

minimal R-symmetric SSM  
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	$(1, \mathbf{1}, \mathbf{1})$
$\hat{S}$	$S$	$\tilde{S}$	1	$(0, \mathbf{1}, \mathbf{1})$
$\hat{T}$	$T$	$\tilde{T}$	1	$(0, \mathbf{3}, \mathbf{1})$
$\hat{oc}$	$O$	$\tilde{O}$	1	$(0, \mathbf{1}, \mathbf{8})$
SF(Rd)	SRd	FRd	1	$(\frac{1}{2}, \mathbf{2}, \mathbf{1})$
SF(Ru)	SRu	FRu	1	$(-\frac{1}{2}, \mathbf{2}, \mathbf{1})$

# 2 Superpotential and Lagrangian

## 2.1 Superpotential

$$\begin{aligned}
W = & \mu \hat{H}_u \hat{H}_d + \mu_D \text{SF}(\text{Rd}) \hat{H}_d + \mu_U \text{SF}(\text{Ru}) \hat{H}_u - Y_d \hat{d} \hat{q} \hat{H}_d - Y_e \hat{e} \hat{l} \hat{H}_d + \Lambda_D \text{SF}(\text{Rd}) \hat{T} \hat{H}_d + \Lambda_U \text{SF}(\text{Ru}) \hat{T} \hat{H}_u \\
& + \lambda_D \hat{S} \text{SF}(\text{Rd}) \hat{H}_d + \lambda_U \hat{S} \text{SF}(\text{Ru}) \hat{H}_u + Y_u \hat{u} \hat{q} \hat{H}_u
\end{aligned} \tag{1}$$

## 2.2 Softbreaking terms

$$\begin{aligned}
-L_{SB,W} = & -H_d^0 H_u^0 B_\mu - H_d^0 R_d^0 B_D + H_d^- H_u^+ B_\mu + H_d^- R_d^+ B_D + H_u^0 R_u^0 B_U - H_u^+ R_u^- B_U + \text{h.c.} \\
-L_{SB,\phi} = & + m_{H_d}^2 |H_d^0|^2 + m_{H_d}^2 |H_d^-|^2 + m_{H_u}^2 |H_u^0|^2 + m_{H_u}^2 |H_u^+|^2 + m_{R_d}^2 |R_d^0|^2 + m_{R_d}^2 |R_d^+|^2 + m_{R_u}^2 |R_u^0|^2 \\
& + m_{R_u}^2 |R_u^-|^2 + m_S^2 |S|^2 + m_t^2 |T^0|^2 + m_t^2 |T^-|^2 + m_t^2 |T^+|^2 + \tilde{d}_{L,i\alpha}^* \delta_{\alpha\beta} m_{q,ij}^2 \tilde{d}_{L,j\beta}
\end{aligned} \tag{2}$$

$$\begin{aligned}
& + \tilde{d}_{R,i\alpha}^* \delta_{\alpha\beta} m_{d,ij}^2 \tilde{d}_{R,j\beta} + \tilde{e}_{L,i}^* m_{l,ij}^2 \tilde{e}_{L,j} + \tilde{e}_{R,i}^* m_{e,ij}^2 \tilde{e}_{R,j} + m_O^2 O_\alpha^* \delta_{\alpha\beta} O_\beta + \tilde{u}_{L,i\alpha}^* \delta_{\alpha\beta} m_{q,ij}^2 \tilde{u}_{L,j\beta} \\
& + \tilde{u}_{R,i\alpha}^* \delta_{\alpha\beta} m_{u,ij}^2 \tilde{u}_{R,j\beta} + \tilde{\nu}_{L,i}^* m_{l,ij}^2 \tilde{\nu}_{L,j}
\end{aligned} \tag{3}$$

$$-L_{SB,\lambda} = \frac{1}{2} (0 + \text{h.c.}) \tag{4}$$

$$\begin{aligned}
-L_{SB,DG} = \frac{1}{2} & \left( 4\lambda_{\tilde{B}} \tilde{S} M_D^B + 2M_D^O \delta_{\alpha\beta} \lambda_{\tilde{g},\beta} \tilde{O}_\alpha + 2M_D^O \delta_{\alpha\beta} \lambda_{\tilde{g},\alpha} \tilde{O}_\beta + 2\sqrt{2}\tilde{T}^- M_D^W \lambda_{\tilde{W},1} + 2\sqrt{2}\tilde{T}^+ M_D^W \lambda_{\tilde{W},1} \right. \\
& \left. - 2i\sqrt{2}\tilde{T}^- M_D^W \lambda_{\tilde{W},2} + 2i\sqrt{2}\tilde{T}^+ M_D^W \lambda_{\tilde{W},2} + 4\tilde{T}^0 M_D^W \lambda_{\tilde{W},3} \right)
\end{aligned} \tag{5}$$

## 2.3 Gauge fixing terms

### 2.3.1 Gauge fixing terms for eigenstates 'GaugeES'

$$L_{GF} = -\frac{1}{2} |\partial_\mu B|^2 \xi_B^{-1} - \frac{1}{2} |\partial_\mu g|^2 \xi_g^{-1} - \frac{1}{2} |\partial_\mu W|^2 \xi_W^{-1} \tag{6}$$

### 2.3.2 Gauge fixing terms for eigenstates 'EWSB'

$$\begin{aligned}
L_{GF} = & -\frac{1}{2} |\partial_\mu g|^2 \xi_g^{-1} - \frac{1}{2} |\partial_\mu \gamma|^2 \xi_\gamma^{-1} \\
& - \left| \frac{1}{2} \left( 2\partial_\mu W^- - ig_2 \left( H_d^- v_d + \sqrt{2} T^- v_T + \sqrt{2} v_T T^{+,*} - v_u H_u^{+,*} \right) \xi_{W^-} \right) \right|^2 \xi_{W^-}^{-1} \\
& - \frac{1}{2} \left| \frac{1}{2} \left( 2\partial_\mu Z + (\sigma_d v_d - \sigma_u v_u) \xi_Z (g_1 \sin \Theta_W + g_2 \cos \Theta_W) \right) \right|^2 \xi_Z^{-1}
\end{aligned} \tag{7}$$

## 2.4 Fields integrated out

None

# 3 Renormalization Group Equations

## 3.1 Anomalous Dimensions

$$\gamma_{\hat{q}}^{(1)} = -\frac{1}{30} (45g_2^2 + 80g_3^2 + g_1^2) \mathbf{1} + Y_d^\dagger Y_d + Y_u^\dagger Y_u \tag{8}$$

$$\begin{aligned}
\gamma_{\hat{q}}^{(2)} = & + \left( 8g_2^2 g_3^2 + \frac{1}{90} g_1^2 (16g_3^2 + 9g_2^2) + \frac{217}{900} g_1^4 + \frac{33}{4} g_2^4 + \frac{64}{9} g_3^4 \right) \mathbf{1} + \frac{4}{5} g_1^2 Y_u^\dagger Y_u - |\lambda_U|^2 Y_u^\dagger Y_u \\
& - \frac{3}{2} |\Lambda_U|^2 Y_u^\dagger Y_u - 2Y_d^\dagger Y_d Y_d^\dagger Y_d - 2Y_u^\dagger Y_u Y_u^\dagger Y_u \\
& + Y_d^\dagger Y_d \left( -3\text{Tr}(Y_d Y_d^\dagger) + \frac{2}{5} g_1^2 - \frac{3}{2} |\Lambda_D|^2 - |\lambda_D|^2 - \text{Tr}(Y_e Y_e^\dagger) \right) - 3Y_u^\dagger Y_u \text{Tr}(Y_u Y_u^\dagger)
\end{aligned} \tag{9}$$

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

$$\gamma_{\hat{l}}^{(2)} = +\frac{3}{20} (15g_1^4 + 55g_2^4 + 6g_1^2 g_2^2) \mathbf{1} - 2Y_e^\dagger Y_e Y_e^\dagger Y_e$$

$$+ Y_e^\dagger Y_e \left( -3\text{Tr}(Y_d Y_d^\dagger) - \frac{3}{2}|\Lambda_D|^2 + \frac{6}{5}g_1^2 - |\lambda_D|^2 - \text{Tr}(Y_e Y_e^\dagger) \right) \quad (11)$$

$$\gamma_{\hat{H}_d}^{(1)} = 3\text{Tr}(Y_d Y_d^\dagger) - \frac{3}{10}g_1^2 - \frac{3}{2}g_2^2 + \frac{3}{2}|\Lambda_D|^2 + |\lambda_D|^2 + \text{Tr}(Y_e Y_e^\dagger) \quad (12)$$

$$\begin{aligned} \gamma_{\hat{H}_d}^{(2)} = & +\frac{9}{4}g_1^4 + \frac{9}{10}g_1^2 g_2^2 + \frac{33}{4}g_2^4 - 3\lambda_D^2 \lambda_D^{*2} + \left(6g_2^2 \Lambda_D - \frac{3}{2}\Lambda_D |\Lambda_U|^2\right) \Lambda_D^* - \frac{15}{4}\Lambda_D^2 \Lambda_D^{*2} \\ & - |\lambda_D|^2 \left(2\lambda_U \lambda_U^* + 3\Lambda_D \Lambda_D^*\right) - \frac{2}{5}g_1^2 \text{Tr}(Y_d Y_d^\dagger) + 16g_3^2 \text{Tr}(Y_d Y_d^\dagger) + \frac{6}{5}g_1^2 \text{Tr}(Y_e Y_e^\dagger) \\ & - 9\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 3\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \end{aligned} \quad (13)$$

$$\gamma_{\hat{H}_u}^{(1)} = -\frac{3}{10} \left( -10\text{Tr}(Y_u Y_u^\dagger) + 5g_2^2 - 5|\Lambda_U|^2 + g_1^2 \right) + |\lambda_U|^2 \quad (14)$$

$$\begin{aligned} \gamma_{\hat{H}_u}^{(2)} = & +\frac{9}{4}g_1^4 + \frac{9}{10}g_1^2 g_2^2 + \frac{33}{4}g_2^4 + 6g_2^2 |\Lambda_U|^2 - 2\lambda_U |\lambda_D|^2 \lambda_U^* - 3\lambda_U^2 \lambda_U^{*2} - 3\Lambda_U |\lambda_U|^2 \Lambda_U^* \\ & - \frac{3}{2}\Lambda_U |\Lambda_D|^2 \Lambda_U^* - \frac{15}{4}\Lambda_U^2 \Lambda_U^{*2} + \frac{4}{5}g_1^2 \text{Tr}(Y_u Y_u^\dagger) + 16g_3^2 \text{Tr}(Y_u Y_u^\dagger) - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) \\ & - 9\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) \end{aligned} \quad (15)$$

$$\gamma_{\hat{d}}^{(1)} = 2Y_d^* Y_d^T - \frac{2}{15} \left( 20g_3^2 + g_1^2 \right) \mathbf{1} \quad (16)$$

$$\begin{aligned} \gamma_{\hat{d}}^{(2)} = & +\frac{4}{45} \left( 11g_1^4 + 80g_3^4 + 8g_1^2 g_3^2 \right) \mathbf{1} - 2 \left( Y_d^* Y_d^T Y_d^* Y_d^T + Y_d^* Y_u^T Y_u^* Y_d^T \right) \\ & + Y_d^* Y_d^T \left( -2|\lambda_D|^2 - 2\text{Tr}(Y_e Y_e^\dagger) - 3|\Lambda_D|^2 + 6g_2^2 - 6\text{Tr}(Y_d Y_d^\dagger) + \frac{2}{5}g_1^2 \right) \end{aligned} \quad (17)$$

$$\gamma_{\hat{u}}^{(1)} = 2Y_u^* Y_u^T - \frac{8}{15} \left( 5g_3^2 + g_1^2 \right) \mathbf{1} \quad (18)$$

$$\begin{aligned} \gamma_{\hat{u}}^{(2)} = & +\frac{32}{225} \left( 20g_1^2 g_3^2 + 29g_1^4 + 50g_3^4 \right) \mathbf{1} - 2 \left( Y_u^* Y_d^T Y_d^* Y_u^T + Y_u^* Y_u^T Y_u^* Y_u^T \right) \\ & + Y_u^* Y_u^T \left( -2|\lambda_U|^2 - 3|\Lambda_U|^2 + 6g_2^2 - 6\text{Tr}(Y_u Y_u^\dagger) - \frac{2}{5}g_1^2 \right) \end{aligned} \quad (19)$$

$$\gamma_{\hat{e}}^{(1)} = 2Y_e^* Y_e^T - \frac{6}{5}g_1^2 \mathbf{1} \quad (20)$$

$$\begin{aligned} \gamma_{\hat{e}}^{(2)} = & +\frac{252}{25}g_1^4 \mathbf{1} - 2Y_e^* Y_e^T Y_e^* Y_e^T \\ & + Y_e^* Y_e^T \left( -2|\lambda_D|^2 - 2\text{Tr}(Y_e Y_e^\dagger) - 3|\Lambda_D|^2 + 6g_2^2 - 6\text{Tr}(Y_d Y_d^\dagger) - \frac{6}{5}g_1^2 \right) \end{aligned} \quad (21)$$

$$\gamma_{\hat{S}}^{(1)} = 2 \left( |\lambda_D|^2 + |\lambda_U|^2 \right) \quad (22)$$

$$\begin{aligned} \gamma_{\hat{S}}^{(2)} = & -4\lambda_D^2 \lambda_D^{*2} + \lambda_D^* \left( -2\lambda_D \text{Tr}(Y_e Y_e^\dagger) + 6g_2^2 \lambda_D - 6\lambda_D |\Lambda_D|^2 - 6\lambda_D \text{Tr}(Y_d Y_d^\dagger) + \frac{6}{5}g_1^2 \lambda_D \right) \\ & - \frac{2}{5}|\lambda_U|^2 \left( 10\lambda_U \lambda_U^* - 3 \left( 5g_2^2 - 5\Lambda_U \Lambda_U^* - 5\text{Tr}(Y_u Y_u^\dagger) + g_1^2 \right) \right) \end{aligned} \quad (23)$$

$$\gamma_{\hat{T}}^{(1)} = -4g_2^2 + |\Lambda_D|^2 + |\Lambda_U|^2 \quad (24)$$

$$\gamma_{\hat{T}}^{(2)} = +32g_2^4 - 3\Lambda_D^2 \Lambda_D^{*2} - 3\Lambda_U^2 \Lambda_U^{*2} + \frac{1}{5}|\Lambda_D|^2 \left( -10\lambda_D \lambda_D^* - 15\text{Tr}(Y_d Y_d^\dagger) + 3g_1^2 - 5g_2^2 - 5\text{Tr}(Y_e Y_e^\dagger) \right)$$

$$+ \Lambda_U^* \left( -2\Lambda_U |\lambda_U|^2 - 3\Lambda_U \text{Tr}(Y_u Y_u^\dagger) + \frac{3}{5} g_1^2 \Lambda_U - g_2^2 \Lambda_U \right) \quad (25)$$

$$\gamma_{\hat{oc}}^{(1)} = -6g_3^2 \quad (26)$$

$$\gamma_{\hat{oc}}^{(2)} = 36g_3^4 \quad (27)$$

$$\gamma_{\text{SF}(\text{Rd})}^{(1)} = -\frac{3}{10} \left( 5g_2^2 - 5|\Lambda_D|^2 + g_1^2 \right) + |\lambda_D|^2 \quad (28)$$

$$\begin{aligned} \gamma_{\text{SF}(\text{Rd})}^{(2)} &= -3\lambda_D^2 \lambda_D^{*2} \\ &+ \frac{3}{20} \left( 10|\Lambda_D|^2 \left( -3\text{Tr}(Y_d Y_d^\dagger) + 4g_2^2 - \Lambda_U \Lambda_U^* - \text{Tr}(Y_e Y_e^\dagger) \right) + 15g_1^4 - 25\Lambda_D^2 \Lambda_D^{*2} + 55g_2^4 + 6g_1^2 g_2^2 \right) \\ &- |\lambda_D|^2 \left( 2\lambda_U \lambda_U^* + 3\Lambda_D \Lambda_D^* + 3\text{Tr}(Y_d Y_d^\dagger) + \text{Tr}(Y_e Y_e^\dagger) \right) \end{aligned} \quad (29)$$

$$\gamma_{\text{SF}(\text{Ru})}^{(1)} = -\frac{3}{10} \left( 5g_2^2 - 5|\Lambda_U|^2 + g_1^2 \right) + |\lambda_U|^2 \quad (30)$$

$$\begin{aligned} \gamma_{\text{SF}(\text{Ru})}^{(2)} &= -2\lambda_U |\lambda_D|^2 \lambda_U^* \\ &+ \frac{3}{20} \left( 15g_1^4 + 6g_1^2 g_2^2 + 55g_2^4 - 20\lambda_U^2 \lambda_U^{*2} - 25\Lambda_U^2 \Lambda_U^{*2} + 10|\Lambda_U|^2 \left( -3\text{Tr}(Y_u Y_u^\dagger) + 4g_2^2 - \Lambda_D \Lambda_D^* \right) \right. \\ &\left. - 20|\lambda_U|^2 \left( \Lambda_U \Lambda_U^* + \text{Tr}(Y_u Y_u^\dagger) \right) \right) \end{aligned} \quad (31)$$

### 3.2 Gauge Couplings

$$\beta_{g_1}^{(1)} = \frac{36}{5} g_1^3 \quad (32)$$

$$\begin{aligned} \beta_{g_1}^{(2)} &= \frac{1}{25} g_1^3 \left( 208g_1^2 + 180g_2^2 + 440g_3^2 - 30|\lambda_D|^2 - 30|\lambda_U|^2 - 45|\Lambda_D|^2 - 45|\Lambda_U|^2 - 70\text{Tr}(Y_d Y_d^\dagger) - 90\text{Tr}(Y_e Y_e^\dagger) \right. \\ &\left. - 130\text{Tr}(Y_u Y_u^\dagger) \right) \end{aligned} \quad (33)$$

$$\beta_{g_2}^{(1)} = 4g_2^3 \quad (34)$$

$$\begin{aligned} \beta_{g_2}^{(2)} &= \frac{1}{5} g_2^3 \left( 12g_1^2 + 280g_2^2 + 120g_3^2 - 10|\lambda_D|^2 - 10|\lambda_U|^2 - 35|\Lambda_D|^2 - 35|\Lambda_U|^2 - 30\text{Tr}(Y_d Y_d^\dagger) - 10\text{Tr}(Y_e Y_e^\dagger) \right. \\ &\left. - 30\text{Tr}(Y_u Y_u^\dagger) \right) \end{aligned} \quad (35)$$

$$\beta_{g_3}^{(1)} = 0 \quad (36)$$

$$\beta_{g_3}^{(2)} = \frac{1}{5} g_3^3 \left( 11g_1^2 - 20\text{Tr}(Y_d Y_d^\dagger) - 20\text{Tr}(Y_u Y_u^\dagger) + 340g_3^2 + 45g_2^2 \right) \quad (37)$$

### 3.3 Trilinear Superpotential Parameters

$$\begin{aligned} \beta_{Y_d}^{(1)} &= +3Y_d Y_d^\dagger Y_d + Y_d Y_u^\dagger Y_u \\ &+ Y_d \left( -3g_2^2 + 3\text{Tr}(Y_d Y_d^\dagger) - \frac{16}{3}g_3^2 + \frac{3}{2}|\Lambda_D|^2 - \frac{7}{15}g_1^2 + |\lambda_D|^2 + \text{Tr}(Y_e Y_e^\dagger) \right) \end{aligned} \quad (38)$$

$$\begin{aligned} \beta_{Y_d}^{(2)} &= +\frac{4}{5}g_1^2 Y_d Y_u^\dagger Y_u - |\lambda_U|^2 Y_d Y_u^\dagger Y_u - \frac{3}{2}|\Lambda_U|^2 Y_d Y_u^\dagger Y_u - 4Y_d Y_d^\dagger Y_d Y_d^\dagger Y_d \\ &- 2Y_d Y_u^\dagger Y_u Y_d^\dagger Y_d - 2Y_d Y_u^\dagger Y_u Y_u^\dagger Y_u \\ &+ Y_d Y_d^\dagger Y_d \left( -3|\lambda_D|^2 - 3\text{Tr}(Y_e Y_e^\dagger) + 6g_2^2 - 9\text{Tr}(Y_d Y_d^\dagger) + \frac{4}{5}g_1^2 - \frac{9}{2}|\Lambda_D|^2 \right) \\ &- 3Y_d Y_u^\dagger Y_u \text{Tr}(Y_u Y_u^\dagger) \\ &+ Y_d \left( \frac{1561}{450}g_1^4 + g_1^2 g_2^2 + \frac{33}{2}g_2^4 + \frac{8}{9}g_1^2 g_3^2 + 8g_2^2 g_3^2 + \frac{128}{9}g_3^4 + 6g_2^2 |\Lambda_D|^2 - 3\lambda_D^2 \lambda_D^{*,2} - \frac{15}{4}\Lambda_D^2 \Lambda_D^{*,2} \right. \\ &- |\lambda_D|^2 (2\lambda_U \lambda_U^* + 3\Lambda_U \Lambda_U^*) - \frac{3}{2}\Lambda_U |\Lambda_D|^2 \Lambda_U^* - \frac{2}{5}g_1^2 \text{Tr}(Y_d Y_d^\dagger) + 16g_3^2 \text{Tr}(Y_d Y_d^\dagger) \\ &\left. + \frac{6}{5}g_1^2 \text{Tr}(Y_e Y_e^\dagger) - 9\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 3\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \right) \end{aligned} \quad (39)$$

$$\beta_{Y_e}^{(1)} = 3Y_e Y_e^\dagger Y_e + Y_e \left( -3g_2^2 + 3\text{Tr}(Y_d Y_d^\dagger) + \frac{3}{2}|\Lambda_D|^2 - \frac{9}{5}g_1^2 + |\lambda_D|^2 + \text{Tr}(Y_e Y_e^\dagger) \right) \quad (40)$$

$$\begin{aligned} \beta_{Y_e}^{(2)} &= -4Y_e Y_e^\dagger Y_e Y_e^\dagger Y_e + Y_e Y_e^\dagger Y_e \left( -3|\lambda_D|^2 - 3\text{Tr}(Y_e Y_e^\dagger) + 6g_2^2 - 9\text{Tr}(Y_d Y_d^\dagger) - \frac{9}{2}|\Lambda_D|^2 \right) \\ &+ Y_e \left( \frac{729}{50}g_1^4 + \frac{9}{5}g_1^2 g_2^2 + \frac{33}{2}g_2^4 + 6g_2^2 |\Lambda_D|^2 - 3\lambda_D^2 \lambda_D^{*,2} - \frac{15}{4}\Lambda_D^2 \Lambda_D^{*,2} - |\lambda_D|^2 (2\lambda_U \lambda_U^* + 3\Lambda_U \Lambda_U^*) \right. \\ &- \frac{3}{2}\Lambda_U |\Lambda_D|^2 \Lambda_U^* - \frac{2}{5}g_1^2 \text{Tr}(Y_d Y_d^\dagger) + 16g_3^2 \text{Tr}(Y_d Y_d^\dagger) + \frac{6}{5}g_1^2 \text{Tr}(Y_e Y_e^\dagger) - 9\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) \\ &\left. - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 3\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \right) \end{aligned} \quad (41)$$

$$\beta_{\Lambda_D}^{(1)} = 2\Lambda_D |\lambda_D|^2 + 3\Lambda_D \text{Tr}(Y_d Y_d^\dagger) + 4\Lambda_D^2 \Lambda_D^* - 7g_2^2 \Lambda_D - \frac{3}{5}g_1^2 \Lambda_D + \Lambda_D |\Lambda_U|^2 + \Lambda_D \text{Tr}(Y_e Y_e^\dagger) \quad (42)$$

$$\begin{aligned} \beta_{\Lambda_D}^{(2)} &= -\frac{1}{10}\Lambda_D \left( -45g_1^4 - 18g_1^2 g_2^2 - 485g_2^4 - 6g_1^2 |\Lambda_U|^2 + 10g_2^2 |\Lambda_U|^2 + 60\lambda_D^2 \lambda_D^{*,2} + 105\Lambda_D^2 \Lambda_D^{*,2} \right. \\ &+ 20\Lambda_U |\lambda_U|^2 \Lambda_U^* + 30\Lambda_U^2 \Lambda_U^{*,2} + 4g_1^2 \text{Tr}(Y_d Y_d^\dagger) - 160g_3^2 \text{Tr}(Y_d Y_d^\dagger) - 12g_1^2 \text{Tr}(Y_e Y_e^\dagger) \\ &+ 10|\lambda_D|^2 (3\text{Tr}(Y_d Y_d^\dagger) + 4\lambda_U \lambda_U^* + 8\Lambda_U \Lambda_U^* + \text{Tr}(Y_e Y_e^\dagger)) \\ &\left. + |\Lambda_D|^2 (-110g_2^2 + 25\text{Tr}(Y_e Y_e^\dagger) + 30\Lambda_U \Lambda_U^* - 6g_1^2 + 75\text{Tr}(Y_d Y_d^\dagger)) + 30|\Lambda_U|^2 \text{Tr}(Y_u Y_u^\dagger) \right. \\ &\left. + 90\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) + 30\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) + 30\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \right) \end{aligned} \quad (43)$$

$$\beta_{\Lambda_U}^{(1)} = 2\Lambda_U |\lambda_U|^2 + 3\Lambda_U \text{Tr}(Y_u Y_u^\dagger) + 4\Lambda_U^2 \Lambda_U^* - 7g_2^2 \Lambda_U - \frac{3}{5}g_1^2 \Lambda_U + \Lambda_U |\Lambda_D|^2 \quad (44)$$

$$\begin{aligned} \beta_{\Lambda_U}^{(2)} &= -\frac{1}{10}\Lambda_U \left( -45g_1^4 - 18g_1^2 g_2^2 - 485g_2^4 - 6g_1^2 |\Lambda_D|^2 + 10g_2^2 |\Lambda_D|^2 - 6g_1^2 |\Lambda_U|^2 - 110g_2^2 |\Lambda_U|^2 \right. \\ &\left. + 60\lambda_U^2 \lambda_U^{*,2} + 30\Lambda_D^2 \Lambda_D^{*,2} + 20|\lambda_D|^2 (2\lambda_U \lambda_U^* + \Lambda_D \Lambda_D^*) + 30\Lambda_U |\Lambda_D|^2 \Lambda_U^* + 105\Lambda_U^2 \Lambda_U^{*,2} \right) \end{aligned}$$



$$\begin{aligned}
& + 30|\Lambda_D|^2 \text{Tr}(Y_d Y_d^\dagger) + 10|\Lambda_D|^2 \text{Tr}(Y_e Y_e^\dagger) - 8g_1^2 \text{Tr}(Y_u Y_u^\dagger) - 160g_3^2 \text{Tr}(Y_u Y_u^\dagger) \\
& + 75|\Lambda_U|^2 \text{Tr}(Y_u Y_u^\dagger) + 10|\lambda_U|^2 (3\text{Tr}(Y_u Y_u^\dagger) + 8\Lambda_U \Lambda_U^*) + 30\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) + 90\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger)
\end{aligned} \tag{45}$$

$$\beta_{\lambda_D}^{(1)} = 2\lambda_D |\lambda_U|^2 - 3g_2^2 \lambda_D + 3\lambda_D |\Lambda_D|^2 + 3\lambda_D \text{Tr}(Y_d Y_d^\dagger) + 4\lambda_D^2 \lambda_D^* - \frac{3}{5}g_1^2 \lambda_D + \lambda_D \text{Tr}(Y_e Y_e^\dagger) \tag{46}$$

$$\begin{aligned}
\beta_{\lambda_D}^{(2)} = & -\frac{1}{10}\lambda_D \left( -45g_1^4 - 18g_1^2 g_2^2 - 165g_2^4 - 120g_2^2 |\Lambda_D|^2 + 100\lambda_D^2 \lambda_D^{*2} + 40\lambda_U^2 \lambda_U^{*2} + 75\Lambda_D^2 \Lambda_D^{*2} \right. \\
& + 30\Lambda_U |\Lambda_D|^2 \Lambda_U^* + 4g_1^2 \text{Tr}(Y_d Y_d^\dagger) - 160g_3^2 \text{Tr}(Y_d Y_d^\dagger) + 45|\Lambda_D|^2 \text{Tr}(Y_d Y_d^\dagger) \\
& - 12g_1^2 \text{Tr}(Y_e Y_e^\dagger) + 15|\Lambda_D|^2 \text{Tr}(Y_e Y_e^\dagger) \\
& + 2|\lambda_D|^2 (15\text{Tr}(Y_e Y_e^\dagger) + 20\lambda_U \lambda_U^* - 30g_2^2 + 45\text{Tr}(Y_d Y_d^\dagger) + 60\Lambda_D \Lambda_D^* - 6g_1^2) \\
& - 12|\lambda_U|^2 (5g_2^2 - 5\Lambda_U \Lambda_U^* - 5\text{Tr}(Y_u Y_u^\dagger) + g_1^2) + 90\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) + 30\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) \\
& \left. + 30\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \right)
\end{aligned} \tag{47}$$

$$\beta_{\lambda_U}^{(1)} = 2\lambda_U |\lambda_D|^2 + 4\lambda_U^2 \lambda_U^* - \frac{3}{5}\lambda_U (5g_2^2 - 5|\Lambda_U|^2 - 5\text{Tr}(Y_u Y_u^\dagger) + g_1^2) \tag{48}$$

$$\begin{aligned}
\beta_{\lambda_U}^{(2)} = & -\frac{1}{10}\lambda_U \left( -45g_1^4 - 18g_1^2 g_2^2 - 165g_2^4 - 120g_2^2 |\Lambda_U|^2 + 40\lambda_D^2 \lambda_D^{*2} + 100\lambda_U^2 \lambda_U^{*2} + 30\Lambda_U |\Lambda_D|^2 \Lambda_U^* \right. \\
& + 75\Lambda_U^2 \Lambda_U^{*2} + 4|\lambda_D|^2 (10\lambda_U \lambda_U^* - 15g_2^2 + 15\Lambda_D \Lambda_D^* + 15\text{Tr}(Y_d Y_d^\dagger) - 3g_1^2 + 5\text{Tr}(Y_e Y_e^\dagger)) \\
& - 6|\lambda_U|^2 (10g_2^2 - 15\text{Tr}(Y_u Y_u^\dagger) - 20\Lambda_U \Lambda_U^* + 2g_1^2) - 8g_1^2 \text{Tr}(Y_u Y_u^\dagger) - 160g_3^2 \text{Tr}(Y_u Y_u^\dagger) \\
& \left. + 45|\Lambda_U|^2 \text{Tr}(Y_u Y_u^\dagger) + 30\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) + 90\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) \right)
\end{aligned} \tag{49}$$

$$\beta_{Y_u}^{(1)} = 3Y_u Y_u^\dagger Y_u + Y_u \left( -3g_2^2 + 3\text{Tr}(Y_u Y_u^\dagger) - \frac{13}{15}g_1^2 - \frac{16}{3}g_3^2 + \frac{3}{2}|\Lambda_U|^2 + |\lambda_U|^2 \right) + Y_u Y_d^\dagger Y_d \tag{50}$$

$$\begin{aligned}
\beta_{Y_u}^{(2)} = & +\frac{2}{5}g_1^2 Y_u Y_u^\dagger Y_u + 6g_2^2 Y_u Y_u^\dagger Y_u - 3|\lambda_U|^2 Y_u Y_u^\dagger Y_u - \frac{9}{2}|\Lambda_U|^2 Y_u Y_u^\dagger Y_u \\
& - 2Y_u Y_d^\dagger Y_d Y_d^\dagger Y_u - 2Y_u Y_d^\dagger Y_d Y_u^\dagger Y_u - 4Y_u Y_u^\dagger Y_u Y_u^\dagger Y_u \\
& + Y_u Y_d^\dagger Y_d \left( -3\text{Tr}(Y_d Y_d^\dagger) + \frac{2}{5}g_1^2 - \frac{3}{2}|\Lambda_D|^2 - |\lambda_D|^2 - \text{Tr}(Y_e Y_e^\dagger) \right) \\
& - 9Y_u Y_u^\dagger Y_u \text{Tr}(Y_u Y_u^\dagger) \\
& + Y_u \left( \frac{2977}{450}g_1^4 + g_1^2 g_2^2 + \frac{33}{2}g_2^4 + \frac{136}{45}g_1^2 g_3^2 + 8g_2^2 g_3^2 + \frac{128}{9}g_3^4 + 6g_2^2 |\Lambda_U|^2 - 2\lambda_U |\lambda_D|^2 \lambda_U^* \right. \\
& - 3\lambda_U^2 \lambda_U^{*2} - 3\Lambda_U |\lambda_U|^2 \Lambda_U^* - \frac{3}{2}\Lambda_U |\Lambda_D|^2 \Lambda_U^* - \frac{15}{4}\Lambda_U^2 \Lambda_U^{*2} + \frac{4}{5}g_1^2 \text{Tr}(Y_u Y_u^\dagger) \\
& \left. + 16g_3^2 \text{Tr}(Y_u Y_u^\dagger) - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 9\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) \right)
\end{aligned} \tag{51}$$

### 3.4 Bilinear Superpotential Parameters

$$\beta_\mu^{(1)} = -\frac{3}{5}g_1^2\mu - 3g_2^2\mu + \mu|\lambda_D|^2 + \mu|\lambda_U|^2 + \frac{3}{2}\mu|\Lambda_D|^2 + \frac{3}{2}\mu|\Lambda_U|^2 + 3\mu\text{Tr}(Y_d Y_d^\dagger) + \mu\text{Tr}(Y_e Y_e^\dagger) + 3\mu\text{Tr}(Y_u Y_u^\dagger) \quad (52)$$

$$\begin{aligned} \beta_\mu^{(2)} = & \frac{1}{20}\mu(90g_1^4 + 36g_1^2g_2^2 + 330g_2^4 + 120g_2^2|\Lambda_D|^2 + 120g_2^2|\Lambda_U|^2 - 60\lambda_D^2\lambda_D^{*,2} - 60\lambda_U^2\lambda_U^{*,2} \\ & - 75\Lambda_D^2\Lambda_D^{*,2} - 20|\lambda_D|^2(3\Lambda_D\Lambda_D^* + 4\lambda_U\lambda_U^*) - 60\Lambda_U|\lambda_U|^2\Lambda_U^* - 60\Lambda_U|\Lambda_D|^2\Lambda_U^* - 75\Lambda_U^2\Lambda_U^{*,2} \\ & - 8g_1^2\text{Tr}(Y_d Y_d^\dagger) + 320g_3^2\text{Tr}(Y_d Y_d^\dagger) + 24g_1^2\text{Tr}(Y_e Y_e^\dagger) + 16g_1^2\text{Tr}(Y_u Y_u^\dagger) \\ & + 320g_3^2\text{Tr}(Y_u Y_u^\dagger) - 180\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) - 120\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 60\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \\ & - 180\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger)) \end{aligned} \quad (53)$$

$$\beta_{\mu_D}^{(1)} = 2\mu_D|\lambda_D|^2 - 3g_2^2\mu_D + 3\mu_D|\Lambda_D|^2 + 3\mu_D\text{Tr}(Y_d Y_d^\dagger) - \frac{3}{5}g_1^2\mu_D + \mu_D\text{Tr}(Y_e Y_e^\dagger) \quad (54)$$

$$\begin{aligned} \beta_{\mu_D}^{(2)} = & \frac{1}{10}\mu_D(45g_1^4 + 18g_1^2g_2^2 + 165g_2^4 - 60\lambda_D^2\lambda_D^{*,2} - 75\Lambda_D^2\Lambda_D^{*,2} - 4g_1^2\text{Tr}(Y_d Y_d^\dagger) + 160g_3^2\text{Tr}(Y_d Y_d^\dagger) \\ & + 15|\Lambda_D|^2(-2\Lambda_U\Lambda_U^* - 3\text{Tr}(Y_d Y_d^\dagger) + 8g_2^2 - \text{Tr}(Y_e Y_e^\dagger)) + 12g_1^2\text{Tr}(Y_e Y_e^\dagger) \\ & - 10|\lambda_D|^2(3\text{Tr}(Y_d Y_d^\dagger) + 4\lambda_U\lambda_U^* + 6\Lambda_D\Lambda_D^* + \text{Tr}(Y_e Y_e^\dagger)) - 90\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) - 30\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) \\ & - 30\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger)) \end{aligned} \quad (55)$$

$$\beta_{\mu_U}^{(1)} = 2\mu_U|\lambda_U|^2 - \frac{3}{5}\mu_U(5g_2^2 - 5|\Lambda_U|^2 - 5\text{Tr}(Y_u Y_u^\dagger) + g_1^2) \quad (56)$$

$$\begin{aligned} \beta_{\mu_U}^{(2)} = & \frac{1}{10}\mu_U(45g_1^4 + 18g_1^2g_2^2 + 165g_2^4 + 120g_2^2|\Lambda_U|^2 - 40\lambda_U|\lambda_D|^2\lambda_U^* - 60\lambda_U^2\lambda_U^{*,2} - 30\Lambda_U|\Lambda_D|^2\Lambda_U^* \\ & - 75\Lambda_U^2\Lambda_U^{*,2} + 8g_1^2\text{Tr}(Y_u Y_u^\dagger) + 160g_3^2\text{Tr}(Y_u Y_u^\dagger) - 45|\Lambda_U|^2\text{Tr}(Y_u Y_u^\dagger) \\ & - 30|\lambda_U|^2(2\Lambda_U\Lambda_U^* + \text{Tr}(Y_u Y_u^\dagger)) - 30\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 90\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger)) \end{aligned} \quad (57)$$

