

NMSSM without flavor violation
Superpotential, Rotations and Interactions for eigenstates 'EWSB'
including Renormalization Group Equations

SARAH 4.6.0

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References: **arXiv: 1309.7223** , **Comput.Phys.Commun.184:1792-1809,2011 (1207.0906)** , **Comput.Phys.Commun.182:833,2011 (1002.0840)** , **Comput.Phys.Commun.181:1077-1086,2010 (0909.2863)** , **arXiv: 0806.0538**

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1 Superfields

1.1 Vector Superfields

SF	Spin $\frac{1}{2}$	Spin 1	$SU(N)$	Coupling	Name
\hat{B}	$\lambda_{\hat{B}}$	B	$U(1)$	g_1	hypercharge
\hat{W}	$\lambda_{\hat{W}}$	W	$SU(2)$	g_2	left
\hat{g}	$\lambda_{\hat{g}}$	g	$SU(3)$	g_3	color

1.2 Chiral Superfields

SF	Spin 0	Spin $\frac{1}{2}$	Generations	$(U(1) \otimes SU(2) \otimes SU(3))$
\hat{q}	\tilde{q}	q	3	$(\frac{1}{6}, \mathbf{2}, \mathbf{3})$
\hat{l}	\tilde{l}	l	3	$(-\frac{1}{2}, \mathbf{2}, \mathbf{1})$
\hat{H}_d	H_d	\tilde{H}_d	1	$(-\frac{1}{2}, \mathbf{2}, \mathbf{1})$
\hat{H}_u	H_u	\tilde{H}_u	1	$(\frac{1}{2}, \mathbf{2}, \mathbf{1})$
\hat{d}	\tilde{d}_R^*	conj $\left(\text{FdR0} \right)$	3	$(\frac{1}{3}, \mathbf{1}, \bar{\mathbf{3}})$
\hat{u}	\tilde{u}_R^*	conj $\left(\text{FuR0} \right)$	3	$(-\frac{2}{3}, \mathbf{1}, \bar{\mathbf{3}})$
\hat{e}	\tilde{e}_R^*	conj $\left(\text{FeR0} \right)$	3	$(1, \mathbf{1}, \mathbf{1})$
\hat{s}	S	\tilde{S}	1	$(0, \mathbf{1}, \mathbf{1})$

2 Superpotential and Lagrangian

2.1 Superpotential

$$W = -Y_d \hat{d} \hat{q} \hat{H}_d - Y_e \hat{e} \hat{l} \hat{H}_d + \lambda \hat{H}_u \hat{H}_d \hat{s} + \frac{1}{3} \kappa \hat{s} \hat{s} \hat{s} + Y_u \hat{u} \hat{q} \hat{H}_u \quad (1)$$

2.2 Softbreaking terms

$$\begin{aligned}
-L_{SB,W} = & + \frac{1}{3} S^3 T_\kappa - H_d^0 H_u^0 S T_\lambda + H_d^- H_u^+ S T_\lambda + H_d^0 \tilde{d}_{R,i\alpha}^* \delta_{\alpha\beta} \delta_{ij} \tilde{d}_{L,j\beta} T_{d,ij} \\
& - H_d^- \tilde{d}_{R,i\alpha}^* \delta_{\alpha\beta} \delta_{ij} \tilde{u}_{L,j\beta} T_{d,ij} + H_d^0 \tilde{e}_{R,i}^* \delta_{ij} \tilde{e}_{L,j} T_{e,ij} - H_d^- \tilde{e}_{R,i}^* \delta_{ij} \tilde{\nu}_{L,j} T_{e,ij} \\
& - H_u^+ \tilde{u}_{R,i\alpha}^* \delta_{\alpha\beta} \delta_{ij} \tilde{d}_{L,j\beta} T_{u,ij} + H_u^0 \tilde{u}_{R,i\alpha}^* \delta_{\alpha\beta} \delta_{ij} \tilde{u}_{L,j\beta} T_{u,ij} + \text{h.c.} \quad (2)
\end{aligned}$$

$$\begin{aligned}
-L_{SB,\phi} = & + m_{H_d}^2 |H_d^0|^2 + m_{H_d}^2 |H_d^-|^2 + m_{H_u}^2 |H_u^0|^2 + m_{H_u}^2 |H_u^+|^2 + m_S^2 |S|^2 + \tilde{d}_{L,i\alpha}^* \delta_{\alpha\beta} \delta_{ij} m_{q,ij}^2 \tilde{d}_{L,j\beta} \\
& + \tilde{d}_{R,i\alpha}^* \delta_{\alpha\beta} \delta_{ij} m_{d,ij}^2 \tilde{d}_{R,j\beta} + \tilde{e}_{L,i}^* \delta_{ij} m_{l,ij}^2 \tilde{e}_{L,j} + \tilde{e}_{R,i}^* \delta_{ij} m_{e,ij}^2 \tilde{e}_{R,j} + \tilde{u}_{L,i\alpha}^* \delta_{\alpha\beta} \delta_{ij} m_{q,ij}^2 \tilde{u}_{L,j\beta} \\
& + \tilde{u}_{R,i\alpha}^* \delta_{\alpha\beta} \delta_{ij} m_{u,ij}^2 \tilde{u}_{R,j\beta} + \tilde{\nu}_{L,i}^* \delta_{ij} m_{l,ij}^2 \tilde{\nu}_{L,j} \quad (3)
\end{aligned}$$

$$-L_{SB,\lambda} = \frac{1}{2} \left(\lambda_B^2 M_1 \delta_{ij} + M_2 \delta_{ij} \lambda_{\hat{W},i} \lambda_{\hat{W},j} + M_3 \delta_{ij} \lambda_{\hat{g},\alpha} \lambda_{\hat{g},\beta} + \text{h.c.} \right) \quad (4)$$

2.3 Gauge fixing terms

2.3.1 Gauge fixing terms for eigenstates 'GaugeES'

$$L_{GF} = -\frac{1}{2}|\partial_\mu B|^2\xi_B^{-1} - \frac{1}{2}|\partial_\mu g|^2\xi_g^{-1} - \frac{1}{2}|\partial_\mu W|^2\xi_W^{-1} \quad (5)$$

2.3.2 Gauge fixing terms for eigenstates 'EWSB'

$$L_{GF} = -\frac{1}{2}|\partial_\mu g|^2\xi_g^{-1} - \frac{1}{2}|\partial_\mu \gamma|^2\xi_\gamma^{-1} - \left| -\frac{i}{2}g_2(H_d^- v_d - v_u H_u^{+,*})\xi_{W^-} + \partial_\mu W^- \right|^2\xi_{W^-}^{-1} \\ - \frac{1}{2}\left| \frac{1}{2}(2\partial_\mu Z + (\sigma_d v_d - \sigma_u v_u)\xi_Z(g_1 \sin \Theta_W + g_2 \cos \Theta_W)) \right|^2\xi_Z^{-1} \quad (6)$$

2.4 Fields integrated out

None

3 Renormalization Group Equations

3.1 Anomalous Dimensions

$$\gamma_{\hat{q}}^{(1)} = -\frac{1}{30}(45g_2^2 + 80g_3^2 + g_1^2)\mathbf{1} + Y_d^\dagger Y_d + Y_u^\dagger Y_u \quad (7)$$

$$\gamma_{\hat{q}}^{(2)} = +\left(8g_2^2 g_3^2 + \frac{15}{4}g_2^4 + \frac{1}{90}g_1^2(16g_3^2 + 9g_2^2) + \frac{199}{900}g_1^4 - \frac{8}{9}g_3^4\right)\mathbf{1} + \frac{4}{5}g_1^2 Y_u^\dagger Y_u - |\lambda|^2 Y_u^\dagger Y_u \\ - 2Y_d^\dagger Y_d Y_d^\dagger Y_d - 2Y_u^\dagger Y_u Y_u^\dagger Y_u + Y_d^\dagger Y_d \left(-3\text{Tr}(Y_d Y_d^\dagger) + \frac{2}{5}g_1^2 - |\lambda|^2 - \text{Tr}(Y_e Y_e^\dagger)\right) \\ - 3Y_u^\dagger Y_u \text{Tr}(Y_u Y_u^\dagger) \quad (8)$$

$$\gamma_{\hat{i}}^{(1)} = -\frac{3}{10}(5g_2^2 + g_1^2)\mathbf{1} + Y_e^\dagger Y_e \quad (9)$$

$$\gamma_{\hat{i}}^{(2)} = +\frac{3}{100}(125g_2^4 + 30g_1^2 g_2^2 + 69g_1^4)\mathbf{1} - 2Y_e^\dagger Y_e Y_e^\dagger Y_e \\ + Y_e^\dagger Y_e \left(-3\text{Tr}(Y_d Y_d^\dagger) + \frac{6}{5}g_1^2 - |\lambda|^2 - \text{Tr}(Y_e Y_e^\dagger)\right) \quad (10)$$

$$\gamma_{\hat{H}_d}^{(1)} = 3\text{Tr}(Y_d Y_d^\dagger) - \frac{3}{10}g_1^2 - \frac{3}{2}g_2^2 + |\lambda|^2 + \text{Tr}(Y_e Y_e^\dagger) \quad (11)$$

$$\gamma_{\hat{H}_d}^{(2)} = +\frac{207}{100}g_1^4 + \frac{9}{10}g_1^2 g_2^2 + \frac{15}{4}g_2^4 - 2\lambda|\kappa|^2\lambda^* - 3\lambda^2\lambda^{*,2} - \frac{2}{5}g_1^2 \text{Tr}(Y_d Y_d^\dagger) + 16g_3^2 \text{Tr}(Y_d Y_d^\dagger) \\ + \frac{6}{5}g_1^2 \text{Tr}(Y_e Y_e^\dagger) - 3|\lambda|^2 \text{Tr}(Y_u Y_u^\dagger) - 9\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) \\ - 3\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \quad (12)$$

$$\gamma_{\hat{H}_u}^{(1)} = -\frac{3}{10}\left(-10\text{Tr}(Y_u Y_u^\dagger) + 5g_2^2 + g_1^2\right) + |\lambda|^2 \quad (13)$$

$$\begin{aligned}\gamma_{\hat{H}_u}^{(2)} = & +\frac{207}{100}g_1^4 + \frac{9}{10}g_1^2g_2^2 + \frac{15}{4}g_2^4 - 2\lambda|\kappa|^2\lambda^* - 3\lambda^2\lambda^{*,2} - |\lambda|^2\left(3\text{Tr}\left(Y_dY_d^\dagger\right) + \text{Tr}\left(Y_eY_e^\dagger\right)\right) \\ & + \frac{4}{5}g_1^2\text{Tr}\left(Y_uY_u^\dagger\right) + 16g_3^2\text{Tr}\left(Y_uY_u^\dagger\right) - 3\text{Tr}\left(Y_dY_u^\dagger Y_uY_d^\dagger\right) - 9\text{Tr}\left(Y_uY_u^\dagger Y_uY_u^\dagger\right)\end{aligned}\quad (14)$$

$$\gamma_{\hat{d}}^{(1)} = 2Y_d^*Y_d^T - \frac{2}{15}\left(20g_3^2 + g_1^2\right)\mathbf{1}\quad (15)$$

$$\begin{aligned}\gamma_{\hat{d}}^{(2)} = & +\frac{2}{225}\left(-100g_3^4 + 101g_1^4 + 80g_1^2g_3^2\right)\mathbf{1} - 2\left(Y_d^*Y_d^TY_d^*Y_d^T + Y_d^*Y_u^TY_u^*Y_d^T\right) \\ & + Y_d^*Y_d^T\left(-2|\lambda|^2 - 2\text{Tr}\left(Y_eY_e^\dagger\right) + 6g_2^2 - 6\text{Tr}\left(Y_dY_d^\dagger\right) + \frac{2}{5}g_1^2\right)\end{aligned}\quad (16)$$

$$\gamma_{\hat{u}}^{(1)} = 2Y_u^*Y_u^T - \frac{8}{15}\left(5g_3^2 + g_1^2\right)\mathbf{1}\quad (17)$$

$$\begin{aligned}\gamma_{\hat{u}}^{(2)} = & +\frac{8}{225}\left(107g_1^4 - 25g_3^4 + 80g_1^2g_3^2\right)\mathbf{1} \\ & - \frac{2}{5}\left(5\left(Y_u^*Y_d^TY_d^*Y_u^T + Y_u^*Y_u^TY_u^*Y_u^T\right) + Y_u^*Y_u^T\left(-15g_2^2 + 15\text{Tr}\left(Y_uY_u^\dagger\right) + 5|\lambda|^2 + g_1^2\right)\right)\end{aligned}\quad (18)$$

$$\gamma_{\hat{e}}^{(1)} = 2Y_e^*Y_e^T - \frac{6}{5}g_1^2\mathbf{1}\quad (19)$$

$$\gamma_{\hat{e}}^{(2)} = -2Y_e^*Y_e^TY_e^*Y_e^T + \frac{234}{25}g_1^4\mathbf{1} + Y_e^*Y_e^T\left(-2|\lambda|^2 - 2\text{Tr}\left(Y_eY_e^\dagger\right) + 6g_2^2 - 6\text{Tr}\left(Y_dY_d^\dagger\right) - \frac{6}{5}g_1^2\right)\quad (20)$$

$$\gamma_{\hat{s}}^{(1)} = 2\left(|\kappa|^2 + |\lambda|^2\right)\quad (21)$$

$$\begin{aligned}\gamma_{\hat{s}}^{(2)} = & -8\kappa^2\kappa^{*,2} - 8\lambda|\kappa|^2\lambda^* \\ & - \frac{2}{5}|\lambda|^2\left(10\lambda\lambda^* - 15g_2^2 + 15\text{Tr}\left(Y_dY_d^\dagger\right) + 15\text{Tr}\left(Y_uY_u^\dagger\right) - 3g_1^2 + 5\text{Tr}\left(Y_eY_e^\dagger\right)\right)\end{aligned}\quad (22)$$

3.2 Gauge Couplings

$$\beta_{g_1}^{(1)} = \frac{33}{5}g_1^3\quad (23)$$

$$\beta_{g_1}^{(2)} = \frac{1}{25}g_1^3\left(-130\text{Tr}\left(Y_uY_u^\dagger\right) + 135g_2^2 + 199g_1^2 - 30|\lambda|^2 + 440g_3^2 - 70\text{Tr}\left(Y_dY_d^\dagger\right) - 90\text{Tr}\left(Y_eY_e^\dagger\right)\right)\quad (24)$$

$$\beta_{g_2}^{(1)} = g_2^3\quad (25)$$

$$\beta_{g_2}^{(2)} = \frac{1}{5}g_2^3\left(-10|\lambda|^2 - 10\text{Tr}\left(Y_eY_e^\dagger\right) + 120g_3^2 + 125g_2^2 - 30\text{Tr}\left(Y_dY_d^\dagger\right) - 30\text{Tr}\left(Y_uY_u^\dagger\right) + 9g_1^2\right)\quad (26)$$

$$\beta_{g_3}^{(1)} = -3g_3^3\quad (27)$$

$$\beta_{g_3}^{(2)} = \frac{1}{5}g_3^3\left(11g_1^2 - 20\text{Tr}\left(Y_dY_d^\dagger\right) - 20\text{Tr}\left(Y_uY_u^\dagger\right) + 45g_2^2 + 70g_3^2\right)\quad (28)$$

3.3 Gaugino Mass Parameters

$$\beta_{M_1}^{(1)} = \frac{66}{5}g_1^2M_1\quad (29)$$

$$\beta_{M_1}^{(2)} = \frac{2}{25}g_1^2 \left(398g_1^2M_1 + 135g_2^2M_1 + 440g_3^2M_1 + 440g_3^2M_3 + 135g_2^2M_2 - 30\lambda^* \left(M_1\lambda - T_\lambda \right) - 70M_1\text{Tr}\left(Y_dY_d^\dagger\right) \right. \\ \left. - 90M_1\text{Tr}\left(Y_eY_e^\dagger\right) - 130M_1\text{Tr}\left(Y_uY_u^\dagger\right) + 70\text{Tr}\left(Y_d^\dagger T_d\right) + 90\text{Tr}\left(Y_e^\dagger T_e\right) + 130\text{Tr}\left(Y_u^\dagger T_u\right) \right) \quad (30)$$

$$\beta_{M_2}^{(1)} = 2g_2^2M_2 \quad (31)$$

$$\beta_{M_2}^{(2)} = \frac{2}{5}g_2^2 \left(9g_1^2M_1 + 120g_3^2M_3 + 9g_1^2M_2 + 250g_2^2M_2 + 120g_3^2M_2 - 10\lambda^* \left(M_2\lambda - T_\lambda \right) - 30M_2\text{Tr}\left(Y_dY_d^\dagger\right) \right. \\ \left. - 10M_2\text{Tr}\left(Y_eY_e^\dagger\right) - 30M_2\text{Tr}\left(Y_uY_u^\dagger\right) + 30\text{Tr}\left(Y_d^\dagger T_d\right) + 10\text{Tr}\left(Y_e^\dagger T_e\right) + 30\text{Tr}\left(Y_u^\dagger T_u\right) \right) \quad (32)$$

$$\beta_{M_3}^{(1)} = -6g_3^2M_3 \quad (33)$$

$$\beta_{M_3}^{(2)} = \frac{2}{5}g_3^2 \left(11g_1^2M_1 + 11g_1^2M_3 + 45g_2^2M_3 + 140g_3^2M_3 + 45g_2^2M_2 - 20M_3\text{Tr}\left(Y_dY_d^\dagger\right) - 20M_3\text{Tr}\left(Y_uY_u^\dagger\right) \right. \\ \left. + 20\text{Tr}\left(Y_d^\dagger T_d\right) + 20\text{Tr}\left(Y_u^\dagger T_u\right) \right) \quad (34)$$

3.4 Trilinear Superpotential Parameters

$$\beta_{Y_d}^{(1)} = 3Y_dY_d^\dagger Y_d + Y_d \left(-3g_2^2 + 3\text{Tr}\left(Y_dY_d^\dagger\right) - \frac{16}{3}g_3^2 - \frac{7}{15}g_1^2 + |\lambda|^2 + \text{Tr}\left(Y_eY_e^\dagger\right) \right) + Y_dY_u^\dagger Y_u \quad (35)$$

$$\beta_{Y_d}^{(2)} = +\frac{4}{5}g_1^2Y_dY_u^\dagger Y_u - |\lambda|^2Y_dY_u^\dagger Y_u - 4Y_dY_d^\dagger Y_dY_d^\dagger Y_d - 2Y_dY_u^\dagger Y_uY_d^\dagger Y_d \\ - 2Y_dY_u^\dagger Y_uY_u^\dagger Y_u + Y_dY_d^\dagger Y_d \left(-3|\lambda|^2 - 3\text{Tr}\left(Y_eY_e^\dagger\right) + 6g_2^2 - 9\text{Tr}\left(Y_dY_d^\dagger\right) + \frac{4}{5}g_1^2 \right) \\ - 3Y_dY_u^\dagger Y_u\text{Tr}\left(Y_uY_u^\dagger\right) \\ + Y_d \left(\frac{287}{90}g_1^4 + g_1^2g_2^2 + \frac{15}{2}g_2^4 + \frac{8}{9}g_1^2g_3^2 + 8g_2^2g_3^2 - \frac{16}{9}g_3^4 - 2\lambda|\kappa|^2\lambda^* - 3\lambda^2\lambda^{*,2} \right. \\ \left. - \frac{2}{5}g_1^2\text{Tr}\left(Y_dY_d^\dagger\right) + 16g_3^2\text{Tr}\left(Y_dY_d^\dagger\right) + \frac{6}{5}g_1^2\text{Tr}\left(Y_eY_e^\dagger\right) - 3|\lambda|^2\text{Tr}\left(Y_uY_u^\dagger\right) - 9\text{Tr}\left(Y_dY_d^\dagger Y_dY_d^\dagger\right) \right. \\ \left. - 3\text{Tr}\left(Y_dY_u^\dagger Y_uY_d^\dagger\right) - 3\text{Tr}\left(Y_eY_e^\dagger Y_eY_e^\dagger\right) \right) \quad (36)$$

$$\beta_{Y_e}^{(1)} = 3Y_eY_e^\dagger Y_e + Y_e \left(-3g_2^2 + 3\text{Tr}\left(Y_dY_d^\dagger\right) - \frac{9}{5}g_1^2 + |\lambda|^2 + \text{Tr}\left(Y_eY_e^\dagger\right) \right) \quad (37)$$

$$\beta_{Y_e}^{(2)} = -4Y_eY_e^\dagger Y_eY_e^\dagger Y_e + Y_eY_e^\dagger Y_e \left(-3|\lambda|^2 - 3\text{Tr}\left(Y_eY_e^\dagger\right) + 6g_2^2 - 9\text{Tr}\left(Y_dY_d^\dagger\right) \right) \\ + Y_e \left(\frac{27}{2}g_1^4 + \frac{9}{5}g_1^2g_2^2 + \frac{15}{2}g_2^4 - 2\lambda|\kappa|^2\lambda^* - 3\lambda^2\lambda^{*,2} - \frac{2}{5}g_1^2\text{Tr}\left(Y_dY_d^\dagger\right) + 16g_3^2\text{Tr}\left(Y_dY_d^\dagger\right) \right. \\ \left. + \frac{6}{5}g_1^2\text{Tr}\left(Y_eY_e^\dagger\right) - 3|\lambda|^2\text{Tr}\left(Y_uY_u^\dagger\right) - 9\text{Tr}\left(Y_dY_d^\dagger Y_dY_d^\dagger\right) - 3\text{Tr}\left(Y_dY_u^\dagger Y_uY_d^\dagger\right) \right. \\ \left. - 3\text{Tr}\left(Y_eY_e^\dagger Y_eY_e^\dagger\right) \right) \quad (38)$$

$$\beta_\lambda^{(1)} = 2\lambda|\kappa|^2 - 3g_2^2\lambda + 3\lambda\text{Tr}\left(Y_dY_d^\dagger\right) + 3\lambda\text{Tr}\left(Y_uY_u^\dagger\right) + 4\lambda^2\lambda^* - \frac{3}{5}g_1^2\lambda + \lambda\text{Tr}\left(Y_eY_e^\dagger\right) \quad (39)$$

$$\beta_\lambda^{(2)} = -\frac{1}{50}\lambda \left(-207g_1^4 - 90g_1^2g_2^2 - 375g_2^4 + 400\kappa^2\kappa^{*,2} + 600\lambda|\kappa|^2\lambda^* + 500\lambda^2\lambda^{*,2} + 20g_1^2\text{Tr}\left(Y_dY_d^\dagger\right) \right)$$

$$\begin{aligned}
& -800g_3^2\text{Tr}\left(Y_dY_d^\dagger\right) - 60g_1^2\text{Tr}\left(Y_eY_e^\dagger\right) \\
& -30|\lambda|^2\left(10g_2^2 - 15\text{Tr}\left(Y_dY_d^\dagger\right) - 15\text{Tr}\left(Y_uY_u^\dagger\right) + 2g_1^2 - 5\text{Tr}\left(Y_eY_e^\dagger\right)\right) - 40g_1^2\text{Tr}\left(Y_uY_u^\dagger\right) \\
& -800g_3^2\text{Tr}\left(Y_uY_u^\dagger\right) + 450\text{Tr}\left(Y_dY_d^\dagger Y_dY_d^\dagger\right) + 300\text{Tr}\left(Y_dY_u^\dagger Y_uY_d^\dagger\right) + 150\text{Tr}\left(Y_eY_e^\dagger Y_eY_e^\dagger\right) \\
& + 450\text{Tr}\left(Y_uY_u^\dagger Y_uY_u^\dagger\right)
\end{aligned} \tag{40}$$

$$\beta_\kappa^{(1)} = 6\kappa\left(|\kappa|^2 + |\lambda|^2\right) \tag{41}$$

$$\begin{aligned}
\beta_\kappa^{(2)} = & -\frac{6}{5}\kappa\left(20\kappa^2\kappa^{*,2} + 20\lambda|\kappa|^2\lambda^* \right. \\
& \left. + |\lambda|^2\left(10\lambda\lambda^* - 15g_2^2 + 15\text{Tr}\left(Y_dY_d^\dagger\right) + 15\text{Tr}\left(Y_uY_u^\dagger\right) - 3g_1^2 + 5\text{Tr}\left(Y_eY_e^\dagger\right)\right)\right)
\end{aligned} \tag{42}$$

$$\beta_{Y_u}^{(1)} = 3Y_uY_u^\dagger Y_u + Y_u\left(-3g_2^2 + 3\text{Tr}\left(Y_uY_u^\dagger\right) - \frac{13}{15}g_1^2 - \frac{16}{3}g_3^2 + |\lambda|^2\right) + Y_uY_d^\dagger Y_d \tag{43}$$

$$\begin{aligned}
\beta_{Y_u}^{(2)} = & \frac{2}{5}g_1^2Y_uY_u^\dagger Y_u + 6g_2^2Y_uY_u^\dagger Y_u - 3|\lambda|^2Y_uY_u^\dagger Y_u - 2Y_uY_d^\dagger Y_dY_d^\dagger Y_d \\
& - 2Y_uY_d^\dagger Y_dY_u^\dagger Y_u - 4Y_uY_u^\dagger Y_uY_u^\dagger Y_u \\
& + Y_uY_d^\dagger Y_d\left(-3\text{Tr}\left(Y_dY_d^\dagger\right) + \frac{2}{5}g_1^2 - |\lambda|^2 - \text{Tr}\left(Y_eY_e^\dagger\right)\right) - 9Y_uY_u^\dagger Y_u\text{Tr}\left(Y_uY_u^\dagger\right) \\
& + Y_u\left(\frac{2743}{450}g_1^4 + g_2^2g_2^2 + \frac{15}{2}g_2^4 + \frac{136}{45}g_1^2g_3^2 + 8g_2^2g_3^2 - \frac{16}{9}g_3^4 - 2\lambda|\kappa|^2\lambda^* - 3\lambda^2\lambda^{*,2}\right) \\
& - |\lambda|^2\left(3\text{Tr}\left(Y_dY_d^\dagger\right) + \text{Tr}\left(Y_eY_e^\dagger\right)\right) + \frac{4}{5}g_1^2\text{Tr}\left(Y_uY_u^\dagger\right) + 16g_3^2\text{Tr}\left(Y_uY_u^\dagger\right) - 3\text{Tr}\left(Y_dY_u^\dagger Y_uY_d^\dagger\right) \\
& - 9\text{Tr}\left(Y_uY_u^\dagger Y_uY_u^\dagger\right)
\end{aligned} \tag{44}$$

3.5 Trilinear Soft-Breaking Parameters

$$\begin{aligned}
\beta_{T_d}^{(1)} = & +4Y_dY_d^\dagger T_d + 2Y_dY_u^\dagger T_u + 5T_dY_d^\dagger Y_d + T_dY_u^\dagger Y_u - \frac{7}{15}g_1^2T_d - 3g_2^2T_d - \frac{16}{3}g_3^2T_d \\
& + |\lambda|^2T_d + 3T_d\text{Tr}\left(Y_dY_d^\dagger\right) + T_d\text{Tr}\left(Y_eY_e^\dagger\right) \\
& + Y_d\left(2\lambda^*T_\lambda + 2\text{Tr}\left(Y_e^\dagger T_e\right) + 6g_2^2M_2 + 6\text{Tr}\left(Y_d^\dagger T_d\right) + \frac{14}{15}g_1^2M_1 + \frac{32}{3}g_3^2M_3\right) \\
\beta_{T_d}^{(2)} = & +\frac{6}{5}g_1^2Y_dY_d^\dagger T_d + 6g_2^2Y_dY_d^\dagger T_d - 4|\lambda|^2Y_dY_d^\dagger T_d - \frac{8}{5}g_1^2M_1Y_dY_u^\dagger Y_u \\
& + \frac{8}{5}g_1^2Y_dY_u^\dagger T_u - 2|\lambda|^2Y_dY_u^\dagger T_u + \frac{6}{5}g_1^2T_dY_d^\dagger Y_d + 12g_2^2T_dY_d^\dagger Y_d \\
& - 5|\lambda|^2T_dY_d^\dagger Y_d + \frac{4}{5}g_1^2T_dY_u^\dagger Y_u - |\lambda|^2T_dY_u^\dagger Y_u - 6Y_dY_d^\dagger Y_dY_d^\dagger T_d \\
& - 8Y_dY_d^\dagger T_dY_d^\dagger Y_d - 2Y_dY_u^\dagger Y_uY_d^\dagger T_d - 4Y_dY_u^\dagger Y_uY_u^\dagger T_u - 4Y_dY_u^\dagger T_uY_d^\dagger Y_d \\
& - 4Y_dY_u^\dagger T_uY_u^\dagger Y_u - 6T_dY_d^\dagger Y_dY_d^\dagger Y_d - 4T_dY_u^\dagger Y_uY_d^\dagger Y_d - 2T_dY_u^\dagger Y_uY_u^\dagger Y_u
\end{aligned} \tag{45}$$

$$\begin{aligned}
& + \frac{287}{90}g_1^4T_d + g_1^2g_2^2T_d + \frac{15}{2}g_2^4T_d + \frac{8}{9}g_1^2g_3^2T_d + 8g_2^2g_3^2T_d - \frac{16}{9}g_3^4T_d - 2\lambda|\kappa|^2\lambda^*T_d \\
& - 3\lambda^2\lambda^{*,2}T_d - 2\lambda^*Y_dY_u^\dagger Y_uT_\lambda - 12Y_dY_d^\dagger T_d\text{Tr}(Y_dY_d^\dagger) \\
& - 15T_dY_d^\dagger Y_d\text{Tr}(Y_dY_d^\dagger) - \frac{2}{5}g_1^2T_d\text{Tr}(Y_dY_d^\dagger) + 16g_3^2T_d\text{Tr}(Y_dY_d^\dagger) \\
& - 4Y_dY_d^\dagger T_d\text{Tr}(Y_eY_e^\dagger) - 5T_dY_d^\dagger Y_d\text{Tr}(Y_eY_e^\dagger) + \frac{6}{5}g_1^2T_d\text{Tr}(Y_eY_e^\dagger) \\
& - 6Y_dY_u^\dagger T_u\text{Tr}(Y_uY_u^\dagger) - 3T_dY_u^\dagger Y_u\text{Tr}(Y_uY_u^\dagger) - 3|\lambda|^2T_d\text{Tr}(Y_uY_u^\dagger) \\
& - \frac{2}{5}Y_dY_d^\dagger Y_d(15\lambda^*T_\lambda + 15\text{Tr}(Y_e^\dagger T_e) + 30g_2^2M_2 + 45\text{Tr}(Y_d^\dagger T_d) + 4g_1^2M_1) \\
& - 6Y_dY_u^\dagger Y_u\text{Tr}(Y_u^\dagger T_u) - 9T_d\text{Tr}(Y_dY_d^\dagger Y_dY_d^\dagger) - 3T_d\text{Tr}(Y_dY_u^\dagger Y_uY_d^\dagger) \\
& - 3T_d\text{Tr}(Y_eY_e^\dagger Y_eY_e^\dagger) \\
& - \frac{2}{45}Y_d(287g_1^4M_1 + 45g_1^2g_2^2M_1 + 40g_1^2g_3^2M_1 + 40g_1^2g_3^2M_3 + 360g_2^2g_3^2M_3 - 160g_3^4M_3 \\
& + 45g_1^2g_2^2M_2 + 675g_2^4M_2 + 360g_2^2g_3^2M_2 + 270\lambda\lambda^{*,2}T_\lambda + 90\kappa^*\lambda^*(\kappa T_\lambda + \lambda T_\kappa) \\
& - 18g_1^2M_1\text{Tr}(Y_dY_d^\dagger) + 720g_3^2M_3\text{Tr}(Y_dY_d^\dagger) + 54g_1^2M_1\text{Tr}(Y_eY_e^\dagger) + 18g_1^2\text{Tr}(Y_d^\dagger T_d) \\
& - 720g_3^2\text{Tr}(Y_d^\dagger T_d) - 54g_1^2\text{Tr}(Y_e^\dagger T_e) + 135\lambda^*(\lambda\text{Tr}(Y_u^\dagger T_u) + T_\lambda\text{Tr}(Y_uY_u^\dagger)) \\
& + 810\text{Tr}(Y_dY_d^\dagger T_dY_d^\dagger) + 135\text{Tr}(Y_dY_u^\dagger T_uY_d^\dagger) + 270\text{Tr}(Y_eY_e^\dagger T_eY_e^\dagger) + 135\text{Tr}(Y_uY_d^\dagger T_dY_u^\dagger)
\end{aligned} \tag{46}$$

$$\begin{aligned}
\beta_{T_e}^{(1)} & = +4Y_eY_e^\dagger T_e + 5T_eY_e^\dagger Y_e - \frac{9}{5}g_1^2T_e - 3g_2^2T_e + |\lambda|^2T_e + 3T_e\text{Tr}(Y_dY_d^\dagger) + T_e\text{Tr}(Y_eY_e^\dagger) \\
& + Y_e(2\lambda^*T_\lambda + 2\text{Tr}(Y_e^\dagger T_e) + 6g_2^2M_2 + 6\text{Tr}(Y_d^\dagger T_d) + \frac{18}{5}g_1^2M_1)
\end{aligned} \tag{47}$$

$$\begin{aligned}
\beta_{T_e}^{(2)} & = +\frac{6}{5}g_1^2Y_eY_e^\dagger T_e + 6g_2^2Y_eY_e^\dagger T_e - 4|\lambda|^2Y_eY_e^\dagger T_e - \frac{6}{5}g_1^2T_eY_e^\dagger Y_e \\
& + 12g_2^2T_eY_e^\dagger Y_e - 5|\lambda|^2T_eY_e^\dagger Y_e - 6Y_eY_e^\dagger Y_eY_e^\dagger T_e - 8Y_eY_e^\dagger T_eY_e^\dagger Y_e \\
& - 6T_eY_e^\dagger Y_eY_e^\dagger Y_e + \frac{27}{2}g_1^4T_e + \frac{9}{5}g_1^2g_2^2T_e + \frac{15}{2}g_2^4T_e - 2\lambda|\kappa|^2\lambda^*T_e - 3\lambda^2\lambda^{*,2}T_e \\
& - 12Y_eY_e^\dagger T_e\text{Tr}(Y_dY_d^\dagger) - 15T_eY_e^\dagger Y_e\text{Tr}(Y_dY_d^\dagger) - \frac{2}{5}g_1^2T_e\text{Tr}(Y_dY_d^\dagger) \\
& + 16g_3^2T_e\text{Tr}(Y_dY_d^\dagger) - 4Y_eY_e^\dagger T_e\text{Tr}(Y_eY_e^\dagger) - 5T_eY_e^\dagger Y_e\text{Tr}(Y_eY_e^\dagger) \\
& + \frac{6}{5}g_1^2T_e\text{Tr}(Y_eY_e^\dagger) - 3|\lambda|^2T_e\text{Tr}(Y_uY_u^\dagger) \\
& - 6Y_eY_e^\dagger Y_e(2g_2^2M_2 + 3\text{Tr}(Y_d^\dagger T_d) + \lambda^*T_\lambda + \text{Tr}(Y_e^\dagger T_e)) - 9T_e\text{Tr}(Y_dY_d^\dagger Y_dY_d^\dagger) \\
& - 3T_e\text{Tr}(Y_dY_u^\dagger Y_uY_d^\dagger) - 3T_e\text{Tr}(Y_eY_e^\dagger Y_eY_e^\dagger) \\
& - \frac{2}{5}Y_e(135g_1^4M_1 + 9g_1^2g_2^2M_1 + 9g_1^2g_2^2M_2 + 75g_2^4M_2 + 30\lambda\lambda^{*,2}T_\lambda + 10\kappa^*\lambda^*(\kappa T_\lambda + \lambda T_\kappa)
\end{aligned}$$

$$\begin{aligned}
& -2g_1^2 M_1 \text{Tr}(Y_d Y_d^\dagger) + 80g_3^2 M_3 \text{Tr}(Y_d Y_d^\dagger) + 6g_1^2 M_1 \text{Tr}(Y_e Y_e^\dagger) + 2g_1^2 \text{Tr}(Y_d^\dagger T_d) \\
& -80g_3^2 \text{Tr}(Y_d^\dagger T_d) - 6g_1^2 \text{Tr}(Y_e^\dagger T_e) + 15\lambda^* (\lambda \text{Tr}(Y_u^\dagger T_u) + T_\lambda \text{Tr}(Y_u Y_u^\dagger)) + 90 \text{Tr}(Y_d Y_d^\dagger T_d Y_d^\dagger) \\
& + 15 \text{Tr}(Y_d Y_u^\dagger T_u Y_d^\dagger) + 30 \text{Tr}(Y_e Y_e^\dagger T_e Y_e^\dagger) + 15 \text{Tr}(Y_u Y_d^\dagger T_d Y_u^\dagger)
\end{aligned} \tag{48}$$

$$\begin{aligned}
\beta_{T_\lambda}^{(1)} &= +\frac{6}{5}g_1^2 M_1 \lambda + 6g_2^2 M_2 \lambda + 2\kappa^* (2\lambda T_\kappa + \kappa T_\lambda) \\
& + T_\lambda (12|\lambda|^2 - 3g_2^2 + 3\text{Tr}(Y_d Y_d^\dagger) + 3\text{Tr}(Y_u Y_u^\dagger) - \frac{3}{5}g_1^2 + \text{Tr}(Y_e Y_e^\dagger)) + 6\lambda \text{Tr}(Y_d^\dagger T_d) \\
& + 2\lambda \text{Tr}(Y_e^\dagger T_e) + 6\lambda \text{Tr}(Y_u^\dagger T_u)
\end{aligned} \tag{49}$$

$$\begin{aligned}
\beta_{T_\lambda}^{(2)} &= -\frac{414}{25}g_1^4 M_1 \lambda - \frac{18}{5}g_1^2 g_2^2 M_1 \lambda - \frac{18}{5}g_1^2 g_2^2 M_2 \lambda - 30g_2^4 M_2 \lambda + \frac{207}{50}g_1^4 T_\lambda + \frac{9}{5}g_1^2 g_2^2 T_\lambda \\
& + \frac{15}{2}g_2^4 T_\lambda - 50\lambda^2 \lambda^{*,2} T_\lambda - 8\kappa \kappa^{*,2} (4\lambda T_\kappa + \kappa T_\lambda) + \frac{4}{5}g_1^2 M_1 \lambda \text{Tr}(Y_d Y_d^\dagger) \\
& - 32g_3^2 M_3 \lambda \text{Tr}(Y_d Y_d^\dagger) - \frac{2}{5}g_1^2 T_\lambda \text{Tr}(Y_d Y_d^\dagger) + 16g_3^2 T_\lambda \text{Tr}(Y_d Y_d^\dagger) - \frac{12}{5}g_1^2 M_1 \lambda \text{Tr}(Y_e Y_e^\dagger) \\
& + \frac{6}{5}g_1^2 T_\lambda \text{Tr}(Y_e Y_e^\dagger) - \frac{8}{5}g_1^2 M_1 \lambda \text{Tr}(Y_u Y_u^\dagger) - 32g_3^2 M_3 \lambda \text{Tr}(Y_u Y_u^\dagger) + \frac{4}{5}g_1^2 T_\lambda \text{Tr}(Y_u Y_u^\dagger) \\
& + 16g_3^2 T_\lambda \text{Tr}(Y_u Y_u^\dagger) - \frac{4}{5}g_1^2 \lambda \text{Tr}(Y_d^\dagger T_d) + 32g_3^2 \lambda \text{Tr}(Y_d^\dagger T_d) + \frac{12}{5}g_1^2 \lambda \text{Tr}(Y_e^\dagger T_e) \\
& + \frac{8}{5}g_1^2 \lambda \text{Tr}(Y_u^\dagger T_u) + 32g_3^2 \lambda \text{Tr}(Y_u^\dagger T_u) \\
& - \frac{3}{5}|\lambda|^2 (20\kappa^* (2\lambda T_\kappa + 3\kappa T_\lambda) + T_\lambda (15\text{Tr}(Y_e Y_e^\dagger) - 30g_2^2 + 45\text{Tr}(Y_d Y_d^\dagger) + 45\text{Tr}(Y_u Y_u^\dagger) - 6g_1^2) \\
& + 2\lambda (10g_2^2 M_2 + 15\text{Tr}(Y_d^\dagger T_d) + 15\text{Tr}(Y_u^\dagger T_u) + 2g_1^2 M_1 + 5\text{Tr}(Y_e^\dagger T_e))) \\
& - 9T_\lambda \text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) - 36\lambda \text{Tr}(Y_d Y_d^\dagger T_d Y_d^\dagger) - 6T_\lambda \text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 12\lambda \text{Tr}(Y_d Y_u^\dagger T_u Y_d^\dagger) \\
& - 3T_\lambda \text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) - 12\lambda \text{Tr}(Y_e Y_e^\dagger T_e Y_e^\dagger) - 12\lambda \text{Tr}(Y_u Y_d^\dagger T_d Y_u^\dagger) - 9T_\lambda \text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) \\
& - 36\lambda \text{Tr}(Y_u Y_u^\dagger T_u Y_u^\dagger)
\end{aligned} \tag{50}$$

$$\beta_{T_\kappa}^{(1)} = 6(3|\kappa|^2 T_\kappa + \lambda^* (2\kappa T_\lambda + \lambda T_\kappa)) \tag{51}$$

$$\begin{aligned}
\beta_{T_\kappa}^{(2)} &= -\frac{6}{5} (100\kappa^2 \kappa^{*,2} T_\kappa + 10\lambda \lambda^{*,2} (4\kappa T_\lambda + \lambda T_\kappa) \\
& + \lambda^* (\lambda T_\kappa (-15g_2^2 + 15\text{Tr}(Y_d Y_d^\dagger) + 15\text{Tr}(Y_u Y_u^\dagger) - 3g_1^2 + 5\text{Tr}(Y_e Y_e^\dagger) + 60|\kappa|^2) \\
& + 2\kappa (T_\lambda (-15g_2^2 + 15\text{Tr}(Y_d Y_d^\dagger) + 15\text{Tr}(Y_u Y_u^\dagger) + 20|\kappa|^2 - 3g_1^2 + 5\text{Tr}(Y_e Y_e^\dagger)) \\
& + \lambda (15g_2^2 M_2 + 15\text{Tr}(Y_d^\dagger T_d) + 15\text{Tr}(Y_u^\dagger T_u) + 3g_1^2 M_1 + 5\text{Tr}(Y_e^\dagger T_e))))))
\end{aligned} \tag{52}$$

$$\begin{aligned}
\beta_{T_u}^{(1)} &= +2Y_u Y_d^\dagger T_d + 4Y_u Y_u^\dagger T_u + T_u Y_d^\dagger Y_d + 5T_u Y_u^\dagger Y_u - \frac{13}{15}g_1^2 T_u - 3g_2^2 T_u - \frac{16}{3}g_3^2 T_u \\
& + |\lambda|^2 T_u + 3T_u \text{Tr}(Y_u Y_u^\dagger) + Y_u (2\lambda^* T_\lambda + 6g_2^2 M_2 + 6\text{Tr}(Y_u^\dagger T_u) + \frac{26}{15}g_1^2 M_1 + \frac{32}{3}g_3^2 M_3)
\end{aligned} \tag{53}$$

$$\begin{aligned}
\beta_{T_u}^{(2)} = & +\frac{4}{5}g_1^2 Y_u Y_d^\dagger T_d - 2|\lambda|^2 Y_u Y_d^\dagger T_d - \frac{4}{5}g_1^2 M_1 Y_u Y_u^\dagger Y_u - 12g_2^2 M_2 Y_u Y_u^\dagger Y_u \\
& + \frac{6}{5}g_1^2 Y_u Y_u^\dagger T_u + 6g_2^2 Y_u Y_u^\dagger T_u - 4|\lambda|^2 Y_u Y_u^\dagger T_u + \frac{2}{5}g_1^2 T_u Y_d^\dagger Y_d \\
& - |\lambda|^2 T_u Y_d^\dagger Y_d + 12g_2^2 T_u Y_u^\dagger Y_u - 5|\lambda|^2 T_u Y_u^\dagger Y_u - 4Y_u Y_d^\dagger Y_d Y_d^\dagger T_d \\
& - 2Y_u Y_d^\dagger Y_d Y_u^\dagger T_u - 4Y_u Y_d^\dagger T_d Y_d^\dagger Y_d - 4Y_u Y_d^\dagger T_d Y_u^\dagger Y_u - 6Y_u Y_u^\dagger Y_u Y_u^\dagger T_u \\
& - 8Y_u Y_u^\dagger T_u Y_u^\dagger Y_u - 2T_u Y_d^\dagger Y_d Y_d^\dagger Y_d - 4T_u Y_d^\dagger Y_d Y_u^\dagger Y_u - 6T_u Y_u^\dagger Y_u Y_u^\dagger Y_u + \frac{2743}{450}g_1^4 T_u \\
& + g_1^2 g_2^2 T_u + \frac{15}{2}g_2^4 T_u + \frac{136}{45}g_1^2 g_3^2 T_u + 8g_2^2 g_3^2 T_u - \frac{16}{9}g_3^4 T_u - 2\lambda|\kappa|^2 \lambda^* T_u - 3\lambda^2 \lambda^{*,2} T_u \\
& - 6\lambda^* Y_u Y_u^\dagger Y_u T_\lambda - 6Y_u Y_d^\dagger T_d \text{Tr}(Y_d Y_d^\dagger) - 3T_u Y_d^\dagger Y_d \text{Tr}(Y_d Y_d^\dagger) \\
& - 3|\lambda|^2 T_u \text{Tr}(Y_d Y_d^\dagger) - 2Y_u Y_d^\dagger T_d \text{Tr}(Y_e Y_e^\dagger) - T_u Y_d^\dagger Y_d \text{Tr}(Y_e Y_e^\dagger) \\
& - |\lambda|^2 T_u \text{Tr}(Y_e Y_e^\dagger) - 12Y_u Y_u^\dagger T_u \text{Tr}(Y_u Y_u^\dagger) - 15T_u Y_u^\dagger Y_u \text{Tr}(Y_u Y_u^\dagger) \\
& + \frac{4}{5}g_1^2 T_u \text{Tr}(Y_u Y_u^\dagger) + 16g_3^2 T_u \text{Tr}(Y_u Y_u^\dagger) \\
& - \frac{2}{5}Y_u Y_d^\dagger Y_d (15\text{Tr}(Y_d^\dagger T_d) + 2g_1^2 M_1 + 5\lambda^* T_\lambda + 5\text{Tr}(Y_e^\dagger T_e)) - 18Y_u Y_u^\dagger Y_u \text{Tr}(Y_u^\dagger T_u) \\
& - 3T_u \text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 9T_u \text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) \\
& - \frac{2}{225}Y_u (2743g_1^4 M_1 + 225g_1^2 g_2^2 M_1 + 680g_1^2 g_3^2 M_1 + 680g_1^2 g_3^2 M_3 + 1800g_2^2 g_3^2 M_3 - 800g_3^4 M_3 \\
& + 225g_1^2 g_2^2 M_2 + 3375g_2^4 M_2 + 1800g_2^2 g_3^2 M_2 + 1350\lambda\lambda^{*,2} T_\lambda + 450\kappa^* \lambda^* (\kappa T_\lambda + \lambda T_\kappa) \\
& + 180g_1^2 M_1 \text{Tr}(Y_u Y_u^\dagger) + 3600g_3^2 M_3 \text{Tr}(Y_u Y_u^\dagger) \\
& + 225\lambda^* (\lambda (3\text{Tr}(Y_d^\dagger T_d) + \text{Tr}(Y_e^\dagger T_e)) + T_\lambda (3\text{Tr}(Y_d Y_d^\dagger) + \text{Tr}(Y_e Y_e^\dagger))) - 180g_1^2 \text{Tr}(Y_u^\dagger T_u) \\
& - 3600g_3^2 \text{Tr}(Y_u^\dagger T_u) + 675\text{Tr}(Y_d Y_u^\dagger T_u Y_d^\dagger) + 675\text{Tr}(Y_u Y_d^\dagger T_d Y_u^\dagger) + 4050\text{Tr}(Y_u Y_u^\dagger T_u Y_u^\dagger) \tag{54}
\end{aligned}$$

3.6 Soft-Breaking Scalar Masses

$$\sigma_{1,1} = \sqrt{\frac{3}{5}}g_1 \left(-2\text{Tr}(m_u^2) - \text{Tr}(m_l^2) - m_{H_d}^2 + m_{H_u}^2 + \text{Tr}(m_d^2) + \text{Tr}(m_e^2) + \text{Tr}(m_q^2) \right) \tag{55}$$

$$\sigma_{2,11} = \frac{1}{10}g_1^2 \left(2\text{Tr}(m_d^2) + 3\text{Tr}(m_l^2) + 3m_{H_d}^2 + 3m_{H_u}^2 + 6\text{Tr}(m_e^2) + 8\text{Tr}(m_u^2) + \text{Tr}(m_q^2) \right) \tag{56}$$

$$\begin{aligned}
\sigma_{3,1} = & \frac{1}{20} \frac{1}{\sqrt{15}} g_1 \left(-9g_1^2 m_{H_d}^2 - 45g_2^2 m_{H_d}^2 + 9g_1^2 m_{H_u}^2 + 45g_2^2 m_{H_u}^2 + 30(-m_{H_u}^2 + m_{H_d}^2)|\lambda|^2 + 4(20g_3^2 + g_1^2) \text{Tr}(m_d^2) \right. \\
& + 36g_1^2 \text{Tr}(m_e^2) - 9g_1^2 \text{Tr}(m_l^2) - 45g_2^2 \text{Tr}(m_l^2) + g_1^2 \text{Tr}(m_q^2) + 45g_2^2 \text{Tr}(m_q^2) + 80g_3^2 \text{Tr}(m_q^2) \\
& \left. - 32g_1^2 \text{Tr}(m_u^2) - 160g_3^2 \text{Tr}(m_u^2) + 90m_{H_d}^2 \text{Tr}(Y_d Y_d^\dagger) + 30m_{H_d}^2 \text{Tr}(Y_e Y_e^\dagger) - 90m_{H_u}^2 \text{Tr}(Y_u Y_u^\dagger) \right)
\end{aligned}$$

$$\begin{aligned}
& -60\text{Tr}\left(Y_d Y_d^\dagger m_d^{2*}\right) - 30\text{Tr}\left(Y_d m_q^{2*} Y_d^\dagger\right) - 60\text{Tr}\left(Y_e Y_e^\dagger m_e^{2*}\right) + 30\text{Tr}\left(Y_e m_l^{2*} Y_e^\dagger\right) \\
& + 120\text{Tr}\left(Y_u Y_u^\dagger m_u^{2*}\right) - 30\text{Tr}\left(Y_u m_q^{2*} Y_u^\dagger\right)
\end{aligned} \tag{57}$$

$$\sigma_{2,2} = \frac{1}{2} \left(3\text{Tr}\left(m_q^2\right) + m_{H_d}^2 + m_{H_u}^2 + \text{Tr}\left(m_l^2\right) \right) \tag{58}$$

$$\sigma_{2,3} = \frac{1}{2} \left(2\text{Tr}\left(m_q^2\right) + \text{Tr}\left(m_d^2\right) + \text{Tr}\left(m_u^2\right) \right) \tag{59}$$

$$\begin{aligned}
\beta_{m_q^2}^{(1)} = & -\frac{2}{15} g_1^2 \mathbf{1} |M_1|^2 - \frac{32}{3} g_3^2 \mathbf{1} |M_3|^2 - 6g_2^2 \mathbf{1} |M_2|^2 + 2m_{H_d}^2 Y_d^\dagger Y_d + 2m_{H_u}^2 Y_u^\dagger Y_u + 2T_d^\dagger T_d \\
& + 2T_u^\dagger T_u + m_q^2 Y_d^\dagger Y_d + m_q^2 Y_u^\dagger Y_u + 2Y_d^\dagger m_d^2 Y_d + Y_d^\dagger Y_d m_q^2 + 2Y_u^\dagger m_u^2 Y_u \\
& + Y_u^\dagger Y_u m_q^2 + \frac{1}{\sqrt{15}} g_1 \mathbf{1} \sigma_{1,1}
\end{aligned} \tag{60}$$

$$\begin{aligned}
\beta_{m_q^2}^{(2)} = & +\frac{2}{5} g_1^2 g_2^2 \mathbf{1} |M_2|^2 + 33g_4^2 \mathbf{1} |M_2|^2 + 32g_2^2 g_3^2 \mathbf{1} |M_2|^2 \\
& + \frac{16}{45} g_3^2 \left(15 \left(3g_2^2 (2M_3 + M_2) - 8g_3^2 M_3 \right) + g_1^2 (2M_3 + M_1) \right) \mathbf{1} M_3^* + \frac{1}{5} g_1^2 g_2^2 M_1 \mathbf{1} M_2^* + 16g_2^2 g_3^2 M_3 \mathbf{1} M_2^* \\
& + \frac{4}{5} g_1^2 m_{H_d}^2 Y_d^\dagger Y_d - 4m_{H_d}^2 |\lambda|^2 Y_d^\dagger Y_d - 2m_{H_u}^2 |\lambda|^2 Y_d^\dagger Y_d \\
& - 2m_S^2 |\lambda|^2 Y_d^\dagger Y_d - 2|T_\lambda|^2 Y_d^\dagger Y_d - 2\lambda T_\lambda^* Y_d^\dagger T_d + \frac{8}{5} g_1^2 m_{H_u}^2 Y_u^\dagger Y_u \\
& - 2m_{H_d}^2 |\lambda|^2 Y_u^\dagger Y_u - 4m_{H_u}^2 |\lambda|^2 Y_u^\dagger Y_u - 2m_S^2 |\lambda|^2 Y_u^\dagger Y_u - 2|T_\lambda|^2 Y_u^\dagger Y_u \\
& + \frac{1}{225} g_1^2 M_1^* \left(\left(5 \left(16g_3^2 (2M_1 + M_3) + 9g_2^2 (2M_1 + M_2) \right) + 597g_1^2 M_1 \right) \mathbf{1} \right. \\
& \left. + 180 \left(2M_1 Y_d^\dagger Y_d - 2Y_u^\dagger T_u + 4M_1 Y_u^\dagger Y_u - Y_d^\dagger T_d \right) \right) \\
& - 2\lambda T_\lambda^* Y_u^\dagger T_u - \frac{4}{5} g_1^2 M_1 T_d^\dagger Y_d + \frac{4}{5} g_1^2 T_d^\dagger T_d - 2|\lambda|^2 T_d^\dagger T_d \\
& - \frac{8}{5} g_1^2 M_1 T_u^\dagger Y_u + \frac{8}{5} g_1^2 T_u^\dagger T_u - 2|\lambda|^2 T_u^\dagger T_u + \frac{2}{5} g_1^2 m_q^2 Y_d^\dagger Y_d \\
& - |\lambda|^2 m_q^2 Y_d^\dagger Y_d + \frac{4}{5} g_1^2 m_q^2 Y_u^\dagger Y_u - |\lambda|^2 m_q^2 Y_u^\dagger Y_u + \frac{4}{5} g_1^2 Y_d^\dagger m_d^2 Y_d \\
& - 2|\lambda|^2 Y_d^\dagger m_d^2 Y_d + \frac{2}{5} g_1^2 Y_d^\dagger Y_d m_q^2 - |\lambda|^2 Y_d^\dagger Y_d m_q^2 + \frac{8}{5} g_1^2 Y_u^\dagger m_u^2 Y_u \\
& - 2|\lambda|^2 Y_u^\dagger m_u^2 Y_u + \frac{4}{5} g_1^2 Y_u^\dagger Y_u m_q^2 - |\lambda|^2 Y_u^\dagger Y_u m_q^2 - 8m_{H_d}^2 Y_d^\dagger Y_d Y_d^\dagger Y_d \\
& - 4Y_d^\dagger Y_d T_d^\dagger T_d - 4Y_d^\dagger T_d T_d^\dagger Y_d - 8m_{H_u}^2 Y_u^\dagger Y_u Y_u^\dagger Y_u - 4Y_u^\dagger Y_u T_u^\dagger T_u \\
& - 4Y_u^\dagger T_u T_u^\dagger Y_u - 4T_d^\dagger Y_d Y_d^\dagger T_d - 4T_d^\dagger T_d Y_d^\dagger Y_d - 4T_u^\dagger Y_u Y_u^\dagger T_u \\
& - 4T_u^\dagger T_u Y_u^\dagger Y_u - 2m_q^2 Y_d^\dagger Y_d Y_d^\dagger Y_d - 2m_q^2 Y_u^\dagger Y_u Y_u^\dagger Y_u - 4Y_d^\dagger m_d^2 Y_d Y_d^\dagger Y_d \\
& - 4Y_d^\dagger Y_d m_q^2 Y_d^\dagger Y_d - 4Y_d^\dagger Y_d Y_d^\dagger m_d^2 Y_d - 2Y_d^\dagger Y_d Y_d^\dagger Y_d m_q^2 - 4Y_u^\dagger m_u^2 Y_u Y_u^\dagger Y_u \\
& - 4Y_u^\dagger Y_u m_q^2 Y_u^\dagger Y_u - 4Y_u^\dagger Y_u Y_u^\dagger m_u^2 Y_u - 2Y_u^\dagger Y_u Y_u^\dagger Y_u m_q^2 - 2\lambda^* T_d^\dagger Y_d T_\lambda
\end{aligned}$$

$$\begin{aligned}
& -2\lambda^* T_u^\dagger Y_u T_\lambda + 6g_2^4 \mathbf{1}\sigma_{2,2} + \frac{32}{3} g_3^4 \mathbf{1}\sigma_{2,3} + \frac{2}{15} g_1^2 \mathbf{1}\sigma_{2,11} + 4 \frac{1}{\sqrt{15}} g_1 \mathbf{1}\sigma_{3,1} \\
& -12m_{H_d}^2 Y_d^\dagger Y_d \text{Tr}(Y_d Y_d^\dagger) - 6T_d^\dagger T_d \text{Tr}(Y_d Y_d^\dagger) - 3m_q^2 Y_d^\dagger Y_d \text{Tr}(Y_d Y_d^\dagger) \\
& -6Y_d^\dagger m_d^2 Y_d \text{Tr}(Y_d Y_d^\dagger) - 3Y_d^\dagger Y_d m_q^2 \text{Tr}(Y_d Y_d^\dagger) - 4m_{H_d}^2 Y_d^\dagger Y_d \text{Tr}(Y_e Y_e^\dagger) \\
& -2T_d^\dagger T_d \text{Tr}(Y_e Y_e^\dagger) - m_q^2 Y_d^\dagger Y_d \text{Tr}(Y_e Y_e^\dagger) - 2Y_d^\dagger m_d^2 Y_d \text{Tr}(Y_e Y_e^\dagger) \\
& -Y_d^\dagger Y_d m_q^2 \text{Tr}(Y_e Y_e^\dagger) - 12m_{H_u}^2 Y_u^\dagger Y_u \text{Tr}(Y_u Y_u^\dagger) - 6T_u^\dagger T_u \text{Tr}(Y_u Y_u^\dagger) \\
& -3m_q^2 Y_u^\dagger Y_u \text{Tr}(Y_u Y_u^\dagger) - 6Y_u^\dagger m_u^2 Y_u \text{Tr}(Y_u Y_u^\dagger) - 3Y_u^\dagger Y_u m_q^2 \text{Tr}(Y_u Y_u^\dagger) \\
& -6T_d^\dagger Y_d \text{Tr}(Y_d^\dagger T_d) - 2T_d^\dagger Y_d \text{Tr}(Y_e^\dagger T_e) - 6T_u^\dagger Y_u \text{Tr}(Y_u^\dagger T_u) \\
& -6Y_d^\dagger T_d \text{Tr}(T_d^* Y_d^T) - 6Y_d^\dagger Y_d \text{Tr}(T_d^* T_d^T) - 2Y_d^\dagger T_d \text{Tr}(T_e^* Y_e^T) \\
& -2Y_d^\dagger Y_d \text{Tr}(T_e^* T_e^T) - 6Y_u^\dagger T_u \text{Tr}(T_u^* Y_u^T) - 6Y_u^\dagger Y_u \text{Tr}(T_u^* T_u^T) \\
& -6Y_d^\dagger Y_d \text{Tr}(m_d^2 Y_d Y_d^\dagger) - 2Y_d^\dagger Y_d \text{Tr}(m_e^2 Y_e Y_e^\dagger) - 2Y_d^\dagger Y_d \text{Tr}(m_l^2 Y_l Y_l^\dagger) \\
& -6Y_d^\dagger Y_d \text{Tr}(m_q^2 Y_d^\dagger Y_d) - 6Y_u^\dagger Y_u \text{Tr}(m_q^2 Y_u^\dagger Y_u) - 6Y_u^\dagger Y_u \text{Tr}(m_u^2 Y_u Y_u^\dagger)
\end{aligned} \tag{61}$$

$$\begin{aligned}
\beta_{m_l^2}^{(1)} &= -\frac{6}{5} g_1^2 \mathbf{1}|M_1|^2 - 6g_2^2 \mathbf{1}|M_2|^2 + 2m_{H_d}^2 Y_e^\dagger Y_e + 2T_e^\dagger T_e + m_l^2 Y_e^\dagger Y_e + 2Y_e^\dagger m_e^2 Y_e \\
&+ Y_e^\dagger Y_e m_l^2 - \sqrt{\frac{3}{5}} g_1 \mathbf{1}\sigma_{1,1}
\end{aligned} \tag{62}$$

$$\begin{aligned}
\beta_{m_l^2}^{(2)} &= +\frac{3}{5} g_2^2 \left(3g_1^2 (2M_2 + M_1) + 55g_2^2 M_2 \right) \mathbf{1}M_2^* + \frac{12}{5} g_1^2 m_{H_d}^2 Y_e^\dagger Y_e - 4m_{H_d}^2 |\lambda|^2 Y_e^\dagger Y_e \\
&- 2m_{H_u}^2 |\lambda|^2 Y_e^\dagger Y_e - 2m_S^2 |\lambda|^2 Y_e^\dagger Y_e - 2|T_\lambda|^2 Y_e^\dagger Y_e \\
&+ \frac{3}{25} g_1^2 M_1^* \left(-20Y_e^\dagger T_e + 3(5g_2^2 (2M_1 + M_2) + 69g_1^2 M_1) \mathbf{1} + 40M_1 Y_e^\dagger Y_e \right) - 2\lambda T_\lambda^* Y_e^\dagger T_e \\
&- \frac{12}{5} g_1^2 M_1 T_e^\dagger Y_e + \frac{12}{5} g_1^2 T_e^\dagger T_e - 2|\lambda|^2 T_e^\dagger T_e + \frac{6}{5} g_1^2 m_l^2 Y_e^\dagger Y_e \\
&- |\lambda|^2 m_l^2 Y_e^\dagger Y_e + \frac{12}{5} g_1^2 Y_e^\dagger m_e^2 Y_e - 2|\lambda|^2 Y_e^\dagger m_e^2 Y_e + \frac{6}{5} g_1^2 Y_e^\dagger Y_e m_l^2 \\
&- |\lambda|^2 Y_e^\dagger Y_e m_l^2 - 8m_{H_d}^2 Y_e^\dagger Y_e Y_e^\dagger Y_e - 4Y_e^\dagger Y_e T_e^\dagger T_e - 4Y_e^\dagger T_e T_e^\dagger Y_e \\
&- 4T_e^\dagger Y_e Y_e^\dagger T_e - 4T_e^\dagger T_e Y_e^\dagger Y_e - 2m_l^2 Y_e^\dagger Y_e Y_e^\dagger Y_e - 4Y_e^\dagger m_e^2 Y_e Y_e^\dagger Y_e \\
&- 4Y_e^\dagger Y_e m_l^2 Y_e^\dagger Y_e - 4Y_e^\dagger Y_e Y_e^\dagger m_e^2 Y_e - 2Y_e^\dagger Y_e Y_e^\dagger Y_e m_l^2 - 2\lambda^* T_e^\dagger Y_e T_\lambda + 6g_2^4 \mathbf{1}\sigma_{2,2} \\
&+ \frac{6}{5} g_1^2 \mathbf{1}\sigma_{2,11} - 4\sqrt{\frac{3}{5}} g_1 \mathbf{1}\sigma_{3,1} - 12m_{H_d}^2 Y_e^\dagger Y_e \text{Tr}(Y_d Y_d^\dagger) - 6T_e^\dagger T_e \text{Tr}(Y_d Y_d^\dagger) \\
&- 3m_l^2 Y_e^\dagger Y_e \text{Tr}(Y_d Y_d^\dagger) - 6Y_e^\dagger m_e^2 Y_e \text{Tr}(Y_d Y_d^\dagger) - 3Y_e^\dagger Y_e m_l^2 \text{Tr}(Y_d Y_d^\dagger) \\
&- 4m_{H_d}^2 Y_e^\dagger Y_e \text{Tr}(Y_e Y_e^\dagger) - 2T_e^\dagger T_e \text{Tr}(Y_e Y_e^\dagger) - m_l^2 Y_e^\dagger Y_e \text{Tr}(Y_e Y_e^\dagger) \\
&- 2Y_e^\dagger m_e^2 Y_e \text{Tr}(Y_e Y_e^\dagger) - Y_e^\dagger Y_e m_l^2 \text{Tr}(Y_e Y_e^\dagger) - 6T_e^\dagger Y_e \text{Tr}(Y_d^\dagger T_d)
\end{aligned}$$

$$\begin{aligned}
& -2T_e^\dagger Y_e \text{Tr}(Y_e^\dagger T_e) - 6Y_e^\dagger T_e \text{Tr}(T_d^* Y_d^T) - 6Y_e^\dagger Y_e \text{Tr}(T_d^* T_d^T) \\
& -2Y_e^\dagger T_e \text{Tr}(T_e^* Y_e^T) - 2Y_e^\dagger Y_e \text{Tr}(T_e^* T_e^T) - 6Y_e^\dagger Y_e \text{Tr}(m_d^2 Y_d Y_d^\dagger) \\
& -2Y_e^\dagger Y_e \text{Tr}(m_e^2 Y_e Y_e^\dagger) - 2Y_e^\dagger Y_e \text{Tr}(m_l^2 Y_e^\dagger Y_e) - 6Y_e^\dagger Y_e \text{Tr}(m_q^2 Y_d^\dagger Y_d)
\end{aligned} \tag{63}$$

$$\begin{aligned}
\beta_{m_{H_d}^2}^{(1)} &= -\frac{6}{5}g_1^2|M_1|^2 - 6g_2^2|M_2|^2 + 2m_{H_d}^2|\lambda|^2 + 2m_{H_u}^2|\lambda|^2 + 2m_S^2|\lambda|^2 + 2|T_\lambda|^2 - \sqrt{\frac{3}{5}}g_1\sigma_{1,1} \\
&+ 6m_{H_d}^2 \text{Tr}(Y_d Y_d^\dagger) + 2m_{H_d}^2 \text{Tr}(Y_e Y_e^\dagger) + 6\text{Tr}(T_d^* T_d^T) + 2\text{Tr}(T_e^* T_e^T) + 6\text{Tr}(m_d^2 Y_d Y_d^\dagger) \\
&+ 2\text{Tr}(m_e^2 Y_e Y_e^\dagger) + 2\text{Tr}(m_l^2 Y_e^\dagger Y_e) + 6\text{Tr}(m_q^2 Y_d^\dagger Y_d)
\end{aligned} \tag{64}$$

$$\begin{aligned}
\beta_{m_{H_d}^2}^{(2)} &= \frac{1}{25} \left(g_1^2 M_1^* (621g_1^2 M_1 + 90g_2^2 M_1 + 45g_2^2 M_2 - 40M_1 \text{Tr}(Y_d Y_d^\dagger) + 120M_1 \text{Tr}(Y_e Y_e^\dagger) + 20\text{Tr}(Y_d^\dagger T_d) \right. \\
&- 60\text{Tr}(Y_e^\dagger T_e) \left. \right) \\
&+ 5 \left(3g_2^2 (3g_1^2 (2M_2 + M_1) + 55g_2^2 M_2) M_2^* \right. \\
&- 2 \left(30(m_{H_d}^2 + m_{H_u}^2 + m_S^2) \lambda^2 \lambda^{*,2} + 10\kappa^* \left((4m_S^2 + m_{H_d}^2 + m_{H_u}^2) \kappa |\lambda|^2 + T_\lambda^* (\kappa T_\lambda + \lambda T_\kappa) \right) \right. \\
&- 15g_2^4 \sigma_{2,2} - 3g_1^2 \sigma_{2,11} \\
&+ 2\sqrt{15}g_1\sigma_{3,1} + 2g_1^2 m_{H_d}^2 \text{Tr}(Y_d Y_d^\dagger) - 80g_3^2 m_{H_d}^2 \text{Tr}(Y_d Y_d^\dagger) - 160g_3^2 |M_3|^2 \text{Tr}(Y_d Y_d^\dagger) \\
&- 6g_1^2 m_{H_d}^2 \text{Tr}(Y_e Y_e^\dagger) + 15|T_\lambda|^2 \text{Tr}(Y_u Y_u^\dagger) + 80g_3^2 M_3^* \text{Tr}(Y_d^\dagger T_d) + 15\lambda T_\lambda^* \text{Tr}(Y_u^\dagger T_u) \\
&- 2g_1^2 M_1 \text{Tr}(T_d^* Y_d^T) + 80g_3^2 M_3 \text{Tr}(T_d^* Y_d^T) + 2g_1^2 \text{Tr}(T_d^* T_d^T) - 80g_3^2 \text{Tr}(T_d^* T_d^T) \\
&+ 6g_1^2 M_1 \text{Tr}(T_e^* Y_e^T) - 6g_1^2 \text{Tr}(T_e^* T_e^T) + 2g_1^2 \text{Tr}(m_d^2 Y_d Y_d^\dagger) - 80g_3^2 \text{Tr}(m_d^2 Y_d Y_d^\dagger) \\
&- 6g_1^2 \text{Tr}(m_e^2 Y_e Y_e^\dagger) - 6g_1^2 \text{Tr}(m_l^2 Y_e^\dagger Y_e) + 2g_1^2 \text{Tr}(m_q^2 Y_d^\dagger Y_d) - 80g_3^2 \text{Tr}(m_q^2 Y_d^\dagger Y_d) \\
&+ 5\lambda^* \left(2T_\kappa^* (\kappa T_\lambda + \lambda T_\kappa) \right. \\
&+ 3 \left(4\lambda |T_\lambda|^2 + (2m_{H_u}^2 + m_{H_d}^2 + m_S^2) \lambda \text{Tr}(Y_u Y_u^\dagger) + T_\lambda \text{Tr}(T_u^* Y_u^T) + \lambda \text{Tr}(T_u^* T_u^T) + \lambda \text{Tr}(m_q^2 Y_u^\dagger Y_u) \right. \\
&+ \left. \left. \lambda \text{Tr}(m_u^2 Y_u Y_u^\dagger) \right) \right) \\
&+ 90m_{H_d}^2 \text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) + 90\text{Tr}(Y_d Y_d^\dagger T_d T_d^\dagger) + 15m_{H_d}^2 \text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) \\
&+ 15m_{H_u}^2 \text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) + 15\text{Tr}(Y_d Y_u^\dagger T_u T_u^\dagger) + 90\text{Tr}(Y_d T_d^\dagger T_d Y_d^\dagger) \\
&+ 15\text{Tr}(Y_d T_u^\dagger T_u Y_d^\dagger) + 30m_{H_d}^2 \text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) + 30\text{Tr}(Y_e Y_e^\dagger T_e T_e^\dagger) + 30\text{Tr}(Y_e T_e^\dagger T_e Y_e^\dagger) \\
&+ 15\text{Tr}(Y_u Y_d^\dagger T_d T_u^\dagger) + 15\text{Tr}(Y_u T_d^\dagger T_d Y_u^\dagger) + 90\text{Tr}(m_d^2 Y_d Y_d^\dagger Y_d Y_d^\dagger) + 15\text{Tr}(m_d^2 Y_d Y_u^\dagger Y_u Y_d^\dagger) \\
&+ 30\text{Tr}(m_e^2 Y_e Y_e^\dagger Y_e Y_e^\dagger) + 30\text{Tr}(m_l^2 Y_e^\dagger Y_e Y_e^\dagger Y_e) + 90\text{Tr}(m_q^2 Y_d^\dagger Y_d Y_d^\dagger Y_d) + 15\text{Tr}(m_q^2 Y_d^\dagger Y_d Y_u^\dagger Y_u) \\
&+ 15\text{Tr}(m_q^2 Y_u^\dagger Y_u Y_d^\dagger Y_d) + 15\text{Tr}(m_u^2 Y_u Y_d^\dagger Y_d Y_u^\dagger) \left. \right) \left. \right) \tag{65}
\end{aligned}$$

