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Lagrangian terms:

$$Y_1 + Y_2 + Y_3 = 0 \longrightarrow$$

$$\bar{\tau}_1 + \bar{\tau}_2 + \bar{\tau}_3 = 0$$

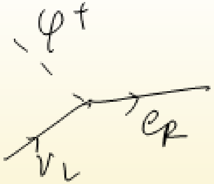
$$\cancel{|T_1 \; T_{13}\rangle + |T_2 + T_{23}\rangle + |T_3 \rangle}$$

$$|T_1 \; T_{13}\rangle \oplus |T_2 \; T_{23}\rangle \oplus |T_3 \; T_{33}\rangle = |0 \; 0\rangle$$

$$(T_1, T_2, T_3) \qquad T_{13} + T_{23} + T_{33} = 0 \longrightarrow$$

can make spin-0

$$\boxed{\begin{matrix} \bar{l}_L & \Phi & e_R \\ (2,+1) & (2,1) & (1,-2) \end{matrix}}$$



$$(\bar{\nu}_L \;\; \bar{e}_L)\begin{pmatrix}\varphi^+ \\ \varphi^0\end{pmatrix} e_R \longrightarrow \bar{\nu}_L \varphi^+ e_R + \bar{e}_L \varphi^0 e_R$$

T_3: $\underbrace{-\tfrac{1}{2} + \tfrac{1}{2} + 0}_{✓}$ $\quad$ $\underbrace{+\tfrac{1}{2} - \tfrac{1}{2} + 0}_{✓}$

Y: $\underbrace{+1 \; +1 \; -2}_{✓}$ $\quad$ $\underbrace{+1 \; +1 \; -2}_{✓}$

"spin 0": $\boxed{\bar{\nu}_L \varphi^+ + \bar{e}_L \varphi^0}$

$$\begin{matrix} \bar{\nu}_L \varphi^{\oplus} \\ (\bar{\nu}_L \varphi^{+} - \bar{e}_L \varphi^{\oplus})/\sqrt{2} \\ \bar{e}_L \; \varphi^{+} \end{matrix}$$

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$$\bar{q}_L \phi\, d_R$$

$$\downarrow$$

$$\cancel{(\bar{u}_L}\quad (\bar{u}_L \;\; \bar{d}_L)\begin{pmatrix}\varphi^+ \\ \varphi^0\end{pmatrix} d_R \to \bar{u}_L \varphi^+ d_R + \bar{d}_L \varphi^0 d_R$$

$$\bar{q}_L \varphi^c u_R$$

$$\hookrightarrow (\bar{u}_L \;\; \bar{d}_L)\begin{pmatrix}\varphi_0^* \\ -\varphi^-\end{pmatrix} u_R \to \bar{u}_L \varphi_0^* u_R - \bar{d}_L \varphi^- u_R$$

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$$\phi^c = i\tau_2\phi^* = i\begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}\begin{pmatrix} \varphi^{+*} \\ \varphi_0^* \end{pmatrix}$$

$$= \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}\begin{pmatrix} \varphi^- \\ \varphi_0^* \end{pmatrix}$$

$$= \begin{pmatrix} \varphi_0^* \\ -\varphi^- \end{pmatrix}$$

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$$\bar{\psi}\psi \rightarrow \bar{\psi}_L \psi_R + \bar{\psi}_R \psi_L \qquad \cancel{\bar{\psi}_L \psi_L}$$

$$\bar{\psi}_L \psi_R + h.c$$

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$$\frac{1}{8}\left[\cancel{g|W_1 - iW_2|^2 v^2 + |-g'B + gW_3|^2 v^2}\right]$$

$$\frac{1}{8}\left|\begin{pmatrix} g(W_1 - iW_2)v \\ (-g'B + gW_3)v \end{pmatrix}\right|^2$$

$$\underline{\underline{\frac{1}{8}g^2v^2}}\,\underline{\underline{|W_1|^2}} + \frac{1}{8}g^2v^2|W_2|^2 + \frac{1}{8}v^2|-g'B+gW_3|^2$$

$$\frac{1}{2}m^2 A_\mu A^\mu \qquad m_{W_1} = \frac{1}{2}gv \qquad m_{W_2} = \frac{1}{2}gv$$

$$\frac{1}{8} v^2 \left| -g' B + g W_3 \right|^2 \longrightarrow \frac{1}{8} v^2 \left[g'^2 B^2 + g^2 W_3^2 - 2 g g' B W_3 \right]$$

$$\frac{1}{8} v^2 (g^2 + g'^2) \underbrace{\left| \frac{-g' B + g W_3}{\sqrt{g^2 + g'^2}} \right|^2}$$

$$\frac{1}{8} v^2 (g^2 + g'^2) \left| Z \right|^2$$

$$\hookrightarrow \quad m_Z = \frac{1}{2} v \sqrt{g^2 + g'^2}$$

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$$\left|\frac{gB + g'W}{\sqrt{g^2+g'^2}}\right|^2$$

$$|A_\mu|^2$$

$$\frac{1}{2}m_A^2 \longrightarrow 0$$

$$\rho = 1 \longleftarrow Y(\phi) = 1$$

$$\begin{pmatrix} Q = T_3 + \frac{Y}{2} = \frac{1}{2} + \frac{1}{2} = 1 \\ Q = -\frac{1}{2} + \frac{1}{2} = 0 \end{pmatrix}$$

$$\begin{pmatrix} \varphi^+ \\ \varphi^0 \end{pmatrix}$$

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$$-\lambda_e \bar{l}_L \Phi e_R$$

$$-\lambda_e \left(\bar{\nu}_L \ \bar{e}_L\right) \begin{pmatrix} \varphi^+ \\ \varphi^0 \end{pmatrix} e_R$$

$$-\lambda_e \left(\bar{\nu}_L \ \bar{e}_L\right) \begin{pmatrix} 0 \\ v \end{pmatrix} e_R$$

$$-\lambda_e \bar{e}_L e_R v$$

$$-(\lambda_e v) \bar{e}_L e_R$$

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$$-\lambda_e \bar{l}_L \Phi e_R$$

$$-\lambda_e \left(\bar{\nu}_L \;\; \bar{e}_L \right) \begin{pmatrix} \varphi^+ \\ \varphi^0 \end{pmatrix} e_R$$

$$-\lambda_e \left(\bar{\nu}_L \;\; \bar{e}_L \right) \begin{pmatrix} 0 \\ v \end{pmatrix} e_R$$

$$-\lambda_e \bar{e}_L e_R v$$

$$-(\lambda_e v) \bar{e}_L e_R$$

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$$m_e \bar{e}_L e_R + h.c$$

$$e = e_L + e_R$$

$$m_e \underline{\bar{e}\, e}$$

$$\hookrightarrow$$

$$\bar{\nu}_L \cancel{\nu_R}$$