### 3.5 Bilinear Soft-Breaking Parameters

$$\beta_{B_\mu}^{(1)} = \frac{1}{10}B_\mu(-6g_1^2 - 30g_2^2 + 10|\lambda_D|^2 + 10|\lambda_U|^2 + 15|\Lambda_D|^2 + 15|\Lambda_U|^2 + 30\text{Tr}(Y_d Y_d^\dagger) + 10\text{Tr}(Y_e Y_e^\dagger) + 30\text{Tr}(Y_u Y_u^\dagger)) \quad (58)$$

$$\begin{aligned} \beta_{B_\mu}^{(2)} = & \frac{1}{20}B_\mu(90g_1^4 + 36g_1^2g_2^2 + 330g_2^4 + 120g_2^2|\Lambda_D|^2 + 120g_2^2|\Lambda_U|^2 - 60\lambda_D^2\lambda_D^{*,2} - 60\lambda_U^2\lambda_U^{*,2} \\ & - 75\Lambda_D^2\Lambda_D^{*,2} - 20|\lambda_D|^2(3\Lambda_D\Lambda_D^* + 4\lambda_U\lambda_U^*) - 60\Lambda_U|\lambda_U|^2\Lambda_U^* - 60\Lambda_U|\Lambda_D|^2\Lambda_U^* - 75\Lambda_U^2\Lambda_U^{*,2} \\ & - 8g_1^2\text{Tr}(Y_d Y_d^\dagger) + 320g_3^2\text{Tr}(Y_d Y_d^\dagger) + 24g_1^2\text{Tr}(Y_e Y_e^\dagger) + 16g_1^2\text{Tr}(Y_u Y_u^\dagger) \end{aligned}$$

$$\begin{aligned}
& + 320g_3^2 \text{Tr}(Y_u Y_u^\dagger) - 180 \text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) - 120 \text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 60 \text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \\
& - 180 \text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger)
\end{aligned} \tag{59}$$

$$\beta_{B_D}^{(1)} = 4\lambda_D B_U \lambda_U^* + B_D \left( -3g_2^2 + 3|\Lambda_D|^2 + 3\text{Tr}(Y_d Y_d^\dagger) + 6|\lambda_D|^2 - \frac{3}{5}g_1^2 + \text{Tr}(Y_e Y_e^\dagger) \right) \tag{60}$$

$$\begin{aligned}
\beta_{B_D}^{(2)} = & \frac{1}{10} \left( -8\lambda_D B_U \lambda_U^* \left( 10|\lambda_U|^2 + 15|\Lambda_U|^2 + 15\text{Tr}(Y_u Y_u^\dagger) - 45g_2^2 - 9g_1^2 \right) \right. \\
& + B_D \left( 45g_1^4 + 18g_1^2 g_2^2 + 165g_2^4 - 140\lambda_D^2 \lambda_D^{*2} - 75\Lambda_D^2 \Lambda_D^{*2} - 4g_1^2 \text{Tr}(Y_d Y_d^\dagger) + 160g_3^2 \text{Tr}(Y_d Y_d^\dagger) \right. \\
& + 2|\lambda_D|^2 \left( 180g_2^2 - 20\lambda_U \lambda_U^* - 25\text{Tr}(Y_e Y_e^\dagger) + 36g_1^2 - 75\text{Tr}(Y_d Y_d^\dagger) - 90\Lambda_D \Lambda_D^* \right) \\
& + 15|\Lambda_D|^2 \left( -2\Lambda_U \Lambda_U^* - 3\text{Tr}(Y_d Y_d^\dagger) + 8g_2^2 - \text{Tr}(Y_e Y_e^\dagger) \right) + 12g_1^2 \text{Tr}(Y_e Y_e^\dagger) - 90\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) \\
& \left. \left. - 30\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 30\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \right) \right)
\end{aligned} \tag{61}$$

$$\beta_{B_U}^{(1)} = 4\lambda_U B_D \lambda_D^* + B_U \left( -3g_2^2 + 3|\Lambda_U|^2 + 3\text{Tr}(Y_u Y_u^\dagger) + 6|\lambda_U|^2 - \frac{3}{5}g_1^2 \right) \tag{62}$$

$$\begin{aligned}
\beta_{B_U}^{(2)} = & \frac{1}{10} \left( -8\lambda_U B_D \lambda_D^* \left( 10|\lambda_D|^2 + 15|\Lambda_D|^2 + 15\text{Tr}(Y_d Y_d^\dagger) - 45g_2^2 + 5\text{Tr}(Y_e Y_e^\dagger) - 9g_1^2 \right) \right. \\
& + B_U \left( 45g_1^4 + 18g_1^2 g_2^2 + 165g_2^4 - 140\lambda_U^2 \lambda_U^{*2} - 75\Lambda_U^2 \Lambda_U^{*2} \right. \\
& + 2|\lambda_U|^2 \left( 180g_2^2 - 20\lambda_D \lambda_D^* + 36g_1^2 - 75\text{Tr}(Y_u Y_u^\dagger) - 90\Lambda_U \Lambda_U^* \right) \\
& + 15|\Lambda_U|^2 \left( -2\Lambda_D \Lambda_D^* - 3\text{Tr}(Y_u Y_u^\dagger) + 8g_2^2 \right) + 8g_1^2 \text{Tr}(Y_u Y_u^\dagger) + 160g_3^2 \text{Tr}(Y_u Y_u^\dagger) \\
& \left. \left. - 30\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 90\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) \right) \right)
\end{aligned} \tag{63}$$

### 3.6 Fayet-Iliopoulos $D$ -terms

$$\beta_{M_B^B}^{(1)} = \frac{2}{5} M_D^B \left( 18g_1^2 + 5|\lambda_D|^2 + 5|\lambda_U|^2 \right) \tag{64}$$

$$\begin{aligned}
\beta_{M_B^B}^{(2)} = & -\frac{1}{25} M_D^B \left( 100\lambda_D^2 \lambda_D^{*2} + 100\lambda_U^2 \lambda_U^{*2} - 50|\lambda_D|^2 \left( 3g_2^2 - 3\Lambda_D \Lambda_D^* - 3\text{Tr}(Y_d Y_d^\dagger) - \text{Tr}(Y_e Y_e^\dagger) \right) \right. \\
& - 150|\lambda_U|^2 \left( -\Lambda_U \Lambda_U^* - \text{Tr}(Y_u Y_u^\dagger) + g_2^2 \right) \\
& \left. + g_1^2 \left( 130\text{Tr}(Y_u Y_u^\dagger) - 180g_2^2 - 208g_1^2 - 440g_3^2 + 45|\Lambda_D|^2 + 45|\Lambda_U|^2 + 70\text{Tr}(Y_d Y_d^\dagger) + 90\text{Tr}(Y_e Y_e^\dagger) \right) \right)
\end{aligned} \tag{65}$$

$$\beta_{M_B^W}^{(1)} = M_D^W \left( |\Lambda_D|^2 + |\Lambda_U|^2 \right) \tag{66}$$

$$\begin{aligned}
\beta_{M_B^W}^{(2)} = & \frac{1}{5} M_D^W \left( 12g_1^2 g_2^2 + 440g_2^4 + 120g_2^2 g_3^2 + 3g_1^2 |\Lambda_D|^2 - 40g_2^2 |\Lambda_D|^2 + 3g_1^2 |\Lambda_U|^2 - 40g_2^2 |\Lambda_U|^2 \right. \\
& - 15\Lambda_D^2 \Lambda_D^{*2} - 10|\lambda_D|^2 \left( \Lambda_D \Lambda_D^* + g_2^2 \right) - 15\Lambda_U^2 \Lambda_U^{*2} - 10|\lambda_U|^2 \left( \Lambda_U \Lambda_U^* + g_2^2 \right) - 30g_2^2 \text{Tr}(Y_d Y_d^\dagger) \\
& \left. - 15|\Lambda_D|^2 \text{Tr}(Y_d Y_d^\dagger) - 10g_2^2 \text{Tr}(Y_e Y_e^\dagger) - 5|\Lambda_D|^2 \text{Tr}(Y_e Y_e^\dagger) - 30g_2^2 \text{Tr}(Y_u Y_u^\dagger) \right)
\end{aligned}$$

$$- 15|\Lambda_U|^2 \text{Tr}(Y_u Y_u^\dagger) \quad (67)$$

$$\beta_{M_D^O}^{(1)} = -6g_3^2 M_D^O \quad (68)$$

$$\beta_{M_D^O}^{(2)} = \frac{1}{5}g_3^2 M_D^O \left( 11g_1^2 - 20\text{Tr}(Y_d Y_d^\dagger) - 20\text{Tr}(Y_u Y_u^\dagger) + 45g_2^2 + 520g_3^2 \right) \quad (69)$$

### 3.7 Soft-Breaking Scalar Masses

$$\sigma_{1,1} = \sqrt{\frac{3}{5}}g_1 \left( -2\text{Tr}(m_u^2) - \text{Tr}(m_l^2) - m_{H_d}^2 - m_{R_u}^2 + m_{H_u}^2 + m_{R_d}^2 + \text{Tr}(m_d^2) + \text{Tr}(m_e^2) + \text{Tr}(m_q^2) \right) \quad (70)$$

$$\sigma_{2,11} = \frac{1}{10}g_1^2 \left( 2\text{Tr}(m_d^2) + 3\text{Tr}(m_l^2) + 3m_{H_d}^2 + 3m_{H_u}^2 + 3m_{R_d}^2 + 3m_{R_u}^2 + 6\text{Tr}(m_e^2) + 8\text{Tr}(m_u^2) + \text{Tr}(m_q^2) \right) \quad (71)$$

$$\begin{aligned} \sigma_{3,1} = & \frac{1}{20} \frac{1}{\sqrt{15}} g_1 \left( -9g_1^2 m_{H_d}^2 - 45g_2^2 m_{H_d}^2 + 9g_1^2 m_{H_u}^2 + 45g_2^2 m_{H_u}^2 + 9g_1^2 m_{R_d}^2 + 45g_2^2 m_{R_d}^2 - 9g_1^2 m_{R_u}^2 - 45g_2^2 m_{R_u}^2 \right. \\ & + 30 \left( -m_{R_d}^2 + m_{H_d}^2 \right) |\lambda_D|^2 - 30 \left( -m_{R_u}^2 + m_{H_u}^2 \right) |\lambda_U|^2 + 45m_{H_d}^2 |\Lambda_D|^2 - 45m_{R_d}^2 |\Lambda_D|^2 - 45m_{H_u}^2 |\Lambda_U|^2 \\ & + 45m_{R_u}^2 |\Lambda_U|^2 + 4g_1^2 \text{Tr}(m_d^2) + 80g_3^2 \text{Tr}(m_d^2) + 36g_1^2 \text{Tr}(m_e^2) - 9g_1^2 \text{Tr}(m_l^2) - 45g_2^2 \text{Tr}(m_l^2) \\ & + g_1^2 \text{Tr}(m_q^2) + 45g_2^2 \text{Tr}(m_q^2) + 80g_3^2 \text{Tr}(m_q^2) - 32g_1^2 \text{Tr}(m_u^2) - 160g_3^2 \text{Tr}(m_u^2) + 90m_{H_d}^2 \text{Tr}(Y_d Y_d^\dagger) \\ & + 30m_{H_d}^2 \text{Tr}(Y_e Y_e^\dagger) - 90m_{H_u}^2 \text{Tr}(Y_u Y_u^\dagger) - 60\text{Tr}(Y_d Y_d^\dagger m_d^{2*}) - 30\text{Tr}(Y_d m_q^{2*} Y_d^\dagger) \\ & \left. - 60\text{Tr}(Y_e Y_e^\dagger m_e^{2*}) + 30\text{Tr}(Y_e m_l^{2*} Y_e^\dagger) + 120\text{Tr}(Y_u Y_u^\dagger m_u^{2*}) - 30\text{Tr}(Y_u m_q^{2*} Y_u^\dagger) \right) \quad (72) \end{aligned}$$

$$\sigma_{2,2} = \frac{1}{2} \left( 3\text{Tr}(m_q^2) + 4m_l^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2 + \text{Tr}(m_l^2) \right) \quad (73)$$

$$\sigma_{2,3} = \frac{1}{2} \left( 2\text{Tr}(m_q^2) + 6m_O^2 + \text{Tr}(m_d^2) + \text{Tr}(m_u^2) \right) \quad (74)$$

$$\begin{aligned} \beta_{m_q^2}^{(1)} = & +2m_{H_d}^2 Y_d^\dagger Y_d + 2m_{H_u}^2 Y_u^\dagger Y_u + m_q^2 Y_d^\dagger Y_d + m_q^2 Y_u^\dagger Y_u + 2Y_d^\dagger m_d^2 Y_d \\ & + Y_d^\dagger Y_d m_q^2 + 2Y_u^\dagger m_u^2 Y_u + Y_u^\dagger Y_u m_q^2 + \frac{1}{\sqrt{15}} g_1 \mathbf{1} \sigma_{1,1} \quad (75) \end{aligned}$$

$$\begin{aligned} \beta_{m_q^2}^{(2)} = & +\frac{8}{5}g_1^2 m_{H_u}^2 Y_u^\dagger Y_u - 4m_{H_u}^2 |\lambda_U|^2 Y_u^\dagger Y_u - 2m_{R_u}^2 |\lambda_U|^2 Y_u^\dagger Y_u \\ & - 2m_S^2 |\lambda_U|^2 Y_u^\dagger Y_u - 6m_{H_u}^2 |\Lambda_U|^2 Y_u^\dagger Y_u - 3m_{R_u}^2 |\Lambda_U|^2 Y_u^\dagger Y_u \\ & - 3m_l^2 |\Lambda_U|^2 Y_u^\dagger Y_u + \frac{2}{5}g_1^2 m_q^2 Y_d^\dagger Y_d - |\lambda_D|^2 m_q^2 Y_d^\dagger Y_d \\ & - \frac{3}{2}|\Lambda_D|^2 m_q^2 Y_d^\dagger Y_d + \frac{4}{5}g_1^2 m_q^2 Y_u^\dagger Y_u - |\lambda_U|^2 m_q^2 Y_u^\dagger Y_u \\ & - \frac{3}{2}|\Lambda_U|^2 m_q^2 Y_u^\dagger Y_u + \frac{4}{5}g_1^2 Y_d^\dagger m_d^2 Y_d - 2|\lambda_D|^2 Y_d^\dagger m_d^2 Y_d \\ & - 3|\Lambda_D|^2 Y_d^\dagger m_d^2 Y_d + \frac{2}{5}g_1^2 Y_d^\dagger Y_d m_q^2 - |\lambda_D|^2 Y_d^\dagger Y_d m_q^2 \end{aligned}$$

$$\begin{aligned}
& -\frac{3}{2}|\Lambda_D|^2 Y_d^\dagger Y_d m_q^2 + \frac{8}{5}g_1^2 Y_u^\dagger m_u^2 Y_u - 2|\lambda_U|^2 Y_u^\dagger m_u^2 Y_u \\
& -3|\Lambda_U|^2 Y_u^\dagger m_u^2 Y_u + \frac{4}{5}g_1^2 Y_u^\dagger Y_u m_q^2 - |\lambda_U|^2 Y_u^\dagger Y_u m_q^2 \\
& -\frac{3}{2}|\Lambda_U|^2 Y_u^\dagger Y_u m_q^2 - 8m_{H_d}^2 Y_d^\dagger Y_d Y_d^\dagger Y_d - 8m_{H_u}^2 Y_u^\dagger Y_u Y_u^\dagger Y_u - 2m_q^2 Y_d^\dagger Y_d Y_d^\dagger Y_d \\
& -2m_q^2 Y_u^\dagger Y_u Y_u^\dagger Y_u - 4Y_d^\dagger m_d^2 Y_d Y_d^\dagger Y_d - 4Y_d^\dagger Y_d m_q^2 Y_d^\dagger Y_d - 4Y_d^\dagger Y_d Y_d^\dagger m_d^2 Y_d \\
& -2Y_d^\dagger Y_d Y_d^\dagger Y_d m_q^2 - 4Y_u^\dagger m_u^2 Y_u Y_u^\dagger Y_u - 4Y_u^\dagger Y_u m_q^2 Y_u^\dagger Y_u - 4Y_u^\dagger Y_u Y_u^\dagger m_u^2 Y_u \\
& -2Y_u^\dagger Y_u Y_u^\dagger Y_u m_q^2 + \frac{2}{15}\mathbf{1}\left(45g_2^4\sigma_{2,2} + 80g_3^4\sigma_{2,3} + g_1\left(2\sqrt{15}\sigma_{3,1} + g_1\sigma_{2,11}\right)\right) \\
& -3m_q^2 Y_d^\dagger Y_d \text{Tr}\left(Y_d Y_d^\dagger\right) - 6Y_d^\dagger m_d^2 Y_d \text{Tr}\left(Y_d Y_d^\dagger\right) - 3Y_d^\dagger Y_d m_q^2 \text{Tr}\left(Y_d Y_d^\dagger\right) \\
& -m_q^2 Y_d^\dagger Y_d \text{Tr}\left(Y_e Y_e^\dagger\right) - 2Y_d^\dagger m_d^2 Y_d \text{Tr}\left(Y_e Y_e^\dagger\right) - Y_d^\dagger Y_d m_q^2 \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& -12m_{H_u}^2 Y_u^\dagger Y_u \text{Tr}\left(Y_u Y_u^\dagger\right) - 3m_q^2 Y_u^\dagger Y_u \text{Tr}\left(Y_u Y_u^\dagger\right) - 6Y_u^\dagger m_u^2 Y_u \text{Tr}\left(Y_u Y_u^\dagger\right) \\
& -3Y_u^\dagger Y_u m_q^2 \text{Tr}\left(Y_u Y_u^\dagger\right) \\
& + Y_d^\dagger Y_d \left(\frac{4}{5}g_1^2 m_{H_d}^2 - 2\left(2m_{H_d}^2 + m_{R_d}^2 + m_S^2\right)|\lambda_D|^2 - 3\left(2m_{H_d}^2 + m_{R_d}^2 + m_t^2\right)|\Lambda_D|^2 - 12m_{H_d}^2 \text{Tr}\left(Y_d Y_d^\dagger\right)\right) \\
& -4m_{H_d}^2 \text{Tr}\left(Y_e Y_e^\dagger\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) \\
& -6Y_u^\dagger Y_u \text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) - 6Y_u^\dagger Y_u \text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right)
\end{aligned} \tag{76}$$

$$\beta_{m_l^2}^{(1)} = 2m_{H_d}^2 Y_e^\dagger Y_e + 2Y_e^\dagger m_e^2 Y_e - \sqrt{\frac{3}{5}}g_1 \mathbf{1}\sigma_{1,1} + m_l^2 Y_e^\dagger Y_e + Y_e^\dagger Y_e m_l^2 \tag{77}$$

$$\begin{aligned}
\beta_{m_l^2}^{(2)} & = +\frac{6}{5}g_1^2 m_l^2 Y_e^\dagger Y_e - |\lambda_D|^2 m_l^2 Y_e^\dagger Y_e - \frac{3}{2}|\Lambda_D|^2 m_l^2 Y_e^\dagger Y_e + \frac{12}{5}g_1^2 Y_e^\dagger m_e^2 Y_e \\
& -2|\lambda_D|^2 Y_e^\dagger m_e^2 Y_e - 3|\Lambda_D|^2 Y_e^\dagger m_e^2 Y_e + \frac{6}{5}g_1^2 Y_e^\dagger Y_e m_l^2 \\
& -|\lambda_D|^2 Y_e^\dagger Y_e m_l^2 - \frac{3}{2}|\Lambda_D|^2 Y_e^\dagger Y_e m_l^2 - 8m_{H_d}^2 Y_e^\dagger Y_e Y_e^\dagger Y_e - 2m_l^2 Y_e^\dagger Y_e Y_e^\dagger Y_e \\
& -4Y_e^\dagger m_e^2 Y_e Y_e^\dagger Y_e - 4Y_e^\dagger Y_e m_l^2 Y_e^\dagger Y_e - 4Y_e^\dagger Y_e Y_e^\dagger m_e^2 Y_e - 2Y_e^\dagger Y_e Y_e^\dagger Y_e m_l^2 \\
& + \mathbf{1}\left(6g_2^4\sigma_{2,2} + \frac{2}{5}g_1\left(-2\sqrt{15}\sigma_{3,1} + 3g_1\sigma_{2,11}\right)\right) - 3m_l^2 Y_e^\dagger Y_e \text{Tr}\left(Y_d Y_d^\dagger\right) \\
& -6Y_e^\dagger m_e^2 Y_e \text{Tr}\left(Y_d Y_d^\dagger\right) - 3Y_e^\dagger Y_e m_l^2 \text{Tr}\left(Y_d Y_d^\dagger\right) - m_l^2 Y_e^\dagger Y_e \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& -2Y_e^\dagger m_e^2 Y_e \text{Tr}\left(Y_e Y_e^\dagger\right) - Y_e^\dagger Y_e m_l^2 \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& -\frac{1}{5}Y_e^\dagger Y_e \left(10\left(2m_{H_d}^2 + m_{R_d}^2 + m_S^2\right)|\lambda_D|^2 + 15\left(2m_{H_d}^2 + m_{R_d}^2 + m_t^2\right)|\Lambda_D|^2\right) \\
& + 2\left(-6g_1^2 m_{H_d}^2 + 30m_{H_d}^2 \text{Tr}\left(Y_d Y_d^\dagger\right) + 10m_{H_d}^2 \text{Tr}\left(Y_e Y_e^\dagger\right) + 15\text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) + 5\text{Tr}\left(m_e^2 Y_e Y_e^\dagger\right)\right) \\
& + 5\text{Tr}\left(m_l^2 Y_e^\dagger Y_e\right) + 15\text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right)
\end{aligned} \tag{78}$$

$$\begin{aligned}
\beta_{m_{H_d}^2}^{(1)} &= +2\left(m_{H_d}^2 + m_{R_d}^2 + m_S^2\right)|\lambda_D|^2 + 3\left(m_{H_d}^2 + m_{R_d}^2 + m_t^2\right)|\Lambda_D|^2 - \sqrt{\frac{3}{5}}g_1\sigma_{1,1} + 6m_{H_d}^2\text{Tr}\left(Y_d Y_d^\dagger\right) + 2m_{H_d}^2\text{Tr}\left(Y_e Y_e^\dagger\right) \\
&+ 6\text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) + 2\text{Tr}\left(m_e^2 Y_e Y_e^\dagger\right) + 2\text{Tr}\left(m_l^2 Y_e^\dagger Y_e\right) + 6\text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right)
\end{aligned} \tag{79}$$

$$\begin{aligned}
\beta_{m_{H_d}^2}^{(2)} &= -12\lambda_D^2\left(m_{H_d}^2 + m_{R_d}^2 + m_S^2\right)\lambda_D^{*,2} - 15\Lambda_D^2\left(m_{H_d}^2 + m_{R_d}^2 + m_t^2\right)\Lambda_D^{*,2} \\
&- 2|\lambda_D|^2\left(2\lambda_U\left(2m_S^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2\right)\lambda_U^* + 3\Lambda_D\left(2m_{H_d}^2 + 2m_{R_d}^2 + m_S^2 + m_t^2\right)\Lambda_D^*\right) \\
&+ 3|\Lambda_D|^2\left(4g_2^2\left(m_{H_d}^2 + m_{R_d}^2 + m_t^2\right) - \Lambda_U\left(2m_t^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2\right)\Lambda_U^*\right) \\
&+ \frac{2}{5}\left(15g_2^4\sigma_{2,2} + 3g_1^2\sigma_{2,11} - 2\sqrt{15}g_1\sigma_{3,1} - 2\left(-40g_3^2 + g_1^2\right)m_{H_d}^2\text{Tr}\left(Y_d Y_d^\dagger\right) + 6g_1^2 m_{H_d}^2\text{Tr}\left(Y_e Y_e^\dagger\right)\right) \\
&- 2g_1^2\text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) + 80g_3^2\text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) + 6g_1^2\text{Tr}\left(m_e^2 Y_e Y_e^\dagger\right) + 6g_1^2\text{Tr}\left(m_l^2 Y_e^\dagger Y_e\right) \\
&- 2g_1^2\text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right) + 80g_3^2\text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right) - 90m_{H_d}^2\text{Tr}\left(Y_d Y_d^\dagger Y_d Y_d^\dagger\right) \\
&- 15m_{H_d}^2\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - 15m_{H_u}^2\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - 30m_{H_d}^2\text{Tr}\left(Y_e Y_e^\dagger Y_e Y_e^\dagger\right) \\
&- 90\text{Tr}\left(m_d^2 Y_d Y_d^\dagger Y_d Y_d^\dagger\right) - 15\text{Tr}\left(m_d^2 Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - 30\text{Tr}\left(m_e^2 Y_e Y_e^\dagger Y_e Y_e^\dagger\right) - 30\text{Tr}\left(m_l^2 Y_e^\dagger Y_e Y_e^\dagger Y_e\right) \\
&- 90\text{Tr}\left(m_q^2 Y_d^\dagger Y_d Y_d^\dagger Y_d\right) - 15\text{Tr}\left(m_q^2 Y_d^\dagger Y_d Y_u^\dagger Y_u\right) - 15\text{Tr}\left(m_q^2 Y_u^\dagger Y_u Y_d^\dagger Y_d\right) \\
&- 15\text{Tr}\left(m_u^2 Y_u Y_d^\dagger Y_d Y_u^\dagger\right)
\end{aligned} \tag{80}$$

$$\begin{aligned}
\beta_{m_{H_u}^2}^{(1)} &= +2\left(m_{H_u}^2 + m_{R_u}^2 + m_S^2\right)|\lambda_U|^2 + 3\left(m_{H_u}^2 + m_{R_u}^2 + m_t^2\right)|\Lambda_U|^2 + \sqrt{\frac{3}{5}}g_1\sigma_{1,1} + 6m_{H_u}^2\text{Tr}\left(Y_u Y_u^\dagger\right) + 6\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) \\
&+ 6\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right)
\end{aligned} \tag{81}$$

$$\begin{aligned}
\beta_{m_{H_u}^2}^{(2)} &= +12g_2^2 m_{H_u}^2 |\Lambda_U|^2 + 12g_2^2 m_{R_u}^2 |\Lambda_U|^2 + 12g_2^2 m_t^2 |\Lambda_U|^2 \\
&- 4\lambda_U\left(2m_S^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2\right)|\lambda_D|^2\lambda_U^* - 12\lambda_U^2\left(m_{H_u}^2 + m_{R_u}^2 + m_S^2\right)\lambda_U^{*,2} \\
&- 6\Lambda_U\left(2m_{H_u}^2 + 2m_{R_u}^2 + m_S^2 + m_t^2\right)|\lambda_U|^2\Lambda_U^* - 3\Lambda_U m_{H_d}^2 |\Lambda_D|^2\Lambda_U^* - 3\Lambda_U m_{H_u}^2 |\Lambda_D|^2\Lambda_U^* \\
&- 3\Lambda_U m_{R_d}^2 |\Lambda_D|^2\Lambda_U^* - 3\Lambda_U m_{R_u}^2 |\Lambda_D|^2\Lambda_U^* - 6\Lambda_U m_t^2 |\Lambda_D|^2\Lambda_U^* - 15\Lambda_U^2 m_{H_u}^2 \Lambda_U^{*,2} \\
&- 15\Lambda_U^2 m_{R_u}^2 \Lambda_U^{*,2} - 15\Lambda_U^2 m_t^2 \Lambda_U^{*,2} + 6g_2^4\sigma_{2,2} + \frac{6}{5}g_1^2\sigma_{2,11} + 4\sqrt{\frac{3}{5}}g_1\sigma_{3,1} + \frac{8}{5}g_1^2 m_{H_u}^2\text{Tr}\left(Y_u Y_u^\dagger\right) \\
&+ 32g_3^2 m_{H_u}^2\text{Tr}\left(Y_u Y_u^\dagger\right) + \frac{8}{5}g_1^2\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) + 32g_3^2\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) + \frac{8}{5}g_1^2\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) \\
&+ 32g_3^2\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) - 6m_{H_d}^2\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - 6m_{H_u}^2\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) \\
&- 36m_{H_u}^2\text{Tr}\left(Y_u Y_u^\dagger Y_u Y_u^\dagger\right) - 6\text{Tr}\left(m_d^2 Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - 6\text{Tr}\left(m_q^2 Y_d^\dagger Y_d Y_u^\dagger Y_u\right) \\
&- 6\text{Tr}\left(m_q^2 Y_u^\dagger Y_u Y_d^\dagger Y_d\right) - 36\text{Tr}\left(m_q^2 Y_u^\dagger Y_u Y_u^\dagger Y_u\right) - 6\text{Tr}\left(m_u^2 Y_u Y_d^\dagger Y_d Y_u^\dagger\right) \\
&- 36\text{Tr}\left(m_u^2 Y_u Y_u^\dagger Y_u Y_u^\dagger\right)
\end{aligned} \tag{82}$$

$$\beta_{m_d^2}^{(1)} = 2\left(2m_{H_d}^2 Y_d Y_d^\dagger + 2Y_d m_q^2 Y_d^\dagger + m_d^2 Y_d Y_d^\dagger + Y_d Y_d^\dagger m_d^2\right) + 2\frac{1}{\sqrt{15}}g_1 \mathbf{1}\sigma_{1,1} \quad (83)$$

$$\begin{aligned} \beta_{m_d^2}^{(2)} = & +\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 - 2|\lambda_D|^2 m_d^2 Y_d Y_d^\dagger - 3|\Lambda_D|^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 - 4|\lambda_D|^2 Y_d m_q^2 Y_d^\dagger - 6|\Lambda_D|^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 - 2|\lambda_D|^2 Y_d Y_d^\dagger m_d^2 - 3|\Lambda_D|^2 Y_d Y_d^\dagger m_d^2 \\ & - 8m_{H_d}^2 Y_d Y_d^\dagger Y_d Y_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 \\ & - 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{8}{15}\mathbf{1}\left(20g_3^4 \sigma_{2,3} + g_1\left(g_1 \sigma_{2,11} + \sqrt{15}\sigma_{3,1}\right)\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) \\ & - 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) \\ & - \frac{2}{5}Y_d Y_d^\dagger \left(-2g_1^2 m_{H_d}^2 - 30g_2^2 m_{H_d}^2 + 10\left(2m_{H_d}^2 + m_{R_d}^2 + m_S^2\right)|\lambda_D|^2 + 15\left(2m_{H_d}^2 + m_{R_d}^2 + m_t^2\right)|\Lambda_D|^2 + 60m_{H_d}^2 \text{Tr}\left(Y_d Y_d^\dagger\right)\right. \\ & \left.+ 20m_{H_d}^2 \text{Tr}\left(Y_e Y_e^\dagger\right) + 30\text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) + 10\text{Tr}\left(m_e^2 Y_e Y_e^\dagger\right) + 10\text{Tr}\left(m_l^2 Y_e^\dagger Y_e\right) + 30\text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right)\right) \quad (84) \end{aligned}$$

$$\beta_{m_u^2}^{(1)} = 2\left(2m_{H_u}^2 Y_u Y_u^\dagger + 2Y_u m_q^2 Y_u^\dagger + m_u^2 Y_u Y_u^\dagger + Y_u Y_u^\dagger m_u^2\right) - 4\frac{1}{\sqrt{15}}g_1 \mathbf{1}\sigma_{1,1} \quad (85)$$

$$\begin{aligned} \beta_{m_u^2}^{(2)} = & -\frac{2}{5}g_1^2 m_u^2 Y_u Y_u^\dagger + 6g_2^2 m_u^2 Y_u Y_u^\dagger - 2|\lambda_U|^2 m_u^2 Y_u Y_u^\dagger - 3|\Lambda_U|^2 m_u^2 Y_u Y_u^\dagger \\ & -\frac{4}{5}g_1^2 Y_u m_q^2 Y_u^\dagger + 12g_2^2 Y_u m_q^2 Y_u^\dagger - 4|\lambda_U|^2 Y_u m_q^2 Y_u^\dagger - 6|\Lambda_U|^2 Y_u m_q^2 Y_u^\dagger \\ & -\frac{2}{5}g_1^2 Y_u Y_u^\dagger m_u^2 + 6g_2^2 Y_u Y_u^\dagger m_u^2 - 2|\lambda_U|^2 Y_u Y_u^\dagger m_u^2 - 3|\Lambda_U|^2 Y_u Y_u^\dagger m_u^2 \\ & - 4m_{H_d}^2 Y_u Y_d^\dagger Y_d Y_u^\dagger - 4m_{H_u}^2 Y_u Y_d^\dagger Y_d Y_u^\dagger - 8m_{H_u}^2 Y_u Y_u^\dagger Y_u Y_u^\dagger \\ & - 2m_u^2 Y_u Y_d^\dagger Y_d Y_u^\dagger - 2m_u^2 Y_u Y_u^\dagger Y_u Y_u^\dagger - 4Y_u m_q^2 Y_d^\dagger Y_d Y_u^\dagger - 4Y_u m_q^2 Y_u^\dagger Y_u Y_u^\dagger \\ & - 4Y_u Y_d^\dagger m_d^2 Y_d Y_u^\dagger - 4Y_u Y_d^\dagger Y_d m_q^2 Y_u^\dagger - 2Y_u Y_d^\dagger Y_d Y_u^\dagger m_u^2 \\ & - 4Y_u Y_u^\dagger m_u^2 Y_u Y_u^\dagger - 4Y_u Y_u^\dagger Y_u m_q^2 Y_u^\dagger - 2Y_u Y_u^\dagger Y_u Y_u^\dagger m_u^2 \\ & + \frac{16}{15}\mathbf{1}\left(10g_3^4 \sigma_{2,3} + g_1\left(2g_1 \sigma_{2,11} - \sqrt{15}\sigma_{3,1}\right)\right) - 6m_u^2 Y_u Y_u^\dagger \text{Tr}\left(Y_u Y_u^\dagger\right) \\ & - 12Y_u m_q^2 Y_u^\dagger \text{Tr}\left(Y_u Y_u^\dagger\right) - 6Y_u Y_u^\dagger m_u^2 \text{Tr}\left(Y_u Y_u^\dagger\right) \\ & - \frac{2}{5}Y_u Y_u^\dagger \left(2g_1^2 m_{H_u}^2 - 30g_2^2 m_{H_u}^2 + 10\left(2m_{H_u}^2 + m_{R_u}^2 + m_S^2\right)|\lambda_U|^2 + 15\left(2m_{H_u}^2 + m_{R_u}^2 + m_t^2\right)|\Lambda_U|^2 + 60m_{H_u}^2 \text{Tr}\left(Y_u Y_u^\dagger\right)\right. \\ & \left.+ 30\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) + 30\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right)\right) \quad (86) \end{aligned}$$

$$\beta_{m_e^2}^{(1)} = 2\left(2m_{H_d}^2 Y_e Y_e^\dagger + 2Y_e m_l^2 Y_e^\dagger + m_e^2 Y_e Y_e^\dagger + Y_e Y_e^\dagger m_e^2\right) + 2\sqrt{\frac{3}{5}}g_1 \mathbf{1}\sigma_{1,1} \quad (87)$$

$$\begin{aligned}
\beta_{m_e^2}^{(2)} = & -\frac{6}{5}g_1^2m_e^2Y_eY_e^\dagger + 6g_2^2m_e^2Y_eY_e^\dagger - 2|\lambda_D|^2m_e^2Y_eY_e^\dagger - 3|\Lambda_D|^2m_e^2Y_eY_e^\dagger \\
& - \frac{12}{5}g_1^2Y_em_l^2Y_e^\dagger + 12g_2^2Y_em_l^2Y_e^\dagger - 4|\lambda_D|^2Y_em_l^2Y_e^\dagger - 6|\Lambda_D|^2Y_em_l^2Y_e^\dagger \\
& - \frac{6}{5}g_1^2Y_eY_e^\dagger m_e^2 + 6g_2^2Y_eY_e^\dagger m_e^2 - 2|\lambda_D|^2Y_eY_e^\dagger m_e^2 - 3|\Lambda_D|^2Y_eY_e^\dagger m_e^2 \\
& - 8m_{H_d}^2Y_eY_e^\dagger Y_eY_e^\dagger - 2m_e^2Y_eY_e^\dagger Y_eY_e^\dagger - 4Y_em_l^2Y_e^\dagger Y_eY_e^\dagger - 4Y_eY_e^\dagger m_e^2Y_eY_e^\dagger \\
& - 4Y_eY_e^\dagger Y_em_l^2Y_e^\dagger - 2Y_eY_e^\dagger Y_eY_e^\dagger m_e^2 + \frac{8}{5}g_1\mathbf{1}\left(3g_1\sigma_{2,11} + \sqrt{15}\sigma_{3,1}\right) \\
& - 6m_e^2Y_eY_e^\dagger \text{Tr}\left(Y_dY_d^\dagger\right) - 12Y_em_l^2Y_e^\dagger \text{Tr}\left(Y_dY_d^\dagger\right) - 6Y_eY_e^\dagger m_e^2 \text{Tr}\left(Y_dY_d^\dagger\right) \\
& - 2m_e^2Y_eY_e^\dagger \text{Tr}\left(Y_eY_e^\dagger\right) - 4Y_em_l^2Y_e^\dagger \text{Tr}\left(Y_eY_e^\dagger\right) - 2Y_eY_e^\dagger m_e^2 \text{Tr}\left(Y_eY_e^\dagger\right) \\
& - \frac{2}{5}Y_eY_e^\dagger \left(10\left(2m_{H_d}^2 + m_{R_d}^2 + m_S^2\right)|\lambda_D|^2 + 15\left(2m_{H_d}^2 + m_{R_d}^2 + m_t^2\right)|\Lambda_D|^2\right. \\
& \left. + 2\left(3g_1^2m_{H_d}^2 - 15g_2^2m_{H_d}^2 + 30m_{H_d}^2 \text{Tr}\left(Y_dY_d^\dagger\right) + 10m_{H_d}^2 \text{Tr}\left(Y_eY_e^\dagger\right) + 15\text{Tr}\left(m_d^2Y_dY_d^\dagger\right)\right.\right. \\
& \left. + 5\text{Tr}\left(m_e^2Y_eY_e^\dagger\right) + 5\text{Tr}\left(m_l^2Y_e^\dagger Y_e\right) + 15\text{Tr}\left(m_q^2Y_d^\dagger Y_d\right)\right) \tag{88}
\end{aligned}$$

$$\beta_{m_S^2}^{(1)} = 4\left(\left(m_{H_d}^2 + m_{R_d}^2 + m_S^2\right)|\lambda_D|^2 + \left(m_{H_u}^2 + m_{R_u}^2 + m_S^2\right)|\lambda_U|^2\right) \tag{89}$$

$$\begin{aligned}
\beta_{m_S^2}^{(2)} = & -\frac{4}{5}\left(20\lambda_D^2\left(m_{H_d}^2 + m_{R_d}^2 + m_S^2\right)\lambda_D^{*,2}\right. \\
& + |\lambda_D|^2\left(-3g_1^2m_{H_d}^2 - 15g_2^2m_{H_d}^2 - 3g_1^2m_{R_d}^2 - 15g_2^2m_{R_d}^2 - 3g_1^2m_S^2 - 15g_2^2m_S^2\right. \\
& + 15\Lambda_D\left(2m_{H_d}^2 + 2m_{R_d}^2 + m_S^2 + m_t^2\right)\Lambda_D^* + 15\left(2m_{H_d}^2 + m_{R_d}^2 + m_S^2\right)\text{Tr}\left(Y_dY_d^\dagger\right) + 10m_{H_d}^2 \text{Tr}\left(Y_eY_e^\dagger\right) \\
& + 5m_{R_d}^2 \text{Tr}\left(Y_eY_e^\dagger\right) + 5m_S^2 \text{Tr}\left(Y_eY_e^\dagger\right) + 15\text{Tr}\left(m_d^2Y_dY_d^\dagger\right) + 5\text{Tr}\left(m_e^2Y_eY_e^\dagger\right) + 5\text{Tr}\left(m_l^2Y_e^\dagger Y_e\right) \\
& \left. + 15\text{Tr}\left(m_q^2Y_d^\dagger Y_d\right)\right) \\
& + |\lambda_U|^2\left(20\lambda_U\left(m_{H_u}^2 + m_{R_u}^2 + m_S^2\right)\lambda_U^*\right. \\
& - 3\left(g_1^2m_{H_u}^2 + 5g_2^2m_{H_u}^2 + g_1^2m_{R_u}^2 + 5g_2^2m_{R_u}^2 + g_1^2m_S^2 + 5g_2^2m_S^2 - 5\Lambda_U\left(2m_{H_u}^2 + 2m_{R_u}^2 + m_S^2 + m_t^2\right)\Lambda_U^*\right. \\
& \left. - 5\left(2m_{H_u}^2 + m_{R_u}^2 + m_S^2\right)\text{Tr}\left(Y_uY_u^\dagger\right) - 5\text{Tr}\left(m_q^2Y_u^\dagger Y_u\right) - 5\text{Tr}\left(m_u^2Y_uY_u^\dagger\right)\right) \tag{90}
\end{aligned}$$

$$\beta_{m_t^2}^{(1)} = 2\left(\left(m_{H_d}^2 + m_{R_d}^2 + m_t^2\right)|\Lambda_D|^2 + \left(m_{H_u}^2 + m_{R_u}^2 + m_t^2\right)|\Lambda_U|^2\right) \tag{91}$$

$$\begin{aligned}
\beta_{m_t^2}^{(2)} = & -\frac{2}{5}\left(30\Lambda_D^2\left(m_{H_d}^2 + m_{R_d}^2 + m_t^2\right)\Lambda_D^{*,2} + 30\Lambda_U^2\left(m_{H_u}^2 + m_{R_u}^2 + m_t^2\right)\Lambda_U^{*,2} - 40g_2^4\sigma_{2,2}\right. \\
& + |\Lambda_D|^2\left(-3g_1^2m_{H_d}^2 + 5g_2^2m_{H_d}^2 - 3g_1^2m_{R_d}^2 + 5g_2^2m_{R_d}^2 - 3g_1^2m_t^2 + 5g_2^2m_t^2\right. \\
& + 10\lambda_D\left(2m_{H_d}^2 + 2m_{R_d}^2 + m_S^2 + m_t^2\right)\lambda_D^* + 15\left(2m_{H_d}^2 + m_{R_d}^2 + m_t^2\right)\text{Tr}\left(Y_dY_d^\dagger\right) + 10m_{H_d}^2 \text{Tr}\left(Y_eY_e^\dagger\right) \\
& \left. + 5m_{R_d}^2 \text{Tr}\left(Y_eY_e^\dagger\right) + 5m_t^2 \text{Tr}\left(Y_eY_e^\dagger\right) + 15\text{Tr}\left(m_d^2Y_dY_d^\dagger\right) + 5\text{Tr}\left(m_e^2Y_eY_e^\dagger\right) + 5\text{Tr}\left(m_l^2Y_e^\dagger Y_e\right)\right)
\end{aligned}$$