$$\begin{aligned}
\beta_{m_{H_u}^2}^{(1)} &= -\frac{6}{5}g_1^2|M_1|^2 - 6g_2^2|M_2|^2 + 2m_{H_d}^2|\lambda|^2 + 2m_{H_u}^2|\lambda|^2 + 2m_S^2|\lambda|^2 + 2|T_\lambda|^2 + \sqrt{\frac{3}{5}}g_1\sigma_{1,1} \\
&+ 6m_{H_u}^2\text{Tr}(Y_u Y_u^\dagger) + 6\text{Tr}(T_u^* T_u^T) + 6\text{Tr}(m_q^2 Y_u^\dagger Y_u) + 6\text{Tr}(m_u^2 Y_u Y_u^\dagger)
\end{aligned} \tag{66}$$

$$\begin{aligned}
\beta_{m_{H_u}^2}^{(2)} &= \frac{1}{25}\left(g_1^2 M_1^* \left(-40\text{Tr}(Y_u^\dagger T_u) + 45g_2^2 M_2 + 621g_1^2 M_1 + 80M_1\text{Tr}(Y_u Y_u^\dagger) + 90g_2^2 M_1\right)\right. \\
&+ 5\left(3g_2^2\left(3g_1^2(2M_2 + M_1) + 55g_2^2 M_2\right)M_2^* \right. \\
&- 2\left(30\left(m_{H_d}^2 + m_{H_u}^2 + m_S^2\right)\lambda^2 \lambda^{*,2} + 10\kappa^* \left(\left(4m_S^2 + m_{H_d}^2 + m_{H_u}^2\right)\kappa|\lambda|^2 + T_\lambda^* \left(\kappa T_\lambda + \lambda T_\kappa\right)\right) - 15g_2^4 \sigma_{2,2} - 3g_1^2 \sigma_{2,11} \\
&- 2\sqrt{15}g_1\sigma_{3,1} + 15|T_\lambda|^2\text{Tr}(Y_d Y_d^\dagger) + 5|T_\lambda|^2\text{Tr}(Y_e Y_e^\dagger) - 4g_1^2 m_{H_u}^2 \text{Tr}(Y_u Y_u^\dagger) \\
&- 80g_3^2 m_{H_u}^2 \text{Tr}(Y_u Y_u^\dagger) - 160g_3^2 |M_3|^2 \text{Tr}(Y_u Y_u^\dagger) + 15\lambda T_\lambda^* \text{Tr}(Y_d^\dagger T_d) + 5\lambda T_\lambda^* \text{Tr}(Y_e^\dagger T_e) \\
&+ 80g_3^2 M_3^* \text{Tr}(Y_u^\dagger T_u) + 4g_1^2 M_1 \text{Tr}(T_u^* Y_u^T) + 80g_3^2 M_3 \text{Tr}(T_u^* Y_u^T) - 4g_1^2 \text{Tr}(T_u^* T_u^T) \\
&- 80g_3^2 \text{Tr}(T_u^* T_u^T) \\
&+ 5\lambda^* \left(12\lambda|T_\lambda|^2 + 2T_\kappa^* \left(\kappa T_\lambda + \lambda T_\kappa\right) + 6m_{H_d}^2 \lambda \text{Tr}(Y_d Y_d^\dagger) + 3m_{H_u}^2 \lambda \text{Tr}(Y_d Y_d^\dagger) + 3m_S^2 \lambda \text{Tr}(Y_d Y_d^\dagger) \right. \\
&+ 2m_{H_d}^2 \lambda \text{Tr}(Y_e Y_e^\dagger) + m_{H_u}^2 \lambda \text{Tr}(Y_e Y_e^\dagger) + m_S^2 \lambda \text{Tr}(Y_e Y_e^\dagger) + 3T_\lambda \text{Tr}(T_d^* Y_d^T) + 3\lambda \text{Tr}(T_d^* T_d^T) \\
&+ T_\lambda \text{Tr}(T_e^* Y_e^T) + \lambda \text{Tr}(T_e^* T_e^T) + 3\lambda \text{Tr}(m_d^2 Y_d Y_d^\dagger) + \lambda \text{Tr}(m_e^2 Y_e Y_e^\dagger) + \lambda \text{Tr}(m_l^2 Y_e^\dagger Y_e) \\
&+ 3\lambda \text{Tr}(m_q^2 Y_d^\dagger Y_d) \left. \right) \\
&- 4g_1^2 \text{Tr}(m_q^2 Y_u^\dagger Y_u) - 80g_3^2 \text{Tr}(m_q^2 Y_u^\dagger Y_u) - 4g_1^2 \text{Tr}(m_u^2 Y_u Y_u^\dagger) - 80g_3^2 \text{Tr}(m_u^2 Y_u Y_u^\dagger) \\
&+ 15m_{H_d}^2 \text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) + 15m_{H_u}^2 \text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) + 15\text{Tr}(Y_d Y_u^\dagger T_u T_d^\dagger) \\
&+ 15\text{Tr}(Y_d T_u^\dagger T_u Y_d^\dagger) + 15\text{Tr}(Y_u Y_d^\dagger T_d T_u^\dagger) + 90m_{H_u}^2 \text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) + 90\text{Tr}(Y_u Y_u^\dagger T_u T_u^\dagger) \\
&+ 15\text{Tr}(Y_u T_u^\dagger T_d Y_u^\dagger) + 90\text{Tr}(Y_u T_u^\dagger T_u Y_u^\dagger) + 15\text{Tr}(m_d^2 Y_d Y_u^\dagger Y_u Y_d^\dagger) \\
&+ 15\text{Tr}(m_q^2 Y_d^\dagger Y_d Y_u^\dagger Y_u) + 15\text{Tr}(m_q^2 Y_u^\dagger Y_u Y_d^\dagger Y_d) + 90\text{Tr}(m_q^2 Y_u^\dagger Y_u Y_u^\dagger Y_u) \\
&+ 15\text{Tr}(m_u^2 Y_u Y_d^\dagger Y_d Y_u^\dagger) + 90\text{Tr}(m_u^2 Y_u Y_u^\dagger Y_u Y_u^\dagger) \left. \right) \tag{67}
\end{aligned}$$

$$\begin{aligned}
\beta_{m_d^2}^{(1)} &= -\frac{8}{15}g_1^2 \mathbf{1}|M_1|^2 - \frac{32}{3}g_3^2 \mathbf{1}|M_3|^2 + 4m_{H_d}^2 Y_d Y_d^\dagger + 4T_d T_d^\dagger + 2m_d^2 Y_d Y_d^\dagger + 4Y_d m_q^2 Y_d^\dagger \\
&+ 2Y_d Y_d^\dagger m_d^2 + 2\frac{1}{\sqrt{15}}g_1 \mathbf{1}\sigma_{1,1}
\end{aligned} \tag{68}$$

$$\begin{aligned}
\beta_{m_d^2}^{(2)} &= +\frac{64}{45}g_3^2 \left(-30g_3^2 M_3 + g_1^2(2M_3 + M_1)\right) \mathbf{1}M_3^* + \frac{4}{5}g_1^2 m_{H_d}^2 Y_d Y_d^\dagger + 12g_2^2 m_{H_d}^2 Y_d Y_d^\dagger \\
&+ 24g_2^2 |M_2|^2 Y_d Y_d^\dagger - 8m_{H_d}^2 |\lambda|^2 Y_d Y_d^\dagger - 4m_{H_u}^2 |\lambda|^2 Y_d Y_d^\dagger \\
&- 4m_S^2 |\lambda|^2 Y_d Y_d^\dagger - 4|T_\lambda|^2 Y_d Y_d^\dagger - \frac{4}{5}g_1^2 M_1 Y_d T_d^\dagger - 12g_2^2 M_2 Y_d T_d^\dagger
\end{aligned}$$

$$\begin{aligned}
& + \frac{4}{225} g_1^2 M_1^* \left(2 \left(303 g_1^2 M_1 + 40 g_3^2 (2M_1 + M_3) \right) \mathbf{1} - 45 T_d Y_d^\dagger + 90 M_1 Y_d Y_d^\dagger \right) - 12 g_2^2 M_2^* T_d Y_d^\dagger \\
& - 4 \lambda T_\lambda^* T_d Y_d^\dagger + \frac{4}{5} g_1^2 T_d T_d^\dagger + 12 g_2^2 T_d T_d^\dagger - 4 |\lambda|^2 T_d T_d^\dagger \\
& + \frac{2}{5} g_1^2 m_d^2 Y_d Y_d^\dagger + 6 g_2^2 m_d^2 Y_d Y_d^\dagger - 2 |\lambda|^2 m_d^2 Y_d Y_d^\dagger + \frac{4}{5} g_1^2 Y_d m_q^2 Y_d^\dagger \\
& + 12 g_2^2 Y_d m_q^2 Y_d^\dagger - 4 |\lambda|^2 Y_d m_q^2 Y_d^\dagger + \frac{2}{5} g_1^2 Y_d Y_d^\dagger m_d^2 + 6 g_2^2 Y_d Y_d^\dagger m_d^2 \\
& - 2 |\lambda|^2 Y_d Y_d^\dagger m_d^2 - 8 m_{H_d}^2 Y_d Y_d^\dagger Y_d Y_d^\dagger - 4 Y_d Y_d^\dagger T_d T_d^\dagger - 4 m_{H_d}^2 Y_d Y_u^\dagger Y_u Y_d^\dagger \\
& - 4 m_{H_u}^2 Y_d Y_u^\dagger Y_u Y_d^\dagger - 4 Y_d Y_u^\dagger T_u T_u^\dagger - 4 Y_d T_d^\dagger T_d Y_d^\dagger - 4 Y_d T_u^\dagger T_u Y_d^\dagger \\
& - 4 T_d Y_d^\dagger Y_d T_d^\dagger - 4 T_d Y_u^\dagger Y_u T_d^\dagger - 4 T_d T_d^\dagger Y_d Y_d^\dagger - 4 T_d T_u^\dagger Y_u Y_d^\dagger \\
& - 2 m_d^2 Y_d Y_d^\dagger Y_d Y_d^\dagger - 2 m_d^2 Y_d Y_u^\dagger Y_u Y_d^\dagger - 4 Y_d m_q^2 Y_d^\dagger Y_d Y_d^\dagger - 4 Y_d m_q^2 Y_u^\dagger Y_u Y_d^\dagger \\
& - 4 Y_d Y_d^\dagger m_d^2 Y_d Y_d^\dagger - 4 Y_d Y_d^\dagger Y_d m_q^2 Y_d^\dagger - 2 Y_d Y_d^\dagger Y_d Y_d^\dagger m_d^2 - 4 Y_d Y_u^\dagger m_u^2 Y_u Y_d^\dagger \\
& - 4 Y_d Y_u^\dagger Y_u m_q^2 Y_d^\dagger - 2 Y_d Y_u^\dagger Y_u Y_d^\dagger m_d^2 - 4 \lambda^* Y_d T_d^\dagger T_\lambda + \frac{32}{3} g_3^4 \mathbf{1}_{\sigma_{2,3}} + \frac{8}{15} g_1^2 \mathbf{1}_{\sigma_{2,11}} \\
& + 8 \frac{1}{\sqrt{15}} g_1 \mathbf{1}_{\sigma_{3,1}} - 24 m_{H_d}^2 Y_d Y_d^\dagger \text{Tr} \left(Y_d Y_d^\dagger \right) - 12 T_d T_d^\dagger \text{Tr} \left(Y_d Y_d^\dagger \right) \\
& - 6 m_d^2 Y_d Y_d^\dagger \text{Tr} \left(Y_d Y_d^\dagger \right) - 12 Y_d m_q^2 Y_d^\dagger \text{Tr} \left(Y_d Y_d^\dagger \right) - 6 Y_d Y_d^\dagger m_d^2 \text{Tr} \left(Y_d Y_d^\dagger \right) \\
& - 8 m_{H_d}^2 Y_d Y_d^\dagger \text{Tr} \left(Y_e Y_e^\dagger \right) - 4 T_d T_d^\dagger \text{Tr} \left(Y_e Y_e^\dagger \right) - 2 m_d^2 Y_d Y_d^\dagger \text{Tr} \left(Y_e Y_e^\dagger \right) \\
& - 4 Y_d m_q^2 Y_d^\dagger \text{Tr} \left(Y_e Y_e^\dagger \right) - 2 Y_d Y_d^\dagger m_d^2 \text{Tr} \left(Y_e Y_e^\dagger \right) - 12 Y_d T_d^\dagger \text{Tr} \left(Y_d^\dagger T_d \right) \\
& - 4 Y_d T_d^\dagger \text{Tr} \left(Y_e^\dagger T_e \right) - 12 T_d Y_d^\dagger \text{Tr} \left(T_d^* Y_d^T \right) - 12 Y_d Y_d^\dagger \text{Tr} \left(T_d^* T_d^T \right) \\
& - 4 T_d Y_d^\dagger \text{Tr} \left(T_e^* Y_e^T \right) - 4 Y_d Y_d^\dagger \text{Tr} \left(T_e^* T_e^T \right) - 12 Y_d Y_d^\dagger \text{Tr} \left(m_d^2 Y_d Y_d^\dagger \right) \\
& - 4 Y_d Y_d^\dagger \text{Tr} \left(m_e^2 Y_e Y_e^\dagger \right) - 4 Y_d Y_d^\dagger \text{Tr} \left(m_l^2 Y_l Y_l^\dagger \right) - 12 Y_d Y_d^\dagger \text{Tr} \left(m_q^2 Y_d^\dagger Y_d \right)
\end{aligned} \tag{69}$$

$$\begin{aligned}
\beta_{m_u^2}^{(1)} & = -\frac{32}{15} g_1^2 \mathbf{1} |M_1|^2 - \frac{32}{3} g_3^2 \mathbf{1} |M_3|^2 + 4 m_{H_u}^2 Y_u Y_u^\dagger + 4 T_u T_u^\dagger + 2 m_u^2 Y_u Y_u^\dagger + 4 Y_u m_q^2 Y_u^\dagger \\
& + 2 Y_u Y_u^\dagger m_u^2 - 4 \frac{1}{\sqrt{15}} g_1 \mathbf{1}_{\sigma_{1,1}}
\end{aligned} \tag{70}$$

$$\begin{aligned}
\beta_{m_u^2}^{(2)} & = -\frac{128}{45} g_3^2 \left(15 g_3^2 M_3 - 2 g_1^2 (2M_3 + M_1) \right) \mathbf{1} M_3^* - \frac{4}{5} g_1^2 m_{H_u}^2 Y_u Y_u^\dagger + 12 g_2^2 m_{H_u}^2 Y_u Y_u^\dagger \\
& + 24 g_2^2 |M_2|^2 Y_u Y_u^\dagger - 4 m_{H_d}^2 |\lambda|^2 Y_u Y_u^\dagger - 8 m_{H_u}^2 |\lambda|^2 Y_u Y_u^\dagger \\
& - 4 m_S^2 |\lambda|^2 Y_u Y_u^\dagger - 4 |T_\lambda|^2 Y_u Y_u^\dagger + \frac{4}{5} g_1^2 M_1 Y_u T_u^\dagger - 12 g_2^2 M_2 Y_u T_u^\dagger \\
& - 12 g_2^2 M_2^* T_u Y_u^\dagger - 4 \lambda T_\lambda^* T_u Y_u^\dagger \\
& + \frac{4}{225} g_1^2 M_1^* \left(45 \left(-2 M_1 Y_u Y_u^\dagger + T_u Y_u^\dagger \right) + 8 \left(321 g_1^2 M_1 + 40 g_3^2 (2M_1 + M_3) \right) \mathbf{1} \right) - \frac{4}{5} g_1^2 T_u T_u^\dagger \\
& + 12 g_2^2 T_u T_u^\dagger - 4 |\lambda|^2 T_u T_u^\dagger - \frac{2}{5} g_1^2 m_u^2 Y_u Y_u^\dagger + 6 g_2^2 m_u^2 Y_u Y_u^\dagger
\end{aligned}$$

$$\begin{aligned}
& -2|\lambda|^2 m_u^2 Y_u Y_u^\dagger - \frac{4}{5} g_1^2 Y_u m_q^2 Y_u^\dagger + 12 g_2^2 Y_u m_q^2 Y_u^\dagger - 4|\lambda|^2 Y_u m_q^2 Y_u^\dagger \\
& - \frac{2}{5} g_1^2 Y_u Y_u^\dagger m_u^2 + 6 g_2^2 Y_u Y_u^\dagger m_u^2 - 2|\lambda|^2 Y_u Y_u^\dagger m_u^2 - 4 m_{H_d}^2 Y_u Y_d^\dagger Y_d Y_u^\dagger \\
& - 4 m_{H_u}^2 Y_u Y_d^\dagger Y_d Y_u^\dagger - 4 Y_u Y_d^\dagger T_d T_u^\dagger - 8 m_{H_u}^2 Y_u Y_u^\dagger Y_u Y_u^\dagger - 4 Y_u Y_u^\dagger T_u T_u^\dagger \\
& - 4 Y_u T_d^\dagger T_d Y_u^\dagger - 4 Y_u T_u^\dagger T_u Y_u^\dagger - 4 T_u Y_d^\dagger Y_d T_u^\dagger - 4 T_u Y_u^\dagger Y_u T_u^\dagger \\
& - 4 T_u T_d^\dagger Y_d Y_u^\dagger - 4 T_u T_u^\dagger Y_u Y_u^\dagger - 2 m_u^2 Y_u Y_d^\dagger Y_d Y_u^\dagger - 2 m_u^2 Y_u Y_u^\dagger Y_u Y_u^\dagger \\
& - 4 Y_u m_q^2 Y_d^\dagger Y_d Y_u^\dagger - 4 Y_u m_q^2 Y_u^\dagger Y_u Y_u^\dagger - 4 Y_u Y_d^\dagger m_d^2 Y_d Y_u^\dagger \\
& - 4 Y_u Y_d^\dagger Y_d m_q^2 Y_u^\dagger - 2 Y_u Y_d^\dagger Y_d Y_u^\dagger m_u^2 - 4 Y_u Y_u^\dagger m_u^2 Y_u Y_u^\dagger - 4 Y_u Y_u^\dagger Y_u m_q^2 Y_u^\dagger \\
& - 2 Y_u Y_u^\dagger Y_u Y_u^\dagger m_u^2 - 4 \lambda^* Y_u T_u^\dagger T_\lambda + \frac{32}{3} g_3^4 \mathbf{1} \sigma_{2,3} + \frac{32}{15} g_1^2 \mathbf{1} \sigma_{2,11} - 16 \frac{1}{\sqrt{15}} g_1 \mathbf{1} \sigma_{3,1} \\
& - 24 m_{H_u}^2 Y_u Y_u^\dagger \text{Tr}(Y_u Y_u^\dagger) - 12 T_u T_u^\dagger \text{Tr}(Y_u Y_u^\dagger) - 6 m_u^2 Y_u Y_u^\dagger \text{Tr}(Y_u Y_u^\dagger) \\
& - 12 Y_u m_q^2 Y_u^\dagger \text{Tr}(Y_u Y_u^\dagger) - 6 Y_u Y_u^\dagger m_u^2 \text{Tr}(Y_u Y_u^\dagger) - 12 Y_u T_u^\dagger \text{Tr}(Y_u^\dagger T_u) \\
& - 12 T_u Y_u^\dagger \text{Tr}(T_u^* Y_u^T) - 12 Y_u Y_u^\dagger \text{Tr}(T_u^* T_u^T) - 12 Y_u Y_u^\dagger \text{Tr}(m_q^2 Y_u^\dagger Y_u) \\
& - 12 Y_u Y_u^\dagger \text{Tr}(m_u^2 Y_u Y_u^\dagger)
\end{aligned} \tag{71}$$

$$\begin{aligned}
\beta_{m_e^2}^{(1)} &= -\frac{24}{5} g_1^2 \mathbf{1} |M_1|^2 + 2 \left(2 m_{H_d}^2 Y_e Y_e^\dagger + 2 T_e T_e^\dagger + 2 Y_e m_l^2 Y_e^\dagger + m_e^2 Y_e Y_e^\dagger + Y_e Y_e^\dagger m_e^2 \right) \\
&+ 2 \sqrt{\frac{3}{5}} g_1 \mathbf{1} \sigma_{1,1}
\end{aligned} \tag{72}$$

$$\begin{aligned}
\beta_{m_e^2}^{(2)} &= \frac{2}{25} \left(6 g_1^2 M_1^* \left(234 g_1^2 M_1 \mathbf{1} + 5 \left(-2 M_1 Y_e Y_e^\dagger + T_e Y_e^\dagger \right) \right) + 20 g_1 \mathbf{1} \left(3 g_1 \sigma_{2,11} + \sqrt{15} \sigma_{3,1} \right) \right. \\
&- 5 \left(30 g_2^2 M_2^* T_e Y_e^\dagger + 10 \lambda T_\lambda^* T_e Y_e^\dagger + 6 g_1^2 T_e T_e^\dagger - 30 g_2^2 T_e T_e^\dagger \right. \\
&+ 10 |\lambda|^2 T_e T_e^\dagger + 3 g_1^2 m_e^2 Y_e Y_e^\dagger - 15 g_2^2 m_e^2 Y_e Y_e^\dagger + 5 |\lambda|^2 m_e^2 Y_e Y_e^\dagger \\
&+ 6 g_1^2 Y_e m_l^2 Y_e^\dagger - 30 g_2^2 Y_e m_l^2 Y_e^\dagger + 10 |\lambda|^2 Y_e m_l^2 Y_e^\dagger + 3 g_1^2 Y_e Y_e^\dagger m_e^2 \\
&- 15 g_2^2 Y_e Y_e^\dagger m_e^2 + 5 |\lambda|^2 Y_e Y_e^\dagger m_e^2 + 20 m_{H_d}^2 Y_e Y_e^\dagger Y_e Y_e^\dagger + 10 Y_e Y_e^\dagger T_e T_e^\dagger \\
&+ 10 Y_e T_e^\dagger T_e Y_e^\dagger + 10 T_e Y_e^\dagger Y_e T_e^\dagger + 10 T_e T_e^\dagger Y_e Y_e^\dagger + 5 m_e^2 Y_e Y_e^\dagger Y_e Y_e^\dagger \\
&+ 10 Y_e m_l^2 Y_e^\dagger Y_e Y_e^\dagger + 10 Y_e Y_e^\dagger m_e^2 Y_e Y_e^\dagger + 10 Y_e Y_e^\dagger Y_e m_l^2 Y_e^\dagger + 5 Y_e Y_e^\dagger Y_e Y_e^\dagger m_e^2 \\
&+ 30 T_e T_e^\dagger \text{Tr}(Y_d Y_d^\dagger) + 15 m_e^2 Y_e Y_e^\dagger \text{Tr}(Y_d Y_d^\dagger) + 30 Y_e m_l^2 Y_e^\dagger \text{Tr}(Y_d Y_d^\dagger) \\
&+ 15 Y_e Y_e^\dagger m_e^2 \text{Tr}(Y_d Y_d^\dagger) + 10 T_e T_e^\dagger \text{Tr}(Y_e Y_e^\dagger) + 5 m_e^2 Y_e Y_e^\dagger \text{Tr}(Y_e Y_e^\dagger) \\
&+ 10 Y_e m_l^2 Y_e^\dagger \text{Tr}(Y_e Y_e^\dagger) + 5 Y_e Y_e^\dagger m_e^2 \text{Tr}(Y_e Y_e^\dagger) \\
&+ Y_e T_e^\dagger \left(10 \lambda^* T_\lambda + 10 \text{Tr}(Y_e^\dagger T_e) \right) + 30 g_2^2 M_2 + 30 \text{Tr}(Y_d^\dagger T_d) - 6 g_1^2 M_1 + 30 T_e Y_e^\dagger \text{Tr}(T_d^* Y_d^T) \\
&+ 10 T_e Y_e^\dagger \text{Tr}(T_e^* Y_e^T)
\end{aligned}$$

$$\begin{aligned}
& + 2Y_e Y_e^\dagger \left(3g_1^2 m_{H_d}^2 - 15g_2^2 m_{H_d}^2 - 30g_2^2 |M_2|^2 + 5(2m_{H_d}^2 + m_{H_u}^2 + m_S^2) |\lambda|^2 + 5|T_\lambda|^2 + 30m_{H_d}^2 \text{Tr}(Y_d Y_d^\dagger) \right. \\
& + 10m_{H_d}^2 \text{Tr}(Y_e Y_e^\dagger) + 15\text{Tr}(T_d^* T_d^T) + 5\text{Tr}(T_e^* T_e^T) + 15\text{Tr}(m_d^2 Y_d Y_d^\dagger) + 5\text{Tr}(m_e^2 Y_e Y_e^\dagger) \\
& \left. + 5\text{Tr}(m_l^2 Y_e^\dagger Y_e) + 15\text{Tr}(m_q^2 Y_d^\dagger Y_d) \right) \quad (73)
\end{aligned}$$

$$\beta_{m_S^2}^{(1)} = 4 \left(3m_S^2 |\kappa|^2 + (m_{H_d}^2 + m_{H_u}^2 + m_S^2) |\lambda|^2 + |T_\kappa|^2 + |T_\lambda|^2 \right) \quad (74)$$

$$\begin{aligned}
\beta_{m_S^2}^{(2)} = & -\frac{4}{5} \left(120m_S^2 \kappa^2 \kappa^{*,2} + 20(m_{H_d}^2 + m_{H_u}^2 + m_S^2) \lambda^2 \lambda^{*,2} \right. \\
& + 20\kappa^* \left(4\kappa |T_\kappa|^2 + (4m_S^2 + m_{H_d}^2 + m_{H_u}^2) \kappa |\lambda|^2 + T_\lambda^* (\kappa T_\lambda + \lambda T_\kappa) \right) \\
& + T_\lambda^* \left(T_\lambda (15\text{Tr}(Y_d Y_d^\dagger) - 3(5g_2^2 - 5\text{Tr}(Y_u Y_u^\dagger) + g_1^2) + 5\text{Tr}(Y_e Y_e^\dagger)) \right. \\
& \left. + \lambda (15\text{Tr}(Y_d^\dagger T_d) + 3(5g_2^2 M_2 + 5\text{Tr}(Y_u^\dagger T_u) + g_1^2 M_1) + 5\text{Tr}(Y_e^\dagger T_e)) \right) \\
& + \lambda^* \left(-3g_1^2 m_{H_d}^2 \lambda - 15g_2^2 m_{H_d}^2 \lambda - 3g_1^2 m_{H_u}^2 \lambda - 15g_2^2 m_{H_u}^2 \lambda - 3g_1^2 m_S^2 \lambda - 15g_2^2 m_S^2 \lambda \right. \\
& + 20\lambda |T_\kappa|^2 + 40\lambda |T_\lambda|^2 + 20\kappa T_\kappa^* T_\lambda + 3g_1^2 M_1^* (-2M_1 \lambda + T_\lambda) + 15g_2^2 M_2^* (-2M_2 \lambda + T_\lambda) \\
& + 30m_{H_d}^2 \lambda \text{Tr}(Y_d Y_d^\dagger) + 15m_{H_u}^2 \lambda \text{Tr}(Y_d Y_d^\dagger) + 15m_S^2 \lambda \text{Tr}(Y_d Y_d^\dagger) + 10m_{H_d}^2 \lambda \text{Tr}(Y_e Y_e^\dagger) \\
& + 5m_{H_u}^2 \lambda \text{Tr}(Y_e Y_e^\dagger) + 5m_S^2 \lambda \text{Tr}(Y_e Y_e^\dagger) + 15m_{H_d}^2 \lambda \text{Tr}(Y_u Y_u^\dagger) + 30m_{H_u}^2 \lambda \text{Tr}(Y_u Y_u^\dagger) \\
& + 15m_S^2 \lambda \text{Tr}(Y_u Y_u^\dagger) + 15T_\lambda \text{Tr}(T_d^* Y_d^T) + 15\lambda \text{Tr}(T_d^* T_d^T) + 5T_\lambda \text{Tr}(T_e^* Y_e^T) + 5\lambda \text{Tr}(T_e^* T_e^T) \\
& + 15T_\lambda \text{Tr}(T_u^* Y_u^T) + 15\lambda \text{Tr}(T_u^* T_u^T) + 15\lambda \text{Tr}(m_d^2 Y_d Y_d^\dagger) + 5\lambda \text{Tr}(m_e^2 Y_e Y_e^\dagger) + 5\lambda \text{Tr}(m_l^2 Y_e^\dagger Y_e) \\
& \left. + 15\lambda \text{Tr}(m_q^2 Y_d^\dagger Y_d) + 15\lambda \text{Tr}(m_q^2 Y_u^\dagger Y_u) + 15\lambda \text{Tr}(m_u^2 Y_u Y_u^\dagger) \right) \quad (75)
\end{aligned}$$

3.7 Vacuum expectation values

$$\beta_{v_d}^{(1)} = \frac{1}{20} v_d \left(15g_2^2 + 15g_2^2 \text{Xi} - 20|\lambda|^2 - 20\text{Tr}(Y_e Y_e^\dagger) + 3g_1^2 + 3g_1^2 \text{Xi} - 60\text{Tr}(Y_d Y_d^\dagger) \right) \quad (76)$$

$$\begin{aligned}
\beta_{v_d}^{(2)} = & \frac{1}{400} v_d \left(-414g_1^4 - 180g_1^2 g_2^2 - 1200g_2^4 - 9g_1^4 \text{Xi} - 90g_1^2 g_2^2 \text{Xi} + 875g_2^4 \text{Xi} + 9g_1^4 \text{Xi}^2 + 90g_1^2 g_2^2 \text{Xi}^2 \right. \\
& - 225g_2^4 \text{Xi}^2 + 1200\lambda^2 \lambda^{*,2} - 40 \left(5(32g_3^2 + 9g_2^2 \text{Xi}) + g_1^2 (9\text{Xi} - 4) \right) \text{Tr}(Y_d Y_d^\dagger) - 480g_1^2 \text{Tr}(Y_e Y_e^\dagger) \\
& - 120g_1^2 \text{Xi} \text{Tr}(Y_e Y_e^\dagger) - 600g_2^2 \text{Xi} \text{Tr}(Y_e Y_e^\dagger) - 40|\lambda|^2 (15g_2^2 \text{Xi} - 20\kappa \kappa^* - 30\text{Tr}(Y_u Y_u^\dagger) + 3g_1^2 \text{Xi}) \\
& \left. + 3600\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) + 1200\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) + 1200\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \right) \quad (77)
\end{aligned}$$

$$\beta_{v_u}^{(1)} = \frac{1}{20} v_u \left(-20|\lambda|^2 + 3 \left(-20\text{Tr}(Y_u Y_u^\dagger) + (5g_2^2 + g_1^2) (1 + \text{Xi}) \right) \right) \quad (78)$$

$$\beta_{v_u}^{(2)} = \frac{1}{400} v_u \left(-414g_1^4 - 180g_1^2 g_2^2 - 1200g_2^4 - 9g_1^4 \text{Xi} - 90g_1^2 g_2^2 \text{Xi} + 875g_2^4 \text{Xi} + 9g_1^4 \text{Xi}^2 + 90g_1^2 g_2^2 \text{Xi}^2 \right)$$

$$\begin{aligned}
& -225g_2^4\text{Xi}^2 + 1200\lambda^2\lambda^{*,2} - 40|\lambda|^2 \left(-10\text{Tr}\left(Y_e Y_e^\dagger\right) + 15g_2^2\text{Xi} - 20\kappa\kappa^* - 30\text{Tr}\left(Y_d Y_d^\dagger\right) + 3g_1^2\text{Xi} \right) \\
& - 40 \left(5 \left(32g_3^2 + 9g_2^2\text{Xi} \right) + g_1^2 \left(9\text{Xi} + 8 \right) \right) \text{Tr}\left(Y_u Y_u^\dagger\right) + 1200\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) + 3600\text{Tr}\left(Y_u Y_u^\dagger Y_u Y_u^\dagger\right)
\end{aligned} \tag{79}$$

$$\beta_{v_s}^{(1)} = -2v_s \left(|\kappa|^2 + |\lambda|^2 \right) \tag{80}$$

$$\begin{aligned}
\beta_{v_s}^{(2)} &= +8v_s\kappa^2\kappa^{*,2} + 8v_s\lambda|\kappa|^2\lambda^* \\
&+ \frac{2}{5}v_s|\lambda|^2 \left(10\lambda\lambda^* - 15g_2^2 + 15\text{Tr}\left(Y_d Y_d^\dagger\right) + 15\text{Tr}\left(Y_u Y_u^\dagger\right) - 3g_1^2 + 5\text{Tr}\left(Y_e Y_e^\dagger\right) \right)
\end{aligned} \tag{81}$$

4 Field Rotations

4.1 Rotations in gauge sector for eigenstates 'EWSB'

$$\begin{pmatrix} B_\rho \\ W_{3\rho} \end{pmatrix} = Z^{\gamma Z} \begin{pmatrix} \gamma_\rho \\ Z_\rho \end{pmatrix} \tag{82}$$

$$\begin{pmatrix} W_{1\rho} \\ W_{2\rho} \end{pmatrix} = Z^W \begin{pmatrix} W_\rho^- \\ W_\rho^- \end{pmatrix} \tag{83}$$

$$\begin{pmatrix} \lambda_{\tilde{W},1} \\ \lambda_{\tilde{W},2} \\ \lambda_{\tilde{W},3} \end{pmatrix} = Z^{\tilde{W}} \begin{pmatrix} \tilde{W}^- \\ \tilde{W}^+ \\ \tilde{W}^0 \end{pmatrix} \tag{84}$$

$$\tag{85}$$

The mixing matrices are parametrized by

$$Z^{\gamma Z} = \begin{pmatrix} \cos \Theta_W & -\sin \Theta_W \\ \sin \Theta_W & \cos \Theta_W \end{pmatrix} \tag{86}$$

$$Z^W = \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -i\frac{1}{\sqrt{2}} & i\frac{1}{\sqrt{2}} \end{pmatrix} \tag{87}$$

$$Z^{\tilde{W}} = \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ -i\frac{1}{\sqrt{2}} & i\frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{pmatrix} \tag{88}$$

$$\tag{89}$$

4.2 Rotations in Mass sector for eigenstates 'EWSB'

4.2.1 Mass Matrices for Scalars

- Mass matrix for Down Squark, Basis: $\left(\tilde{d}_{L,\alpha_1}, \tilde{d}_{R,\alpha_2} \right), \left(\tilde{d}_{L,\beta_1}^*, \tilde{d}_{R,\beta_2}^* \right)$

$$m_{\tilde{d}}^2 = \begin{pmatrix} m_{\tilde{d}_L \tilde{d}_L^*} & \frac{1}{2} \left(\sqrt{2} v_d T_{d,11}^* - v_s v_u \lambda Y_{d,11}^* \right) \delta_{\alpha_1 \beta_2} \\ \frac{1}{2} \delta_{\alpha_2 \beta_1} \left(\sqrt{2} v_d T_{d,11} - v_s v_u \lambda^* Y_{d,11} \right) & m_{\tilde{d}_R \tilde{d}_R^*} \end{pmatrix} \quad (90)$$

$$m_{\tilde{d}_L \tilde{d}_L^*} = -\frac{1}{24} (3g_2^2 + g_1^2) \left(-v_u^2 + v_d^2 \right) \delta_{\alpha_1 \beta_1} + \frac{1}{2} \delta_{\alpha_1 \beta_1} \left(2m_{q,11}^2 + v_d^2 |Y_{d,11}|^2 \right) \quad (91)$$

$$m_{\tilde{d}_R \tilde{d}_R^*} = \frac{1}{12} g_1^2 \left(-v_d^2 + v_u^2 \right) \delta_{\alpha_2 \beta_2} + \frac{1}{2} \delta_{\alpha_2 \beta_2} \left(2m_{d,11}^2 + v_d^2 |Y_{d,11}|^2 \right) \quad (92)$$

This matrix is diagonalized by Z^D :

$$Z^D m_{\tilde{d}}^2 Z^{D,\dagger} = m_{2,\tilde{d}}^{dia} \quad (93)$$

with

$$\tilde{d}_{L,\alpha} = \sum_j Z_{j1}^{D,*} \tilde{d}_{j\alpha}, \quad \tilde{d}_{R,\alpha} = \sum_j Z_{j2}^{D,*} \tilde{d}_{j\alpha} \quad (94)$$

- **Mass matrix for Up Squark**, Basis: $(\tilde{u}_{L,\alpha_1}, \tilde{u}_{R,\alpha_2}), (\tilde{u}_{L,\beta_1}^*, \tilde{u}_{R,\beta_2}^*)$

$$m_{\tilde{u}}^2 = \begin{pmatrix} m_{\tilde{u}_L \tilde{u}_L^*} & \frac{1}{2} \left(\sqrt{2} v_u T_{u,11}^* - v_d v_s \lambda Y_{u,11}^* \right) \delta_{\alpha_1 \beta_2} \\ \frac{1}{2} \delta_{\alpha_2 \beta_1} \left(\sqrt{2} v_u T_{u,11} - v_d v_s \lambda^* Y_{u,11} \right) & m_{\tilde{u}_R \tilde{u}_R^*} \end{pmatrix} \quad (95)$$

$$m_{\tilde{u}_L \tilde{u}_L^*} = -\frac{1}{24} \left(-3g_2^2 + g_1^2 \right) \left(-v_u^2 + v_d^2 \right) \delta_{\alpha_1 \beta_1} + \frac{1}{2} \delta_{\alpha_1 \beta_1} \left(2m_{q,11}^2 + v_u^2 |Y_{u,11}|^2 \right) \quad (96)$$

$$m_{\tilde{u}_R \tilde{u}_R^*} = \frac{1}{2} \delta_{\alpha_2 \beta_2} \left(2m_{u,11}^2 + v_u^2 |Y_{u,11}|^2 \right) + \frac{1}{6} g_1^2 \left(-v_u^2 + v_d^2 \right) \delta_{\alpha_2 \beta_2} \quad (97)$$

This matrix is diagonalized by Z^U :

$$Z^U m_{\tilde{u}}^2 Z^{U,\dagger} = m_{2,\tilde{u}}^{dia} \quad (98)$$

with

$$\tilde{u}_{L,\alpha} = \sum_j Z_{j1}^{U,*} \tilde{u}_{j\alpha}, \quad \tilde{u}_{R,\alpha} = \sum_j Z_{j2}^{U,*} \tilde{u}_{j\alpha} \quad (99)$$

- **Mass matrix for Selectron**, Basis: $(\tilde{e}_L, \tilde{e}_R), (\tilde{e}_L^*, \tilde{e}_R^*)$

$$m_{\tilde{e}}^2 = \begin{pmatrix} m_{\tilde{e}_L \tilde{e}_L^*} & -\frac{1}{2} v_s v_u \lambda Y_{e,11}^* + \frac{1}{\sqrt{2}} v_d T_{e,11}^* \\ -\frac{1}{2} v_s v_u \lambda^* Y_{e,11} + \frac{1}{\sqrt{2}} v_d T_{e,11} & \frac{1}{2} v_d^2 |Y_{e,11}|^2 + \frac{1}{4} g_1^2 \left(-v_d^2 + v_u^2 \right) + m_{e,11}^2 \end{pmatrix} \quad (100)$$

$$m_{\tilde{e}_L \tilde{e}_L^*} = \frac{1}{2} v_d^2 |Y_{e,11}|^2 + \frac{1}{8} \left(-g_2^2 + g_1^2 \right) \left(-v_u^2 + v_d^2 \right) + m_{l,11}^2 \quad (101)$$

This matrix is diagonalized by Z^E :

$$Z^E m_{\tilde{e}}^2 Z^{E,\dagger} = m_{2,\tilde{e}}^{dia} \quad (102)$$

with

$$\tilde{e}_L = \sum_j Z_{j1}^{E,*} \tilde{e}_j, \quad \tilde{e}_R = \sum_j Z_{j2}^{E,*} \tilde{e}_j \quad (103)$$

- **Mass matrix for Smuon**, Basis: $(\tilde{\mu}_L, \tilde{\mu}_R), (\tilde{\mu}_L^*, \tilde{\mu}_R^*)$

$$m_{\tilde{\mu}}^2 = \begin{pmatrix} m_{\tilde{\mu}_L \tilde{\mu}_L^*} & -\frac{1}{2} v_s v_u \lambda Y_{e,22}^* + \frac{1}{\sqrt{2}} v_d T_{e,22}^* \\ -\frac{1}{2} v_s v_u \lambda^* Y_{e,22} + \frac{1}{\sqrt{2}} v_d T_{e,22} & \frac{1}{2} v_d^2 |Y_{e,22}|^2 + \frac{1}{4} g_1^2 (-v_d^2 + v_u^2) + m_{e,22}^2 \end{pmatrix} \quad (104)$$

$$m_{\tilde{\mu}_L \tilde{\mu}_L^*} = \frac{1}{2} v_d^2 |Y_{e,22}|^2 + \frac{1}{8} (-g_2^2 + g_1^2) (-v_u^2 + v_d^2) + m_{l,22}^2 \quad (105)$$

This matrix is diagonalized by Z^μ :

$$Z^\mu m_{\tilde{\mu}}^2 Z^{\mu,\dagger} = m_{2,\tilde{\mu}}^{dia} \quad (106)$$

with

$$\tilde{\mu}_L = \sum_j Z_{j1}^{\mu,*} \tilde{\mu}_j, \quad \tilde{\mu}_R = \sum_j Z_{j2}^{\mu,*} \tilde{\mu}_j \quad (107)$$

- **Mass matrix for Stau**, Basis: $(\tilde{\tau}_L, \tilde{\tau}_R), (\tilde{\tau}_L^*, \tilde{\tau}_R^*)$

$$m_{\tilde{\tau}}^2 = \begin{pmatrix} m_{\tilde{\tau}_L \tilde{\tau}_L^*} & -\frac{1}{2} v_s v_u \lambda Y_{e,33}^* + \frac{1}{\sqrt{2}} v_d T_{e,33}^* \\ -\frac{1}{2} v_s v_u \lambda^* Y_{e,33} + \frac{1}{\sqrt{2}} v_d T_{e,33} & \frac{1}{2} v_d^2 |Y_{e,33}|^2 + \frac{1}{4} g_1^2 (-v_d^2 + v_u^2) + m_{e,33}^2 \end{pmatrix} \quad (108)$$

$$m_{\tilde{\tau}_L \tilde{\tau}_L^*} = \frac{1}{2} v_d^2 |Y_{e,33}|^2 + \frac{1}{8} (-g_2^2 + g_1^2) (-v_u^2 + v_d^2) + m_{l,33}^2 \quad (109)$$

This matrix is diagonalized by Z^τ :

$$Z^\tau m_{\tilde{\tau}}^2 Z^{\tau,\dagger} = m_{2,\tilde{\tau}}^{dia} \quad (110)$$

with

$$\tilde{\tau}_L = \sum_j Z_{j1}^{\tau,*} \tilde{\tau}_j, \quad \tilde{\tau}_R = \sum_j Z_{j2}^{\tau,*} \tilde{\tau}_j \quad (111)$$

- **Mass matrix for Strange Squark**, Basis: $(\tilde{s}_{L,\alpha_1}, \tilde{s}_{R,\alpha_2}), (\tilde{s}_{L,\beta_1}^*, \tilde{s}_{R,\beta_2}^*)$

$$m_{\tilde{s}}^2 = \begin{pmatrix} m_{\tilde{s}_L \tilde{s}_L^*} & \frac{1}{2} (\sqrt{2} v_d T_{d,22}^* - v_s v_u \lambda Y_{d,22}^*) \delta_{\alpha_1 \beta_2} \\ \frac{1}{2} \delta_{\alpha_2 \beta_1} (\sqrt{2} v_d T_{d,22} - v_s v_u \lambda^* Y_{d,22}) & m_{\tilde{s}_R \tilde{s}_R^*} \end{pmatrix} \quad (112)$$

$$m_{\tilde{s}_L \tilde{s}_L^*} = -\frac{1}{24} (3g_2^2 + g_1^2) (-v_u^2 + v_d^2) \delta_{\alpha_1 \beta_1} + \frac{1}{2} \delta_{\alpha_1 \beta_1} (2m_{q,22}^2 + v_d^2 |Y_{d,22}|^2) \quad (113)$$

$$m_{\tilde{s}_R \tilde{s}_R^*} = \frac{1}{12} g_1^2 \left(-v_d^2 + v_u^2 \right) \delta_{\alpha_2 \beta_2} + \frac{1}{2} \delta_{\alpha_2 \beta_2} \left(2m_{d,22}^2 + v_d^2 |Y_{d,22}|^2 \right) \quad (114)$$

This matrix is diagonalized by Z^S :

$$Z^S m_{\tilde{s}}^2 Z^{S,\dagger} = m_{2,\tilde{s}}^{dia} \quad (115)$$

with

$$\tilde{s}_{L,\alpha} = \sum_j Z_{j1}^{S,*} \tilde{s}_{j\alpha}, \quad \tilde{s}_{R,\alpha} = \sum_j Z_{j2}^{S,*} \tilde{s}_{j\alpha} \quad (116)$$

- **Mass matrix for Charmed Squark**, Basis: $(\tilde{c}_{L,\alpha_1}, \tilde{c}_{R,\alpha_2}), (\tilde{c}_{L,\beta_1}^*, \tilde{c}_{R,\beta_2}^*)$

$$m_{\tilde{c}}^2 = \begin{pmatrix} m_{\tilde{c}_L \tilde{c}_L^*} & \frac{1}{2} \left(\sqrt{2} v_u T_{u,22}^* - v_d v_s \lambda Y_{u,22}^* \right) \delta_{\alpha_1 \beta_2} \\ \frac{1}{2} \delta_{\alpha_2 \beta_1} \left(\sqrt{2} v_u T_{u,22} - v_d v_s \lambda^* Y_{u,22} \right) & m_{\tilde{c}_R \tilde{c}_R^*} \end{pmatrix} \quad (117)$$

$$m_{\tilde{c}_L \tilde{c}_L^*} = -\frac{1}{24} \left(-3g_2^2 + g_1^2 \right) \left(-v_u^2 + v_d^2 \right) \delta_{\alpha_1 \beta_1} + \frac{1}{2} \delta_{\alpha_1 \beta_1} \left(2m_{q,22}^2 + v_u^2 |Y_{u,22}|^2 \right) \quad (118)$$

$$m_{\tilde{c}_R \tilde{c}_R^*} = \frac{1}{2} \delta_{\alpha_2 \beta_2} \left(2m_{u,22}^2 + v_u^2 |Y_{u,22}|^2 \right) + \frac{1}{6} g_1^2 \left(-v_u^2 + v_d^2 \right) \delta_{\alpha_2 \beta_2} \quad (119)$$

This matrix is diagonalized by Z^C :

$$Z^C m_{\tilde{c}}^2 Z^{C,\dagger} = \bar{m}_{2,\tilde{c}}^{dia} \quad (120)$$

with

$$\tilde{c}_{L,\alpha} = \sum_j Z_{j1}^{C,*} \tilde{c}_{j\alpha}, \quad \tilde{c}_{R,\alpha} = \sum_j Z_{j2}^{C,*} \tilde{c}_{j\alpha} \quad (121)$$

- **Mass matrix for Bottom Squark**, Basis: $(\tilde{b}_{L,\alpha_1}, \tilde{b}_{R,\alpha_2}), (\tilde{b}_{L,\beta_1}^*, \tilde{b}_{R,\beta_2}^*)$

$$m_{\tilde{b}}^2 = \begin{pmatrix} m_{\tilde{b}_L \tilde{b}_L^*} & \frac{1}{2} \left(\sqrt{2} v_d T_{d,33}^* - v_s v_u \lambda Y_{d,33}^* \right) \delta_{\alpha_1 \beta_2} \\ \frac{1}{2} \delta_{\alpha_2 \beta_1} \left(\sqrt{2} v_d T_{d,33} - v_s v_u \lambda^* Y_{d,33} \right) & m_{\tilde{b}_R \tilde{b}_R^*} \end{pmatrix} \quad (122)$$

$$m_{\tilde{b}_L \tilde{b}_L^*} = -\frac{1}{24} \left(3g_2^2 + g_1^2 \right) \left(-v_u^2 + v_d^2 \right) \delta_{\alpha_1 \beta_1} + \frac{1}{2} \delta_{\alpha_1 \beta_1} \left(2m_{q,33}^2 + v_d^2 |Y_{d,33}|^2 \right) \quad (123)$$

$$m_{\tilde{b}_R \tilde{b}_R^*} = \frac{1}{12} g_1^2 \left(-v_d^2 + v_u^2 \right) \delta_{\alpha_2 \beta_2} + \frac{1}{2} \delta_{\alpha_2 \beta_2} \left(2m_{d,33}^2 + v_d^2 |Y_{d,33}|^2 \right) \quad (124)$$

This matrix is diagonalized by Z^B :

$$Z^B m_{\tilde{b}}^2 Z^{B,\dagger} = m_{2,\tilde{b}}^{dia} \quad (125)$$

with

$$\tilde{b}_{L,\alpha} = \sum_j Z_{j1}^{B,*} \tilde{b}_{j\alpha}, \quad \tilde{b}_{R,\alpha} = \sum_j Z_{j2}^{B,*} \tilde{b}_{j\alpha} \quad (126)$$

- **Mass matrix for Top Squark, Basis:** $(\tilde{t}_{L,\alpha_1}, \tilde{t}_{R,\alpha_2}), (\tilde{t}_{L,\beta_1}^*, \tilde{t}_{R,\beta_2}^*)$

$$m_{\tilde{t}}^2 = \begin{pmatrix} m_{\tilde{t}_L \tilde{t}_L^*} & \frac{1}{2}(\sqrt{2}v_u T_{u,33}^* - v_d v_s \lambda Y_{u,33}^*) \delta_{\alpha_1 \beta_2} \\ \frac{1}{2} \delta_{\alpha_2 \beta_1} (\sqrt{2}v_u T_{u,33} - v_d v_s \lambda^* Y_{u,33}) & m_{\tilde{t}_R \tilde{t}_R^*} \end{pmatrix} \quad (127)$$

$$m_{\tilde{t}_L \tilde{t}_L^*} = -\frac{1}{24}(-3g_2^2 + g_1^2)(-v_u^2 + v_d^2) \delta_{\alpha_1 \beta_1} + \frac{1}{2} \delta_{\alpha_1 \beta_1} (2m_{q,33}^2 + v_u^2 |Y_{u,33}|^2) \quad (128)$$

$$m_{\tilde{t}_R \tilde{t}_R^*} = \frac{1}{2} \delta_{\alpha_2 \beta_2} (2m_{u,33}^2 + v_u^2 |Y_{u,33}|^2) + \frac{1}{6} g_1^2 (-v_u^2 + v_d^2) \delta_{\alpha_2 \beta_2} \quad (129)$$

This matrix is diagonalized by Z^T :

$$Z^T m_{\tilde{t}}^2 Z^{T,\dagger} = m_{2,\tilde{t}}^{dia} \quad (130)$$

with

$$\tilde{t}_{L,\alpha} = \sum_j Z_{j1}^{T,*} \tilde{t}_{j\alpha}, \quad \tilde{t}_{R,\alpha} = \sum_j Z_{j2}^{T,*} \tilde{t}_{j\alpha} \quad (131)$$

- **Mass matrix for Higgs, Basis:** $(\phi_d, \phi_u, \phi_s), (\phi_d, \phi_u, \phi_s)$

$$m_h^2 = \begin{pmatrix} m_{\phi_d \phi_d} & m_{\phi_u \phi_d} & m_{\phi_s \phi_d} \\ m_{\phi_d \phi_u} & m_{\phi_u \phi_u} & m_{\phi_s \phi_u} \\ m_{\phi_d \phi_s} & m_{\phi_u \phi_s} & m_{\phi_s \phi_s} \end{pmatrix} \quad (132)$$

$$m_{\phi_d \phi_d} = \frac{1}{2}(v_s^2 + v_u^2)|\lambda|^2 + \frac{1}{8}(g_1^2 + g_2^2)(3v_d^2 - v_u^2) + m_{H_d}^2 \quad (133)$$

$$m_{\phi_d \phi_u} = \frac{1}{4}(-2\sqrt{2}v_s \Re(T_\lambda) + (4v_d v_u \lambda - v_s^2 \kappa) \lambda^* - v_s^2 \lambda \kappa^*) - \frac{1}{4}(g_1^2 + g_2^2)v_d v_u \quad (134)$$

$$m_{\phi_u \phi_u} = \frac{1}{2}(v_d^2 + v_s^2)|\lambda|^2 - \frac{1}{8}(g_1^2 + g_2^2)(-3v_u^2 + v_d^2) + m_{H_u}^2 \quad (135)$$

$$m_{\phi_d \phi_s} = -\frac{1}{\sqrt{2}}v_u \Re(T_\lambda) + v_s \left(-\frac{1}{2}v_u \kappa + v_d \lambda \right) \lambda^* - \frac{1}{2}v_u \lambda \kappa^* \quad (136)$$

$$m_{\phi_u \phi_s} = \frac{1}{2}(-v_d(\sqrt{2}\Re(T_\lambda) + v_s \lambda \kappa^*) - v_s(-2v_u \lambda + v_d \kappa) \lambda^*) \quad (137)$$

$$m_{\phi_s \phi_s} = \frac{1}{2}(2\sqrt{2}v_s \Re(T_\kappa) + (6v_s^2 \kappa - v_d v_u \lambda) \kappa^* + ((v_d^2 + v_u^2)\lambda - v_d v_u \kappa) \lambda^*) + m_S^2 \quad (138)$$

This matrix is diagonalized by Z^H :

$$Z^H m_h^2 Z^{H,\dagger} = m_{2,h}^{dia} \quad (139)$$

with

$$\phi_d = \sum_j Z_{j1}^H h_j, \quad \phi_u = \sum_j Z_{j2}^H h_j, \quad \phi_s = \sum_j Z_{j3}^H h_j \quad (140)$$

- **Mass matrix for Pseudo-Scalar Higgs**, Basis: $(\sigma_d, \sigma_u, \sigma_s), (\sigma_d, \sigma_u, \sigma_s)$

$$m_{A^0}^2 = \begin{pmatrix} m_{\sigma_d \sigma_d} & \frac{1}{4} v_s \left(2\sqrt{2} \Re(T_\lambda) + 2v_s \Re(\lambda \kappa^*) \right) & m_{\sigma_s \sigma_d} \\ \frac{1}{4} v_s \left(2\sqrt{2} \Re(T_\lambda) + 2v_s \Re(\lambda \kappa^*) \right) & m_{\sigma_u \sigma_u} & m_{\sigma_s \sigma_u} \\ m_{\sigma_d \sigma_s} & m_{\sigma_u \sigma_s} & m_{\sigma_s \sigma_s} \end{pmatrix} + \xi_Z m^2(Z) \quad (141)$$

$$m_{\sigma_d \sigma_d} = \frac{1}{2} (v_s^2 + v_u^2) |\lambda|^2 + \frac{1}{8} (g_1^2 + g_2^2) (-v_u^2 + v_d^2) + m_{H_d}^2 \quad (142)$$

$$m_{\sigma_u \sigma_u} = \frac{1}{2} (v_d^2 + v_s^2) |\lambda|^2 - \frac{1}{8} (g_1^2 + g_2^2) (-v_u^2 + v_d^2) + m_{H_u}^2 \quad (143)$$

$$m_{\sigma_d \sigma_s} = -\frac{1}{2} v_u \left(2v_s \Re(\lambda \kappa^*) - \sqrt{2} \Re(T_\lambda) \right) \quad (144)$$

$$m_{\sigma_u \sigma_s} = -\frac{1}{2} v_d \left(2v_s \Re(\lambda \kappa^*) - \sqrt{2} \Re(T_\lambda) \right) \quad (145)$$

$$m_{\sigma_s \sigma_s} = \frac{1}{2} \left(-2\sqrt{2} v_s \Re(T_\kappa) + (2v_s^2 \kappa + v_d v_u \lambda) \kappa^* + \left((v_d^2 + v_u^2) \lambda + v_d v_u \kappa \right) \lambda^* \right) + m_\xi^2 \quad (146)$$

Gauge fixing contributions:

$$m^2(\xi_Z) = \begin{pmatrix} m_{\sigma_d \sigma_d} & m_{\sigma_u \sigma_d} & 0 \\ m_{\sigma_d \sigma_u} & m_{\sigma_u \sigma_u} & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad (147)$$

$$m_{\sigma_d \sigma_d} = \frac{1}{4} v_d^2 (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 \quad (148)$$

$$m_{\sigma_d \sigma_u} = -\frac{1}{4} v_d v_u (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 \quad (149)$$

$$m_{\sigma_u \sigma_u} = \frac{1}{4} v_u^2 (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 \quad (150)$$

This matrix is diagonalized by Z^A :

$$Z^A m_{A^0}^2 Z^{A,\dagger} = m_{2,A^0}^{dia} \quad (151)$$

with

$$\sigma_d = \sum_j Z_{j1}^A A_j^0, \quad \sigma_u = \sum_j Z_{j2}^A A_j^0, \quad \sigma_s = \sum_j Z_{j3}^A A_j^0 \quad (152)$$

- **Mass matrix for Charged Higgs**, Basis: $(H_d^-, H_u^{+,*}), (H_d^{-,*}, H_u^+)$

$$m_{H^-}^2 = \begin{pmatrix} m_{H_d^- H_d^{-,*}} & m_{H_u^{+,*} H_d^{-,*}} \\ m_{H_d^- H_u^+} & m_{H_u^{+,*} H_u^+} \end{pmatrix} + \xi_{W^-} m^2(W^-) \quad (153)$$

$$m_{H_d^- H_d^{-,*}} = \frac{1}{2} v_s^2 |\lambda|^2 + \frac{1}{8} \left(g_1^2 (-v_u^2 + v_d^2) + g_2^2 (v_d^2 + v_u^2) \right) + m_{H_d}^2 \quad (154)$$

$$m_{H_d^- H_u^+} = \frac{1}{2} \left(\lambda (-v_d v_u \lambda^* + v_s^2 \kappa^*) + \sqrt{2} v_s T \lambda \right) + \frac{1}{4} g_2^2 v_d v_u \quad (155)$$

$$m_{H_u^{+,*} H_u^+} = \frac{1}{2} v_s^2 |\lambda|^2 + \frac{1}{8} \left(g_1^2 (-v_d^2 + v_u^2) + g_2^2 (v_d^2 + v_u^2) \right) + m_{H_u}^2 \quad (156)$$

Gauge fixing contributions:

$$m^2(\xi_{W^-}) = \begin{pmatrix} \frac{1}{4} g_2^2 v_d^2 & -\frac{1}{4} g_2^2 v_d v_u \\ -\frac{1}{4} g_2^2 v_d v_u & \frac{1}{4} g_2^2 v_u^2 \end{pmatrix} \quad (157)$$

This matrix is diagonalized by Z^+ :

$$Z^+ m_{H^-}^2 Z^{+,\dagger} = m_{2,H^-}^{dia} \quad (158)$$

with

$$H_d^- = \sum_j Z_{j1}^+ H_j^-, \quad H_u^+ = \sum_j Z_{j2}^+ H_j^+ \quad (159)$$

4.2.2 Mass Matrices for Fermions

- **Mass matrix for Neutralinos**, Basis: $(\lambda_{\tilde{B}}, \tilde{W}^0, \tilde{H}_d^0, \tilde{H}_u^0, \tilde{S})$, $(\lambda_{\tilde{B}}, \tilde{W}^0, \tilde{H}_d^0, \tilde{H}_u^0, \tilde{S})$

$$m_{\tilde{\chi}^0} = \begin{pmatrix} M_1 & 0 & -\frac{1}{2} g_1 v_d & \frac{1}{2} g_1 v_u & 0 \\ 0 & M_2 & \frac{1}{2} g_2 v_d & -\frac{1}{2} g_2 v_u & 0 \\ -\frac{1}{2} g_1 v_d & \frac{1}{2} g_2 v_d & 0 & -\frac{1}{\sqrt{2}} v_s \lambda & -\frac{1}{\sqrt{2}} v_u \lambda \\ \frac{1}{2} g_1 v_u & -\frac{1}{2} g_2 v_u & -\frac{1}{\sqrt{2}} v_s \lambda & 0 & -\frac{1}{\sqrt{2}} v_d \lambda \\ 0 & 0 & -\frac{1}{\sqrt{2}} v_u \lambda & -\frac{1}{\sqrt{2}} v_d \lambda & \sqrt{2} v_s \kappa \end{pmatrix} \quad (160)$$

This matrix is diagonalized by N :

$$N^* m_{\tilde{\chi}^0} N^\dagger = m_{\tilde{\chi}^0}^{dia} \quad (161)$$

with

$$\lambda_{\tilde{B}} = \sum_j N_{j1}^* \lambda_j^0, \quad \tilde{W}^0 = \sum_j N_{j2}^* \lambda_j^0, \quad \tilde{H}_d^0 = \sum_j N_{j3}^* \lambda_j^0 \quad (162)$$

$$\tilde{H}_u^0 = \sum_j N_{j4}^* \lambda_j^0, \quad \tilde{S} = \sum_j N_{j5}^* \lambda_j^0 \quad (163)$$

- **Mass matrix for Charginos**, Basis: $(\tilde{W}^-, \tilde{H}_d^-)$, $(\tilde{W}^+, \tilde{H}_u^+)$

$$m_{\tilde{\chi}^-} = \begin{pmatrix} M_2 & \frac{1}{\sqrt{2}} g_2 v_u \\ \frac{1}{\sqrt{2}} g_2 v_d & \frac{1}{\sqrt{2}} v_s \lambda \end{pmatrix} \quad (164)$$

This matrix is diagonalized by U and V

$$U^* m_{\tilde{\chi}^-} V^\dagger = m_{\tilde{\chi}^-}^{dia} \quad (165)$$

with

$$\tilde{W}^- = \sum_{t_2} U_{j_1}^* \lambda_j^-, \quad \tilde{H}_d^- = \sum_{t_2} U_{j_2}^* \lambda_j^- \quad (166)$$

$$\tilde{W}^+ = \sum_{t_2} V_{1j}^* \lambda_j^+, \quad \tilde{H}_u^+ = \sum_{t_2} V_{2j}^* \lambda_j^+ \quad (167)$$

5 Vacuum Expectation Values

$$H_d^0 = \frac{1}{\sqrt{2}} \phi_d + \frac{1}{\sqrt{2}} v_d + i \frac{1}{\sqrt{2}} \sigma_d \quad (168)$$

$$H_u^0 = \frac{1}{\sqrt{2}} \phi_u + \frac{1}{\sqrt{2}} v_u + i \frac{1}{\sqrt{2}} \sigma_u \quad (169)$$

$$S = \frac{1}{\sqrt{2}} \phi_s + \frac{1}{\sqrt{2}} v_s + i \frac{1}{\sqrt{2}} \sigma_s \quad (170)$$

6 Flavor decomposition

$$\text{FdR0} \rightarrow d_R, \text{FstR}, \text{FbR} \quad (171)$$

$$\text{FdL0} \rightarrow d_L, \text{FstL}, \text{FbL} \quad (172)$$

$$\text{FuL0} \rightarrow u_L, \text{FcL}, \text{FtL} \quad (173)$$

$$\text{FuR0} \rightarrow u_R, \text{FcR}, \text{FtR} \quad (174)$$

$$\text{FvL0} \rightarrow \text{FveL}, \text{FvmL}, \text{FvtL} \quad (175)$$

$$\tilde{d}_R \rightarrow \tilde{d}_R, \tilde{s}_R, \tilde{b}_R \quad (176)$$

$$\tilde{d}_L \rightarrow \tilde{d}_L, \tilde{s}_L, \tilde{b}_L \quad (177)$$

$$\tilde{u}_L \rightarrow \tilde{u}_L, \tilde{c}_L, \tilde{t}_L \quad (178)$$

$$\tilde{u}_R \rightarrow \tilde{u}_R, \tilde{c}_R, \tilde{t}_R \quad (179)$$

$$\text{FeL0} \rightarrow e_L, \text{FmL}, \text{FtauL} \quad (180)$$

$$\text{FeR0} \rightarrow e_R, \text{FmR}, \text{FtauR} \quad (181)$$

$$\tilde{e}_R \rightarrow \tilde{e}_R, \tilde{\mu}_R, \tilde{\tau}_R \quad (182)$$

$$\tilde{e}_L \rightarrow \tilde{e}_L, \tilde{\mu}_L, \tilde{\tau}_L \quad (183)$$

$$\tilde{\nu}_L \rightarrow \tilde{\nu}_e, \tilde{\nu}_\mu, \tilde{\nu}_\tau \quad (184)$$

7 Tadpole Equations

$$\frac{\partial V}{\partial \phi_d} = \frac{1}{4} \left((2v_d(v_s^2 + v_u^2)\lambda - v_s^2 v_u \kappa) \lambda^* + 4m_{H_d}^2 v_d - v_s v_u (2\sqrt{2}\Re(T_\lambda) + v_s \lambda \kappa^*) \right) + \frac{1}{8} (g_1^2 + g_2^2) v_d (-v_u + v_d) (v_d + v_u) \quad (185)$$

$$\begin{aligned} \frac{\partial V}{\partial \phi_u} &= +\frac{1}{8}(g_1^2 + g_2^2)v_u(-v_d^2 + v_u^2) \\ &+ \frac{1}{4}\left(\left(2(v_d^2 + v_s^2)v_u\lambda - v_d v_s^2 \kappa\right)\lambda^* + 4m_{H_u}^2 v_u - v_d v_s(2\sqrt{2}\Re(T_\lambda) + v_s \lambda \kappa^*)\right) \end{aligned} \quad (186)$$

$$\begin{aligned} \frac{\partial V}{\partial \phi_s} &= \frac{1}{4}\left(\left(-2v_d v_s v_u \lambda + 4v_s^3 \kappa\right)\kappa^* + v_s\left(2\left((v_d^2 + v_u^2)\lambda - v_d v_u \kappa\right)\lambda^* + 4m_S^2\right)\right. \\ &\left. + \sqrt{2}\left(-v_d v_u(T_\lambda^* + T_\lambda) + v_s^2(T_\kappa^* + T_\kappa)\right)\right) \end{aligned} \quad (187)$$

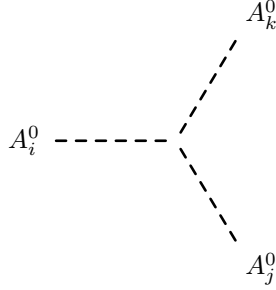
8 Particle content for eigenstates 'EWSB'

Name	Type	complex/real	Generations	Indices
$\tilde{\nu}_e$	Scalar	complex	1	
$\tilde{\nu}_\mu$	Scalar	complex	1	
$\tilde{\nu}_\tau$	Scalar	complex	1	
\tilde{d}	Scalar	complex	2	generation, 2, color, 3
\tilde{u}	Scalar	complex	2	generation, 2, color, 3
\tilde{e}	Scalar	complex	2	generation, 2
$\tilde{\mu}$	Scalar	complex	2	generation, 2
$\tilde{\tau}$	Scalar	complex	2	generation, 2
\tilde{s}	Scalar	complex	2	generation, 2, color, 3
\tilde{c}	Scalar	complex	2	generation, 2, color, 3
\tilde{b}	Scalar	complex	2	generation, 2, color, 3
\tilde{t}	Scalar	complex	2	generation, 2, color, 3
h	Scalar	real	3	generation, 3
A^0	Scalar	real	3	generation, 3
H^-	Scalar	complex	2	generation, 2
\tilde{g}	Fermion	Majorana	1	color, 8
d	Fermion	Dirac	1	color, 3
s	Fermion	Dirac	1	color, 3
b	Fermion	Dirac	1	color, 3
u	Fermion	Dirac	1	color, 3
c	Fermion	Dirac	1	color, 3
t	Fermion	Dirac	1	color, 3
ν_e	Fermion	Dirac	1	
ν_μ	Fermion	Dirac	1	
ν_τ	Fermion	Dirac	1	

e	Fermion	Dirac	1	
m	Fermion	Dirac	1	
τ	Fermion	Dirac	1	
$\tilde{\chi}^0$	Fermion	Majorana	5	generation, 5
$\tilde{\chi}^-$	Fermion	Dirac	2	generation, 2
g	Vector	real	1	color, 8, lorentz, 4
γ	Vector	real	1	lorentz, 4
Z	Vector	real	1	lorentz, 4
W^-	Vector	complex	1	lorentz, 4
η^G	Ghost	real	1	color, 8
η^γ	Ghost	real	1	
η^Z	Ghost	real	1	
η^-	Ghost	complex	1	
η^+	Ghost	complex	1	

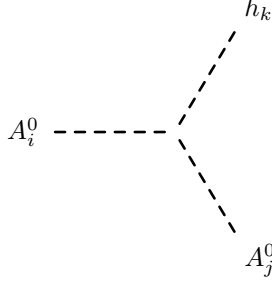
9 Interactions for eigenstates 'EWSB'

9.1 Three Scalar-Interaction

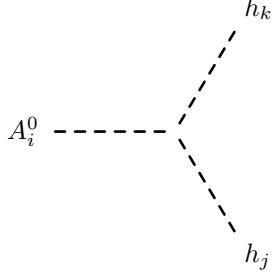


$$\begin{aligned}
& \frac{1}{4} \left(-2\lambda\kappa^* \left(Z_{i2}^A \left(v_s Z_{j1}^A Z_{k3}^A + Z_{j3}^A \left(-v_d Z_{k3}^A + v_s Z_{k1}^A \right) \right) + Z_{i1}^A \left(v_s Z_{j2}^A Z_{k3}^A + Z_{j3}^A \left(v_s Z_{k2}^A - v_u Z_{k3}^A \right) \right) \right) \right. \\
& \left. - Z_{i3}^A \left(Z_{j1}^A \left(-v_s Z_{k2}^A + v_u Z_{k3}^A \right) + Z_{j2}^A \left(v_d Z_{k3}^A - v_s Z_{k1}^A \right) + Z_{j3}^A \left(v_d Z_{k2}^A + v_u Z_{k1}^A \right) \right) \right) \\
& + 2\kappa\lambda^* \left(Z_{i2}^A \left(v_s Z_{j1}^A Z_{k3}^A + Z_{j3}^A \left(-v_d Z_{k3}^A + v_s Z_{k1}^A \right) \right) + Z_{i1}^A \left(v_s Z_{j2}^A Z_{k3}^A + Z_{j3}^A \left(v_s Z_{k2}^A - v_u Z_{k3}^A \right) \right) \right) \\
& \left. - Z_{i3}^A \left(Z_{j1}^A \left(-v_s Z_{k2}^A + v_u Z_{k3}^A \right) + Z_{j2}^A \left(v_d Z_{k3}^A - v_s Z_{k1}^A \right) + Z_{j3}^A \left(v_d Z_{k2}^A + v_u Z_{k1}^A \right) \right) \right) \\
& - \sqrt{2} \left(2 \left(-T_\kappa^* + T_\kappa \right) Z_{i3}^A Z_{j3}^A Z_{k3}^A \right)
\end{aligned}$$

