

Linear Seesaw  
Superpotential, Rotations and Interactions for eigenstates 'EWSB'  
including Renormalization Group Equations  
including one-loop Self-Energies

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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	$(\frac{1}{2}, \mathbf{2}, \mathbf{1})$
$\hat{d}$	$\tilde{d}_R^*$	$d_R^*$	3	$(\frac{1}{3}, \mathbf{1}, \bar{\mathbf{3}})$
$\hat{u}$	$\tilde{u}_R^*$	$u_R^*$	3	$(-\frac{2}{3}, \mathbf{1}, \bar{\mathbf{3}})$
$\hat{e}$	$\tilde{e}_R^*$	$e_R^*$	3	$(1, \mathbf{1}, \mathbf{1})$
$\hat{\nu}$	$\tilde{\nu}_R^*$	$\nu_R^*$	3	$(0, \mathbf{1}, \mathbf{1})$
$\hat{s}$	$S$	$\tilde{S}$	3	$(0, \mathbf{1}, \mathbf{1})$

# 2 Superpotential and Lagrangian

## 2.1 Superpotential

$$W = \mu \hat{H}_u \hat{H}_d + M_R \hat{\nu} \hat{s} - Y_d \hat{d} \hat{q} \hat{H}_d - Y_e \hat{e} \hat{l} \hat{H}_d + Y_{SL} \hat{s} \hat{l} \hat{H}_u + Y_u \hat{u} \hat{q} \hat{H}_u + Y_\nu \hat{\nu} \hat{l} \hat{H}_u \quad (1)$$

## 2.2 Softbreaking terms

$$\begin{aligned} -L_{SB,W} = & -H_d^0 H_u^0 B_\mu + H_d^- H_u^+ B_\mu + \tilde{\nu}_{R,i}^* S_j B_{MR,ij} + H_d^0 \tilde{d}_{R,i\alpha}^* \delta_{\alpha\beta} \tilde{d}_{L,j\beta} T_{d,ij} - H_d^- \tilde{d}_{R,i\alpha}^* \delta_{\alpha\beta} \tilde{u}_{L,j\beta} T_{d,ij} \\ & + H_d^0 \tilde{e}_{R,i}^* \tilde{e}_{L,j} T_{e,ij} - H_d^- \tilde{e}_{R,i}^* \tilde{\nu}_{L,j} T_{e,ij} - H_u^+ \tilde{e}_{L,j} S_i T_{Y_{SL},ij} + H_u^0 S_i \tilde{\nu}_{L,j} T_{Y_{SL},ij} \\ & - H_u^+ \tilde{u}_{R,i\alpha}^* \delta_{\alpha\beta} \tilde{d}_{L,j\beta} T_{u,ij} + H_u^0 \tilde{u}_{R,i\alpha}^* \delta_{\alpha\beta} \tilde{u}_{L,j\beta} T_{u,ij} - H_u^+ \tilde{\nu}_{R,i}^* \tilde{e}_{L,j} T_{\nu,ij} + H_u^0 \tilde{\nu}_{R,i}^* \tilde{\nu}_{L,j} T_{\nu,ij} + \text{h.c.} \end{aligned} \quad (2)$$

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

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

## 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

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

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

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

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

$$\gamma_{\hat{H}_d}^{(1)} = 3\text{Tr}(Y_d Y_d^\dagger) - \frac{3}{10}(5g_2^2 + g_1^2) + \text{Tr}(Y_e Y_e^\dagger) \quad (11)$$

$$\gamma_{\hat{H}_d}^{(2)} = +\frac{207}{100}g_1^4 + \frac{9}{10}g_1^2 g_2^2 + \frac{15}{4}g_2^4 - \frac{2}{5}\left(-40g_3^2 + g_1^2\right)\text{Tr}(Y_d Y_d^\dagger) + \frac{6}{5}g_1^2 \text{Tr}(Y_e Y_e^\dagger) - 9\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) \\ - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 3\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) - \text{Tr}(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger) - \text{Tr}(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger) \quad (12)$$

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

$$\begin{aligned} \gamma_{\hat{H}_u}^{(2)} = & +\frac{207}{100}g_1^4 + \frac{9}{10}g_1^2 g_2^2 + \frac{15}{4}g_2^4 + \frac{4}{5}\left(20g_3^2 + g_1^2\right)\text{Tr}\left(Y_u Y_u^\dagger\right) - 3\text{Tr}\left(Y_d Y_d^\dagger Y_u Y_u^\dagger\right) \\ & - \text{Tr}\left(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger\right) - \text{Tr}\left(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger\right) - 3\text{Tr}\left(Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger\right) - 6\text{Tr}\left(Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger\right) \\ & - 9\text{Tr}\left(Y_u Y_u^\dagger Y_u Y_u^\dagger\right) - 3\text{Tr}\left(Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger\right) \end{aligned} \quad (14)$$

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

$$\begin{aligned} \gamma_d^{(2)} = & +\frac{2}{225}\left(-100g_3^4 + 101g_1^4 + 80g_1^2 g_3^2\right)\mathbf{1} - 2\left(Y_d^* Y_d^T Y_d^* Y_d^T + Y_d^* Y_u^T Y_u^* Y_d^T\right) \\ & + Y_d^* Y_d^T\left(-2\text{Tr}\left(Y_e Y_e^\dagger\right) + 6g_2^2 - 6\text{Tr}\left(Y_d Y_d^\dagger\right) + \frac{2}{5}g_1^2\right) \end{aligned} \quad (16)$$

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

$$\begin{aligned} \gamma_u^{(2)} = & +\frac{8}{225}\left(107g_1^4 - 25g_3^4 + 80g_1^2 g_3^2\right)\mathbf{1} \\ & - \frac{2}{5}\left(5\left(Y_u^* Y_d^T Y_d^* Y_u^T + Y_u^* Y_u^T Y_u^* Y_u^T\right)\right. \\ & \left.+ Y_u^* Y_u^T\left(-15g_2^2 + 15\text{Tr}\left(Y_u Y_u^\dagger\right) + 5\text{Tr}\left(Y_\nu Y_\nu^\dagger\right) + 5\text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) + g_1^2\right)\right) \end{aligned} \quad (18)$$

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

$$\begin{aligned} \gamma_e^{(2)} = & +\frac{234}{25}g_1^4\mathbf{1} \\ & - \frac{2}{5}\left(5\left(Y_e^* Y_e^T Y_e^* Y_e^T + Y_e^* Y_{SL}^T Y_{SL}^* Y_e^T + Y_e^* Y_\nu^T Y_\nu^* Y_e^T\right)\right. \\ & \left.+ Y_e^* Y_e^T\left(-15g_2^2 + 15\text{Tr}\left(Y_d Y_d^\dagger\right) + 3g_1^2 + 5\text{Tr}\left(Y_e Y_e^\dagger\right)\right)\right) \end{aligned} \quad (20)$$

$$\gamma_\nu^{(1)} = 2Y_\nu^* Y_\nu^T \quad (21)$$

$$\begin{aligned} \gamma_\nu^{(2)} = & -2\left(Y_\nu^* Y_e^T Y_e^* Y_\nu^T + Y_\nu^* Y_{SL}^T Y_{SL}^* Y_\nu^T + Y_\nu^* Y_\nu^T Y_\nu^* Y_\nu^T\right) \\ & + Y_\nu^* Y_\nu^T\left(-2\text{Tr}\left(Y_\nu Y_\nu^\dagger\right) - 2\text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) + 6g_2^2 - 6\text{Tr}\left(Y_u Y_u^\dagger\right) + \frac{6}{5}g_1^2\right) \end{aligned} \quad (22)$$

$$\gamma_s^{(1)} = 2Y_{SL}^* Y_{SL}^T \quad (23)$$

$$\begin{aligned} \gamma_s^{(2)} = & -2\left(Y_{SL}^* Y_e^T Y_e^* Y_{SL}^T + Y_{SL}^* Y_{SL}^T Y_{SL}^* Y_{SL}^T + Y_{SL}^* Y_\nu^T Y_\nu^* Y_{SL}^T\right) \\ & + Y_{SL}^* Y_{SL}^T\left(-2\text{Tr}\left(Y_\nu Y_\nu^\dagger\right) - 2\text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) + 6g_2^2 - 6\text{Tr}\left(Y_u Y_u^\dagger\right) + \frac{6}{5}g_1^2\right) \end{aligned} \quad (24)$$

### 3.2 Gauge Couplings

$$\beta_{g_1}^{(1)} = \frac{33}{5}g_1^3 \quad (25)$$

$$\beta_{g_1}^{(2)} = \frac{1}{25}g_1^3 \left( 199g_1^2 + 135g_2^2 + 440g_3^2 - 70\text{Tr}(Y_d Y_d^\dagger) - 90\text{Tr}(Y_e Y_e^\dagger) - 30\text{Tr}(Y_{SL} Y_{SL}^\dagger) - 130\text{Tr}(Y_u Y_u^\dagger) - 30\text{Tr}(Y_\nu Y_\nu^\dagger) \right) \quad (26)$$

$$\beta_{g_2}^{(1)} = g_2^3 \quad (27)$$

$$\beta_{g_2}^{(2)} = \frac{1}{5}g_2^3 \left( 9g_1^2 + 125g_2^2 + 120g_3^2 - 30\text{Tr}(Y_d Y_d^\dagger) - 10\text{Tr}(Y_e Y_e^\dagger) - 10\text{Tr}(Y_{SL} Y_{SL}^\dagger) - 30\text{Tr}(Y_u Y_u^\dagger) - 10\text{Tr}(Y_\nu Y_\nu^\dagger) \right) \quad (28)$$

$$\beta_{g_3}^{(1)} = -3g_3^3 \quad (29)$$

$$\beta_{g_3}^{(2)} = \frac{1}{5}g_3^3 \left( 11g_1^2 - 20\text{Tr}(Y_d Y_d^\dagger) - 20\text{Tr}(Y_u Y_u^\dagger) + 45g_2^2 + 70g_3^2 \right) \quad (30)$$

### 3.3 Gaugino Mass Parameters

$$\beta_{M_1}^{(1)} = \frac{66}{5}g_1^2 M_1 \quad (31)$$

$$\begin{aligned} \beta_{M_1}^{(2)} = & \frac{2}{25}g_1^2 \left( 398g_1^2 M_1 + 135g_2^2 M_1 + 440g_3^2 M_1 + 440g_3^2 M_3 + 135g_2^2 M_2 - 70M_1 \text{Tr}(Y_d Y_d^\dagger) - 90M_1 \text{Tr}(Y_e Y_e^\dagger) \right. \\ & - 30M_1 \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 130M_1 \text{Tr}(Y_u Y_u^\dagger) - 30M_1 \text{Tr}(Y_\nu Y_\nu^\dagger) + 70\text{Tr}(Y_d^\dagger T_d) + 90\text{Tr}(Y_e^\dagger T_e) \\ & \left. + 30\text{Tr}(Y_{SL}^\dagger T_{Y_{SL}}) + 130\text{Tr}(Y_u^\dagger T_u) + 30\text{Tr}(Y_\nu^\dagger T_\nu) \right) \end{aligned} \quad (32)$$

$$\beta_{M_2}^{(1)} = 2g_2^2 M_2 \quad (33)$$

$$\begin{aligned} \beta_{M_2}^{(2)} = & \frac{2}{5}g_2^2 \left( 9g_1^2 M_1 + 120g_3^2 M_3 + 9g_1^2 M_2 + 250g_2^2 M_2 + 120g_3^2 M_2 - 30M_2 \text{Tr}(Y_d Y_d^\dagger) - 10M_2 \text{Tr}(Y_e Y_e^\dagger) \right. \\ & - 10M_2 \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 30M_2 \text{Tr}(Y_u Y_u^\dagger) - 10M_2 \text{Tr}(Y_\nu Y_\nu^\dagger) + 30\text{Tr}(Y_d^\dagger T_d) + 10\text{Tr}(Y_e^\dagger T_e) \\ & \left. + 10\text{Tr}(Y_{SL}^\dagger T_{Y_{SL}}) + 30\text{Tr}(Y_u^\dagger T_u) + 10\text{Tr}(Y_\nu^\dagger T_\nu) \right) \end{aligned} \quad (34)$$

$$\beta_{M_3}^{(1)} = -6g_3^2 M_3 \quad (35)$$

$$\begin{aligned} \beta_{M_3}^{(2)} = & \frac{2}{5}g_3^2 \left( 11g_1^2 M_1 + 11g_1^2 M_3 + 45g_2^2 M_3 + 140g_3^2 M_3 + 45g_2^2 M_2 - 20M_3 \text{Tr}(Y_d Y_d^\dagger) - 20M_3 \text{Tr}(Y_u Y_u^\dagger) \right. \\ & \left. + 20\text{Tr}(Y_d^\dagger T_d) + 20\text{Tr}(Y_u^\dagger T_u) \right) \end{aligned} \quad (36)$$

### 3.4 Trilinear Superpotential Parameters

$$\beta_{Y_d}^{(1)} = 3Y_d Y_d^\dagger Y_d + Y_d \left( -3g_2^2 + 3\text{Tr}(Y_d Y_d^\dagger) - \frac{16}{3}g_3^2 - \frac{7}{15}g_1^2 + \text{Tr}(Y_e Y_e^\dagger) \right) + Y_d Y_u^\dagger Y_u \quad (37)$$

$$\beta_{Y_d}^{(2)} = +\frac{4}{5}g_1^2 Y_d Y_u^\dagger Y_u - 4Y_d Y_d^\dagger Y_d Y_d^\dagger Y_d - 2Y_d Y_u^\dagger Y_u Y_d^\dagger Y_d - 2Y_d Y_u^\dagger Y_u Y_u^\dagger Y_u$$

$$\begin{aligned}
& + Y_d Y_d^\dagger Y_d \left( -3\text{Tr}(Y_e Y_e^\dagger) + 6g_2^2 - 9\text{Tr}(Y_d Y_d^\dagger) + \frac{4}{5}g_1^2 \right) - Y_d Y_u^\dagger Y_u \text{Tr}(Y_{SL} Y_{SL}^\dagger) \\
& - 3Y_d Y_u^\dagger Y_u \text{Tr}(Y_u Y_u^\dagger) - Y_d Y_u^\dagger Y_u \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& + Y_d \left( \frac{287}{90}g_1^4 + g_1^2 g_2^2 + \frac{15}{2}g_2^4 + \frac{8}{9}g_1^2 g_3^2 + 8g_2^2 g_3^2 - \frac{16}{9}g_3^4 - \frac{2}{5}(-40g_3^2 + g_1^2) \right) \text{Tr}(Y_d Y_d^\dagger) \\
& + \frac{6}{5}g_1^2 \text{Tr}(Y_e Y_e^\dagger) - 9\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 3\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \\
& - \text{Tr}(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger) - \text{Tr}(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger)
\end{aligned} \tag{38}$$

$$\beta_{Y_e}^{(1)} = 3Y_e Y_e^\dagger Y_e + Y_e \left( -3g_2^2 + 3\text{Tr}(Y_d Y_d^\dagger) - \frac{9}{5}g_1^2 + \text{Tr}(Y_e Y_e^\dagger) \right) + Y_e Y_{SL}^\dagger Y_{SL} + Y_e Y_\nu^\dagger Y_\nu \tag{39}$$

$$\begin{aligned}
\beta_{Y_e}^{(2)} = & -4Y_e Y_e^\dagger Y_e Y_e^\dagger Y_e - 2Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger Y_e - 2Y_e Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger Y_{SL} - 2Y_e Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger Y_\nu \\
& - 2Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger Y_e - 2Y_e Y_\nu^\dagger Y_\nu Y_{SL}^\dagger Y_{SL} - 2Y_e Y_\nu^\dagger Y_\nu Y_\nu^\dagger Y_\nu \\
& + Y_e Y_e^\dagger Y_e \left( -3\text{Tr}(Y_e Y_e^\dagger) + 6g_2^2 - 9\text{Tr}(Y_d Y_d^\dagger) \right) - Y_e Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_{SL} Y_{SL}^\dagger) \\
& - Y_e Y_\nu^\dagger Y_\nu \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 3Y_e Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_u Y_u^\dagger) - 3Y_e Y_\nu^\dagger Y_\nu \text{Tr}(Y_u Y_u^\dagger) \\
& - Y_e Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_\nu Y_\nu^\dagger) - Y_e Y_\nu^\dagger Y_\nu \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& + Y_e \left( \frac{27}{2}g_1^4 + \frac{9}{5}g_1^2 g_2^2 + \frac{15}{2}g_2^4 - \frac{2}{5}(-40g_3^2 + g_1^2) \right) \text{Tr}(Y_d Y_d^\dagger) + \frac{6}{5}g_1^2 \text{Tr}(Y_e Y_e^\dagger) - 9\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) \\
& - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 3\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) - \text{Tr}(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger) - \text{Tr}(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger)
\end{aligned} \tag{40}$$

$$\begin{aligned}
\beta_{Y_{SL}}^{(1)} = & +Y_{SL} Y_e^\dagger Y_e + 3Y_{SL} Y_{SL}^\dagger Y_{SL} + Y_{SL} Y_\nu^\dagger Y_\nu \\
& + Y_{SL} \left( -3g_2^2 + 3\text{Tr}(Y_u Y_u^\dagger) - \frac{3}{5}g_1^2 + \text{Tr}(Y_{SL} Y_{SL}^\dagger) + \text{Tr}(Y_\nu Y_\nu^\dagger) \right)
\end{aligned} \tag{41}$$

$$\begin{aligned}
\beta_{Y_{SL}}^{(2)} = & +\frac{6}{5}g_1^2 Y_{SL} Y_{SL}^\dagger Y_{SL} + 6g_2^2 Y_{SL} Y_{SL}^\dagger Y_{SL} - 2Y_{SL} Y_e^\dagger Y_e Y_e^\dagger Y_e - 2Y_{SL} Y_e^\dagger Y_e Y_{SL}^\dagger Y_{SL} \\
& - 4Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger Y_{SL} - 2Y_{SL} Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger Y_\nu - 4Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger Y_{SL} - 2Y_{SL} Y_\nu^\dagger Y_\nu Y_\nu^\dagger Y_\nu \\
& + Y_{SL} Y_e^\dagger Y_e \left( -3\text{Tr}(Y_d Y_d^\dagger) + \frac{6}{5}g_1^2 - \text{Tr}(Y_e Y_e^\dagger) \right) - 3Y_{SL} Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_{SL} Y_{SL}^\dagger) \\
& - Y_{SL} Y_\nu^\dagger Y_\nu \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 9Y_{SL} Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_u Y_u^\dagger) - 3Y_{SL} Y_\nu^\dagger Y_\nu \text{Tr}(Y_u Y_u^\dagger) \\
& - 3Y_{SL} Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_\nu Y_\nu^\dagger) - Y_{SL} Y_\nu^\dagger Y_\nu \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& + Y_{SL} \left( \frac{207}{50}g_1^4 + \frac{9}{5}g_1^2 g_2^2 + \frac{15}{2}g_2^4 + \frac{4}{5}(20g_3^2 + g_1^2) \right) \text{Tr}(Y_u Y_u^\dagger) - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) \\
& - \text{Tr}(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger) - \text{Tr}(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger) - 3\text{Tr}(Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger) - 6\text{Tr}(Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger) \\
& - 9\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) - 3\text{Tr}(Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger)
\end{aligned} \tag{42}$$

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

$$\beta_{Y_u}^{(2)} = +\frac{2}{5}g_1^2 Y_u Y_u^\dagger Y_u + 6g_2^2 Y_u Y_u^\dagger Y_u - 2Y_u Y_d^\dagger Y_d Y_d^\dagger Y_d - 2Y_u Y_d^\dagger Y_d Y_u^\dagger Y_u$$



$$\begin{aligned}
& -4Y_u Y_u^\dagger Y_u Y_u^\dagger Y_u + Y_u Y_d^\dagger Y_d \left( -3\text{Tr}(Y_d Y_d^\dagger) + \frac{2}{5}g_1^2 - \text{Tr}(Y_e Y_e^\dagger) \right) - 3Y_u Y_u^\dagger Y_u \text{Tr}(Y_{SL} Y_{SL}^\dagger) \\
& -9Y_u Y_u^\dagger Y_u \text{Tr}(Y_u Y_u^\dagger) - 3Y_u Y_u^\dagger Y_u \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& + Y_u \left( \frac{2743}{450}g_1^4 + g_2^2 g_2^2 + \frac{15}{2}g_2^4 + \frac{136}{45}g_1^2 g_3^2 + 8g_2^2 g_3^2 - \frac{16}{9}g_3^4 + \frac{4}{5}(20g_3^2 + g_1^2) \right) \text{Tr}(Y_u Y_u^\dagger) \\
& - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - \text{Tr}(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger) - \text{Tr}(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger) - 3\text{Tr}(Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger) \\
& - 6\text{Tr}(Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger) - 9\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) - 3\text{Tr}(Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger)
\end{aligned} \tag{44}$$

$$\begin{aligned}
\beta_{Y_\nu}^{(1)} & = +Y_\nu Y_e^\dagger Y_e + Y_\nu Y_{SL}^\dagger Y_{SL} + 3Y_\nu Y_\nu^\dagger Y_\nu \\
& + Y_\nu \left( -3g_2^2 + 3\text{Tr}(Y_u Y_u^\dagger) - \frac{3}{5}g_1^2 + \text{Tr}(Y_{SL} Y_{SL}^\dagger) + \text{Tr}(Y_\nu Y_\nu^\dagger) \right)
\end{aligned} \tag{45}$$

$$\begin{aligned}
\beta_{Y_\nu}^{(2)} & = +\frac{6}{5}g_1^2 Y_\nu Y_\nu^\dagger Y_\nu + 6g_2^2 Y_\nu Y_\nu^\dagger Y_\nu - 2Y_\nu Y_e^\dagger Y_e Y_e^\dagger Y_e - 2Y_\nu Y_e^\dagger Y_e Y_\nu^\dagger Y_\nu \\
& - 2Y_\nu Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger Y_{SL} - 4Y_\nu Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger Y_\nu - 2Y_\nu Y_\nu^\dagger Y_\nu Y_{SL}^\dagger Y_{SL} - 4Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger Y_\nu \\
& + Y_\nu Y_e^\dagger Y_e \left( -3\text{Tr}(Y_d Y_d^\dagger) + \frac{6}{5}g_1^2 - \text{Tr}(Y_e Y_e^\dagger) \right) - Y_\nu Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_{SL} Y_{SL}^\dagger) \\
& - 3Y_\nu Y_\nu^\dagger Y_\nu \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 3Y_\nu Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_u Y_u^\dagger) - 9Y_\nu Y_\nu^\dagger Y_\nu \text{Tr}(Y_u Y_u^\dagger) \\
& - Y_\nu Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_\nu Y_\nu^\dagger) - 3Y_\nu Y_\nu^\dagger Y_\nu \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& + Y_\nu \left( \frac{207}{50}g_1^4 + \frac{9}{5}g_1^2 g_2^2 + \frac{15}{2}g_2^4 + \frac{4}{5}(20g_3^2 + g_1^2) \right) \text{Tr}(Y_u Y_u^\dagger) - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) \\
& - \text{Tr}(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger) - \text{Tr}(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger) - 3\text{Tr}(Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger) - 6\text{Tr}(Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger) \\
& - 9\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) - 3\text{Tr}(Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger)
\end{aligned} \tag{46}$$

### 3.5 Bilinear Superpotential Parameters

$$\begin{aligned}
\beta_\mu^{(1)} & = -\frac{3}{5}g_1^2 \mu - 3g_2^2 \mu + 3\mu \text{Tr}(Y_d Y_d^\dagger) + \mu \text{Tr}(Y_e Y_e^\dagger) + \mu \text{Tr}(Y_{SL} Y_{SL}^\dagger) + 3\mu \text{Tr}(Y_u Y_u^\dagger) \\
& + \mu \text{Tr}(Y_\nu Y_\nu^\dagger)
\end{aligned} \tag{47}$$

$$\begin{aligned}
\beta_\mu^{(2)} & = +\frac{207}{50}g_1^4 \mu + \frac{9}{5}g_1^2 g_2^2 \mu + \frac{15}{2}g_2^4 \mu - \frac{2}{5} \left( -40g_3^2 + g_1^2 \right) \mu \text{Tr}(Y_d Y_d^\dagger) + \frac{6}{5}g_1^2 \mu \text{Tr}(Y_e Y_e^\dagger) \\
& + \frac{4}{5}g_1^2 \mu \text{Tr}(Y_u Y_u^\dagger) + 16g_3^2 \mu \text{Tr}(Y_u Y_u^\dagger) - 9\mu \text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) - 6\mu \text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) \\
& - 3\mu \text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) - 2\mu \text{Tr}(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger) - 2\mu \text{Tr}(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger) - 3\mu \text{Tr}(Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger) \\
& - 6\mu \text{Tr}(Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger) - 9\mu \text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) - 3\mu \text{Tr}(Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger)
\end{aligned} \tag{48}$$

$$\beta_{M_R}^{(1)} = 2 \left( M_R Y_{SL}^* Y_{SL}^T + Y_\nu Y_\nu^\dagger M_R \right) \tag{49}$$

$$\begin{aligned}
\beta_{M_R}^{(2)} = & -2\left(M_R Y_{SL}^* Y_e^T Y_e^* Y_{SL}^T + M_R Y_{SL}^* Y_{SL}^T Y_{SL}^* Y_{SL}^T + M_R Y_{SL}^* Y_\nu^T Y_\nu^* Y_{SL}^T + Y_\nu Y_e^\dagger Y_e Y_\nu^\dagger M_R \right. \\
& + \left. Y_\nu Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger M_R + Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger M_R\right) \\
& + M_R Y_{SL}^* Y_{SL}^T \left(-2\text{Tr}\left(Y_\nu Y_\nu^\dagger\right) - 2\text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) + 6g_2^2 - 6\text{Tr}\left(Y_u Y_u^\dagger\right) + \frac{6}{5}g_1^2\right) \\
& + Y_\nu Y_\nu^\dagger M_R \left(-2\text{Tr}\left(Y_\nu Y_\nu^\dagger\right) - 2\text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) + 6g_2^2 - 6\text{Tr}\left(Y_u Y_u^\dagger\right) + \frac{6}{5}g_1^2\right)
\end{aligned} \tag{50}$$

### 3.6 Trilinear Soft-Breaking Parameters

$$\begin{aligned}
\beta_{T_d}^{(1)} = & +4Y_d Y_d^\dagger T_d + 2Y_d Y_u^\dagger T_u + 5T_d Y_d^\dagger Y_d + T_d Y_u^\dagger Y_u - \frac{7}{15}g_1^2 T_d - 3g_2^2 T_d - \frac{16}{3}g_3^2 T_d \\
& + 3T_d \text{Tr}\left(Y_d Y_d^\dagger\right) + T_d \text{Tr}\left(Y_e Y_e^\dagger\right) + Y_d \left(2\text{Tr}\left(Y_e^\dagger T_e\right) + 6g_2^2 M_2 + 6\text{Tr}\left(Y_d^\dagger T_d\right) + \frac{14}{15}g_1^2 M_1 + \frac{32}{3}g_3^2 M_3\right) \\
\beta_{T_d}^{(2)} = & +\frac{6}{5}g_1^2 Y_d Y_d^\dagger T_d + 6g_2^2 Y_d Y_d^\dagger T_d - \frac{8}{5}g_1^2 M_1 Y_d Y_u^\dagger Y_u + \frac{8}{5}g_1^2 Y_d Y_u^\dagger T_u \\
& + \frac{6}{5}g_1^2 T_d Y_d^\dagger Y_d + 12g_2^2 T_d Y_d^\dagger Y_d + \frac{4}{5}g_1^2 T_d Y_u^\dagger Y_u - 6Y_d Y_d^\dagger Y_d Y_d^\dagger T_d \\
& - 8Y_d Y_d^\dagger T_d Y_d^\dagger Y_d - 2Y_d Y_u^\dagger Y_u Y_d^\dagger T_d - 4Y_d Y_u^\dagger Y_u Y_u^\dagger T_u - 4Y_d Y_u^\dagger T_u Y_d^\dagger Y_d \\
& - 4Y_d Y_u^\dagger T_u Y_u^\dagger Y_u - 6T_d Y_d^\dagger Y_d Y_d^\dagger Y_d - 4T_d Y_u^\dagger Y_u Y_d^\dagger Y_d - 2T_d Y_u^\dagger Y_u Y_u^\dagger Y_u \\
& + \frac{287}{90}g_1^4 T_d + g_1^2 g_2^2 T_d + \frac{15}{2}g_2^4 T_d + \frac{8}{9}g_1^2 g_3^2 T_d + 8g_2^2 g_3^2 T_d - \frac{16}{9}g_3^4 T_d \\
& - 12Y_d Y_d^\dagger T_d \text{Tr}\left(Y_d Y_d^\dagger\right) - 15T_d Y_d^\dagger Y_d \text{Tr}\left(Y_d Y_d^\dagger\right) - \frac{2}{5}g_1^2 T_d \text{Tr}\left(Y_d Y_d^\dagger\right) \\
& + 16g_3^2 T_d \text{Tr}\left(Y_d Y_d^\dagger\right) - 4Y_d Y_d^\dagger T_d \text{Tr}\left(Y_e Y_e^\dagger\right) - 5T_d Y_d^\dagger Y_d \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& + \frac{6}{5}g_1^2 T_d \text{Tr}\left(Y_e Y_e^\dagger\right) - 2Y_d Y_u^\dagger T_u \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) - T_d Y_u^\dagger Y_u \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) \\
& - 6Y_d Y_u^\dagger T_u \text{Tr}\left(Y_u Y_u^\dagger\right) - 3T_d Y_u^\dagger Y_u \text{Tr}\left(Y_u Y_u^\dagger\right) - 2Y_d Y_u^\dagger T_u \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) \\
& - T_d Y_u^\dagger Y_u \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) - \frac{2}{5}Y_d Y_d^\dagger Y_d \left(15\text{Tr}\left(Y_e^\dagger T_e\right) + 30g_2^2 M_2 + 45\text{Tr}\left(Y_d^\dagger T_d\right) + 4g_1^2 M_1\right) \\
& - 2Y_d Y_u^\dagger Y_u \text{Tr}\left(Y_{SL}^\dagger T_{Y_{SL}}\right) - 6Y_d Y_u^\dagger Y_u \text{Tr}\left(Y_u^\dagger T_u\right) - 2Y_d Y_u^\dagger Y_u \text{Tr}\left(Y_\nu^\dagger T_\nu\right) \\
& - 9T_d \text{Tr}\left(Y_d Y_d^\dagger Y_d Y_d^\dagger\right) - 3T_d \text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - 3T_d \text{Tr}\left(Y_e Y_e^\dagger Y_e Y_e^\dagger\right) - T_d \text{Tr}\left(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger\right) \\
& - T_d \text{Tr}\left(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger\right) \\
& - \frac{2}{45}Y_d \left(287g_1^4 M_1 + 45g_1^2 g_2^2 M_1 + 40g_1^2 g_3^2 M_1 + 40g_1^2 g_3^2 M_3 + 360g_2^2 g_3^2 M_3 - 160g_3^4 M_3 \right. \\
& + 45g_1^2 g_2^2 M_2 + 675g_2^4 M_2 + 360g_2^2 g_3^2 M_2 - 18\left(-40g_3^2 M_3 + g_1^2 M_1\right) \text{Tr}\left(Y_d Y_d^\dagger\right) \\
& \left. + 54g_1^2 M_1 \text{Tr}\left(Y_e Y_e^\dagger\right) + 18g_1^2 \text{Tr}\left(Y_d^\dagger T_d\right) - 720g_3^2 \text{Tr}\left(Y_d^\dagger T_d\right) - 54g_1^2 \text{Tr}\left(Y_e^\dagger T_e\right)\right)
\end{aligned} \tag{51}$$

$$\begin{aligned}
& + 810\text{Tr}\left(Y_d Y_d^\dagger T_d Y_d^\dagger\right) + 135\text{Tr}\left(Y_d Y_u^\dagger T_u Y_d^\dagger\right) + 270\text{Tr}\left(Y_e Y_e^\dagger T_e Y_e^\dagger\right) + 45\text{Tr}\left(Y_e Y_{SL}^\dagger T_{Y_{SL}} Y_e^\dagger\right) \\
& + 45\text{Tr}\left(Y_e Y_\nu^\dagger T_\nu Y_e^\dagger\right) + 45\text{Tr}\left(Y_{SL} Y_e^\dagger T_e Y_{SL}^\dagger\right) + 135\text{Tr}\left(Y_u Y_d^\dagger T_d Y_u^\dagger\right) + 45\text{Tr}\left(Y_\nu Y_e^\dagger T_e Y_\nu^\dagger\right)
\end{aligned} \tag{52}$$

$$\begin{aligned}
\beta_{T_e}^{(1)} & = +4Y_e Y_e^\dagger T_e + 2Y_e Y_{SL}^\dagger T_{Y_{SL}} + 2Y_e Y_\nu^\dagger T_\nu + 5T_e Y_e^\dagger Y_e + T_e Y_{SL}^\dagger Y_{SL} + T_e Y_\nu^\dagger Y_\nu \\
& - \frac{9}{5}g_1^2 T_e - 3g_2^2 T_e + 3T_e \text{Tr}\left(Y_d Y_d^\dagger\right) + T_e \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& + Y_e \left(2\text{Tr}\left(Y_e^\dagger T_e\right) + 6g_2^2 M_2 + 6\text{Tr}\left(Y_d^\dagger T_d\right) + \frac{18}{5}g_1^2 M_1\right)
\end{aligned} \tag{53}$$

$$\begin{aligned}
\beta_{T_e}^{(2)} & = +\frac{6}{5}g_1^2 Y_e Y_e^\dagger T_e + 6g_2^2 Y_e Y_e^\dagger T_e - \frac{6}{5}g_1^2 T_e Y_e^\dagger Y_e + 12g_2^2 T_e Y_e^\dagger Y_e \\
& - 6Y_e Y_e^\dagger Y_e Y_e^\dagger T_e - 8Y_e Y_e^\dagger T_e Y_e^\dagger Y_e - 2Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger T_e - 4Y_e Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} \\
& - 4Y_e Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger T_\nu - 4Y_e Y_{SL}^\dagger T_{Y_{SL}} Y_e^\dagger Y_e - 4Y_e Y_{SL}^\dagger T_{Y_{SL}} Y_{SL}^\dagger Y_{SL} \\
& - 4Y_e Y_{SL}^\dagger T_{Y_{SL}} Y_\nu^\dagger Y_\nu - 2Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger T_e - 4Y_e Y_\nu^\dagger Y_\nu Y_{SL}^\dagger T_{Y_{SL}} \\
& - 4Y_e Y_\nu^\dagger Y_\nu Y_\nu^\dagger T_\nu - 4Y_e Y_\nu^\dagger T_\nu Y_e^\dagger Y_e - 4Y_e Y_\nu^\dagger T_\nu Y_{SL}^\dagger Y_{SL} - 4Y_e Y_\nu^\dagger T_\nu Y_\nu^\dagger Y_\nu \\
& - 6T_e Y_e^\dagger Y_e Y_e^\dagger Y_e - 4T_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger Y_e - 2T_e Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger Y_{SL} - 2T_e Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger Y_\nu \\
& - 4T_e Y_\nu^\dagger Y_\nu Y_e^\dagger Y_e - 2T_e Y_\nu^\dagger Y_\nu Y_{SL}^\dagger Y_{SL} - 2T_e Y_\nu^\dagger Y_\nu Y_\nu^\dagger Y_\nu + \frac{27}{2}g_1^4 T_e \\
& + \frac{9}{5}g_1^2 g_2^2 T_e + \frac{15}{2}g_2^4 T_e - 12Y_e Y_e^\dagger T_e \text{Tr}\left(Y_d Y_d^\dagger\right) - 15T_e Y_e^\dagger Y_e \text{Tr}\left(Y_d Y_d^\dagger\right) \\
& - \frac{2}{5}g_1^2 T_e \text{Tr}\left(Y_d Y_d^\dagger\right) + 16g_3^2 T_e \text{Tr}\left(Y_d Y_d^\dagger\right) - 4Y_e Y_e^\dagger T_e \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& - 5T_e Y_e^\dagger Y_e \text{Tr}\left(Y_e Y_e^\dagger\right) + \frac{6}{5}g_1^2 T_e \text{Tr}\left(Y_e Y_e^\dagger\right) - 2Y_e Y_{SL}^\dagger T_{Y_{SL}} \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) \\
& - 2Y_e Y_\nu^\dagger T_\nu \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) - T_e Y_{SL}^\dagger Y_{SL} \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) - T_e Y_\nu^\dagger Y_\nu \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) \\
& - 6Y_e Y_{SL}^\dagger T_{Y_{SL}} \text{Tr}\left(Y_u Y_u^\dagger\right) - 6Y_e Y_\nu^\dagger T_\nu \text{Tr}\left(Y_u Y_u^\dagger\right) - 3T_e Y_{SL}^\dagger Y_{SL} \text{Tr}\left(Y_u Y_u^\dagger\right) \\
& - 3T_e Y_\nu^\dagger Y_\nu \text{Tr}\left(Y_u Y_u^\dagger\right) - 2Y_e Y_{SL}^\dagger T_{Y_{SL}} \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) - 2Y_e Y_\nu^\dagger T_\nu \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) \\
& - T_e Y_{SL}^\dagger Y_{SL} \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) - T_e Y_\nu^\dagger Y_\nu \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) \\
& - 6Y_e Y_e^\dagger Y_e \left(2g_2^2 M_2 + 3\text{Tr}\left(Y_d^\dagger T_d\right) + \text{Tr}\left(Y_e^\dagger T_e\right)\right) - 2Y_e Y_{SL}^\dagger Y_{SL} \text{Tr}\left(Y_{SL}^\dagger T_{Y_{SL}}\right) \\
& - 2Y_e Y_\nu^\dagger Y_\nu \text{Tr}\left(Y_{SL}^\dagger T_{Y_{SL}}\right) - 6Y_e Y_{SL}^\dagger Y_{SL} \text{Tr}\left(Y_u^\dagger T_u\right) - 6Y_e Y_\nu^\dagger Y_\nu \text{Tr}\left(Y_u^\dagger T_u\right) \\
& - 2Y_e Y_{SL}^\dagger Y_{SL} \text{Tr}\left(Y_\nu^\dagger T_\nu\right) - 2Y_e Y_\nu^\dagger Y_\nu \text{Tr}\left(Y_\nu^\dagger T_\nu\right) - 9T_e \text{Tr}\left(Y_d Y_d^\dagger Y_d Y_d^\dagger\right) \\
& - 3T_e \text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - 3T_e \text{Tr}\left(Y_e Y_e^\dagger Y_e Y_e^\dagger\right) - T_e \text{Tr}\left(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger\right) \\
& - T_e \text{Tr}\left(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger\right) \\
& - \frac{2}{5}Y_e \left(135g_1^4 M_1 + 9g_1^2 g_2^2 M_1 + 9g_1^2 g_2^2 M_2 + 75g_2^4 M_2 + \left(-2g_1^2 M_1 + 80g_3^2 M_3\right)\right) \text{Tr}\left(Y_d Y_d^\dagger\right)
\end{aligned}$$

$$\begin{aligned}
& + 6g_1^2 M_1 \text{Tr}(Y_e Y_e^\dagger) + 2g_1^2 \text{Tr}(Y_d^\dagger T_d) - 80g_3^2 \text{Tr}(Y_d^\dagger T_d) - 6g_1^2 \text{Tr}(Y_e^\dagger T_e) \\
& + 90 \text{Tr}(Y_d Y_d^\dagger T_d Y_d^\dagger) + 15 \text{Tr}(Y_d Y_u^\dagger T_u Y_d^\dagger) + 30 \text{Tr}(Y_e Y_e^\dagger T_e Y_e^\dagger) + 5 \text{Tr}(Y_e Y_{SL}^\dagger T_{Y_{SL}} Y_e^\dagger) \\
& + 5 \text{Tr}(Y_e Y_\nu^\dagger T_\nu Y_e^\dagger) + 5 \text{Tr}(Y_{SL} Y_e^\dagger T_e Y_{SL}^\dagger) + 15 \text{Tr}(Y_u Y_d^\dagger T_d Y_u^\dagger) + 5 \text{Tr}(Y_\nu Y_e^\dagger T_e Y_\nu^\dagger)
\end{aligned} \tag{54}$$

$$\begin{aligned}
\beta_{T_{Y_{SL}}}^{(1)} & = +2Y_{SL} Y_e^\dagger T_e + 4Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} + 4Y_{SL} Y_\nu^\dagger T_\nu + T_{Y_{SL}} Y_e^\dagger Y_e + 5T_{Y_{SL}} Y_{SL}^\dagger Y_{SL} \\
& + 5T_{Y_{SL}} Y_\nu^\dagger Y_\nu - \frac{3}{5}g_1^2 T_{Y_{SL}} - 3g_2^2 T_{Y_{SL}} + T_{Y_{SL}} \text{Tr}(Y_{SL} Y_{SL}^\dagger) + 3T_{Y_{SL}} \text{Tr}(Y_u Y_u^\dagger) + T_{Y_{SL}} \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& + Y_{SL} (2\text{Tr}(Y_\nu^\dagger T_\nu) + 2\text{Tr}(Y_{SL}^\dagger T_{Y_{SL}})) + 6g_2^2 M_2 + 6\text{Tr}(Y_u^\dagger T_u) + \frac{6}{5}g_1^2 M_1
\end{aligned} \tag{55}$$

$$\begin{aligned}
\beta_{T_{Y_{SL}}}^{(2)} & = +\frac{12}{5}g_1^2 Y_{SL} Y_e^\dagger T_e - \frac{12}{5}g_1^2 M_1 Y_{SL} Y_{SL}^\dagger Y_{SL} - 12g_2^2 M_2 Y_{SL} Y_{SL}^\dagger Y_{SL} + \frac{6}{5}g_1^2 Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} \\
& + 6g_2^2 Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} - \frac{12}{5}g_1^2 M_1 Y_{SL} Y_\nu^\dagger Y_\nu - 12g_2^2 M_2 Y_{SL} Y_\nu^\dagger Y_\nu + \frac{6}{5}g_1^2 Y_{SL} Y_\nu^\dagger T_\nu \\
& + 6g_2^2 Y_{SL} Y_\nu^\dagger T_\nu + \frac{6}{5}g_1^2 T_{Y_{SL}} Y_e^\dagger Y_e + \frac{12}{5}g_1^2 T_{Y_{SL}} Y_{SL}^\dagger Y_{SL} + 12g_2^2 T_{Y_{SL}} Y_{SL}^\dagger Y_{SL} \\
& + \frac{12}{5}g_1^2 T_{Y_{SL}} Y_\nu^\dagger Y_\nu + 12g_2^2 T_{Y_{SL}} Y_\nu^\dagger Y_\nu - 4Y_{SL} Y_e^\dagger Y_e Y_e^\dagger T_e - 2Y_{SL} Y_e^\dagger Y_e Y_{SL}^\dagger T_{Y_{SL}} \\
& - 2Y_{SL} Y_e^\dagger Y_e Y_\nu^\dagger T_\nu - 4Y_{SL} Y_e^\dagger T_e Y_e^\dagger Y_e - 4Y_{SL} Y_e^\dagger T_e Y_{SL}^\dagger Y_{SL} \\
& - 4Y_{SL} Y_e^\dagger T_e Y_\nu^\dagger Y_\nu - 6Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} - 6Y_{SL} Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger T_\nu - 8Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} Y_{SL}^\dagger Y_{SL} \\
& - 8Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} Y_\nu^\dagger Y_\nu - 6Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger T_{Y_{SL}} - 6Y_{SL} Y_\nu^\dagger Y_\nu Y_\nu^\dagger T_\nu \\
& - 8Y_{SL} Y_\nu^\dagger T_\nu Y_{SL}^\dagger Y_{SL} - 8Y_{SL} Y_\nu^\dagger T_\nu Y_\nu^\dagger Y_\nu - 2T_{Y_{SL}} Y_e^\dagger Y_e Y_e^\dagger Y_e - 4T_{Y_{SL}} Y_e^\dagger Y_e Y_{SL}^\dagger Y_{SL} \\
& - 4T_{Y_{SL}} Y_e^\dagger Y_e Y_\nu^\dagger Y_\nu - 6T_{Y_{SL}} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger Y_{SL} - 6T_{Y_{SL}} Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger Y_\nu \\
& - 6T_{Y_{SL}} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger Y_{SL} - 6T_{Y_{SL}} Y_\nu^\dagger Y_\nu Y_\nu^\dagger Y_\nu + \frac{207}{50}g_1^4 T_{Y_{SL}} + \frac{9}{5}g_1^2 g_2^2 T_{Y_{SL}} + \frac{15}{2}g_2^4 T_{Y_{SL}} \\
& - 6Y_{SL} Y_e^\dagger T_e \text{Tr}(Y_d Y_d^\dagger) - 3T_{Y_{SL}} Y_e^\dagger Y_e \text{Tr}(Y_d Y_d^\dagger) - 2Y_{SL} Y_e^\dagger T_e \text{Tr}(Y_e Y_e^\dagger) \\
& - T_{Y_{SL}} Y_e^\dagger Y_e \text{Tr}(Y_e Y_e^\dagger) - 4Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 4Y_{SL} Y_\nu^\dagger T_\nu \text{Tr}(Y_{SL} Y_{SL}^\dagger) \\
& - 5T_{Y_{SL}} Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 5T_{Y_{SL}} Y_\nu^\dagger Y_\nu \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 12Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} \text{Tr}(Y_u Y_u^\dagger) \\
& - 12Y_{SL} Y_\nu^\dagger T_\nu \text{Tr}(Y_u Y_u^\dagger) - 15T_{Y_{SL}} Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_u Y_u^\dagger) - 15T_{Y_{SL}} Y_\nu^\dagger Y_\nu \text{Tr}(Y_u Y_u^\dagger) \\
& + \frac{4}{5}g_1^2 T_{Y_{SL}} \text{Tr}(Y_u Y_u^\dagger) + 16g_3^2 T_{Y_{SL}} \text{Tr}(Y_u Y_u^\dagger) - 4Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& - 4Y_{SL} Y_\nu^\dagger T_\nu \text{Tr}(Y_\nu Y_\nu^\dagger) - 5T_{Y_{SL}} Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_\nu Y_\nu^\dagger) - 5T_{Y_{SL}} Y_\nu^\dagger Y_\nu \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& - \frac{2}{5}Y_{SL} Y_e^\dagger Y_e (15\text{Tr}(Y_d^\dagger T_d) + 5\text{Tr}(Y_e^\dagger T_e) + 6g_1^2 M_1) - 6Y_{SL} Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_{SL}^\dagger T_{Y_{SL}}) \\
& - 6Y_{SL} Y_\nu^\dagger Y_\nu \text{Tr}(Y_{SL}^\dagger T_{Y_{SL}}) - 18Y_{SL} Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_u^\dagger T_u) - 18Y_{SL} Y_\nu^\dagger Y_\nu \text{Tr}(Y_u^\dagger T_u) \\
& - 6Y_{SL} Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_\nu^\dagger T_\nu) - 6Y_{SL} Y_\nu^\dagger Y_\nu \text{Tr}(Y_\nu^\dagger T_\nu) - 3T_{Y_{SL}} \text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger)
\end{aligned}$$

$$\begin{aligned}
& -T_{Y_{SL}} \text{Tr}\left(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger\right) - T_{Y_{SL}} \text{Tr}\left(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger\right) - 3T_{Y_{SL}} \text{Tr}\left(Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger\right) \\
& - 6T_{Y_{SL}} \text{Tr}\left(Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger\right) - 9T_{Y_{SL}} \text{Tr}\left(Y_u Y_u^\dagger Y_u Y_u^\dagger\right) - 3T_{Y_{SL}} \text{Tr}\left(Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger\right) \\
& - \frac{2}{25} Y_{SL} \left(207g_1^4 M_1 + 45g_1^2 g_2^2 M_1 + 45g_1^2 g_2^2 M_2 + 375g_2^4 M_2 + 20\left(20g_3^2 M_3 + g_1^2 M_1\right)\right) \text{Tr}\left(Y_u Y_u^\dagger\right) \\
& - 20\left(20g_3^2 + g_1^2\right) \text{Tr}\left(Y_u^\dagger T_u\right) + 75 \text{Tr}\left(Y_d Y_u^\dagger T_u Y_d^\dagger\right) + 25 \text{Tr}\left(Y_e Y_{SL}^\dagger T_{Y_{SL}} Y_e^\dagger\right) \\
& + 25 \text{Tr}\left(Y_e Y_\nu^\dagger T_\nu Y_e^\dagger\right) + 25 \text{Tr}\left(Y_{SL} Y_e^\dagger T_e Y_{SL}^\dagger\right) + 150 \text{Tr}\left(Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} Y_{SL}^\dagger\right) + 150 \text{Tr}\left(Y_{SL} Y_\nu^\dagger T_\nu Y_{SL}^\dagger\right) \\
& + 75 \text{Tr}\left(Y_u Y_d^\dagger T_d Y_u^\dagger\right) + 450 \text{Tr}\left(Y_u Y_u^\dagger T_u Y_u^\dagger\right) + 25 \text{Tr}\left(Y_\nu Y_e^\dagger T_e Y_\nu^\dagger\right) + 150 \text{Tr}\left(Y_\nu Y_{SL}^\dagger T_{Y_{SL}} Y_\nu^\dagger\right) \\
& + 150 \text{Tr}\left(Y_\nu Y_\nu^\dagger T_\nu Y_\nu^\dagger\right)
\end{aligned} \tag{56}$$

$$\begin{aligned}
\beta_{T_u}^{(1)} & = +2Y_u Y_d^\dagger T_d + 4Y_u Y_u^\dagger T_u + T_u Y_d^\dagger Y_d + 5T_u Y_u^\dagger Y_u - \frac{13}{15} g_1^2 T_u - 3g_2^2 T_u - \frac{16}{3} g_3^2 T_u \\
& + T_u \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) + 3T_u \text{Tr}\left(Y_u Y_u^\dagger\right) + T_u \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) \\
& + Y_u \left(2\text{Tr}\left(Y_\nu^\dagger T_\nu\right) + 2\text{Tr}\left(Y_{SL}^\dagger T_{Y_{SL}}\right) + 6g_2^2 M_2 + 6\text{Tr}\left(Y_u^\dagger T_u\right) + \frac{26}{15} g_1^2 M_1 + \frac{32}{3} g_3^2 M_3\right)
\end{aligned} \tag{57}$$

$$\begin{aligned}
\beta_{T_u}^{(2)} & = +\frac{4}{5} g_1^2 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 + \frac{2}{5} g_1^2 T_u Y_d^\dagger Y_d + 12g_2^2 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 - 6Y_u Y_d^\dagger T_d \text{Tr}\left(Y_d Y_d^\dagger\right) \\
& - 3T_u Y_d^\dagger Y_d \text{Tr}\left(Y_d Y_d^\dagger\right) - 2Y_u Y_d^\dagger T_d \text{Tr}\left(Y_e Y_e^\dagger\right) - T_u Y_d^\dagger Y_d \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& - 4Y_u Y_u^\dagger T_u \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) - 5T_u Y_u^\dagger Y_u \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) - 12Y_u Y_u^\dagger T_u \text{Tr}\left(Y_u Y_u^\dagger\right) \\
& - 15T_u Y_u^\dagger Y_u \text{Tr}\left(Y_u Y_u^\dagger\right) + \frac{4}{5} g_1^2 T_u \text{Tr}\left(Y_u Y_u^\dagger\right) + 16g_3^2 T_u \text{Tr}\left(Y_u Y_u^\dagger\right) \\
& - 4Y_u Y_u^\dagger T_u \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) - 5T_u Y_u^\dagger Y_u \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) \\
& - \frac{2}{5} Y_u Y_d^\dagger Y_d \left(15\text{Tr}\left(Y_d^\dagger T_d\right) + 2g_1^2 M_1 + 5\text{Tr}\left(Y_e^\dagger T_e\right)\right) - 6Y_u Y_u^\dagger Y_u \text{Tr}\left(Y_{SL}^\dagger T_{Y_{SL}}\right) \\
& - 18Y_u Y_u^\dagger Y_u \text{Tr}\left(Y_u^\dagger T_u\right) - 6Y_u Y_u^\dagger Y_u \text{Tr}\left(Y_\nu^\dagger T_\nu\right) - 3T_u \text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) \\
& - T_u \text{Tr}\left(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger\right) - T_u \text{Tr}\left(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger\right) - 3T_u \text{Tr}\left(Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger\right) \\
& - 6T_u \text{Tr}\left(Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger\right) - 9T_u \text{Tr}\left(Y_u Y_u^\dagger Y_u Y_u^\dagger\right) - 3T_u \text{Tr}\left(Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger\right) \\
& + Y_u \left(-\frac{5486}{225} g_1^4 M_1 - 2g_1^2 g_2^2 M_1 - \frac{272}{45} g_1^2 g_3^2 M_1 - \frac{272}{45} g_1^2 g_3^2 M_3 - 16g_2^2 g_3^2 M_3 + \frac{64}{9} g_3^4 M_3\right)
\end{aligned}$$

$$\begin{aligned}
& -2g_1^2 g_2^2 M_2 - 30g_2^4 M_2 - 16g_2^2 g_3^2 M_2 - \frac{8}{5} (20g_3^2 M_3 + g_1^2 M_1) \text{Tr}(Y_u Y_u^\dagger) \\
& + \frac{8}{5} (20g_3^2 + g_1^2) \text{Tr}(Y_u^\dagger T_u) - 6\text{Tr}(Y_d Y_u^\dagger T_u Y_d^\dagger) - 2\text{Tr}(Y_e Y_{SL}^\dagger T_{Y_{SL}} Y_e^\dagger) \\
& - 2\text{Tr}(Y_e Y_\nu^\dagger T_\nu Y_e^\dagger) - 2\text{Tr}(Y_{SL} Y_e^\dagger T_e Y_{SL}^\dagger) - 12\text{Tr}(Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} Y_{SL}^\dagger) - 12\text{Tr}(Y_{SL} Y_\nu^\dagger T_\nu Y_{SL}^\dagger) \\
& - 6\text{Tr}(Y_u Y_d^\dagger T_d Y_u^\dagger) - 36\text{Tr}(Y_u Y_u^\dagger T_u Y_u^\dagger) - 2\text{Tr}(Y_\nu Y_e^\dagger T_e Y_\nu^\dagger) - 12\text{Tr}(Y_\nu Y_{SL}^\dagger T_{Y_{SL}} Y_\nu^\dagger) \\
& - 12\text{Tr}(Y_\nu Y_\nu^\dagger T_\nu Y_\nu^\dagger)
\end{aligned} \tag{58}$$

$$\begin{aligned}
\beta_{T_\nu}^{(1)} & = +2Y_\nu Y_e^\dagger T_e + 4Y_\nu Y_{SL}^\dagger T_{Y_{SL}} + 4Y_\nu Y_\nu^\dagger T_\nu + T_\nu Y_e^\dagger Y_e + 5T_\nu Y_{SL}^\dagger Y_{SL} + 5T_\nu Y_\nu^\dagger Y_\nu \\
& - \frac{3}{5} g_1^2 T_\nu - 3g_2^2 T_\nu + T_\nu \text{Tr}(Y_{SL} Y_{SL}^\dagger) + 3T_\nu \text{Tr}(Y_u Y_u^\dagger) + T_\nu \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& + Y_\nu (2\text{Tr}(Y_\nu^\dagger T_\nu) + 2\text{Tr}(Y_{SL}^\dagger T_{Y_{SL}}) + 6g_2^2 M_2 + 6\text{Tr}(Y_u^\dagger T_u) + \frac{6}{5} g_1^2 M_1)
\end{aligned} \tag{59}$$

$$\begin{aligned}
\beta_{T_\nu}^{(2)} & = +\frac{12}{5} g_1^2 Y_\nu Y_e^\dagger T_e - \frac{12}{5} g_1^2 M_1 Y_\nu Y_{SL}^\dagger Y_{SL} - 12g_2^2 M_2 Y_\nu Y_{SL}^\dagger Y_{SL} + \frac{6}{5} g_1^2 Y_\nu Y_{SL}^\dagger T_{Y_{SL}} \\
& + 6g_2^2 Y_\nu Y_{SL}^\dagger T_{Y_{SL}} - \frac{12}{5} g_1^2 M_1 Y_\nu Y_\nu^\dagger Y_\nu - 12g_2^2 M_2 Y_\nu Y_\nu^\dagger Y_\nu + \frac{6}{5} g_1^2 Y_\nu Y_\nu^\dagger T_\nu \\
& + 6g_2^2 Y_\nu Y_\nu^\dagger T_\nu + \frac{6}{5} g_1^2 T_\nu Y_e^\dagger Y_e + \frac{12}{5} g_1^2 T_\nu Y_{SL}^\dagger Y_{SL} + 12g_2^2 T_\nu Y_{SL}^\dagger Y_{SL} \\
& + \frac{12}{5} g_1^2 T_\nu Y_\nu^\dagger Y_\nu + 12g_2^2 T_\nu Y_\nu^\dagger Y_\nu - 4Y_\nu Y_e^\dagger Y_e Y_e^\dagger T_e - 2Y_\nu Y_e^\dagger Y_e Y_{SL}^\dagger T_{Y_{SL}} \\
& - 2Y_\nu Y_e^\dagger Y_e Y_\nu^\dagger T_\nu - 4Y_\nu Y_e^\dagger T_e Y_e^\dagger Y_e - 4Y_\nu Y_e^\dagger T_e Y_{SL}^\dagger Y_{SL} \\
& - 4Y_\nu Y_e^\dagger T_e Y_\nu^\dagger Y_\nu - 6Y_\nu Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} - 6Y_\nu Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger T_\nu - 8Y_\nu Y_{SL}^\dagger T_{Y_{SL}} Y_{SL}^\dagger Y_{SL} \\
& - 8Y_\nu Y_{SL}^\dagger T_{Y_{SL}} Y_\nu^\dagger Y_\nu - 6Y_\nu Y_\nu^\dagger Y_\nu Y_{SL}^\dagger T_{Y_{SL}} - 6Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger T_\nu - 8Y_\nu Y_\nu^\dagger T_\nu Y_{SL}^\dagger Y_{SL} \\
& - 8Y_\nu Y_\nu^\dagger T_\nu Y_\nu^\dagger Y_\nu - 2T_\nu Y_e^\dagger Y_e Y_e^\dagger Y_e - 4T_\nu Y_e^\dagger Y_e Y_{SL}^\dagger Y_{SL} - 4T_\nu Y_e^\dagger Y_e Y_\nu^\dagger Y_\nu \\
& - 6T_\nu Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger Y_{SL} - 6T_\nu Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger Y_\nu - 6T_\nu Y_\nu^\dagger Y_\nu Y_{SL}^\dagger Y_{SL} - 6T_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger Y_\nu \\
& + \frac{207}{50} g_1^4 T_\nu + \frac{9}{5} g_1^2 g_2^2 T_\nu + \frac{15}{2} g_2^4 T_\nu - 6Y_\nu Y_e^\dagger T_e \text{Tr}(Y_d Y_d^\dagger) - 3T_\nu Y_e^\dagger Y_e \text{Tr}(Y_d Y_d^\dagger) \\
& - 2Y_\nu Y_e^\dagger T_e \text{Tr}(Y_e Y_e^\dagger) - T_\nu Y_e^\dagger Y_e \text{Tr}(Y_e Y_e^\dagger) - 4Y_\nu Y_{SL}^\dagger T_{Y_{SL}} \text{Tr}(Y_{SL} Y_{SL}^\dagger) \\
& - 4Y_\nu Y_\nu^\dagger T_\nu \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 5T_\nu Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 5T_\nu Y_\nu^\dagger Y_\nu \text{Tr}(Y_{SL} Y_{SL}^\dagger) \\
& - 12Y_\nu Y_{SL}^\dagger T_{Y_{SL}} \text{Tr}(Y_u Y_u^\dagger) - 12Y_\nu Y_\nu^\dagger T_\nu \text{Tr}(Y_u Y_u^\dagger) - 15T_\nu Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_u Y_u^\dagger) \\
& - 15T_\nu Y_\nu^\dagger Y_\nu \text{Tr}(Y_u Y_u^\dagger) + \frac{4}{5} g_1^2 T_\nu \text{Tr}(Y_u Y_u^\dagger) + 16g_3^2 T_\nu \text{Tr}(Y_u Y_u^\dagger) \\
& - 4Y_\nu Y_{SL}^\dagger T_{Y_{SL}} \text{Tr}(Y_\nu Y_\nu^\dagger) - 4Y_\nu Y_\nu^\dagger T_\nu \text{Tr}(Y_\nu Y_\nu^\dagger) - 5T_\nu Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& - 5T_\nu Y_\nu^\dagger Y_\nu \text{Tr}(Y_\nu Y_\nu^\dagger) - \frac{2}{5} Y_\nu Y_e^\dagger Y_e (15\text{Tr}(Y_d^\dagger T_d) + 5\text{Tr}(Y_e^\dagger T_e) + 6g_1^2 M_1) \\
& - 6Y_\nu Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_{SL}^\dagger T_{Y_{SL}}) - 6Y_\nu Y_\nu^\dagger Y_\nu \text{Tr}(Y_{SL}^\dagger T_{Y_{SL}}) - 18Y_\nu Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_u^\dagger T_u)
\end{aligned}$$

$$\begin{aligned}
& -18Y_\nu Y_\nu^\dagger Y_\nu \text{Tr}\left(Y_u^\dagger T_u\right) - 6Y_\nu Y_{SL}^\dagger Y_{SL} \text{Tr}\left(Y_\nu^\dagger T_\nu\right) - 6Y_\nu Y_\nu^\dagger Y_\nu \text{Tr}\left(Y_\nu^\dagger T_\nu\right) \\
& -3T_\nu \text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - T_\nu \text{Tr}\left(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger\right) - T_\nu \text{Tr}\left(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger\right) \\
& -3T_\nu \text{Tr}\left(Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger\right) - 6T_\nu \text{Tr}\left(Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger\right) - 9T_\nu \text{Tr}\left(Y_u Y_u^\dagger Y_u Y_u^\dagger\right) - 3T_\nu \text{Tr}\left(Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger\right) \\
& -\frac{2}{25}Y_\nu \left(207g_1^4 M_1 + 45g_1^2 g_2^2 M_1 + 45g_1^2 g_2^2 M_2 + 375g_2^4 M_2 + 20\left(20g_3^2 M_3 + g_1^2 M_1\right)\right) \text{Tr}\left(Y_u Y_u^\dagger\right) \\
& -20\left(20g_3^2 + g_1^2\right) \text{Tr}\left(Y_u^\dagger T_u\right) + 75 \text{Tr}\left(Y_d Y_u^\dagger T_u Y_d^\dagger\right) + 25 \text{Tr}\left(Y_e Y_{SL}^\dagger T_{Y_{SL}} Y_e^\dagger\right) \\
& + 25 \text{Tr}\left(Y_e Y_\nu^\dagger T_\nu Y_e^\dagger\right) + 25 \text{Tr}\left(Y_{SL} Y_e^\dagger T_e Y_{SL}^\dagger\right) + 150 \text{Tr}\left(Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} Y_{SL}^\dagger\right) + 150 \text{Tr}\left(Y_{SL} Y_\nu^\dagger T_\nu Y_{SL}^\dagger\right) \\
& + 75 \text{Tr}\left(Y_u Y_d^\dagger T_d Y_u^\dagger\right) + 450 \text{Tr}\left(Y_u Y_u^\dagger T_u Y_u^\dagger\right) + 25 \text{Tr}\left(Y_\nu Y_e^\dagger T_e Y_\nu^\dagger\right) + 150 \text{Tr}\left(Y_\nu Y_{SL}^\dagger T_{Y_{SL}} Y_\nu^\dagger\right) \\
& + 150 \text{Tr}\left(Y_\nu Y_\nu^\dagger T_\nu Y_\nu^\dagger\right)
\end{aligned} \tag{60}$$

