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The Muon Mass and the Unified Gauge Field Theory of Leptons *

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It is well known that the unified gauge field theory of weak and electromagnetic interactions as developed by SALAM AND WARD and by WEINBERG [1] for electron-type leptons, seems to loose its elegance when one tries to incorporate muons into it. If one assumes that the lepton masses result from the vacuum expectation value of only one doublet scalar field, in interaction with the leptons, one seems to be forced to break the universality of the scalar-lepton interaction in order to get a muon mass different from that of the electron:

Let

$$\varphi(x) = \begin{pmatrix} \chi(x) \\ \varphi_0(x) \end{pmatrix} \tag{1}$$

be a doublet scalar field and

$$L_l(x) = \frac{1}{2}(1-\gamma^5)\begin{pmatrix} l(x) \\ \nu_l(x) \end{pmatrix}, \; R_l(x) = \\ = \frac{1}{2}(1+\gamma^5)\, l(x), \; l = e, \mu, \tag{2}$$

the left-handed and right-handed spinor fields for electron-type and muon-type leptons, respectively.

It would follow from an interaction of the form:

$$G\{\bar{L}_e \varphi R_e + \bar{R}_e \varphi^+ L_e\} + G'\{\bar{L}_\mu \varphi R_\mu + \\ + \bar{R}_\mu \varphi^+ L_\mu\} \tag{3}$$

that the constants G and G' would have to be such that:

$$G' = \frac{M_\mu}{M_e} G \tag{4}$$

This would be a better assumption than an alternative one of introducing two scalar doublets with different vacuum expectation values.

In a later paper, WEINBERG [2] proposed to replace the theory based on a SU (2)⊗ U(1) gauge group by a model in which the leptons are assumed to constitute a triplet and the lagrangian is invariant under a SU(3)⊗ SU(3) gauge group. This theory, however, introduces sixteen real Yang-Mill fields and a complex scalar multiplet with nine components. This seems to be too high a price to be paid for accomodating the muons into a theory for leptons — one is forced to invoke conditions to suppress the unobserved effects of most of these particles. Now the beauty of the initial model is just its economy of basic fields to realize the inclusion of photons and

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Dedicated to the memory of PROFESSOR PLINIO SUSSEKIND ROCHA.