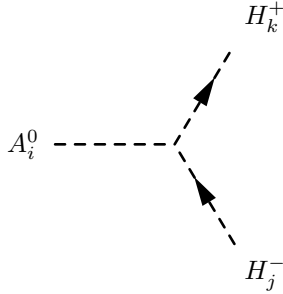
$$\begin{aligned}
& + T_\lambda^* \left(Z_{i1}^A \left(Z_{j2}^A Z_{k3}^A + Z_{j3}^A Z_{k2}^A \right) + Z_{i2}^A \left(Z_{j1}^A Z_{k3}^A + Z_{j3}^A Z_{k1}^A \right) + Z_{i3}^A \left(Z_{j1}^A Z_{k2}^A + Z_{j2}^A Z_{k1}^A \right) \right) \\
& - T_\lambda \left(Z_{i1}^A \left(Z_{j2}^A Z_{k3}^A + Z_{j3}^A Z_{k2}^A \right) + Z_{i2}^A \left(Z_{j1}^A Z_{k3}^A + Z_{j3}^A Z_{k1}^A \right) + Z_{i3}^A \left(Z_{j1}^A Z_{k2}^A + Z_{j2}^A Z_{k1}^A \right) \right) \Big) \Big) \Big) \Big) \quad (188)
\end{aligned}$$



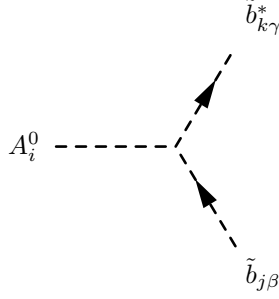
$$\begin{aligned}
& \frac{i}{4} \left(- Z_{i1}^A \left(- 2v_s \lambda \kappa^* Z_{j3}^A Z_{k2}^H - 2v_s \kappa \lambda^* Z_{j3}^A Z_{k2}^H + \sqrt{2} T_\lambda^* Z_{j3}^A Z_{k2}^H + \sqrt{2} T_\lambda Z_{j3}^A Z_{k2}^H \right. \right. \\
& + 2v_s \lambda \kappa^* Z_{j2}^A Z_{k3}^H + 2v_s \kappa \lambda^* Z_{j2}^A Z_{k3}^H + \sqrt{2} T_\lambda^* Z_{j2}^A Z_{k3}^H + \sqrt{2} T_\lambda Z_{j2}^A Z_{k3}^H \\
& - 2v_u \lambda \kappa^* Z_{j3}^A Z_{k3}^H - 2v_u \kappa \lambda^* Z_{j3}^A Z_{k3}^H \\
& + Z_{j1}^A \left(4v_s |\lambda|^2 Z_{k3}^H + (g_1^2 + g_2^2) v_d Z_{k1}^H - v_u \left(- 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k2}^H \right) \\
& + Z_{i2}^A \left(2v_s \kappa \lambda^* Z_{j3}^A Z_{k1}^H - \sqrt{2} T_\lambda^* Z_{j3}^A Z_{k1}^H - \sqrt{2} T_\lambda Z_{j3}^A Z_{k1}^H - 2v_s \kappa \lambda^* Z_{j1}^A Z_{k3}^H \right. \\
& - \sqrt{2} T_\lambda^* Z_{j1}^A Z_{k3}^H - \sqrt{2} T_\lambda Z_{j1}^A Z_{k3}^H + 2v_d \kappa \lambda^* Z_{j3}^A Z_{k3}^H \\
& + Z_{j2}^A \left(- 4v_s |\lambda|^2 Z_{k3}^H - (g_1^2 + g_2^2) v_u Z_{k2}^H + v_d \left(- 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k1}^H \right) \\
& + 2\lambda \kappa^* \left(- v_s Z_{j1}^A Z_{k3}^H + Z_{j3}^A \left(v_d Z_{k3}^H + v_s Z_{k1}^H \right) \right) \\
& + Z_{i3}^A \left(- \sqrt{2} \left(- 2 \left(T_\kappa^* + T_\kappa \right) Z_{j3}^A Z_{k3}^H + T_\lambda^* \left(Z_{j1}^A Z_{k2}^H + Z_{j2}^A Z_{k1}^H \right) + T_\lambda \left(Z_{j1}^A Z_{k2}^H + Z_{j2}^A Z_{k1}^H \right) \right) \right. \\
& + 2\lambda^* \left(- Z_{j3}^A \left(\left(2v_d \lambda + v_u \kappa \right) Z_{k1}^H + \left(2v_u \lambda + v_d \kappa \right) Z_{k2}^H \right) + \kappa Z_{j2}^A \left(v_d Z_{k3}^H + v_s Z_{k1}^H \right) \right. \\
& + \kappa Z_{j1}^A \left(v_s Z_{k2}^H + v_u Z_{k3}^H \right) \\
& + 2\kappa^* \left(\lambda Z_{j2}^A \left(v_d Z_{k3}^H + v_s Z_{k1}^H \right) + \lambda Z_{j1}^A \left(v_s Z_{k2}^H + v_u Z_{k3}^H \right) \right. \\
& \left. \left. \left. \left. \left. - Z_{j3}^A \left(4v_s \kappa Z_{k3}^H + v_d \lambda Z_{k2}^H + v_u \lambda Z_{k1}^H \right) \right) \right) \right) \right) \right) \Big) \Big) \Big) \Big) \quad (189)
\end{aligned}$$



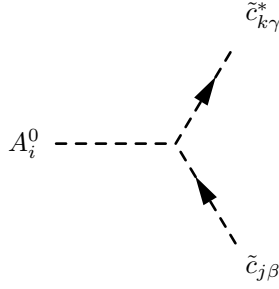
$$\begin{aligned}
& \frac{1}{4} \left(2\lambda\kappa^* \left(-Z_{i2}^A \left(v_s Z_{j1}^H Z_{k3}^H + Z_{j3}^H \left(v_d Z_{k3}^H + v_s Z_{k1}^H \right) \right) \right. \right. \\
& + Z_{i3}^A \left(Z_{j1}^H \left(v_s Z_{k2}^H + v_u Z_{k3}^H \right) + Z_{j2}^H \left(v_d Z_{k3}^H + v_s Z_{k1}^H \right) + Z_{j3}^H \left(v_d Z_{k2}^H + v_u Z_{k1}^H \right) \right) \\
& \left. - Z_{i1}^A \left(v_s Z_{j2}^H Z_{k3}^H + Z_{j3}^H \left(v_s Z_{k2}^H + v_u Z_{k3}^H \right) \right) \right) \\
& - 2\kappa\lambda^* \left(-Z_{i2}^A \left(v_s Z_{j1}^H Z_{k3}^H + Z_{j3}^H \left(v_d Z_{k3}^H + v_s Z_{k1}^H \right) \right) \right. \\
& + Z_{i3}^A \left(Z_{j1}^H \left(v_s Z_{k2}^H + v_u Z_{k3}^H \right) + Z_{j2}^H \left(v_d Z_{k3}^H + v_s Z_{k1}^H \right) + Z_{j3}^H \left(v_d Z_{k2}^H + v_u Z_{k1}^H \right) \right) \\
& \left. - Z_{i1}^A \left(v_s Z_{j2}^H Z_{k3}^H + Z_{j3}^H \left(v_s Z_{k2}^H + v_u Z_{k3}^H \right) \right) \right) \\
& - \sqrt{2} \left(2 \left(-T_\kappa + T_\kappa^* \right) Z_{i3}^A Z_{j3}^H Z_{k3}^H \right. \\
& - T_\lambda^* \left(Z_{i1}^A \left(Z_{j2}^H Z_{k3}^H + Z_{j3}^H Z_{k2}^H \right) + Z_{i2}^A \left(Z_{j1}^H Z_{k3}^H + Z_{j3}^H Z_{k1}^H \right) + Z_{i3}^A \left(Z_{j1}^H Z_{k2}^H + Z_{j2}^H Z_{k1}^H \right) \right) \\
& \left. + T_\lambda \left(Z_{i1}^A \left(Z_{j2}^H Z_{k3}^H + Z_{j3}^H Z_{k2}^H \right) + Z_{i2}^A \left(Z_{j1}^H Z_{k3}^H + Z_{j3}^H Z_{k1}^H \right) + Z_{i3}^A \left(Z_{j1}^H Z_{k2}^H + Z_{j2}^H Z_{k1}^H \right) \right) \right) \right) \quad (190)
\end{aligned}$$



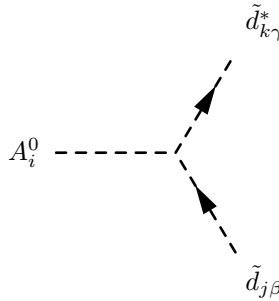
$$\begin{aligned}
& \frac{1}{4} \left(v_u \left(-2|\lambda|^2 + g_2^2 \right) Z_{i1}^A \left(-Z_{j1}^+ Z_{k2}^+ + Z_{j2}^+ Z_{k1}^+ \right) \right. \\
& + v_d \left(-2|\lambda|^2 + g_2^2 \right) Z_{i2}^A \left(-Z_{j1}^+ Z_{k2}^+ + Z_{j2}^+ Z_{k1}^+ \right) \\
& \left. + 2Z_{i3}^A \left(2v_s \kappa \lambda^* Z_{j2}^+ Z_{k1}^+ + \left(-2v_s \lambda \kappa^* + \sqrt{2} T_\lambda \right) Z_{j1}^+ Z_{k2}^+ - \sqrt{2} T_\lambda^* Z_{j2}^+ Z_{k1}^+ \right) \right) \quad (191)
\end{aligned}$$



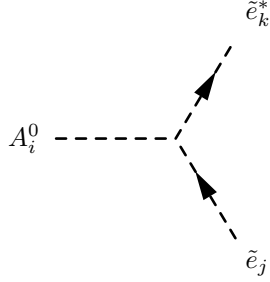
$$\begin{aligned}
& -\frac{1}{2}\delta_{\beta\gamma}\left(Z_{j2}^{B,*}\left(\lambda Y_{d,33}^*\left(v_s Z_{i2}^A + v_u Z_{i3}^A\right) + \sqrt{2}T_{d,33}^* Z_{i1}^A\right)Z_{k1}^B\right. \\
& \left. - Z_{j1}^{B,*}Z_{k2}^B\left(\lambda^* Y_{d,33}\left(v_s Z_{i2}^A + v_u Z_{i3}^A\right) + \sqrt{2}Z_{i1}^A T_{d,33}\right)\right)
\end{aligned} \tag{192}$$



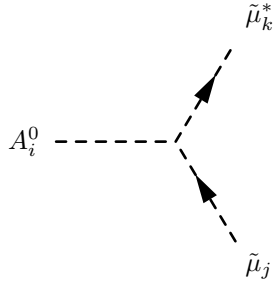
$$\begin{aligned}
& -\frac{1}{2}\delta_{\beta\gamma}\left(\sqrt{2}Z_{j2}^{C,*}T_{u,22}^*Z_{i2}^A Z_{k1}^C + \lambda Y_{u,22}^*Z_{j2}^{C,*}\left(v_d Z_{i3}^A + v_s Z_{i1}^A\right)Z_{k1}^C\right. \\
& \left. - Z_{j1}^{C,*}Z_{k2}^C\left(\lambda^* Y_{u,22}\left(v_d Z_{i3}^A + v_s Z_{i1}^A\right) + \sqrt{2}Z_{i2}^A T_{u,22}\right)\right)
\end{aligned} \tag{193}$$



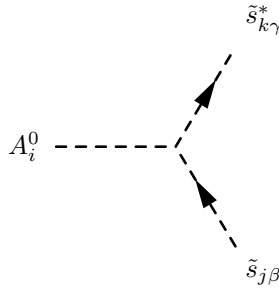
$$\begin{aligned}
& -\frac{1}{2}\delta_{\beta\gamma}\left(Z_{j2}^{D,*}\left(\lambda Y_{d,11}^*\left(v_s Z_{i2}^A + v_u Z_{i3}^A\right) + \sqrt{2}T_{d,11}^* Z_{i1}^A\right)Z_{k1}^D\right. \\
& \left. - Z_{j1}^{D,*}Z_{k2}^D\left(\lambda^* Y_{d,11}\left(v_s Z_{i2}^A + v_u Z_{i3}^A\right) + \sqrt{2}Z_{i1}^A T_{d,11}\right)\right)
\end{aligned} \tag{194}$$



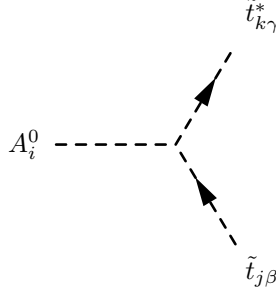
$$\begin{aligned} & \frac{1}{2} \left(-Z_{j2}^{E,*} \left(\lambda Y_{e,11}^* \left(v_s Z_{i2}^A + v_u Z_{i3}^A \right) + \sqrt{2} T_{e,11}^* Z_{i1}^A \right) Z_{k1}^E \right. \\ & \left. + Z_{j1}^{E,*} Z_{k2}^E \left(\lambda^* Y_{e,11} \left(v_s Z_{i2}^A + v_u Z_{i3}^A \right) + \sqrt{2} Z_{i1}^A T_{e,11} \right) \right) \end{aligned} \quad (195)$$



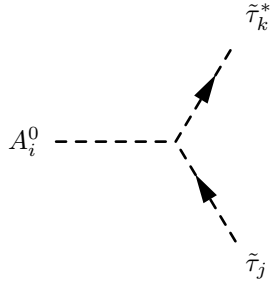
$$\begin{aligned} & \frac{1}{2} \left(-Z_{j2}^{\mu,*} \left(\lambda Y_{e,22}^* \left(v_s Z_{i2}^A + v_u Z_{i3}^A \right) + \sqrt{2} T_{e,22}^* Z_{i1}^A \right) Z_{k1}^{\mu} \right. \\ & \left. + Z_{j1}^{\mu,*} Z_{k2}^{\mu} \left(\lambda^* Y_{e,22} \left(v_s Z_{i2}^A + v_u Z_{i3}^A \right) + \sqrt{2} Z_{i1}^A T_{e,22} \right) \right) \end{aligned} \quad (196)$$



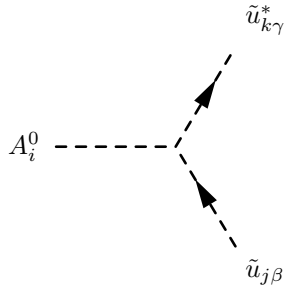
$$\begin{aligned} & -\frac{1}{2} \delta_{\beta\gamma} \left(Z_{j2}^{S,*} \left(\lambda Y_{d,22}^* \left(v_s Z_{i2}^A + v_u Z_{i3}^A \right) + \sqrt{2} T_{d,22}^* Z_{i1}^A \right) Z_{k1}^S \right. \\ & \left. - Z_{j1}^{S,*} Z_{k2}^S \left(\lambda^* Y_{d,22} \left(v_s Z_{i2}^A + v_u Z_{i3}^A \right) + \sqrt{2} Z_{i1}^A T_{d,22} \right) \right) \end{aligned} \quad (197)$$



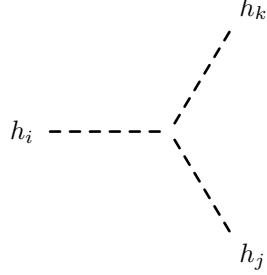
$$\begin{aligned}
& -\frac{1}{2}\delta_{\beta\gamma}\left(\sqrt{2}Z_{j2}^{T,*}T_{u,33}^*Z_{i2}^AZ_{k1}^T + \lambda Y_{u,33}^*Z_{j2}^{T,*}\left(v_dZ_{i3}^A + v_sZ_{i1}^A\right)Z_{k1}^T\right. \\
& \left. - Z_{j1}^{T,*}Z_{k2}^T\left(\lambda^*Y_{u,33}\left(v_dZ_{i3}^A + v_sZ_{i1}^A\right) + \sqrt{2}Z_{i2}^AT_{u,33}\right)\right)
\end{aligned} \tag{198}$$



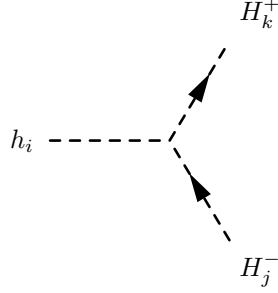
$$\begin{aligned}
& \frac{1}{2}\left(-Z_{j2}^{\tau,*}\left(\lambda Y_{e,33}^*\left(v_sZ_{i2}^A + v_uZ_{i3}^A\right) + \sqrt{2}T_{e,33}^*Z_{i1}^A\right)Z_{k1}^T\right. \\
& \left. + Z_{j1}^{\tau,*}Z_{k2}^T\left(\lambda^*Y_{e,33}\left(v_sZ_{i2}^A + v_uZ_{i3}^A\right) + \sqrt{2}Z_{i1}^AT_{e,33}\right)\right)
\end{aligned} \tag{199}$$



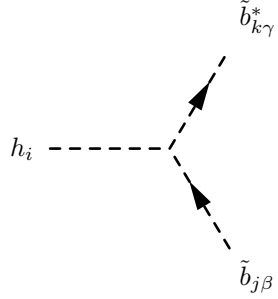
$$\begin{aligned}
& -\frac{1}{2}\delta_{\beta\gamma}\left(\sqrt{2}Z_{j2}^{U,*}T_{u,11}^*Z_{i2}^AZ_{k1}^U + \lambda Y_{u,11}^*Z_{j2}^{U,*}\left(v_dZ_{i3}^A + v_sZ_{i1}^A\right)Z_{k1}^U\right. \\
& \left. - Z_{j1}^{U,*}Z_{k2}^U\left(\lambda^*Y_{u,11}\left(v_dZ_{i3}^A + v_sZ_{i1}^A\right) + \sqrt{2}Z_{i2}^AT_{u,11}\right)\right)
\end{aligned} \tag{200}$$



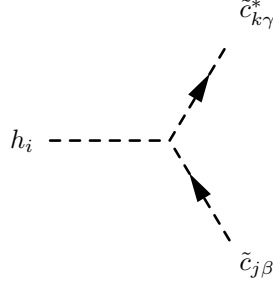
$$\begin{aligned}
& \frac{i}{4} \left(Z_{i1}^H \left(Z_{j1}^H \left(-3(g_1^2 + g_2^2) v_d Z_{k1}^H - 4v_s |\lambda|^2 Z_{k3}^H + v_u \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k2}^H \right) \right. \right. \\
& + Z_{j2}^H \left(v_u \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k1}^H + v_d \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k2}^H \right. \\
& + \left. \left. \left(2v_s \kappa \lambda^* + 2v_s \lambda \kappa^* + \sqrt{2} (T_\lambda^* + T_\lambda) \right) Z_{k3}^H \right) \right. \\
& + Z_{j3}^H \left(\sqrt{2} (T_\lambda^* + T_\lambda) Z_{k2}^H + 2\lambda \kappa^* \left(v_s Z_{k2}^H + v_u Z_{k3}^H \right) \right. \\
& + \left. \left. 2\lambda^* \left(\left(-2v_d \lambda + v_u \kappa \right) Z_{k3}^H - 2v_s \lambda Z_{k1}^H + v_s \kappa Z_{k2}^H \right) \right) \right) \\
& + Z_{i2}^H \left(Z_{j2}^H \left(-3(g_1^2 + g_2^2) v_u Z_{k2}^H - 4v_s |\lambda|^2 Z_{k3}^H + v_d \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k1}^H \right) \right. \\
& + Z_{j1}^H \left(v_u \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k1}^H + v_d \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k2}^H \right. \\
& + \left. \left. \left(2v_s \kappa \lambda^* + 2v_s \lambda \kappa^* + \sqrt{2} (T_\lambda^* + T_\lambda) \right) Z_{k3}^H \right) \right. \\
& + Z_{j3}^H \left(\sqrt{2} (T_\lambda^* + T_\lambda) Z_{k1}^H + 2\lambda \kappa^* \left(v_d Z_{k3}^H + v_s Z_{k1}^H \right) \right. \\
& + \left. \left. 2\lambda^* \left(-2v_s \lambda Z_{k2}^H + \left(-2v_u \lambda + v_d \kappa \right) Z_{k3}^H + v_s \kappa Z_{k1}^H \right) \right) \right) \\
& + Z_{i3}^H \left(\sqrt{2} \left(-2(T_\kappa^* + T_\kappa) Z_{j3}^H Z_{k3}^H + T_\lambda^* \left(Z_{j1}^H Z_{k2}^H + Z_{j2}^H Z_{k1}^H \right) + T_\lambda \left(Z_{j1}^H Z_{k2}^H + Z_{j2}^H Z_{k1}^H \right) \right) \right. \\
& + 2\kappa^* \left(\lambda Z_{j2}^H \left(v_d Z_{k3}^H + v_s Z_{k1}^H \right) + \lambda Z_{j1}^H \left(v_s Z_{k2}^H + v_u Z_{k3}^H \right) \right. \\
& + \left. \left. Z_{j3}^H \left(-12v_s \kappa Z_{k3}^H + v_d \lambda Z_{k2}^H + v_u \lambda Z_{k1}^H \right) \right) \right. \\
& + 2\lambda^* \left(Z_{j3}^H \left(\left(-2v_d \lambda + v_u \kappa \right) Z_{k1}^H + \left(-2v_u \lambda + v_d \kappa \right) Z_{k2}^H \right) \right. \\
& + Z_{j1}^H \left(\left(-2v_d \lambda + v_u \kappa \right) Z_{k3}^H - 2v_s \lambda Z_{k1}^H + v_s \kappa Z_{k2}^H \right) \\
& + \left. \left. Z_{j2}^H \left(-2v_s \lambda Z_{k2}^H + \left(-2v_u \lambda + v_d \kappa \right) Z_{k3}^H + v_s \kappa Z_{k1}^H \right) \right) \right) \right) \tag{201}
\end{aligned}$$



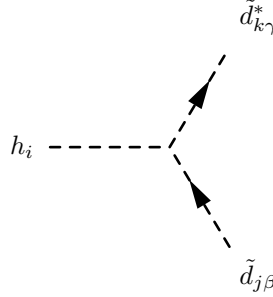
$$\begin{aligned}
& \frac{i}{4} \left(Z_{i2}^H \left(-Z_{j2}^+ \left((g_1^2 + g_2^2) v_u Z_{k2}^+ + v_d \left(-2|\lambda|^2 + g_2^2 \right) Z_{k1}^+ \right) \right. \right. \\
& + Z_{j1}^+ \left(\left(-g_2^2 + g_1^2 \right) v_u Z_{k1}^+ - v_d \left(-2|\lambda|^2 + g_2^2 \right) Z_{k2}^+ \right) \left. \right) \\
& - Z_{i1}^H \left(Z_{j2}^+ \left(\left(-g_1^2 + g_2^2 \right) v_d Z_{k2}^+ + v_u \left(-2|\lambda|^2 + g_2^2 \right) Z_{k1}^+ \right) \right. \\
& + Z_{j1}^+ \left(\left(g_1^2 + g_2^2 \right) v_d Z_{k1}^+ + v_u \left(-2|\lambda|^2 + g_2^2 \right) Z_{k2}^+ \right) \left. \right) \\
& - 2Z_{i3}^H \left(\left(2v_s \lambda \kappa^* + \sqrt{2} T \lambda \right) Z_{j1}^+ Z_{k2}^+ + 2v_s \lambda^* \left(\lambda Z_{j1}^+ Z_{k1}^+ + Z_{j2}^+ \left(\kappa Z_{k1}^+ + \lambda Z_{k2}^+ \right) \right) + \sqrt{2} T \lambda^* Z_{j2}^+ Z_{k1}^+ \right) \quad (202)
\end{aligned}$$



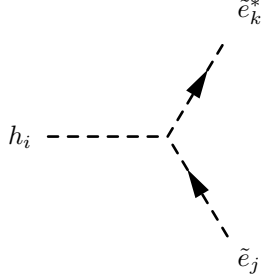
$$\begin{aligned}
& \frac{i}{12} \delta_{\beta\gamma} \left(2Z_{j2}^{B,*} \left(-3\sqrt{2} T_{d,33}^* Z_{k1}^B Z_{i1}^H + Z_{k2}^B \left(-g_1^2 v_u Z_{i2}^H + v_d \left(-6|Y_{d,33}|^2 + g_1^2 \right) Z_{i1}^H \right) \right. \right. \\
& + 3\lambda Y_{d,33}^* Z_{k1}^B \left(v_s Z_{i2}^H + v_u Z_{i3}^H \right) \left. \right) \\
& + Z_{j1}^{B,*} \left(Z_{k1}^B \left(- \left(3g_2^2 + g_1^2 \right) v_u Z_{i2}^H + v_d \left(-12|Y_{d,33}|^2 + 3g_2^2 + g_1^2 \right) Z_{i1}^H \right) \right. \\
& + 6Z_{k2}^B \left(\lambda^* Y_{d,33} \left(v_s Z_{i2}^H + v_u Z_{i3}^H \right) - \sqrt{2} Z_{i1}^H T_{d,33} \right) \left. \right) \quad (203)
\end{aligned}$$



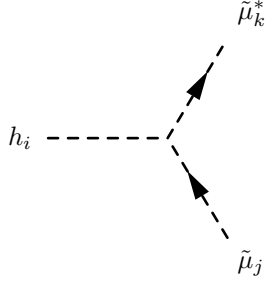
$$\begin{aligned}
& \frac{i}{12} \delta_{\beta\gamma} \left(2Z_{j2}^{C,*} \left(-3\sqrt{2}T_{u,22}^* Z_{k1}^C Z_{i2}^H + 2g_1^2 Z_{k2}^C \left(-v_d Z_{i1}^H + v_u Z_{i2}^H \right) \right. \right. \\
& \quad \left. \left. + 3Y_{u,22}^* \left(-2v_u Y_{u,22} Z_{k2}^C Z_{i2}^H + \lambda Z_{k1}^C \left(v_d Z_{i3}^H + v_s Z_{i1}^H \right) \right) \right) \right) \\
& \quad + Z_{j1}^{C,*} \left(Z_{k1}^C \left(\left(-3g_2^2 + g_1^2 \right) v_d Z_{i1}^H - v_u \left(12|Y_{u,22}|^2 - 3g_2^2 + g_1^2 \right) Z_{i2}^H \right) \right. \\
& \quad \left. + 6Z_{k2}^C \left(\lambda^* Y_{u,22} \left(v_d Z_{i3}^H + v_s Z_{i1}^H \right) - \sqrt{2} Z_{i2}^H T_{u,22} \right) \right) \right) \tag{204}
\end{aligned}$$



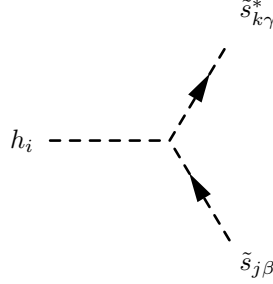
$$\begin{aligned}
& \frac{i}{12} \delta_{\beta\gamma} \left(2Z_{j2}^{D,*} \left(-3\sqrt{2}T_{d,11}^* Z_{k1}^D Z_{i1}^H + Z_{k2}^D \left(-g_1^2 v_u Z_{i2}^H + v_d \left(-6|Y_{d,11}|^2 + g_1^2 \right) Z_{i1}^H \right) \right. \right. \\
& \quad \left. \left. + 3\lambda Y_{d,11}^* Z_{k1}^D \left(v_s Z_{i2}^H + v_u Z_{i3}^H \right) \right) \right) \\
& \quad + Z_{j1}^{D,*} \left(Z_{k1}^D \left(- \left(3g_2^2 + g_1^2 \right) v_u Z_{i2}^H + v_d \left(-12|Y_{d,11}|^2 + 3g_2^2 + g_1^2 \right) Z_{i1}^H \right) \right. \\
& \quad \left. + 6Z_{k2}^D \left(\lambda^* Y_{d,11} \left(v_s Z_{i2}^H + v_u Z_{i3}^H \right) - \sqrt{2} Z_{i1}^H T_{d,11} \right) \right) \right) \tag{205}
\end{aligned}$$



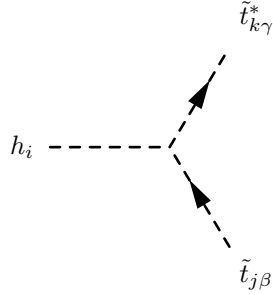
$$\begin{aligned}
& \frac{i}{4} \left(2Z_{j2}^{E,*} \left(-\sqrt{2}T_{e,11}^* Z_{k1}^E Z_{i1}^H + Z_{k2}^E \left(-g_1^2 v_u Z_{i2}^H + v_d \left(-2|Y_{e,11}|^2 + g_1^2 \right) Z_{i1}^H \right) \right) \right. \\
& + \lambda Y_{e,11}^* Z_{k1}^E \left(v_s Z_{i2}^H + v_u Z_{i3}^H \right) \\
& + Z_{j1}^{E,*} \left(Z_{k1}^E \left(\left(-g_2^2 + g_1^2 \right) v_u Z_{i2}^H + v_d \left(-4|Y_{e,11}|^2 - g_1^2 + g_2^2 \right) Z_{i1}^H \right) \right. \\
& \left. \left. + 2Z_{k2}^E \left(\lambda^* Y_{e,11} \left(v_s Z_{i2}^H + v_u Z_{i3}^H \right) - \sqrt{2} Z_{i1}^H T_{e,11} \right) \right) \right) \quad (206)
\end{aligned}$$



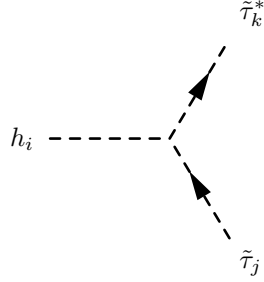
$$\begin{aligned}
& \frac{i}{4} \left(2Z_{j2}^{\mu,*} \left(-\sqrt{2}T_{e,22}^* Z_{i1}^H Z_{k1}^\mu + g_1^2 \left(v_d Z_{i1}^H - v_u Z_{i2}^H \right) Z_{k2}^\mu \right) \right. \\
& + Y_{e,22}^* \left(-2v_d Y_{e,22} Z_{i1}^H Z_{k2}^\mu + v_s \lambda Z_{i2}^H Z_{k1}^\mu + v_u \lambda Z_{i3}^H Z_{k1}^\mu \right) \\
& + Z_{j1}^{\mu,*} \left(2v_u \lambda^* Y_{e,22} Z_{i3}^H Z_{k2}^\mu + Z_{i2}^H \left(2v_s \lambda^* Y_{e,22} Z_{k2}^\mu + \left(-g_2^2 + g_1^2 \right) v_u Z_{k1}^\mu \right) \right. \\
& \left. \left. - Z_{i1}^H \left(2\sqrt{2} Z_{k2}^\mu T_{e,22} + v_d \left(4|Y_{e,22}|^2 - g_2^2 + g_1^2 \right) Z_{k1}^\mu \right) \right) \right) \quad (207)
\end{aligned}$$



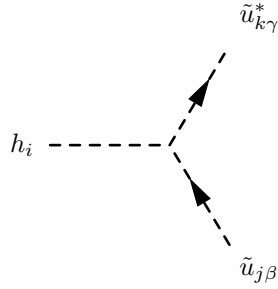
$$\begin{aligned}
& \frac{i}{12} \delta_{\beta\gamma} \left(2Z_{j2}^{S,*} \left(-3\sqrt{2}T_{d,22}^* Z_{i1}^H Z_{k1}^S + g_1^2 (v_d Z_{i1}^H - v_u Z_{i2}^H) Z_{k2}^S \right. \right. \\
& + 3Y_{d,22}^* \left(-2v_d Y_{d,22} Z_{i1}^H Z_{k2}^S + v_s \lambda Z_{i2}^H Z_{k1}^S + v_u \lambda Z_{i3}^H Z_{k1}^S \right) \left. \right) \\
& + Z_{j1}^{S,*} \left(6v_u \lambda^* Y_{d,22} Z_{i3}^H Z_{k2}^S - Z_{i2}^H \left((3g_2^2 + g_1^2) v_u Z_{k1}^S - 6v_s \lambda^* Y_{d,22} Z_{k2}^S \right) \right. \\
& \left. \left. + Z_{i1}^H \left(-6\sqrt{2}Z_{k2}^S T_{d,22} + v_d \left(-12|Y_{d,22}|^2 + 3g_2^2 + g_1^2 \right) Z_{k1}^S \right) \right) \right) \quad (208)
\end{aligned}$$



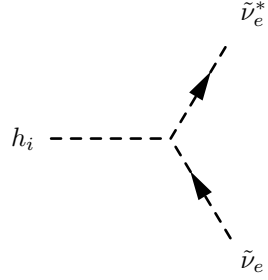
$$\begin{aligned}
& \frac{i}{12} \delta_{\beta\gamma} \left(2Z_{j2}^{T,*} \left(-3\sqrt{2}T_{u,33}^* Z_{i2}^H Z_{k1}^T + 2g_1^2 \left(-v_d Z_{i1}^H + v_u Z_{i2}^H \right) Z_{k2}^T \right. \right. \\
& + 3Y_{u,33}^* \left(-2v_u Y_{u,33} Z_{i2}^H Z_{k2}^T + v_d \lambda Z_{i3}^H Z_{k1}^T + v_s \lambda Z_{i1}^H Z_{k1}^T \right) \left. \right) \\
& + Z_{j1}^{T,*} \left(6v_d \lambda^* Y_{u,33} Z_{i3}^H Z_{k2}^T + Z_{i1}^H \left(\left(-3g_2^2 + g_1^2 \right) v_d Z_{k1}^T + 6v_s \lambda^* Y_{u,33} Z_{k2}^T \right) \right. \\
& \left. \left. - Z_{i2}^H \left(6\sqrt{2}Z_{k2}^T T_{u,33} + v_u \left(12|Y_{u,33}|^2 - 3g_2^2 + g_1^2 \right) Z_{k1}^T \right) \right) \right) \quad (209)
\end{aligned}$$



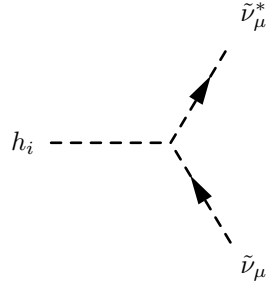
$$\begin{aligned}
& \frac{i}{4} \left(2Z_{j2}^{\tau,*} \left(-\sqrt{2}T_{e,33}^* Z_{i1}^H Z_{k1}^\tau + g_1^2 (v_d Z_{i1}^H - v_u Z_{i2}^H) Z_{k2}^\tau \right. \right. \\
& + Y_{e,33}^* \left(-2v_d Y_{e,33} Z_{i1}^H Z_{k2}^\tau + v_s \lambda Z_{i2}^H Z_{k1}^\tau + v_u \lambda Z_{i3}^H Z_{k1}^\tau \right) \left. \right) \\
& + Z_{j1}^{\tau,*} \left(2v_u \lambda^* Y_{e,33} Z_{i3}^H Z_{k2}^\tau + Z_{i2}^H \left(2v_s \lambda^* Y_{e,33} Z_{k2}^\tau + (-g_2^2 + g_1^2) v_u Z_{k1}^\tau \right) \right. \\
& \left. \left. - Z_{i1}^H \left(2\sqrt{2} Z_{k2}^\tau T_{e,33} + v_d \left(4|Y_{e,33}|^2 - g_2^2 + g_1^2 \right) Z_{k1}^\tau \right) \right) \right) \tag{210}
\end{aligned}$$



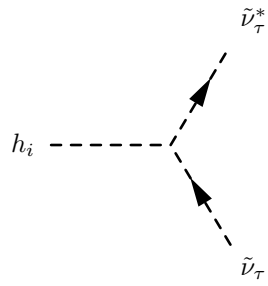
$$\begin{aligned}
& \frac{i}{12} \delta_{\beta\gamma} \left(2Z_{j2}^{U,*} \left(-3\sqrt{2}T_{u,11}^* Z_{i2}^H Z_{k1}^U + 2g_1^2 (-v_d Z_{i1}^H + v_u Z_{i2}^H) Z_{k2}^U \right. \right. \\
& + 3Y_{u,11}^* \left(-2v_u Y_{u,11} Z_{i2}^H Z_{k2}^U + v_d \lambda Z_{i3}^H Z_{k1}^U + v_s \lambda Z_{i1}^H Z_{k1}^U \right) \left. \right) \\
& + Z_{j1}^{U,*} \left(6v_d \lambda^* Y_{u,11} Z_{i3}^H Z_{k2}^U + Z_{i1}^H \left((-3g_2^2 + g_1^2) v_d Z_{k1}^U + 6v_s \lambda^* Y_{u,11} Z_{k2}^U \right) \right. \\
& \left. \left. - Z_{i2}^H \left(6\sqrt{2} Z_{k2}^U T_{u,11} + v_u \left(12|Y_{u,11}|^2 - 3g_2^2 + g_1^2 \right) Z_{k1}^U \right) \right) \right) \tag{211}
\end{aligned}$$



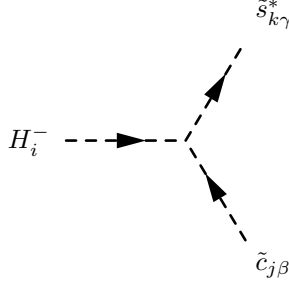
$$-\frac{i}{4}(g_1^2 + g_2^2)(v_d Z_{i1}^H - v_u Z_{i2}^H) \quad (212)$$



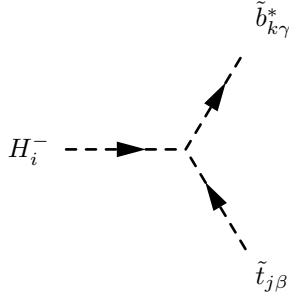
$$-\frac{i}{4}(g_1^2 + g_2^2)(v_d Z_{i1}^H - v_u Z_{i2}^H) \quad (213)$$



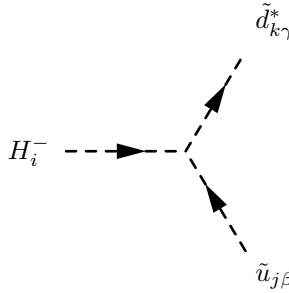
$$-\frac{i}{4}(g_1^2 + g_2^2)(v_d Z_{i1}^H - v_u Z_{i2}^H) \quad (214)$$



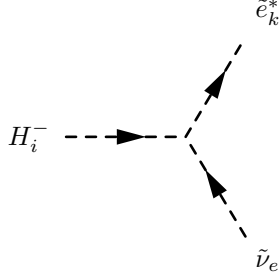
$$\begin{aligned}
& -\frac{i}{4}\delta_{\beta\gamma}\left(-2Z_{j2}^{C,*}\left(2T_{u,22}^*Z_{i2}^+Z_{k1}^S+\sqrt{2}Y_{u,22}^*\left(v_dY_{d,22}Z_{i2}^+Z_{k2}^S+Z_{i1}^+\left(v_s\lambda Z_{k1}^S+v_uY_{d,22}Z_{k2}^S\right)\right)\right)\right) \\
& +Z_{j1}^{C,*}\left(\sqrt{2}Z_{i2}^+\left(-2v_s\lambda^*Y_{d,22}Z_{k2}^S+v_u\left(-2|Y_{u,22}|^2+g_2^2\right)Z_{k1}^S\right)\right) \\
& +Z_{i1}^+\left(-4Z_{k2}^S T_{d,22}+\sqrt{2}v_d\left(-2|Y_{d,22}|^2+g_2^2\right)Z_{k1}^S\right)
\end{aligned} \tag{215}$$



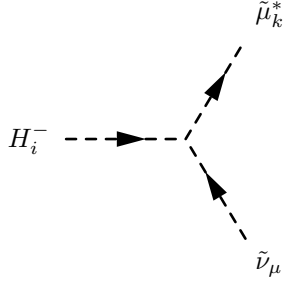
$$\begin{aligned}
& \frac{i}{4}\delta_{\beta\gamma}\left(2Z_{j2}^{T,*}\left(2T_{u,33}^*Z_{k1}^BZ_{i2}^++\sqrt{2}Y_{u,33}^*\left(v_s\lambda Z_{k1}^BZ_{i1}^++Y_{d,33}Z_{k2}^B\left(v_dZ_{i2}^++v_uZ_{i1}^+\right)\right)\right)\right) \\
& +Z_{j1}^{T,*}\left(-\sqrt{2}Z_{k1}^B\left(v_d\left(-2|Y_{d,33}|^2+g_2^2\right)Z_{i1}^++v_u\left(-2|Y_{u,33}|^2+g_2^2\right)Z_{i2}^+\right)\right) \\
& +2Z_{k2}^B\left(2Z_{i1}^+T_{d,33}+\sqrt{2}v_s\lambda^*Y_{d,33}Z_{i2}^+\right)
\end{aligned} \tag{216}$$



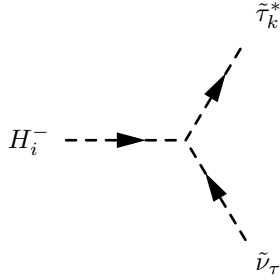
$$\begin{aligned}
& \frac{i}{4} \delta_{\beta\gamma} \left(2Z_{j2}^{U,*} \left(2T_{u,11}^* Z_{k1}^D Z_{i2}^+ + \sqrt{2} Y_{u,11}^* \left(v_s \lambda Z_{k1}^D Z_{i1}^+ + Y_{d,11} Z_{k2}^D \left(v_d Z_{i2}^+ + v_u Z_{i1}^+ \right) \right) \right) \right. \\
& + Z_{j1}^{U,*} \left(-\sqrt{2} Z_{k1}^D \left(v_d \left(-2|Y_{d,11}|^2 + g_2^2 \right) Z_{i1}^+ + v_u \left(-2|Y_{u,11}|^2 + g_2^2 \right) Z_{i2}^+ \right) \right. \\
& \left. \left. + 2Z_{k2}^D \left(2Z_{i1}^+ T_{d,11} + \sqrt{2} v_s \lambda^* Y_{d,11} Z_{i2}^+ \right) \right) \right) \tag{217}
\end{aligned}$$



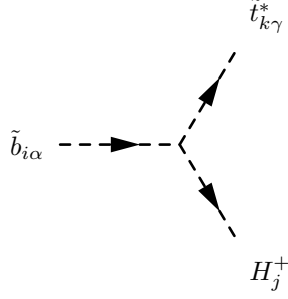
$$\frac{i}{4} \left(2Z_{k2}^E \left(2Z_{i1}^+ T_{e,11} + \sqrt{2} v_s \lambda^* Y_{e,11} Z_{i2}^+ \right) - \sqrt{2} Z_{k1}^E \left(g_2^2 v_u Z_{i2}^+ + v_d \left(-2|Y_{e,11}|^2 + g_2^2 \right) Z_{i1}^+ \right) \right) \tag{218}$$



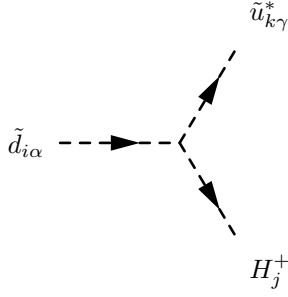
$$\frac{i}{4} \left(2Z_{k2}^\mu \left(2Z_{i1}^+ T_{e,22} + \sqrt{2} v_s \lambda^* Y_{e,22} Z_{i2}^+ \right) - \sqrt{2} Z_{k1}^\mu \left(g_2^2 v_u Z_{i2}^+ + v_d \left(-2|Y_{e,22}|^2 + g_2^2 \right) Z_{i1}^+ \right) \right) \tag{219}$$



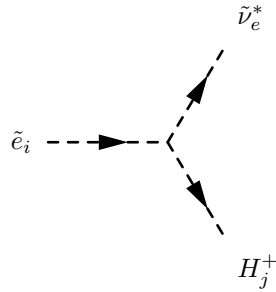
$$\frac{i}{4} \left(\sqrt{2} Z_{i2}^+ (2v_s \lambda^* Y_{e,33} Z_{k2}^T - g_2^2 v_u Z_{k1}^T) + Z_{i1}^+ (4Z_{k2}^T T_{e,33} - \sqrt{2} v_d (-2|Y_{e,33}|^2 + g_2^2) Z_{k1}^T) \right) \quad (220)$$



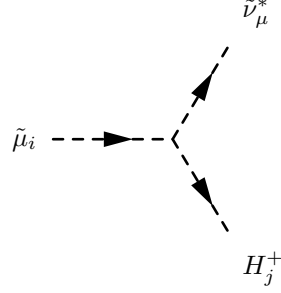
$$\begin{aligned} & -\frac{i}{4} \delta_{\alpha\gamma} \left(-2Z_{i2}^{B,*} \left(2T_{d,33}^* Z_{j1}^+ Z_{k1}^T + \sqrt{2} Y_{d,33}^* (v_u Y_{u,33} Z_{j1}^+ Z_{k2}^T + Z_{j2}^+ (v_d Y_{u,33} Z_{k2}^T + v_s \lambda Z_{k1}^T)) \right) \right) \\ & + Z_{i1}^{B,*} \left(\sqrt{2} Z_{j1}^+ \left(-2v_s \lambda^* Y_{u,33} Z_{k2}^T + v_d (-2|Y_{d,33}|^2 + g_2^2) Z_{k1}^T \right) \right) \\ & + Z_{j2}^+ \left(-4Z_{k2}^T T_{u,33} + \sqrt{2} v_u (-2|Y_{u,33}|^2 + g_2^2) Z_{k1}^T \right) \end{aligned} \quad (221)$$



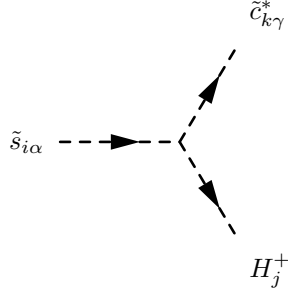
$$\begin{aligned} & -\frac{i}{4} \delta_{\alpha\gamma} \left(-2Z_{i2}^{D,*} \left(2T_{d,11}^* Z_{j1}^+ Z_{k1}^U + \sqrt{2} Y_{d,11}^* (v_u Y_{u,11} Z_{j1}^+ Z_{k2}^U + Z_{j2}^+ (v_d Y_{u,11} Z_{k2}^U + v_s \lambda Z_{k1}^U)) \right) \right) \\ & + Z_{i1}^{D,*} \left(\sqrt{2} Z_{j1}^+ \left(-2v_s \lambda^* Y_{u,11} Z_{k2}^U + v_d (-2|Y_{d,11}|^2 + g_2^2) Z_{k1}^U \right) \right) \\ & + Z_{j2}^+ \left(-4Z_{k2}^U T_{u,11} + \sqrt{2} v_u (-2|Y_{u,11}|^2 + g_2^2) Z_{k1}^U \right) \end{aligned} \quad (222)$$



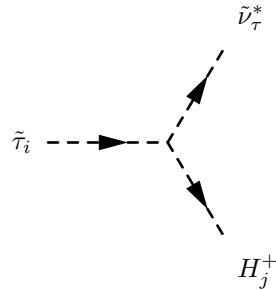
$$\frac{i}{4} \left(2Z_{i2}^{E,*} \left(2T_{e,11}^* Z_{j1}^+ + \sqrt{2} v_s \lambda Y_{e,11}^* Z_{j2}^+ \right) - \sqrt{2} Z_{i1}^{E,*} \left(g_2^2 v_u Z_{j2}^+ + v_d \left(-2|Y_{e,11}|^2 + g_2^2 \right) Z_{j1}^+ \right) \right) \quad (223)$$



$$\frac{i}{4} \left(2Z_{i2}^{\mu,*} \left(2T_{e,22}^* Z_{j1}^+ + \sqrt{2} v_s \lambda Y_{e,22}^* Z_{j2}^+ \right) - \sqrt{2} Z_{i1}^{\mu,*} \left(g_2^2 v_u Z_{j2}^+ + v_d \left(-2|Y_{e,22}|^2 + g_2^2 \right) Z_{j1}^+ \right) \right) \quad (224)$$

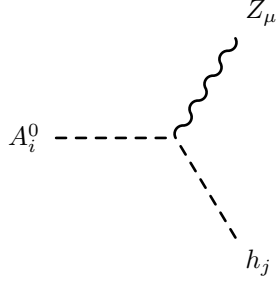


$$\begin{aligned} & \frac{i}{4} \delta_{\alpha\gamma} \left(2Z_{i2}^{S,*} \left(2T_{d,22}^* Z_{k1}^C Z_{j1}^+ + \sqrt{2} Y_{d,22}^* \left(v_s \lambda Z_{k1}^C Z_{j2}^+ + Y_{u,22} Z_{k2}^C \left(v_d Z_{j2}^+ + v_u Z_{j1}^+ \right) \right) \right) \right) \\ & + Z_{i1}^{S,*} \left(-\sqrt{2} Z_{k1}^C \left(v_d \left(-2|Y_{d,22}|^2 + g_2^2 \right) Z_{j1}^+ + v_u \left(-2|Y_{u,22}|^2 + g_2^2 \right) Z_{j2}^+ \right) \right) \\ & + 2Z_{k2}^C \left(2Z_{j2}^+ T_{u,22} + \sqrt{2} v_s \lambda^* Y_{u,22} Z_{j1}^+ \right) \end{aligned} \quad (225)$$

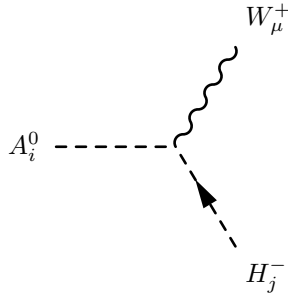


$$\frac{i}{4} \left(2Z_{i2}^{\tau,*} \left(2T_{e,33}^* Z_{j1}^+ + \sqrt{2} v_s \lambda Y_{e,33}^* Z_{j2}^+ \right) - \sqrt{2} Z_{i1}^{\tau,*} \left(g_2^2 v_u Z_{j2}^+ + v_d \left(-2|Y_{e,33}|^2 + g_2^2 \right) Z_{j1}^+ \right) \right) \quad (226)$$

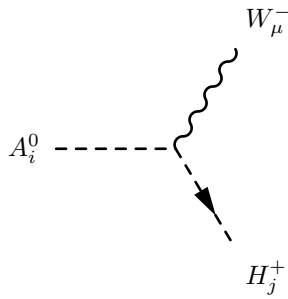
9.2 Two Scalar-One Vector Boson-Interaction



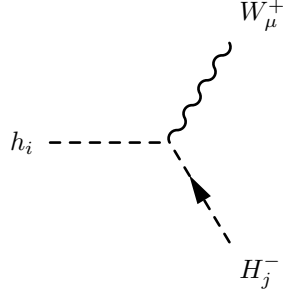
$$\frac{1}{2} \left(g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(Z_{i1}^A Z_{j1}^H - Z_{i2}^A Z_{j2}^H \right) \left(-p_\mu^{h_j} + p_\mu^{A_i^0} \right) \quad (227)$$



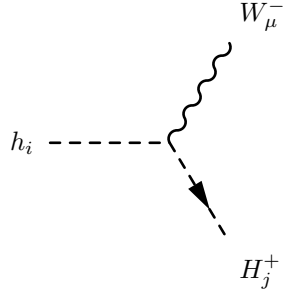
$$\frac{1}{2} g_2 \left(Z_{i1}^A Z_{j1}^+ + Z_{i2}^A Z_{j2}^+ \right) \left(-p_\mu^{H_j^-} + p_\mu^{A_i^0} \right) \quad (228)$$



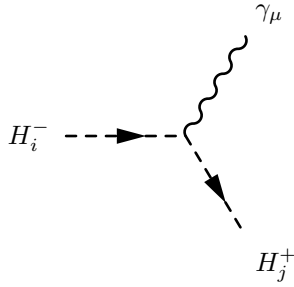
$$\frac{1}{2} g_2 \left(Z_{i1}^A Z_{j1}^+ + Z_{i2}^A Z_{j2}^+ \right) \left(-p_\mu^{H_j^+} + p_\mu^{A_i^0} \right) \quad (229)$$



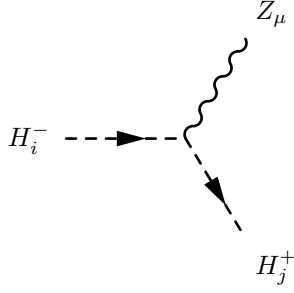
$$\frac{i}{2}g_2\left(Z_{i1}^H Z_{j1}^+ - Z_{i2}^H Z_{j2}^+\right)\left(-p_\mu^{H_j^-} + p_\mu^{h_i}\right) \quad (230)$$



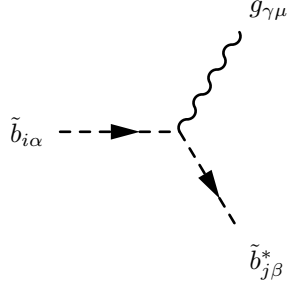
$$-\frac{i}{2}g_2\left(Z_{i1}^H Z_{j1}^+ - Z_{i2}^H Z_{j2}^+\right)\left(-p_\mu^{H_j^+} + p_\mu^{h_i}\right) \quad (231)$$



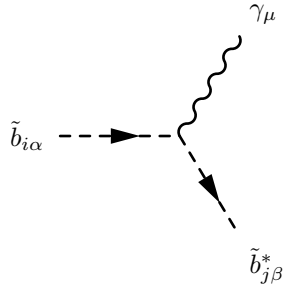
$$\frac{i}{2}\delta_{ij}\left(g_1 \cos \Theta_W + g_2 \sin \Theta_W\right)\left(-p_\mu^{H_j^+} + p_\mu^{H_i^-}\right) \quad (232)$$



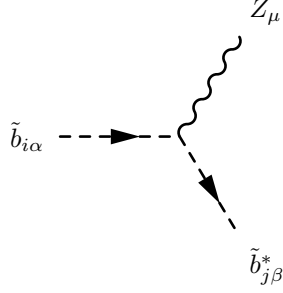
$$\frac{i}{2} \delta_{ij} \left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(-p_\mu^{H_j^+} + p_\mu^{H_i^-} \right) \quad (233)$$



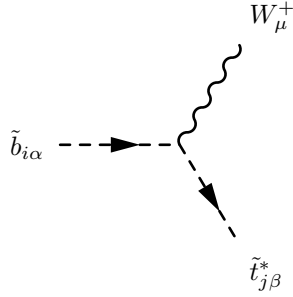
$$-\frac{i}{2} g_3 \delta_{ij} \lambda_{\beta, \alpha}^\gamma \left(-p_\mu^{\tilde{b}_{j\beta}^*} + p_\mu^{\tilde{b}_{i\alpha}} \right) \quad (234)$$



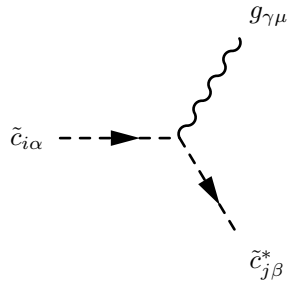
$$-\frac{i}{6} \delta_{\alpha\beta} \left(-2g_1 Z_{i2}^{B,*} \cos \Theta_W Z_{j2}^B + Z_{i1}^{B,*} \left(-3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right) Z_{j1}^B \right) \left(-p_\mu^{\tilde{b}_{j\beta}^*} + p_\mu^{\tilde{b}_{i\alpha}} \right) \quad (235)$$



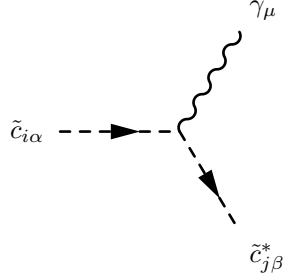
$$\frac{i}{6}\delta_{\alpha\beta}\left(-2g_1Z_{i2}^{B,*}\sin\Theta_W Z_{j2}^B + Z_{i1}^{B,*}\left(3g_2\cos\Theta_W + g_1\sin\Theta_W\right)Z_{j1}^B\right)\left(-p_\mu^{\tilde{b}_{j\beta}^*} + p_\mu^{\tilde{b}_{i\alpha}}\right) \quad (236)$$



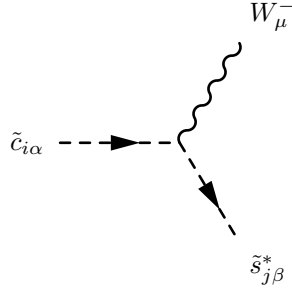
$$-i\frac{1}{\sqrt{2}}g_2Z_{i1}^{B,*}\delta_{\alpha\beta}Z_{j1}^T\left(-p_\mu^{\tilde{t}_{j\beta}^*} + p_\mu^{\tilde{b}_{i\alpha}}\right) \quad (237)$$



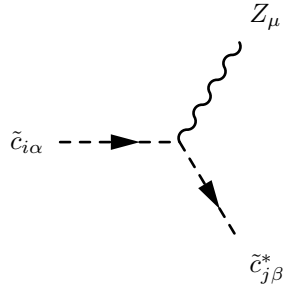
$$-\frac{i}{2}g_3\delta_{ij}\lambda_{\beta,\alpha}^\gamma\left(-p_\mu^{\tilde{c}_{j\beta}^*} + p_\mu^{\tilde{c}_{i\alpha}}\right) \quad (238)$$



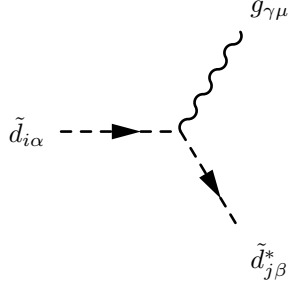
$$-\frac{i}{6}\delta_{\alpha\beta}\left(4g_1Z_{i2}^{C,*}\cos\Theta_W Z_{j2}^C+Z_{i1}^{C,*}\left(3g_2\sin\Theta_W+g_1\cos\Theta_W\right)Z_{j1}^C\right)\left(-p_\mu^{\tilde{c}_{j\beta}^*}+p_\mu^{\tilde{c}_{i\alpha}}\right) \quad (239)$$



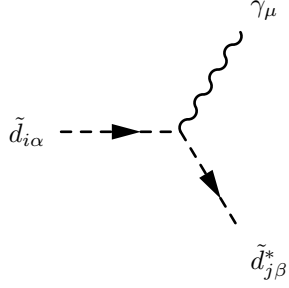
$$-i\frac{1}{\sqrt{2}}g_2Z_{i1}^{C,*}\delta_{\alpha\beta}Z_{j1}^S\left(-p_\mu^{\tilde{s}_{j\beta}^*}+p_\mu^{\tilde{c}_{i\alpha}}\right) \quad (240)$$



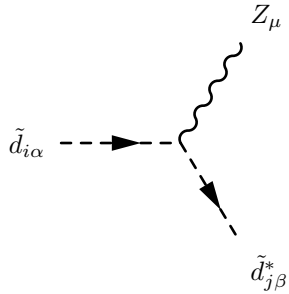
$$-\frac{i}{6}\delta_{\alpha\beta}\left(-4g_1Z_{i2}^{C,*}\sin\Theta_W Z_{j2}^C+Z_{i1}^{C,*}\left(3g_2\cos\Theta_W-g_1\sin\Theta_W\right)Z_{j1}^C\right)\left(-p_\mu^{\tilde{c}_{j\beta}^*}+p_\mu^{\tilde{c}_{i\alpha}}\right) \quad (241)$$



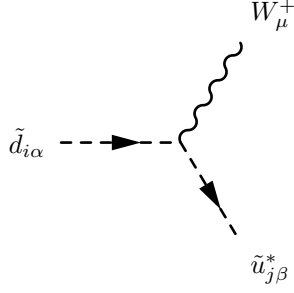
$$-\frac{i}{2}g_3\delta_{ij}\lambda_{\beta,\alpha}^\gamma\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{d}_{i\alpha}}\right) \quad (242)$$



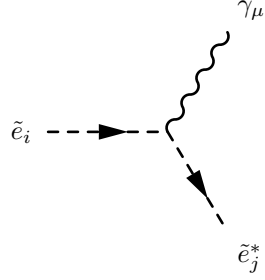
$$-\frac{i}{6}\delta_{\alpha\beta}\left(-2g_1Z_{i2}^{D,*}\cos\Theta_W Z_{j2}^D+Z_{i1}^{D,*}\left(-3g_2\sin\Theta_W+g_1\cos\Theta_W\right)Z_{j1}^D\right)\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{d}_{i\alpha}}\right) \quad (243)$$



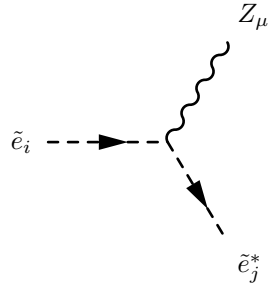
$$\frac{i}{6}\delta_{\alpha\beta}\left(-2g_1Z_{i2}^{D,*}\sin\Theta_W Z_{j2}^D+Z_{i1}^{D,*}\left(3g_2\cos\Theta_W+g_1\sin\Theta_W\right)Z_{j1}^D\right)\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{d}_{i\alpha}}\right) \quad (244)$$



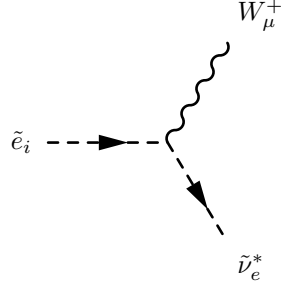
$$-i \frac{1}{\sqrt{2}} g_2 Z_{i1}^{D,*} \delta_{\alpha\beta} Z_{j1}^U \left(-p_\mu^{\tilde{u}_{j\beta}^*} + p_\mu^{\tilde{d}_{i\alpha}} \right) \quad (245)$$



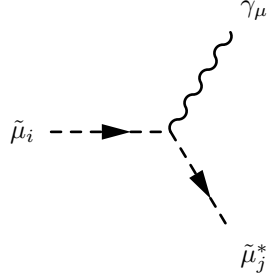
$$\frac{i}{2} \left(2g_1 Z_{i2}^{E,*} \cos \Theta_W Z_{j2}^E + Z_{i1}^{E,*} \left(g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) Z_{j1}^E \right) \left(-p_\mu^{\tilde{e}_j^*} + p_\mu^{\tilde{e}_i} \right) \quad (246)$$



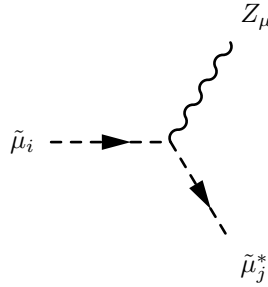
$$\frac{i}{2} \left(-2g_1 Z_{i2}^{E,*} \sin \Theta_W Z_{j2}^E + Z_{i1}^{E,*} \left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) Z_{j1}^E \right) \left(-p_\mu^{\tilde{e}_j^*} + p_\mu^{\tilde{e}_i} \right) \quad (247)$$



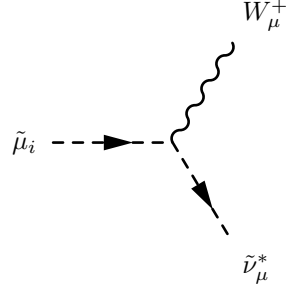
$$-i \frac{1}{\sqrt{2}} g_2 Z_{i1}^{E,*} \left(-p_\mu^{\tilde{\nu}_e^*} + p_\mu^{\tilde{e}_i} \right) \quad (248)$$



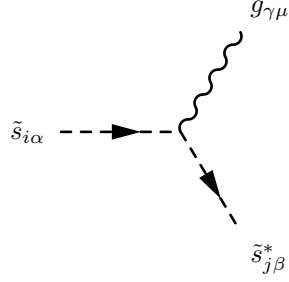
$$\frac{i}{2} \left(2g_1 Z_{i2}^{\mu,*} \cos \Theta_W Z_{j2}^\mu + Z_{i1}^{\mu,*} \left(g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) Z_{j1}^\mu \right) \left(-p_\mu^{\tilde{\mu}_j^*} + p_\mu^{\tilde{\mu}_i} \right) \quad (249)$$



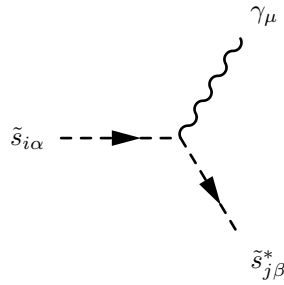
$$\frac{i}{2} \left(-2g_1 Z_{i2}^{\mu,*} \sin \Theta_W Z_{j2}^\mu + Z_{i1}^{\mu,*} \left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) Z_{j1}^\mu \right) \left(-p_\mu^{\tilde{\mu}_j^*} + p_\mu^{\tilde{\mu}_i} \right) \quad (250)$$



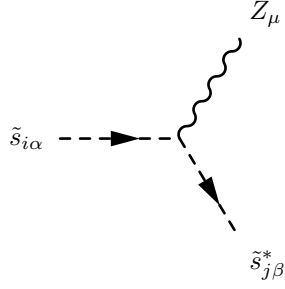
$$-i \frac{1}{\sqrt{2}} g_2 Z_{i1}^{\mu,*} \left(-p_\mu^{\tilde{\nu}_\mu^*} + p_\mu^{\tilde{\mu}_i} \right) \quad (251)$$



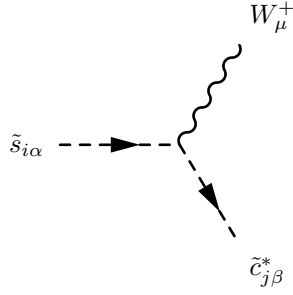
$$-\frac{i}{2} g_3 \delta_{ij} \lambda_{\beta,\alpha}^\gamma \left(-p_\mu^{\tilde{s}_{j\beta}^*} + p_\mu^{\tilde{s}_{i\alpha}} \right) \quad (252)$$



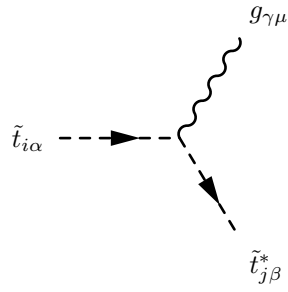
$$-\frac{i}{6} \delta_{\alpha\beta} \left(-2g_1 Z_{i2}^{S,*} \cos \Theta_W Z_{j2}^S + Z_{i1}^{S,*} \left(-3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right) Z_{j1}^S \right) \left(-p_\mu^{\tilde{s}_{j\beta}^*} + p_\mu^{\tilde{s}_{i\alpha}} \right) \quad (253)$$



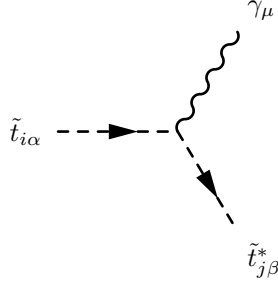
$$\frac{i}{6}\delta_{\alpha\beta}\left(-2g_1Z_{i2}^{S,*}\sin\Theta_W Z_{j2}^S + Z_{i1}^{S,*}\left(3g_2\cos\Theta_W + g_1\sin\Theta_W\right)Z_{j1}^S\right)\left(-p_\mu^{\tilde{s}_{j\beta}^*} + p_\mu^{\tilde{s}_{i\alpha}}\right) \quad (254)$$



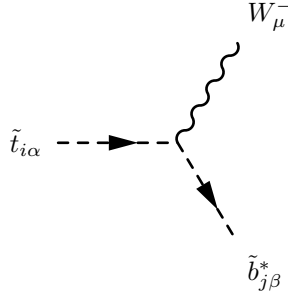
$$-i\frac{1}{\sqrt{2}}g_2Z_{i1}^{S,*}\delta_{\alpha\beta}Z_{j1}^C\left(-p_\mu^{\tilde{c}_{j\beta}^*} + p_\mu^{\tilde{s}_{i\alpha}}\right) \quad (255)$$



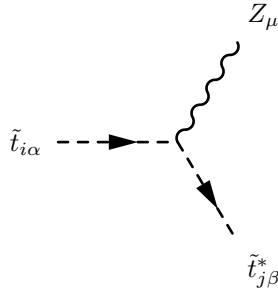
$$-\frac{i}{2}g_3\delta_{ij}\lambda_{\beta,\alpha}^\gamma\left(-p_\mu^{\tilde{t}_{j\beta}^*} + p_\mu^{\tilde{t}_{i\alpha}}\right) \quad (256)$$



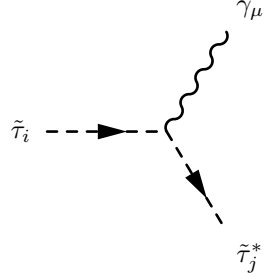
$$-\frac{i}{6}\delta_{\alpha\beta}\left(4g_1Z_{i2}^{T,*}\cos\Theta_W Z_{j2}^T+Z_{i1}^{T,*}\left(3g_2\sin\Theta_W+g_1\cos\Theta_W\right)Z_{j1}^T\right)\left(-p_\mu^{\tilde{t}_{j\beta}^*}+p_\mu^{\tilde{t}_{i\alpha}}\right) \quad (257)$$



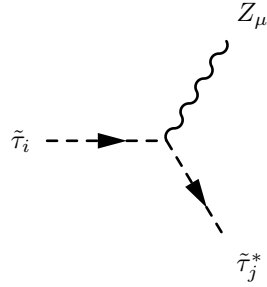
$$-i\frac{1}{\sqrt{2}}g_2Z_{i1}^{T,*}\delta_{\alpha\beta}Z_{j1}^B\left(-p_\mu^{\tilde{b}_{j\beta}^*}+p_\mu^{\tilde{t}_{i\alpha}}\right) \quad (258)$$



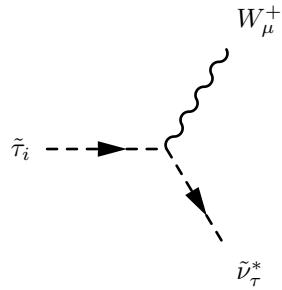
$$-\frac{i}{6}\delta_{\alpha\beta}\left(-4g_1Z_{i2}^{T,*}\sin\Theta_W Z_{j2}^T+Z_{i1}^{T,*}\left(3g_2\cos\Theta_W-g_1\sin\Theta_W\right)Z_{j1}^T\right)\left(-p_\mu^{\tilde{t}_{j\beta}^*}+p_\mu^{\tilde{t}_{i\alpha}}\right) \quad (259)$$



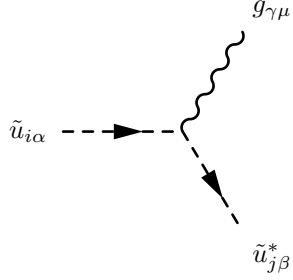
$$\frac{i}{2} \left(2g_1 Z_{i2}^{\tau,*} \cos \Theta_W Z_{j2}^\tau + Z_{i1}^{\tau,*} \left(g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) Z_{j1}^\tau \right) \left(-p_\mu^{\tilde{\tau}_j^*} + p_\mu^{\tilde{\tau}_i} \right) \quad (260)$$