$$\begin{aligned}
& + 15\text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right) \\
& + |\Lambda_U|^2\left(-3g_1^2 m_{H_u}^2 + 5g_2^2 m_{H_u}^2 - 3g_1^2 m_{R_u}^2 + 5g_2^2 m_{R_u}^2 - 3g_1^2 m_t^2 + 5g_2^2 m_t^2\right. \\
& + 10\lambda_U\left(2m_{H_u}^2 + 2m_{R_u}^2 + m_S^2 + m_t^2\right)\lambda_U^* + 15\left(2m_{H_u}^2 + m_{R_u}^2 + m_t^2\right)\text{Tr}\left(Y_u Y_u^\dagger\right) + 15\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) \\
& \left. + 15\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right)\right) \tag{92}
\end{aligned}$$

$$\beta_{m_O^2}^{(1)} = 0 \tag{93}$$

$$\beta_{m_O^2}^{(2)} = 24g_3^4 \sigma_{2,3} \tag{94}$$

$$\beta_{m_{R_d}^2}^{(1)} = 2\left(m_{H_d}^2 + m_{R_d}^2 + m_S^2\right)|\lambda_D|^2 + 3\left(m_{H_d}^2 + m_{R_d}^2 + m_t^2\right)|\Lambda_D|^2 + \sqrt{\frac{3}{5}}g_1\sigma_{1,1} \tag{95}$$

$$\begin{aligned}
\beta_{m_{R_d}^2}^{(2)} = & -12\lambda_D^2\left(m_{H_d}^2 + m_{R_d}^2 + m_S^2\right)\lambda_D^{*,2} - 15\Lambda_D^2\left(m_{H_d}^2 + m_{R_d}^2 + m_t^2\right)\Lambda_D^{*,2} + 6g_2^4\sigma_{2,2} + \frac{6}{5}g_1^2\sigma_{2,11} + 4\sqrt{\frac{3}{5}}g_1\sigma_{3,1} \\
& + 3|\Lambda_D|^2\left(4g_2^2 m_{H_d}^2 + 4g_2^2 m_{R_d}^2 + 4g_2^2 m_t^2 - \Lambda_U\left(2m_t^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2\right)\Lambda_U^* \right. \\
& - 3\left(2m_{H_d}^2 + m_{R_d}^2 + m_t^2\right)\text{Tr}\left(Y_d Y_d^\dagger\right) - 2m_{H_d}^2\text{Tr}\left(Y_e Y_e^\dagger\right) - m_{R_d}^2\text{Tr}\left(Y_e Y_e^\dagger\right) - m_t^2\text{Tr}\left(Y_e Y_e^\dagger\right) \\
& - 3\text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) - \text{Tr}\left(m_e^2 Y_e Y_e^\dagger\right) - \text{Tr}\left(m_t^2 Y_e^\dagger Y_e\right) - 3\text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right) \\
& - 2|\lambda_D|^2\left(2\lambda_U\left(2m_S^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2\right)\lambda_U^* + 3\Lambda_D\left(2m_{H_d}^2 + 2m_{R_d}^2 + m_S^2 + m_t^2\right)\Lambda_D^* + 6m_{H_d}^2\text{Tr}\left(Y_d Y_d^\dagger\right) \right. \\
& + 3m_{R_d}^2\text{Tr}\left(Y_d Y_d^\dagger\right) + 3m_S^2\text{Tr}\left(Y_d Y_d^\dagger\right) + 2m_{H_d}^2\text{Tr}\left(Y_e Y_e^\dagger\right) + m_{R_d}^2\text{Tr}\left(Y_e Y_e^\dagger\right) + m_S^2\text{Tr}\left(Y_e Y_e^\dagger\right) \\
& \left. + 3\text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) + \text{Tr}\left(m_e^2 Y_e Y_e^\dagger\right) + \text{Tr}\left(m_t^2 Y_e^\dagger Y_e\right) + 3\text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right)\right) \tag{96}
\end{aligned}$$

$$\beta_{m_{R_u}^2}^{(1)} = 2\left(m_{H_u}^2 + m_{R_u}^2 + m_S^2\right)|\lambda_U|^2 + 3\left(m_{H_u}^2 + m_{R_u}^2 + m_t^2\right)|\Lambda_U|^2 - \sqrt{\frac{3}{5}}g_1\sigma_{1,1} \tag{97}$$

$$\begin{aligned}
\beta_{m_{R_u}^2}^{(2)} = & +12g_2^2 m_{H_u}^2 |\Lambda_U|^2 + 12g_2^2 m_{R_u}^2 |\Lambda_U|^2 + 12g_2^2 m_t^2 |\Lambda_U|^2 \\
& - 4\lambda_U\left(2m_S^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2\right)|\lambda_D|^2\lambda_U^* - 12\lambda_U^2\left(m_{H_u}^2 + m_{R_u}^2 + m_S^2\right)\lambda_U^{*,2} - 3\Lambda_U m_{H_d}^2 |\Lambda_D|^2 \Lambda_U^* \\
& - 3\Lambda_U m_{H_u}^2 |\Lambda_D|^2 \Lambda_U^* - 3\Lambda_U m_{R_d}^2 |\Lambda_D|^2 \Lambda_U^* - 3\Lambda_U m_{R_u}^2 |\Lambda_D|^2 \Lambda_U^* - 6\Lambda_U m_t^2 |\Lambda_D|^2 \Lambda_U^*
\end{aligned}$$

$$\begin{aligned}
& - 15\Lambda_U^2 m_{H_u}^2 \Lambda_U^{*,2} - 15\Lambda_U^2 m_{R_u}^2 \Lambda_U^{*,2} - 15\Lambda_U^2 m_t^2 \Lambda_U^{*,2} + 6g_2^4\sigma_{2,2} + \frac{6}{5}g_1^2\sigma_{2,11} - 4\sqrt{\frac{3}{5}}g_1\sigma_{3,1} \\
& - 18m_{H_u}^2 |\Lambda_U|^2 \text{Tr}\left(Y_u Y_u^\dagger\right) - 9m_{R_u}^2 |\Lambda_U|^2 \text{Tr}\left(Y_u Y_u^\dagger\right) - 9m_t^2 |\Lambda_U|^2 \text{Tr}\left(Y_u Y_u^\dagger\right) \\
& - 9|\Lambda_U|^2 \text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) - 9|\Lambda_U|^2 \text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) \\
& - 6|\lambda_U|^2\left(\left(2m_{H_u}^2 + m_{R_u}^2 + m_S^2\right)\text{Tr}\left(Y_u Y_u^\dagger\right) + \Lambda_U\left(2m_{H_u}^2 + 2m_{R_u}^2 + m_S^2 + m_t^2\right)\Lambda_U^* + \text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) + \text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right)\right) \tag{98}
\end{aligned}$$

### 3.8 Vacuum expectation values

$$\beta_{v_d}^{(1)} = \frac{1}{20}v_d \left( 15g_2^2 + 15g_2^2\text{Xi} - 20|\lambda_D|^2 - 20\text{Tr}(Y_e Y_e^\dagger) - 30|\Lambda_D|^2 + 3g_1^2 + 3g_1^2\text{Xi} - 60\text{Tr}(Y_d Y_d^\dagger) \right) \quad (99)$$

$$\begin{aligned} \beta_{v_d}^{(2)} = & \frac{1}{400}v_d \left( -450g_1^4 - 180g_1^2g_2^2 - 2100g_2^4 - 9g_1^4\text{Xi} - 90g_1^2g_2^2\text{Xi} + 875g_2^4\text{Xi} + 9g_1^4\text{Xi}^2 + 90g_1^2g_2^2\text{Xi}^2 \right. \\ & - 225g_2^4\text{Xi}^2 + 1200\lambda_D^2\lambda_D^{*,2} + 1500\Lambda_D^2\Lambda_D^{*,2} - 40|\lambda_D|^2 \left( 15g_2^2\text{Xi} - 20\lambda_U\lambda_U^* - 30\Lambda_D\Lambda_D^* + 3g_1^2\text{Xi} \right) \\ & - 60|\Lambda_D|^2 \left( -10\Lambda_U\Lambda_U^* + 3g_1^2\text{Xi} + 5g_2^2(3\text{Xi} + 8) \right) + 160g_1^2\text{Tr}(Y_d Y_d^\dagger) - 6400g_3^2\text{Tr}(Y_d Y_d^\dagger) \\ & - 360g_1^2\text{Xi}\text{Tr}(Y_d Y_d^\dagger) - 1800g_2^2\text{Xi}\text{Tr}(Y_d Y_d^\dagger) - 480g_1^2\text{Tr}(Y_e Y_e^\dagger) - 120g_1^2\text{Xi}\text{Tr}(Y_e Y_e^\dagger) \\ & \left. - 600g_2^2\text{Xi}\text{Tr}(Y_e Y_e^\dagger) + 3600\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) + 1200\text{Tr}(Y_d Y_d^\dagger Y_u Y_u^\dagger) + 1200\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \right) \quad (100) \end{aligned}$$

$$\beta_{v_u}^{(1)} = \frac{1}{20}v_u \left( -20|\lambda_U|^2 + 3 \left( -10|\Lambda_U|^2 - 20\text{Tr}(Y_u Y_u^\dagger) + (5g_2^2 + g_1^2)(1 + \text{Xi}) \right) \right) \quad (101)$$

$$\begin{aligned} \beta_{v_u}^{(2)} = & \frac{1}{400}v_u \left( -450g_1^4 - 180g_1^2g_2^2 - 2100g_2^4 - 9g_1^4\text{Xi} - 90g_1^2g_2^2\text{Xi} + 875g_2^4\text{Xi} + 9g_1^4\text{Xi}^2 + 90g_1^2g_2^2\text{Xi}^2 \right. \\ & - 225g_2^4\text{Xi}^2 + 1200\lambda_U^2\lambda_U^{*,2} - 60|\Lambda_U|^2 \left( -10\Lambda_D\Lambda_D^* + 3g_1^2\text{Xi} + 5g_2^2(3\text{Xi} + 8) \right) + 1500\Lambda_U^2\Lambda_U^{*,2} \\ & - 40|\lambda_U|^2 \left( 15g_2^2\text{Xi} - 20\lambda_D\lambda_D^* - 30\Lambda_U\Lambda_U^* + 3g_1^2\text{Xi} \right) - 320g_1^2\text{Tr}(Y_u Y_u^\dagger) - 6400g_3^2\text{Tr}(Y_u Y_u^\dagger) \\ & \left. - 360g_1^2\text{Xi}\text{Tr}(Y_u Y_u^\dagger) - 1800g_2^2\text{Xi}\text{Tr}(Y_u Y_u^\dagger) + 1200\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) + 3600\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) \right) \quad (102) \end{aligned}$$

$$\beta_{v_T}^{(1)} = v_T \left( 2g_2^2(1 + \text{Xi}) - |\Lambda_D|^2 - |\Lambda_U|^2 \right) \quad (103)$$

$$\begin{aligned} \beta_{v_T}^{(2)} = & \frac{1}{15}v_T \left( 5g_2^4(10\text{Xi} + 3\text{Xi}^2 - 57) + 45\Lambda_D^2\Lambda_D^{*,2} + 45\Lambda_U^2\Lambda_U^{*,2} \right. \\ & + 3|\Lambda_D|^2 \left( 10\lambda_D\lambda_D^* + 15\text{Tr}(Y_d Y_d^\dagger) - 20g_2^2\text{Xi} - 3g_1^2 + 5g_2^2 + 5\text{Tr}(Y_e Y_e^\dagger) \right) \\ & \left. + 3|\Lambda_U|^2 \left( 10\lambda_U\lambda_U^* + 15\text{Tr}(Y_u Y_u^\dagger) - 20g_2^2\text{Xi} - 3g_1^2 + 5g_2^2 \right) \right) \quad (104) \end{aligned}$$

$$\beta_{v_s}^{(1)} = -2v_s \left( |\lambda_D|^2 + |\lambda_U|^2 \right) \quad (105)$$

$$\begin{aligned} \beta_{v_s}^{(2)} = & \frac{2}{5}v_s \left( 10\lambda_D^2\lambda_D^{*,2} + |\lambda_D|^2 \left( -15g_2^2 + 15\Lambda_D\Lambda_D^* + 15\text{Tr}(Y_d Y_d^\dagger) - 3g_1^2 + 5\text{Tr}(Y_e Y_e^\dagger) \right) \right. \\ & \left. + |\lambda_U|^2 \left( 10\lambda_U\lambda_U^* - 3(5g_2^2 - 5\Lambda_U\Lambda_U^* - 5\text{Tr}(Y_u Y_u^\dagger) + g_1^2) \right) \right) \quad (106) \end{aligned}$$

## 4 Field Rotations

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

$$\begin{pmatrix} B_\rho \\ W_{3\rho} \end{pmatrix} = Z^{\gamma Z} \begin{pmatrix} \gamma_\rho \\ Z_\rho \end{pmatrix} \quad (107)$$

$$\begin{pmatrix} W_{1\rho} \\ W_{2\rho} \end{pmatrix} = Z^W \begin{pmatrix} W_\rho^- \\ W_\rho^- \end{pmatrix} \quad (108)$$

$$\begin{pmatrix} \lambda_{\tilde{W},1} \\ \lambda_{\tilde{W},2} \\ \lambda_{\tilde{W},3} \end{pmatrix} = Z^{\tilde{W}} \begin{pmatrix} \tilde{W}^- \\ \tilde{W}^+ \\ \tilde{W}^0 \end{pmatrix} \quad (109)$$

$$(110)$$

The mixing matrices are parametrized by

$$Z^{\gamma Z} = \begin{pmatrix} \cos \Theta_W & -\sin \Theta_W \\ \sin \Theta_W & \cos \Theta_W \end{pmatrix} \quad (111)$$

$$Z^W = \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -i\frac{1}{\sqrt{2}} & i\frac{1}{\sqrt{2}} \end{pmatrix} \quad (112)$$

$$Z^{\tilde{W}} = \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ -i\frac{1}{\sqrt{2}} & i\frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{pmatrix} \quad (113)$$

$$(114)$$

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

### 4.2.1 Mass Matrices for Scalars

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

$$m_{\tilde{d}}^2 = \begin{pmatrix} m_{\tilde{d}_L \tilde{d}_L^*} & -\frac{1}{\sqrt{2}} v_u \mu Y_d^\dagger \delta_{\alpha_1 \beta_2} \\ -\frac{1}{\sqrt{2}} v_u Y_d \mu^* \delta_{\alpha_2 \beta_1} & m_{\tilde{d}_R \tilde{d}_R^*} \end{pmatrix} \quad (115)$$

$$\begin{aligned} m_{\tilde{d}_L \tilde{d}_L^*} &= +\frac{1}{2} \delta_{\alpha_1 \beta_1} \left( 2m_q^2 + v_d^2 Y_d^\dagger Y_d \right) \\ &\quad - \frac{1}{24} \mathbf{1}_{\delta_{\alpha_1 \beta_1}} \left( -8g_1 v_s \Re(M_D^B) + g_1^2 \left( -v_u^2 + v_d^2 \right) + g_2 \left( 12v_T M_D^{W,*} + 3 \left( 4M_D^W v_T + g_2 \left( -v_u^2 + v_d^2 \right) \right) \right) \right) \end{aligned} \quad (116)$$

$$m_{\tilde{d}_R \tilde{d}_R^*} = \frac{1}{12} g_1 \mathbf{1}_{\delta_{\alpha_2 \beta_2}} \left( 8v_s \Re(M_D^B) + g_1 \left( -v_d^2 + v_u^2 \right) \right) + \frac{1}{2} \delta_{\alpha_2 \beta_2} \left( 2m_d^2 + v_d^2 Y_d Y_d^\dagger \right) \quad (117)$$

This matrix is diagonalized by  $Z^D$ :

$$Z^D m_{\tilde{d}}^2 Z^{D,\dagger} = m_{2,\tilde{d}}^{dia} \quad (118)$$

with

$$\tilde{d}_{L,i\alpha} = \sum_j Z_{ji}^{D,*} \tilde{d}_{j\alpha}, \quad \tilde{d}_{R,i\alpha} = \sum_j Z_{ji}^{D,*} \tilde{d}_{j\alpha} \quad (119)$$

- **Mass matrix for Sneutrinos**, Basis:  $(\tilde{\nu}_L), (\tilde{\nu}_L^*)$

$$m_{\tilde{\nu}}^2 = \left( \frac{1}{8} \mathbf{1} \left( -8g_1 v_s \Re(M_D^B) + g_1^2 (-v_u^2 + v_d^2) + g_2 (8v_T \Re(M_D^W) + g_2 (-v_u^2 + v_d^2)) \right) + m_l^2 \right) \quad (120)$$

This matrix is diagonalized by  $Z^V$ :

$$Z^V m_{\tilde{\nu}}^2 Z^{V,\dagger} = m_{2,\tilde{\nu}}^{dia} \quad (121)$$

with

$$\tilde{\nu}_{L,i} = \sum_j Z_{ji}^{V,*} \tilde{\nu}_j \quad (122)$$

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

$$m_{\tilde{u}}^2 = \begin{pmatrix} m_{\tilde{u}_L \tilde{u}_L^*} & -\frac{1}{\sqrt{2}} v_d \mu Y_u^\dagger \delta_{\alpha_1 \beta_2} \\ -\frac{1}{\sqrt{2}} v_d Y_u \mu^* \delta_{\alpha_2 \beta_1} & m_{\tilde{u}_R \tilde{u}_R^*} \end{pmatrix} \quad (123)$$

$$\begin{aligned} m_{\tilde{u}_L \tilde{u}_L^*} &= +\frac{1}{2} \delta_{\alpha_1 \beta_1} (2m_q^2 + v_u^2 Y_u^\dagger Y_u) \\ &+ \frac{1}{24} \mathbf{1} \delta_{\alpha_1 \beta_1} \left( 8g_1 v_s \Re(M_D^B) + g_1^2 (-v_d^2 + v_u^2) + g_2 (12v_T M_D^{W,*} + 3(4M_D^W v_T + g_2 (-v_u^2 + v_d^2))) \right) \end{aligned} \quad (124)$$

$$m_{\tilde{u}_R \tilde{u}_R^*} = \frac{1}{2} \delta_{\alpha_2 \beta_2} (2m_u^2 + v_u^2 Y_u Y_u^\dagger) + \frac{1}{6} g_1 \mathbf{1} \delta_{\alpha_2 \beta_2} (-8v_s \Re(M_D^B) + g_1 (-v_u^2 + v_d^2)) \quad (125)$$

This matrix is diagonalized by  $Z^U$ :

$$Z^U m_{\tilde{u}}^2 Z^{U,\dagger} = m_{2,\tilde{u}}^{dia} \quad (126)$$

with

$$\tilde{u}_{L,i\alpha} = \sum_j Z_{ji}^{U,*} \tilde{u}_{j\alpha}, \quad \tilde{u}_{R,i\alpha} = \sum_j Z_{ji}^{U,*} \tilde{u}_{j\alpha} \quad (127)$$

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

$$m_{\tilde{e}}^2 = \begin{pmatrix} m_{\tilde{e}_L \tilde{e}_L^*} & -\frac{1}{\sqrt{2}} v_u \mu Y_e^\dagger \\ -\frac{1}{\sqrt{2}} v_u Y_e \mu^* & m_{\tilde{e}_R \tilde{e}_R^*} \end{pmatrix} \quad (128)$$

$$m_{\tilde{e}_L \tilde{e}_L^*} = \frac{1}{2} v_d^2 Y_e^\dagger Y_e + \frac{1}{8} \mathbf{1} \left( -8g_1 v_s \Re(M_D^B) + g_1^2 (-v_u^2 + v_d^2) + g_2 (-8v_T \Re(M_D^W) + g_2 (-v_d^2 + v_u^2)) \right) + m_l^2 \quad (129)$$

$$m_{\tilde{e}_R \tilde{e}_R^*} = \frac{1}{2} v_d^2 Y_e Y_e^\dagger + \frac{1}{4} g_1 \mathbf{1} (8v_s \Re(M_D^B) + g_1 (-v_d^2 + v_u^2)) + m_e^2 \quad (130)$$

This matrix is diagonalized by  $Z^E$ :

$$Z^E m_{\tilde{e}}^2 Z^{E,\dagger} = m_{2,\tilde{e}}^{dia} \quad (131)$$

with

$$\tilde{e}_{L,i} = \sum_j Z_{ji}^{E,*} \tilde{e}_j, \quad \tilde{e}_{R,i} = \sum_j Z_{ji}^{E,*} \tilde{e}_j \quad (132)$$

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

$$m_h^2 = \begin{pmatrix} m_{\phi_d \phi_d} & m_{\phi_u \phi_d} & m_{\phi_S \phi_d} & m_{\phi_T \phi_d} \\ m_{\phi_d \phi_u} & m_{\phi_u \phi_u} & m_{\phi_S \phi_u} & m_{\phi_T \phi_u} \\ m_{\phi_d \phi_S} & m_{\phi_u \phi_S} & m_{\phi_S \phi_S} & m_{\phi_T \phi_S} \\ m_{\phi_d \phi_T} & m_{\phi_u \phi_T} & m_{\phi_S \phi_T} & m_{\phi_T \phi_T} \end{pmatrix} \quad (133)$$

$$m_{\phi_d \phi_d} = +m_{H_d}^2 + \frac{1}{4} \left( (2\mu_D + \Lambda_D v_T + \sqrt{2}\lambda_D v_s) (2\mu_D^* + v_T \Lambda_D^*) + 4|\mu|^2 + v_s (2(\lambda_D v_s + \sqrt{2}\mu_D) + \sqrt{2}\Lambda_D v_T) \lambda_D^* \right) + \frac{1}{8} \left( -8g_1 v_s \Re(M_D^B) + 8g_2 v_T \Re(M_D^W) + (g_1^2 + g_2^2) (3v_d^2 - v_u^2) \right) \quad (134)$$

$$m_{\phi_d \phi_u} = -\frac{1}{4} (g_1^2 + g_2^2) v_d v_u - \Re(B_\mu) \quad (135)$$

$$m_{\phi_u \phi_u} = +m_{H_u}^2 + \frac{1}{4} \left( - (2\mu_U - \Lambda_U v_T + \sqrt{2}\lambda_U v_s) (-2\mu_U^* + v_T \Lambda_U^*) + 4|\mu|^2 + v_s (2(\lambda_U v_s + \sqrt{2}\mu_U) - \sqrt{2}\Lambda_U v_T) \lambda_U^* \right) + \frac{1}{8} \left( 3(g_1^2 + g_2^2) v_u^2 + 8g_1 v_s \Re(M_D^B) - 8g_2 v_T \Re(M_D^W) + (-g_1^2 - g_2^2) v_d^2 \right) \quad (136)$$

$$m_{\phi_d \phi_S} = \frac{1}{4} v_d \left( (4\lambda_D v_s + \sqrt{2}(2\mu_D + \Lambda_D v_T)) \lambda_D^* + \sqrt{2}\lambda_D (2\mu_D^* + v_T \Lambda_D^*) \right) - g_1 v_d \Re(M_D^B) \quad (137)$$

$$m_{\phi_u \phi_S} = \frac{1}{4} v_u \left( (4\lambda_U v_s + \sqrt{2}(2\mu_U - \Lambda_U v_T)) \lambda_U^* + \sqrt{2}\lambda_U (2\mu_U^* - v_T \Lambda_U^*) \right) + g_1 v_u \Re(M_D^B) \quad (138)$$

$$m_{\phi_S \phi_S} = \frac{1}{2} \left( 8M_D^{B,2} + v_d^2 |\lambda_D|^2 + v_u^2 |\lambda_U|^2 \right) + m_S^2 \quad (139)$$

$$m_{\phi_d \phi_T} = \frac{1}{4} v_d \left( (2(\Lambda_D v_T + \mu_D) + \sqrt{2}\lambda_D v_s) \Lambda_D^* + \Lambda_D (2\mu_D^* + \sqrt{2}v_s \Lambda_D^*) \right) + g_2 v_d \Re(M_D^W) \quad (140)$$

$$m_{\phi_u \phi_T} = -\frac{1}{4} v_u \left( (-2\Lambda_U v_T + 2\mu_U + \sqrt{2}\lambda_U v_s) \Lambda_U^* + \Lambda_U (2\mu_U^* + \sqrt{2}v_s \Lambda_U^*) \right) - g_2 v_u \Re(M_D^W) \quad (141)$$

$$m_{\phi_S \phi_T} = \frac{1}{4} \frac{1}{\sqrt{2}} \left( 2v_d^2 \Re(\Lambda_D \lambda_D^*) - 2v_u^2 \Re(\Lambda_U \lambda_U^*) \right) \quad (142)$$

$$m_{\phi_T \phi_T} = \frac{1}{4} \left( 16M_D^{W,2} + v_d^2 |\Lambda_D|^2 + v_u^2 |\Lambda_U|^2 \right) + m_t^2 \quad (143)$$

This matrix is diagonalized by  $Z^H$ :

$$Z^H m_h^2 Z^{H,\dagger} = m_{2,h}^{dia} \quad (144)$$

with

$$\phi_d = \sum_j Z_{j1}^H h_j, \quad \phi_u = \sum_j Z_{j2}^H h_j, \quad \phi_S = \sum_j Z_{j3}^H h_j \quad (145)$$

$$\phi_T = \sum_j Z_{j4}^H h_j \quad (146)$$

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

$$m_{A^0}^2 = \begin{pmatrix} m_{\sigma_d \sigma_d} & \Re(B_\mu) & 0 & 0 \\ \Re(B_\mu) & m_{\sigma_u \sigma_u} & 0 & 0 \\ 0 & 0 & m_{\sigma_S \sigma_S} & m_{\sigma_T \sigma_S} \\ 0 & 0 & m_{\sigma_S \sigma_T} & m_{\sigma_T \sigma_T} \end{pmatrix} + \xi_Z m^2(Z) \quad (147)$$

$$m_{\sigma_d \sigma_d} = +m_{H_d}^2 + \frac{1}{4} \left( (2\mu_D + \Lambda_D v_T + \sqrt{2}\lambda_D v_s) (2\mu_D^* + v_T \Lambda_D^*) + 4|\mu|^2 + v_s (2(\lambda_D v_s + \sqrt{2}\mu_D) + \sqrt{2}\Lambda_D v_T) \lambda_D^* \right) + \frac{1}{8} \left( -8g_1 v_s \Re(M_D^B) + 8g_2 v_T \Re(M_D^W) + (g_1^2 + g_2^2) (-v_u^2 + v_d^2) \right) \quad (148)$$

$$m_{\sigma_u \sigma_u} = +m_{H_u}^2 + \frac{1}{4} \left( -(2\mu_U - \Lambda_U v_T + \sqrt{2}\lambda_U v_s) (-2\mu_U^* + v_T \Lambda_U^*) + 4|\mu|^2 + v_s (2(\lambda_U v_s + \sqrt{2}\mu_U) - \sqrt{2}\Lambda_U v_T) \lambda_U^* \right) + \frac{1}{8} \left( 8g_1 v_s \Re(M_D^B) - 8g_2 v_T \Re(M_D^W) + (-g_1^2 - g_2^2) v_d^2 + (g_1^2 + g_2^2) v_u^2 \right) \quad (149)$$

$$m_{\sigma_S \sigma_S} = \frac{1}{2} (v_d^2 |\lambda_D|^2 + v_u^2 |\lambda_U|^2) + m_S^2 \quad (150)$$

$$m_{\sigma_S \sigma_T} = \frac{1}{4} \frac{1}{\sqrt{2}} (2v_d^2 \Re(\Lambda_D \lambda_D^*) - 2v_u^2 \Re(\Lambda_U \lambda_U^*)) \quad (151)$$

$$m_{\sigma_T \sigma_T} = \frac{1}{4} (v_d^2 |\Lambda_D|^2 + v_u^2 |\Lambda_U|^2) + m_t^2 \quad (152)$$

Gauge fixing contributions:

$$m^2(\xi_Z) = \begin{pmatrix} m_{\sigma_d \sigma_d} & m_{\sigma_u \sigma_d} & 0 & 0 \\ m_{\sigma_d \sigma_u} & m_{\sigma_u \sigma_u} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \quad (153)$$

$$m_{\sigma_d \sigma_d} = \frac{1}{4} v_d^2 (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 \quad (154)$$

$$m_{\sigma_d \sigma_u} = -\frac{1}{4} v_d v_u (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 \quad (155)$$

$$m_{\sigma_u \sigma_u} = \frac{1}{4} v_u^2 (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 \quad (156)$$

This matrix is diagonalized by  $Z^A$ :

$$Z^A m_{A^0}^2 Z^{A,\dagger} = m_{2,A^0}^{dia} \quad (157)$$

with

$$\sigma_d = \sum_j Z_{j1}^A A_j^0, \quad \sigma_u = \sum_j Z_{j2}^A A_j^0, \quad \sigma_S = \sum_j Z_{j3}^A A_j^0 \quad (158)$$

$$\sigma_T = \sum_j Z_{j4}^A A_j^0 \quad (159)$$

- **Mass matrix for Rh**, Basis:  $(R_d^0, R_u^0), (R_d^{0,*}, R_u^{0,*})$

$$m_{R^h}^2 = \begin{pmatrix} m_{R_d^0 R_d^{0,*}} & \frac{1}{4} v_d v_u (-2\lambda_U \lambda_D^* + \Lambda_U \Lambda_D^*) \\ \frac{1}{4} v_d v_u (-2\lambda_D \lambda_U^* + \Lambda_D \Lambda_U^*) & m_{R_u^0 R_u^{0,*}} \end{pmatrix} \quad (160)$$

$$\begin{aligned} m_{R_d^0 R_d^{0,*}} &= +m_{R_d}^2 \\ &+ \frac{1}{4} \left( (2\lambda_D (v_d^2 + v_s^2) + \sqrt{2} v_s (2\mu_D + \Lambda_D v_T)) \lambda_D^* + \left( (2\mu_D + \sqrt{2} \lambda_D v_s) v_T + \Lambda_D (v_d^2 + v_T^2) \right) \Lambda_D^* \right. \\ &+ 2(2\mu_D + \Lambda_D v_T + \sqrt{2} \lambda_D v_s) \mu_D^* \\ &\left. + \frac{1}{8} (8g_1 v_s \Re(M_D^B) + g_1^2 (-v_d^2 + v_u^2) + g_2 (-8v_T \Re(M_D^W) + g_2 (-v_d^2 + v_u^2))) \right) \end{aligned} \quad (161)$$

$$\begin{aligned} m_{R_u^0 R_u^{0,*}} &= +m_{R_u}^2 \\ &+ \frac{1}{4} \left( (2\lambda_U (v_s^2 + v_u^2) + \sqrt{2} v_s (2\mu_U - \Lambda_U v_T)) \lambda_U^* + \left( (-2\mu_U - \sqrt{2} \lambda_U v_s) v_T + \Lambda_U (v_T^2 + v_u^2) \right) \Lambda_U^* \right. \\ &+ 2(2\mu_U - \Lambda_U v_T + \sqrt{2} \lambda_U v_s) \mu_U^* \\ &\left. + \frac{1}{8} (-8g_1 v_s \Re(M_D^B) + g_1^2 (-v_u^2 + v_d^2) + g_2 (8v_T \Re(M_D^W) + g_2 (-v_u^2 + v_d^2))) \right) \end{aligned} \quad (162)$$

This matrix is diagonalized by  $Z^R$ :

$$Z^R m_{R^h}^2 Z^{R,\dagger} = m_{2,R^h}^{dia} \quad (163)$$

with

$$R_d^0 = \sum_j Z_{j1}^R R_j^h, \quad R_u^0 = \sum_j Z_{j2}^R R_j^h \quad (164)$$

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

$$m_{H^-}^2 = \begin{pmatrix} m_{H_d^- H_d^{-,*}} & \frac{1}{4} g_2^2 v_d v_u + B_\mu^* & m_{T^- H_d^{-,*}}^* & m_{T^{+,*} H_d^{-,*}}^* \\ \frac{1}{4} g_2^2 v_d v_u + B_\mu & m_{H_u^{+,*} H_u^+} & m_{T^- H_u^+}^* & m_{T^{+,*} H_u^+}^* \\ m_{H_d^- T^{-,*}} & m_{H_u^{+,*} T^{-,*}} & m_{T^- T^{-,*}} & 2M_D^{W,2} - \frac{1}{2} g_2^2 v_T^2 \\ m_{H_d^- T^+} & m_{H_u^{+,*} T^+} & 2M_D^{W,2} - \frac{1}{2} g_2^2 v_T^2 & m_{T^{+,*} T^+} \end{pmatrix} + \xi_{W^-} m^2(W^-) \quad (165)$$

$$\begin{aligned} m_{H_d^- H_d^{-,*}} &= +m_{H_d}^2 + \frac{1}{4} \left( - (2\mu_D - \Lambda_D v_T + \sqrt{2} \lambda_D v_s) (-2\mu_D^* + v_T \Lambda_D^*) + 4|\mu|^2 + v_s (2(\lambda_D v_s + \sqrt{2} \mu_D) - \sqrt{2} \Lambda_D v_T) \lambda_D^* \right) \\ &+ \frac{1}{8} \left( -8g_1 v_s \Re(M_D^B) + g_1^2 (-v_u^2 + v_d^2) + g_2 (-8v_T \Re(M_D^W) + g_2 (v_d^2 + v_u^2)) \right) \end{aligned} \quad (166)$$

$$\begin{aligned} m_{H_u^{+,*} H_u^+} &= +m_{H_u}^2 + \frac{1}{4} \left( (2\mu_U + \Lambda_U v_T + \sqrt{2} \lambda_U v_s) (2\mu_U^* + v_T \Lambda_U^*) + 4|\mu|^2 + v_s (2(\lambda_U v_s + \sqrt{2} \mu_U) + \sqrt{2} \Lambda_U v_T) \lambda_U^* \right) \\ &+ \frac{1}{8} \left( 8g_1 v_s \Re(M_D^B) + g_1^2 (-v_d^2 + v_u^2) + g_2 (8v_T \Re(M_D^W) + g_2 (v_d^2 + v_u^2)) \right) \end{aligned} \quad (167)$$

$$m_{H_d^- T^-,*} = \frac{1}{2} \frac{1}{\sqrt{2}} g_2 v_d \left( 2M_D^{W,*} + g_2 v_T \right) + \frac{1}{4} v_d \left( 2 \left( \lambda_D v_s + \sqrt{2} \mu_D \right) - \sqrt{2} \Lambda_D v_T \right) \Lambda_D^* \quad (168)$$

$$m_{H_u^{+,*} T^-,*} = \frac{1}{2} \frac{1}{\sqrt{2}} g_2 v_u \left( 2M_D^{W,*} + g_2 v_T \right) + \frac{1}{4} \left( 2 \left( \lambda_U v_s + \sqrt{2} \mu_U \right) - \sqrt{2} \Lambda_U v_T \right) v_u \Lambda_U^* \quad (169)$$

$$m_{T^- T^-,*} = 2M_D^{W,2} + \frac{1}{2} v_d^2 |\Lambda_D|^2 + \frac{1}{4} g_2^2 \left( 2v_T^2 - v_d^2 + v_u^2 \right) + m_t^2 \quad (170)$$

$$m_{H_d^- T^+} = \frac{1}{2} \frac{1}{\sqrt{2}} g_2 v_d \left( 2M_D^W - g_2 v_T \right) + \frac{1}{4} \Lambda_D v_d \left( 2v_s \lambda_D^* + \sqrt{2} \left( 2\mu_D^* + v_T \Lambda_D^* \right) \right) \quad (171)$$

$$m_{H_u^{+,*} T^+} = -\frac{1}{2} \frac{1}{\sqrt{2}} g_2 \left( -2M_D^W + g_2 v_T \right) v_u + \frac{1}{4} \Lambda_U v_u \left( 2v_s \lambda_U^* + \sqrt{2} \left( 2\mu_U^* + v_T \Lambda_U^* \right) \right) \quad (172)$$

$$m_{T^+ T^+} = 2M_D^{W,2} + \frac{1}{2} v_u^2 |\Lambda_U|^2 + \frac{1}{4} g_2^2 \left( 2v_T^2 - v_u^2 + v_d^2 \right) + m_t^2 \quad (173)$$

Gauge fixing contributions:

$$m^2(\xi_{W^-}) = \begin{pmatrix} \frac{1}{4} g_2^2 v_d^2 & -\frac{1}{4} g_2^2 v_d v_u & \frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_d v_T & \frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_d v_T \\ -\frac{1}{4} g_2^2 v_d v_u & \frac{1}{4} g_2^2 v_u^2 & -\frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_T v_u & -\frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_T v_u \\ \frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_d v_T & -\frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_T v_u & \frac{1}{2} g_2^2 v_T^2 & \frac{1}{2} g_2^2 v_T^2 \\ \frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_d v_T & -\frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_T v_u & \frac{1}{2} g_2^2 v_T^2 & \frac{1}{2} g_2^2 v_T^2 \end{pmatrix} \quad (174)$$

This matrix is diagonalized by  $Z^+$ :

$$Z^+ m_{H^-}^2 Z^{+,\dagger} = m_{2,H^-}^{dia} \quad (175)$$

with

$$H_d^- = \sum_j Z_{j1}^+ H_j^-, \quad H_u^+ = \sum_j Z_{j2}^+ H_j^+, \quad T^- = \sum_j Z_{j3}^+ H_j^- \quad (176)$$

$$T^+ = \sum_j Z_{j4}^+ H_j^+ \quad (177)$$

#### 4.2.2 Mass Matrices for Fermions

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

$$m_{\tilde{\chi}^0} = \begin{pmatrix} M_D^B & 0 & -\frac{1}{2} g_1 v_d & \frac{1}{2} g_1 v_u \\ 0 & M_D^W & \frac{1}{2} g_2 v_d & -\frac{1}{2} g_2 v_u \\ -\frac{1}{\sqrt{2}} \lambda_D v_d & -\frac{1}{2} \Lambda_D v_d & m_{R_d^0 \tilde{H}_d^0} & 0 \\ \frac{1}{\sqrt{2}} \lambda_U v_u & -\frac{1}{2} \Lambda_U v_u & 0 & m_{R_u^0 \tilde{H}_u^0} \end{pmatrix} \quad (178)$$

$$m_{R_d^0 \tilde{H}_d^0} = -\frac{1}{2} \Lambda_D v_T - \frac{1}{\sqrt{2}} \lambda_D v_s - \mu_D \quad (179)$$

$$m_{R_u^0 \tilde{H}_u^0} = -\frac{1}{2} \Lambda_U v_T + \frac{1}{\sqrt{2}} \lambda_U v_s + \mu_U \quad (180)$$



This matrix is diagonalized by  $N^1$  and  $N^2$

$$N^{1,*} m_{\tilde{\chi}^0} N^{2,\dagger} = m_{\tilde{\chi}^0}^{dia} \quad (181)$$

with

$$\lambda_{\tilde{B}} = \sum_{t_2} N_{j1}^{1,*} \lambda_j^0, \quad \tilde{W}^0 = \sum_{t_2} N_{j2}^{1,*} \lambda_j^0, \quad R_d^0 = \sum_{t_2} N_{j3}^{1,*} \lambda_j^0 \quad (182)$$

$$R_u^0 = \sum_{t_2} N_{j4}^{1,*} \lambda_j^0 \quad (183)$$

$$\tilde{S} = \sum_{t_2} N_{1j}^{2,*} \rho_j^0, \quad \tilde{T}^0 = \sum_{t_2} N_{2j}^{2,*} \rho_j^0, \quad \tilde{H}_d^0 = \sum_{t_2} N_{3j}^{2,*} \rho_j^0 \quad (184)$$

$$\tilde{H}_u^0 = \sum_{t_2} N_{4j}^{2,*} \rho_j^0 \quad (185)$$

- **Mass matrix for Cha1**, Basis:  $(\tilde{T}^-, \tilde{H}_d^-), (\tilde{W}^+, R_d^+)$

$$m_{\tilde{\chi}^+} = \begin{pmatrix} g_2 v_T + M_D^W & \frac{1}{\sqrt{2}} \Lambda_D v_d \\ \frac{1}{\sqrt{2}} g_2 v_d & -\frac{1}{2} \Lambda_D v_T + \frac{1}{\sqrt{2}} \lambda_D v_s + \mu_D \end{pmatrix} \quad (186)$$