### 3.7 Bilinear Soft-Breaking Parameters

$$\begin{aligned}
\beta_{B_\mu}^{(1)} & = +B_\mu \left( -3g_2^2 + 3\text{Tr}\left(Y_d Y_d^\dagger\right) + 3\text{Tr}\left(Y_u Y_u^\dagger\right) - \frac{3}{5}g_1^2 + \text{Tr}\left(Y_e Y_e^\dagger\right) + \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) + \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) \right) \\
& + \frac{2}{5}\mu \left( 15g_2^2 M_2 + 15\text{Tr}\left(Y_d^\dagger T_d\right) + 15\text{Tr}\left(Y_u^\dagger T_u\right) + 3g_1^2 M_1 + 5\text{Tr}\left(Y_e^\dagger T_e\right) + 5\text{Tr}\left(Y_\nu^\dagger T_\nu\right) + 5\text{Tr}\left(Y_{SL}^\dagger T_{Y_{SL}}\right) \right) \tag{61} \\
\beta_{B_\mu}^{(2)} & = +B_\mu \left( \frac{207}{50}g_1^4 + \frac{9}{5}g_1^2 g_2^2 + \frac{15}{2}g_2^4 - \frac{2}{5}\left(-40g_3^2 + g_1^2\right) \text{Tr}\left(Y_d Y_d^\dagger\right) + \frac{6}{5}g_1^2 \text{Tr}\left(Y_e Y_e^\dagger\right) + \frac{4}{5}g_1^2 \text{Tr}\left(Y_u Y_u^\dagger\right) \right) \\
& + 16g_3^2 \text{Tr}\left(Y_u Y_u^\dagger\right) - 9\text{Tr}\left(Y_d Y_d^\dagger Y_d Y_d^\dagger\right) - 6\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - 3\text{Tr}\left(Y_e Y_e^\dagger Y_e Y_e^\dagger\right) \\
& - 2\text{Tr}\left(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger\right) - 2\text{Tr}\left(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger\right) - 3\text{Tr}\left(Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger\right) - 6\text{Tr}\left(Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger\right) \\
& - 9\text{Tr}\left(Y_u Y_u^\dagger Y_u Y_u^\dagger\right) - 3\text{Tr}\left(Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger\right) \\
& - \frac{2}{25}\mu \left( 207g_1^4 M_1 + 45g_1^2 g_2^2 M_1 + 45g_1^2 g_2^2 M_2 + 375g_2^4 M_2 - 10\left(-40g_3^2 M_3 + g_1^2 M_1\right) \text{Tr}\left(Y_d Y_d^\dagger\right) \right) \\
& + 30g_1^2 M_1 \text{Tr}\left(Y_e Y_e^\dagger\right) + 20g_1^2 M_1 \text{Tr}\left(Y_u Y_u^\dagger\right) + 400g_3^2 M_3 \text{Tr}\left(Y_u Y_u^\dagger\right) + 10g_1^2 \text{Tr}\left(Y_d^\dagger T_d\right) \\
& - 400g_3^2 \text{Tr}\left(Y_d^\dagger T_d\right) - 30g_1^2 \text{Tr}\left(Y_e^\dagger T_e\right) - 20g_1^2 \text{Tr}\left(Y_u^\dagger T_u\right) - 400g_3^2 \text{Tr}\left(Y_u^\dagger T_u\right) \\
& + 450 \text{Tr}\left(Y_d Y_d^\dagger T_d Y_d^\dagger\right) + 150 \text{Tr}\left(Y_d Y_u^\dagger T_u Y_d^\dagger\right) + 150 \text{Tr}\left(Y_e Y_e^\dagger T_e Y_e^\dagger\right) + 50 \text{Tr}\left(Y_e Y_{SL}^\dagger T_{Y_{SL}} Y_e^\dagger\right) \\
& + 50 \text{Tr}\left(Y_e Y_\nu^\dagger T_\nu Y_e^\dagger\right) + 50 \text{Tr}\left(Y_{SL} Y_e^\dagger T_e Y_{SL}^\dagger\right) + 150 \text{Tr}\left(Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} Y_{SL}^\dagger\right) + 150 \text{Tr}\left(Y_{SL} Y_\nu^\dagger T_\nu Y_{SL}^\dagger\right) \\
& + 150 \text{Tr}\left(Y_u Y_d^\dagger T_d Y_u^\dagger\right) + 450 \text{Tr}\left(Y_u Y_u^\dagger T_u Y_u^\dagger\right) + 50 \text{Tr}\left(Y_\nu Y_e^\dagger T_e Y_\nu^\dagger\right) + 150 \text{Tr}\left(Y_\nu Y_{SL}^\dagger T_{Y_{SL}} Y_\nu^\dagger\right) \\
& + 150 \text{Tr}\left(Y_\nu Y_\nu^\dagger T_\nu Y_\nu^\dagger\right)
\end{aligned} \tag{62}$$

$$\beta_{B_{MR}}^{(1)} = 2\left(2M_R Y_{SL}^* T_{Y_{SL}}^T + 2T_\nu Y_\nu^\dagger M_R + Y_\nu Y_\nu^\dagger B_{MR} + B_{MR} Y_{SL}^* Y_{SL}^T\right) \tag{63}$$

$$\begin{aligned}
\beta_{B_{MR}}^{(2)} = & -\frac{2}{5} \left( 6g_1^2 M_1 Y_\nu Y_\nu^\dagger M_R + 30g_2^2 M_2 Y_\nu Y_\nu^\dagger M_R - 3g_1^2 Y_\nu Y_\nu^\dagger B_{MR} - 15g_2^2 Y_\nu Y_\nu^\dagger B_{MR} \right. \\
& - 3g_1^2 B_{MR} Y_{SL}^* Y_{SL}^T - 15g_2^2 B_{MR} Y_{SL}^* Y_{SL}^T - 6g_1^2 T_\nu Y_\nu^\dagger M_R - 30g_2^2 T_\nu Y_\nu^\dagger M_R \\
& + 10M_R Y_{SL}^* Y_e^T Y_e^* T_{Y_{SL}}^T + 10M_R Y_{SL}^* Y_{SL}^T Y_{SL}^* T_{Y_{SL}}^T + 10M_R Y_{SL}^* Y_\nu^T Y_\nu^* T_{Y_{SL}}^T \\
& + 10M_R Y_{SL}^* T_e^T Y_e^* Y_{SL}^T + 10M_R Y_{SL}^* T_{Y_{SL}}^T Y_{SL}^* Y_{SL}^T + 10M_R Y_{SL}^* T_\nu^T Y_\nu^* Y_{SL}^T \\
& + 5Y_\nu Y_e^\dagger Y_e Y_\nu^\dagger B_{MR} + 10Y_\nu Y_e^\dagger T_e Y_\nu^\dagger M_R + 5Y_\nu Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger B_{MR} \\
& + 10Y_\nu Y_{SL}^\dagger T_{Y_{SL}} Y_\nu^\dagger M_R + 5Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger B_{MR} + 10Y_\nu Y_\nu^\dagger T_\nu Y_\nu^\dagger M_R + 5B_{MR} Y_{SL}^* Y_e^T Y_e^* Y_{SL}^T \\
& + 5B_{MR} Y_{SL}^* Y_{SL}^T Y_{SL}^* Y_{SL}^T + 5B_{MR} Y_{SL}^* Y_\nu^T Y_\nu^* Y_{SL}^T + 10T_\nu Y_e^\dagger Y_e Y_\nu^\dagger M_R \\
& + 10T_\nu Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger M_R + 10T_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger M_R + 5Y_\nu Y_\nu^\dagger B_{MR} \text{Tr} \left( Y_{SL} Y_{SL}^\dagger \right) \\
& + 5B_{MR} Y_{SL}^* Y_{SL}^T \text{Tr} \left( Y_{SL} Y_{SL}^\dagger \right) + 10T_\nu Y_\nu^\dagger M_R \text{Tr} \left( Y_{SL} Y_{SL}^\dagger \right) + 15Y_\nu Y_\nu^\dagger B_{MR} \text{Tr} \left( Y_u Y_u^\dagger \right) \\
& + 15B_{MR} Y_{SL}^* Y_{SL}^T \text{Tr} \left( Y_u Y_u^\dagger \right) + 30T_\nu Y_\nu^\dagger M_R \text{Tr} \left( Y_u Y_u^\dagger \right) + 5Y_\nu Y_\nu^\dagger B_{MR} \text{Tr} \left( Y_\nu Y_\nu^\dagger \right) \\
& + 5B_{MR} Y_{SL}^* Y_{SL}^T \text{Tr} \left( Y_\nu Y_\nu^\dagger \right) + 10T_\nu Y_\nu^\dagger M_R \text{Tr} \left( Y_\nu Y_\nu^\dagger \right) \\
& + M_R Y_{SL}^* T_{Y_{SL}}^T \left( 10\text{Tr} \left( Y_\nu Y_\nu^\dagger \right) + 10\text{Tr} \left( Y_{SL} Y_{SL}^\dagger \right) - 30g_2^2 + 30\text{Tr} \left( Y_u Y_u^\dagger \right) - 6g_1^2 \right) \\
& + 10Y_\nu Y_\nu^\dagger M_R \text{Tr} \left( Y_{SL}^\dagger T_{Y_{SL}} \right) + 30Y_\nu Y_\nu^\dagger M_R \text{Tr} \left( Y_u^\dagger T_u \right) + 10Y_\nu Y_\nu^\dagger M_R \text{Tr} \left( Y_\nu^\dagger T_\nu \right) \\
& \left. + 2M_R Y_{SL}^* Y_{SL}^T \left( 15g_2^2 M_2 + 15\text{Tr} \left( Y_u^\dagger T_u \right) + 3g_1^2 M_1 + 5\text{Tr} \left( Y_\nu^\dagger T_\nu \right) + 5\text{Tr} \left( Y_{SL}^\dagger T_{Y_{SL}} \right) \right) \right) \quad (64)
\end{aligned}$$

### 3.8 Soft-Breaking Scalar Masses

$$\sigma_{1,1} = \sqrt{\frac{3}{5}} g_1 \left( -2\text{Tr} \left( m_u^2 \right) - \text{Tr} \left( m_l^2 \right) - m_{H_d}^2 + m_{H_u}^2 + \text{Tr} \left( m_d^2 \right) + \text{Tr} \left( m_e^2 \right) + \text{Tr} \left( m_q^2 \right) \right) \quad (65)$$

$$\sigma_{2,11} = \frac{1}{10} g_1^2 \left( 2\text{Tr} \left( m_d^2 \right) + 3\text{Tr} \left( m_l^2 \right) + 3m_{H_d}^2 + 3m_{H_u}^2 + 6\text{Tr} \left( m_e^2 \right) + 8\text{Tr} \left( m_u^2 \right) + \text{Tr} \left( m_q^2 \right) \right) \quad (66)$$

$$\begin{aligned}
\sigma_{3,1} = & \frac{1}{20} \frac{1}{\sqrt{15}} g_1 \left( -9g_1^2 m_{H_d}^2 - 45g_2^2 m_{H_d}^2 + 9g_1^2 m_{H_u}^2 + 45g_2^2 m_{H_u}^2 + 4 \left( 20g_3^2 + g_1^2 \right) \text{Tr} \left( m_d^2 \right) + 36g_1^2 \text{Tr} \left( m_e^2 \right) \right. \\
& - 9g_1^2 \text{Tr} \left( m_l^2 \right) - 45g_2^2 \text{Tr} \left( m_l^2 \right) + g_1^2 \text{Tr} \left( m_q^2 \right) + 45g_2^2 \text{Tr} \left( m_q^2 \right) + 80g_3^2 \text{Tr} \left( m_q^2 \right) - 32g_1^2 \text{Tr} \left( m_u^2 \right) \\
& - 160g_3^2 \text{Tr} \left( m_u^2 \right) + 90m_{H_d}^2 \text{Tr} \left( Y_d Y_d^\dagger \right) + 30m_{H_d}^2 \text{Tr} \left( Y_e Y_e^\dagger \right) - 30m_{H_u}^2 \text{Tr} \left( Y_{SL} Y_{SL}^\dagger \right) - 90m_{H_u}^2 \text{Tr} \left( Y_u Y_u^\dagger \right) \\
& - 30m_{H_u}^2 \text{Tr} \left( Y_\nu Y_\nu^\dagger \right) - 60\text{Tr} \left( Y_d Y_d^\dagger m_d^{2*} \right) - 30\text{Tr} \left( Y_d m_q^{2*} Y_d^\dagger \right) - 60\text{Tr} \left( Y_e Y_e^\dagger m_e^{2*} \right) \\
& + 30\text{Tr} \left( Y_e m_l^{2*} Y_e^\dagger \right) + 30\text{Tr} \left( Y_{SL} m_l^{2*} Y_{SL}^\dagger \right) + 120\text{Tr} \left( Y_u Y_u^\dagger m_u^{2*} \right) - 30\text{Tr} \left( Y_u m_q^{2*} Y_u^\dagger \right) \\
& \left. + 30\text{Tr} \left( Y_\nu m_l^{2*} Y_\nu^\dagger \right) \right) \quad (67)
\end{aligned}$$

$$\sigma_{2,2} = \frac{1}{2} \left( 3\text{Tr} \left( m_q^2 \right) + m_{H_d}^2 + m_{H_u}^2 + \text{Tr} \left( m_l^2 \right) \right) \quad (68)$$



$$\sigma_{2,3} = \frac{1}{2} \left( 2\text{Tr}(m_q^2) + \text{Tr}(m_d^2) + \text{Tr}(m_u^2) \right) \quad (69)$$

$$\begin{aligned} \beta_{m_q^2}^{(1)} = & -\frac{2}{15}g_1^2\mathbf{1}|M_1|^2 - \frac{32}{3}g_3^2\mathbf{1}|M_3|^2 - 6g_2^2\mathbf{1}|M_2|^2 + 2m_{H_d}^2Y_d^\dagger Y_d + 2m_{H_u}^2Y_u^\dagger Y_u + 2T_d^\dagger T_d \\ & + 2T_u^\dagger T_u + m_q^2Y_d^\dagger Y_d + m_q^2Y_u^\dagger Y_u + 2Y_d^\dagger m_d^2 Y_d + Y_d^\dagger Y_d m_q^2 + 2Y_u^\dagger m_u^2 Y_u \\ & + Y_u^\dagger Y_u m_q^2 + \frac{1}{\sqrt{15}}g_1\mathbf{1}\sigma_{1,1} \end{aligned} \quad (70)$$

$$\begin{aligned} \beta_{m_q^2}^{(2)} = & \frac{2}{5}g_1^2g_2^2\mathbf{1}|M_2|^2 + 33g_2^4\mathbf{1}|M_2|^2 + 32g_2^2g_3^2\mathbf{1}|M_2|^2 \\ & + \frac{16}{45}g_3^2 \left( 15 \left( 3g_2^2(2M_3 + M_2) - 8g_3^2M_3 \right) + g_1^2(2M_3 + M_1) \right) \mathbf{1}M_3^* + \frac{1}{5}g_1^2g_2^2M_1\mathbf{1}M_2^* + 16g_2^2g_3^2M_3\mathbf{1}M_2^* \\ & + \frac{4}{5}g_1^2m_{H_d}^2Y_d^\dagger Y_d + \frac{8}{5}g_1^2m_{H_u}^2Y_u^\dagger Y_u \\ & + \frac{1}{225}g_1^2M_1^* \left( \left( 5 \left( 16g_3^2(2M_1 + M_3) + 9g_2^2(2M_1 + M_2) \right) + 597g_1^2M_1 \right) \mathbf{1} \right. \\ & \left. + 180 \left( 2M_1Y_d^\dagger Y_d - 2Y_u^\dagger T_u + 4M_1Y_u^\dagger Y_u - Y_d^\dagger T_d \right) \right) \\ & - \frac{4}{5}g_1^2M_1T_d^\dagger Y_d + \frac{4}{5}g_1^2T_d^\dagger T_d - \frac{8}{5}g_1^2M_1T_u^\dagger Y_u + \frac{8}{5}g_1^2T_u^\dagger T_u \\ & + \frac{2}{5}g_1^2m_q^2Y_d^\dagger Y_d + \frac{4}{5}g_1^2m_q^2Y_u^\dagger Y_u + \frac{4}{5}g_1^2Y_d^\dagger m_d^2 Y_d + \frac{2}{5}g_1^2Y_d^\dagger Y_d m_q^2 \\ & + \frac{8}{5}g_1^2Y_u^\dagger m_u^2 Y_u + \frac{4}{5}g_1^2Y_u^\dagger Y_u m_q^2 - 8m_{H_d}^2Y_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}^2Y_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^2Y_d^\dagger Y_d Y_d^\dagger Y_d - 2m_q^2Y_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 + 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}^2Y_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^2Y_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}^2Y_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^2Y_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) - 4m_{H_u}^2Y_u^\dagger Y_u \text{Tr}(Y_{SL}Y_{SL}^\dagger) - 2T_u^\dagger T_u \text{Tr}(Y_{SL}Y_{SL}^\dagger) \\ & - m_q^2Y_u^\dagger Y_u \text{Tr}(Y_{SL}Y_{SL}^\dagger) - 2Y_u^\dagger m_u^2 Y_u \text{Tr}(Y_{SL}Y_{SL}^\dagger) - Y_u^\dagger Y_u m_q^2 \text{Tr}(Y_{SL}Y_{SL}^\dagger) \\ & - 12m_{H_u}^2Y_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^2Y_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) - 4m_{H_u}^2Y_u^\dagger Y_u \text{Tr}(Y_\nu Y_\nu^\dagger) \end{aligned}$$

$$\begin{aligned}
& -2T_u^\dagger T_u \text{Tr}(Y_\nu Y_\nu^\dagger) - m_q^2 Y_u^\dagger Y_u \text{Tr}(Y_\nu Y_\nu^\dagger) - 2Y_u^\dagger m_u^2 Y_u \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& - Y_u^\dagger Y_u m_q^2 \text{Tr}(Y_\nu Y_\nu^\dagger) - 6T_d^\dagger Y_d \text{Tr}(Y_d^\dagger T_d) - 2T_d^\dagger Y_d \text{Tr}(Y_e^\dagger T_e) \\
& - 2T_u^\dagger Y_u \text{Tr}(Y_{SL}^\dagger T_{Y_{SL}}) - 6T_u^\dagger Y_u \text{Tr}(Y_u^\dagger T_u) - 2T_u^\dagger Y_u \text{Tr}(Y_\nu^\dagger T_\nu) \\
& - 6Y_d^\dagger T_d \text{Tr}(T_d^* Y_d^T) - 6Y_d^\dagger Y_d \text{Tr}(T_d^* T_d^T) - 2Y_d^\dagger T_d \text{Tr}(T_e^* Y_e^T) \\
& - 2Y_d^\dagger Y_d \text{Tr}(T_e^* T_e^T) - 2Y_u^\dagger T_u \text{Tr}(T_{Y_{SL}^*} Y_{SL}^T) - 2Y_u^\dagger Y_u \text{Tr}(T_{Y_{SL}^*} T_{Y_{SL}}^T) \\
& - 6Y_u^\dagger T_u \text{Tr}(T_u^* Y_u^T) - 6Y_u^\dagger Y_u \text{Tr}(T_u^* T_u^T) - 2Y_u^\dagger T_u \text{Tr}(T_\nu^* Y_\nu^T) \\
& - 2Y_u^\dagger Y_u \text{Tr}(T_\nu^* T_\nu^T) - 6Y_d^\dagger Y_d \text{Tr}(m_d^2 Y_d Y_d^\dagger) - 2Y_d^\dagger Y_d \text{Tr}(m_e^2 Y_e Y_e^\dagger) \\
& - 2Y_d^\dagger Y_d \text{Tr}(m_l^2 Y_e^\dagger Y_e) - 2Y_u^\dagger Y_u \text{Tr}(m_l^2 Y_{SL}^\dagger Y_{SL}) - 2Y_u^\dagger Y_u \text{Tr}(m_l^2 Y_\nu^\dagger Y_\nu) \\
& - 6Y_d^\dagger Y_d \text{Tr}(m_q^2 Y_d^\dagger Y_d) - 6Y_u^\dagger Y_u \text{Tr}(m_q^2 Y_u^\dagger Y_u) - 6Y_u^\dagger Y_u \text{Tr}(m_u^2 Y_u Y_u^\dagger) \\
& - 2Y_u^\dagger Y_u \text{Tr}(m_\nu^2 Y_\nu Y_\nu^\dagger) - 2Y_u^\dagger Y_u \text{Tr}(Y_{SL} Y_{SL}^\dagger m_S^{2*}) \tag{71}
\end{aligned}$$

$$\begin{aligned}
\beta_{m_l^2}^{(1)} &= -\frac{6}{5} g_1^2 \mathbf{1} |M_1|^2 - 6g_2^2 \mathbf{1} |M_2|^2 + 2m_{H_d}^2 Y_e^\dagger Y_e + 2m_{H_u}^2 Y_{SL}^\dagger Y_{SL} + 2m_{H_u}^2 Y_\nu^\dagger Y_\nu + 2T_e^\dagger T_e \\
& + 2T_{Y_{SL}}^\dagger T_{Y_{SL}} + 2T_\nu^\dagger T_\nu + m_l^2 Y_e^\dagger Y_e + m_l^2 Y_{SL}^\dagger Y_{SL} + m_l^2 Y_\nu^\dagger Y_\nu + 2Y_e^\dagger m_e^2 Y_e \\
& + Y_e^\dagger Y_e m_l^2 + Y_{SL}^\dagger Y_{SL} m_l^2 + 2Y_{SL}^\dagger m_S^{2*} Y_{SL} + 2Y_\nu^\dagger m_\nu^2 Y_\nu + Y_\nu^\dagger Y_\nu m_l^2 - \sqrt{\frac{3}{5}} g_1 \mathbf{1} \sigma_{1,1} \tag{72}
\end{aligned}$$

$$\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 \\
& + \frac{3}{25} g_1^2 M_1^* \left( -20Y_e^\dagger T_e + 3 \left( 5g_2^2 (2M_1 + M_2) + 69g_1^2 M_1 \right) \mathbf{1} + 40M_1 Y_e^\dagger Y_e \right) - \frac{12}{5} g_1^2 M_1 T_e^\dagger Y_e \\
& + \frac{12}{5} g_1^2 T_e^\dagger T_e + \frac{6}{5} g_1^2 m_l^2 Y_e^\dagger Y_e + \frac{12}{5} g_1^2 Y_e^\dagger m_e^2 Y_e + \frac{6}{5} g_1^2 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 - 8m_{H_u}^2 Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger Y_{SL} \\
& - 8m_{H_u}^2 Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger Y_\nu - 4Y_{SL}^\dagger Y_{SL} T_{Y_{SL}}^\dagger T_{Y_{SL}} - 4Y_{SL}^\dagger Y_{SL} T_\nu^\dagger T_\nu \\
& - 4Y_{SL}^\dagger T_{Y_{SL}} T_{Y_{SL}}^\dagger Y_{SL} - 4Y_{SL}^\dagger T_{Y_{SL}} T_\nu^\dagger Y_\nu - 8m_{H_u}^2 Y_\nu^\dagger Y_\nu Y_{SL}^\dagger Y_{SL} - 8m_{H_u}^2 Y_\nu^\dagger Y_\nu Y_\nu^\dagger Y_\nu \\
& - 4Y_\nu^\dagger Y_\nu T_{Y_{SL}}^\dagger T_{Y_{SL}} - 4Y_\nu^\dagger Y_\nu T_\nu^\dagger T_\nu - 4Y_\nu^\dagger T_\nu T_{Y_{SL}}^\dagger Y_{SL} - 4Y_\nu^\dagger T_\nu T_\nu^\dagger Y_\nu \\
& - 4T_e^\dagger Y_e Y_e^\dagger T_e - 4T_e^\dagger T_e Y_e^\dagger Y_e - 4T_{Y_{SL}}^\dagger Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} - 4T_{Y_{SL}}^\dagger Y_{SL} Y_\nu^\dagger T_\nu \\
& - 4T_{Y_{SL}}^\dagger T_{Y_{SL}} Y_{SL}^\dagger Y_{SL} - 4T_{Y_{SL}}^\dagger T_{Y_{SL}} Y_\nu^\dagger Y_\nu - 4T_\nu^\dagger Y_\nu Y_{SL}^\dagger T_{Y_{SL}} - 4T_\nu^\dagger Y_\nu Y_\nu^\dagger T_\nu \\
& - 4T_\nu^\dagger T_\nu Y_{SL}^\dagger Y_{SL} - 4T_\nu^\dagger T_\nu Y_\nu^\dagger Y_\nu - 2m_l^2 Y_e^\dagger Y_e Y_e^\dagger Y_e - 2m_l^2 Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger Y_{SL} \\
& - 2m_l^2 Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger Y_\nu - 2m_l^2 Y_\nu^\dagger Y_\nu Y_{SL}^\dagger Y_{SL} - 2m_l^2 Y_\nu^\dagger Y_\nu Y_\nu^\dagger Y_\nu - 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 - 4Y_{SL}^\dagger Y_{SL} m_l^2 Y_{SL}^\dagger Y_{SL} \\
& - 4Y_{SL}^\dagger Y_{SL} m_l^2 Y_\nu^\dagger Y_\nu - 2Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger Y_{SL} m_l^2 - 4Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger m_S^{2*} Y_{SL} - 4Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger m_\nu^2 Y_\nu \\
& - 2Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger Y_\nu m_l^2 - 4Y_{SL}^\dagger m_S^{2*} Y_{SL} Y_{SL}^\dagger Y_{SL} - 4Y_{SL}^\dagger m_S^{2*} Y_{SL} Y_\nu^\dagger Y_\nu
\end{aligned}$$

$$\begin{aligned}
& -4Y_\nu^\dagger m_\nu^2 Y_\nu Y_{SL}^\dagger Y_{SL} - 4Y_\nu^\dagger m_\nu^2 Y_\nu Y_\nu^\dagger Y_\nu - 4Y_\nu^\dagger Y_\nu m_l^2 Y_{SL}^\dagger Y_{SL} - 4Y_\nu^\dagger Y_\nu m_l^2 Y_\nu^\dagger Y_\nu \\
& -2Y_\nu^\dagger Y_\nu Y_{SL}^\dagger Y_{SL} m_l^2 - 4Y_\nu^\dagger Y_\nu Y_{SL}^\dagger m_S^{2*} Y_{SL} - 4Y_\nu^\dagger Y_\nu Y_\nu^\dagger m_\nu^2 Y_\nu - 2Y_\nu^\dagger Y_\nu Y_\nu^\dagger Y_\nu m_l^2 \\
& + 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) - 4m_{H_u}^2 Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_{SL} Y_{SL}^\dagger) \\
& - 4m_{H_u}^2 Y_\nu^\dagger Y_\nu \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 2T_{Y_{SL}}^\dagger T_{Y_{SL}} \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 2T_\nu^\dagger T_\nu \text{Tr}(Y_{SL} Y_{SL}^\dagger) \\
& - m_l^2 Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_{SL} Y_{SL}^\dagger) - m_l^2 Y_\nu^\dagger Y_\nu \text{Tr}(Y_{SL} Y_{SL}^\dagger) - Y_{SL}^\dagger Y_{SL} m_l^2 \text{Tr}(Y_{SL} Y_{SL}^\dagger) \\
& - 2Y_{SL}^\dagger m_S^{2*} Y_{SL} \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 2Y_\nu^\dagger m_\nu^2 Y_\nu \text{Tr}(Y_{SL} Y_{SL}^\dagger) - Y_\nu^\dagger Y_\nu m_l^2 \text{Tr}(Y_{SL} Y_{SL}^\dagger) \\
& - 12m_{H_u}^2 Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_u Y_u^\dagger) - 12m_{H_u}^2 Y_\nu^\dagger Y_\nu \text{Tr}(Y_u Y_u^\dagger) - 6T_{Y_{SL}}^\dagger T_{Y_{SL}} \text{Tr}(Y_u Y_u^\dagger) \\
& - 6T_\nu^\dagger T_\nu \text{Tr}(Y_u Y_u^\dagger) - 3m_l^2 Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_u Y_u^\dagger) - 3m_l^2 Y_\nu^\dagger Y_\nu \text{Tr}(Y_u Y_u^\dagger) \\
& - 3Y_{SL}^\dagger Y_{SL} m_l^2 \text{Tr}(Y_u Y_u^\dagger) - 6Y_{SL}^\dagger m_S^{2*} Y_{SL} \text{Tr}(Y_u Y_u^\dagger) - 6Y_\nu^\dagger m_\nu^2 Y_\nu \text{Tr}(Y_u Y_u^\dagger) \\
& - 3Y_\nu^\dagger Y_\nu m_l^2 \text{Tr}(Y_u Y_u^\dagger) - 4m_{H_u}^2 Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_\nu Y_\nu^\dagger) - 4m_{H_u}^2 Y_\nu^\dagger Y_\nu \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& - 2T_{Y_{SL}}^\dagger T_{Y_{SL}} \text{Tr}(Y_\nu Y_\nu^\dagger) - 2T_\nu^\dagger T_\nu \text{Tr}(Y_\nu Y_\nu^\dagger) - m_l^2 Y_{SL}^\dagger Y_{SL} \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& - m_l^2 Y_\nu^\dagger Y_\nu \text{Tr}(Y_\nu Y_\nu^\dagger) - Y_{SL}^\dagger Y_{SL} m_l^2 \text{Tr}(Y_\nu Y_\nu^\dagger) - 2Y_{SL}^\dagger m_S^{2*} Y_{SL} \text{Tr}(Y_\nu Y_\nu^\dagger) \\
& - 2Y_\nu^\dagger m_\nu^2 Y_\nu \text{Tr}(Y_\nu Y_\nu^\dagger) - Y_\nu^\dagger Y_\nu m_l^2 \text{Tr}(Y_\nu Y_\nu^\dagger) - 6T_e^\dagger Y_e \text{Tr}(Y_d^\dagger T_d) \\
& - 2T_e^\dagger Y_e \text{Tr}(Y_e^\dagger T_e) - 2T_{Y_{SL}}^\dagger Y_{SL} \text{Tr}(Y_{SL}^\dagger T_{Y_{SL}}) - 2T_\nu^\dagger Y_\nu \text{Tr}(Y_{SL}^\dagger T_{Y_{SL}}) \\
& - 6T_{Y_{SL}}^\dagger Y_{SL} \text{Tr}(Y_u^\dagger T_u) - 6T_\nu^\dagger Y_\nu \text{Tr}(Y_u^\dagger T_u) - 2T_{Y_{SL}}^\dagger Y_{SL} \text{Tr}(Y_\nu^\dagger T_\nu) \\
& - 2T_\nu^\dagger Y_\nu \text{Tr}(Y_\nu^\dagger T_\nu) - 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) - 2Y_{SL}^\dagger T_{Y_{SL}} \text{Tr}(T_{Y_{SL}^*} Y_{SL}^T) \\
& - 2Y_\nu^\dagger T_\nu \text{Tr}(T_{Y_{SL}^*} Y_{SL}^T) - 2Y_{SL}^\dagger Y_{SL} \text{Tr}(T_{Y_{SL}^*} T_{Y_{SL}}^T) - 2Y_\nu^\dagger Y_\nu \text{Tr}(T_{Y_{SL}^*} T_{Y_{SL}}^T) \\
& - 6Y_{SL}^\dagger T_{Y_{SL}} \text{Tr}(T_u^* Y_u^T) - 6Y_\nu^\dagger T_\nu \text{Tr}(T_u^* Y_u^T) - 6Y_{SL}^\dagger Y_{SL} \text{Tr}(T_u^* T_u^T) \\
& - 6Y_\nu^\dagger Y_\nu \text{Tr}(T_u^* T_u^T) - 2Y_{SL}^\dagger T_{Y_{SL}} \text{Tr}(T_\nu^* Y_\nu^T) - 2Y_\nu^\dagger T_\nu \text{Tr}(T_\nu^* Y_\nu^T) \\
& - 2Y_{SL}^\dagger Y_{SL} \text{Tr}(T_\nu^* T_\nu^T) - 2Y_\nu^\dagger Y_\nu \text{Tr}(T_\nu^* T_\nu^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) - 2Y_{SL}^\dagger Y_{SL} \text{Tr}(m_l^2 Y_{SL}^\dagger Y_{SL})
\end{aligned}$$

$$\begin{aligned}
& -2Y_\nu^\dagger Y_\nu \text{Tr}\left(m_l^2 Y_{SL}^\dagger Y_{SL}\right) - 2Y_{SL}^\dagger Y_{SL} \text{Tr}\left(m_l^2 Y_\nu^\dagger Y_\nu\right) - 2Y_\nu^\dagger Y_\nu \text{Tr}\left(m_l^2 Y_\nu^\dagger Y_\nu\right) \\
& -6Y_e^\dagger Y_e \text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right) - 6Y_{SL}^\dagger Y_{SL} \text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) - 6Y_\nu^\dagger Y_\nu \text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) \\
& -6Y_{SL}^\dagger Y_{SL} \text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) - 6Y_\nu^\dagger Y_\nu \text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) - 2Y_{SL}^\dagger Y_{SL} \text{Tr}\left(m_\nu^2 Y_\nu Y_\nu^\dagger\right) \\
& -2Y_\nu^\dagger Y_\nu \text{Tr}\left(m_\nu^2 Y_\nu Y_\nu^\dagger\right) - 2Y_{SL}^\dagger Y_{SL} \text{Tr}\left(Y_{SL} Y_{SL}^\dagger m_S^{2*}\right) - 2Y_\nu^\dagger Y_\nu \text{Tr}\left(Y_{SL} Y_{SL}^\dagger m_S^{2*}\right)
\end{aligned} \tag{73}$$

$$\begin{aligned}
\beta_{m_{H_d}^2}^{(1)} &= -\frac{6}{5}g_1^2|M_1|^2 - 6g_2^2|M_2|^2 - \sqrt{\frac{3}{5}}g_1\sigma_{1,1} + 6m_{H_d}^2 \text{Tr}\left(Y_d Y_d^\dagger\right) + 2m_{H_d}^2 \text{Tr}\left(Y_e Y_e^\dagger\right) + 6\text{Tr}\left(T_d^* T_d^T\right) \\
&+ 2\text{Tr}\left(T_e^* T_e^T\right) + 6\text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) + 2\text{Tr}\left(m_e^2 Y_e Y_e^\dagger\right) + 2\text{Tr}\left(m_l^2 Y_e^\dagger Y_e\right) + 6\text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right)
\end{aligned} \tag{74}$$

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

$$\begin{aligned}
& -15\text{Tr}\left(m_q^2 Y_u^\dagger Y_u Y_d^\dagger Y_d\right) - 15\text{Tr}\left(m_u^2 Y_u Y_d^\dagger Y_d Y_u^\dagger\right) - 5\text{Tr}\left(m_\nu^2 Y_\nu Y_e^\dagger Y_e Y_\nu^\dagger\right) \\
& - 5\text{Tr}\left(Y_e Y_{SL}^\dagger m_S^{2*} Y_{SL} Y_e^\dagger\right)
\end{aligned} \tag{75}$$

$$\begin{aligned}
\beta_{m_{H_u}^2}^{(1)} &= -\frac{6}{5}g_1^2|M_1|^2 - 6g_2^2|M_2|^2 + \sqrt{\frac{3}{5}}g_1\sigma_{1,1} + 2m_{H_u}^2\text{Tr}\left(Y_{SL}Y_{SL}^\dagger\right) + 6m_{H_u}^2\text{Tr}\left(Y_u Y_u^\dagger\right) + 2m_{H_u}^2\text{Tr}\left(Y_\nu Y_\nu^\dagger\right) \\
& + 2\text{Tr}\left(T_{Y_{SL}^*} T_{Y_{SL}}^T\right) + 6\text{Tr}\left(T_u^* T_u^T\right) + 2\text{Tr}\left(T_\nu^* T_\nu^T\right) + 2\text{Tr}\left(m_l^2 Y_{SL}^\dagger Y_{SL}\right) + 2\text{Tr}\left(m_l^2 Y_\nu^\dagger Y_\nu\right) + 6\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) \\
& + 6\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) + 2\text{Tr}\left(m_\nu^2 Y_\nu Y_\nu^\dagger\right) + 2\text{Tr}\left(Y_{SL} Y_{SL}^\dagger m_S^{2*}\right)
\end{aligned} \tag{76}$$

$$\begin{aligned}
\beta_{m_{H_u}^2}^{(2)} &= \frac{3}{5}g_2^2\left(3g_1^2\left(2M_2 + M_1\right) + 55g_2^2 M_2\right)M_2^* + 6g_2^4\sigma_{2,2} + \frac{6}{5}g_1^2\sigma_{2,11} + 4\sqrt{\frac{3}{5}}g_1\sigma_{3,1} + \frac{8}{5}g_1^2 m_{H_u}^2\text{Tr}\left(Y_u Y_u^\dagger\right) \\
& + 32g_3^2 m_{H_u}^2\text{Tr}\left(Y_u Y_u^\dagger\right) + 64g_3^2|M_3|^2\text{Tr}\left(Y_u Y_u^\dagger\right) \\
& + \frac{1}{25}g_1^2 M_1^* \left(-40\text{Tr}\left(Y_u^\dagger T_u\right) + 45g_2^2 M_2 + 621g_1^2 M_1 + 80M_1\text{Tr}\left(Y_u Y_u^\dagger\right) + 90g_2^2 M_1\right) \\
& - 32g_3^2 M_3^* \text{Tr}\left(Y_u^\dagger T_u\right) - \frac{8}{5}g_1^2 M_1\text{Tr}\left(T_u^* Y_u^T\right) - 32g_3^2 M_3\text{Tr}\left(T_u^* Y_u^T\right) + \frac{8}{5}g_1^2\text{Tr}\left(T_u^* T_u^T\right) \\
& + 32g_3^2\text{Tr}\left(T_u^* T_u^T\right) + \frac{8}{5}g_1^2\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) + 32g_3^2\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) + \frac{8}{5}g_1^2\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) \\
& + 32g_3^2\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) - 6m_{H_d}^2\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - 6m_{H_u}^2\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) \\
& - 6\text{Tr}\left(Y_d Y_u^\dagger T_u T_d^\dagger\right) - 6\text{Tr}\left(Y_d T_u^\dagger T_u Y_d^\dagger\right) - 2m_{H_d}^2\text{Tr}\left(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger\right) \\
& - 2m_{H_u}^2\text{Tr}\left(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger\right) - 2\text{Tr}\left(Y_e Y_{SL}^\dagger T_{Y_{SL}} T_e^\dagger\right) - 2m_{H_d}^2\text{Tr}\left(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger\right) \\
& - 2m_{H_u}^2\text{Tr}\left(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger\right) - 2\text{Tr}\left(Y_e Y_\nu^\dagger T_\nu T_e^\dagger\right) - 2\text{Tr}\left(Y_e T_{Y_{SL}}^\dagger T_{Y_{SL}} Y_e^\dagger\right) \\
& - 2\text{Tr}\left(Y_e T_\nu^\dagger T_\nu Y_e^\dagger\right) - 2\text{Tr}\left(Y_{SL} Y_e^\dagger T_e T_{Y_{SL}}^\dagger\right) - 12m_{H_u}^2\text{Tr}\left(Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger\right) - 12\text{Tr}\left(Y_{SL} Y_{SL}^\dagger T_{Y_{SL}} T_{Y_{SL}}^\dagger\right) \\
& - 24m_{H_u}^2\text{Tr}\left(Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger\right) - 12\text{Tr}\left(Y_{SL} Y_\nu^\dagger T_\nu T_{Y_{SL}}^\dagger\right) - 2\text{Tr}\left(Y_{SL} T_e^\dagger T_e Y_{SL}^\dagger\right) \\
& - 12\text{Tr}\left(Y_{SL} T_{Y_{SL}}^\dagger T_{Y_{SL}} Y_{SL}^\dagger\right) - 12\text{Tr}\left(Y_{SL} T_\nu^\dagger T_\nu Y_{SL}^\dagger\right) - 6\text{Tr}\left(Y_u Y_d^\dagger T_d T_u^\dagger\right) - 36m_{H_u}^2\text{Tr}\left(Y_u Y_u^\dagger Y_u Y_u^\dagger\right) \\
& - 36\text{Tr}\left(Y_u Y_u^\dagger T_u T_u^\dagger\right) - 6\text{Tr}\left(Y_u T_d^\dagger T_d Y_u^\dagger\right) - 36\text{Tr}\left(Y_u T_u^\dagger T_u Y_u^\dagger\right) - 2\text{Tr}\left(Y_\nu Y_e^\dagger T_e T_\nu^\dagger\right) \\
& - 12\text{Tr}\left(Y_\nu Y_{SL}^\dagger T_{Y_{SL}} T_\nu^\dagger\right) - 12m_{H_u}^2\text{Tr}\left(Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger\right) - 12\text{Tr}\left(Y_\nu Y_\nu^\dagger T_\nu T_\nu^\dagger\right) - 2\text{Tr}\left(Y_\nu T_e^\dagger T_e Y_\nu^\dagger\right) \\
& - 12\text{Tr}\left(Y_\nu T_{Y_{SL}}^\dagger T_{Y_{SL}} Y_\nu^\dagger\right) - 12\text{Tr}\left(Y_\nu T_\nu^\dagger T_\nu Y_\nu^\dagger\right) - 6\text{Tr}\left(m_d^2 Y_d Y_u^\dagger Y_u Y_d^\dagger\right) \\
& - 2\text{Tr}\left(m_e^2 Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger\right) - 2\text{Tr}\left(m_e^2 Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger\right) - 2\text{Tr}\left(m_l^2 Y_e^\dagger Y_e Y_{SL}^\dagger Y_{SL}\right) \\
& - 2\text{Tr}\left(m_l^2 Y_e^\dagger Y_e Y_\nu^\dagger Y_\nu\right) - 2\text{Tr}\left(m_l^2 Y_{SL}^\dagger Y_{SL} Y_e^\dagger Y_e\right) - 12\text{Tr}\left(m_l^2 Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger Y_{SL}\right) \\
& - 12\text{Tr}\left(m_l^2 Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger Y_\nu\right) - 2\text{Tr}\left(m_l^2 Y_\nu^\dagger Y_\nu Y_e^\dagger Y_e\right) - 12\text{Tr}\left(m_l^2 Y_\nu^\dagger Y_\nu Y_{SL}^\dagger Y_{SL}\right) \\
& - 12\text{Tr}\left(m_l^2 Y_\nu^\dagger Y_\nu Y_\nu^\dagger Y_\nu\right) - 6\text{Tr}\left(m_q^2 Y_d^\dagger Y_d Y_u^\dagger Y_u\right) - 6\text{Tr}\left(m_q^2 Y_u^\dagger Y_u Y_d^\dagger Y_d\right)
\end{aligned}$$

$$\begin{aligned}
& -36\text{Tr}\left(m_q^2 Y_u^\dagger Y_u Y_u^\dagger Y_u\right) - 6\text{Tr}\left(m_u^2 Y_u Y_d^\dagger Y_d Y_u^\dagger\right) - 36\text{Tr}\left(m_u^2 Y_u Y_u^\dagger Y_u Y_u^\dagger\right) \\
& -2\text{Tr}\left(m_\nu^2 Y_\nu Y_e^\dagger Y_e Y_\nu^\dagger\right) - 12\text{Tr}\left(m_\nu^2 Y_\nu Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger\right) - 12\text{Tr}\left(m_\nu^2 Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger\right) \\
& -2\text{Tr}\left(Y_e Y_{SL}^\dagger m_S^{2*} Y_{SL} Y_e^\dagger\right) - 6\text{Tr}\left(Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger m_S^{2*}\right) - 6\text{Tr}\left(Y_{SL} Y_{SL}^\dagger m_S^{2*} Y_{SL} Y_{SL}^\dagger\right) \\
& -12\text{Tr}\left(Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger m_S^{2*}\right)
\end{aligned} \tag{77}$$

$$\begin{aligned}
\beta_{m_d^2}^{(1)} &= -\frac{8}{15} g_1^2 \mathbf{1} |M_1|^2 - \frac{32}{3} g_3^2 \mathbf{1} |M_3|^2 + 4m_{H_d}^2 Y_d Y_d^\dagger + 4T_d T_d^\dagger + 2m_d^2 Y_d Y_d^\dagger + 4Y_d m_q^2 Y_d^\dagger \\
& + 2Y_d Y_d^\dagger m_d^2 + 2\frac{1}{\sqrt{15}} g_1 \mathbf{1} \sigma_{1,1}
\end{aligned} \tag{78}$$

$$\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 - \frac{4}{5} g_1^2 M_1 Y_d T_d^\dagger - 12g_2^2 M_2 Y_d T_d^\dagger \\
& + \frac{4}{225} g_1^2 M_1^* \left(2(303g_1^2 M_1 + 40g_3^2 (2M_1 + M_3))\right) \mathbf{1} - 45T_d Y_d^\dagger + 90M_1 Y_d Y_d^\dagger - 12g_2^2 M_2^* T_d Y_d^\dagger \\
& + \frac{4}{5} g_1^2 T_d T_d^\dagger + 12g_2^2 T_d T_d^\dagger + \frac{2}{5} g_1^2 m_d^2 Y_d Y_d^\dagger + 6g_2^2 m_d^2 Y_d Y_d^\dagger \\
& + \frac{4}{5} g_1^2 Y_d m_q^2 Y_d^\dagger + 12g_2^2 Y_d m_q^2 Y_d^\dagger + \frac{2}{5} g_1^2 Y_d Y_d^\dagger m_d^2 + 6g_2^2 Y_d Y_d^\dagger m_d^2 \\
& - 8m_{H_d}^2 Y_d Y_d^\dagger Y_d Y_d^\dagger - 4Y_d Y_d^\dagger T_d T_d^\dagger - 4m_{H_d}^2 Y_d Y_u^\dagger Y_u Y_d^\dagger \\
& - 4m_{H_u}^2 Y_d Y_u^\dagger Y_u Y_d^\dagger - 4Y_d Y_u^\dagger T_u T_d^\dagger - 4Y_d T_d^\dagger T_d Y_d^\dagger - 4Y_d T_u^\dagger T_u Y_d^\dagger \\
& - 4T_d Y_d^\dagger Y_d T_d^\dagger - 4T_d Y_u^\dagger Y_u T_d^\dagger - 4T_d T_d^\dagger Y_d Y_d^\dagger - 4T_d T_u^\dagger Y_u Y_d^\dagger \\
& - 2m_d^2 Y_d Y_d^\dagger Y_d Y_d^\dagger - 2m_d^2 Y_d Y_u^\dagger Y_u Y_d^\dagger - 4Y_d m_q^2 Y_d^\dagger Y_d Y_d^\dagger - 4Y_d m_q^2 Y_u^\dagger Y_u Y_d^\dagger \\
& - 4Y_d Y_d^\dagger m_d^2 Y_d Y_d^\dagger - 4Y_d Y_d^\dagger Y_d m_q^2 Y_d^\dagger - 2Y_d Y_d^\dagger Y_d Y_d^\dagger m_d^2 - 4Y_d Y_u^\dagger m_u^2 Y_u Y_d^\dagger \\
& - 4Y_d Y_u^\dagger Y_u m_q^2 Y_d^\dagger - 2Y_d Y_u^\dagger Y_u Y_d^\dagger m_d^2 + \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} \\
& - 24m_{H_d}^2 Y_d Y_d^\dagger \text{Tr}\left(Y_d Y_d^\dagger\right) - 12T_d T_d^\dagger \text{Tr}\left(Y_d Y_d^\dagger\right) - 6m_d^2 Y_d Y_d^\dagger \text{Tr}\left(Y_d Y_d^\dagger\right) \\
& - 12Y_d m_q^2 Y_d^\dagger \text{Tr}\left(Y_d Y_d^\dagger\right) - 6Y_d Y_d^\dagger m_d^2 \text{Tr}\left(Y_d Y_d^\dagger\right) - 8m_{H_d}^2 Y_d Y_d^\dagger \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& - 4T_d T_d^\dagger \text{Tr}\left(Y_e Y_e^\dagger\right) - 2m_d^2 Y_d Y_d^\dagger \text{Tr}\left(Y_e Y_e^\dagger\right) - 4Y_d m_q^2 Y_d^\dagger \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& - 2Y_d Y_d^\dagger m_d^2 \text{Tr}\left(Y_e Y_e^\dagger\right) - 12Y_d T_d^\dagger \text{Tr}\left(Y_d^\dagger T_d\right) - 4Y_d T_d^\dagger \text{Tr}\left(Y_e^\dagger T_e\right) \\
& - 12T_d Y_d^\dagger \text{Tr}\left(T_d^* Y_d^T\right) - 12Y_d Y_d^\dagger \text{Tr}\left(T_d^* T_d^T\right) - 4T_d Y_d^\dagger \text{Tr}\left(T_e^* Y_e^T\right) \\
& - 4Y_d Y_d^\dagger \text{Tr}\left(T_e^* T_e^T\right) - 12Y_d Y_d^\dagger \text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) - 4Y_d Y_d^\dagger \text{Tr}\left(m_e^2 Y_e Y_e^\dagger\right) \\
& - 4Y_d Y_d^\dagger \text{Tr}\left(m_l^2 Y_e^\dagger Y_e\right) - 12Y_d Y_d^\dagger \text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right)
\end{aligned} \tag{79}$$

$$\beta_{m_u^2}^{(1)} = -\frac{32}{15} g_1^2 \mathbf{1} |M_1|^2 - \frac{32}{3} g_3^2 \mathbf{1} |M_3|^2 + 4m_{H_u}^2 Y_u Y_u^\dagger + 4T_u T_u^\dagger + 2m_u^2 Y_u Y_u^\dagger + 4Y_u m_q^2 Y_u^\dagger$$

$$+ 2Y_u Y_u^\dagger m_u^2 - 4 \frac{1}{\sqrt{15}} g_1 \mathbf{1} \sigma_{1,1} \quad (80)$$

$$\begin{aligned} \beta_{m_u^2}^{(2)} = & -\frac{128}{45} g_3^2 \left( 15g_3^2 M_3 - 2g_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 + 12g_2^2 m_{H_u}^2 Y_u Y_u^\dagger \\ & + 24g_2^2 |M_2|^2 Y_u Y_u^\dagger + \frac{4}{5} g_1^2 M_1 Y_u T_u^\dagger - 12g_2^2 M_2 Y_u T_u^\dagger - 12g_2^2 M_2^* T_u Y_u^\dagger \\ & + \frac{4}{225} g_1^2 M_1^* \left( 45 \left( -2M_1 Y_u Y_u^\dagger + T_u Y_u^\dagger \right) + 8 \left( 321g_1^2 M_1 + 40g_3^2 (2M_1 + M_3) \right) \mathbf{1} \right) - \frac{4}{5} g_1^2 T_u T_u^\dagger \\ & + 12g_2^2 T_u T_u^\dagger - \frac{2}{5} g_1^2 m_u^2 Y_u Y_u^\dagger + 6g_2^2 m_u^2 Y_u Y_u^\dagger - \frac{4}{5} g_1^2 Y_u m_q^2 Y_u^\dagger \\ & + 12g_2^2 Y_u m_q^2 Y_u^\dagger - \frac{2}{5} g_1^2 Y_u Y_u^\dagger m_u^2 + 6g_2^2 Y_u Y_u^\dagger m_u^2 - 4m_{H_d}^2 Y_u Y_d^\dagger Y_d Y_u^\dagger \\ & - 4m_{H_u}^2 Y_u Y_d^\dagger Y_d Y_u^\dagger - 4Y_u Y_d^\dagger T_d T_u^\dagger - 8m_{H_u}^2 Y_u Y_u^\dagger Y_u Y_u^\dagger - 4Y_u Y_u^\dagger T_u T_u^\dagger \\ & - 4Y_u T_d^\dagger T_d Y_u^\dagger - 4Y_u T_u^\dagger T_u Y_u^\dagger - 4T_u Y_d^\dagger Y_d T_u^\dagger - 4T_u Y_u^\dagger Y_u T_u^\dagger \\ & - 4T_u T_d^\dagger Y_d Y_u^\dagger - 4T_u T_u^\dagger Y_u Y_u^\dagger - 2m_u^2 Y_u Y_d^\dagger Y_d Y_u^\dagger - 2m_u^2 Y_u Y_u^\dagger Y_u Y_u^\dagger \\ & - 4Y_u m_q^2 Y_d^\dagger Y_d Y_u^\dagger - 4Y_u m_q^2 Y_u^\dagger Y_u Y_u^\dagger - 4Y_u Y_d^\dagger m_d^2 Y_d Y_u^\dagger \\ & - 4Y_u Y_d^\dagger Y_d m_q^2 Y_u^\dagger - 2Y_u Y_d^\dagger Y_d Y_u^\dagger m_u^2 - 4Y_u Y_u^\dagger m_u^2 Y_u Y_u^\dagger - 4Y_u Y_u^\dagger Y_u m_q^2 Y_u^\dagger \\ & - 2Y_u Y_u^\dagger Y_u Y_u^\dagger m_u^2 + \frac{32}{3} g_3^4 \mathbf{1} \sigma_{2,3} + \frac{32}{15} g_1^4 \mathbf{1} \sigma_{2,11} - 16 \frac{1}{\sqrt{15}} g_1 \mathbf{1} \sigma_{3,1} - 8m_{H_u}^2 Y_u Y_u^\dagger \text{Tr} \left( Y_{SL} Y_{SL}^\dagger \right) \\ & - 4T_u T_u^\dagger \text{Tr} \left( Y_{SL} Y_{SL}^\dagger \right) - 2m_u^2 Y_u Y_u^\dagger \text{Tr} \left( Y_{SL} Y_{SL}^\dagger \right) - 4Y_u m_q^2 Y_u^\dagger \text{Tr} \left( Y_{SL} Y_{SL}^\dagger \right) \\ & - 2Y_u Y_u^\dagger m_u^2 \text{Tr} \left( Y_{SL} Y_{SL}^\dagger \right) - 24m_{H_u}^2 Y_u Y_u^\dagger \text{Tr} \left( Y_u Y_u^\dagger \right) - 12T_u T_u^\dagger \text{Tr} \left( Y_u Y_u^\dagger \right) \\ & - 6m_u^2 Y_u Y_u^\dagger \text{Tr} \left( Y_u Y_u^\dagger \right) - 12Y_u m_q^2 Y_u^\dagger \text{Tr} \left( Y_u Y_u^\dagger \right) - 6Y_u Y_u^\dagger m_u^2 \text{Tr} \left( Y_u Y_u^\dagger \right) \\ & - 8m_{H_u}^2 Y_u Y_u^\dagger \text{Tr} \left( Y_\nu Y_\nu^\dagger \right) - 4T_u T_u^\dagger \text{Tr} \left( Y_\nu Y_\nu^\dagger \right) - 2m_u^2 Y_u Y_u^\dagger \text{Tr} \left( Y_\nu Y_\nu^\dagger \right) \\ & - 4Y_u m_q^2 Y_u^\dagger \text{Tr} \left( Y_\nu Y_\nu^\dagger \right) - 2Y_u Y_u^\dagger m_u^2 \text{Tr} \left( Y_\nu Y_\nu^\dagger \right) - 4Y_u T_u^\dagger \text{Tr} \left( Y_{SL}^\dagger T_{Y_{SL}} \right) \\ & - 12Y_u T_u^\dagger \text{Tr} \left( Y_u^\dagger T_u \right) - 4Y_u T_u^\dagger \text{Tr} \left( Y_\nu^\dagger T_\nu \right) - 4T_u Y_u^\dagger \text{Tr} \left( T_{Y_{SL}}^* Y_{SL}^T \right) \\ & - 4Y_u Y_u^\dagger \text{Tr} \left( T_{Y_{SL}}^* T_{Y_{SL}}^T \right) - 12T_u Y_u^\dagger \text{Tr} \left( T_u^* Y_u^T \right) - 12Y_u Y_u^\dagger \text{Tr} \left( T_u^* T_u^T \right) \\ & - 4T_u Y_u^\dagger \text{Tr} \left( T_\nu^* Y_\nu^T \right) - 4Y_u Y_u^\dagger \text{Tr} \left( T_\nu^* T_\nu^T \right) - 4Y_u Y_u^\dagger \text{Tr} \left( m_l^2 Y_{SL}^\dagger Y_{SL} \right) \\ & - 4Y_u Y_u^\dagger \text{Tr} \left( m_l^2 Y_\nu^\dagger Y_\nu \right) - 12Y_u Y_u^\dagger \text{Tr} \left( m_q^2 Y_u^\dagger Y_u \right) - 12Y_u Y_u^\dagger \text{Tr} \left( m_u^2 Y_u Y_u^\dagger \right) \\ & - 4Y_u Y_u^\dagger \text{Tr} \left( m_\nu^2 Y_\nu Y_\nu^\dagger \right) - 4Y_u Y_u^\dagger \text{Tr} \left( Y_{SL} Y_{SL}^\dagger m_S^{2*} \right) \end{aligned} \quad (81)$$

$$\begin{aligned} \beta_{m_e^2}^{(1)} = & -\frac{24}{5} g_1^2 \mathbf{1} |M_1|^2 + 2 \left( 2m_{H_d}^2 Y_e Y_e^\dagger + 2T_e T_e^\dagger + 2Y_e m_l^2 Y_e^\dagger + m_e^2 Y_e Y_e^\dagger + Y_e Y_e^\dagger m_e^2 \right) \\ & + 2 \sqrt{\frac{3}{5}} g_1 \mathbf{1} \sigma_{1,1} \end{aligned} \quad (82)$$

$$\beta_{m_e^2}^{(2)} = \frac{2}{25} \left( 6g_1^2 M_1^* \left( 234g_1^2 M_1 \mathbf{1} + 5 \left( -2M_1 Y_e Y_e^\dagger + T_e Y_e^\dagger \right) \right) + 20g_1 \mathbf{1} \left( 3g_1 \sigma_{2,11} + \sqrt{15} \sigma_{3,1} \right) \right)$$

$$\begin{aligned}
& -5 \left( 30g_2^2 M_2^* T_e Y_e^\dagger + 6g_1^2 T_e T_e^\dagger - 30g_2^2 T_e T_e^\dagger + 3g_1^2 m_e^2 Y_e Y_e^\dagger \right. \\
& - 15g_2^2 m_e^2 Y_e Y_e^\dagger + 6g_1^2 Y_e m_l^2 Y_e^\dagger - 30g_2^2 Y_e m_l^2 Y_e^\dagger + 3g_1^2 Y_e Y_e^\dagger m_e^2 \\
& - 15g_2^2 Y_e Y_e^\dagger m_e^2 + 20m_{H_d}^2 Y_e Y_e^\dagger Y_e Y_e^\dagger + 10Y_e Y_e^\dagger T_e T_e^\dagger + 10m_{H_d}^2 Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger \\
& + 10m_{H_u}^2 Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger + 10Y_e Y_{SL}^\dagger T_{Y_{SL}} T_e^\dagger + 10m_{H_d}^2 Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger \\
& + 10m_{H_u}^2 Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger + 10Y_e Y_\nu^\dagger T_\nu T_e^\dagger + 10Y_e T_e^\dagger T_e Y_e^\dagger + 10Y_e T_{Y_{SL}}^\dagger T_{Y_{SL}} Y_e^\dagger \\
& + 10Y_e T_\nu^\dagger T_\nu Y_e^\dagger + 10T_e Y_e^\dagger Y_e T_e^\dagger + 10T_e Y_{SL}^\dagger Y_{SL} T_e^\dagger + 10T_e Y_\nu^\dagger Y_\nu T_e^\dagger \\
& + 10T_e T_e^\dagger Y_e Y_e^\dagger + 10T_e T_{Y_{SL}}^\dagger Y_{SL} Y_e^\dagger + 10T_e T_\nu^\dagger Y_\nu Y_e^\dagger + 5m_e^2 Y_e Y_e^\dagger Y_e Y_e^\dagger \\
& + 5m_e^2 Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger + 5m_e^2 Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger + 10Y_e m_l^2 Y_e^\dagger Y_e Y_e^\dagger \\
& + 10Y_e m_l^2 Y_{SL}^\dagger Y_{SL} Y_e^\dagger + 10Y_e m_l^2 Y_\nu^\dagger Y_\nu Y_e^\dagger + 10Y_e Y_e^\dagger m_e^2 Y_e Y_e^\dagger + 10Y_e Y_e^\dagger Y_e m_l^2 Y_e^\dagger \\
& + 5Y_e Y_e^\dagger Y_e Y_e^\dagger m_e^2 + 10Y_e Y_{SL}^\dagger Y_{SL} m_l^2 Y_e^\dagger + 5Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger m_e^2 \\
& + 10Y_e Y_{SL}^\dagger m_S^* Y_{SL} Y_e^\dagger + 10Y_e Y_\nu^\dagger m_\nu^2 Y_\nu Y_e^\dagger + 10Y_e Y_\nu^\dagger Y_\nu m_l^2 Y_e^\dagger \\
& + 5Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger m_e^2 + 30T_e T_e^\dagger \text{Tr} \left( Y_d Y_d^\dagger \right) + 15m_e^2 Y_e Y_e^\dagger \text{Tr} \left( Y_d Y_d^\dagger \right) \\
& + 30Y_e m_l^2 Y_e^\dagger \text{Tr} \left( Y_d Y_d^\dagger \right) + 15Y_e Y_e^\dagger m_e^2 \text{Tr} \left( Y_d Y_d^\dagger \right) + 10T_e T_e^\dagger \text{Tr} \left( Y_e Y_e^\dagger \right) \\
& + 5m_e^2 Y_e Y_e^\dagger \text{Tr} \left( Y_e Y_e^\dagger \right) + 10Y_e m_l^2 Y_e^\dagger \text{Tr} \left( Y_e Y_e^\dagger \right) + 5Y_e Y_e^\dagger m_e^2 \text{Tr} \left( Y_e Y_e^\dagger \right) \\
& + Y_e T_e^\dagger \left( 10 \text{Tr} \left( Y_e^\dagger T_e \right) + 30g_2^2 M_2 + 30 \text{Tr} \left( Y_d^\dagger T_d \right) - 6g_1^2 M_1 \right) + 30T_e Y_e^\dagger \text{Tr} \left( T_d^* Y_d^T \right) \\
& + 10T_e Y_e^\dagger \text{Tr} \left( T_e^* Y_e^T \right) \\
& + 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 + 30m_{H_d}^2 \text{Tr} \left( Y_d Y_d^\dagger \right) + 10m_{H_d}^2 \text{Tr} \left( Y_e Y_e^\dagger \right) + 15 \text{Tr} \left( T_d^* T_d^T \right) \right. \\
& \left. + 5 \text{Tr} \left( T_e^* T_e^T \right) + 15 \text{Tr} \left( m_d^2 Y_d Y_d^\dagger \right) + 5 \text{Tr} \left( m_e^2 Y_e Y_e^\dagger \right) + 5 \text{Tr} \left( m_l^2 Y_l Y_l^\dagger \right) + 15 \text{Tr} \left( m_q^2 Y_q^\dagger Y_q \right) \right) \Big) \quad (83)
\end{aligned}$$

$$\beta_{m_\nu^2}^{(1)} = 2 \left( 2m_{H_u}^2 Y_\nu Y_\nu^\dagger + 2T_\nu T_\nu^\dagger + 2Y_\nu m_l^2 Y_\nu^\dagger + m_\nu^2 Y_\nu Y_\nu^\dagger + Y_\nu Y_\nu^\dagger m_\nu^2 \right) \quad (84)$$

$$\begin{aligned}
\beta_{m_\nu^2}^{(2)} = & -\frac{2}{5} \left( 6g_1^2 M_1^* T_\nu Y_\nu^\dagger + 30g_2^2 M_2^* T_\nu Y_\nu^\dagger - 6g_1^2 T_\nu T_\nu^\dagger - 30g_2^2 T_\nu T_\nu^\dagger \right. \\
& - 3g_1^2 m_\nu^2 Y_\nu Y_\nu^\dagger - 15g_2^2 m_\nu^2 Y_\nu Y_\nu^\dagger - 6g_1^2 Y_\nu m_l^2 Y_\nu^\dagger - 30g_2^2 Y_\nu m_l^2 Y_\nu^\dagger \\
& - 3g_1^2 Y_\nu Y_\nu^\dagger m_\nu^2 - 15g_2^2 Y_\nu Y_\nu^\dagger m_\nu^2 + 10m_{H_d}^2 Y_\nu Y_e^\dagger Y_e Y_\nu^\dagger \\
& + 10m_{H_u}^2 Y_\nu Y_e^\dagger Y_e Y_\nu^\dagger + 10Y_\nu Y_e^\dagger T_e T_\nu^\dagger + 20m_{H_u}^2 Y_\nu Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger \\
& + 10Y_\nu Y_{SL}^\dagger T_{Y_{SL}} T_\nu^\dagger + 20m_{H_u}^2 Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger + 10Y_\nu Y_\nu^\dagger T_\nu T_\nu^\dagger + 10Y_\nu T_e^\dagger T_e Y_\nu^\dagger \\
& + 10Y_\nu T_{Y_{SL}}^\dagger T_{Y_{SL}} Y_\nu^\dagger + 10Y_\nu T_\nu^\dagger T_\nu Y_\nu^\dagger + 10T_\nu Y_e^\dagger Y_e T_\nu^\dagger + 10T_\nu Y_{SL}^\dagger Y_{SL} T_\nu^\dagger \\
& + 10T_\nu Y_\nu^\dagger Y_\nu T_\nu^\dagger + 10T_\nu T_e^\dagger Y_e Y_\nu^\dagger + 10T_\nu T_{Y_{SL}}^\dagger Y_{SL} Y_\nu^\dagger + 10T_\nu T_\nu^\dagger Y_\nu Y_\nu^\dagger \\
& + 5m_\nu^2 Y_\nu Y_e^\dagger Y_e Y_\nu^\dagger + 5m_\nu^2 Y_\nu Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger + 5m_\nu^2 Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger \\
& + 10Y_\nu m_l^2 Y_e^\dagger Y_e Y_\nu^\dagger + 10Y_\nu m_l^2 Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger + 10Y_\nu m_l^2 Y_\nu^\dagger Y_\nu Y_\nu^\dagger \\
& \left. + 10Y_\nu Y_e^\dagger m_e^2 Y_e Y_\nu^\dagger + 10Y_\nu Y_e^\dagger Y_e m_l^2 Y_\nu^\dagger + 5Y_\nu Y_e^\dagger Y_e Y_\nu^\dagger m_\nu^2 \right)
\end{aligned}$$



