A Model for Leptons.

J. LEITE LOPES and N. FLEURY

Centre de Recherches Nucléaires, Université Louis Pasteur - Strasbourg

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As is well known, one of the most intriguing puzzles of particle physics has been the existence of muons. Although mouns and electrons display the same kind of (electromagnetic and weak) interactions with the same effective coupling constants (e and G_F, respectively), the muon (the probably massless muonic neutrino) cannot apparently give rise (¹) to an electron (to a probably massless electronic neutrino) with the simultaneous occurrence of a particle system equivalent to a Majorana (purely neutral) boson in the reaction.

As muons and electrons display no strong interactions (at the energies so far observed), this separation of leptons into a muon with its massless neutrino and an electron with its massless neutrino is a puzzle. The Higgs mechanism, as is well known, offers no explanation of the muon mass since (²) it replaces it by a new constant proportional to this mass.

It is indeed difficult, in the present theoretical framework of ideas, to find a solution of this problem if one raises the present evidence of electron-muon symmetry and the absence of strong interactions among leptons and leptons and hadrons to the rank of absolute principles.

Recently, it has been pointed out (³) that perhaps there is some kind of family relationship between the e-neutrino–electron doublet and the nonstrange, noncharmed-quark doublet u-d_c, on the one hand, and between the μ-neutrino–muon doublet and the charmed, strange-quark doublet c-s_c, on the other.

We wish to point out that it is possible to formulate a simple, naive model that gives a more unified description of leptons and hadrons if one assumes that the nonoccurrence of strong interactions for leptons at the presently known energies is the result of some suppression mechanism and not a consequence of a fundamental principle.

It seems to us that an unsatisfactory feature of the presently known models of elementary particles is that they put on the same theoretical level quarks and leptons as the fundamental objects of observable matter. Now leptons share this property of constituents of matter with hadrons, not with quarks, and hadrons are supposed to be

(¹) C. H. LLEWELLYN SMITH: *Phys. Rep.*, **3** C, 261 (1972).

(²) See, for istance, S. WEINBERG: *Phys. Rev. Lett.*, **19**, 1264 (1967); A. SALAM: *Proceedings of the Eighth Nobel Symposium*, edited by N. SVARTHOHN (New York, N. Y., 1968).

(³) S. L. GLASHOW: *La physique du neutrino à haute energie*, in *Colloques International du CNRS* (Paris, 1975); S. BARSHAY: *Phys. Lett.*, **58** B, 86 (1975).

is compared to that corresponding to weak interactions given by fig. 9

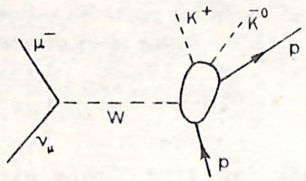

Fig. 9.

one sees that the lagrangian (12) will give a contribution to the reaction

$$\nu_\mu + P \to \mu^- + P + K^+ + \bar{K}^0 .$$

An estimation based on the coupling constants in the two processes indicates that the weak reaction of fig. 9 is about 10^2 stronger than that in fig. 8 for $g \sim e$, $M_L \sim 100$ GeV, that is $\sim (G^2/g^4)(m_L/m_p)^4$, where G_F is the Fermi constant and $G = G_F m_p^2$.

Similarly for the reaction $\mu^- + P \to \nu_\mu + P + K^- + K^0$.

However, it is not evident that the neutral current which enters the interaction of neutrinos with pions and kaons and heavy leptons is of the form given in eq. (1). This question is related to the difficult problem of the structure of the two neutrinos in this model.

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