This matrix is diagonalized by  $U^1$  and  $V^1$

$$U^{1,*} m_{\tilde{\chi}^+} V^{1,\dagger} = m_{\tilde{\chi}^+}^{dia} \quad (187)$$

with

$$\tilde{T}^- = \sum_{t_2} U_{j1}^{1,*} \lambda_j^-, \quad \tilde{H}_d^- = \sum_{t_2} U_{j2}^{1,*} \lambda_j^- \quad (188)$$

$$\tilde{W}^+ = \sum_{t_2} V_{1j}^{1,*} \lambda_j^+, \quad R_d^+ = \sum_{t_2} V_{2j}^{1,*} \lambda_j^+ \quad (189)$$

- **Mass matrix for Cha2**, Basis:  $(\tilde{W}^-, R_u^-), (\tilde{T}^+, \tilde{H}_u^+)$

$$m_{\tilde{\rho}^-} = \begin{pmatrix} -g_2 v_T + M_D^W & \frac{1}{\sqrt{2}} g_2 v_u \\ -\frac{1}{\sqrt{2}} \Lambda_U v_u & -\frac{1}{2} \Lambda_U v_T - \frac{1}{\sqrt{2}} \lambda_U v_s - \mu_U \end{pmatrix} \quad (190)$$

This matrix is diagonalized by  $U^2$  and  $V^2$

$$U^{2,*} m_{\tilde{\rho}^-} V^{2,\dagger} = m_{\tilde{\rho}^-}^{dia} \quad (191)$$

with

$$\tilde{W}^- = \sum_{t_2} U_{j1}^{2,*} \rho_j^-, \quad R_u^- = \sum_{t_2} U_{j2}^{2,*} \rho_j^- \quad (192)$$

$$\tilde{T}^+ = \sum_{t_2} V_{1j}^{2,*} \rho_j^+, \quad \tilde{H}_u^+ = \sum_{t_2} V_{2j}^{2,*} \rho_j^+ \quad (193)$$

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

$$m_e = \left( \frac{1}{\sqrt{2}} v_d Y_e^T \right) \quad (194)$$

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

$$U_L^{e,*} m_e U_R^{e,\dagger} = m_e^{dia} \quad (195)$$

with

$$e_{L,i} = \sum_{t_2} U_{L,ji}^{e,*} E_{L,j} \quad (196)$$

$$e_{R,i} = \sum_{t_2} U_{R,ij}^e E_{R,j}^* \quad (197)$$

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

$$m_d = \left( \frac{1}{\sqrt{2}} v_d \delta_{\alpha_1 \beta_1} Y_d^T \right) \quad (198)$$

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

$$U_L^{d,*} m_d U_R^{d,\dagger} = m_d^{dia} \quad (199)$$

with

$$d_{L,i\alpha} = \sum_{t_2} U_{L,ji}^{d,*} D_{L,j\alpha} \quad (200)$$

$$d_{R,i\alpha} = \sum_{t_2} U_{R,ij}^d D_{R,j\alpha}^* \quad (201)$$

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

$$m_u = \left( \frac{1}{\sqrt{2}} v_u \delta_{\alpha_1 \beta_1} Y_u^T \right) \quad (202)$$

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

$$U_L^{u,*} m_u U_R^{u,\dagger} = m_u^{dia} \quad (203)$$

with

$$u_{L,i\alpha} = \sum_{t_2} U_{L,ji}^{u,*} U_{L,j\alpha} \quad (204)$$

$$u_{R,i\alpha} = \sum_{t_2} U_{R,ij}^u U_{R,j\alpha}^* \quad (205)$$

## 5 Vacuum Expectation Values

$$H_d^0 = \frac{1}{\sqrt{2}}\phi_d + \frac{1}{\sqrt{2}}v_d + i\frac{1}{\sqrt{2}}\sigma_d \quad (206)$$

$$H_u^0 = \frac{1}{\sqrt{2}}\phi_u + \frac{1}{\sqrt{2}}v_u + i\frac{1}{\sqrt{2}}\sigma_u \quad (207)$$

$$T^0 = \frac{1}{\sqrt{2}}\phi_T + \frac{1}{\sqrt{2}}v_T + i\frac{1}{\sqrt{2}}\sigma_T \quad (208)$$

$$S = \frac{1}{\sqrt{2}}\phi_S + \frac{1}{\sqrt{2}}v_s + i\frac{1}{\sqrt{2}}\sigma_S \quad (209)$$

$$O = \frac{1}{\sqrt{2}}\phi_o + i\frac{1}{\sqrt{2}}\sigma_o \quad (210)$$

## 6 Tadpole Equations

$$\begin{aligned} \frac{\partial V}{\partial \phi_d} = & +\frac{1}{4}\left(v_d\left((2\mu_D + \Lambda_D v_T + \sqrt{2}\lambda_D v_s)\left(2\mu_D^* + v_T \Lambda_D^*\right) + 4\left(m_{H_d}^2 + |\mu|^2\right) + v_s\left(2\left(\lambda_D v_s + \sqrt{2}\mu_D\right) + \sqrt{2}\Lambda_D v_T\right)\lambda_D^*\right)\right. \\ & \left. - 2v_u\left(B_\mu + B_\mu^*\right)\right) \\ & + \frac{1}{8}v_d\left(-8g_1 v_s \Re\left(M_D^B\right) + g_1^2\left(-v_u + v_d\right)\left(v_d + v_u\right) + g_2\left(4v_T\left(M_D^W + M_D^{W,*}\right) + g_2\left(-v_u + v_d\right)\left(v_d + v_u\right)\right)\right) \end{aligned} \quad (211)$$

$$\begin{aligned} \frac{\partial V}{\partial \phi_u} = & +\frac{1}{8}v_u\left(4g_1 v_s\left(M_D^B + M_D^{B,*}\right) + g_1^2\left(-v_d^2 + v_u^2\right) + g_2\left(-4v_T\left(M_D^W + M_D^{W,*}\right) + g_2\left(-v_d^2 + v_u^2\right)\right)\right) \\ & + \frac{1}{4}\left(v_u\left(-\left(2\mu_U - \Lambda_U v_T + \sqrt{2}\lambda_U v_s\right)\left(-2\mu_U^* + v_T \Lambda_U^*\right) + 4\left(m_{H_u}^2 + |\mu|^2\right) + v_s\left(2\left(\lambda_U v_s + \sqrt{2}\mu_U\right) - \sqrt{2}\Lambda_U v_T\right)\lambda_U^*\right)\right. \\ & \left. - 4v_d \Re\left(B_\mu\right)\right) \end{aligned} \quad (212)$$

$$\begin{aligned} \frac{\partial V}{\partial \phi_T} = & +\frac{1}{8}\left(8\left(4M_D^{W,2} + m_t^2\right)v_T + \sqrt{2}v_s\left(\Lambda_D v_d^2 \lambda_D^* - \Lambda_U v_u^2 \lambda_U^*\right) + v_d^2\left(2\Lambda_D \mu_D^* + \left(2\left(\Lambda_D v_T + \mu_D\right) + \sqrt{2}\lambda_D v_s\right)\Lambda_D^*\right)\right. \\ & \left. - v_u^2\left(2\Lambda_U \mu_U^* + \left(-2\Lambda_U v_T + 2\mu_U + \sqrt{2}\lambda_U v_s\right)\Lambda_U^*\right)\right) \\ & + \frac{1}{2}g_2\left(-v_u + v_d\right)\left(v_d + v_u\right)\Re\left(M_D^W\right) \end{aligned} \quad (213)$$

$$\begin{aligned} \frac{\partial V}{\partial \phi_S} = & +\frac{1}{8}\left(4v_s\left(2m_S^2 + 8M_D^{B,2} + v_d^2|\lambda_D|^2 + v_u^2|\lambda_U|^2\right)\right. \\ & \left. + \sqrt{2}\left(v_d^2\left(\left(2\mu_D + \Lambda_D v_T\right)\lambda_D^* + \lambda_D\left(2\mu_D^* + v_T \Lambda_D^*\right)\right) + v_u^2\left(\left(2\mu_U - \Lambda_U v_T\right)\lambda_U^* + \lambda_U\left(2\mu_U^* - v_T \Lambda_U^*\right)\right)\right)\right) \\ & + \frac{1}{2}g_1\left(-v_d^2 + v_u^2\right)\Re\left(M_D^B\right) \end{aligned} \quad (214)$$

$$\frac{\partial V}{\partial \phi_o} = 0 \quad (215)$$

## 7 Particle content for eigenstates 'EWSB'

Name	Type	complex/real	Generations	Indices
$R_d^+$	Scalar	complex	1	
$R_d^-$	Scalar	complex	1	
$\sigma_o$	Scalar	real	1	color, 8
$\phi_o$	Scalar	real	1	color, 8
$\tilde{d}$	Scalar	complex	6	generation, 6, color, 3
$\tilde{\nu}$	Scalar	complex	3	generation, 3
$\tilde{u}$	Scalar	complex	6	generation, 6, color, 3
$\tilde{e}$	Scalar	complex	6	generation, 6
$h$	Scalar	real	4	generation, 4
$A^0$	Scalar	real	4	generation, 4
$R^h$	Scalar	complex	2	generation, 2
$H^-$	Scalar	complex	4	generation, 4
$\tilde{g}$	Fermion	Dirac	1	color, 8
$\nu$	Fermion	Dirac	3	generation, 3
$\tilde{\chi}^0$	Fermion	Dirac	4	generation, 4
$\tilde{\chi}^+$	Fermion	Dirac	2	generation, 2
$\tilde{\rho}^-$	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) = & -A_0(m_{R_d^+}^2)\Gamma_{\tilde{d}_i,\tilde{d}_j^*,R_d^-,R_d^+} - A_0(m_{R_u^-}^2)\Gamma_{\tilde{d}_i,\tilde{d}_j^*,R_u^+,R_u^-} \\
& + 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) \\
& - \sum_{a=1}^2 A_0(m_{R_a^h}^2)\Gamma_{\tilde{d}_i,\tilde{d}_j^*,R_a^{h,*},R_a^h} \\
& - 2\sum_{a=1}^2 m_{\tilde{\chi}_a^+} \sum_{b=1}^3 B_0(p^2, m_{\tilde{\chi}_a^+}^2, m_{u_b}^2) m_{u_b} \left( \Gamma_{\tilde{d}_j^*,\tilde{\chi}_a^-,u_b}^{L*} \Gamma_{\tilde{d}_i^*,\tilde{\chi}_a^-,u_b}^R + \Gamma_{\tilde{d}_j^*,\tilde{\chi}_a^-,u_b}^{R*} \Gamma_{\tilde{d}_i^*,\tilde{\chi}_a^-,u_b}^L \right) \\
& + \sum_{a=1}^2 \sum_{b=1}^3 G_0(p^2, m_{\tilde{\chi}_a^+}^2, m_{u_b}^2) \left( \Gamma_{\tilde{d}_j^*,\tilde{\chi}_a^-,u_b}^{L*} \Gamma_{\tilde{d}_i^*,\tilde{\chi}_a^-,u_b}^L + \Gamma_{\tilde{d}_j^*,\tilde{\chi}_a^-,u_b}^{R*} \Gamma_{\tilde{d}_i^*,\tilde{\chi}_a^-,u_b}^R \right) \\
& - \sum_{a=1}^3 A_0(m_{\tilde{\nu}_a}^2)\Gamma_{\tilde{d}_i,\tilde{d}_j^*,\tilde{\nu}_a^*,\tilde{\nu}_a} \\
& - 2\sum_{a=1}^3 m_{u_a} \sum_{b=1}^2 B_0(p^2, m_{u_a}^2, m_{\tilde{\rho}_b^-}^2) m_{\tilde{\rho}_b^-} \left( \Gamma_{\tilde{d}_j^*,u_a,\tilde{\rho}_b^-}^{L*} \Gamma_{\tilde{d}_i^*,u_a,\tilde{\rho}_b^-}^R + \Gamma_{\tilde{d}_j^*,u_a,\tilde{\rho}_b^-}^{R*} \Gamma_{\tilde{d}_i^*,u_a,\tilde{\rho}_b^-}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^2 G_0(p^2, m_{u_a}^2, m_{\tilde{\rho}_b^-}^2) \left( \Gamma_{\tilde{d}_j^*,u_a,\tilde{\rho}_b^-}^{L*} \Gamma_{\tilde{d}_i^*,u_a,\tilde{\rho}_b^-}^L + \Gamma_{\tilde{d}_j^*,u_a,\tilde{\rho}_b^-}^{R*} \Gamma_{\tilde{d}_i^*,u_a,\tilde{\rho}_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) \\
& - \frac{1}{2}\sum_{a=1}^4 A_0(m_{A_a^0}^2)\Gamma_{\tilde{d}_i,\tilde{d}_j^*,A_a^0,A_a^0} - \sum_{a=1}^4 A_0(m_{H_a^-}^2)\Gamma_{\tilde{d}_i,\tilde{d}_j^*,H_a^+,H_a^-} \\
& - \frac{1}{2}\sum_{a=1}^4 A_0(m_{h_a}^2)\Gamma_{\tilde{d}_i,\tilde{d}_j^*,h_a,h_a} \\
& - 2\sum_{a=1}^4 m_{\tilde{\chi}_a^0} \sum_{b=1}^3 B_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{d_b}^2) m_{d_b} \left( \Gamma_{\tilde{d}_j^*,\tilde{\chi}_a^0,d_b}^{L*} \Gamma_{\tilde{d}_i^*,\tilde{\chi}_a^0,d_b}^R + \Gamma_{\tilde{d}_j^*,\tilde{\chi}_a^0,d_b}^{R*} \Gamma_{\tilde{d}_i^*,\tilde{\chi}_a^0,d_b}^L \right) \\
& + \sum_{a=1}^4 \sum_{b=1}^3 G_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{d_b}^2) \left( \Gamma_{\tilde{d}_j^*,\tilde{\chi}_a^0,d_b}^{L*} \Gamma_{\tilde{d}_i^*,\tilde{\chi}_a^0,d_b}^L + \Gamma_{\tilde{d}_j^*,\tilde{\chi}_a^0,d_b}^{R*} \Gamma_{\tilde{d}_i^*,\tilde{\chi}_a^0,d_b}^R \right)
\end{aligned}$$

$$\begin{aligned}
& + \frac{4}{3} \sum_{a=1}^6 B_0(p^2, m_{\tilde{d}_a}^2, m_{\tilde{\phi}_o}^2) \Gamma_{\tilde{d}_j^*, \tilde{d}_a, \phi_o}^* \Gamma_{\tilde{d}_i^*, \tilde{d}_a, \phi_o} + \sum_{a=1}^6 B_0(p^2, m_{\tilde{u}_a}^2, m_{R_u^-}^2) \Gamma_{\tilde{d}_j^*, \tilde{u}_a, R_u^-}^* \Gamma_{\tilde{d}_i^*, \tilde{u}_a, R_u^-} \\
& - 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_{R_b^h}^2) \Gamma_{\tilde{d}_j^*, \tilde{d}_a, R_b^h}^* \Gamma_{\tilde{d}_i^*, \tilde{d}_a, R_b^h} \\
& + \sum_{a=1}^6 \sum_{b=1}^4 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}^4 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}^4 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{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{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 B_0(p^2, m_{\sigma_o}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{d}_j^*, \sigma_o, \tilde{d}_b}^* \Gamma_{\tilde{d}_i^*, \sigma_o, \tilde{d}_b} + \sum_{b=1}^6 B_0(p^2, m_{R_d^+}^2, m_{\tilde{u}_b}^2) \Gamma_{\tilde{d}_j^*, R_d^+, \tilde{u}_b}^* \Gamma_{\tilde{d}_i^*, R_d^+, \tilde{u}_b} \\
& + \frac{4}{3} \sum_{b=1}^6 \Gamma_{\tilde{d}_j^*, g, \tilde{d}_b}^* \Gamma_{\tilde{d}_i^*, g, \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} 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} 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} F_0(p^2, m_{\tilde{u}_b}^2, m_{W^-}^2) \tag{216}
\end{aligned}$$

• **Self-Energy for Sneutrinos** ( $\tilde{\nu}$ )

$$\begin{aligned}
\Pi_{i,j}(p^2) & = -A_0(m_{R_d^+}^2) \Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, R_d^+, R_d^+} - A_0(m_{R_u^-}^2) \Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, R_u^+, R_u^-} \\
& + 4\Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - \sum_{a=1}^2 A_0(m_{R_a^h}^2) \Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, R_a^{h,*}, R_a^h} - \sum_{a=1}^3 A_0(m_{\tilde{\nu}_a}^2) \Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, \tilde{\nu}_a^*, \tilde{\nu}_a}
\end{aligned}$$

$$\begin{aligned}
& -2 \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^*, e_a, \tilde{\chi}_b^+}^{L*} \Gamma_{\tilde{\nu}_i^*, e_a, \tilde{\chi}_b^+}^R + \Gamma_{\tilde{\nu}_j^*, e_a, \tilde{\chi}_b^+}^{R*} \Gamma_{\tilde{\nu}_i^*, e_a, \tilde{\chi}_b^+}^L \right) \\
& + \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^*, e_a, \tilde{\chi}_b^+}^{L*} \Gamma_{\tilde{\nu}_i^*, e_a, \tilde{\chi}_b^+}^L + \Gamma_{\tilde{\nu}_j^*, e_a, \tilde{\chi}_b^+}^{R*} \Gamma_{\tilde{\nu}_i^*, e_a, \tilde{\chi}_b^+}^R \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^4 B_0(p^2, m_{\tilde{\nu}_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{\nu}_j^*, \tilde{\nu}_a, A_b^0}^* \Gamma_{\tilde{\nu}_i^*, \tilde{\nu}_a, A_b^0} + \sum_{a=1}^3 \sum_{b=1}^4 B_0(p^2, m_{\tilde{\nu}_a}^2, m_{h_b}^2) \Gamma_{\tilde{\nu}_j^*, \tilde{\nu}_a, h_b}^* \Gamma_{\tilde{\nu}_i^*, \tilde{\nu}_a, h_b} \\
& - 2 \sum_{a=1}^3 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^*, \nu_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\nu}_i^*, \nu_a, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{\nu}_j^*, \nu_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\nu}_i^*, \nu_a, \tilde{\chi}_b^0}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^4 G_0(p^2, m_{\nu_a}^2, m_{\tilde{\chi}_b^0}^2) \left( \Gamma_{\tilde{\nu}_j^*, \nu_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\nu}_i^*, \nu_a, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{\nu}_j^*, \nu_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\nu}_i^*, \nu_a, \tilde{\chi}_b^0}^R \right) \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{A_a^0}^2) \Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, A_a^0, A_a^0} - \sum_{a=1}^4 A_0(m_{H_a^-}^2) \Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{h_a}^2) \Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, h_a, h_a} + \sum_{a=1}^4 \sum_{b=1}^6 B_0(p^2, m_{H_a^-}^2, m_{\tilde{e}_b}^2) \Gamma_{\tilde{\nu}_j^*, H_a^+, \tilde{e}_b}^* \Gamma_{\tilde{\nu}_i^*, H_a^+, \tilde{e}_b} \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, \tilde{d}_a^*, \tilde{d}_a} - \sum_{a=1}^6 A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, \tilde{e}_a^*, \tilde{e}_a} \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, \tilde{u}_a^*, \tilde{u}_a} + \sum_{b=1}^3 \Gamma_{\tilde{\nu}_j^*, Z, \tilde{\nu}_b}^* \Gamma_{\tilde{\nu}_i^*, Z, \tilde{\nu}_b} F_0(p^2, m_{\tilde{\nu}_b}^2, m_Z^2) \\
& + \sum_{b=1}^6 B_0(p^2, m_{R_d^+}^2, m_{\tilde{e}_b}^2) \Gamma_{\tilde{\nu}_j^*, R_d^+, \tilde{e}_b}^* \Gamma_{\tilde{\nu}_i^*, R_d^+, \tilde{e}_b} + \sum_{b=1}^6 \Gamma_{\tilde{\nu}_j^*, W^+, \tilde{e}_b}^* \Gamma_{\tilde{\nu}_i^*, W^+, \tilde{e}_b} F_0(p^2, m_{\tilde{e}_b}^2, m_{W^-}^2) \quad (217)
\end{aligned}$$

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

$$\begin{aligned}
\Pi_{i,j}(p^2) & = -A_0(m_{R_d^+}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, R_d^-, R_d^+} - A_0(m_{R_u^-}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, R_u^+, R_u^-} \\
& + 4\Gamma_{\tilde{u}_i, \tilde{u}_j^*, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{u}_i, \tilde{u}_j^*, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - \sum_{a=1}^2 A_0(m_{R_a^h}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, R_a^{h,*}, R_a^h} \\
& - 2 \sum_{a=1}^2 m_{\tilde{\rho}_a^-} \sum_{b=1}^3 B_0(p^2, m_{\tilde{\rho}_a^-}^2, m_{d_b}^2) m_{d_b} \left( \Gamma_{\tilde{u}_j^*, \tilde{\rho}_a^+, d_b}^{L*} \Gamma_{\tilde{u}_i^*, \tilde{\rho}_a^+, d_b}^R + \Gamma_{\tilde{u}_j^*, \tilde{\rho}_a^+, d_b}^{R*} \Gamma_{\tilde{u}_i^*, \tilde{\rho}_a^+, d_b}^L \right) \\
& + \sum_{a=1}^2 \sum_{b=1}^3 G_0(p^2, m_{\tilde{\rho}_a^-}^2, m_{d_b}^2) \left( \Gamma_{\tilde{u}_j^*, \tilde{\rho}_a^+, d_b}^{L*} \Gamma_{\tilde{u}_i^*, \tilde{\rho}_a^+, d_b}^L + \Gamma_{\tilde{u}_j^*, \tilde{\rho}_a^+, d_b}^{R*} \Gamma_{\tilde{u}_i^*, \tilde{\rho}_a^+, d_b}^R \right)
\end{aligned}$$

$$\begin{aligned}
& - \sum_{a=1}^3 A_0 \left( m_{\tilde{\nu}_a}^2 \right) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, \tilde{\nu}_a^*, \tilde{\nu}_a} \\
& - 2 \sum_{a=1}^3 m_{d_a} \sum_{b=1}^2 B_0 \left( p^2, m_{d_a}^2, m_{\tilde{\chi}_b^+}^2 \right) m_{\tilde{\chi}_b^+} \left( \Gamma_{\tilde{u}_j^*, d_a, \tilde{\chi}_b^+}^{L*} \Gamma_{\tilde{u}_i^*, d_a, \tilde{\chi}_b^+}^R + \Gamma_{\tilde{u}_j^*, d_a, \tilde{\chi}_b^+}^{R*} \Gamma_{\tilde{u}_i^*, d_a, \tilde{\chi}_b^+}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^2 G_0 \left( p^2, m_{d_a}^2, m_{\tilde{\chi}_b^+}^2 \right) \left( \Gamma_{\tilde{u}_j^*, d_a, \tilde{\chi}_b^+}^{L*} \Gamma_{\tilde{u}_i^*, d_a, \tilde{\chi}_b^+}^L + \Gamma_{\tilde{u}_j^*, d_a, \tilde{\chi}_b^+}^{R*} \Gamma_{\tilde{u}_i^*, d_a, \tilde{\chi}_b^+}^R \right) \\
& - 2 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^4 B_0 \left( p^2, m_{u_a}^2, m_{\tilde{\chi}_b^0}^2 \right) 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 \left( p^2, m_{u_a}^2, m_{\tilde{\chi}_b^0}^2 \right) \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) \\
& - \frac{1}{2} \sum_{a=1}^4 A_0 \left( m_{A_a^0}^2 \right) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, A_a^0, A_a^0} - \sum_{a=1}^4 A_0 \left( m_{H_a^-}^2 \right) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^4 A_0 \left( m_{h_a}^2 \right) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, h_a, h_a} \\
& - 2 \sum_{a=1}^4 m_{\tilde{\chi}_a^0} \sum_{b=1}^3 B_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{u_b}^2 \right) m_{u_b} \left( \Gamma_{\tilde{u}_j^*, \tilde{\chi}_a^0, u_b}^{L*} \Gamma_{\tilde{u}_i^*, \tilde{\chi}_a^0, u_b}^R + \Gamma_{\tilde{u}_j^*, \tilde{\chi}_a^0, u_b}^{R*} \Gamma_{\tilde{u}_i^*, \tilde{\chi}_a^0, u_b}^L \right) \\
& + \sum_{a=1}^4 \sum_{b=1}^3 G_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{u_b}^2 \right) \left( \Gamma_{\tilde{u}_j^*, \tilde{\chi}_a^0, u_b}^{L*} \Gamma_{\tilde{u}_i^*, \tilde{\chi}_a^0, u_b}^L + \Gamma_{\tilde{u}_j^*, \tilde{\chi}_a^0, u_b}^{R*} \Gamma_{\tilde{u}_i^*, \tilde{\chi}_a^0, u_b}^R \right) \\
& + \sum_{a=1}^4 \sum_{b=1}^6 B_0 \left( p^2, m_{H_a^-}^2, m_{\tilde{d}_b}^2 \right) \Gamma_{\tilde{u}_j^*, H_a^+, \tilde{d}_b}^* \Gamma_{\tilde{u}_i^*, H_a^+, \tilde{d}_b} + \frac{4}{3} \sum_{a=1}^6 B_0 \left( p^2, m_{\tilde{u}_a}^2, m_{\phi_o}^2 \right) \Gamma_{\tilde{u}_j^*, \tilde{u}_a, \phi_o}^* \Gamma_{\tilde{u}_i^*, \tilde{u}_a, \phi_o} \\
& + \frac{4}{3} \sum_{a=1}^6 B_0 \left( p^2, m_{\tilde{u}_a}^2, m_{\sigma_o}^2 \right) \Gamma_{\tilde{u}_j^*, \tilde{u}_a, \sigma_o}^* \Gamma_{\tilde{u}_i^*, \tilde{u}_a, \sigma_o} - C \sum_{a=1}^6 A_0 \left( m_{\tilde{d}_a}^2 \right) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, \tilde{d}_a^*, \tilde{d}_a} \\
& - \sum_{a=1}^6 A_0 \left( m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, \tilde{e}_a^*, \tilde{e}_a} - C \sum_{a=1}^6 A_0 \left( m_{\tilde{u}_a}^2 \right) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, \tilde{u}_a^*, \tilde{u}_a} \\
& + \sum_{a=1}^6 \sum_{b=1}^2 B_0 \left( p^2, m_{\tilde{u}_a}^2, m_{R_b^h}^2 \right) \Gamma_{\tilde{u}_j^*, \tilde{u}_a, R_b^h}^* \Gamma_{\tilde{u}_i^*, \tilde{u}_a, R_b^h} \\
& + \sum_{a=1}^6 \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{u}_a}^2, m_{A_b^0}^2 \right) \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}^4 B_0 \left( p^2, m_{\tilde{u}_a}^2, m_{h_b}^2 \right) \Gamma_{\tilde{u}_j^*, \tilde{u}_a, h_b}^* \Gamma_{\tilde{u}_i^*, \tilde{u}_a, h_b} \\
& - \frac{8}{3} m_{\tilde{g}} \sum_{b=1}^3 B_0 \left( p^2, m_{\tilde{g}}^2, m_{u_b}^2 \right) 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 \left( p^2, m_{\tilde{g}}^2, m_{u_b}^2 \right) \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)
\end{aligned}$$



$$\begin{aligned}
& -\frac{8}{3}m_{\tilde{g}}\sum_{b=1}^3B_0\left(p^2,m_{\tilde{g}}^2,m_{u_b}^2\right)m_{u_b}\left(\Gamma_{\tilde{u}_j^*,\tilde{g}_1,u_b}^{L*}\Gamma_{\tilde{u}_i^*,\tilde{g}_1,u_b}^R+\Gamma_{\tilde{u}_j^*,\tilde{g}_1,u_b}^{R*}\Gamma_{\tilde{u}_i^*,\tilde{g}_1,u_b}^L\right) \\
& +\frac{4}{3}\sum_{b=1}^3G_0\left(p^2,m_{\tilde{g}}^2,m_{u_b}^2\right)\left(\Gamma_{\tilde{u}_j^*,\tilde{g}_1,u_b}^{L*}\Gamma_{\tilde{u}_i^*,\tilde{g}_1,u_b}^L+\Gamma_{\tilde{u}_j^*,\tilde{g}_1,u_b}^{R*}\Gamma_{\tilde{u}_i^*,\tilde{g}_1,u_b}^R\right) \\
& +\sum_{b=1}^6B_0\left(p^2,m_{R_d^+}^2,m_{\tilde{d}_b}^2\right)\Gamma_{\tilde{u}_j^*,R_d^+,\tilde{d}_b}^*\Gamma_{\tilde{u}_i^*,R_d^+,\tilde{d}_b}+\sum_{b=1}^6B_0\left(p^2,m_{R_u^-}^2,m_{\tilde{d}_b}^2\right)\Gamma_{\tilde{u}_j^*,R_u^+,\tilde{d}_b}^*\Gamma_{\tilde{u}_i^*,R_u^+,\tilde{d}_b} \\
& +\sum_{b=1}^6\Gamma_{\tilde{u}_j^*,W^+,\tilde{d}_b}^*\Gamma_{\tilde{u}_i^*,W^+,\tilde{d}_b}F_0\left(p^2,m_{\tilde{d}_b}^2,m_{W^-}^2\right)+\frac{4}{3}\sum_{b=1}^6\Gamma_{\tilde{u}_j^*,g,\tilde{u}_b}^*\Gamma_{\tilde{u}_i^*,g,\tilde{u}_b}F_0\left(p^2,m_{\tilde{u}_b}^2,0\right) \\
& +\sum_{b=1}^6\Gamma_{\tilde{u}_j^*,\gamma,\tilde{u}_b}^*\Gamma_{\tilde{u}_i^*,\gamma,\tilde{u}_b}F_0\left(p^2,m_{\tilde{u}_b}^2,0\right)+\sum_{b=1}^6\Gamma_{\tilde{u}_j^*,Z,\tilde{u}_b}^*\Gamma_{\tilde{u}_i^*,Z,\tilde{u}_b}F_0\left(p^2,m_{\tilde{u}_b}^2,m_Z^2\right)
\end{aligned} \tag{218}$$

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

$$\begin{aligned}
\Pi_{i,j}(p^2) & = -A_0\left(m_{R_d^+}^2\right)\Gamma_{\tilde{e}_i,\tilde{e}_j^*,R_d^-,R_d^+} - A_0\left(m_{R_u^-}^2\right)\Gamma_{\tilde{e}_i,\tilde{e}_j^*,R_u^+,R_u^-} \\
& + 4\Gamma_{\tilde{e}_i,\tilde{e}_j^*,W^+,W^-}\left(-\frac{1}{2}\text{rMS}m_{W^-}^2+A_0\left(m_{W^-}^2\right)\right)+2\Gamma_{\tilde{e}_i,\tilde{e}_j^*,Z,Z}\left(-\frac{1}{2}\text{rMS}m_Z^2+A_0\left(m_Z^2\right)\right) \\
& -\sum_{a=1}^2A_0\left(m_{R_a^h}^2\right)\Gamma_{\tilde{e}_i,\tilde{e}_j^*,R_a^h,*,R_a^h} \\
& -2\sum_{a=1}^2m_{\tilde{\chi}_a^+}\sum_{b=1}^3B_0\left(p^2,m_{\tilde{\chi}_a^+}^2,m_{\nu_b}^2\right)m_{\nu_b}\left(\Gamma_{\tilde{e}_j^*,\tilde{\chi}_a^-, \nu_b}^{L*}\Gamma_{\tilde{e}_i^*,\tilde{\chi}_a^-, \nu_b}^R+\Gamma_{\tilde{e}_j^*,\tilde{\chi}_a^-, \nu_b}^{R*}\Gamma_{\tilde{e}_i^*,\tilde{\chi}_a^-, \nu_b}^L\right) \\
& +\sum_{a=1}^2\sum_{b=1}^3G_0\left(p^2,m_{\tilde{\chi}_a^+}^2,m_{\nu_b}^2\right)\left(\Gamma_{\tilde{e}_j^*,\tilde{\chi}_a^-, \nu_b}^{L*}\Gamma_{\tilde{e}_i^*,\tilde{\chi}_a^-, \nu_b}^L+\Gamma_{\tilde{e}_j^*,\tilde{\chi}_a^-, \nu_b}^{R*}\Gamma_{\tilde{e}_i^*,\tilde{\chi}_a^-, \nu_b}^R\right) \\
& -\sum_{a=1}^3A_0\left(m_{\tilde{\nu}_a}^2\right)\Gamma_{\tilde{e}_i,\tilde{e}_j^*,\tilde{\nu}_a^*,\tilde{\nu}_a} \\
& -2\sum_{a=1}^3m_{\nu_a}\sum_{b=1}^2B_0\left(p^2,m_{\nu_a}^2,m_{\tilde{\rho}_b^-}^2\right)m_{\tilde{\rho}_b^-}\left(\Gamma_{\tilde{e}_j^*,\nu_a,\tilde{\rho}_b^-}^{L*}\Gamma_{\tilde{e}_i^*,\nu_a,\tilde{\rho}_b^-}^R+\Gamma_{\tilde{e}_j^*,\nu_a,\tilde{\rho}_b^-}^{R*}\Gamma_{\tilde{e}_i^*,\nu_a,\tilde{\rho}_b^-}^L\right) \\
& +\sum_{a=1}^3\sum_{b=1}^2G_0\left(p^2,m_{\nu_a}^2,m_{\tilde{\rho}_b^-}^2\right)\left(\Gamma_{\tilde{e}_j^*,\nu_a,\tilde{\rho}_b^-}^{L*}\Gamma_{\tilde{e}_i^*,\nu_a,\tilde{\rho}_b^-}^L+\Gamma_{\tilde{e}_j^*,\nu_a,\tilde{\rho}_b^-}^{R*}\Gamma_{\tilde{e}_i^*,\nu_a,\tilde{\rho}_b^-}^R\right) \\
& +\sum_{a=1}^3\sum_{b=1}^4B_0\left(p^2,m_{\tilde{\nu}_a}^2,m_{H_b^-}^2\right)\Gamma_{\tilde{e}_j^*,\tilde{\nu}_a,H_b^-}^*\Gamma_{\tilde{e}_i^*,\tilde{\nu}_a,H_b^-} \\
& -2\sum_{a=1}^3m_{e_a}\sum_{b=1}^4B_0\left(p^2,m_{e_a}^2,m_{\tilde{\chi}_b^0}^2\right)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)
\end{aligned}$$

$$\begin{aligned}
& + \sum_{a=1}^3 \sum_{b=1}^4 G_0 \left( p^2, m_{e_a}^2, m_{\tilde{\chi}_b^0}^2 \right) \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) \\
& - \frac{1}{2} \sum_{a=1}^4 A_0 \left( m_{A_a^0}^2 \right) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, A_a^0, A_a^0} - \sum_{a=1}^4 A_0 \left( m_{H_a^-}^2 \right) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^4 A_0 \left( m_{h_a}^2 \right) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, h_a, h_a} \\
& - 2 \sum_{a=1}^4 m_{\tilde{\chi}_a^0} \sum_{b=1}^3 B_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{e_b}^2 \right) m_{e_b} \left( \Gamma_{\tilde{e}_j^*, \tilde{\chi}_a^0, e_b}^{L*} \Gamma_{\tilde{e}_i^*, \tilde{\chi}_a^0, e_b}^R + \Gamma_{\tilde{e}_j^*, \tilde{\chi}_a^0, e_b}^{R*} \Gamma_{\tilde{e}_i^*, \tilde{\chi}_a^0, e_b}^L \right) \\
& + \sum_{a=1}^4 \sum_{b=1}^3 G_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{e_b}^2 \right) \left( \Gamma_{\tilde{e}_j^*, \tilde{\chi}_a^0, e_b}^{L*} \Gamma_{\tilde{e}_i^*, \tilde{\chi}_a^0, e_b}^L + \Gamma_{\tilde{e}_j^*, \tilde{\chi}_a^0, e_b}^{R*} \Gamma_{\tilde{e}_i^*, \tilde{\chi}_a^0, e_b}^R \right) \\
& - 3 \sum_{a=1}^6 A_0 \left( m_{\tilde{d}_a}^2 \right) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, \tilde{d}_a^*, \tilde{d}_a} - \sum_{a=1}^6 A_0 \left( m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, \tilde{e}_a^*, \tilde{e}_a} \\
& - 3 \sum_{a=1}^6 A_0 \left( m_{\tilde{u}_a}^2 \right) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, \tilde{u}_a^*, \tilde{u}_a} + \sum_{a=1}^6 \sum_{b=1}^2 B_0 \left( p^2, m_{\tilde{e}_a}^2, m_{R_b^h}^2 \right) \Gamma_{\tilde{e}_j^*, \tilde{e}_a, R_b^h}^* \Gamma_{\tilde{e}_i^*, \tilde{e}_a, R_b^h} \\
& + \sum_{a=1}^6 \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{e}_a}^2, m_{A_b^0}^2 \right) \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}^4 B_0 \left( p^2, m_{\tilde{e}_a}^2, m_{h_b}^2 \right) \Gamma_{\tilde{e}_j^*, \tilde{e}_a, h_b}^* \Gamma_{\tilde{e}_i^*, \tilde{e}_a, h_b} \\
& + \sum_{b=1}^3 B_0 \left( p^2, m_{R_d^+}^2, m_{\tilde{\nu}_b}^2 \right) \Gamma_{\tilde{e}_j^*, R_d^+, \tilde{\nu}_b}^* \Gamma_{\tilde{e}_i^*, R_d^+, \tilde{\nu}_b} + \sum_{b=1}^3 \Gamma_{\tilde{e}_j^*, W^-, \tilde{\nu}_b}^* \Gamma_{\tilde{e}_i^*, W^-, \tilde{\nu}_b} F_0 \left( p^2, m_{\tilde{\nu}_b}^2, m_{W^-}^2 \right) \\
& + \sum_{b=1}^6 \Gamma_{\tilde{e}_j^*, \gamma, \tilde{e}_b}^* \Gamma_{\tilde{e}_i^*, \gamma, \tilde{e}_b} F_0 \left( p^2, m_{\tilde{e}_b}^2, 0 \right) + \sum_{b=1}^6 \Gamma_{\tilde{e}_j^*, Z, \tilde{e}_b}^* \Gamma_{\tilde{e}_i^*, Z, \tilde{e}_b} F_0 \left( p^2, m_{\tilde{e}_b}^2, m_Z^2 \right) \tag{219}
\end{aligned}$$

• **Self-Energy for Higgs ( $h$ )**

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

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

$$\begin{aligned}
& + \sum_{a=1}^4 \sum_{b=1}^4 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^-} \\
& + \sum_{a=1}^4 \sum_{b=1}^4 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} + \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 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} \\
& - 2 \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{h}_j, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{h}_i, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{h}_j, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{h}_i, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^L \right) \\
& + \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{h}_j, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{h}_i, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{h}_j, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{h}_i, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^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} \\
& - 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} \\
& + 2 \sum_{b=1}^4 B_0(p^2, m_{R_d^+}^2, m_{H_b^-}^2) \Gamma_{\tilde{h}_j, R_d^+, H_b^-}^* \Gamma_{\tilde{h}_i, R_d^+, H_b^-} + 2 \sum_{b=1}^4 B_0(p^2, m_{R_u}^2, m_{H_b^-}^2) \Gamma_{\tilde{h}_j, R_u^+, H_b^-}^* \Gamma_{\tilde{h}_i, R_u^+, H_b^-} \\
& + \sum_{b=1}^4 \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}^4 \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) \quad (220)
\end{aligned}$$