$$\begin{aligned}
& + 10Y_\nu Y_{SL}^\dagger Y_{SL} m_l^2 Y_\nu^\dagger + 5Y_\nu Y_{SL}^\dagger Y_{SL} Y_\nu^\dagger m_\nu^2 + 10Y_\nu Y_{SL}^\dagger m_S^{2*} Y_{SL} Y_\nu^\dagger \\
& + 10Y_\nu Y_\nu^\dagger m_\nu^2 Y_\nu Y_\nu^\dagger + 10Y_\nu Y_\nu^\dagger Y_\nu m_l^2 Y_\nu^\dagger + 5Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger m_\nu^2 + 10T_\nu T_\nu^\dagger \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) \\
& + 5m_\nu^2 Y_\nu Y_\nu^\dagger \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) + 10Y_\nu m_l^2 Y_\nu^\dagger \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) + 5Y_\nu Y_\nu^\dagger m_\nu^2 \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) \\
& + 30T_\nu T_\nu^\dagger \text{Tr}\left(Y_u Y_u^\dagger\right) + 15m_\nu^2 Y_\nu Y_\nu^\dagger \text{Tr}\left(Y_u Y_u^\dagger\right) + 30Y_\nu m_l^2 Y_\nu^\dagger \text{Tr}\left(Y_u Y_u^\dagger\right) \\
& + 15Y_\nu Y_\nu^\dagger m_\nu^2 \text{Tr}\left(Y_u Y_u^\dagger\right) + 10T_\nu T_\nu^\dagger \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) + 5m_\nu^2 Y_\nu Y_\nu^\dagger \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) \\
& + 10Y_\nu m_l^2 Y_\nu^\dagger \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) + 5Y_\nu Y_\nu^\dagger m_\nu^2 \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) \\
& + 2Y_\nu T_\nu^\dagger \left(15g_2^2 M_2 + 15\text{Tr}\left(Y_u^\dagger T_u\right) + 3g_1^2 M_1 + 5\text{Tr}\left(Y_\nu^\dagger T_\nu\right) + 5\text{Tr}\left(Y_{SL}^\dagger T_{Y_{SL}}\right)\right) \\
& + 10T_\nu Y_\nu^\dagger \text{Tr}\left(T_{Y_{SL}^*} Y_{SL}^T\right) + 30T_\nu Y_\nu^\dagger \text{Tr}\left(T_u^* Y_u^T\right) + 10T_\nu Y_\nu^\dagger \text{Tr}\left(T_\nu^* Y_\nu^T\right) \\
& + \frac{4}{5} Y_\nu Y_\nu^\dagger \left(3g_1^2 m_{H_u}^2 + 15g_2^2 m_{H_u}^2 + 6g_1^2 |M_1|^2 + 30g_2^2 |M_2|^2 - 10m_{H_u}^2 \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) - 30m_{H_u}^2 \text{Tr}\left(Y_u Y_u^\dagger\right) \right. \\
& - 10m_{H_u}^2 \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) - 5\text{Tr}\left(T_{Y_{SL}^*} T_{Y_{SL}}^T\right) - 15\text{Tr}\left(T_u^* T_u^T\right) - 5\text{Tr}\left(T_\nu^* T_\nu^T\right) - 5\text{Tr}\left(m_l^2 Y_{SL}^\dagger Y_{SL}\right) \\
& \left. - 5\text{Tr}\left(m_l^2 Y_\nu^\dagger Y_\nu\right) - 15\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) - 15\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) - 5\text{Tr}\left(m_\nu^2 Y_\nu Y_\nu^\dagger\right) - 5\text{Tr}\left(Y_{SL} Y_{SL}^\dagger m_S^{2*}\right)\right) \tag{85}
\end{aligned}$$

$$\beta_{m_S^2}^{(1)} = 2\left(2m_{H_u}^2 Y_{SL}^* Y_{SL}^T + 2T_{Y_{SL}^*} T_{Y_{SL}}^T + 2Y_{SL}^* m_l^{2*} Y_{SL}^T + m_S^2 Y_{SL}^* Y_{SL}^T + Y_{SL}^* Y_{SL}^T m_S^2\right) \tag{86}$$

$$\begin{aligned}
\beta_{m_S^2}^{(2)} = & -\frac{2}{5}\left(6g_1^2 M_1^* Y_{SL}^* T_{Y_{SL}}^T + 30g_2^2 M_2^* Y_{SL}^* T_{Y_{SL}}^T + 6g_1^2 M_1 T_{Y_{SL}^*} Y_{SL}^T + 30g_2^2 M_2 T_{Y_{SL}^*} Y_{SL}^T \right. \\
& - 6g_1^2 T_{Y_{SL}^*} T_{Y_{SL}}^T - 30g_2^2 T_{Y_{SL}^*} T_{Y_{SL}}^T - 3g_1^2 m_S^2 Y_{SL}^* Y_{SL}^T - 15g_2^2 m_S^2 Y_{SL}^* Y_{SL}^T \\
& - 6g_1^2 Y_{SL}^* m_l^{2*} Y_{SL}^T - 30g_2^2 Y_{SL}^* m_l^{2*} Y_{SL}^T - 3g_1^2 Y_{SL}^* Y_{SL}^T m_S^2 - 15g_2^2 Y_{SL}^* Y_{SL}^T m_S^2 \\
& \left. + 10m_{H_d}^2 Y_{SL}^* Y_e^T Y_e^* Y_{SL}^T + 10m_{H_u}^2 Y_{SL}^* Y_e^T Y_e^* Y_{SL}^T + 10Y_{SL}^* Y_e^T T_e^* T_{Y_{SL}}^T \right)
\end{aligned}$$

$$\begin{aligned}
& + 20m_{H_u}^2 Y_{SL}^* Y_{SL}^T Y_{SL}^* Y_{SL}^T + 10Y_{SL}^* Y_{SL}^T T_{Y_{SL}^*} T_{Y_{SL}}^T + 20m_{H_u}^2 Y_{SL}^* Y_\nu^T Y_\nu^* Y_{SL}^T + 10Y_{SL}^* Y_\nu^T T_\nu^* T_{Y_{SL}}^T \\
& + 10Y_{SL}^* T_e^T T_e^* Y_{SL}^T + 10Y_{SL}^* T_{Y_{SL}}^T T_{Y_{SL}^*} Y_{SL}^T + 10Y_{SL}^* T_\nu^T T_\nu^* Y_{SL}^T + 10T_{Y_{SL}^*} Y_e^T Y_e^* T_{Y_{SL}}^T \\
& + 10T_{Y_{SL}^*} Y_{SL}^T Y_{SL}^* T_{Y_{SL}}^T + 10T_{Y_{SL}^*} Y_\nu^T Y_\nu^* T_{Y_{SL}}^T + 10T_{Y_{SL}^*} T_e^T Y_e^* Y_{SL}^T + 10T_{Y_{SL}^*} T_{Y_{SL}}^T Y_{SL}^* Y_{SL}^T \\
& + 10T_{Y_{SL}^*} T_\nu^T Y_\nu^* Y_{SL}^T + 5m_S^2 Y_{SL}^* Y_e^T Y_e^* Y_{SL}^T + 5m_S^2 Y_{SL}^* Y_{SL}^T Y_{SL}^* Y_{SL}^T + 5m_S^2 Y_{SL}^* Y_\nu^T Y_\nu^* Y_{SL}^T \\
& + 10Y_{SL}^* m_l^{2*} Y_e^T Y_e^* Y_{SL}^T + 10Y_{SL}^* m_l^{2*} Y_{SL}^T Y_{SL}^* Y_{SL}^T + 10Y_{SL}^* m_l^{2*} Y_\nu^T Y_\nu^* Y_{SL}^T \\
& + 10Y_{SL}^* Y_e^T m_e^{2*} Y_e^* Y_{SL}^T + 10Y_{SL}^* Y_e^T Y_e^* m_l^{2*} Y_{SL}^T + 5Y_{SL}^* Y_e^T Y_e^* Y_{SL}^T m_S^2 \\
& + 10Y_{SL}^* Y_{SL}^T m_S^2 Y_{SL}^* Y_{SL}^T + 10Y_{SL}^* Y_{SL}^T Y_{SL}^* m_l^{2*} Y_{SL}^T + 5Y_{SL}^* Y_{SL}^T Y_{SL}^* Y_{SL}^T m_S^2 + 10Y_{SL}^* Y_\nu^T m_\nu^{2*} Y_\nu^* Y_{SL}^T \\
& + 10Y_{SL}^* Y_\nu^T Y_\nu^* m_l^{2*} Y_{SL}^T + 5Y_{SL}^* Y_\nu^T Y_\nu^* Y_{SL}^T m_S^2 + 10T_{Y_{SL}^*} T_{Y_{SL}}^T \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) \\
& + 5m_S^2 Y_{SL}^* Y_{SL}^T \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) + 10Y_{SL}^* m_l^{2*} Y_{SL}^T \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) + 5Y_{SL}^* Y_{SL}^T m_S^2 \text{Tr}\left(Y_{SL} Y_{SL}^\dagger\right) \\
& + 30T_{Y_{SL}^*} T_{Y_{SL}}^T \text{Tr}\left(Y_u Y_u^\dagger\right) + 15m_S^2 Y_{SL}^* Y_{SL}^T \text{Tr}\left(Y_u Y_u^\dagger\right) + 30Y_{SL}^* m_l^{2*} Y_{SL}^T \text{Tr}\left(Y_u Y_u^\dagger\right) \\
& + 15Y_{SL}^* Y_{SL}^T m_S^2 \text{Tr}\left(Y_u Y_u^\dagger\right) + 10T_{Y_{SL}^*} T_{Y_{SL}}^T \text{Tr}\left(Y_\nu Y_\nu^\dagger\right) + 5m_S^2 Y_{SL}^* Y_{SL}^T \text{Tr}\left(Y_\nu Y_\nu^\dagger\right)
\end{aligned}$$

$$\begin{aligned}
& + 10Y_{SL}^* m_l^{2*} Y_{SL}^T \text{Tr}(Y_\nu Y_\nu^\dagger) + 5Y_{SL}^* Y_{SL}^T m_S^2 \text{Tr}(Y_\nu Y_\nu^\dagger) + 10T_{Y_{SL}^*} Y_{SL}^T \text{Tr}(Y_{SL}^\dagger T_{Y_{SL}}) \\
& + 30T_{Y_{SL}^*} Y_{SL}^T \text{Tr}(Y_u^\dagger T_u) + 10T_{Y_{SL}^*} Y_{SL}^T \text{Tr}(Y_\nu^\dagger T_\nu) + 10Y_{SL}^* T_{Y_{SL}}^T \text{Tr}(T_{Y_{SL}^*} Y_{SL}^T) \\
& + 30Y_{SL}^* T_{Y_{SL}}^T \text{Tr}(T_u^* Y_u^T) + 10Y_{SL}^* T_{Y_{SL}}^T \text{Tr}(T_\nu^* Y_\nu^T) \\
& + \frac{4}{5} Y_{SL}^* Y_{SL}^T (3g_1^2 m_{H_u}^2 + 15g_2^2 m_{H_u}^2 + 6g_1^2 |M_1|^2 + 30g_2^2 |M_2|^2 - 10m_{H_u}^2 \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 30m_{H_u}^2 \text{Tr}(Y_u Y_u^\dagger) \\
& - 10m_{H_u}^2 \text{Tr}(Y_\nu Y_\nu^\dagger) - 5\text{Tr}(T_{Y_{SL}^*} T_{Y_{SL}}^T) - 15\text{Tr}(T_u^* T_u^T) - 5\text{Tr}(T_\nu^* T_\nu^T) - 5\text{Tr}(m_l^2 Y_{SL}^\dagger Y_{SL}) \\
& - 5\text{Tr}(m_l^2 Y_\nu^\dagger Y_\nu) - 15\text{Tr}(m_q^2 Y_u^\dagger Y_u) - 15\text{Tr}(m_u^2 Y_u Y_u^\dagger) - 5\text{Tr}(m_\nu^2 Y_\nu Y_\nu^\dagger) - 5\text{Tr}(Y_{SL} Y_{SL}^\dagger m_S^{2*}))
\end{aligned} \tag{87}$$

### 3.9 Vacuum expectation values

$$\beta_{v_d}^{(1)} = \frac{1}{20} v_d \left( -20\text{Tr}(Y_e Y_e^\dagger) + 3(5g_2^2 + g_1^2)(1 + \text{Xi}) - 60\text{Tr}(Y_d Y_d^\dagger) \right) \tag{88}$$

$$\begin{aligned}
\beta_{v_d}^{(2)} = & \frac{1}{400} v_d \left( -414g_1^4 - 180g_1^2 g_2^2 - 1200g_2^4 - 9g_1^4 \text{Xi} - 90g_1^2 g_2^2 \text{Xi} + 875g_2^4 \text{Xi} + 9g_1^4 \text{Xi}^2 + 90g_1^2 g_2^2 \text{Xi}^2 \right. \\
& - 225g_2^4 \text{Xi}^2 - 40 \left( 5(32g_3^2 + 9g_2^2 \text{Xi}) + g_1^2(9\text{Xi} - 4) \right) \text{Tr}(Y_d Y_d^\dagger) - 120(5g_2^2 \text{Xi} + g_1^2(4 + \text{Xi})) \text{Tr}(Y_e Y_e^\dagger) \\
& + 3600\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) + 1200\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) + 1200\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) + 400\text{Tr}(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger) \\
& \left. + 400\text{Tr}(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger) \right)
\end{aligned} \tag{89}$$

$$\beta_{v_u}^{(1)} = \frac{1}{20} v_u \left( 15g_2^2 + 15g_2^2 \text{Xi} - 20\text{Tr}(Y_\nu Y_\nu^\dagger) - 20\text{Tr}(Y_{SL} Y_{SL}^\dagger) + 3g_1^2 + 3g_1^2 \text{Xi} - 60\text{Tr}(Y_u Y_u^\dagger) \right) \tag{90}$$

$$\begin{aligned}
\beta_{v_u}^{(2)} = & \frac{1}{400} v_u \left( -414g_1^4 - 180g_1^2 g_2^2 - 1200g_2^4 - 9g_1^4 \text{Xi} - 90g_1^2 g_2^2 \text{Xi} + 875g_2^4 \text{Xi} + 9g_1^4 \text{Xi}^2 + 90g_1^2 g_2^2 \text{Xi}^2 \right. \\
& - 225g_2^4 \text{Xi}^2 - 120(5g_2^2 + g_1^2) \text{Xi} \text{Tr}(Y_{SL} Y_{SL}^\dagger) - 40 \left( 5(32g_3^2 + 9g_2^2 \text{Xi}) + g_1^2(9\text{Xi} + 8) \right) \text{Tr}(Y_u Y_u^\dagger) \\
& - 120g_1^2 \text{Xi} \text{Tr}(Y_\nu Y_\nu^\dagger) - 600g_2^2 \text{Xi} \text{Tr}(Y_\nu Y_\nu^\dagger) + 1200\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) + 400\text{Tr}(Y_e Y_{SL}^\dagger Y_{SL} Y_e^\dagger) \\
& + 400\text{Tr}(Y_e Y_\nu^\dagger Y_\nu Y_e^\dagger) + 1200\text{Tr}(Y_{SL} Y_{SL}^\dagger Y_{SL} Y_{SL}^\dagger) + 2400\text{Tr}(Y_{SL} Y_\nu^\dagger Y_\nu Y_{SL}^\dagger) + 3600\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) \\
& \left. + 1200\text{Tr}(Y_\nu Y_\nu^\dagger Y_\nu Y_\nu^\dagger) \right)
\end{aligned} \tag{91}$$

## 4 Field Rotations

### 4.1 Rotations in gauge sector for eigenstates 'EWSB'

$$\begin{pmatrix} B_\rho \\ W_{3\rho} \end{pmatrix} = Z^{\gamma Z} \begin{pmatrix} \gamma_\rho \\ Z_\rho \end{pmatrix} \tag{92}$$

$$\begin{pmatrix} W_{1\rho} \\ W_{2\rho} \end{pmatrix} = Z^W \begin{pmatrix} W_\rho^- \\ W_\rho^- \end{pmatrix} \quad (93)$$

$$\begin{pmatrix} \lambda_{\tilde{W},1} \\ \lambda_{\tilde{W},2} \\ \lambda_{\tilde{W},3} \end{pmatrix} = Z^{\tilde{W}} \begin{pmatrix} \tilde{W}^- \\ \tilde{W}^+ \\ \tilde{W}^0 \end{pmatrix} \quad (94)$$

$$(95)$$

The mixing matrices are parametrized by

$$Z^{\gamma Z} = \begin{pmatrix} \cos \Theta_W & -\sin \Theta_W \\ \sin \Theta_W & \cos \Theta_W \end{pmatrix} \quad (96)$$

$$Z^W = \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -i\frac{1}{\sqrt{2}} & i\frac{1}{\sqrt{2}} \end{pmatrix} \quad (97)$$

$$Z^{\tilde{W}} = \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ -i\frac{1}{\sqrt{2}} & i\frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{pmatrix} \quad (98)$$

$$(99)$$

## 4.2 Rotations in Mass sector for eigenstates 'EWSB'

### 4.2.1 Mass Matrices for Scalars

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

$$m_{\tilde{d}}^2 = \begin{pmatrix} m_{\tilde{d}_L \tilde{d}_L^*} & \frac{1}{\sqrt{2}}(v_d T_d^\dagger - v_u \mu Y_d^\dagger) \delta_{\alpha_1 \beta_2} \\ \frac{1}{\sqrt{2}} \delta_{\alpha_2 \beta_1} (v_d T_d - v_u Y_d \mu^*) & m_{\tilde{d}_R \tilde{d}_R^*} \end{pmatrix} \quad (100)$$

$$m_{\tilde{d}_L \tilde{d}_L^*} = -\frac{1}{24}(3g_2^2 + g_1^2) \mathbf{1}(-v_u^2 + v_d^2) \delta_{\alpha_1 \beta_1} + \frac{1}{2} \delta_{\alpha_1 \beta_1} (2m_q^2 + v_d^2 Y_d^\dagger Y_d) \quad (101)$$

$$m_{\tilde{d}_R \tilde{d}_R^*} = \frac{1}{12} g_1^2 \mathbf{1}(-v_d^2 + v_u^2) \delta_{\alpha_2 \beta_2} + \frac{1}{2} \delta_{\alpha_2 \beta_2} (2m_d^2 + v_d^2 Y_d Y_d^\dagger) \quad (102)$$

This matrix is diagonalized by  $Z^D$ :

$$Z^D m_{\tilde{d}}^2 Z^{D,\dagger} = m_{2,\tilde{d}}^{dia} \quad (103)$$

with

$$\tilde{d}_{L,i\alpha} = \sum_j Z_{ji}^{D,*} \tilde{d}_{j\alpha}, \quad \tilde{d}_{R,i\alpha} = \sum_j Z_{ji}^{D,*} \tilde{d}_{j\alpha} \quad (104)$$

- **Mass matrix for CP-even Sneutrino, Basis:**  $(\phi_L, \phi_R, \sigma_s), (\phi_L, \phi_R, \sigma_s)$

$$m_{\nu R}^2 = \begin{pmatrix} m_{\phi_L \phi_L} & m_{\phi_R \phi_L}^T & m_{\sigma_s \phi_L}^T \\ m_{\phi_L \phi_R} & m_{\phi_R \phi_R} & m_{\sigma_s \phi_R}^T \\ m_{\phi_L \sigma_s} & m_{\phi_R \sigma_s} & m_{\sigma_s \sigma_s} \end{pmatrix} \quad (105)$$

$$m_{\phi_L \phi_L} = \frac{1}{4} \left( 4\Re(m_l^2) + v_u^2 \left( 2\Re(Y_\nu^T Y_\nu^*) + 2\Re(Y_{SL}^T Y_{SL}^*) \right) \right) + \frac{1}{8} (g_1^2 + g_2^2) \mathbf{1} (-v_u^2 + v_d^2) \quad (106)$$

$$m_{\phi_L \phi_R} = \frac{1}{2} \frac{1}{\sqrt{2}} \left( -2v_d \Re(\mu Y_\nu^*) + v_u \left( 2\Re(M_R Y_{SL}^*) + 2\Re(T_\nu) \right) \right) \quad (107)$$

$$m_{\phi_R \phi_R} = \frac{1}{4} \left( 2 \left( 2\Re(m_\nu^2) + 2\Re(M_R M_R^\dagger) \right) + 2v_u^2 \Re(Y_\nu Y_\nu^\dagger) \right) \quad (108)$$

$$m_{\phi_L \sigma_s} = \frac{1}{2} \frac{1}{\sqrt{2}} \left( -2v_d \Re(\mu Y_{SL}^*) + v_u \left( 2\Re(M_R^T Y_\nu^*) + 2\Re(T_{Y_{SL}}) \right) \right) \quad (109)$$

$$m_{\phi_R \sigma_s} = \frac{1}{4} \left( 2v_u^2 \Re(Y_{SL} Y_\nu^\dagger) + 4\Re(B_{M_R}^T) \right) \quad (110)$$

$$m_{\sigma_s \sigma_s} = \frac{1}{4} \left( 2 \left( 2\Re(M_R^T M_R^*) + 2\Re(m_S^2) \right) + 2v_u^2 \Re(Y_{SL} Y_{SL}^\dagger) \right) \quad (111)$$

This matrix is diagonalized by  $Z_{\phi\nu}$ :

$$Z_{\phi\nu} m_{\nu R}^2 Z_{\phi\nu}^\dagger = m_{2,\nu R}^{dia} \quad (112)$$

with

$$\phi_{L,i} = \sum_j Z_{\phi\nu,ji}^* \nu_j^R, \quad \phi_{R,i} = \sum_j Z_{\phi\nu,ji} \nu_j^R, \quad \sigma_{s,i} = \sum_j Z_{\phi\nu,ji}^* \nu_j^R \quad (113)$$

- **Mass matrix for CP-odd Sneutrino, Basis:**  $(\sigma_L, \sigma_R, \phi_s), (\sigma_L, \sigma_R, \phi_s)$

$$m_{\nu i}^2 = \begin{pmatrix} m_{\sigma_L \sigma_L} & m_{\sigma_R \sigma_L}^T & m_{\phi_s \sigma_L}^T \\ m_{\sigma_L \sigma_R} & m_{\sigma_R \sigma_R} & -\frac{1}{2} v_u^2 \Re(Y_\nu Y_{SL}^\dagger) + \Re(B_{M_R}) \\ m_{\sigma_L \phi_s} & -\frac{1}{2} v_u^2 \Re(Y_{SL} Y_\nu^\dagger) + \Re(B_{M_R}^T) & m_{\phi_s \phi_s} \end{pmatrix} \quad (114)$$

$$m_{\sigma_L \sigma_L} = \frac{1}{4} \left( 4\Re(m_l^2) + v_u^2 \left( 2\Re(Y_\nu^T Y_\nu^*) + 2\Re(Y_{SL}^T Y_{SL}^*) \right) \right) + \frac{1}{8} (g_1^2 + g_2^2) \mathbf{1} (-v_u^2 + v_d^2) \quad (115)$$

$$m_{\sigma_L \sigma_R} = -\frac{1}{2} \frac{1}{\sqrt{2}} \left( 2v_d \Re(\mu Y_\nu^*) + v_u \left( 2\Re(M_R Y_{SL}^*) - 2\Re(T_\nu) \right) \right) \quad (116)$$

$$m_{\sigma_R \sigma_R} = \frac{1}{4} \left( 2 \left( 2\Re(m_\nu^2) + 2\Re(M_R M_R^\dagger) \right) + 2v_u^2 \Re(Y_\nu Y_\nu^\dagger) \right) \quad (117)$$

$$m_{\sigma_L \phi_s} = \frac{1}{2} \frac{1}{\sqrt{2}} \left( 2v_d \Re(\mu Y_{SL}^*) + v_u \left( 2\Re(M_R^T Y_\nu^*) - 2\Re(T_{Y_{SL}}) \right) \right) \quad (118)$$

$$m_{\phi_s \phi_s} = \frac{1}{4} \left( 2 \left( 2\Re(M_R^T M_R^*) + 2\Re(m_S^2) \right) + 2v_u^2 \Re(Y_{SL} Y_{SL}^\dagger) \right) \quad (119)$$

This matrix is diagonalized by  $Z_{\sigma v}$ :

$$Z_{\sigma v} m_{\nu^i}^2 Z_{\sigma v}^\dagger = m_{2,\nu^i}^{dia} \quad (120)$$

with

$$\sigma_{L,i} = \sum_j Z_{\sigma v,j}^* \nu_j^i, \quad \sigma_{R,i} = \sum_j Z_{\sigma v,j}^* \nu_j^i, \quad \phi_{s,i} = \sum_j Z_{\sigma v,j}^* \nu_j^i \quad (121)$$

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

$$m_{\tilde{u}}^2 = \begin{pmatrix} m_{\tilde{u}_L \tilde{u}_L^*} & \frac{1}{\sqrt{2}} \left( -v_d \mu Y_u^\dagger + v_u T_u^\dagger \right) \delta_{\alpha_1 \beta_2} \\ \frac{1}{\sqrt{2}} \delta_{\alpha_2 \beta_1} \left( -v_d Y_u \mu^* + v_u T_u \right) & m_{\tilde{u}_R \tilde{u}_R^*} \end{pmatrix} \quad (122)$$

$$m_{\tilde{u}_L \tilde{u}_L^*} = -\frac{1}{24} \left( -3g_2^2 + g_1^2 \right) \mathbf{1} \left( -v_u^2 + v_d^2 \right) \delta_{\alpha_1 \beta_1} + \frac{1}{2} \delta_{\alpha_1 \beta_1} \left( 2m_q^2 + v_u^2 Y_u^\dagger Y_u \right) \quad (123)$$

$$m_{\tilde{u}_R \tilde{u}_R^*} = \frac{1}{2} \delta_{\alpha_2 \beta_2} \left( 2m_u^2 + v_u^2 Y_u Y_u^\dagger \right) + \frac{1}{6} g_1^2 \mathbf{1} \left( -v_u^2 + v_d^2 \right) \delta_{\alpha_2 \beta_2} \quad (124)$$

This matrix is diagonalized by  $Z^U$ :

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

with

$$\tilde{u}_{L,i\alpha} = \sum_j Z_{ji}^{U,*} \tilde{u}_{j\alpha}, \quad \tilde{u}_{R,i\alpha} = \sum_j Z_{ji}^{U,*} \tilde{u}_{j\alpha} \quad (126)$$

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

$$m_{\tilde{e}}^2 = \begin{pmatrix} m_{\tilde{e}_L \tilde{e}_L^*} & \frac{1}{\sqrt{2}} \left( v_d T_e^\dagger - v_u \mu Y_e^\dagger \right) \\ \frac{1}{\sqrt{2}} \left( v_d T_e - v_u Y_e \mu^* \right) & m_{\tilde{e}_R \tilde{e}_R^*} \end{pmatrix} \quad (127)$$

$$m_{\tilde{e}_L \tilde{e}_L^*} = \frac{1}{2} v_d^2 Y_e^\dagger Y_e + \frac{1}{8} \left( -g_2^2 + g_1^2 \right) \mathbf{1} \left( -v_u^2 + v_d^2 \right) + m_l^2 \quad (128)$$

$$m_{\tilde{e}_R \tilde{e}_R^*} = \frac{1}{2} v_d^2 Y_e Y_e^\dagger + \frac{1}{4} g_1^2 \mathbf{1} \left( -v_d^2 + v_u^2 \right) + m_e^2 \quad (129)$$

This matrix is diagonalized by  $Z^E$ :

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

with

$$\tilde{e}_{L,i} = \sum_j Z_{ji}^{E,*} \tilde{e}_j, \quad \tilde{e}_{R,i} = \sum_j Z_{ji}^{E,*} \tilde{e}_j \quad (131)$$

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

$$m_h^2 = \begin{pmatrix} \frac{1}{8}(g_1^2 + g_2^2)(3v_d^2 - v_u^2) + m_{H_d}^2 + |\mu|^2 & -\frac{1}{4}(g_1^2 + g_2^2)v_d v_u - \Re(B_\mu) \\ -\frac{1}{4}(g_1^2 + g_2^2)v_d v_u - \Re(B_\mu) & -\frac{1}{8}(g_1^2 + g_2^2)(-3v_u^2 + v_d^2) + m_{H_u}^2 + |\mu|^2 \end{pmatrix} \quad (132)$$

This matrix is diagonalized by  $Z^H$ :

$$Z^H m_h^2 Z^{H,\dagger} = m_{2,h}^{dia} \quad (133)$$

with

$$\phi_d = \sum_j Z_{j1}^H h_j, \quad \phi_u = \sum_j Z_{j2}^H h_j \quad (134)$$

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

$$m_{A^0}^2 = \begin{pmatrix} \frac{1}{8}(g_1^2 + g_2^2)(-v_u^2 + v_d^2) + m_{H_d}^2 + |\mu|^2 & \Re(B_\mu) \\ \Re(B_\mu) & -\frac{1}{8}(g_1^2 + g_2^2)(-v_u^2 + v_d^2) + m_{H_u}^2 + |\mu|^2 \end{pmatrix} + \xi_Z m^2(Z) \quad (135)$$

Gauge fixing contributions:

$$m^2(\xi_Z) = \begin{pmatrix} \frac{1}{4}v_d^2(g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 & -\frac{1}{4}v_d v_u(g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 \\ -\frac{1}{4}v_d v_u(g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 & \frac{1}{4}v_u^2(g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 \end{pmatrix} \quad (136)$$

This matrix is diagonalized by  $Z^A$ :

$$Z^A m_{A^0}^2 Z^{A,\dagger} = m_{2,A^0}^{dia} \quad (137)$$

with

$$\sigma_d = \sum_j Z_{j1}^A A_j^0, \quad \sigma_u = \sum_j Z_{j2}^A A_j^0 \quad (138)$$

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

$$m_{H^-}^2 = \begin{pmatrix} m_{H_d^- H_d^{-,*}} & \frac{1}{4}g_2^2 v_d v_u + B_\mu^* \\ \frac{1}{4}g_2^2 v_d v_u + B_\mu & m_{H_u^{+,*} H_u^+} \end{pmatrix} + \xi_{W^-} m^2(W^-) \quad (139)$$

$$m_{H_d^- H_d^{-,*}} = \frac{1}{8}(g_1^2(-v_u^2 + v_d^2) + g_2^2(v_d^2 + v_u^2)) + m_{H_d}^2 + |\mu|^2 \quad (140)$$

$$m_{H_u^{+,*} H_u^+} = \frac{1}{8}(g_1^2(-v_d^2 + v_u^2) + g_2^2(v_d^2 + v_u^2)) + m_{H_u}^2 + |\mu|^2 \quad (141)$$

Gauge fixing contributions:

$$m^2(\xi_{W^-}) = \begin{pmatrix} \frac{1}{4}g_2^2 v_d^2 & -\frac{1}{4}g_2^2 v_d v_u \\ -\frac{1}{4}g_2^2 v_d v_u & \frac{1}{4}g_2^2 v_u^2 \end{pmatrix} \quad (142)$$

This matrix is diagonalized by  $Z^+$ :

$$Z^+ m_{H^-}^2 Z^{+\dagger} = m_{2,H^-}^{dia} \quad (143)$$

with

$$H_d^- = \sum_j Z_{j1}^+ H_j^-, \quad H_u^+ = \sum_j Z_{j2}^+ H_j^+ \quad (144)$$

#### 4.2.2 Mass Matrices for Fermions

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

$$m_{\tilde{\chi}^0} = \begin{pmatrix} M_1 & 0 & -\frac{1}{2}g_1 v_d & \frac{1}{2}g_1 v_u \\ 0 & M_2 & \frac{1}{2}g_2 v_d & -\frac{1}{2}g_2 v_u \\ -\frac{1}{2}g_1 v_d & \frac{1}{2}g_2 v_d & 0 & -\mu \\ \frac{1}{2}g_1 v_u & -\frac{1}{2}g_2 v_u & -\mu & 0 \end{pmatrix} \quad (145)$$

This matrix is diagonalized by  $N$ :

$$N^* m_{\tilde{\chi}^0} N^\dagger = m_{\tilde{\chi}^0}^{dia} \quad (146)$$

with

$$\lambda_{\tilde{B}} = \sum_j N_{j1}^* \lambda_j^0, \quad \tilde{W}^0 = \sum_j N_{j2}^* \lambda_j^0, \quad \tilde{H}_d^0 = \sum_j N_{j3}^* \lambda_j^0 \quad (147)$$

$$\tilde{H}_u^0 = \sum_j N_{j4}^* \lambda_j^0 \quad (148)$$

- **Mass matrix for Neutrinos**, Basis:  $(\nu_L, \nu_R^*, \tilde{S})$ ,  $(\nu_L, \nu_R^*, \tilde{S})$

$$m_\nu = \begin{pmatrix} 0 & \frac{1}{\sqrt{2}}v_u Y_\nu^T & \frac{1}{\sqrt{2}}v_u Y_{SL}^T \\ \frac{1}{\sqrt{2}}v_u Y_\nu & 0 & M_R \\ \frac{1}{\sqrt{2}}v_u Y_{SL} & M_R^T & 0 \end{pmatrix} \quad (149)$$

This matrix is diagonalized by  $U^V$ :

$$U^{V,*} m_\nu U^{V\dagger} = m_\nu^{dia} \quad (150)$$

with

$$\nu_{L,i} = \sum_j U_{ji}^{V,*} \nu_{M,j}, \quad \nu_{R,i} = \sum_j U_{ji}^V \nu_{M,j}^*, \quad \tilde{S}_i = \sum_j U_{ji}^{V,*} \nu_{M,j} \quad (151)$$

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

$$m_{\tilde{\chi}^\pm} = \begin{pmatrix} M_2 & \frac{1}{\sqrt{2}}g_2 v_u \\ \frac{1}{\sqrt{2}}g_2 v_d & \mu \end{pmatrix} \quad (152)$$

This matrix is diagonalized by  $U$  and  $V$

$$U^* m_{\tilde{\chi}^-} V^\dagger = m_{\tilde{\chi}^-}^{dia} \quad (153)$$

with

$$\tilde{W}^- = \sum_{t_2} U_{j1}^* \lambda_j^-, \quad \tilde{H}_d^- = \sum_{t_2} U_{j2}^* \lambda_j^- \quad (154)$$

$$\tilde{W}^+ = \sum_{t_2} V_{1j}^* \lambda_j^+, \quad \tilde{H}_u^+ = \sum_{t_2} V_{2j}^* \lambda_j^+ \quad (155)$$

- **Mass matrix for Leptons**, Basis:  $(e_L), (e_R^*)$

$$m_e = \left( \frac{1}{\sqrt{2}} v_d Y_e^T \right) \quad (156)$$

This matrix is diagonalized by  $U_L^e$  and  $U_R^e$

$$U_L^{e,*} m_e U_R^{e,\dagger} = m_e^{dia} \quad (157)$$

with

$$e_{L,i} = \sum_{t_2} U_{L,ji}^{e,*} E_{L,j} \quad (158)$$

$$e_{R,i} = \sum_{t_2} U_{R,ij}^e E_{R,j}^* \quad (159)$$

- **Mass matrix for Down-Quarks**, Basis:  $(d_{L,\alpha_1}), (d_{R,\beta_1}^*)$

$$m_d = \left( \frac{1}{\sqrt{2}} v_d \delta_{\alpha_1 \beta_1} Y_d^T \right) \quad (160)$$

This matrix is diagonalized by  $U_L^d$  and  $U_R^d$

$$U_L^{d,*} m_d U_R^{d,\dagger} = m_d^{dia} \quad (161)$$

with

$$d_{L,i\alpha} = \sum_{t_2} U_{L,ji}^{d,*} D_{L,j\alpha} \quad (162)$$

$$d_{R,i\alpha} = \sum_{t_2} U_{R,ij}^d D_{R,j\alpha}^* \quad (163)$$

- **Mass matrix for Up-Quarks**, Basis:  $(u_{L,\alpha_1}), (u_{R,\beta_1}^*)$

$$m_u = \left( \frac{1}{\sqrt{2}} v_u \delta_{\alpha_1 \beta_1} Y_u^T \right) \quad (164)$$

This matrix is diagonalized by  $U_L^u$  and  $U_R^u$

$$U_L^{u,*} m_u U_R^{u,\dagger} = m_u^{dia} \quad (165)$$



with

$$u_{L,i\alpha} = \sum_{t_2} U_{L,ji}^{u,*} U_{L,j\alpha} \quad (166)$$

$$u_{R,i\alpha} = \sum_{t_2} U_{R,ij}^u U_{R,j\alpha}^* \quad (167)$$

## 5 Vacuum Expectation Values

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

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

$$\tilde{\nu}_L = \frac{1}{\sqrt{2}}\phi_L + i\frac{1}{\sqrt{2}}\sigma_L \quad (170)$$

$$\tilde{\nu}_R = \frac{1}{\sqrt{2}}\phi_R + i\frac{1}{\sqrt{2}}\sigma_R \quad (171)$$

$$S = \frac{1}{\sqrt{2}}\sigma_s + i\frac{1}{\sqrt{2}}\phi_s \quad (172)$$

## 6 Tadpole Equations

$$\frac{\partial V}{\partial \phi_d} = -\frac{1}{2}v_u(B_\mu + B_\mu^*) + \frac{1}{8}(g_1^2 + g_2^2)v_d(-v_u + v_d)(v_d + v_u) + v_d(m_{H_d}^2 + |\mu|^2) \quad (173)$$

$$\frac{\partial V}{\partial \phi_u} = \frac{1}{8}(g_1^2 + g_2^2)v_u(-v_d^2 + v_u^2) - v_d\Re(B_\mu) + v_u(m_{H_u}^2 + |\mu|^2) \quad (174)$$

$$\frac{\partial V}{\partial \phi_{L_i}} = 0 \quad (175)$$

$$\frac{\partial V}{\partial \phi_{R_i}} = 0 \quad (176)$$

$$\frac{\partial V}{\partial \sigma_{s_i}} = 0 \quad (177)$$

## 7 Particle content for eigenstates 'EWSB'

Name	Type	complex/real	Generations	Indices
$\tilde{d}$	Scalar	complex	6	generation, 6, color, 3
$\nu^R$	Scalar	real	9	generation, 9
$\nu^I$	Scalar	real	9	generation, 9

$\tilde{u}$	Scalar	complex	6	generation, 6, color, 3
$\tilde{e}$	Scalar	complex	6	generation, 6
$h$	Scalar	real	2	generation, 2
$A^0$	Scalar	real	2	generation, 2
$H^-$	Scalar	complex	2	generation, 2
$\tilde{g}$	Fermion	Majorana	1	color, 8
$\tilde{\chi}^0$	Fermion	Majorana	4	generation, 4
$\nu$	Fermion	Majorana	9	generation, 9
$\tilde{\chi}^-$	Fermion	Dirac	2	generation, 2
$e$	Fermion	Dirac	3	generation, 3
$d$	Fermion	Dirac	3	generation, 3, color, 3
$u$	Fermion	Dirac	3	generation, 3, color, 3
$g$	Vector	real	1	color, 8, lorentz, 4
$\gamma$	Vector	real	1	lorentz, 4
$Z$	Vector	real	1	lorentz, 4
$W^-$	Vector	complex	1	lorentz, 4
$\eta^G$	Ghost	real	1	color, 8
$\eta^\gamma$	Ghost	real	1	
$\eta^Z$	Ghost	real	1	
$\eta^-$	Ghost	complex	1	
$\eta^+$	Ghost	complex	1	

## 8 One Loop Self-Energy and One Loop Tadpoles for eigenstates 'EWSB'

### 8.1 One Loop Self-Energy

- Self-Energy for Down-Squarks ( $\tilde{d}$ )

$$\begin{aligned}
\Pi_{i,j}(p^2) = & +4\Gamma_{\tilde{d}_i, \tilde{d}_j^*, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{d}_i, \tilde{d}_j^*, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - \frac{1}{2} \sum_{a=1}^2 A_0(m_{A_a^0}^2) \Gamma_{\tilde{d}_i, \tilde{d}_j^*, A_a^0, A_a^0} - \sum_{a=1}^2 A_0(m_{H_a^-}^2) \Gamma_{\tilde{d}_i, \tilde{d}_j^*, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^2 A_0(m_{h_a}^2) \Gamma_{\tilde{d}_i, \tilde{d}_j^*, h_a, h_a}
\end{aligned}$$

$$\begin{aligned}
& -2 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^2 B_0(p^2, m_{u_a}^2, m_{\tilde{\chi}_b^-}^2) m_{\tilde{\chi}_b^-} \left( \Gamma_{\tilde{d}_j^*, u_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{d}_i^*, u_a, \tilde{\chi}_b^-}^R + \Gamma_{\tilde{d}_j^*, u_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{d}_i^*, u_a, \tilde{\chi}_b^-}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^2 G_0(p^2, m_{u_a}^2, m_{\tilde{\chi}_b^-}^2) \left( \Gamma_{\tilde{d}_j^*, u_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{d}_i^*, u_a, \tilde{\chi}_b^-}^L + \Gamma_{\tilde{d}_j^*, u_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{d}_i^*, u_a, \tilde{\chi}_b^-}^R \right) \\
& -2 \sum_{a=1}^3 m_{d_a} \sum_{b=1}^4 B_0(p^2, m_{d_a}^2, m_{\tilde{\chi}_b^0}^2) m_{\tilde{\chi}_b^0} \left( \Gamma_{\tilde{d}_j^*, d_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{d}_i^*, d_a, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{d}_j^*, d_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{d}_i^*, d_a, \tilde{\chi}_b^0}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^4 G_0(p^2, m_{d_a}^2, m_{\tilde{\chi}_b^0}^2) \left( \Gamma_{\tilde{d}_j^*, d_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{d}_i^*, d_a, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{d}_j^*, d_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{d}_i^*, d_a, \tilde{\chi}_b^0}^R \right) \\
& - C \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_i^*, \tilde{d}_j^*, \tilde{d}_a^*, \tilde{d}_a} - \sum_{a=1}^6 A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{d}_i^*, \tilde{d}_j^*, \tilde{e}_a^*, \tilde{e}_a} \\
& - C \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{d}_i^*, \tilde{d}_j^*, \tilde{u}_a^*, \tilde{u}_a} + \sum_{a=1}^6 \sum_{b=1}^2 B_0(p^2, m_{\tilde{d}_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{d}_j^*, \tilde{d}_a, A_b^0}^* \Gamma_{\tilde{d}_i^*, \tilde{d}_a, A_b^0} \\
& + \sum_{a=1}^6 \sum_{b=1}^2 B_0(p^2, m_{\tilde{d}_a}^2, m_{h_b}^2) \Gamma_{\tilde{d}_j^*, \tilde{d}_a, h_b}^* \Gamma_{\tilde{d}_i^*, \tilde{d}_a, h_b} + \sum_{a=1}^6 \sum_{b=1}^2 B_0(p^2, m_{\tilde{u}_a}^2, m_{H_b^-}^2) \Gamma_{\tilde{d}_j^*, \tilde{u}_a, H_b^-}^* \Gamma_{\tilde{d}_i^*, \tilde{u}_a, H_b^-} \\
& - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^i}^2) \Gamma_{\tilde{d}_i^*, \tilde{d}_j^*, \nu_a^i, \nu_a^i} - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^R}^2) \Gamma_{\tilde{d}_i^*, \tilde{d}_j^*, \nu_a^R, \nu_a^R} \\
& - \frac{8}{3} m_{\tilde{g}} \sum_{b=1}^3 B_0(p^2, m_{\tilde{g}}^2, m_{d_b}^2) m_{d_b} \left( \Gamma_{\tilde{d}_j^*, \tilde{g}_1, d_b}^{L*} \Gamma_{\tilde{d}_i^*, \tilde{g}_1, d_b}^R + \Gamma_{\tilde{d}_j^*, \tilde{g}_1, d_b}^{R*} \Gamma_{\tilde{d}_i^*, \tilde{g}_1, d_b}^L \right) \\
& + \frac{4}{3} \sum_{b=1}^3 G_0(p^2, m_{\tilde{g}}^2, m_{d_b}^2) \left( \Gamma_{\tilde{d}_j^*, \tilde{g}_1, d_b}^{L*} \Gamma_{\tilde{d}_i^*, \tilde{g}_1, d_b}^L + \Gamma_{\tilde{d}_j^*, \tilde{g}_1, d_b}^{R*} \Gamma_{\tilde{d}_i^*, \tilde{g}_1, d_b}^R \right) \\
& + \frac{4}{3} \sum_{b=1}^6 \Gamma_{\tilde{d}_j^*, g, \tilde{d}_b}^* \Gamma_{\tilde{d}_i^*, g, \tilde{d}_b} \Gamma_{\tilde{d}_i^*, \tilde{d}_b} F_0(p^2, m_{\tilde{d}_b}^2, 0) + \sum_{b=1}^6 \Gamma_{\tilde{d}_j^*, \gamma, \tilde{d}_b}^* \Gamma_{\tilde{d}_i^*, \gamma, \tilde{d}_b} \Gamma_{\tilde{d}_i^*, \tilde{d}_b} F_0(p^2, m_{\tilde{d}_b}^2, 0) \\
& + \sum_{b=1}^6 \Gamma_{\tilde{d}_j^*, Z, \tilde{d}_b}^* \Gamma_{\tilde{d}_i^*, Z, \tilde{d}_b} \Gamma_{\tilde{d}_i^*, \tilde{d}_b} F_0(p^2, m_{\tilde{d}_b}^2, m_Z^2) + \sum_{b=1}^6 \Gamma_{\tilde{d}_j^*, W^-, \tilde{u}_b}^* \Gamma_{\tilde{d}_i^*, W^-, \tilde{u}_b} \Gamma_{\tilde{d}_i^*, \tilde{u}_b} F_0(p^2, m_{\tilde{u}_b}^2, m_{W^-}^2) \tag{178}
\end{aligned}$$

• Self-Energy for CP-even Sneutrino ( $\nu^R$ )

$$\begin{aligned}
\Pi_{i,j}(p^2) & = +4\Gamma_{\tilde{\nu}_i^R, \tilde{\nu}_j^R, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{\nu}_i^R, \tilde{\nu}_j^R, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - \frac{1}{2} \sum_{a=1}^2 A_0(m_{A_a^0}^2) \Gamma_{\tilde{\nu}_i^R, \tilde{\nu}_j^R, A_a^0, A_a^0} - \sum_{a=1}^2 A_0(m_{H_a^-}^2) \Gamma_{\tilde{\nu}_i^R, \tilde{\nu}_j^R, H_a^-, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^2 A_0(m_{h_a}^2) \Gamma_{\tilde{\nu}_i^R, \tilde{\nu}_j^R, h_a, h_a}
\end{aligned}$$

$$\begin{aligned}
& -4 \sum_{a=1}^3 m_{e_a} \sum_{b=1}^2 B_0(p^2, m_{e_a}^2, m_{\tilde{\chi}_b^-}^2) m_{\tilde{\chi}_b^-} \left( \Gamma_{\tilde{\nu}_j^R, \bar{e}_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\nu}_i^R, \bar{e}_a, \tilde{\chi}_b^-}^R + \Gamma_{\tilde{\nu}_j^R, \bar{e}_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\nu}_i^R, \bar{e}_a, \tilde{\chi}_b^-}^L \right) \\
& + 2 \sum_{a=1}^3 \sum_{b=1}^2 G_0(p^2, m_{e_a}^2, m_{\tilde{\chi}_b^-}^2) \left( \Gamma_{\tilde{\nu}_j^R, \bar{e}_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\nu}_i^R, \bar{e}_a, \tilde{\chi}_b^-}^L + \Gamma_{\tilde{\nu}_j^R, \bar{e}_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\nu}_i^R, \bar{e}_a, \tilde{\chi}_b^-}^R \right) \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\tilde{\nu}_i^R, \tilde{\nu}_j^R, \tilde{d}_a^*, \tilde{d}_a} - \sum_{a=1}^6 A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{\nu}_i^R, \tilde{\nu}_j^R, \tilde{e}_a^*, \tilde{e}_a} \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{\nu}_i^R, \tilde{\nu}_j^R, \tilde{u}_a^*, \tilde{u}_a} + 2 \sum_{a=1}^6 \sum_{b=1}^2 B_0(p^2, m_{\tilde{e}_a}^2, m_{H_b^-}^2) \Gamma_{\tilde{\nu}_j^R, \tilde{e}_a^*, H_b^-}^* \Gamma_{\tilde{\nu}_i^R, \tilde{e}_a^*, H_b^-} \\
& - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^i}^2) \Gamma_{\tilde{\nu}_i^R, \tilde{\nu}_j^R, \nu_a^i, \nu_a^i} - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^R}^2) \Gamma_{\tilde{\nu}_i^R, \tilde{\nu}_j^R, \nu_a^R, \nu_a^R} \\
& + \sum_{a=1}^9 \sum_{b=1}^2 B_0(p^2, m_{\nu_a^i}^2, m_{A_b^0}^2) \Gamma_{\tilde{\nu}_j^R, \nu_a^i, A_b^0}^* \Gamma_{\tilde{\nu}_i^R, \nu_a^i, A_b^0} \\
& + \sum_{a=1}^9 \sum_{b=1}^2 B_0(p^2, m_{\nu_a^i}^2, m_{h_b}^2) \Gamma_{\tilde{\nu}_j^R, \nu_a^i, h_b}^* \Gamma_{\tilde{\nu}_i^R, \nu_a^i, h_b} \\
& + \sum_{a=1}^9 \sum_{b=1}^2 B_0(p^2, m_{\nu_a^R}^2, m_{A_b^0}^2) \Gamma_{\tilde{\nu}_j^R, \nu_a^R, A_b^0}^* \Gamma_{\tilde{\nu}_i^R, \nu_a^R, A_b^0} \\
& + \sum_{a=1}^9 \sum_{b=1}^2 B_0(p^2, m_{\nu_a^R}^2, m_{h_b}^2) \Gamma_{\tilde{\nu}_j^R, \nu_a^R, h_b}^* \Gamma_{\tilde{\nu}_i^R, \nu_a^R, h_b} \\
& - 2 \sum_{a=1}^9 m_{\nu_a} \sum_{b=1}^4 B_0(p^2, m_{\nu_a}^2, m_{\tilde{\chi}_b^0}^2) m_{\tilde{\chi}_b^0} \left( \Gamma_{\tilde{\nu}_j^R, \nu_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\nu}_i^R, \nu_a, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{\nu}_j^R, \nu_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\nu}_i^R, \nu_a, \tilde{\chi}_b^0}^L \right) \\
& + \sum_{a=1}^9 \sum_{b=1}^4 G_0(p^2, m_{\nu_a}^2, m_{\tilde{\chi}_b^0}^2) \left( \Gamma_{\tilde{\nu}_j^R, \nu_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\nu}_i^R, \nu_a, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{\nu}_j^R, \nu_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\nu}_i^R, \nu_a, \tilde{\chi}_b^0}^R \right) \\
& + 2 \sum_{b=1}^6 \Gamma_{\tilde{\nu}_j^R, W^+, \tilde{e}_b}^* \Gamma_{\tilde{\nu}_i^R, W^+, \tilde{e}_b} F_0(p^2, m_{\tilde{e}_b}^2, m_{W^-}^2) + \sum_{b=1}^9 \Gamma_{\tilde{\nu}_j^R, Z, \nu_b^i}^* \Gamma_{\tilde{\nu}_i^R, Z, \nu_b^i} F_0(p^2, m_{\nu_b^i}^2, m_Z^2) \quad (179)
\end{aligned}$$

• **Self-Energy for CP-odd Sneutrino ( $\nu^i$ )**

$$\begin{aligned}
\Pi_{i,j}(p^2) & = +4\Gamma_{\tilde{\nu}_i^i, \tilde{\nu}_j^i, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{\nu}_i^i, \tilde{\nu}_j^i, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - \frac{1}{2} \sum_{a=1}^2 A_0(m_{A_a^0}^2) \Gamma_{\tilde{\nu}_i^i, \tilde{\nu}_j^i, A_a^0, A_a^0} - \sum_{a=1}^2 A_0(m_{H_a^-}^2) \Gamma_{\tilde{\nu}_i^i, \tilde{\nu}_j^i, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^2 A_0(m_{h_a}^2) \Gamma_{\tilde{\nu}_i^i, \tilde{\nu}_j^i, h_a, h_a}
\end{aligned}$$

$$\begin{aligned}
& -4 \sum_{a=1}^3 m_{e_a} \sum_{b=1}^2 B_0(p^2, m_{e_a}^2, m_{\tilde{\chi}_b^-}^2) m_{\tilde{\chi}_b^-} \left( \Gamma_{\tilde{\nu}_j^i, \bar{e}_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\nu}_i^i, \bar{e}_a, \tilde{\chi}_b^-}^R + \Gamma_{\tilde{\nu}_j^i, \bar{e}_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\nu}_i^i, \bar{e}_a, \tilde{\chi}_b^-}^L \right) \\
& + 2 \sum_{a=1}^3 \sum_{b=1}^2 G_0(p^2, m_{e_a}^2, m_{\tilde{\chi}_b^-}^2) \left( \Gamma_{\tilde{\nu}_j^i, \bar{e}_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\nu}_i^i, \bar{e}_a, \tilde{\chi}_b^-}^L + \Gamma_{\tilde{\nu}_j^i, \bar{e}_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\nu}_i^i, \bar{e}_a, \tilde{\chi}_b^-}^R \right) \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\tilde{\nu}_i^i, \tilde{\nu}_j^i, \tilde{d}_a^*, \tilde{d}_a} - \sum_{a=1}^6 A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{\nu}_i^i, \tilde{\nu}_j^i, \tilde{e}_a^*, \tilde{e}_a} \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{\nu}_i^i, \tilde{\nu}_j^i, \tilde{u}_a^*, \tilde{u}_a} + 2 \sum_{a=1}^6 \sum_{b=1}^2 B_0(p^2, m_{\tilde{e}_a}^2, m_{H_b^-}^2) \Gamma_{\tilde{\nu}_j^i, \tilde{e}_a^*, H_b^-}^* \Gamma_{\tilde{\nu}_i^i, \tilde{e}_a^*, H_b^-} \\
& - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^i}^2) \Gamma_{\tilde{\nu}_i^i, \tilde{\nu}_j^i, \nu_a^i, \nu_a^i} - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^R}^2) \Gamma_{\tilde{\nu}_i^i, \tilde{\nu}_j^i, \nu_a^R, \nu_a^R} \\
& + \sum_{a=1}^9 \sum_{b=1}^2 B_0(p^2, m_{\nu_a^i}^2, m_{A_b^0}^2) \Gamma_{\tilde{\nu}_j^i, \nu_a^i, A_b^0}^* \Gamma_{\tilde{\nu}_i^i, \nu_a^i, A_b^0} \\
& + \sum_{a=1}^9 \sum_{b=1}^2 B_0(p^2, m_{\nu_a^i}^2, m_{h_b}^2) \Gamma_{\tilde{\nu}_j^i, \nu_a^i, h_b}^* \Gamma_{\tilde{\nu}_i^i, \nu_a^i, h_b} \\
& + \sum_{a=1}^9 \sum_{b=1}^2 B_0(p^2, m_{\nu_a^R}^2, m_{A_b^0}^2) \Gamma_{\tilde{\nu}_j^i, \nu_a^R, A_b^0}^* \Gamma_{\tilde{\nu}_i^i, \nu_a^R, A_b^0} \\
& + \sum_{a=1}^9 \sum_{b=1}^2 B_0(p^2, m_{\nu_a^R}^2, m_{h_b}^2) \Gamma_{\tilde{\nu}_j^i, \nu_a^R, h_b}^* \Gamma_{\tilde{\nu}_i^i, \nu_a^R, h_b} \\
& - 2 \sum_{a=1}^9 m_{\nu_a} \sum_{b=1}^4 B_0(p^2, m_{\nu_a}^2, m_{\tilde{\chi}_b^0}^2) m_{\tilde{\chi}_b^0} \left( \Gamma_{\tilde{\nu}_j^i, \nu_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\nu}_i^i, \nu_a, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{\nu}_j^i, \nu_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\nu}_i^i, \nu_a, \tilde{\chi}_b^0}^L \right) \\
& + \sum_{a=1}^9 \sum_{b=1}^4 G_0(p^2, m_{\nu_a}^2, m_{\tilde{\chi}_b^0}^2) \left( \Gamma_{\tilde{\nu}_j^i, \nu_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\nu}_i^i, \nu_a, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{\nu}_j^i, \nu_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\nu}_i^i, \nu_a, \tilde{\chi}_b^0}^R \right) \\
& + 2 \sum_{b=1}^6 \Gamma_{\tilde{\nu}_j^i, W^+, \bar{e}_b}^* \Gamma_{\tilde{\nu}_i^i, W^+, \bar{e}_b} F_0(p^2, m_{\tilde{e}_b}^2, m_{W^-}^2) + \sum_{b=1}^9 \Gamma_{\tilde{\nu}_j^i, Z, \nu_b^R}^* \Gamma_{\tilde{\nu}_i^i, Z, \nu_b^R} F_0(p^2, m_{\nu_b^R}^2, m_Z^2) \quad (180)
\end{aligned}$$

• Self-Energy for Up-Squarks ( $\tilde{u}$ )

$$\begin{aligned}
\Pi_{i,j}(p^2) & = +4\Gamma_{\tilde{u}_i, \tilde{u}_j^*, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{u}_i, \tilde{u}_j^*, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - \frac{1}{2} \sum_{a=1}^2 A_0(m_{A_a^0}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, A_a^0, A_a^0} - \sum_{a=1}^2 A_0(m_{H_a^-}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^2 A_0(m_{h_a}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, h_a, h_a}
\end{aligned}$$

$$\begin{aligned}
& - 2 \sum_{a=1}^2 m_{\tilde{\chi}_a^-} \sum_{b=1}^3 B_0(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{d}_b}^2) m_{\tilde{d}_b} \left( \Gamma_{\tilde{u}_j^*, \tilde{\chi}_a^+, \tilde{d}_b}^{L*} \Gamma_{\tilde{u}_i^*, \tilde{\chi}_a^+, \tilde{d}_b}^R + \Gamma_{\tilde{u}_j^*, \tilde{\chi}_a^+, \tilde{d}_b}^{R*} \Gamma_{\tilde{u}_i^*, \tilde{\chi}_a^+, \tilde{d}_b}^L \right) \\
& + \sum_{a=1}^2 \sum_{b=1}^3 G_0(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{d}_b}^2) \left( \Gamma_{\tilde{u}_j^*, \tilde{\chi}_a^+, \tilde{d}_b}^{L*} \Gamma_{\tilde{u}_i^*, \tilde{\chi}_a^+, \tilde{d}_b}^L + \Gamma_{\tilde{u}_j^*, \tilde{\chi}_a^+, \tilde{d}_b}^{R*} \Gamma_{\tilde{u}_i^*, \tilde{\chi}_a^+, \tilde{d}_b}^R \right) \\
& + \sum_{a=1}^2 \sum_{b=1}^6 B_0(p^2, m_{H_a^-}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{u}_j^*, H_a^+, \tilde{d}_b}^* \Gamma_{\tilde{u}_i^*, H_a^+, \tilde{d}_b} \\
& - 2 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^4 B_0(p^2, m_{u_a}^2, m_{\tilde{\chi}_b^0}^2) m_{\tilde{\chi}_b^0} \left( \Gamma_{\tilde{u}_j^*, u_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{u}_i^*, u_a, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{u}_j^*, u_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{u}_i^*, u_a, \tilde{\chi}_b^0}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^4 G_0(p^2, m_{u_a}^2, m_{\tilde{\chi}_b^0}^2) \left( \Gamma_{\tilde{u}_j^*, u_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{u}_i^*, u_a, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{u}_j^*, u_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{u}_i^*, u_a, \tilde{\chi}_b^0}^R \right) \\
& - C \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, \tilde{d}_a^*, \tilde{d}_a} - \sum_{a=1}^6 A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, \tilde{e}_a^*, \tilde{e}_a} \\
& - C \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, \tilde{u}_a^*, \tilde{u}_a} + \sum_{a=1}^6 \sum_{b=1}^2 B_0(p^2, m_{\tilde{u}_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{u}_j^*, \tilde{u}_a, A_b^0}^* \Gamma_{\tilde{u}_i^*, \tilde{u}_a, A_b^0} \\
& + \sum_{a=1}^6 \sum_{b=1}^2 B_0(p^2, m_{\tilde{u}_a}^2, m_{\tilde{h}_b}^2) \Gamma_{\tilde{u}_j^*, \tilde{u}_a, \tilde{h}_b}^* \Gamma_{\tilde{u}_i^*, \tilde{u}_a, \tilde{h}_b} - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^i}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, \nu_a^i, \nu_a^i} \\
& - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^R}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, \nu_a^R, \nu_a^R} \\
& - \frac{8}{3} m_{\tilde{g}} \sum_{b=1}^3 B_0(p^2, m_{\tilde{g}}^2, m_{u_b}^2) m_{u_b} \left( \Gamma_{\tilde{u}_j^*, \tilde{g}_1, u_b}^{L*} \Gamma_{\tilde{u}_i^*, \tilde{g}_1, u_b}^R + \Gamma_{\tilde{u}_j^*, \tilde{g}_1, u_b}^{R*} \Gamma_{\tilde{u}_i^*, \tilde{g}_1, u_b}^L \right) \\
& + \frac{4}{3} \sum_{b=1}^3 G_0(p^2, m_{\tilde{g}}^2, m_{u_b}^2) \left( \Gamma_{\tilde{u}_j^*, \tilde{g}_1, u_b}^{L*} \Gamma_{\tilde{u}_i^*, \tilde{g}_1, u_b}^L + \Gamma_{\tilde{u}_j^*, \tilde{g}_1, u_b}^{R*} \Gamma_{\tilde{u}_i^*, \tilde{g}_1, u_b}^R \right) \\
& + \sum_{b=1}^6 \Gamma_{\tilde{u}_j^*, W^+, \tilde{d}_b}^* \Gamma_{\tilde{u}_i^*, W^+, \tilde{d}_b} F_0(p^2, m_{\tilde{d}_b}^2, m_{W^-}^2) + \frac{4}{3} \sum_{b=1}^6 \Gamma_{\tilde{u}_j^*, g, \tilde{u}_b}^* \Gamma_{\tilde{u}_i^*, g, \tilde{u}_b} F_0(p^2, m_{\tilde{u}_b}^2, 0) \\
& + \sum_{b=1}^6 \Gamma_{\tilde{u}_j^*, \gamma, \tilde{u}_b}^* \Gamma_{\tilde{u}_i^*, \gamma, \tilde{u}_b} F_0(p^2, m_{\tilde{u}_b}^2, 0) + \sum_{b=1}^6 \Gamma_{\tilde{u}_j^*, Z, \tilde{u}_b}^* \Gamma_{\tilde{u}_i^*, Z, \tilde{u}_b} F_0(p^2, m_{\tilde{u}_b}^2, m_Z^2) \tag{181}
\end{aligned}$$

• Self-Energy for Sleptons ( $\tilde{e}$ )

$$\begin{aligned}
\Pi_{i,j}(p^2) & = +4\Gamma_{\tilde{e}_i, \tilde{e}_j^*, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{e}_i, \tilde{e}_j^*, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - \frac{1}{2} \sum_{a=1}^2 A_0(m_{A_a^0}^2) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, A_a^0, A_a^0} - \sum_{a=1}^2 A_0(m_{H_a^-}^2) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, H_a^+, H_a^-}
\end{aligned}$$

$$\begin{aligned}
& -\frac{1}{2} \sum_{a=1}^2 A_0(m_{h_a}^2) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, h_a, h_a} \\
& -2 \sum_{a=1}^3 m_{e_a} \sum_{b=1}^4 B_0(p^2, m_{e_a}^2, m_{\tilde{\chi}_b^0}^2) m_{\tilde{\chi}_b^0} \left( \Gamma_{\tilde{e}_j^*, e_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{e}_i^*, e_a, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{e}_j^*, e_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{e}_i^*, e_a, \tilde{\chi}_b^0}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^4 G_0(p^2, m_{e_a}^2, m_{\tilde{\chi}_b^0}^2) \left( \Gamma_{\tilde{e}_j^*, e_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{e}_i^*, e_a, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{e}_j^*, e_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{e}_i^*, e_a, \tilde{\chi}_b^0}^R \right) \\
& -3 \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, \tilde{d}_a^*, \tilde{d}_a} - \sum_{a=1}^6 A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, \tilde{e}_a^*, \tilde{e}_a} \\
& -3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, \tilde{u}_a^*, \tilde{u}_a} + \sum_{a=1}^6 \sum_{b=1}^2 B_0(p^2, m_{\tilde{e}_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{e}_j^*, \tilde{e}_a, A_b^0}^* \Gamma_{\tilde{e}_i^*, \tilde{e}_a, A_b^0} \\
& + \sum_{a=1}^6 \sum_{b=1}^2 B_0(p^2, m_{\tilde{e}_a}^2, m_{h_b}^2) \Gamma_{\tilde{e}_j^*, \tilde{e}_a, h_b}^* \Gamma_{\tilde{e}_i^*, \tilde{e}_a, h_b} - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^i}^2) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, \nu_a^i, \nu_a^i} \\
& - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^R}^2) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, \nu_a^R, \nu_a^R} + \sum_{a=1}^9 \sum_{b=1}^2 B_0(p^2, m_{\nu_a^i}^2, m_{H_b^-}^2) \Gamma_{\tilde{e}_j^*, \nu_a^i, H_b^-}^* \Gamma_{\tilde{e}_i^*, \nu_a^i, H_b^-} \\
& + \sum_{a=1}^9 \sum_{b=1}^2 B_0(p^2, m_{\nu_a^R}^2, m_{H_b^-}^2) \Gamma_{\tilde{e}_j^*, \nu_a^R, H_b^-}^* \Gamma_{\tilde{e}_i^*, \nu_a^R, H_b^-} \\
& -2 \sum_{a=1}^9 m_{\nu_a} \sum_{b=1}^2 B_0(p^2, m_{\nu_a}^2, m_{\tilde{\chi}_b^-}^2) m_{\tilde{\chi}_b^-} \left( \Gamma_{\tilde{e}_j^*, \nu_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{e}_i^*, \nu_a, \tilde{\chi}_b^-}^R + \Gamma_{\tilde{e}_j^*, \nu_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{e}_i^*, \nu_a, \tilde{\chi}_b^-}^L \right) \\
& + \sum_{a=1}^9 \sum_{b=1}^2 G_0(p^2, m_{\nu_a}^2, m_{\tilde{\chi}_b^-}^2) \left( \Gamma_{\tilde{e}_j^*, \nu_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{e}_i^*, \nu_a, \tilde{\chi}_b^-}^L + \Gamma_{\tilde{e}_j^*, \nu_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{e}_i^*, \nu_a, \tilde{\chi}_b^-}^R \right) \\
& + \sum_{b=1}^6 \Gamma_{\tilde{e}_j^*, \gamma, \tilde{e}_b}^* \Gamma_{\tilde{e}_i^*, \gamma, \tilde{e}_b} F_0(p^2, m_{\tilde{e}_b}^2, 0) + \sum_{b=1}^6 \Gamma_{\tilde{e}_j^*, Z, \tilde{e}_b}^* \Gamma_{\tilde{e}_i^*, Z, \tilde{e}_b} F_0(p^2, m_{\tilde{e}_b}^2, m_Z^2) \\
& + \sum_{b=1}^9 \Gamma_{\tilde{e}_j^*, W^-, \nu_b^i}^* \Gamma_{\tilde{e}_i^*, W^-, \nu_b^i} F_0(p^2, m_{\nu_b^i}^2, m_{W^-}^2) + \sum_{b=1}^9 \Gamma_{\tilde{e}_j^*, W^-, \nu_b^R}^* \Gamma_{\tilde{e}_i^*, W^-, \nu_b^R} F_0(p^2, m_{\nu_b^R}^2, m_{W^-}^2) \quad (182)
\end{aligned}$$