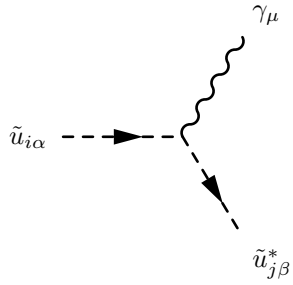
$$\frac{i}{2} \left(-2g_1 Z_{i2}^{\tau,*} \sin \Theta_W Z_{j2}^\tau + Z_{i1}^{\tau,*} \left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) Z_{j1}^\tau \right) \left(-p_\mu^{\tilde{\tau}_j^*} + p_\mu^{\tilde{\tau}_i} \right) \quad (261)$$



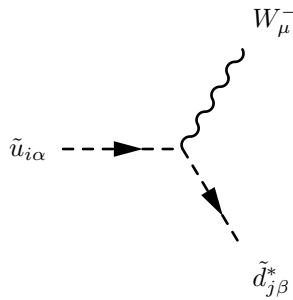
$$-i \frac{1}{\sqrt{2}} g_2 Z_{i1}^{\tau,*} \left(-p_\mu^{\tilde{\nu}_\tau^*} + p_\mu^{\tilde{\tau}_i} \right) \quad (262)$$



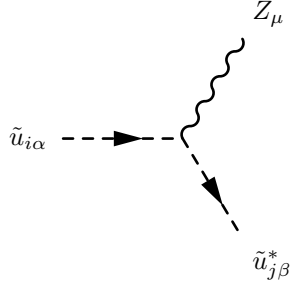
$$-\frac{i}{2}g_3\delta_{ij}\lambda_{\beta,\alpha}^\gamma\left(-p_\mu^{\tilde{u}_{j\beta}^*}+p_\mu^{\tilde{u}_{i\alpha}}\right) \quad (263)$$



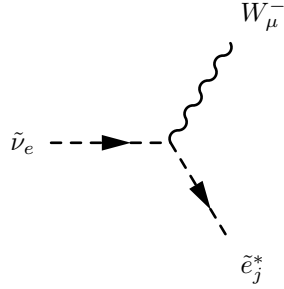
$$-\frac{i}{6}\delta_{\alpha\beta}\left(4g_1Z_{i2}^{U,*}\cos\Theta_W Z_{j2}^U+Z_{i1}^{U,*}\left(3g_2\sin\Theta_W+g_1\cos\Theta_W\right)Z_{j1}^U\right)\left(-p_\mu^{\tilde{u}_{j\beta}^*}+p_\mu^{\tilde{u}_{i\alpha}}\right) \quad (264)$$



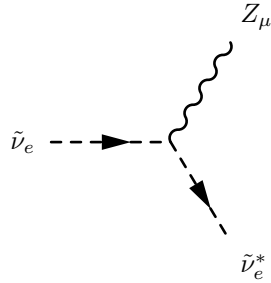
$$-i\frac{1}{\sqrt{2}}g_2Z_{i1}^{U,*}\delta_{\alpha\beta}Z_{j1}^D\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{u}_{i\alpha}}\right) \quad (265)$$



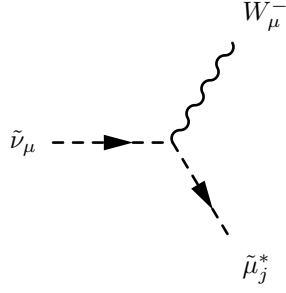
$$-\frac{i}{6}\delta_{\alpha\beta}\left(-4g_1Z_{i2}^{U,*}\sin\Theta_W Z_{j2}^U + Z_{i1}^{U,*}\left(3g_2\cos\Theta_W - g_1\sin\Theta_W\right)Z_{j1}^U\right)\left(-p_\mu^{\tilde{u}_{j\beta}^*} + p_\mu^{\tilde{u}_{i\alpha}}\right) \quad (266)$$



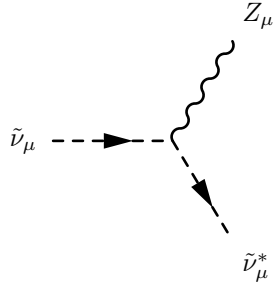
$$-i\frac{1}{\sqrt{2}}g_2Z_{j1}^E\left(-p_\mu^{\tilde{e}_j^*} + p_\mu^{\tilde{\nu}_e}\right) \quad (267)$$



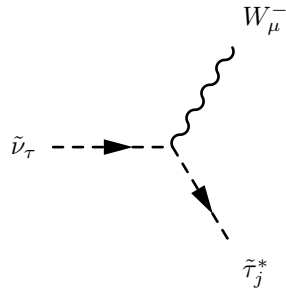
$$-\frac{i}{2}\left(g_1\sin\Theta_W + g_2\cos\Theta_W\right)\left(-p_\mu^{\tilde{\nu}_e^*} + p_\mu^{\tilde{\nu}_e}\right) \quad (268)$$



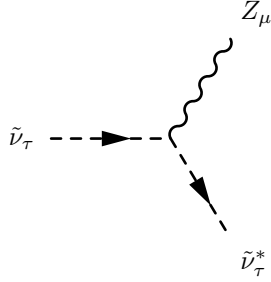
$$-i \frac{1}{\sqrt{2}} g_2 Z_{j1}^\mu \left(-p_\mu^{\tilde{\mu}_j^*} + p_\mu^{\tilde{\nu}_\mu} \right) \quad (269)$$



$$- \frac{i}{2} \left(g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(-p_\mu^{\tilde{\nu}_\mu^*} + p_\mu^{\tilde{\nu}_\mu} \right) \quad (270)$$

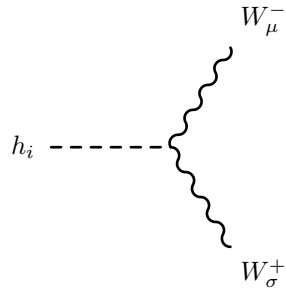


$$-i \frac{1}{\sqrt{2}} g_2 Z_{j1}^\tau \left(-p_\mu^{\tilde{\tau}_j^*} + p_\mu^{\tilde{\nu}_\tau} \right) \quad (271)$$

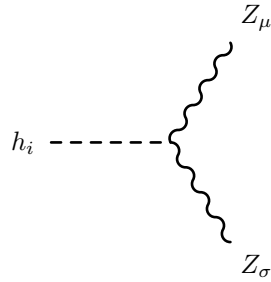


$$-\frac{i}{2}(g_1 \sin \Theta_W + g_2 \cos \Theta_W)(-p_\mu^{\tilde{\nu}_\tau^*} + p_\mu^{\tilde{\nu}_\tau}) \quad (272)$$

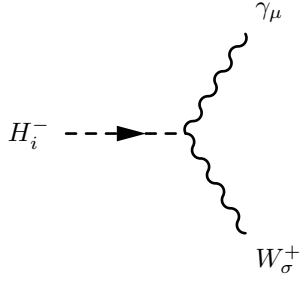
9.3 One Scalar-Two Vector Boson-Interaction



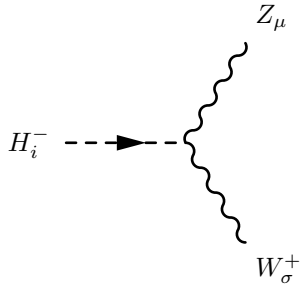
$$\frac{i}{2}g_2^2(v_d Z_{i1}^H + v_u Z_{i2}^H)(g_{\sigma\mu}) \quad (273)$$



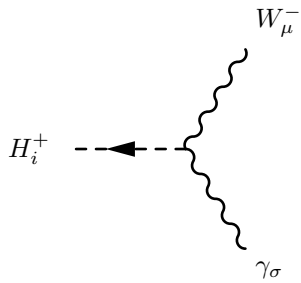
$$\frac{i}{2}(g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2(v_d Z_{i1}^H + v_u Z_{i2}^H)(g_{\sigma\mu}) \quad (274)$$



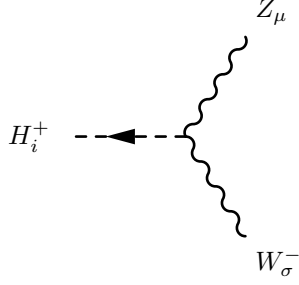
$$-\frac{i}{2}g_1g_2\cos\Theta_W\left(v_dZ_{i1}^+ - v_uZ_{i2}^+\right)\left(g_{\sigma\mu}\right) \quad (275)$$



$$\frac{i}{2}g_1g_2\sin\Theta_W\left(v_dZ_{i1}^+ - v_uZ_{i2}^+\right)\left(g_{\sigma\mu}\right) \quad (276)$$

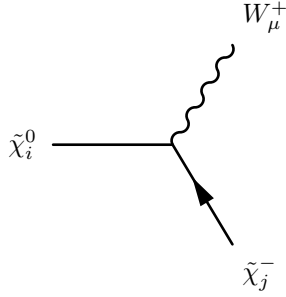


$$-\frac{i}{2}g_1g_2\cos\Theta_W\left(v_dZ_{i1}^+ - v_uZ_{i2}^+\right)\left(g_{\sigma\mu}\right) \quad (277)$$



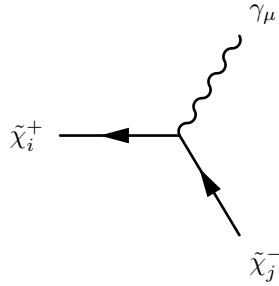
$$\frac{i}{2} g_1 g_2 \sin \Theta_W (v_d Z_{i1}^+ - v_u Z_{i2}^+) (g_{\sigma\mu}) \quad (278)$$

9.4 Two Fermion-One Vector Boson-Interaction



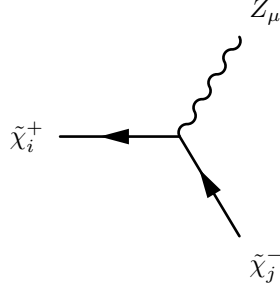
$$-\frac{i}{2} g_2 (2U_{j1}^* N_{i2} + \sqrt{2} U_{j2}^* N_{i3}) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (279)$$

$$+ \frac{i}{2} g_2 (2N_{i2}^* V_{j1} - \sqrt{2} N_{i4}^* V_{j2}) \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (280)$$



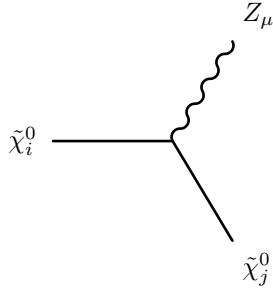
$$\frac{i}{2} \left(2g_2 U_{j1}^* \sin \Theta_W U_{i1} + U_{j2}^* (g_1 \cos \Theta_W + g_2 \sin \Theta_W) U_{i2} \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (281)$$

$$+ \frac{i}{2} \left(2g_2 V_{i1}^* \sin \Theta_W V_{j1} + V_{i2}^* (g_1 \cos \Theta_W + g_2 \sin \Theta_W) V_{j2} \right) \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (282)$$



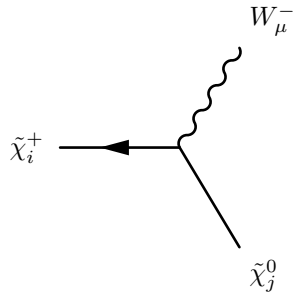
$$\frac{i}{2} \left(2g_2 U_{j1}^* \cos \Theta_W U_{i1} + U_{j2}^* \left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) U_{i2} \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (283)$$

$$+ \frac{i}{2} \left(2g_2 V_{i1}^* \cos \Theta_W V_{j1} + V_{i2}^* \left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) V_{j2} \right) \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (284)$$



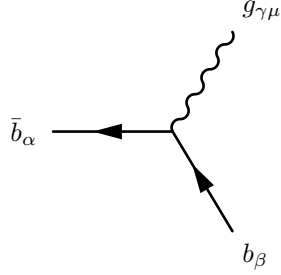
$$- \frac{i}{2} \left(g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(N_{j3}^* N_{i3} - N_{j4}^* N_{i4} \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (285)$$

$$+ \frac{i}{2} \left(g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(N_{i3}^* N_{j3} - N_{i4}^* N_{j4} \right) \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (286)$$



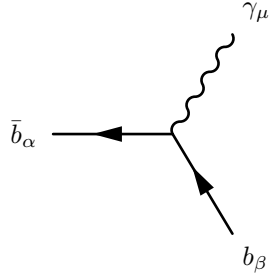
$$- \frac{i}{2} g_2 \left(2N_{j2}^* U_{i1} + \sqrt{2} N_{j3}^* U_{i2} \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (287)$$

$$+ - \frac{i}{2} g_2 \left(2V_{i1}^* N_{j2} - \sqrt{2} V_{i2}^* N_{j4} \right) \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (288)$$



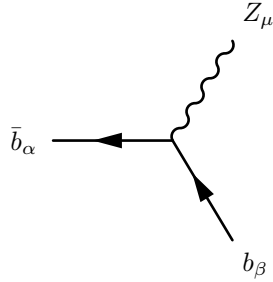
$$-\frac{i}{2}g_3\lambda_{\alpha,\beta}^\gamma\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (289)$$

$$+\frac{i}{2}g_3\lambda_{\alpha,\beta}^\gamma\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (290)$$



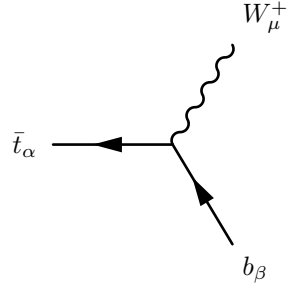
$$-\frac{i}{6}\delta_{\alpha\beta}\left(-3g_2\sin\Theta_W+g_1\cos\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (291)$$

$$+\frac{i}{3}g_1\cos\Theta_W\delta_{\alpha\beta}\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (292)$$

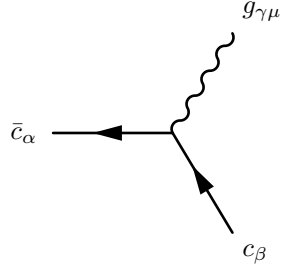


$$\frac{i}{6}\delta_{\alpha\beta}\left(3g_2\cos\Theta_W+g_1\sin\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (293)$$

$$+\frac{i}{3}g_1\delta_{\alpha\beta}\sin\Theta_W\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (294)$$

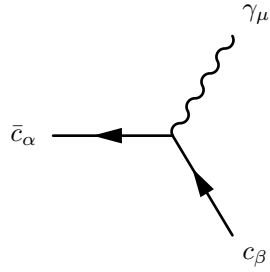


$$-i \frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (295)$$



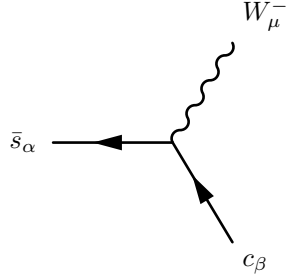
$$- \frac{i}{2} g_3 \lambda_{\alpha,\beta}^\gamma \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (296)$$

$$+ - \frac{i}{2} g_3 \lambda_{\alpha,\beta}^\gamma \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (297)$$

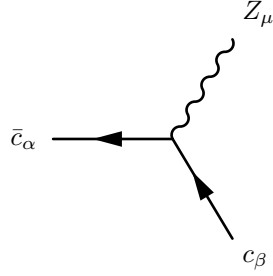


$$- \frac{i}{6} \delta_{\alpha\beta} \left(3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (298)$$

$$+ - \frac{2i}{3} g_1 \cos \Theta_W \delta_{\alpha\beta} \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (299)$$

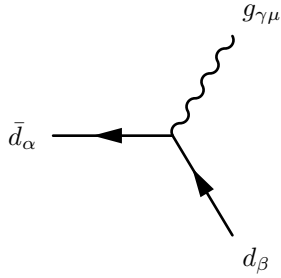


$$-i \frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (300)$$



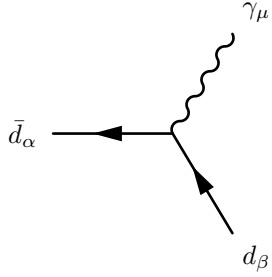
$$- \frac{i}{6} \delta_{\alpha\beta} \left(3g_2 \cos \Theta_W - g_1 \sin \Theta_W \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (301)$$

$$+ \frac{2i}{3} g_1 \delta_{\alpha\beta} \sin \Theta_W \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (302)$$



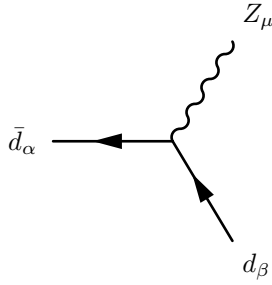
$$- \frac{i}{2} g_3 \lambda_{\alpha,\beta}^\gamma \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (303)$$

$$+ - \frac{i}{2} g_3 \lambda_{\alpha,\beta}^\gamma \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (304)$$



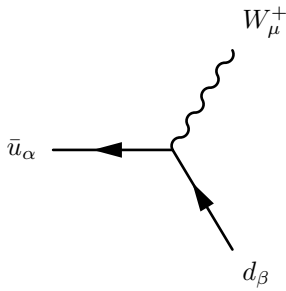
$$-\frac{i}{6}\delta_{\alpha\beta}\left(-3g_2\sin\Theta_W+g_1\cos\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (305)$$

$$+\frac{i}{3}g_1\cos\Theta_W\delta_{\alpha\beta}\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (306)$$

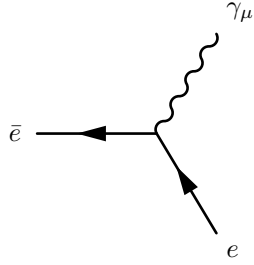


$$\frac{i}{6}\delta_{\alpha\beta}\left(3g_2\cos\Theta_W+g_1\sin\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (307)$$

$$+\frac{i}{3}g_1\delta_{\alpha\beta}\sin\Theta_W\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (308)$$

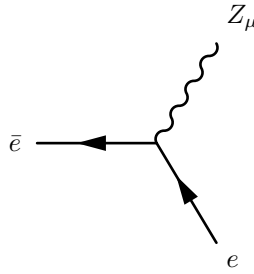


$$-i\frac{1}{\sqrt{2}}g_2\delta_{\alpha\beta}\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (309)$$



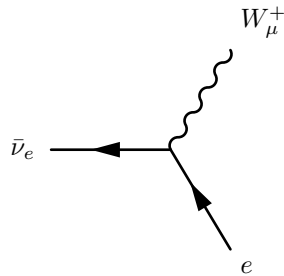
$$\frac{i}{2} \left(g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (310)$$

$$+ i g_1 \cos \Theta_W \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (311)$$

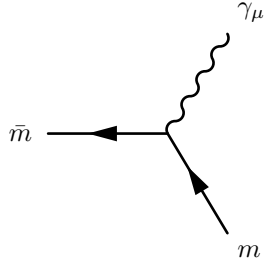


$$\frac{i}{2} \left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (312)$$

$$+ -i g_1 \sin \Theta_W \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (313)$$

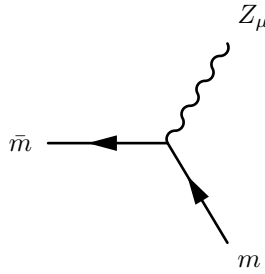


$$-i \frac{1}{\sqrt{2}} g_2 \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (314)$$



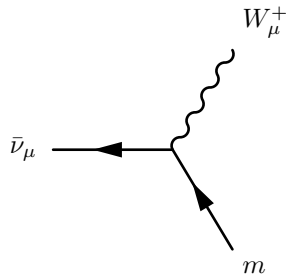
$$\frac{i}{2} \left(g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (315)$$

$$+ i g_1 \cos \Theta_W \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (316)$$

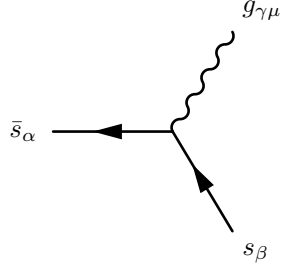


$$\frac{i}{2} \left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (317)$$

$$+ -i g_1 \sin \Theta_W \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (318)$$

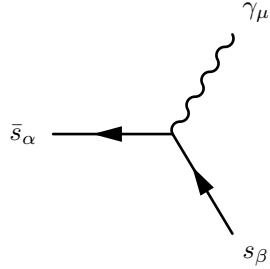


$$- i \frac{1}{\sqrt{2}} g_2 \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (319)$$



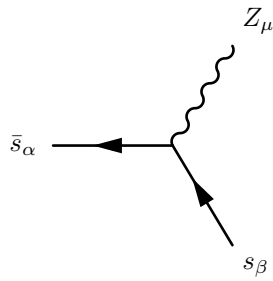
$$-\frac{i}{2}g_3\lambda_{\alpha,\beta}^\gamma\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (320)$$

$$+\frac{i}{2}g_3\lambda_{\alpha,\beta}^\gamma\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (321)$$



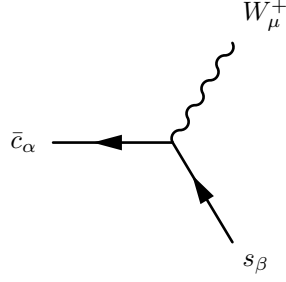
$$-\frac{i}{6}\delta_{\alpha\beta}\left(-3g_2\sin\Theta_W+g_1\cos\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (322)$$

$$+\frac{i}{3}g_1\cos\Theta_W\delta_{\alpha\beta}\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (323)$$

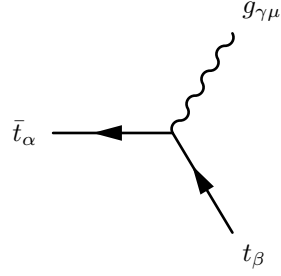


$$\frac{i}{6}\delta_{\alpha\beta}\left(3g_2\cos\Theta_W+g_1\sin\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (324)$$

$$+\frac{i}{3}g_1\delta_{\alpha\beta}\sin\Theta_W\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (325)$$

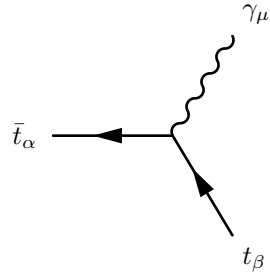


$$-i \frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (326)$$



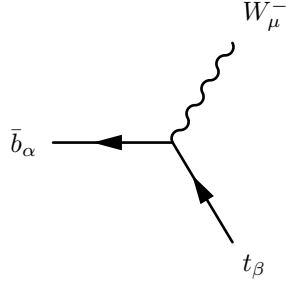
$$-\frac{i}{2} g_3 \lambda_{\alpha,\beta}^\gamma \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (327)$$

$$+ \frac{i}{2} g_3 \lambda_{\alpha,\beta}^\gamma \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (328)$$

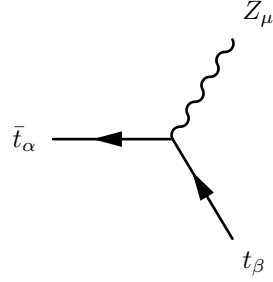


$$-\frac{i}{6} \delta_{\alpha\beta} \left(3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (329)$$

$$+ \frac{2i}{3} g_1 \cos \Theta_W \delta_{\alpha\beta} \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (330)$$

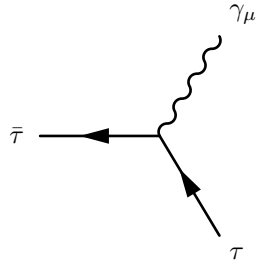


$$-i \frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (331)$$



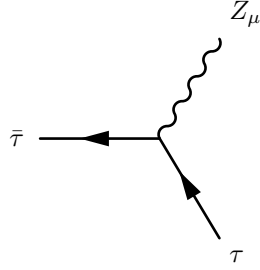
$$-\frac{i}{6} \delta_{\alpha\beta} \left(3g_2 \cos \Theta_W - g_1 \sin \Theta_W \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (332)$$

$$+\frac{2i}{3} g_1 \delta_{\alpha\beta} \sin \Theta_W \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (333)$$



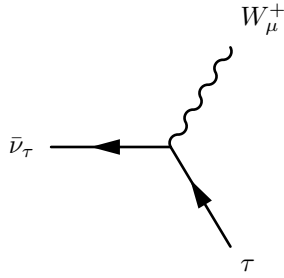
$$\frac{i}{2} \left(g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (334)$$

$$+ i g_1 \cos \Theta_W \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (335)$$

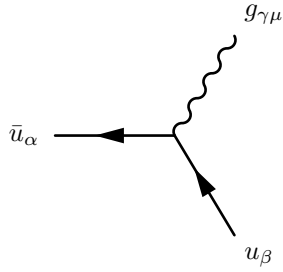


$$\frac{i}{2} \left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (336)$$

$$+ -ig_1 \sin \Theta_W \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (337)$$

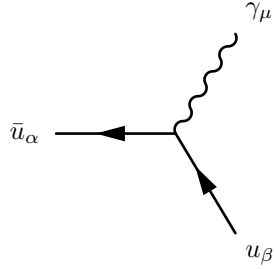


$$- i \frac{1}{\sqrt{2}} g_2 \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (338)$$



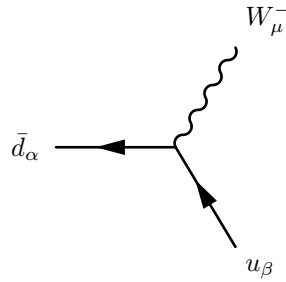
$$- \frac{i}{2} g_3 \lambda_{\alpha,\beta}^\gamma \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (339)$$

$$+ - \frac{i}{2} g_3 \lambda_{\alpha,\beta}^\gamma \left(\gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (340)$$

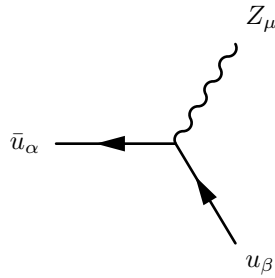


$$-\frac{i}{6}\delta_{\alpha\beta}\left(3g_2\sin\Theta_W+g_1\cos\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (341)$$

$$+\frac{2i}{3}g_1\cos\Theta_W\delta_{\alpha\beta}\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (342)$$

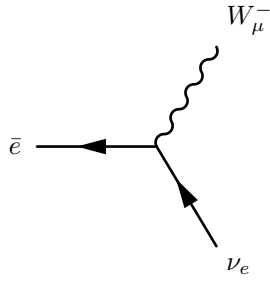


$$-i\frac{1}{\sqrt{2}}g_2\delta_{\alpha\beta}\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (343)$$

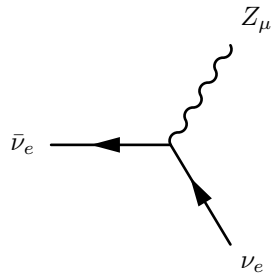


$$-\frac{i}{6}\delta_{\alpha\beta}\left(3g_2\cos\Theta_W-g_1\sin\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (344)$$

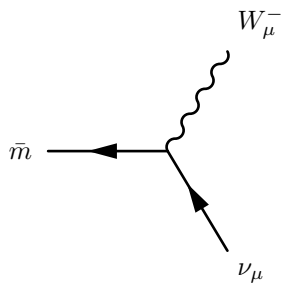
$$+\frac{2i}{3}g_1\delta_{\alpha\beta}\sin\Theta_W\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (345)$$



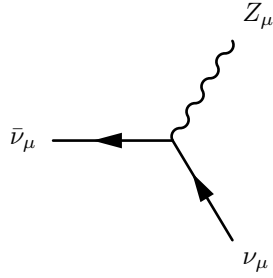
$$-i \frac{1}{\sqrt{2}} g_2 \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (346)$$



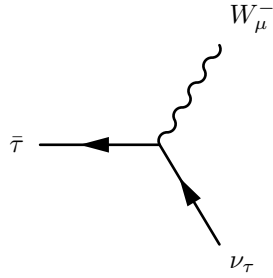
$$-\frac{i}{2} \left(g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (347)$$



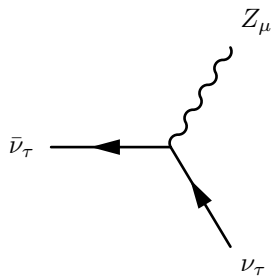
$$-i \frac{1}{\sqrt{2}} g_2 \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (348)$$



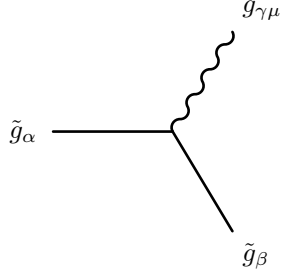
$$-\frac{i}{2} \left(g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (349)$$



$$-i \frac{1}{\sqrt{2}} g_2 \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (350)$$



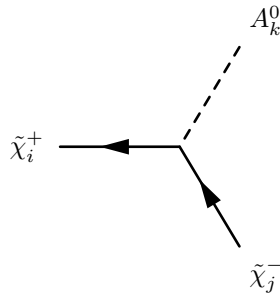
$$-\frac{i}{2} \left(g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(\gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (351)$$



$$-g_3|\phi_{\tilde{g}}|^2 f_{\alpha,\beta,\gamma}\left(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\right) \quad (352)$$

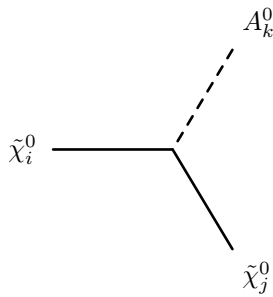
$$+ -g_3|\phi_{\tilde{g}}|^2 f_{\alpha,\beta,\gamma}\left(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\right) \quad (353)$$

9.5 Two Fermion-One Scalar Boson-Interaction



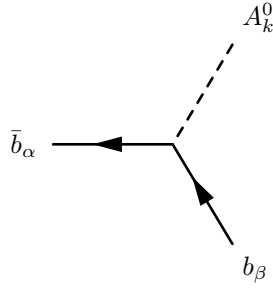
$$-\frac{1}{\sqrt{2}}\left(g_2 U_{j1}^* V_{i2}^* Z_{k2}^A + U_{j2}^*\left(g_2 V_{i1}^* Z_{k1}^A - \lambda V_{i2}^* Z_{k3}^A\right)\right)\left(\frac{1-\gamma_5}{2}\right) \quad (354)$$

$$+\frac{1}{\sqrt{2}}\left(g_2 U_{i1} V_{j2} Z_{k2}^A + U_{i2}\left(g_2 V_{j1} Z_{k1}^A - \lambda^* V_{j2} Z_{k3}^A\right)\right)\left(\frac{1+\gamma_5}{2}\right) \quad (355)$$



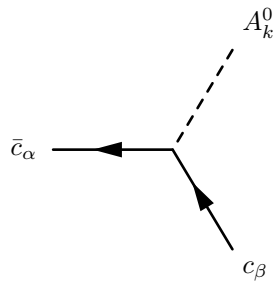
$$\begin{aligned}
& \frac{1}{2} \left(-g_2 N_{i2}^* N_{j3}^* Z_{k1}^A - \sqrt{2} \lambda N_{i5}^* N_{j4}^* Z_{k1}^A - \sqrt{2} \lambda N_{i4}^* N_{j5}^* Z_{k1}^A - g_1 N_{i4}^* N_{j1}^* Z_{k2}^A \right. \\
& + g_2 N_{i4}^* N_{j2}^* Z_{k2}^A - \sqrt{2} \lambda N_{i5}^* N_{j3}^* Z_{k2}^A + g_2 N_{i2}^* N_{j4}^* Z_{k2}^A \\
& - N_{i1}^* \left(-g_1 N_{j3}^* Z_{k1}^A + g_1 N_{j4}^* Z_{k2}^A \right) - \sqrt{2} \lambda N_{i4}^* N_{j3}^* Z_{k3}^A + 2\sqrt{2} \kappa N_{i5}^* N_{j5}^* Z_{k3}^A \\
& \left. - N_{i3}^* \left(-g_1 N_{j1}^* Z_{k1}^A + g_2 N_{j2}^* Z_{k1}^A + \sqrt{2} \lambda \left(N_{j4}^* Z_{k3}^A + N_{j5}^* Z_{k2}^A \right) \right) \right) \left(\frac{1-\gamma_5}{2} \right) \tag{356}
\end{aligned}$$

$$\begin{aligned}
& + \frac{1}{2} \left(-Z_{k1}^A \left(g_1 N_{i1} N_{j3} - g_2 N_{i2} N_{j3} + N_{i3} \left(g_1 N_{j1} - g_2 N_{j2} \right) - \sqrt{2} \lambda^* N_{i4} N_{j5} - \sqrt{2} \lambda^* N_{i5} N_{j4} \right) \right. \\
& + \sqrt{2} Z_{k3}^A \left(-2\kappa^* N_{i5} N_{j5} + \lambda^* \left(N_{i3} N_{j4} + N_{i4} N_{j3} \right) \right) \\
& \left. + Z_{k2}^A \left(\left(g_1 N_{i1} - g_2 N_{i2} \right) N_{j4} + N_{i4} \left(g_1 N_{j1} - g_2 N_{j2} \right) + \sqrt{2} \lambda^* \left(N_{i3} N_{j5} + N_{i5} N_{j3} \right) \right) \right) \left(\frac{1+\gamma_5}{2} \right) \tag{357}
\end{aligned}$$



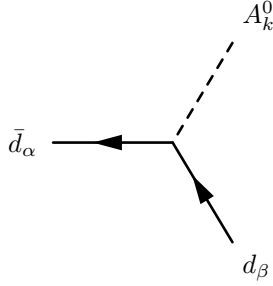
$$\frac{1}{\sqrt{2}} \delta_{\alpha\beta} Y_{d,33} Z_{k1}^A \left(\frac{1-\gamma_5}{2} \right) \tag{358}$$

$$+ -\frac{1}{\sqrt{2}} Y_{d,33}^* \delta_{\alpha\beta} Z_{k1}^A \left(\frac{1+\gamma_5}{2} \right) \tag{359}$$



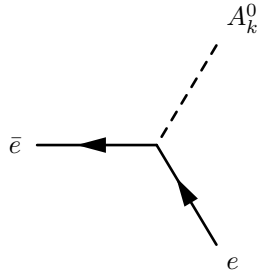
$$\frac{1}{\sqrt{2}} \delta_{\alpha\beta} Y_{u,22} Z_{k2}^A \left(\frac{1-\gamma_5}{2} \right) \tag{360}$$

$$+ -\frac{1}{\sqrt{2}} Y_{u,22}^* \delta_{\alpha\beta} Z_{k2}^A \left(\frac{1+\gamma_5}{2} \right) \tag{361}$$



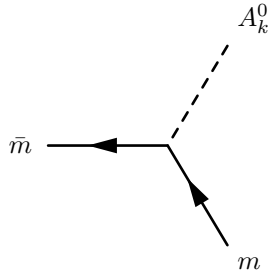
$$\frac{1}{\sqrt{2}}\delta_{\alpha\beta}Y_{d,11}Z_{k1}^A\left(\frac{1-\gamma_5}{2}\right) \quad (362)$$

$$+ -\frac{1}{\sqrt{2}}Y_{d,11}^*\delta_{\alpha\beta}Z_{k1}^A\left(\frac{1+\gamma_5}{2}\right) \quad (363)$$



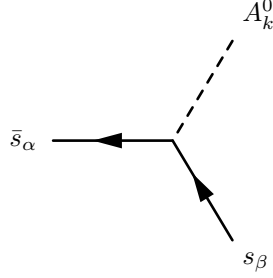
$$\frac{1}{\sqrt{2}}Y_{e,11}Z_{k1}^A\left(\frac{1-\gamma_5}{2}\right) \quad (364)$$

$$+ -\frac{1}{\sqrt{2}}Y_{e,11}^*Z_{k1}^A\left(\frac{1+\gamma_5}{2}\right) \quad (365)$$



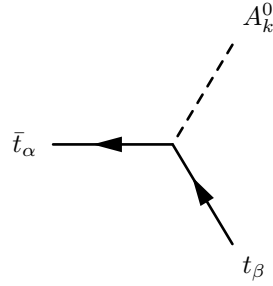
$$\frac{1}{\sqrt{2}}Y_{e,22}Z_{k1}^A\left(\frac{1-\gamma_5}{2}\right) \quad (366)$$

$$+ -\frac{1}{\sqrt{2}}Y_{e,22}^*Z_{k1}^A\left(\frac{1+\gamma_5}{2}\right) \quad (367)$$



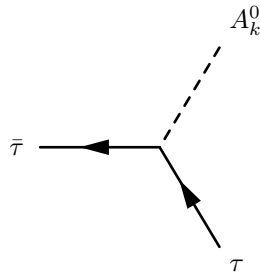
$$\frac{1}{\sqrt{2}}\delta_{\alpha\beta}Y_{d,22}Z_{k1}^A\left(\frac{1-\gamma_5}{2}\right) \quad (368)$$

$$+ -\frac{1}{\sqrt{2}}Y_{d,22}^*\delta_{\alpha\beta}Z_{k1}^A\left(\frac{1+\gamma_5}{2}\right) \quad (369)$$



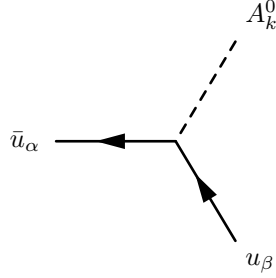
$$\frac{1}{\sqrt{2}}\delta_{\alpha\beta}Y_{u,33}Z_{k2}^A\left(\frac{1-\gamma_5}{2}\right) \quad (370)$$

$$+ -\frac{1}{\sqrt{2}}Y_{u,33}^*\delta_{\alpha\beta}Z_{k2}^A\left(\frac{1+\gamma_5}{2}\right) \quad (371)$$



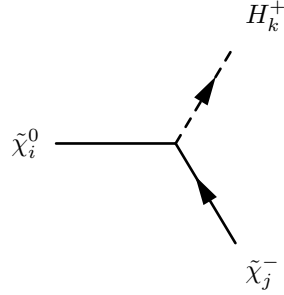
$$\frac{1}{\sqrt{2}}Y_{e,33}Z_{k1}^A\left(\frac{1-\gamma_5}{2}\right) \quad (372)$$

$$+ -\frac{1}{\sqrt{2}}Y_{e,33}^*Z_{k1}^A\left(\frac{1+\gamma_5}{2}\right) \quad (373)$$



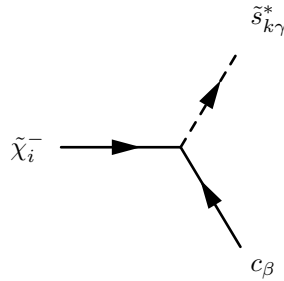
$$\frac{1}{\sqrt{2}}\delta_{\alpha\beta}Y_{u,11}Z_{k2}^A\left(\frac{1-\gamma_5}{2}\right) \quad (374)$$

$$+ -\frac{1}{\sqrt{2}}Y_{u,11}^*\delta_{\alpha\beta}Z_{k2}^A\left(\frac{1+\gamma_5}{2}\right) \quad (375)$$



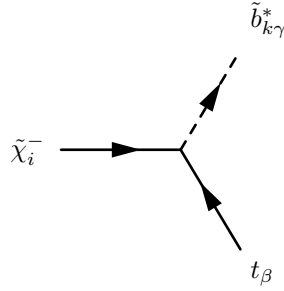
$$i\left(-g_2U_{j1}^*N_{i3}^*Z_{k1}^+ + U_{j2}^*\left(\frac{1}{\sqrt{2}}g_1N_{i1}^*Z_{k1}^+ + \frac{1}{\sqrt{2}}g_2N_{i2}^*Z_{k1}^+ - \lambda N_{i5}^*Z_{k2}^+\right)\right)\left(\frac{1-\gamma_5}{2}\right) \quad (376)$$

$$+ i\left(-\frac{1}{2}\left(2g_2V_{j1}N_{i4} + \sqrt{2}V_{j2}\left(g_1N_{i1} + g_2N_{i2}\right)\right)Z_{k2}^+ - \lambda^*V_{j2}N_{i5}Z_{k1}^+\right)\left(\frac{1+\gamma_5}{2}\right) \quad (377)$$



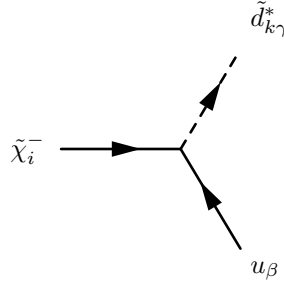
$$i\delta_{\beta\gamma}\left(-g_2U_{i1}^*Z_{k1}^S+U_{i2}^*Y_{d,22}Z_{k2}^S\right)\left(\frac{1-\gamma_5}{2}\right) \quad (378)$$

$$+iY_{u,22}^*\delta_{\beta\gamma}V_{i2}Z_{k1}^S\left(\frac{1+\gamma_5}{2}\right) \quad (379)$$



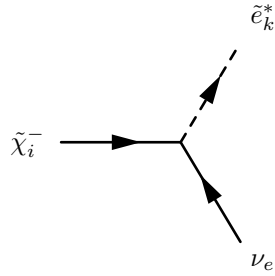
$$i\delta_{\beta\gamma}\left(-g_2U_{i1}^*Z_{k1}^B+U_{i2}^*Y_{d,33}Z_{k2}^B\right)\left(\frac{1-\gamma_5}{2}\right) \quad (380)$$

$$+iY_{u,33}^*\delta_{\beta\gamma}V_{i2}Z_{k1}^B\left(\frac{1+\gamma_5}{2}\right) \quad (381)$$

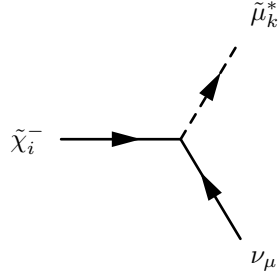


$$i\delta_{\beta\gamma}\left(-g_2U_{i1}^*Z_{k1}^D+U_{i2}^*Y_{d,11}Z_{k2}^D\right)\left(\frac{1-\gamma_5}{2}\right) \quad (382)$$

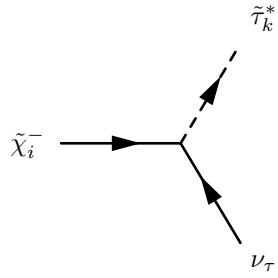
$$+iY_{u,11}^*\delta_{\beta\gamma}V_{i2}Z_{k1}^D\left(\frac{1+\gamma_5}{2}\right) \quad (383)$$



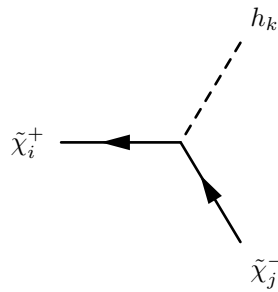
$$i \left(-g_2 U_{i1}^* Z_{k1}^E + U_{i2}^* Y_{e,11} Z_{k2}^E \right) \left(\frac{1 - \gamma_5}{2} \right) \quad (384)$$



$$i \left(-g_2 U_{i1}^* Z_{k1}^\mu + U_{i2}^* Y_{e,22} Z_{k2}^\mu \right) \left(\frac{1 - \gamma_5}{2} \right) \quad (385)$$

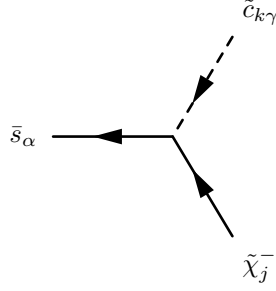


$$i \left(-g_2 U_{i1}^* Z_{k1}^\tau + U_{i2}^* Y_{e,33} Z_{k2}^\tau \right) \left(\frac{1 - \gamma_5}{2} \right) \quad (386)$$



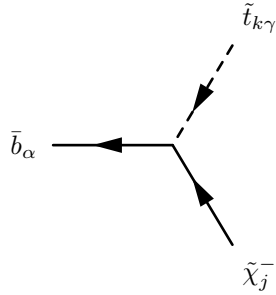
$$-i \frac{1}{\sqrt{2}} \left(g_2 U_{j1}^* V_{i2}^* Z_{k2}^H + U_{j2} \left(g_2 V_{i1}^* Z_{k1}^H + \lambda V_{i2}^* Z_{k3}^H \right) \right) \left(\frac{1 - \gamma_5}{2} \right) \quad (387)$$

$$+ -i \frac{1}{\sqrt{2}} \left(g_2 U_{i1} V_{j2} Z_{k2}^H + U_{i2} \left(g_2 V_{j1} Z_{k1}^H + \lambda^* V_{j2} Z_{k3}^H \right) \right) \left(\frac{1 + \gamma_5}{2} \right) \quad (388)$$



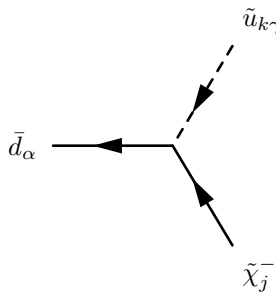
$$iU_{j2}^* Z_{k1}^{C,*} \delta_{\alpha\gamma} Y_{d,22} \left(\frac{1-\gamma_5}{2} \right) \quad (389)$$

$$+ i\delta_{\alpha\gamma} \left(-g_2 Z_{k1}^{C,*} V_{j1} + Y_{u,22}^* Z_{k2}^{C,*} V_{j2} \right) \left(\frac{1+\gamma_5}{2} \right) \quad (390)$$



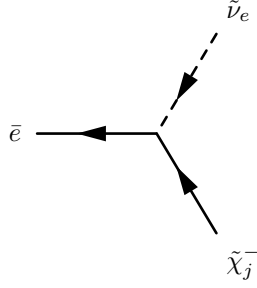
$$iU_{j2}^* Z_{k1}^{T,*} \delta_{\alpha\gamma} Y_{d,33} \left(\frac{1-\gamma_5}{2} \right) \quad (391)$$

$$+ i\delta_{\alpha\gamma} \left(-g_2 Z_{k1}^{T,*} V_{j1} + Y_{u,33}^* Z_{k2}^{T,*} V_{j2} \right) \left(\frac{1+\gamma_5}{2} \right) \quad (392)$$



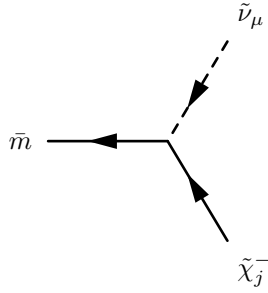
$$iU_{j2}^* Z_{k1}^{U,*} \delta_{\alpha\gamma} Y_{d,11} \left(\frac{1-\gamma_5}{2} \right) \quad (393)$$

$$+ i\delta_{\alpha\gamma} \left(-g_2 Z_{k1}^{U,*} V_{j1} + Y_{u,11}^* Z_{k2}^{U,*} V_{j2} \right) \left(\frac{1+\gamma_5}{2} \right) \quad (394)$$



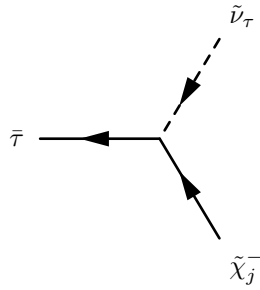
$$iU_{j2}^* Y_{e,11} \left(\frac{1-\gamma_5}{2} \right) \quad (395)$$

$$+ -ig_2 V_{j1} \left(\frac{1+\gamma_5}{2} \right) \quad (396)$$



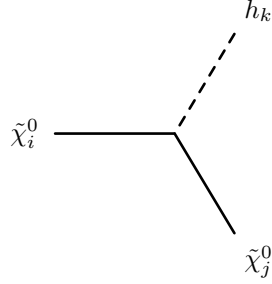
$$iU_{j2}^* Y_{e,22} \left(\frac{1-\gamma_5}{2} \right) \quad (397)$$

$$+ -ig_2 V_{j1} \left(\frac{1+\gamma_5}{2} \right) \quad (398)$$



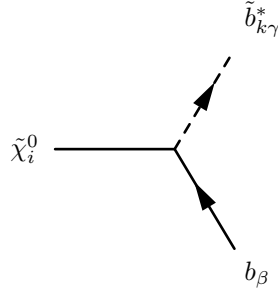
$$iU_{j2}^* Y_{e,33} \left(\frac{1-\gamma_5}{2} \right) \quad (399)$$

$$+ -ig_2 V_{j1} \left(\frac{1+\gamma_5}{2} \right) \quad (400)$$



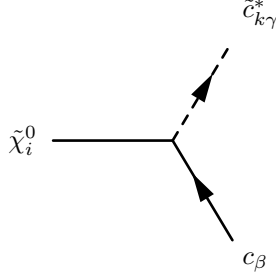
$$\begin{aligned}
& \frac{i}{2} \left(-g_2 N_{i2}^* N_{j3}^* Z_{k1}^H + \sqrt{2} \lambda N_{i5}^* N_{j4}^* Z_{k1}^H + \sqrt{2} \lambda N_{i4}^* N_{j5}^* Z_{k1}^H - g_1 N_{i4}^* N_{j1}^* Z_{k2}^H \right. \\
& + g_2 N_{i4}^* N_{j2}^* Z_{k2}^H + \sqrt{2} \lambda N_{i5}^* N_{j3}^* Z_{k2}^H + g_2 N_{i2}^* N_{j4}^* Z_{k2}^H \\
& + g_1 N_{i1}^* \left(N_{j3}^* Z_{k1}^H - N_{j4}^* Z_{k2}^H \right) + \sqrt{2} \lambda N_{i4}^* N_{j3}^* Z_{k3}^H - 2\sqrt{2} \kappa N_{i5}^* N_{j5}^* Z_{k3}^H \\
& \left. + N_{i3}^* \left(g_1 N_{j1}^* Z_{k1}^H - g_2 N_{j2}^* Z_{k1}^H + \sqrt{2} \lambda \left(N_{j4}^* Z_{k3}^H + N_{j5}^* Z_{k2}^H \right) \right) \right) \left(\frac{1 - \gamma_5}{2} \right) \tag{401}
\end{aligned}$$

$$\begin{aligned}
& + \frac{i}{2} \left(Z_{k1}^H \left(g_1 N_{i1} N_{j3} - g_2 N_{i2} N_{j3} + N_{i3} \left(g_1 N_{j1} - g_2 N_{j2} \right) + \sqrt{2} \lambda^* N_{i4} N_{j5} + \sqrt{2} \lambda^* N_{i5} N_{j4} \right) \right. \\
& + \sqrt{2} Z_{k3}^H \left(-2\kappa^* N_{i5} N_{j5} + \lambda^* \left(N_{i3} N_{j4} + N_{i4} N_{j3} \right) \right) \\
& \left. + Z_{k2}^H \left(\left(-g_1 N_{i1} + g_2 N_{i2} \right) N_{j4} + N_{i4} \left(-g_1 N_{j1} + g_2 N_{j2} \right) + \sqrt{2} \lambda^* \left(N_{i3} N_{j5} + N_{i5} N_{j3} \right) \right) \right) \left(\frac{1 + \gamma_5}{2} \right) \tag{402}
\end{aligned}$$



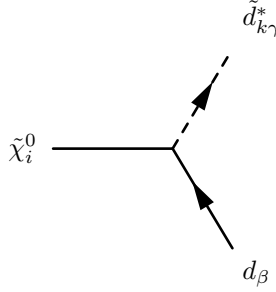
$$-\frac{i}{6} \delta_{\beta\gamma} \left(-3\sqrt{2} g_2 N_{i2}^* Z_{k1}^B + 6N_{i3}^* Y_{d,33} Z_{k2}^B + \sqrt{2} g_1 N_{i1}^* Z_{k1}^B \right) \left(\frac{1 - \gamma_5}{2} \right) \tag{403}$$

$$+\frac{i}{3} \delta_{\beta\gamma} \left(3Y_{d,33}^* Z_{k1}^B N_{i3} + \sqrt{2} g_1 Z_{k2}^B N_{i1} \right) \left(\frac{1 + \gamma_5}{2} \right) \tag{404}$$



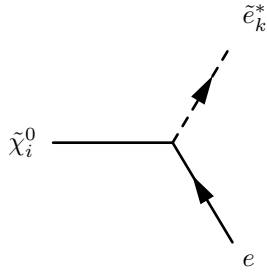
$$-\frac{i}{6}\delta_{\beta\gamma}\left(3\sqrt{2}g_2N_{i2}^*Z_{k1}^C+6N_{i4}^*Y_{u,22}Z_{k2}^C+\sqrt{2}g_1N_{i1}^*Z_{k1}^C\right)\left(\frac{1-\gamma_5}{2}\right) \quad (405)$$

$$+\frac{i}{3}\delta_{\beta\gamma}\left(2\sqrt{2}g_1Z_{k2}^CN_{i1}-3Y_{u,22}^*Z_{k1}^CN_{i4}\right)\left(\frac{1+\gamma_5}{2}\right) \quad (406)$$



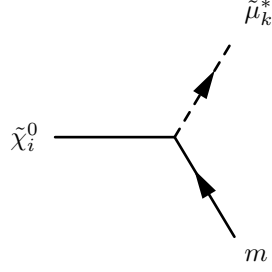
$$-\frac{i}{6}\delta_{\beta\gamma}\left(-3\sqrt{2}g_2N_{i2}^*Z_{k1}^D+6N_{i3}^*Y_{d,11}Z_{k2}^D+\sqrt{2}g_1N_{i1}^*Z_{k1}^D\right)\left(\frac{1-\gamma_5}{2}\right) \quad (407)$$

$$+\frac{i}{3}\delta_{\beta\gamma}\left(3Y_{d,11}^*Z_{k1}^DN_{i3}+\sqrt{2}g_1Z_{k2}^DN_{i1}\right)\left(\frac{1+\gamma_5}{2}\right) \quad (408)$$



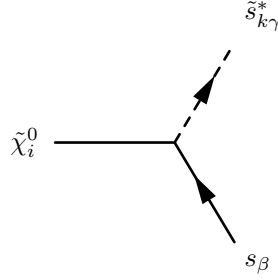
$$i\left(\frac{1}{\sqrt{2}}g_1N_{i1}^*Z_{k1}^E+\frac{1}{\sqrt{2}}g_2N_{i2}^*Z_{k1}^E-N_{i3}^*Y_{e,11}Z_{k2}^E\right)\left(\frac{1-\gamma_5}{2}\right) \quad (409)$$

$$+ i \left(-\sqrt{2}g_1 Z_{k2}^E N_{i1} - Y_{e,11}^* Z_{k1}^E N_{i3} \right) \left(\frac{1+\gamma_5}{2} \right) \quad (410)$$



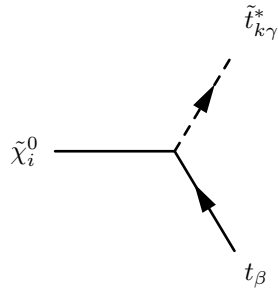
$$i \left(\frac{1}{\sqrt{2}}g_1 N_{i1}^* Z_{k1}^\mu + \frac{1}{\sqrt{2}}g_2 N_{i2}^* Z_{k1}^\mu - N_{i3}^* Y_{e,22} Z_{k2}^\mu \right) \left(\frac{1-\gamma_5}{2} \right) \quad (411)$$

$$+ i \left(-\sqrt{2}g_1 Z_{k2}^\mu N_{i1} - Y_{e,22}^* Z_{k1}^\mu N_{i3} \right) \left(\frac{1+\gamma_5}{2} \right) \quad (412)$$



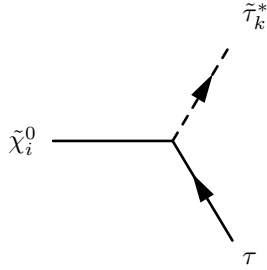
$$-\frac{i}{6} \delta_{\beta\gamma} \left(-3\sqrt{2}g_2 N_{i2}^* Z_{k1}^S + 6N_{i3}^* Y_{d,22} Z_{k2}^S + \sqrt{2}g_1 N_{i1}^* Z_{k1}^S \right) \left(\frac{1-\gamma_5}{2} \right) \quad (413)$$

$$+ -\frac{i}{3} \delta_{\beta\gamma} \left(3Y_{d,22}^* N_{i3} Z_{k1}^S + \sqrt{2}g_1 N_{i1} Z_{k2}^S \right) \left(\frac{1+\gamma_5}{2} \right) \quad (414)$$



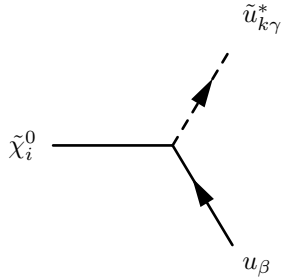
$$-\frac{i}{6}\delta_{\beta\gamma}\left(3\sqrt{2}g_2N_{i2}^*Z_{k1}^T+6N_{i4}^*Y_{u,33}Z_{k2}^T+\sqrt{2}g_1N_{i1}^*Z_{k1}^T\right)\left(\frac{1-\gamma_5}{2}\right) \quad (415)$$

$$+\frac{i}{3}\delta_{\beta\gamma}\left(2\sqrt{2}g_1N_{i1}Z_{k2}^T-3Y_{u,33}^*N_{i4}Z_{k1}^T\right)\left(\frac{1+\gamma_5}{2}\right) \quad (416)$$



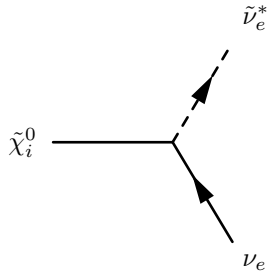
$$i\left(\frac{1}{\sqrt{2}}g_1N_{i1}^*Z_{k1}^T+\frac{1}{\sqrt{2}}g_2N_{i2}^*Z_{k1}^T-N_{i3}^*Y_{e,33}Z_{k2}^T\right)\left(\frac{1-\gamma_5}{2}\right) \quad (417)$$

$$+i\left(-\sqrt{2}g_1N_{i1}Z_{k2}^T-Y_{e,33}^*N_{i3}Z_{k1}^T\right)\left(\frac{1+\gamma_5}{2}\right) \quad (418)$$

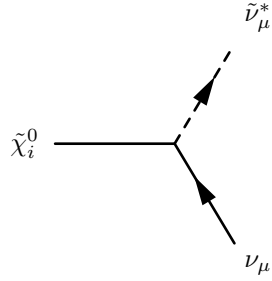


$$-\frac{i}{6}\delta_{\beta\gamma}\left(3\sqrt{2}g_2N_{i2}^*Z_{k1}^U+6N_{i4}^*Y_{u,11}Z_{k2}^U+\sqrt{2}g_1N_{i1}^*Z_{k1}^U\right)\left(\frac{1-\gamma_5}{2}\right) \quad (419)$$

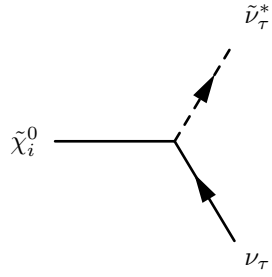
$$+\frac{i}{3}\delta_{\beta\gamma}\left(2\sqrt{2}g_1N_{i1}Z_{k2}^U-3Y_{u,11}^*N_{i4}Z_{k1}^U\right)\left(\frac{1+\gamma_5}{2}\right) \quad (420)$$



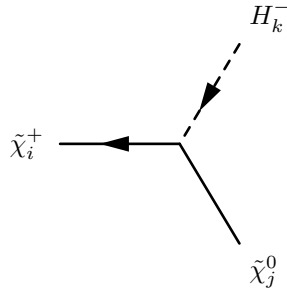
$$i \frac{1}{\sqrt{2}} (g_1 N_{i1}^* - g_2 N_{i2}^*) \left(\frac{1 - \gamma_5}{2} \right) \quad (421)$$



$$i \frac{1}{\sqrt{2}} (g_1 N_{i1}^* - g_2 N_{i2}^*) \left(\frac{1 - \gamma_5}{2} \right) \quad (422)$$

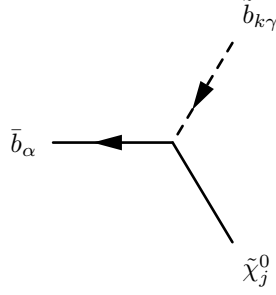


$$i \frac{1}{\sqrt{2}} (g_1 N_{i1}^* - g_2 N_{i2}^*) \left(\frac{1 - \gamma_5}{2} \right) \quad (423)$$



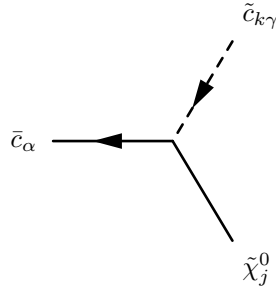
$$i \left(-\frac{1}{2} V_{i2}^* \left(2\lambda N_{j5}^* Z_{k1}^+ + \sqrt{2} (g_1 N_{j1}^* + g_2 N_{j2}^*) Z_{k2}^+ \right) - g_2 V_{i1}^* N_{j4}^* Z_{k2}^+ \right) \left(\frac{1 - \gamma_5}{2} \right) \quad (424)$$

$$+ i \left(-g_2 U_{i1} N_{j3} Z_{k1}^+ + U_{i2} \left(\frac{1}{\sqrt{2}} g_1 N_{j1} Z_{k1}^+ + \frac{1}{\sqrt{2}} g_2 N_{j2} Z_{k1}^+ - \lambda^* N_{j5} Z_{k2}^+ \right) \right) \left(\frac{1 + \gamma_5}{2} \right) \quad (425)$$



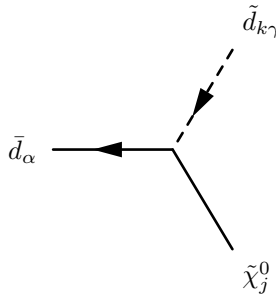
$$-\frac{i}{3}\delta_{\alpha\gamma}\left(3Z_{k_1}^{B,*}N_{j_3}^*Y_{d,33}+\sqrt{2}g_1Z_{k_2}^{B,*}N_{j_1}^*\right)\left(\frac{1-\gamma_5}{2}\right) \quad (426)$$

$$+\frac{i}{6}\delta_{\alpha\gamma}\left(6Y_{d,33}^*Z_{k_2}^{B,*}N_{j_3}+\sqrt{2}Z_{k_1}^{B,*}\left(-3g_2N_{j_2}+g_1N_{j_1}\right)\right)\left(\frac{1+\gamma_5}{2}\right) \quad (427)$$



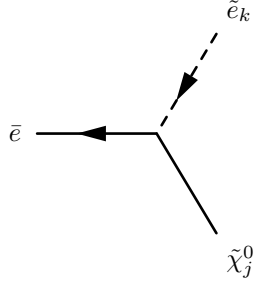
$$\frac{i}{3}\delta_{\alpha\gamma}\left(2\sqrt{2}g_1Z_{k_2}^{C,*}N_{j_1}^*-3Z_{k_1}^{C,*}N_{j_4}^*Y_{u,22}\right)\left(\frac{1-\gamma_5}{2}\right) \quad (428)$$

$$+\frac{i}{6}\delta_{\alpha\gamma}\left(6Y_{u,22}^*Z_{k_2}^{C,*}N_{j_4}+\sqrt{2}Z_{k_1}^{C,*}\left(3g_2N_{j_2}+g_1N_{j_1}\right)\right)\left(\frac{1+\gamma_5}{2}\right) \quad (429)$$



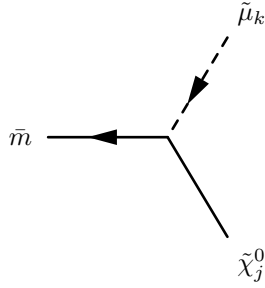
$$-\frac{i}{3}\delta_{\alpha\gamma}\left(3Z_{k_1}^{D,*}N_{j_3}^*Y_{d,11}+\sqrt{2}g_1Z_{k_2}^{D,*}N_{j_1}^*\right)\left(\frac{1-\gamma_5}{2}\right) \quad (430)$$

$$+\frac{i}{6}\delta_{\alpha\gamma}\left(6Y_{d,11}^*Z_{k_2}^{D,*}N_{j_3}+\sqrt{2}Z_{k_1}^{D,*}\left(-3g_2N_{j_2}+g_1N_{j_1}\right)\right)\left(\frac{1+\gamma_5}{2}\right) \quad (431)$$



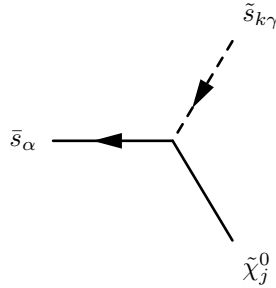
$$i \left(-\sqrt{2}g_1 Z_{k2}^{E,*} N_{j1}^* - Z_{k1}^{E,*} N_{j3}^* Y_{e,11} \right) \left(\frac{1-\gamma_5}{2} \right) \quad (432)$$

$$+ i \left(\frac{1}{\sqrt{2}} Z_{k1}^{E,*} (g_1 N_{j1} + g_2 N_{j2}) - Y_{e,11}^* Z_{k2}^{E,*} N_{j3} \right) \left(\frac{1+\gamma_5}{2} \right) \quad (433)$$



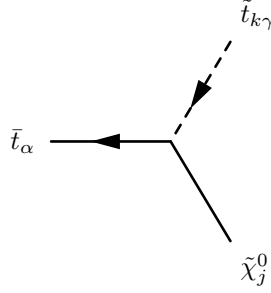
$$i \left(-\sqrt{2}g_1 Z_{k2}^{\mu,*} N_{j1}^* - Z_{k1}^{\mu,*} N_{j3}^* Y_{e,22} \right) \left(\frac{1-\gamma_5}{2} \right) \quad (434)$$

$$+ i \left(\frac{1}{\sqrt{2}} Z_{k1}^{\mu,*} (g_1 N_{j1} + g_2 N_{j2}) - Y_{e,22}^* Z_{k2}^{\mu,*} N_{j3} \right) \left(\frac{1+\gamma_5}{2} \right) \quad (435)$$



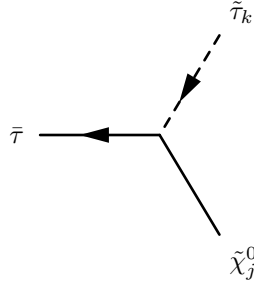
$$-\frac{i}{3} \delta_{\alpha\gamma} \left(3N_{j3}^* Z_{k1}^{S,*} Y_{d,22} + \sqrt{2}g_1 N_{j1}^* Z_{k2}^{S,*} \right) \left(\frac{1-\gamma_5}{2} \right) \quad (436)$$

$$+ -\frac{i}{6}\delta_{\alpha\gamma}\left(6Y_{d,22}^*Z_{k2}^{S,*}N_{j3} + \sqrt{2}Z_{k1}^{S,*}\left(-3g_2N_{j2} + g_1N_{j1}\right)\right)\left(\frac{1+\gamma_5}{2}\right) \quad (437)$$



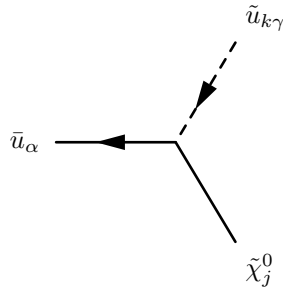
$$\frac{i}{3}\delta_{\alpha\gamma}\left(2\sqrt{2}g_1N_{j1}^*Z_{k2}^{T,*} - 3N_{j4}^*Z_{k1}^{T,*}Y_{u,33}\right)\left(\frac{1-\gamma_5}{2}\right) \quad (438)$$

$$+ -\frac{i}{6}\delta_{\alpha\gamma}\left(6Y_{u,33}^*Z_{k2}^{T,*}N_{j4} + \sqrt{2}Z_{k1}^{T,*}\left(3g_2N_{j2} + g_1N_{j1}\right)\right)\left(\frac{1+\gamma_5}{2}\right) \quad (439)$$



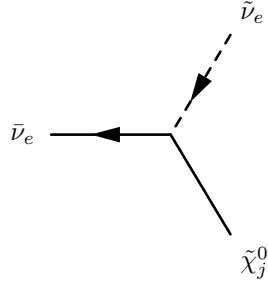
$$i\left(-N_{j3}^*Z_{k1}^{T,*}Y_{e,33} - \sqrt{2}g_1N_{j1}^*Z_{k2}^{T,*}\right)\left(\frac{1-\gamma_5}{2}\right) \quad (440)$$

$$+ i\left(\frac{1}{\sqrt{2}}Z_{k1}^{T,*}\left(g_1N_{j1} + g_2N_{j2}\right) - Y_{e,33}^*Z_{k2}^{T,*}N_{j3}\right)\left(\frac{1+\gamma_5}{2}\right) \quad (441)$$



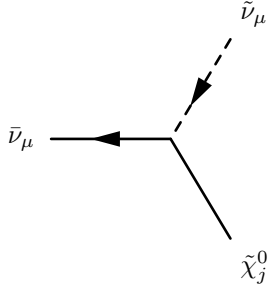
$$\frac{i}{3}\delta_{\alpha\gamma}\left(2\sqrt{2}g_1N_{j1}^*Z_{k2}^{U,*}-3N_{j4}^*Z_{k1}^{U,*}Y_{u,11}\right)\left(\frac{1-\gamma_5}{2}\right) \quad (442)$$

$$+ -\frac{i}{6}\delta_{\alpha\gamma}\left(6Y_{u,11}^*Z_{k2}^{U,*}N_{j4}+\sqrt{2}Z_{k1}^{U,*}\left(3g_2N_{j2}+g_1N_{j1}\right)\right)\left(\frac{1+\gamma_5}{2}\right) \quad (443)$$



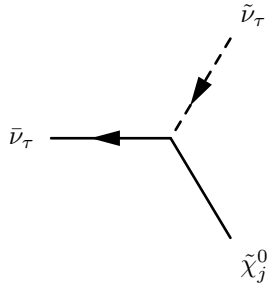
(444)

$$+ i\frac{1}{\sqrt{2}}\left(g_1N_{j1}-g_2N_{j2}\right)\left(\frac{1+\gamma_5}{2}\right) \quad (445)$$



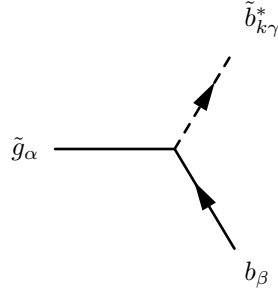
(446)

$$+ i\frac{1}{\sqrt{2}}\left(g_1N_{j1}-g_2N_{j2}\right)\left(\frac{1+\gamma_5}{2}\right) \quad (447)$$



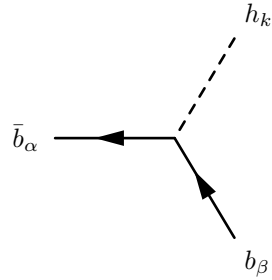
(448)

$$+ i \frac{1}{\sqrt{2}} (g_1 N_{j1} - g_2 N_{j2}) \left(\frac{1 + \gamma_5}{2} \right) \quad (449)$$



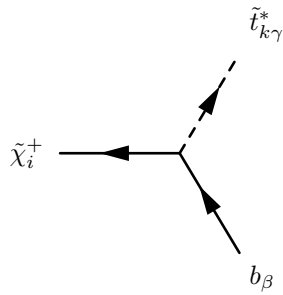
$$- i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}} \lambda_{\gamma, \beta}^\alpha Z_{k1}^B \left(\frac{1 - \gamma_5}{2} \right) \quad (450)$$

$$+ i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}}^* \lambda_{\gamma, \beta}^\alpha Z_{k2}^B \left(\frac{1 + \gamma_5}{2} \right) \quad (451)$$



