Standard Model 1

Note Title 11/10/2009

Start with charges

$$SU(3) \not\subset SU(2)_L \times U(1)_{L,R}$$

1) $SU(N)$ charges are fixed

$$F^a_{\mu\nu} = \partial_\mu A^c_\nu - \partial_\nu A^c_\mu - i g f^{abc} A^b_\mu A^c_\nu$$

$$D^\mu \psi = \left(\partial_\mu + i g \frac{\lambda^a}{2} A^a_\mu\right) \psi$$

2) $U(1)$ charges are not fixed

Ex QED $|e|$, $q_{e^-} = -1$, $q_u = 2/3$ --

could $e' = \frac{|e|}{3}$, $q_e = -3$, $q_u = 2$ --

$$D_\mu = \partial_\mu + i(Qe)A_\mu$$

Constructing SM $SU(2)$

1) LH Quarks + Leptons are in doublets — WHY?!!

$$\psi_{q_L} = \begin{pmatrix} u \\ d \end{pmatrix}_L \quad , \quad \psi_{\ell_L} = \begin{pmatrix} \nu_e \\ e \end{pmatrix}_L$$

2) $SU(2)_L \times U(1)_Y \longrightarrow U_{EM}(1)$

$\uparrow *$ $\quad$ 1

2 conventions

$U(1)_Y$, charge g_1, $Q_{e^-} = -1$

$U(1)_{EM}$, charge $|e|$, $Q_{e^-} = -1$

$a Q_i = T_{3_i} + b Y_i \Rightarrow a = 1 \, , \; b = \frac{1}{2}$

$$Q_i = T_{3,i} + \frac{1}{2} Y_i$$

Check $-1 = -\frac{1}{2} + \frac{1}{2} \cdot (-1)$ ✓

3) Anomaly relations

$Z_3\, BB \Rightarrow Tr(T_3 Y Y) = 0$

$BBB \Rightarrow Tr(Y Y Y) = 0$

$BGG \Rightarrow Tr(Y \lambda^a \lambda^b) = 0$

$\Rightarrow$ Constraints on Y assignment