• Self-Energy for Higgs ( $h$ )

$$\begin{aligned}
\Pi_{i,j}(p^2) = & +2 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_Z^2, m_Z^2) \right) \Gamma_{\tilde{h}_j, Z, Z}^* \Gamma_{\tilde{h}_i, Z, Z} + 4 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{W^-}^2, m_{W^-}^2) \right) \Gamma_{\tilde{h}_j, W^+, W^-}^* \Gamma_{\tilde{h}_i, W^+, W^-} \\
& - B_0(p^2, m_{\eta^-}^2, m_{\eta^-}^2) \Gamma_{\tilde{h}_i, \eta^-, \eta^-} \Gamma_{\tilde{h}_j, \eta^-, \eta^-} - B_0(p^2, m_{\eta^+}^2, m_{\eta^+}^2) \Gamma_{\tilde{h}_i, \eta^+, \eta^+} \Gamma_{\tilde{h}_j, \eta^+, \eta^+} \\
& - B_0(p^2, m_{\eta^Z}^2, m_{\eta^Z}^2) \Gamma_{\tilde{h}_i, \eta^Z, \eta^Z} \Gamma_{\tilde{h}_j, \eta^Z, \eta^Z} + 4 \Gamma_{\tilde{h}_i, \tilde{h}_j, W^+, W^-} + \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) \\
& + 2 \Gamma_{\tilde{h}_i, \tilde{h}_j, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) - \frac{1}{2} \sum_{a=1}^2 A_0(m_{A_a^0}^2) \Gamma_{\tilde{h}_i, \tilde{h}_j, A_a^0, A_a^0}
\end{aligned}$$

$$\begin{aligned}
& - \sum_{a=1}^2 A_0(m_{H_a^-}^2) \Gamma_{\check{h}_i, \check{h}_j, H_a^+, H_a^-} - \frac{1}{2} \sum_{a=1}^2 A_0(m_{\check{h}_a}^2) \Gamma_{\check{h}_i, \check{h}_j, h_a, h_a} \\
& + \frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^2 B_0(p^2, m_{A_a^0}^2, m_{A_b^0}^2) \Gamma_{\check{h}_j, A_a^0, A_b^0}^* \Gamma_{\check{h}_i, A_a^0, A_b^0} \\
& + \sum_{a=1}^2 \sum_{b=1}^2 B_0(p^2, m_{H_a^-}^2, m_{H_b^-}^2) \Gamma_{\check{h}_j, H_a^+, H_b^-}^* \Gamma_{\check{h}_i, H_a^+, H_b^-} \\
& + \frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^2 B_0(p^2, m_{\check{h}_a}^2, m_{\check{h}_b}^2) \Gamma_{\check{h}_j, h_a, h_b}^* \Gamma_{\check{h}_i, h_a, h_b} \\
& - 2 \sum_{a=1}^2 m_{\check{\chi}_a^-} \sum_{b=1}^2 B_0(p^2, m_{\check{\chi}_a^-}^2, m_{\check{\chi}_b^-}^2) m_{\check{\chi}_b^-} \left( \Gamma_{\check{h}_j, \check{\chi}_a^+, \check{\chi}_b^-}^{L*} \Gamma_{\check{h}_i, \check{\chi}_a^+, \check{\chi}_b^-}^R + \Gamma_{\check{h}_j, \check{\chi}_a^+, \check{\chi}_b^-}^{R*} \Gamma_{\check{h}_i, \check{\chi}_a^+, \check{\chi}_b^-}^L \right) \\
& + \sum_{a=1}^2 \sum_{b=1}^2 G_0(p^2, m_{\check{\chi}_a^-}^2, m_{\check{\chi}_b^-}^2) \left( \Gamma_{\check{h}_j, \check{\chi}_a^+, \check{\chi}_b^-}^{L*} \Gamma_{\check{h}_i, \check{\chi}_a^+, \check{\chi}_b^-}^L + \Gamma_{\check{h}_j, \check{\chi}_a^+, \check{\chi}_b^-}^{R*} \Gamma_{\check{h}_i, \check{\chi}_a^+, \check{\chi}_b^-}^R \right) \\
& - 6 \sum_{a=1}^3 m_{d_a} \sum_{b=1}^3 B_0(p^2, m_{d_a}^2, m_{d_b}^2) m_{d_b} \left( \Gamma_{\check{h}_j, \bar{d}_a, d_b}^{L*} \Gamma_{\check{h}_i, \bar{d}_a, d_b}^R + \Gamma_{\check{h}_j, \bar{d}_a, d_b}^{R*} \Gamma_{\check{h}_i, \bar{d}_a, d_b}^L \right) \\
& + 3 \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{d_a}^2, m_{d_b}^2) \left( \Gamma_{\check{h}_j, \bar{d}_a, d_b}^{L*} \Gamma_{\check{h}_i, \bar{d}_a, d_b}^L + \Gamma_{\check{h}_j, \bar{d}_a, d_b}^{R*} \Gamma_{\check{h}_i, \bar{d}_a, d_b}^R \right) \\
& - 2 \sum_{a=1}^3 m_{e_a} \sum_{b=1}^3 B_0(p^2, m_{e_a}^2, m_{e_b}^2) m_{e_b} \left( \Gamma_{\check{h}_j, \bar{e}_a, e_b}^{L*} \Gamma_{\check{h}_i, \bar{e}_a, e_b}^R + \Gamma_{\check{h}_j, \bar{e}_a, e_b}^{R*} \Gamma_{\check{h}_i, \bar{e}_a, e_b}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{e_a}^2, m_{e_b}^2) \left( \Gamma_{\check{h}_j, \bar{e}_a, e_b}^{L*} \Gamma_{\check{h}_i, \bar{e}_a, e_b}^L + \Gamma_{\check{h}_j, \bar{e}_a, e_b}^{R*} \Gamma_{\check{h}_i, \bar{e}_a, e_b}^R \right) \\
& - 6 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^3 B_0(p^2, m_{u_a}^2, m_{u_b}^2) m_{u_b} \left( \Gamma_{\check{h}_j, \bar{u}_a, u_b}^{L*} \Gamma_{\check{h}_i, \bar{u}_a, u_b}^R + \Gamma_{\check{h}_j, \bar{u}_a, u_b}^{R*} \Gamma_{\check{h}_i, \bar{u}_a, u_b}^L \right) \\
& + 3 \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{u_a}^2, m_{u_b}^2) \left( \Gamma_{\check{h}_j, \bar{u}_a, u_b}^{L*} \Gamma_{\check{h}_i, \bar{u}_a, u_b}^L + \Gamma_{\check{h}_j, \bar{u}_a, u_b}^{R*} \Gamma_{\check{h}_i, \bar{u}_a, u_b}^R \right) \\
& - \sum_{a=1}^4 m_{\check{\chi}_a^0} \sum_{b=1}^4 B_0(p^2, m_{\check{\chi}_a^0}^2, m_{\check{\chi}_b^0}^2) m_{\check{\chi}_b^0} \left( \Gamma_{\check{h}_j, \check{\chi}_a^0, \check{\chi}_b^0}^{L*} \Gamma_{\check{h}_i, \check{\chi}_a^0, \check{\chi}_b^0}^R + \Gamma_{\check{h}_j, \check{\chi}_a^0, \check{\chi}_b^0}^{R*} \Gamma_{\check{h}_i, \check{\chi}_a^0, \check{\chi}_b^0}^L \right) \\
& + \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 G_0(p^2, m_{\check{\chi}_a^0}^2, m_{\check{\chi}_b^0}^2) \left( \Gamma_{\check{h}_j, \check{\chi}_a^0, \check{\chi}_b^0}^{L*} \Gamma_{\check{h}_i, \check{\chi}_a^0, \check{\chi}_b^0}^L + \Gamma_{\check{h}_j, \check{\chi}_a^0, \check{\chi}_b^0}^{R*} \Gamma_{\check{h}_i, \check{\chi}_a^0, \check{\chi}_b^0}^R \right) \\
& - 3 \sum_{a=1}^6 A_0(m_{d_a}^2) \Gamma_{\check{h}_i, \check{h}_j, \bar{d}_a^*, \bar{d}_a} - \sum_{a=1}^6 A_0(m_{e_a}^2) \Gamma_{\check{h}_i, \check{h}_j, \bar{e}_a^*, \bar{e}_a}
\end{aligned}$$



$$\begin{aligned}
& -3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{h}_i, \tilde{h}_j, \tilde{u}_a^*, \tilde{u}_a} + 3 \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{h}_j, \tilde{d}_a^*, \tilde{d}_b} \Gamma_{\tilde{h}_i, \tilde{d}_a^*, \tilde{d}_b} \\
& + \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{\tilde{e}_a}^2, m_{\tilde{e}_b}^2) \Gamma_{\tilde{h}_j, \tilde{e}_a^*, \tilde{e}_b} \Gamma_{\tilde{h}_i, \tilde{e}_a^*, \tilde{e}_b} + 3 \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{\tilde{u}_a}^2, m_{\tilde{u}_b}^2) \Gamma_{\tilde{h}_j, \tilde{u}_a^*, \tilde{u}_b} \Gamma_{\tilde{h}_i, \tilde{u}_a^*, \tilde{u}_b} \\
& - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^i}^2) \Gamma_{\tilde{h}_i, \tilde{h}_j, \nu_a^i, \nu_a^i} - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^R}^2) \Gamma_{\tilde{h}_i, \tilde{h}_j, \nu_a^R, \nu_a^R} \\
& + \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^9 B_0(p^2, m_{\nu_a^i}^2, m_{\nu_b^i}^2) \Gamma_{\tilde{h}_j, \nu_a^i, \nu_b^i} \Gamma_{\tilde{h}_i, \nu_a^i, \nu_b^i} \\
& + \sum_{a=1}^9 \sum_{b=1}^9 B_0(p^2, m_{\nu_a^R}^2, m_{\nu_b^i}^2) \Gamma_{\tilde{h}_j, \nu_a^R, \nu_b^i} \Gamma_{\tilde{h}_i, \nu_a^R, \nu_b^i} \\
& + \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^9 B_0(p^2, m_{\nu_a^R}^2, m_{\nu_b^R}^2) \Gamma_{\tilde{h}_j, \nu_a^R, \nu_b^R} \Gamma_{\tilde{h}_i, \nu_a^R, \nu_b^R} \\
& - \sum_{a=1}^9 m_{\nu_a} \sum_{b=1}^9 B_0(p^2, m_{\nu_a}^2, m_{\nu_b}^2) m_{\nu_b} \left( \Gamma_{\tilde{h}_j, \nu_a, \nu_b}^{L*} \Gamma_{\tilde{h}_i, \nu_a, \nu_b}^R + \Gamma_{\tilde{h}_j, \nu_a, \nu_b}^{R*} \Gamma_{\tilde{h}_i, \nu_a, \nu_b}^L \right) \\
& + \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^9 G_0(p^2, m_{\nu_a}^2, m_{\nu_b}^2) \left( \Gamma_{\tilde{h}_j, \nu_a, \nu_b}^{L*} \Gamma_{\tilde{h}_i, \nu_a, \nu_b}^L + \Gamma_{\tilde{h}_j, \nu_a, \nu_b}^{R*} \Gamma_{\tilde{h}_i, \nu_a, \nu_b}^R \right) \\
& + \sum_{b=1}^2 \Gamma_{\tilde{h}_j, Z, A_b^0}^* \Gamma_{\tilde{h}_i, Z, A_b^0} F_0(p^2, m_{A_b^0}^2, m_Z^2) + 2 \sum_{b=1}^2 \Gamma_{\tilde{h}_j, W^+, H_b^-}^* \Gamma_{\tilde{h}_i, W^+, H_b^-} F_0(p^2, m_{H_b^-}^2, m_{W^-}^2) \tag{183}
\end{aligned}$$

• **Self-Energy for Pseudo-Scalar Higgs ( $A^0$ )**

$$\begin{aligned}
\Pi_{i,j}(p^2) &= -B_0(p^2, m_{\eta^-}^2, m_{\eta^-}^2) \Gamma_{\tilde{A}_i^0, \eta^-, \eta^-} \Gamma_{\tilde{A}_j^0, \eta^-, \eta^-} - B_0(p^2, m_{\eta^+}^2, m_{\eta^+}^2) \Gamma_{\tilde{A}_i^0, \eta^+, \eta^+} \Gamma_{\tilde{A}_j^0, \eta^+, \eta^+} \\
& + 4\Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - \frac{1}{2} \sum_{a=1}^2 A_0(m_{A_a^0}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, A_a^0, A_a^0} - \sum_{a=1}^2 A_0(m_{H_a^-}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^2 A_0(m_{h_a}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, h_a, h_a} + \sum_{a=1}^2 \sum_{b=1}^2 B_0(p^2, m_{H_a^-}^2, m_{H_b^-}^2) \Gamma_{\tilde{A}_j^0, H_a^+, H_b^-}^* \Gamma_{\tilde{A}_i^0, H_a^+, H_b^-} \\
& + \sum_{a=1}^2 \sum_{b=1}^2 B_0(p^2, m_{h_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{A}_j^0, h_a, A_b^0}^* \Gamma_{\tilde{A}_i^0, h_a, A_b^0} \\
& - 2 \sum_{a=1}^2 m_{\tilde{\chi}_a^-} \sum_{b=1}^2 B_0(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{\chi}_b^-}^2) m_{\tilde{\chi}_b^-} \left( \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^R + \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^L \right)
\end{aligned}$$

$$\begin{aligned}
& + \sum_{a=1}^2 \sum_{b=1}^2 G_0(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{\chi}_b^-}^2) \left( \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^L + \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^R \right) \\
& - 6 \sum_{a=1}^3 m_{d_a} \sum_{b=1}^3 B_0(p^2, m_{d_a}^2, m_{d_b}^2) m_{d_b} \left( \Gamma_{\tilde{A}_j^0, \tilde{d}_a, d_b}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{d}_a, d_b}^R + \Gamma_{\tilde{A}_j^0, \tilde{d}_a, d_b}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{d}_a, d_b}^L \right) \\
& + 3 \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{d_a}^2, m_{d_b}^2) \left( \Gamma_{\tilde{A}_j^0, \tilde{d}_a, d_b}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{d}_a, d_b}^L + \Gamma_{\tilde{A}_j^0, \tilde{d}_a, d_b}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{d}_a, d_b}^R \right) \\
& - 2 \sum_{a=1}^3 m_{e_a} \sum_{b=1}^3 B_0(p^2, m_{e_a}^2, m_{e_b}^2) m_{e_b} \left( \Gamma_{\tilde{A}_j^0, \tilde{e}_a, e_b}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{e}_a, e_b}^R + \Gamma_{\tilde{A}_j^0, \tilde{e}_a, e_b}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{e}_a, e_b}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{e_a}^2, m_{e_b}^2) \left( \Gamma_{\tilde{A}_j^0, \tilde{e}_a, e_b}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{e}_a, e_b}^L + \Gamma_{\tilde{A}_j^0, \tilde{e}_a, e_b}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{e}_a, e_b}^R \right) \\
& - 6 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^3 B_0(p^2, m_{u_a}^2, m_{u_b}^2) m_{u_b} \left( \Gamma_{\tilde{A}_j^0, \tilde{u}_a, u_b}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{u}_a, u_b}^R + \Gamma_{\tilde{A}_j^0, \tilde{u}_a, u_b}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{u}_a, u_b}^L \right) \\
& + 3 \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{u_a}^2, m_{u_b}^2) \left( \Gamma_{\tilde{A}_j^0, \tilde{u}_a, u_b}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{u}_a, u_b}^L + \Gamma_{\tilde{A}_j^0, \tilde{u}_a, u_b}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{u}_a, u_b}^R \right) \\
& - \sum_{a=1}^4 m_{\tilde{\chi}_a^0} \sum_{b=1}^4 B_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^0}^2) m_{\tilde{\chi}_b^0} \left( \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^L \right) \\
& + \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 G_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^0}^2) \left( \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^R \right) \\
& - 3 \sum_{a=1}^6 A_0(m_{d_a}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, \tilde{d}_a^*, \tilde{d}_a} - \sum_{a=1}^6 A_0(m_{e_a}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, \tilde{e}_a^*, \tilde{e}_a} \\
& - 3 \sum_{a=1}^6 A_0(m_{u_a}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, \tilde{u}_a^*, \tilde{u}_a} + 3 \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{d_a}^2, m_{d_b}^2) \Gamma_{\tilde{A}_j^0, \tilde{d}_a^*, \tilde{d}_b}^* \Gamma_{\tilde{A}_i^0, \tilde{d}_a^*, \tilde{d}_b} \\
& + \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{e_a}^2, m_{e_b}^2) \Gamma_{\tilde{A}_j^0, \tilde{e}_a^*, \tilde{e}_b}^* \Gamma_{\tilde{A}_i^0, \tilde{e}_a^*, \tilde{e}_b} \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{u_a}^2, m_{u_b}^2) \Gamma_{\tilde{A}_j^0, \tilde{u}_a^*, \tilde{u}_b}^* \Gamma_{\tilde{A}_i^0, \tilde{u}_a^*, \tilde{u}_b} - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^i}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, \nu_a^i, \nu_a^i} \\
& - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^R}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, \nu_a^R, \nu_a^R} + \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^9 B_0(p^2, m_{\nu_a^i}^2, m_{\nu_b^i}^2) \Gamma_{\tilde{A}_j^0, \nu_a^i, \nu_b^i}^* \Gamma_{\tilde{A}_i^0, \nu_a^i, \nu_b^i} \\
& + \sum_{a=1}^9 \sum_{b=1}^9 B_0(p^2, m_{\nu_a^R}^2, m_{\nu_b^i}^2) \Gamma_{\tilde{A}_j^0, \nu_a^R, \nu_b^i}^* \Gamma_{\tilde{A}_i^0, \nu_a^R, \nu_b^i}
\end{aligned}$$

$$\begin{aligned}
& + \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^9 B_0(p^2, m_{\nu_a^R}^2, m_{\nu_b^R}^2) \Gamma_{\tilde{A}_j^0, \nu_a^R, \nu_b^R}^* \Gamma_{\tilde{A}_i^0, \nu_a^R, \nu_b^R} \\
& - \sum_{a=1}^9 m_{\nu_a} \sum_{b=1}^9 B_0(p^2, m_{\nu_a}^2, m_{\nu_b}^2) m_{\nu_b} \left( \Gamma_{\tilde{A}_j^0, \nu_a, \nu_b}^{L*} \Gamma_{\tilde{A}_i^0, \nu_a, \nu_b}^R + \Gamma_{\tilde{A}_j^0, \nu_a, \nu_b}^{R*} \Gamma_{\tilde{A}_i^0, \nu_a, \nu_b}^L \right) \\
& + \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^9 G_0(p^2, m_{\nu_a}^2, m_{\nu_b}^2) \left( \Gamma_{\tilde{A}_j^0, \nu_a, \nu_b}^{L*} \Gamma_{\tilde{A}_i^0, \nu_a, \nu_b}^L + \Gamma_{\tilde{A}_j^0, \nu_a, \nu_b}^{R*} \Gamma_{\tilde{A}_i^0, \nu_a, \nu_b}^R \right) \\
& + \sum_{b=1}^2 \Gamma_{\tilde{A}_j^0, Z, h_b}^* \Gamma_{\tilde{A}_i^0, Z, h_b} F_0(p^2, m_{h_b}^2, m_Z^2) + 2 \sum_{b=1}^2 \Gamma_{\tilde{A}_j^0, W^+, H_b^-}^* \Gamma_{\tilde{A}_i^0, W^+, H_b^-} F_0(p^2, m_{H_b^-}^2, m_{W^-}^2) \quad (184)
\end{aligned}$$

• Self-Energy for Charged Higgs ( $H^-$ )

$$\begin{aligned}
\Pi_{i,j}(p^2) = & +4 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, 0, m_{W^-}^2) \right) \Gamma_{\tilde{H}_j^+, W^-, \gamma}^* \Gamma_{\tilde{H}_i^+, W^-, \gamma} + 4 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{W^-}^2, m_Z^2) \right) \Gamma_{\tilde{H}_j^+, Z, W^-}^* \Gamma_{\tilde{H}_i^+, Z, W^-} \\
& - B_0(p^2, m_{\eta^Z}^2, m_{\eta^+}^2) \Gamma_{\tilde{H}_j^+, \eta^+, \eta^Z} \Gamma_{\tilde{H}_i^-, \eta^+, \eta^Z} - B_0(p^2, m_{\eta^-}^2, m_{\eta^Z}^2) \Gamma_{\tilde{H}_j^+, \eta^Z, \eta^-} \Gamma_{\tilde{H}_i^-, \eta^Z, \eta^-} \\
& + 4 \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2 \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - \frac{1}{2} \sum_{a=1}^2 A_0(m_{A_a^0}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, A_a^0, A_a^0} - \sum_{a=1}^2 A_0(m_{H_a^-}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^2 A_0(m_{h_a}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, h_a, h_a} + \sum_{a=1}^2 \sum_{b=1}^2 B_0(p^2, m_{H_a^-}^2, m_{A_b^0}^2) \Gamma_{\tilde{H}_j^+, H_a^-, A_b^0}^* \Gamma_{\tilde{H}_i^+, H_a^-, A_b^0} \\
& + \sum_{a=1}^2 \sum_{b=1}^2 B_0(p^2, m_{H_a^-}^2, m_{h_b}^2) \Gamma_{\tilde{H}_j^+, H_a^-, h_b}^* \Gamma_{\tilde{H}_i^+, H_a^-, h_b} \\
& - 6 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^3 B_0(p^2, m_{u_a}^2, m_{d_b}^2) m_{d_b} \left( \Gamma_{\tilde{H}_j^+, \bar{u}_a, d_b}^{L*} \Gamma_{\tilde{H}_i^+, \bar{u}_a, d_b}^R + \Gamma_{\tilde{H}_j^+, \bar{u}_a, d_b}^{R*} \Gamma_{\tilde{H}_i^+, \bar{u}_a, d_b}^L \right) \\
& + 3 \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{u_a}^2, m_{d_b}^2) \left( \Gamma_{\tilde{H}_j^+, \bar{u}_a, d_b}^{L*} \Gamma_{\tilde{H}_i^+, \bar{u}_a, d_b}^L + \Gamma_{\tilde{H}_j^+, \bar{u}_a, d_b}^{R*} \Gamma_{\tilde{H}_i^+, \bar{u}_a, d_b}^R \right) \\
& - 2 \sum_{a=1}^4 m_{\tilde{\chi}_a^0} \sum_{b=1}^2 B_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^-}^2) m_{\tilde{\chi}_b^-} \left( \Gamma_{\tilde{H}_j^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{H}_i^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^R + \Gamma_{\tilde{H}_j^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{H}_i^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^L \right) \\
& + \sum_{a=1}^4 \sum_{b=1}^2 G_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^-}^2) \left( \Gamma_{\tilde{H}_j^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{H}_i^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^L + \Gamma_{\tilde{H}_j^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{H}_i^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^R \right) \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, \tilde{d}_a, \tilde{d}_a} - \sum_{a=1}^6 A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, \tilde{e}_a, \tilde{e}_a}
\end{aligned}$$

$$\begin{aligned}
& -3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, \tilde{u}_a^*, \tilde{u}_a} + 3 \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{\tilde{u}_a}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{H}_j^+, \tilde{u}_a^*, \tilde{d}_b} \Gamma_{\tilde{H}_i^+, \tilde{u}_a^*, \tilde{d}_b} \\
& - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^i}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, \nu_a^i, \nu_a^i} - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^R}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, \nu_a^R, \nu_a^R} \\
& - 2 \sum_{a=1}^9 m_{\nu_a} \sum_{b=1}^3 B_0(p^2, m_{\nu_a}^2, m_{e_b}^2) m_{e_b} \left( \Gamma_{\tilde{H}_j^+, \nu_a, e_b}^{L*} \Gamma_{\tilde{H}_i^+, \nu_a, e_b}^R + \Gamma_{\tilde{H}_j^+, \nu_a, e_b}^{R*} \Gamma_{\tilde{H}_i^+, \nu_a, e_b}^L \right) \\
& + \sum_{a=1}^9 \sum_{b=1}^3 G_0(p^2, m_{\nu_a}^2, m_{e_b}^2) \left( \Gamma_{\tilde{H}_j^+, \nu_a, e_b}^{L*} \Gamma_{\tilde{H}_i^+, \nu_a, e_b}^L + \Gamma_{\tilde{H}_j^+, \nu_a, e_b}^{R*} \Gamma_{\tilde{H}_i^+, \nu_a, e_b}^R \right) \\
& + \sum_{a=1}^9 \sum_{b=1}^6 B_0(p^2, m_{\nu_a^i}^2, m_{\tilde{e}_b}^2) \Gamma_{\tilde{H}_j^+, \nu_a^i, \tilde{e}_b} \Gamma_{\tilde{H}_i^+, \nu_a^i, \tilde{e}_b} \\
& + \sum_{a=1}^9 \sum_{b=1}^6 B_0(p^2, m_{\nu_a^R}^2, m_{\tilde{e}_b}^2) \Gamma_{\tilde{H}_j^+, \nu_a^R, \tilde{e}_b} \Gamma_{\tilde{H}_i^+, \nu_a^R, \tilde{e}_b} + \sum_{b=1}^2 \Gamma_{\tilde{H}_j^+, W^-, A_b^0} \Gamma_{\tilde{H}_i^+, W^-, A_b^0} F_0(p^2, m_{A_b^0}^2, m_{W^-}^2) \\
& + \sum_{b=1}^2 \Gamma_{\tilde{H}_j^+, W^-, h_b} \Gamma_{\tilde{H}_i^+, W^-, h_b} F_0(p^2, m_{h_b}^2, m_{W^-}^2) + \sum_{b=1}^2 \Gamma_{\tilde{H}_j^+, \gamma, H_b^-} \Gamma_{\tilde{H}_i^+, \gamma, H_b^-} F_0(p^2, m_{H_b^-}^2, 0) \\
& + \sum_{b=1}^2 \Gamma_{\tilde{H}_j^+, Z, H_b^-} \Gamma_{\tilde{H}_i^+, Z, H_b^-} F_0(p^2, m_{H_b^-}^2, m_Z^2) \tag{185}
\end{aligned}$$

• Self-Energy for Neutralinos ( $\tilde{\chi}^0$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) & = +2 \sum_{a=1}^2 \sum_{b=1}^2 B_0(p^2, m_{\tilde{\chi}_b^-}^2, m_{H_a^-}^2) \Gamma_{\tilde{\chi}_j^0, H_a^+, \tilde{\chi}_b^-}^{L*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{\chi}_i^0, H_a^+, \tilde{\chi}_b^-}^R \\
& + \sum_{a=1}^2 \sum_{b=1}^4 B_0(p^2, m_{\tilde{\chi}_b^0}^2, m_{h_a}^2) \Gamma_{\tilde{\chi}_j^0, h_a, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\chi}_i^0, h_a, \tilde{\chi}_b^0}^R \\
& + \sum_{a=1}^4 m_{\tilde{\chi}_a^0} \sum_{b=1}^2 B_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{A_b^0}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{\chi}_a^0, A_b^0}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{\chi}_a^0, A_b^0}^R \\
& + 6 \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{d_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{d}_a^*, d_b}^{L*} m_{d_b} \Gamma_{\tilde{\chi}_i^0, \tilde{d}_a^*, d_b}^R \\
& + 2 \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{e_b}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{e}_a^*, e_b}^{L*} m_{e_b} \Gamma_{\tilde{\chi}_i^0, \tilde{e}_a^*, e_b}^R \\
& + 6 \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{u_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{u}_a^*, u_b}^{L*} m_{u_b} \Gamma_{\tilde{\chi}_i^0, \tilde{u}_a^*, u_b}^R
\end{aligned}$$

$$\begin{aligned}
& + \sum_{a=1}^9 \sum_{b=1}^9 B_0 \left( p^2, m_{\nu_b}^2, m_{\nu_a^i}^2 \right) \Gamma_{\tilde{\chi}_j^0, \nu_a^i, \nu_b}^{L*} m_{\nu_b} \Gamma_{\tilde{\chi}_i^0, \nu_a^i, \nu_b}^R \\
& + \sum_{a=1}^9 \sum_{b=1}^9 B_0 \left( p^2, m_{\nu_b}^2, m_{\nu_a^R}^2 \right) \Gamma_{\tilde{\chi}_j^0, \nu_a^R, \nu_b}^{L*} m_{\nu_b} \Gamma_{\tilde{\chi}_i^0, \nu_a^R, \nu_b}^R \\
& - 8 \sum_{b=1}^2 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{W^-}^2 \right) \right) \Gamma_{\tilde{\chi}_j^0, W^+, \tilde{\chi}_b^-}^{R*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{\chi}_i^0, W^+, \tilde{\chi}_b^-}^L \\
& - 4 \sum_{b=1}^4 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_Z^2 \right) \right) \Gamma_{\tilde{\chi}_j^0, Z, \tilde{\chi}_b^0}^{R*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\chi}_i^0, Z, \tilde{\chi}_b^0}^L \tag{186}
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^R(p^2) = & - \sum_{a=1}^2 \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{\chi}_j^0, H_a^+, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\chi}_i^0, H_a^+, \tilde{\chi}_b^-}^R \\
& - \frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^4 B_1 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{h_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, h_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\chi}_i^0, h_a, \tilde{\chi}_b^0}^R \\
& - \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{\chi}_a^0, A_b^0}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{\chi}_a^0, A_b^0}^R \\
& - 3 \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{d_b}^2, m_{\tilde{d}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{d}_a^*, d_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{d}_a^*, d_b}^R \\
& - \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{e_b}^2, m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{e}_a^*, e_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{e}_a^*, e_b}^R \\
& - 3 \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{u_b}^2, m_{\tilde{u}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{u}_a^*, u_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{u}_a^*, u_b}^R \\
& - \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^9 B_1 \left( p^2, m_{\nu_b}^2, m_{\nu_a^i}^2 \right) \Gamma_{\tilde{\chi}_j^0, \nu_a^i, \nu_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \nu_a^i, \nu_b}^R \\
& - \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^9 B_1 \left( p^2, m_{\nu_b}^2, m_{\nu_a^R}^2 \right) \Gamma_{\tilde{\chi}_j^0, \nu_a^R, \nu_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \nu_a^R, \nu_b}^R \\
& - 2 \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{W^-}^2 \right) \Gamma_{\tilde{\chi}_j^0, W^+, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\chi}_i^0, W^+, \tilde{\chi}_b^-}^L - \sum_{b=1}^4 B_1 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_Z^2 \right) \Gamma_{\tilde{\chi}_j^0, Z, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\chi}_i^0, Z, \tilde{\chi}_b^0}^L \tag{187}
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) = & - \sum_{a=1}^2 \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{\chi}_j^0, H_a^+, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\chi}_i^0, H_a^+, \tilde{\chi}_b^-}^L \\
& - \frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^4 B_1 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{h_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, h_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\chi}_i^0, h_a, \tilde{\chi}_b^0}^L
\end{aligned}$$

$$\begin{aligned}
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{\chi}_a^0, A_b^0}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{\chi}_a^0, A_b^0}^L \\
& - 3 \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{d_b}^2, m_{\tilde{d}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{d}_a^*, d_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{d}_a^*, d_b}^L \\
& - \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{e_b}^2, m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{e}_a^*, e_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{e}_a^*, e_b}^L \\
& - 3 \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{u_b}^2, m_{\tilde{u}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{u}_a^*, u_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{u}_a^*, u_b}^L \\
& - \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^9 B_1 \left( p^2, m_{\nu_b}^2, m_{\nu_a^i}^2 \right) \Gamma_{\tilde{\chi}_j^0, \nu_a^i, \nu_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \nu_a^i, \nu_b}^L \\
& - \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^9 B_1 \left( p^2, m_{\nu_b}^2, m_{\nu_a^R}^2 \right) \Gamma_{\tilde{\chi}_j^0, \nu_a^R, \nu_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \nu_a^R, \nu_b}^L \\
& - 2 \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{W^-}^2 \right) \Gamma_{\tilde{\chi}_j^0, W^+, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\chi}_i^0, W^+, \tilde{\chi}_b^-}^R - \sum_{b=1}^4 B_1 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_Z^2 \right) \Gamma_{\tilde{\chi}_j^0, Z, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\chi}_i^0, Z, \tilde{\chi}_b^0}^R \quad (188)
\end{aligned}$$

• Self-Energy for Neutrinos ( $\nu$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) & = +2 \sum_{a=1}^2 \sum_{b=1}^3 B_0 \left( p^2, m_{e_b}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{\nu}_j, H_a^+, e_b}^{L*} m_{e_b} \Gamma_{\tilde{\nu}_i, H_a^+, e_b}^R \\
& + \sum_{a=1}^2 \sum_{b=1}^9 B_0 \left( p^2, m_{\nu_b}^2, m_{h_a}^2 \right) \Gamma_{\tilde{\nu}_j, h_a, \nu_b}^{L*} m_{\nu_b} \Gamma_{\tilde{\nu}_i, h_a, \nu_b}^R \\
& + 2 \sum_{a=1}^6 \sum_{b=1}^2 B_0 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{\nu}_j, \tilde{e}_a^*, \tilde{\chi}_b^-}^{L*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{\nu}_i, \tilde{e}_a^*, \tilde{\chi}_b^-}^R \\
& + \sum_{a=1}^9 m_{\nu_a} \sum_{b=1}^2 B_0 \left( p^2, m_{\nu_a}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{\nu}_j, \nu_a, A_b^0}^{L*} \Gamma_{\tilde{\nu}_i, \nu_a, A_b^0}^R \\
& + \sum_{a=1}^9 \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{\nu_a^i}^2 \right) \Gamma_{\tilde{\nu}_j, \nu_a^i, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\nu}_i, \nu_a^i, \tilde{\chi}_b^0}^R \\
& + \sum_{a=1}^9 \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{\nu_a^R}^2 \right) \Gamma_{\tilde{\nu}_j, \nu_a^R, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\nu}_i, \nu_a^R, \tilde{\chi}_b^0}^R \\
& - 8 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_{e_b}^2, m_{W^-}^2 \right) \right) \Gamma_{\tilde{\nu}_j, W^+, e_b}^{R*} m_{e_b} \Gamma_{\tilde{\nu}_i, W^+, e_b}^L
\end{aligned}$$

$$\begin{aligned}
& -4 \sum_{b=1}^9 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\nu_b}^2, m_Z^2) \right) \Gamma_{\tilde{\nu}_j, Z, \nu_b}^{R*} m_{\nu_b} \Gamma_{\tilde{\nu}_i, Z, \nu_b}^L \quad (189) \\
\Sigma_{i,j}^R(p^2) = & - \sum_{a=1}^2 \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{\nu}_j, H_a^+, e_b}^{R*} \Gamma_{\tilde{\nu}_i, H_a^+, e_b}^R \\
& - \frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^9 B_1(p^2, m_{\nu_b}^2, m_{h_a}^2) \Gamma_{\tilde{\nu}_j, h_a, \nu_b}^{R*} \Gamma_{\tilde{\nu}_i, h_a, \nu_b}^R \\
& - \sum_{a=1}^6 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{\nu}_j, \tilde{e}_a^*, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\nu}_i, \tilde{e}_a^*, \tilde{\chi}_b^-}^R \\
& - \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^2 B_1(p^2, m_{\nu_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{\nu}_j, \nu_a, A_b^0}^{R*} \Gamma_{\tilde{\nu}_i, \nu_a, A_b^0}^R \\
& - \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\nu_a^i}^2) \Gamma_{\tilde{\nu}_j, \nu_a^i, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\nu}_i, \nu_a^i, \tilde{\chi}_b^0}^R \\
& - \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\nu_a^R}^2) \Gamma_{\tilde{\nu}_j, \nu_a^R, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\nu}_i, \nu_a^R, \tilde{\chi}_b^0}^R - 2 \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_{W^-}^2) \Gamma_{\tilde{\nu}_j, W^+, e_b}^{L*} \Gamma_{\tilde{\nu}_i, W^+, e_b}^L \\
& - \sum_{b=1}^9 B_1(p^2, m_{\nu_b}^2, m_Z^2) \Gamma_{\tilde{\nu}_j, Z, \nu_b}^{L*} \Gamma_{\tilde{\nu}_i, Z, \nu_b}^L \quad (190)
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) = & - \sum_{a=1}^2 \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{\nu}_j, H_a^+, e_b}^{L*} \Gamma_{\tilde{\nu}_i, H_a^+, e_b}^L \\
& - \frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^9 B_1(p^2, m_{\nu_b}^2, m_{h_a}^2) \Gamma_{\tilde{\nu}_j, h_a, \nu_b}^{L*} \Gamma_{\tilde{\nu}_i, h_a, \nu_b}^L \\
& - \sum_{a=1}^6 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{\nu}_j, \tilde{e}_a^*, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\nu}_i, \tilde{e}_a^*, \tilde{\chi}_b^-}^L \\
& - \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^2 B_1(p^2, m_{\nu_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{\nu}_j, \nu_a, A_b^0}^{L*} \Gamma_{\tilde{\nu}_i, \nu_a, A_b^0}^L \\
& - \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\nu_a^i}^2) \Gamma_{\tilde{\nu}_j, \nu_a^i, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\nu}_i, \nu_a^i, \tilde{\chi}_b^0}^L \\
& - \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\nu_a^R}^2) \Gamma_{\tilde{\nu}_j, \nu_a^R, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\nu}_i, \nu_a^R, \tilde{\chi}_b^0}^L - 2 \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_{W^-}^2) \Gamma_{\tilde{\nu}_j, W^+, e_b}^{R*} \Gamma_{\tilde{\nu}_i, W^+, e_b}^R \\
& - \sum_{b=1}^9 B_1(p^2, m_{\nu_b}^2, m_Z^2) \Gamma_{\tilde{\nu}_j, Z, \nu_b}^{R*} \Gamma_{\tilde{\nu}_i, Z, \nu_b}^R \quad (191)
\end{aligned}$$

• Self-Energy for Charginos ( $\tilde{\chi}^-$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) = & + \sum_{a=1}^2 m_{\tilde{\chi}_a^-} \sum_{b=1}^2 B_0(p^2, m_{\tilde{\chi}_a^-}^2, m_{A_b^0}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{\chi}_a^-, A_b^0}^{L*} \Gamma_{\tilde{\chi}_i^+, \tilde{\chi}_a^-, A_b^0}^R \\
& + \sum_{a=1}^2 \sum_{b=1}^2 B_0(p^2, m_{\tilde{\chi}_b^-}^2, m_{h_a}^2) \Gamma_{\tilde{\chi}_j^+, h_a, \tilde{\chi}_b^-}^{L*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{\chi}_i^+, h_a, \tilde{\chi}_b^-}^R \\
& + \sum_{a=1}^2 \sum_{b=1}^4 B_0(p^2, m_{\tilde{\chi}_b^0}^2, m_{H_a^-}^2) \Gamma_{\tilde{\chi}_j^+, H_a^-, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\chi}_i^+, H_a^-, \tilde{\chi}_b^0}^R \\
& + 3 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^6 B_0(p^2, m_{u_a}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{u}_a, \tilde{d}_b}^{L*} \Gamma_{\tilde{\chi}_i^+, \tilde{u}_a, \tilde{d}_b}^R \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{d_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{u}_a^*, d_b}^{L*} m_{d_b} \Gamma_{\tilde{\chi}_i^+, \tilde{u}_a^*, d_b}^R \\
& + \sum_{a=1}^6 \sum_{b=1}^9 B_0(p^2, m_{\nu_b}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{e}_a, \nu_b}^{L*} m_{\nu_b} \Gamma_{\tilde{\chi}_i^+, \tilde{e}_a, \nu_b}^R \\
& + \sum_{a=1}^9 \sum_{b=1}^3 B_0(p^2, m_{e_b}^2, m_{\nu_a^i}^2) \Gamma_{\tilde{\chi}_j^+, \nu_a^i, e_b}^{L*} m_{e_b} \Gamma_{\tilde{\chi}_i^+, \nu_a^i, e_b}^R \\
& + \sum_{a=1}^9 \sum_{b=1}^3 B_0(p^2, m_{e_b}^2, m_{\nu_a^R}^2) \Gamma_{\tilde{\chi}_j^+, \nu_a^R, e_b}^{L*} m_{e_b} \Gamma_{\tilde{\chi}_i^+, \nu_a^R, e_b}^R \\
& - 4 \sum_{b=1}^2 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\tilde{\chi}_b^-}^2, 0) \right) \Gamma_{\tilde{\chi}_j^+, \gamma, \tilde{\chi}_b^-}^{R*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{\chi}_i^+, \gamma, \tilde{\chi}_b^-}^L \\
& - 4 \sum_{b=1}^2 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\tilde{\chi}_b^-}^2, m_Z^2) \right) \Gamma_{\tilde{\chi}_j^+, Z, \tilde{\chi}_b^-}^{R*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{\chi}_i^+, Z, \tilde{\chi}_b^-}^L \\
& - 4 \sum_{b=1}^4 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\tilde{\chi}_b^0}^2, m_{W^-}^2) \right) \Gamma_{\tilde{\chi}_j^+, W^-, \tilde{\chi}_b^0}^{R*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\chi}_i^+, W^-, \tilde{\chi}_b^0}^L \tag{192}
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^R(p^2) = & -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_a^-}^2, m_{A_b^0}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{\chi}_a^-, A_b^0}^{R*} \Gamma_{\tilde{\chi}_i^+, \tilde{\chi}_a^-, A_b^0}^R \\
& - \frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{h_a}^2) \Gamma_{\tilde{\chi}_j^+, h_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\chi}_i^+, h_a, \tilde{\chi}_b^-}^R \\
& - \frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{H_a^-}^2) \Gamma_{\tilde{\chi}_j^+, H_a^-, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\chi}_i^+, H_a^-, \tilde{\chi}_b^0}^R \\
& - \frac{3}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1(p^2, m_{u_a}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{u}_a, \tilde{d}_b}^{R*} \Gamma_{\tilde{\chi}_i^+, \tilde{u}_a, \tilde{d}_b}^R
\end{aligned}$$



$$\begin{aligned}
& -\frac{3}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{u}_a^*, d_b}^{R*} \Gamma_{\tilde{\chi}_i^+, \tilde{u}_a^*, d_b}^R \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^9 B_1(p^2, m_{\nu_b}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{e}_a, \nu_b}^{R*} \Gamma_{\tilde{\chi}_i^+, \tilde{e}_a, \nu_b}^R \\
& -\frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_{\nu_a^i}^2) \Gamma_{\tilde{\chi}_j^+, \nu_a^i, e_b}^{R*} \Gamma_{\tilde{\chi}_i^+, \nu_a^i, e_b}^R \\
& -\frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_{\nu_a^R}^2) \Gamma_{\tilde{\chi}_j^+, \nu_a^R, e_b}^{R*} \Gamma_{\tilde{\chi}_i^+, \nu_a^R, e_b}^R - \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, 0) \Gamma_{\tilde{\chi}_j^+, \gamma, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\chi}_i^+, \gamma, \tilde{\chi}_b^-}^L \\
& - \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_Z^2) \Gamma_{\tilde{\chi}_j^+, Z, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\chi}_i^+, Z, \tilde{\chi}_b^-}^L - \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{W^-}^2) \Gamma_{\tilde{\chi}_j^+, W^-, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\chi}_i^+, W^-, \tilde{\chi}_b^0}^L \quad (193)
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) &= -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_a^-}^2, m_{A_b^0}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{\chi}_a^-, A_b^0}^{L*} \Gamma_{\tilde{\chi}_i^+, \tilde{\chi}_a^-, A_b^0}^L \\
& -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{h_a}^2) \Gamma_{\tilde{\chi}_j^+, h_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\chi}_i^+, h_a, \tilde{\chi}_b^-}^L \\
& -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{H_a^-}^2) \Gamma_{\tilde{\chi}_j^+, H_a^-, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\chi}_i^+, H_a^-, \tilde{\chi}_b^0}^L \\
& -\frac{3}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1(p^2, m_{u_a}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{u}_a, \tilde{d}_b}^{L*} \Gamma_{\tilde{\chi}_i^+, \tilde{u}_a, \tilde{d}_b}^L \\
& -\frac{3}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{u}_a^*, d_b}^{L*} \Gamma_{\tilde{\chi}_i^+, \tilde{u}_a^*, d_b}^L \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^9 B_1(p^2, m_{\nu_b}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{e}_a, \nu_b}^{L*} \Gamma_{\tilde{\chi}_i^+, \tilde{e}_a, \nu_b}^L \\
& -\frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_{\nu_a^i}^2) \Gamma_{\tilde{\chi}_j^+, \nu_a^i, e_b}^{L*} \Gamma_{\tilde{\chi}_i^+, \nu_a^i, e_b}^L \\
& -\frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_{\nu_a^R}^2) \Gamma_{\tilde{\chi}_j^+, \nu_a^R, e_b}^{L*} \Gamma_{\tilde{\chi}_i^+, \nu_a^R, e_b}^L - \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, 0) \Gamma_{\tilde{\chi}_j^+, \gamma, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\chi}_i^+, \gamma, \tilde{\chi}_b^-}^R \\
& - \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_Z^2) \Gamma_{\tilde{\chi}_j^+, Z, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\chi}_i^+, Z, \tilde{\chi}_b^-}^R - \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{W^-}^2) \Gamma_{\tilde{\chi}_j^+, W^-, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\chi}_i^+, W^-, \tilde{\chi}_b^0}^R \quad (194)
\end{aligned}$$

• Self-Energy for Leptons ( $e$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) = & + \sum_{a=1}^2 \sum_{b=1}^3 B_0(p^2, m_{e_b}^2, m_{h_a}^2) \Gamma_{\tilde{e}_j, h_a, e_b}^{L*} m_{e_b} \Gamma_{\tilde{e}_i, h_a, e_b}^R \\
& + \sum_{a=1}^2 \sum_{b=1}^9 B_0(p^2, m_{\nu_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{e}_j, H_a^-, \nu_b}^{L*} m_{\nu_b} \Gamma_{\tilde{e}_i, H_a^-, \nu_b}^R \\
& + \sum_{a=1}^3 m_{e_a} \sum_{b=1}^2 B_0(p^2, m_{e_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{e}_j, e_a, A_b^0}^{L*} \Gamma_{\tilde{e}_i, e_a, A_b^0}^R \\
& + \sum_{a=1}^6 \sum_{b=1}^4 B_0(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{e}_j, \tilde{e}_a, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{e}_i, \tilde{e}_a, \tilde{\chi}_b^0}^R \\
& + \sum_{a=1}^9 \sum_{b=1}^2 B_0(p^2, m_{\tilde{\chi}_b^-}^2, m_{\nu_a^i}^2) \Gamma_{\tilde{e}_j, \nu_a^i, \tilde{\chi}_b^-}^{L*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{e}_i, \nu_a^i, \tilde{\chi}_b^-}^R \\
& + \sum_{a=1}^9 \sum_{b=1}^2 B_0(p^2, m_{\tilde{\chi}_b^-}^2, m_{\nu_a^R}^2) \Gamma_{\tilde{e}_j, \nu_a^R, \tilde{\chi}_b^-}^{L*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{e}_i, \nu_a^R, \tilde{\chi}_b^-}^R \\
& - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{e_b}^2, 0) \right) \Gamma_{\tilde{e}_j, \gamma, e_b}^{R*} m_{e_b} \Gamma_{\tilde{e}_i, \gamma, e_b}^L - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{e_b}^2, m_Z^2) \right) \Gamma_{\tilde{e}_j, Z, e_b}^{R*} m_{e_b} \Gamma_{\tilde{e}_i, Z, e_b}^L \\
& - 4 \sum_{b=1}^9 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\nu_b}^2, m_{W^-}^2) \right) \Gamma_{\tilde{e}_j, W^-, \nu_b}^{R*} m_{\nu_b} \Gamma_{\tilde{e}_i, W^-, \nu_b}^L \tag{195}
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^R(p^2) = & -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_{h_a}^2) \Gamma_{\tilde{e}_j, h_a, e_b}^{R*} \Gamma_{\tilde{e}_i, h_a, e_b}^R \\
& - \frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^9 B_1(p^2, m_{\nu_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{e}_j, H_a^-, \nu_b}^{R*} \Gamma_{\tilde{e}_i, H_a^-, \nu_b}^R \\
& - \frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^2 B_1(p^2, m_{e_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{e}_j, e_a, A_b^0}^{R*} \Gamma_{\tilde{e}_i, e_a, A_b^0}^R \\
& - \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{e}_j, \tilde{e}_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{e}_i, \tilde{e}_a, \tilde{\chi}_b^0}^R \\
& - \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{\nu_a^i}^2) \Gamma_{\tilde{e}_j, \nu_a^i, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{e}_i, \nu_a^i, \tilde{\chi}_b^-}^R \\
& - \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{\nu_a^R}^2) \Gamma_{\tilde{e}_j, \nu_a^R, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{e}_i, \nu_a^R, \tilde{\chi}_b^-}^R - \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, 0) \Gamma_{\tilde{e}_j, \gamma, e_b}^{L*} \Gamma_{\tilde{e}_i, \gamma, e_b}^L \\
& - \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_Z^2) \Gamma_{\tilde{e}_j, Z, e_b}^{L*} \Gamma_{\tilde{e}_i, Z, e_b}^L - \sum_{b=1}^9 B_1(p^2, m_{\nu_b}^2, m_{W^-}^2) \Gamma_{\tilde{e}_j, W^-, \nu_b}^{L*} \Gamma_{\tilde{e}_i, W^-, \nu_b}^L \tag{196}
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) = & -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_{h_a}^2) \Gamma_{\tilde{e}_j, h_a, e_b}^{L*} \Gamma_{\tilde{e}_i, h_a, e_b}^L \\
& -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^9 B_1(p^2, m_{\nu_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{e}_j, H_a^-, \nu_b}^{L*} \Gamma_{\tilde{e}_i, H_a^-, \nu_b}^L \\
& -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^2 B_1(p^2, m_{e_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{e}_j, e_a, A_b^0}^{L*} \Gamma_{\tilde{e}_i, e_a, A_b^0}^L \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{e}_j, \tilde{e}_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{e}_i, \tilde{e}_a, \tilde{\chi}_b^0}^L \\
& -\frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{\nu_a^i}^2) \Gamma_{\tilde{e}_j, \nu_a^i, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{e}_i, \nu_a^i, \tilde{\chi}_b^-}^L \\
& -\frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{\nu_a^R}^2) \Gamma_{\tilde{e}_j, \nu_a^R, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{e}_i, \nu_a^R, \tilde{\chi}_b^-}^L - \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, 0) \Gamma_{\tilde{e}_j, \gamma, e_b}^{R*} \Gamma_{\tilde{e}_i, \gamma, e_b}^R \\
& - \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_Z^2) \Gamma_{\tilde{e}_j, Z, e_b}^{R*} \Gamma_{\tilde{e}_i, Z, e_b}^R - \sum_{b=1}^9 B_1(p^2, m_{\nu_b}^2, m_{W^-}^2) \Gamma_{\tilde{e}_j, W^-, \nu_b}^{R*} \Gamma_{\tilde{e}_i, W^-, \nu_b}^R
\end{aligned} \tag{197}$$

• Self-Energy for Down-Quarks (d)

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) = & + \sum_{a=1}^2 \sum_{b=1}^3 B_0(p^2, m_{d_b}^2, m_{h_a}^2) \Gamma_{\tilde{d}_j, h_a, d_b}^{L*} m_{d_b} \Gamma_{\tilde{d}_i, h_a, d_b}^R \\
& + \sum_{a=1}^2 \sum_{b=1}^3 B_0(p^2, m_{u_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{d}_j, H_a^-, u_b}^{L*} m_{u_b} \Gamma_{\tilde{d}_i, H_a^-, u_b}^R \\
& + \sum_{a=1}^3 m_{d_a} \sum_{b=1}^2 B_0(p^2, m_{d_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{d}_j, d_a, A_b^0}^{L*} \Gamma_{\tilde{d}_i, d_a, A_b^0}^R \\
& + \sum_{a=1}^6 \sum_{b=1}^2 B_0(p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{d}_j, \tilde{u}_a, \tilde{\chi}_b^-}^{L*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{d}_i, \tilde{u}_a, \tilde{\chi}_b^-}^R \\
& + \sum_{a=1}^6 \sum_{b=1}^4 B_0(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{\chi}_b^0}^R \\
& + \frac{4}{3} m_{\tilde{g}} \sum_{a=1}^6 B_0(p^2, m_{\tilde{g}}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{g}_1}^{L*} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{g}_1}^R - \frac{16}{3} \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{d_b}^2, 0) \right) \Gamma_{\tilde{d}_j, g, d_b}^{R*} m_{d_b} \Gamma_{\tilde{d}_i, g, d_b}^L \\
& - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{d_b}^2, 0) \right) \Gamma_{\tilde{d}_j, \gamma, d_b}^{R*} m_{d_b} \Gamma_{\tilde{d}_i, \gamma, d_b}^L
\end{aligned}$$

$$\begin{aligned}
& -4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{u_b}^2, m_{W^-}^2) \right) \Gamma_{\tilde{d}_j, W^-, u_b}^{R*} m_{u_b} \Gamma_{\tilde{d}_i, W^-, u_b}^L \\
& -4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{d_b}^2, m_Z^2) \right) \Gamma_{\tilde{d}_j, Z, d_b}^{R*} m_{d_b} \Gamma_{\tilde{d}_i, Z, d_b}^L
\end{aligned} \tag{198}$$

$$\begin{aligned}
\Sigma_{i,j}^R(p^2) &= -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{h_a}^2) \Gamma_{\tilde{d}_j, h_a, d_b}^{R*} \Gamma_{\tilde{d}_i, h_a, d_b}^R \\
& -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{d}_j, H_a^-, u_b}^{R*} \Gamma_{\tilde{d}_i, H_a^-, u_b}^R \\
& -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^2 B_1(p^2, m_{d_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{d}_j, d_a, A_b^0}^{R*} \Gamma_{\tilde{d}_i, d_a, A_b^0}^R \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{d}_j, \tilde{u}_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{d}_i, \tilde{u}_a, \tilde{\chi}_b^-}^R \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{\chi}_b^0}^R \\
& -\frac{2}{3} \sum_{a=1}^6 B_1(p^2, m_{\tilde{g}}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{g}_1}^{R*} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{g}_1}^R - \frac{4}{3} \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, 0) \Gamma_{\tilde{d}_j, g, d_b}^{L*} \Gamma_{\tilde{d}_i, g, d_b}^L \\
& -\sum_{b=1}^3 B_1(p^2, m_{d_b}^2, 0) \Gamma_{\tilde{d}_j, \gamma, d_b}^{L*} \Gamma_{\tilde{d}_i, \gamma, d_b}^L - \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{W^-}^2) \Gamma_{\tilde{d}_j, W^-, u_b}^{L*} \Gamma_{\tilde{d}_i, W^-, u_b}^L \\
& -\sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_Z^2) \Gamma_{\tilde{d}_j, Z, d_b}^{L*} \Gamma_{\tilde{d}_i, Z, d_b}^L
\end{aligned} \tag{199}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) &= -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{h_a}^2) \Gamma_{\tilde{d}_j, h_a, d_b}^{L*} \Gamma_{\tilde{d}_i, h_a, d_b}^L \\
& -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{d}_j, H_a^-, u_b}^{L*} \Gamma_{\tilde{d}_i, H_a^-, u_b}^L \\
& -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^2 B_1(p^2, m_{d_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{d}_j, d_a, A_b^0}^{L*} \Gamma_{\tilde{d}_i, d_a, A_b^0}^L \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{d}_j, \tilde{u}_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{d}_i, \tilde{u}_a, \tilde{\chi}_b^-}^L \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{\chi}_b^0}^L
\end{aligned}$$

$$\begin{aligned}
& -\frac{2}{3} \sum_{a=1}^6 B_1(p^2, m_{\tilde{g}}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{g}_1}^{L*} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{g}_1}^L - \frac{4}{3} \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, 0) \Gamma_{\tilde{d}_j, g, d_b}^{R*} \Gamma_{\tilde{d}_i, g, d_b}^R \\
& - \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, 0) \Gamma_{\tilde{d}_j, \gamma, d_b}^{R*} \Gamma_{\tilde{d}_i, \gamma, d_b}^R - \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{W^-}^2) \Gamma_{\tilde{d}_j, W^-, u_b}^{R*} \Gamma_{\tilde{d}_i, W^-, u_b}^R \\
& - \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_Z^2) \Gamma_{\tilde{d}_j, Z, d_b}^{R*} \Gamma_{\tilde{d}_i, Z, d_b}^R
\end{aligned} \tag{200}$$

• Self-Energy for Up-Quarks ( $u$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) &= + \sum_{a=1}^2 \sum_{b=1}^3 B_0(p^2, m_{d_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{u}_j, H_a^+, d_b}^{L*} m_{d_b} \Gamma_{\tilde{u}_i, H_a^+, d_b}^R \\
& + \sum_{a=1}^2 \sum_{b=1}^3 B_0(p^2, m_{u_b}^2, m_{h_a}^2) \Gamma_{\tilde{u}_j, h_a, u_b}^{L*} m_{u_b} \Gamma_{\tilde{u}_i, h_a, u_b}^R \\
& + \sum_{a=1}^2 m_{\tilde{\chi}_a^-} \sum_{b=1}^6 B_0(p^2, m_{\tilde{\chi}_a}^2, m_{d_b}^2) \Gamma_{\tilde{u}_j, \tilde{\chi}_a^+, \tilde{d}_b}^{L*} \Gamma_{\tilde{u}_i, \tilde{\chi}_a^+, \tilde{d}_b}^R \\
& + \sum_{a=1}^3 m_{u_a} \sum_{b=1}^2 B_0(p^2, m_{u_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{u}_j, u_a, A_b^0}^{L*} \Gamma_{\tilde{u}_i, u_a, A_b^0}^R \\
& + \sum_{a=1}^6 \sum_{b=1}^4 B_0(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{\chi}_b^0}^R \\
& + \frac{4}{3} m_{\tilde{g}} \sum_{a=1}^6 B_0(p^2, m_{\tilde{g}}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{g}_1}^{L*} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{g}_1}^R - \frac{16}{3} \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{u_b}^2, 0) \right) \Gamma_{\tilde{u}_j, g, u_b}^{R*} m_{u_b} \Gamma_{\tilde{u}_i, g, u_b}^L \\
& - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{u_b}^2, 0) \right) \Gamma_{\tilde{u}_j, \gamma, u_b}^{R*} m_{u_b} \Gamma_{\tilde{u}_i, \gamma, u_b}^L - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{u_b}^2, m_Z^2) \right) \Gamma_{\tilde{u}_j, Z, u_b}^{R*} m_{u_b} \Gamma_{\tilde{u}_i, Z, u_b}^L \\
& - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{d_b}^2, m_{W^-}^2) \right) \Gamma_{\tilde{u}_j, W^+, d_b}^{R*} m_{d_b} \Gamma_{\tilde{u}_i, W^+, d_b}^L
\end{aligned} \tag{201}$$

$$\begin{aligned}
\Sigma_{i,j}^R(p^2) &= -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{u}_j, H_a^+, d_b}^{R*} \Gamma_{\tilde{u}_i, H_a^+, d_b}^R \\
& - \frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{h_a}^2) \Gamma_{\tilde{u}_j, h_a, u_b}^{R*} \Gamma_{\tilde{u}_i, h_a, u_b}^R \\
& - \frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_a}^2, m_{d_b}^2) \Gamma_{\tilde{u}_j, \tilde{\chi}_a^+, \tilde{d}_b}^{R*} \Gamma_{\tilde{u}_i, \tilde{\chi}_a^+, \tilde{d}_b}^R
\end{aligned}$$

$$\begin{aligned}
& -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^2 B_1(p^2, m_{u_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{u}_j, u_a, A_b^0}^{R*} \Gamma_{\tilde{u}_i, u_a, A_b^0}^R \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{\chi}_b^0}^R \\
& -\frac{2}{3} \sum_{a=1}^6 B_1(p^2, m_{\tilde{g}}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{g}_1}^{R*} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{g}_1}^R - \frac{4}{3} \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, 0) \Gamma_{\tilde{u}_j, g, u_b}^{L*} \Gamma_{\tilde{u}_i, g, u_b}^L \\
& -\sum_{b=1}^3 B_1(p^2, m_{u_b}^2, 0) \Gamma_{\tilde{u}_j, \gamma, u_b}^{L*} \Gamma_{\tilde{u}_i, \gamma, u_b}^L - \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_Z^2) \Gamma_{\tilde{u}_j, Z, u_b}^{L*} \Gamma_{\tilde{u}_i, Z, u_b}^L \\
& -\sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{W^-}^2) \Gamma_{\tilde{u}_j, W^+, d_b}^{L*} \Gamma_{\tilde{u}_i, W^+, d_b}^L \tag{202}
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) &= -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{u}_j, H_a^+, d_b}^{L*} \Gamma_{\tilde{u}_i, H_a^+, d_b}^L \\
& -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{h_a}^2) \Gamma_{\tilde{u}_j, h_a, u_b}^{L*} \Gamma_{\tilde{u}_i, h_a, u_b}^L \\
& -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{u}_j, \tilde{\chi}_a^+, \tilde{d}_b}^{L*} \Gamma_{\tilde{u}_i, \tilde{\chi}_a^+, \tilde{d}_b}^L \\
& -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^2 B_1(p^2, m_{u_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{u}_j, u_a, A_b^0}^{L*} \Gamma_{\tilde{u}_i, u_a, A_b^0}^L \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{\chi}_b^0}^L \\
& -\frac{2}{3} \sum_{a=1}^6 B_1(p^2, m_{\tilde{g}}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{g}_1}^{L*} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{g}_1}^L - \frac{4}{3} \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, 0) \Gamma_{\tilde{u}_j, g, u_b}^{R*} \Gamma_{\tilde{u}_i, g, u_b}^R \\
& -\sum_{b=1}^3 B_1(p^2, m_{u_b}^2, 0) \Gamma_{\tilde{u}_j, \gamma, u_b}^{R*} \Gamma_{\tilde{u}_i, \gamma, u_b}^R - \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_Z^2) \Gamma_{\tilde{u}_j, Z, u_b}^{R*} \Gamma_{\tilde{u}_i, Z, u_b}^R \\
& -\sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{W^-}^2) \Gamma_{\tilde{u}_j, W^+, d_b}^{R*} \Gamma_{\tilde{u}_i, W^+, d_b}^R \tag{203}
\end{aligned}$$

