224(3): Criticisms of the Standard Model's Electroweak Sector.

The obvious flaw in this theory is that the lagrangian is written for particles that are "initially massless". The Higgs mechanism is asserted to apply to initially massless particles. However, a massless particle is not correctly covariant under the most general Lorentz transform. It does not transform as $u(1)$, it transforms as $E(2)$. The Dirac lagrangian:

$$\mathcal{L} = i\bar{\psi}\gamma^\mu \partial_\mu \psi - m\bar{\psi}\psi \qquad -(1)$$

is written with:

$$m = ?\, 0. \qquad -(2)$$

The lagrangian of the theory is:

$$\mathcal{L} = i\bar{e}_R \gamma \cdot \partial e_R + i\bar{e}_L \gamma \cdot \partial e_L \qquad -(3)$$
$$+ i\bar{\nu}_e \gamma \cdot \partial \nu_e + (e \to \mu)$$

Gauge theory enters with the covariant derivative:

$$D_\mu \mathcal{L} = \partial_\mu \mathcal{L} - \frac{i}{2} g\, \underline{\tau} \cdot \underline{W}_\mu \mathcal{L} \qquad -(4)$$

so the lagrangian is initially:

$$\mathcal{L}_1 = i\bar{R}\gamma^\mu(\partial_\mu + ig' X_\mu)R + i\bar{L}\gamma^\mu\left(\partial_\mu + \frac{i}{2}g' X_\mu - \frac{i}{2}g\,\underline{\tau}\cdot\underline{W}_\mu\right)L - \frac{1}{4}\left(\partial_\mu \underline{W}_\nu - \partial_\nu \underline{W}_\mu + g\,\underline{W}_\mu \times \underline{W}_\nu\right)^2 - \frac{1}{4}\left(\partial_\mu X_\nu - \partial_\nu X_\mu\right)^2$$
$$-(5)$$

2) This has parameters $R, g', X_\mu, L, \Sigma, W_\mu$.

The Higgs field is claimed to be:

$$\phi = \begin{bmatrix} \phi^+ \\ \phi^0 \end{bmatrix} = \frac{1}{\sqrt{2}} \begin{bmatrix} \phi_3 + i\phi_4 \\ \phi_1 + i\phi_2 \end{bmatrix} \quad -(6)$$

So even at this stage of the theory there are ten parameters. The lagrangian is eventually developed as:

$$\mathcal{L}_2 = (D_\mu \phi)^+ (D_\mu \phi) - \frac{m^2}{2} \phi^+ \phi - \frac{\lambda}{4} (\phi^+ \phi)^2 \quad -(7)$$
$$- G_e (\bar{L} \phi R + \bar{R} \phi^+ L)$$

where

$$\bar{L}\phi R + \bar{R}\phi^+ L = \bar{\nu}_e e_R \phi^+ + \bar{e}_L e_R \phi^0 \quad -(8)$$
$$+ \bar{e}_R \nu_e \phi^- + \bar{e}_R e_L \phi^0,$$

$$\phi^+ \phi = (\phi^+)^* \phi^+ + (\phi^0)^* \phi^0 \quad -(9)$$
$$= \frac{1}{2} (\phi_1^2 + \phi_2^2 + \phi_3^2 + \phi_4^2),$$

so this means fourteen parameters.

The covariant derivative is defined as:

$$D_\mu = -\frac{i}{2} \begin{bmatrix} g\eta (W_\mu^1 - i W_\mu^2) + \frac{g\sigma}{\sqrt{2}} (W_\mu^1 - i W_\mu^2) \\ i\sqrt{2}\partial_\mu \sigma + \eta(-g W_\mu^3 + g' X_\mu) + \frac{\sigma}{\sqrt{2}} (-g W_\mu^3 + g' X_\mu) \end{bmatrix} \quad -(10)$$

3) So at this stage there are about seventeen parameters.

It follows that:

$$(D_\mu \phi)^+ (D_\mu \phi) = \frac{1}{2} (\partial_\mu \sigma)^2 + \frac{g^2 \eta^2}{4} \left((W_\mu^1)^2 + (W_\mu^2)^2 \right)$$
$$+ \frac{\eta^2}{4} \left(g W_\mu^3 - g' X_\mu \right)^2 + \dots \quad -(11)$$

The masses are defined as:

$$m_{W_1}^2 = m_{W_2}^2 = g^2 \eta^2 / 2 \quad -(12)$$

and:

$$m_Z^2 = \frac{g^2 \eta^2}{2 \cos^2 \theta_W} = \frac{g^2 \eta^2}{2} \frac{(g^2 + g_1^2)}{g^2} \quad -(13)$$

the quantity:

$$Z_\mu = \frac{g W_\mu^3 - g' X_\mu}{(g^2 + g'^2)^{1/2}} \quad -(14)$$

is claimed to be a boson, and is written as:

$$Z_\mu = W_\mu^3 \cos \theta_W - X_\mu \sin \theta_W \quad -(15)$$

However, the only quantity actually appearing in eq. (11) is $(g W_\mu^3 - g' X_\mu)^2$.

4) This quantity has four unknown parameters g, W_μ^3, g' and X_μ. The mass associated with this quantity is $\eta / 2$.

The electromagnetic field is defined arbitrarily as:

$$A_\mu = \frac{g' W_\mu^3 + g X_\mu}{(g^2 + g'^2)^{1/2}} \quad - (16)$$

but there is no theoretical justification for this identification. Here:

$$W_\mu = \frac{1}{\sqrt{2}} \left(W_\mu^1 + i W_\mu^2 \right) \quad - (17)$$

The A_μ field is still the heavily criticised A_μ field of the $U(1)$ sector.

The electromagnetic field is chosen from the lepton gauge field coupling:

$$i \bar{R} \gamma^\mu (\partial_\mu + i g' X_\mu) R + i \bar{L} \gamma^\mu \left(\partial_\mu + \frac{i}{2} g' X_\mu - \frac{i}{2} g \underline{\tau} \cdot \underline{W}_\mu \right) L$$

$$= i \bar{e} \gamma^\mu \partial_\mu e + i \bar{\nu} \gamma^\mu \partial_\mu \nu - g \sin\theta_W \bar{e} \gamma^\mu e A_\mu + \ldots \quad - (18)$$

This leads to:

$$e = g \sin\theta_W \quad - (19)$$

5) Here g is the coupling of the weak field to the neutrino current, and is asserted to account for muon decay:

$$\mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu \quad -(20)$$

From this, the Fermi constant is:

$$G = \frac{g^2}{4\sqrt{2}\, m_W^2} \quad -(21)$$

The neutral field Z couples to neutrinos and charged leptons, so:

$$\nu_\mu + e^- \rightarrow \nu_\mu + e^- \quad -(22)$$

This cross section is asserted to give a value for θ_W, and assuming eq. (19), for g. Then eq. (21) gives:

$$m_W^2 = 78.6\, (GeV/c^2)^2 \quad -(23)$$

and finally it is asserted that:

$$m_Z^2 = \frac{g^2 n^2}{2\cos^2\theta_W} = \frac{m_W^2}{\cos^2\theta_W} \quad -(24)$$

$$= 89.3\, GeV/c^2$$

However, what actually appears from eq. (11) is the field $g W_\mu^3 - g' X_\mu$.

The Weinberg angle is an existing relation between g and g'