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Electroweak Interactions at an Infinite Sublayer Quark Level. II

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It is shown that the standard model of the electroweak interactions holds at an infinite sublayer quark level, insofar as we consider the weak isospin doublet $(u_{\infty L}, u^{cp}_{\infty L})^T$, where u_∞ is an infinite number of quarks at an infinite sublayer level.

In a previous paper (Sugita *et al.*, 1991), we applied the standard model of the electroweak interactions to the weak isospin doublet $(u_{\infty L}, u^{c}_{\infty L})^T$ at an infinite sublayer quark level. It was then shown that the parameters α^1 and α^2 in $SU(2)_L$ should be zero and hence there exists only one gauge field W^3_μ associated with the electromagnetic field $A_\mu = W^3_\mu \cos\theta_W$ and the neutral vector boson field $Z^0_\mu = W^3_\mu \sin\theta_W$, where θ_W is the Weinberg angle.

As an alternative to the doublet $(u_{\infty L}, u^{c}_{\infty L})^T$, here we consider the doublet $(u_{\infty L}, u^{cp}_{\infty L})^T$, where $u^{cp}_{\infty L}$ means the left-handed particle operated on by charge conjugation C and then parity transformation P, viz.,

$$u^{cp}_{\infty L} \equiv \gamma^0 C \gamma^0 (1/2)(1-\gamma_5) u^*_\infty \tag{1}$$

At an infinite sublayer quark level, the hypercharge is zero. Therefore, the Lagrangian describing the electroweak interactions is written as follows:

$$L = \bar{\chi}\gamma^\mu[i\partial_\mu - (g/2)\tau\cdot W_\mu]\chi \tag{2}$$

where $\chi = (u_{\infty L}, u^{cp}_{\infty L})^T$.

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The Lagrangian in equation (2) is invariant under the following infinitesimal gauge transformation:

$$\chi' = (1 + i(g/2)\alpha \cdot \tau)\chi \tag{3}$$

Thus, we obtain

$$u'_{\infty L} = [1 + i(g/2)\alpha^3]u_{\infty L} + i(g/2)(\alpha^1 - i\alpha^2)u^{cp}_{\infty L} \tag{4}$$

$$u^{cp'}_{\infty L} = i(g/2)(\alpha^1 + i\alpha^2)u_{\infty L} + [1 - i(g/2)\alpha^3]u^{cp}_{\infty L} \tag{5}$$

However, $u_{\infty L}$ and $u^{cp}_{\infty L}$ are not independent of each other. Therefore, $u^{cp'}_{\infty L}$ should be equal to CP transformation of $u'_{\infty L}$, that is, $u'^{cp}_{\infty L}$. From equation (4), we obtain

$$\begin{aligned} u^{cp'}_{\infty L} &\equiv u'^{cp}_{\infty L} = \gamma^0 C \gamma^0 u^{*\prime}_{\infty L} \\ &= \gamma^0 C \gamma^0 [1 - i(g/2)\alpha^3]u^*_{\infty L} - i(g/2)\gamma^0 C \gamma^0 (\alpha^1 + i\alpha^2)\gamma^0 C \gamma^0 u_{\infty L} \\ &= [1 - i(g/2)\alpha^3]\gamma^0 C \gamma^0 u^*_{\infty L} - i(g/2)(\alpha^1 + i\alpha^2)\gamma^0 C \gamma^0 \gamma^0 C \gamma^0 u_{\infty L} \\ &= [1 - i(g/2)\alpha^3]u^{cp}_{\infty L} + i(g/2)(\alpha^1 + i\alpha^2)u_{\infty L} \end{aligned} \tag{6}$$

Equation (6) is quite the same as equation (5). Therefore, the weak isospin doublet $(u_{\infty L}, u^{cp}_{\infty L})^T$ does not give any limitations to the parameters α under the condition that $u_{\infty L}$ and $u^{cp}_{\infty L}$ are not independent of each other. This result is quite different from the case of the doublet $(u_{\infty L}, u^{c}_{\infty L})^T$. Thus, we can conclude that the standard model of the electroweak interactions holds even at an infinite sublayer quark level, insofar as we consider the weak isospin doublet $(u_{\infty L}, u^{cp}_{\infty L})^T$.

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