• Self-Energy for Gluino ( $\tilde{g}$ )

$$\Sigma^S(p^2) = + \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{d_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{g}_j, \tilde{d}_a^*, d_b}^{L*} m_{d_b} \Gamma_{\tilde{g}_i, \tilde{d}_a^*, d_b}^R$$

$$+ \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{u_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{g}_j, \tilde{u}_a^*, u_b}^{L*} m_{u_b} \Gamma_{\tilde{g}_i, \tilde{u}_a^*, u_b}^R - 12 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\tilde{g}}^2, 0) \right) \Gamma_{\tilde{g}_j, g, \tilde{g}_1}^{R*} m_{\tilde{g}} \Gamma_{\tilde{g}_i, g, \tilde{g}_1}^L \quad (204)$$

$$\begin{aligned} \Sigma^R(p^2) &= -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{g}_j, \tilde{d}_a^*, d_b}^{R*} \Gamma_{\tilde{g}_i, \tilde{d}_a^*, d_b}^R \\ &\quad - \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{g}_j, \tilde{u}_a^*, u_b}^{R*} \Gamma_{\tilde{g}_i, \tilde{u}_a^*, u_b}^R - 3B_1(p^2, m_{\tilde{g}}^2, 0) \Gamma_{\tilde{g}_j, g, \tilde{g}_1}^{L*} \Gamma_{\tilde{g}_i, g, \tilde{g}_1}^L \end{aligned} \quad (205)$$

$$\begin{aligned} \Sigma^L(p^2) &= -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{g}_j, \tilde{d}_a^*, d_b}^{L*} \Gamma_{\tilde{g}_i, \tilde{d}_a^*, d_b}^L \\ &\quad - \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{g}_j, \tilde{u}_a^*, u_b}^{L*} \Gamma_{\tilde{g}_i, \tilde{u}_a^*, u_b}^L - 3B_1(p^2, m_{\tilde{g}}^2, 0) \Gamma_{\tilde{g}_j, g, \tilde{g}_1}^{R*} \Gamma_{\tilde{g}_i, g, \tilde{g}_1}^R \end{aligned} \quad (206)$$

• **Self-Energy for Z-Boson ( $Z$ )**

$$\begin{aligned} \Pi(p^2) &= +|\Gamma_{Z, \eta^-, \eta^-}|^2 B_{00}(p^2, m_{\eta^-}^2, m_{\eta^-}^2) + |\Gamma_{Z, \eta^+, \eta^+}|^2 B_{00}(p^2, m_{\eta^+}^2, m_{\eta^+}^2) \\ &\quad - |\Gamma_{Z, W^+, W^-}|^2 \left( 10B_{00}(p^2, m_{W^-}^2, m_{W^-}^2) + 2A_0(m_{W^-}^2) - 2\text{rMS}(2m_{W^-}^2 - \frac{1}{3}p^2) + B_0(p^2, m_{W^-}^2, m_{W^-}^2) (2m_{W^-}^2 + 4p^2) \right) \\ &\quad + \frac{1}{2} \sum_{a=1}^2 A_0(m_{A_a^0}^2) \Gamma_{Z, Z, A_a^0, A_a^0} + \sum_{a=1}^2 A_0(m_{H_a^-}^2) \Gamma_{Z, Z, H_a^+, H_a^-} + \frac{1}{2} \sum_{a=1}^2 A_0(m_{h_a}^2) \Gamma_{Z, Z, h_a, h_a} \\ &\quad - 4 \sum_{a=1}^2 \sum_{b=1}^2 |\Gamma_{Z, h_a, A_b^0}|^2 B_{00}(p^2, m_{A_b^0}^2, m_{h_a}^2) - 4 \sum_{a=1}^2 \sum_{b=1}^2 |\Gamma_{Z, H_a^+, H_b^-}|^2 B_{00}(p^2, m_{H_a^-}^2, m_{H_b^-}^2) \\ &\quad + \sum_{a=1}^2 \sum_{b=1}^2 \left[ (|\Gamma_{Z, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^L|^2 + |\Gamma_{Z, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^R|^2) H_0(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{\chi}_b^-}^2) \right. \\ &\quad \left. + 4B_0(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{\chi}_b^-}^2) m_{\tilde{\chi}_a^-} m_{\tilde{\chi}_b^-} \Re(\Gamma_{Z, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^{L*} \Gamma_{Z, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^R) \right] \\ &\quad + 3 \sum_{a=1}^3 \sum_{b=1}^3 \left[ (|\Gamma_{Z, \tilde{d}_a, d_b}^L|^2 + |\Gamma_{Z, \tilde{d}_a, d_b}^R|^2) H_0(p^2, m_{d_a}^2, m_{d_b}^2) \right. \\ &\quad \left. + 4B_0(p^2, m_{d_a}^2, m_{d_b}^2) m_{d_a} m_{d_b} \Re(\Gamma_{Z, \tilde{d}_a, d_b}^{L*} \Gamma_{Z, \tilde{d}_a, d_b}^R) \right] \\ &\quad + \sum_{a=1}^3 \sum_{b=1}^3 \left[ (|\Gamma_{Z, \tilde{e}_a, e_b}^L|^2 + |\Gamma_{Z, \tilde{e}_a, e_b}^R|^2) H_0(p^2, m_{e_a}^2, m_{e_b}^2) \right. \\ &\quad \left. + 4B_0(p^2, m_{e_a}^2, m_{e_b}^2) m_{e_a} m_{e_b} \Re(\Gamma_{Z, \tilde{e}_a, e_b}^{L*} \Gamma_{Z, \tilde{e}_a, e_b}^R) \right] \\ &\quad + 3 \sum_{a=1}^3 \sum_{b=1}^3 \left[ (|\Gamma_{Z, \tilde{u}_a, u_b}^L|^2 + |\Gamma_{Z, \tilde{u}_a, u_b}^R|^2) H_0(p^2, m_{u_a}^2, m_{u_b}^2) \right. \end{aligned}$$

$$\begin{aligned}
& + 4B_0\left(p^2, m_{u_a}^2, m_{u_b}^2\right) m_{u_a} m_{u_b} \Re\left(\Gamma_{Z, \bar{u}_a, u_b}^{L*} \Gamma_{Z, \bar{u}_a, u_b}^R\right) \\
& + \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 \left[ \left( |\Gamma_{Z, \bar{\chi}_a^0, \bar{\chi}_b^0}^L|^2 + |\Gamma_{Z, \bar{\chi}_a^0, \bar{\chi}_b^0}^R|^2 \right) H_0\left(p^2, m_{\bar{\chi}_a^0}^2, m_{\bar{\chi}_b^0}^2\right) \right. \\
& + 4B_0\left(p^2, m_{\bar{\chi}_a^0}^2, m_{\bar{\chi}_b^0}^2\right) m_{\bar{\chi}_a^0} m_{\bar{\chi}_b^0} \Re\left(\Gamma_{Z, \bar{\chi}_a^0, \bar{\chi}_b^0}^{L*} \Gamma_{Z, \bar{\chi}_a^0, \bar{\chi}_b^0}^R\right) \\
& + 3 \sum_{a=1}^6 A_0\left(m_{\bar{d}_a}^2\right) \Gamma_{Z, Z, \bar{d}_a, \bar{d}_a} + \sum_{a=1}^6 A_0\left(m_{\bar{e}_a}^2\right) \Gamma_{Z, Z, \bar{e}_a, \bar{e}_a} + 3 \sum_{a=1}^6 A_0\left(m_{\bar{u}_a}^2\right) \Gamma_{Z, Z, \bar{u}_a, \bar{u}_a} \\
& - 12 \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{Z, \bar{d}_a, \bar{d}_b}|^2 B_{00}\left(p^2, m_{\bar{d}_a}^2, m_{\bar{d}_b}^2\right) - 4 \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{Z, \bar{e}_a, \bar{e}_b}|^2 B_{00}\left(p^2, m_{\bar{e}_a}^2, m_{\bar{e}_b}^2\right) \\
& - 12 \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{Z, \bar{u}_a, \bar{u}_b}|^2 B_{00}\left(p^2, m_{\bar{u}_a}^2, m_{\bar{u}_b}^2\right) + \frac{1}{2} \sum_{a=1}^9 A_0\left(m_{\nu_a^i}^2\right) \Gamma_{Z, Z, \nu_a^i, \nu_a^i} \\
& + \frac{1}{2} \sum_{a=1}^9 A_0\left(m_{\nu_a^R}^2\right) \Gamma_{Z, Z, \nu_a^R, \nu_a^R} - 4 \sum_{a=1}^9 \sum_{b=1}^9 |\Gamma_{Z, \nu_a^R, \nu_b^i}|^2 B_{00}\left(p^2, m_{\nu_b^i}^2, m_{\nu_a^R}^2\right) \\
& + \frac{1}{2} \sum_{a=1}^9 \sum_{b=1}^9 \left[ \left( |\Gamma_{Z, \nu_a, \nu_b}^L|^2 + |\Gamma_{Z, \nu_a, \nu_b}^R|^2 \right) H_0\left(p^2, m_{\nu_a}^2, m_{\nu_b}^2\right) \right. \\
& + 4B_0\left(p^2, m_{\nu_a}^2, m_{\nu_b}^2\right) m_{\nu_a} m_{\nu_b} \Re\left(\Gamma_{Z, \nu_a, \nu_b}^{L*} \Gamma_{Z, \nu_a, \nu_b}^R\right) \\
& + 2 \sum_{b=1}^2 |\Gamma_{Z, W^+, H_b^-}|^2 B_0\left(p^2, m_{W^-}^2, m_{H_b^-}^2\right) + \sum_{b=1}^2 |\Gamma_{Z, Z, h_b}|^2 B_0\left(p^2, m_Z^2, m_{h_b}^2\right) + 2\text{rMS} m_W^2 - \Gamma_{Z, Z, W^+, W^-}^1 \\
& - A_0\left(m_{W^-}^2\right) \left( 4\Gamma_{Z, Z, W^+, W^-}^1 + \Gamma_{Z, Z, W^+, W^-}^2 + \Gamma_{Z, Z, W^+, W^-}^3 \right) \tag{207}
\end{aligned}$$

• Self-Energy for W-Boson ( $W^-$ )

$$\begin{aligned}
\Pi(p^2) = & -12 \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{W^+, \bar{u}_a, \bar{d}_b}|^2 B_{00}\left(p^2, m_{\bar{d}_b}^2, m_{\bar{u}_a}^2\right) + 2\text{rMS} m_W^2 - \Gamma_{W^-, W^+, W^+, W^-}^1 + 3 \sum_{a=1}^3 \sum_{b=1}^3 \left[ \left( |\Gamma_{W^+, \bar{u}_a, d_b}^L|^2 + |\Gamma_{W^+, \bar{u}_a, d_b}^R|^2 \right) H_0\left(p^2, m_{\bar{u}_a}^2, m_{d_b}^2\right) \right. \\
& + 4B_0\left(p^2, m_{u_a}^2, m_{d_b}^2\right) m_{d_b} m_{u_a} \Re\left(\Gamma_{W^+, \bar{u}_a, d_b}^{L*} \Gamma_{W^+, \bar{u}_a, d_b}^R\right) \left. + 3 \sum_{a=1}^6 A_0\left(m_{\bar{d}_a}^2\right) \Gamma_{W^-, W^+, \bar{d}_a, \bar{d}_a} + 3 \sum_{a=1}^6 A_0\left(m_{\bar{u}_a}^2\right) \Gamma_{W^-, W^+, \bar{u}_a, \bar{u}_a} \right. \\
& + 4B_0\left(p^2, m_{\bar{\chi}_a^0}^2, m_{\bar{\chi}_b^-}^2\right) m_{\bar{\chi}_b^-} m_{\bar{\chi}_a^0} \Re\left(\Gamma_{W^+, \bar{\chi}_a^0, \bar{\chi}_b^-}^{L*} \Gamma_{W^+, \bar{\chi}_a^0, \bar{\chi}_b^-}^R\right) \left. + \sum_{a=1}^6 A_0\left(m_{\bar{e}_a}^2\right) \Gamma_{W^-, W^+, \bar{e}_a, \bar{e}_a} + \sum_{a=1}^9 \sum_{b=1}^3 \left[ \left( |\Gamma_{W^+, \nu_a, e_b}^L|^2 + |\Gamma_{W^+, \nu_a, e_b}^R|^2 \right) H_0\left(p^2, m_{\nu_a}^2, m_{e_b}^2\right) \right. \right. \\
& \left. + 4B_0\left(p^2, m_{\nu_a}^2, m_{e_b}^2\right) m_{e_b} m_{\nu_a} \Re\left(\Gamma_{W^+, \nu_a, e_b}^{L*} \Gamma_{W^+, \nu_a, e_b}^R\right) \right. \left. + \sum_{b=1}^2 |\Gamma_{W^+, \gamma, H_b^-}|^2 B_0\left(p^2, 0, m_{H_b^-}^2\right) + \sum_{b=1}^2 |\Gamma_{W^+, W^-, h_b}|^2 B_0\left(p^2, m_{W^-}^2, m_{h_b}^2\right) \right] \tag{208}
\end{aligned}$$



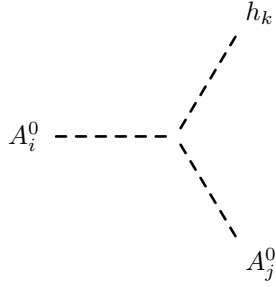
## 8.2 Tadpoles

$$\begin{aligned}
\delta t_h^{(1)} = & + A_0(m_{\eta^-}^2) \Gamma_{\tilde{h}_i, \eta^-, \eta^-} + A_0(m_{\eta^+}^2) \Gamma_{\tilde{h}_i, \eta^+, \eta^+} + A_0(m_{\eta^Z}^2) \Gamma_{\tilde{h}_i, \eta^Z, \eta^Z} \\
& + 4\Gamma_{\tilde{h}_i, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{h}_i, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) - \frac{1}{2} \sum_{a=1}^2 A_0(m_{A_a^0}^2) \Gamma_{\tilde{h}_i, A_a^0, A_a^0} \\
& - \sum_{a=1}^2 A_0(m_{H_a^-}^2) \Gamma_{\tilde{h}_i, H_a^+, H_a^-} - \frac{1}{2} \sum_{a=1}^2 A_0(m_{h_a}^2) \Gamma_{\tilde{h}_i, h_a, h_a} \\
& + 2 \sum_{a=1}^2 A_0(m_{\tilde{\chi}_a^-}^2) m_{\tilde{\chi}_a^-} \left( \Gamma_{\tilde{h}_i, \tilde{\chi}_a^+, \tilde{\chi}_a^-}^L + \Gamma_{\tilde{h}_i, \tilde{\chi}_a^+, \tilde{\chi}_a^-}^R \right) \\
& + 6 \sum_{a=1}^3 A_0(m_{\tilde{d}_a}^2) m_{\tilde{d}_a} \left( \Gamma_{\tilde{h}_i, \tilde{d}_a, \tilde{d}_a}^L + \Gamma_{\tilde{h}_i, \tilde{d}_a, \tilde{d}_a}^R \right) \\
& + 2 \sum_{a=1}^3 A_0(m_{\tilde{e}_a}^2) m_{\tilde{e}_a} \left( \Gamma_{\tilde{h}_i, \tilde{e}_a, \tilde{e}_a}^L + \Gamma_{\tilde{h}_i, \tilde{e}_a, \tilde{e}_a}^R \right) \\
& + 6 \sum_{a=1}^3 A_0(m_{\tilde{u}_a}^2) m_{\tilde{u}_a} \left( \Gamma_{\tilde{h}_i, \tilde{u}_a, \tilde{u}_a}^L + \Gamma_{\tilde{h}_i, \tilde{u}_a, \tilde{u}_a}^R \right) + \sum_{a=1}^4 A_0(m_{\tilde{\chi}_a^0}^2) m_{\tilde{\chi}_a^0} \left( \Gamma_{\tilde{h}_i, \tilde{\chi}_a^0, \tilde{\chi}_a^0}^L + \Gamma_{\tilde{h}_i, \tilde{\chi}_a^0, \tilde{\chi}_a^0}^R \right) \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\tilde{h}_i, \tilde{d}_a^*, \tilde{d}_a} - \sum_{a=1}^6 A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{h}_i, \tilde{e}_a^*, \tilde{e}_a} - 3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{h}_i, \tilde{u}_a^*, \tilde{u}_a} \\
& - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^i}^2) \Gamma_{\tilde{h}_i, \nu_a^i, \nu_a^i} - \frac{1}{2} \sum_{a=1}^9 A_0(m_{\nu_a^R}^2) \Gamma_{\tilde{h}_i, \nu_a^R, \nu_a^R} \\
& + \sum_{a=1}^9 A_0(m_{\nu_a}^2) m_{\nu_a} \left( \Gamma_{\tilde{h}_i, \nu_a, \nu_a}^L + \Gamma_{\tilde{h}_i, \nu_a, \nu_a}^R \right) \tag{209}
\end{aligned}$$

$$\delta t_{\nu^R}^{(1)} = 0 \tag{210}$$

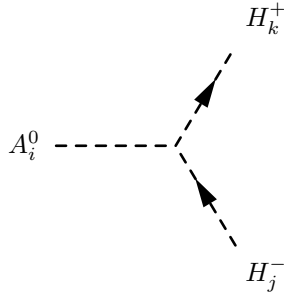
## 9 Interactions for eigenstates 'EWSB'

### 9.1 Three Scalar-Interaction



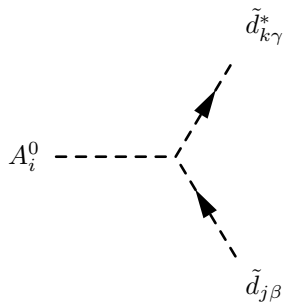
$$-\frac{i}{4}(g_1^2 + g_2^2)(Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A)(v_d Z_{k1}^H - v_u Z_{k2}^H) \quad (211)$$


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$$\frac{1}{4}g_2^2(v_d Z_{i2}^A + v_u Z_{i1}^A)(-Z_{j1}^+ Z_{k2}^+ + Z_{j2}^+ Z_{k1}^+) \quad (212)$$

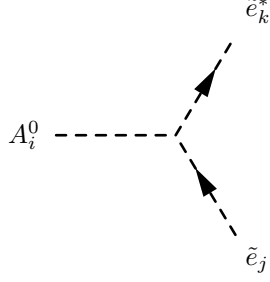

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$$\frac{1}{\sqrt{2}}\delta_{\beta\gamma}\left(\sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Z_{k3+a}^D T_{d,ab} Z_{i1}^A - \sum_{b=1}^3 \sum_{a=1}^3 Z_{j3+a}^{D,*} T_{d,ab}^* Z_{kb}^D Z_{i1}^A\right)$$

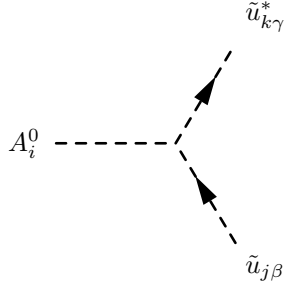
$$+ \left( -\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D + \mu^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \right) Z_{i2}^A \quad (213)$$


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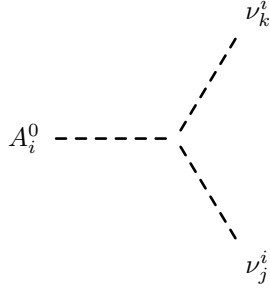
$$\frac{1}{\sqrt{2}} \left( \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Z_{k3+a}^E T_{e,ab} Z_{i1}^A - \sum_{b=1}^3 \sum_{a=1}^3 Z_{j3+a}^{E,*} T_{e,ab}^* Z_{kb}^E Z_{i1}^A \right) + \left( -\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E + \mu^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \right) Z_{i2}^A \quad (214)$$


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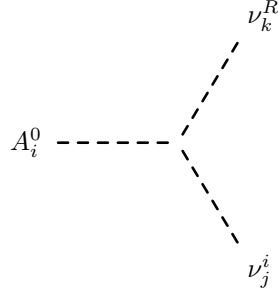


$$\frac{1}{\sqrt{2}} \delta_{\beta\gamma} \left( \mu^* \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U Z_{i1}^A - \mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{kb}^U Z_{i1}^A \right) + \left( -\sum_{b=1}^3 \sum_{a=1}^3 Z_{j3+a}^{U,*} T_{u,ab}^* Z_{kb}^U + \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Z_{k3+a}^U T_{u,ab} \right) Z_{i2}^A \quad (215)$$


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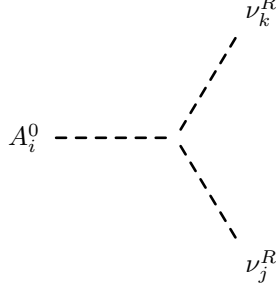


$$\begin{aligned}
& \frac{1}{2} \frac{1}{\sqrt{2}} \left( -\mu \sum_{b=1}^3 Z_{\sigma\nu, kb}^* \sum_{a=1}^3 Y_{\nu, ab}^* Z_{\sigma\nu, j3+a}^* Z_{i1}^A + \mu \sum_{b=1}^3 Z_{\sigma\nu, kb}^* \sum_{a=1}^3 Y_{SL, ab}^* Z_{\sigma\nu, j6+a}^* Z_{i1}^A \right. \\
& - \mu \sum_{b=1}^3 Z_{\sigma\nu, jb}^* \sum_{a=1}^3 Y_{\nu, ab}^* Z_{\sigma\nu, k3+a}^* Z_{i1}^A + \mu \sum_{b=1}^3 Z_{\sigma\nu, jb}^* \sum_{a=1}^3 Y_{SL, ab}^* Z_{\sigma\nu, k6+a}^* Z_{i1}^A \\
& - \mu^* \sum_{b=1}^3 Z_{\sigma\nu, kb}^* \sum_{a=1}^3 Z_{\sigma\nu, j6+a}^* Y_{SL, ab} Z_{i1}^A - \mu^* \sum_{b=1}^3 Z_{\sigma\nu, jb}^* \sum_{a=1}^3 Z_{\sigma\nu, k6+a}^* Y_{SL, ab} Z_{i1}^A \\
& + \mu^* \sum_{b=1}^3 Z_{\sigma\nu, kb}^* \sum_{a=1}^3 Z_{\sigma\nu, j3+a}^* Y_{\nu, ab} Z_{i1}^A + \mu^* \sum_{b=1}^3 Z_{\sigma\nu, jb}^* \sum_{a=1}^3 Z_{\sigma\nu, k3+a}^* Y_{\nu, ab} Z_{i1}^A \\
& + \sum_{b=1}^3 Z_{\sigma\nu, kb}^* \sum_{a=1}^3 Z_{\sigma\nu, j6+a}^* T_{Y, SL_{ab}^*} Z_{i2}^A + \sum_{b=1}^3 Z_{\sigma\nu, jb}^* \sum_{a=1}^3 Z_{\sigma\nu, k6+a}^* T_{Y, SL_{ab}^*} Z_{i2}^A \\
& - \sum_{b=1}^3 Z_{\sigma\nu, kb}^* \sum_{a=1}^3 Z_{\sigma\nu, j3+a}^* T_{\nu, ab}^* Z_{i2}^A - \sum_{b=1}^3 Z_{\sigma\nu, jb}^* \sum_{a=1}^3 Z_{\sigma\nu, k3+a}^* T_{\nu, ab}^* Z_{i2}^A \\
& - \sum_{b=1}^3 Z_{\sigma\nu, kb}^* \sum_{a=1}^3 Z_{\sigma\nu, j6+a}^* T_{Y_{SL, ab}} Z_{i2}^A - \sum_{b=1}^3 Z_{\sigma\nu, jb}^* \sum_{a=1}^3 Z_{\sigma\nu, k6+a}^* T_{Y_{SL, ab}} Z_{i2}^A \\
& + \sum_{b=1}^3 Z_{\sigma\nu, kb}^* \sum_{a=1}^3 Z_{\sigma\nu, j3+a}^* T_{\nu, ab} Z_{i2}^A + \sum_{b=1}^3 Z_{\sigma\nu, jb}^* \sum_{a=1}^3 Z_{\sigma\nu, k3+a}^* T_{\nu, ab} Z_{i2}^A \\
& - \sum_{c=1}^3 Z_{\sigma\nu, kc}^* \sum_{b=1}^3 Z_{\sigma\nu, j6+b}^* \sum_{a=1}^3 Y_{\nu, ac}^* M_{R, ab} Z_{i2}^A - \sum_{c=1}^3 Z_{\sigma\nu, jc}^* \sum_{b=1}^3 Z_{\sigma\nu, k6+b}^* \sum_{a=1}^3 Y_{\nu, ac}^* M_{R, ab} Z_{i2}^A \\
& + \sum_{c=1}^3 Z_{\sigma\nu, kc}^* \sum_{b=1}^3 Z_{\sigma\nu, j3+b}^* \sum_{a=1}^3 Y_{SL, ac}^* M_{R, ba} Z_{i2}^A + \sum_{c=1}^3 Z_{\sigma\nu, jc}^* \sum_{b=1}^3 Z_{\sigma\nu, k3+b}^* \sum_{a=1}^3 Y_{SL, ac}^* M_{R, ba} Z_{i2}^A \\
& - \sum_{c=1}^3 Z_{\sigma\nu, k3+c}^* \sum_{b=1}^3 Z_{\sigma\nu, jb}^* \sum_{a=1}^3 M_{R, ca}^* Y_{SL, ab} Z_{i2}^A - \sum_{c=1}^3 Z_{\sigma\nu, j3+c}^* \sum_{b=1}^3 Z_{\sigma\nu, kb}^* \sum_{a=1}^3 M_{R, ca}^* Y_{SL, ab} Z_{i2}^A \\
& \left. + \sum_{c=1}^3 Z_{\sigma\nu, k6+c}^* \sum_{b=1}^3 Z_{\sigma\nu, jb}^* \sum_{a=1}^3 M_{R, ac}^* Y_{\nu, ab} Z_{i2}^A + \sum_{c=1}^3 Z_{\sigma\nu, j6+c}^* \sum_{b=1}^3 Z_{\sigma\nu, kb}^* \sum_{a=1}^3 M_{R, ac}^* Y_{\nu, ab} Z_{i2}^A \right) \quad (216)
\end{aligned}$$



$$\begin{aligned}
& \frac{i}{2} \frac{1}{\sqrt{2}} \left( \mu \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{\nu, ab}^* Z_{\phi v, k3+a}^* Z_{i1}^A + \mu \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{SL, ab}^* Z_{\phi v, k6+a}^* Z_{i1}^A \right. \\
& - \mu \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{\nu, ab}^* Z_{\sigma v, j3+a}^* Z_{i1}^A + \mu \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{SL, ab}^* Z_{\sigma v, j6+a}^* Z_{i1}^A \\
& + \mu^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} Z_{i1}^A + \mu^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} Z_{i1}^A \\
& + \mu^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} Z_{i1}^A - \mu^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} Z_{i1}^A \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* T_{Y, SL_{ab}}^* Z_{i2}^A + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* T_{Y, SL_{ab}}^* Z_{i2}^A \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* T_{\nu, ab}^* Z_{i2}^A - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* T_{\nu, ab}^* Z_{i2}^A \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* T_{Y_{SL, ab}} Z_{i2}^A + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* T_{Y_{SL, ab}} Z_{i2}^A \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* T_{\nu, ab} Z_{i2}^A - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* T_{\nu, ab} Z_{i2}^A \\
& + \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ac}^* M_{R, ab} Z_{i2}^A - \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{\nu, ac}^* M_{R, ab} Z_{i2}^A \\
& + \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{SL, ac}^* M_{R, ba} Z_{i2}^A + \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\sigma v, j3+b}^* \sum_{a=1}^3 Y_{SL, ac}^* M_{R, ba} Z_{i2}^A \\
& + \sum_{c=1}^3 Z_{\sigma v, j3+c}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 M_{R, ca}^* Y_{SL, ab} Z_{i2}^A + \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 M_{R, ca}^* Y_{SL, ab} Z_{i2}^A
\end{aligned}$$

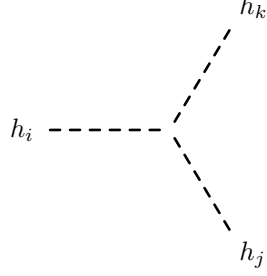
$$- \sum_{c=1}^3 Z_{\sigma v, j6+c}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 M_{R,ac}^* Y_{\nu, ab} Z_{i2}^A + \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 M_{R,ac}^* Y_{\nu, ab} Z_{i2}^A \quad (217)$$



$$\begin{aligned} & \frac{1}{2} \frac{1}{\sqrt{2}} \left( -\mu \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{\nu, ab}^* Z_{\phi v, j3+a}^* Z_{i1}^A - \mu \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{SL, ab}^* Z_{\phi v, j6+a}^* Z_{i1}^A \right. \\ & - \mu \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Y_{\nu, ab}^* Z_{\phi v, k3+a}^* Z_{i1}^A - \mu \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Y_{SL, ab}^* Z_{\phi v, k6+a}^* Z_{i1}^A \\ & + \mu^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} Z_{i1}^A + \mu^* \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} Z_{i1}^A \\ & + \mu^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} Z_{i1}^A + \mu^* \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} Z_{i1}^A \\ & - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* T_{Y, SL_{ab}^*} Z_{i2}^A - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* T_{Y, SL_{ab}^*} Z_{i2}^A \\ & - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* T_{\nu, ab}^* Z_{i2}^A - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* T_{\nu, ab}^* Z_{i2}^A \\ & + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* T_{Y_{SL, ab}} Z_{i2}^A + \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* T_{Y_{SL, ab}} Z_{i2}^A \\ & + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* T_{\nu, ab} Z_{i2}^A + \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* T_{\nu, ab} Z_{i2}^A \\ & - \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\phi v, j6+b}^* \sum_{a=1}^3 Y_{\nu, ac}^* M_{R, ab} Z_{i2}^A - \sum_{c=1}^3 Z_{\phi v, jc}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ac}^* M_{R, ab} Z_{i2}^A \\ & - \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\phi v, j3+b}^* \sum_{a=1}^3 Y_{SL, ac}^* M_{R, ba} Z_{i2}^A - \sum_{c=1}^3 Z_{\phi v, jc}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{SL, ac}^* M_{R, ba} Z_{i2}^A \\ & + \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 M_{R, ca}^* Y_{SL, ab} Z_{i2}^A + \sum_{c=1}^3 Z_{\phi v, j3+c}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 M_{R, ca}^* Y_{SL, ab} Z_{i2}^A \end{aligned}$$

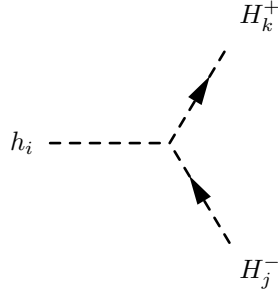
$$+ \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 M_{R,ac}^* Y_{\nu,ab} Z_{i2}^A + \sum_{c=1}^3 Z_{\phi v, j6+c}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 M_{R,ac}^* Y_{\nu,ab} Z_{i2}^A \quad (218)$$


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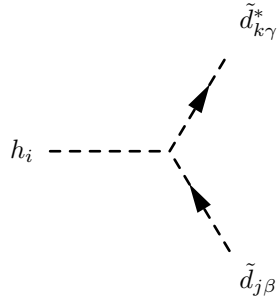
$$\begin{aligned} & \frac{i}{4} (g_1^2 + g_2^2) \left( Z_{i2}^H \left( Z_{j1}^H (v_d Z_{k2}^H + v_u Z_{k1}^H) + Z_{j2}^H (-3v_u Z_{k2}^H + v_d Z_{k1}^H) \right) \right. \\ & \left. + Z_{i1}^H \left( Z_{j1}^H (-3v_d Z_{k1}^H + v_u Z_{k2}^H) + Z_{j2}^H (v_d Z_{k2}^H + v_u Z_{k1}^H) \right) \right) \end{aligned} \quad (219)$$


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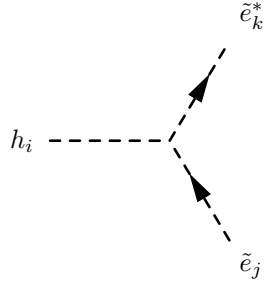


$$\begin{aligned} & -\frac{i}{4} \left( Z_{i1}^H \left( Z_{j1}^+ \left( (g_1^2 + g_2^2) v_d Z_{k1}^+ + g_2^2 v_u Z_{k2}^+ \right) + Z_{j2}^+ \left( (-g_1^2 + g_2^2) v_d Z_{k2}^+ + g_2^2 v_u Z_{k1}^+ \right) \right) \right. \\ & \left. + Z_{i2}^H \left( Z_{j1}^+ \left( (-g_1^2 + g_2^2) v_u Z_{k1}^+ + g_2^2 v_d Z_{k2}^+ \right) + Z_{j2}^+ \left( (g_1^2 + g_2^2) v_u Z_{k2}^+ + g_2^2 v_d Z_{k1}^+ \right) \right) \right) \end{aligned} \quad (220)$$


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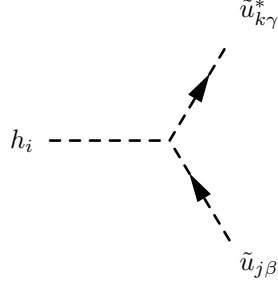


$$\begin{aligned}
& \frac{i}{12} \delta_{\beta\gamma} \left( (3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D (v_d Z_{i1}^H - v_u Z_{i2}^H) \right. \\
& + 2 \left( g_1^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D (v_d Z_{i1}^H - v_u Z_{i2}^H) \right. \\
& - 3 \left( \sqrt{2} \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Z_{k3+a}^D T_{d,ab} Z_{i1}^H + \sqrt{2} \sum_{b=1}^3 \sum_{a=1}^3 Z_{j3+a}^{D,*} T_{d,ab}^* Z_{kb}^D Z_{i1}^H \right. \\
& + 2v_d \sum_{c=1}^3 Z_{j3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{d,ba} Z_{k3+b}^D Z_{i1}^H + 2v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{kc}^D Z_{i1}^H \\
& \left. \left. - \sqrt{2} \mu^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D Z_{i2}^H - \sqrt{2} \mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D Z_{i2}^H \right) \right) \quad (221)
\end{aligned}$$

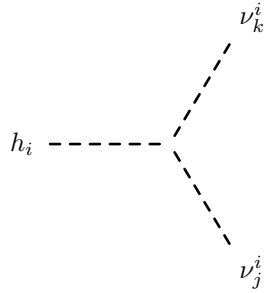


$$\begin{aligned}
& - \frac{i}{4} \left( (-g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E (v_d Z_{i1}^H - v_u Z_{i2}^H) \right. \\
& + 2 \left( \sqrt{2} \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Z_{k3+a}^E T_{e,ab} Z_{i1}^H + \sqrt{2} \sum_{b=1}^3 \sum_{a=1}^3 Z_{j3+a}^{E,*} T_{e,ab}^* Z_{kb}^E Z_{i1}^H \right. \\
& + 2v_d \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ca}^* Y_{e,ba} Z_{k3+b}^E Z_{i1}^H + 2v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{kc}^E Z_{i1}^H \\
& \left. - \sqrt{2} \mu^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i2}^H - \sqrt{2} \mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E Z_{i2}^H \right) \\
& + g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E \left( -v_d Z_{i1}^H + v_u Z_{i2}^H \right) \quad (222)
\end{aligned}$$





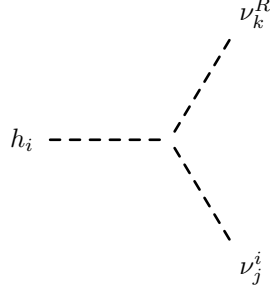
$$\begin{aligned}
& \frac{i}{12} \delta_{\beta\gamma} \left( \left( -3g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \left( v_d Z_{i1}^H - v_u Z_{i2}^H \right) \right. \\
& - 2 \left( -3\sqrt{2}\mu^* \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U Z_{i1}^H - 3\sqrt{2}\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{kb}^U Z_{i1}^H \right. \\
& + 3\sqrt{2} \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Z_{k3+a}^U T_{u,ab} Z_{i2}^H + 3\sqrt{2} \sum_{b=1}^3 \sum_{a=1}^3 Z_{j3+a}^{U,*} T_{u,ab}^* Z_{kb}^U Z_{i2}^H \\
& + 6v_u \sum_{c=1}^3 Z_{j3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{u,ba} Z_{k3+b}^U Z_{i2}^H + 6v_u \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{kc}^U Z_{i2}^H \\
& \left. \left. + 2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \left( v_d Z_{i1}^H - v_u Z_{i2}^H \right) \right) \right) \tag{223}
\end{aligned}$$



$$\begin{aligned}
& -\frac{i}{4} \left( -\sqrt{2}\mu \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Y_{\nu, ab}^* Z_{\sigma v, j3+a}^* Z_{i1}^H + \sqrt{2}\mu \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Y_{SL, ab}^* Z_{\sigma v, j6+a}^* Z_{i1}^H \right. \\
& - \sqrt{2}\mu \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{\nu, ab}^* Z_{\sigma v, k3+a}^* Z_{i1}^H + \sqrt{2}\mu \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{SL, ab}^* Z_{\sigma v, k6+a}^* Z_{i1}^H \\
& \left. + \sqrt{2}\mu^* \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} Z_{i1}^H + \sqrt{2}\mu^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} Z_{i1}^H \right)
\end{aligned}$$

$$\begin{aligned}
& -\sqrt{2}\mu^* \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} Z_{i1}^H - \sqrt{2}\mu^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} Z_{i1}^H \\
& -\sqrt{2} \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* T_{Y, SL_{ab}^*} Z_{i2}^H - \sqrt{2} \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* T_{Y, SL_{ab}^*} Z_{i2}^H \\
& +\sqrt{2} \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* T_{\nu, ab}^* Z_{i2}^H + \sqrt{2} \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* T_{\nu, ab}^* Z_{i2}^H \\
& -\sqrt{2} \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* T_{Y_{SL, ab}} Z_{i2}^H - \sqrt{2} \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* T_{Y_{SL, ab}} Z_{i2}^H \\
& +\sqrt{2} \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* T_{\nu, ab} Z_{i2}^H + \sqrt{2} \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* T_{\nu, ab} Z_{i2}^H \\
& +\sqrt{2} \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{\nu, ac}^* M_{R, ab} Z_{i2}^H + \sqrt{2} \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{\sigma v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ac}^* M_{R, ab} Z_{i2}^H \\
& -\sqrt{2} \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{\sigma v, j3+b}^* \sum_{a=1}^3 Y_{SL, ac}^* M_{R, ba} Z_{i2}^H \\
& -\sqrt{2} \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{SL, ac}^* M_{R, ba} Z_{i2}^H \\
& -\sqrt{2} \sum_{c=1}^3 Z_{\sigma v, k3+c}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 M_{R, ca}^* Y_{SL, ab} Z_{i2}^H \\
& -\sqrt{2} \sum_{c=1}^3 Z_{\sigma v, j3+c}^* \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 M_{R, ca}^* Y_{SL, ab} Z_{i2}^H + 2v_u \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} Z_{i2}^H + 2v_u \sum_{c=1}^3 Z_{\sigma v, k6+c}^* \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\sigma v, j6+c}^* \sum_{b=1}^3 Z_{\sigma v, k6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} Z_{i2}^H \\
& - 2v_u \sum_{c=1}^3 Z_{\sigma v, k3+c}^* \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} Z_{i2}^H \\
& - 2v_u \sum_{c=1}^3 Z_{\sigma v, j3+c}^* \sum_{b=1}^3 Z_{\sigma v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} Z_{i2}^H \\
& + \sqrt{2} \sum_{c=1}^3 Z_{\sigma v, k6+c}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 M_{R, ac}^* Y_{\nu, ab} Z_{i2}^H + \sqrt{2} \sum_{c=1}^3 Z_{\sigma v, j6+c}^* \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 M_{R, ac}^* Y_{\nu, ab} Z_{i2}^H
\end{aligned}$$

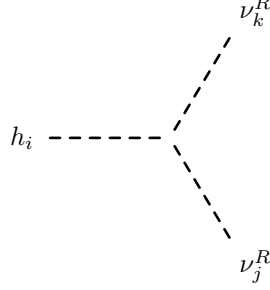
$$\begin{aligned}
& + 2v_u \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} Z_{i2}^H + 2v_u \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} Z_{i2}^H \\
& - 2v_u \sum_{c=1}^3 Z_{\sigma v, k6+c}^* \sum_{b=1}^3 Z_{\sigma v, j3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} Z_{i2}^H \\
& - 2v_u \sum_{c=1}^3 Z_{\sigma v, j6+c}^* \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\sigma v, k3+c}^* \sum_{b=1}^3 Z_{\sigma v, j3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\sigma v, j3+c}^* \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} Z_{i2}^H \\
& + \left( g_1^2 + g_2^2 \right) \sum_{a=1}^3 Z_{\sigma v, ja}^* Z_{\sigma v, ka}^* \left( v_d Z_{i1}^H - v_u Z_{i2}^H \right)
\end{aligned} \tag{224}$$



$$\begin{aligned}
& \frac{1}{4} \left( \sqrt{2}\mu \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{\nu, ab}^* Z_{\phi v, k3+a}^* Z_{i1}^H + \sqrt{2}\mu \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{SL, ab}^* Z_{\phi v, k6+a}^* Z_{i1}^H \right. \\
& - \sqrt{2}\mu \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{\nu, ab}^* Z_{\sigma v, j3+a}^* Z_{i1}^H + \sqrt{2}\mu \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{SL, ab}^* Z_{\sigma v, j6+a}^* Z_{i1}^H \\
& - \sqrt{2}\mu^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab}^* Z_{i1}^H - \sqrt{2}\mu^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab}^* Z_{i1}^H \\
& - \sqrt{2}\mu^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab}^* Z_{i1}^H + \sqrt{2}\mu^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab}^* Z_{i1}^H \\
& - \sqrt{2} \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* T_{Y, SL_{ab}^*} Z_{i2}^H - \sqrt{2} \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* T_{Y, SL_{ab}^*} Z_{i2}^H \\
& \left. - \sqrt{2} \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* T_{\nu, ab}^* Z_{i2}^H + \sqrt{2} \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* T_{\nu, ab}^* Z_{i2}^H \right)
\end{aligned}$$

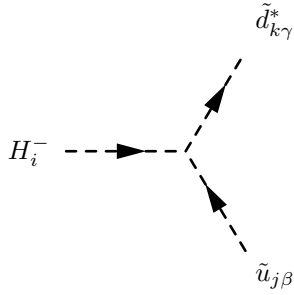
$$\begin{aligned}
& + \sqrt{2} \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* T_{Y_{SL}, ab} Z_{i2}^H + \sqrt{2} \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* T_{Y_{SL}, ab} Z_{i2}^H \\
& + \sqrt{2} \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* T_{\nu, ab} Z_{i2}^H - \sqrt{2} \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* T_{\nu, ab} Z_{i2}^H \\
& - \sqrt{2} \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ac}^* M_{R, ab} Z_{i2}^H + \sqrt{2} \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{\nu, ac}^* M_{R, ab} Z_{i2}^H \\
& - \sqrt{2} \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{SL, ac}^* M_{R, ba} Z_{i2}^H \\
& - \sqrt{2} \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\sigma v, j3+b}^* \sum_{a=1}^3 Y_{SL, ac}^* M_{R, ba} Z_{i2}^H + \sqrt{2} \sum_{c=1}^3 Z_{\sigma v, j3+c}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 M_{R, ca}^* Y_{SL, ab} Z_{i2}^H \\
& + \sqrt{2} \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 M_{R, ca}^* Y_{SL, ab} Z_{i2}^H - 2v_u \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} Z_{i2}^H \\
& - 2v_u \sum_{c=1}^3 Z_{\sigma v, j6+c}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\sigma v, j3+c}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} Z_{i2}^H \\
& - \sqrt{2} \sum_{c=1}^3 Z_{\sigma v, j6+c}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 M_{R, ac}^* Y_{\nu, ab} Z_{i2}^H + \sqrt{2} \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 M_{R, ac}^* Y_{\nu, ab} Z_{i2}^H \\
& - 2v_u \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} Z_{i2}^H + 2v_u \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} Z_{i2}^H \\
& - 2v_u \sum_{c=1}^3 Z_{\sigma v, j6+c}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} Z_{i2}^H \\
& - 2v_u \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\sigma v, j3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} Z_{i2}^H
\end{aligned}$$

$$\begin{aligned}
& + 2v_u \sum_{c=1}^3 Z_{\sigma\nu,j3+c}^* \sum_{b=1}^3 Z_{\phi\nu,k3+b}^* \sum_{a=1}^3 Y_{\nu,ca}^* Y_{\nu,ba} Z_{i2}^H \\
& - 2v_u \sum_{c=1}^3 Z_{\phi\nu,k3+c}^* \sum_{b=1}^3 Z_{\sigma\nu,j3+b}^* \sum_{a=1}^3 Y_{\nu,ca}^* Y_{\nu,ba} Z_{i2}^H
\end{aligned} \tag{225}$$

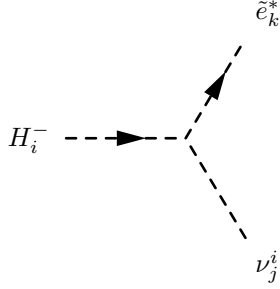


$$\begin{aligned}
& - \frac{i}{4} \left( -\sqrt{2}\mu \sum_{b=1}^3 Z_{\phi\nu,kb}^* \sum_{a=1}^3 Y_{\nu,ab}^* Z_{\phi\nu,j3+a}^* Z_{i1}^H - \sqrt{2}\mu \sum_{b=1}^3 Z_{\phi\nu,kb}^* \sum_{a=1}^3 Y_{SL,ab}^* Z_{\phi\nu,j6+a}^* Z_{i1}^H \right. \\
& - \sqrt{2}\mu \sum_{b=1}^3 Z_{\phi\nu,jb}^* \sum_{a=1}^3 Y_{\nu,ab}^* Z_{\phi\nu,k3+a}^* Z_{i1}^H - \sqrt{2}\mu \sum_{b=1}^3 Z_{\phi\nu,jb}^* \sum_{a=1}^3 Y_{SL,ab}^* Z_{\phi\nu,k6+a}^* Z_{i1}^H \\
& - \sqrt{2}\mu^* \sum_{b=1}^3 Z_{\phi\nu,kb}^* \sum_{a=1}^3 Z_{\phi\nu,j6+a}^* Y_{SL,ab} Z_{i1}^H - \sqrt{2}\mu^* \sum_{b=1}^3 Z_{\phi\nu,jb}^* \sum_{a=1}^3 Z_{\phi\nu,k6+a}^* Y_{SL,ab} Z_{i1}^H \\
& - \sqrt{2}\mu^* \sum_{b=1}^3 Z_{\phi\nu,kb}^* \sum_{a=1}^3 Z_{\phi\nu,j3+a}^* Y_{\nu,ab} Z_{i1}^H - \sqrt{2}\mu^* \sum_{b=1}^3 Z_{\phi\nu,jb}^* \sum_{a=1}^3 Z_{\phi\nu,k3+a}^* Y_{\nu,ab} Z_{i1}^H \\
& + \sqrt{2} \sum_{b=1}^3 Z_{\phi\nu,kb}^* \sum_{a=1}^3 Z_{\phi\nu,j6+a}^* T_{Y,SL_{ab}^*} Z_{i2}^H + \sqrt{2} \sum_{b=1}^3 Z_{\phi\nu,jb}^* \sum_{a=1}^3 Z_{\phi\nu,k6+a}^* T_{Y,SL_{ab}^*} Z_{i2}^H \\
& + \sqrt{2} \sum_{b=1}^3 Z_{\phi\nu,kb}^* \sum_{a=1}^3 Z_{\phi\nu,j3+a}^* T_{\nu,ab}^* Z_{i2}^H + \sqrt{2} \sum_{b=1}^3 Z_{\phi\nu,jb}^* \sum_{a=1}^3 Z_{\phi\nu,k3+a}^* T_{\nu,ab}^* Z_{i2}^H \\
& + \sqrt{2} \sum_{b=1}^3 Z_{\phi\nu,kb}^* \sum_{a=1}^3 Z_{\phi\nu,j6+a}^* T_{Y_{SL,ab}} Z_{i2}^H + \sqrt{2} \sum_{b=1}^3 Z_{\phi\nu,jb}^* \sum_{a=1}^3 Z_{\phi\nu,k6+a}^* T_{Y_{SL,ab}} Z_{i2}^H \\
& + \sqrt{2} \sum_{b=1}^3 Z_{\phi\nu,kb}^* \sum_{a=1}^3 Z_{\phi\nu,j3+a}^* T_{\nu,ab} Z_{i2}^H + \sqrt{2} \sum_{b=1}^3 Z_{\phi\nu,jb}^* \sum_{a=1}^3 Z_{\phi\nu,k3+a}^* T_{\nu,ab} Z_{i2}^H \\
& + \sqrt{2} \sum_{c=1}^3 Z_{\phi\nu,kc}^* \sum_{b=1}^3 Z_{\phi\nu,j6+b}^* \sum_{a=1}^3 Y_{\nu,ac}^* M_{R,ab} Z_{i2}^H + \sqrt{2} \sum_{c=1}^3 Z_{\phi\nu,jc}^* \sum_{b=1}^3 Z_{\phi\nu,k6+b}^* \sum_{a=1}^3 Y_{\nu,ac}^* M_{R,ab} Z_{i2}^H \\
& + \sqrt{2} \sum_{c=1}^3 Z_{\phi\nu,kc}^* \sum_{b=1}^3 Z_{\phi\nu,j3+b}^* \sum_{a=1}^3 Y_{SL,ac}^* M_{R,ba} Z_{i2}^H + \sqrt{2} \sum_{c=1}^3 Z_{\phi\nu,jc}^* \sum_{b=1}^3 Z_{\phi\nu,k3+b}^* \sum_{a=1}^3 Y_{SL,ac}^* M_{R,ba} Z_{i2}^H
\end{aligned}$$

$$\begin{aligned}
& + \sqrt{2} \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 M_{R, ca}^* Y_{SL, ab} Z_{i2}^H + \sqrt{2} \sum_{c=1}^3 Z_{\phi v, j3+c}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 M_{R, ca}^* Y_{SL, ab} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} Z_{i2}^H + 2v_u \sum_{c=1}^3 Z_{\phi v, jc}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, j6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\phi v, j6+c}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, j6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\phi v, j3+c}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} Z_{i2}^H + \sqrt{2} \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 M_{R, ac}^* Y_{\nu, ab} Z_{i2}^H \\
& + \sqrt{2} \sum_{c=1}^3 Z_{\phi v, j6+c}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 M_{R, ac}^* Y_{\nu, ab} Z_{i2}^H + 2v_u \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\phi v, jc}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} Z_{i2}^H + 2v_u \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, j3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\phi v, j6+c}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, j3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} Z_{i2}^H \\
& + 2v_u \sum_{c=1}^3 Z_{\phi v, j3+c}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} Z_{i2}^H \\
& + \left( g_1^2 + g_2^2 \right) \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{\phi v, ka}^* \left( v_d Z_{i1}^H - v_u Z_{i2}^H \right)
\end{aligned} \tag{226}$$

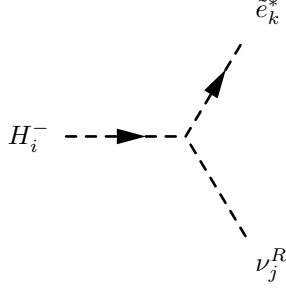


$$\begin{aligned}
& -\frac{i}{4}\delta_{\beta\gamma}\left(\sqrt{2}g_2^2\sum_{a=1}^3Z_{ja}^{U,*}Z_{ka}^D\left(v_dZ_{i1}^++v_uZ_{i2}^+\right)\right. \\
& -2\left(2\sum_{b=1}^3Z_{jb}^{U,*}\sum_{a=1}^3Z_{k3+a}^DT_{d,ab}Z_{i1}^++2\mu\sum_{b=1}^3\sum_{a=1}^3Y_{u,ab}^*Z_{j3+a}^{U,*}Z_{kb}^DZ_{i1}^+\right. \\
& +\sqrt{2}v_u\sum_{c=1}^3Z_{j3+c}^{U,*}\sum_{b=1}^3\sum_{a=1}^3Y_{u,ca}^*Y_{d,ba}Z_{k3+b}^DZ_{i1}^+ \\
& +\sqrt{2}v_d\sum_{c=1}^3\sum_{b=1}^3Z_{jb}^{U,*}\sum_{a=1}^3Y_{d,ac}^*Y_{d,ab}Z_{kc}^DZ_{i1}^++2\mu^*\sum_{b=1}^3Z_{jb}^{U,*}\sum_{a=1}^3Y_{d,ab}Z_{k3+a}^DZ_{i2}^+ \\
& +2\sum_{b=1}^3\sum_{a=1}^3Z_{j3+a}^{U,*}T_{u,ab}^*Z_{kb}^DZ_{i2}^++\sqrt{2}v_d\sum_{c=1}^3Z_{j3+c}^{U,*}\sum_{b=1}^3\sum_{a=1}^3Y_{u,ca}^*Y_{d,ba}Z_{k3+b}^DZ_{i2}^+ \\
& \left.+\sqrt{2}v_u\sum_{c=1}^3\sum_{b=1}^3Z_{jb}^{U,*}\sum_{a=1}^3Y_{u,ac}^*Y_{u,ab}Z_{kc}^DZ_{i2}^+\right) \tag{227}
\end{aligned}$$



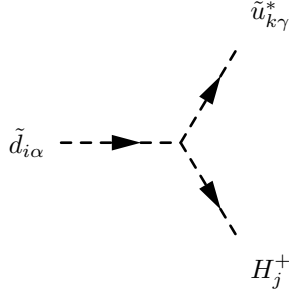
$$\begin{aligned}
& \frac{1}{4}\left(g_2^2\sum_{a=1}^3Z_{\sigma v,ja}^*Z_{ka}^E\left(v_dZ_{i1}^++v_uZ_{i2}^+\right)\right. \\
& -2\left(\sqrt{2}\sum_{b=1}^3Z_{\sigma v,jb}^*\sum_{a=1}^3Z_{k3+a}^ET_{e,ab}Z_{i1}^++\sqrt{2}\mu\sum_{b=1}^3\sum_{a=1}^3Y_{\nu,ab}^*Z_{\sigma v,j3+a}^*Z_{kb}^E Z_{i1}^+\right. \\
& -\sqrt{2}\mu\sum_{b=1}^3\sum_{a=1}^3Y_{SL,ab}^*Z_{\sigma v,j6+a}^*Z_{kb}^E Z_{i1}^+-v_u\sum_{c=1}^3Z_{\sigma v,j6+c}^*\sum_{b=1}^3\sum_{a=1}^3Y_{SL,ca}^*Y_{e,ba}Z_{k3+b}^E Z_{i1}^+ \\
& +v_u\sum_{c=1}^3Z_{\sigma v,j3+c}^*\sum_{b=1}^3\sum_{a=1}^3Y_{\nu,ca}^*Y_{e,ba}Z_{k3+b}^E Z_{i1}^++v_d\sum_{c=1}^3\sum_{b=1}^3Z_{\sigma v,jb}^*\sum_{a=1}^3Y_{e,ac}^*Y_{e,ab}Z_{kc}^E Z_{i1}^+ \\
& +\sqrt{2}\mu^*\sum_{b=1}^3Z_{\sigma v,jb}^*\sum_{a=1}^3Y_{e,ab}Z_{k3+a}^E Z_{i2}^+-\sqrt{2}\sum_{b=1}^3\sum_{a=1}^3Z_{\sigma v,j6+a}^*T_{Y,SL_{ab}^*}Z_{kb}^E Z_{i2}^+ \\
& \left.+\sqrt{2}\sum_{b=1}^3\sum_{a=1}^3Z_{\sigma v,j3+a}^*T_{\nu,ab}^*Z_{kb}^E Z_{i2}^+-v_d\sum_{c=1}^3Z_{\sigma v,j6+c}^*\sum_{b=1}^3\sum_{a=1}^3Y_{SL,ca}^*Y_{e,ba}Z_{k3+b}^E Z_{i2}^+\right)
\end{aligned}$$

$$\begin{aligned}
& + v_d \sum_{c=1}^3 Z_{\sigma v, j3+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu, ca}^* Y_{e, ba} Z_{k3+b}^E Z_{i2}^+ + \sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{\nu, ac}^* M_{R, ab} Z_{kc}^E Z_{i2}^+ \\
& - \sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{\sigma v, j3+b}^* \sum_{a=1}^3 Y_{SL, ac}^* M_{R, ba} Z_{kc}^E Z_{i2}^+ + v_u \sum_{c=1}^3 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} Z_{kc}^E Z_{i2}^+ \\
& + v_u \sum_{c=1}^3 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} Z_{kc}^E Z_{i2}^+ \Big) \Big) \tag{228}
\end{aligned}$$



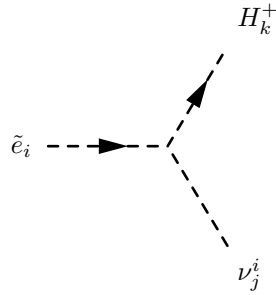
$$\begin{aligned}
& - \frac{i}{4} \left( g_2^2 \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{ka}^E \left( v_d Z_{i1}^+ + v_u Z_{i2}^+ \right) \right. \\
& - 2 \left( \sqrt{2} \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{k3+a}^E T_{e, ab} Z_{i1}^+ + \sqrt{2} \mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu, ab}^* Z_{\phi v, j3+a}^* Z_{kb}^E Z_{i1}^+ \right. \\
& + \sqrt{2} \mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL, ab}^* Z_{\phi v, j6+a}^* Z_{kb}^E Z_{i1}^+ + v_u \sum_{c=1}^3 Z_{\phi v, j6+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL, ca}^* Y_{e, ba} Z_{k3+b}^E Z_{i1}^+ \\
& + v_u \sum_{c=1}^3 Z_{\phi v, j3+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu, ca}^* Y_{e, ba} Z_{k3+b}^E Z_{i1}^+ + v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Y_{e, ac}^* Y_{e, ab} Z_{kc}^E Z_{i1}^+ \\
& + \sqrt{2} \mu^* \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Y_{e, ab} Z_{k3+a}^E Z_{i2}^+ + \sqrt{2} \sum_{b=1}^3 \sum_{a=1}^3 Z_{\phi v, j6+a}^* T_{Y, SL_{ab}^*} Z_{kb}^E Z_{i2}^+ \\
& + \sqrt{2} \sum_{b=1}^3 \sum_{a=1}^3 Z_{\phi v, j3+a}^* T_{\nu, ab}^* Z_{kb}^E Z_{i2}^+ + v_d \sum_{c=1}^3 Z_{\phi v, j6+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL, ca}^* Y_{e, ba} Z_{k3+b}^E Z_{i2}^+ \\
& + v_d \sum_{c=1}^3 Z_{\phi v, j3+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu, ca}^* Y_{e, ba} Z_{k3+b}^E Z_{i2}^+ + \sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{\phi v, j6+b}^* \sum_{a=1}^3 Y_{\nu, ac}^* M_{R, ab} Z_{kc}^E Z_{i2}^+ \\
& + \sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{\phi v, j3+b}^* \sum_{a=1}^3 Y_{SL, ac}^* M_{R, ba} Z_{kc}^E Z_{i2}^+ + v_u \sum_{c=1}^3 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} Z_{kc}^E Z_{i2}^+ \\
& \left. \left. + v_u \sum_{c=1}^3 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} Z_{kc}^E Z_{i2}^+ \right) \right) \tag{229}
\end{aligned}$$





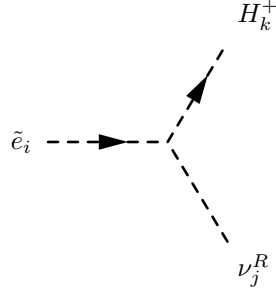
$$\begin{aligned}
& -\frac{i}{4}\delta_{\alpha\gamma}\left(\sqrt{2}g_2^2\sum_{a=1}^3Z_{ia}^{D,*}Z_{ka}^U\left(v_dZ_{j1}^++v_uZ_{j2}^+\right)\right. \\
& -2\left(2\mu^*\sum_{b=1}^3Z_{ib}^{D,*}\sum_{a=1}^3Y_{u,ab}Z_{k3+a}^UZ_{j1}^++2\sum_{b=1}^3\sum_{a=1}^3Z_{i3+a}^{D,*}T_{d,ab}^*Z_{kb}^UZ_{j1}^+\right. \\
& +\sqrt{2}v_u\sum_{c=1}^3Z_{i3+c}^{D,*}\sum_{b=1}^3\sum_{a=1}^3Y_{d,ca}^*Y_{u,ba}Z_{k3+b}^UZ_{j1}^+ \\
& +\sqrt{2}v_d\sum_{c=1}^3\sum_{b=1}^3Z_{ib}^{D,*}\sum_{a=1}^3Y_{d,ac}^*Y_{d,ab}Z_{kc}^UZ_{j1}^++2\sum_{b=1}^3Z_{ib}^{D,*}\sum_{a=1}^3Z_{k3+a}^UT_{u,ab}Z_{j2}^+ \\
& +2\mu\sum_{b=1}^3\sum_{a=1}^3Y_{d,ab}^*Z_{i3+a}^{D,*}Z_{kb}^UZ_{j2}^++\sqrt{2}v_d\sum_{c=1}^3Z_{i3+c}^{D,*}\sum_{b=1}^3\sum_{a=1}^3Y_{d,ca}^*Y_{u,ba}Z_{k3+b}^UZ_{j2}^+ \\
& \left.\left.+\sqrt{2}v_u\sum_{c=1}^3\sum_{b=1}^3Z_{ib}^{D,*}\sum_{a=1}^3Y_{u,ac}^*Y_{u,ab}Z_{kc}^UZ_{j2}^+\right)\right) \tag{230}
\end{aligned}$$


---



$$\frac{1}{4}\left(-g_2^2\sum_{a=1}^3Z_{ia}^{E,*}Z_{\sigma v,ja}^*\left(v_dZ_{k1}^++v_uZ_{k2}^+\right)\right)$$

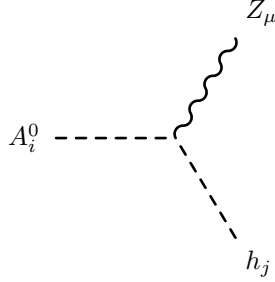
$$\begin{aligned}
& + 2\left(\sqrt{2}\sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{i3+a}^{E,*} T_{e,ab}^* Z_{k1}^+ \right. \\
& + \sqrt{2}\mu^* \left( -\sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL,ab} + \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu,ab} \right) Z_{k1}^+ \\
& + v_d \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{k1}^+ - v_u \sum_{c=1}^3 Z_{i3+c}^{E,*} \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{SL,ba} Z_{k1}^+ \\
& + v_u \sum_{c=1}^3 Z_{i3+c}^{E,*} \sum_{b=1}^3 Z_{\sigma v, j3+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{\nu,ba} Z_{k1}^+ + \sqrt{2}\mu \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{e,ab}^* Z_{i3+a}^{E,*} Z_{k2}^+ \\
& - \sqrt{2}\sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, j6+a}^* T_{Y_{SL,ab}} Z_{k2}^+ + \sqrt{2}\sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, j3+a}^* T_{\nu,ab} Z_{k2}^+ \\
& - \sqrt{2}\sum_{c=1}^3 Z_{\sigma v, j3+c}^* \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 M_{R,ca}^* Y_{SL,ab} Z_{k2}^+ + v_u \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{SL,ac}^* Y_{SL,ab} Z_{k2}^+ \\
& - v_d \sum_{c=1}^3 Z_{i3+c}^{E,*} \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{SL,ba} Z_{k2}^+ \\
& + \sqrt{2}\sum_{c=1}^3 Z_{\sigma v, j6+c}^* \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 M_{R,ac}^* Y_{\nu,ab} Z_{k2}^+ + v_u \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{\nu,ac}^* Y_{\nu,ab} Z_{k2}^+ \\
& \left. + v_d \sum_{c=1}^3 Z_{i3+c}^{E,*} \sum_{b=1}^3 Z_{\sigma v, j3+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{\nu,ba} Z_{k2}^+ \right) \tag{231}
\end{aligned}$$



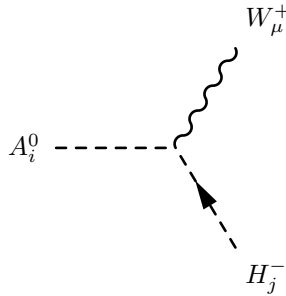
$$\begin{aligned}
& - \frac{i}{4} \left( g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\phi v, ja}^* \left( v_d Z_{k1}^+ + v_u Z_{k2}^+ \right) \right. \\
& - 2 \left( \sqrt{2} \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{i3+a}^{E,*} T_{e,ab}^* Z_{k1}^+ \right. \\
& \left. \left. + \sqrt{2}\mu^* \left( \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL,ab} + \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu,ab} \right) Z_{k1}^+ \right) \right)
\end{aligned}$$

$$\begin{aligned}
& + v_d \sum_{c=1}^3 Z_{\phi v, jc}^* \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{k1}^+ + v_u \sum_{c=1}^3 Z_{i3+c}^{E,*} \sum_{b=1}^3 Z_{\phi v, j6+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{SL,ba} Z_{k1}^+ \\
& + v_u \sum_{c=1}^3 Z_{i3+c}^{E,*} \sum_{b=1}^3 Z_{\phi v, j3+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{\nu,ba} Z_{k1}^+ + \sqrt{2}\mu \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Y_{e,ab}^* Z_{i3+a}^{E,*} Z_{k2}^+ \\
& + \sqrt{2} \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, j6+a}^* T_{Y_{SL},ab} Z_{k2}^+ + \sqrt{2} \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, j3+a}^* T_{\nu,ab} Z_{k2}^+ \\
& + \sqrt{2} \sum_{c=1}^3 Z_{\phi v, j3+c}^* \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 M_{R,ca}^* Y_{SL,ab} Z_{k2}^+ + v_u \sum_{c=1}^3 Z_{\phi v, jc}^* \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{SL,ac}^* Y_{SL,ab} Z_{k2}^+ \\
& + v_d \sum_{c=1}^3 Z_{i3+c}^{E,*} \sum_{b=1}^3 Z_{\phi v, j6+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{SL,ba} Z_{k2}^+ + \sqrt{2} \sum_{c=1}^3 Z_{\phi v, j6+c}^* \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 M_{R,ac}^* Y_{\nu,ab} Z_{k2}^+ \\
& + v_u \sum_{c=1}^3 Z_{\phi v, jc}^* \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{\nu,ac}^* Y_{\nu,ab} Z_{k2}^+ + v_d \sum_{c=1}^3 Z_{i3+c}^{E,*} \sum_{b=1}^3 Z_{\phi v, j3+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{\nu,ba} Z_{k2}^+ \Big) \quad (232)
\end{aligned}$$

