bar{m} \qquad (14)$$

$$D^- \to e^- + \bar{\nu} \quad (2.5\%) \longleftrightarrow \quad \bar{c}d \to d\bar{\hat{e}} + \bar{c}\hat{e} \qquad (15)$$

Notice that just one among the two decays (14) and (15) already suffices to decide between the two options of compositeness for e^- and μ^-.

This automatically implies that one decay appears to confirm a prediction made by means of the other decay.

Notice that ν_τ carries muonic number and strangeness.

This neutrino is, in effect, a strange neutrino. τ^- is an electronic and strange lepton of charge. There is not a "tauonic number" in this model. There are two classes of leptons: muonic and electronic. The interpretation of τ^- is achieved through the serial characteristic that the flavour series increases the masses of the produced particles.

Other reasons to elect $s\bar{\hat{e}}$ to be τ^- are its decay modes. Many decay modes of τ^- generates strange particles.

There is a correction of a historical error: the series of the neutrinos is: ν_μ, ν_e, ν_τ ... and not: ν_e, ν_μ, ν_τ... as we first thought.

Indeed, there is a difficult involved in the model. In effect the masses of these leptons are small and the masses of $\hat{e}$ and m are about 40-50 GeV. We shall discuss this matter latter. This effect will be named "lightness" and we will postulate that it is a field.

A characteristic of this model is the prevision of the flavour conservation by the reinterpretations of experimental data.

For example:

$s \to u+\pi^-$ reinterpreted as: $s \to \overline{\nu}_\tau+\nu_\mu+u+\pi^- \leftrightarrow s \to s\overline{m}+m\overline{d}+u+\overline{u}d$

$s \to d+\pi^0$ reinterpreted as: $s \to \overline{\nu}_\tau+\nu_\mu+d+\pi^0 \leftrightarrow s \to s\overline{m}+m\overline{d}+d+\pi^0$

The assumption of pairs of neutrinos may balance all the decay modes of particles with heavy flavours which seem not have conservation of flavour (we have to observe that this assumption is not often necessary).

The energies of the neutrino pairs in some processes are necessarily low for reasons of experimentla detection.

To explain such a fact let us recall that the cross section for neutrino reactions is very low in any channel (or "crossing") of the Feynman graphs for the reactions in question.

Indeed, reactions with the formation of two (or more) neutrinos are much suppressed in view of the smallness of the corresponding cross section. In the case of the "cracking" of muons in almost pure energy (wich is one of the slowest among the weak decays), we have an exception imposed by conservation laws.

Since the cross section for neutrino processes is proportional to λ^3/c (it is a massless pseudo-particle), it turns out to be proportional to $(4\pi h)^3 \frac{C^2}{E^3} \sim \frac{1}{E^3}$, so justifying that, for low energies, events with the appearance of neutrino become more significant. This explains why the neutrino-antineutrino pairs, necessary for the consistency of the model, have low energy.

This explanation could however be objected by the observation that, for the known decays where neutrinos are produced energies of eV's or KeV's (which are equally invisible) are not the only possibility.

In some other cases, it suffices to remind the conservation laws which forbid these low energies. This does not occur for the cases:

$$s \to u + \pi^- + \bar{\nu}_\tau + \nu_\mu \longleftrightarrow s \to u + \bar{u}d + s\bar{m} + m\bar{d} \quad .$$

An example is:

$$K^- \to \pi^- + \pi^0 + \bar{\nu}_t + \nu_\mu \longleftrightarrow \bar{u}s + \bar{u}d + \pi^0 + s\bar{m} + \bar{\alpha}m \ ,$$

since the conservation laws do not fix an almost- vanishing energy for the neutrinos, since the decay involve four particles.

We have to observe that this assumption of pairs of neutrinos to balance the equation is not often necessary. Examples:

$$K^- \to \mu^- + \bar{\nu}_\tau \quad (63\%) \tag{14'}$$

$$D^- \to c^- + \bar{\nu}_c \quad (2.5\%) \quad . \tag{15'}$$

It is sufficient to interpret the neutrinos as $\bar{\nu}_\tau$ and $\bar{\nu}_c$

$$K^- \rightarrow \mu^- + \bar{\nu}_\tau \longleftrightarrow \bar{u}s \rightarrow \bar{u}m + s\bar{m} \qquad (14'')$$

$$D^- \rightarrow e^- + \nu_c \longleftrightarrow \bar{c}d \rightarrow d\overline{\hat{e}} + \bar{c}\bar{e} \qquad (15'')$$

The conservation of the flavours (in this model) is due to the fact that the neutrinos act as "magicians" and hide the flavours. We decide name this effect as flavour-fluorescence, because the flavours can be emitted (by neutrino-fields) and absorbed in analogy with fluorescence.