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

$$\begin{aligned}
\Pi_{i,j}(p^2) = & + B_0(p^2, m_{R_d^+}^2, m_{R_d^+}^2) \Gamma_{\tilde{A}_j^0, R_d^-, R_d^+}^* \Gamma_{\tilde{A}_i^0, R_d^-, R_d^+} + B_0(p^2, m_{R_u}^2, m_{R_u}^2) \Gamma_{\tilde{A}_j^0, R_u^+, R_u^-}^* \Gamma_{\tilde{A}_i^0, R_u^+, R_u^-} \\
& - B_0(p^2, m_{\eta^-}^2, m_{\eta^-}^2) \Gamma_{\tilde{A}_j^0, \eta^-, \eta^-} \Gamma_{\tilde{A}_i^0, \eta^-, \eta^-} - B_0(p^2, m_{\eta^+}^2, m_{\eta^+}^2) \Gamma_{\tilde{A}_j^0, \eta^+, \eta^+} \Gamma_{\tilde{A}_i^0, \eta^+, \eta^+} \\
& - A_0(m_{R_d^+}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, R_d^-, R_d^+} - A_0(m_{R_u}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, R_u^+, R_u^-} \\
& + 4\Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - \sum_{a=1}^2 A_0(m_{R_a^h}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, R_a^{h,*}, R_a^h} + \sum_{a=1}^2 \sum_{b=1}^2 B_0(p^2, m_{R_a^h}^2, m_{R_b^h}^2) \Gamma_{\tilde{A}_j^0, R_a^{h,*}, R_b^h}^* \Gamma_{\tilde{A}_i^0, R_a^{h,*}, R_b^h} \\
& - 2 \sum_{a=1}^2 m_{\tilde{\chi}_a^+} \sum_{b=1}^2 B_0(p^2, m_{\tilde{\chi}_a^+}^2, m_{\tilde{\chi}_b^+}^2) m_{\tilde{\chi}_b^+} \left( \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^-, \tilde{\chi}_b^+}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^-, \tilde{\chi}_b^+}^R + \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^-, \tilde{\chi}_b^+}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^-, \tilde{\chi}_b^+}^L \right) \\
& + \sum_{a=1}^2 \sum_{b=1}^2 G_0(p^2, m_{\tilde{\chi}_a^+}^2, m_{\tilde{\chi}_b^+}^2) \left( \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^-, \tilde{\chi}_b^+}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^-, \tilde{\chi}_b^+}^L + \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^-, \tilde{\chi}_b^+}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^-, \tilde{\chi}_b^+}^R \right)
\end{aligned}$$

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

$$\begin{aligned}
& + \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 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} \\
& - 2 \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) \\
& + \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_{\tilde{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_{\tilde{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_{\tilde{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_{\tilde{d}_a}^2, m_{\tilde{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_{\tilde{e}_a}^2, m_{\tilde{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_{\tilde{u}_a}^2, m_{\tilde{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} \\
& + 2 \sum_{b=1}^4 B_0(p^2, m_{R_d^+}^2, m_{H_b^-}^2) \Gamma_{\tilde{A}_j^0, R_d^+, H_b^-}^* \Gamma_{\tilde{A}_i^0, R_d^+, H_b^-} \\
& + 2 \sum_{b=1}^4 B_0(p^2, m_{R_u^+}^2, m_{H_b^-}^2) \Gamma_{\tilde{A}_j^0, R_u^+, H_b^-}^* \Gamma_{\tilde{A}_i^0, R_u^+, H_b^-} + \sum_{b=1}^4 \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}^4 \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) \tag{221}
\end{aligned}$$

• Self-Energy for Rh ( $R^h$ )

$$\begin{aligned}
\Pi_{i,j}(p^2) & = -A_0(m_{R_d^+}^2) \Gamma_{\tilde{R}_i^h, \tilde{R}_j^{h,*}, R_d^-, R_d^+} - A_0(m_{R_u^-}^2) \Gamma_{\tilde{R}_i^h, \tilde{R}_j^{h,*}, R_u^+, R_u^-} \\
& + \Gamma_{\tilde{R}_j^{h,*}, W^-, R_d^+}^* \Gamma_{\tilde{R}_i^h, *, W^-, R_d^+} F_0(p^2, m_{R_d^+}^2, m_{W^-}^2) + \Gamma_{\tilde{R}_j^{h,*}, W^+, R_u^-}^* \Gamma_{\tilde{R}_i^h, *, W^+, R_u^-} F_0(p^2, m_{R_u^-}^2, m_{W^-}^2) \\
& + 4\Gamma_{\tilde{R}_i^h, \tilde{R}_j^{h,*}, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{R}_i^h, \tilde{R}_j^{h,*}, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - \sum_{a=1}^2 A_0(m_{R_a^h}^2) \Gamma_{\tilde{R}_i^h, \tilde{R}_j^{h,*}, R_a^h, *, R_a^h} \\
& - 2 \sum_{a=1}^2 m_{\tilde{\rho}_a^-} \sum_{b=1}^2 B_0(p^2, m_{\tilde{\rho}_a^-}^2, m_{\tilde{\chi}_b^+}^2) m_{\tilde{\chi}_b^+} \left( \Gamma_{\tilde{R}_j^{h,*}, \tilde{\rho}_a^-, \tilde{\chi}_b^+}^{L*} \Gamma_{\tilde{R}_i^h, *, \tilde{\rho}_a^-, \tilde{\chi}_b^+}^R + \Gamma_{\tilde{R}_j^{h,*}, \tilde{\rho}_a^-, \tilde{\chi}_b^+}^{R*} \Gamma_{\tilde{R}_i^h, *, \tilde{\rho}_a^-, \tilde{\chi}_b^+}^L \right) \\
& + \sum_{a=1}^2 \sum_{b=1}^2 G_0(p^2, m_{\tilde{\rho}_a^-}^2, m_{\tilde{\chi}_b^+}^2) \left( \Gamma_{\tilde{R}_j^{h,*}, \tilde{\rho}_a^-, \tilde{\chi}_b^+}^{L*} \Gamma_{\tilde{R}_i^h, *, \tilde{\rho}_a^-, \tilde{\chi}_b^+}^L + \Gamma_{\tilde{R}_j^{h,*}, \tilde{\rho}_a^-, \tilde{\chi}_b^+}^{R*} \Gamma_{\tilde{R}_i^h, *, \tilde{\rho}_a^-, \tilde{\chi}_b^+}^R \right)
\end{aligned}$$

$$\begin{aligned}
& + \sum_{a=1}^2 \sum_{b=1}^4 B_0 \left( p^2, m_{R_a^h}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{R}_j^{h,*}, R_a^h, A_b^0}^* \Gamma_{\tilde{R}_i^{h,*}, R_a^h, A_b^0} \\
& + \sum_{a=1}^2 \sum_{b=1}^4 B_0 \left( p^2, m_{R_a^h}^2, m_{h_b}^2 \right) \Gamma_{\tilde{R}_j^{h,*}, R_a^h, h_b}^* \Gamma_{\tilde{R}_i^{h,*}, R_a^h, h_b} - \sum_{a=1}^3 A_0 \left( m_{\tilde{\nu}_a}^2 \right) \Gamma_{\tilde{R}_i^h, \tilde{R}_j^{h,*}, \tilde{\nu}_a^*, \tilde{\nu}_a} \\
& + \sum_{a=1}^4 B_0 \left( p^2, m_{H_a^-}^2, m_{R_u^-}^2 \right) \Gamma_{\tilde{R}_j^{h,*}, H_a^+, R_u^-}^* \Gamma_{\tilde{R}_i^{h,*}, H_a^+, R_u^-} - \frac{1}{2} \sum_{a=1}^4 A_0 \left( m_{A_a^0}^2 \right) \Gamma_{\tilde{R}_i^h, \tilde{R}_j^{h,*}, A_a^0, A_a^0} \\
& - \sum_{a=1}^4 A_0 \left( m_{H_a^-}^2 \right) \Gamma_{\tilde{R}_i^h, \tilde{R}_j^{h,*}, H_a^+, H_a^-} - \frac{1}{2} \sum_{a=1}^4 A_0 \left( m_{h_a}^2 \right) \Gamma_{\tilde{R}_i^h, \tilde{R}_j^{h,*}, h_a, h_a} \\
& + \frac{1}{4} \sum_{a=1}^4 \sum_{b=1}^4 B_0 \left( p^2, m_{A_a^0}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{R}_j^{h,*}, A_a^0, A_b^0}^* \Gamma_{\tilde{R}_i^{h,*}, A_a^0, A_b^0} \\
& + \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 B_0 \left( p^2, m_{H_a^-}^2, m_{H_b^-}^2 \right) \Gamma_{\tilde{R}_j^{h,*}, H_a^+, H_b^-}^* \Gamma_{\tilde{R}_i^{h,*}, H_a^+, H_b^-} \\
& + \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 B_0 \left( p^2, m_{h_a}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{R}_j^{h,*}, h_a, A_b^0}^* \Gamma_{\tilde{R}_i^{h,*}, h_a, A_b^0} \\
& + \frac{1}{4} \sum_{a=1}^4 \sum_{b=1}^4 B_0 \left( p^2, m_{h_a}^2, m_{h_b}^2 \right) \Gamma_{\tilde{R}_j^{h,*}, h_a, h_b}^* \Gamma_{\tilde{R}_i^{h,*}, h_a, h_b} \\
& - \sum_{a=1}^4 m_{\tilde{\chi}_a^0} \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^0}^2 \right) m_{\tilde{\chi}_b^0} \left( \Gamma_{\tilde{R}_j^{h,*}, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{R}_i^{h,*}, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{R}_j^{h,*}, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{R}_i^{h,*}, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^L \right) \\
& + \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 G_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^0}^2 \right) \left( \Gamma_{\tilde{R}_j^{h,*}, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{R}_i^{h,*}, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{R}_j^{h,*}, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{R}_i^{h,*}, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^R \right) \\
& - 3 \sum_{a=1}^6 A_0 \left( m_{\tilde{d}_a}^2 \right) \Gamma_{\tilde{R}_i^h, \tilde{R}_j^{h,*}, \tilde{d}_a^*, \tilde{d}_a} - \sum_{a=1}^6 A_0 \left( m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{R}_i^h, \tilde{R}_j^{h,*}, \tilde{e}_a^*, \tilde{e}_a} \\
& - 3 \sum_{a=1}^6 A_0 \left( m_{\tilde{u}_a}^2 \right) \Gamma_{\tilde{R}_i^h, \tilde{R}_j^{h,*}, \tilde{u}_a^*, \tilde{u}_a} + \frac{3}{2} \sum_{a=1}^6 \sum_{b=1}^6 B_0 \left( p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2 \right) \Gamma_{\tilde{R}_j^{h,*}, \tilde{d}_a^*, \tilde{d}_b}^* \Gamma_{\tilde{R}_i^{h,*}, \tilde{d}_a^*, \tilde{d}_b} \\
& + \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 B_0 \left( p^2, m_{\tilde{e}_a}^2, m_{\tilde{e}_b}^2 \right) \Gamma_{\tilde{R}_j^{h,*}, \tilde{e}_a^*, \tilde{e}_b}^* \Gamma_{\tilde{R}_i^{h,*}, \tilde{e}_a^*, \tilde{e}_b} \\
& + \frac{3}{2} \sum_{a=1}^6 \sum_{b=1}^6 B_0 \left( p^2, m_{\tilde{u}_a}^2, m_{\tilde{u}_b}^2 \right) \Gamma_{\tilde{R}_j^{h,*}, \tilde{u}_a^*, \tilde{u}_b}^* \Gamma_{\tilde{R}_i^{h,*}, \tilde{u}_a^*, \tilde{u}_b} + \sum_{b=1}^2 \Gamma_{\tilde{R}_j^{h,*}, Z, R_b^h}^* \Gamma_{\tilde{R}_i^{h,*}, Z, R_b^h} F_0 \left( p^2, m_{R_b^h}^2, m_Z^2 \right) \\
& + \sum_{b=1}^4 B_0 \left( p^2, m_{R_d^+}^2, m_{H_b^-}^2 \right) \Gamma_{\tilde{R}_j^{h,*}, R_d^+, H_b^-}^* \Gamma_{\tilde{R}_i^{h,*}, R_d^+, H_b^-} \tag{222}
\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_{\check{H}_j^+, W^-, \gamma}^* \Gamma_{\check{H}_i^+, W^-, \gamma} + 4\left(-\frac{1}{2}\text{rMS} + B_0(p^2, m_{W^-}^2, m_Z^2)\right)\Gamma_{\check{H}_j^+, Z, W^-}^* \Gamma_{\check{H}_i^+, Z, W^-} \\
& - B_0(p^2, m_{\eta^Z}^2, m_{\eta^+}^2)\Gamma_{\check{H}_i^+, \eta^+, \eta^Z} \Gamma_{\check{H}_j^-, \eta^+, \eta^Z} - B_0(p^2, m_{\eta^-}^2, m_{\eta^Z}^2)\Gamma_{\check{H}_i^+, \eta^Z, \eta^-} \Gamma_{\check{H}_j^-, \eta^Z, \eta^-} \\
& - A_0(m_{R_d^+}^2)\Gamma_{\check{H}_i^-, \check{H}_j^+, R_d^-, R_d^+} - A_0(m_{R_u^-}^2)\Gamma_{\check{H}_i^-, \check{H}_j^+, R_u^+, R_u^-} \\
& + 4\Gamma_{\check{H}_i^-, \check{H}_j^+, W^+, W^-} \left(-\frac{1}{2}\text{rMS}m_{W^-}^2 + A_0(m_{W^-}^2)\right) + 2\Gamma_{\check{H}_i^-, \check{H}_j^+, Z, Z} \left(-\frac{1}{2}\text{rMS}m_Z^2 + A_0(m_Z^2)\right) \\
& + \sum_{a=1}^2 B_0(p^2, m_{R_a^h}^2, m_{R_u^-}^2)\Gamma_{\check{H}_j^+, R_a^{h,*}, R_u^-} \Gamma_{\check{H}_i^+, R_a^{h,*}, R_u^-} - \sum_{a=1}^2 A_0(m_{R_a^h}^2)\Gamma_{\check{H}_i^-, \check{H}_j^+, R_a^{h,*}, R_a^h} \\
& + \sum_{a=1}^2 \sum_{b=1}^4 B_0(p^2, m_{R_a^h}^2, m_{H_b^-}^2)\Gamma_{\check{H}_j^+, R_a^{h,*}, H_b^-} \Gamma_{\check{H}_i^+, R_a^{h,*}, H_b^-} \\
& - 2\sum_{a=1}^2 m_{\check{\chi}_a^+} \sum_{b=1}^4 B_0(p^2, m_{\check{\chi}_a^+}^2, m_{\check{\chi}_b^0}^2) m_{\check{\chi}_b^0} \left(\Gamma_{\check{H}_j^+, \check{\chi}_a^-, \check{\chi}_b^0}^{L*} \Gamma_{\check{H}_i^+, \check{\chi}_a^-, \check{\chi}_b^0}^R + \Gamma_{\check{H}_j^+, \check{\chi}_a^-, \check{\chi}_b^0}^{R*} \Gamma_{\check{H}_i^+, \check{\chi}_a^-, \check{\chi}_b^0}^L\right) \\
& + \sum_{a=1}^2 \sum_{b=1}^4 G_0(p^2, m_{\check{\chi}_a^+}^2, m_{\check{\chi}_b^0}^2) \left(\Gamma_{\check{H}_j^+, \check{\chi}_a^-, \check{\chi}_b^0}^{L*} \Gamma_{\check{H}_i^+, \check{\chi}_a^-, \check{\chi}_b^0}^L + \Gamma_{\check{H}_j^+, \check{\chi}_a^-, \check{\chi}_b^0}^{R*} \Gamma_{\check{H}_i^+, \check{\chi}_a^-, \check{\chi}_b^0}^R\right) \\
& - \sum_{a=1}^3 A_0(m_{\check{\nu}_a}^2)\Gamma_{\check{H}_i^-, \check{H}_j^+, \check{\nu}_a^*, \check{\nu}_a} \\
& - 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_{\check{H}_j^+, \bar{u}_a, d_b}^{L*} \Gamma_{\check{H}_i^+, \bar{u}_a, d_b}^R + \Gamma_{\check{H}_j^+, \bar{u}_a, d_b}^{R*} \Gamma_{\check{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_{\check{H}_j^+, \bar{u}_a, d_b}^{L*} \Gamma_{\check{H}_i^+, \bar{u}_a, d_b}^L + \Gamma_{\check{H}_j^+, \bar{u}_a, d_b}^{R*} \Gamma_{\check{H}_i^+, \bar{u}_a, d_b}^R\right) \\
& - 2\sum_{a=1}^3 m_{\nu_a} \sum_{b=1}^3 B_0(p^2, m_{\nu_a}^2, m_{e_b}^2) m_{e_b} \left(\Gamma_{\check{H}_j^+, \bar{\nu}_a, e_b}^{L*} \Gamma_{\check{H}_i^+, \bar{\nu}_a, e_b}^R + \Gamma_{\check{H}_j^+, \bar{\nu}_a, e_b}^{R*} \Gamma_{\check{H}_i^+, \bar{\nu}_a, e_b}^L\right) \\
& + \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{\nu_a}^2, m_{e_b}^2) \left(\Gamma_{\check{H}_j^+, \bar{\nu}_a, e_b}^{L*} \Gamma_{\check{H}_i^+, \bar{\nu}_a, e_b}^L + \Gamma_{\check{H}_j^+, \bar{\nu}_a, e_b}^{R*} \Gamma_{\check{H}_i^+, \bar{\nu}_a, e_b}^R\right) \\
& + \sum_{a=1}^3 \sum_{b=1}^6 B_0(p^2, m_{\check{\nu}_a}^2, m_{\check{e}_b}^2)\Gamma_{\check{H}_j^+, \check{\nu}_a^*, \check{e}_b} \Gamma_{\check{H}_i^+, \check{\nu}_a^*, \check{e}_b} - \frac{1}{2}\sum_{a=1}^4 A_0(m_{A_a^0}^2)\Gamma_{\check{H}_i^-, \check{H}_j^+, A_a^0, A_a^0} \\
& - \sum_{a=1}^4 A_0(m_{H_a^-}^2)\Gamma_{\check{H}_i^-, \check{H}_j^+, H_a^+, H_a^-} - \frac{1}{2}\sum_{a=1}^4 A_0(m_{h_a}^2)\Gamma_{\check{H}_i^-, \check{H}_j^+, h_a, h_a} \\
& - 2\sum_{a=1}^4 m_{\check{\chi}_a^0} \sum_{b=1}^2 B_0(p^2, m_{\check{\chi}_a^0}^2, m_{\check{\rho}_b^-}^2) m_{\check{\rho}_b^-} \left(\Gamma_{\check{H}_j^+, \check{\chi}_a^0, \check{\rho}_b^-}^{L*} \Gamma_{\check{H}_i^+, \check{\chi}_a^0, \check{\rho}_b^-}^R + \Gamma_{\check{H}_j^+, \check{\chi}_a^0, \check{\rho}_b^-}^{R*} \Gamma_{\check{H}_i^+, \check{\chi}_a^0, \check{\rho}_b^-}^L\right)
\end{aligned}$$



$$\begin{aligned}
& + \sum_{a=1}^4 \sum_{b=1}^2 G_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\rho}_b^-}^2 \right) \left( \Gamma_{\tilde{H}_j^+, \tilde{\chi}_a^0, \tilde{\rho}_b^-}^{L*} \Gamma_{\tilde{H}_i^+, \tilde{\chi}_a^0, \tilde{\rho}_b^-}^L + \Gamma_{\tilde{H}_j^+, \tilde{\chi}_a^0, \tilde{\rho}_b^-}^{R*} \Gamma_{\tilde{H}_i^+, \tilde{\chi}_a^0, \tilde{\rho}_b^-}^R \right) \\
& + \sum_{a=1}^4 \sum_{b=1}^4 B_0 \left( p^2, m_{H_a^-}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{H}_j^+, H_a^-, A_b^0}^* \Gamma_{\tilde{H}_i^+, H_a^-, A_b^0} \\
& + \sum_{a=1}^4 \sum_{b=1}^4 B_0 \left( p^2, m_{H_a^-}^2, m_{h_b}^2 \right) \Gamma_{\tilde{H}_j^+, H_a^-, h_b}^* \Gamma_{\tilde{H}_i^+, H_a^-, h_b} - 3 \sum_{a=1}^6 A_0 \left( m_{\tilde{d}_a}^2 \right) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, \tilde{d}_a^*, \tilde{d}_a} \\
& - \sum_{a=1}^6 A_0 \left( m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, \tilde{e}_a^*, \tilde{e}_a} - 3 \sum_{a=1}^6 A_0 \left( m_{\tilde{u}_a}^2 \right) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, \tilde{u}_a^*, \tilde{u}_a} \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^6 B_0 \left( p^2, m_{\tilde{u}_a}^2, m_{\tilde{d}_b}^2 \right) \Gamma_{\tilde{H}_j^+, \tilde{u}_a^*, \tilde{d}_b}^* \Gamma_{\tilde{H}_i^+, \tilde{u}_a^*, \tilde{d}_b} \\
& + \sum_{b=1}^2 B_0 \left( p^2, m_{R_d^+}^2, m_{R_b^h}^2 \right) \Gamma_{\tilde{H}_j^+, R_d^-, R_b^h}^* \Gamma_{\tilde{H}_i^+, R_d^-, R_b^h} \\
& + \sum_{b=1}^4 B_0 \left( p^2, m_{R_u^-}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{H}_j^+, R_u^-, A_b^0}^* \Gamma_{\tilde{H}_i^+, R_u^-, A_b^0} + \sum_{b=1}^4 B_0 \left( p^2, m_{R_u^-}^2, m_{h_b}^2 \right) \Gamma_{\tilde{H}_j^+, R_u^-, h_b}^* \Gamma_{\tilde{H}_i^+, R_u^-, h_b} \\
& + \sum_{b=1}^4 B_0 \left( p^2, m_{R_d^+}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{H}_j^+, R_d^-, A_b^0}^* \Gamma_{\tilde{H}_i^+, R_d^-, A_b^0} + \sum_{b=1}^4 B_0 \left( p^2, m_{R_d^+}^2, m_{h_b}^2 \right) \Gamma_{\tilde{H}_j^+, R_d^-, h_b}^* \Gamma_{\tilde{H}_i^+, R_d^-, h_b} \\
& + \sum_{b=1}^4 \Gamma_{\tilde{H}_j^+, W^-, A_b^0}^* \Gamma_{\tilde{H}_i^+, W^-, A_b^0} F_0 \left( p^2, m_{A_b^0}^2, m_{W^-}^2 \right) + \sum_{b=1}^4 \Gamma_{\tilde{H}_j^+, W^-, h_b}^* \Gamma_{\tilde{H}_i^+, W^-, h_b} F_0 \left( p^2, m_{h_b}^2, m_{W^-}^2 \right) \\
& + \sum_{b=1}^4 \Gamma_{\tilde{H}_j^+, \gamma, H_b^-}^* \Gamma_{\tilde{H}_i^+, \gamma, H_b^-} F_0 \left( p^2, m_{H_b^-}^2, 0 \right) + \sum_{b=1}^4 \Gamma_{\tilde{H}_j^+, Z, H_b^-}^* \Gamma_{\tilde{H}_i^+, Z, H_b^-} F_0 \left( p^2, m_{H_b^-}^2, m_Z^2 \right) \tag{223}
\end{aligned}$$

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

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) & = + \sum_{a=1}^2 B_0 \left( p^2, m_{\tilde{\chi}_a^+}^2, m_{R_d^+}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{\chi}_a^-, R_d^+}^{L*} m_{\tilde{\chi}_a^+} \Gamma_{\tilde{\chi}_i^0, \tilde{\chi}_a^-, R_d^+}^R \\
& + \sum_{a=1}^2 B_0 \left( p^2, m_{\tilde{\rho}_a^-}^2, m_{R_u^-}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{\rho}_a^+, R_u^-}^{L*} m_{\tilde{\rho}_a^-} \Gamma_{\tilde{\chi}_i^0, \tilde{\rho}_a^+, R_u^-}^R \\
& + \sum_{a=1}^3 m_{\nu_a} \sum_{b=1}^3 B_0 \left( p^2, m_{\nu_a}^2, m_{\tilde{\nu}_b}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{\nu}_a, \tilde{\nu}_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{\nu}_a, \tilde{\nu}_b}^R \\
& + 3 \sum_{a=1}^3 m_{d_a} \sum_{b=1}^6 B_0 \left( p^2, m_{d_a}^2, m_{\tilde{d}_b}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{d}_a, \tilde{d}_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{d}_a, \tilde{d}_b}^R \\
& + \sum_{a=1}^3 m_{e_a} \sum_{b=1}^6 B_0 \left( p^2, m_{e_a}^2, m_{\tilde{e}_b}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{e}_a, \tilde{e}_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{e}_a, \tilde{e}_b}^R
\end{aligned}$$

$$\begin{aligned}
& + 3 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^6 B_0 \left( p^2, m_{u_a}^2, m_{\tilde{u}_b}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{u}_a, \tilde{u}_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{u}_a, \tilde{u}_b}^R \\
& + \sum_{a=1}^4 m_{\tilde{\chi}_a^0} \sum_{b=1}^2 B_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{R_b^h}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{\chi}_a^0, R_b^h}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{\chi}_a^0, R_b^h}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^2 B_0 \left( p^2, m_{\tilde{\rho}_b^-}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{\chi}_j^0, H_a^+, \tilde{\rho}_b^-}^{L*} m_{\tilde{\rho}_b^-} \Gamma_{\tilde{\chi}_i^0, H_a^+, \tilde{\rho}_b^-}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^2 B_0 \left( p^2, m_{\tilde{\chi}_b^+}^2, m_{H_a^-}^2 \right) \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}^4 m_{\tilde{\chi}_a^0} \sum_{b=1}^4 B_0 \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}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^4 B_0 \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*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\chi}_i^0, h_a, \tilde{\chi}_b^0}^R \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^3 B_0 \left( p^2, m_{d_b}^2, m_{\tilde{d}_a}^2 \right) \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 \\
& + \sum_{a=1}^6 \sum_{b=1}^3 B_0 \left( p^2, m_{e_b}^2, m_{\tilde{e}_a}^2 \right) \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 \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^3 B_0 \left( p^2, m_{u_b}^2, m_{\tilde{u}_a}^2 \right) \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 \\
& - 4 \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}^2 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_{\tilde{\rho}_b^-}^2, m_{W^-}^2 \right) \right) \Gamma_{\tilde{\chi}_j^0, W^+, \tilde{\rho}_b^-}^{R*} m_{\tilde{\rho}_b^-} \Gamma_{\tilde{\chi}_i^0, W^+, \tilde{\rho}_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
\end{aligned} \tag{224}$$

$$\begin{aligned}
\Sigma_{i,j}^R(p^2) &= -\frac{1}{2} \sum_{a=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_a^+}^2, m_{R_d^+}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{\chi}_a^-, R_d^+}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{\chi}_a^-, R_d^+}^R \\
& - \frac{1}{2} \sum_{a=1}^2 B_1 \left( p^2, m_{\tilde{\rho}_a^-}^2, m_{R_u^-}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{\rho}_a^+, R_u^-}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{\rho}_a^+, R_u^-}^R \\
& - \frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^3 B_1 \left( p^2, m_{\nu_a}^2, m_{\tilde{\nu}_b}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{\nu}_a, \tilde{\nu}_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{\nu}_a, \tilde{\nu}_b}^R
\end{aligned}$$

$$\begin{aligned}
& -\frac{3}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1 \left( p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{d}_a, \tilde{d}_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{d}_a, \tilde{d}_b}^R \\
& -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1 \left( p^2, m_{\tilde{e}_a}^2, m_{\tilde{e}_b}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{e}_a, \tilde{e}_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{e}_a, \tilde{e}_b}^R \\
& -\frac{3}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1 \left( p^2, m_{\tilde{u}_a}^2, m_{\tilde{u}_b}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{u}_a, \tilde{u}_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{u}_a, \tilde{u}_b}^R \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{R_b^h}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{\chi}_a^0, R_b^h}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{\chi}_a^0, R_b^h}^R \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\rho}_b^-}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{\chi}_j^0, H_a^+, \tilde{\rho}_b^-}^{R*} \Gamma_{\tilde{\chi}_i^0, H_a^+, \tilde{\rho}_b^-}^R \\
& -\frac{1}{2} \sum_{a=1}^4 \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}^4 \sum_{b=1}^4 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 \\
& -\frac{1}{2} \sum_{a=1}^4 \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{3}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{\tilde{d}_b}^2, m_{\tilde{d}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{d}_a^*, \tilde{d}_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{d}_a^*, \tilde{d}_b}^R \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{\tilde{e}_b}^2, m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{e}_a^*, \tilde{e}_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{e}_a^*, \tilde{e}_b}^R \\
& -\frac{3}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{\tilde{u}_b}^2, m_{\tilde{u}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{u}_a^*, \tilde{u}_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{u}_a^*, \tilde{u}_b}^R \\
& -\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}^2 B_1 \left( p^2, m_{\tilde{\rho}_b^-}^2, m_{W^-}^2 \right) \Gamma_{\tilde{\chi}_j^0, W^+, \tilde{\rho}_b^-}^{L*} \Gamma_{\tilde{\chi}_i^0, W^+, \tilde{\rho}_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 \quad (225)
\end{aligned}$$

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

$$\begin{aligned}
& -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^3 B_1(p^2, m_{\nu_a}^2, m_{\tilde{\nu}_b}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{\nu}_a, \tilde{\nu}_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{\nu}_a, \tilde{\nu}_b}^L \\
& -\frac{3}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1(p^2, m_{d_a}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{d}_a, \tilde{d}_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{d}_a, \tilde{d}_b}^L \\
& -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1(p^2, m_{e_a}^2, m_{\tilde{e}_b}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{e}_a, \tilde{e}_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{e}_a, \tilde{e}_b}^L \\
& -\frac{3}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1(p^2, m_{u_a}^2, m_{\tilde{u}_b}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{u}_a, \tilde{u}_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{u}_a, \tilde{u}_b}^L \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_a^0}^2, m_{R_b^h}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{\chi}_a^0, R_b^h}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{\chi}_a^0, R_b^h}^L \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\rho}_b^-}^2, m_{H_a^-}^2) \Gamma_{\tilde{\chi}_j^0, H_a^-, \tilde{\rho}_b^-}^{L*} \Gamma_{\tilde{\chi}_i^0, H_a^-, \tilde{\rho}_b^-}^L \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^+}^2, m_{H_a^-}^2) \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}^4 \sum_{b=1}^4 B_1(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}^L \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{h_a}^2) \Gamma_{\tilde{\chi}_j^0, h_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\chi}_i^0, h_a, \tilde{\chi}_b^0}^L \\
& -\frac{3}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{d}_a^*, d_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{d}_a^*, d_b}^L \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{e}_a^*, e_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{e}_a^*, e_b}^L \\
& -\frac{3}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{u}_a^*, u_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{u}_a^*, u_b}^L \\
& -\sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^+}^2, m_{W^-}^2) \Gamma_{\tilde{\chi}_j^0, W^-, \tilde{\chi}_b^+}^{R*} \Gamma_{\tilde{\chi}_i^0, W^-, \tilde{\chi}_b^+}^R \\
& -\sum_{b=1}^2 B_1(p^2, m_{\tilde{\rho}_b^-}^2, m_{W^-}^2) \Gamma_{\tilde{\chi}_j^0, W^+, \tilde{\rho}_b^-}^{R*} \Gamma_{\tilde{\chi}_i^0, W^+, \tilde{\rho}_b^-}^R - \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_Z^2) \Gamma_{\tilde{\chi}_j^0, Z, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\chi}_i^0, Z, \tilde{\chi}_b^0}^R \quad (226)
\end{aligned}$$

• Self-Energy for Cha1 ( $\tilde{\chi}^+$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) = & + \sum_{a=1}^2 m_{\tilde{\rho}_a^-} \sum_{b=1}^2 B_0(p^2, m_{\tilde{\rho}_a^-}^2, m_{R_b^h}^2) \Gamma_{\tilde{\chi}_j^-}^{L*} \tilde{\rho}_a^+, R_b^h \Gamma_{\tilde{\chi}_i^-}^R \tilde{\rho}_a^+, R_b^h \\
& + \sum_{a=1}^2 m_{\tilde{\chi}_a^+} \sum_{b=1}^4 B_0(p^2, m_{\tilde{\chi}_a^+}^2, m_{A_b^0}^2) \Gamma_{\tilde{\chi}_j^-}^{L*} \tilde{\chi}_a^+, A_b^0 \Gamma_{\tilde{\chi}_i^-}^R \tilde{\chi}_a^+, A_b^0 \\
& + \sum_{a=1}^3 m_{e_a} \sum_{b=1}^3 B_0(p^2, m_{e_a}^2, m_{\tilde{\nu}_b}^2) \Gamma_{\tilde{\chi}_j^-}^{L*} \tilde{e}_a, \tilde{\nu}_b \Gamma_{\tilde{\chi}_i^-}^R \tilde{e}_a, \tilde{\nu}_b \\
& + 3 \sum_{a=1}^3 m_{d_a} \sum_{b=1}^6 B_0(p^2, m_{d_a}^2, m_{\tilde{u}_b}^2) \Gamma_{\tilde{\chi}_j^-}^{L*} \tilde{d}_a, \tilde{u}_b \Gamma_{\tilde{\chi}_i^-}^R \tilde{d}_a, \tilde{u}_b \\
& + \sum_{a=1}^4 \sum_{b=1}^2 B_0(p^2, m_{\tilde{\chi}_b^+}^2, m_{h_a}^2) \Gamma_{\tilde{\chi}_j^-}^{L*} \tilde{h}_a, \tilde{\chi}_b^+ m_{\tilde{\chi}_b^+} \Gamma_{\tilde{\chi}_i^-}^R \tilde{h}_a, \tilde{\chi}_b^+ \\
& + \sum_{a=1}^4 \sum_{b=1}^4 B_0(p^2, m_{\tilde{\chi}_b^0}^2, m_{H_a^-}^2) \Gamma_{\tilde{\chi}_j^-}^{L*} \tilde{H}_a^+, \tilde{\chi}_b^0 m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\chi}_i^-}^R \tilde{H}_a^+, \tilde{\chi}_b^0 \\
& + \sum_{a=1}^4 B_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{R_d^+}^2) \Gamma_{\tilde{\chi}_j^-}^{L*} \tilde{\chi}_a^0, R_d^+ m_{\tilde{\chi}_a^0} \Gamma_{\tilde{\chi}_i^-}^R \tilde{\chi}_a^0, R_d^+ \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{u_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{\chi}_j^-}^{L*} \tilde{d}_a^*, u_b m_{u_b} \Gamma_{\tilde{\chi}_i^-}^R \tilde{d}_a^*, u_b \\
& + \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{\nu_b}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{\chi}_j^-}^{L*} \tilde{e}_a^*, \nu_b m_{\nu_b} \Gamma_{\tilde{\chi}_i^-}^R \tilde{e}_a^*, \nu_b \\
& - 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^-}^{R*} \gamma, \tilde{\chi}_b^+ m_{\tilde{\chi}_b^+} \Gamma_{\tilde{\chi}_i^-}^L \gamma, \tilde{\chi}_b^+ \\
& - 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^-}^{R*} Z, \tilde{\chi}_b^+ m_{\tilde{\chi}_b^+} \Gamma_{\tilde{\chi}_i^-}^L Z, \tilde{\chi}_b^+ \\
& - 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^-}^{R*} W^+, \tilde{\chi}_b^0 m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\chi}_i^-}^L W^+, \tilde{\chi}_b^0
\end{aligned} \tag{227}$$

$$\begin{aligned}
\Sigma_{i,j}^R(p^2) = & -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\rho}_a^-}^2, m_{R_b^h}^2) \Gamma_{\tilde{\chi}_j^-}^{R*} \tilde{\rho}_a^+, R_b^h \Gamma_{\tilde{\chi}_i^-}^R \tilde{\rho}_a^+, R_b^h \\
& -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_a^+}^2, m_{A_b^0}^2) \Gamma_{\tilde{\chi}_j^-}^{R*} \tilde{\chi}_a^+, A_b^0 \Gamma_{\tilde{\chi}_i^-}^R \tilde{\chi}_a^+, A_b^0 \\
& -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^3 B_1(p^2, m_{e_a}^2, m_{\tilde{\nu}_b}^2) \Gamma_{\tilde{\chi}_j^-}^{R*} \tilde{e}_a, \tilde{\nu}_b \Gamma_{\tilde{\chi}_i^-}^R \tilde{e}_a, \tilde{\nu}_b
\end{aligned}$$

$$\begin{aligned}
& -\frac{3}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1 \left( p^2, m_{\tilde{d}_a}^2, m_{\tilde{u}_b}^2 \right) \Gamma_{\tilde{\chi}_j^-}^{R*} \Gamma_{\tilde{\chi}_i^-}^R \Gamma_{\tilde{d}_a, \tilde{u}_b}^R \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_b^+}^2, m_{h_a}^2 \right) \Gamma_{\tilde{\chi}_j^-}^{R*} \Gamma_{\tilde{\chi}_i^-}^R \Gamma_{h_a, \tilde{\chi}_b^+}^R \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 B_1 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{\chi}_j^-}^{R*} \Gamma_{\tilde{\chi}_i^-}^R \Gamma_{H_a^+, \tilde{\chi}_b^0}^R \\
& -\frac{1}{2} \sum_{a=1}^4 B_1 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{R_d^+}^2 \right) \Gamma_{\tilde{\chi}_j^-}^{R*} \Gamma_{\tilde{\chi}_i^-}^R \Gamma_{\tilde{\chi}_a^0, R_d^+}^R \\
& -\frac{3}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{\tilde{u}_b}^2, m_{\tilde{d}_a}^2 \right) \Gamma_{\tilde{\chi}_j^-}^{R*} \Gamma_{\tilde{\chi}_i^-}^R \Gamma_{\tilde{d}_a^*, \tilde{u}_b}^R \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{\tilde{\nu}_b}^2, m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{\chi}_j^-}^{R*} \Gamma_{\tilde{\chi}_i^-}^R \Gamma_{\tilde{e}_a^*, \tilde{\nu}_b}^R - \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_b^+}^2, 0 \right) \Gamma_{\tilde{\chi}_j^-}^{L*} \Gamma_{\tilde{\chi}_i^-}^L \Gamma_{\tilde{\chi}_b^+, \gamma}^L \\
& - \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_b^+}^2, m_Z^2 \right) \Gamma_{\tilde{\chi}_j^-}^{L*} \Gamma_{\tilde{\chi}_i^-}^L \Gamma_{Z, \tilde{\chi}_b^+}^L - \sum_{b=1}^4 B_1 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{W^-}^2 \right) \Gamma_{\tilde{\chi}_j^-}^{L*} \Gamma_{\tilde{\chi}_i^-}^L \Gamma_{W^+, \tilde{\chi}_b^0}^L \quad (228)
\end{aligned}$$

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

$$\begin{aligned}
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{\nu_b}^2, m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{\chi}_j^-, \tilde{e}_a^*, \nu_b}^{L*} \Gamma_{\tilde{\chi}_i^-, \tilde{e}_a^*, \nu_b}^L - \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_b^+}^2, 0 \right) \Gamma_{\tilde{\chi}_j^-, \gamma, \tilde{\chi}_b^+}^{R*} \Gamma_{\tilde{\chi}_i^-, \gamma, \tilde{\chi}_b^+}^R \\
& - \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_b^+}^2, m_Z^2 \right) \Gamma_{\tilde{\chi}_j^-, Z, \tilde{\chi}_b^+}^{R*} \Gamma_{\tilde{\chi}_i^-, Z, \tilde{\chi}_b^+}^R - \sum_{b=1}^4 B_1 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{W^-}^2 \right) \Gamma_{\tilde{\chi}_j^-, W^+, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\chi}_i^-, W^+, \tilde{\chi}_b^0}^R \quad (229)
\end{aligned}$$