## 9.2 Two Scalar-One Vector Boson-Interaction

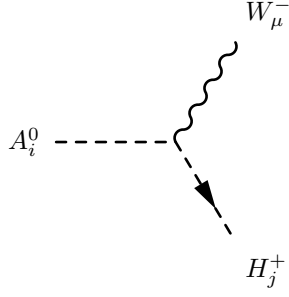


$$\frac{1}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( Z_{i1}^A Z_{j1}^H - Z_{i2}^A Z_{j2}^H \right) \left( -p_\mu^{h_j} + p_\mu^{A_i^0} \right) \quad (233)$$



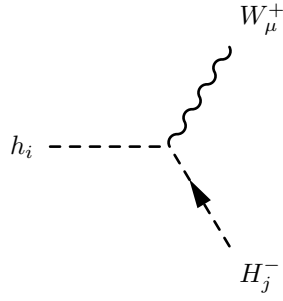
$$\frac{1}{2}g_2\left(Z_{i1}^AZ_{j1}^+ + Z_{i2}^AZ_{j2}^+\right)\left(-p_\mu^{H_j^-} + p_\mu^{A_i^0}\right) \quad (234)$$


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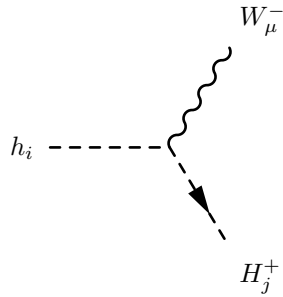
$$\frac{1}{2}g_2\left(Z_{i1}^AZ_{j1}^+ + Z_{i2}^AZ_{j2}^+\right)\left(-p_\mu^{H_j^+} + p_\mu^{A_i^0}\right) \quad (235)$$


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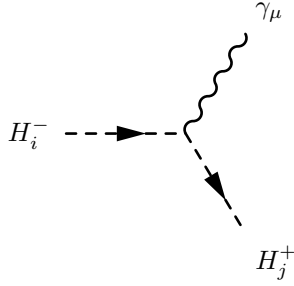
$$\frac{i}{2}g_2\left(Z_{i1}^HZ_{j1}^+ - Z_{i2}^HZ_{j2}^+\right)\left(-p_\mu^{H_j^-} + p_\mu^{h_i}\right) \quad (236)$$


---



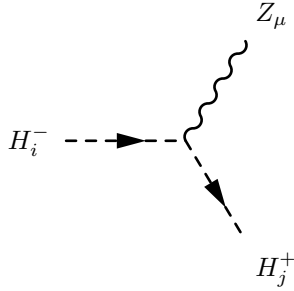
$$-\frac{i}{2}g_2\left(Z_{i1}^HZ_{j1}^+ - Z_{i2}^HZ_{j2}^+\right)\left(-p_\mu^{H_j^+} + p_\mu^{h_i}\right) \quad (237)$$


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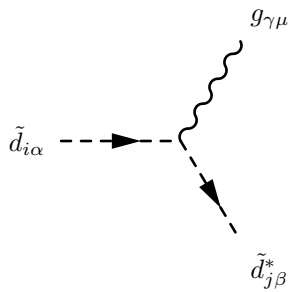
$$\frac{i}{2} \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) \left( Z_{i1}^+ Z_{j1}^+ + Z_{i2}^+ Z_{j2}^+ \right) \left( -p_\mu^{H_j^+} + p_\mu^{H_i^-} \right) \quad (238)$$


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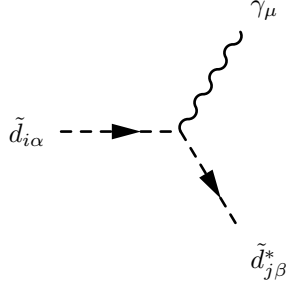
$$\frac{i}{2} \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( Z_{i1}^+ Z_{j1}^+ + Z_{i2}^+ Z_{j2}^+ \right) \left( -p_\mu^{H_j^+} + p_\mu^{H_i^-} \right) \quad (239)$$


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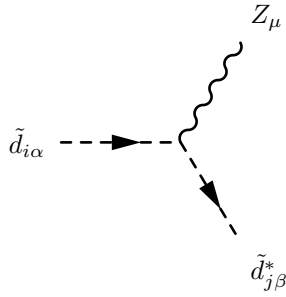
$$-\frac{i}{2} g_3 \delta_{ij} \lambda_{\beta, \alpha}^\gamma \left( -p_\mu^{\tilde{d}_{j\beta}^*} + p_\mu^{\tilde{d}_{i\alpha}} \right) \quad (240)$$


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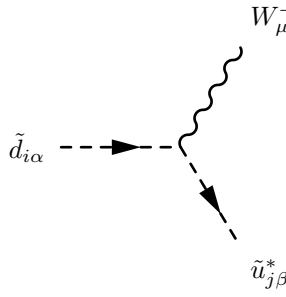
$$-\frac{i}{6}\delta_{\alpha\beta}\left(-2g_1\cos\Theta_W\sum_{a=1}^3Z_{i3+a}^{D,*}Z_{j3+a}^D+\left(-3g_2\sin\Theta_W+g_1\cos\Theta_W\right)\sum_{a=1}^3Z_{ia}^{D,*}Z_{ja}^D\right)\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{d}_{i\alpha}}\right)\quad (241)$$


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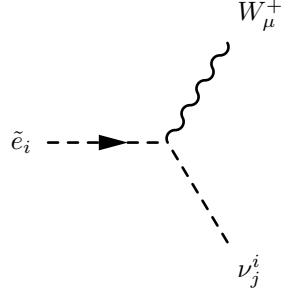
$$\frac{i}{6}\delta_{\alpha\beta}\left(-2g_1\sin\Theta_W\sum_{a=1}^3Z_{i3+a}^{D,*}Z_{j3+a}^D+\left(3g_2\cos\Theta_W+g_1\sin\Theta_W\right)\sum_{a=1}^3Z_{ia}^{D,*}Z_{ja}^D\right)\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{d}_{i\alpha}}\right)\quad (242)$$


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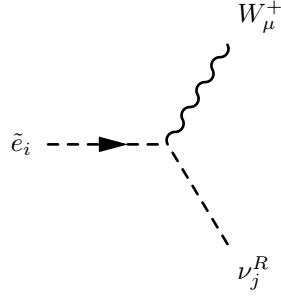
$$-i\frac{1}{\sqrt{2}}g_2\delta_{\alpha\beta}\sum_{a=1}^3Z_{ia}^{D,*}Z_{ja}^U\left(-p_\mu^{\tilde{u}_{j\beta}^*}+p_\mu^{\tilde{d}_{i\alpha}}\right)\quad (243)$$


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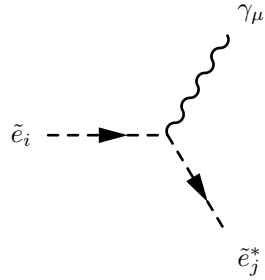
$$-\frac{1}{2}g_2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\sigma\nu,ja}^* \left( -p_\mu^{\nu^i} + p_\mu^{\tilde{e}_i} \right) \quad (244)$$


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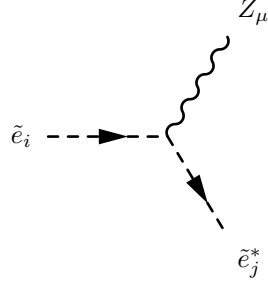
$$-\frac{i}{2}g_2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\phi\nu,ja}^* \left( -p_\mu^{\nu_j^R} + p_\mu^{\tilde{e}_i} \right) \quad (245)$$


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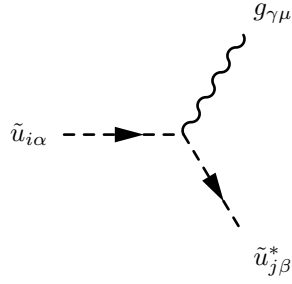
$$\frac{i}{2} \left( 2g_1 \cos \Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E + \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E \right) \left( -p_\mu^{\tilde{e}_j^*} + p_\mu^{\tilde{e}_i} \right) \quad (246)$$


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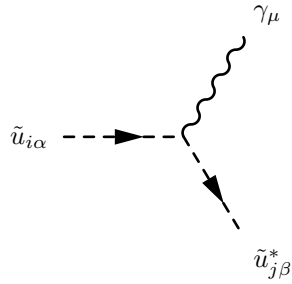
$$\frac{i}{2} \left( -2g_1 \sin \Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E + \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E \right) \left( -p_\mu^{\tilde{e}_j^*} + p_\mu^{\tilde{e}_i} \right) \quad (247)$$


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$$-\frac{i}{2} g_3 \delta_{ij} \lambda_{\beta,\alpha}^\gamma \left( -p_\mu^{\tilde{u}_{j\beta}^*} + p_\mu^{\tilde{u}_{i\alpha}} \right) \quad (248)$$

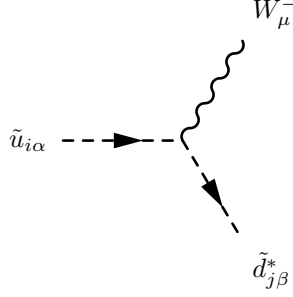

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$$-\frac{i}{6} \delta_{\alpha,\beta} \left( \left( 3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U + 4g_1 \cos \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U \right) \left( -p_\mu^{\tilde{u}_{j\beta}^*} + p_\mu^{\tilde{u}_{i\alpha}} \right) \quad (249)$$

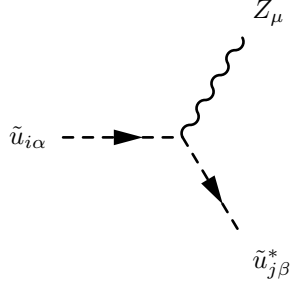

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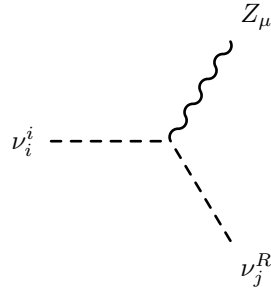
$$-i \frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^D \left( -p_\mu^{\tilde{d}_{j\beta}^*} + p_\mu^{\tilde{u}_{i\alpha}} \right) \quad (250)$$


---



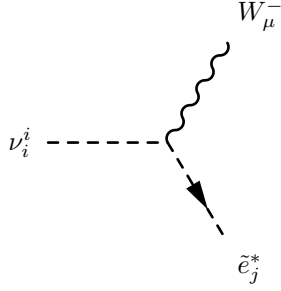
$$-\frac{i}{6} \delta_{\alpha\beta} \left( (3g_2 \cos \Theta_W - g_1 \sin \Theta_W) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U - 4g_1 \sin \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U \right) \left( -p_\mu^{\tilde{u}_{j\beta}^*} + p_\mu^{\tilde{u}_{i\alpha}} \right) \quad (251)$$


---



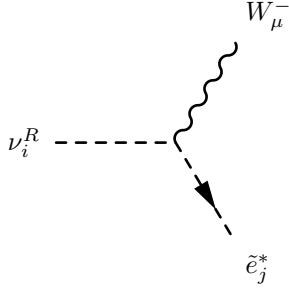
$$\frac{1}{2} (g_1 \sin \Theta_W + g_2 \cos \Theta_W) \sum_{a=1}^3 Z_{\phi\nu,ja}^* Z_{\sigma\nu,ia}^* \left( -p_\mu^{\nu_j^R} + p_\mu^{\nu_i^i} \right) \quad (252)$$


---



$$\frac{1}{2}g_2 \sum_{a=1}^3 Z_{\sigma\nu,ia}^* Z_{ja}^E \left( -p_\mu^{\tilde{e}_j^*} + p_\mu^{\nu_i^i} \right) \quad (253)$$

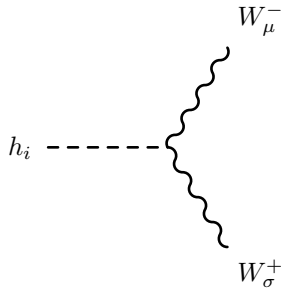

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$$-\frac{i}{2}g_2 \sum_{a=1}^3 Z_{\phi\nu,ia}^* Z_{ja}^E \left( -p_\mu^{\tilde{e}_j^*} + p_\mu^{\nu_i^R} \right) \quad (254)$$

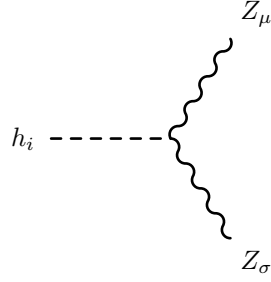

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### 9.3 One Scalar-Two Vector Boson-Interaction



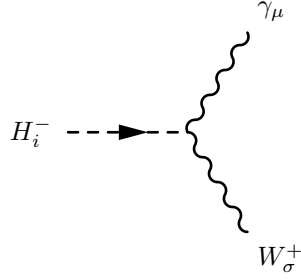
$$\frac{i}{2}g_2^2 \left( v_d Z_{i1}^H + v_u Z_{i2}^H \right) \left( g_{\sigma\mu} \right) \quad (255)$$


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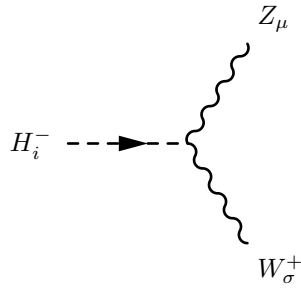
$$\frac{i}{2} (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 (v_d Z_{i1}^H + v_u Z_{i2}^H) (g_{\sigma\mu}) \quad (256)$$


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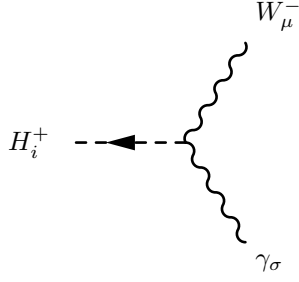
$$-\frac{i}{2} g_1 g_2 \cos \Theta_W (v_d Z_{i1}^+ - v_u Z_{i2}^+) (g_{\sigma\mu}) \quad (257)$$


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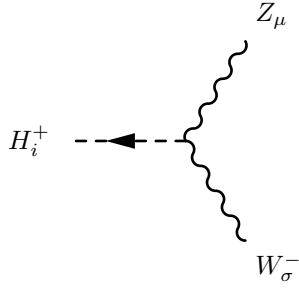
$$\frac{i}{2} g_1 g_2 \sin \Theta_W (v_d Z_{i1}^+ - v_u Z_{i2}^+) (g_{\sigma\mu}) \quad (258)$$


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$$-\frac{i}{2}g_1g_2\cos\Theta_W\left(v_dZ_{i1}^+ - v_uZ_{i2}^+\right)\left(g_{\sigma\mu}\right) \quad (259)$$

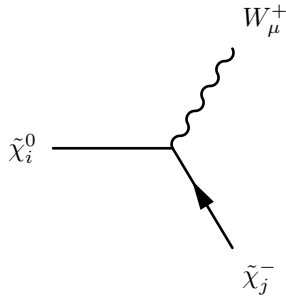

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$$\frac{i}{2}g_1g_2\sin\Theta_W\left(v_dZ_{i1}^+ - v_uZ_{i2}^+\right)\left(g_{\sigma\mu}\right) \quad (260)$$


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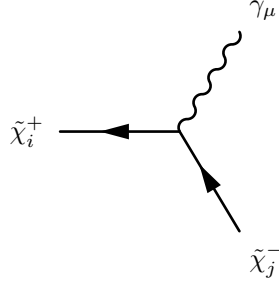
#### 9.4 Two Fermion-One Vector Boson-Interaction



$$-\frac{i}{2}g_2\left(2U_{j1}^*N_{i2} + \sqrt{2}U_{j2}^*N_{i3}\right)\left(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\right) \quad (261)$$

$$+ \left(i\frac{1}{\sqrt{2}}g_2N_{i4}^*V_{j2} - ig_2N_{i2}^*V_{j1}\right)\left(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\right) \quad (262)$$

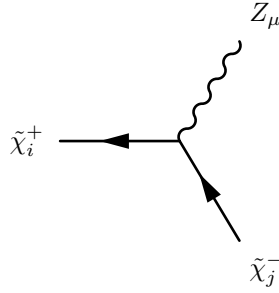

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$$\frac{i}{2} \left( 2g_2 U_{j1}^* \sin \Theta_W U_{i1} + U_{j2}^* (g_1 \cos \Theta_W + g_2 \sin \Theta_W) U_{i2} \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (263)$$

$$+ \frac{i}{2} \left( 2g_2 V_{i1}^* \sin \Theta_W V_{j1} + V_{i2}^* (g_1 \cos \Theta_W + g_2 \sin \Theta_W) V_{j2} \right) \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (264)$$

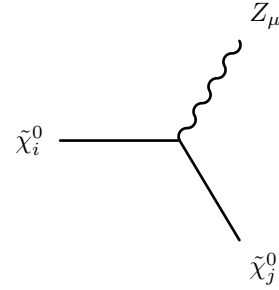

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$$\frac{i}{2} \left( 2g_2 U_{j1}^* \cos \Theta_W U_{i1} + U_{j2}^* (-g_1 \sin \Theta_W + g_2 \cos \Theta_W) U_{i2} \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (265)$$

$$+ \frac{i}{2} \left( 2g_2 V_{i1}^* \cos \Theta_W V_{j1} + V_{i2}^* (-g_1 \sin \Theta_W + g_2 \cos \Theta_W) V_{j2} \right) \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (266)$$

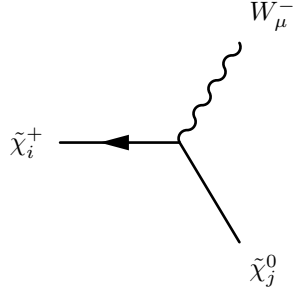

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$$- \frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( N_{j3}^* N_{i3} - N_{j4}^* N_{i4} \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (267)$$

$$+ \frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( N_{i3}^* N_{j3} - N_{i4}^* N_{j4} \right) \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (268)$$

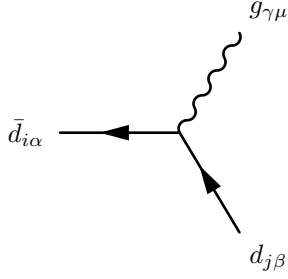

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$$-\frac{i}{2}g_2\left(2N_{j2}^*U_{i1} + \sqrt{2}N_{j3}^*U_{i2}\right)\left(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\right) \quad (269)$$

$$+ \left(i\frac{1}{\sqrt{2}}g_2V_{i2}^*N_{j4} - ig_2V_{i1}^*N_{j2}\right)\left(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\right) \quad (270)$$

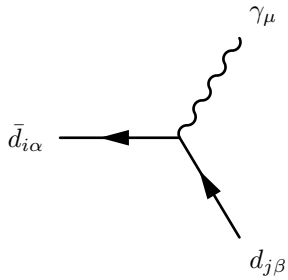

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$$-\frac{i}{2}g_3\delta_{ij}\lambda_{\alpha,\beta}^\gamma\left(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\right) \quad (271)$$

$$+ -\frac{i}{2}g_3\delta_{ij}\lambda_{\alpha,\beta}^\gamma\left(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\right) \quad (272)$$

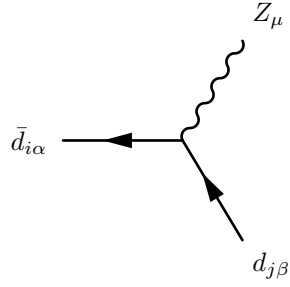

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$$-\frac{i}{6}\delta_{\alpha,\beta}\delta_{ij}\left(-3g_2\sin\Theta_W + g_1\cos\Theta_W\right)\left(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\right) \quad (273)$$

$$+ \frac{i}{3} g_1 \cos \Theta_W \delta_{\alpha\beta} \delta_{ij} \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (274)$$

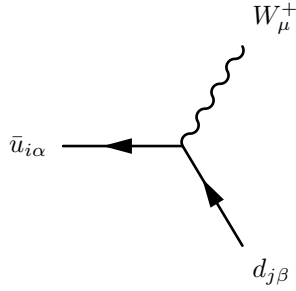

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$$\frac{i}{6} \delta_{\alpha\beta} \delta_{ij} \left( 3g_2 \cos \Theta_W + g_1 \sin \Theta_W \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (275)$$

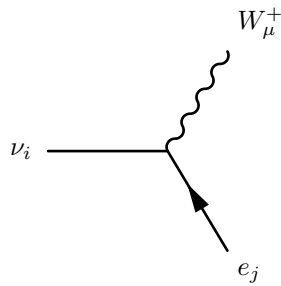
$$+ -\frac{i}{3} g_1 \delta_{\alpha\beta} \delta_{ij} \sin \Theta_W \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (276)$$


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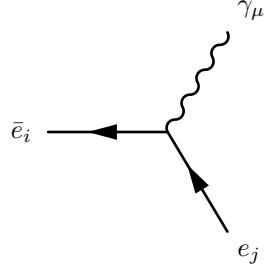
$$-i \frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \sum_{a=1}^3 U_{L,ja}^{d,*} U_{L,ia}^u \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (277)$$


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$$-i \frac{1}{\sqrt{2}} g_2 \sum_{a=1}^3 U_{L,ja}^{e,*} U_{ia}^V \left( \gamma_\mu \cdot \frac{1-\gamma_5}{2} \right) \quad (278)$$

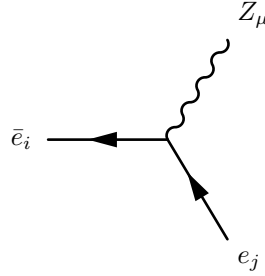

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$$\frac{i}{2} \delta_{ij} \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) \left( \gamma_\mu \cdot \frac{1-\gamma_5}{2} \right) \quad (279)$$

$$+ i g_1 \cos \Theta_W \delta_{ij} \left( \gamma_\mu \cdot \frac{1+\gamma_5}{2} \right) \quad (280)$$

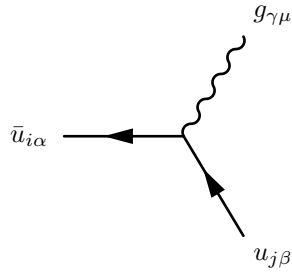

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$$\frac{i}{2} \delta_{ij} \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( \gamma_\mu \cdot \frac{1-\gamma_5}{2} \right) \quad (281)$$

$$+ -i g_1 \delta_{ij} \sin \Theta_W \left( \gamma_\mu \cdot \frac{1+\gamma_5}{2} \right) \quad (282)$$


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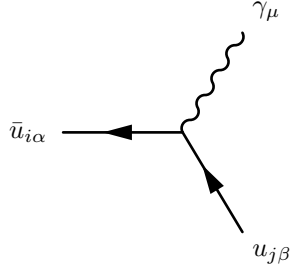




$$-\frac{i}{2}g_3\delta_{ij}\lambda_{\alpha,\beta}^\gamma\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (283)$$

$$+\frac{i}{2}g_3\delta_{ij}\lambda_{\alpha,\beta}^\gamma\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (284)$$

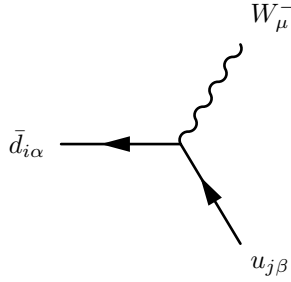

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$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\left(3g_2\sin\Theta_W+g_1\cos\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (285)$$

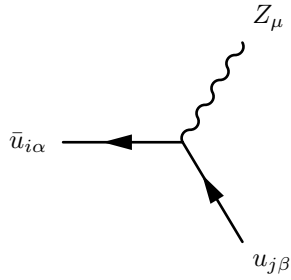
$$+\frac{2i}{3}g_1\cos\Theta_W\delta_{\alpha\beta}\delta_{ij}\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (286)$$


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$$-i\frac{1}{\sqrt{2}}g_2\delta_{\alpha\beta}\sum_{a=1}^3U_{L,ja}^{u,*}U_{L,ia}^d\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (287)$$

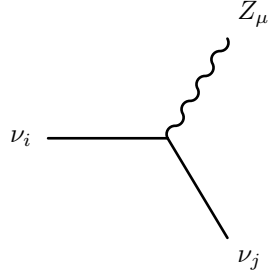

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$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\left(3g_2\cos\Theta_W-g_1\sin\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (288)$$

$$+\frac{2i}{3}g_1\delta_{\alpha\beta}\delta_{ij}\sin\Theta_W\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (289)$$

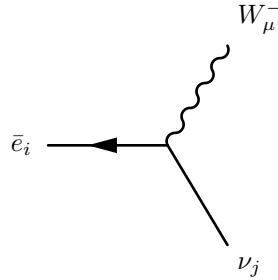

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$$-\frac{i}{2}\left(g_1\sin\Theta_W+g_2\cos\Theta_W\right)\sum_{a=1}^3U_{ja}^{V,*}U_{ia}^V\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (290)$$

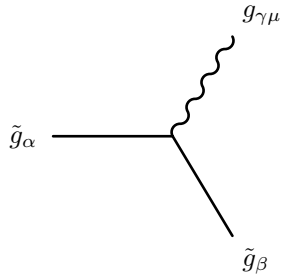
$$+\frac{i}{2}\left(g_1\sin\Theta_W+g_2\cos\Theta_W\right)\sum_{a=1}^3U_{ia}^{V,*}U_{ja}^V\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (291)$$


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$$-i\frac{1}{\sqrt{2}}g_2\sum_{a=1}^3U_{ja}^{V,*}U_{L,ia}^e\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (292)$$

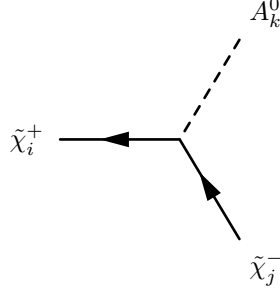

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$$-g_3|\phi_{\tilde{g}}|^2 f_{\alpha,\beta,\gamma}\left(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\right) \quad (293)$$

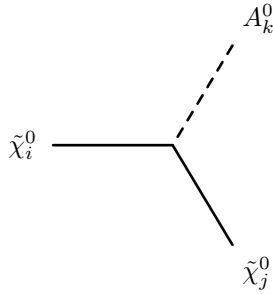
$$+ -g_3|\phi_{\tilde{g}}|^2 f_{\alpha,\beta,\gamma}\left(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\right) \quad (294)$$

## 9.5 Two Fermion-One Scalar Boson-Interaction



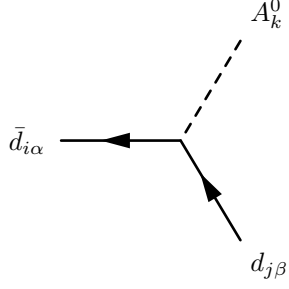
$$- \frac{1}{\sqrt{2}}g_2\left(U_{j1}^*V_{i2}^*Z_{k2}^A + U_{j2}^*V_{i1}^*Z_{k1}^A\right)\left(\frac{1-\gamma_5}{2}\right) \quad (295)$$

$$+ \frac{1}{\sqrt{2}}g_2\left(U_{i1}V_{j2}Z_{k2}^A + U_{i2}V_{j1}Z_{k1}^A\right)\left(\frac{1+\gamma_5}{2}\right) \quad (296)$$



$$\begin{aligned} & \frac{1}{2}\left(N_{i3}^*\left(g_1N_{j1}^* - g_2N_{j2}^*\right)Z_{k1}^A - g_2N_{i2}^*N_{j3}^*Z_{k1}^A - g_1N_{i4}^*N_{j1}^*Z_{k2}^A + g_2N_{i4}^*N_{j2}^*Z_{k2}^A \right. \\ & \left. + g_2N_{i2}^*N_{j4}^*Z_{k2}^A + g_1N_{i1}^*\left(N_{j3}^*Z_{k1}^A - N_{j4}^*Z_{k2}^A\right)\right)\left(\frac{1-\gamma_5}{2}\right) \end{aligned} \quad (297)$$

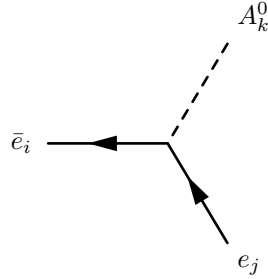
$$\begin{aligned} & + \frac{1}{2}\left(Z_{k1}^A\left(\left(-g_1N_{i1} + g_2N_{i2}\right)N_{j3} + N_{i3}\left(-g_1N_{j1} + g_2N_{j2}\right)\right) \right. \\ & \left. + Z_{k2}^A\left(\left(g_1N_{i1} - g_2N_{i2}\right)N_{j4} + N_{i4}\left(g_1N_{j1} - g_2N_{j2}\right)\right)\right)\left(\frac{1+\gamma_5}{2}\right) \end{aligned} \quad (298)$$



$$\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{b=1}^3U_{L,jb}^{d,*}\sum_{a=1}^3U_{R,ia}^{d,*}Y_{d,ab}Z_{k1}^A\left(\frac{1-\gamma_5}{2}\right) \quad (299)$$

$$+ -\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{b=1}^3\sum_{a=1}^3Y_{d,ab}^*U_{R,ja}^dU_{L,ib}^dZ_{k1}^A\left(\frac{1+\gamma_5}{2}\right) \quad (300)$$

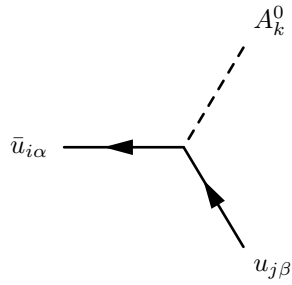

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$$\frac{1}{\sqrt{2}}\sum_{b=1}^3U_{L,jb}^{e,*}\sum_{a=1}^3U_{R,ia}^{e,*}Y_{e,ab}Z_{k1}^A\left(\frac{1-\gamma_5}{2}\right) \quad (301)$$

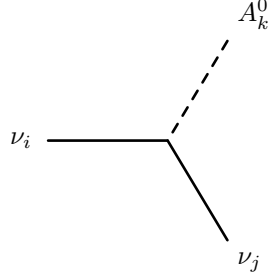
$$+ -\frac{1}{\sqrt{2}}\sum_{b=1}^3\sum_{a=1}^3Y_{e,ab}^*U_{R,ja}^eU_{L,ib}^eZ_{k1}^A\left(\frac{1+\gamma_5}{2}\right) \quad (302)$$


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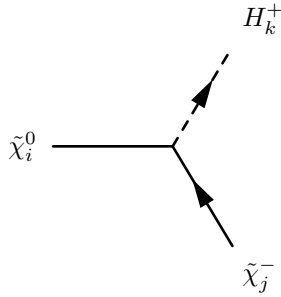
$$\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{b=1}^3U_{L,jb}^{u,*}\sum_{a=1}^3U_{R,ia}^{u,*}Y_{u,ab}Z_{k2}^A\left(\frac{1-\gamma_5}{2}\right) \quad (303)$$

$$+ -\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{b=1}^3\sum_{a=1}^3Y_{u,ab}^*U_{R,ja}^uU_{L,ib}^uZ_{k2}^A\left(\frac{1+\gamma_5}{2}\right) \quad (304)$$



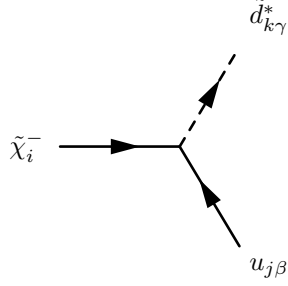
$$\frac{1}{\sqrt{2}}\left(\sum_{b=1}^3U_{jb}^{V,*}\sum_{a=1}^3U_{i6+a}^{V,*}Y_{SL,ab}+\sum_{b=1}^3U_{ib}^{V,*}\sum_{a=1}^3U_{j6+a}^{V,*}Y_{SL,ab}+\sum_{b=1}^3U_{jb}^{V,*}\sum_{a=1}^3U_{i3+a}^{V,*}Y_{\nu,ab}\right. \\ \left.+\sum_{b=1}^3U_{ib}^{V,*}\sum_{a=1}^3U_{j3+a}^{V,*}Y_{\nu,ab}\right)Z_{k2}^A\left(\frac{1-\gamma_5}{2}\right) \quad (305)$$

$$+ -\frac{1}{\sqrt{2}}\left(\sum_{b=1}^3\sum_{a=1}^3Y_{\nu,ab}^*U_{j3+a}^VU_{ib}^V+\sum_{b=1}^3\sum_{a=1}^3Y_{SL,ab}^*U_{j6+a}^VU_{ib}^V+\sum_{b=1}^3\sum_{a=1}^3Y_{\nu,ab}^*U_{i3+a}^VU_{jb}^V\right. \\ \left.+\sum_{b=1}^3\sum_{a=1}^3Y_{SL,ab}^*U_{i6+a}^VU_{jb}^V\right)Z_{k2}^A\left(\frac{1+\gamma_5}{2}\right) \quad (306)$$



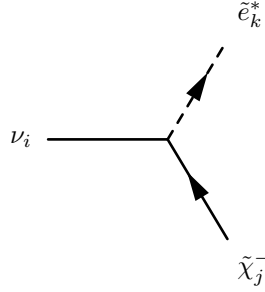
$$\frac{i}{2}\left(-2g_2U_{j1}^*N_{i3}^*+\sqrt{2}U_{j2}^*(g_1N_{i1}^*+g_2N_{i2}^*)\right)Z_{k1}^+\left(\frac{1-\gamma_5}{2}\right) \quad (307)$$

$$+ -\frac{i}{2}\left(2g_2V_{j1}N_{i4}+\sqrt{2}V_{j2}(g_1N_{i1}+g_2N_{i2})\right)Z_{k2}^+\left(\frac{1+\gamma_5}{2}\right) \quad (308)$$



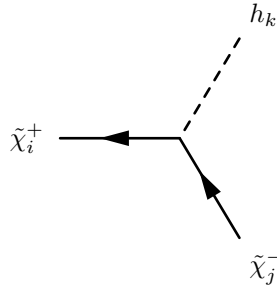
$$-i\delta_{\beta\gamma}\left(g_2U_{i1}^*\sum_{a=1}^3U_{L,ja}^{u,*}Z_{ka}^D-U_{i2}^*\sum_{b=1}^3U_{L,jb}^{u,*}\sum_{a=1}^3Y_{d,ab}Z_{k3+a}^D\right)\left(\frac{1-\gamma_5}{2}\right) \quad (309)$$

$$+i\delta_{\beta\gamma}\sum_{b=1}^3\sum_{a=1}^3Y_{u,ab}^*U_{R,ja}^uZ_{kb}^DV_{i2}\left(\frac{1+\gamma_5}{2}\right) \quad (310)$$



$$-i\left(g_2U_{j1}^*\sum_{a=1}^3U_{ia}^{V,*}Z_{ka}^E-U_{j2}^*\sum_{b=1}^3U_{ib}^{V,*}\sum_{a=1}^3Y_{e,ab}Z_{k3+a}^E\right)\left(\frac{1-\gamma_5}{2}\right) \quad (311)$$

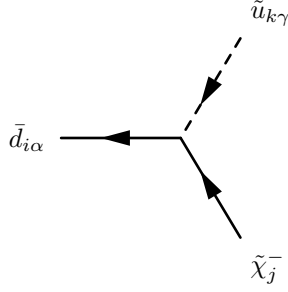
$$+i\left(\sum_{b=1}^3\sum_{a=1}^3Y_{\nu,ab}^*U_{i3+a}^VZ_{kb}^E+\sum_{b=1}^3\sum_{a=1}^3Y_{SL,ab}^*U_{i6+a}^VZ_{kb}^E\right)V_{j2}\left(\frac{1+\gamma_5}{2}\right) \quad (312)$$



$$-i \frac{1}{\sqrt{2}} g_2 \left( U_{j1}^* V_{i2}^* Z_{k2}^H + U_{j2}^* V_{i1}^* Z_{k1}^H \right) \left( \frac{1-\gamma_5}{2} \right) \quad (313)$$

$$+ -i \frac{1}{\sqrt{2}} g_2 \left( U_{i1} V_{j2} Z_{k2}^H + U_{i2} V_{j1} Z_{k1}^H \right) \left( \frac{1+\gamma_5}{2} \right) \quad (314)$$

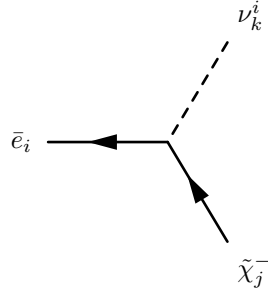

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$$i U_{j2}^* \delta_{\alpha\gamma} \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 U_{R,ia}^{d,*} Y_{d,ab} \left( \frac{1-\gamma_5}{2} \right) \quad (315)$$

$$+ -i \delta_{\alpha\gamma} \left( g_2 \sum_{a=1}^3 Z_{ka}^{U,*} U_{L,ia}^d V_{j1} - \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} U_{L,ib}^d V_{j2} \right) \left( \frac{1+\gamma_5}{2} \right) \quad (316)$$

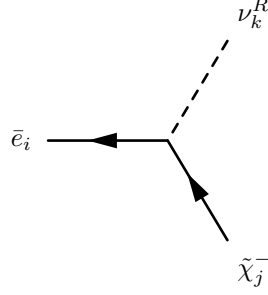

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$$- \frac{1}{\sqrt{2}} U_{j2}^* \sum_{b=1}^3 Z_{\sigma\nu,kb}^* \sum_{a=1}^3 U_{R,ia}^{e,*} Y_{e,ab} \left( \frac{1-\gamma_5}{2} \right) \quad (317)$$

$$+ \frac{1}{\sqrt{2}} \left( g_2 \sum_{a=1}^3 Z_{\sigma\nu,ka}^* U_{L,ia}^e V_{j1} + \left( - \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu,ab}^* Z_{\sigma\nu,k3+a}^* U_{L,ib}^e + \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL,ab}^* Z_{\sigma\nu,k6+a}^* U_{L,ib}^e \right) V_{j2} \right) \left( \frac{1+\gamma_5}{2} \right) \quad (318)$$

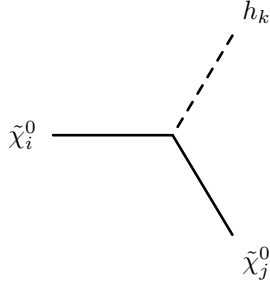

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$$i \frac{1}{\sqrt{2}} U_{j2}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 U_{R, ia}^{e,*} Y_{e, ab} \left( \frac{1 - \gamma_5}{2} \right) \quad (319)$$

$$+ -i \frac{1}{\sqrt{2}} \left( g_2 \sum_{a=1}^3 Z_{\phi v, ka}^* U_{L, ia}^e V_{j1} - \left( \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu, ab}^* Z_{\phi v, k3+a}^* U_{L, ib}^e + \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL, ab}^* Z_{\phi v, k6+a}^* U_{L, ib}^e \right) V_{j2} \right) \left( \frac{1 + \gamma_5}{2} \right) \quad (320)$$

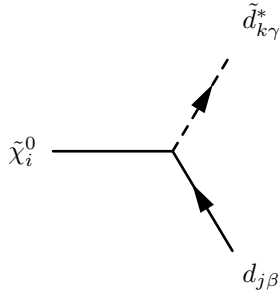

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$$\begin{aligned} & \frac{i}{2} \left( N_{i3}^* \left( g_1 N_{j1}^* - g_2 N_{j2}^* \right) Z_{k1}^H - g_2 N_{i2}^* N_{j3}^* Z_{k1}^H - g_1 N_{i4}^* N_{j1}^* Z_{k2}^H + g_2 N_{i4}^* N_{j2}^* Z_{k2}^H \right. \\ & \left. + g_2 N_{i2}^* N_{j4}^* Z_{k2}^H + g_1 N_{i1}^* \left( N_{j3}^* Z_{k1}^H - N_{j4}^* Z_{k2}^H \right) \right) \left( \frac{1 - \gamma_5}{2} \right) \quad (321) \end{aligned}$$

$$\begin{aligned} & + \frac{i}{2} \left( Z_{k1}^H \left( \left( g_1 N_{i1} - g_2 N_{i2} \right) N_{j3} + N_{i3} \left( g_1 N_{j1} - g_2 N_{j2} \right) \right) \right. \\ & \left. + Z_{k2}^H \left( \left( -g_1 N_{i1} + g_2 N_{i2} \right) N_{j4} + N_{i4} \left( -g_1 N_{j1} + g_2 N_{j2} \right) \right) \right) \left( \frac{1 + \gamma_5}{2} \right) \quad (322) \end{aligned}$$

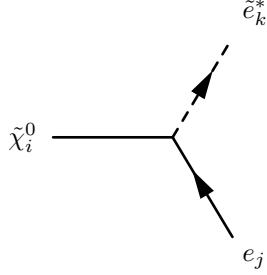

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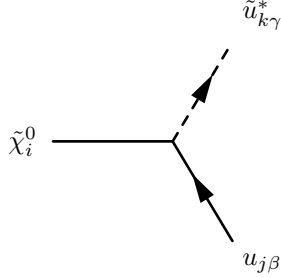
$$-\frac{i}{6}\delta_{\beta\gamma}\left(-3\sqrt{2}g_2N_{i2}^*\sum_{a=1}^3U_{L,ja}^{d,*}Z_{ka}^D+6N_{i3}^*\sum_{b=1}^3U_{L,jb}^{d,*}\sum_{a=1}^3Y_{d,ab}Z_{k3+a}^D+\sqrt{2}g_1N_{i1}^*\sum_{a=1}^3U_{L,ja}^{d,*}Z_{ka}^D\right)\left(\frac{1-\gamma_5}{2}\right) \quad (323)$$

$$+\frac{i}{3}\delta_{\beta\gamma}\left(3\sum_{b=1}^3\sum_{a=1}^3Y_{d,ab}^*U_{R,ja}^dZ_{kb}^DN_{i3}+\sqrt{2}g_1\sum_{a=1}^3Z_{k3+a}^DU_{R,ja}^dN_{i1}\right)\left(\frac{1+\gamma_5}{2}\right) \quad (324)$$



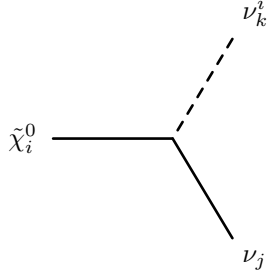
$$\frac{i}{2}\left(-2N_{i3}^*\sum_{b=1}^3U_{L,jb}^{e,*}\sum_{a=1}^3Y_{e,ab}Z_{k3+a}^E+\sqrt{2}g_1N_{i1}^*\sum_{a=1}^3U_{L,ja}^{e,*}Z_{ka}^E+\sqrt{2}g_2N_{i2}^*\sum_{a=1}^3U_{L,ja}^{e,*}Z_{ka}^E\right)\left(\frac{1-\gamma_5}{2}\right) \quad (325)$$

$$+i\left(\sqrt{2}g_1\sum_{a=1}^3Z_{k3+a}^EU_{R,ja}^eN_{i1}+\sum_{b=1}^3\sum_{a=1}^3Y_{e,ab}^*U_{R,ja}^eZ_{kb}^EN_{i3}\right)\left(\frac{1+\gamma_5}{2}\right) \quad (326)$$



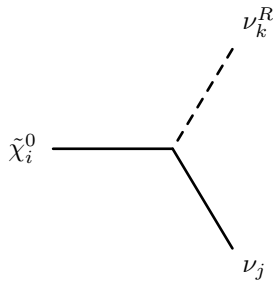
$$-\frac{i}{6}\delta_{\beta\gamma}\left(3\sqrt{2}g_2N_{i2}^*\sum_{a=1}^3U_{L,ja}^{u,*}Z_{ka}^U+6N_{i4}^*\sum_{b=1}^3U_{L,jb}^{u,*}\sum_{a=1}^3Y_{u,ab}Z_{k3+a}^U+\sqrt{2}g_1N_{i1}^*\sum_{a=1}^3U_{L,ja}^{u,*}Z_{ka}^U\right)\left(\frac{1-\gamma_5}{2}\right) \quad (327)$$

$$+\frac{i}{3}\delta_{\beta\gamma}\left(2\sqrt{2}g_1\sum_{a=1}^3Z_{k3+a}^Uu_{R,ja}^uN_{i1}-3\sum_{b=1}^3\sum_{a=1}^3Y_{u,ab}^*u_{R,ja}^uZ_{kb}^UN_{i4}\right)\left(\frac{1+\gamma_5}{2}\right) \quad (328)$$



$$\begin{aligned}
& \frac{1}{2} \left( g_1 N_{i1}^* \sum_{a=1}^3 U_{ja}^{V,*} Z_{\sigma v,ka}^* - g_2 N_{i2}^* \sum_{a=1}^3 U_{ja}^{V,*} Z_{\sigma v,ka}^* \right. \\
& + \sqrt{2} N_{i4}^* \left( \sum_{b=1}^3 Z_{\sigma v,kb}^* \sum_{a=1}^3 U_{j6+a}^{V,*} Y_{SL,ab} + \sum_{b=1}^3 U_{jb}^{V,*} \sum_{a=1}^3 Z_{\sigma v,k6+a}^* Y_{SL,ab} + \sum_{b=1}^3 Z_{\sigma v,kb}^* \sum_{a=1}^3 U_{j3+a}^{V,*} Y_{\nu,ab} \right. \\
& \left. \left. - \sum_{b=1}^3 U_{jb}^{V,*} \sum_{a=1}^3 Z_{\sigma v,k3+a}^* Y_{\nu,ab} \right) \right) \left( \frac{1-\gamma_5}{2} \right) \tag{329}
\end{aligned}$$

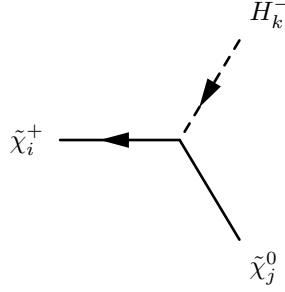
$$\begin{aligned}
& + \frac{1}{2} \left( \sum_{a=1}^3 Z_{\sigma v,ka}^* U_{ja}^V \left( -g_1 N_{i1} + g_2 N_{i2} \right) \right. \\
& - \sqrt{2} \left( \sum_{b=1}^3 Z_{\sigma v,kb}^* \sum_{a=1}^3 Y_{\nu,ab}^* U_{j3+a}^V + \sum_{b=1}^3 Z_{\sigma v,kb}^* \sum_{a=1}^3 Y_{SL,ab}^* U_{j6+a}^V - \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu,ab}^* Z_{\sigma v,k3+a}^* U_{jb}^V \right. \\
& \left. \left. + \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL,ab}^* Z_{\sigma v,k6+a}^* U_{jb}^V \right) N_{i4} \right) \left( \frac{1+\gamma_5}{2} \right) \tag{330}
\end{aligned}$$



$$\begin{aligned}
& \frac{i}{2} \left( g_1 N_{i1}^* \sum_{a=1}^3 U_{ja}^{V,*} Z_{\phi v,ka}^* - g_2 N_{i2}^* \sum_{a=1}^3 U_{ja}^{V,*} Z_{\phi v,ka}^* \right. \\
& - \sqrt{2} N_{i4}^* \left( \sum_{b=1}^3 Z_{\phi v,kb}^* \sum_{a=1}^3 U_{j6+a}^{V,*} Y_{SL,ab} + \sum_{b=1}^3 U_{jb}^{V,*} \sum_{a=1}^3 Z_{\phi v,k6+a}^* Y_{SL,ab} + \sum_{b=1}^3 Z_{\phi v,kb}^* \sum_{a=1}^3 U_{j3+a}^{V,*} Y_{\nu,ab} \right.
\end{aligned}$$

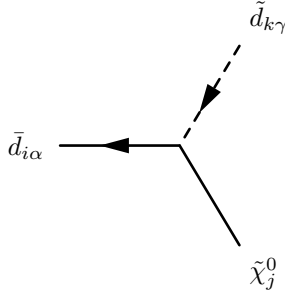
$$+ \sum_{b=1}^3 U_{jb}^{V,*} \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \left) \left( \frac{1-\gamma_5}{2} \right) \quad (331)$$

$$+ \frac{i}{2} \left( \sum_{a=1}^3 Z_{\phi v, ka}^* U_{ja}^V (g_1 N_{i1} - g_2 N_{i2}) \right. \\ \left. - \sqrt{2} \left( \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{\nu, ab}^* U_{j3+a}^V + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{SL, ab}^* U_{j6+a}^V + \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu, ab}^* Z_{\phi v, k3+a}^* U_{jb}^V \right. \right. \\ \left. \left. + \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL, ab}^* Z_{\phi v, k6+a}^* U_{jb}^V \right) N_{i4} \right) \left( \frac{1+\gamma_5}{2} \right) \quad (332)$$



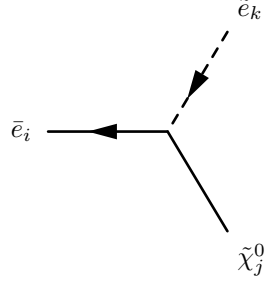
$$- \frac{i}{2} \left( 2g_2 V_{i1}^* N_{j4}^* + \sqrt{2} V_{i2}^* (g_1 N_{j1}^* + g_2 N_{j2}^*) \right) Z_{k2}^+ \left( \frac{1-\gamma_5}{2} \right) \quad (333)$$

$$+ \frac{i}{2} \left( -2g_2 U_{i1} N_{j3} + \sqrt{2} U_{i2} (g_1 N_{j1} + g_2 N_{j2}) \right) Z_{k1}^+ \left( \frac{1+\gamma_5}{2} \right) \quad (334)$$



$$- \frac{i}{3} \delta_{\alpha\gamma} \left( 3N_{j3}^* \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 U_{R, ia}^{d,*} Y_{d, ab} + \sqrt{2} g_1 N_{j1}^* \sum_{a=1}^3 Z_{k3+a}^{D,*} U_{R, ia}^{d,*} \right) \left( \frac{1-\gamma_5}{2} \right) \quad (335)$$

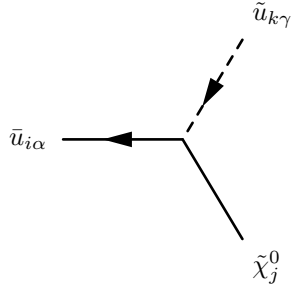
$$+ -\frac{i}{6} \delta_{\alpha\gamma} \left( 6 \sum_{b=1}^3 \sum_{a=1}^3 Y_{d, ab}^* Z_{k3+a}^{D,*} U_{L, ib}^d N_{j3} + \sqrt{2} \sum_{a=1}^3 Z_{ka}^{D,*} U_{L, ia}^d (-3g_2 N_{j2} + g_1 N_{j1}) \right) \left( \frac{1+\gamma_5}{2} \right) \quad (336)$$



$$-i \left( N_{j3}^* \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 U_{R,ia}^{e,*} Y_{e,ab} + \sqrt{2} g_1 N_{j1}^* \sum_{a=1}^3 Z_{k3+a}^{E,*} U_{R,ia}^{e,*} \right) \left( \frac{1-\gamma_5}{2} \right) \quad (337)$$

$$+ \frac{i}{2} \left( -2 \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} U_{L,ib}^e N_{j3} + \sqrt{2} \sum_{a=1}^3 Z_{ka}^{E,*} U_{L,ia}^e (g_1 N_{j1} + g_2 N_{j2}) \right) \left( \frac{1+\gamma_5}{2} \right) \quad (338)$$

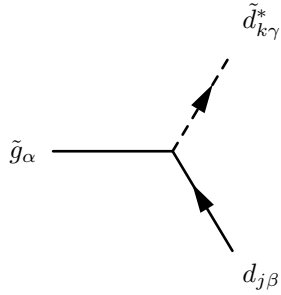

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$$\frac{i}{3} \delta_{\alpha\gamma} \left( 2\sqrt{2} g_1 N_{j1}^* \sum_{a=1}^3 Z_{k3+a}^{U,*} U_{R,ia}^{u,*} - 3N_{j4}^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 U_{R,ia}^{u,*} Y_{u,ab} \right) \left( \frac{1-\gamma_5}{2} \right) \quad (339)$$

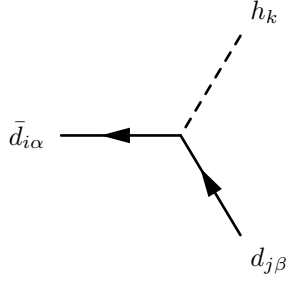
$$+ \frac{i}{6} \delta_{\alpha\gamma} \left( 6 \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} U_{L,ib}^u N_{j4} + \sqrt{2} \sum_{a=1}^3 Z_{ka}^{U,*} U_{L,ia}^u (3g_2 N_{j2} + g_1 N_{j1}) \right) \left( \frac{1+\gamma_5}{2} \right) \quad (340)$$


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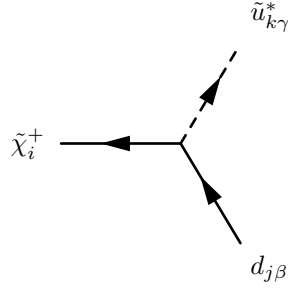
$$-i \frac{1}{\sqrt{2}} g_3 \phi_{\bar{g}} \lambda_{\gamma, \beta}^{\alpha} \sum_{a=1}^3 U_{L, ja}^{d,*} Z_{ka}^D \left( \frac{1-\gamma_5}{2} \right) \quad (341)$$

$$+ i \frac{1}{\sqrt{2}} g_3 \phi_{\bar{g}}^* \lambda_{\gamma, \beta}^{\alpha} \sum_{a=1}^3 Z_{k3+a}^D U_{R, ja}^d \left( \frac{1+\gamma_5}{2} \right) \quad (342)$$



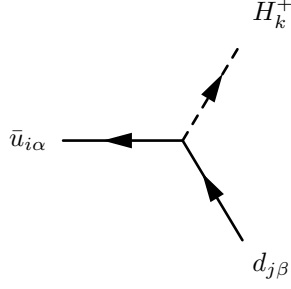
$$-i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 U_{L, jb}^{d,*} \sum_{a=1}^3 U_{R, ia}^{d,*} Y_{d, ab} Z_{k1}^H \left( \frac{1-\gamma_5}{2} \right) \quad (343)$$

$$+ -i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d, ab}^* U_{R, ja}^d U_{L, ib}^d Z_{k1}^H \left( \frac{1+\gamma_5}{2} \right) \quad (344)$$



$$-i \delta_{\beta\gamma} \left( g_2 V_{i1}^* \sum_{a=1}^3 U_{L, ja}^{d,*} Z_{ka}^U - V_{i2}^* \sum_{b=1}^3 U_{L, jb}^{d,*} \sum_{a=1}^3 Y_{u, ab} Z_{k3+a}^U \right) \left( \frac{1-\gamma_5}{2} \right) \quad (345)$$

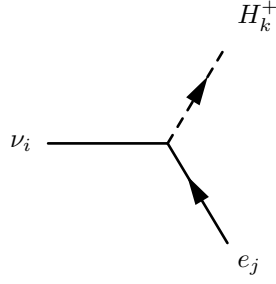
$$+ i \delta_{\beta\gamma} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d, ab}^* U_{R, ja}^d Z_{kb}^U U_{i2} \left( \frac{1+\gamma_5}{2} \right) \quad (346)$$



$$i\delta_{\alpha\beta} \sum_{b=1}^3 U_{L,jb}^{d,*} \sum_{a=1}^3 U_{R,ia}^{u,*} Y_{u,ab} Z_{k2}^+ \left( \frac{1-\gamma_5}{2} \right) \quad (347)$$

$$+ i\delta_{\alpha\beta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* U_{R,ja}^d U_{L,ib}^u Z_{k1}^+ \left( \frac{1+\gamma_5}{2} \right) \quad (348)$$

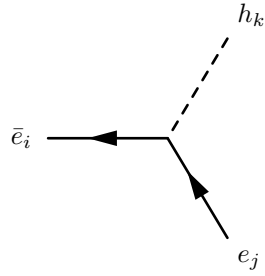

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$$i \left( \sum_{b=1}^3 U_{L,jb}^{e,*} \sum_{a=1}^3 U_{i6+a}^{V,*} Y_{SL,ab} + \sum_{b=1}^3 U_{L,jb}^{e,*} \sum_{a=1}^3 U_{i3+a}^{V,*} Y_{\nu,ab} \right) Z_{k2}^+ \left( \frac{1-\gamma_5}{2} \right) \quad (349)$$

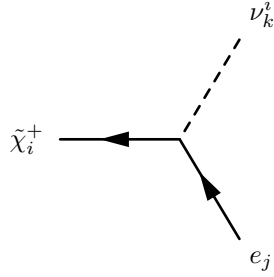
$$+ i \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* U_{R,ja}^e U_{ib}^V Z_{k1}^+ \left( \frac{1+\gamma_5}{2} \right) \quad (350)$$


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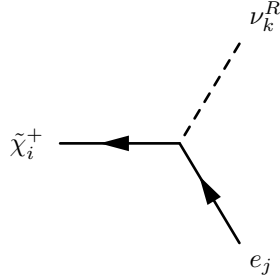
$$-i \frac{1}{\sqrt{2}} \sum_{b=1}^3 U_{L,jb}^{e,*} \sum_{a=1}^3 U_{R,ia}^{e,*} Y_{e,ab} Z_{k1}^H \left( \frac{1-\gamma_5}{2} \right) \quad (351)$$

$$+ -i \frac{1}{\sqrt{2}} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* U_{R,ja}^e U_{L,ib}^e Z_{k1}^H \left( \frac{1+\gamma_5}{2} \right) \quad (352)$$



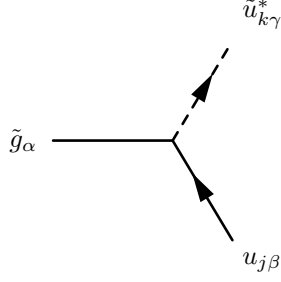
$$\frac{1}{\sqrt{2}} \left( -g_2 V_{i1}^* \sum_{a=1}^3 U_{L,ja}^{e,*} Z_{\sigma\nu,ka}^* + V_{i2}^* \left( - \sum_{b=1}^3 U_{L,jb}^{e,*} \sum_{a=1}^3 Z_{\sigma\nu,k6+a}^* Y_{SL,ab} + \sum_{b=1}^3 U_{L,jb}^{e,*} \sum_{a=1}^3 Z_{\sigma\nu,k3+a}^* Y_{\nu,ab} \right) \right) \left( \frac{1-\gamma_5}{2} \right) \quad (353)$$

$$+ \frac{1}{\sqrt{2}} \sum_{b=1}^3 Z_{\sigma\nu,kb}^* \sum_{a=1}^3 Y_{e,ab}^* U_{R,ja}^e U_{i2} \left( \frac{1+\gamma_5}{2} \right) \quad (354)$$



$$-i \frac{1}{\sqrt{2}} \left( g_2 V_{i1}^* \sum_{a=1}^3 U_{L,ja}^{e,*} Z_{\phi\nu,ka}^* - V_{i2}^* \left( \sum_{b=1}^3 U_{L,jb}^{e,*} \sum_{a=1}^3 Z_{\phi\nu,k6+a}^* Y_{SL,ab} + \sum_{b=1}^3 U_{L,jb}^{e,*} \sum_{a=1}^3 Z_{\phi\nu,k3+a}^* Y_{\nu,ab} \right) \right) \left( \frac{1-\gamma_5}{2} \right) \quad (355)$$

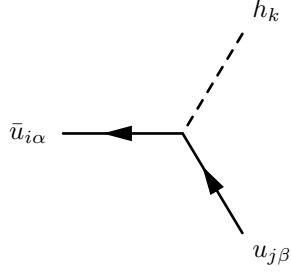
$$+ i \frac{1}{\sqrt{2}} \sum_{b=1}^3 Z_{\phi\nu,kb}^* \sum_{a=1}^3 Y_{e,ab}^* U_{R,ja}^e U_{i2} \left( \frac{1+\gamma_5}{2} \right) \quad (356)$$



$$-i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}}^* \lambda_{\gamma, \beta}^\alpha \sum_{a=1}^3 U_{L,ja}^{u,*} Z_{ka}^U \left( \frac{1-\gamma_5}{2} \right) \quad (357)$$

$$+ i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}}^* \lambda_{\gamma, \beta}^\alpha \sum_{a=1}^3 Z_{k3+a}^U U_{R,ja}^u \left( \frac{1+\gamma_5}{2} \right) \quad (358)$$

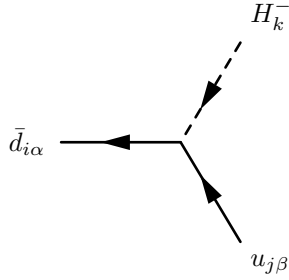

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$$-i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 U_{L,jb}^{u,*} \sum_{a=1}^3 U_{R,ia}^{u,*} Y_{u,ab} Z_{k2}^H \left( \frac{1-\gamma_5}{2} \right) \quad (359)$$

$$+ -i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* U_{R,ja}^u U_{L,ib}^u Z_{k2}^H \left( \frac{1+\gamma_5}{2} \right) \quad (360)$$

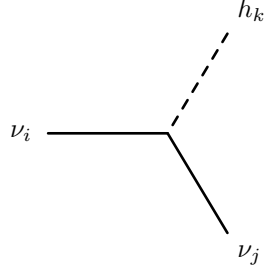

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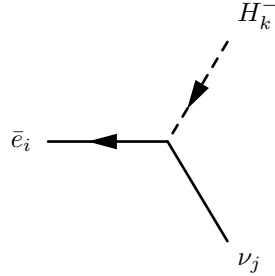
$$i\delta_{\alpha\beta} \sum_{b=1}^3 U_{L,jb}^{u,*} \sum_{a=1}^3 U_{R,ia}^{d,*} Y_{d,ab} Z_{k1}^+ \left( \frac{1-\gamma_5}{2} \right) \quad (361)$$

$$+ i\delta_{\alpha\beta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* U_{R,ja}^u U_{L,ib}^d Z_{k2}^+ \left( \frac{1+\gamma_5}{2} \right) \quad (362)$$



$$-i \frac{1}{\sqrt{2}} \left( \sum_{b=1}^3 U_{jb}^{V,*} \sum_{a=1}^3 U_{i6+a}^{V,*} Y_{SL,ab} + \sum_{b=1}^3 U_{ib}^{V,*} \sum_{a=1}^3 U_{j6+a}^{V,*} Y_{SL,ab} + \sum_{b=1}^3 U_{jb}^{V,*} \sum_{a=1}^3 U_{i3+a}^{V,*} Y_{\nu,ab} \right. \\ \left. + \sum_{b=1}^3 U_{ib}^{V,*} \sum_{a=1}^3 U_{j3+a}^{V,*} Y_{\nu,ab} \right) Z_{k2}^H \left( \frac{1-\gamma_5}{2} \right) \quad (363)$$

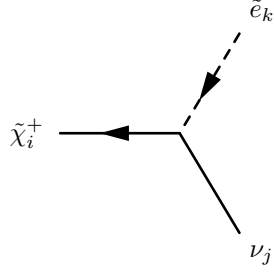
$$+ -i \frac{1}{\sqrt{2}} \left( \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu,ab}^* U_{j3+a}^V U_{ib}^V + \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL,ab}^* U_{j6+a}^V U_{ib}^V + \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu,ab}^* U_{i3+a}^V U_{jb}^V \right. \\ \left. + \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL,ab}^* U_{i6+a}^V U_{jb}^V \right) Z_{k2}^H \left( \frac{1+\gamma_5}{2} \right) \quad (364)$$



$$i \sum_{b=1}^3 U_{jb}^{V,*} \sum_{a=1}^3 U_{R,ia}^{e,*} Y_{e,ab} Z_{k1}^+ \left( \frac{1-\gamma_5}{2} \right) \quad (365)$$

$$+ i \left( \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu,ab}^* U_{j3+a}^V U_{L,ib}^e + \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL,ab}^* U_{j6+a}^V U_{L,ib}^e \right) Z_{k2}^+ \left( \frac{1+\gamma_5}{2} \right) \quad (366)$$

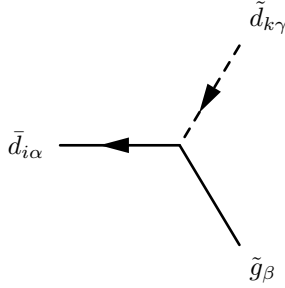

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$$iV_{i2}^* \left( \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 U_{j6+a}^{V,*} Y_{SL,ab} + \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 U_{j3+a}^{V,*} Y_{\nu,ab} \right) \left( \frac{1-\gamma_5}{2} \right) \quad (367)$$

$$+ -i \left( g_2 \sum_{a=1}^3 Z_{ka}^{E,*} U_{ja}^V U_{i1} - \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} U_{jb}^V U_{i2} \right) \left( \frac{1+\gamma_5}{2} \right) \quad (368)$$