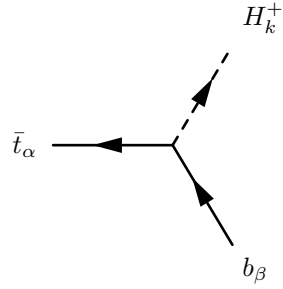
$$- i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} Y_{d,33} Z_{k1}^H \left(\frac{1 - \gamma_5}{2} \right) \quad (452)$$

$$+ -i \frac{1}{\sqrt{2}} Y_{d,33}^* \delta_{\alpha\beta} Z_{k1}^H \left(\frac{1 + \gamma_5}{2} \right) \quad (453)$$



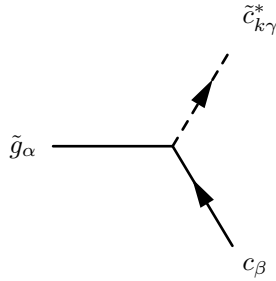
$$i\delta_{\beta\gamma}\left(-g_2V_{i1}^*Z_{k1}^T+V_{i2}^*Y_{u,33}Z_{k2}^T\right)\left(\frac{1-\gamma_5}{2}\right) \quad (454)$$

$$+iY_{d,33}^*\delta_{\beta\gamma}U_{i2}Z_{k1}^T\left(\frac{1+\gamma_5}{2}\right) \quad (455)$$



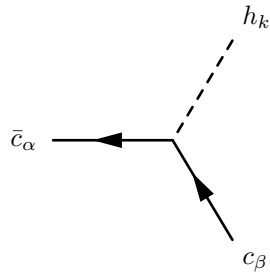
$$i\delta_{\alpha\beta}Y_{u,33}Z_{k2}^+\left(\frac{1-\gamma_5}{2}\right) \quad (456)$$

$$+iY_{d,33}^*\delta_{\alpha\beta}Z_{k1}^+\left(\frac{1+\gamma_5}{2}\right) \quad (457)$$



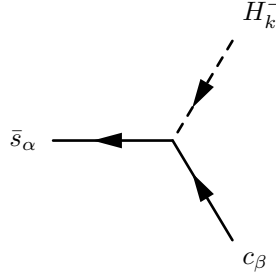
$$-i\frac{1}{\sqrt{2}}g_3\phi_{\tilde{g}}\lambda_{\gamma,\beta}^\alpha Z_{k1}^C\left(\frac{1-\gamma_5}{2}\right) \quad (458)$$

$$+i\frac{1}{\sqrt{2}}g_3\phi_{\tilde{g}}^*\lambda_{\gamma,\beta}^\alpha Z_{k2}^C\left(\frac{1+\gamma_5}{2}\right) \quad (459)$$



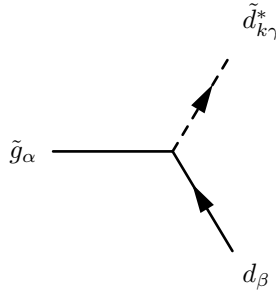
$$-i\frac{1}{\sqrt{2}}\delta_{\alpha\beta}Y_{u,22}Z_{k2}^H\left(\frac{1-\gamma_5}{2}\right) \quad (460)$$

$$+ -i\frac{1}{\sqrt{2}}Y_{u,22}^*\delta_{\alpha\beta}Z_{k2}^H\left(\frac{1+\gamma_5}{2}\right) \quad (461)$$



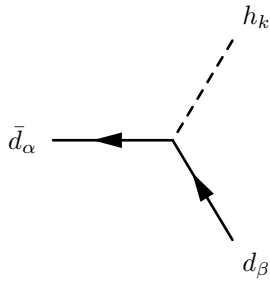
$$i\delta_{\alpha\beta}Y_{d,22}Z_{k1}^+\left(\frac{1-\gamma_5}{2}\right) \quad (462)$$

$$+ iY_{u,22}^*\delta_{\alpha\beta}Z_{k2}^+\left(\frac{1+\gamma_5}{2}\right) \quad (463)$$



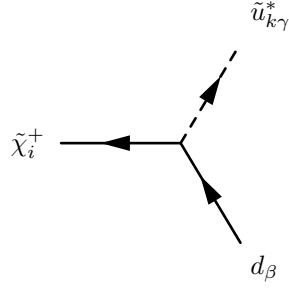
$$-i\frac{1}{\sqrt{2}}g_3\phi_{\tilde{g}}\lambda_{\gamma,\beta}^\alpha Z_{k1}^D\left(\frac{1-\gamma_5}{2}\right) \quad (464)$$

$$+ i\frac{1}{\sqrt{2}}g_3\phi_{\tilde{g}}^*\lambda_{\gamma,\beta}^\alpha Z_{k2}^D\left(\frac{1+\gamma_5}{2}\right) \quad (465)$$



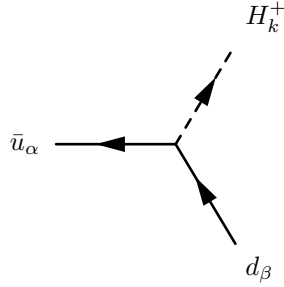
$$-i\frac{1}{\sqrt{2}}\delta_{\alpha\beta}Y_{d,11}Z_{k1}^H\left(\frac{1-\gamma_5}{2}\right) \quad (466)$$

$$+ -i\frac{1}{\sqrt{2}}Y_{d,11}^*\delta_{\alpha\beta}Z_{k1}^H\left(\frac{1+\gamma_5}{2}\right) \quad (467)$$



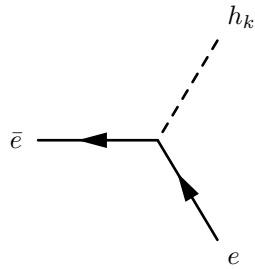
$$i\delta_{\beta\gamma}\left(-g_2V_{i1}^*Z_{k1}^U + V_{i2}^*Y_{u,11}Z_{k2}^U\right)\left(\frac{1-\gamma_5}{2}\right) \quad (468)$$

$$+ iY_{d,11}^*\delta_{\beta\gamma}U_{i2}Z_{k1}^U\left(\frac{1+\gamma_5}{2}\right) \quad (469)$$



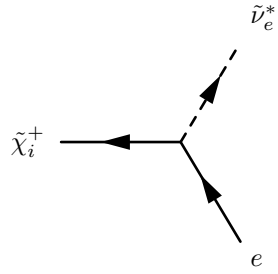
$$i\delta_{\alpha\beta}Y_{u,11}Z_{k2}^+\left(\frac{1-\gamma_5}{2}\right) \quad (470)$$

$$+ iY_{d,11}^*\delta_{\alpha\beta}Z_{k1}^+\left(\frac{1+\gamma_5}{2}\right) \quad (471)$$



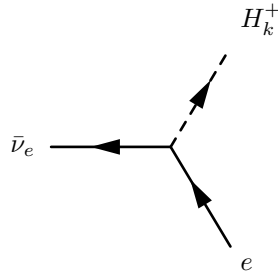
$$-i \frac{1}{\sqrt{2}} Y_{e,11} Z_{k1}^H \left(\frac{1 - \gamma_5}{2} \right) \quad (472)$$

$$+ -i \frac{1}{\sqrt{2}} Y_{e,11}^* Z_{k1}^H \left(\frac{1 + \gamma_5}{2} \right) \quad (473)$$



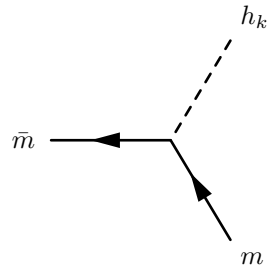
$$-ig_2 V_{i1}^* \left(\frac{1 - \gamma_5}{2} \right) \quad (474)$$

$$+ iY_{e,11}^* U_{i2} \left(\frac{1 + \gamma_5}{2} \right) \quad (475)$$



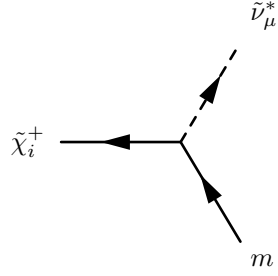
$$(476)$$

$$+ iY_{e,11}^* Z_{k1}^+ \left(\frac{1 + \gamma_5}{2} \right) \quad (477)$$



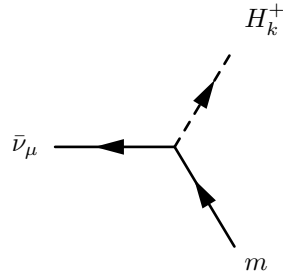
$$-i \frac{1}{\sqrt{2}} Y_{e,22} Z_{k1}^H \left(\frac{1 - \gamma_5}{2} \right) \quad (478)$$

$$+ -i \frac{1}{\sqrt{2}} Y_{e,22}^* Z_{k1}^H \left(\frac{1 + \gamma_5}{2} \right) \quad (479)$$



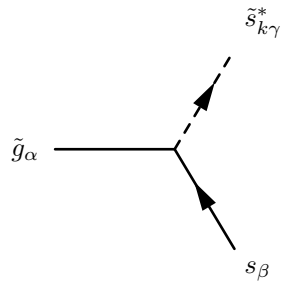
$$-ig_2 V_{i1}^* \left(\frac{1 - \gamma_5}{2} \right) \quad (480)$$

$$+ iY_{e,22}^* U_{i2} \left(\frac{1 + \gamma_5}{2} \right) \quad (481)$$



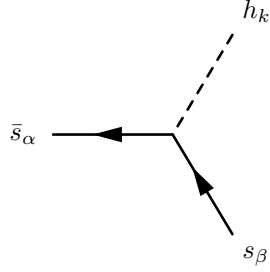
$$(482)$$

$$+ iY_{e,22}^* Z_{k1}^+ \left(\frac{1 + \gamma_5}{2} \right) \quad (483)$$



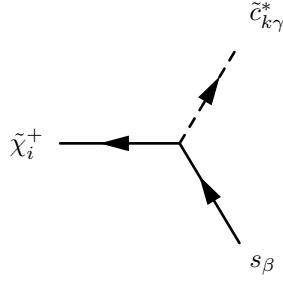
$$-i \frac{1}{\sqrt{2}} g_3 \phi_{\bar{g}} \lambda_{\gamma, \beta}^\alpha Z_{k1}^S \left(\frac{1 - \gamma_5}{2} \right) \quad (484)$$

$$+ i \frac{1}{\sqrt{2}} g_3 \phi_{\bar{g}}^* \lambda_{\gamma, \beta}^\alpha Z_{k2}^S \left(\frac{1 + \gamma_5}{2} \right) \quad (485)$$



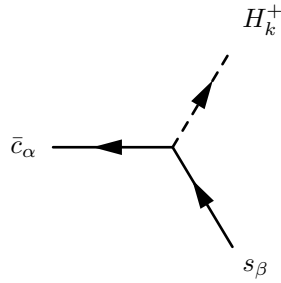
$$-i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} Y_{d,22} Z_{k1}^H \left(\frac{1 - \gamma_5}{2} \right) \quad (486)$$

$$+ -i \frac{1}{\sqrt{2}} Y_{d,22}^* \delta_{\alpha\beta} Z_{k1}^H \left(\frac{1 + \gamma_5}{2} \right) \quad (487)$$



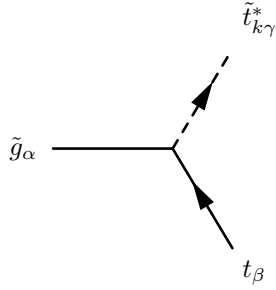
$$i \delta_{\beta\gamma} \left(-g_2 V_{i1}^* Z_{k1}^C + V_{i2}^* Y_{u,22} Z_{k2}^C \right) \left(\frac{1 - \gamma_5}{2} \right) \quad (488)$$

$$+ i Y_{d,22}^* \delta_{\beta\gamma} U_{i2} Z_{k1}^C \left(\frac{1 + \gamma_5}{2} \right) \quad (489)$$



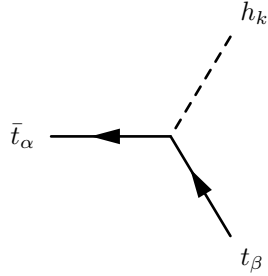
$$i\delta_{\alpha\beta}Y_{u,22}Z_{k2}^+\left(\frac{1-\gamma_5}{2}\right) \quad (490)$$

$$+ iY_{d,22}^*\delta_{\alpha\beta}Z_{k1}^+\left(\frac{1+\gamma_5}{2}\right) \quad (491)$$



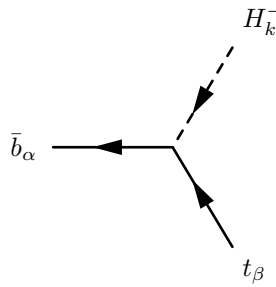
$$-i\frac{1}{\sqrt{2}}g_3\phi_{\tilde{g}}\lambda_{\gamma,\beta}^\alpha Z_{k1}^T\left(\frac{1-\gamma_5}{2}\right) \quad (492)$$

$$+ i\frac{1}{\sqrt{2}}g_3\phi_{\tilde{g}}^*\lambda_{\gamma,\beta}^\alpha Z_{k2}^T\left(\frac{1+\gamma_5}{2}\right) \quad (493)$$



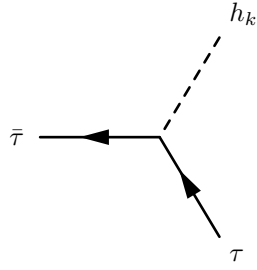
$$-i\frac{1}{\sqrt{2}}\delta_{\alpha\beta}Y_{u,33}Z_{k2}^H\left(\frac{1-\gamma_5}{2}\right) \quad (494)$$

$$+ -i\frac{1}{\sqrt{2}}Y_{u,33}^*\delta_{\alpha\beta}Z_{k2}^H\left(\frac{1+\gamma_5}{2}\right) \quad (495)$$



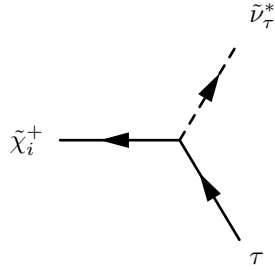
$$i\delta_{\alpha\beta}Y_{d,33}Z_{k1}^+\left(\frac{1-\gamma_5}{2}\right) \quad (496)$$

$$+ iY_{u,33}^*\delta_{\alpha\beta}Z_{k2}^+\left(\frac{1+\gamma_5}{2}\right) \quad (497)$$



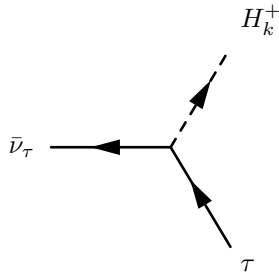
$$-i\frac{1}{\sqrt{2}}Y_{e,33}Z_{k1}^H\left(\frac{1-\gamma_5}{2}\right) \quad (498)$$

$$+ -i\frac{1}{\sqrt{2}}Y_{e,33}^*Z_{k1}^H\left(\frac{1+\gamma_5}{2}\right) \quad (499)$$



$$-ig_2V_{i1}^*\left(\frac{1-\gamma_5}{2}\right) \quad (500)$$

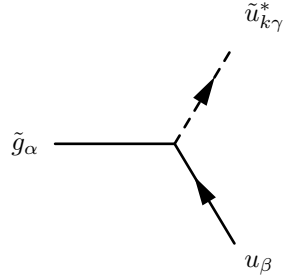
$$+ iY_{e,33}^*U_{i2}\left(\frac{1+\gamma_5}{2}\right) \quad (501)$$



(502)

$$+ iY_{e,33}^* Z_{k1}^+ \left(\frac{1 + \gamma_5}{2} \right)$$

(503)

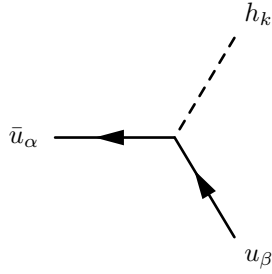


$$- i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}} \lambda_{\gamma,\beta}^\alpha Z_{k1}^U \left(\frac{1 - \gamma_5}{2} \right)$$

(504)

$$+ i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}}^* \lambda_{\gamma,\beta}^\alpha Z_{k2}^U \left(\frac{1 + \gamma_5}{2} \right)$$

(505)

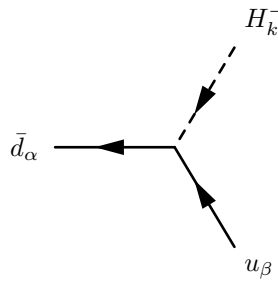


$$- i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} Y_{u,11} Z_{k2}^H \left(\frac{1 - \gamma_5}{2} \right)$$

(506)

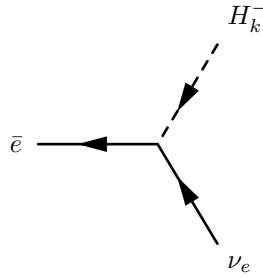
$$+ -i \frac{1}{\sqrt{2}} Y_{u,11}^* \delta_{\alpha\beta} Z_{k2}^H \left(\frac{1 + \gamma_5}{2} \right)$$

(507)

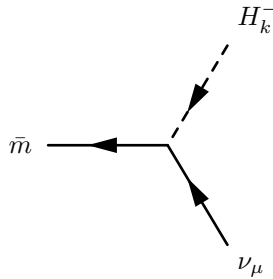


$$i\delta_{\alpha\beta}Y_{d,11}Z_{k1}^+\left(\frac{1-\gamma_5}{2}\right) \quad (508)$$

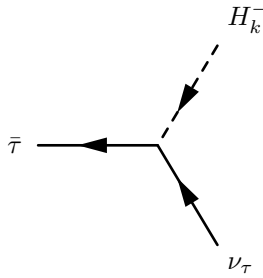
$$+ iY_{u,11}^*\delta_{\alpha\beta}Z_{k2}^+\left(\frac{1+\gamma_5}{2}\right) \quad (509)$$



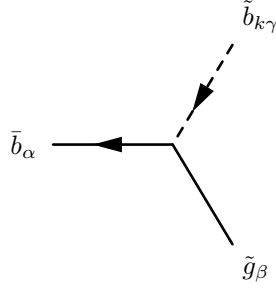
$$iY_{e,11}Z_{k1}^+\left(\frac{1-\gamma_5}{2}\right) \quad (510)$$



$$iY_{e,22}Z_{k1}^+\left(\frac{1-\gamma_5}{2}\right) \quad (511)$$

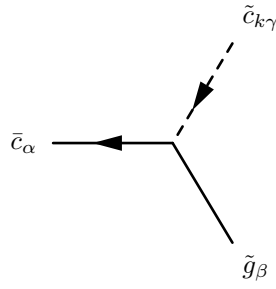


$$iY_{e,33}Z_{k1}^+\left(\frac{1-\gamma_5}{2}\right) \quad (512)$$



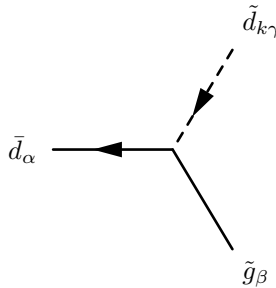
$$i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}} Z_{k2}^{B,*} \lambda_{\alpha,\gamma}^\beta \left(\frac{1 - \gamma_5}{2} \right) \quad (513)$$

$$+ -i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}}^* Z_{k1}^{B,*} \lambda_{\alpha,\gamma}^\beta \left(\frac{1 + \gamma_5}{2} \right) \quad (514)$$



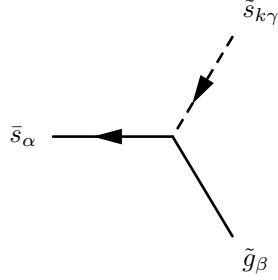
$$i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}} Z_{k2}^{C,*} \lambda_{\alpha,\gamma}^\beta \left(\frac{1 - \gamma_5}{2} \right) \quad (515)$$

$$+ -i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}}^* Z_{k1}^{C,*} \lambda_{\alpha,\gamma}^\beta \left(\frac{1 + \gamma_5}{2} \right) \quad (516)$$



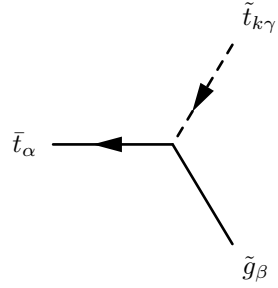
$$i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}} Z_{k2}^{D,*} \lambda_{\alpha,\gamma}^\beta \left(\frac{1 - \gamma_5}{2} \right) \quad (517)$$

$$+ -i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}}^* Z_{k1}^{D,*} \lambda_{\alpha,\gamma}^\beta \left(\frac{1+\gamma_5}{2} \right) \quad (518)$$



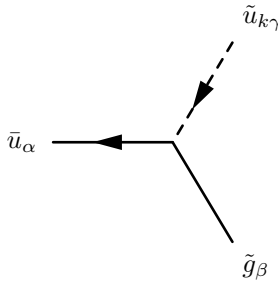
$$i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}} Z_{k2}^{S,*} \lambda_{\alpha,\gamma}^\beta \left(\frac{1-\gamma_5}{2} \right) \quad (519)$$

$$+ -i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}}^* Z_{k1}^{S,*} \lambda_{\alpha,\gamma}^\beta \left(\frac{1+\gamma_5}{2} \right) \quad (520)$$



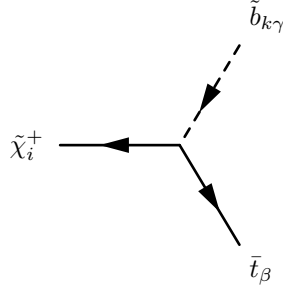
$$i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}} Z_{k2}^{T,*} \lambda_{\alpha,\gamma}^\beta \left(\frac{1-\gamma_5}{2} \right) \quad (521)$$

$$+ -i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}}^* Z_{k1}^{T,*} \lambda_{\alpha,\gamma}^\beta \left(\frac{1+\gamma_5}{2} \right) \quad (522)$$



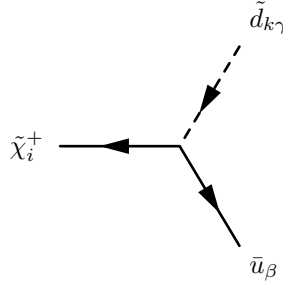
$$i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}} Z_{k2}^{U,*} \lambda_{\alpha,\gamma}^\beta \left(\frac{1-\gamma_5}{2} \right) \quad (523)$$

$$+ -i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}}^* Z_{k1}^{U,*} \lambda_{\alpha,\gamma}^\beta \left(\frac{1+\gamma_5}{2} \right) \quad (524)$$



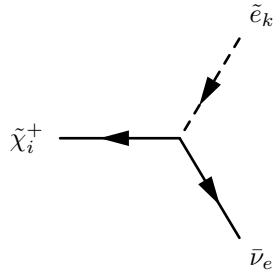
$$i V_{i2}^* Z_{k1}^{B,*} \delta_{\beta\gamma} Y_{u,33} \left(\frac{1-\gamma_5}{2} \right) \quad (525)$$

$$+ i \delta_{\beta\gamma} \left(-g_2 Z_{k1}^{B,*} U_{i1} + Y_{d,33}^* Z_{k2}^{B,*} U_{i2} \right) \left(\frac{1+\gamma_5}{2} \right) \quad (526)$$



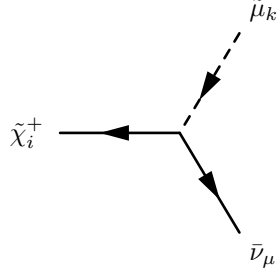
$$i V_{i2}^* Z_{k1}^{D,*} \delta_{\beta\gamma} Y_{u,11} \left(\frac{1-\gamma_5}{2} \right) \quad (527)$$

$$+ i \delta_{\beta\gamma} \left(-g_2 Z_{k1}^{D,*} U_{i1} + Y_{d,11}^* Z_{k2}^{D,*} U_{i2} \right) \left(\frac{1+\gamma_5}{2} \right) \quad (528)$$



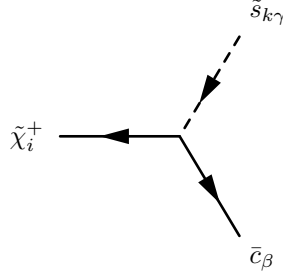
(529)

$$+ i \left(-g_2 Z_{k1}^{E,*} U_{i1} + Y_{e,11}^* Z_{k2}^{E,*} U_{i2} \right) \left(\frac{1 + \gamma_5}{2} \right) \quad (530)$$



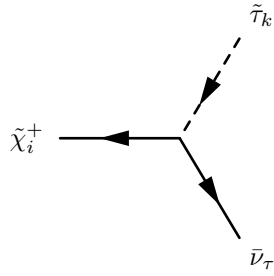
(531)

$$+ i \left(-g_2 Z_{k1}^{\mu,*} U_{i1} + Y_{e,22}^* Z_{k2}^{\mu,*} U_{i2} \right) \left(\frac{1 + \gamma_5}{2} \right) \quad (532)$$



$$i V_{i2}^* Z_{k1}^{S,*} \delta_{\beta\gamma} Y_{u,22} \left(\frac{1 - \gamma_5}{2} \right) \quad (533)$$

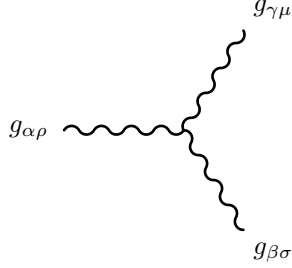
$$+ i \delta_{\beta\gamma} \left(-g_2 Z_{k1}^{S,*} U_{i1} + Y_{d,22}^* Z_{k2}^{S,*} U_{i2} \right) \left(\frac{1 + \gamma_5}{2} \right) \quad (534)$$



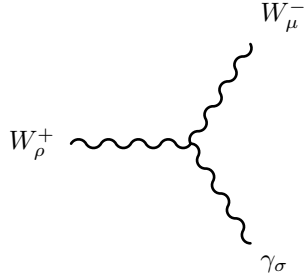
(535)

$$+ i \left(-g_2 Z_{k1}^{T,*} U_{i1} + Y_{e,33}^* Z_{k2}^{T,*} U_{i2} \right) \left(\frac{1 + \gamma_5}{2} \right) \quad (536)$$

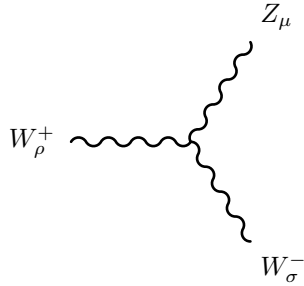
9.6 Three Vector Boson-Interaction



$$g_3 f_{\alpha,\beta,\gamma} \left(g_{\rho\mu} \left(-p_\sigma^{g_{\gamma\mu}} + p_\sigma^{g_{\alpha\rho}} \right) + g_{\rho\sigma} \left(-p_\mu^{g_{\alpha\rho}} + p_\mu^{g_{\beta\sigma}} \right) + g_{\sigma\mu} \left(-p_\rho^{g_{\beta\sigma}} + p_\rho^{g_{\gamma\mu}} \right) \right) \quad (537)$$

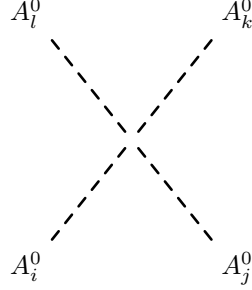


$$ig_2 \sin \Theta_W \left(g_{\rho\mu} \left(-p_\sigma^{W^-} + p_\sigma^{W^+} \right) + g_{\rho\sigma} \left(-p_\mu^{W^+} + p_\mu^{\gamma_\sigma} \right) + g_{\sigma\mu} \left(-p_\rho^{\gamma_\sigma} + p_\rho^{W^-} \right) \right) \quad (538)$$

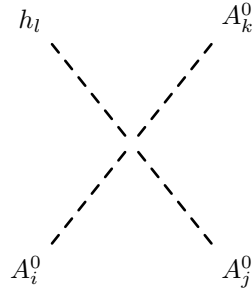


$$-ig_2 \cos \Theta_W \left(g_{\rho\mu} \left(-p_\sigma^{Z^\mu} + p_\sigma^{W^+} \right) + g_{\rho\sigma} \left(-p_\mu^{W^+} + p_\mu^{W^-} \right) + g_{\sigma\mu} \left(-p_\rho^{W^-} + p_\rho^{Z^\mu} \right) \right) \quad (539)$$

9.7 Four Scalar-Interaction

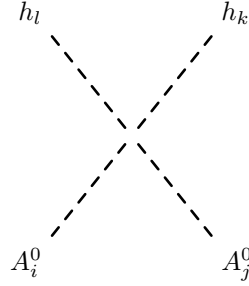


$$\begin{aligned}
& \frac{i}{4} \left(Z_{i1}^A \left(Z_{j1}^A \left(-3(g_1^2 + g_2^2) Z_{k1}^A Z_{l1}^A + \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k2}^A Z_{l2}^A - 4|\lambda|^2 Z_{k3}^A Z_{l3}^A \right) \right. \right. \\
& + Z_{j2}^A \left(2(\kappa\lambda^* + \lambda\kappa^*) Z_{k3}^A Z_{l3}^A + \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k1}^A Z_{l2}^A + \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k2}^A Z_{l1}^A \right) \\
& + 2Z_{j3}^A \left(\lambda^* \left(\left(-2\lambda Z_{k1}^A + \kappa Z_{k2}^A \right) Z_{l3}^A + Z_{k3}^A \left(-2\lambda Z_{l1}^A + \kappa Z_{l2}^A \right) \right) + \lambda\kappa^* \left(Z_{k2}^A Z_{l3}^A + Z_{k3}^A Z_{l2}^A \right) \right) \\
& + Z_{i2}^A \left(Z_{j2}^A \left(-3(g_1^2 + g_2^2) Z_{k2}^A Z_{l2}^A + \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k1}^A Z_{l1}^A - 4|\lambda|^2 Z_{k3}^A Z_{l3}^A \right) \right. \\
& + Z_{j1}^A \left(2(\kappa\lambda^* + \lambda\kappa^*) Z_{k3}^A Z_{l3}^A + \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k1}^A Z_{l2}^A + \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k2}^A Z_{l1}^A \right) \\
& + 2Z_{j3}^A \left(\lambda^* \left(\left(-2\lambda Z_{k2}^A + \kappa Z_{k1}^A \right) Z_{l3}^A + Z_{k3}^A \left(-2\lambda Z_{l2}^A + \kappa Z_{l1}^A \right) \right) + \lambda\kappa^* \left(Z_{k1}^A Z_{l3}^A + Z_{k3}^A Z_{l1}^A \right) \right) \\
& + 2Z_{i3}^A \left(\lambda^* \left(Z_{j3}^A \left(Z_{k1}^A \left(-2\lambda Z_{l1}^A + \kappa Z_{l2}^A \right) + Z_{k2}^A \left(-2\lambda Z_{l2}^A + \kappa Z_{l1}^A \right) \right) \right. \right. \\
& + Z_{j1}^A \left(\left(-2\lambda Z_{k1}^A + \kappa Z_{k2}^A \right) Z_{l3}^A + Z_{k3}^A \left(-2\lambda Z_{l1}^A + \kappa Z_{l2}^A \right) \right) \\
& + Z_{j2}^A \left(\left(-2\lambda Z_{k2}^A + \kappa Z_{k1}^A \right) Z_{l3}^A + Z_{k3}^A \left(-2\lambda Z_{l2}^A + \kappa Z_{l1}^A \right) \right) \\
& + \kappa^* \left(Z_{j3}^A \left(-12\kappa Z_{k3}^A Z_{l3}^A + \lambda Z_{k1}^A Z_{l2}^A + \lambda Z_{k2}^A Z_{l1}^A \right) \right. \\
& \left. \left. + \lambda \left(Z_{j1}^A \left(Z_{k2}^A Z_{l3}^A + Z_{k3}^A Z_{l2}^A \right) + Z_{j2}^A \left(Z_{k1}^A Z_{l3}^A + Z_{k3}^A Z_{l1}^A \right) \right) \right) \right) \right) \tag{540}
\end{aligned}$$

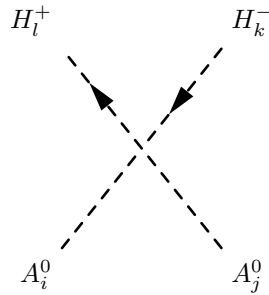


$$-\frac{1}{2} \left(-\kappa\lambda^* + \lambda\kappa^* \right) \left(Z_{i2}^A \left(Z_{j1}^A Z_{k3}^A Z_{l3}^H + Z_{j3}^A \left(Z_{k1}^A Z_{l3}^H - Z_{k3}^A Z_{l1}^H \right) \right) \right)$$

$$\begin{aligned}
& -Z_{i3}^A \left(Z_{j1}^A \left(-Z_{k2}^A Z_{l3}^H + Z_{k3}^A Z_{l2}^H \right) + Z_{j2}^A \left(-Z_{k1}^A Z_{l3}^H + Z_{k3}^A Z_{l1}^H \right) + Z_{j3}^A \left(Z_{k1}^A Z_{l2}^H + Z_{k2}^A Z_{l1}^H \right) \right) \\
& + Z_{i1}^A \left(Z_{j2}^A Z_{k3}^A Z_{l3}^H + Z_{j3}^A \left(Z_{k2}^A Z_{l3}^H - Z_{k3}^A Z_{l2}^H \right) \right)
\end{aligned} \tag{541}$$

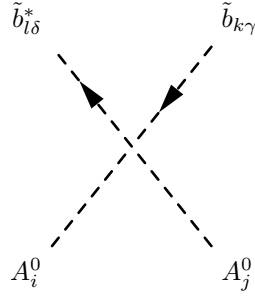


$$\begin{aligned}
& \frac{i}{4} \left(Z_{i2}^A \left(Z_{j2}^A \left(\left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k1}^H Z_{l1}^H - 4|\lambda|^2 Z_{k3}^H Z_{l3}^H - \left(g_1^2 + g_2^2 \right) Z_{k2}^H Z_{l2}^H \right) \right. \right. \\
& + 2 \left(\kappa \lambda^* + \lambda \kappa^* \right) \left(-Z_{j1}^A Z_{k3}^H Z_{l3}^H + Z_{j3}^A \left(Z_{k1}^H Z_{l3}^H + Z_{k3}^H Z_{l1}^H \right) \right) \left. \right) \\
& + Z_{i1}^A \left(-Z_{j1}^A \left(- \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k2}^H Z_{l2}^H + 4|\lambda|^2 Z_{k3}^H Z_{l3}^H + \left(g_1^2 + g_2^2 \right) Z_{k1}^H Z_{l1}^H \right) \right. \\
& + 2 \left(\kappa \lambda^* + \lambda \kappa^* \right) \left(-Z_{j2}^A Z_{k3}^H Z_{l3}^H + Z_{j3}^A \left(Z_{k2}^H Z_{l3}^H + Z_{k3}^H Z_{l2}^H \right) \right) \left. \right) \\
& + 2 Z_{i3}^A \left(\lambda^* \left(-Z_{j3}^A \left(Z_{k1}^H \left(2\lambda Z_{l1}^H + \kappa Z_{l2}^H \right) + Z_{k2}^H \left(2\lambda Z_{l2}^H + \kappa Z_{l1}^H \right) \right) \right. \right. \\
& + \kappa \left(Z_{j1}^A \left(Z_{k2}^H Z_{l3}^H + Z_{k3}^H Z_{l2}^H \right) + Z_{j2}^A \left(Z_{k1}^H Z_{l3}^H + Z_{k3}^H Z_{l1}^H \right) \right) \left. \right) \\
& + \kappa^* \left(-Z_{j3}^A \left(4\kappa Z_{k3}^H Z_{l3}^H + \lambda Z_{k1}^H Z_{l2}^H + \lambda Z_{k2}^H Z_{l1}^H \right) \right. \\
& \left. \left. + \lambda \left(Z_{j1}^A \left(Z_{k2}^H Z_{l3}^H + Z_{k3}^H Z_{l2}^H \right) + Z_{j2}^A \left(Z_{k1}^H Z_{l3}^H + Z_{k3}^H Z_{l1}^H \right) \right) \right) \right)
\end{aligned} \tag{542}$$

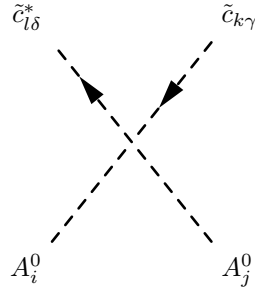


$$\frac{i}{4} \left(-Z_{i1}^A \left(- \left(-2|\lambda|^2 + g_2^2 \right) Z_{j2}^A \left(Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) \right) \right)$$

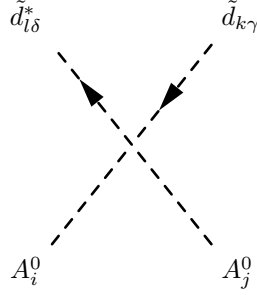
$$\begin{aligned}
& + Z_{j1}^A \left((g_1^2 + g_2^2) Z_{k1}^+ Z_{l1}^+ + (-g_1^2 + g_2^2) Z_{k2}^+ Z_{l2}^+ \right) \\
& + Z_{i2}^A \left((-2|\lambda|^2 + g_2^2) Z_{j1}^A (Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+) \right. \\
& + Z_{j2}^A \left(-(g_1^2 + g_2^2) Z_{k2}^+ Z_{l2}^+ + (-g_2^2 + g_1^2) Z_{k1}^+ Z_{l1}^+ \right) \\
& \left. + 4Z_{i3}^A Z_{j3}^A (\lambda \kappa^* Z_{k1}^+ Z_{l2}^+ - \lambda^* (\lambda Z_{k1}^+ Z_{l1}^+ + Z_{k2}^+ (-\kappa Z_{l1}^+ + \lambda Z_{l2}^+))) \right)
\end{aligned} \tag{543}$$



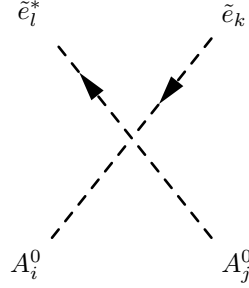
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left(-2Z_{k2}^{B,*} \left(g_1^2 \left(-Z_{i1}^A Z_{j1}^A + Z_{i2}^A Z_{j2}^A \right) Z_{l2}^B \right. \right. \\
& + 3Y_{d,33}^* \left(2Y_{d,33} Z_{i1}^A Z_{j1}^A Z_{l2}^B + \lambda Z_{i2}^A Z_{j3}^A Z_{l1}^B + \lambda Z_{i3}^A Z_{j2}^A Z_{l1}^B \right) \\
& + Z_{k1}^{B,*} \left((-12|Y_{d,33}|^2 + 3g_2^2 + g_1^2) Z_{i1}^A Z_{j1}^A Z_{l1}^B - 6\lambda^* Y_{d,33} Z_{i3}^A Z_{j2}^A Z_{l2}^B \right. \\
& \left. \left. - Z_{i2}^A \left((3g_2^2 + g_1^2) Z_{j2}^A Z_{l1}^B + 6\lambda^* Y_{d,33} Z_{j3}^A Z_{l2}^B \right) \right) \right)
\end{aligned} \tag{544}$$



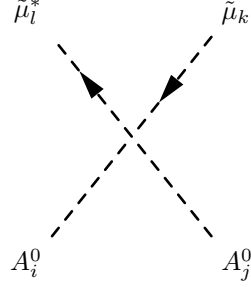
$$\begin{aligned}
& - \frac{i}{12} \delta_{\gamma\delta} \left(2Z_{k2}^{C,*} \left(2g_1^2 \left(Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A \right) Z_{l2}^C \right. \right. \\
& + 3Y_{u,22}^* \left(2Y_{u,22} Z_{i2}^A Z_{j2}^A Z_{l2}^C + \lambda Z_{i1}^A Z_{j3}^A Z_{l1}^C + \lambda Z_{i3}^A Z_{j1}^A Z_{l1}^C \right) \\
& + Z_{k1}^{C,*} \left((12|Y_{u,22}|^2 - 3g_2^2 + g_1^2) Z_{i2}^A Z_{j2}^A Z_{l1}^C + 6\lambda^* Y_{u,22} Z_{i3}^A Z_{j1}^A Z_{l2}^C \right. \\
& \left. \left. + Z_{i1}^A \left(-(-3g_2^2 + g_1^2) Z_{j1}^A Z_{l1}^C + 6\lambda^* Y_{u,22} Z_{j3}^A Z_{l2}^C \right) \right) \right)
\end{aligned} \tag{545}$$



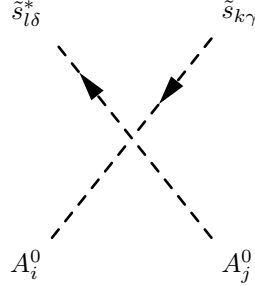
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left(-2Z_{k2}^{D,*} \left(g_1^2 \left(-Z_{i1}^A Z_{j1}^A + Z_{i2}^A Z_{j2}^A \right) Z_{l2}^D \right. \right. \\
& \left. \left. + 3Y_{d,11}^* \left(2Y_{d,11} Z_{i1}^A Z_{j1}^A Z_{l2}^D + \lambda Z_{i2}^A Z_{j3}^A Z_{l1}^D + \lambda Z_{i3}^A Z_{j2}^A Z_{l1}^D \right) \right) \right) \\
& + Z_{k1}^{D,*} \left(\left(-12|Y_{d,11}|^2 + 3g_2^2 + g_1^2 \right) Z_{i1}^A Z_{j1}^A Z_{l1}^D - 6\lambda^* Y_{d,11} Z_{i3}^A Z_{j2}^A Z_{l2}^D \right. \\
& \left. - Z_{i2}^A \left(\left(3g_2^2 + g_1^2 \right) Z_{j2}^A Z_{l1}^D + 6\lambda^* Y_{d,11} Z_{j3}^A Z_{l2}^D \right) \right) \right) \tag{546}
\end{aligned}$$



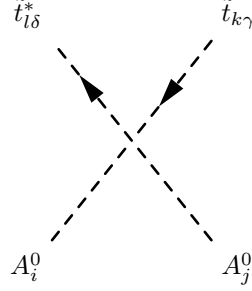
$$\begin{aligned}
& \frac{i}{4} \left(-2Z_{k2}^{E,*} \left(g_1^2 \left(-Z_{i1}^A Z_{j1}^A + Z_{i2}^A Z_{j2}^A \right) Z_{l2}^E \right. \right. \\
& \left. \left. + Y_{e,11}^* \left(2Y_{e,11} Z_{i1}^A Z_{j1}^A Z_{l2}^E + \lambda Z_{i2}^A Z_{j3}^A Z_{l1}^E + \lambda Z_{i3}^A Z_{j2}^A Z_{l1}^E \right) \right) \right) \\
& - Z_{k1}^{E,*} \left(\left(4|Y_{e,11}|^2 - g_2^2 + g_1^2 \right) Z_{i1}^A Z_{j1}^A Z_{l1}^E + 2\lambda^* Y_{e,11} Z_{i3}^A Z_{j2}^A Z_{l2}^E \right. \\
& \left. + Z_{i2}^A \left(2\lambda^* Y_{e,11} Z_{j3}^A Z_{l2}^E + \left(-g_1^2 + g_2^2 \right) Z_{j2}^A Z_{l1}^E \right) \right) \right) \tag{547}
\end{aligned}$$



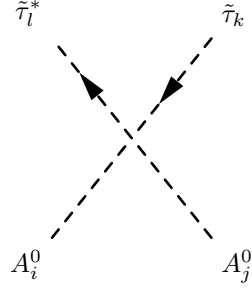
$$\begin{aligned}
& \frac{i}{4} \left(-2Z_{k2}^{\mu,*} \left(g_1^2 \left(-Z_{i1}^A Z_{j1}^A + Z_{i2}^A Z_{j2}^A \right) Z_{l2}^\mu \right. \right. \\
& \left. \left. + Y_{e,22}^* \left(2Y_{e,22} Z_{i1}^A Z_{j1}^A Z_{l2}^\mu + \lambda Z_{i2}^A Z_{j3}^A Z_{l1}^\mu + \lambda Z_{i3}^A Z_{j2}^A Z_{l1}^\mu \right) \right) \right. \\
& \left. - Z_{k1}^{\mu,*} \left(\left(4|Y_{e,22}|^2 - g_2^2 + g_1^2 \right) Z_{i1}^A Z_{j1}^A Z_{l1}^\mu + 2\lambda^* Y_{e,22} Z_{i3}^A Z_{j2}^A Z_{l2}^\mu \right. \right. \\
& \left. \left. + Z_{i2}^A \left(2\lambda^* Y_{e,22} Z_{j3}^A Z_{l2}^\mu + \left(-g_1^2 + g_2^2 \right) Z_{j2}^A Z_{l1}^\mu \right) \right) \right) \tag{548}
\end{aligned}$$



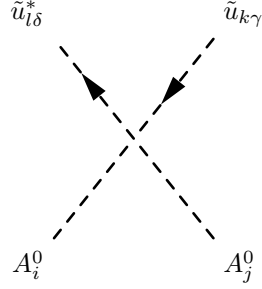
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left(-2Z_{k2}^{S,*} \left(g_1^2 \left(-Z_{i1}^A Z_{j1}^A + Z_{i2}^A Z_{j2}^A \right) Z_{l2}^S \right. \right. \\
& \left. \left. + 3Y_{d,22}^* \left(2Y_{d,22} Z_{i1}^A Z_{j1}^A Z_{l2}^S + \lambda Z_{i2}^A Z_{j3}^A Z_{l1}^S + \lambda Z_{i3}^A Z_{j2}^A Z_{l1}^S \right) \right) \right. \\
& \left. + Z_{k1}^{S,*} \left(\left(-12|Y_{d,22}|^2 + 3g_2^2 + g_1^2 \right) Z_{i1}^A Z_{j1}^A Z_{l1}^S - 6\lambda^* Y_{d,22} Z_{i3}^A Z_{j2}^A Z_{l2}^S \right. \right. \\
& \left. \left. - Z_{i2}^A \left(\left(3g_2^2 + g_1^2 \right) Z_{j2}^A Z_{l1}^S + 6\lambda^* Y_{d,22} Z_{j3}^A Z_{l2}^S \right) \right) \right) \tag{549}
\end{aligned}$$



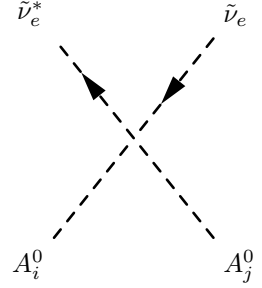
$$\begin{aligned}
& -\frac{i}{12}\delta_{\gamma\delta}\left(2Z_{k2}^{T,*}\left(2g_1^2\left(Z_{i1}^AZ_{j1}^A-Z_{i2}^AZ_{j2}^A\right)Z_{l2}^T\right.\right. \\
& \left.\left.+3Y_{u,33}^*\left(2Y_{u,33}Z_{i2}^AZ_{j2}^AZ_{l2}^T+\lambda Z_{i1}^AZ_{j3}^AZ_{l1}^T+\lambda Z_{i3}^AZ_{j1}^AZ_{l1}^T\right)\right)\right) \\
& +Z_{k1}^{T,*}\left(\left(12|Y_{u,33}|^2-3g_2^2+g_1^2\right)Z_{i2}^AZ_{j2}^AZ_{l1}^T+6\lambda^*Y_{u,33}Z_{i3}^AZ_{j1}^AZ_{l2}^T\right. \\
& \left.+Z_{i1}^A\left(-\left(-3g_2^2+g_1^2\right)Z_{j1}^AZ_{l1}^T+6\lambda^*Y_{u,33}Z_{j3}^AZ_{l2}^T\right)\right) \tag{550}
\end{aligned}$$



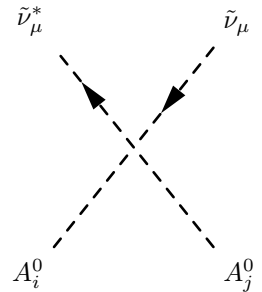
$$\begin{aligned}
& \frac{i}{4}\left(-2Z_{k2}^{\tau,*}\left(g_1^2\left(-Z_{i1}^AZ_{j1}^A+Z_{i2}^AZ_{j2}^A\right)Z_{l2}^T\right.\right. \\
& \left.\left.+Y_{e,33}^*\left(2Y_{e,33}Z_{i1}^AZ_{j1}^AZ_{l2}^T+\lambda Z_{i2}^AZ_{j3}^AZ_{l1}^T+\lambda Z_{i3}^AZ_{j2}^AZ_{l1}^T\right)\right)\right) \\
& -Z_{k1}^{\tau,*}\left(\left(4|Y_{e,33}|^2-g_2^2+g_1^2\right)Z_{i1}^AZ_{j1}^AZ_{l1}^T+2\lambda^*Y_{e,33}Z_{i3}^AZ_{j2}^AZ_{l2}^T\right. \\
& \left.+Z_{i2}^A\left(2\lambda^*Y_{e,33}Z_{j3}^AZ_{l2}^T+\left(-g_1^2+g_2^2\right)Z_{j2}^AZ_{l1}^T\right)\right) \tag{551}
\end{aligned}$$



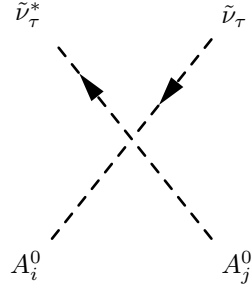
$$\begin{aligned}
& -\frac{i}{12}\delta_{\gamma\delta}\left(2Z_{k2}^{U,*}\left(2g_1^2\left(Z_{i1}^AZ_{j1}^A-Z_{i2}^AZ_{j2}^A\right)Z_{l2}^U\right.\right. \\
& \left.\left.+3Y_{u,11}^*\left(2Y_{u,11}Z_{i2}^AZ_{j2}^AZ_{l2}^U+\lambda Z_{i1}^AZ_{j3}^AZ_{l1}^U+\lambda Z_{i3}^AZ_{j1}^AZ_{l1}^U\right)\right)\right) \\
& +Z_{k1}^{U,*}\left(\left(12|Y_{u,11}|^2-3g_2^2+g_1^2\right)Z_{i2}^AZ_{j2}^AZ_{l1}^U+6\lambda^*Y_{u,11}Z_{i3}^AZ_{j1}^AZ_{l2}^U\right. \\
& \left.+Z_{i1}^A\left(-\left(-3g_2^2+g_1^2\right)Z_{j1}^AZ_{l1}^U+6\lambda^*Y_{u,11}Z_{j3}^AZ_{l2}^U\right)\right)
\end{aligned} \tag{552}$$



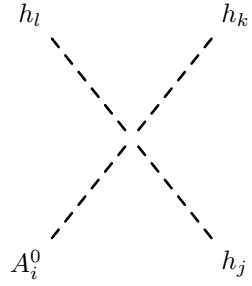
$$-\frac{i}{4}\left(g_1^2+g_2^2\right)\left(Z_{i1}^AZ_{j1}^A-Z_{i2}^AZ_{j2}^A\right) \tag{553}$$



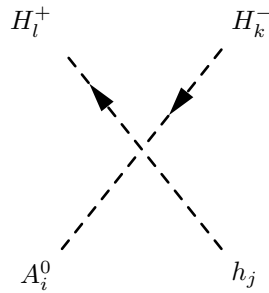
$$-\frac{i}{4}(g_1^2 + g_2^2)(Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A) \quad (554)$$



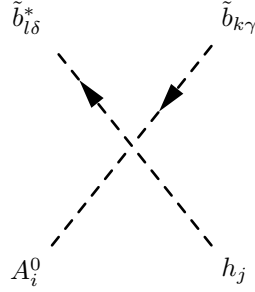
$$-\frac{i}{4}(g_1^2 + g_2^2)(Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A) \quad (555)$$



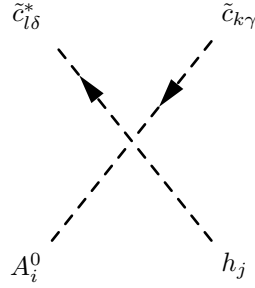
$$\begin{aligned} & -\frac{1}{2}(-\kappa\lambda^* + \lambda\kappa^*)(Z_{i2}^A(Z_{j1}^H Z_{k3}^H Z_{l3}^H + Z_{j3}^H(Z_{k1}^H Z_{l3}^H + Z_{k3}^H Z_{l1}^H))) \\ & - Z_{i3}^A(Z_{j1}^H(Z_{k2}^H Z_{l3}^H + Z_{k3}^H Z_{l2}^H) + Z_{j2}^H(Z_{k1}^H Z_{l3}^H + Z_{k3}^H Z_{l1}^H) + Z_{j3}^H(Z_{k1}^H Z_{l2}^H + Z_{k2}^H Z_{l1}^H)) \\ & + Z_{i1}^A(Z_{j2}^H Z_{k3}^H Z_{l3}^H + Z_{j3}^H(Z_{k2}^H Z_{l3}^H + Z_{k3}^H Z_{l2}^H)) \end{aligned} \quad (556)$$



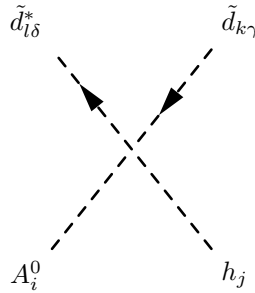
$$\begin{aligned}
& \frac{1}{4} \left((-2|\lambda|^2 + g_2^2) Z_{i2}^A Z_{j1}^H (-Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+) \right. \\
& + (-2|\lambda|^2 + g_2^2) Z_{i1}^A Z_{j2}^H (-Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+) \\
& \left. + 4Z_{i3}^A Z_{j3}^H (\kappa \lambda^* Z_{k2}^+ Z_{l1}^+ - \lambda \kappa^* Z_{k1}^+ Z_{l2}^+) \right) \tag{557}
\end{aligned}$$



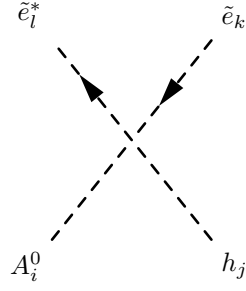
$$-\frac{1}{2} \delta_{\gamma\delta} \left(\lambda Y_{d,33}^* Z_{k2}^{B,*} Z_{l1}^B - \lambda^* Z_{k1}^{B,*} Y_{d,33} Z_{l2}^B \right) \left(Z_{i2}^A Z_{j3}^H + Z_{i3}^A Z_{j2}^H \right) \tag{558}$$



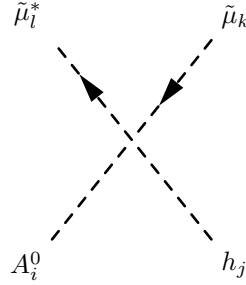
$$-\frac{1}{2} \delta_{\gamma\delta} \left(\lambda Y_{u,22}^* Z_{k2}^{C,*} Z_{l1}^C - \lambda^* Z_{k1}^{C,*} Y_{u,22} Z_{l2}^C \right) \left(Z_{i1}^A Z_{j3}^H + Z_{i3}^A Z_{j1}^H \right) \tag{559}$$



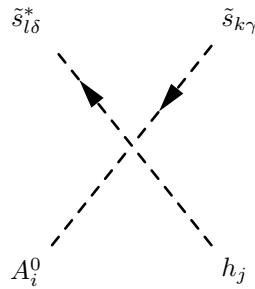
$$-\frac{1}{2}\delta_{\gamma\delta}\left(\lambda Y_{d,11}^* Z_{k2}^{D,*} Z_{l1}^D - \lambda^* Z_{k1}^{D,*} Y_{d,11} Z_{l2}^D\right)\left(Z_{i2}^A Z_{j3}^H + Z_{i3}^A Z_{j2}^H\right) \quad (560)$$



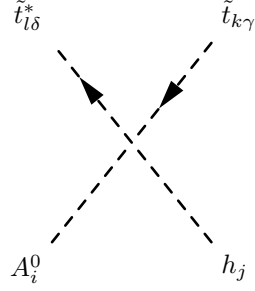
$$-\frac{1}{2}\left(\lambda Y_{e,11}^* Z_{k2}^{E,*} Z_{l1}^E - \lambda^* Z_{k1}^{E,*} Y_{e,11} Z_{l2}^E\right)\left(Z_{i2}^A Z_{j3}^H + Z_{i3}^A Z_{j2}^H\right) \quad (561)$$



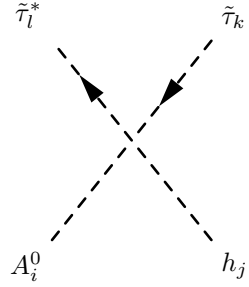
$$-\frac{1}{2}\left(Z_{i2}^A Z_{j3}^H + Z_{i3}^A Z_{j2}^H\right)\left(\lambda Y_{e,22}^* Z_{k2}^{\mu,*} Z_{l1}^{\mu} - \lambda^* Z_{k1}^{\mu,*} Y_{e,22} Z_{l2}^{\mu}\right) \quad (562)$$



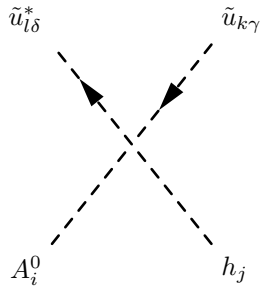
$$-\frac{1}{2}\delta_{\gamma\delta}\left(Z_{i2}^A Z_{j3}^H + Z_{i3}^A Z_{j2}^H\right)\left(\lambda Y_{d,22}^* Z_{k2}^{S,*} Z_{l1}^S - \lambda^* Z_{k1}^{S,*} Y_{d,22} Z_{l2}^S\right) \quad (563)$$



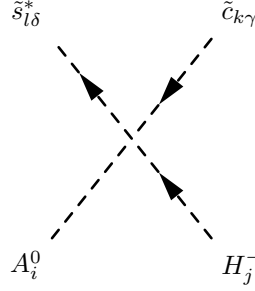
$$-\frac{1}{2}\delta_{\gamma\delta}\left(Z_{i1}^AZ_{j3}^H+Z_{i3}^AZ_{j1}^H\right)\left(\lambda Y_{u,33}^*Z_{k2}^{T,*}Z_{l1}^T-\lambda^*Z_{k1}^{T,*}Y_{u,33}Z_{l2}^T\right) \quad (564)$$



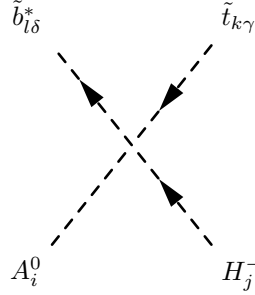
$$-\frac{1}{2}\left(Z_{i2}^AZ_{j3}^H+Z_{i3}^AZ_{j2}^H\right)\left(\lambda Y_{e,33}^*Z_{k2}^{T,*}Z_{l1}^T-\lambda^*Z_{k1}^{T,*}Y_{e,33}Z_{l2}^T\right) \quad (565)$$



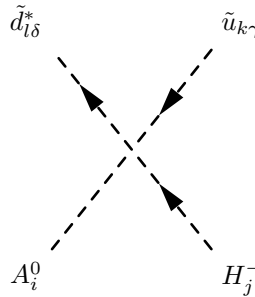
$$-\frac{1}{2}\delta_{\gamma\delta}\left(Z_{i1}^AZ_{j3}^H+Z_{i3}^AZ_{j1}^H\right)\left(\lambda Y_{u,11}^*Z_{k2}^{U,*}Z_{l1}^U-\lambda^*Z_{k1}^{U,*}Y_{u,11}Z_{l2}^U\right) \quad (566)$$



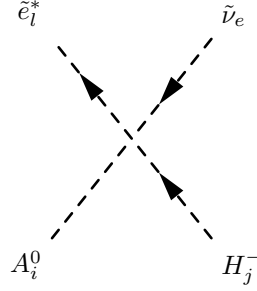
$$\begin{aligned}
& -\frac{1}{2} \frac{1}{\sqrt{2}} \delta_{\gamma\delta} \left(2Y_{u,22}^* Z_{k2}^{C,*} \left(\lambda Z_{i3}^A Z_{j1}^+ Z_{l1}^S + Y_{d,22} \left(Z_{i1}^A Z_{j2}^+ - Z_{i2}^A Z_{j1}^+ \right) Z_{l2}^S \right) \right. \\
& \left. + Z_{k1}^{C,*} \left(\left(-2|Y_{d,22}|^2 + g_2^2 \right) Z_{i1}^A Z_{j1}^+ Z_{l1}^S - Z_{j2}^+ \left(2\lambda^* Y_{d,22} Z_{i3}^A Z_{l2}^S + \left(-2|Y_{u,22}|^2 + g_2^2 \right) Z_{i2}^A Z_{l1}^S \right) \right) \right) \quad (567)
\end{aligned}$$



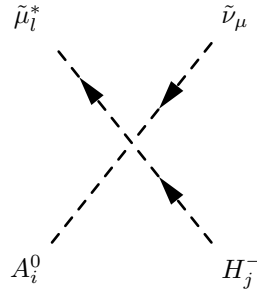
$$\begin{aligned}
& -\frac{1}{2} \frac{1}{\sqrt{2}} \delta_{\gamma\delta} \left(Z_{k1}^{T,*} \left(- \left(2\lambda^* Y_{d,33} Z_{i3}^A Z_{l2}^B + \left(-2|Y_{u,33}|^2 + g_2^2 \right) Z_{i2}^A Z_{l1}^B \right) Z_{j2}^+ + \left(-2|Y_{d,33}|^2 + g_2^2 \right) Z_{i1}^A Z_{l1}^B Z_{j1}^+ \right) \right. \\
& \left. + 2Y_{u,33}^* Z_{k2}^{T,*} \left(\lambda Z_{i3}^A Z_{l1}^B Z_{j1}^+ + Y_{d,33} Z_{l2}^B \left(Z_{i1}^A Z_{j2}^+ - Z_{i2}^A Z_{j1}^+ \right) \right) \right) \quad (568)
\end{aligned}$$



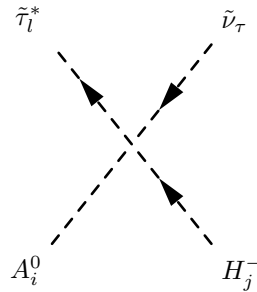
$$\begin{aligned}
& -\frac{1}{2} \frac{1}{\sqrt{2}} \delta_{\gamma\delta} \left(Z_{k1}^{U,*} \left(- \left(2\lambda^* Y_{d,11} Z_{i3}^A Z_{l2}^D + \left(-2|Y_{u,11}|^2 + g_2^2 \right) Z_{i2}^A Z_{l1}^D \right) Z_{j2}^+ + \left(-2|Y_{d,11}|^2 + g_2^2 \right) Z_{i1}^A Z_{l1}^D Z_{j1}^+ \right) \right. \\
& \left. + 2Y_{u,11}^* Z_{k2}^{U,*} \left(\lambda Z_{i3}^A Z_{l1}^D Z_{j1}^+ + Y_{d,11} Z_{l2}^D \left(Z_{i1}^A Z_{j2}^+ - Z_{i2}^A Z_{j1}^+ \right) \right) \right) \quad (569)
\end{aligned}$$



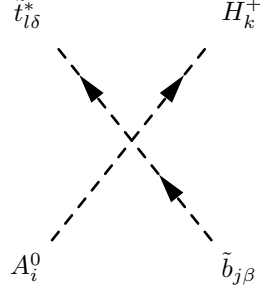
$$-\frac{1}{2} \frac{1}{\sqrt{2}} \left(- \left(2\lambda^* Y_{e,11} Z_{i3}^A Z_{l2}^E + g_2^2 Z_{i2}^A Z_{l1}^E \right) Z_{j2}^+ + \left(-2|Y_{e,11}|^2 + g_2^2 \right) Z_{i1}^A Z_{l1}^E Z_{j1}^+ \right) \quad (570)$$



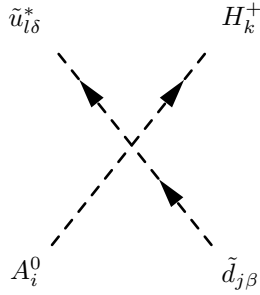
$$-\frac{1}{2} \frac{1}{\sqrt{2}} \left(- \left(2\lambda^* Y_{e,22} Z_{i3}^A Z_{l2}^\mu + g_2^2 Z_{i2}^A Z_{l1}^\mu \right) Z_{j2}^+ + \left(-2|Y_{e,22}|^2 + g_2^2 \right) Z_{i1}^A Z_{l1}^\mu Z_{j1}^+ \right) \quad (571)$$



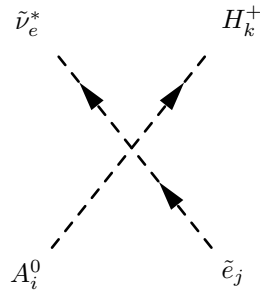
$$-\frac{1}{2} \frac{1}{\sqrt{2}} \left(\left(-2|Y_{e,33}|^2 + g_2^2 \right) Z_{i1}^A Z_{j1}^+ Z_{l1}^\tau - Z_{j2}^+ \left(2\lambda^* Y_{e,33} Z_{i3}^A Z_{l2}^\tau + g_2^2 Z_{i2}^A Z_{l1}^\tau \right) \right) \quad (572)$$



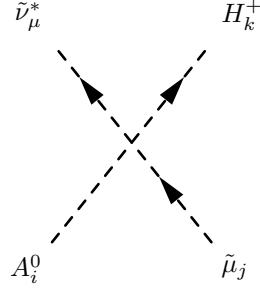
$$\begin{aligned} & \frac{1}{2} \frac{1}{\sqrt{2}} \delta_{\beta\delta} \left(Z_{j1}^{B,*} \left(2\lambda^* Y_{u,33} Z_{i3}^A Z_{k1}^+ Z_{l2}^T + \left(-2|Y_{d,33}|^2 + g_2^2 \right) Z_{i1}^A Z_{k1}^+ Z_{l1}^T - \left(-2|Y_{u,33}|^2 + g_2^2 \right) Z_{i2}^A Z_{k2}^+ Z_{l1}^T \right) \right. \\ & \left. - 2Y_{d,33}^* Z_{j2}^{B,*} \left(\lambda Z_{i3}^A Z_{k2}^+ Z_{l1}^T + Y_{u,33} \left(-Z_{i1}^A Z_{k2}^+ + Z_{i2}^A Z_{k1}^+ \right) Z_{l2}^T \right) \right) \end{aligned} \quad (573)$$



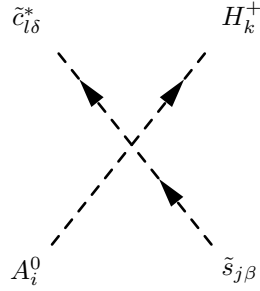
$$\begin{aligned} & \frac{1}{2} \frac{1}{\sqrt{2}} \delta_{\beta\delta} \left(Z_{j1}^{D,*} \left(2\lambda^* Y_{u,11} Z_{i3}^A Z_{k1}^+ Z_{l2}^U + \left(-2|Y_{d,11}|^2 + g_2^2 \right) Z_{i1}^A Z_{k1}^+ Z_{l1}^U - \left(-2|Y_{u,11}|^2 + g_2^2 \right) Z_{i2}^A Z_{k2}^+ Z_{l1}^U \right) \right. \\ & \left. - 2Y_{d,11}^* Z_{j2}^{D,*} \left(\lambda Z_{i3}^A Z_{k2}^+ Z_{l1}^U + Y_{u,11} \left(-Z_{i1}^A Z_{k2}^+ + Z_{i2}^A Z_{k1}^+ \right) Z_{l2}^U \right) \right) \end{aligned} \quad (574)$$



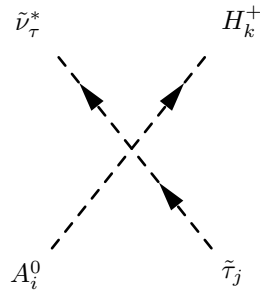
$$- \frac{1}{2} \frac{1}{\sqrt{2}} \left(2\lambda Y_{e,11}^* Z_{j2}^{E,*} Z_{i3}^A Z_{k2}^+ + Z_{j1}^{E,*} \left(- \left(-2|Y_{e,11}|^2 + g_2^2 \right) Z_{i1}^A Z_{k1}^+ + g_2^2 Z_{i2}^A Z_{k2}^+ \right) \right) \quad (575)$$



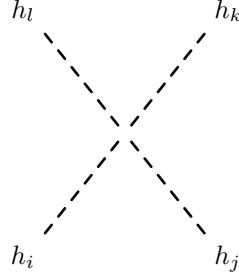
$$-\frac{1}{2} \frac{1}{\sqrt{2}} \left(2\lambda Y_{e,22}^* Z_{j2}^{\mu,*} Z_{i3}^A Z_{k2}^+ + Z_{j1}^{\mu,*} \left(- \left(-2|Y_{e,22}|^2 + g_2^2 \right) Z_{i1}^A Z_{k1}^+ + g_2^2 Z_{i2}^A Z_{k2}^+ \right) \right) \quad (576)$$



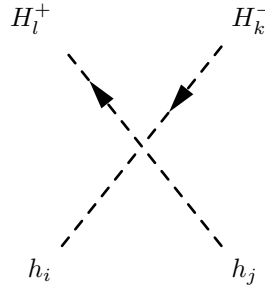
$$\frac{1}{2} \frac{1}{\sqrt{2}} \delta_{\beta\delta} \left(Z_{j1}^{S,*} \left(2\lambda^* Y_{u,22} Z_{i3}^A Z_{l2}^C Z_{k1}^+ + \left(-2|Y_{d,22}|^2 + g_2^2 \right) Z_{i1}^A Z_{l1}^C Z_{k1}^+ - \left(-2|Y_{u,22}|^2 + g_2^2 \right) Z_{i2}^A Z_{l1}^C Z_{k2}^+ \right) \right. \\ \left. - 2Y_{d,22}^* Z_{j2}^{S,*} \left(\left(\lambda Z_{i3}^A Z_{l1}^C - Y_{u,22} Z_{i1}^A Z_{l2}^C \right) Z_{k2}^+ + Y_{u,22} Z_{i2}^A Z_{l2}^C Z_{k1}^+ \right) \right) \quad (577)$$



$$-\frac{1}{2} \frac{1}{\sqrt{2}} \left(2\lambda Y_{e,33}^* Z_{j2}^{\tau,*} Z_{i3}^A Z_{k2}^+ + Z_{j1}^{\tau,*} \left(- \left(-2|Y_{e,33}|^2 + g_2^2 \right) Z_{i1}^A Z_{k1}^+ + g_2^2 Z_{i2}^A Z_{k2}^+ \right) \right) \quad (578)$$