• Self-Energy for Cha2 ( $\tilde{\rho}^-$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) = & + \sum_{a=1}^2 m_{\tilde{\chi}_a^+} \sum_{b=1}^2 B_0 \left( p^2, m_{\tilde{\chi}_a^+}^2, m_{R_b^h}^2 \right) \Gamma_{\tilde{\rho}_j^+, \tilde{\chi}_a^-, R_b^h}^{L*} \Gamma_{\tilde{\rho}_i^+, \tilde{\chi}_a^-, R_b^h}^R \\
& + \sum_{a=1}^2 m_{\tilde{\rho}_a^-} \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{\rho}_a^-}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{\rho}_j^+, \tilde{\rho}_a^-, A_b^0}^{L*} \Gamma_{\tilde{\rho}_i^+, \tilde{\rho}_a^-, A_b^0}^R \\
& + 3 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^6 B_0 \left( p^2, m_{u_a}^2, m_{\tilde{d}_b}^2 \right) \Gamma_{\tilde{\rho}_j^+, \tilde{u}_a, \tilde{d}_b}^{L*} \Gamma_{\tilde{\rho}_i^+, \tilde{u}_a, \tilde{d}_b}^R \\
& + \sum_{a=1}^3 m_{\nu_a} \sum_{b=1}^6 B_0 \left( p^2, m_{\nu_a}^2, m_{\tilde{e}_b}^2 \right) \Gamma_{\tilde{\rho}_j^+, \tilde{\nu}_a, \tilde{e}_b}^{L*} \Gamma_{\tilde{\rho}_i^+, \tilde{\nu}_a, \tilde{e}_b}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^2 B_0 \left( p^2, m_{\tilde{\rho}_b^-}^2, m_{h_a}^2 \right) \Gamma_{\tilde{\rho}_j^+, h_a, \tilde{\rho}_b^-}^{L*} m_{\tilde{\rho}_b^-} \Gamma_{\tilde{\rho}_i^+, h_a, \tilde{\rho}_b^-}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{\rho}_j^+, H_a^-, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\rho}_i^+, H_a^-, \tilde{\chi}_b^0}^R \\
& + \sum_{a=1}^4 B_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{R_u^-}^2 \right) \Gamma_{\tilde{\rho}_j^+, \tilde{\chi}_a^0, R_u^-}^{L*} m_{\tilde{\chi}_a^0} \Gamma_{\tilde{\rho}_i^+, \tilde{\chi}_a^0, R_u^-}^R \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^3 B_0 \left( p^2, m_{\tilde{d}_b}^2, m_{\tilde{u}_a}^2 \right) \Gamma_{\tilde{\rho}_j^+, \tilde{u}_a^*, d_b}^{L*} m_{d_b} \Gamma_{\tilde{\rho}_i^+, \tilde{u}_a^*, d_b}^R \\
& - 4 \sum_{b=1}^2 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_{\tilde{\rho}_b^-}^2, 0 \right) \right) \Gamma_{\tilde{\rho}_j^+, \gamma, \tilde{\rho}_b^-}^{R*} m_{\tilde{\rho}_b^-} \Gamma_{\tilde{\rho}_i^+, \gamma, \tilde{\rho}_b^-}^L \\
& - 4 \sum_{b=1}^2 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_{\tilde{\rho}_b^-}^2, m_Z^2 \right) \right) \Gamma_{\tilde{\rho}_j^+, Z, \tilde{\rho}_b^-}^{R*} m_{\tilde{\rho}_b^-} \Gamma_{\tilde{\rho}_i^+, Z, \tilde{\rho}_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_{W^-}^2 \right) \right) \Gamma_{\tilde{\rho}_j^+, W^-, \tilde{\chi}_b^0}^{R*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\rho}_i^+, W^-, \tilde{\chi}_b^0}^L \quad (230) \\
\Sigma_{i,j}^R(p^2) = & -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^2 B_1 \left( p^2, m_{\tilde{\chi}_a^+}^2, m_{R_b^h}^2 \right) \Gamma_{\tilde{\rho}_j^+, \tilde{\chi}_a^-, R_b^h}^{R*} \Gamma_{\tilde{\rho}_i^+, \tilde{\chi}_a^-, R_b^h}^R
\end{aligned}$$

$$\begin{aligned}
& -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^4 B_1 \left( p^2, m_{\bar{\rho}_a}^2, m_{A_b^0}^2 \right) \Gamma_{\bar{\rho}_j^+, \bar{\rho}_a^-, A_b^0}^{R*} \Gamma_{\bar{\rho}_i^+, \bar{\rho}_a^-, A_b^0}^R \\
& -\frac{3}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1 \left( p^2, m_{u_a}^2, m_{\bar{d}_b}^2 \right) \Gamma_{\bar{\rho}_j^+, \bar{u}_a, \bar{d}_b}^{R*} \Gamma_{\bar{\rho}_i^+, \bar{u}_a, \bar{d}_b}^R \\
& -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1 \left( p^2, m_{\nu_a}^2, m_{\bar{e}_b}^2 \right) \Gamma_{\bar{\rho}_j^+, \bar{\nu}_a, \bar{e}_b}^{R*} \Gamma_{\bar{\rho}_i^+, \bar{\nu}_a, \bar{e}_b}^R \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^2 B_1 \left( p^2, m_{\bar{\rho}_b}^2, m_{h_a}^2 \right) \Gamma_{\bar{\rho}_j^+, h_a, \bar{\rho}_b^-}^{R*} \Gamma_{\bar{\rho}_i^+, h_a, \bar{\rho}_b^-}^R \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 B_1 \left( p^2, m_{\bar{\chi}_b^0}, m_{H_a^-}^2 \right) \Gamma_{\bar{\rho}_j^+, H_a^-, \bar{\chi}_b^0}^{R*} \Gamma_{\bar{\rho}_i^+, H_a^-, \bar{\chi}_b^0}^R \\
& -\frac{1}{2} \sum_{a=1}^4 B_1 \left( p^2, m_{\bar{\chi}_a^0}, m_{R_u^-}^2 \right) \Gamma_{\bar{\rho}_j^+, \bar{\chi}_a^0, R_u^-}^{R*} \Gamma_{\bar{\rho}_i^+, \bar{\chi}_a^0, R_u^-}^R \\
& -\frac{3}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{d_b}^2, m_{\bar{u}_a}^2 \right) \Gamma_{\bar{\rho}_j^+, \bar{u}_a^*, d_b}^{R*} \Gamma_{\bar{\rho}_i^+, \bar{u}_a^*, d_b}^R - \sum_{b=1}^2 B_1 \left( p^2, m_{\bar{\rho}_b}^2, 0 \right) \Gamma_{\bar{\rho}_j^+, \gamma, \bar{\rho}_b^-}^{L*} \Gamma_{\bar{\rho}_i^+, \gamma, \bar{\rho}_b^-}^L \\
& - \sum_{b=1}^2 B_1 \left( p^2, m_{\bar{\rho}_b}^2, m_Z^2 \right) \Gamma_{\bar{\rho}_j^+, Z, \bar{\rho}_b^-}^{L*} \Gamma_{\bar{\rho}_i^+, Z, \bar{\rho}_b^-}^L - \sum_{b=1}^4 B_1 \left( p^2, m_{\bar{\chi}_b^0}, m_{W^-}^2 \right) \Gamma_{\bar{\rho}_j^+, W^-, \bar{\chi}_b^0}^{L*} \Gamma_{\bar{\rho}_i^+, W^-, \bar{\chi}_b^0}^L \quad (231)
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) &= -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^2 B_1 \left( p^2, m_{\bar{\chi}_a^+}^2, m_{R_b^h}^2 \right) \Gamma_{\bar{\rho}_j^+, \bar{\chi}_a^-, R_b^h}^{L*} \Gamma_{\bar{\rho}_i^+, \bar{\chi}_a^-, R_b^h}^L \\
& -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^4 B_1 \left( p^2, m_{\bar{\rho}_a}^2, m_{A_b^0}^2 \right) \Gamma_{\bar{\rho}_j^+, \bar{\rho}_a^-, A_b^0}^{L*} \Gamma_{\bar{\rho}_i^+, \bar{\rho}_a^-, A_b^0}^L \\
& -\frac{3}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1 \left( p^2, m_{u_a}^2, m_{\bar{d}_b}^2 \right) \Gamma_{\bar{\rho}_j^+, \bar{u}_a, \bar{d}_b}^{L*} \Gamma_{\bar{\rho}_i^+, \bar{u}_a, \bar{d}_b}^L \\
& -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1 \left( p^2, m_{\nu_a}^2, m_{\bar{e}_b}^2 \right) \Gamma_{\bar{\rho}_j^+, \bar{\nu}_a, \bar{e}_b}^{L*} \Gamma_{\bar{\rho}_i^+, \bar{\nu}_a, \bar{e}_b}^L \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^2 B_1 \left( p^2, m_{\bar{\rho}_b}^2, m_{h_a}^2 \right) \Gamma_{\bar{\rho}_j^+, h_a, \bar{\rho}_b^-}^{L*} \Gamma_{\bar{\rho}_i^+, h_a, \bar{\rho}_b^-}^L \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 B_1 \left( p^2, m_{\bar{\chi}_b^0}, m_{H_a^-}^2 \right) \Gamma_{\bar{\rho}_j^+, H_a^-, \bar{\chi}_b^0}^{L*} \Gamma_{\bar{\rho}_i^+, H_a^-, \bar{\chi}_b^0}^L \\
& -\frac{1}{2} \sum_{a=1}^4 B_1 \left( p^2, m_{\bar{\chi}_a^0}, m_{R_u^-}^2 \right) \Gamma_{\bar{\rho}_j^+, \bar{\chi}_a^0, R_u^-}^{L*} \Gamma_{\bar{\rho}_i^+, \bar{\chi}_a^0, R_u^-}^L
\end{aligned}$$



$$\begin{aligned}
& -\frac{3}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{\rho}_j^+, \tilde{u}_a^*, d_b}^{L*} \Gamma_{\tilde{\rho}_i^+, \tilde{u}_a^*, d_b}^L - \sum_{b=1}^2 B_1(p^2, m_{\tilde{\rho}_b^-}^2, 0) \Gamma_{\tilde{\rho}_j^+, \gamma, \tilde{\rho}_b^-}^{R*} \Gamma_{\tilde{\rho}_i^+, \gamma, \tilde{\rho}_b^-}^R \\
& - \sum_{b=1}^2 B_1(p^2, m_{\tilde{\rho}_b^-}^2, m_Z^2) \Gamma_{\tilde{\rho}_j^+, Z, \tilde{\rho}_b^-}^{R*} \Gamma_{\tilde{\rho}_i^+, Z, \tilde{\rho}_b^-}^R - \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{W^-}^2) \Gamma_{\tilde{\rho}_j^+, W^-, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\rho}_i^+, W^-, \tilde{\chi}_b^0}^R
\end{aligned} \tag{232}$$

• Self-Energy for Leptons ( $e$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) &= + \sum_{a=1}^2 m_{\tilde{\chi}_a^+} \sum_{b=1}^3 B_0(p^2, m_{\tilde{\chi}_a^+}^2, m_{\tilde{\nu}_b}^2) \Gamma_{\tilde{e}_j, \tilde{\chi}_a^-, \tilde{\nu}_b}^{L*} \Gamma_{\tilde{e}_i, \tilde{\chi}_a^-, \tilde{\nu}_b}^R \\
&+ \sum_{a=1}^3 m_{e_a} \sum_{b=1}^4 B_0(p^2, m_{e_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{e}_j, e_a, A_b^0}^{L*} \Gamma_{\tilde{e}_i, e_a, A_b^0}^R \\
&+ \sum_{a=1}^4 \sum_{b=1}^3 B_0(p^2, m_{e_b}^2, m_{h_a}^2) \Gamma_{\tilde{e}_j, h_a, e_b}^{L*} m_{e_b} \Gamma_{\tilde{e}_i, h_a, e_b}^R \\
&+ \sum_{a=1}^4 \sum_{b=1}^3 B_0(p^2, m_{\nu_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{e}_j, H_a^-, \nu_b}^{L*} m_{\nu_b} \Gamma_{\tilde{e}_i, H_a^-, \nu_b}^R \\
&+ \sum_{a=1}^4 m_{\tilde{\chi}_a^0} \sum_{b=1}^6 B_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{e}_b}^2) \Gamma_{\tilde{e}_j, \tilde{\chi}_a^0, \tilde{e}_b}^{L*} \Gamma_{\tilde{e}_i, \tilde{\chi}_a^0, \tilde{e}_b}^R \\
&+ \sum_{a=1}^6 \sum_{b=1}^4 B_0(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{e}_j, \tilde{e}_a, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{e}_i, \tilde{e}_a, \tilde{\chi}_b^0}^R \\
&- 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{e_b}^2, 0) \right) \Gamma_{\tilde{e}_j, \gamma, e_b}^{R*} m_{e_b} \Gamma_{\tilde{e}_i, \gamma, e_b}^L \\
&- 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\nu_b}^2, m_{W^-}^2) \right) \Gamma_{\tilde{e}_j, W^-, \nu_b}^{R*} m_{\nu_b} \Gamma_{\tilde{e}_i, W^-, \nu_b}^L \\
&- 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{e_b}^2, m_Z^2) \right) \Gamma_{\tilde{e}_j, Z, e_b}^{R*} m_{e_b} \Gamma_{\tilde{e}_i, Z, e_b}^L
\end{aligned} \tag{233}$$

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

$$\begin{aligned}
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^3 B_1(p^2, m_{\nu_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{e}_j, H_a^-, \nu_b}^{R*} \Gamma_{\tilde{e}_i, H_a^-, \nu_b}^R \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{e}_b}^2) \Gamma_{\tilde{e}_j, \tilde{\chi}_a^0, \tilde{e}_b}^{R*} \Gamma_{\tilde{e}_i, \tilde{\chi}_a^0, \tilde{e}_b}^R \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{e}_j, \tilde{e}_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{e}_i, \tilde{e}_a, \tilde{\chi}_b^0}^R - \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, 0) \Gamma_{\tilde{e}_j, \gamma, e_b}^{L*} \Gamma_{\tilde{e}_i, \gamma, e_b}^L \\
& - \sum_{b=1}^3 B_1(p^2, m_{\nu_b}^2, m_{W^-}^2) \Gamma_{\tilde{e}_j, W^-, \nu_b}^{L*} \Gamma_{\tilde{e}_i, W^-, \nu_b}^L - \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_Z^2) \Gamma_{\tilde{e}_j, Z, e_b}^{L*} \Gamma_{\tilde{e}_i, Z, e_b}^L \quad (234)
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) &= -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^3 B_1(p^2, m_{\tilde{\chi}_a^+}^2, m_{\tilde{\nu}_b}^2) \Gamma_{\tilde{e}_j, \tilde{\chi}_a^+, \tilde{\nu}_b}^{L*} \Gamma_{\tilde{e}_i, \tilde{\chi}_a^+, \tilde{\nu}_b}^L \\
& -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^4 B_1(p^2, m_{e_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{e}_j, e_a, A_b^0}^{L*} \Gamma_{\tilde{e}_i, e_a, A_b^0}^L \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_{h_a}^2) \Gamma_{\tilde{e}_j, h_a, e_b}^{L*} \Gamma_{\tilde{e}_i, h_a, e_b}^L \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^3 B_1(p^2, m_{\nu_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{e}_j, H_a^-, \nu_b}^{L*} \Gamma_{\tilde{e}_i, H_a^-, \nu_b}^L \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{e}_b}^2) \Gamma_{\tilde{e}_j, \tilde{\chi}_a^0, \tilde{e}_b}^{L*} \Gamma_{\tilde{e}_i, \tilde{\chi}_a^0, \tilde{e}_b}^L \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{e}_j, \tilde{e}_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{e}_i, \tilde{e}_a, \tilde{\chi}_b^0}^L - \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, 0) \Gamma_{\tilde{e}_j, \gamma, e_b}^{R*} \Gamma_{\tilde{e}_i, \gamma, e_b}^R \\
& - \sum_{b=1}^3 B_1(p^2, m_{\nu_b}^2, m_{W^-}^2) \Gamma_{\tilde{e}_j, W^-, \nu_b}^{R*} \Gamma_{\tilde{e}_i, W^-, \nu_b}^R - \sum_{b=1}^3 B_1(p^2, m_{e_b}^2, m_Z^2) \Gamma_{\tilde{e}_j, Z, e_b}^{R*} \Gamma_{\tilde{e}_i, Z, e_b}^R \quad (235)
\end{aligned}$$

• Self-Energy for Down-Quarks (d)

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

$$\begin{aligned}
& + \sum_{a=1}^4 \sum_{b=1}^3 B_0 \left( p^2, m_{u_b}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{d}_j, H_a^-, u_b}^{L*} m_{u_b} \Gamma_{\tilde{d}_i, H_a^-, u_b}^R \\
& + \sum_{a=1}^4 m_{\tilde{\chi}_a^0} \sum_{b=1}^6 B_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{d}_b}^2 \right) \Gamma_{\tilde{d}_j, \tilde{\chi}_a^0, \tilde{d}_b}^{L*} \Gamma_{\tilde{d}_i, \tilde{\chi}_a^0, \tilde{d}_b}^R \\
& + \sum_{a=1}^6 \sum_{b=1}^2 B_0 \left( p^2, m_{\tilde{\rho}_b^-}^2, m_{\tilde{u}_a}^2 \right) \Gamma_{\tilde{d}_j, \tilde{u}_a, \tilde{\rho}_b^-}^{L*} m_{\tilde{\rho}_b^-} \Gamma_{\tilde{d}_i, \tilde{u}_a, \tilde{\rho}_b^-}^R \\
& + \sum_{a=1}^6 \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{d}_a}^2 \right) \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 \left( p^2, m_{\tilde{g}}^2, m_{\tilde{d}_a}^2 \right) \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 \left( p^2, m_{d_b}^2, 0 \right) \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 \left( p^2, m_{d_b}^2, 0 \right) \right) \Gamma_{\tilde{d}_j, \gamma, d_b}^{R*} m_{d_b} \Gamma_{\tilde{d}_i, \gamma, d_b}^L \\
& - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_{u_b}^2, m_{W^-}^2 \right) \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 \left( p^2, m_{d_b}^2, m_Z^2 \right) \right) \Gamma_{\tilde{d}_j, Z, d_b}^{R*} m_{d_b} \Gamma_{\tilde{d}_i, Z, d_b}^L \\
& + \frac{4}{3} m_{\tilde{g}} \sum_{b=1}^6 B_0 \left( p^2, m_{\tilde{g}}^2, m_{\tilde{d}_b}^2 \right) \Gamma_{\tilde{d}_j, \tilde{g}_1, \tilde{d}_b}^{L*} \Gamma_{\tilde{d}_i, \tilde{g}_1, \tilde{d}_b}^R \tag{236}
\end{aligned}$$

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

$$\begin{aligned}
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{\chi}_b^0}^R \\
& -\frac{2}{3} \sum_{a=1}^6 B_1(p^2, m_{\tilde{g}}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{g}_1}^{R*} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{g}_1}^R - \frac{4}{3} \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, 0) \Gamma_{\tilde{d}_j, g, d_b}^{L*} \Gamma_{\tilde{d}_i, g, d_b}^L \\
& -\sum_{b=1}^3 B_1(p^2, m_{d_b}^2, 0) \Gamma_{\tilde{d}_j, \gamma, d_b}^{L*} \Gamma_{\tilde{d}_i, \gamma, d_b}^L - \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{W^-}^2) \Gamma_{\tilde{d}_j, W^-, u_b}^{L*} \Gamma_{\tilde{d}_i, W^-, u_b}^L \\
& -\sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_Z^2) \Gamma_{\tilde{d}_j, Z, d_b}^{L*} \Gamma_{\tilde{d}_i, Z, d_b}^L - \frac{2}{3} \sum_{b=1}^6 B_1(p^2, m_{\tilde{g}}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{d}_j, \tilde{g}_1, \tilde{d}_b}^{R*} \Gamma_{\tilde{d}_i, \tilde{g}_1, \tilde{d}_b}^R
\end{aligned} \tag{237}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) = & -\frac{1}{2} \sum_{a=1}^2 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_a^+}^2, m_{\tilde{u}_b}^2) \Gamma_{\tilde{d}_j, \tilde{\chi}_a^-, \tilde{u}_b}^{L*} \Gamma_{\tilde{d}_i, \tilde{\chi}_a^-, \tilde{u}_b}^L \\
& -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^4 B_1(p^2, m_{\tilde{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}^4 \sum_{b=1}^3 B_1(p^2, m_{\tilde{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}^4 \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}^4 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{d}_j, \tilde{\chi}_a^0, \tilde{d}_b}^{L*} \Gamma_{\tilde{d}_i, \tilde{\chi}_a^0, \tilde{d}_b}^L \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\rho}_b^-}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{d}_j, \tilde{u}_a, \tilde{\rho}_b^-}^{L*} \Gamma_{\tilde{d}_i, \tilde{u}_a, \tilde{\rho}_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 \\
& -\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 - \frac{2}{3} \sum_{b=1}^6 B_1(p^2, m_{\tilde{g}}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{d}_j, \tilde{g}_1, \tilde{d}_b}^{L*} \Gamma_{\tilde{d}_i, \tilde{g}_1, \tilde{d}_b}^L
\end{aligned} \tag{238}$$

• Self-Energy for Up-Quarks ( $u$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) = & + \sum_{a=1}^2 m_{\bar{\rho}_a^-} \sum_{b=1}^6 B_0(p^2, m_{\bar{\rho}_a^-}^2, m_{\bar{d}_b}^2) \Gamma_{\bar{u}_j, \bar{\rho}_a^+, \bar{d}_b}^{L*} \Gamma_{\bar{u}_i, \bar{\rho}_a^+, \bar{d}_b}^R \\
& + \sum_{a=1}^3 m_{u_a} \sum_{b=1}^4 B_0(p^2, m_{u_a}^2, m_{A_b^0}^2) \Gamma_{\bar{u}_j, u_a, A_b^0}^{L*} \Gamma_{\bar{u}_i, u_a, A_b^0}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^3 B_0(p^2, m_{d_b}^2, m_{H_a^-}^2) \Gamma_{\bar{u}_j, H_a^+, d_b}^{L*} m_{d_b} \Gamma_{\bar{u}_i, H_a^+, d_b}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^3 B_0(p^2, m_{u_b}^2, m_{h_a}^2) \Gamma_{\bar{u}_j, h_a, u_b}^{L*} m_{u_b} \Gamma_{\bar{u}_i, h_a, u_b}^R \\
& + \sum_{a=1}^4 m_{\bar{\chi}_a^0} \sum_{b=1}^6 B_0(p^2, m_{\bar{\chi}_a^0}^2, m_{\bar{u}_b}^2) \Gamma_{\bar{u}_j, \bar{\chi}_a^0, \bar{u}_b}^{L*} \Gamma_{\bar{u}_i, \bar{\chi}_a^0, \bar{u}_b}^R \\
& + \sum_{a=1}^6 \sum_{b=1}^2 B_0(p^2, m_{\bar{\chi}_b^+}^2, m_{\bar{d}_a}^2) \Gamma_{\bar{u}_j, \bar{d}_a, \bar{\chi}_b^+}^{L*} m_{\bar{\chi}_b^+} \Gamma_{\bar{u}_i, \bar{d}_a, \bar{\chi}_b^+}^R \\
& + \sum_{a=1}^6 \sum_{b=1}^4 B_0(p^2, m_{\bar{\chi}_b^0}^2, m_{\bar{u}_a}^2) \Gamma_{\bar{u}_j, \bar{u}_a, \bar{\chi}_b^0}^{L*} m_{\bar{\chi}_b^0} \Gamma_{\bar{u}_i, \bar{u}_a, \bar{\chi}_b^0}^R \\
& + \frac{4}{3} m_{\bar{g}} \sum_{a=1}^6 B_0(p^2, m_{\bar{g}}^2, m_{\bar{u}_a}^2) \Gamma_{\bar{u}_j, \bar{u}_a, \bar{g}_1}^{L*} \Gamma_{\bar{u}_i, \bar{u}_a, \bar{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_{\bar{u}_j, g, u_b}^{R*} m_{u_b} \Gamma_{\bar{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_{\bar{u}_j, \gamma, u_b}^{R*} m_{u_b} \Gamma_{\bar{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_{\bar{u}_j, Z, u_b}^{R*} m_{u_b} \Gamma_{\bar{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_{\bar{u}_j, W^+, d_b}^{R*} m_{d_b} \Gamma_{\bar{u}_i, W^+, d_b}^L \\
& + \frac{4}{3} m_{\bar{g}} \sum_{b=1}^6 B_0(p^2, m_{\bar{g}}^2, m_{\bar{u}_b}^2) \Gamma_{\bar{u}_j, \bar{g}_1, \bar{u}_b}^{L*} \Gamma_{\bar{u}_i, \bar{g}_1, \bar{u}_b}^R \tag{239}
\end{aligned}$$

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

$$\begin{aligned}
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{u}_b}^2) \Gamma_{\tilde{u}_j, \tilde{\chi}_a^0, \tilde{u}_b}^{R*} \Gamma_{\tilde{u}_i, \tilde{\chi}_a^0, \tilde{u}_b}^R \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^2 B_1(p^2, m_{\tilde{\chi}_b^+}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{u}_j, \tilde{d}_a, \tilde{\chi}_b^+}^{R*} \Gamma_{\tilde{u}_i, \tilde{d}_a, \tilde{\chi}_b^+}^R \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{\chi}_b^0}^R \\
& -\frac{2}{3} \sum_{a=1}^6 B_1(p^2, m_{\tilde{g}}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{g}_1}^{R*} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{g}_1}^R - \frac{4}{3} \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, 0) \Gamma_{\tilde{u}_j, g, u_b}^{L*} \Gamma_{\tilde{u}_i, g, u_b}^L \\
& -\sum_{b=1}^3 B_1(p^2, m_{u_b}^2, 0) \Gamma_{\tilde{u}_j, \gamma, u_b}^{L*} \Gamma_{\tilde{u}_i, \gamma, u_b}^L - \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_Z^2) \Gamma_{\tilde{u}_j, Z, u_b}^{L*} \Gamma_{\tilde{u}_i, Z, u_b}^L \\
& -\sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{W^-}^2) \Gamma_{\tilde{u}_j, W^+, d_b}^{L*} \Gamma_{\tilde{u}_i, W^+, d_b}^L - \frac{2}{3} \sum_{b=1}^6 B_1(p^2, m_{\tilde{g}}^2, m_{\tilde{u}_b}^2) \Gamma_{\tilde{u}_j, \tilde{g}_1, \tilde{u}_b}^{R*} \Gamma_{\tilde{u}_i, \tilde{g}_1, \tilde{u}_b}^R \tag{240}
\end{aligned}$$

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

$$- \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{W^-}^2) \Gamma_{\tilde{u}_j, W^+, d_b}^{R*} \Gamma_{\tilde{u}_i, W^+, d_b}^R - \frac{2}{3} \sum_{b=1}^6 B_1(p^2, m_{\tilde{g}}^2, m_{\tilde{u}_b}^2) \Gamma_{\tilde{u}_j, \tilde{g}_1, \tilde{u}_b}^{L*} \Gamma_{\tilde{u}_i, \tilde{g}_1, \tilde{u}_b}^L \quad (241)$$

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

$$\begin{aligned} \Sigma^S(p^2) &= + \frac{1}{2} \sum_{a=1}^3 m_{d_a} \sum_{b=1}^6 B_0(p^2, m_{d_a}^2, m_{d_b}^2) \Gamma_{\tilde{g}_j, \bar{d}_a, \bar{d}_b}^{L*} \Gamma_{\tilde{g}_i, \bar{d}_a, \bar{d}_b}^R \\ &+ \frac{1}{2} \sum_{a=1}^3 m_{u_a} \sum_{b=1}^6 B_0(p^2, m_{u_a}^2, m_{u_b}^2) \Gamma_{\tilde{g}_j, \bar{u}_a, \bar{u}_b}^{L*} \Gamma_{\tilde{g}_i, \bar{u}_a, \bar{u}_b}^R \\ &+ \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{d_b}^2, m_{\bar{d}_a}^2) \Gamma_{\tilde{g}_j, \bar{d}_a^*, d_b}^{L*} m_{d_b} \Gamma_{\tilde{g}_i, \bar{d}_a^*, d_b}^R \\ &+ \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{u_b}^2, m_{\bar{u}_a}^2) \Gamma_{\tilde{g}_j, \bar{u}_a^*, u_b}^{L*} m_{u_b} \Gamma_{\tilde{g}_i, \bar{u}_a^*, u_b}^R \\ &+ 3B_0(p^2, m_{\tilde{g}}^2, m_{\phi_o}^2) \Gamma_{\tilde{g}_j, \phi_o, \tilde{g}_1}^{L*} m_{\tilde{g}} \Gamma_{\tilde{g}_i, \phi_o, \tilde{g}_1}^R + 3B_0(p^2, m_{\tilde{g}}^2, m_{\sigma_o}^2) \Gamma_{\tilde{g}_j, \sigma_o, \tilde{g}_1}^{L*} m_{\tilde{g}} \Gamma_{\tilde{g}_i, \sigma_o, \tilde{g}_1}^R \\ &- 12 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\tilde{g}}^2, 0) \right) \Gamma_{\tilde{g}_j, g, \tilde{g}_1}^{R*} m_{\tilde{g}} \Gamma_{\tilde{g}_i, g, \tilde{g}_1}^L \quad (242) \end{aligned}$$

$$\begin{aligned} \Sigma^R(p^2) &= - \frac{1}{4} \sum_{a=1}^3 \sum_{b=1}^6 B_1(p^2, m_{d_a}^2, m_{d_b}^2) \Gamma_{\tilde{g}_j, \bar{d}_a, \bar{d}_b}^{R*} \Gamma_{\tilde{g}_i, \bar{d}_a, \bar{d}_b}^R \\ &- \frac{1}{4} \sum_{a=1}^3 \sum_{b=1}^6 B_1(p^2, m_{u_a}^2, m_{u_b}^2) \Gamma_{\tilde{g}_j, \bar{u}_a, \bar{u}_b}^{R*} \Gamma_{\tilde{g}_i, \bar{u}_a, \bar{u}_b}^R \\ &- \frac{1}{4} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{\bar{d}_a}^2) \Gamma_{\tilde{g}_j, \bar{d}_a^*, d_b}^{R*} \Gamma_{\tilde{g}_i, \bar{d}_a^*, d_b}^R \\ &- \frac{1}{4} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{\bar{u}_a}^2) \Gamma_{\tilde{g}_j, \bar{u}_a^*, u_b}^{R*} \Gamma_{\tilde{g}_i, \bar{u}_a^*, u_b}^R \\ &- \frac{3}{2} B_1(p^2, m_{\tilde{g}}^2, m_{\phi_o}^2) \Gamma_{\tilde{g}_j, \phi_o, \tilde{g}_1}^{R*} \Gamma_{\tilde{g}_i, \phi_o, \tilde{g}_1}^R - \frac{3}{2} B_1(p^2, m_{\tilde{g}}^2, m_{\sigma_o}^2) \Gamma_{\tilde{g}_j, \sigma_o, \tilde{g}_1}^{R*} \Gamma_{\tilde{g}_i, \sigma_o, \tilde{g}_1}^R \\ &- 3B_1(p^2, m_{\tilde{g}}^2, 0) \Gamma_{\tilde{g}_j, g, \tilde{g}_1}^{L*} \Gamma_{\tilde{g}_i, g, \tilde{g}_1}^L \quad (243) \end{aligned}$$

$$\begin{aligned} \Sigma^L(p^2) &= - \frac{1}{4} \sum_{a=1}^3 \sum_{b=1}^6 B_1(p^2, m_{d_a}^2, m_{d_b}^2) \Gamma_{\tilde{g}_j, \bar{d}_a, \bar{d}_b}^{L*} \Gamma_{\tilde{g}_i, \bar{d}_a, \bar{d}_b}^L \\ &- \frac{1}{4} \sum_{a=1}^3 \sum_{b=1}^6 B_1(p^2, m_{u_a}^2, m_{u_b}^2) \Gamma_{\tilde{g}_j, \bar{u}_a, \bar{u}_b}^{L*} \Gamma_{\tilde{g}_i, \bar{u}_a, \bar{u}_b}^L \\ &- \frac{1}{4} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{\bar{d}_a}^2) \Gamma_{\tilde{g}_j, \bar{d}_a^*, d_b}^{L*} \Gamma_{\tilde{g}_i, \bar{d}_a^*, d_b}^L \end{aligned}$$

$$\begin{aligned}
& -\frac{1}{4} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{g}_j, \tilde{u}_a^*, u_b}^{L*} \Gamma_{\tilde{g}_i, \tilde{u}_a^*, u_b}^L \\
& -\frac{3}{2} B_1(p^2, m_{\tilde{g}}^2, m_{\phi_o}^2) \Gamma_{\tilde{g}_j, \phi_o, \tilde{g}_1}^{L*} \Gamma_{\tilde{g}_i, \phi_o, \tilde{g}_1}^L - \frac{3}{2} B_1(p^2, m_{\tilde{g}}^2, m_{\sigma_o}^2) \Gamma_{\tilde{g}_j, \sigma_o, \tilde{g}_1}^{L*} \Gamma_{\tilde{g}_i, \sigma_o, \tilde{g}_1}^L \\
& -3 B_1(p^2, m_{\tilde{g}}^2, 0) \Gamma_{\tilde{g}_j, g, \tilde{g}_1}^{R*} \Gamma_{\tilde{g}_i, g, \tilde{g}_1}^R
\end{aligned} \tag{244}$$

• Self-Energy for SRdp ( $R_d^+$ )

$$\begin{aligned}
\Pi(p^2) = & -A_0(m_{R_d^+}^2) \Gamma_{R_d^+, R_d^-, R_d^-, R_d^+} - A_0(m_{R_u^-}^2) \Gamma_{R_d^+, R_d^-, R_u^+, R_u^-} + |\Gamma_{R_d^-, \gamma, R_d^+}|^2 F_0(p^2, m_{R_d^+}^2, 0) \\
& + |\Gamma_{R_d^-, Z, R_d^+}|^2 F_0(p^2, m_{R_d^+}^2, m_Z^2) + 4\Gamma_{R_d^+, R_d^-, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) \\
& + 2\Gamma_{R_d^+, R_d^-, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) - \sum_{a=1}^2 A_0(m_{R_a^h}^2) \Gamma_{R_d^+, R_d^-, R_a^{h,*}, R_a^h} \\
& - \sum_{a=1}^3 A_0(m_{\tilde{\nu}_a}^2) \Gamma_{R_d^+, R_d^-, \tilde{\nu}_a^*, \tilde{\nu}_a} - \frac{1}{2} \sum_{a=1}^4 A_0(m_{A_a^0}^2) \Gamma_{R_d^+, R_d^-, A_a^0, A_a^0} \\
& - \sum_{a=1}^4 A_0(m_{H_a^-}^2) \Gamma_{R_d^+, R_d^-, H_a^+, H_a^-} - \frac{1}{2} \sum_{a=1}^4 A_0(m_{h_a}^2) \Gamma_{R_d^+, R_d^-, h_a, h_a} \\
& + \sum_{a=1}^4 \sum_{b=1}^2 |\Gamma_{R_d^-, H_a^+, R_b^h}|^2 B_0(p^2, m_{H_a^-}^2, m_{R_b^h}^2) \\
& + \sum_{a=1}^4 \sum_{b=1}^2 \left( |\Gamma_{R_d^-, \tilde{\chi}_a^0, \tilde{\chi}_b^+}|^2 + |\Gamma_{R_d^-, \tilde{\chi}_a^0, \tilde{\chi}_b^+}|^2 \right) G_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^+}^2) \\
& - 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_{R_d^-, \tilde{\chi}_a^0, \tilde{\chi}_b^+}^{L*} \Gamma_{R_d^-, \tilde{\chi}_a^0, \tilde{\chi}_b^+}^R + \Gamma_{R_d^-, \tilde{\chi}_a^0, \tilde{\chi}_b^+}^{R*} \Gamma_{R_d^-, \tilde{\chi}_a^0, \tilde{\chi}_b^+}^L \right) \\
& + \sum_{a=1}^4 \sum_{b=1}^4 |\Gamma_{R_d^-, H_a^+, A_b^0}|^2 B_0(p^2, m_{H_a^-}^2, m_{A_b^0}^2) + \sum_{a=1}^4 \sum_{b=1}^4 |\Gamma_{R_d^-, H_a^+, h_b}|^2 B_0(p^2, m_{H_a^-}^2, m_{h_b}^2) \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{R_d^+, R_d^-, \tilde{d}_a^*, \tilde{d}_a} - \sum_{a=1}^6 A_0(m_{\tilde{e}_a}^2) \Gamma_{R_d^+, R_d^-, \tilde{e}_a^*, \tilde{e}_a} \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{R_d^+, R_d^-, \tilde{u}_a^*, \tilde{u}_a} + \sum_{a=1}^6 \sum_{b=1}^3 |\Gamma_{R_d^-, \tilde{e}_a^*, \tilde{\nu}_b}|^2 B_0(p^2, m_{\tilde{e}_a}^2, m_{\tilde{\nu}_b}^2) \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{R_d^-, \tilde{d}_a^*, \tilde{u}_b}|^2 B_0(p^2, m_{\tilde{d}_a}^2, m_{\tilde{u}_b}^2) + \sum_{b=1}^2 |\Gamma_{R_d^-, W^+, R_b^h}|^2 F_0(p^2, m_{R_b^h}^2, m_{W^-}^2) \\
& + \sum_{b=1}^4 |\Gamma_{R_d^-, R_d^+, A_b^0}|^2 B_0(p^2, m_{R_d^+}^2, m_{A_b^0}^2) + \sum_{b=1}^4 |\Gamma_{R_d^-, R_d^+, h_b}|^2 B_0(p^2, m_{R_d^+}^2, m_{h_b}^2)
\end{aligned} \tag{245}$$