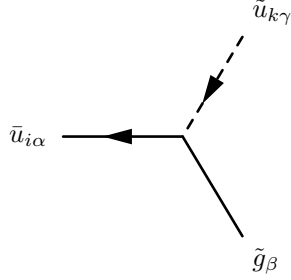

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$$i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}}^* \lambda_{\alpha,\gamma}^\beta \sum_{a=1}^3 Z_{k3+a}^{D,*} U_{R,ia}^{d,*} \left( \frac{1-\gamma_5}{2} \right) \quad (369)$$

$$+ -i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}}^* \lambda_{\alpha,\gamma}^\beta \sum_{a=1}^3 Z_{ka}^{D,*} U_{L,ia}^d \left( \frac{1+\gamma_5}{2} \right) \quad (370)$$

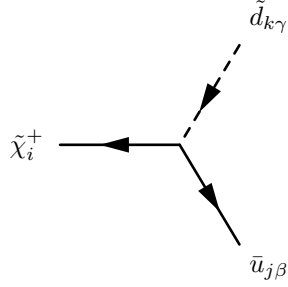

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$$i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}} \lambda_{\alpha,\gamma}^\beta \sum_{a=1}^3 Z_{k3+a}^{U,*} U_{R,ia}^{u,*} \left( \frac{1-\gamma_5}{2} \right) \quad (371)$$

$$+ -i \frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}}^* \lambda_{\alpha,\gamma}^\beta \sum_{a=1}^3 Z_{ka}^{U,*} U_{L,ia}^u \left( \frac{1+\gamma_5}{2} \right) \quad (372)$$


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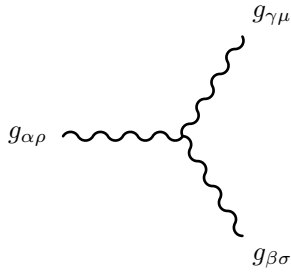


$$i V_{i2}^* \delta_{\beta\gamma} \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 U_{R,ja}^{u,*} Y_{u,ab} \left( \frac{1-\gamma_5}{2} \right) \quad (373)$$

$$+ -i \delta_{\beta\gamma} \left( g_2 \sum_{a=1}^3 Z_{ka}^{D,*} U_{L,ja}^u U_{i1} - \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} U_{L,jb}^u U_{i2} \right) \left( \frac{1+\gamma_5}{2} \right) \quad (374)$$

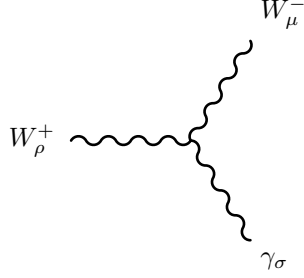

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## 9.6 Three Vector Boson-Interaction



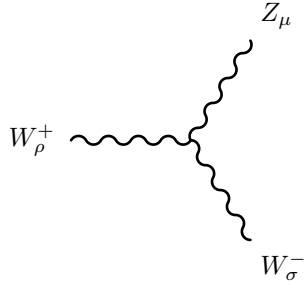
$$g_3 f_{\alpha,\beta,\gamma} \left( g_{\rho\mu} \left( -p_\sigma^{g\gamma\mu} + p_\sigma^{g\alpha\rho} \right) + g_{\rho\sigma} \left( -p_\mu^{g\alpha\rho} + p_\mu^{g\beta\sigma} \right) + g_{\sigma\mu} \left( -p_\rho^{g\beta\sigma} + p_\rho^{g\gamma\mu} \right) \right) \quad (375)$$


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$$ig_2 \sin \Theta_W \left( g_{\rho\mu} \left( -p_\sigma^{W_\mu^-} + p_\sigma^{W_\rho^+} \right) + g_{\rho\sigma} \left( -p_\mu^{W_\rho^+} + p_\mu^{\gamma\sigma} \right) + g_{\sigma\mu} \left( -p_\rho^{\gamma\sigma} + p_\rho^{W_\mu^-} \right) \right) \quad (376)$$

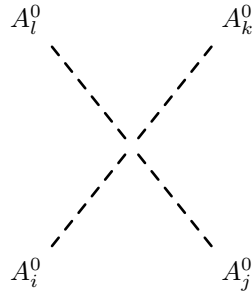

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$$-ig_2 \cos \Theta_W \left( g_{\rho\mu} \left( -p_\sigma^{Z_\mu} + p_\sigma^{W_\rho^+} \right) + g_{\rho\sigma} \left( -p_\mu^{W_\rho^+} + p_\mu^{W_\sigma^-} \right) + g_{\sigma\mu} \left( -p_\rho^{W_\sigma^-} + p_\rho^{Z_\mu} \right) \right) \quad (377)$$

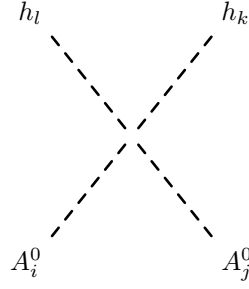

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## 9.7 Four Scalar-Interaction



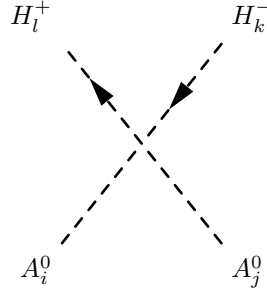
$$\begin{aligned}
& \frac{i}{4} (g_1^2 + g_2^2) \left( Z_{i2}^A \left( Z_{j1}^A \left( Z_{k1}^A Z_{l2}^A + Z_{k2}^A Z_{l1}^A \right) + Z_{j2}^A \left( -3Z_{k2}^A Z_{l2}^A + Z_{k1}^A Z_{l1}^A \right) \right) \right. \\
& \left. + Z_{i1}^A \left( Z_{j1}^A \left( -3Z_{k1}^A Z_{l1}^A + Z_{k2}^A Z_{l2}^A \right) + Z_{j2}^A \left( Z_{k1}^A Z_{l2}^A + Z_{k2}^A Z_{l1}^A \right) \right) \right)
\end{aligned} \tag{378}$$


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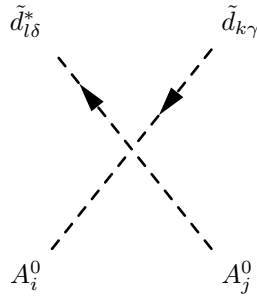
$$-\frac{i}{4} (g_1^2 + g_2^2) \left( Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A \right) \left( Z_{k1}^H Z_{l1}^H - Z_{k2}^H Z_{l2}^H \right) \tag{379}$$


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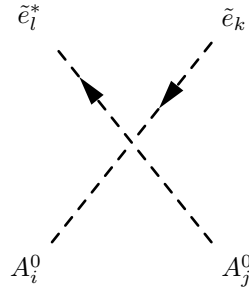
$$\begin{aligned}
& \frac{i}{4} \left( Z_{i1}^A \left( g_2^2 Z_{j2}^A \left( Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) - Z_{j1}^A \left( (g_1^2 + g_2^2) Z_{k1}^+ Z_{l1}^+ + (-g_1^2 + g_2^2) Z_{k2}^+ Z_{l2}^+ \right) \right) \right. \\
& \left. + Z_{i2}^A \left( g_2^2 Z_{j1}^A \left( Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) + Z_{j2}^A \left( -(g_1^2 + g_2^2) Z_{k2}^+ Z_{l2}^+ + (-g_2^2 + g_1^2) Z_{k1}^+ Z_{l1}^+ \right) \right) \right)
\end{aligned} \tag{380}$$


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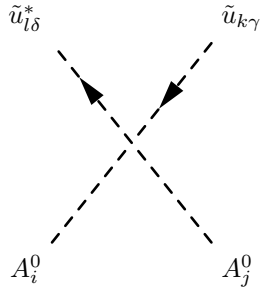
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left( (3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ka}^{D,*} Z_{la}^D (Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A) \right. \\
& + 2 \left( -6 \left( \sum_{c=1}^3 Z_{k3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{d,ba} Z_{l3+b}^D + \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{lc}^D \right) Z_{i1}^A Z_{j1}^A \right. \\
& \left. \left. + g_1^2 \sum_{a=1}^3 Z_{k3+a}^{D,*} Z_{l3+a}^D (Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A) \right) \right) \tag{381}
\end{aligned}$$


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$$\begin{aligned}
& -\frac{i}{4} \left( 4 \left( \sum_{c=1}^3 Z_{k3+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ca}^* Y_{e,ba} Z_{l3+b}^E + \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^E \right) Z_{i1}^A Z_{j1}^A \right. \\
& + \left( -g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ka}^{E,*} Z_{la}^E (Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A) \\
& \left. + 2g_1^2 \sum_{a=1}^3 Z_{k3+a}^{E,*} Z_{l3+a}^E (-Z_{i1}^A Z_{j1}^A + Z_{i2}^A Z_{j2}^A) \right) \tag{382}
\end{aligned}$$

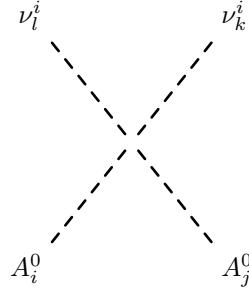

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$$\frac{i}{12} \delta_{\gamma\delta} \left( (-3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ka}^{U,*} Z_{la}^U (Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A) \right)$$

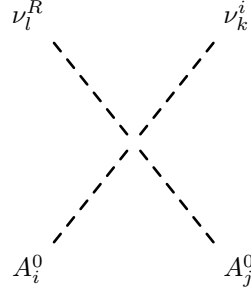
$$\begin{aligned}
& -4 \left( 3 \left( \sum_{c=1}^3 Z_{k3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{u,ba} Z_{l3+b}^U + \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{lc}^U \right) Z_{i2}^A Z_{j2}^A \right. \\
& \left. + g_1^2 \sum_{a=1}^3 Z_{k3+a}^{U,*} Z_{l3+a}^U \left( Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A \right) \right) \tag{383}
\end{aligned}$$


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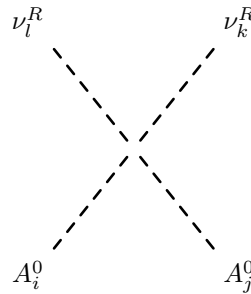


$$\begin{aligned}
& -\frac{i}{4} \left( 2 \left( \sum_{c=1}^3 Z_{\sigma v,lc}^* \sum_{b=1}^3 Z_{\sigma v,kb}^* \sum_{a=1}^3 Y_{SL,ac}^* Y_{SL,ab} + \sum_{c=1}^3 Z_{\sigma v,kc}^* \sum_{b=1}^3 Z_{\sigma v,lb}^* \sum_{a=1}^3 Y_{SL,ac}^* Y_{SL,ab} \right. \right. \\
& + \sum_{c=1}^3 Z_{\sigma v,l6+c}^* \sum_{b=1}^3 Z_{\sigma v,k6+b}^* \sum_{a=1}^3 Y_{SL,ca}^* Y_{SL,ba} + \sum_{c=1}^3 Z_{\sigma v,k6+c}^* \sum_{b=1}^3 Z_{\sigma v,l6+b}^* \sum_{a=1}^3 Y_{SL,ca}^* Y_{SL,ba} \\
& - \sum_{c=1}^3 Z_{\sigma v,l3+c}^* \sum_{b=1}^3 Z_{\sigma v,k6+b}^* \sum_{a=1}^3 Y_{\nu,ca}^* Y_{SL,ba} - \sum_{c=1}^3 Z_{\sigma v,k3+c}^* \sum_{b=1}^3 Z_{\sigma v,l6+b}^* \sum_{a=1}^3 Y_{\nu,ca}^* Y_{SL,ba} \\
& + \sum_{c=1}^3 Z_{\sigma v,lc}^* \sum_{b=1}^3 Z_{\sigma v,kb}^* \sum_{a=1}^3 Y_{\nu,ac}^* Y_{\nu,ab} + \sum_{c=1}^3 Z_{\sigma v,kc}^* \sum_{b=1}^3 Z_{\sigma v,lb}^* \sum_{a=1}^3 Y_{\nu,ac}^* Y_{\nu,ab} \\
& - \sum_{c=1}^3 Z_{\sigma v,l6+c}^* \sum_{b=1}^3 Z_{\sigma v,k3+b}^* \sum_{a=1}^3 Y_{SL,ca}^* Y_{\nu,ba} - \sum_{c=1}^3 Z_{\sigma v,k6+c}^* \sum_{b=1}^3 Z_{\sigma v,l3+b}^* \sum_{a=1}^3 Y_{SL,ca}^* Y_{\nu,ba} \\
& \left. + \sum_{c=1}^3 Z_{\sigma v,l3+c}^* \sum_{b=1}^3 Z_{\sigma v,k3+b}^* \sum_{a=1}^3 Y_{\nu,ca}^* Y_{\nu,ba} + \sum_{c=1}^3 Z_{\sigma v,k3+c}^* \sum_{b=1}^3 Z_{\sigma v,l3+b}^* \sum_{a=1}^3 Y_{\nu,ca}^* Y_{\nu,ba} \right) Z_{i2}^A Z_{j2}^A \\
& + \left( g_1^2 + g_2^2 \right) \sum_{a=1}^3 Z_{\sigma v,ka}^* Z_{\sigma v,la}^* \left( Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A \right) \tag{384}
\end{aligned}$$


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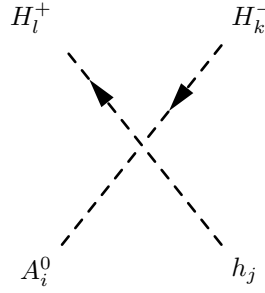
$$\begin{aligned}
& \frac{1}{2} \left( - \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} + \sum_{c=1}^3 Z_{\phi v, lc}^* \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} \right. \\
& - \sum_{c=1}^3 Z_{\sigma v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, l6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} + \sum_{c=1}^3 Z_{\phi v, l6+c}^* \sum_{b=1}^3 Z_{\sigma v, k6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} \\
& + \sum_{c=1}^3 Z_{\sigma v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, l6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} + \sum_{c=1}^3 Z_{\phi v, l3+c}^* \sum_{b=1}^3 Z_{\sigma v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} \\
& - \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} + \sum_{c=1}^3 Z_{\phi v, lc}^* \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} \\
& - \sum_{c=1}^3 Z_{\sigma v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, l3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} - \sum_{c=1}^3 Z_{\phi v, l6+c}^* \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} \\
& \left. + \sum_{c=1}^3 Z_{\sigma v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, l3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} - \sum_{c=1}^3 Z_{\phi v, l3+c}^* \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} \right) Z_{i2}^A Z_{j2}^A \quad (385)
\end{aligned}$$



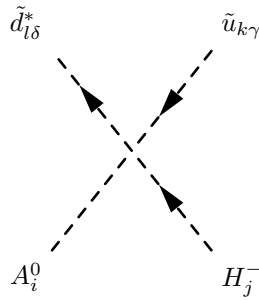
$$\begin{aligned}
& - \frac{i}{4} \left( 2 \left( \sum_{c=1}^3 Z_{\phi v, lc}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} + \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} \right) \right. \\
& \left. + \sum_{c=1}^3 Z_{\phi v, l6+c}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} + \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, l6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} \right)
\end{aligned}$$



$$\begin{aligned}
& + \sum_{c=1}^3 Z_{\phi v, l3+c}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} + \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, l6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} \\
& + \sum_{c=1}^3 Z_{\phi v, lc}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} + \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} \\
& + \sum_{c=1}^3 Z_{\phi v, l6+c}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} + \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, l3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} \\
& + \sum_{c=1}^3 Z_{\phi v, l3+c}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} + \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, l3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} \Big) Z_{i2}^A Z_{j2}^A \\
& + \left( g_1^2 + g_2^2 \right) \sum_{a=1}^3 Z_{\phi v, ka}^* Z_{\phi v, la}^* \left( Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A \right)
\end{aligned} \tag{386}$$

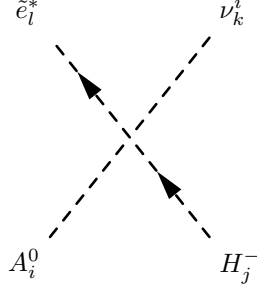


$$\frac{1}{4} g_2^2 \left( Z_{i1}^A Z_{j2}^H + Z_{i2}^A Z_{j1}^H \right) \left( -Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) \tag{387}$$

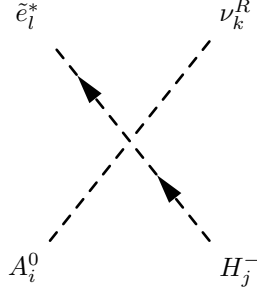


$$\begin{aligned}
& \frac{1}{2} \frac{1}{\sqrt{2}} \delta_{\gamma\delta} \left( g_2^2 \sum_{a=1}^3 Z_{ka}^{U,*} Z_{la}^D \left( -Z_{i1}^A Z_{j1}^+ + Z_{i2}^A Z_{j2}^+ \right) \right. \\
& \left. + 2 \left( \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{d, ac}^* Y_{d, ab} Z_{lc}^D Z_{i1}^A Z_{j1}^+ - \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u, ac}^* Y_{u, ab} Z_{lc}^D Z_{i2}^A Z_{j2}^+ \right) \right)
\end{aligned}$$

$$+ \sum_{c=1}^3 Z_{k3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{d,ba} Z_{l3+b}^D \left( -Z_{i1}^A Z_{j2}^+ + Z_{i2}^A Z_{j1}^+ \right) \Big) \quad (388)$$



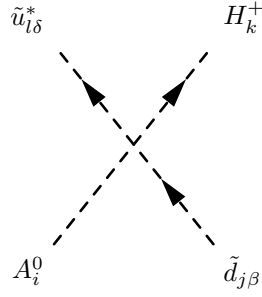
$$\begin{aligned}
& - \frac{i}{4} \left( g_2^2 \sum_{a=1}^3 Z_{\sigma v,ka}^* Z_{la}^E \left( Z_{i1}^A Z_{j1}^+ - Z_{i2}^A Z_{j2}^+ \right) \right. \\
& + 2 \left( - \sum_{c=1}^3 \sum_{b=1}^3 Z_{\sigma v,kb}^* \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^E Z_{i1}^A Z_{j1}^+ \right. \\
& - \sum_{c=1}^3 Z_{\sigma v,k3+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu,ca}^* Y_{e,ba} Z_{l3+b}^E Z_{i2}^A Z_{j1}^+ \\
& + \sum_{c=1}^3 Z_{\sigma v,k3+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu,ca}^* Y_{e,ba} Z_{l3+b}^E Z_{i1}^A Z_{j2}^+ + \sum_{c=1}^3 \sum_{b=1}^3 Z_{\sigma v,kb}^* \sum_{a=1}^3 Y_{SL,ac}^* Y_{SL,ab} Z_{lc}^E Z_{i2}^A Z_{j2}^+ \\
& + \sum_{c=1}^3 \sum_{b=1}^3 Z_{\sigma v,kb}^* \sum_{a=1}^3 Y_{\nu,ac}^* Y_{\nu,ab} Z_{lc}^E Z_{i2}^A Z_{j2}^+ \\
& \left. \left. + \sum_{c=1}^3 Z_{\sigma v,k6+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL,ca}^* Y_{e,ba} Z_{l3+b}^E \left( -Z_{i1}^A Z_{j2}^+ + Z_{i2}^A Z_{j1}^+ \right) \right) \right) \quad (389)
\end{aligned}$$



$$\frac{1}{4} \left( g_2^2 \sum_{a=1}^3 Z_{\phi v,ka}^* Z_{la}^E \left( -Z_{i1}^A Z_{j1}^+ + Z_{i2}^A Z_{j2}^+ \right) \right)$$

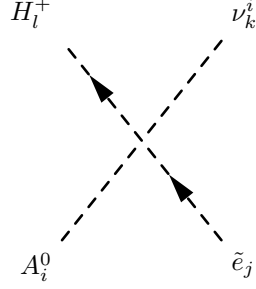
$$\begin{aligned}
& + 2 \left( \sum_{c=1}^3 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{e, ac}^* Y_{e, ab} Z_{lc}^E Z_{i1}^A Z_{j1}^+ + \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu, ca}^* Y_{e, ba} Z_{l3+b}^E Z_{i2}^A Z_{j1}^+ \right. \\
& - \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu, ca}^* Y_{e, ba} Z_{l3+b}^E Z_{i1}^A Z_{j2}^+ \\
& - \sum_{c=1}^3 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} Z_{lc}^E Z_{i2}^A Z_{j2}^+ \\
& - \sum_{c=1}^3 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} Z_{lc}^E Z_{i2}^A Z_{j2}^+ \\
& \left. + \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL, ca}^* Y_{e, ba} Z_{l3+b}^E \left( - Z_{i1}^A Z_{j2}^+ + Z_{i2}^A Z_{j1}^+ \right) \right) \tag{390}
\end{aligned}$$


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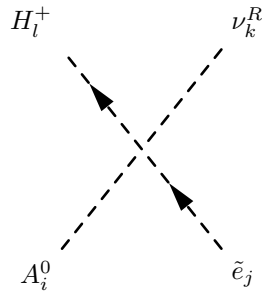


$$\begin{aligned}
& \frac{1}{2} \frac{1}{\sqrt{2}} \delta_{\beta\delta} \left( - 2 \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d, ac}^* Y_{d, ab} Z_{lc}^U Z_{i1}^A Z_{k1}^+ \right. \\
& - 2 \sum_{c=1}^3 Z_{j3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d, ca}^* Y_{u, ba} Z_{l3+b}^U Z_{i2}^A Z_{k1}^+ \\
& + 2 \sum_{c=1}^3 Z_{j3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d, ca}^* Y_{u, ba} Z_{l3+b}^U Z_{i1}^A Z_{k2}^+ \\
& \left. + 2 \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{u, ac}^* Y_{u, ab} Z_{lc}^U Z_{i2}^A Z_{k2}^+ + g_2^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{la}^U \left( Z_{i1}^A Z_{k1}^+ - Z_{i2}^A Z_{k2}^+ \right) \right) \tag{391}
\end{aligned}$$


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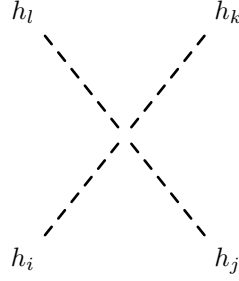
$$\begin{aligned}
& -\frac{i}{4} \left( g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{\sigma v, ka}^* \left( Z_{i1}^A Z_{l1}^+ - Z_{i2}^A Z_{l2}^+ \right) \right. \\
& + 2 \left( - \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{i1}^A Z_{l1}^+ \right. \\
& - \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{\nu,ba} Z_{i2}^A Z_{l1}^+ \\
& + \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{\nu,ba} Z_{i1}^A Z_{l2}^+ \\
& + \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{SL,ac}^* Y_{SL,ab} Z_{i2}^A Z_{l2}^+ + \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{\nu,ac}^* Y_{\nu,ab} Z_{i2}^A Z_{l2}^+ \\
& \left. \left. + \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 Z_{\sigma v, k6+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{SL,ba} \left( - Z_{i1}^A Z_{l2}^+ + Z_{i2}^A Z_{l1}^+ \right) \right) \right) \quad (392)
\end{aligned}$$



$$\begin{aligned}
& \frac{1}{4} \left( g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{\phi v, ka}^* \left( Z_{i1}^A Z_{l1}^+ - Z_{i2}^A Z_{l2}^+ \right) \right. \\
& + 2 \left( - \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{i1}^A Z_{l1}^+ \right.
\end{aligned}$$

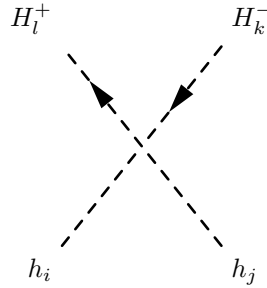
$$\begin{aligned}
& - \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{\nu,ba} Z_{i2}^A Z_{l1}^+ \\
& + \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{\nu,ba} Z_{i1}^A Z_{l2}^+ \\
& + \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{SL,ac}^* Y_{SL,ab} Z_{i2}^A Z_{l2}^+ + \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{\nu,ac}^* Y_{\nu,ab} Z_{i2}^A Z_{l2}^+ \\
& + \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{SL,ba} \left( Z_{i1}^A Z_{l2}^+ - Z_{i2}^A Z_{l1}^+ \right) \Big) \tag{393}
\end{aligned}$$


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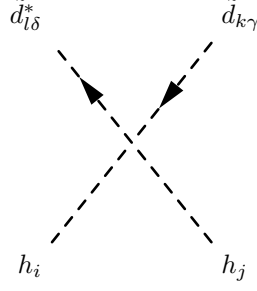
$$\begin{aligned}
& \frac{i}{4} \left( g_1^2 + g_2^2 \right) \left( Z_{i2}^H \left( Z_{j1}^H \left( Z_{k1}^H Z_{l2}^H + Z_{k2}^H Z_{l1}^H \right) + Z_{j2}^H \left( -3Z_{k2}^H Z_{l2}^H + Z_{k1}^H Z_{l1}^H \right) \right) \right. \\
& \left. + Z_{i1}^H \left( Z_{j1}^H \left( -3Z_{k1}^H Z_{l1}^H + Z_{k2}^H Z_{l2}^H \right) + Z_{j2}^H \left( Z_{k1}^H Z_{l2}^H + Z_{k2}^H Z_{l1}^H \right) \right) \right) \tag{394}
\end{aligned}$$


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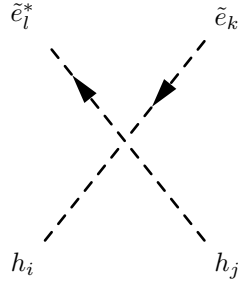
$$\begin{aligned}
& - \frac{i}{4} \left( Z_{i1}^H \left( g_2^2 Z_{j2}^H \left( Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) + Z_{j1}^H \left( \left( g_1^2 + g_2^2 \right) Z_{k1}^+ Z_{l1}^+ + \left( -g_1^2 + g_2^2 \right) Z_{k2}^+ Z_{l2}^+ \right) \right) \right. \\
& \left. + Z_{i2}^H \left( g_2^2 Z_{j1}^H \left( Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) + Z_{j2}^H \left( \left( -g_1^2 + g_2^2 \right) Z_{k1}^+ Z_{l1}^+ + \left( g_1^2 + g_2^2 \right) Z_{k2}^+ Z_{l2}^+ \right) \right) \right) \tag{395}
\end{aligned}$$


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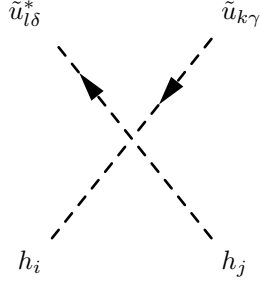
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left( (3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ka}^{D,*} Z_{la}^D (Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \right. \\
& + 2 \left( -6 \left( \sum_{c=1}^3 Z_{k3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{d,ba} Z_{l3+b}^D + \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{lc}^D \right) Z_{i1}^H Z_{j1}^H \right. \\
& \left. \left. + g_1^2 \sum_{a=1}^3 Z_{k3+a}^{D,*} Z_{l3+a}^D (Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \right) \right) \tag{396}
\end{aligned}$$


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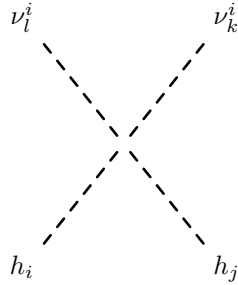


$$\begin{aligned}
& -\frac{i}{4} \left( 4 \left( \sum_{c=1}^3 Z_{k3+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ca}^* Y_{e,ba} Z_{l3+b}^E + \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^E \right) Z_{i1}^H Z_{j1}^H \right. \\
& + \left( -g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ka}^{E,*} Z_{la}^E (Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \\
& \left. + 2g_1^2 \sum_{a=1}^3 Z_{k3+a}^{E,*} Z_{l3+a}^E (-Z_{i1}^H Z_{j1}^H + Z_{i2}^H Z_{j2}^H) \right) \tag{397}
\end{aligned}$$


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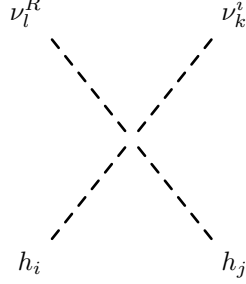
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left( \left( -3g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ka}^{U,*} Z_{la}^U \left( Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H \right) \right. \\
& - 4 \left( 3 \left( \sum_{c=1}^3 Z_{k3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{u,ba} Z_{l3+b}^U + \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{lc}^U \right) Z_{i2}^H Z_{j2}^H \right. \\
& \left. \left. + g_1^2 \sum_{a=1}^3 Z_{k3+a}^{U,*} Z_{l3+a}^U \left( Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H \right) \right) \right) \tag{398}
\end{aligned}$$



$$\begin{aligned}
& -\frac{i}{4} \left( 2 \left( \sum_{c=1}^3 Z_{\sigma v,lc}^* \sum_{b=1}^3 Z_{\sigma v,kb}^* \sum_{a=1}^3 Y_{SL,ac}^* Y_{SL,ab} + \sum_{c=1}^3 Z_{\sigma v,kc}^* \sum_{b=1}^3 Z_{\sigma v,lb}^* \sum_{a=1}^3 Y_{SL,ac}^* Y_{SL,ab} \right) \right. \\
& + \sum_{c=1}^3 Z_{\sigma v,l6+c}^* \sum_{b=1}^3 Z_{\sigma v,k6+b}^* \sum_{a=1}^3 Y_{SL,ca}^* Y_{SL,ba} + \sum_{c=1}^3 Z_{\sigma v,k6+c}^* \sum_{b=1}^3 Z_{\sigma v,l6+b}^* \sum_{a=1}^3 Y_{SL,ca}^* Y_{SL,ba} \\
& - \sum_{c=1}^3 Z_{\sigma v,l3+c}^* \sum_{b=1}^3 Z_{\sigma v,k6+b}^* \sum_{a=1}^3 Y_{\nu,ca}^* Y_{SL,ba} - \sum_{c=1}^3 Z_{\sigma v,k3+c}^* \sum_{b=1}^3 Z_{\sigma v,l6+b}^* \sum_{a=1}^3 Y_{\nu,ca}^* Y_{SL,ba} \\
& + \sum_{c=1}^3 Z_{\sigma v,lc}^* \sum_{b=1}^3 Z_{\sigma v,kb}^* \sum_{a=1}^3 Y_{\nu,ac}^* Y_{\nu,ab} + \sum_{c=1}^3 Z_{\sigma v,kc}^* \sum_{b=1}^3 Z_{\sigma v,lb}^* \sum_{a=1}^3 Y_{\nu,ac}^* Y_{\nu,ab} \\
& \left. - \sum_{c=1}^3 Z_{\sigma v,l6+c}^* \sum_{b=1}^3 Z_{\sigma v,k3+b}^* \sum_{a=1}^3 Y_{SL,ca}^* Y_{\nu,ba} - \sum_{c=1}^3 Z_{\sigma v,k6+c}^* \sum_{b=1}^3 Z_{\sigma v,l3+b}^* \sum_{a=1}^3 Y_{SL,ca}^* Y_{\nu,ba} \right)
\end{aligned}$$

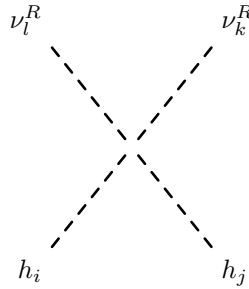
$$\begin{aligned}
& + \sum_{c=1}^3 Z_{\sigma v, l3+c}^* \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} + \sum_{c=1}^3 Z_{\sigma v, k3+c}^* \sum_{b=1}^3 Z_{\sigma v, l3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} \Big) Z_{i2}^H Z_{j2}^H \\
& + \left( g_1^2 + g_2^2 \right) \sum_{a=1}^3 Z_{\sigma v, ka}^* Z_{\sigma v, la}^* \left( Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H \right)
\end{aligned} \tag{399}$$


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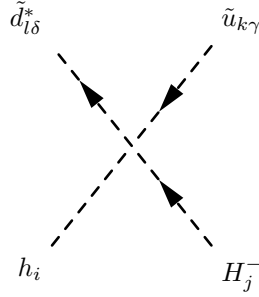
$$\begin{aligned}
& \frac{1}{2} \left( - \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} + \sum_{c=1}^3 Z_{\phi v, lc}^* \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} \right. \\
& - \sum_{c=1}^3 Z_{\sigma v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, l6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} + \sum_{c=1}^3 Z_{\phi v, l6+c}^* \sum_{b=1}^3 Z_{\sigma v, k6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} \\
& + \sum_{c=1}^3 Z_{\sigma v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, l6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} + \sum_{c=1}^3 Z_{\phi v, l3+c}^* \sum_{b=1}^3 Z_{\sigma v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} \\
& - \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} + \sum_{c=1}^3 Z_{\phi v, lc}^* \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} \\
& - \sum_{c=1}^3 Z_{\sigma v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, l3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} - \sum_{c=1}^3 Z_{\phi v, l6+c}^* \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} \\
& \left. + \sum_{c=1}^3 Z_{\sigma v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, l3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} - \sum_{c=1}^3 Z_{\phi v, l3+c}^* \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} \right) Z_{i2}^H Z_{j2}^H
\end{aligned} \tag{400}$$


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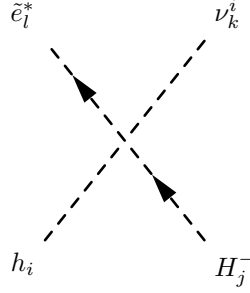




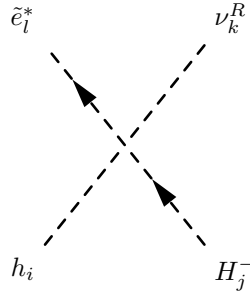
$$\begin{aligned}
& -\frac{i}{4} \left( 2 \left( \sum_{c=1}^3 Z_{\phi v, lc}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} + \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} \right. \right. \\
& + \sum_{c=1}^3 Z_{\phi v, l6+c}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} + \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, l6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} \\
& + \sum_{c=1}^3 Z_{\phi v, l3+c}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} + \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, l6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} \\
& + \sum_{c=1}^3 Z_{\phi v, lc}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} + \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} \\
& + \sum_{c=1}^3 Z_{\phi v, l6+c}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} + \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, l3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} \\
& \left. + \sum_{c=1}^3 Z_{\phi v, l3+c}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} + \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, l3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} \right) Z_{i2}^H Z_{j2}^H \\
& + \left( g_1^2 + g_2^2 \right) \sum_{a=1}^3 Z_{\phi v, ka}^* Z_{\phi v, la}^* \left( Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H \right)
\end{aligned} \tag{401}$$



$$\begin{aligned}
& -\frac{i}{2} \frac{1}{\sqrt{2}} \delta_{\gamma\delta} \left( g_2^2 \sum_{a=1}^3 Z_{ka}^{U,*} Z_{la}^D \left( Z_{i1}^H Z_{j1}^+ + Z_{i2}^H Z_{j2}^+ \right) \right. \\
& - 2 \left( \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{d, ac}^* Y_{d, ab} Z_{lc}^D Z_{i1}^H Z_{j1}^+ + \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u, ac}^* Y_{u, ab} Z_{lc}^D Z_{i2}^H Z_{j2}^+ \right. \\
& \left. \left. + \sum_{c=1}^3 Z_{k3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u, ca}^* Y_{d, ba} Z_{l3+b}^D \left( Z_{i1}^H Z_{j2}^+ + Z_{i2}^H Z_{j1}^+ \right) \right) \right)
\end{aligned} \tag{402}$$



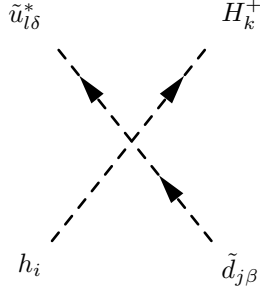
$$\begin{aligned}
& \frac{1}{4} \left( g_2^2 \sum_{a=1}^3 Z_{\sigma v, ka}^* Z_{la}^E \left( Z_{i1}^H Z_{j1}^+ + Z_{i2}^H Z_{j2}^+ \right) \right. \\
& - 2 \left( \sum_{c=1}^3 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Y_{e, ac}^* Y_{e, ab} Z_{lc}^E Z_{i1}^H Z_{j1}^+ + \sum_{c=1}^3 Z_{\sigma v, k3+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu, ca}^* Y_{e, ba} Z_{l3+b}^E Z_{i2}^H Z_{j1}^+ \right. \\
& + \sum_{c=1}^3 Z_{\sigma v, k3+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu, ca}^* Y_{e, ba} Z_{l3+b}^E Z_{i1}^H Z_{j2}^+ + \sum_{c=1}^3 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} Z_{lc}^E Z_{i2}^H Z_{j2}^+ \\
& + \sum_{c=1}^3 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} Z_{lc}^E Z_{i2}^H Z_{j2}^+ \\
& \left. \left. - \sum_{c=1}^3 Z_{\sigma v, k6+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL, ca}^* Y_{e, ba} Z_{l3+b}^E \left( Z_{i1}^H Z_{j2}^+ + Z_{i2}^H Z_{j1}^+ \right) \right) \right) \quad (403)
\end{aligned}$$



$$\begin{aligned}
& - \frac{i}{4} \left( g_2^2 \sum_{a=1}^3 Z_{\phi v, ka}^* Z_{la}^E \left( Z_{i1}^H Z_{j1}^+ + Z_{i2}^H Z_{j2}^+ \right) \right. \\
& - 2 \left( \sum_{c=1}^3 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{e, ac}^* Y_{e, ab} Z_{lc}^E Z_{i1}^H Z_{j1}^+ + \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu, ca}^* Y_{e, ba} Z_{l3+b}^E Z_{i2}^H Z_{j1}^+ \right. \\
& + \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{\nu, ca}^* Y_{e, ba} Z_{l3+b}^E Z_{i1}^H Z_{j2}^+ + \sum_{c=1}^3 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{SL, ac}^* Y_{SL, ab} Z_{lc}^E Z_{i2}^H Z_{j2}^+ \\
& \left. \left. - \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL, ca}^* Y_{e, ba} Z_{l3+b}^E \left( Z_{i1}^H Z_{j2}^+ + Z_{i2}^H Z_{j1}^+ \right) \right) \right)
\end{aligned}$$

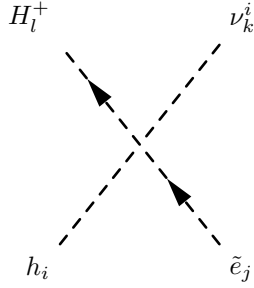
$$\begin{aligned}
& + \sum_{c=1}^3 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{\nu, ac}^* Y_{\nu, ab} Z_{lc}^E Z_{i2}^H Z_{j2}^+ \\
& + \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 \sum_{a=1}^3 Y_{SL, ca}^* Y_{e, ba} Z_{l3+b}^E \left( Z_{i1}^H Z_{j2}^+ + Z_{i2}^H Z_{j1}^+ \right) \Big) \tag{404}
\end{aligned}$$


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$$\begin{aligned}
& - \frac{i}{2} \frac{1}{\sqrt{2}} \delta_{\beta\delta} \left( g_2^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{la}^U \left( Z_{i1}^H Z_{k1}^+ + Z_{i2}^H Z_{k2}^+ \right) \right. \\
& - 2 \left( \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d, ac}^* Y_{d, ab} Z_{lc}^U Z_{i1}^H Z_{k1}^+ + \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{u, ac}^* Y_{u, ab} Z_{lc}^U Z_{i2}^H Z_{k2}^+ \right. \\
& \left. \left. + \sum_{c=1}^3 Z_{j3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d, ca}^* Y_{u, ba} Z_{l3+b}^U \left( Z_{i1}^H Z_{k2}^+ + Z_{i2}^H Z_{k1}^+ \right) \right) \right) \tag{405}
\end{aligned}$$

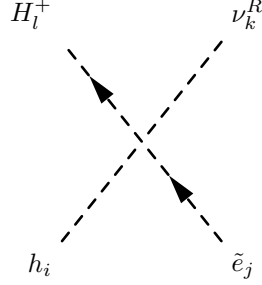

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$$\begin{aligned}
& \frac{1}{4} \left( -g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{\sigma v, ka}^* \left( Z_{i1}^H Z_{l1}^+ + Z_{i2}^H Z_{l2}^+ \right) \right. \\
& \left. + 2 \left( \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e, ac}^* Y_{e, ab} Z_{i1}^H Z_{l1}^+ \right) \right)
\end{aligned}$$

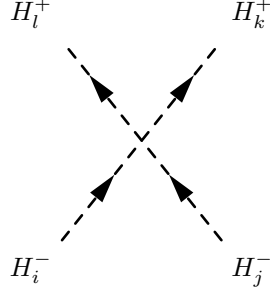
$$\begin{aligned}
& + \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{\nu,ba} Z_{i2}^H Z_{l1}^+ \\
& + \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{\nu,ba} Z_{i1}^H Z_{l2}^+ \\
& + \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{SL,ac}^* Y_{SL,ab} Z_{i2}^H Z_{l2}^+ + \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{\nu,ac}^* Y_{\nu,ab} Z_{i2}^H Z_{l2}^+ \\
& - \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 Z_{\sigma v, k6+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{SL,ba} \left( Z_{i1}^H Z_{l2}^+ + Z_{i2}^H Z_{l1}^+ \right) \Big) \tag{406}
\end{aligned}$$


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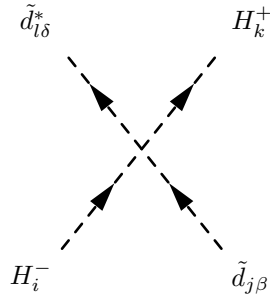
$$\begin{aligned}
& - \frac{i}{4} \left( g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{\phi v, ka}^* \left( Z_{i1}^H Z_{l1}^+ + Z_{i2}^H Z_{l2}^+ \right) \right. \\
& - 2 \left( \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{i1}^H Z_{l1}^+ \right. \\
& + \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{\nu,ba} Z_{i2}^H Z_{l1}^+ \\
& + \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{\nu,ba} Z_{i1}^H Z_{l2}^+ \\
& + \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{SL,ac}^* Y_{SL,ab} Z_{i2}^H Z_{l2}^+ + \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{\nu,ac}^* Y_{\nu,ab} Z_{i2}^H Z_{l2}^+ \\
& \left. \left. + \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{e,ca}^* Y_{SL,ba} \left( Z_{i1}^H Z_{l2}^+ + Z_{i2}^H Z_{l1}^+ \right) \right) \right) \tag{407}
\end{aligned}$$


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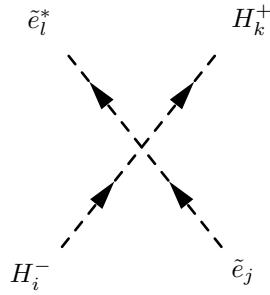
$$\begin{aligned}
& -\frac{i}{4}(g_1^2 + g_2^2) \left( -Z_{i2}^+ \left( -2Z_{j2}^+ Z_{k2}^+ Z_{l2}^+ + Z_{j1}^+ \left( Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) \right) \right. \\
& \left. + Z_{i1}^+ \left( 2Z_{j1}^+ Z_{k1}^+ Z_{l1}^+ - Z_{j2}^+ \left( Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) \right) \right) \quad (408)
\end{aligned}$$


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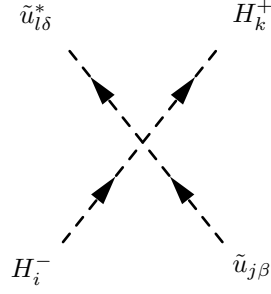
$$\begin{aligned}
& \frac{i}{12} \delta_{\beta\delta} \left( \left( -3g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ja}^{D,*} Z_{la}^D \left( Z_{i1}^+ Z_{k1}^+ - Z_{i2}^+ Z_{k2}^+ \right) \right. \\
& + 2 \left( g_1^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{l3+a}^D \left( Z_{i1}^+ Z_{k1}^+ - Z_{i2}^+ Z_{k2}^+ \right) \right. \\
& \left. \left. - 6 \left( \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{lc}^D Z_{i2}^+ Z_{k2}^+ + \sum_{c=1}^3 Z_{j3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{d,ba} Z_{l3+b}^D Z_{i1}^+ Z_{k1}^+ \right) \right) \right) \quad (409)
\end{aligned}$$


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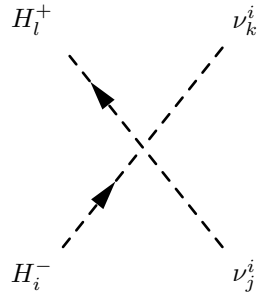
$$\begin{aligned}
& -\frac{i}{4} \left( (g_1^2 + g_2^2) \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E (Z_{i1}^+ Z_{k1}^+ - Z_{i2}^+ Z_{k2}^+) \right. \\
& + 2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E (-Z_{i1}^+ Z_{k1}^+ + Z_{i2}^+ Z_{k2}^+) \\
& + 4 \left( \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ca}^* Y_{e,ba} Z_{l3+b}^E Z_{i1}^+ Z_{k1}^+ \right. \\
& \left. \left. + \left( \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{SL,ac}^* Y_{SL,ab} Z_{lc}^E + \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{\nu,ac}^* Y_{\nu,ab} Z_{lc}^E \right) Z_{i2}^+ Z_{k2}^+ \right) \right) \quad (410)
\end{aligned}$$


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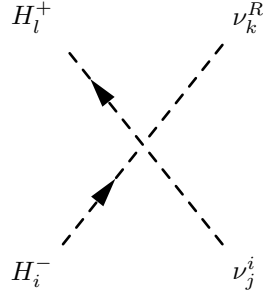
$$\begin{aligned}
& \frac{i}{12} \delta_{\beta\delta} \left( (3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U (Z_{i1}^+ Z_{k1}^+ - Z_{i2}^+ Z_{k2}^+) \right. \\
& - 4 \left( g_1^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U (Z_{i1}^+ Z_{k1}^+ - Z_{i2}^+ Z_{k2}^+) \right. \\
& \left. \left. + 3 \left( \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{lc}^U Z_{i1}^+ Z_{k1}^+ + \sum_{c=1}^3 Z_{j3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{u,ba} Z_{l3+b}^U Z_{i2}^+ Z_{k2}^+ \right) \right) \right) \quad (411)
\end{aligned}$$


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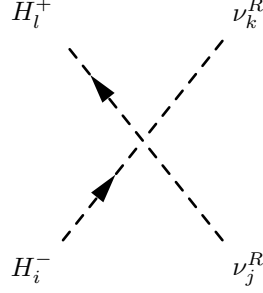


$$-\frac{i}{4} \left( (-g_2^2 + g_1^2) \sum_{a=1}^3 Z_{\sigma\nu,ja}^* Z_{\sigma\nu,ka}^* (Z_{i1}^+ Z_{l1}^+ - Z_{i2}^+ Z_{l2}^+) \right)$$

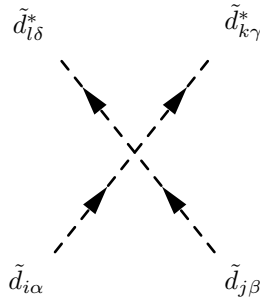
$$\begin{aligned}
& + 2 \left( \sum_{c=1}^3 Z_{\sigma v, kc}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{e, ac}^* Y_{e, ab} Z_{i1}^+ Z_{l1}^+ + \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Y_{e, ac}^* Y_{e, ab} Z_{i1}^+ Z_{l1}^+ \right. \\
& + \left( \sum_{c=1}^3 Z_{\sigma v, k6+c}^* \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} + \sum_{c=1}^3 Z_{\sigma v, j6+c}^* \sum_{b=1}^3 Z_{\sigma v, k6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} \right. \\
& - \sum_{c=1}^3 Z_{\sigma v, k3+c}^* \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} - \sum_{c=1}^3 Z_{\sigma v, j3+c}^* \sum_{b=1}^3 Z_{\sigma v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} \\
& - \sum_{c=1}^3 Z_{\sigma v, k6+c}^* \sum_{b=1}^3 Z_{\sigma v, j3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} - \sum_{c=1}^3 Z_{\sigma v, j6+c}^* \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} \\
& \left. + \sum_{c=1}^3 Z_{\sigma v, k3+c}^* \sum_{b=1}^3 Z_{\sigma v, j3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} + \sum_{c=1}^3 Z_{\sigma v, j3+c}^* \sum_{b=1}^3 Z_{\sigma v, k3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} \right) Z_{i2}^+ Z_{l2}^+ \Big) \quad (412)
\end{aligned}$$



$$\begin{aligned}
& \frac{1}{2} \left( - \sum_{c=1}^3 Z_{\sigma v, jc}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{e, ac}^* Y_{e, ab} Z_{i1}^+ Z_{l1}^+ \right. \\
& + \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{e, ac}^* Y_{e, ab} Z_{i1}^+ Z_{l1}^+ \\
& + \left( - \sum_{c=1}^3 Z_{\sigma v, j6+c}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} + \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} \right. \\
& + \sum_{c=1}^3 Z_{\sigma v, j3+c}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} + \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\sigma v, j6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} \\
& - \sum_{c=1}^3 Z_{\sigma v, j6+c}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} - \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\sigma v, j3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} \\
& \left. + \sum_{c=1}^3 Z_{\sigma v, j3+c}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} - \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\sigma v, j3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} \right) Z_{i2}^+ Z_{l2}^+ \Big) \quad (413)
\end{aligned}$$



$$\begin{aligned}
& -\frac{i}{4} \left( (-g_2^2 + g_1^2) \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{\phi v, ka}^* (Z_{i1}^+ Z_{l1}^+ - Z_{i2}^+ Z_{l2}^+) \right. \\
& + 2 \left( \sum_{c=1}^3 Z_{\phi v, kc}^* \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Y_{e, ac}^* Y_{e, ab} Z_{i1}^+ Z_{l1}^+ + \sum_{c=1}^3 Z_{\phi v, jc}^* \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{e, ac}^* Y_{e, ab} Z_{i1}^+ Z_{l1}^+ \right. \\
& + \left( \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, j6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} + \sum_{c=1}^3 Z_{\phi v, j6+c}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{SL, ba} \right. \\
& + \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, j6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} + \sum_{c=1}^3 Z_{\phi v, j3+c}^* \sum_{b=1}^3 Z_{\phi v, k6+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{SL, ba} \\
& + \sum_{c=1}^3 Z_{\phi v, k6+c}^* \sum_{b=1}^3 Z_{\phi v, j3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} + \sum_{c=1}^3 Z_{\phi v, j6+c}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{SL, ca}^* Y_{\nu, ba} \\
& \left. \left. + \sum_{c=1}^3 Z_{\phi v, k3+c}^* \sum_{b=1}^3 Z_{\phi v, j3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} + \sum_{c=1}^3 Z_{\phi v, j3+c}^* \sum_{b=1}^3 Z_{\phi v, k3+b}^* \sum_{a=1}^3 Y_{\nu, ca}^* Y_{\nu, ba} \right) Z_{i2}^+ Z_{l2}^+ \right) \quad (414)
\end{aligned}$$

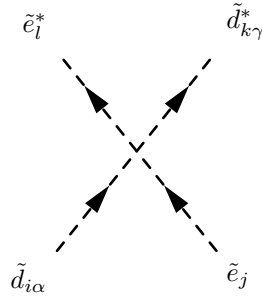


$$\begin{aligned}
& -\frac{i}{72} \left( \delta_{\alpha\delta} \delta_{\beta\gamma} \left( g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D + 9g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D \right. \right. \\
& \left. \left. - 6g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D + 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D \right) \right)
\end{aligned}$$

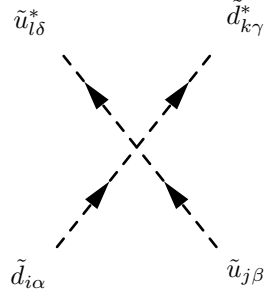


$$\begin{aligned}
& + 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D \\
& + 18g_3^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{la}^D \left( - \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \\
& - 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{l3+a}^D \left( - \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \\
& + 2g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{k3+b}^D + 6g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{k3+b}^D \\
& + 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{k3+b}^D - 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{k3+b}^D \\
& + g_1^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D + 9g_2^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D \\
& - 6g_3^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D + 2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D \\
& + 6g_3^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D + 18g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D \\
& - 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D + 2g_1^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D \\
& + 6g_3^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D + 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D \\
& - 6g_3^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D - 18g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{l3+b}^D \\
& + 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{l3+b}^D \\
& + 72 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd} Z_{j3+c}^{D,*} Z_{kd}^D \\
& + 72 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd} Z_{i3+c}^{D,*} Z_{ld}^D \\
& + \delta_{\alpha\gamma} \delta_{\beta\delta} \left( 18g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D - 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D \right)
\end{aligned}$$

$$\begin{aligned}
& + 2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{l3+a}^D \left( (2g_1^2 - 3g_3^2) \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + (3g_3^2 + g_1^2) \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \\
& + \sum_{a=1}^3 Z_{ja}^{D,*} Z_{la}^D \left( 2(3g_3^2 + g_1^2) \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + (-6g_3^2 + 9g_2^2 + g_1^2) \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \\
& - 18g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{k3+b}^D + 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{k3+b}^D \\
& + 18g_3^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D - 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D \\
& + g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D + 9g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D \\
& - 6g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D + 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D \\
& + 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D - 18g_3^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D \\
& + 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D + 2g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{l3+b}^D \\
& + 6g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{l3+b}^D + 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{l3+b}^D \\
& - 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{l3+b}^D \\
& + 72 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{i3+c}^{D,*} Z_{kd}^D \\
& + 72 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{j3+c}^{D,*} Z_{ld}^D \Big)
\end{aligned} \tag{415}$$

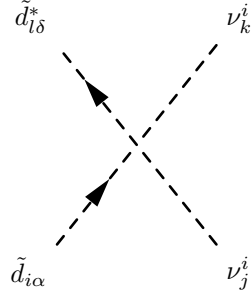


$$\begin{aligned}
& \frac{i}{24} \delta_{\alpha\gamma} \left( -2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E \left( 2 \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \right. \\
& + \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E \left( 2g_1^2 \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + \left( -3g_2^2 + g_1^2 \right) \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \\
& + g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E - 3g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E \\
& + 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E - 2g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E \\
& - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E \\
& - 24 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{i3+c}^{D,*} Z_{kd}^D \\
& \left. - 24 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{j3+c}^{E,*} Z_{ld}^E \right) \tag{416}
\end{aligned}$$

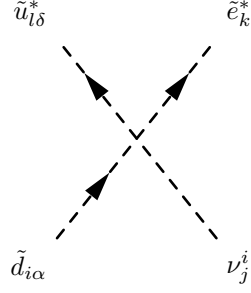


$$\begin{aligned}
& - \frac{i}{72} \left( \delta_{\alpha\gamma} \delta_{\beta\delta} \left( \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( 2 \left( 3g_3^2 + g_1^2 \right) \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + \left( -6g_3^2 - 9g_2^2 + g_1^2 \right) \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \right. \right. \\
& - 2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \left( \left( 2g_1^2 - 3g_3^2 \right) \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D + \left( 3g_3^2 + 4g_1^2 \right) \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D \right) \\
& + g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 9g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& - 6g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U + 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& \left. + 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 4g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \right)
\end{aligned}$$

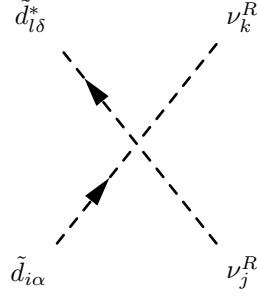
$$\begin{aligned}
& + 6g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U - 8g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& - 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \Big) \\
& + 18\delta_{\alpha\delta}\delta_{\beta\gamma} \left( g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^D + g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( - \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \right. \\
& + g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \left( - \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D + \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D \right) \\
& + g_2^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^U + g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& - g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& + g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U + 4 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{u,cd} Z_{j3+c}^{U,*} Z_{kd}^D \\
& \left. + 4 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd} Z_{i3+c}^{D,*} Z_{ld}^U \right) \tag{417}
\end{aligned}$$



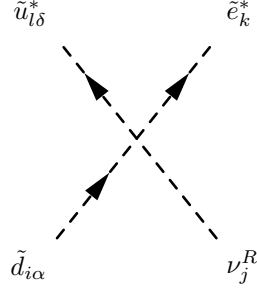
$$\begin{aligned}
& \frac{i}{24} \delta_{\alpha\delta} \left( \left( 3g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{\sigma v,jb}^* Z_{\sigma v,kb}^* + 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{\sigma v,jb}^* Z_{\sigma v,kb}^* \right. \\
& \left. + \sum_{a=1}^3 Z_{\sigma v,ja}^* Z_{\sigma v,ka}^* \left( 2g_1^2 \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D + \left( 3g_2^2 + g_1^2 \right) \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D \right) \right) \tag{418}
\end{aligned}$$



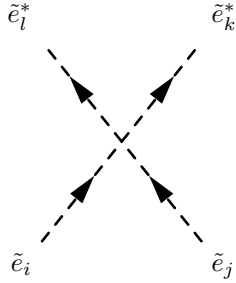
$$\begin{aligned}
& \frac{1}{4} \frac{1}{\sqrt{2}} \delta_{\alpha\delta} \left( g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^U \sum_{b=1}^3 Z_{\sigma v, jb}^* Z_{kb}^E + g_2^2 \sum_{a=1}^3 Z_{\sigma v, ja}^* Z_{ka}^E \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^U \right. \\
& + 4 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{u, ab} Z_{l3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* Z_{kd}^E \\
& - 4 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{u, ab} Z_{l3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* Z_{kd}^E \\
& \left. + 4 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{e, ab} Z_{k3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{d, cd}^* Z_{i3+c}^{D,*} Z_{ld}^U \right) \quad (419)
\end{aligned}$$



$$\begin{aligned}
& \frac{i}{24} \delta_{\alpha\delta} \left( (3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{\phi v, jb}^* Z_{\phi v, kb}^* + 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{\phi v, jb}^* Z_{\phi v, kb}^* \right. \\
& \left. + \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{\phi v, ka}^* \left( 2g_1^2 \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D + (3g_2^2 + g_1^2) \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D \right) \right) \quad (420)
\end{aligned}$$

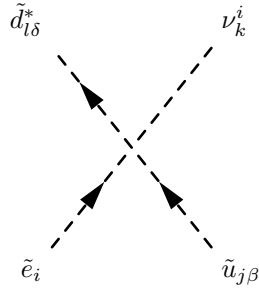


$$\begin{aligned}
& -\frac{i}{4}\frac{1}{\sqrt{2}}\delta_{\alpha\delta}\left(g_2^2\sum_{a=1}^3Z_{ia}^{D,*}Z_{la}^U\sum_{b=1}^3Z_{\phi v,jb}^*Z_{kb}^E+g_2^2\sum_{a=1}^3Z_{\phi v,ja}^*Z_{ka}^E\sum_{b=1}^3Z_{ib}^{D,*}Z_{lb}^U\right. \\
& +4\left(\sum_{b=1}^3Z_{ib}^{D,*}\sum_{a=1}^3Y_{u,ab}Z_{l3+a}^U\sum_{d=1}^3\sum_{c=1}^3Y_{\nu,cd}^*Z_{\phi v,j3+c}^*Z_{kd}^E\right. \\
& +\sum_{b=1}^3Z_{ib}^{D,*}\sum_{a=1}^3Y_{u,ab}Z_{l3+a}^U\sum_{d=1}^3\sum_{c=1}^3Y_{SL,cd}^*Z_{\phi v,j6+c}^*Z_{kd}^E \\
& \left.\left.+\sum_{b=1}^3Z_{\phi v,jb}^*\sum_{a=1}^3Y_{e,ab}Z_{k3+a}^E\sum_{d=1}^3\sum_{c=1}^3Y_{d,cd}^*Z_{i3+c}^{D,*}Z_{ld}^U\right)\right) \tag{421}
\end{aligned}$$



$$\begin{aligned}
& -\frac{i}{8}\left(g_1^2\sum_{a=1}^3Z_{ia}^{E,*}Z_{la}^E\sum_{b=1}^3Z_{jb}^{E,*}Z_{kb}^E+g_2^2\sum_{a=1}^3Z_{ia}^{E,*}Z_{la}^E\sum_{b=1}^3Z_{jb}^{E,*}Z_{kb}^E\right. \\
& -2g_1^2\sum_{a=1}^3Z_{i3+a}^{E,*}Z_{l3+a}^E\sum_{b=1}^3Z_{jb}^{E,*}Z_{kb}^E \\
& -2g_1^2\sum_{a=1}^3Z_{j3+a}^{E,*}Z_{l3+a}^E\left(-2\sum_{b=1}^3Z_{i3+b}^{E,*}Z_{k3+b}^E+\sum_{b=1}^3Z_{ib}^{E,*}Z_{kb}^E\right) \\
& \left.+\sum_{a=1}^3Z_{ja}^{E,*}Z_{la}^E\left(-2g_1^2\sum_{b=1}^3Z_{i3+b}^{E,*}Z_{k3+b}^E+\left(g_1^2+g_2^2\right)\sum_{b=1}^3Z_{ib}^{E,*}Z_{kb}^E\right)\right)
\end{aligned}$$

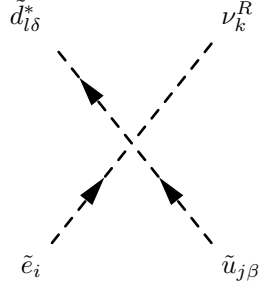
$$\begin{aligned}
& -2g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{k3+b}^E + 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{k3+b}^E \\
& + g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E + g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E + g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E \\
& + g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E - 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{l3+b}^E + 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{l3+b}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E + 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E \\
& + 8 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{i3+c}^{E,*} Z_{kd}^E \\
& + 8 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{j3+c}^{E,*} Z_{kd}^E \\
& + 8 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{i3+c}^{E,*} Z_{ld}^E \\
& + 8 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{j3+c}^{E,*} Z_{ld}^E \tag{422}
\end{aligned}$$



$$\begin{aligned}
& -\frac{1}{4} \frac{1}{\sqrt{2}} \delta_{\beta\delta} \left( g_2^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^D \sum_{b=1}^3 Z_{ib}^{E,*} Z_{\sigma v, kb}^* + g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\sigma v, ka}^* \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^D \right. \\
& \left. + 4 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{e,cd}^* Z_{i3+c}^{E,*} \right)
\end{aligned}$$

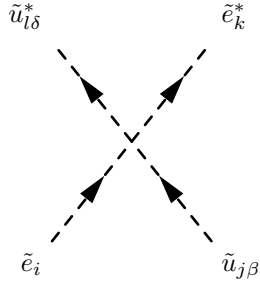
$$\begin{aligned}
& -4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{u, cd}^* Z_{j3+c}^{U,*} Z_{ld}^D \\
& + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{u, cd}^* Z_{j3+c}^{U,*} Z_{ld}^D
\end{aligned} \tag{423}$$


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$$\begin{aligned}
& -\frac{i}{4} \frac{1}{\sqrt{2}} \delta_{\beta\delta} \left( g_2^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^D \sum_{b=1}^3 Z_{ib}^{E,*} Z_{\phi v, kb}^* + g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\phi v, ka}^* \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^D \right. \\
& + 4 \left( \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d, ab} Z_{l3+a}^D \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{e, cd}^* Z_{i3+c}^{E,*} \right. \\
& + \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{u, cd}^* Z_{j3+c}^{U,*} Z_{ld}^D \\
& \left. \left. + \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{u, cd}^* Z_{j3+c}^{U,*} Z_{ld}^D \right) \right)
\end{aligned} \tag{424}$$

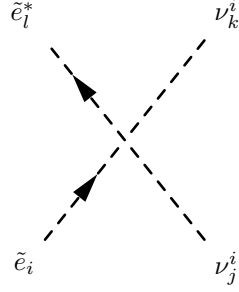

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$$\frac{i}{24} \delta_{\beta\delta} \left( -4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \left( -2 \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{k3+b}^E + \sum_{b=1}^3 Z_{ib}^{E,*} Z_{kb}^E \right) \right)$$

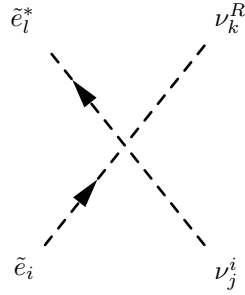


$$\begin{aligned}
& + \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( -2g_1^2 \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{k3+b}^E + (3g_2^2 + g_1^2) \sum_{b=1}^3 Z_{ib}^{E,*} Z_{kb}^E \right) \\
& + g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U + 3g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& - 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 4g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& + 8g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \tag{425}
\end{aligned}$$



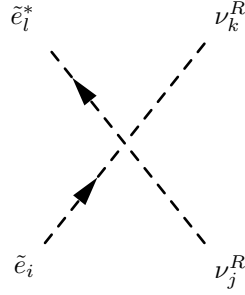
$$\begin{aligned}
& - \frac{i}{8} \left( g_2^2 \sum_{a=1}^3 Z_{\sigma v,ka}^* Z_{la}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{\sigma v,jb}^* + g_2^2 \sum_{a=1}^3 Z_{\sigma v,ja}^* Z_{la}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{\sigma v,kb}^* \right. \\
& + g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{\sigma v,jb}^* Z_{\sigma v,kb}^* - g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{\sigma v,jb}^* Z_{\sigma v,kb}^* \\
& - 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^3 Z_{\sigma v,jb}^* Z_{\sigma v,kb}^* + g_1^2 \sum_{a=1}^3 Z_{\sigma v,ja}^* Z_{\sigma v,ka}^* \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E \\
& - g_2^2 \sum_{a=1}^3 Z_{\sigma v,ja}^* Z_{\sigma v,ka}^* \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E + g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\sigma v,ka}^* \sum_{b=1}^3 Z_{\sigma v,jb}^* Z_{lb}^E \\
& + g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\sigma v,ja}^* \sum_{b=1}^3 Z_{\sigma v,kb}^* Z_{lb}^E - 2g_1^2 \sum_{a=1}^3 Z_{\sigma v,ja}^* Z_{\sigma v,ka}^* \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{l3+b}^E \\
& + 4 \sum_{b=1}^3 Z_{\sigma v,kb}^* \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{d=1}^3 Z_{\sigma v,jd}^* \sum_{c=1}^3 Y_{e,cd} Z_{i3+c}^{E,*} \\
& + 4 \sum_{b=1}^3 Z_{\sigma v,jb}^* \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{d=1}^3 Z_{\sigma v,kd}^* \sum_{c=1}^3 Y_{e,cd} Z_{i3+c}^{E,*} \\
& - 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v,k6+a}^* Y_{SL,ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma v,j3+c}^* Z_{ld}^E
\end{aligned}$$

$$\begin{aligned}
& + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* Z_{ld}^E \\
& + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* Z_{ld}^E \\
& - 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* Z_{ld}^E \\
& - 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* Z_{ld}^E \\
& + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* Z_{ld}^E \\
& + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* Z_{ld}^E \\
& - 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* Z_{ld}^E
\end{aligned} \tag{426}$$



