THE STANDARD MODEL LAGRANGIAN

for broken U(1)xSU(2)xSU(3)

$$\mathcal{L}_{SM} = \mathcal{L}_{Boson} + \mathcal{L}_{Lepton} + \mathcal{L}_{Quark}$$

$$\mathcal{L}_{Boson} =$$

$$-\frac{1}{4}(\partial_\alpha A_\beta - \partial_\beta A_\alpha)^2 - \frac{1}{4}(\partial_\alpha Z_\beta - \partial_\beta Z_\alpha)^2 - \frac{1}{2}(\partial_\alpha W^-_\beta - \partial_\beta W^-_\alpha)(\partial_\alpha W^+_\beta - \partial_\beta W^+_\alpha)$$

$$+ig\left\{(\partial_\alpha W^+_\beta - \partial_\beta W^+_\alpha)W^-_\beta - (\partial_\alpha W^-_\beta - \partial_\beta W^-_\alpha)W^+_\beta\right\}(\mathit{Cos}\,\vartheta_W Z_\alpha + \mathit{Sin}\,\vartheta_W A_\alpha)$$

$$+ig(W^+_\alpha W^-_\beta - W^-_\alpha W^+_\beta)\partial_\beta(\mathit{Cos}\,\vartheta_W Z_\alpha + \mathit{Sin}\,\vartheta_W A_\alpha)$$

$$+g^2\left\{W^+_\beta W^-_\alpha(\mathit{Cos}\vartheta_W Z_\alpha + \mathit{Sin}\vartheta_W A_\alpha) - W^+_\alpha W^-_\alpha(\mathit{Cos}\vartheta_W Z_\beta + \mathit{Sin}\vartheta_W A_\beta)\right\}(\mathit{Cos}\vartheta_W Z_\beta + \mathit{Sin}\vartheta_W A_\beta)$$

$$+\frac{1}{2}g^2 W^-_\beta W^+_\alpha(W^-_\beta W^+_\alpha - W^-_\alpha W^+_\beta) - \frac{1}{4}(\partial_\alpha G^a_\beta - \partial_\beta G^a_\alpha + g_s f^{abc}G^b_\alpha G^c_\beta)^2$$

$$+\frac{1}{2}\partial_\alpha\Phi\,\partial_\alpha\Phi + M_W^2 W^-_\alpha W^+_\alpha + \frac{1}{2}M_Z^2 Z_\alpha Z_\alpha + \frac{1}{4}g^2(2v\Phi + \Phi^2)W^-_\alpha W^+_\alpha$$

$$+\frac{1}{8}\frac{g^2}{\mathit{Cos}^2\vartheta_W}(2v\Phi + \Phi^2)Z_\alpha Z_\alpha - \frac{1}{2}M_\Phi^2\Phi^2 - \frac{\sigma}{4}(4v\Phi^3 + \Phi^4)$$

$$\mathcal{L}_{Lepton} = \sum_{3\text{ generations},\ g} i\,\bar{e}^g\gamma.\partial e^g + i\,\bar{\nu}^g\gamma.\partial\nu^g + e\,\bar{e}^g\gamma_\alpha e^g A_\alpha$$

$$-\frac{g}{2\,\mathit{Cos}\,\vartheta_W}Z_\alpha\left\{\bar{\nu}^g\gamma_\alpha\frac{1}{2}(1-\gamma_5)\nu^g + \bar{e}^g\gamma_\alpha(2\,\mathit{Sin}^2\vartheta_W - \frac{1}{2}(1-\gamma_5))e^g\right\}$$

$$-\frac{g}{\sqrt{2}}\left\{\bar{\nu}^g\gamma_\alpha\frac{1}{2}(1-\gamma_5)e^g W^+_\alpha + \bar{e}^g\gamma_\alpha\frac{1}{2}(1-\gamma_5)\nu^g W^-_\alpha\right\}$$

$$-\left(1 + \frac{\Phi}{v}\right)M^g\,\bar{e}^g e^g$$

$$\mathcal{L}_{Quark} = \sum_g\sum_{3\text{ colours},\ c} i\,\bar{u}^g_c\gamma.\partial u^g_c + i\,\bar{d}^g_c\gamma.\partial d^g_c - eA_\alpha\left(\frac{2}{3}\bar{u}^g_c\gamma_\alpha u^g_c - \frac{1}{3}\bar{d}^g_c\gamma_\alpha d^g_c\right)$$

$$-g_s\,\bar{u}^g_c\gamma_\alpha\left(\frac{1}{2}T^aG^a_\alpha\right)_{cd}u^g_d - g_s\,\bar{d}^g_c\gamma_\alpha\left(\frac{1}{2}T^aG^a_\alpha\right)_{cd}d^g_d$$

$$-\frac{g}{2\,\mathit{Cos}\,\vartheta_W}Z_\alpha\left\{\bar{u}^g_c\gamma_\alpha\left(\frac{1}{2}(1+\gamma_5) - \frac{4}{3}\mathit{Sin}^2\vartheta_W\right)u^g_c + \bar{d}^g_c\gamma_\alpha\left(-\frac{1}{2}(1+\gamma_5) + \frac{2}{3}\mathit{Sin}^2\vartheta_W\right)d^g_c\right\}$$

$$-\frac{g}{\sqrt{2}}\left\{\bar{u}^g_c\gamma_\alpha\frac{1}{2}(1-\gamma_5)V_{gf}d^f_c W^+_\alpha + \bar{d}^g_c\gamma_\alpha\frac{1}{2}(1-\gamma_5)V^\dagger_{gf}u^f_c W^-_\alpha\right\}$$

$$-\left(1 + \frac{\Phi}{v}\right)\left\{M^g_{up}\,\bar{u}^g_c u^g_c + M^g_{down}\,\bar{d}^g_c d^g_c\right\}$$

Coded in DERIVE:

Standard Lagrangian 29/11/90

BOSON3.MTH
LEPTON3.MTH
QUARK3.MTH