How to detect the neutrino ν_τ (the strange-fluorescence) ? The reactions will be:

$$\begin{aligned}
&p+\bar{\nu}_\tau \rightarrow \Sigma^+ + \bar{\nu}_\mu \ , && E_{min} \cong 255 \text{ MeV for the neutrino,}\\
&p+\bar{\nu}_\tau \rightarrow \Lambda + \mu^+ \ , && E_{min} \cong 290 \text{ MeV for the neutrino,}\\
&p+\bar{\nu}_\tau \rightarrow \Sigma^0 + \mu^+ \ , && E_{min} \cong 375 \text{ MeV for the neutrino,}\\
&n+\bar{\nu}_\tau \rightarrow \Lambda + \bar{\nu}_\mu \ , && E_{min} \cong 180 \text{ MeV for the neutrino,}\\
&n+\bar{\nu}_\tau \rightarrow \Sigma^0 + \bar{\nu}_\mu \ , && E_{min} \cong 260 \text{ MeV for the neutrino,}\\
&n+\bar{\nu}_\tau \rightarrow \Sigma^- + \mu^+ \ , && E_{min} \cong 370 \text{ MeV for the neutrino,}
\end{aligned} \qquad (17)$$

and one must use a target of heavy nuclei to obtain the reactions with these minimum energies.

(a) We may use the decay modes below as sources for $\bar{\nu}_\tau$:

$$\begin{aligned}
&\tau^- \rightarrow e^- + \bar{\nu}_\tau + \nu_\mu \quad (17\%)\\
&\tau^- \rightarrow \mu^- + \bar{\nu}_\tau + \nu_e \quad (17\%) \ ,
\end{aligned} \qquad (18)$$

both with sufficient energy in the neutrino channel.

(b) It is adequate to use K^- as source of $\bar{\nu}_\tau$, because it is necessary to confirm conservative law of the flavours.

It is necessary to garantee that the K^- has sufficient velocity to produce, by the Doopler-Fizeau effect, a sufficient energy in the neutrino channel in its decay:

$$K^- \to \mu^- + \bar{\nu}_\tau \longleftrightarrow \bar{u}s \to \bar{u}\hat{m} + s\bar{\hat{m}} \quad (63\%) \qquad (14''')$$

It is necessary that the K^- decay occurs in the vacuum, before it penetrates in a material medium and get reduced its velocity. With $C\pi(K^-) = 3{,}709$m, which is experimentally reasonable, it is not difficult to obtain a K = decay in the vacuum.

How to detect the neutrino ν_c (the charm-fluorescence) ? A good source for the ν_c neutrino is the decay:

$$D^+ \to e^+ + \nu_c \longleftrightarrow c\bar{d} \to \bar{d}\hat{e} + c\bar{\hat{e}} \quad (2{,}5\%) \quad , \qquad (15''')$$

with an energy of about 900 MeV in the neutrino channel.

The following reactions are expected (using a target of large nuclei):

$$p + \nu_c \to \Lambda_c^+ + \nu_e \longleftrightarrow uud + c\bar{\hat{e}} \to udc + u\bar{\hat{e}} \qquad (19)$$

$$n + \nu_c \to \Lambda_c^+ + e^- \longleftrightarrow udd + c\bar{\hat{e}} \to udc + d\bar{\hat{e}} \qquad (20)$$

It is required an energy of about 1350 MeV for the neutrino. This is a minimal requirement.

The Doopler-Fizeau effect can produce a significant effect in this reaction since $cT(D^+) = 0{,}028$ cm.

Therefore, it is unavoidable that D^+ decay in the vacuum.

On characteristics of $\tau^\pm$.

In spite of the difficulty of having to assume a neutrino-antineutrino pair to balance some of the τ^- decay modes, the model anyhow presents some advantages; it allows for observers decays without creation of these pairs.

Examples:

$$
\begin{aligned}
&\tau^- \to K^- + &&\longleftrightarrow \quad s\bar{\hat{e}} \to \bar{u}s + u\bar{\hat{e}}\\
&\tau^- \to K^- + \pi^+ + \pi^- + \pi^0 + \nu &&\longleftrightarrow \quad s\bar{\hat{e}} \to \bar{u}s + u\bar{\hat{d}} + \bar{u}d + \pi^0 + u\bar{\hat{e}}\\
&\tau^- \to K^*(892)^- + \nu &&\longleftrightarrow \quad s\hat{e} \to \bar{u}s \text{ res.} + u\bar{\hat{e}}\\
&\tau^- \to K_2^*(1430)^- + \nu &&\longleftrightarrow \quad s\bar{\hat{e}} \to \bar{u}s \text{ res.} + u\bar{\hat{e}}
\end{aligned}
\tag{21}
$$