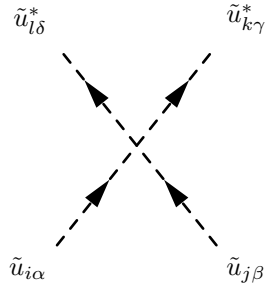
$$\begin{aligned}
& \frac{1}{8} \left( g_2^2 \sum_{a=1}^3 Z_{\sigma v, ja}^* Z_{la}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{\phi v, kb}^* - g_2^2 \sum_{a=1}^3 Z_{\phi v, ka}^* Z_{la}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{\sigma v, jb}^* \right. \\
& - g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\sigma v, ja}^* \sum_{b=1}^3 Z_{\phi v, kb}^* Z_{lb}^E + g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\phi v, ka}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* Z_{lb}^E \\
& + 4 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Y_{e, ab} Z_{l3+a}^E \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{e, cd}^* Z_{i3+c}^{E,*} \\
& - 4 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{e, ab} Z_{l3+a}^E \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{e, cd}^* Z_{i3+c}^{E,*} \\
& \left. + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* Z_{ld}^E \right)
\end{aligned}$$

$$\begin{aligned}
& -4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* Z_{ld}^E \\
& +4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* Z_{ld}^E \\
& -4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* Z_{ld}^E \\
& +4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* Z_{ld}^E \\
& +4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* Z_{ld}^E \\
& -4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* Z_{ld}^E \\
& -4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* Z_{ld}^E
\end{aligned} \tag{427}$$



$$\begin{aligned}
& -\frac{i}{8} \left( g_2^2 \sum_{a=1}^3 Z_{\phi v, ka}^* Z_{la}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{\phi v, jb}^* + g_2^2 \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{la}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{\phi v, kb}^* \right. \\
& + g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{\phi v, jb}^* Z_{\phi v, kb}^* - g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{\phi v, jb}^* Z_{\phi v, kb}^* \\
& - 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^3 Z_{\phi v, jb}^* Z_{\phi v, kb}^* + g_1^2 \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{\phi v, ka}^* \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E \\
& - g_2^2 \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{\phi v, ka}^* \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E + g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\phi v, ka}^* \sum_{b=1}^3 Z_{\phi v, jb}^* Z_{lb}^E \\
& \left. + g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\phi v, ja}^* \sum_{b=1}^3 Z_{\phi v, kb}^* Z_{lb}^E - 2g_1^2 \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{\phi v, ka}^* \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{l3+b}^E \right)
\end{aligned}$$

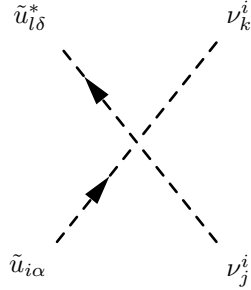
$$\begin{aligned}
& + 4 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Y_{e, ab} Z_{l3+a}^E \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{e, cd}^* Z_{i3+c}^{E,*} \\
& + 4 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Y_{e, ab} Z_{l3+a}^E \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{e, cd}^* Z_{i3+c}^{E,*} \\
& + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* Z_{ld}^E \\
& + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* Z_{ld}^E \\
& + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* Z_{ld}^E \\
& + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* Z_{ld}^E \\
& + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* Z_{ld}^E \\
& + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* Z_{ld}^E \\
& + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* Z_{ld}^E \\
& + 4 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* Z_{ld}^E \Big) \tag{428}
\end{aligned}$$



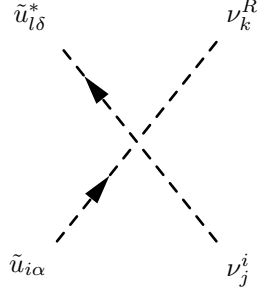
$$\begin{aligned}
& - \frac{i}{72} \left( \delta_{\alpha\delta} \delta_{\beta\gamma} \left( g_1^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U + 9g_2^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U \right. \right. \\
& \left. \left. - 6g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U \right) \right)
\end{aligned}$$

$$\begin{aligned}
& + 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U \\
& + 18g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( - \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{k3+b}^U + \sum_{b=1}^3 Z_{ib}^{U,*} Z_{kb}^U \right) \\
& - 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \left( - \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{k3+b}^U + \sum_{b=1}^3 Z_{ib}^{U,*} Z_{kb}^U \right) \\
& - 4g_1^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U + 6g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U \\
& + 16g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U - 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U \\
& + g_1^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U + 9g_2^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U \\
& - 6g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U - 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U \\
& + 6g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U + 18g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& - 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 4g_1^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U \\
& + 6g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U + 16g_1^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U \\
& - 6g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U - 18g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& + 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& + 72 \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{u,cd}^* Z_{j3+c}^{U,*} Z_{kd}^U \\
& + 72 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{u,cd}^* Z_{i3+c}^{U,*} Z_{ld}^U \\
& + \delta_{\alpha\gamma} \delta_{\beta\delta} \left( 18g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U - 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U \right)
\end{aligned}$$

$$\begin{aligned}
& + \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \left( 2 \left( -3g_3^2 + 8g_1^2 \right) \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{k3+b}^U + \left( -4g_1^2 + 6g_3^2 \right) \sum_{b=1}^3 Z_{ib}^{U,*} Z_{kb}^U \right) \\
& + \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( 2 \left( -2g_1^2 + 3g_3^2 \right) \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{k3+b}^U + \left( -6g_3^2 + 9g_2^2 + g_1^2 \right) \sum_{b=1}^3 Z_{ib}^{U,*} Z_{kb}^U \right) \\
& - 18g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U + 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U \\
& + 18g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U - 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U \\
& + g_1^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U + 9g_2^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& - 6g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& + 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 18g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U \\
& + 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U - 4g_1^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& + 6g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U + 16g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& - 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& + 72 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{u,cd}^* Z_{i3+c}^{U,*} Z_{kd}^U \\
& + 72 \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{u,cd}^* Z_{j3+c}^{U,*} Z_{ld}^U \Big) \tag{429}
\end{aligned}$$

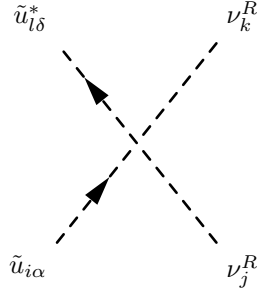


$$\begin{aligned}
& \frac{i}{24} \delta_{\alpha\delta} \left( \left( -3g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{\sigma v, jb}^* Z_{\sigma v, kb}^* - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{\sigma v, jb}^* Z_{\sigma v, kb}^* \right. \\
& + g_1^2 \sum_{a=1}^3 Z_{\sigma v, ja}^* Z_{\sigma v, ka}^* \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U - 3g_2^2 \sum_{a=1}^3 Z_{\sigma v, ja}^* Z_{\sigma v, ka}^* \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U \\
& - 4g_1^2 \sum_{a=1}^3 Z_{\sigma v, ja}^* Z_{\sigma v, ka}^* \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U \\
& - 12 \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u, ab} Z_{l3+a}^U \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + 12 \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u, ab} Z_{l3+a}^U \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - 12 \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u, ab} Z_{l3+a}^U \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* \\
& + 12 \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u, ab} Z_{l3+a}^U \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& + 12 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{u, cd}^* Z_{i3+c}^{U,*} Z_{ld}^U \\
& + 12 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{u, cd}^* Z_{i3+c}^{U,*} Z_{ld}^U \\
& - 12 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{u, cd}^* Z_{i3+c}^{U,*} Z_{ld}^U \\
& \left. - 12 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{u, cd}^* Z_{i3+c}^{U,*} Z_{ld}^U \right) \tag{430}
\end{aligned}$$



$$\frac{1}{2} \delta_{\alpha\delta} \left( - \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u, ab} Z_{l3+a}^U \left( \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* + \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* - \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \right) \right)$$

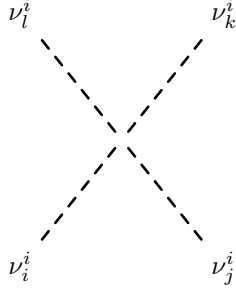
$$\begin{aligned}
& + \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + \left( \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \right. \\
& \left. - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \right) \sum_{d=1}^3 \sum_{c=1}^3 Y_{u, cd}^* Z_{i3+c}^{U,*} Z_{ld}^U
\end{aligned} \tag{431}$$



$$\begin{aligned}
& \frac{i}{24} \delta_{\alpha\delta} \left( \left( -3g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{\phi v, jb}^* Z_{\phi v, kb}^* - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{\phi v, jb}^* Z_{\phi v, kb}^* \right. \\
& + g_1^2 \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{\phi v, ka}^* \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U - 3g_2^2 \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{\phi v, ka}^* \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U \\
& - 4g_1^2 \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{\phi v, ka}^* \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U \\
& - 12 \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u, ab} Z_{l3+a}^U \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& - 12 \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u, ab} Z_{l3+a}^U \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& - 12 \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u, ab} Z_{l3+a}^U \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& - 12 \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u, ab} Z_{l3+a}^U \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - 12 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{u, cd}^* Z_{i3+c}^{U,*} Z_{ld}^U \\
& \left. - 12 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{u, cd}^* Z_{i3+c}^{U,*} Z_{ld}^U \right)
\end{aligned}$$



$$\begin{aligned}
& -12 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{u, cd}^* Z_{i3+c}^{U,*} Z_{ld}^U \\
& -12 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 \sum_{c=1}^3 Y_{u, cd}^* Z_{i3+c}^{U,*} Z_{ld}^U
\end{aligned} \tag{432}$$



$$\begin{aligned}
& -\frac{i}{8} \left( (g_1^2 + g_2^2) \sum_{a=1}^3 Z_{\sigma v, ka}^* Z_{\sigma v, la}^* \sum_{b=1}^3 Z_{\sigma v, ib}^* Z_{\sigma v, jb}^* + (g_1^2 + g_2^2) \sum_{a=1}^3 Z_{\sigma v, ja}^* Z_{\sigma v, la}^* \sum_{b=1}^3 Z_{\sigma v, ib}^* Z_{\sigma v, kb}^* \right. \\
& + g_1^2 \sum_{a=1}^3 Z_{\sigma v, ia}^* Z_{\sigma v, la}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* Z_{\sigma v, kb}^* + g_2^2 \sum_{a=1}^3 Z_{\sigma v, ia}^* Z_{\sigma v, la}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* Z_{\sigma v, kb}^* \\
& + g_1^2 \sum_{a=1}^3 Z_{\sigma v, ja}^* Z_{\sigma v, ka}^* \sum_{b=1}^3 Z_{\sigma v, ib}^* Z_{\sigma v, lb}^* + g_2^2 \sum_{a=1}^3 Z_{\sigma v, ja}^* Z_{\sigma v, ka}^* \sum_{b=1}^3 Z_{\sigma v, ib}^* Z_{\sigma v, lb}^* \\
& + g_1^2 \sum_{a=1}^3 Z_{\sigma v, ia}^* Z_{\sigma v, ka}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* Z_{\sigma v, lb}^* + g_2^2 \sum_{a=1}^3 Z_{\sigma v, ia}^* Z_{\sigma v, ka}^* \sum_{b=1}^3 Z_{\sigma v, jb}^* Z_{\sigma v, lb}^* \\
& \left. + g_1^2 \sum_{a=1}^3 Z_{\sigma v, ia}^* Z_{\sigma v, ja}^* \sum_{b=1}^3 Z_{\sigma v, kb}^* Z_{\sigma v, lb}^* + g_2^2 \sum_{a=1}^3 Z_{\sigma v, ia}^* Z_{\sigma v, ja}^* \sum_{b=1}^3 Z_{\sigma v, kb}^* Z_{\sigma v, lb}^* \right) \\
& -2 \sum_{b=1}^3 Z_{\sigma v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^*
\end{aligned}$$

$$\begin{aligned}
& -2 \sum_{b=1}^3 Z_{\sigma\nu,jb}^* \sum_{a=1}^3 Z_{\sigma\nu,l6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,kd}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,i3+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma\nu,lb}^* \sum_{a=1}^3 Z_{\sigma\nu,j3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,kd}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,i3+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma\nu,jb}^* \sum_{a=1}^3 Z_{\sigma\nu,l3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,kd}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,i3+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma\nu,kb}^* \sum_{a=1}^3 Z_{\sigma\nu,j6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,ld}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,i3+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma\nu,jb}^* \sum_{a=1}^3 Z_{\sigma\nu,k6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,ld}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,i3+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma\nu,kb}^* \sum_{a=1}^3 Z_{\sigma\nu,j3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,ld}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,i3+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma\nu,jb}^* \sum_{a=1}^3 Z_{\sigma\nu,k3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,ld}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,i3+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma\nu,lb}^* \sum_{a=1}^3 Z_{\sigma\nu,k6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,jd}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\sigma\nu,i6+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma\nu,kb}^* \sum_{a=1}^3 Z_{\sigma\nu,l6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,jd}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\sigma\nu,i6+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma\nu,lb}^* \sum_{a=1}^3 Z_{\sigma\nu,k3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,jd}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\sigma\nu,i6+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma\nu,kb}^* \sum_{a=1}^3 Z_{\sigma\nu,l3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,jd}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\sigma\nu,i6+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma\nu,lb}^* \sum_{a=1}^3 Z_{\sigma\nu,j6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,kd}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\sigma\nu,i6+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma\nu,jb}^* \sum_{a=1}^3 Z_{\sigma\nu,l6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,kd}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\sigma\nu,i6+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma\nu,lb}^* \sum_{a=1}^3 Z_{\sigma\nu,j3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,kd}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\sigma\nu,i6+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma\nu,jb}^* \sum_{a=1}^3 Z_{\sigma\nu,l3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,kd}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\sigma\nu,i6+c}^*
\end{aligned}$$

$$\begin{aligned}
& + 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^*
\end{aligned}$$

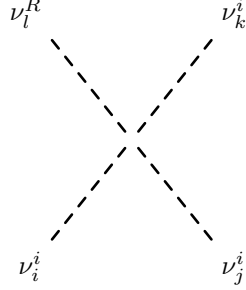
$$\begin{aligned}
& + 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^*
\end{aligned}$$

$$\begin{aligned}
& + 2 \sum_{b=1}^3 Z_{\sigma\nu,lb}^* \sum_{a=1}^3 Z_{\sigma\nu,j3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,id}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma\nu,jb}^* \sum_{a=1}^3 Z_{\sigma\nu,l3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,id}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,k3+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma\nu,lb}^* \sum_{a=1}^3 Z_{\sigma\nu,i6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,jd}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,k3+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma\nu,ib}^* \sum_{a=1}^3 Z_{\sigma\nu,l6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,jd}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma\nu,lb}^* \sum_{a=1}^3 Z_{\sigma\nu,i3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,jd}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma\nu,ib}^* \sum_{a=1}^3 Z_{\sigma\nu,l3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,jd}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,k3+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma\nu,jb}^* \sum_{a=1}^3 Z_{\sigma\nu,i6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,ld}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,k3+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma\nu,ib}^* \sum_{a=1}^3 Z_{\sigma\nu,j6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,ld}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma\nu,jb}^* \sum_{a=1}^3 Z_{\sigma\nu,i3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,ld}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma\nu,ib}^* \sum_{a=1}^3 Z_{\sigma\nu,j3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,ld}^* \sum_{c=1}^3 Y_{\nu,cd}^* Z_{\sigma\nu,k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma\nu,lb}^* \sum_{a=1}^3 Z_{\sigma\nu,j6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,id}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\sigma\nu,k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma\nu,jb}^* \sum_{a=1}^3 Z_{\sigma\nu,l6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,id}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\sigma\nu,k6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma\nu,lb}^* \sum_{a=1}^3 Z_{\sigma\nu,j3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,id}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\sigma\nu,k6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma\nu,jb}^* \sum_{a=1}^3 Z_{\sigma\nu,l3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\sigma\nu,id}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\sigma\nu,k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma\nu,lb}^* \sum_{a=1}^3 Z_{\sigma\nu,i6+a}^* Y_{SL,ab} \sum_{d=1}^3 Z_{\sigma\nu,jd}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\sigma\nu,k6+c}^*
\end{aligned}$$

$$\begin{aligned}
& + 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, l3+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, l3+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, l3+c}^* \\
& - 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, l3+c}^*
\end{aligned}$$

$$\begin{aligned}
& -2 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, l3+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, l3+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, l3+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, l3+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, l6+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, l6+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, l6+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, l6+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, l6+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, l6+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, l6+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, l6+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, l6+c}^* \\
& +2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, l6+c}^* \\
& -2 \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, l6+c}^*
\end{aligned}$$

$$- 2 \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, l6+c}^* \quad (433)$$



$$\begin{aligned} & \frac{1}{4} \left( - \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \right. \\ & - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\ & + \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\ & + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\ & - \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\ & - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\ & + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\ & + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\ & - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\ & - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\ & \left. - \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \right) \end{aligned}$$



$$\begin{aligned}
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^*
\end{aligned}$$

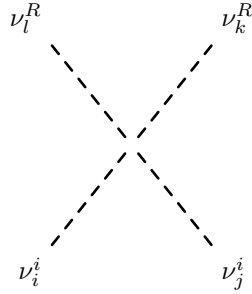
$$\begin{aligned}
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \left( \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* + \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* - \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \right. \\
& \left. + \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \right) \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \left( \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* + \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* - \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \right. \\
& \left. + \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \right) \\
& - \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^*
\end{aligned}$$

$$\begin{aligned}
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^*
\end{aligned}$$

$$\begin{aligned}
& + \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^*
\end{aligned}$$

$$\begin{aligned}
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, k3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^*
\end{aligned}$$

$$\begin{aligned}
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, k6+c}^* \quad (434)
\end{aligned}$$



$$\begin{aligned}
& - \frac{i}{8} \left( (g_1^2 + g_2^2) \sum_{a=1}^3 Z_{\sigma v, ia}^* Z_{\sigma v, ja}^* \sum_{b=1}^3 Z_{\phi v, kb}^* Z_{\phi v, lb}^* + (g_1^2 + g_2^2) \sum_{a=1}^3 Z_{\phi v, ka}^* Z_{\phi v, la}^* \sum_{b=1}^3 Z_{\sigma v, ib}^* Z_{\sigma v, jb}^* \right) \\
& - 2 \left( - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \right. \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& \left. - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \right)
\end{aligned}$$

$$\begin{aligned}
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^*
\end{aligned}$$

$$\begin{aligned}
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \left( \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* + \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* + \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \right. \\
& \left. + \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \right) \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \left( \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* + \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* + \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \right.
\end{aligned}$$

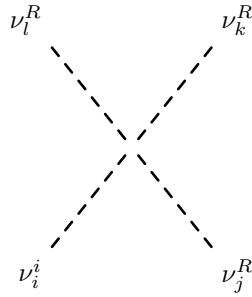


$$\begin{aligned}
& + \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* ) \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^*
\end{aligned}$$

$$\begin{aligned}
& + \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^*
\end{aligned}$$

$$\begin{aligned}
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, j3+c}^*
\end{aligned}$$

$$\begin{aligned}
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, j6+c}^* \Big)
\end{aligned} \tag{435}$$



$$\begin{aligned}
& \frac{1}{4} \left( \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \right. \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^*
\end{aligned}$$

$$\begin{aligned}
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^*
\end{aligned}$$

$$\begin{aligned}
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \left( \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* + \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* + \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \right. \\
& \left. + \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \right) \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \left( \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* + \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* + \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \right. \\
& \left. + \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \right) \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^*
\end{aligned}$$

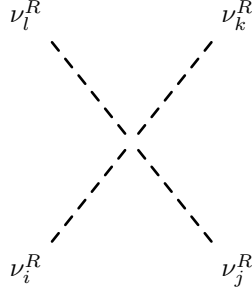
$$\begin{aligned}
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
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\end{aligned}$$



$$\begin{aligned}
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\sigma v, ib}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\sigma v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\sigma v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
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& + \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^*
\end{aligned}$$

$$\begin{aligned}
& + \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& + \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\sigma v, i3+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
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& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^*
\end{aligned}$$

$$\begin{aligned}
& - \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^* \\
& - \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\sigma v, i6+c}^*
\end{aligned} \tag{436}$$



$$\begin{aligned}
& - \frac{i}{8} \left( (g_1^2 + g_2^2) \sum_{a=1}^3 Z_{\phi v, ka}^* Z_{\phi v, la}^* \sum_{b=1}^3 Z_{\phi v, ib}^* Z_{\phi v, jb}^* + (g_1^2 + g_2^2) \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{\phi v, la}^* \sum_{b=1}^3 Z_{\phi v, ib}^* Z_{\phi v, kb}^* \right. \\
& + g_1^2 \sum_{a=1}^3 Z_{\phi v, ia}^* Z_{\phi v, la}^* \sum_{b=1}^3 Z_{\phi v, jb}^* Z_{\phi v, kb}^* + g_2^2 \sum_{a=1}^3 Z_{\phi v, ia}^* Z_{\phi v, la}^* \sum_{b=1}^3 Z_{\phi v, jb}^* Z_{\phi v, kb}^* \\
& + g_1^2 \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{\phi v, ka}^* \sum_{b=1}^3 Z_{\phi v, ib}^* Z_{\phi v, lb}^* + g_2^2 \sum_{a=1}^3 Z_{\phi v, ja}^* Z_{\phi v, ka}^* \sum_{b=1}^3 Z_{\phi v, ib}^* Z_{\phi v, lb}^* \\
& + g_1^2 \sum_{a=1}^3 Z_{\phi v, ia}^* Z_{\phi v, ka}^* \sum_{b=1}^3 Z_{\phi v, jb}^* Z_{\phi v, lb}^* + g_2^2 \sum_{a=1}^3 Z_{\phi v, ia}^* Z_{\phi v, ka}^* \sum_{b=1}^3 Z_{\phi v, jb}^* Z_{\phi v, lb}^* \\
& + g_1^2 \sum_{a=1}^3 Z_{\phi v, ia}^* Z_{\phi v, ja}^* \sum_{b=1}^3 Z_{\phi v, kb}^* Z_{\phi v, lb}^* + g_2^2 \sum_{a=1}^3 Z_{\phi v, ia}^* Z_{\phi v, ja}^* \sum_{b=1}^3 Z_{\phi v, kb}^* Z_{\phi v, lb}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, i3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, i3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, i3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, i3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, i3+c}^*
\end{aligned}$$

$$\begin{aligned}
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, i3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, i3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, i3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, i3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, i3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, i3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, i3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, i6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, i6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, i6+c}^* \\
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\end{aligned}$$

$$\begin{aligned}
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, i6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, i6+c}^* \\
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& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, i6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
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& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^*
\end{aligned}$$

$$\begin{aligned}
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, j3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
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& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, j6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^*
\end{aligned}$$

$$\begin{aligned}
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, k3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^*
\end{aligned}$$

$$\begin{aligned}
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, l6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, lb}^* \sum_{a=1}^3 Z_{\phi v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, l3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, ld}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, k6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^*
\end{aligned}$$

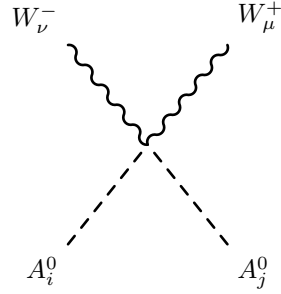


$$\begin{aligned}
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{\nu, cd}^* Z_{\phi v, l3+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, j3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, id}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, k6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, kb}^* \sum_{a=1}^3 Z_{\phi v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, k3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, jd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, i6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, ib}^* \sum_{a=1}^3 Z_{\phi v, j6+a}^* Y_{SL, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^* \\
& + 2 \sum_{b=1}^3 Z_{\phi v, jb}^* \sum_{a=1}^3 Z_{\phi v, i3+a}^* Y_{\nu, ab} \sum_{d=1}^3 Z_{\phi v, kd}^* \sum_{c=1}^3 Y_{SL, cd}^* Z_{\phi v, l6+c}^*
\end{aligned}$$

$$+ 2 \sum_{b=1}^3 Z_{\phi\nu,ib}^* \sum_{a=1}^3 Z_{\phi\nu,j3+a}^* Y_{\nu,ab} \sum_{d=1}^3 Z_{\phi\nu,kd}^* \sum_{c=1}^3 Y_{SL,cd}^* Z_{\phi\nu,16+c}^* \quad (437)$$

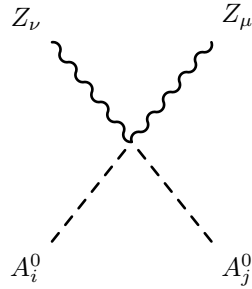

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## 9.8 Two Scalar-Two Vector Boson-Interaction



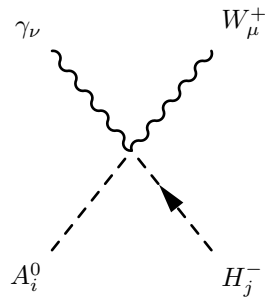
$$\frac{i}{2} g_2^2 (Z_{i1}^A Z_{j1}^A + Z_{i2}^A Z_{j2}^A) (g_{\mu\nu}) \quad (438)$$


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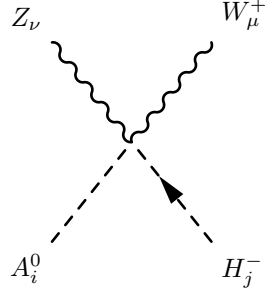
$$\frac{i}{2} (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 (Z_{i1}^A Z_{j1}^A + Z_{i2}^A Z_{j2}^A) (g_{\mu\nu}) \quad (439)$$


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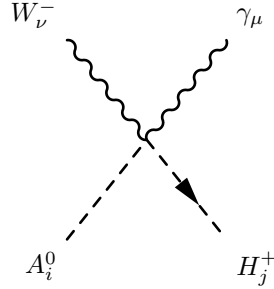
$$-\frac{1}{2}g_1g_2\cos\Theta_W\left(Z_{i1}^AZ_{j1}^++Z_{i2}^AZ_{j2}^+\right)\left(g_{\mu\nu}\right) \quad (440)$$


---



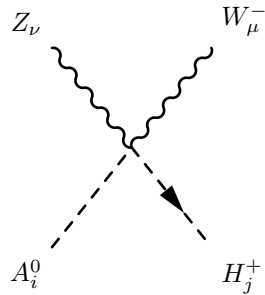
$$\frac{1}{2}g_1g_2\sin\Theta_W\left(Z_{i1}^AZ_{j1}^++Z_{i2}^AZ_{j2}^+\right)\left(g_{\mu\nu}\right) \quad (441)$$


---



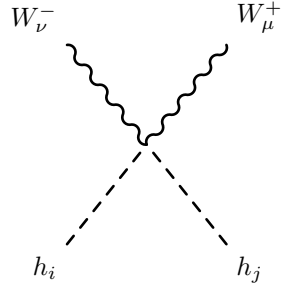
$$\frac{1}{2}g_1g_2\cos\Theta_W\left(Z_{i1}^AZ_{j1}^++Z_{i2}^AZ_{j2}^+\right)\left(g_{\mu\nu}\right) \quad (442)$$


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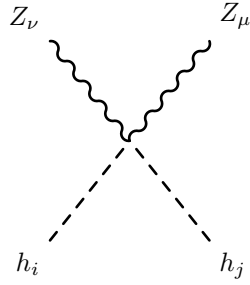
$$-\frac{1}{2}g_1g_2\sin\Theta_W\left(Z_{i1}^AZ_{j1}^++Z_{i2}^AZ_{j2}^+\right)\left(g_{\mu\nu}\right) \quad (443)$$


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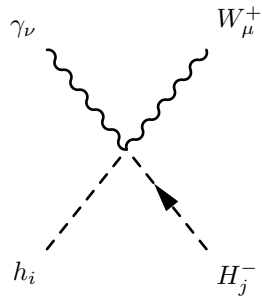
$$\frac{i}{2} g_2^2 \left( Z_{i1}^H Z_{j1}^H + Z_{i2}^H Z_{j2}^H \right) (g_{\mu\nu}) \quad (444)$$


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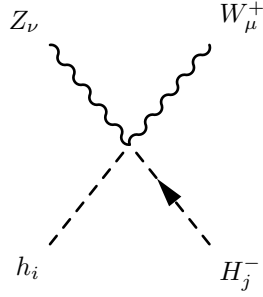
$$\frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right)^2 \left( Z_{i1}^H Z_{j1}^H + Z_{i2}^H Z_{j2}^H \right) (g_{\mu\nu}) \quad (445)$$


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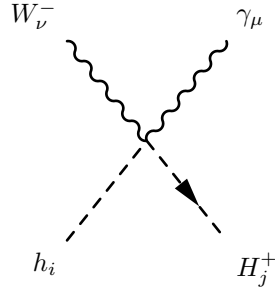
$$-\frac{i}{2} g_1 g_2 \cos \Theta_W \left( Z_{i1}^H Z_{j1}^+ - Z_{i2}^H Z_{j2}^+ \right) (g_{\mu\nu}) \quad (446)$$


---



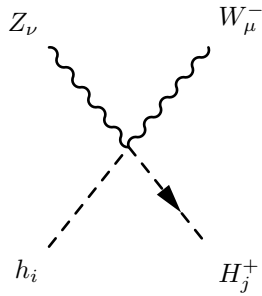
$$\frac{i}{2} g_1 g_2 \sin \Theta_W \left( Z_{i1}^H Z_{j1}^+ - Z_{i2}^H Z_{j2}^+ \right) \left( g_{\mu\nu} \right) \quad (447)$$


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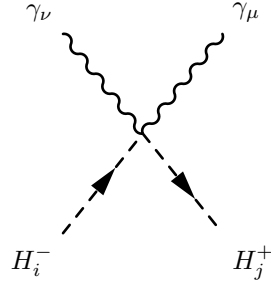
$$- \frac{i}{2} g_1 g_2 \cos \Theta_W \left( Z_{i1}^H Z_{j1}^+ - Z_{i2}^H Z_{j2}^+ \right) \left( g_{\mu\nu} \right) \quad (448)$$


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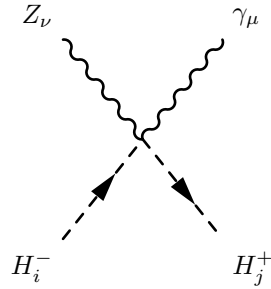
$$\frac{i}{2} g_1 g_2 \sin \Theta_W \left( Z_{i1}^H Z_{j1}^+ - Z_{i2}^H Z_{j2}^+ \right) \left( g_{\mu\nu} \right) \quad (449)$$


---



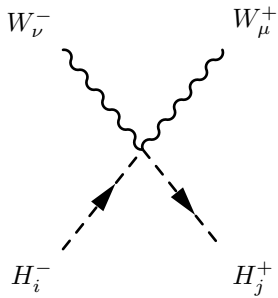
$$\frac{i}{2} (g_1 \cos \Theta_W + g_2 \sin \Theta_W)^2 (Z_{i1}^+ Z_{j1}^+ + Z_{i2}^+ Z_{j2}^+) (g_{\mu\nu}) \quad (450)$$


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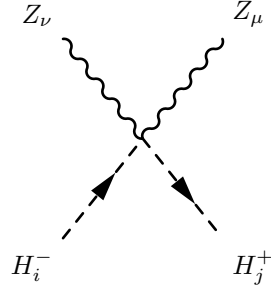
$$-\frac{i}{4} \left( -2g_1 g_2 \cos 2\Theta_W + (-g_2^2 + g_1^2) \sin 2\Theta_W \right) (Z_{i1}^+ Z_{j1}^+ + Z_{i2}^+ Z_{j2}^+) (g_{\mu\nu}) \quad (451)$$


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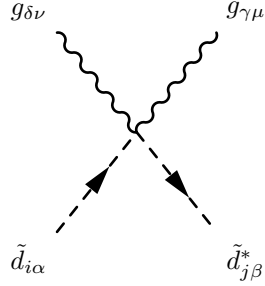
$$\frac{i}{2} g_2^2 (Z_{i1}^+ Z_{j1}^+ + Z_{i2}^+ Z_{j2}^+) (g_{\mu\nu}) \quad (452)$$


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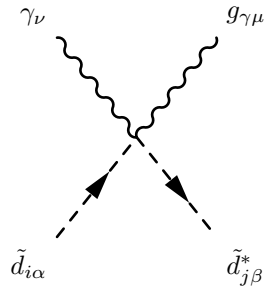
$$\frac{i}{2} \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right)^2 \left( Z_{i1}^+ Z_{j1}^+ + Z_{i2}^+ Z_{j2}^+ \right) (g_{\mu\nu}) \quad (453)$$


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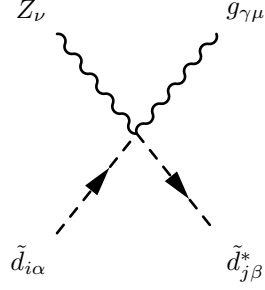
$$\frac{i}{4} g_3^2 \delta_{ij} \left( \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta + \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta \right) (g_{\mu\nu}) \quad (454)$$


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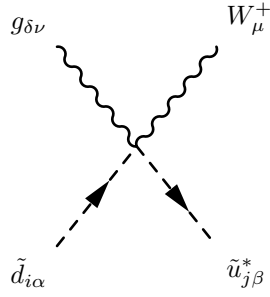
$$\frac{i}{6} g_3 \lambda_{\beta,\alpha}^\gamma \left( -2g_1 \cos \Theta_W \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{j3+a}^D + \left( -3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D \right) (g_{\mu\nu}) \quad (455)$$


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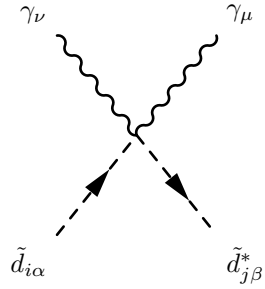
$$-\frac{i}{6}g_3\lambda_{\beta,\alpha}^\gamma\left(-2g_1\sin\Theta_W\sum_{a=1}^3Z_{i3+a}^{D,*}Z_{j3+a}^D+(3g_2\cos\Theta_W+g_1\sin\Theta_W)\sum_{a=1}^3Z_{ia}^{D,*}Z_{ja}^D\right)(g_{\mu\nu}) \quad (456)$$


---



$$i\frac{1}{\sqrt{2}}g_2g_3\lambda_{\beta,\alpha}^\delta\sum_{a=1}^3Z_{ia}^{D,*}Z_{ja}^U(g_{\mu\nu}) \quad (457)$$

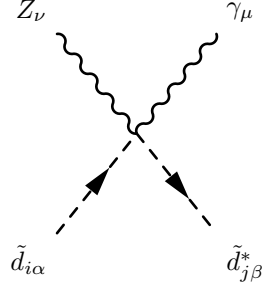

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$$\frac{i}{18}\delta_{\alpha\beta}\left(\left(-3g_2\sin\Theta_W+g_1\cos\Theta_W\right)^2\sum_{a=1}^3Z_{ia}^{D,*}Z_{ja}^D+4g_1^2\cos^2\Theta_W\sum_{a=1}^3Z_{i3+a}^{D,*}Z_{j3+a}^D\right)(g_{\mu\nu}) \quad (458)$$

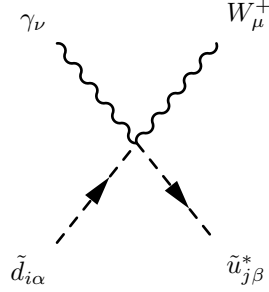

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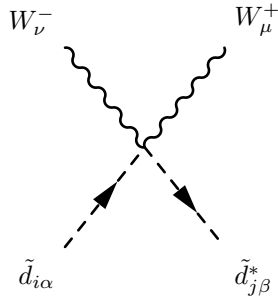
$$\begin{aligned}
& -\frac{i}{36}\delta_{\alpha\beta}\left(\left(6g_1g_2\cos 2\Theta_W + \left(-9g_2^2 + g_1^2\right)\sin 2\Theta_W\right)\sum_{a=1}^3 Z_{ia}^{D,*}Z_{ja}^D\right. \\
& \left.+ 4g_1^2\sin 2\Theta_W\sum_{a=1}^3 Z_{i3+a}^{D,*}Z_{j3+a}^D\right)\left(g_{\mu\nu}\right) \tag{459}
\end{aligned}$$


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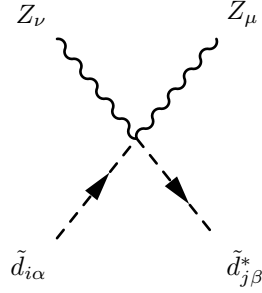
$$\frac{i}{3}\frac{1}{\sqrt{2}}g_1g_2\cos\Theta_W\delta_{\alpha\beta}\sum_{a=1}^3 Z_{ia}^{D,*}Z_{ja}^U\left(g_{\mu\nu}\right) \tag{460}$$


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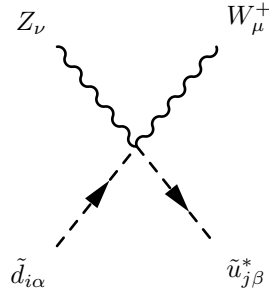
$$\frac{i}{2}g_2^2\delta_{\alpha\beta}\sum_{a=1}^3 Z_{ia}^{D,*}Z_{ja}^D\left(g_{\mu\nu}\right) \tag{461}$$


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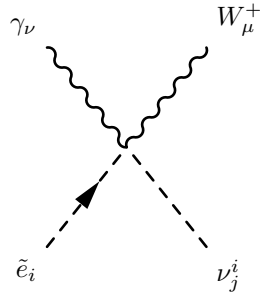
$$\frac{i}{18} \delta_{\alpha\beta} \left( (3g_2 \cos \Theta_W + g_1 \sin \Theta_W)^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D + 4g_1^2 \sin^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{j3+a}^D \right) (g_{\mu\nu}) \quad (462)$$


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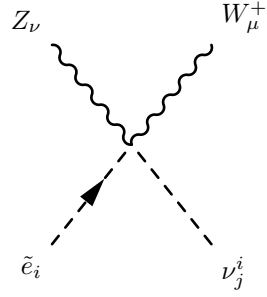
$$-\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 \delta_{\alpha\beta} \sin \Theta_W \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^U (g_{\mu\nu}) \quad (463)$$


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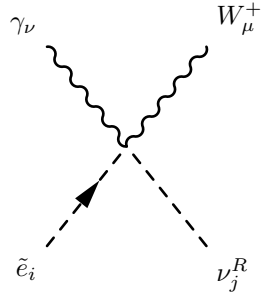
$$-\frac{1}{2} g_1 g_2 \cos \Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\sigma\nu,ja}^* (g_{\mu\nu}) \quad (464)$$


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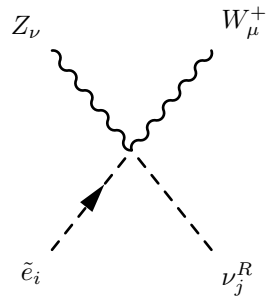
$$\frac{1}{2}g_1g_2 \sin \Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\sigma\nu,ja}^* (g_{\mu\nu}) \quad (465)$$


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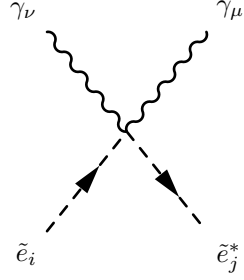
$$-\frac{i}{2}g_1g_2 \cos \Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\phi\nu,ja}^* (g_{\mu\nu}) \quad (466)$$


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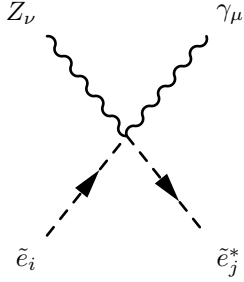
$$\frac{i}{2}g_1g_2 \sin \Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{\phi\nu,ja}^* (g_{\mu\nu}) \quad (467)$$


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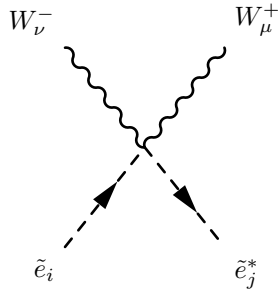
$$\frac{i}{2} \left( 4g_1^2 \cos^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E + \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right)^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E \right) (g_{\mu\nu}) \quad (468)$$


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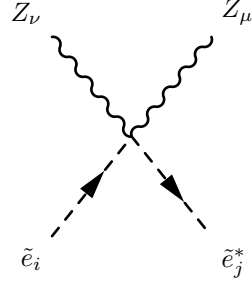
$$-\frac{i}{4} \left( \left( -2g_1 g_2 \cos 2\Theta_W + \left( -g_2^2 + g_1^2 \right) \sin 2\Theta_W \right) \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E + 4g_1^2 \sin 2\Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E \right) (g_{\mu\nu}) \quad (469)$$


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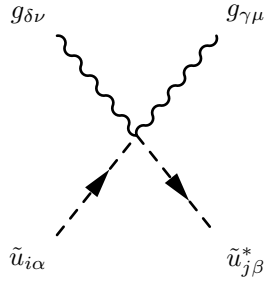
$$\frac{i}{2} g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E (g_{\mu\nu}) \quad (470)$$


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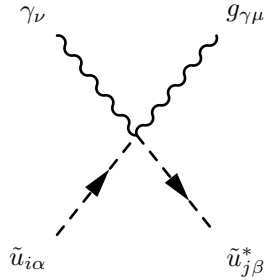
$$\frac{i}{2} \left( 4g_1^2 \sin^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E + \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right)^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E \right) (g_{\mu\nu}) \quad (471)$$


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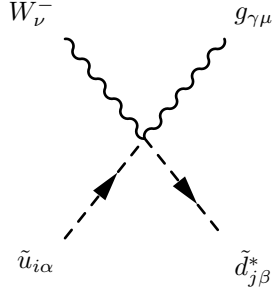
$$\frac{i}{4} g_3^2 \delta_{ij} \left( \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta + \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta \right) (g_{\mu\nu}) \quad (472)$$


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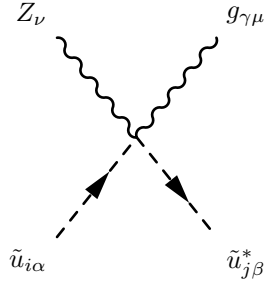
$$\frac{i}{6} g_3 \lambda_{\beta,\alpha}^\gamma \left( \left( 3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U + 4g_1 \cos \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U \right) (g_{\mu\nu}) \quad (473)$$


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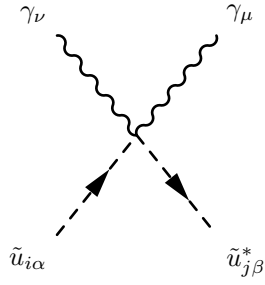
$$i \frac{1}{\sqrt{2}} g_2 g_3 \lambda_{\beta,\alpha}^\gamma \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^D (g_{\mu\nu}) \quad (474)$$


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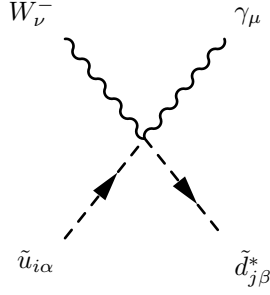
$$\frac{i}{6} g_3 \lambda_{\beta,\alpha}^\gamma \left( (3g_2 \cos \Theta_W - g_1 \sin \Theta_W) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U - 4g_1 \sin \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U \right) (g_{\mu\nu}) \quad (475)$$


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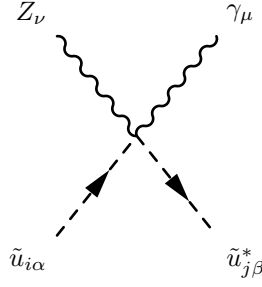
$$\frac{i}{18} \delta_{\alpha\beta} \left( 16g_1^2 \cos^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U + (3g_2 \sin \Theta_W + g_1 \cos \Theta_W)^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U \right) (g_{\mu\nu}) \quad (476)$$


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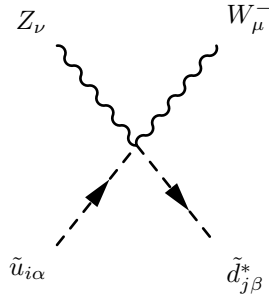
$$\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W \delta_{\alpha\beta} \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^D (g_{\mu\nu}) \quad (477)$$


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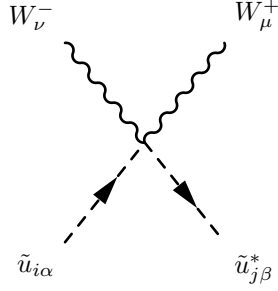
$$\begin{aligned} & - \frac{i}{36} \delta_{\alpha\beta} \left( (-6g_1 g_2 \cos 2\Theta_W + (-9g_2^2 + g_1^2) \sin 2\Theta_W) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U \right. \\ & \left. + 16g_1^2 \sin 2\Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U \right) (g_{\mu\nu}) \quad (478) \end{aligned}$$


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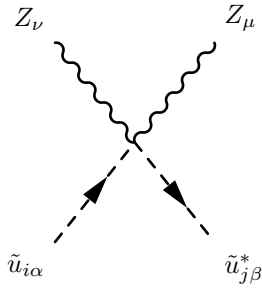
$$- \frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 \delta_{\alpha\beta} \sin \Theta_W \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^D (g_{\mu\nu}) \quad (479)$$


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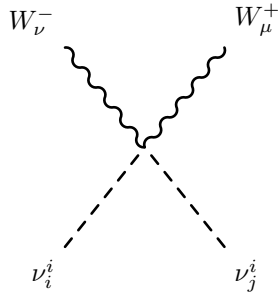
$$\frac{i}{2} g_2^2 \delta_{\alpha\beta} \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U (g_{\mu\nu}) \quad (480)$$


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$$\frac{i}{18} \delta_{\alpha\beta} \left( 16g_1^2 \sin^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U + \left( -3g_2 \cos \Theta_W + g_1 \sin \Theta_W \right)^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U \right) (g_{\mu\nu}) \quad (481)$$

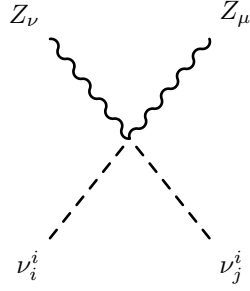

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$$\frac{i}{2} g_2^2 \sum_{a=1}^3 Z_{\sigma\nu,ia}^* Z_{\sigma\nu,ja}^* (g_{\mu\nu}) \quad (482)$$

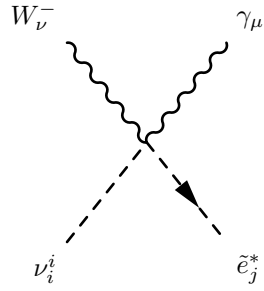

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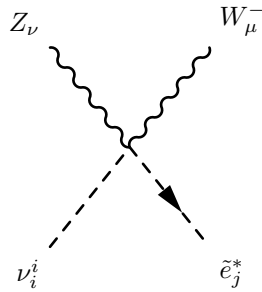
$$\frac{i}{2} (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 \sum_{a=1}^3 Z_{\sigma\nu,ia}^* Z_{\sigma\nu,ja}^* (g_{\mu\nu}) \quad (483)$$


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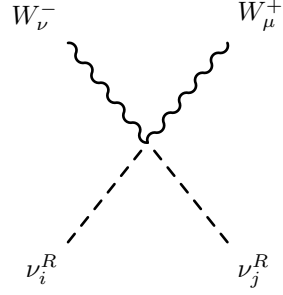
$$\frac{1}{2} g_1 g_2 \cos \Theta_W \sum_{a=1}^3 Z_{\sigma\nu,ia}^* Z_{ja}^E (g_{\mu\nu}) \quad (484)$$


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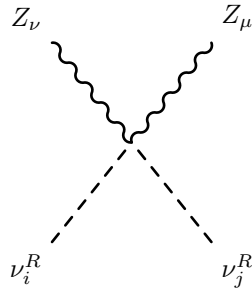
$$-\frac{1}{2} g_1 g_2 \sin \Theta_W \sum_{a=1}^3 Z_{\sigma\nu,ia}^* Z_{ja}^E (g_{\mu\nu}) \quad (485)$$


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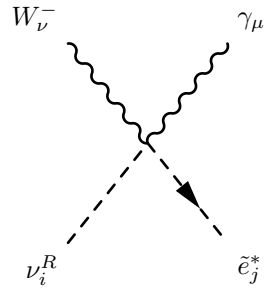
$$\frac{i}{2} g_2^2 \sum_{a=1}^3 Z_{\phi\nu,ia}^* Z_{\phi\nu,ja}^* (g_{\mu\nu}) \quad (486)$$


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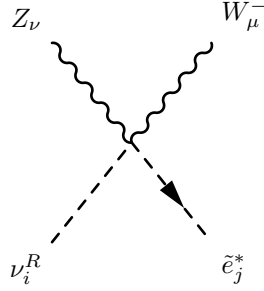
$$\frac{i}{2} (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 \sum_{a=1}^3 Z_{\phi\nu,ia}^* Z_{\phi\nu,ja}^* (g_{\mu\nu}) \quad (487)$$


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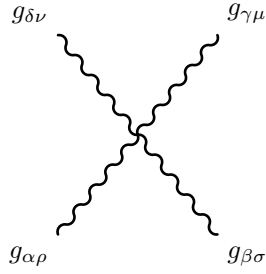
$$-\frac{i}{2} g_1 g_2 \cos \Theta_W \sum_{a=1}^3 Z_{\phi\nu,ia}^* Z_{ja}^E (g_{\mu\nu}) \quad (488)$$


---



$$\frac{i}{2} g_1 g_2 \sin \Theta_W \sum_{a=1}^3 Z_{\phi\nu,ia}^* Z_{ja}^E (g_{\mu\nu}) \quad (489)$$

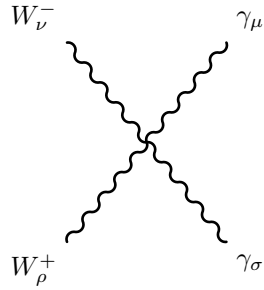
### 9.9 Four Vector Boson-Interaction



$$-i g_3^2 \left( \sum_{a=1}^8 f_{\alpha,\delta,a} f_{\beta,\gamma,a} + \sum_{a=1}^8 f_{\alpha,\gamma,a} f_{\beta,\delta,a} \right) (g_{\rho\sigma} g_{\mu\nu}) \quad (490)$$

$$+ i g_3^2 \left( - \sum_{a=1}^8 f_{\alpha,\beta,a} f_{\gamma,\delta,a} + \sum_{a=1}^8 f_{\alpha,\delta,a} f_{\beta,\gamma,a} \right) (g_{\rho\mu} g_{\sigma\nu}) \quad (491)$$

$$+ i g_3^2 \left( \sum_{a=1}^8 f_{\alpha,\gamma,a} f_{\beta,\delta,a} + \sum_{a=1}^8 f_{\alpha,\beta,a} f_{\gamma,\delta,a} \right) (g_{\rho\nu} g_{\sigma\mu}) \quad (492)$$

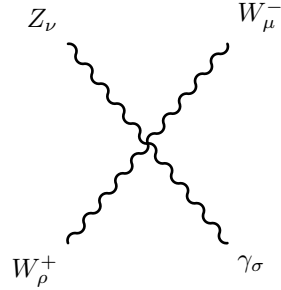


$$ig_2^2 \sin \Theta_W^2 (g_{\rho\sigma} g_{\mu\nu}) \quad (493)$$

$$+ ig_2^2 \sin \Theta_W^2 (g_{\rho\mu} g_{\sigma\nu}) \quad (494)$$

$$+ -2ig_2^2 \sin \Theta_W^2 (g_{\rho\nu} g_{\sigma\mu}) \quad (495)$$


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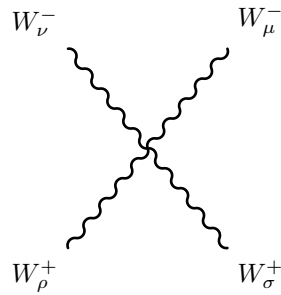


$$ig_2^2 \cos \Theta_W \sin \Theta_W (g_{\rho\sigma} g_{\mu\nu}) \quad (496)$$

$$+ -ig_2^2 \sin 2\Theta_W (g_{\rho\mu} g_{\sigma\nu}) \quad (497)$$

$$+ ig_2^2 \cos \Theta_W \sin \Theta_W (g_{\rho\nu} g_{\sigma\mu}) \quad (498)$$


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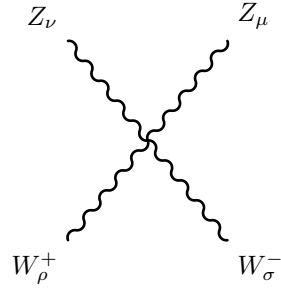


$$2ig_2^2 (g_{\rho\sigma} g_{\mu\nu}) \quad (499)$$

$$+ -ig_2^2 (g_{\rho\mu} g_{\sigma\nu}) \quad (500)$$

$$+ -ig_2^2 (g_{\rho\nu} g_{\sigma\mu}) \quad (501)$$


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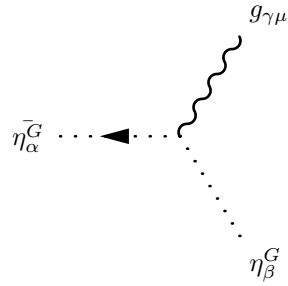


$$- 2ig_2^2 \cos \Theta_W^2 (g_{\rho\sigma}g_{\mu\nu}) \quad (502)$$

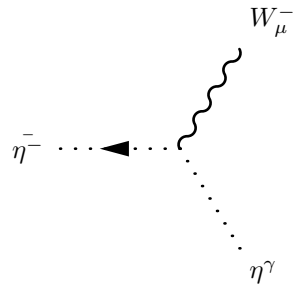
$$+ ig_2^2 \cos \Theta_W^2 (g_{\rho\mu}g_{\sigma\nu}) \quad (503)$$

$$+ ig_2^2 \cos \Theta_W^2 (g_{\rho\nu}g_{\sigma\mu}) \quad (504)$$

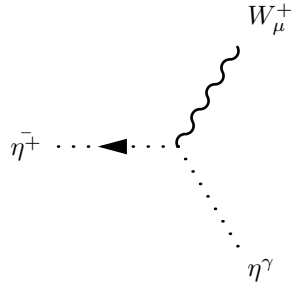
### 9.10 Two Ghosts-One Vector Boson-Interaction



$$g_3 f_{\alpha,\beta,\gamma} (p_\mu^{\eta_\beta^G}) \quad (505)$$

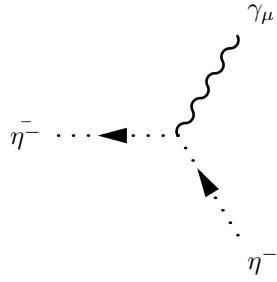


$$ig_2 \sin \Theta_W (p_\mu^{\eta^\gamma}) \quad (506)$$



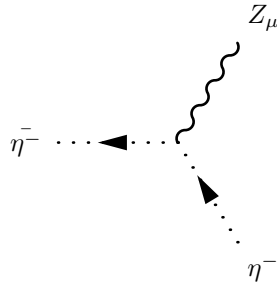
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$$-ig_2 \sin \Theta_W (p_\mu^{\eta^\gamma}) \quad (507)$$



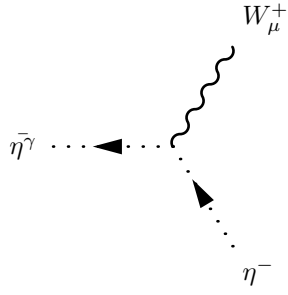
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$$-ig_2 \sin \Theta_W (p_\mu^{\eta^-}) \quad (508)$$



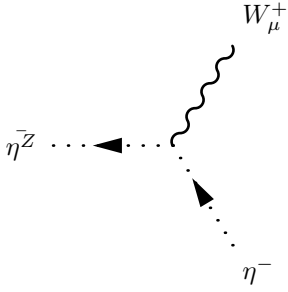
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$$-ig_2 \cos \Theta_W (p_\mu^{\eta^-}) \quad (509)$$



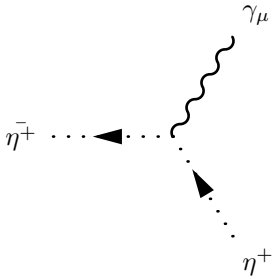
$$ig_2 \sin \Theta_W (p_\mu^{\eta^{\bar{s}}}) \tag{510}$$


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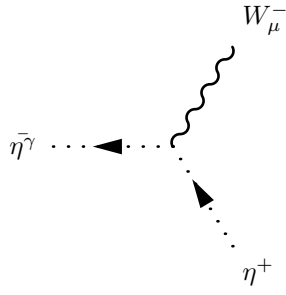
$$ig_2 \cos \Theta_W (p_\mu^{\eta^{\bar{s}}}) \tag{511}$$


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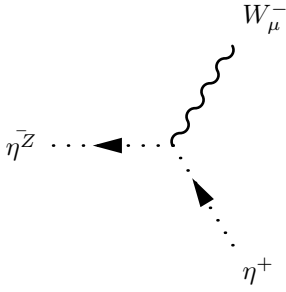
$$ig_2 \sin \Theta_W (p_\mu^{\eta^{\bar{s}}}) \tag{512}$$


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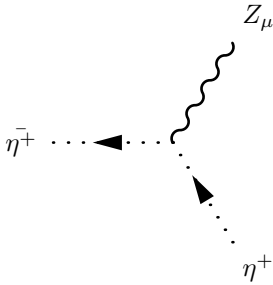
$$-ig_2 \sin \Theta_W (p_\mu^{\eta^+}) \quad (513)$$


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$$-ig_2 \cos \Theta_W (p_\mu^{\eta^+}) \quad (514)$$

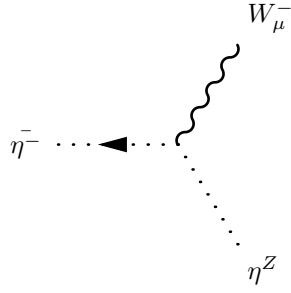

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$$ig_2 \cos \Theta_W (p_\mu^{\eta^+}) \quad (515)$$

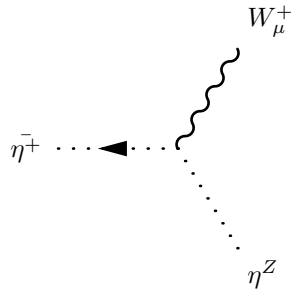

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$$ig_2 \cos \Theta_W (p_\mu^{\eta^0}) \quad (516)$$

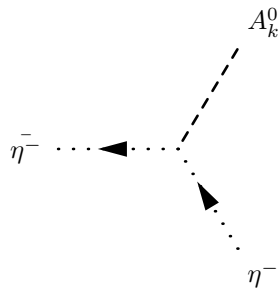

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$$-ig_2 \cos \Theta_W (p_\mu^{\eta^0}) \quad (517)$$

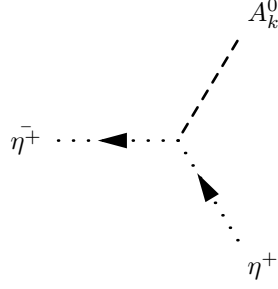

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### 9.11 Two Ghosts-One Scalar-Interaction



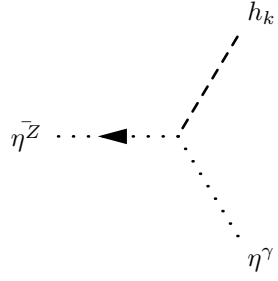
$$\frac{1}{4} g_2^2 \xi_{W^-} (v_d Z_{k1}^A - v_u Z_{k2}^A) \quad (518)$$


---



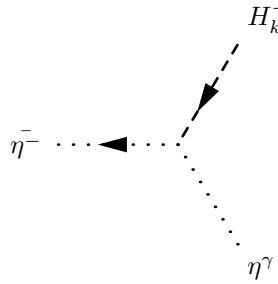
$$\frac{1}{4}g_2^2\xi_{W^-}\left(-v_dZ_{k1}^A+v_uZ_{k2}^A\right) \quad (519)$$


---



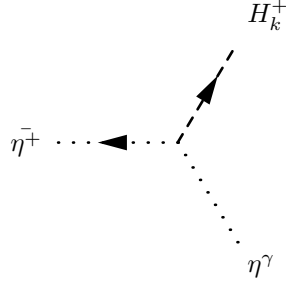
$$\frac{i}{8}\xi_Z\left(2g_1g_2\cos 2\Theta_W+\left(-g_2^2+g_1^2\right)\sin 2\Theta_W\right)\left(v_dZ_{k1}^H+v_uZ_{k2}^H\right) \quad (520)$$


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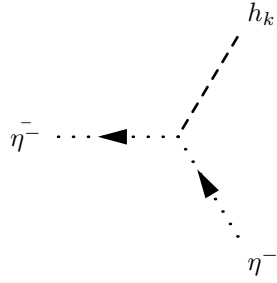
$$\frac{i}{4}g_2\xi_{W^-}\left(g_1\cos \Theta_W+g_2\sin \Theta_W\right)\left(v_dZ_{k1}^+-v_uZ_{k2}^+\right) \quad (521)$$


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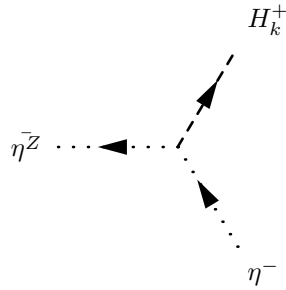
$$\frac{i}{4} g_2 \xi_{W^-} \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) \left( v_d Z_{k1}^+ - v_u Z_{k2}^+ \right) \quad (522)$$


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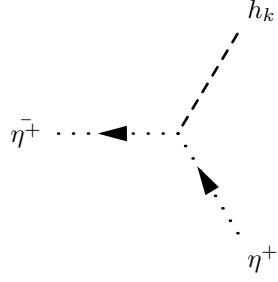
$$-\frac{i}{4} g_2^2 \xi_{W^-} \left( v_d Z_{k1}^H + v_u Z_{k2}^H \right) \quad (523)$$


---



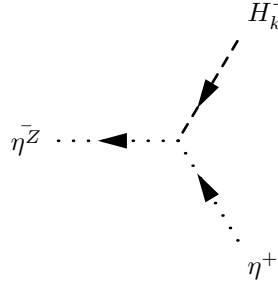
$$-\frac{i}{4} g_2 \xi_Z \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( v_d Z_{k1}^+ - v_u Z_{k2}^+ \right) \quad (524)$$


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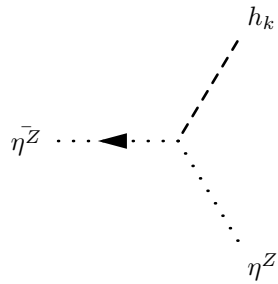
$$-\frac{i}{4}g_2^2\xi_{W^-}\left(v_d Z_{k1}^H + v_u Z_{k2}^H\right) \quad (525)$$


---



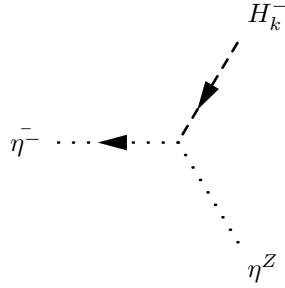
$$-\frac{i}{4}g_2\xi_Z\left(g_1\sin\Theta_W + g_2\cos\Theta_W\right)\left(v_d Z_{k1}^+ - v_u Z_{k2}^+\right) \quad (526)$$


---



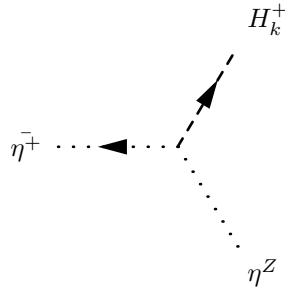
$$-\frac{i}{4}\xi_Z\left(g_1\sin\Theta_W + g_2\cos\Theta_W\right)^2\left(v_d Z_{k1}^H + v_u Z_{k2}^H\right) \quad (527)$$


---



$$\frac{i}{4} g_2 \xi_{W^-} \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( v_d Z_{k1}^+ - v_u Z_{k2}^+ \right) \quad (528)$$


---



$$\frac{i}{4} g_2 \xi_{W^-} \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( v_d Z_{k1}^+ - v_u Z_{k2}^+ \right) \quad (529)$$


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## 10 Clebsch-Gordan Coefficients