• **Self-Energy for SRum** ( $R_u^-$ )

$$\begin{aligned}
\Pi(p^2) = & -A_0(m_{R_d^+}^2)\Gamma_{R_u^-,R_u^+,R_d^-,R_d^+} - A_0(m_{R_u^-}^2)\Gamma_{R_u^-,R_u^+,R_u^+,R_u^-} + |\Gamma_{R_u^+,\gamma,R_u^-}|^2 F_0(p^2, m_{R_u^-}^2, 0) \\
& + |\Gamma_{R_u^+,Z,R_u^-}|^2 F_0(p^2, m_{R_u^-}^2, m_Z^2) + 4\Gamma_{R_u^-,R_u^+,W^+,W^-} \left( -\frac{1}{2}\text{rMS}m_{W^-}^2 + A_0(m_{W^-}^2) \right) \\
& + 2\Gamma_{R_u^-,R_u^+,Z,Z} \left( -\frac{1}{2}\text{rMS}m_Z^2 + A_0(m_Z^2) \right) - \sum_{a=1}^2 A_0(m_{R_a^h}^2)\Gamma_{R_u^-,R_u^+,R_a^{h,*},R_a^h} \\
& + \sum_{a=1}^2 \sum_{b=1}^4 |\Gamma_{R_u^+,R_a^h,H_b^-}|^2 B_0(p^2, m_{R_a^h}^2, m_{H_b^-}^2) - \sum_{a=1}^3 A_0(m_{\tilde{\nu}_a}^2)\Gamma_{R_u^-,R_u^+,\tilde{\nu}_a^*,\tilde{\nu}_a} \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{A_a^0}^2)\Gamma_{R_u^-,R_u^+,A_a^0,A_a^0} - \sum_{a=1}^4 A_0(m_{H_a^-}^2)\Gamma_{R_u^-,R_u^+,H_a^+,H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{h_a}^2)\Gamma_{R_u^-,R_u^+,h_a,h_a} + \sum_{a=1}^4 \sum_{b=1}^2 \left( |\Gamma_{R_u^+,\tilde{\chi}_a^0,\tilde{\rho}_b^-}|^2 + |\Gamma_{R_u^+,\tilde{\chi}_a^0,\tilde{\rho}_b^-}|^2 \right) G_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\rho}_b^-}^2) \\
& - 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{\rho}_b^-}^2) m_{\tilde{\rho}_b^-} \left( \Gamma_{R_u^+,\tilde{\chi}_a^0,\tilde{\rho}_b^-}^{L*} \Gamma_{R_u^+,\tilde{\chi}_a^0,\tilde{\rho}_b^-}^R + \Gamma_{R_u^+,\tilde{\chi}_a^0,\tilde{\rho}_b^-}^{R*} \Gamma_{R_u^+,\tilde{\chi}_a^0,\tilde{\rho}_b^-}^L \right) \\
& + \sum_{a=1}^4 \sum_{b=1}^4 |\Gamma_{R_u^+,H_a^-,A_b^0}|^2 B_0(p^2, m_{H_a^-}^2, m_{A_b^0}^2) + \sum_{a=1}^4 \sum_{b=1}^4 |\Gamma_{R_u^+,H_a^-,h_b}|^2 B_0(p^2, m_{H_a^-}^2, m_{h_b}^2) \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2)\Gamma_{R_u^-,R_u^+,\tilde{d}_a^*,\tilde{d}_a} - \sum_{a=1}^6 A_0(m_{\tilde{e}_a}^2)\Gamma_{R_u^-,R_u^+,\tilde{e}_a^*,\tilde{e}_a} \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2)\Gamma_{R_u^-,R_u^+,\tilde{u}_a^*,\tilde{u}_a} + 3 \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{R_u^+,\tilde{u}_a^*,\tilde{d}_b}|^2 B_0(p^2, m_{\tilde{u}_a}^2, m_{\tilde{d}_b}^2) \\
& + \sum_{b=1}^2 |\Gamma_{R_u^+,W^-,R_b^h}|^2 F_0(p^2, m_{R_b^h}^2, m_{W^-}^2) + \sum_{b=1}^4 |\Gamma_{R_u^+,R_u^-,A_b^0}|^2 B_0(p^2, m_{R_u^-}^2, m_{A_b^0}^2) \\
& + \sum_{b=1}^4 |\Gamma_{R_u^+,R_u^-,h_b}|^2 B_0(p^2, m_{R_u^-}^2, m_{h_b}^2) \tag{246}
\end{aligned}$$

• **Self-Energy for sigmaO** ( $\sigma_o$ )

$$\begin{aligned}
\Pi(p^2) = & -\frac{1}{2}CA_0(m_{\phi_o}^2)\Gamma_{\sigma_o,\sigma_o,\phi_o,\phi_o} + 3|\Gamma_{\sigma_o,g,\sigma_o}|^2 F_0(p^2, m_{\sigma_o}^2, 0) + 3 \left( |\Gamma_{\sigma_o,\tilde{g}_1,\tilde{g}_1}^L|^2 + |\Gamma_{\sigma_o,\tilde{g}_1,\tilde{g}_1}^R|^2 \right) G_0(p^2, m_{\tilde{g}}^2, m_{\tilde{g}}^2) \\
& + \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{\sigma_o,\tilde{d}_a^*,\tilde{d}_b}|^2 B_0(p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2) + \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{\sigma_o,\tilde{u}_a^*,\tilde{u}_b}|^2 B_0(p^2, m_{\tilde{u}_a}^2, m_{\tilde{u}_b}^2) \\
& - 6B_0(p^2, m_{\tilde{g}}^2, m_{\tilde{g}}^2) m_{\tilde{g}}^2 \left( \Gamma_{\sigma_o,\tilde{g}_1,\tilde{g}_1}^{L*} \Gamma_{\sigma_o,\tilde{g}_1,\tilde{g}_1}^R + \Gamma_{\sigma_o,\tilde{g}_1,\tilde{g}_1}^{R*} \Gamma_{\sigma_o,\tilde{g}_1,\tilde{g}_1}^L \right) \tag{247}
\end{aligned}$$

• **Self-Energy for phiO** ( $\phi_o$ )

$$\begin{aligned}
\Pi(p^2) = & -\frac{1}{2}CA_0(m_{\sigma_o}^2)\Gamma_{\phi_o,\phi_o,\sigma_o,\sigma_o} + 3|\Gamma_{\phi_o,g,\phi_o}|^2F_0(p^2, m_{\phi_o}^2, 0) + 3\left(|\Gamma_{\phi_o,\bar{g}_1,\bar{g}_1}^L|^2 + |\Gamma_{\phi_o,\bar{g}_1,\bar{g}_1}^R|^2\right)G_0(p^2, m_{\bar{g}}^2, m_{\bar{g}}^2) \\
& + \frac{1}{2}\sum_{a=1}^6\sum_{b=1}^6|\Gamma_{\phi_o,\bar{d}_a^*,\bar{d}_b}|^2B_0(p^2, m_{\bar{d}_a}^2, m_{\bar{d}_b}^2) + \frac{1}{2}\sum_{a=1}^6\sum_{b=1}^6|\Gamma_{\phi_o,\bar{u}_a^*,\bar{u}_b}|^2B_0(p^2, m_{\bar{u}_a}^2, m_{\bar{u}_b}^2) \\
& - 6B_0(p^2, m_{\bar{g}}^2, m_{\bar{g}}^2)m_{\bar{g}}^2\left(\Gamma_{\phi_o,\bar{g}_1,\bar{g}_1}^{L*}\Gamma_{\phi_o,\bar{g}_1,\bar{g}_1}^R + \Gamma_{\phi_o,\bar{g}_1,\bar{g}_1}^{R*}\Gamma_{\phi_o,\bar{g}_1,\bar{g}_1}^L\right)
\end{aligned} \tag{248}$$

• **Self-Energy for Z-Boson** ( $Z$ )

$$\begin{aligned}
\Pi(p^2) = & +|\Gamma_{Z,\eta^-, \eta^-}|^2B_{00}(p^2, m_{\eta^-}^2, m_{\eta^-}^2) + |\Gamma_{Z,\eta^+, \eta^+}|^2B_{00}(p^2, m_{\eta^+}^2, m_{\eta^+}^2) \\
& - 4|\Gamma_{Z,R_d^-, R_d^-}|^2B_{00}(p^2, m_{R_d^-}^2, m_{R_d^-}^2) - 4|\Gamma_{Z,R_u^+, R_u^+}|^2B_{00}(p^2, m_{R_u^+}^2, m_{R_u^+}^2) \\
& + A_0(m_{R_d^+}^2)\Gamma_{Z,Z,R_d^-, R_d^+} + A_0(m_{R_u^-}^2)\Gamma_{Z,Z,R_u^+, R_u^-} \\
& - |\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) \\
& + \sum_{a=1}^2A_0(m_{R_a^h}^2)\Gamma_{Z,Z,R_a^{h,*}, R_a^h} - 4\sum_{a=1}^2\sum_{b=1}^2|\Gamma_{Z,R_a^{h,*}, R_b^h}|^2B_{00}(p^2, m_{R_a^h}^2, m_{R_b^h}^2) \\
& + \sum_{a=1}^2\sum_{b=1}^2\left[\left(|\Gamma_{Z,\bar{\chi}_a^-, \bar{\chi}_b^+}^L|^2 + |\Gamma_{Z,\bar{\chi}_a^-, \bar{\chi}_b^+}^R|^2\right)H_0(p^2, m_{\bar{\chi}_a^+}^2, m_{\bar{\chi}_b^+}^2) \right. \\
& \left. + 4B_0(p^2, m_{\bar{\chi}_a^+}^2, m_{\bar{\chi}_b^+}^2)m_{\bar{\chi}_a^+}m_{\bar{\chi}_b^+}\Re\left(\Gamma_{Z,\bar{\chi}_a^-, \bar{\chi}_b^+}^{L*}\Gamma_{Z,\bar{\chi}_a^-, \bar{\chi}_b^+}^R\right)\right] \\
& + \sum_{a=1}^2\sum_{b=1}^2\left[\left(|\Gamma_{Z,\bar{\rho}_a^+, \bar{\rho}_b^-}^L|^2 + |\Gamma_{Z,\bar{\rho}_a^+, \bar{\rho}_b^-}^R|^2\right)H_0(p^2, m_{\bar{\rho}_a^-}^2, m_{\bar{\rho}_b^-}^2) \right. \\
& \left. + 4B_0(p^2, m_{\bar{\rho}_a^-}^2, m_{\bar{\rho}_b^-}^2)m_{\bar{\rho}_a^-}m_{\bar{\rho}_b^-}\Re\left(\Gamma_{Z,\bar{\rho}_a^+, \bar{\rho}_b^-}^{L*}\Gamma_{Z,\bar{\rho}_a^+, \bar{\rho}_b^-}^R\right)\right] \\
& + \sum_{a=1}^3A_0(m_{\bar{\nu}_a}^2)\Gamma_{Z,Z,\bar{\nu}_a^*, \bar{\nu}_a} - 4\sum_{a=1}^3\sum_{b=1}^3|\Gamma_{Z,\bar{\nu}_a^*, \bar{\nu}_b}|^2B_{00}(p^2, m_{\bar{\nu}_a}^2, m_{\bar{\nu}_b}^2) \\
& + 3\sum_{a=1}^3\sum_{b=1}^3\left[\left(|\Gamma_{Z,\bar{d}_a, d_b}^L|^2 + |\Gamma_{Z,\bar{d}_a, d_b}^R|^2\right)H_0(p^2, m_{\bar{d}_a}^2, m_{d_b}^2) \right. \\
& \left. + 4B_0(p^2, m_{\bar{d}_a}^2, m_{d_b}^2)m_{\bar{d}_a}m_{d_b}\Re\left(\Gamma_{Z,\bar{d}_a, d_b}^{L*}\Gamma_{Z,\bar{d}_a, d_b}^R\right)\right] \\
& + \sum_{a=1}^3\sum_{b=1}^3\left[\left(|\Gamma_{Z,\bar{e}_a, e_b}^L|^2 + |\Gamma_{Z,\bar{e}_a, e_b}^R|^2\right)H_0(p^2, m_{\bar{e}_a}^2, m_{e_b}^2) \right. \\
& \left. + 4B_0(p^2, m_{\bar{e}_a}^2, m_{e_b}^2)m_{\bar{e}_a}m_{e_b}\Re\left(\Gamma_{Z,\bar{e}_a, e_b}^{L*}\Gamma_{Z,\bar{e}_a, e_b}^R\right)\right]
\end{aligned}$$

$$\begin{aligned}
& + 3 \sum_{a=1}^3 \sum_{b=1}^3 \left[ \left( |\Gamma_{Z, \bar{u}_a, u_b}^L|^2 + |\Gamma_{Z, \bar{u}_a, u_b}^R|^2 \right) H_0 \left( p^2, m_{u_a}^2, m_{u_b}^2 \right) \right. \\
& + 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) \left. \right] \\
& + \sum_{a=1}^3 \sum_{b=1}^3 \left[ \left( |\Gamma_{Z, \bar{\nu}_a, \nu_b}^L|^2 + |\Gamma_{Z, \bar{\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, \bar{\nu}_a, \nu_b}^{L*} \Gamma_{Z, \bar{\nu}_a, \nu_b}^R \right) \left. \right] \\
& + \frac{1}{2} \sum_{a=1}^4 A_0 \left( m_{A_a^0}^2 \right) \Gamma_{Z, Z, A_a^0, A_a^0} + \sum_{a=1}^4 A_0 \left( m_{H_a^-}^2 \right) \Gamma_{Z, Z, H_a^+, H_a^-} + \frac{1}{2} \sum_{a=1}^4 A_0 \left( m_{h_a}^2 \right) \Gamma_{Z, Z, h_a, h_a} \\
& - 4 \sum_{a=1}^4 \sum_{b=1}^4 |\Gamma_{Z, h_a, A_b^0}|^2 B_{00} \left( p^2, m_{A_b^0}^2, m_{h_a}^2 \right) - 4 \sum_{a=1}^4 \sum_{b=1}^4 |\Gamma_{Z, H_a^+, H_b^-}|^2 B_{00} \left( p^2, m_{H_a^-}^2, m_{H_b^-}^2 \right) \\
& + \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) \left. \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) + 2 \sum_{b=1}^4 |\Gamma_{Z, W^+, H_b^-}|^2 B_0 \left( p^2, m_{W^-}^2, m_{H_b^-}^2 \right) \\
& + \sum_{b=1}^4 |\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)
\end{aligned} \tag{249}$$

• **Self-Energy for W-Boson ( $W^-$ )**

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

$$\begin{aligned}
& + 4B_0\left(p^2, m_{\nu_a}^2, m_{e_b}^2\right) m_{e_b} m_{\nu_a} \Re\left(\Gamma_{W^+, \bar{\nu}_a, e_b}^{L*} \Gamma_{W^+, \bar{\nu}_a, e_b}^R\right) + \sum_{a=1}^4 A_0\left(m_{H_a^-}^2\right) \Gamma_{W^-, W^+, H_a^+, H_a^-} + \sum_{a=1}^4 \sum_{b=1}^2 \left[ \left| \Gamma_{W^+, \bar{\chi}_a^0, \bar{\rho}_b^-}^L \right|^2 + \left| \Gamma_{W^+}^R \right|^2 \right] \\
& + 4B_0\left(p^2, m_{\bar{\chi}_a^0}^2, m_{\bar{\rho}_b^-}^2\right) m_{\bar{\rho}_b^-} m_{\bar{\chi}_a^0} \Re\left(\Gamma_{W^+, \bar{\chi}_a^0, \bar{\rho}_b^-}^{L*} \Gamma_{W^+, \bar{\chi}_a^0, \bar{\rho}_b^-}^R\right) + \sum_{a=1}^6 A_0\left(m_{\bar{e}_a}^2\right) \Gamma_{W^-, W^+, \bar{e}_a^*, \bar{e}_a} + \sum_{b=1}^4 \left| \Gamma_{W^+, \gamma, H_b^-} \right|^2 B_0\left(p^2, 0, m_{H_b^-}^2\right)
\end{aligned} \tag{250}$$

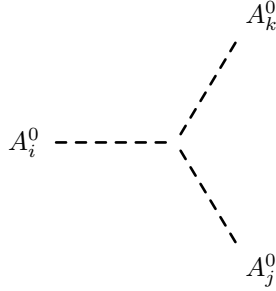
## 8.2 Tadpoles

$$\begin{aligned}
\delta t_h^{(1)} = & + A_0\left(m_{\eta^-}^2\right) \Gamma_{\check{h}_i, \eta^-, \eta^-} + A_0\left(m_{\eta^+}^2\right) \Gamma_{\check{h}_i, \eta^+, \eta^+} + A_0\left(m_{\eta^Z}^2\right) \Gamma_{\check{h}_i, \eta^Z, \eta^Z} \\
& - A_0\left(m_{R_d^+}^2\right) \Gamma_{\check{h}_i, R_d^-, R_d^+} - A_0\left(m_{R_u^-}^2\right) \Gamma_{\check{h}_i, R_u^+, R_u^-} + 4\Gamma_{\check{h}_i, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0\left(m_{W^-}^2\right) \right) \\
& + 2\Gamma_{\check{h}_i, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0\left(m_Z^2\right) \right) - \sum_{a=1}^2 A_0\left(m_{R_a^h}^2\right) \Gamma_{\check{h}_i, R_a^{h,*}, R_a^h} \\
& + 2 \sum_{a=1}^2 A_0\left(m_{\bar{\chi}_a^+}^2\right) m_{\bar{\chi}_a^+} \left( \Gamma_{\check{h}_i, \bar{\chi}_a^-, \bar{\chi}_a^+}^L + \Gamma_{\check{h}_i, \bar{\chi}_a^-, \bar{\chi}_a^+}^R \right) \\
& + 2 \sum_{a=1}^2 A_0\left(m_{\bar{\rho}_a^-}^2\right) m_{\bar{\rho}_a^-} \left( \Gamma_{\check{h}_i, \bar{\rho}_a^+, \bar{\rho}_a^-}^L + \Gamma_{\check{h}_i, \bar{\rho}_a^+, \bar{\rho}_a^-}^R \right) - \sum_{a=1}^3 A_0\left(m_{\bar{\nu}_a}^2\right) \Gamma_{\check{h}_i, \bar{\nu}_a^*, \bar{\nu}_a} \\
& + 6 \sum_{a=1}^3 A_0\left(m_{d_a}^2\right) m_{d_a} \left( \Gamma_{\check{h}_i, \bar{d}_a, d_a}^L + \Gamma_{\check{h}_i, \bar{d}_a, d_a}^R \right) \\
& + 2 \sum_{a=1}^3 A_0\left(m_{e_a}^2\right) m_{e_a} \left( \Gamma_{\check{h}_i, \bar{e}_a, e_a}^L + \Gamma_{\check{h}_i, \bar{e}_a, e_a}^R \right) \\
& + 6 \sum_{a=1}^3 A_0\left(m_{u_a}^2\right) m_{u_a} \left( \Gamma_{\check{h}_i, \bar{u}_a, u_a}^L + \Gamma_{\check{h}_i, \bar{u}_a, u_a}^R \right) - \frac{1}{2} \sum_{a=1}^4 A_0\left(m_{A_a^0}^2\right) \Gamma_{\check{h}_i, A_a^0, A_a^0} \\
& - \sum_{a=1}^4 A_0\left(m_{H_a^-}^2\right) \Gamma_{\check{h}_i, H_a^+, H_a^-} - \frac{1}{2} \sum_{a=1}^4 A_0\left(m_{h_a}^2\right) \Gamma_{\check{h}_i, h_a, h_a} \\
& + 2 \sum_{a=1}^4 A_0\left(m_{\bar{\chi}_a^0}^2\right) m_{\bar{\chi}_a^0} \left( \Gamma_{\check{h}_i, \bar{\chi}_a^0, \bar{\chi}_a^0}^L + \Gamma_{\check{h}_i, \bar{\chi}_a^0, \bar{\chi}_a^0}^R \right) - 3 \sum_{a=1}^6 A_0\left(m_{\bar{d}_a}^2\right) \Gamma_{\check{h}_i, \bar{d}_a^*, \bar{d}_a} \\
& - \sum_{a=1}^6 A_0\left(m_{\bar{e}_a}^2\right) \Gamma_{\check{h}_i, \bar{e}_a^*, \bar{e}_a} - 3 \sum_{a=1}^6 A_0\left(m_{\bar{u}_a}^2\right) \Gamma_{\check{h}_i, \bar{u}_a^*, \bar{u}_a}
\end{aligned} \tag{251}$$

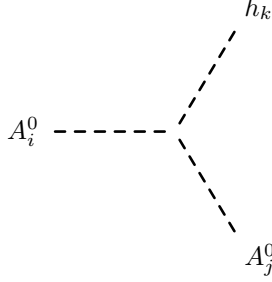
$$\begin{aligned}
\delta t_{\phi_o}^{(1)} = & -\frac{1}{2} \sum_{a=1}^6 A_0\left(m_{\bar{d}_a}^2\right) \Gamma_{\phi_o, \bar{d}_a^*, \bar{d}_a} - \frac{1}{2} \sum_{a=1}^6 A_0\left(m_{\bar{u}_a}^2\right) \Gamma_{\phi_o, \bar{u}_a^*, \bar{u}_a} \\
& + 6A_0\left(m_{\bar{g}}^2\right) m_{\bar{g}} \left( \Gamma_{\phi_o, \bar{g}_1, \bar{g}_1}^L + \Gamma_{\phi_o, \bar{g}_1, \bar{g}_1}^R \right)
\end{aligned} \tag{252}$$

## 9 Interactions for eigenstates 'EWSB'

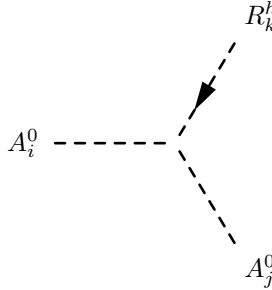
### 9.1 Three Scalar-Interaction



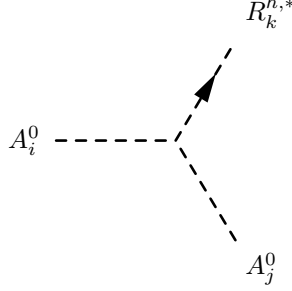
$$\begin{aligned}
& \frac{1}{4} \left( -2g_1 M_D^B Z_{i1}^A Z_{j3}^A Z_{k1}^A - 2\sqrt{2}\mu_D \lambda_D^* Z_{i1}^A Z_{j3}^A Z_{k1}^A - \sqrt{2}\Lambda_D v_T \lambda_D^* Z_{i1}^A Z_{j3}^A Z_{k1}^A \right. \\
& + \sqrt{2}\lambda_D v_T \Lambda_D^* Z_{i1}^A Z_{j3}^A Z_{k1}^A + 2g_1 M_D^{B,*} Z_{i1}^A Z_{j3}^A Z_{k1}^A + 2\sqrt{2}\lambda_D \mu_D^* Z_{i1}^A Z_{j3}^A Z_{k1}^A \\
& + 2g_2 M_D^W Z_{i1}^A Z_{j4}^A Z_{k1}^A + \sqrt{2}\Lambda_D v_s \lambda_D^* Z_{i1}^A Z_{j4}^A Z_{k1}^A - 2\mu_D \Lambda_D^* Z_{i1}^A Z_{j4}^A Z_{k1}^A \\
& - \sqrt{2}\lambda_D v_s \Lambda_D^* Z_{i1}^A Z_{j4}^A Z_{k1}^A - 2g_2 M_D^{W,*} Z_{i1}^A Z_{j4}^A Z_{k1}^A + 2\Lambda_D \mu_D^* Z_{i1}^A Z_{j4}^A Z_{k1}^A \\
& + 2g_1 M_D^B Z_{i2}^A Z_{j3}^A Z_{k2}^A - 2\sqrt{2}\mu_U \lambda_U^* Z_{i2}^A Z_{j3}^A Z_{k2}^A + \sqrt{2}\Lambda_U v_T \lambda_U^* Z_{i2}^A Z_{j3}^A Z_{k2}^A \\
& - \sqrt{2}\lambda_U v_T \Lambda_U^* Z_{i2}^A Z_{j3}^A Z_{k2}^A - 2g_1 M_D^{B,*} Z_{i2}^A Z_{j3}^A Z_{k2}^A + 2\sqrt{2}\lambda_U \mu_U^* Z_{i2}^A Z_{j3}^A Z_{k2}^A \\
& - 2g_2 M_D^W Z_{i2}^A Z_{j4}^A Z_{k2}^A - \sqrt{2}\Lambda_U v_s \lambda_U^* Z_{i2}^A Z_{j4}^A Z_{k2}^A + 2\mu_U \Lambda_U^* Z_{i2}^A Z_{j4}^A Z_{k2}^A \\
& + \sqrt{2}\lambda_U v_s \Lambda_U^* Z_{i2}^A Z_{j4}^A Z_{k2}^A + 2g_2 M_D^{W,*} Z_{i2}^A Z_{j4}^A Z_{k2}^A - 2\Lambda_U \mu_U^* Z_{i2}^A Z_{j4}^A Z_{k2}^A \\
& + Z_{i3}^A \left( \left( -2g_1 M_D^B + 2g_1 M_D^{B,*} + 2\sqrt{2}\lambda_D \mu_D^* - \sqrt{2}(2\mu_D + \Lambda_D v_T) \lambda_D^* + \sqrt{2}\lambda_D v_T \Lambda_D^* \right) Z_{j1}^A Z_{k1}^A \right. \\
& + \left( -2g_1 M_D^{B,*} + 2g_1 M_D^B + 2\sqrt{2}\lambda_U \mu_U^* + \sqrt{2}(-2\mu_U + \Lambda_U v_T) \lambda_U^* - \sqrt{2}\lambda_U v_T \Lambda_U^* \right) Z_{j2}^A Z_{k2}^A \Big) \\
& + Z_{i4}^A \left( \left( -2g_2 M_D^{W,*} + 2g_2 M_D^W + 2\Lambda_D \mu_D^* - 2\mu_D \Lambda_D^* - \sqrt{2}\lambda_D v_s \Lambda_D^* + \sqrt{2}\Lambda_D v_s \lambda_D^* \right) Z_{j1}^A Z_{k1}^A \right. \\
& + \left( -2g_2 M_D^W + 2g_2 M_D^{W,*} - 2\Lambda_U \mu_U^* + 2\mu_U \Lambda_U^* - \sqrt{2}\lambda_U v_s \lambda_U^* + \sqrt{2}\lambda_U v_s \Lambda_U^* \right) Z_{j2}^A Z_{k2}^A \Big) \\
& - 2g_1 M_D^B Z_{i1}^A Z_{j1}^A Z_{k3}^A - 2\sqrt{2}\mu_D \lambda_D^* Z_{i1}^A Z_{j1}^A Z_{k3}^A - \sqrt{2}\Lambda_D v_T \lambda_D^* Z_{i1}^A Z_{j1}^A Z_{k3}^A \\
& + \sqrt{2}\lambda_D v_T \Lambda_D^* Z_{i1}^A Z_{j1}^A Z_{k3}^A + 2g_1 M_D^{B,*} Z_{i1}^A Z_{j1}^A Z_{k3}^A + 2\sqrt{2}\lambda_D \mu_D^* Z_{i1}^A Z_{j1}^A Z_{k3}^A \\
& + 2g_1 M_D^B Z_{i2}^A Z_{j2}^A Z_{k3}^A - 2\sqrt{2}\mu_U \lambda_U^* Z_{i2}^A Z_{j2}^A Z_{k3}^A + \sqrt{2}\Lambda_U v_T \lambda_U^* Z_{i2}^A Z_{j2}^A Z_{k3}^A \\
& - \sqrt{2}\lambda_U v_T \Lambda_U^* Z_{i2}^A Z_{j2}^A Z_{k3}^A - 2g_1 M_D^{B,*} Z_{i2}^A Z_{j2}^A Z_{k3}^A + 2\sqrt{2}\lambda_U \mu_U^* Z_{i2}^A Z_{j2}^A Z_{k3}^A \\
& + 2g_2 M_D^W Z_{i1}^A Z_{j1}^A Z_{k4}^A + \sqrt{2}\Lambda_D v_s \lambda_D^* Z_{i1}^A Z_{j1}^A Z_{k4}^A - 2\mu_D \Lambda_D^* Z_{i1}^A Z_{j1}^A Z_{k4}^A \\
& - \sqrt{2}\lambda_D v_s \Lambda_D^* Z_{i1}^A Z_{j1}^A Z_{k4}^A - 2g_2 M_D^{W,*} Z_{i1}^A Z_{j1}^A Z_{k4}^A + 2\Lambda_D \mu_D^* Z_{i1}^A Z_{j1}^A Z_{k4}^A \\
& - 2g_2 M_D^W Z_{i2}^A Z_{j2}^A Z_{k4}^A - \sqrt{2}\Lambda_U v_s \lambda_U^* Z_{i2}^A Z_{j2}^A Z_{k4}^A + 2\mu_U \Lambda_U^* Z_{i2}^A Z_{j2}^A Z_{k4}^A \\
& + \sqrt{2}\lambda_U v_s \Lambda_U^* Z_{i2}^A Z_{j2}^A Z_{k4}^A + 2g_2 M_D^{W,*} Z_{i2}^A Z_{j2}^A Z_{k4}^A - 2\Lambda_U \mu_U^* Z_{i2}^A Z_{j2}^A Z_{k4}^A \Big)
\end{aligned} \tag{253}$$



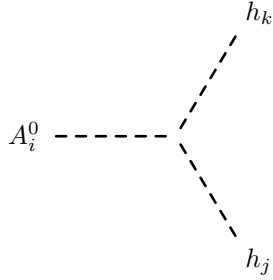
$$\begin{aligned}
& -\frac{i}{4} \left( 4v_d |\lambda_D|^2 Z_{i3}^A Z_{j3}^A Z_{k1}^H + \sqrt{2} \Lambda_D v_d \lambda_D^* Z_{i4}^A Z_{j3}^A Z_{k1}^H + \sqrt{2} \Lambda_D v_d \Lambda_D^* Z_{i4}^A Z_{j3}^A Z_{k1}^H \right. \\
& + \sqrt{2} \Lambda_D v_d \lambda_D^* Z_{i3}^A Z_{j4}^A Z_{k1}^H + \sqrt{2} \Lambda_D v_d \Lambda_D^* Z_{i3}^A Z_{j4}^A Z_{k1}^H + 2v_d |\Lambda_D|^2 Z_{i4}^A Z_{j4}^A Z_{k1}^H \\
& + 4v_u |\lambda_U|^2 Z_{i3}^A Z_{j3}^A Z_{k2}^H - \sqrt{2} \Lambda_U v_u \lambda_U^* Z_{i4}^A Z_{j3}^A Z_{k2}^H - \sqrt{2} \Lambda_U v_u \Lambda_U^* Z_{i4}^A Z_{j3}^A Z_{k2}^H \\
& - \sqrt{2} \Lambda_U v_u \lambda_U^* Z_{i3}^A Z_{j4}^A Z_{k2}^H - \sqrt{2} \Lambda_U v_u \Lambda_U^* Z_{i3}^A Z_{j4}^A Z_{k2}^H + 2v_u |\Lambda_U|^2 Z_{i4}^A Z_{j4}^A Z_{k2}^H \\
& + Z_{i1}^A Z_{j1}^A \left( (g_1^2 + g_2^2) v_d Z_{k1}^H - (g_1^2 + g_2^2) v_u Z_{k2}^H - 2g_1 M_D^B Z_{k3}^H + 4v_s |\lambda_D|^2 Z_{k3}^H + 2\sqrt{2} \mu_D \lambda_D^* Z_{k3}^H \right. \\
& + \sqrt{2} \Lambda_D v_T \lambda_D^* Z_{k3}^H + \sqrt{2} \Lambda_D v_T \Lambda_D^* Z_{k3}^H - 2g_1 M_D^{B,*} Z_{k3}^H + 2\sqrt{2} \lambda_D \mu_D^* Z_{k3}^H + 2g_2 M_D^W Z_{k4}^H \\
& + 2v_T |\Lambda_D|^2 Z_{k4}^H + \sqrt{2} \Lambda_D v_s \lambda_D^* Z_{k4}^H + 2\mu_D \Lambda_D^* Z_{k4}^H + \sqrt{2} \lambda_D v_s \Lambda_D^* Z_{k4}^H + 2g_2 M_D^{W,*} Z_{k4}^H \\
& \left. + 2\Lambda_D \mu_D^* Z_{k4}^H \right) \\
& - Z_{i2}^A Z_{j2}^A \left( (g_1^2 + g_2^2) v_d Z_{k1}^H - (g_1^2 + g_2^2) v_u Z_{k2}^H - 2g_1 M_D^B Z_{k3}^H - 4v_s |\lambda_U|^2 Z_{k3}^H - 2\sqrt{2} \mu_U \lambda_U^* Z_{k3}^H \right. \\
& + \sqrt{2} \Lambda_U v_T \lambda_U^* Z_{k3}^H + \sqrt{2} \Lambda_U v_T \Lambda_U^* Z_{k3}^H - 2g_1 M_D^{B,*} Z_{k3}^H - 2\sqrt{2} \lambda_U \mu_U^* Z_{k3}^H + 2g_2 M_D^W Z_{k4}^H \\
& - 2v_T |\Lambda_U|^2 Z_{k4}^H + \sqrt{2} \Lambda_U v_s \lambda_U^* Z_{k4}^H + 2\mu_U \Lambda_U^* Z_{k4}^H + \sqrt{2} \lambda_U v_s \Lambda_U^* Z_{k4}^H + 2g_2 M_D^{W,*} Z_{k4}^H \\
& \left. + 2\Lambda_U \mu_U^* Z_{k4}^H \right) \Big) \tag{254}
\end{aligned}$$



$$\begin{aligned}
& -\frac{i}{4} \mu^* \left( 2\lambda_D Z_{i2}^A Z_{j3}^A Z_{k1}^R + \sqrt{2} \Lambda_D Z_{i2}^A Z_{j4}^A Z_{k1}^R - 2\lambda_U Z_{i1}^A Z_{j3}^A Z_{k2}^R + \sqrt{2} \Lambda_U Z_{i1}^A Z_{j4}^A Z_{k2}^R \right. \\
& \left. + 2Z_{i3}^A \left( \lambda_D Z_{j2}^A Z_{k1}^R - \lambda_U Z_{j1}^A Z_{k2}^R \right) + \sqrt{2} Z_{i4}^A \left( \Lambda_D Z_{j2}^A Z_{k1}^R + \Lambda_U Z_{j1}^A Z_{k2}^R \right) \right) \tag{255}
\end{aligned}$$



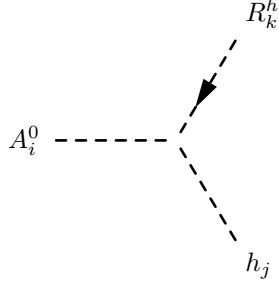
$$\begin{aligned}
& -\frac{i}{4}\mu\left(2\lambda_D^*\left(Z_{i2}^AZ_{j3}^A+Z_{i3}^AZ_{j2}^A\right)Z_{k1}^R+\sqrt{2}\Lambda_D^*\left(Z_{i2}^AZ_{j4}^A+Z_{i4}^AZ_{j2}^A\right)Z_{k1}^R\right. \\
& \left.+ \left(-2\lambda_U^*\left(Z_{i1}^AZ_{j3}^A+Z_{i3}^AZ_{j1}^A\right)+\sqrt{2}\Lambda_U^*\left(Z_{i1}^AZ_{j4}^A+Z_{i4}^AZ_{j1}^A\right)\right)Z_{k2}^R\right)
\end{aligned} \tag{256}$$



$$\begin{aligned}
& \frac{1}{4}\left(Z_{i4}^A\left(\sqrt{2}\Lambda_D v_d \lambda_D^* Z_{j3}^H Z_{k1}^H - \sqrt{2}\lambda_D v_d \Lambda_D^* Z_{j3}^H Z_{k1}^H - 2g_2 M_D^W Z_{j2}^H Z_{k2}^H\right.\right. \\
& - \sqrt{2}\Lambda_U v_s \lambda_U^* Z_{j2}^H Z_{k2}^H + 2\mu_U \Lambda_U^* Z_{j2}^H Z_{k2}^H + \sqrt{2}\lambda_U v_s \Lambda_U^* Z_{j2}^H Z_{k2}^H + 2g_2 M_D^{W,*} Z_{j2}^H Z_{k2}^H \\
& - 2\Lambda_U \mu_U^* Z_{j2}^H Z_{k2}^H - \sqrt{2}\Lambda_U v_u \lambda_U^* Z_{j3}^H Z_{k2}^H + \sqrt{2}\lambda_U v_u \Lambda_U^* Z_{j3}^H Z_{k2}^H \\
& - \sqrt{2}\Lambda_U v_u \lambda_U^* Z_{j2}^H Z_{k3}^H + \sqrt{2}\lambda_U v_u \Lambda_U^* Z_{j2}^H Z_{k3}^H \\
& \left. + Z_{j1}^H\left(\left(-2g_2 M_D^{W,*} + 2g_2 M_D^W + 2\Lambda_D \mu_D^* - 2\mu_D \Lambda_D^* - \sqrt{2}\lambda_D v_s \Lambda_D^* + \sqrt{2}\Lambda_D v_s \lambda_D^*\right)Z_{k1}^H\right.\right. \\
& \left. + \sqrt{2}v_d\left(-\lambda_D \Lambda_D^* + \Lambda_D \lambda_D^*\right)Z_{k3}^H\right) \\
& + Z_{i3}^A\left(-\sqrt{2}\Lambda_D v_d \lambda_D^* Z_{j4}^H Z_{k1}^H + \sqrt{2}\lambda_D v_d \Lambda_D^* Z_{j4}^H Z_{k1}^H + 2g_1 M_D^B Z_{j2}^H Z_{k2}^H\right. \\
& - 2\sqrt{2}\mu_U \lambda_U^* Z_{j2}^H Z_{k2}^H + \sqrt{2}\Lambda_U v_T \lambda_U^* Z_{j2}^H Z_{k2}^H - \sqrt{2}\lambda_U v_T \Lambda_U^* Z_{j2}^H Z_{k2}^H \\
& - 2g_1 M_D^{B,*} Z_{j2}^H Z_{k2}^H + 2\sqrt{2}\lambda_U \mu_U^* Z_{j2}^H Z_{k2}^H + \sqrt{2}\Lambda_U v_u \lambda_U^* Z_{j4}^H Z_{k2}^H \\
& - \sqrt{2}\lambda_U v_u \Lambda_U^* Z_{j4}^H Z_{k2}^H + \sqrt{2}\Lambda_U v_u \lambda_U^* Z_{j2}^H Z_{k4}^H - \sqrt{2}\lambda_U v_u \Lambda_U^* Z_{j2}^H Z_{k4}^H \\
& \left. + Z_{j1}^H\left(\left(-2g_1 M_D^B + 2g_1 M_D^{B,*} + 2\sqrt{2}\lambda_D \mu_D^* - \sqrt{2}\left(2\mu_D + \Lambda_D v_T\right)\lambda_D^* + \sqrt{2}\lambda_D v_T \Lambda_D^*\right)Z_{k1}^H\right.\right.
\end{aligned}$$

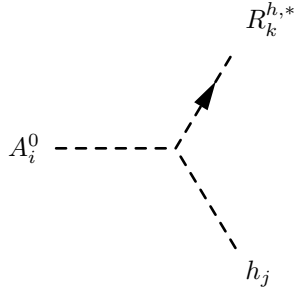
$$+ \sqrt{2}v_d \left( -\Lambda_D \lambda_D^* + \lambda_D \Lambda_D^* \right) Z_{k4}^H \Big) \Big) \quad (257)$$


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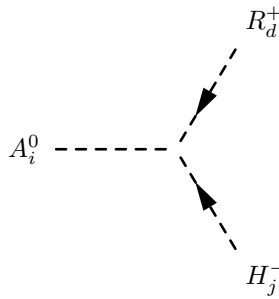
$$\begin{aligned} & \frac{1}{4} \mu^* \left( -2\lambda_D Z_{i2}^A Z_{j3}^H Z_{k1}^R - \sqrt{2}\Lambda_D Z_{i2}^A Z_{j4}^H Z_{k1}^R + 2\lambda_U Z_{i1}^A Z_{j3}^H Z_{k2}^R - \sqrt{2}\Lambda_U Z_{i1}^A Z_{j4}^H Z_{k2}^R \right. \\ & \left. + 2Z_{i3}^A \left( \lambda_D Z_{j2}^H Z_{k1}^R - \lambda_U Z_{j1}^H Z_{k2}^R \right) + \sqrt{2}Z_{i4}^A \left( \Lambda_D Z_{j2}^H Z_{k1}^R + \Lambda_U Z_{j1}^H Z_{k2}^R \right) \right) \quad (258) \end{aligned}$$


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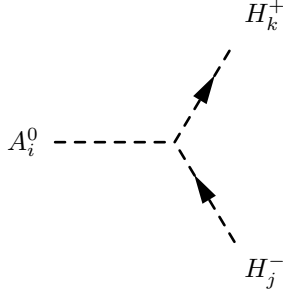
$$\begin{aligned} & \frac{1}{4} \mu \left( 2\lambda_D^* \left( Z_{i2}^A Z_{j3}^H - Z_{i3}^A Z_{j2}^H \right) Z_{k1}^R + \sqrt{2}\Lambda_D^* \left( Z_{i2}^A Z_{j4}^H - Z_{i4}^A Z_{j2}^H \right) Z_{k1}^R \right. \\ & \left. + \left( 2\lambda_U^* \left( -Z_{i1}^A Z_{j3}^H + Z_{i3}^A Z_{j1}^H \right) + \sqrt{2}\Lambda_U^* \left( Z_{i1}^A Z_{j4}^H - Z_{i4}^A Z_{j1}^H \right) \right) Z_{k2}^R \right) \quad (259) \end{aligned}$$