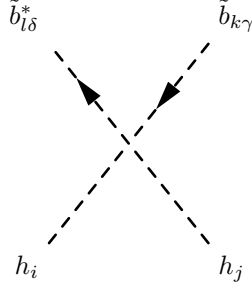


$$\begin{aligned}
& \frac{i}{4} \left(Z_{i1}^H \left(Z_{j1}^H \left(-3(g_1^2 + g_2^2) Z_{k1}^H Z_{l1}^H + (-4|\lambda|^2 + g_1^2 + g_2^2) Z_{k2}^H Z_{l2}^H - 4|\lambda|^2 Z_{k3}^H Z_{l3}^H \right) \right. \right. \\
& + Z_{j2}^H \left(2(\kappa\lambda^* + \lambda\kappa^*) Z_{k3}^H Z_{l3}^H + (-4|\lambda|^2 + g_1^2 + g_2^2) Z_{k1}^H Z_{l2}^H + (-4|\lambda|^2 + g_1^2 + g_2^2) Z_{k2}^H Z_{l1}^H \right) \\
& + 2Z_{j3}^H \left(\lambda^* \left((-2\lambda Z_{k1}^H + \kappa Z_{k2}^H) Z_{l3}^H + Z_{k3}^H (-2\lambda Z_{l1}^H + \kappa Z_{l2}^H) \right) + \lambda\kappa^* \left(Z_{k2}^H Z_{l3}^H + Z_{k3}^H Z_{l2}^H \right) \right) \left. \right) \\
& + Z_{i2}^H \left(Z_{j2}^H \left(-3(g_1^2 + g_2^2) Z_{k2}^H Z_{l2}^H + (-4|\lambda|^2 + g_1^2 + g_2^2) Z_{k1}^H Z_{l1}^H - 4|\lambda|^2 Z_{k3}^H Z_{l3}^H \right) \right. \\
& + Z_{j1}^H \left(2(\kappa\lambda^* + \lambda\kappa^*) Z_{k3}^H Z_{l3}^H + (-4|\lambda|^2 + g_1^2 + g_2^2) Z_{k1}^H Z_{l2}^H + (-4|\lambda|^2 + g_1^2 + g_2^2) Z_{k2}^H Z_{l1}^H \right) \\
& + 2Z_{j3}^H \left(\lambda^* \left((-2\lambda Z_{k2}^H + \kappa Z_{k1}^H) Z_{l3}^H + Z_{k3}^H (-2\lambda Z_{l2}^H + \kappa Z_{l1}^H) \right) + \lambda\kappa^* \left(Z_{k1}^H Z_{l3}^H + Z_{k3}^H Z_{l1}^H \right) \right) \left. \right) \\
& + 2Z_{i3}^H \left(\lambda^* \left(Z_{j3}^H \left(Z_{k1}^H (-2\lambda Z_{l1}^H + \kappa Z_{l2}^H) + Z_{k2}^H (-2\lambda Z_{l2}^H + \kappa Z_{l1}^H) \right) \right. \right. \\
& + Z_{j1}^H \left((-2\lambda Z_{k1}^H + \kappa Z_{k2}^H) Z_{l3}^H + Z_{k3}^H (-2\lambda Z_{l1}^H + \kappa Z_{l2}^H) \right) \\
& + Z_{j2}^H \left((-2\lambda Z_{k2}^H + \kappa Z_{k1}^H) Z_{l3}^H + Z_{k3}^H (-2\lambda Z_{l2}^H + \kappa Z_{l1}^H) \right) \left. \right) \\
& + \kappa^* \left(Z_{j3}^H \left(-12\kappa Z_{k3}^H Z_{l3}^H + \lambda Z_{k1}^H Z_{l2}^H + \lambda Z_{k2}^H Z_{l1}^H \right) \right. \\
& \left. \left. + \lambda \left(Z_{j1}^H \left(Z_{k2}^H Z_{l3}^H + Z_{k3}^H Z_{l2}^H \right) + Z_{j2}^H \left(Z_{k1}^H Z_{l3}^H + Z_{k3}^H Z_{l1}^H \right) \right) \right) \right) \right) \tag{579}
\end{aligned}$$

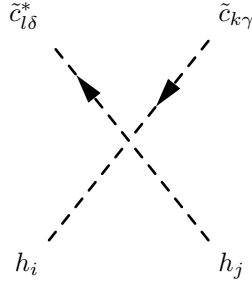


$$\frac{i}{4} \left(-Z_{i1}^H \left((-2|\lambda|^2 + g_2^2) Z_{j2}^H \left(Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) + Z_{j1}^H \left((g_1^2 + g_2^2) Z_{k1}^+ Z_{l1}^+ + (-g_1^2 + g_2^2) Z_{k2}^+ Z_{l2}^+ \right) \right) \right)$$

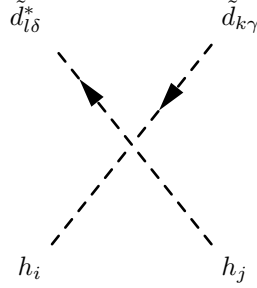
$$\begin{aligned}
& + Z_{i2}^H \left(- \left(-2|\lambda|^2 + g_2^2 \right) Z_{j1}^H \left(Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) \right. \\
& + Z_{j2}^H \left(- \left(g_1^2 + g_2^2 \right) Z_{k2}^+ Z_{l2}^+ + \left(-g_2^2 + g_1^2 \right) Z_{k1}^+ Z_{l1}^+ \right) \\
& \left. - 4Z_{i3}^H Z_{j3}^H \left(\lambda \kappa^* Z_{k1}^+ Z_{l2}^+ + \lambda^* \left(\lambda Z_{k1}^+ Z_{l1}^+ + Z_{k2}^+ \left(\kappa Z_{l1}^+ + \lambda Z_{l2}^+ \right) \right) \right) \right)
\end{aligned} \tag{580}$$



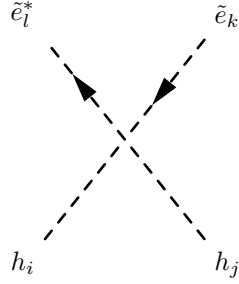
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left(2Z_{k2}^{B,*} \left(3\lambda Y_{d,33}^* Z_{l1}^B \left(Z_{i2}^H Z_{j3}^H + Z_{i3}^H Z_{j2}^H \right) + Z_{l2}^B \left(\left(-6|Y_{d,33}|^2 + g_1^2 \right) Z_{i1}^H Z_{j1}^H - g_1^2 Z_{i2}^H Z_{j2}^H \right) \right) \right. \\
& + Z_{k1}^{B,*} \left(Z_{l1}^B \left(\left(-12|Y_{d,33}|^2 + 3g_2^2 + g_1^2 \right) Z_{i1}^H Z_{j1}^H - \left(3g_2^2 + g_1^2 \right) Z_{i2}^H Z_{j2}^H \right) \right. \\
& \left. \left. + 6\lambda^* Y_{d,33} Z_{l2}^B \left(Z_{i2}^H Z_{j3}^H + Z_{i3}^H Z_{j2}^H \right) \right) \right)
\end{aligned} \tag{581}$$



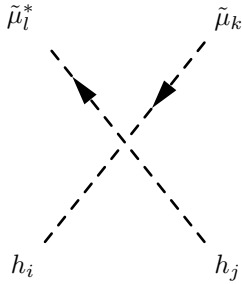
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left(2Z_{k2}^{C,*} \left(-2Z_{l2}^C \left(- \left(-3|Y_{u,22}|^2 + g_1^2 \right) Z_{i2}^H Z_{j2}^H + g_1^2 Z_{i1}^H Z_{j1}^H \right) + 3\lambda Y_{u,22}^* Z_{l1}^C \left(Z_{i1}^H Z_{j3}^H + Z_{i3}^H Z_{j1}^H \right) \right) \right. \\
& + Z_{k1}^{C,*} \left(Z_{l1}^C \left(- \left(12|Y_{u,22}|^2 - 3g_2^2 + g_1^2 \right) Z_{i2}^H Z_{j2}^H + \left(-3g_2^2 + g_1^2 \right) Z_{i1}^H Z_{j1}^H \right) \right. \\
& \left. \left. + 6\lambda^* Y_{u,22} Z_{l2}^C \left(Z_{i1}^H Z_{j3}^H + Z_{i3}^H Z_{j1}^H \right) \right) \right)
\end{aligned} \tag{582}$$



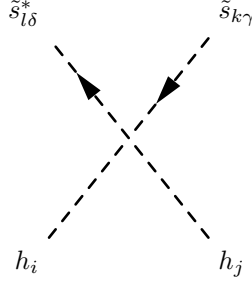
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left(2Z_{k2}^{D,*} \left(3\lambda Y_{d,11}^* Z_{l1}^D \left(Z_{i2}^H Z_{j3}^H + Z_{i3}^H Z_{j2}^H \right) + Z_{l2}^D \left(\left(-6|Y_{d,11}|^2 + g_1^2 \right) Z_{i1}^H Z_{j1}^H - g_1^2 Z_{i2}^H Z_{j2}^H \right) \right) \right. \\
& + Z_{k1}^{D,*} \left(Z_{l1}^D \left(\left(-12|Y_{d,11}|^2 + 3g_2^2 + g_1^2 \right) Z_{i1}^H Z_{j1}^H - \left(3g_2^2 + g_1^2 \right) Z_{i2}^H Z_{j2}^H \right) \right. \\
& \left. \left. + 6\lambda^* Y_{d,11} Z_{l2}^D \left(Z_{i2}^H Z_{j3}^H + Z_{i3}^H Z_{j2}^H \right) \right) \right) \quad (583)
\end{aligned}$$



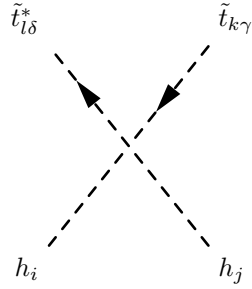
$$\begin{aligned}
& \frac{i}{4} \left(2Z_{k2}^{E,*} \left(\lambda Y_{e,11}^* Z_{l1}^E \left(Z_{i2}^H Z_{j3}^H + Z_{i3}^H Z_{j2}^H \right) + Z_{l2}^E \left(\left(-2|Y_{e,11}|^2 + g_1^2 \right) Z_{i1}^H Z_{j1}^H - g_1^2 Z_{i2}^H Z_{j2}^H \right) \right) \right. \\
& + Z_{k1}^{E,*} \left(Z_{l1}^E \left(\left(-4|Y_{e,11}|^2 - g_1^2 + g_2^2 \right) Z_{i1}^H Z_{j1}^H + \left(-g_2^2 + g_1^2 \right) Z_{i2}^H Z_{j2}^H \right) \right. \\
& \left. \left. + 2\lambda^* Y_{e,11} Z_{l2}^E \left(Z_{i2}^H Z_{j3}^H + Z_{i3}^H Z_{j2}^H \right) \right) \right) \quad (584)
\end{aligned}$$



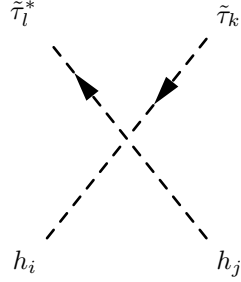
$$\begin{aligned}
& \frac{i}{4} \left(2Z_{k2}^{\mu,*} \left(g_1^2 \left(Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H \right) Z_{l2}^\mu \right. \right. \\
& + Y_{e,22}^* \left(-2Y_{e,22} Z_{i1}^H Z_{j1}^H Z_{l2}^\mu + \lambda Z_{i2}^H Z_{j3}^H Z_{l1}^\mu + \lambda Z_{i3}^H Z_{j2}^H Z_{l1}^\mu \right) \\
& + Z_{k1}^{\mu,*} \left(\left(-4|Y_{e,22}|^2 - g_1^2 + g_2^2 \right) Z_{i1}^H Z_{j1}^H Z_{l1}^\mu + 2\lambda^* Y_{e,22} Z_{i3}^H Z_{j2}^H Z_{l2}^\mu \right. \\
& \left. \left. + Z_{i2}^H \left(2\lambda^* Y_{e,22} Z_{j3}^H Z_{l2}^\mu + \left(-g_2^2 + g_1^2 \right) Z_{j2}^H Z_{l1}^\mu \right) \right) \right) \quad (585)
\end{aligned}$$



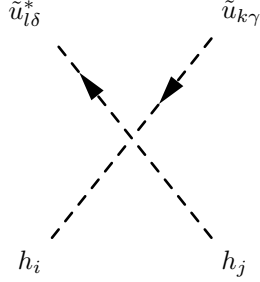
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left(2Z_{k2}^{S,*} \left(g_1^2 \left(Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H \right) Z_{l2}^S \right. \right. \\
& + 3Y_{d,22}^* \left(-2Y_{d,22} Z_{i1}^H Z_{j1}^H Z_{l2}^S + \lambda Z_{i2}^H Z_{j3}^H Z_{l1}^S + \lambda Z_{i3}^H Z_{j2}^H Z_{l1}^S \right) \\
& + Z_{k1}^{S,*} \left(\left(-12|Y_{d,22}|^2 + 3g_2^2 + g_1^2 \right) Z_{i1}^H Z_{j1}^H Z_{l1}^S + 6\lambda^* Y_{d,22} Z_{i3}^H Z_{j2}^H Z_{l2}^S \right. \\
& \left. \left. - Z_{i2}^H \left(\left(3g_2^2 + g_1^2 \right) Z_{j2}^H Z_{l1}^S - 6\lambda^* Y_{d,22} Z_{j3}^H Z_{l2}^S \right) \right) \right) \quad (586)
\end{aligned}$$



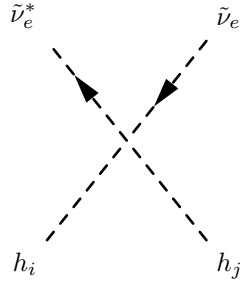
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left(2Z_{k2}^{T,*} \left(2g_1^2 \left(-Z_{i1}^H Z_{j1}^H + Z_{i2}^H Z_{j2}^H \right) Z_{l2}^T \right. \right. \\
& + 3Y_{u,33}^* \left(-2Y_{u,33} Z_{i2}^H Z_{j2}^H Z_{l2}^T + \lambda Z_{i1}^H Z_{j3}^H Z_{l1}^T + \lambda Z_{i3}^H Z_{j1}^H Z_{l1}^T \right) \\
& + Z_{k1}^{T,*} \left(- \left(12|Y_{u,33}|^2 - 3g_2^2 + g_1^2 \right) Z_{i2}^H Z_{j2}^H Z_{l1}^T + 6\lambda^* Y_{u,33} Z_{i3}^H Z_{j1}^H Z_{l2}^T \right. \\
& \left. \left. + Z_{i1}^H \left(\left(-3g_2^2 + g_1^2 \right) Z_{j1}^H Z_{l1}^T + 6\lambda^* Y_{u,33} Z_{j3}^H Z_{l2}^T \right) \right) \right) \quad (587)
\end{aligned}$$



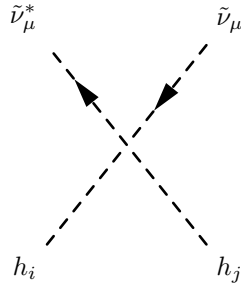
$$\begin{aligned}
& \frac{i}{4} \left(2Z_{k2}^{\tau,*} \left(g_1^2 \left(Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H \right) Z_{l2}^\tau \right. \right. \\
& + Y_{e,33}^* \left(-2Y_{e,33} Z_{i1}^H Z_{j1}^H Z_{l2}^\tau + \lambda Z_{i2}^H Z_{j3}^H Z_{l1}^\tau + \lambda Z_{i3}^H Z_{j2}^H Z_{l1}^\tau \right) \left. \right) \\
& + Z_{k1}^{\tau,*} \left(\left(-4|Y_{e,33}|^2 - g_1^2 + g_2^2 \right) Z_{i1}^H Z_{j1}^H Z_{l1}^\tau + 2\lambda^* Y_{e,33} Z_{i3}^H Z_{j2}^H Z_{l2}^\tau \right. \\
& \left. \left. + Z_{i2}^H \left(2\lambda^* Y_{e,33} Z_{j3}^H Z_{l2}^\tau + \left(-g_2^2 + g_1^2 \right) Z_{j2}^H Z_{l1}^\tau \right) \right) \right) \quad (588)
\end{aligned}$$



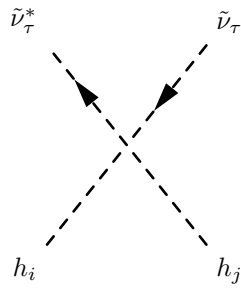
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left(2Z_{k2}^{U,*} \left(2g_1^2 \left(-Z_{i1}^H Z_{j1}^H + Z_{i2}^H Z_{j2}^H \right) Z_{l2}^U \right. \right. \\
& + 3Y_{u,11}^* \left(-2Y_{u,11} Z_{i2}^H Z_{j2}^H Z_{l2}^U + \lambda Z_{i1}^H Z_{j3}^H Z_{l1}^U + \lambda Z_{i3}^H Z_{j1}^H Z_{l1}^U \right) \left. \right) \\
& + Z_{k1}^{U,*} \left(- \left(12|Y_{u,11}|^2 - 3g_2^2 + g_1^2 \right) Z_{i2}^H Z_{j2}^H Z_{l1}^U + 6\lambda^* Y_{u,11} Z_{i3}^H Z_{j1}^H Z_{l2}^U \right. \\
& \left. \left. + Z_{i1}^H \left(\left(-3g_2^2 + g_1^2 \right) Z_{j1}^H Z_{l1}^U + 6\lambda^* Y_{u,11} Z_{j3}^H Z_{l2}^U \right) \right) \right) \quad (589)
\end{aligned}$$



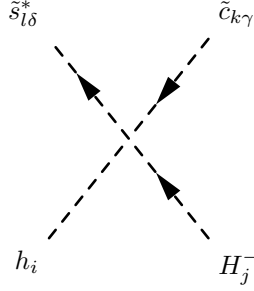
$$-\frac{i}{4}(g_1^2 + g_2^2)(Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \quad (590)$$



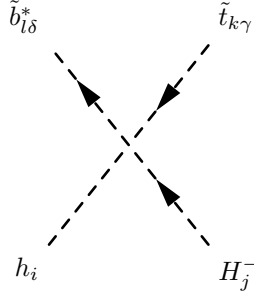
$$-\frac{i}{4}(g_1^2 + g_2^2)(Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \quad (591)$$



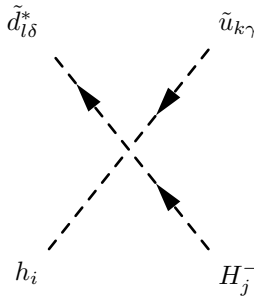
$$-\frac{i}{4}(g_1^2 + g_2^2)(Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \quad (592)$$



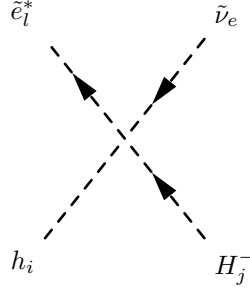
$$\begin{aligned}
& \frac{i}{2} \frac{1}{\sqrt{2}} \delta_{\gamma\delta} \left(2Y_{u,22}^* Z_{k2}^{C,*} \left(\lambda Z_{i3}^H Z_{j1}^+ Z_{l1}^S + Y_{d,22} \left(Z_{i1}^H Z_{j2}^+ + Z_{i2}^H Z_{j1}^+ \right) Z_{l2}^S \right) \right. \\
& \left. + Z_{k1}^{C,*} \left(- \left(-2|Y_{d,22}|^2 + g_2^2 \right) Z_{i1}^H Z_{j1}^+ Z_{l1}^S + Z_{j2}^+ \left(2\lambda^* Y_{d,22} Z_{i3}^H Z_{l2}^S - \left(-2|Y_{u,22}|^2 + g_2^2 \right) Z_{i2}^H Z_{l1}^S \right) \right) \right) \quad (593)
\end{aligned}$$



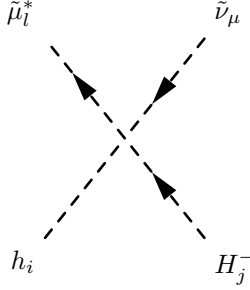
$$\begin{aligned}
& \frac{i}{2} \frac{1}{\sqrt{2}} \delta_{\gamma\delta} \left(2Y_{u,33}^* Z_{k2}^{T,*} \left(\lambda Z_{l1}^B Z_{i3}^H Z_{j1}^+ + Y_{d,33} Z_{l2}^B \left(Z_{i1}^H Z_{j2}^+ + Z_{i2}^H Z_{j1}^+ \right) \right) \right. \\
& \left. + Z_{k1}^{T,*} \left(2\lambda^* Y_{d,33} Z_{l2}^B Z_{i3}^H Z_{j2}^+ - Z_{l1}^B \left(\left(-2|Y_{d,33}|^2 + g_2^2 \right) Z_{i1}^H Z_{j1}^+ + \left(-2|Y_{u,33}|^2 + g_2^2 \right) Z_{i2}^H Z_{j2}^+ \right) \right) \right) \quad (594)
\end{aligned}$$



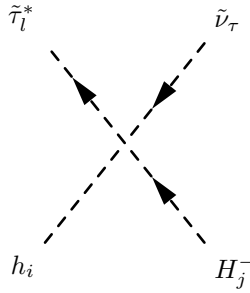
$$\begin{aligned}
& \frac{i}{2} \frac{1}{\sqrt{2}} \delta_{\gamma\delta} \left(2Y_{u,11}^* Z_{k2}^{U,*} \left(\lambda Z_{l1}^D Z_{i3}^H Z_{j1}^+ + Y_{d,11} Z_{l2}^D \left(Z_{i1}^H Z_{j2}^+ + Z_{i2}^H Z_{j1}^+ \right) \right) \right. \\
& \left. + Z_{k1}^{U,*} \left(2\lambda^* Y_{d,11} Z_{l2}^D Z_{i3}^H Z_{j2}^+ - Z_{l1}^D \left(\left(-2|Y_{d,11}|^2 + g_2^2 \right) Z_{i1}^H Z_{j1}^+ + \left(-2|Y_{u,11}|^2 + g_2^2 \right) Z_{i2}^H Z_{j2}^+ \right) \right) \right) \quad (595)
\end{aligned}$$



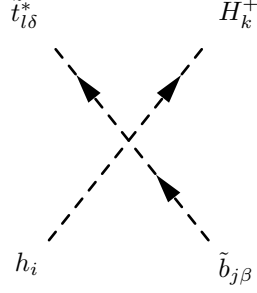
$$\frac{i}{2} \frac{1}{\sqrt{2}} \left(2\lambda^* Y_{e,11} Z_{l2}^E Z_{i3}^H Z_{j2}^+ - Z_{l1}^E \left((-2|Y_{e,11}|^2 + g_2^2) Z_{i1}^H Z_{j1}^+ + g_2^2 Z_{i2}^H Z_{j2}^+ \right) \right) \quad (596)$$



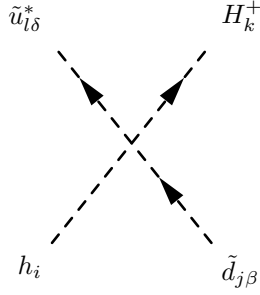
$$-\frac{i}{2} \frac{1}{\sqrt{2}} \left(\left(-2\lambda^* Y_{e,22} Z_{i3}^H Z_{l2}^\mu + g_2^2 Z_{i2}^H Z_{l1}^\mu \right) Z_{j2}^+ + \left(-2|Y_{e,22}|^2 + g_2^2 \right) Z_{i1}^H Z_{l1}^\mu Z_{j1}^+ \right) \quad (597)$$



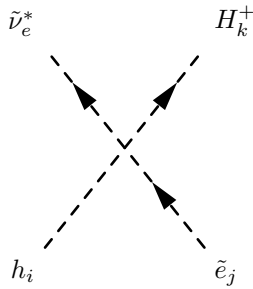
$$-\frac{i}{2} \frac{1}{\sqrt{2}} \left(\left(-2|Y_{e,33}|^2 + g_2^2 \right) Z_{i1}^H Z_{j1}^+ Z_{l1}^\tau + Z_{j2}^+ \left(-2\lambda^* Y_{e,33} Z_{i3}^H Z_{l2}^\tau + g_2^2 Z_{i2}^H Z_{l1}^\tau \right) \right) \quad (598)$$



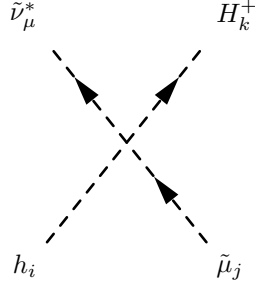
$$\begin{aligned}
& -\frac{i}{2} \frac{1}{\sqrt{2}} \delta_{\beta\delta} \left(Z_{j1}^{B,*} \left(-2\lambda^* Y_{u,33} Z_{i3}^H Z_{k1}^+ Z_{l2}^T + \left(-2|Y_{d,33}|^2 + g_2^2 \right) Z_{i1}^H Z_{k1}^+ Z_{l1}^T + \left(-2|Y_{u,33}|^2 + g_2^2 \right) Z_{i2}^H Z_{k2}^+ Z_{l1}^T \right) \right. \\
& \left. - 2Y_{d,33}^* Z_{j2}^{B,*} \left(\lambda Z_{i3}^H Z_{k2}^+ Z_{l1}^T + Y_{u,33} \left(Z_{i1}^H Z_{k2}^+ + Z_{i2}^H Z_{k1}^+ \right) Z_{l2}^T \right) \right) \quad (599)
\end{aligned}$$



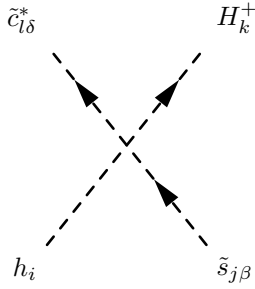
$$\begin{aligned}
& -\frac{i}{2} \frac{1}{\sqrt{2}} \delta_{\beta\delta} \left(Z_{j1}^{D,*} \left(-2\lambda^* Y_{u,11} Z_{i3}^H Z_{k1}^+ Z_{l2}^U + \left(-2|Y_{d,11}|^2 + g_2^2 \right) Z_{i1}^H Z_{k1}^+ Z_{l1}^U + \left(-2|Y_{u,11}|^2 + g_2^2 \right) Z_{i2}^H Z_{k2}^+ Z_{l1}^U \right) \right. \\
& \left. - 2Y_{d,11}^* Z_{j2}^{D,*} \left(\lambda Z_{i3}^H Z_{k2}^+ Z_{l1}^U + Y_{u,11} \left(Z_{i1}^H Z_{k2}^+ + Z_{i2}^H Z_{k1}^+ \right) Z_{l2}^U \right) \right) \quad (600)
\end{aligned}$$



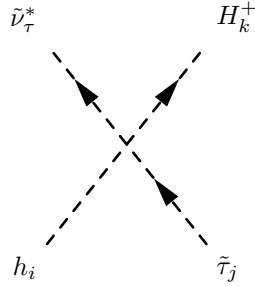
$$\frac{i}{2} \frac{1}{\sqrt{2}} \left(2\lambda Y_{e,11}^* Z_{j2}^{E,*} Z_{i3}^H Z_{k2}^+ - Z_{j1}^{E,*} \left(\left(-2|Y_{e,11}|^2 + g_2^2 \right) Z_{i1}^H Z_{k1}^+ + g_2^2 Z_{i2}^H Z_{k2}^+ \right) \right) \quad (601)$$



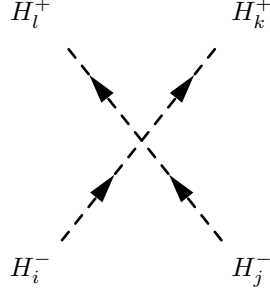
$$\frac{i}{2} \frac{1}{\sqrt{2}} \left(2\lambda Y_{e,22}^* Z_{j2}^{\mu,*} Z_{i3}^H Z_{k2}^+ - Z_{j1}^{\mu,*} \left((-2|Y_{e,22}|^2 + g_2^2) Z_{i1}^H Z_{k1}^+ + g_2^2 Z_{i2}^H Z_{k2}^+ \right) \right) \quad (602)$$



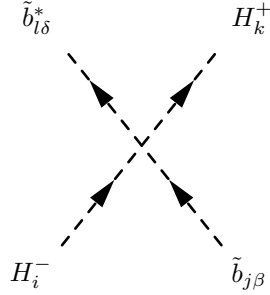
$$\begin{aligned} & \frac{i}{2} \frac{1}{\sqrt{2}} \delta_{\beta\delta} \left(2Y_{d,22}^* Z_{j2}^{S,*} \left(\lambda Z_{l1}^C Z_{i3}^H Z_{k2}^+ + Y_{u,22} Z_{l2}^C \left(Z_{i1}^H Z_{k2}^+ + Z_{i2}^H Z_{k1}^+ \right) \right) \right. \\ & \left. + Z_{j1}^{S,*} \left(2\lambda^* Y_{u,22} Z_{l2}^C Z_{i3}^H Z_{k1}^+ - Z_{l1}^C \left((-2|Y_{d,22}|^2 + g_2^2) Z_{i1}^H Z_{k1}^+ + (-2|Y_{u,22}|^2 + g_2^2) Z_{i2}^H Z_{k2}^+ \right) \right) \right) \end{aligned} \quad (603)$$



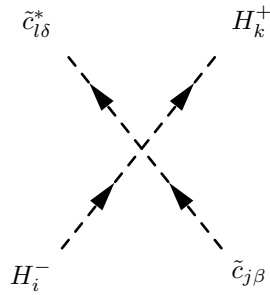
$$\frac{i}{2} \frac{1}{\sqrt{2}} \left(2\lambda Y_{e,33}^* Z_{j2}^{\tau,*} Z_{i3}^H Z_{k2}^+ - Z_{j1}^{\tau,*} \left((-2|Y_{e,33}|^2 + g_2^2) Z_{i1}^H Z_{k1}^+ + g_2^2 Z_{i2}^H Z_{k2}^+ \right) \right) \quad (604)$$



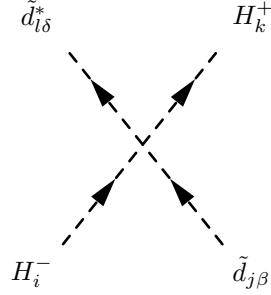
$$\begin{aligned} & \frac{i}{4} \left(Z_{i2}^+ \left(-2(g_1^2 + g_2^2) Z_{j2}^+ Z_{k2}^+ Z_{l2}^+ + \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{j1}^+ \left(Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) \right) \right. \\ & \left. + Z_{i1}^+ \left(-2(g_1^2 + g_2^2) Z_{j1}^+ Z_{k1}^+ Z_{l1}^+ + \left(-4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{j2}^+ \left(Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) \right) \right) \end{aligned} \quad (605)$$



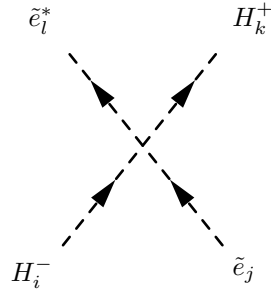
$$\begin{aligned} & \frac{i}{12} \delta_{\beta\delta} \left(2Z_{j2}^{B,*} Z_{l2}^B \left(\left(-6|Y_{d,33}|^2 + g_1^2 \right) Z_{i1}^+ Z_{k1}^+ - g_1^2 Z_{i2}^+ Z_{k2}^+ \right) \right. \\ & \left. + Z_{j1}^{B,*} Z_{l1}^B \left(- \left(12|Y_{u,33}|^2 - 3g_2^2 + g_1^2 \right) Z_{i2}^+ Z_{k2}^+ + \left(-3g_2^2 + g_1^2 \right) Z_{i1}^+ Z_{k1}^+ \right) \right) \end{aligned} \quad (606)$$



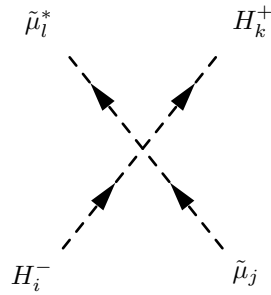
$$\begin{aligned} & \frac{i}{12} \delta_{\beta\delta} \left(Z_{j1}^{C,*} Z_{l1}^C \left(\left(-12|Y_{d,22}|^2 + 3g_2^2 + g_1^2 \right) Z_{i1}^+ Z_{k1}^+ - \left(3g_2^2 + g_1^2 \right) Z_{i2}^+ Z_{k2}^+ \right) \right. \\ & \left. - 4Z_{j2}^{C,*} Z_{l2}^C \left(- \left(-3|Y_{u,22}|^2 + g_1^2 \right) Z_{i2}^+ Z_{k2}^+ + g_1^2 Z_{i1}^+ Z_{k1}^+ \right) \right) \end{aligned} \quad (607)$$



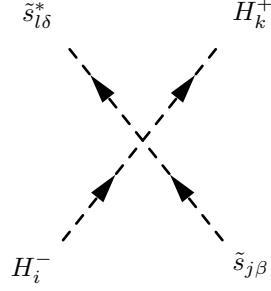
$$\begin{aligned} & \frac{i}{12} \delta_{\beta\delta} \left(2Z_{j2}^{D,*} Z_{i2}^D \left((-6|Y_{d,11}|^2 + g_1^2) Z_{i1}^+ Z_{k1}^+ - g_1^2 Z_{i2}^+ Z_{k2}^+ \right) \right. \\ & \left. + Z_{j1}^{D,*} Z_{i1}^D \left(-(12|Y_{u,11}|^2 - 3g_2^2 + g_1^2) Z_{i2}^+ Z_{k2}^+ + (-3g_2^2 + g_1^2) Z_{i1}^+ Z_{k1}^+ \right) \right) \end{aligned} \quad (608)$$



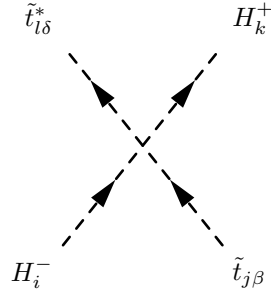
$$\begin{aligned} & \frac{i}{4} \left(-(g_1^2 + g_2^2) Z_{j1}^{E,*} Z_{i1}^E \left(Z_{i1}^+ Z_{k1}^+ - Z_{i2}^+ Z_{k2}^+ \right) \right. \\ & \left. + 2Z_{j2}^{E,*} Z_{i2}^E \left((-2|Y_{e,11}|^2 + g_1^2) Z_{i1}^+ Z_{k1}^+ - g_1^2 Z_{i2}^+ Z_{k2}^+ \right) \right) \end{aligned} \quad (609)$$



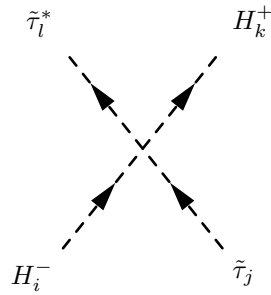
$$\begin{aligned} & \frac{i}{4} \left(-(g_1^2 + g_2^2) Z_{j1}^{\mu,*} Z_{i1}^\mu \left(Z_{i1}^+ Z_{k1}^+ - Z_{i2}^+ Z_{k2}^+ \right) \right. \\ & \left. + 2Z_{j2}^{\mu,*} Z_{i2}^\mu \left((-2|Y_{e,22}|^2 + g_1^2) Z_{i1}^+ Z_{k1}^+ - g_1^2 Z_{i2}^+ Z_{k2}^+ \right) \right) \end{aligned} \quad (610)$$



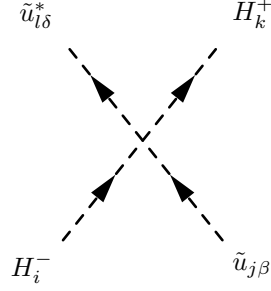
$$\begin{aligned} & \frac{i}{12} \delta_{\beta\delta} \left(Z_{j1}^{S,*} \left(- \left(12|Y_{u,22}|^2 - 3g_2^2 + g_1^2 \right) Z_{i2}^+ Z_{k2}^+ + \left(-3g_2^2 + g_1^2 \right) Z_{i1}^+ Z_{k1}^+ \right) Z_{l1}^S \right. \\ & \left. + 2Z_{j2}^{S,*} \left(\left(-6|Y_{d,22}|^2 + g_1^2 \right) Z_{i1}^+ Z_{k1}^+ - g_1^2 Z_{i2}^+ Z_{k2}^+ \right) Z_{l2}^S \right) \end{aligned} \quad (611)$$



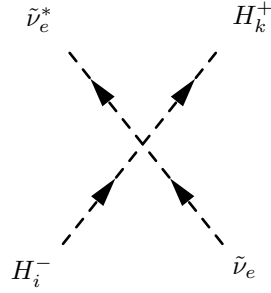
$$\begin{aligned} & \frac{i}{12} \delta_{\beta\delta} \left(Z_{j1}^{T,*} \left(\left(-12|Y_{d,33}|^2 + 3g_2^2 + g_1^2 \right) Z_{i1}^+ Z_{k1}^+ - \left(3g_2^2 + g_1^2 \right) Z_{i2}^+ Z_{k2}^+ \right) Z_{l1}^T \right. \\ & \left. - 4Z_{j2}^{T,*} \left(- \left(-3|Y_{u,33}|^2 + g_1^2 \right) Z_{i2}^+ Z_{k2}^+ + g_1^2 Z_{i1}^+ Z_{k1}^+ \right) Z_{l2}^T \right) \end{aligned} \quad (612)$$



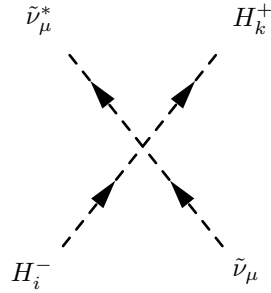
$$\begin{aligned} & \frac{i}{4} \left(- \left(g_1^2 + g_2^2 \right) Z_{j1}^{T,*} \left(Z_{i1}^+ Z_{k1}^+ - Z_{i2}^+ Z_{k2}^+ \right) Z_{l1}^T \right. \\ & \left. + 2Z_{j2}^{T,*} \left(\left(-2|Y_{e,33}|^2 + g_1^2 \right) Z_{i1}^+ Z_{k1}^+ - g_1^2 Z_{i2}^+ Z_{k2}^+ \right) Z_{l2}^T \right) \end{aligned} \quad (613)$$



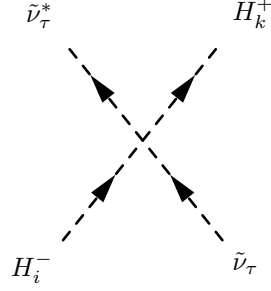
$$\begin{aligned} & \frac{i}{12} \delta_{\beta\delta} \left(Z_{j1}^{U,*} \left((-12|Y_{d,11}|^2 + 3g_2^2 + g_1^2) Z_{i1}^+ Z_{k1}^+ - (3g_2^2 + g_1^2) Z_{i2}^+ Z_{k2}^+ \right) Z_{l1}^U \right. \\ & \left. - 4Z_{j2}^{U,*} \left(-(-3|Y_{u,11}|^2 + g_1^2) Z_{i2}^+ Z_{k2}^+ + g_1^2 Z_{i1}^+ Z_{k1}^+ \right) Z_{l2}^U \right) \end{aligned} \quad (614)$$



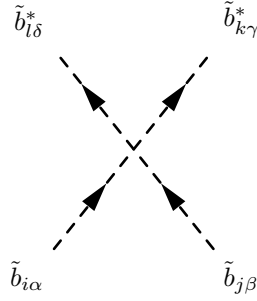
$$\frac{i}{4} \left((-4|Y_{e,11}|^2 - g_1^2 + g_2^2) Z_{i1}^+ Z_{k1}^+ + (-g_2^2 + g_1^2) Z_{i2}^+ Z_{k2}^+ \right) \quad (615)$$



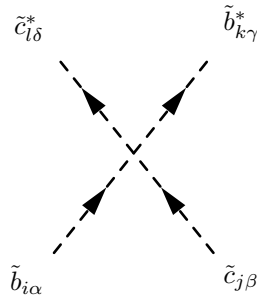
$$\frac{i}{4} \left((-4|Y_{e,22}|^2 - g_1^2 + g_2^2) Z_{i1}^+ Z_{k1}^+ + (-g_2^2 + g_1^2) Z_{i2}^+ Z_{k2}^+ \right) \quad (616)$$



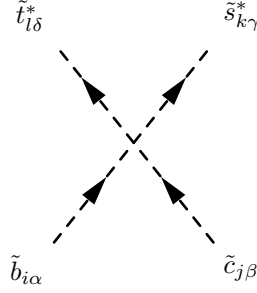
$$\frac{i}{4} \left(\left(-4|Y_{e,33}|^2 - g_1^2 + g_2^2 \right) Z_{i1}^+ Z_{k1}^+ + \left(-g_2^2 + g_1^2 \right) Z_{i2}^+ Z_{k2}^+ \right) \quad (617)$$



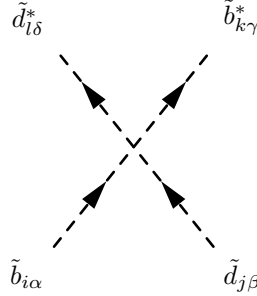
$$\begin{aligned} & \frac{i}{36} \left(-Z_{i1}^{B,*} \left(\left(12g_3^2 + 9g_2^2 + g_1^2 \right) Z_{j1}^{B,*} \left(\delta_{\alpha\delta} \delta_{\beta\gamma} + \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{k1}^B Z_{l1}^B \right. \right. \\ & + 2Z_{j2}^{B,*} \left(\delta_{\alpha\gamma} \delta_{\beta\delta} \left(\left(3g_3^2 + g_1^2 \right) Z_{k1}^B Z_{l2}^B - 9 \left(-2|Y_{d,33}|^2 + g_3^2 \right) Z_{k2}^B Z_{l1}^B \right) \right. \\ & + \left. \left. \delta_{\alpha\delta} \delta_{\beta\gamma} \left(\left(3g_3^2 + g_1^2 \right) Z_{k2}^B Z_{l1}^B - 9 \left(-2|Y_{d,33}|^2 + g_3^2 \right) Z_{k1}^B Z_{l2}^B \right) \right) \right) \\ & + 2Z_{i2}^{B,*} \left(-2 \left(3g_3^2 + g_1^2 \right) Z_{j2}^{B,*} \left(\delta_{\alpha\delta} \delta_{\beta\gamma} + \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{k2}^B Z_{l2}^B \right. \\ & + \left. Z_{j1}^{B,*} \left(\delta_{\alpha\delta} \delta_{\beta\gamma} \left(- \left(3g_3^2 + g_1^2 \right) Z_{k1}^B Z_{l2}^B + 9 \left(-2|Y_{d,33}|^2 + g_3^2 \right) Z_{k2}^B Z_{l1}^B \right) \right. \right. \\ & \left. \left. - \delta_{\alpha\gamma} \delta_{\beta\delta} \left(\left(3g_3^2 + g_1^2 \right) Z_{k2}^B Z_{l1}^B - 9 \left(-2|Y_{d,33}|^2 + g_3^2 \right) Z_{k1}^B Z_{l2}^B \right) \right) \right) \right) \quad (618) \end{aligned}$$



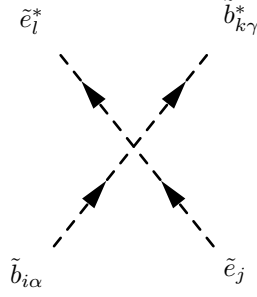
$$\begin{aligned}
& \frac{i}{36} \left(Z_{i1}^{B,*} Z_{k1}^B \left(Z_{j1}^{C,*} \left(-18g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} + (6g_3^2 + 9g_2^2 - g_1^2) \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{l1}^C \right. \right. \\
& + 2Z_{j2}^{C,*} \left((2g_1^2 - 3g_3^2) \delta_{\alpha\gamma} \delta_{\beta\delta} + 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{l2}^C \left. \right) \\
& + 2Z_{i2}^{B,*} Z_{k2}^B \left(Z_{j1}^{C,*} \left(- (3g_3^2 + g_1^2) \delta_{\alpha\gamma} \delta_{\beta\delta} + 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{l1}^C \right. \\
& \left. \left. + Z_{j2}^{C,*} \left((3g_3^2 + 4g_1^2) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{l2}^C \right) \right) \quad (619)
\end{aligned}$$



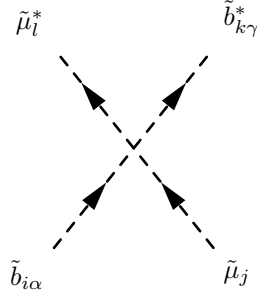
$$-\frac{i}{2} \delta_{\alpha\delta} \delta_{\beta\gamma} \left(2Y_{d,33}^* Z_{i2}^{B,*} Z_{j1}^{C,*} Y_{d,22} Z_{k2}^S Z_{l1}^T + Z_{i1}^{B,*} Z_{k1}^S \left(2Y_{u,22}^* Z_{j2}^{C,*} Y_{u,33} Z_{l2}^T + g_2^2 Z_{j1}^{C,*} Z_{l1}^T \right) \right) \quad (620)$$



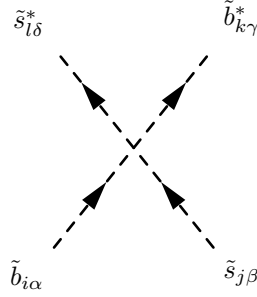
$$\begin{aligned}
& \frac{i}{36} \left(-Z_{i1}^{B,*} \left(Z_{j1}^{D,*} \left(18g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} + (-6g_3^2 + 9g_2^2 + g_1^2) \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{k1}^B Z_{l1}^D \right. \right. \\
& + 2Z_{j2}^{D,*} \left(18Y_{d,11}^* \delta_{\alpha\gamma} \delta_{\beta\delta} Y_{d,33} Z_{k2}^B Z_{l1}^D + \left((3g_3^2 + g_1^2) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{k1}^B Z_{l2}^D \right) \left. \right) \\
& + 2Z_{i2}^{B,*} \left(Z_{j2}^{D,*} \left((-2g_1^2 + 3g_3^2) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{k2}^B Z_{l2}^D \right. \\
& \left. \left. + Z_{j1}^{D,*} \left(9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} Z_{k2}^B Z_{l1}^D - \delta_{\alpha\gamma} \delta_{\beta\delta} \left(18Y_{d,33}^* Y_{d,11} Z_{k1}^B Z_{l2}^D + (3g_3^2 + g_1^2) Z_{k2}^B Z_{l1}^D \right) \right) \right) \right) \quad (621)
\end{aligned}$$



$$\begin{aligned} & \frac{i}{12} \delta_{\alpha\gamma} \left(Z_{i1}^{B,*} \left(-2Z_{j2}^{E,*} \left(6Y_{e,11}^* Y_{d,33} Z_{k2}^B Z_{l1}^E + g_1^2 Z_{k1}^B Z_{l2}^E \right) + \left(-3g_2^2 + g_1^2 \right) Z_{j1}^{E,*} Z_{k1}^B Z_{l1}^E \right) \right. \\ & \left. + 2Z_{i2}^{B,*} \left(-2g_1^2 Z_{j2}^{E,*} Z_{k2}^B Z_{l2}^E + Z_{j1}^{E,*} \left(-6Y_{d,33}^* Y_{e,11} Z_{k1}^B Z_{l2}^E + g_1^2 Z_{k2}^B Z_{l1}^E \right) \right) \right) \end{aligned} \quad (622)$$

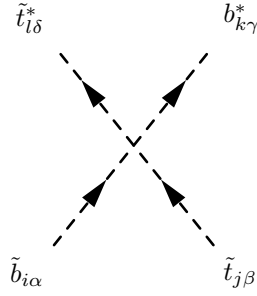


$$\begin{aligned} & \frac{i}{12} \delta_{\alpha\gamma} \left(Z_{i1}^{B,*} \left(-2Z_{j2}^{\mu,*} \left(6Y_{e,22}^* Y_{d,33} Z_{k2}^B Z_{l1}^\mu + g_1^2 Z_{k1}^B Z_{l2}^\mu \right) + \left(-3g_2^2 + g_1^2 \right) Z_{j1}^{\mu,*} Z_{k1}^B Z_{l1}^\mu \right) \right. \\ & \left. + 2Z_{i2}^{B,*} \left(-2g_1^2 Z_{j2}^{\mu,*} Z_{k2}^B Z_{l2}^\mu + Z_{j1}^{\mu,*} \left(-6Y_{d,33}^* Y_{e,22} Z_{k1}^B Z_{l2}^\mu + g_1^2 Z_{k2}^B Z_{l1}^\mu \right) \right) \right) \end{aligned} \quad (623)$$

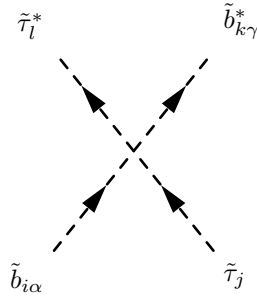


$$\frac{i}{36} \left(-Z_{i1}^{B,*} \left(Z_{j1}^{S,*} \left(18g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} + \left(-6g_3^2 + 9g_2^2 + g_1^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{k1}^B Z_{l1}^S \right) \right)$$

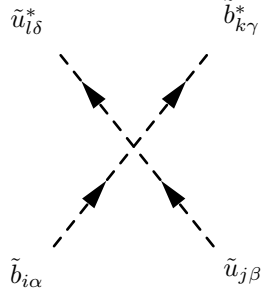
$$\begin{aligned}
& + 2Z_{j_2}^{S,*} \left(18Y_{d,22}^* \delta_{\alpha\gamma} \delta_{\beta\delta} Y_{d,33} Z_{k_2}^B Z_{l_1}^S + \left((3g_3^2 + g_1^2) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{k_1}^B Z_{l_2}^S \right) \\
& + 2Z_{i_2}^{B,*} \left(Z_{j_2}^{S,*} \left(\left(-2g_1^2 + 3g_3^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{k_2}^B Z_{l_2}^S \right. \\
& \left. + Z_{j_1}^{S,*} \left(9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} Z_{k_2}^B Z_{l_1}^S - \delta_{\alpha\gamma} \delta_{\beta\delta} \left(18Y_{d,33}^* Y_{d,22} Z_{k_1}^B Z_{l_2}^S + \left(3g_3^2 + g_1^2 \right) Z_{k_2}^B Z_{l_1}^S \right) \right) \right)
\end{aligned} \tag{624}$$



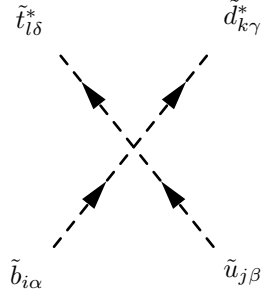
$$\begin{aligned}
& \frac{i}{36} \left(-Z_{i_1}^{B,*} Z_{k_1}^B \left(Z_{j_1}^{T,*} \left(18 \left(g_2^2 + g_3^2 \right) \delta_{\alpha\delta} \delta_{\beta\gamma} + \left(-6g_3^2 - 9g_2^2 + g_1^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{l_1}^T \right. \right. \\
& + 2Z_{j_2}^{T,*} \left(\left(-2g_1^2 + 3g_3^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9 \left(-2|Y_{u,33}|^2 + g_3^2 \right) \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{l_2}^T \left. \right) \\
& + 2Z_{i_2}^{B,*} Z_{k_2}^B \left(Z_{j_1}^{T,*} \left(- \left(3g_3^2 + g_1^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} + 9 \left(-2|Y_{d,33}|^2 + g_3^2 \right) \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{l_1}^T \right. \\
& \left. + Z_{j_2}^{T,*} \left(\left(3g_3^2 + 4g_1^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{l_2}^T \right)
\end{aligned} \tag{625}$$



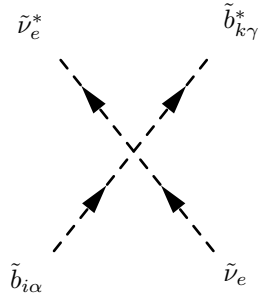
$$\begin{aligned}
& \frac{i}{12} \delta_{\alpha\gamma} \left(Z_{i_1}^{B,*} \left(-2Z_{j_2}^{T,*} \left(6Y_{e,33}^* Y_{d,33} Z_{k_2}^B Z_{l_1}^T + g_1^2 Z_{k_1}^B Z_{l_2}^T \right) + \left(-3g_2^2 + g_1^2 \right) Z_{j_1}^{T,*} Z_{k_1}^B Z_{l_1}^T \right) \right. \\
& \left. + 2Z_{i_2}^{B,*} \left(-2g_1^2 Z_{j_2}^{T,*} Z_{k_2}^B Z_{l_2}^T + Z_{j_1}^{T,*} \left(-6Y_{d,33}^* Y_{e,33} Z_{k_1}^B Z_{l_2}^T + g_1^2 Z_{k_2}^B Z_{l_1}^T \right) \right) \right)
\end{aligned} \tag{626}$$



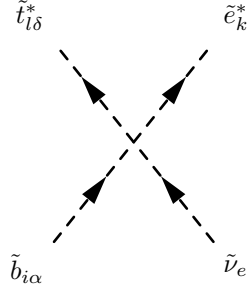
$$\begin{aligned}
& \frac{i}{36} \left(Z_{i1}^{B,*} Z_{k1}^B \left(Z_{j1}^{U,*} \left(-18g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} + (6g_3^2 + 9g_2^2 - g_1^2) \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{l1}^U \right. \right. \\
& + 2Z_{j2}^{U,*} \left((2g_1^2 - 3g_3^2) \delta_{\alpha\gamma} \delta_{\beta\delta} + 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{l2}^U \\
& + 2Z_{i2}^{B,*} Z_{k2}^B \left(Z_{j1}^{U,*} \left(- (3g_3^2 + g_1^2) \delta_{\alpha\gamma} \delta_{\beta\delta} + 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{l1}^U \right. \\
& \left. \left. + Z_{j2}^{U,*} \left((3g_3^2 + 4g_1^2) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{l2}^U \right) \right) \quad (627)
\end{aligned}$$



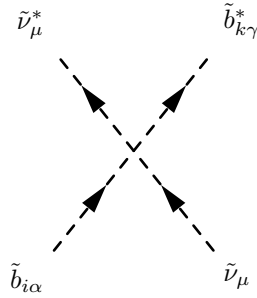
$$- \frac{i}{2} \delta_{\alpha\delta} \delta_{\beta\gamma} \left(2Y_{d,33}^* Z_{i2}^{B,*} Z_{j1}^{U,*} Y_{d,11} Z_{k2}^D Z_{l1}^T + Z_{i1}^{B,*} Z_{k1}^D \left(2Y_{u,11}^* Z_{j2}^{U,*} Y_{u,33} Z_{l2}^T + g_2^2 Z_{j1}^{U,*} Z_{l1}^T \right) \right) \quad (628)$$



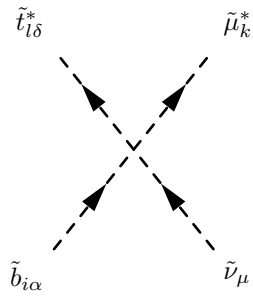
$$\frac{i}{12}\delta_{\alpha\gamma}\left(2g_1^2Z_{i2}^{B,*}Z_{k2}^B+(3g_2^2+g_1^2)Z_{i1}^{B,*}Z_{k1}^B\right) \quad (629)$$



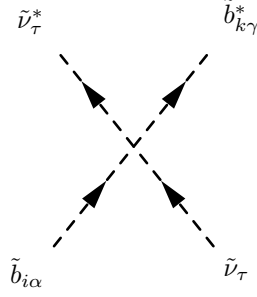
$$-\frac{i}{2}\delta_{\alpha\delta}\left(2Y_{d,33}^*Z_{i2}^{B,*}Y_{e,11}Z_{k2}^E+g_2^2Z_{i1}^{B,*}Z_{k1}^E\right)Z_{l1}^T \quad (630)$$



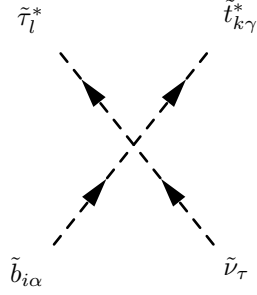
$$\frac{i}{12}\delta_{\alpha\gamma}\left(2g_1^2Z_{i2}^{B,*}Z_{k2}^B+(3g_2^2+g_1^2)Z_{i1}^{B,*}Z_{k1}^B\right) \quad (631)$$



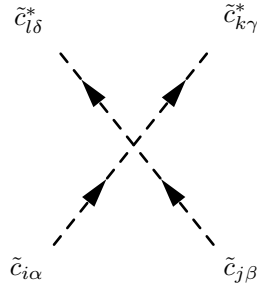
$$-\frac{i}{2}\delta_{\alpha\delta}\left(2Y_{d,33}^*Z_{i2}^{B,*}Y_{e,22}Z_{k2}^\mu+g_2^2Z_{i1}^{B,*}Z_{k1}^\mu\right)Z_{l1}^T \quad (632)$$



$$\frac{i}{12} \delta_{\alpha\gamma} \left(2g_1^2 Z_{i2}^{B,*} Z_{k2}^B + (3g_2^2 + g_1^2) Z_{i1}^{B,*} Z_{k1}^B \right) \quad (633)$$

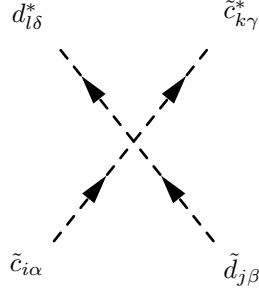


$$-\frac{i}{2} \delta_{\alpha\gamma} Z_{k1}^T \left(2Y_{d,33}^* Z_{i2}^{B,*} Y_{e,33} Z_{l2}^T + g_2^2 Z_{i1}^{B,*} Z_{l1}^T \right) \quad (634)$$

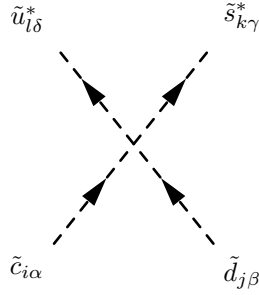


$$\begin{aligned} & \frac{i}{36} \left(-Z_{i1}^{C,*} \left((12g_3^2 + 9g_2^2 + g_1^2) Z_{j1}^{C,*} \left(\delta_{\alpha\delta} \delta_{\beta\gamma} + \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{k1}^C Z_{l1}^C \right. \right. \\ & + 2Z_{j2}^{C,*} \left(\delta_{\alpha\gamma} \delta_{\beta\delta} \left((-2g_1^2 + 3g_3^2) Z_{k1}^C Z_{l2}^C - 9 \left(-2|Y_{u,22}|^2 + g_3^2 \right) Z_{k2}^C Z_{l1}^C \right) \right. \\ & \left. \left. + \delta_{\alpha\delta} \delta_{\beta\gamma} \left((-2g_1^2 + 3g_3^2) Z_{k2}^C Z_{l1}^C - 9 \left(-2|Y_{u,22}|^2 + g_3^2 \right) Z_{k1}^C Z_{l2}^C \right) \right) \right) \end{aligned}$$

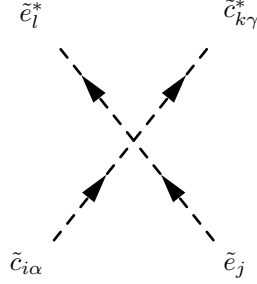
$$\begin{aligned}
& + 2Z_{i2}^{C,*} \left(-2(3g_3^2 + 4g_1^2) Z_{j2}^{C,*} (\delta_{\alpha\delta}\delta_{\beta\gamma} + \delta_{\alpha\gamma}\delta_{\beta\delta}) Z_{k2}^C Z_{l2}^C \right. \\
& + Z_{j1}^{C,*} (\delta_{\alpha\delta}\delta_{\beta\gamma} \left((2g_1^2 - 3g_3^2) Z_{k1}^C Z_{l2}^C + 9(-2|Y_{u,22}|^2 + g_3^2) Z_{k2}^C Z_{l1}^C \right) \\
& \left. + \delta_{\alpha\gamma}\delta_{\beta\delta} \left((2g_1^2 - 3g_3^2) Z_{k2}^C Z_{l1}^C + 9(-2|Y_{u,22}|^2 + g_3^2) Z_{k1}^C Z_{l2}^C \right) \right) \quad (635)
\end{aligned}$$



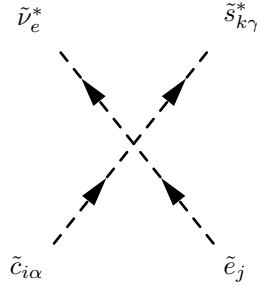
$$\begin{aligned}
& \frac{i}{36} \left(-Z_{i1}^{C,*} Z_{k1}^C \left(Z_{j1}^{D,*} (18g_3^2 \delta_{\alpha\delta}\delta_{\beta\gamma} + (-6g_3^2 - 9g_2^2 + g_1^2) \delta_{\alpha\gamma}\delta_{\beta\delta}) Z_{l1}^D \right. \right. \\
& + 2Z_{j2}^{D,*} \left((3g_3^2 + g_1^2) \delta_{\alpha\gamma}\delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta}\delta_{\beta\gamma} \right) Z_{l2}^D \left. \right) \\
& + 2Z_{i2}^{C,*} Z_{k2}^C \left(Z_{j1}^{D,*} \left((2g_1^2 - 3g_3^2) \delta_{\alpha\gamma}\delta_{\beta\delta} + 9g_3^2 \delta_{\alpha\delta}\delta_{\beta\gamma} \right) Z_{l1}^D \right. \\
& \left. + Z_{j2}^{D,*} \left((3g_3^2 + 4g_1^2) \delta_{\alpha\gamma}\delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta}\delta_{\beta\gamma} \right) Z_{l2}^D \right) \quad (636)
\end{aligned}$$



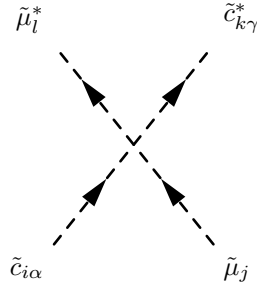
$$-\frac{i}{2} \delta_{\alpha\gamma}\delta_{\beta\delta} \left(2Y_{u,22}^* Z_{i2}^{C,*} Z_{j1}^{D,*} Y_{u,11} Z_{k1}^S Z_{l2}^U + Z_{i1}^{C,*} \left(2Y_{d,11}^* Z_{j2}^{D,*} Y_{d,22} Z_{k2}^S + g_2^2 Z_{j1}^{D,*} Z_{k1}^S \right) Z_{l1}^U \right) \quad (637)$$



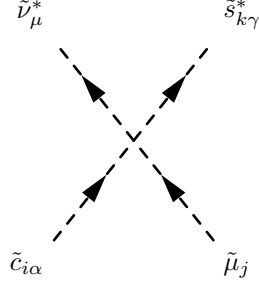
$$\begin{aligned} & \frac{i}{12} \delta_{\alpha\gamma} \left(-4g_1^2 Z_{i2}^{C,*} Z_{k2}^C \left(-2Z_{j2}^{E,*} Z_{l2}^E + Z_{j1}^{E,*} Z_{l1}^E \right) \right. \\ & \left. + Z_{i1}^{C,*} Z_{k1}^C \left(-2g_1^2 Z_{j2}^{E,*} Z_{l2}^E + \left(3g_2^2 + g_1^2 \right) Z_{j1}^{E,*} Z_{l1}^E \right) \right) \end{aligned} \quad (638)$$



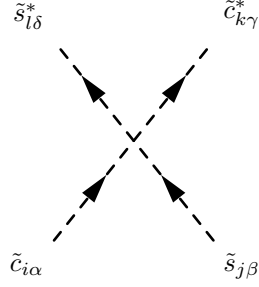
$$-\frac{i}{2} Z_{i1}^{C,*} \delta_{\alpha\gamma} \left(2Y_{e,11}^* Z_{j2}^{E,*} Y_{d,22} Z_{k2}^S + g_2^2 Z_{j1}^{E,*} Z_{k1}^S \right) \quad (639)$$



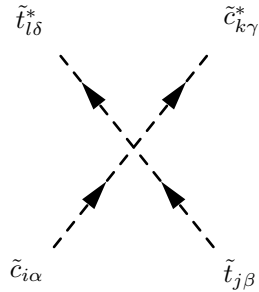
$$\begin{aligned} & \frac{i}{12} \delta_{\alpha\gamma} \left(-4g_1^2 Z_{i2}^{C,*} Z_{k2}^C \left(-2Z_{j2}^{\mu,*} Z_{l2}^\mu + Z_{j1}^{\mu,*} Z_{l1}^\mu \right) \right. \\ & \left. + Z_{i1}^{C,*} Z_{k1}^C \left(-2g_1^2 Z_{j2}^{\mu,*} Z_{l2}^\mu + \left(3g_2^2 + g_1^2 \right) Z_{j1}^{\mu,*} Z_{l1}^\mu \right) \right) \end{aligned} \quad (640)$$



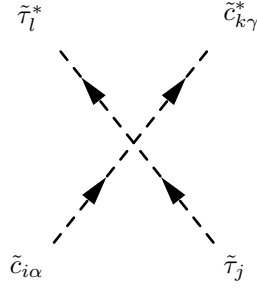
$$-\frac{i}{2}Z_{i1}^{C,*}\delta_{\alpha\gamma}\left(2Y_{e,22}^*Z_{j2}^{\mu,*}Y_{d,22}Z_{k2}^S+g_2^2Z_{j1}^{\mu,*}Z_{k1}^S\right) \quad (641)$$



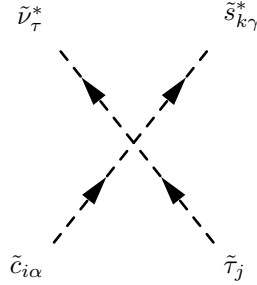
$$\begin{aligned} & \frac{i}{36}\left(-Z_{i1}^{C,*}Z_{k1}^C\left(Z_{j1}^{S,*}\left(18\left(g_2^2+g_3^2\right)\delta_{\alpha\delta}\delta_{\beta\gamma}+\left(-6g_3^2-9g_2^2+g_1^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}\right)Z_{l1}^S\right.\right. \\ & +2Z_{j2}^{S,*}\left(\left(3g_3^2+g_1^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}-9\left(-2|Y_{d,22}|^2+g_3^2\right)\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{l2}^S \\ & +2Z_{i2}^{C,*}Z_{k2}^C\left(Z_{j1}^{S,*}\left(\left(2g_1^2-3g_3^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}+9\left(-2|Y_{u,22}|^2+g_3^2\right)\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{l1}^S\right. \\ & \left.\left.+Z_{j2}^{S,*}\left(\left(3g_3^2+4g_1^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}-9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{l2}^S\right)\right) \quad (642) \end{aligned}$$



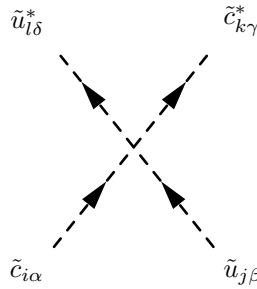
$$\begin{aligned}
& \frac{i}{36} \left(-Z_{i1}^{C,*} \left(Z_{j1}^{T,*} \left(18g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} + \left(-6g_3^2 + 9g_2^2 + g_1^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{k1}^C Z_{l1}^T \right. \right. \\
& + 2Z_{j2}^{T,*} \left(18Y_{u,33}^* \delta_{\alpha\gamma} \delta_{\beta\delta} Y_{u,22} Z_{k2}^C Z_{l1}^T + \left(\left(-2g_1^2 + 3g_3^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{k1}^C Z_{l2}^T \right) \\
& + 2Z_{i2}^{C,*} \left(Z_{j2}^{T,*} \left(\left(3g_3^2 - 8g_1^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{k2}^C Z_{l2}^T \right. \\
& \left. \left. + Z_{j1}^{T,*} \left(9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} Z_{k2}^C Z_{l1}^T + \delta_{\alpha\gamma} \delta_{\beta\delta} \left(-18Y_{u,22}^* Y_{u,33} Z_{k1}^C Z_{l2}^T + \left(2g_1^2 - 3g_3^2 \right) Z_{k2}^C Z_{l1}^T \right) \right) \right) \right) \quad (643)
\end{aligned}$$



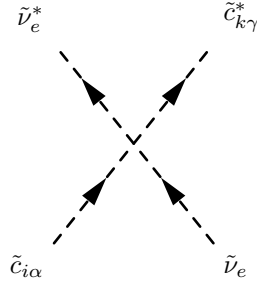
$$\begin{aligned}
& \frac{i}{12} \delta_{\alpha\gamma} \left(-4g_1^2 Z_{i2}^{C,*} Z_{k2}^C \left(-2Z_{j2}^{T,*} Z_{l2}^T + Z_{j1}^{T,*} Z_{l1}^T \right) \right. \\
& \left. + Z_{i1}^{C,*} Z_{k1}^C \left(-2g_1^2 Z_{j2}^{T,*} Z_{l2}^T + \left(3g_2^2 + g_1^2 \right) Z_{j1}^{T,*} Z_{l1}^T \right) \right) \quad (644)
\end{aligned}$$



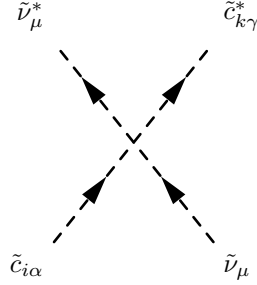
$$- \frac{i}{2} Z_{i1}^{C,*} \delta_{\alpha\gamma} \left(2Y_{e,33}^* Z_{j2}^{T,*} Y_{d,22} Z_{k2}^S + g_2^2 Z_{j1}^{T,*} Z_{k1}^S \right) \quad (645)$$



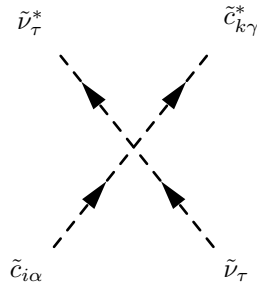
$$\begin{aligned}
& \frac{i}{36} \left(-Z_{i1}^{C,*} \left(Z_{j1}^{U,*} \left(18g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} + \left(-6g_3^2 + 9g_2^2 + g_1^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{k1}^C Z_{l1}^U \right. \right. \\
& + 2Z_{j2}^{U,*} \left(18Y_{u,11}^* \delta_{\alpha\gamma} \delta_{\beta\delta} Y_{u,22} Z_{k2}^C Z_{l1}^U + \left(\left(-2g_1^2 + 3g_3^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{k1}^C Z_{l2}^U \right) \\
& + 2Z_{i2}^{C,*} \left(Z_{j2}^{U,*} \left(\left(3g_3^2 - 8g_1^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{k2}^C Z_{l2}^U \right. \\
& \left. \left. + Z_{j1}^{U,*} \left(9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} Z_{k2}^C Z_{l1}^U + \delta_{\alpha\gamma} \delta_{\beta\delta} \left(-18Y_{u,22}^* Y_{u,11} Z_{k1}^C Z_{l2}^U + \left(2g_1^2 - 3g_3^2 \right) Z_{k2}^C Z_{l1}^U \right) \right) \right) \right) \quad (646)
\end{aligned}$$



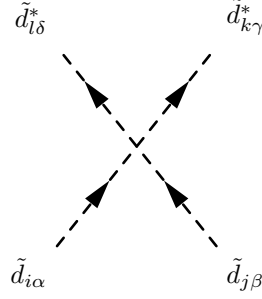
$$\frac{i}{12} \delta_{\alpha\gamma} \left(\left(-3g_2^2 + g_1^2 \right) Z_{i1}^{C,*} Z_{k1}^C - 4g_1^2 Z_{i2}^{C,*} Z_{k2}^C \right) \quad (647)$$



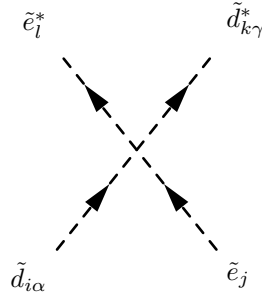
$$\frac{i}{12} \delta_{\alpha\gamma} \left(\left(-3g_2^2 + g_1^2 \right) Z_{i1}^{C,*} Z_{k1}^C - 4g_1^2 Z_{i2}^{C,*} Z_{k2}^C \right) \quad (648)$$