An observation about the decay $\tau^- \to K^0 + \ldots$ is that the K^0 particles have a symmetric decay. For example:

$$
\begin{aligned}
&K^0 \to \pi^0 + \pi^\pm + e^\mp + \nu\\
&K^0 \to \pi^\pm + e^\mp + \nu \qquad , \text{etc}
\end{aligned}
\tag{22}
$$

This leads to the impossibility of distinguishing between K^0 and $\bar{K}^0$, if strangeness conservation is not imposed. This was the historical cause (and method) of the discovery[3] of K^0.

So, the τ^--decay is written in the tables of particles properties as:

$$\tau^- \to K^0 + \pi^- + \pi^- + \pi^+ \tag{23}$$

However, by correcting $K^0 \to \bar{K}^0$, and adding after a neutrino ν_e, we have

$$\tau^- \to \bar{K}^0 + \pi^- + \pi^+ + \pi^- + \nu_e \longleftrightarrow s\bar{\hat{e}}+\bar{u}d+u\bar{\hat{d}}+\bar{u}d+u\bar{\hat{e}} \tag{24}$$

We can see that this reaction is perfectly balanced.

The abundance or creation of pions is a characteristic of strange particles, and our model is able to explain it because the $\tau^\pm$ has the same characteristic in its decay modes.

There are previsible reactions:

τ^{-} + nucleons → strange Barions + Leptons + Pions

$$s\bar{\bar{e}} + uud \rightarrow {}^{-}suu + \bar{\bar{e}}d + \pi s$$

$$\longleftrightarrow \tau^{-} + p \rightarrow \Sigma^{+} + e^{-} + \pi s$$

(where the πs have a total charge equal to zero).

$$s\bar{\bar{e}} + uud \rightarrow uds + \bar{\bar{e}}u + \pi s$$

$$\longleftrightarrow \begin{cases} \tau^{-} + p \rightarrow \Sigma^{0} + \nu_{e} + \pi s \\ \tau^{-} + p \rightarrow \Lambda + \nu_{e} + \pi s \end{cases}$$

$$s\bar{\bar{e}} + udd \rightarrow uds + \bar{\bar{e}}d + \pi s$$

$$\longleftrightarrow \begin{cases} \tau^{-} + n \rightarrow \Lambda + e^{-} + \pi s \\ \tau^{-} + n \rightarrow \Sigma^{0} + e^{-} + \pi s \end{cases}$$

$$s\bar{\bar{e}} + udd \rightarrow dds + \bar{\bar{e}}u + \pi s$$

$$\longleftrightarrow \tau^{-} + n \rightarrow \Sigma^{-} + \nu_{e} + \pi s$$

These reactions are difficult to be did because the $c\mathrm{T}(\tau^{-}) = 1\mathrm{mm}$. But it is possible of to be did with high energies in the futur.

The model presents the difficulty that the masses of neutrinos, electrons, muons, etc are very light (and not of order of 50 GeV).

The lightness occurs only for the couples $q\bar{\hat{e}}$, $\bar{q}\hat{e}$, $m\bar{q}$, $\bar{m}q$, where q is a usual fermionic quark.

We emphasize that particles such as:

$$Z = \frac{1}{\sqrt{2}} (\hat{e}\bar{\hat{e}} - m\bar{m})$$

are enough heavy.

In the low-energy regime the states $\hat{e}qq$, mqq, $\hat{e}mq$, $\hat{e}\hat{e}q$, mmq, $\hat{e}\hat{e}\hat{e}$, mmm, $\hat{e}\hat{e}\bar{m}$, $\hat{e}mm$, $\hat{e}\bar{m}$ have never been observed.

A crude expectation for their masses is: 50 GeV, 50 GeV, 100 Gev, 100 GeV, 100 GeV, 150 GeV, 150 GeV, 150 GeV, 150 GeV, 100 GeV, respectively.

The "lightness" could perhaps be understood as due to a new interaction, and the weak events would appear as the effective result of colour forces, scalar quarks and this "lightness"-interaction.

The flavour-fluorescence (the transmission of a flavour by a neutrino) is a major test of our model that could be tried.

Reactions involving the τ-neutrino (second this model) are impossible without the occurrence of the strange-fluorescence.

These tests are definitive because if neutrinos really transmit quark-flavour (as strangeness, charm, etc) then it will be a conclusive evidence that these neutrinos must be composed by quarks and, more generally, leptons are also composed by quarks.

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