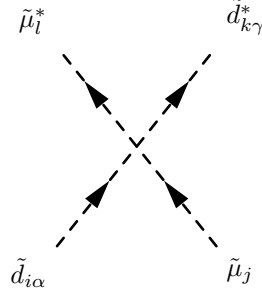
$$\frac{i}{12} \delta_{\alpha\gamma} \left((-3g_2^2 + g_1^2) Z_{i1}^{C,*} Z_{k1}^C - 4g_1^2 Z_{i2}^{C,*} Z_{k2}^C \right) \quad (649)$$



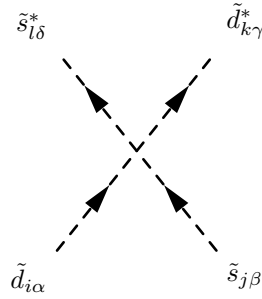
$$\begin{aligned} & \frac{i}{36} \left(-Z_{i1}^{D,*} \left((12g_3^2 + 9g_2^2 + g_1^2) Z_{j1}^{D,*} (\delta_{\alpha\delta} \delta_{\beta\gamma} + \delta_{\alpha\gamma} \delta_{\beta\delta}) Z_{k1}^D Z_{l1}^D \right. \right. \\ & + 2Z_{j2}^{D,*} (\delta_{\alpha\gamma} \delta_{\beta\delta} \left((3g_3^2 + g_1^2) Z_{k1}^D Z_{l2}^D - 9 \left(-2|Y_{d,11}|^2 + g_3^2 \right) Z_{k2}^D Z_{l1}^D \right) \\ & + \delta_{\alpha\delta} \delta_{\beta\gamma} \left((3g_3^2 + g_1^2) Z_{k2}^D Z_{l1}^D - 9 \left(-2|Y_{d,11}|^2 + g_3^2 \right) Z_{k1}^D Z_{l2}^D \right) \left. \right) \\ & + 2Z_{i2}^{D,*} \left(-2 \left(3g_3^2 + g_1^2 \right) Z_{j2}^{D,*} (\delta_{\alpha\delta} \delta_{\beta\gamma} + \delta_{\alpha\gamma} \delta_{\beta\delta}) Z_{k2}^D Z_{l2}^D \right. \\ & + Z_{j1}^{D,*} (\delta_{\alpha\delta} \delta_{\beta\gamma} \left(- \left(3g_3^2 + g_1^2 \right) Z_{k1}^D Z_{l2}^D + 9 \left(-2|Y_{d,11}|^2 + g_3^2 \right) Z_{k2}^D Z_{l1}^D \right) \\ & \left. \left. - \delta_{\alpha\gamma} \delta_{\beta\delta} \left((3g_3^2 + g_1^2) Z_{k2}^D Z_{l1}^D - 9 \left(-2|Y_{d,11}|^2 + g_3^2 \right) Z_{k1}^D Z_{l2}^D \right) \right) \right) \end{aligned} \quad (650)$$



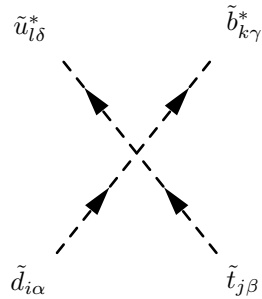
$$\begin{aligned} & \frac{i}{12} \delta_{\alpha\gamma} \left(Z_{i1}^{D,*} \left(-2Z_{j2}^{E,*} \left(6Y_{e,11}^* Y_{d,11} Z_{k2}^D Z_{l1}^E + g_1^2 Z_{k1}^D Z_{l2}^E \right) + \left(-3g_2^2 + g_1^2 \right) Z_{j1}^{E,*} Z_{k1}^D Z_{l1}^E \right) \right. \\ & \left. + 2Z_{i2}^{D,*} \left(-2g_1^2 Z_{j2}^{E,*} Z_{k2}^D Z_{l2}^E + Z_{j1}^{E,*} \left(-6Y_{d,11}^* Y_{e,11} Z_{k1}^D Z_{l2}^E + g_1^2 Z_{k2}^D Z_{l1}^E \right) \right) \right) \end{aligned} \quad (651)$$



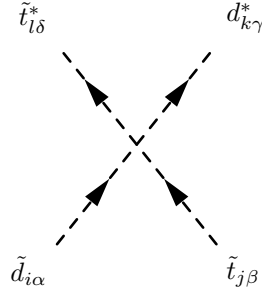
$$\begin{aligned} & \frac{i}{12} \delta_{\alpha\gamma} \left(Z_{i1}^{D,*} \left(-2Z_{j2}^{\mu,*} \left(6Y_{e,22}^* Y_{d,11} Z_{k2}^D Z_{l1}^\mu + g_1^2 Z_{k1}^D Z_{l2}^\mu \right) + \left(-3g_2^2 + g_1^2 \right) Z_{j1}^{\mu,*} Z_{k1}^D Z_{l1}^\mu \right) \right. \\ & \left. + 2Z_{i2}^{D,*} \left(-2g_1^2 Z_{j2}^{\mu,*} Z_{k2}^D Z_{l2}^\mu + Z_{j1}^{\mu,*} \left(-6Y_{d,11}^* Y_{e,22} Z_{k1}^D Z_{l2}^\mu + g_1^2 Z_{k2}^D Z_{l1}^\mu \right) \right) \right) \end{aligned} \quad (652)$$



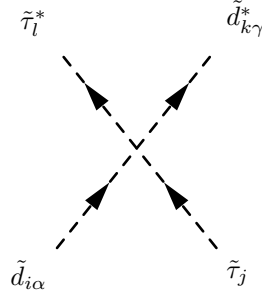
$$\begin{aligned} & \frac{i}{36} \left(-Z_{i1}^{D,*} \left(Z_{j1}^{S,*} \left(18g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} + \left(-6g_3^2 + 9g_2^2 + g_1^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{k1}^D Z_{l1}^S \right. \right. \\ & + 2Z_{j2}^{S,*} \left(18Y_{d,22}^* \delta_{\alpha\gamma} \delta_{\beta\delta} Y_{d,11} Z_{k2}^D Z_{l1}^S + \left(\left(3g_3^2 + g_1^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{k1}^D Z_{l2}^S \right) \\ & + 2Z_{i2}^{D,*} \left(Z_{j2}^{S,*} \left(\left(-2g_1^2 + 3g_3^2 \right) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{k2}^D Z_{l2}^S \right. \\ & \left. \left. + Z_{j1}^{S,*} \left(9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} Z_{k2}^D Z_{l1}^S - \delta_{\alpha\gamma} \delta_{\beta\delta} \left(18Y_{d,11}^* Y_{d,22} Z_{k1}^D Z_{l2}^S + \left(3g_3^2 + g_1^2 \right) Z_{k2}^D Z_{l1}^S \right) \right) \right) \right) \end{aligned} \quad (653)$$



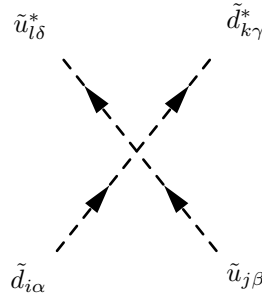
$$-\frac{i}{2}\delta_{\alpha\delta}\delta_{\beta\gamma}\left(2Y_{d,11}^*Z_{i2}^{D,*}Z_{j1}^{T,*}Y_{d,33}Z_{k2}^BZ_{l1}^U+Z_{i1}^{D,*}Z_{k1}^B\left(2Y_{u,33}^*Z_{j2}^{T,*}Y_{u,11}Z_{l2}^U+g_2^2Z_{j1}^{T,*}Z_{l1}^U\right)\right) \quad (654)$$



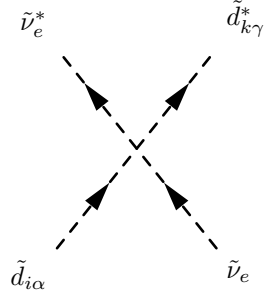
$$\begin{aligned} & \frac{i}{36}\left(Z_{i1}^{D,*}Z_{k1}^D\left(Z_{j1}^{T,*}\left(-18g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}+\left(6g_3^2+9g_2^2-g_1^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}\right)Z_{l1}^T\right.\right. \\ & +2Z_{j2}^{T,*}\left(\left(2g_1^2-3g_3^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}+9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{l2}^T\left.\right) \\ & +2Z_{i2}^{D,*}Z_{k2}^D\left(Z_{j1}^{T,*}\left(-\left(3g_3^2+g_1^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}+9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{l1}^T\right. \\ & \left.\left.+Z_{j2}^{T,*}\left(\left(3g_3^2+4g_1^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}-9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{l2}^T\right)\right) \end{aligned} \quad (655)$$



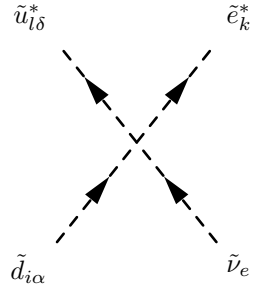
$$\begin{aligned} & \frac{i}{12}\delta_{\alpha\gamma}\left(Z_{i1}^{D,*}\left(-2Z_{j2}^{T,*}\left(6Y_{e,33}^*Y_{d,11}Z_{k2}^DZ_{l1}^T+g_1^2Z_{k1}^DZ_{l2}^T\right)+\left(-3g_2^2+g_1^2\right)Z_{j1}^{T,*}Z_{k1}^DZ_{l1}^T\right)\right. \\ & \left.+2Z_{i2}^{D,*}\left(-2g_1^2Z_{j2}^{T,*}Z_{k2}^DZ_{l2}^T+Z_{j1}^{T,*}\left(-6Y_{d,11}^*Y_{e,33}Z_{k1}^DZ_{l2}^T+g_1^2Z_{k2}^DZ_{l1}^T\right)\right)\right) \end{aligned} \quad (656)$$



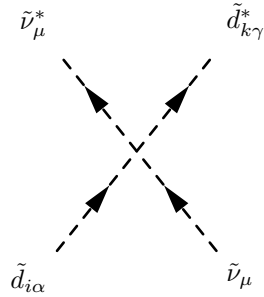
$$\begin{aligned}
& \frac{i}{36} \left(-Z_{i1}^{D,*} Z_{k1}^D \left(Z_{j1}^{U,*} \left(18(g_2^2 + g_3^2) \delta_{\alpha\delta} \delta_{\beta\gamma} + (-6g_3^2 - 9g_2^2 + g_1^2) \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{l1}^U \right. \right. \\
& + 2Z_{j2}^{U,*} \left((-2g_1^2 + 3g_3^2) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9(-2|Y_{u,11}|^2 + g_3^2) \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{l2}^U \left. \right) \\
& + 2Z_{i2}^{D,*} Z_{k2}^D \left(Z_{j1}^{U,*} \left(-(3g_3^2 + g_1^2) \delta_{\alpha\gamma} \delta_{\beta\delta} + 9(-2|Y_{d,11}|^2 + g_3^2) \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{l1}^U \right. \\
& \left. \left. + Z_{j2}^{U,*} \left((3g_3^2 + 4g_1^2) \delta_{\alpha\gamma} \delta_{\beta\delta} - 9g_3^2 \delta_{\alpha\delta} \delta_{\beta\gamma} \right) Z_{l2}^U \right) \right) \tag{657}
\end{aligned}$$



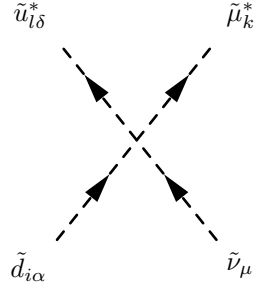
$$\frac{i}{12} \delta_{\alpha\gamma} \left(2g_1^2 Z_{i2}^{D,*} Z_{k2}^D + (3g_2^2 + g_1^2) Z_{i1}^{D,*} Z_{k1}^D \right) \tag{658}$$



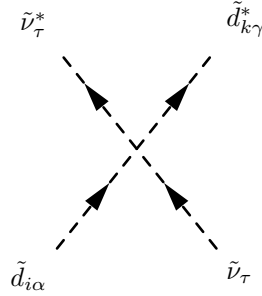
$$-\frac{i}{2} \delta_{\alpha\delta} \left(2Y_{d,11}^* Z_{i2}^{D,*} Y_{e,11} Z_{k2}^E + g_2^2 Z_{i1}^{D,*} Z_{k1}^E \right) Z_{l1}^U \tag{659}$$



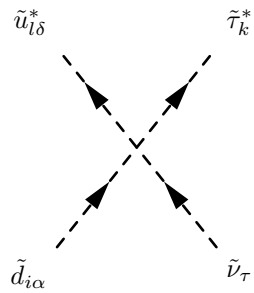
$$\frac{i}{12}\delta_{\alpha\gamma}\left(2g_1^2Z_{i2}^{D,*}Z_{k2}^D+(3g_2^2+g_1^2)Z_{i1}^{D,*}Z_{k1}^D\right) \quad (660)$$



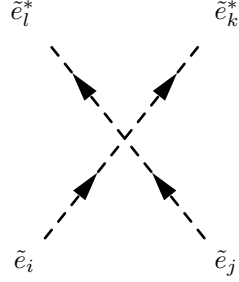
$$-\frac{i}{2}\delta_{\alpha\delta}\left(2Y_{d,11}^*Z_{i2}^{D,*}Y_{e,22}Z_{k2}^\mu+g_2^2Z_{i1}^{D,*}Z_{k1}^\mu\right)Z_{l1}^U \quad (661)$$



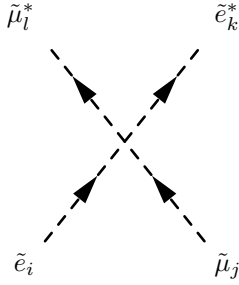
$$\frac{i}{12}\delta_{\alpha\gamma}\left(2g_1^2Z_{i2}^{D,*}Z_{k2}^D+(3g_2^2+g_1^2)Z_{i1}^{D,*}Z_{k1}^D\right) \quad (662)$$



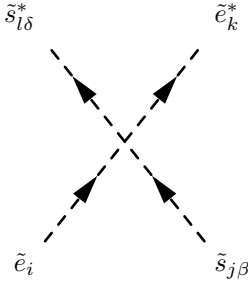
$$-\frac{i}{2}\delta_{\alpha\delta}\left(2Y_{d,11}^*Z_{i2}^{D,*}Y_{e,33}Z_{k2}^\tau+g_2^2Z_{i1}^{D,*}Z_{k1}^\tau\right)Z_{l1}^U \quad (663)$$



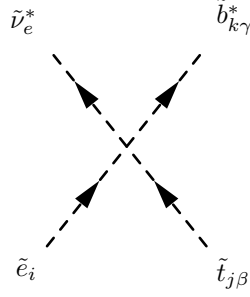
$$\begin{aligned} & \frac{i}{2} \left(Z_{i2}^{E,*} \left((-2|Y_{e,11}|^2 + g_1^2) Z_{j1}^{E,*} \left(Z_{k1}^E Z_{i2}^E + Z_{k2}^E Z_{i1}^E \right) - 4g_1^2 Z_{j2}^{E,*} Z_{k2}^E Z_{i2}^E \right) \right. \\ & \left. - Z_{i1}^{E,*} \left(- \left(-2|Y_{e,11}|^2 + g_1^2 \right) Z_{j2}^{E,*} \left(Z_{k1}^E Z_{i2}^E + Z_{k2}^E Z_{i1}^E \right) + \left(g_1^2 + g_2^2 \right) Z_{j1}^{E,*} Z_{k1}^E Z_{i1}^E \right) \right) \end{aligned} \quad (664)$$



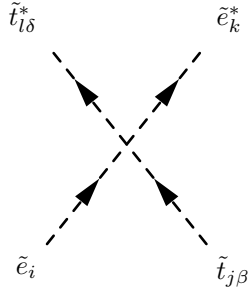
$$\begin{aligned} & \frac{i}{4} \left(- Z_{i1}^{E,*} \left(2Z_{j2}^{\mu,*} \left(2Y_{e,22}^* Y_{e,11} Z_{k2}^E Z_{i1}^\mu - g_1^2 Z_{k1}^E Z_{i2}^\mu \right) + \left(g_1^2 + g_2^2 \right) Z_{j1}^{\mu,*} Z_{k1}^E Z_{i1}^\mu \right) \right. \\ & \left. + 2Z_{i2}^{E,*} \left(-2g_1^2 Z_{j2}^{\mu,*} Z_{k2}^E Z_{i2}^\mu + Z_{j1}^{\mu,*} \left(-2Y_{e,11}^* Y_{e,22} Z_{k1}^E Z_{i2}^\mu + g_1^2 Z_{k2}^E Z_{i1}^\mu \right) \right) \right) \end{aligned} \quad (665)$$



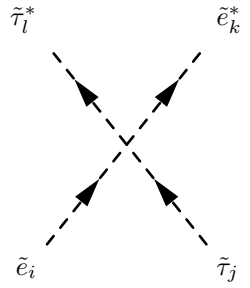
$$\begin{aligned} & \frac{i}{12} \delta_{\beta\delta} \left(Z_{i1}^{E,*} \left(2Z_{j2}^{S,*} \left(-6Y_{d,22}^* Y_{e,11} Z_{k2}^E Z_{i1}^S + g_1^2 Z_{k1}^E Z_{i2}^S \right) + \left(-3g_2^2 + g_1^2 \right) Z_{j1}^{S,*} Z_{k1}^E Z_{i1}^S \right) \right. \\ & \left. - 2Z_{i2}^{E,*} \left(2g_1^2 Z_{j2}^{S,*} Z_{k2}^E Z_{i2}^S + Z_{j1}^{S,*} \left(6Y_{e,11}^* Y_{d,22} Z_{k1}^E Z_{i2}^S + g_1^2 Z_{k2}^E Z_{i1}^S \right) \right) \right) \end{aligned} \quad (666)$$



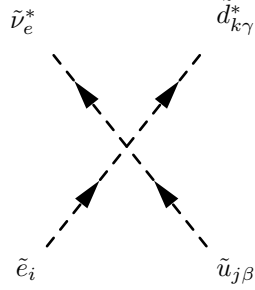
$$-\frac{i}{2}Z_{j1}^{T,*}\delta_{\beta\gamma}\left(2Y_{e,11}^*Z_{i2}^{E,*}Y_{d,33}Z_{k2}^B+g_2^2Z_{i1}^{E,*}Z_{k1}^B\right) \quad (667)$$



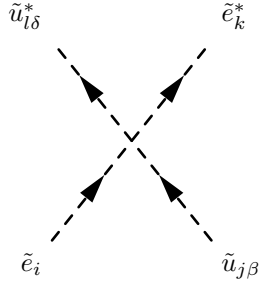
$$\begin{aligned} &\frac{i}{12}\delta_{\beta\delta}\left(-2g_1^2Z_{i2}^{E,*}Z_{k2}^E\left(-4Z_{j2}^{T,*}Z_{l2}^T+Z_{j1}^{T,*}Z_{l1}^T\right)\right. \\ &\left.+Z_{i1}^{E,*}Z_{k1}^E\left(\left(3g_2^2+g_1^2\right)Z_{j1}^{T,*}Z_{l1}^T-4g_1^2Z_{j2}^{T,*}Z_{l2}^T\right)\right) \quad (668) \end{aligned}$$



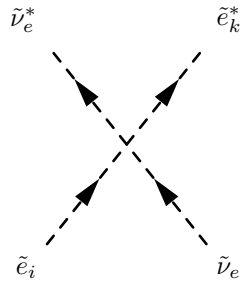
$$\begin{aligned} &\frac{i}{4}\left(-Z_{i1}^{E,*}\left(2Z_{j2}^{T,*}\left(2Y_{e,33}^*Y_{e,11}Z_{k2}^EZ_{l1}^\tau-g_1^2Z_{k1}^EZ_{l2}^\tau\right)+\left(g_1^2+g_2^2\right)Z_{j1}^{T,*}Z_{k1}^EZ_{l1}^\tau\right)\right. \\ &\left.+2Z_{i2}^{E,*}\left(-2g_1^2Z_{j2}^{T,*}Z_{k2}^EZ_{l2}^\tau+Z_{j1}^{T,*}\left(-2Y_{e,11}^*Y_{e,33}Z_{k1}^EZ_{l2}^\tau+g_1^2Z_{k2}^EZ_{l1}^\tau\right)\right)\right) \quad (669) \end{aligned}$$



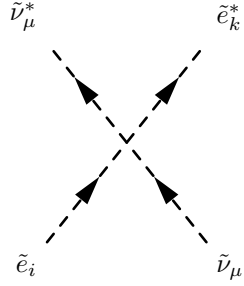
$$-\frac{i}{2} Z_{j1}^{U,*} \delta_{\beta\gamma} \left(2Y_{e,11}^* Z_{i2}^{E,*} Y_{d,11} Z_{k2}^D + g_2^2 Z_{i1}^{E,*} Z_{k1}^D \right) \quad (670)$$



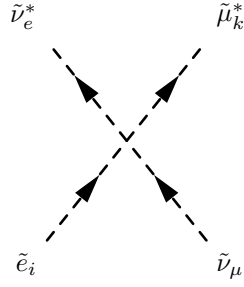
$$\begin{aligned} & \frac{i}{12} \delta_{\beta\delta} \left(-2g_1^2 Z_{i2}^{E,*} Z_{k2}^E \left(-4Z_{j2}^{U,*} Z_{l2}^U + Z_{j1}^{U,*} Z_{l1}^U \right) \right. \\ & \left. + Z_{i1}^{E,*} Z_{k1}^E \left((3g_2^2 + g_1^2) Z_{j1}^{U,*} Z_{l1}^U - 4g_1^2 Z_{j2}^{U,*} Z_{l2}^U \right) \right) \quad (671) \end{aligned}$$



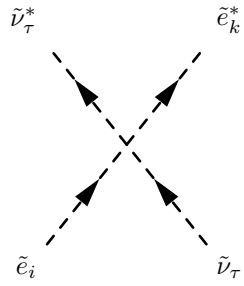
$$\frac{i}{4} \left(2 \left(-2|Y_{e,11}|^2 + g_1^2 \right) Z_{i2}^{E,*} Z_{k2}^E - \left(g_1^2 + g_2^2 \right) Z_{i1}^{E,*} Z_{k1}^E \right) \quad (672)$$



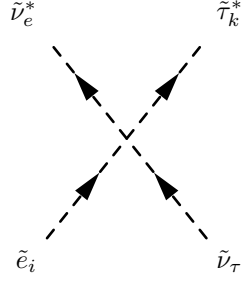
$$\frac{i}{4} \left(2g_1^2 Z_{i2}^{E,*} Z_{k2}^E + (-g_1^2 + g_2^2) Z_{i1}^{E,*} Z_{k1}^E \right) \quad (673)$$



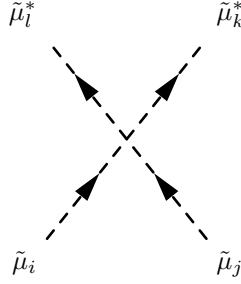
$$i \left(-\frac{1}{2} g_2^2 Z_{i1}^{E,*} Z_{k1}^\mu - Y_{e,11}^* Z_{i2}^{E,*} Y_{e,22} Z_{k2}^\mu \right) \quad (674)$$



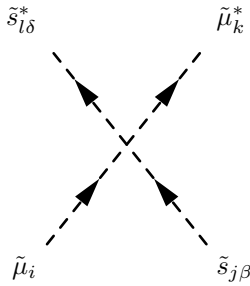
$$\frac{i}{4} \left(2g_1^2 Z_{i2}^{E,*} Z_{k2}^E + (-g_1^2 + g_2^2) Z_{i1}^{E,*} Z_{k1}^E \right) \quad (675)$$



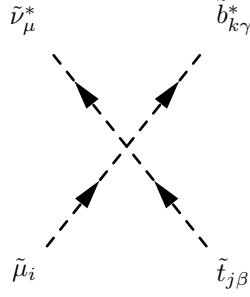
$$i \left(-\frac{1}{2} g_2^2 Z_{i1}^{E,*} Z_{k1}^T - Y_{e,11}^* Z_{i2}^{E,*} Y_{e,33} Z_{k2}^T \right) \quad (676)$$



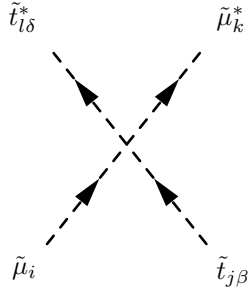
$$\begin{aligned} & \frac{i}{2} \left(Z_{i2}^{\mu,*} \left((-2|Y_{e,22}|^2 + g_1^2) Z_{j1}^{\mu,*} \left(Z_{k1}^\mu Z_{l2}^\mu + Z_{k2}^\mu Z_{l1}^\mu \right) - 4g_1^2 Z_{j2}^{\mu,*} Z_{k2}^\mu Z_{l2}^\mu \right) \right. \\ & \left. - Z_{i1}^{\mu,*} \left(-(-2|Y_{e,22}|^2 + g_1^2) Z_{j2}^{\mu,*} \left(Z_{k1}^\mu Z_{l2}^\mu + Z_{k2}^\mu Z_{l1}^\mu \right) + (g_1^2 + g_2^2) Z_{j1}^{\mu,*} Z_{k1}^\mu Z_{l1}^\mu \right) \right) \end{aligned} \quad (677)$$



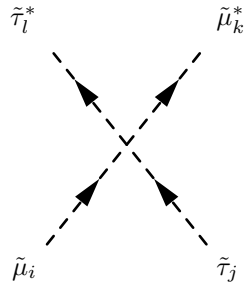
$$\begin{aligned} & \frac{i}{12} \delta_{\beta\delta} \left(Z_{i1}^{\mu,*} \left(2Z_{j2}^{S,*} \left(-6Y_{d,22}^* Y_{e,22} Z_{k2}^\mu Z_{l1}^S + g_1^2 Z_{k1}^\mu Z_{l2}^S \right) + (-3g_2^2 + g_1^2) Z_{j1}^{S,*} Z_{k1}^\mu Z_{l1}^S \right) \right. \\ & \left. - 2Z_{i2}^{\mu,*} \left(2g_1^2 Z_{j2}^{S,*} Z_{k2}^\mu Z_{l2}^S + Z_{j1}^{S,*} \left(6Y_{e,22}^* Y_{d,22} Z_{k1}^\mu Z_{l2}^S + g_1^2 Z_{k2}^\mu Z_{l1}^S \right) \right) \right) \end{aligned} \quad (678)$$



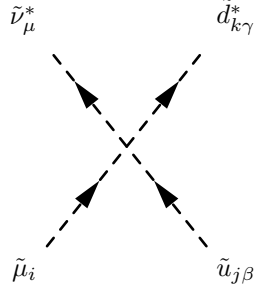
$$-\frac{i}{2} Z_{j1}^{T,*} \delta_{\beta\gamma} \left(2Y_{e,22}^* Z_{i2}^{\mu,*} Y_{d,33} Z_{k2}^B + g_2^2 Z_{i1}^{\mu,*} Z_{k1}^B \right) \quad (679)$$



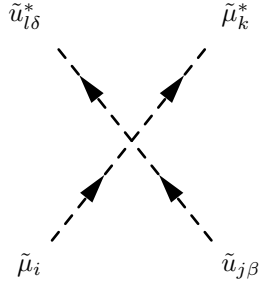
$$\begin{aligned} & \frac{i}{12} \delta_{\beta\delta} \left(-2g_1^2 Z_{i2}^{\mu,*} Z_{k2}^\mu \left(-4Z_{j2}^{T,*} Z_{l2}^T + Z_{j1}^{T,*} Z_{l1}^T \right) \right. \\ & \left. + Z_{i1}^{\mu,*} Z_{k1}^\mu \left(\left(3g_2^2 + g_1^2 \right) Z_{j1}^{T,*} Z_{l1}^T - 4g_1^2 Z_{j2}^{T,*} Z_{l2}^T \right) \right) \quad (680) \end{aligned}$$



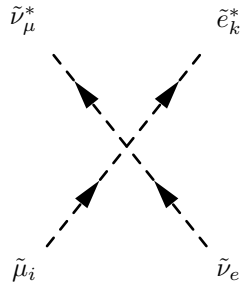
$$\begin{aligned} & \frac{i}{4} \left(-Z_{i1}^{\mu,*} \left(2Z_{j2}^{T,*} \left(2Y_{e,33}^* Y_{e,22} Z_{k2}^\mu Z_{l1}^\tau - g_1^2 Z_{k1}^\mu Z_{l2}^\tau \right) + \left(g_1^2 + g_2^2 \right) Z_{j1}^{T,*} Z_{k1}^\mu Z_{l1}^\tau \right) \right. \\ & \left. + 2Z_{i2}^{\mu,*} \left(-2g_1^2 Z_{j2}^{T,*} Z_{k2}^\mu Z_{l2}^\tau + Z_{j1}^{T,*} \left(-2Y_{e,22}^* Y_{e,33} Z_{k1}^\mu Z_{l2}^\tau + g_1^2 Z_{k2}^\mu Z_{l1}^\tau \right) \right) \right) \quad (681) \end{aligned}$$



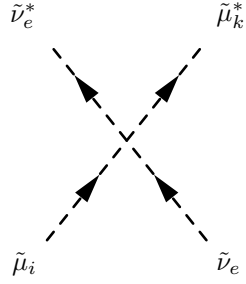
$$-\frac{i}{2} Z_{j1}^{U,*} \delta_{\beta\gamma} \left(2Y_{e,22}^* Z_{i2}^{\mu,*} Y_{d,11} Z_{k2}^D + g_2^2 Z_{i1}^{\mu,*} Z_{k1}^D \right) \quad (682)$$



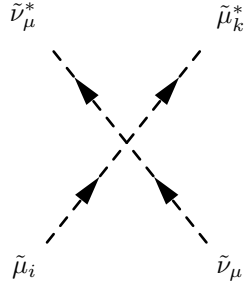
$$\begin{aligned} & \frac{i}{12} \delta_{\beta\delta} \left(-2g_1^2 Z_{i2}^{\mu,*} Z_{k2}^\mu \left(-4Z_{j2}^{U,*} Z_{l2}^U + Z_{j1}^{U,*} Z_{l1}^U \right) \right. \\ & \left. + Z_{i1}^{\mu,*} Z_{k1}^\mu \left(\left(3g_2^2 + g_1^2 \right) Z_{j1}^{U,*} Z_{l1}^U - 4g_1^2 Z_{j2}^{U,*} Z_{l2}^U \right) \right) \quad (683) \end{aligned}$$



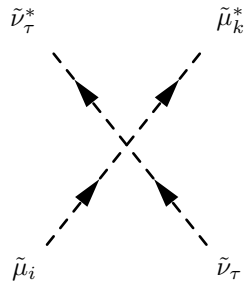
$$i \left(-\frac{1}{2} g_2^2 Z_{i1}^{\mu,*} Z_{k1}^E - Y_{e,22}^* Z_{i2}^{\mu,*} Y_{e,11} Z_{k2}^E \right) \quad (684)$$



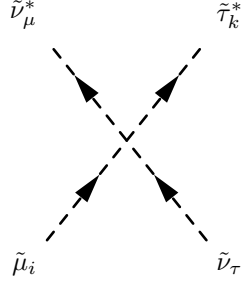
$$\frac{i}{4} \left(2g_1^2 Z_{i2}^{\mu,*} Z_{k2}^\mu + (-g_1^2 + g_2^2) Z_{i1}^{\mu,*} Z_{k1}^\mu \right) \quad (685)$$



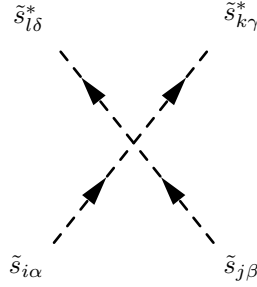
$$\frac{i}{4} \left(2(-2|Y_{e,22}|^2 + g_1^2) Z_{i2}^{\mu,*} Z_{k2}^\mu - (g_1^2 + g_2^2) Z_{i1}^{\mu,*} Z_{k1}^\mu \right) \quad (686)$$



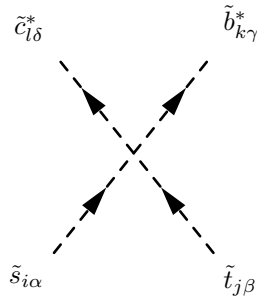
$$\frac{i}{4} \left(2g_1^2 Z_{i2}^{\mu,*} Z_{k2}^\mu + (-g_1^2 + g_2^2) Z_{i1}^{\mu,*} Z_{k1}^\mu \right) \quad (687)$$



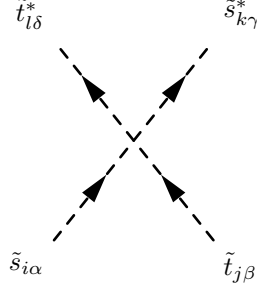
$$i \left(-\frac{1}{2} g_2^2 Z_{i1}^{\mu,*} Z_{k1}^T - Y_{e,22}^* Z_{i2}^{\mu,*} Y_{e,33} Z_{k2}^T \right) \quad (688)$$



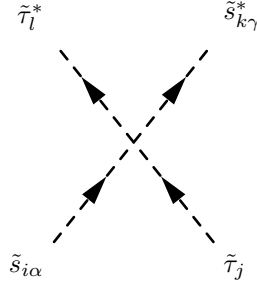
$$\begin{aligned} & \frac{i}{36} \left(-Z_{i1}^{S,*} \left((12g_3^2 + 9g_2^2 + g_1^2) Z_{j1}^{S,*} (\delta_{\alpha\delta} \delta_{\beta\gamma} + \delta_{\alpha\gamma} \delta_{\beta\delta}) Z_{k1}^S Z_{l1}^S \right. \right. \\ & + 2Z_{j2}^{S,*} (\delta_{\alpha\gamma} \delta_{\beta\delta} \left((3g_3^2 + g_1^2) Z_{k1}^S Z_{l2}^S - 9(-2|Y_{d,22}|^2 + g_3^2) Z_{k2}^S Z_{l1}^S \right) \\ & + \delta_{\alpha\delta} \delta_{\beta\gamma} \left((3g_3^2 + g_1^2) Z_{k2}^S Z_{l1}^S - 9(-2|Y_{d,22}|^2 + g_3^2) Z_{k1}^S Z_{l2}^S \right) \left. \left. \right) \right) \\ & + 2Z_{i2}^{S,*} \left(-2(3g_3^2 + g_1^2) Z_{j2}^{S,*} (\delta_{\alpha\delta} \delta_{\beta\gamma} + \delta_{\alpha\gamma} \delta_{\beta\delta}) Z_{k2}^S Z_{l2}^S \right. \\ & + Z_{j1}^{S,*} (\delta_{\alpha\delta} \delta_{\beta\gamma} \left(-(3g_3^2 + g_1^2) Z_{k1}^S Z_{l2}^S + 9(-2|Y_{d,22}|^2 + g_3^2) Z_{k2}^S Z_{l1}^S \right) \\ & \left. \left. - \delta_{\alpha\gamma} \delta_{\beta\delta} \left((3g_3^2 + g_1^2) Z_{k2}^S Z_{l1}^S - 9(-2|Y_{d,22}|^2 + g_3^2) Z_{k1}^S Z_{l2}^S \right) \right) \right) \end{aligned} \quad (689)$$



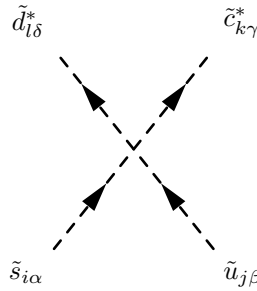
$$-\frac{i}{2}\delta_{\alpha\delta}\delta_{\beta\gamma}\left(2Y_{d,22}^*Z_{i2}^{S,*}Z_{j1}^{T,*}Y_{d,33}Z_{k2}^B Z_{l1}^C + Z_{i1}^{S,*}Z_{k1}^B\left(2Y_{u,33}^*Z_{j2}^{T,*}Y_{u,22}Z_{l2}^C + g_2^2Z_{j1}^{T,*}Z_{l1}^C\right)\right) \quad (690)$$



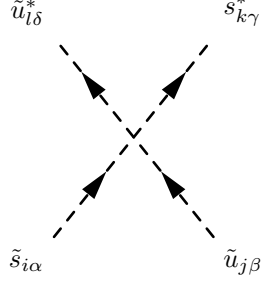
$$\begin{aligned} & \frac{i}{36}\left(Z_{i1}^{S,*}Z_{k1}^S\left(Z_{j1}^{T,*}\left(-18g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma} + (6g_3^2 + 9g_2^2 - g_1^2)\delta_{\alpha\gamma}\delta_{\beta\delta}\right)Z_{l1}^T\right.\right. \\ & + 2Z_{j2}^{T,*}\left(\left(2g_1^2 - 3g_3^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta} + 9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{l2}^T) \\ & + 2Z_{i2}^{S,*}Z_{k2}^S\left(Z_{j1}^{T,*}\left(-\left(3g_3^2 + g_1^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta} + 9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{l1}^T\right. \\ & \left.\left.+ Z_{j2}^{T,*}\left(\left(3g_3^2 + 4g_1^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta} - 9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{l2}^T\right)\right) \quad (691) \end{aligned}$$



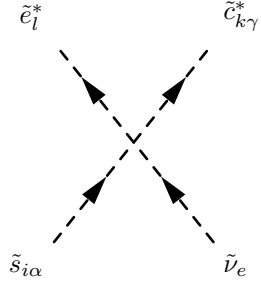
$$\begin{aligned} & \frac{i}{12}\delta_{\alpha\gamma}\left(Z_{i1}^{S,*}\left(-2Z_{j2}^{T,*}\left(6Y_{e,33}^*Y_{d,22}Z_{k2}^S Z_{l1}^T + g_1^2Z_{k1}^S Z_{l2}^T\right) + \left(-3g_2^2 + g_1^2\right)Z_{j1}^{T,*}Z_{k1}^S Z_{l1}^T\right)\right. \\ & \left.+ 2Z_{i2}^{S,*}\left(-2g_1^2Z_{j2}^{T,*}Z_{k2}^S Z_{l2}^T + Z_{j1}^{T,*}\left(-6Y_{d,22}^*Y_{e,33}Z_{k1}^S Z_{l2}^T + g_1^2Z_{k2}^S Z_{l1}^T\right)\right)\right) \quad (692) \end{aligned}$$



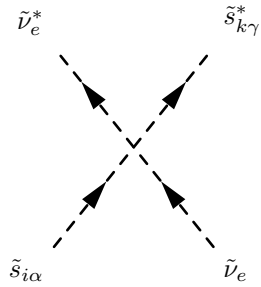
$$-\frac{i}{2}\delta_{\alpha\gamma}\delta_{\beta\delta}\left(2Y_{d,22}^*Z_{i2}^{S,*}Z_{j1}^{U,*}Y_{d,11}Z_{k1}^CZ_{l2}^D+Z_{i1}^{S,*}\left(2Y_{u,11}^*Z_{j2}^{U,*}Y_{u,22}Z_{k2}^C+g_2^2Z_{j1}^{U,*}Z_{k1}^C\right)Z_{l1}^D\right) \quad (693)$$



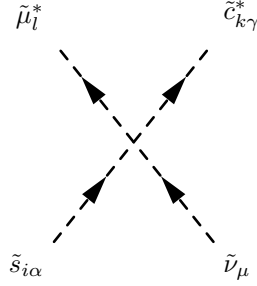
$$\begin{aligned} & \frac{i}{36}\left(Z_{i1}^{S,*}Z_{k1}^S\left(Z_{j1}^{U,*}\left(-18g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}+\left(6g_3^2+9g_2^2-g_1^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}\right)Z_{l1}^U\right.\right. \\ & +2Z_{j2}^{U,*}\left(\left(2g_1^2-3g_3^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}+9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{l2}^U \\ & +2Z_{i2}^{S,*}Z_{k2}^S\left(Z_{j1}^{U,*}\left(-\left(3g_3^2+g_1^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}+9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{l1}^U\right. \\ & \left.\left.+Z_{j2}^{U,*}\left(\left(3g_3^2+4g_1^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}-9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{l2}^U\right)\right) \end{aligned} \quad (694)$$



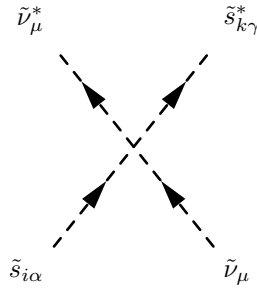
$$-\frac{i}{2}\delta_{\alpha\gamma}Z_{k1}^C\left(2Y_{d,22}^*Z_{i2}^{S,*}Y_{e,11}Z_{l2}^E+g_2^2Z_{i1}^{S,*}Z_{l1}^E\right) \quad (695)$$



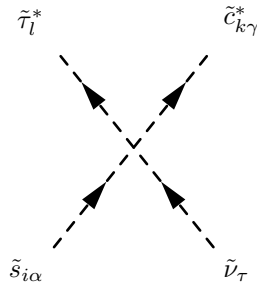
$$\frac{i}{12} \delta_{\alpha\gamma} \left(2g_1^2 Z_{i2}^{S,*} Z_{k2}^S + (3g_2^2 + g_1^2) Z_{i1}^{S,*} Z_{k1}^S \right) \quad (696)$$



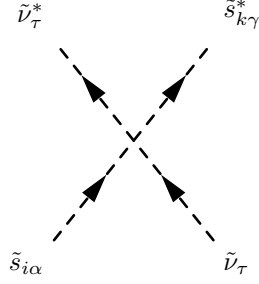
$$-\frac{i}{2} \delta_{\alpha\gamma} Z_{k1}^C \left(2Y_{d,22}^* Z_{i2}^{S,*} Y_{e,22} Z_{l2}^\mu + g_2^2 Z_{i1}^{S,*} Z_{l1}^\mu \right) \quad (697)$$



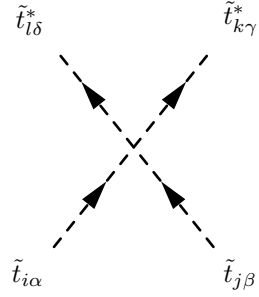
$$\frac{i}{12} \delta_{\alpha\gamma} \left(2g_1^2 Z_{i2}^{S,*} Z_{k2}^S + (3g_2^2 + g_1^2) Z_{i1}^{S,*} Z_{k1}^S \right) \quad (698)$$



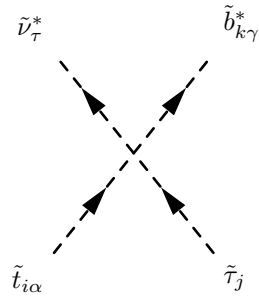
$$-\frac{i}{2} \delta_{\alpha\gamma} Z_{k1}^C \left(2Y_{d,22}^* Z_{i2}^{S,*} Y_{e,33} Z_{l2}^\tau + g_2^2 Z_{i1}^{S,*} Z_{l1}^\tau \right) \quad (699)$$



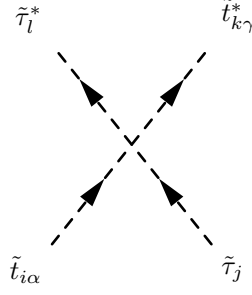
$$\frac{i}{12} \delta_{\alpha\gamma} \left(2g_1^2 Z_{i2}^{S,*} Z_{k2}^S + (3g_2^2 + g_1^2) Z_{i1}^{S,*} Z_{k1}^S \right) \quad (700)$$



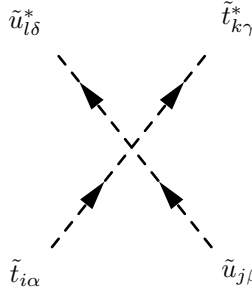
$$\begin{aligned} & \frac{i}{36} \left(-Z_{i1}^{T,*} \left((12g_3^2 + 9g_2^2 + g_1^2) Z_{j1}^{T,*} (\delta_{\alpha\delta} \delta_{\beta\gamma} + \delta_{\alpha\gamma} \delta_{\beta\delta}) Z_{k1}^T Z_{l1}^T \right. \right. \\ & + 2Z_{j2}^{T,*} (\delta_{\alpha\gamma} \delta_{\beta\delta} \left((-2g_1^2 + 3g_3^2) Z_{k1}^T Z_{l2}^T - 9(-2|Y_{u,33}|^2 + g_3^2) Z_{k2}^T Z_{l1}^T \right) \\ & + \delta_{\alpha\delta} \delta_{\beta\gamma} \left((-2g_1^2 + 3g_3^2) Z_{k2}^T Z_{l1}^T - 9(-2|Y_{u,33}|^2 + g_3^2) Z_{k1}^T Z_{l2}^T \right) \left. \right) \\ & + 2Z_{i2}^{T,*} \left(-2(3g_3^2 + 4g_1^2) Z_{j2}^{T,*} (\delta_{\alpha\delta} \delta_{\beta\gamma} + \delta_{\alpha\gamma} \delta_{\beta\delta}) Z_{k2}^T Z_{l2}^T \right. \\ & + Z_{j1}^{T,*} (\delta_{\alpha\delta} \delta_{\beta\gamma} \left((2g_1^2 - 3g_3^2) Z_{k1}^T Z_{l2}^T + 9(-2|Y_{u,33}|^2 + g_3^2) Z_{k2}^T Z_{l1}^T \right) \\ & \left. \left. + \delta_{\alpha\gamma} \delta_{\beta\delta} \left((2g_1^2 - 3g_3^2) Z_{k2}^T Z_{l1}^T + 9(-2|Y_{u,33}|^2 + g_3^2) Z_{k1}^T Z_{l2}^T \right) \right) \right) \quad (701) \end{aligned}$$



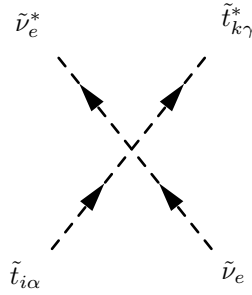
$$-\frac{i}{2}Z_{i1}^{T,*}\delta_{\alpha\gamma}\left(2Y_{e,33}^*Z_{j2}^{\tau,*}Y_{d,33}Z_{k2}^B+g_2^2Z_{j1}^{\tau,*}Z_{k1}^B\right) \quad (702)$$



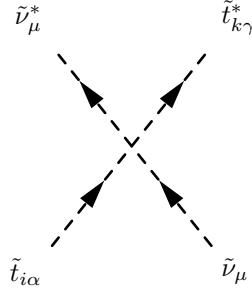
$$\begin{aligned} & \frac{i}{12}\delta_{\alpha\gamma}\left(-4g_1^2Z_{i2}^{T,*}Z_{k2}^T\left(-2Z_{j2}^{\tau,*}Z_{l2}^T+Z_{j1}^{\tau,*}Z_{l1}^T\right)\right. \\ & \left.+Z_{i1}^{T,*}Z_{k1}^T\left(-2g_1^2Z_{j2}^{\tau,*}Z_{l2}^T+\left(3g_2^2+g_1^2\right)Z_{j1}^{\tau,*}Z_{l1}^T\right)\right) \end{aligned} \quad (703)$$



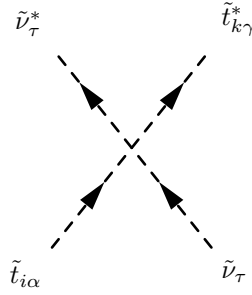
$$\begin{aligned} & \frac{i}{36}\left(-Z_{i1}^{T,*}\left(Z_{j1}^{U,*}\left(18g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}+\left(-6g_3^2+9g_2^2+g_1^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}\right)Z_{k1}^TZ_{l1}^U\right.\right. \\ & \left.+2Z_{j2}^{U,*}\left(18Y_{u,11}^*\delta_{\alpha\gamma}\delta_{\beta\delta}Y_{u,33}Z_{k2}^TZ_{l1}^U+\left(\left(-2g_1^2+3g_3^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}-9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{k1}^TZ_{l2}^U\right)\right) \\ & \left.+2Z_{i2}^{T,*}\left(Z_{j2}^{U,*}\left(\left(3g_3^2-8g_1^2\right)\delta_{\alpha\gamma}\delta_{\beta\delta}-9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\right)Z_{k2}^TZ_{l2}^U\right.\right. \\ & \left.\left.+Z_{j1}^{U,*}\left(9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}Z_{k2}^TZ_{l1}^U+\delta_{\alpha\gamma}\delta_{\beta\delta}\left(-18Y_{u,33}^*Y_{u,11}Z_{k1}^TZ_{l2}^U+\left(2g_1^2-3g_3^2\right)Z_{k2}^TZ_{l1}^U\right)\right)\right)\right) \end{aligned} \quad (704)$$



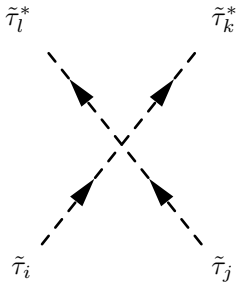
$$\frac{i}{12} \delta_{\alpha\gamma} \left((-3g_2^2 + g_1^2) Z_{i1}^{T,*} Z_{k1}^T - 4g_1^2 Z_{i2}^{T,*} Z_{k2}^T \right) \quad (705)$$



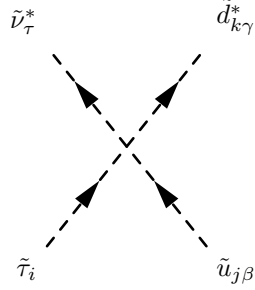
$$\frac{i}{12} \delta_{\alpha\gamma} \left((-3g_2^2 + g_1^2) Z_{i1}^{T,*} Z_{k1}^T - 4g_1^2 Z_{i2}^{T,*} Z_{k2}^T \right) \quad (706)$$



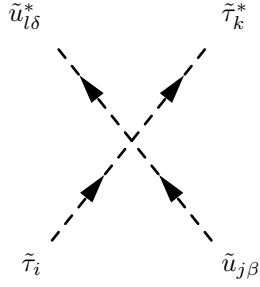
$$\frac{i}{12} \delta_{\alpha\gamma} \left((-3g_2^2 + g_1^2) Z_{i1}^{T,*} Z_{k1}^T - 4g_1^2 Z_{i2}^{T,*} Z_{k2}^T \right) \quad (707)$$



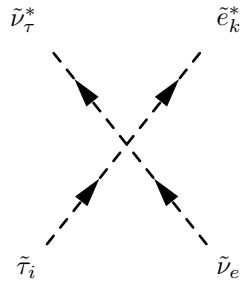
$$\begin{aligned} & \frac{i}{2} \left(Z_{i2}^{\tau,*} \left((-2|Y_{e,33}|^2 + g_1^2) Z_{j1}^{\tau,*} \left(Z_{k1}^\tau Z_{l2}^\tau + Z_{k2}^\tau Z_{l1}^\tau \right) - 4g_1^2 Z_{j2}^{\tau,*} Z_{k2}^\tau Z_{l2}^\tau \right) \right. \\ & \left. - Z_{i1}^{\tau,*} \left(- \left(-2|Y_{e,33}|^2 + g_1^2 \right) Z_{j2}^{\tau,*} \left(Z_{k1}^\tau Z_{l2}^\tau + Z_{k2}^\tau Z_{l1}^\tau \right) + \left(g_1^2 + g_2^2 \right) Z_{j1}^{\tau,*} Z_{k1}^\tau Z_{l1}^\tau \right) \right) \quad (708) \end{aligned}$$



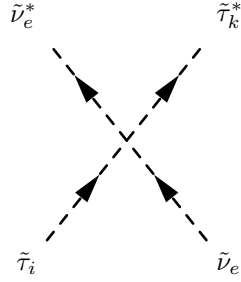
$$-\frac{i}{2}Z_{j1}^{U,*}\delta_{\beta\gamma}\left(2Y_{e,33}^*Z_{i2}^{\tau,*}Y_{d,11}Z_{k2}^D+g_2^2Z_{i1}^{\tau,*}Z_{k1}^D\right) \quad (709)$$



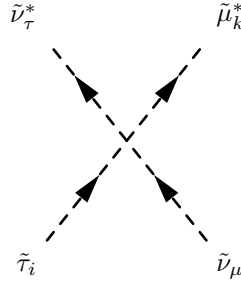
$$\begin{aligned} &\frac{i}{12}\delta_{\beta\delta}\left(-2g_1^2Z_{i2}^{\tau,*}Z_{k2}^{\tau}\left(-4Z_{j2}^{U,*}Z_{l2}^U+Z_{j1}^{U,*}Z_{l1}^U\right)\right. \\ &\left.+Z_{i1}^{\tau,*}Z_{k1}^{\tau}\left(\left(3g_2^2+g_1^2\right)Z_{j1}^{U,*}Z_{l1}^U-4g_1^2Z_{j2}^{U,*}Z_{l2}^U\right)\right) \quad (710) \end{aligned}$$



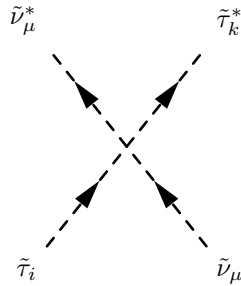
$$i\left(-\frac{1}{2}g_2^2Z_{i1}^{\tau,*}Z_{k1}^E-Y_{e,33}^*Z_{i2}^{\tau,*}Y_{e,11}Z_{k2}^E\right) \quad (711)$$



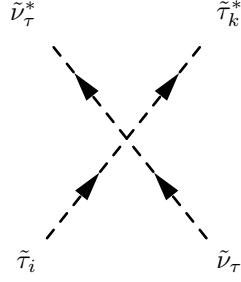
$$\frac{i}{4} \left(2g_1^2 Z_{i2}^{\tau,*} Z_{k2}^{\tau} + (-g_1^2 + g_2^2) Z_{i1}^{\tau,*} Z_{k1}^{\tau} \right) \quad (712)$$



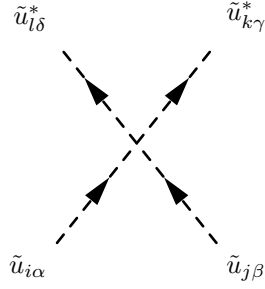
$$i \left(-\frac{1}{2} g_2^2 Z_{i1}^{\tau,*} Z_{k1}^{\mu} - Y_{e,33}^* Z_{i2}^{\tau,*} Y_{e,22} Z_{k2}^{\mu} \right) \quad (713)$$



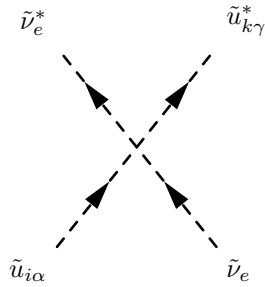
$$\frac{i}{4} \left(2g_1^2 Z_{i2}^{\tau,*} Z_{k2}^{\tau} + (-g_1^2 + g_2^2) Z_{i1}^{\tau,*} Z_{k1}^{\tau} \right) \quad (714)$$



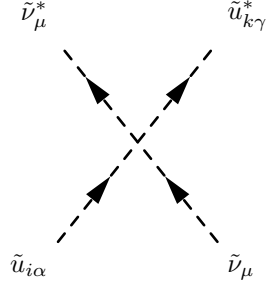
$$\frac{i}{4} \left(2 \left(-2|Y_{e,33}|^2 + g_1^2 \right) Z_{i2}^{\tau,*} Z_{k2}^\tau - \left(g_1^2 + g_2^2 \right) Z_{i1}^{\tau,*} Z_{k1}^\tau \right) \quad (715)$$



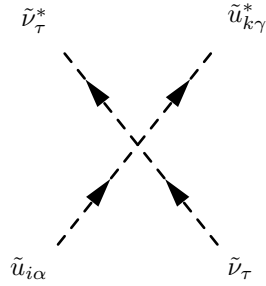
$$\begin{aligned} & \frac{i}{36} \left(-Z_{i1}^{U,*} \left(\left(12g_3^2 + 9g_2^2 + g_1^2 \right) Z_{j1}^{U,*} \left(\delta_{\alpha\delta} \delta_{\beta\gamma} + \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{k1}^U Z_{l1}^U \right. \right. \\ & + 2Z_{j2}^{U,*} \left(\delta_{\alpha\gamma} \delta_{\beta\delta} \left(\left(-2g_1^2 + 3g_3^2 \right) Z_{k1}^U Z_{l2}^U - 9 \left(-2|Y_{u,11}|^2 + g_3^2 \right) Z_{k2}^U Z_{l1}^U \right) \right. \\ & + \left. \left. \delta_{\alpha\delta} \delta_{\beta\gamma} \left(\left(-2g_1^2 + 3g_3^2 \right) Z_{k2}^U Z_{l1}^U - 9 \left(-2|Y_{u,11}|^2 + g_3^2 \right) Z_{k1}^U Z_{l2}^U \right) \right) \right) \\ & + 2Z_{i2}^{U,*} \left(-2 \left(3g_3^2 + 4g_1^2 \right) Z_{j2}^{U,*} \left(\delta_{\alpha\delta} \delta_{\beta\gamma} + \delta_{\alpha\gamma} \delta_{\beta\delta} \right) Z_{k2}^U Z_{l2}^U \right. \\ & + Z_{j1}^{U,*} \left(\delta_{\alpha\delta} \delta_{\beta\gamma} \left(\left(2g_1^2 - 3g_3^2 \right) Z_{k1}^U Z_{l2}^U + 9 \left(-2|Y_{u,11}|^2 + g_3^2 \right) Z_{k2}^U Z_{l1}^U \right) \right. \\ & + \left. \left. \delta_{\alpha\gamma} \delta_{\beta\delta} \left(\left(2g_1^2 - 3g_3^2 \right) Z_{k2}^U Z_{l1}^U + 9 \left(-2|Y_{u,11}|^2 + g_3^2 \right) Z_{k1}^U Z_{l2}^U \right) \right) \right) \right) \quad (716) \end{aligned}$$



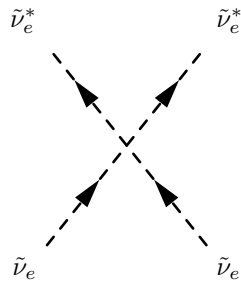
$$\frac{i}{12} \delta_{\alpha\gamma} \left((-3g_2^2 + g_1^2) Z_{i1}^{U,*} Z_{k1}^U - 4g_1^2 Z_{i2}^{U,*} Z_{k2}^U \right) \quad (717)$$



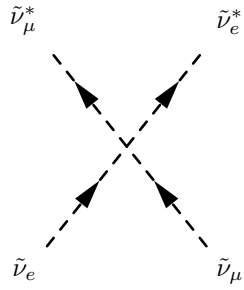
$$\frac{i}{12} \delta_{\alpha\gamma} \left((-3g_2^2 + g_1^2) Z_{i1}^{U,*} Z_{k1}^U - 4g_1^2 Z_{i2}^{U,*} Z_{k2}^U \right) \quad (718)$$



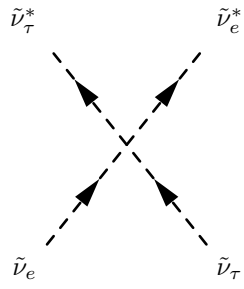
$$\frac{i}{12} \delta_{\alpha\gamma} \left((-3g_2^2 + g_1^2) Z_{i1}^{U,*} Z_{k1}^U - 4g_1^2 Z_{i2}^{U,*} Z_{k2}^U \right) \quad (719)$$



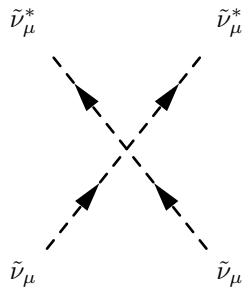
$$\frac{i}{2} \left(-g_1^2 - g_2^2 \right) \quad (720)$$



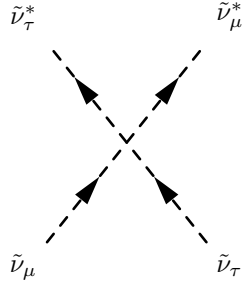
$$\frac{i}{4}(-g_1^2 - g_2^2) \tag{721}$$



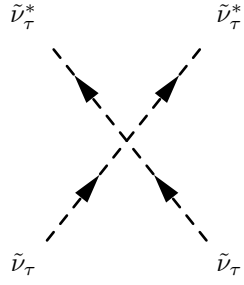
$$\frac{i}{4}(-g_1^2 - g_2^2) \tag{722}$$



$$\frac{i}{2}(-g_1^2 - g_2^2) \tag{723}$$

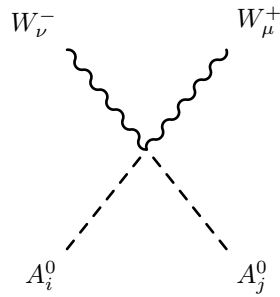


$$\frac{i}{4}(-g_1^2 - g_2^2) \quad (724)$$

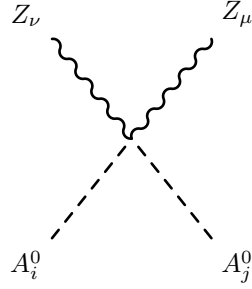


$$\frac{i}{2}(-g_1^2 - g_2^2) \quad (725)$$

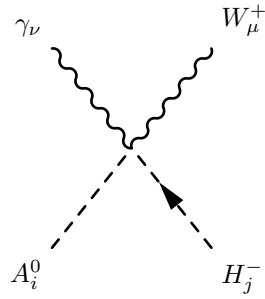
9.8 Two Scalar-Two Vector Boson-Interaction



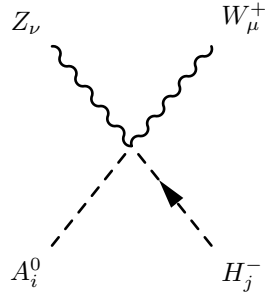
$$\left(\frac{i}{2}g_2^2 Z_{i1}^A Z_{j1}^A + \frac{i}{2}g_2^2 Z_{i2}^A Z_{j2}^A\right)(g_{\mu\nu}) \quad (726)$$



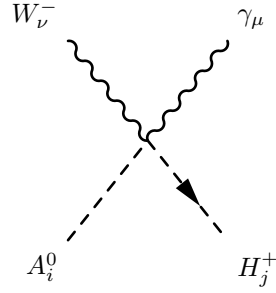
$$\left(+\frac{i}{2}g_2^2 \cos^2 \Theta_W Z_{i1}^A Z_{j1}^A + ig_1 g_2 \cos \Theta_W \sin \Theta_W Z_{i1}^A Z_{j1}^A + \frac{i}{2}g_1^2 \sin^2 \Theta_W Z_{i1}^A Z_{j1}^A \right. \\ \left. + \frac{i}{2}g_2^2 \cos^2 \Theta_W Z_{i2}^A Z_{j2}^A + ig_1 g_2 \cos \Theta_W \sin \Theta_W Z_{i2}^A Z_{j2}^A + \frac{i}{2}g_1^2 \sin^2 \Theta_W Z_{i2}^A Z_{j2}^A \right) (g_{\mu\nu}) \quad (727)$$



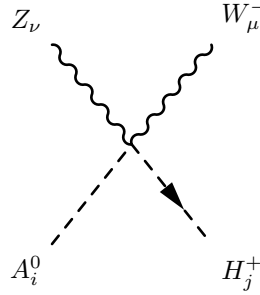
$$\left(-\frac{1}{2}g_1 g_2 \cos \Theta_W Z_{i1}^A Z_{j1}^+ - \frac{1}{2}g_1 g_2 \cos \Theta_W Z_{i2}^A Z_{j2}^+ \right) (g_{\mu\nu}) \quad (728)$$



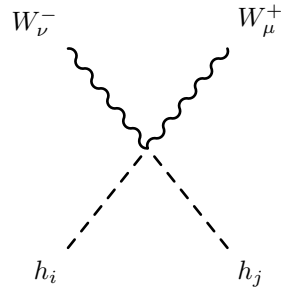
$$\left(\frac{1}{2}g_1 g_2 \sin \Theta_W Z_{i1}^A Z_{j1}^+ + \frac{1}{2}g_1 g_2 \sin \Theta_W Z_{i2}^A Z_{j2}^+ \right) (g_{\mu\nu}) \quad (729)$$



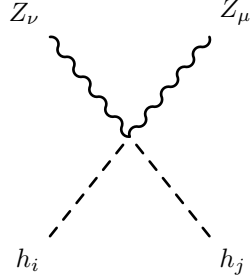
$$\left(\frac{1}{2} g_1 g_2 \cos \Theta_W Z_{i1}^A Z_{j1}^+ + \frac{1}{2} g_1 g_2 \cos \Theta_W Z_{i2}^A Z_{j2}^+ \right) (g_{\mu\nu}) \quad (730)$$



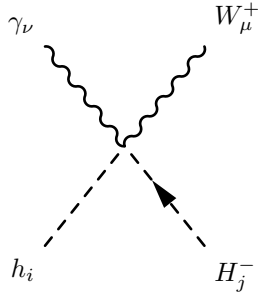
$$\left(-\frac{1}{2} g_1 g_2 \sin \Theta_W Z_{i1}^A Z_{j1}^+ - \frac{1}{2} g_1 g_2 \sin \Theta_W Z_{i2}^A Z_{j2}^+ \right) (g_{\mu\nu}) \quad (731)$$



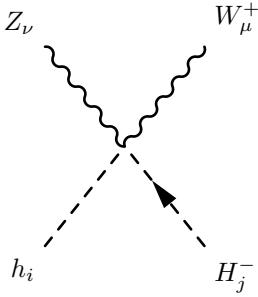
$$\left(\frac{i}{2} g_2^2 Z_{i1}^H Z_{j1}^H + \frac{i}{2} g_2^2 Z_{i2}^H Z_{j2}^H \right) (g_{\mu\nu}) \quad (732)$$



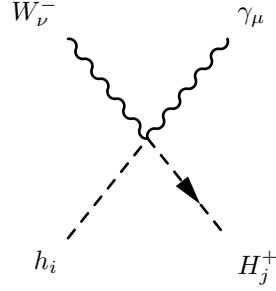
$$\left(+\frac{i}{2}g_2^2 \cos^2 \Theta_W^2 Z_{i1}^H Z_{j1}^H + ig_1 g_2 \cos \Theta_W \sin \Theta_W Z_{i1}^H Z_{j1}^H + \frac{i}{2}g_1^2 \sin^2 \Theta_W^2 Z_{i1}^H Z_{j1}^H \right. \\ \left. + \frac{i}{2}g_2^2 \cos^2 \Theta_W^2 Z_{i2}^H Z_{j2}^H + ig_1 g_2 \cos \Theta_W \sin \Theta_W Z_{i2}^H Z_{j2}^H + \frac{i}{2}g_1^2 \sin^2 \Theta_W^2 Z_{i2}^H Z_{j2}^H \right) (g_{\mu\nu}) \quad (733)$$



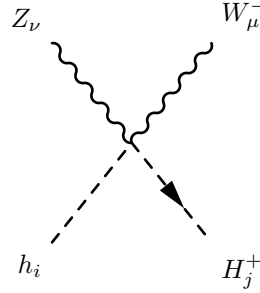
$$\left(-\frac{i}{2}g_1 g_2 \cos \Theta_W Z_{i1}^H Z_{j1}^+ + \frac{i}{2}g_1 g_2 \cos \Theta_W Z_{i2}^H Z_{j2}^+ \right) (g_{\mu\nu}) \quad (734)$$



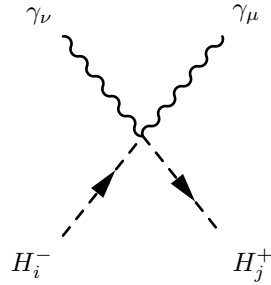
$$\left(\frac{i}{2}g_1 g_2 \sin \Theta_W Z_{i1}^H Z_{j1}^+ - \frac{i}{2}g_1 g_2 \sin \Theta_W Z_{i2}^H Z_{j2}^+ \right) (g_{\mu\nu}) \quad (735)$$



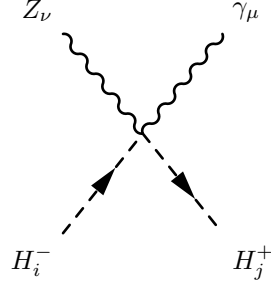
$$\left(-\frac{i}{2}g_1g_2 \cos \Theta_W Z_{i1}^H Z_{j1}^+ + \frac{i}{2}g_1g_2 \cos \Theta_W Z_{i2}^H Z_{j2}^+ \right) (g_{\mu\nu}) \quad (736)$$



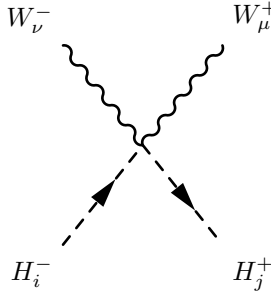
$$\left(\frac{i}{2}g_1g_2 \sin \Theta_W Z_{i1}^H Z_{j1}^+ - \frac{i}{2}g_1g_2 \sin \Theta_W Z_{i2}^H Z_{j2}^+ \right) (g_{\mu\nu}) \quad (737)$$



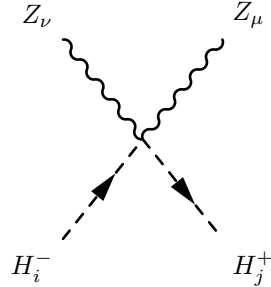
$$\left(+\frac{i}{2}g_1^2 \cos^2 \Theta_W Z_{i1}^+ Z_{j1}^+ + ig_1g_2 \cos \Theta_W \sin \Theta_W Z_{i1}^+ Z_{j1}^+ + \frac{i}{2}g_2^2 \sin^2 \Theta_W Z_{i1}^+ Z_{j1}^+ \right. \\ \left. + \frac{i}{2}g_1^2 \cos^2 \Theta_W Z_{i2}^+ Z_{j2}^+ + ig_1g_2 \cos \Theta_W \sin \Theta_W Z_{i2}^+ Z_{j2}^+ + \frac{i}{2}g_2^2 \sin^2 \Theta_W Z_{i2}^+ Z_{j2}^+ \right) (g_{\mu\nu}) \quad (738)$$



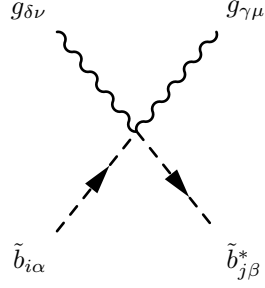
$$\left(+\frac{i}{2}g_1g_2 \cos 2\Theta_W Z_{i1}^+ Z_{j1}^+ - \frac{i}{4}g_1^2 \sin 2\Theta_W Z_{i1}^+ Z_{j1}^+ + \frac{i}{4}g_2^2 \sin 2\Theta_W Z_{i1}^+ Z_{j1}^+ \right. \\ \left. + \frac{i}{2}g_1g_2 \cos 2\Theta_W Z_{i2}^+ Z_{j2}^+ - \frac{i}{4}g_1^2 \sin 2\Theta_W Z_{i2}^+ Z_{j2}^+ + \frac{i}{4}g_2^2 \sin 2\Theta_W Z_{i2}^+ Z_{j2}^+ \right) (g_{\mu\nu}) \quad (739)$$



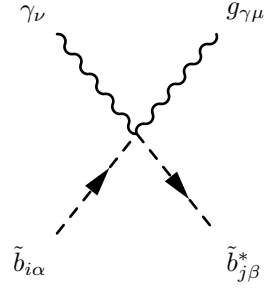
$$\left(\frac{i}{2}g_2^2 Z_{i1}^+ Z_{j1}^+ + \frac{i}{2}g_2^2 Z_{i2}^+ Z_{j2}^+ \right) (g_{\mu\nu}) \quad (740)$$



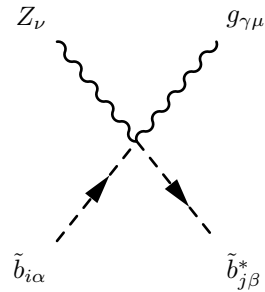
$$\left(+\frac{i}{2}g_2^2 \cos^2 \Theta_W Z_{i1}^+ Z_{j1}^+ - ig_1g_2 \cos \Theta_W \sin \Theta_W Z_{i1}^+ Z_{j1}^+ \right. \\ \left. + \frac{i}{2}g_1^2 \sin^2 \Theta_W Z_{i1}^+ Z_{j1}^+ + \frac{i}{2}g_2^2 \cos^2 \Theta_W Z_{i2}^+ Z_{j2}^+ \right. \\ \left. - ig_1g_2 \cos \Theta_W \sin \Theta_W Z_{i2}^+ Z_{j2}^+ + \frac{i}{2}g_1^2 \sin^2 \Theta_W Z_{i2}^+ Z_{j2}^+ \right) (g_{\mu\nu}) \quad (741)$$



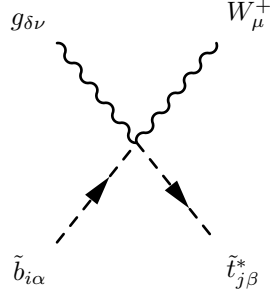
$$\begin{aligned}
& \left(+ \frac{i}{4} g_3^2 Z_{i1}^{B,*} \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta Z_{j1}^B + \frac{i}{4} g_3^2 Z_{i1}^{B,*} \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta Z_{j1}^B + \frac{i}{4} g_3^2 Z_{i2}^{B,*} \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta Z_{j2}^B \right. \\
& \left. + \frac{i}{4} g_3^2 Z_{i2}^{B,*} \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta Z_{j2}^B \right) (g_{\mu\nu})
\end{aligned} \tag{742}$$



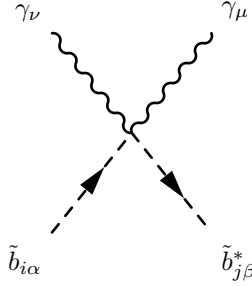
$$\begin{aligned}
& \left(+ \frac{i}{6} g_1 g_3 Z_{i1}^{B,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j1}^B - \frac{i}{2} g_2 g_3 Z_{i1}^{B,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j1}^B \right. \\
& \left. - \frac{i}{3} g_1 g_3 Z_{i2}^{B,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j2}^B \right) (g_{\mu\nu})
\end{aligned} \tag{743}$$



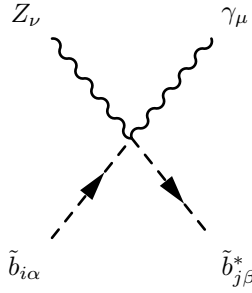
$$\left(-\frac{i}{2}g_2g_3Z_{i1}^{B,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j1}^B - \frac{i}{6}g_1g_3Z_{i1}^{B,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j1}^B + \frac{i}{3}g_1g_3Z_{i2}^{B,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j2}^B \right) (g_{\mu\nu}) \quad (744)$$



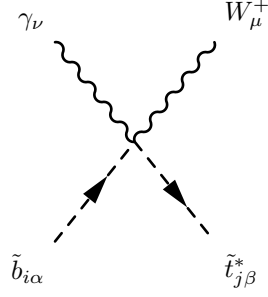
$$i\frac{1}{\sqrt{2}}g_2g_3Z_{i1}^{B,*} \lambda_{\beta,\alpha}^\delta Z_{j1}^T (g_{\mu\nu}) \quad (745)$$



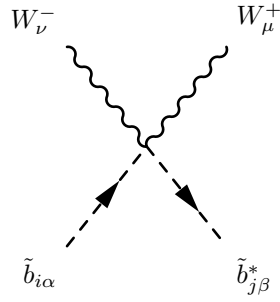
$$\left(+\frac{i}{18}g_1^2Z_{i1}^{B,*} \cos \Theta_W^2 \delta_{\alpha\beta} Z_{j1}^B - \frac{i}{3}g_1g_2Z_{i1}^{B,*} \cos \Theta_W \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^B + \frac{i}{2}g_2^2Z_{i1}^{B,*} \delta_{\alpha\beta} \sin \Theta_W^2 Z_{j1}^B + \frac{2i}{9}g_1^2Z_{i2}^{B,*} \cos \Theta_W^2 \delta_{\alpha\beta} Z_{j2}^B \right) (g_{\mu\nu}) \quad (746)$$



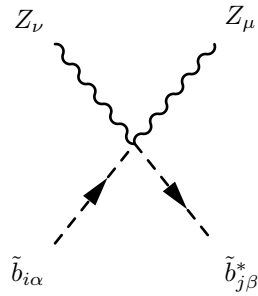
$$\left(-\frac{i}{6}g_1g_2Z_{i1}^{B,*}\cos 2\Theta_W\delta_{\alpha\beta}Z_{j1}^B - \frac{i}{36}g_1^2Z_{i1}^{B,*}\delta_{\alpha\beta}\sin 2\Theta_WZ_{j1}^B + \frac{i}{4}g_2^2Z_{i1}^{B,*}\delta_{\alpha\beta}\sin 2\Theta_WZ_{j1}^B - \frac{i}{9}g_1^2Z_{i2}^{B,*}\delta_{\alpha\beta}\sin 2\Theta_WZ_{j2}^B \right) (g_{\mu\nu}) \quad (747)$$



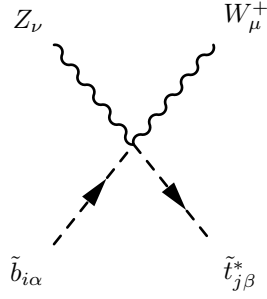
$$\frac{i}{3}\frac{1}{\sqrt{2}}g_1g_2Z_{i1}^{B,*}\cos \Theta_W\delta_{\alpha\beta}Z_{j1}^T (g_{\mu\nu}) \quad (748)$$



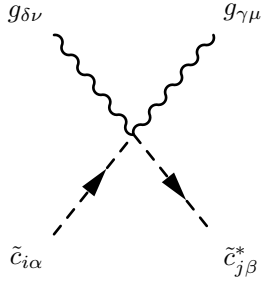
$$\frac{i}{2}g_2^2Z_{i1}^{B,*}\delta_{\alpha\beta}Z_{j1}^B (g_{\mu\nu}) \quad (749)$$



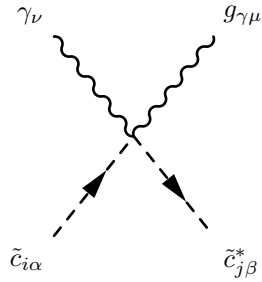
$$\left(+\frac{i}{2}g_2^2 Z_{i1}^{B,*} \cos^2 \Theta_W \delta_{\alpha\beta} Z_{j1}^B + \frac{i}{3}g_1 g_2 Z_{i1}^{B,*} \cos \Theta_W \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^B \right. \\ \left. + \frac{i}{18}g_1^2 Z_{i1}^{B,*} \delta_{\alpha\beta} \sin^2 \Theta_W Z_{j1}^B + \frac{2i}{9}g_1^2 Z_{i2}^{B,*} \delta_{\alpha\beta} \sin^2 \Theta_W Z_{j2}^B \right) (g_{\mu\nu}) \quad (750)$$



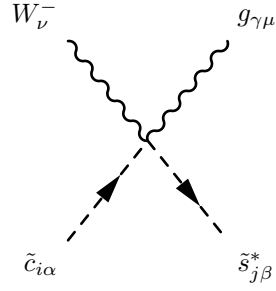
$$-\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{B,*} \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^T (g_{\mu\nu}) \quad (751)$$



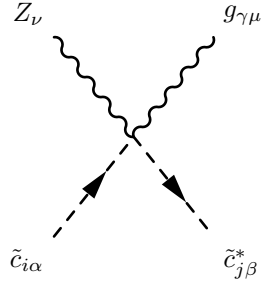
$$\left(+\frac{i}{4}g_3^2 Z_{i1}^{C,*} \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta Z_{j1}^C + \frac{i}{4}g_3^2 Z_{i1}^{C,*} \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta Z_{j1}^C + \frac{i}{4}g_3^2 Z_{i2}^{C,*} \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta Z_{j2}^C \right. \\ \left. + \frac{i}{4}g_3^2 Z_{i2}^{C,*} \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta Z_{j2}^C \right) (g_{\mu\nu}) \quad (752)$$



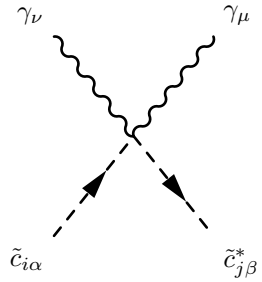
$$\begin{aligned}
& \left(+\frac{i}{6}g_1g_3Z_{i1}^{C,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j1}^C + \frac{i}{2}g_2g_3Z_{i1}^{C,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j1}^C \right. \\
& \left. + \frac{2i}{3}g_1g_3Z_{i2}^{C,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j2}^C \right) (g_{\mu\nu})
\end{aligned} \tag{753}$$



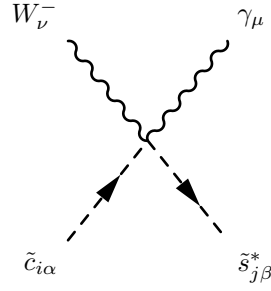
$$i \frac{1}{\sqrt{2}} g_2 g_3 Z_{i1}^{C,*} \lambda_{\beta,\alpha}^\gamma Z_{j1}^S (g_{\mu\nu}) \tag{754}$$



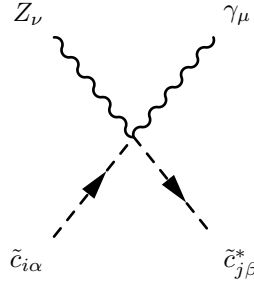
$$\begin{aligned}
& \left(+\frac{i}{2}g_2g_3Z_{i1}^{C,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j1}^C - \frac{i}{6}g_1g_3Z_{i1}^{C,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j1}^C \right. \\
& \left. - \frac{2i}{3}g_1g_3Z_{i2}^{C,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j2}^C \right) (g_{\mu\nu})
\end{aligned} \tag{755}$$



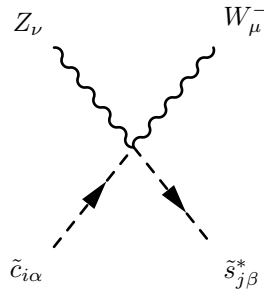
$$\left(+ \frac{i}{18} g_1^2 Z_{i1}^{C,*} \cos \Theta_W^2 \delta_{\alpha\beta} Z_{j1}^C + \frac{i}{3} g_1 g_2 Z_{i1}^{C,*} \cos \Theta_W \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^C \right. \\ \left. + \frac{i}{2} g_2^2 Z_{i1}^{C,*} \delta_{\alpha\beta} \sin \Theta_W^2 Z_{j1}^C + \frac{8i}{9} g_1^2 Z_{i2}^{C,*} \cos \Theta_W^2 \delta_{\alpha\beta} Z_{j2}^C \right) (g_{\mu\nu}) \quad (756)$$



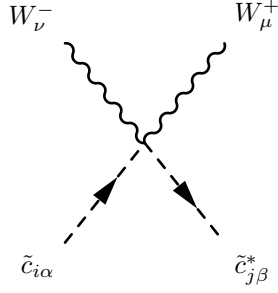
$$\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{C,*} \cos \Theta_W \delta_{\alpha\beta} Z_{j1}^S (g_{\mu\nu}) \quad (757)$$



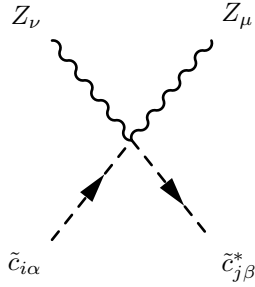
$$\left(+ \frac{i}{6} g_1 g_2 Z_{i1}^{C,*} \cos 2\Theta_W \delta_{\alpha\beta} Z_{j1}^C - \frac{i}{36} g_1^2 Z_{i1}^{C,*} \delta_{\alpha\beta} \sin 2\Theta_W Z_{j1}^C \right. \\ \left. + \frac{i}{4} g_2^2 Z_{i1}^{C,*} \delta_{\alpha\beta} \sin 2\Theta_W Z_{j1}^C - \frac{4i}{9} g_1^2 Z_{i2}^{C,*} \delta_{\alpha\beta} \sin 2\Theta_W Z_{j2}^C \right) (g_{\mu\nu}) \quad (758)$$



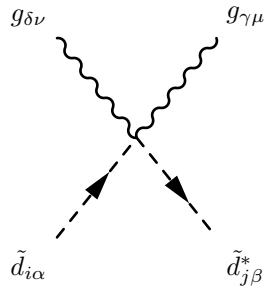
$$-\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{C,*} \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^S (g_{\mu\nu}) \quad (759)$$



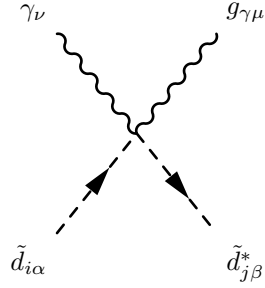
$$\frac{i}{2} g_2^2 Z_{i1}^{C,*} \delta_{\alpha\beta} Z_{j1}^C (g_{\mu\nu}) \quad (760)$$



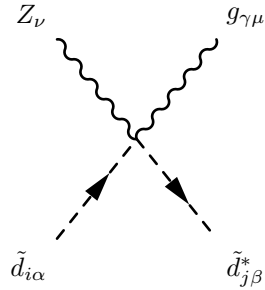
$$\left(+\frac{i}{2} g_2^2 Z_{i1}^{C,*} \cos^2 \Theta_W \delta_{\alpha\beta} Z_{j1}^C - \frac{i}{3} g_1 g_2 Z_{i1}^{C,*} \cos \Theta_W \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^C + \frac{i}{18} g_1^2 Z_{i1}^{C,*} \delta_{\alpha\beta} \sin^2 \Theta_W Z_{j1}^C + \frac{8i}{9} g_1^2 Z_{i2}^{C,*} \delta_{\alpha\beta} \sin^2 \Theta_W Z_{j2}^C \right) (g_{\mu\nu}) \quad (761)$$



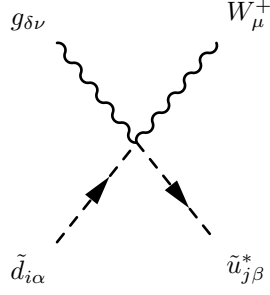
$$\begin{aligned}
& \left(+ \frac{i}{4} g_3^2 Z_{i1}^{D,*} \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta Z_{j1}^D + \frac{i}{4} g_3^2 Z_{i1}^{D,*} \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta Z_{j1}^D + \frac{i}{4} g_3^2 Z_{i2}^{D,*} \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta Z_{j2}^D \right. \\
& \left. + \frac{i}{4} g_3^2 Z_{i2}^{D,*} \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta Z_{j2}^D \right) (g_{\mu\nu})
\end{aligned} \tag{762}$$



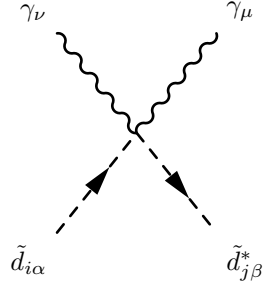
$$\begin{aligned}
& \left(+ \frac{i}{6} g_1 g_3 Z_{i1}^{D,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j1}^D - \frac{i}{2} g_2 g_3 Z_{i1}^{D,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j1}^D \right. \\
& \left. - \frac{i}{3} g_1 g_3 Z_{i2}^{D,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j2}^D \right) (g_{\mu\nu})
\end{aligned} \tag{763}$$



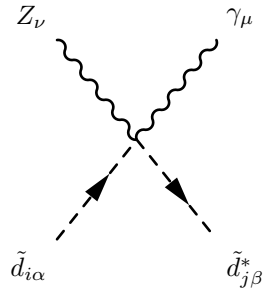
$$\begin{aligned}
& \left(- \frac{i}{2} g_2 g_3 Z_{i1}^{D,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j1}^D - \frac{i}{6} g_1 g_3 Z_{i1}^{D,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j1}^D \right. \\
& \left. + \frac{i}{3} g_1 g_3 Z_{i2}^{D,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j2}^D \right) (g_{\mu\nu})
\end{aligned} \tag{764}$$



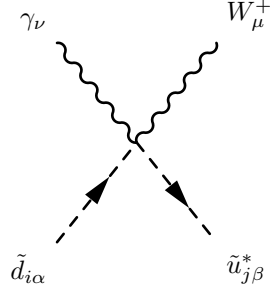
$$i \frac{1}{\sqrt{2}} g_2 g_3 Z_{i1}^{D,*} \lambda_{\beta,\alpha}^\delta Z_{j1}^U (g_{\mu\nu}) \quad (765)$$



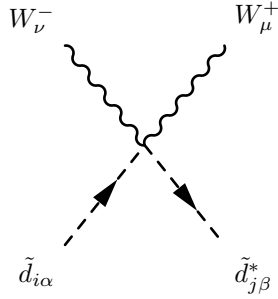
$$\left(+ \frac{i}{18} g_1^2 Z_{i1}^{D,*} \cos \Theta_W^2 \delta_{\alpha\beta} Z_{j1}^D - \frac{i}{3} g_1 g_2 Z_{i1}^{D,*} \cos \Theta_W \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^D \right. \\ \left. + \frac{i}{2} g_2^2 Z_{i1}^{D,*} \delta_{\alpha\beta} \sin \Theta_W^2 Z_{j1}^D + \frac{2i}{9} g_1^2 Z_{i2}^{D,*} \cos \Theta_W^2 \delta_{\alpha\beta} Z_{j2}^D \right) (g_{\mu\nu}) \quad (766)$$



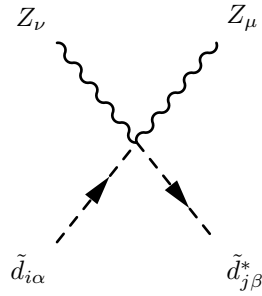
$$\left(- \frac{i}{6} g_1 g_2 Z_{i1}^{D,*} \cos 2\Theta_W \delta_{\alpha\beta} Z_{j1}^D - \frac{i}{36} g_1^2 Z_{i1}^{D,*} \delta_{\alpha\beta} \sin 2\Theta_W Z_{j1}^D \right. \\ \left. + \frac{i}{4} g_2^2 Z_{i1}^{D,*} \delta_{\alpha\beta} \sin 2\Theta_W Z_{j1}^D - \frac{i}{9} g_1^2 Z_{i2}^{D,*} \delta_{\alpha\beta} \sin 2\Theta_W Z_{j2}^D \right) (g_{\mu\nu}) \quad (767)$$



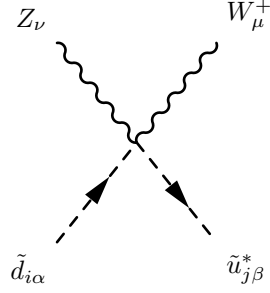
$$\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{D,*} \cos \Theta_W \delta_{\alpha\beta} Z_{j1}^U (g_{\mu\nu}) \quad (768)$$



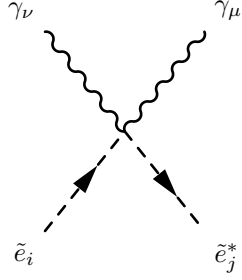
$$\frac{i}{2} g_2^2 Z_{i1}^{D,*} \delta_{\alpha\beta} Z_{j1}^D (g_{\mu\nu}) \quad (769)$$



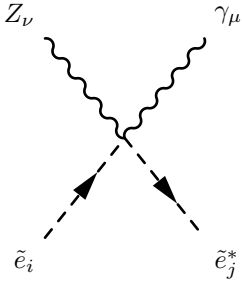
$$\left(+ \frac{i}{2} g_2^2 Z_{i1}^{D,*} \cos^2 \Theta_W \delta_{\alpha\beta} Z_{j1}^D + \frac{i}{3} g_1 g_2 Z_{i1}^{D,*} \cos \Theta_W \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^D \right. \\ \left. + \frac{i}{18} g_1^2 Z_{i1}^{D,*} \delta_{\alpha\beta} \sin^2 \Theta_W Z_{j1}^D + \frac{2i}{9} g_1^2 Z_{i2}^{D,*} \delta_{\alpha\beta} \sin \Theta_W^2 Z_{j2}^D \right) (g_{\mu\nu}) \quad (770)$$



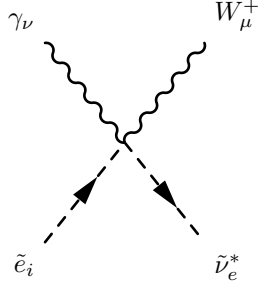
$$-\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{D,*} \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^U (g_{\mu\nu}) \quad (771)$$



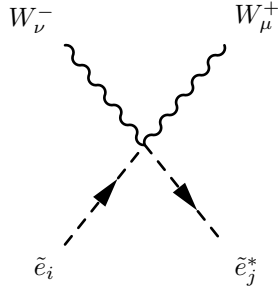
$$\left(+ \frac{i}{2} g_1^2 Z_{i1}^{E,*} \cos^2 \Theta_W Z_{j1}^E + i g_1 g_2 Z_{i1}^{E,*} \cos \Theta_W \sin \Theta_W Z_{j1}^E \right. \\ \left. + \frac{i}{2} g_2^2 Z_{i1}^{E,*} \sin^2 \Theta_W Z_{j1}^E + 2i g_1^2 Z_{i2}^{E,*} \cos \Theta_W Z_{j2}^E \right) (g_{\mu\nu}) \quad (772)$$



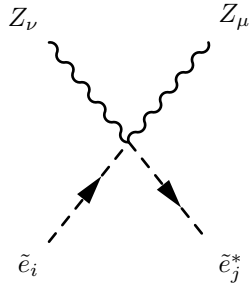
$$\left(+ \frac{i}{2} g_1 g_2 Z_{i1}^{E,*} \cos 2\Theta_W Z_{j1}^E - \frac{i}{4} g_1^2 Z_{i1}^{E,*} \sin 2\Theta_W Z_{j1}^E + \frac{i}{4} g_2^2 Z_{i1}^{E,*} \sin 2\Theta_W Z_{j1}^E \right. \\ \left. - i g_1^2 Z_{i2}^{E,*} \sin 2\Theta_W Z_{j2}^E \right) (g_{\mu\nu}) \quad (773)$$



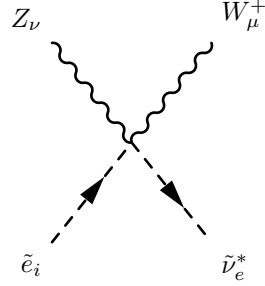
$$-i \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{E,*} \cos \Theta_W (g_{\mu\nu}) \quad (774)$$



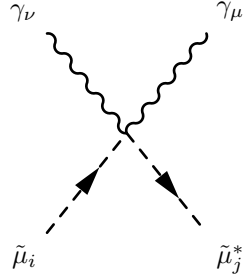
$$\frac{i}{2} g_2^2 Z_{i1}^{E,*} Z_{j1}^E (g_{\mu\nu}) \quad (775)$$



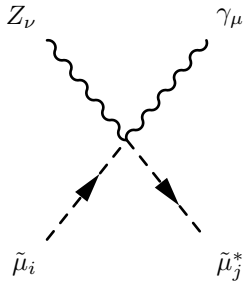
$$\left(+ \frac{i}{2} g_2^2 Z_{i1}^{E,*} \cos^2 \Theta_W Z_{j1}^E - i g_1 g_2 Z_{i1}^{E,*} \cos \Theta_W \sin \Theta_W Z_{j1}^E \right. \\ \left. + \frac{i}{2} g_1^2 Z_{i1}^{E,*} \sin^2 \Theta_W Z_{j1}^E + 2i g_1^2 Z_{i2}^{E,*} \sin \Theta_W^2 Z_{j2}^E \right) (g_{\mu\nu}) \quad (776)$$



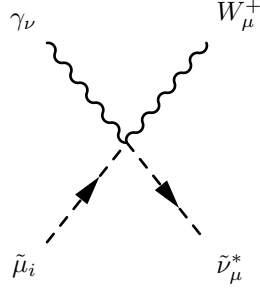
$$i \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{E,*} \sin \Theta_W (g_{\mu\nu}) \quad (777)$$



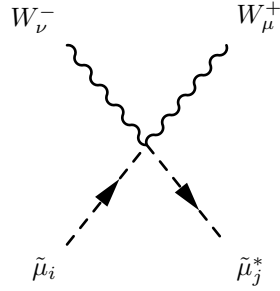
$$\left(+ \frac{i}{2} g_1^2 Z_{i1}^{\mu,*} \cos^2 \Theta_W Z_{j1}^\mu + i g_1 g_2 Z_{i1}^{\mu,*} \cos \Theta_W \sin \Theta_W Z_{j1}^\mu \right. \\ \left. + \frac{i}{2} g_2^2 Z_{i1}^{\mu,*} \sin^2 \Theta_W Z_{j1}^\mu + 2i g_1^2 Z_{i2}^{\mu,*} \cos^2 \Theta_W Z_{j2}^\mu \right) (g_{\mu\nu}) \quad (778)$$



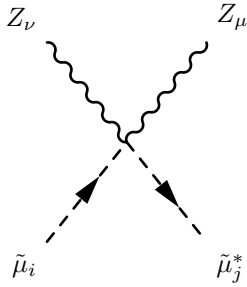
$$\left(+ \frac{i}{2} g_1 g_2 Z_{i1}^{\mu,*} \cos 2\Theta_W Z_{j1}^\mu - \frac{i}{4} g_1^2 Z_{i1}^{\mu,*} \sin 2\Theta_W Z_{j1}^\mu + \frac{i}{4} g_2^2 Z_{i1}^{\mu,*} \sin 2\Theta_W Z_{j1}^\mu \right. \\ \left. - i g_1^2 Z_{i2}^{\mu,*} \sin 2\Theta_W Z_{j2}^\mu \right) (g_{\mu\nu}) \quad (779)$$



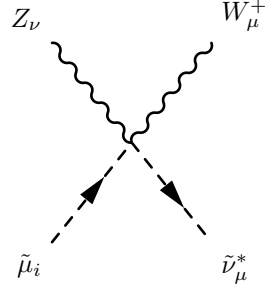
$$-i \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{\mu,*} \cos \Theta_W (g_{\mu\nu}) \quad (780)$$



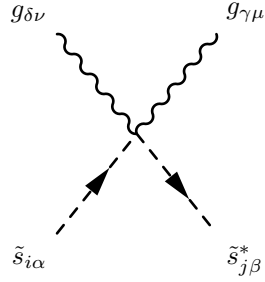
$$\frac{i}{2} g_2^2 Z_{i1}^{\mu,*} Z_{j1}^\mu (g_{\mu\nu}) \quad (781)$$



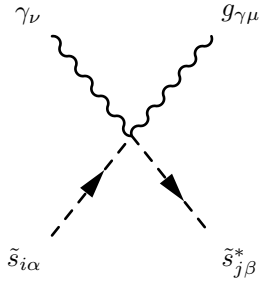
$$\left(+ \frac{i}{2} g_2^2 Z_{i1}^{\mu,*} \cos^2 \Theta_W Z_{j1}^\mu - i g_1 g_2 Z_{i1}^{\mu,*} \cos \Theta_W \sin \Theta_W Z_{j1}^\mu \right. \\ \left. + \frac{i}{2} g_1^2 Z_{i1}^{\mu,*} \sin^2 \Theta_W Z_{j1}^\mu + 2i g_1^2 Z_{i2}^{\mu,*} \sin^2 \Theta_W Z_{j2}^\mu \right) (g_{\mu\nu}) \quad (782)$$



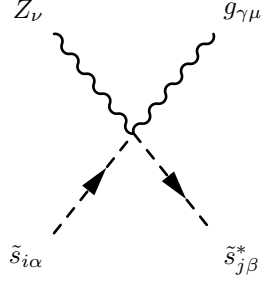
$$i \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{\mu,*} \sin \Theta_W (g_{\mu\nu}) \quad (783)$$



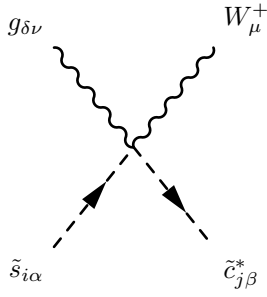
$$\begin{aligned} & \left(+ \frac{i}{4} g_3^2 Z_{i1}^{S,*} \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta Z_{j1}^S + \frac{i}{4} g_3^2 Z_{i1}^{S,*} \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta Z_{j1}^S + \frac{i}{4} g_3^2 Z_{i2}^{S,*} \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta Z_{j2}^S \right. \\ & \left. + \frac{i}{4} g_3^2 Z_{i2}^{S,*} \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta Z_{j2}^S \right) (g_{\mu\nu}) \quad (784) \end{aligned}$$



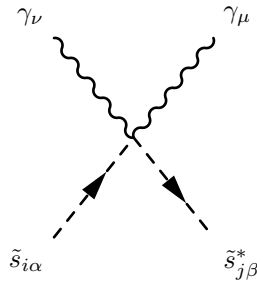
$$\begin{aligned} & \left(+ \frac{i}{6} g_1 g_3 Z_{i1}^{S,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j1}^S - \frac{i}{2} g_2 g_3 Z_{i1}^{S,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j1}^S \right. \\ & \left. - \frac{i}{3} g_1 g_3 Z_{i2}^{S,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j2}^S \right) (g_{\mu\nu}) \quad (785) \end{aligned}$$



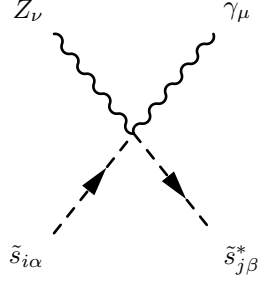
$$\left(-\frac{i}{2}g_2g_3Z_{i1}^{S,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j1}^S - \frac{i}{6}g_1g_3Z_{i1}^{S,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j1}^S + \frac{i}{3}g_1g_3Z_{i2}^{S,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j2}^S \right) (g_{\mu\nu}) \quad (786)$$



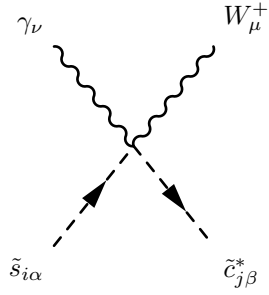
$$i\frac{1}{\sqrt{2}}g_2g_3Z_{i1}^{S,*} \lambda_{\beta,\alpha}^\delta Z_{j1}^C (g_{\mu\nu}) \quad (787)$$



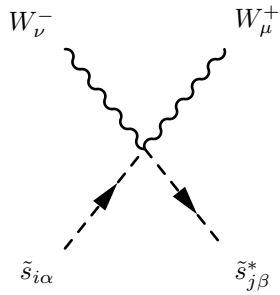
$$\left(+\frac{i}{18}g_1^2Z_{i1}^{S,*} \cos \Theta_W^2 \delta_{\alpha\beta} Z_{j1}^S - \frac{i}{3}g_1g_2Z_{i1}^{S,*} \cos \Theta_W \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^S + \frac{i}{2}g_2^2Z_{i1}^{S,*} \delta_{\alpha\beta} \sin \Theta_W^2 Z_{j1}^S + \frac{2i}{9}g_1^2Z_{i2}^{S,*} \cos \Theta_W^2 \delta_{\alpha\beta} Z_{j2}^S \right) (g_{\mu\nu}) \quad (788)$$



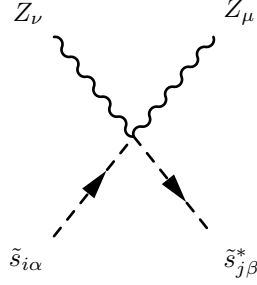
$$\left(-\frac{i}{6}g_1g_2Z_{i1}^{S,*}\cos 2\Theta_W\delta_{\alpha\beta}Z_{j1}^S - \frac{i}{36}g_1^2Z_{i1}^{S,*}\delta_{\alpha\beta}\sin 2\Theta_WZ_{j1}^S \right. \\ \left. + \frac{i}{4}g_2^2Z_{i1}^{S,*}\delta_{\alpha\beta}\sin 2\Theta_WZ_{j1}^S - \frac{i}{9}g_1^2Z_{i2}^{S,*}\delta_{\alpha\beta}\sin 2\Theta_WZ_{j2}^S \right) (g_{\mu\nu}) \quad (789)$$



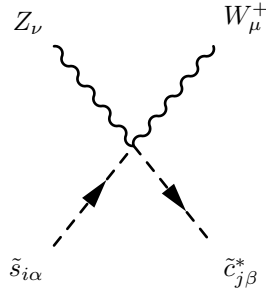
$$\frac{i}{3}\frac{1}{\sqrt{2}}g_1g_2Z_{i1}^{S,*}\cos \Theta_W\delta_{\alpha\beta}Z_{j1}^C (g_{\mu\nu}) \quad (790)$$



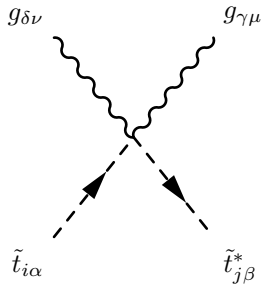
$$\frac{i}{2}g_2^2Z_{i1}^{S,*}\delta_{\alpha\beta}Z_{j1}^S (g_{\mu\nu}) \quad (791)$$



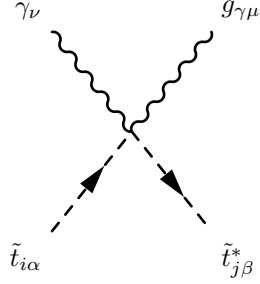
$$\left(+\frac{i}{2}g_2^2 Z_{i1}^{S,*} \cos^2 \Theta_W \delta_{\alpha\beta} Z_{j1}^S + \frac{i}{3}g_1 g_2 Z_{i1}^{S,*} \cos \Theta_W \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^S \right. \\ \left. + \frac{i}{18}g_1^2 Z_{i1}^{S,*} \delta_{\alpha\beta} \sin^2 \Theta_W Z_{j1}^S + \frac{2i}{9}g_1^2 Z_{i2}^{S,*} \delta_{\alpha\beta} \sin^2 \Theta_W Z_{j2}^S \right) (g_{\mu\nu}) \quad (792)$$



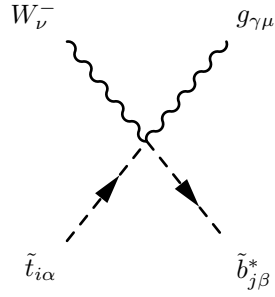
$$-\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{S,*} \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^C (g_{\mu\nu}) \quad (793)$$



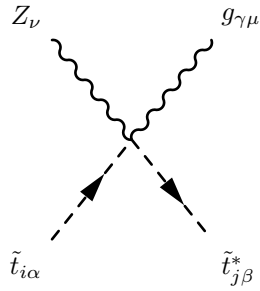
$$\left(+\frac{i}{4}g_3^2 Z_{i1}^{T,*} \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta Z_{j1}^T + \frac{i}{4}g_3^2 Z_{i1}^{T,*} \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta Z_{j1}^T + \frac{i}{4}g_3^2 Z_{i2}^{T,*} \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta Z_{j2}^T \right. \\ \left. + \frac{i}{4}g_3^2 Z_{i2}^{T,*} \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta Z_{j2}^T \right) (g_{\mu\nu}) \quad (794)$$



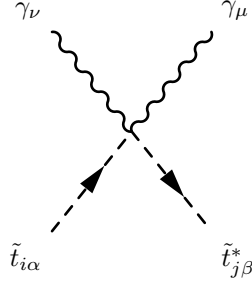
$$\left(+\frac{i}{6}g_1g_3Z_{i1}^{T,*}\cos\Theta_W\lambda_{\beta,\alpha}^\gamma Z_{j1}^T + \frac{i}{2}g_2g_3Z_{i1}^{T,*}\lambda_{\beta,\alpha}^\gamma\sin\Theta_W Z_{j1}^T + \frac{2i}{3}g_1g_3Z_{i2}^{T,*}\cos\Theta_W\lambda_{\beta,\alpha}^\gamma Z_{j2}^T \right) (g_{\mu\nu}) \quad (795)$$



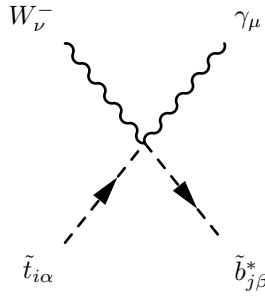
$$i\frac{1}{\sqrt{2}}g_2g_3Z_{i1}^{T,*}\lambda_{\beta,\alpha}^\gamma Z_{j1}^B (g_{\mu\nu}) \quad (796)$$



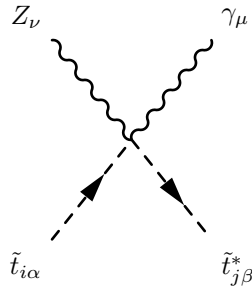
$$\left(+\frac{i}{2}g_2g_3Z_{i1}^{T,*}\cos\Theta_W\lambda_{\beta,\alpha}^\gamma Z_{j1}^T - \frac{i}{6}g_1g_3Z_{i1}^{T,*}\lambda_{\beta,\alpha}^\gamma\sin\Theta_W Z_{j1}^T - \frac{2i}{3}g_1g_3Z_{i2}^{T,*}\lambda_{\beta,\alpha}^\gamma\sin\Theta_W Z_{j2}^T \right) (g_{\mu\nu}) \quad (797)$$



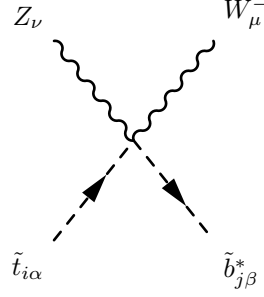
$$\left(+ \frac{i}{18} g_1^2 Z_{i1}^{T,*} \cos \Theta_W^2 \delta_{\alpha\beta} Z_{j1}^T + \frac{i}{3} g_1 g_2 Z_{i1}^{T,*} \cos \Theta_W \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^T + \frac{i}{2} g_2^2 Z_{i1}^{T,*} \delta_{\alpha\beta} \sin \Theta_W^2 Z_{j1}^T + \frac{8i}{9} g_1^2 Z_{i2}^{T,*} \cos \Theta_W^2 \delta_{\alpha\beta} Z_{j2}^T \right) (g_{\mu\nu}) \quad (798)$$



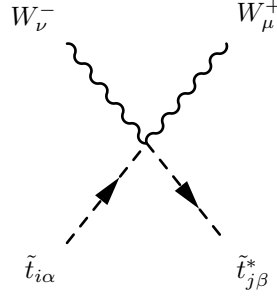
$$\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{T,*} \cos \Theta_W \delta_{\alpha\beta} Z_{j1}^B (g_{\mu\nu}) \quad (799)$$



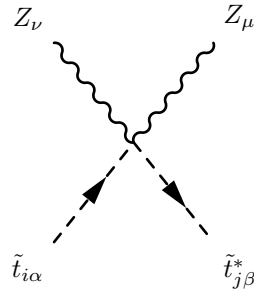
$$\left(+ \frac{i}{6} g_1 g_2 Z_{i1}^{T,*} \cos 2\Theta_W \delta_{\alpha\beta} Z_{j1}^T - \frac{i}{36} g_1^2 Z_{i1}^{T,*} \delta_{\alpha\beta} \sin 2\Theta_W Z_{j1}^T + \frac{i}{4} g_2^2 Z_{i1}^{T,*} \delta_{\alpha\beta} \sin 2\Theta_W Z_{j1}^T - \frac{4i}{9} g_1^2 Z_{i2}^{T,*} \delta_{\alpha\beta} \sin 2\Theta_W Z_{j2}^T \right) (g_{\mu\nu}) \quad (800)$$



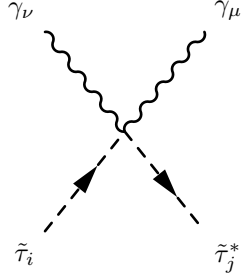
$$-\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{T,*} \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^B (g_{\mu\nu}) \quad (801)$$



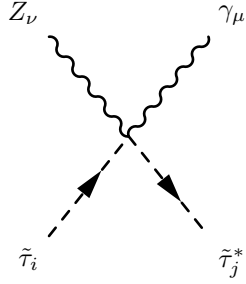
$$\frac{i}{2} g_2^2 Z_{i1}^{T,*} \delta_{\alpha\beta} Z_{j1}^T (g_{\mu\nu}) \quad (802)$$



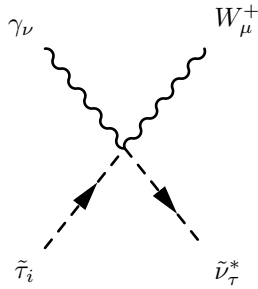
$$\left(+ \frac{i}{2} g_2^2 Z_{i1}^{T,*} \cos^2 \Theta_W \delta_{\alpha\beta} Z_{j1}^T - \frac{i}{3} g_1 g_2 Z_{i1}^{T,*} \cos \Theta_W \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^T \right. \\ \left. + \frac{i}{18} g_1^2 Z_{i1}^{T,*} \delta_{\alpha\beta} \sin^2 \Theta_W Z_{j1}^T + \frac{8i}{9} g_1^2 Z_{i2}^{T,*} \delta_{\alpha\beta} \sin^2 \Theta_W Z_{j2}^T \right) (g_{\mu\nu}) \quad (803)$$



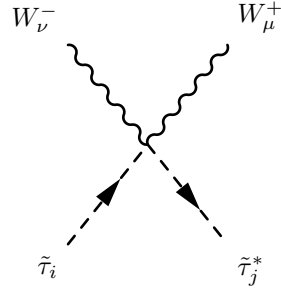
$$\left(+\frac{i}{2}g_1^2 Z_{i1}^{\tau,*} \cos^2 \Theta_W Z_{j1}^\tau + ig_1 g_2 Z_{i1}^{\tau,*} \cos \Theta_W \sin \Theta_W Z_{j1}^\tau + \frac{i}{2}g_2^2 Z_{i1}^{\tau,*} \sin^2 \Theta_W Z_{j1}^\tau + 2ig_1^2 Z_{i2}^{\tau,*} \cos^2 \Theta_W Z_{j2}^\tau \right) (g_{\mu\nu}) \quad (804)$$



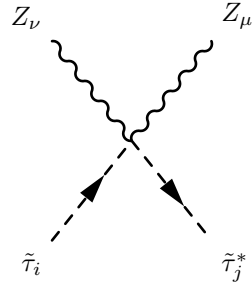
$$\left(+\frac{i}{2}g_1 g_2 Z_{i1}^{\tau,*} \cos 2\Theta_W Z_{j1}^\tau - \frac{i}{4}g_1^2 Z_{i1}^{\tau,*} \sin 2\Theta_W Z_{j1}^\tau + \frac{i}{4}g_2^2 Z_{i1}^{\tau,*} \sin 2\Theta_W Z_{j1}^\tau - ig_1^2 Z_{i2}^{\tau,*} \sin 2\Theta_W Z_{j2}^\tau \right) (g_{\mu\nu}) \quad (805)$$



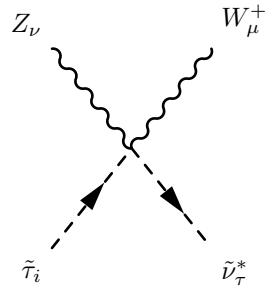
$$-i \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{\tau,*} \cos \Theta_W (g_{\mu\nu}) \quad (806)$$



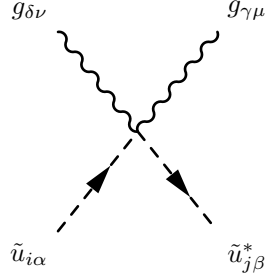
$$\frac{i}{2} g_2^2 Z_{i1}^{\tau,*} Z_{j1}^{\tau} (g_{\mu\nu}) \quad (807)$$



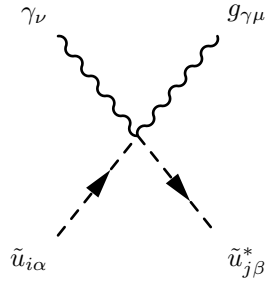
$$\left(+ \frac{i}{2} g_2^2 Z_{i1}^{\tau,*} \cos \Theta_W Z_{j1}^{\tau} - i g_1 g_2 Z_{i1}^{\tau,*} \cos \Theta_W \sin \Theta_W Z_{j1}^{\tau} \right. \\ \left. + \frac{i}{2} g_1^2 Z_{i1}^{\tau,*} \sin \Theta_W Z_{j1}^{\tau} + 2i g_1^2 Z_{i2}^{\tau,*} \sin \Theta_W Z_{j2}^{\tau} \right) (g_{\mu\nu}) \quad (808)$$



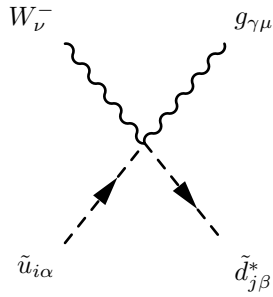
$$i \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{\tau,*} \sin \Theta_W (g_{\mu\nu}) \quad (809)$$



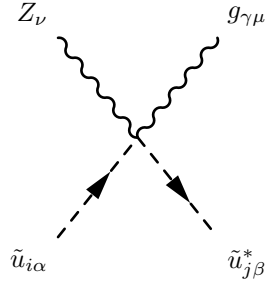
$$\begin{aligned}
& \left(+ \frac{i}{4} g_3^2 Z_{i1}^{U,*} \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta Z_{j1}^U + \frac{i}{4} g_3^2 Z_{i1}^{U,*} \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta Z_{j1}^U + \frac{i}{4} g_3^2 Z_{i2}^{U,*} \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta Z_{j2}^U \right. \\
& \left. + \frac{i}{4} g_3^2 Z_{i2}^{U,*} \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta Z_{j2}^U \right) (g_{\mu\nu})
\end{aligned} \tag{810}$$



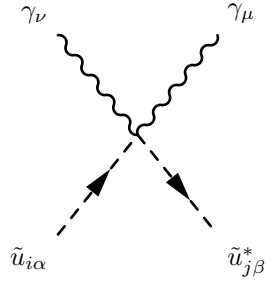
$$\begin{aligned}
& \left(+ \frac{i}{6} g_1 g_3 Z_{i1}^{U,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j1}^U + \frac{i}{2} g_2 g_3 Z_{i1}^{U,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j1}^U \right. \\
& \left. + \frac{2i}{3} g_1 g_3 Z_{i2}^{U,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j2}^U \right) (g_{\mu\nu})
\end{aligned} \tag{811}$$



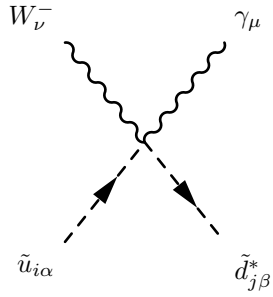
$$i \frac{1}{\sqrt{2}} g_2 g_3 Z_{i1}^{U,*} \lambda_{\beta,\alpha}^\gamma Z_{j1}^D (g_{\mu\nu}) \quad (812)$$



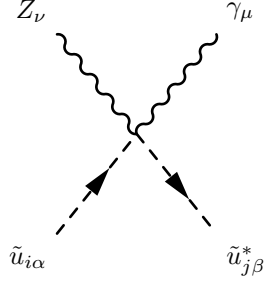
$$\left(+ \frac{i}{2} g_2 g_3 Z_{i1}^{U,*} \cos \Theta_W \lambda_{\beta,\alpha}^\gamma Z_{j1}^U - \frac{i}{6} g_1 g_3 Z_{i1}^{U,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j1}^U \right. \\ \left. - \frac{2i}{3} g_1 g_3 Z_{i2}^{U,*} \lambda_{\beta,\alpha}^\gamma \sin \Theta_W Z_{j2}^U \right) (g_{\mu\nu}) \quad (813)$$



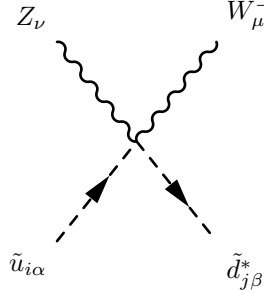
$$\left(+ \frac{i}{18} g_1^2 Z_{i1}^{U,*} \cos^2 \Theta_W \delta_{\alpha\beta} Z_{j1}^U + \frac{i}{3} g_1 g_2 Z_{i1}^{U,*} \cos \Theta_W \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^U \right. \\ \left. + \frac{i}{2} g_2^2 Z_{i1}^{U,*} \delta_{\alpha\beta} \sin^2 \Theta_W Z_{j1}^U + \frac{8i}{9} g_1^2 Z_{i2}^{U,*} \cos^2 \Theta_W \delta_{\alpha\beta} Z_{j2}^U \right) (g_{\mu\nu}) \quad (814)$$



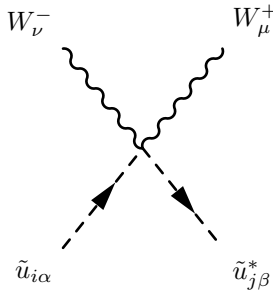
$$\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{U,*} \cos \Theta_W \delta_{\alpha\beta} Z_{j1}^D (g_{\mu\nu}) \quad (815)$$



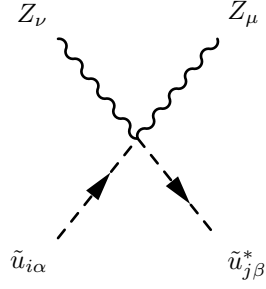
$$\left(+ \frac{i}{6} g_1 g_2 Z_{i1}^{U,*} \cos 2\Theta_W \delta_{\alpha\beta} Z_{j1}^U - \frac{i}{36} g_1^2 Z_{i1}^{U,*} \delta_{\alpha\beta} \sin 2\Theta_W Z_{j1}^U \right. \\ \left. + \frac{i}{4} g_2^2 Z_{i1}^{U,*} \delta_{\alpha\beta} \sin 2\Theta_W Z_{j1}^U - \frac{4i}{9} g_1^2 Z_{i2}^{U,*} \delta_{\alpha\beta} \sin 2\Theta_W Z_{j2}^U \right) (g_{\mu\nu}) \quad (816)$$



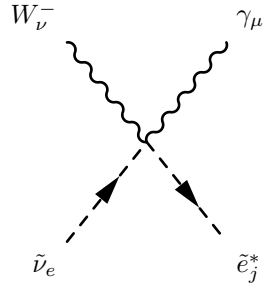
$$- \frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 Z_{i1}^{U,*} \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^D (g_{\mu\nu}) \quad (817)$$



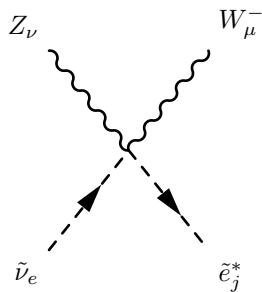
$$\frac{i}{2}g_2^2 Z_{i1}^{U,*} \delta_{\alpha\beta} Z_{j1}^U (g_{\mu\nu}) \quad (818)$$



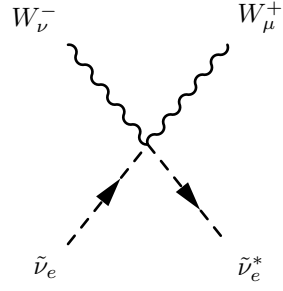
$$\left(+\frac{i}{2}g_2^2 Z_{i1}^{U,*} \cos^2 \Theta_W \delta_{\alpha\beta} Z_{j1}^U - \frac{i}{3}g_1 g_2 Z_{i1}^{U,*} \cos \Theta_W \delta_{\alpha\beta} \sin \Theta_W Z_{j1}^U \right. \\ \left. + \frac{i}{18}g_1^2 Z_{i1}^{U,*} \delta_{\alpha\beta} \sin^2 \Theta_W Z_{j1}^U + \frac{8i}{9}g_1^2 Z_{i2}^{U,*} \delta_{\alpha\beta} \sin^2 \Theta_W Z_{j2}^U \right) (g_{\mu\nu}) \quad (819)$$



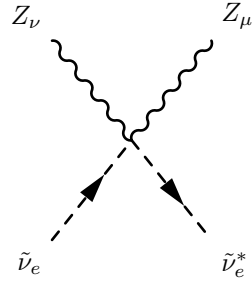
$$-i \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W Z_{j1}^E (g_{\mu\nu}) \quad (820)$$



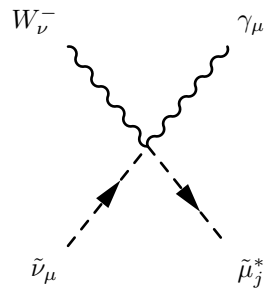
$$i \frac{1}{\sqrt{2}} g_1 g_2 \sin \Theta_W Z_{j1}^E (g_{\mu\nu}) \quad (821)$$



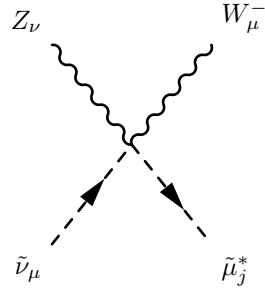
$$\frac{i}{2} g_2^2 (g_{\mu\nu}) \quad (822)$$



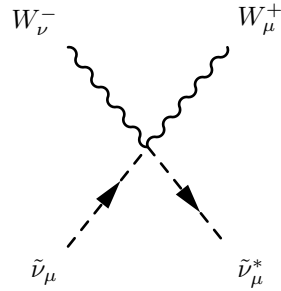
$$\left(\frac{i}{2} g_1^2 \sin^2 \Theta_W + \frac{i}{2} g_2^2 \cos^2 \Theta_W + i g_1 g_2 \cos \Theta_W \sin \Theta_W \right) (g_{\mu\nu}) \quad (823)$$



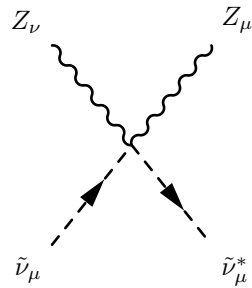
$$-i \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W Z_{j1}^\mu (g_{\mu\nu}) \quad (824)$$



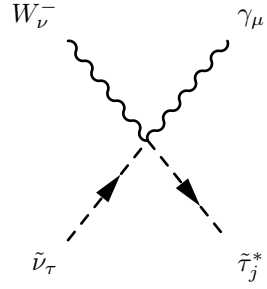
$$i \frac{1}{\sqrt{2}} g_1 g_2 \sin \Theta_W Z_{j1}^\mu (g_{\mu\nu}) \quad (825)$$



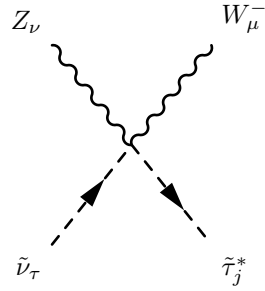
$$\frac{i}{2} g_2^2 (g_{\mu\nu}) \quad (826)$$



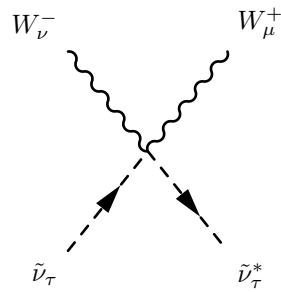
$$\left(\frac{i}{2} g_1^2 \sin^2 \Theta_W + \frac{i}{2} g_2^2 \cos^2 \Theta_W + i g_1 g_2 \cos \Theta_W \sin \Theta_W \right) (g_{\mu\nu}) \quad (827)$$



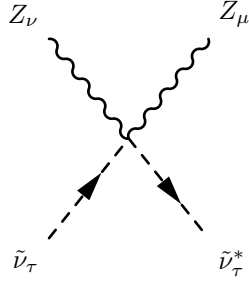
$$-i \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W Z_{j1}^\tau (g_{\mu\nu}) \quad (828)$$



$$i \frac{1}{\sqrt{2}} g_1 g_2 \sin \Theta_W Z_{j1}^\tau (g_{\mu\nu}) \quad (829)$$

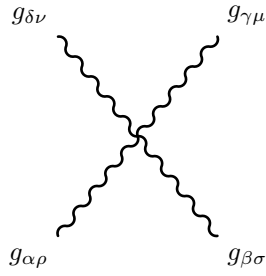


$$\frac{i}{2} g_2^2 (g_{\mu\nu}) \quad (830)$$



$$\left(\frac{i}{2} g_1^2 \sin^2 \Theta_W + \frac{i}{2} g_2^2 \cos^2 \Theta_W + i g_1 g_2 \cos \Theta_W \sin \Theta_W \right) (g_{\mu\nu}) \quad (831)$$

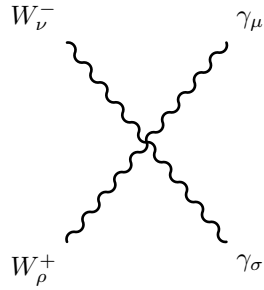
9.9 Four Vector Boson-Interaction



$$i g_3^2 \left(- \sum_{a=1}^8 f_{\alpha,\delta,a} f_{\beta,\gamma,a} - \sum_{a=1}^8 f_{\alpha,\gamma,a} f_{\beta,\delta,a} \right) (g_{\rho\sigma} g_{\mu\nu}) \quad (832)$$

$$+ i g_3^2 \left(- \sum_{a=1}^8 f_{\alpha,\beta,a} f_{\gamma,\delta,a} + \sum_{a=1}^8 f_{\alpha,\delta,a} f_{\beta,\gamma,a} \right) (g_{\rho\mu} g_{\sigma\nu}) \quad (833)$$

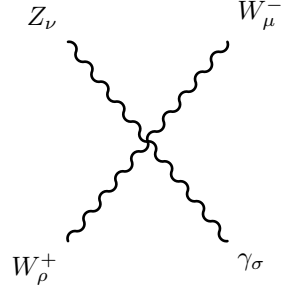
$$+ i g_3^2 \left(\sum_{a=1}^8 f_{\alpha,\gamma,a} f_{\beta,\delta,a} + \sum_{a=1}^8 f_{\alpha,\beta,a} f_{\gamma,\delta,a} \right) (g_{\rho\nu} g_{\sigma\mu}) \quad (834)$$



$$ig_2^2 \sin \Theta_W^2 (g_{\rho\sigma} g_{\mu\nu}) \quad (835)$$

$$+ ig_2^2 \sin \Theta_W^2 (g_{\rho\mu} g_{\sigma\nu}) \quad (836)$$

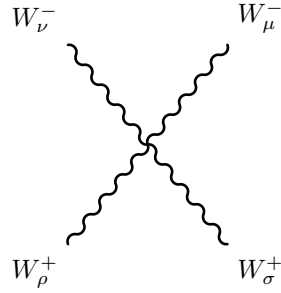
$$+ -2ig_2^2 \sin \Theta_W^2 (g_{\rho\nu} g_{\sigma\mu}) \quad (837)$$



$$\frac{i}{2} g_2^2 \sin 2\Theta_W (g_{\rho\sigma} g_{\mu\nu}) \quad (838)$$

$$+ -ig_2^2 \sin 2\Theta_W (g_{\rho\mu} g_{\sigma\nu}) \quad (839)$$

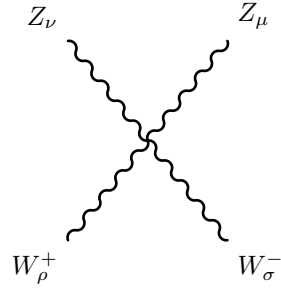
$$+ \frac{i}{2} g_2^2 \sin 2\Theta_W (g_{\rho\nu} g_{\sigma\mu}) \quad (840)$$



$$2ig_2^2 (g_{\rho\sigma} g_{\mu\nu}) \quad (841)$$

$$+ -ig_2^2 (g_{\rho\mu} g_{\sigma\nu}) \quad (842)$$

$$+ -ig_2^2 (g_{\rho\nu} g_{\sigma\mu}) \quad (843)$$

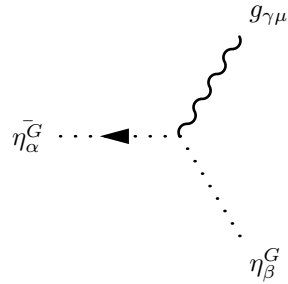


$$- 2ig_2^2 \cos \Theta_W^2 (g_{\rho\sigma}g_{\mu\nu}) \quad (844)$$

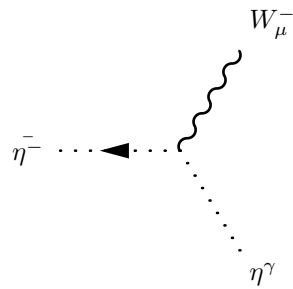
$$+ ig_2^2 \cos \Theta_W^2 (g_{\rho\mu}g_{\sigma\nu}) \quad (845)$$

$$+ ig_2^2 \cos \Theta_W^2 (g_{\rho\nu}g_{\sigma\mu}) \quad (846)$$

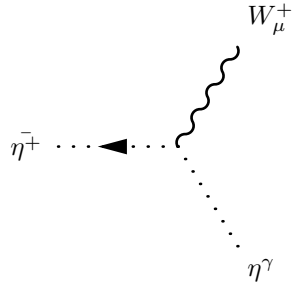
9.10 Two Ghosts-One Vector Boson-Interaction



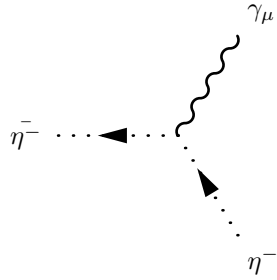
$$g_3 f_{\alpha,\beta,\gamma} (p_\mu^{\eta_\beta^G}) \quad (847)$$



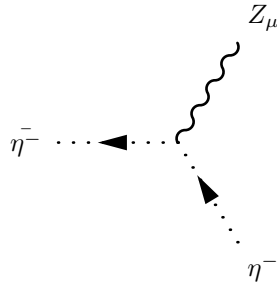
$$ig_2 \sin \Theta_W (p_\mu^{\eta^\gamma}) \quad (848)$$



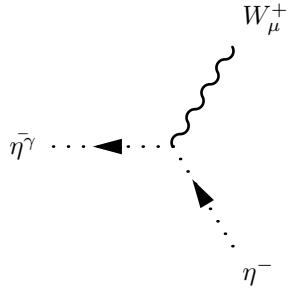
$$-ig_2 \sin \Theta_W (p_\mu^{\eta^\gamma}) \quad (849)$$



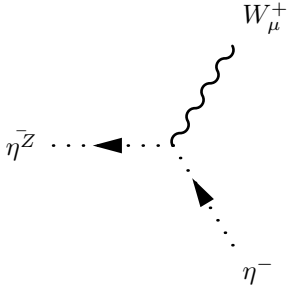
$$-ig_2 \sin \Theta_W (p_\mu^{\eta^-}) \quad (850)$$



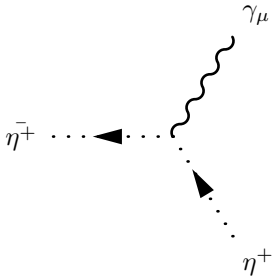
$$-ig_2 \cos \Theta_W (p_\mu^{\eta^-}) \quad (851)$$



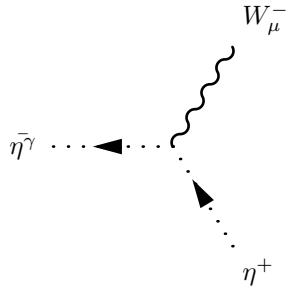
$$ig_2 \sin \Theta_W (p_\mu^{\eta^-}) \quad (852)$$



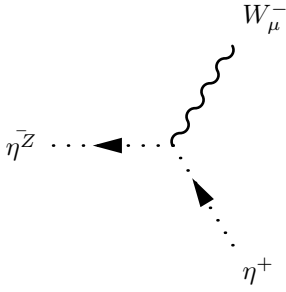
$$ig_2 \cos \Theta_W (p_\mu^{\eta^-}) \quad (853)$$



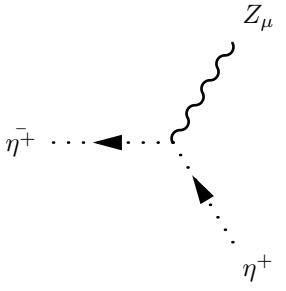
$$ig_2 \sin \Theta_W (p_\mu^{\eta^+}) \quad (854)$$



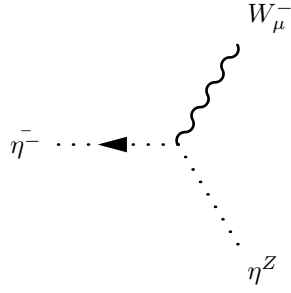
$$-ig_2 \sin \Theta_W (p_\mu^{\eta^+}) \quad (855)$$



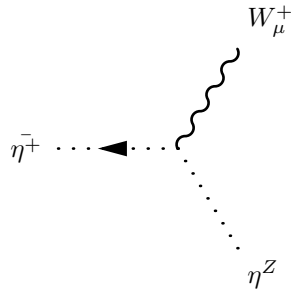
$$-ig_2 \cos \Theta_W (p_\mu^{\eta^+}) \quad (856)$$



$$ig_2 \cos \Theta_W (p_\mu^{\eta^+}) \quad (857)$$

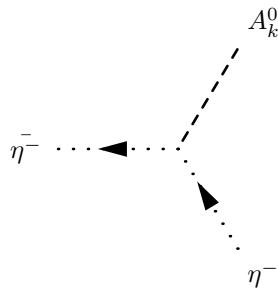


$$ig_2 \cos \Theta_W (p_\mu^{\eta^0}) \quad (858)$$

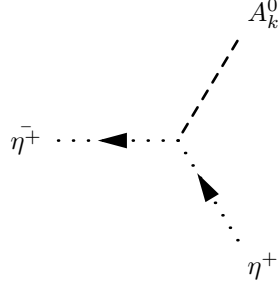


$$-ig_2 \cos \Theta_W (p_\mu^{\eta^0}) \quad (859)$$

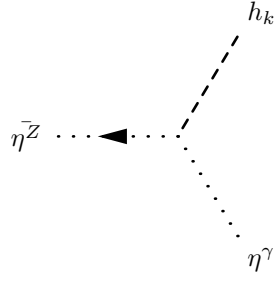
9.11 Two Ghosts-One Scalar-Interaction



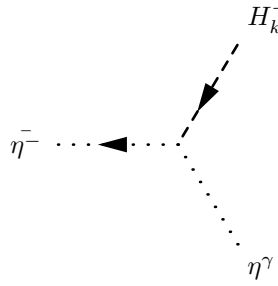
$$\frac{1}{4} g_2^2 \xi_{W^-} (v_d Z_{k1}^A - v_u Z_{k2}^A) \quad (860)$$



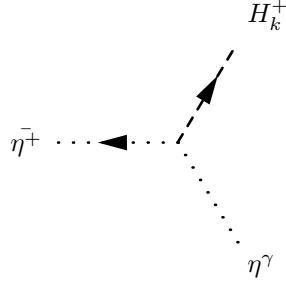
$$-\frac{1}{4}g_2^2\xi_{W^-}\left(v_d Z_{k1}^A - v_u Z_{k2}^A\right) \quad (861)$$



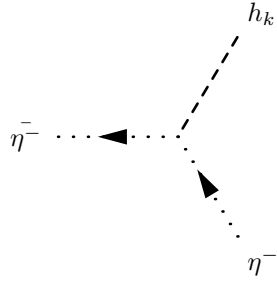
$$\frac{i}{8}\xi_Z\left(2g_1g_2\cos 2\Theta_W + \left(-g_2^2 + g_1^2\right)\sin 2\Theta_W\right)\left(v_d Z_{k1}^H + v_u Z_{k2}^H\right) \quad (862)$$



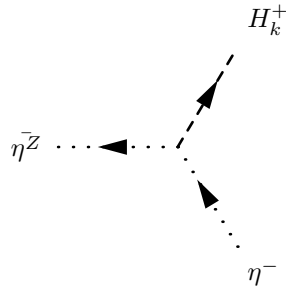
$$\frac{i}{4}g_2\xi_{W^-}\left(g_1\cos \Theta_W + g_2\sin \Theta_W\right)\left(v_d Z_{k1}^+ - v_u Z_{k2}^+\right) \quad (863)$$



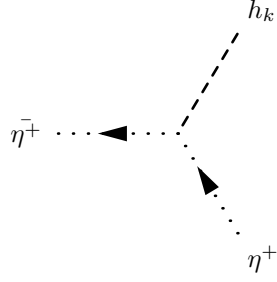
$$\frac{i}{4} g_2 \xi_{W^-} \left(g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) \left(v_d Z_{k1}^+ - v_u Z_{k2}^+ \right) \quad (864)$$



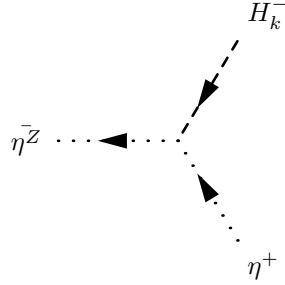
$$-\frac{i}{4} g_2^2 \xi_{W^-} \left(v_d Z_{k1}^H + v_u Z_{k2}^H \right) \quad (865)$$



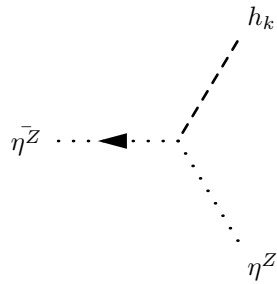
$$-\frac{i}{4} g_2 \xi_Z \left(g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(v_d Z_{k1}^+ - v_u Z_{k2}^+ \right) \quad (866)$$



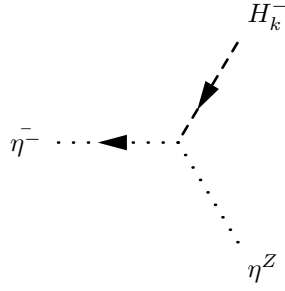
$$-\frac{i}{4}g_2^2\xi_{W^-}\left(v_d Z_{k1}^H + v_u Z_{k2}^H\right) \quad (867)$$



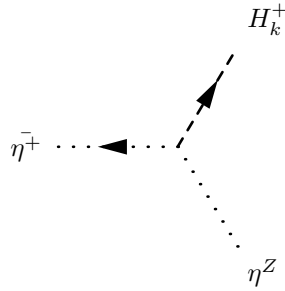
$$-\frac{i}{4}g_2\xi_Z\left(g_1\sin\Theta_W + g_2\cos\Theta_W\right)\left(v_d Z_{k1}^+ - v_u Z_{k2}^+\right) \quad (868)$$



$$-\frac{i}{4}\xi_Z\left(g_1\sin\Theta_W + g_2\cos\Theta_W\right)^2\left(v_d Z_{k1}^H + v_u Z_{k2}^H\right) \quad (869)$$



$$\frac{i}{4} g_2 \xi_{W^-} \left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(v_d Z_{k1}^+ - v_u Z_{k2}^+ \right) \quad (870)$$



$$\frac{i}{4} g_2 \xi_{W^-} \left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left(v_d Z_{k1}^+ - v_u Z_{k2}^+ \right) \quad (871)$$

10 Clebsch-Gordan Coefficients