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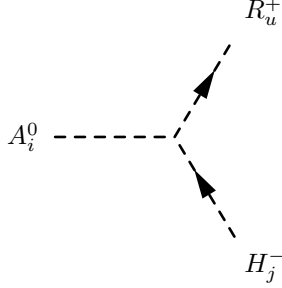


$$\frac{1}{2}\mu^* \left( -\Lambda_D Z_{i4}^A Z_{j2}^+ + \sqrt{2}\Lambda_D Z_{i2}^A Z_{j3}^+ + \sqrt{2}\lambda_D Z_{i3}^A Z_{j2}^+ \right) \quad (260)$$

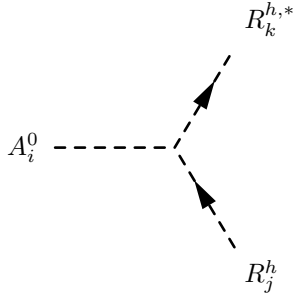


$$\begin{aligned} & \frac{1}{4} \left( g_2^2 v_u Z_{i1}^A Z_{j2}^+ Z_{k1}^+ + g_2^2 v_d Z_{i2}^A Z_{j2}^+ Z_{k1}^+ + 2\sqrt{2}g_2 M_D^W Z_{i1}^A Z_{j3}^+ Z_{k1}^+ \right. \\ & + \sqrt{2}g_2^2 v_T Z_{i1}^A Z_{j3}^+ Z_{k1}^+ - \sqrt{2}v_T |\Lambda_D|^2 Z_{i1}^A Z_{j3}^+ Z_{k1}^+ + 2\Lambda_D v_s \lambda_D^* Z_{i1}^A Z_{j3}^+ Z_{k1}^+ \\ & + 2\sqrt{2}\Lambda_D \mu_D^* Z_{i1}^A Z_{j3}^+ Z_{k1}^+ - \sqrt{2}g_2^2 v_T Z_{i1}^A Z_{j4}^+ Z_{k1}^+ + \sqrt{2}v_T |\Lambda_D|^2 Z_{i1}^A Z_{j4}^+ Z_{k1}^+ \\ & + 2\sqrt{2}\mu_D \Lambda_D^* Z_{i1}^A Z_{j4}^+ Z_{k1}^+ + 2\lambda_D v_s \Lambda_D^* Z_{i1}^A Z_{j4}^+ Z_{k1}^+ + 2\sqrt{2}g_2 M_D^{W,*} Z_{i1}^A Z_{j4}^+ Z_{k1}^+ \\ & - g_2^2 v_u Z_{i1}^A Z_{j1}^+ Z_{k2}^+ - g_2^2 v_d Z_{i2}^A Z_{j1}^+ Z_{k2}^+ - 2\sqrt{2}g_2 M_D^W Z_{i2}^A Z_{j3}^+ Z_{k2}^+ \\ & - \sqrt{2}g_2^2 v_T Z_{i2}^A Z_{j3}^+ Z_{k2}^+ + \sqrt{2}v_T |\Lambda_U|^2 Z_{i2}^A Z_{j3}^+ Z_{k2}^+ - 2\Lambda_U v_s \lambda_U^* Z_{i2}^A Z_{j3}^+ Z_{k2}^+ \\ & - 2\sqrt{2}\Lambda_U \mu_U^* Z_{i2}^A Z_{j3}^+ Z_{k2}^+ + \sqrt{2}g_2^2 v_T Z_{i2}^A Z_{j4}^+ Z_{k2}^+ - \sqrt{2}v_T |\Lambda_U|^2 Z_{i2}^A Z_{j4}^+ Z_{k2}^+ \\ & - 2\sqrt{2}\mu_U \Lambda_U^* Z_{i2}^A Z_{j4}^+ Z_{k2}^+ - 2\lambda_U v_s \Lambda_U^* Z_{i2}^A Z_{j4}^+ Z_{k2}^+ - 2\sqrt{2}g_2 M_D^{W,*} Z_{i2}^A Z_{j4}^+ Z_{k2}^+ \\ & - \sqrt{2}g_2^2 v_T Z_{i1}^A Z_{j1}^+ Z_{k3}^+ + \sqrt{2}v_T |\Lambda_D|^2 Z_{i1}^A Z_{j1}^+ Z_{k3}^+ - 2\sqrt{2}\mu_D \Lambda_D^* Z_{i1}^A Z_{j1}^+ Z_{k3}^+ \\ & - 2\lambda_D v_s \Lambda_D^* Z_{i1}^A Z_{j1}^+ Z_{k3}^+ - 2\sqrt{2}g_2 M_D^{W,*} Z_{i1}^A Z_{j1}^+ Z_{k3}^+ + \sqrt{2}g_2^2 v_T Z_{i2}^A Z_{j2}^+ Z_{k3}^+ \\ & - \sqrt{2}v_T |\Lambda_U|^2 Z_{i2}^A Z_{j2}^+ Z_{k3}^+ + 2\sqrt{2}\mu_U \Lambda_U^* Z_{i2}^A Z_{j2}^+ Z_{k3}^+ + 2\lambda_U v_s \Lambda_U^* Z_{i2}^A Z_{j2}^+ Z_{k3}^+ \\ & + 2\sqrt{2}g_2 M_D^{W,*} Z_{i2}^A Z_{j2}^+ Z_{k3}^+ - 2\sqrt{2}g_2 M_D^W Z_{i1}^A Z_{j1}^+ Z_{k4}^+ + \sqrt{2}g_2^2 v_T Z_{i1}^A Z_{j1}^+ Z_{k4}^+ \\ & - \sqrt{2}v_T |\Lambda_D|^2 Z_{i1}^A Z_{j1}^+ Z_{k4}^+ - 2\Lambda_D v_s \lambda_D^* Z_{i1}^A Z_{j1}^+ Z_{k4}^+ - 2\sqrt{2}\Lambda_D \mu_D^* Z_{i1}^A Z_{j1}^+ Z_{k4}^+ \\ & + 2\sqrt{2}g_2 M_D^W Z_{i2}^A Z_{j2}^+ Z_{k4}^+ - \sqrt{2}g_2^2 v_T Z_{i2}^A Z_{j2}^+ Z_{k4}^+ + \sqrt{2}v_T |\Lambda_U|^2 Z_{i2}^A Z_{j2}^+ Z_{k4}^+ \\ & + 2\Lambda_U v_s \lambda_U^* Z_{i2}^A Z_{j2}^+ Z_{k4}^+ + 2\sqrt{2}\Lambda_U \mu_U^* Z_{i2}^A Z_{j2}^+ Z_{k4}^+ \\ & + Z_{i4}^A \left( -\sqrt{2}g_2^2 v_d Z_{j4}^+ Z_{k1}^+ + \sqrt{2}v_d |\Lambda_D|^2 Z_{j4}^+ Z_{k1}^+ + 2g_2 M_D^W Z_{j2}^+ Z_{k2}^+ \right. \\ & + \sqrt{2}\Lambda_U v_s \lambda_U^* Z_{j2}^+ Z_{k2}^+ - 2\mu_U \Lambda_U^* Z_{j2}^+ Z_{k2}^+ - \sqrt{2}\lambda_U v_s \Lambda_U^* Z_{j2}^+ Z_{k2}^+ - 2g_2 M_D^{W,*} Z_{j2}^+ Z_{k2}^+ \\ & + 2\Lambda_U \mu_U^* Z_{j2}^+ Z_{k2}^+ - \sqrt{2}g_2^2 v_u Z_{j4}^+ Z_{k2}^+ + \sqrt{2}v_u |\Lambda_U|^2 Z_{j4}^+ Z_{k2}^+ + \sqrt{2}g_2^2 v_u Z_{j2}^+ Z_{k3}^+ \\ & - \sqrt{2}v_u |\Lambda_U|^2 Z_{j2}^+ Z_{k3}^+ - 4g_2^2 v_T Z_{j4}^+ Z_{k3}^+ + \sqrt{2}g_2^2 v_u Z_{j2}^+ Z_{k4}^+ \\ & - \sqrt{2}v_u |\Lambda_U|^2 Z_{j2}^+ Z_{k4}^+ \\ & \left. + Z_{j3}^+ \left( 4g_2^2 v_T Z_{k4}^+ + \sqrt{2}v_d \left( -g_2^2 + |\Lambda_D|^2 \right) Z_{k1}^+ + \sqrt{2}v_u \left( -g_2^2 + |\Lambda_U|^2 \right) Z_{k2}^+ \right) \right) \end{aligned}$$

$$\begin{aligned}
& + Z_{j_1}^+ \left( \left( -2g_2 M_D^W + 2g_2 M_D^{W,*} - 2\Lambda_D \mu_D^* + 2\mu_D \Lambda_D^* - \sqrt{2}\Lambda_D v_s \lambda_D^* + \sqrt{2}\lambda_D v_s \Lambda_D^* \right) Z_{k_1}^+ \right. \\
& + \left. \sqrt{2}v_d \left( -|\Lambda_D|^2 + g_2^2 \right) \left( Z_{k_3}^+ + Z_{k_4}^+ \right) \right) \\
& + Z_{i_3}^A \left( -2\Lambda_D v_d \lambda_D^* Z_{j_3}^+ Z_{k_1}^+ + 2\lambda_D v_d \Lambda_D^* Z_{j_4}^+ Z_{k_1}^+ + 2g_1 M_D^B Z_{j_2}^+ Z_{k_2}^+ - 2\sqrt{2}\mu_U \lambda_U^* Z_{j_2}^+ Z_{k_2}^+ \right. \\
& - \left. \sqrt{2}\Lambda_U v_T \lambda_U^* Z_{j_2}^+ Z_{k_2}^+ + \sqrt{2}\lambda_U v_T \Lambda_U^* Z_{j_2}^+ Z_{k_2}^+ - 2g_1 M_D^{B,*} Z_{j_2}^+ Z_{k_2}^+ \right. \\
& + 2\sqrt{2}\lambda_U \mu_U^* Z_{j_2}^+ Z_{k_2}^+ - 2\Lambda_U v_u \lambda_U^* Z_{j_3}^+ Z_{k_2}^+ + 2\lambda_U v_u \Lambda_U^* Z_{j_4}^+ Z_{k_2}^+ + 2\lambda_U v_u \Lambda_U^* Z_{j_2}^+ Z_{k_3}^+ \\
& - \left. 2\Lambda_U v_u \lambda_U^* Z_{j_2}^+ Z_{k_4}^+ \right) \\
& + Z_{j_1}^+ \left( \left( -2g_1 M_D^B + 2g_1 M_D^{B,*} + 2\sqrt{2}\lambda_D \mu_D^* + \sqrt{2} \left( -2\mu_D + \Lambda_D v_T \right) \lambda_D^* - \sqrt{2}\lambda_D v_T \Lambda_D^* \right) Z_{k_1}^+ \right. \\
& + \left. 2v_d \left( \lambda_D \Lambda_D^* Z_{k_3}^+ - \Lambda_D \lambda_D^* Z_{k_4}^+ \right) \right) \Big) \Big) \tag{261}
\end{aligned}$$



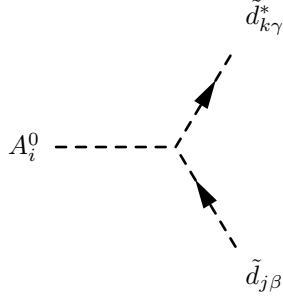
$$\frac{1}{2}\mu \left( \Lambda_U^* \left( \sqrt{2}Z_{i_1}^A Z_{j_4}^+ + Z_{i_4}^A Z_{j_1}^+ \right) + \sqrt{2}\lambda_U^* Z_{i_3}^A Z_{j_1}^+ \right) \tag{262}$$



$$\begin{aligned}
& \frac{1}{4} \left( \left( -v_d Z_{i_2}^A + v_u Z_{i_1}^A \right) \left( \left( -2\lambda_D \lambda_U^* + \Lambda_D \Lambda_U^* \right) Z_{j_1}^R Z_{k_2}^R + 2\lambda_U \lambda_D^* Z_{j_2}^R Z_{k_1}^R - \Lambda_U \Lambda_D^* Z_{j_2}^R Z_{k_1}^R \right) \right. \\
& + Z_{i_3}^A \left( \left( -2g_1 M_D^{B,*} + 2g_1 M_D^B + 2\sqrt{2}\lambda_D \mu_D^* - \sqrt{2} \left( 2\mu_D + \Lambda_D v_T \right) \lambda_D^* + \sqrt{2}\lambda_D v_T \Lambda_D^* \right) Z_{j_1}^R Z_{k_1}^R \right. \\
& + \left. \left( -2g_1 M_D^B + 2g_1 M_D^{B,*} + 2\sqrt{2}\lambda_U \mu_U^* + \sqrt{2} \left( -2\mu_U + \Lambda_U v_T \right) \lambda_U^* - \sqrt{2}\lambda_U v_T \Lambda_U^* \right) Z_{j_2}^R Z_{k_2}^R \right)
\end{aligned}$$

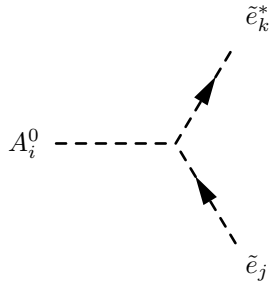
$$\begin{aligned}
& + Z_{i4}^A \left( \left( -2g_2 M_D^W + 2g_2 M_D^{W,*} + 2\Lambda_D \mu_D^* - \left( 2\mu_D + \sqrt{2}\lambda_D v_s \right) \Lambda_D^* + \sqrt{2}\Lambda_D v_s \lambda_D^* \right) Z_{j1}^R Z_{k1}^R \right. \\
& \left. + \left( -2g_2 M_D^{W,*} + 2g_2 M_D^W - 2\Lambda_U \mu_U^* + \left( 2\mu_U + \sqrt{2}\lambda_U v_s \right) \Lambda_U^* - \sqrt{2}\Lambda_U v_s \lambda_U^* \right) Z_{j2}^R Z_{k2}^R \right) \quad (263)
\end{aligned}$$


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$$\begin{aligned}
& \frac{1}{6} \delta_{\beta\gamma} \left( 3\sqrt{2}\mu^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D Z_{i2}^A - 3\sqrt{2}\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D Z_{i2}^A \right. \\
& + g_1 M_D^B \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D Z_{i3}^A - g_1 M_D^{B,*} \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D Z_{i3}^A + 2g_1 M_D^B \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D Z_{i3}^A \\
& - 2g_1 M_D^{B,*} \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D Z_{i3}^A - 3g_2 M_D^W \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D Z_{i4}^A \\
& \left. + 3g_2 M_D^{W,*} \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D Z_{i4}^A \right) \quad (264)
\end{aligned}$$

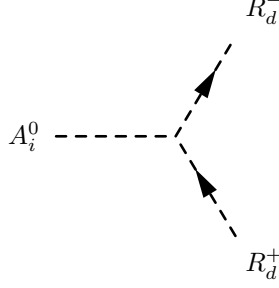

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$$\begin{aligned}
& \frac{1}{2} \left( \sqrt{2}\mu^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i2}^A - \sqrt{2}\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E Z_{i2}^A \right. \\
& - g_1 M_D^B \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i3}^A + g_1 M_D^{B,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i3}^A + 2g_1 M_D^B \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E Z_{i3}^A \\
& \left. + 2g_1 M_D^{B,*} \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E Z_{i3}^A \right)
\end{aligned}$$

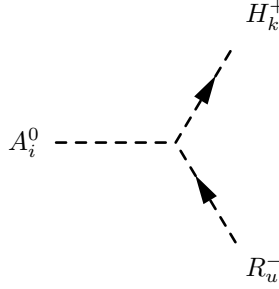
$$-2g_1 M_D^{B,*} \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E Z_{i3}^A - g_2 M_D^W \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i4}^A + g_2 M_D^{W,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i4}^A \quad (265)$$


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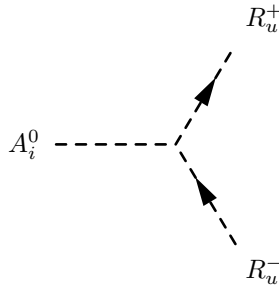
$$\frac{1}{4} \left( \left( -2g_1 M_D^{B,*} + 2g_1 M_D^B + 2\sqrt{2}\lambda_D \mu_D^* + \sqrt{2} \left( -2\mu_D + \Lambda_D v_T \right) \lambda_D^* - \sqrt{2}\lambda_D v_T \Lambda_D^* \right) Z_{i3}^A \right. \\ \left. + \left( -2g_2 M_D^{W,*} + 2g_2 M_D^W - 2\Lambda_D \mu_D^* + 2\mu_D \Lambda_D^* - \sqrt{2}\Lambda_D v_s \lambda_D^* + \sqrt{2}\lambda_D v_s \Lambda_D^* \right) Z_{i4}^A \right) \quad (266)$$


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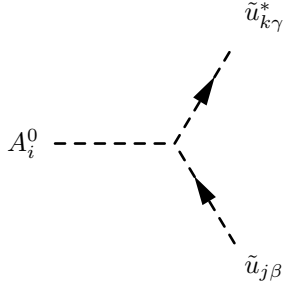
$$-\frac{1}{2} \mu^* \left( \Lambda_U Z_{i4}^A Z_{k1}^+ + \sqrt{2}\Lambda_U Z_{i1}^A Z_{k4}^+ + \sqrt{2}\lambda_U Z_{i3}^A Z_{k1}^+ \right) \quad (267)$$


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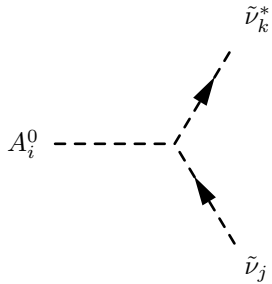
$$\begin{aligned} & \frac{1}{4} \left( \left( -2g_1 M_D^B + 2g_1 M_D^{B,*} + 2\sqrt{2}\lambda_U \mu_U^* - \sqrt{2} \left( 2\mu_U + \Lambda_U v_T \right) \lambda_U^* + \sqrt{2}\lambda_U v_T \Lambda_U^* \right) Z_{i3}^A \right. \\ & \left. + \left( -2g_2 M_D^W + 2g_2 M_D^{W,*} + 2\Lambda_U \mu_U^* - \left( 2\mu_U + \sqrt{2}\lambda_U v_s \right) \Lambda_U^* + \sqrt{2}\Lambda_U v_s \lambda_U^* \right) Z_{i4}^A \right) \end{aligned} \quad (268)$$


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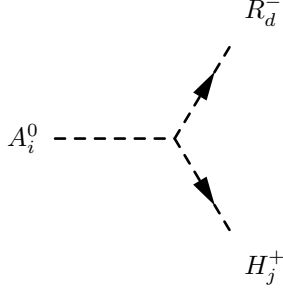
$$\begin{aligned} & \frac{1}{6} \delta_{\beta\gamma} \left( 3\sqrt{2}\mu^* \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U Z_{i1}^A - 3\sqrt{2}\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{kb}^U Z_{i1}^A \right. \\ & + g_1 M_D^B \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U Z_{i3}^A - g_1 M_D^{B,*} \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U Z_{i3}^A - 4g_1 M_D^B \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U Z_{i3}^A \\ & \left. + 4g_1 M_D^{B,*} \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U Z_{i3}^A + 3g_2 M_D^W \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U Z_{i4}^A - 3g_2 M_D^{W,*} \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U Z_{i4}^A \right) \end{aligned} \quad (269)$$


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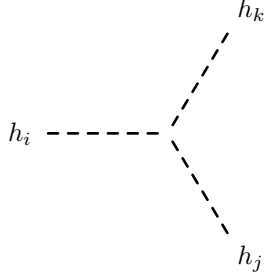


$$\frac{1}{2} \delta_{jk} \left( g_1 \left( -M_D^B + M_D^{B,*} \right) Z_{i3}^A + g_2 \left( -M_D^{W,*} + M_D^W \right) Z_{i4}^A \right) \quad (270)$$


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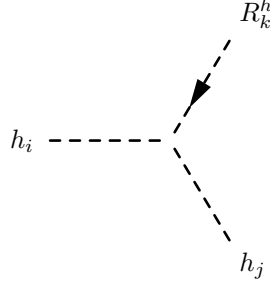


$$-\frac{1}{2}\mu\left(\Lambda_D^*\left(\sqrt{2}Z_{i2}^AZ_{j3}^+ - Z_{i4}^AZ_{j2}^+\right) + \sqrt{2}\lambda_D^*Z_{i3}^AZ_{j2}^+\right) \quad (271)$$



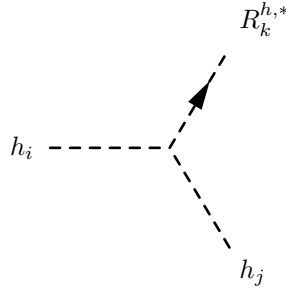
$$\begin{aligned}
& -\frac{i}{4}\left(-2g_1M_D^B Z_{i3}^H Z_{j1}^H Z_{k1}^H + 4v_s|\lambda_D|^2 Z_{i3}^H Z_{j1}^H Z_{k1}^H + 2\sqrt{2}\mu_D\lambda_D^* Z_{i3}^H Z_{j1}^H Z_{k1}^H\right. \\
& + \sqrt{2}\Lambda_D v_T \lambda_D^* Z_{i3}^H Z_{j1}^H Z_{k1}^H + \sqrt{2}\lambda_D v_T \Lambda_D^* Z_{i3}^H Z_{j1}^H Z_{k1}^H - 2g_1M_D^{B,*} Z_{i3}^H Z_{j1}^H Z_{k1}^H \\
& + 2\sqrt{2}\lambda_D\mu_D^* Z_{i3}^H Z_{j1}^H Z_{k1}^H + 2g_2M_D^W Z_{i4}^H Z_{j1}^H Z_{k1}^H + 2v_T|\Lambda_D|^2 Z_{i4}^H Z_{j1}^H Z_{k1}^H \\
& + \sqrt{2}\Lambda_D v_s \lambda_D^* Z_{i4}^H Z_{j1}^H Z_{k1}^H + 2\mu_D\Lambda_D^* Z_{i4}^H Z_{j1}^H Z_{k1}^H + \sqrt{2}\lambda_D v_s \Lambda_D^* Z_{i4}^H Z_{j1}^H Z_{k1}^H \\
& + 2g_2M_D^{W,*} Z_{i4}^H Z_{j1}^H Z_{k1}^H + 2\Lambda_D\mu_D^* Z_{i4}^H Z_{j1}^H Z_{k1}^H + 4v_d|\lambda_D|^2 Z_{i3}^H Z_{j3}^H Z_{k1}^H \\
& + \sqrt{2}\Lambda_D v_d \lambda_D^* Z_{i4}^H Z_{j3}^H Z_{k1}^H + \sqrt{2}\lambda_D v_d \Lambda_D^* Z_{i4}^H Z_{j3}^H Z_{k1}^H + \sqrt{2}\Lambda_D v_d \lambda_D^* Z_{i3}^H Z_{j4}^H Z_{k1}^H \\
& + \sqrt{2}\lambda_D v_d \Lambda_D^* Z_{i3}^H Z_{j4}^H Z_{k1}^H + 2v_d|\Lambda_D|^2 Z_{i4}^H Z_{j4}^H Z_{k1}^H + 2g_1M_D^B Z_{i3}^H Z_{j2}^H Z_{k2}^H \\
& + 4v_s|\lambda_U|^2 Z_{i3}^H Z_{j2}^H Z_{k2}^H + 2\sqrt{2}\mu_U\lambda_U^* Z_{i3}^H Z_{j2}^H Z_{k2}^H - \sqrt{2}\Lambda_U v_T \lambda_U^* Z_{i3}^H Z_{j2}^H Z_{k2}^H \\
& - \sqrt{2}\lambda_U v_T \Lambda_U^* Z_{i3}^H Z_{j2}^H Z_{k2}^H + 2g_1M_D^{B,*} Z_{i3}^H Z_{j2}^H Z_{k2}^H + 2\sqrt{2}\lambda_U\mu_U^* Z_{i3}^H Z_{j2}^H Z_{k2}^H \\
& - 2g_2M_D^W Z_{i4}^H Z_{j2}^H Z_{k2}^H + 2v_T|\Lambda_U|^2 Z_{i4}^H Z_{j2}^H Z_{k2}^H - \sqrt{2}\Lambda_U v_s \lambda_U^* Z_{i4}^H Z_{j2}^H Z_{k2}^H \\
& - 2\mu_U\Lambda_U^* Z_{i4}^H Z_{j2}^H Z_{k2}^H - \sqrt{2}\lambda_U v_s \Lambda_U^* Z_{i4}^H Z_{j2}^H Z_{k2}^H - 2g_2M_D^{W,*} Z_{i4}^H Z_{j2}^H Z_{k2}^H \\
& - 2\Lambda_U\mu_U^* Z_{i4}^H Z_{j2}^H Z_{k2}^H + 4v_u|\lambda_U|^2 Z_{i3}^H Z_{j3}^H Z_{k2}^H - \sqrt{2}\Lambda_U v_u \lambda_U^* Z_{i4}^H Z_{j3}^H Z_{k2}^H \\
& - \sqrt{2}\lambda_U v_u \Lambda_U^* Z_{i4}^H Z_{j3}^H Z_{k2}^H - \sqrt{2}\Lambda_U v_u \lambda_U^* Z_{i3}^H Z_{j4}^H Z_{k2}^H \\
& \left. - \sqrt{2}\lambda_U v_u \Lambda_U^* Z_{i3}^H Z_{j4}^H Z_{k2}^H + 2v_u|\Lambda_U|^2 Z_{i4}^H Z_{j4}^H Z_{k2}^H + 4v_d|\lambda_D|^2 Z_{i3}^H Z_{j1}^H Z_{k3}^H\right)
\end{aligned}$$

$$\begin{aligned}
& + \sqrt{2}\Lambda_D v_d \lambda_D^* Z_{i4}^H Z_{j1}^H Z_{k3}^H + \sqrt{2}\lambda_D v_d \Lambda_D^* Z_{i4}^H Z_{j1}^H Z_{k3}^H + 4v_u |\lambda_U|^2 Z_{i3}^H Z_{j2}^H Z_{k3}^H \\
& - \sqrt{2}\Lambda_U v_u \lambda_U^* Z_{i4}^H Z_{j2}^H Z_{k3}^H - \sqrt{2}\lambda_U v_u \Lambda_U^* Z_{i4}^H Z_{j2}^H Z_{k3}^H \\
& + \sqrt{2}\Lambda_D v_d \lambda_D^* Z_{i3}^H Z_{j1}^H Z_{k4}^H + \sqrt{2}\lambda_D v_d \Lambda_D^* Z_{i3}^H Z_{j1}^H Z_{k4}^H + 2v_d |\Lambda_D|^2 Z_{i4}^H Z_{j1}^H Z_{k4}^H \\
& - \sqrt{2}\Lambda_U v_u \lambda_U^* Z_{i3}^H Z_{j2}^H Z_{k4}^H - \sqrt{2}\lambda_U v_u \Lambda_U^* Z_{i3}^H Z_{j2}^H Z_{k4}^H + 2v_u |\Lambda_U|^2 Z_{i4}^H Z_{j2}^H Z_{k4}^H \\
& + Z_{i1}^H \left( -2g_1 M_D^B Z_{j3}^H Z_{k1}^H + 4v_s |\lambda_D|^2 Z_{j3}^H Z_{k1}^H + 2\sqrt{2}\mu_D \lambda_D^* Z_{j3}^H Z_{k1}^H + \sqrt{2}\Lambda_D v_T \lambda_D^* Z_{j3}^H Z_{k1}^H \right. \\
& + \sqrt{2}\lambda_D v_T \Lambda_D^* Z_{j3}^H Z_{k1}^H - 2g_1 M_D^{B,*} Z_{j3}^H Z_{k1}^H + 2\sqrt{2}\lambda_D \mu_D^* Z_{j3}^H Z_{k1}^H + 2g_2 M_D^W Z_{j4}^H Z_{k1}^H \\
& + 2v_T |\Lambda_D|^2 Z_{j4}^H Z_{k1}^H + \sqrt{2}\Lambda_D v_s \lambda_D^* Z_{j4}^H Z_{k1}^H + 2\mu_D \Lambda_D^* Z_{j4}^H Z_{k1}^H + \sqrt{2}\lambda_D v_s \Lambda_D^* Z_{j4}^H Z_{k1}^H \\
& + 2g_2 M_D^{W,*} Z_{j4}^H Z_{k1}^H + 2\Lambda_D \mu_D^* Z_{j4}^H Z_{k1}^H - \left. \left( g_1^2 + g_2^2 \right) Z_{j2}^H \left( v_d Z_{k2}^H + v_u Z_{k1}^H \right) \right) \\
& + 4v_d |\lambda_D|^2 Z_{j3}^H Z_{k3}^H + \sqrt{2}\Lambda_D v_d \lambda_D^* Z_{j4}^H Z_{k3}^H + \sqrt{2}\lambda_D v_d \Lambda_D^* Z_{j4}^H Z_{k3}^H \\
& + \sqrt{2}\Lambda_D v_d \lambda_D^* Z_{j3}^H Z_{k4}^H + \sqrt{2}\lambda_D v_d \Lambda_D^* Z_{j3}^H Z_{k4}^H + 2v_d |\Lambda_D|^2 Z_{j4}^H Z_{k4}^H \\
& + Z_{j1}^H \left( 3 \left( g_1^2 + g_2^2 \right) v_d Z_{k1}^H - \left( g_1^2 + g_2^2 \right) v_u Z_{k2}^H - 2g_1 M_D^B Z_{k3}^H + 4v_s |\lambda_D|^2 Z_{k3}^H + 2\sqrt{2}\mu_D \lambda_D^* Z_{k3}^H \right. \\
& + \sqrt{2}\lambda_D v_T \lambda_D^* Z_{k3}^H + \sqrt{2}\lambda_D v_T \Lambda_D^* Z_{k3}^H - 2g_1 M_D^{B,*} Z_{k3}^H + 2\sqrt{2}\lambda_D \mu_D^* Z_{k3}^H + 2g_2 M_D^W Z_{k4}^H \\
& + 2v_T |\Lambda_D|^2 Z_{k4}^H + \sqrt{2}\Lambda_D v_s \lambda_D^* Z_{k4}^H + 2\mu_D \Lambda_D^* Z_{k4}^H + \sqrt{2}\lambda_D v_s \Lambda_D^* Z_{k4}^H + 2g_2 M_D^{W,*} Z_{k4}^H \\
& \left. + 2\Lambda_D \mu_D^* Z_{k4}^H \right) \\
& - Z_{i2}^H \left( -2g_1 M_D^B Z_{j3}^H Z_{k2}^H - 4v_s |\lambda_U|^2 Z_{j3}^H Z_{k2}^H - 2\sqrt{2}\mu_U \lambda_U^* Z_{j3}^H Z_{k2}^H + \sqrt{2}\Lambda_U v_T \lambda_U^* Z_{j3}^H Z_{k2}^H \right. \\
& + \sqrt{2}\lambda_U v_T \Lambda_U^* Z_{j3}^H Z_{k2}^H - 2g_1 M_D^{B,*} Z_{j3}^H Z_{k2}^H - 2\sqrt{2}\lambda_U \mu_U^* Z_{j3}^H Z_{k2}^H + 2g_2 M_D^W Z_{j4}^H Z_{k2}^H \\
& - 2v_T |\Lambda_U|^2 Z_{j4}^H Z_{k2}^H + \sqrt{2}\Lambda_U v_s \lambda_U^* Z_{j4}^H Z_{k2}^H + 2\mu_U \Lambda_U^* Z_{j4}^H Z_{k2}^H + \sqrt{2}\lambda_U v_s \Lambda_U^* Z_{j4}^H Z_{k2}^H \\
& + 2g_2 M_D^{W,*} Z_{j4}^H Z_{k2}^H + 2\Lambda_U \mu_U^* Z_{j4}^H Z_{k2}^H + \left. \left( g_1^2 + g_2^2 \right) Z_{j1}^H \left( v_d Z_{k2}^H + v_u Z_{k1}^H \right) \right) \\
& - 4v_u |\lambda_U|^2 Z_{j3}^H Z_{k3}^H + \sqrt{2}\Lambda_U v_u \lambda_U^* Z_{j4}^H Z_{k3}^H + \sqrt{2}\lambda_U v_u \Lambda_U^* Z_{j4}^H Z_{k3}^H \\
& + \sqrt{2}\Lambda_U v_u \lambda_U^* Z_{j3}^H Z_{k4}^H + \sqrt{2}\lambda_U v_u \Lambda_U^* Z_{j3}^H Z_{k4}^H - 2v_u |\Lambda_U|^2 Z_{j4}^H Z_{k4}^H \\
& + Z_{j2}^H \left( \left( g_1^2 + g_2^2 \right) v_d Z_{k1}^H - 3 \left( g_1^2 + g_2^2 \right) v_u Z_{k2}^H - 2g_1 M_D^B Z_{k3}^H - 4v_s |\lambda_U|^2 Z_{k3}^H - 2\sqrt{2}\mu_U \lambda_U^* Z_{k3}^H \right. \\
& + \sqrt{2}\Lambda_U v_T \lambda_U^* Z_{k3}^H + \sqrt{2}\lambda_U v_T \Lambda_U^* Z_{k3}^H - 2g_1 M_D^{B,*} Z_{k3}^H - 2\sqrt{2}\lambda_U \mu_U^* Z_{k3}^H + 2g_2 M_D^W Z_{k4}^H \\
& - 2v_T |\Lambda_U|^2 Z_{k4}^H + \sqrt{2}\Lambda_U v_s \lambda_U^* Z_{k4}^H + 2\mu_U \Lambda_U^* Z_{k4}^H + \sqrt{2}\lambda_U v_s \Lambda_U^* Z_{k4}^H + 2g_2 M_D^{W,*} Z_{k4}^H \\
& \left. + 2\Lambda_U \mu_U^* Z_{k4}^H \right) \Big) \Big) \Big) \Big) \tag{272}
\end{aligned}$$



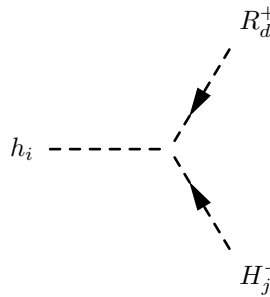
$$\begin{aligned}
& -\frac{i}{4}\mu^* \left( 2\lambda_D Z_{i2}^H Z_{j3}^H Z_{k1}^R + \sqrt{2}\Lambda_D Z_{i2}^H Z_{j4}^H Z_{k1}^R - 2\lambda_U Z_{i1}^H Z_{j3}^H Z_{k2}^R + \sqrt{2}\Lambda_U Z_{i1}^H Z_{j4}^H Z_{k2}^R \right. \\
& \left. + 2Z_{i3}^H \left( \lambda_D Z_{j2}^H Z_{k1}^R - \lambda_U Z_{j1}^H Z_{k2}^R \right) + \sqrt{2}Z_{i4}^H \left( \Lambda_D Z_{j2}^H Z_{k1}^R + \Lambda_U Z_{j1}^H Z_{k2}^R \right) \right) \quad (273)
\end{aligned}$$


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$$\begin{aligned}
& -\frac{i}{4}\mu \left( 2\lambda_D^* \left( Z_{i2}^H Z_{j3}^H + Z_{i3}^H Z_{j2}^H \right) Z_{k1}^R + \sqrt{2}\Lambda_D^* \left( Z_{i2}^H Z_{j4}^H + Z_{i4}^H Z_{j2}^H \right) Z_{k1}^R \right. \\
& \left. + \left( -2\lambda_U^* \left( Z_{i1}^H Z_{j3}^H + Z_{i3}^H Z_{j1}^H \right) + \sqrt{2}\Lambda_U^* \left( Z_{i1}^H Z_{j4}^H + Z_{i4}^H Z_{j1}^H \right) \right) Z_{k2}^R \right) \quad (274)
\end{aligned}$$

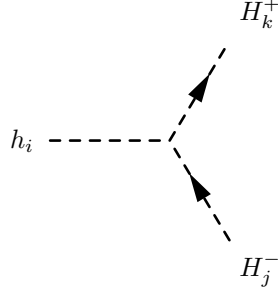

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$$-\frac{i}{2}\mu^* \left( -\Lambda_D \left( \sqrt{2}Z_{i2}^H Z_{j3}^+ + Z_{i4}^H Z_{j2}^+ \right) + \sqrt{2}\lambda_D Z_{i3}^H Z_{j2}^+ \right) \quad (275)$$

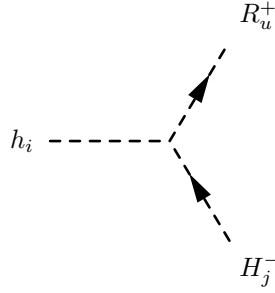

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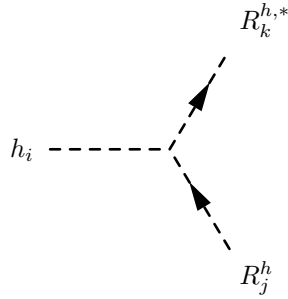


$$\begin{aligned}
& -\frac{i}{4} \left( -2g_1 M_D^B Z_{i3}^H Z_{j1}^+ Z_{k1}^+ + 4v_s |\lambda_D|^2 Z_{i3}^H Z_{j1}^+ Z_{k1}^+ + 2\sqrt{2}\mu_D \lambda_D^* Z_{i3}^H Z_{j1}^+ Z_{k1}^+ \right. \\
& - \sqrt{2}\Lambda_D v_T \lambda_D^* Z_{i3}^H Z_{j1}^+ Z_{k1}^+ - \sqrt{2}\lambda_D v_T \Lambda_D^* Z_{i3}^H Z_{j1}^+ Z_{k1}^+ - 2g_1 M_D^{B,*} Z_{i3}^H Z_{j1}^+ Z_{k1}^+ \\
& + 2\sqrt{2}\lambda_D \mu_D^* Z_{i3}^H Z_{j1}^+ Z_{k1}^+ - 2g_2 M_D^W Z_{i4}^H Z_{j1}^+ Z_{k1}^+ + 2v_T |\Lambda_D|^2 Z_{i4}^H Z_{j1}^+ Z_{k1}^+ \\
& - \sqrt{2}\Lambda_D v_s \lambda_D^* Z_{i4}^H Z_{j1}^+ Z_{k1}^+ - 2\mu_D \Lambda_D^* Z_{i4}^H Z_{j1}^+ Z_{k1}^+ - \sqrt{2}\lambda_D v_s \Lambda_D^* Z_{i4}^H Z_{j1}^+ Z_{k1}^+ \\
& - 2g_2 M_D^{W,*} Z_{i4}^H Z_{j1}^+ Z_{k1}^+ - 2\Lambda_D \mu_D^* Z_{i4}^H Z_{j1}^+ Z_{k1}^+ + 2\Lambda_D v_d \lambda_D^* Z_{i3}^H Z_{j3}^+ Z_{k1}^+ \\
& + \sqrt{2}g_2^2 v_d Z_{i4}^H Z_{j3}^+ Z_{k1}^+ - \sqrt{2}v_d |\Lambda_D|^2 Z_{i4}^H Z_{j3}^+ Z_{k1}^+ + 2\lambda_D v_d \Lambda_D^* Z_{i3}^H Z_{j4}^+ Z_{k1}^+ \\
& - \sqrt{2}g_2^2 v_d Z_{i4}^H Z_{j4}^+ Z_{k1}^+ + \sqrt{2}v_d |\Lambda_D|^2 Z_{i4}^H Z_{j4}^+ Z_{k1}^+ + 2g_1 M_D^B Z_{i3}^H Z_{j2}^+ Z_{k2}^+ \\
& + 4v_s |\lambda_U|^2 Z_{i3}^H Z_{j2}^+ Z_{k2}^+ + 2\sqrt{2}\mu_U \lambda_U^* Z_{i3}^H Z_{j2}^+ Z_{k2}^+ + \sqrt{2}\Lambda_U v_T \lambda_U^* Z_{i3}^H Z_{j2}^+ Z_{k2}^+ \\
& + \sqrt{2}\lambda_U v_T \Lambda_U^* Z_{i3}^H Z_{j2}^+ Z_{k2}^+ + 2g_1 M_D^{B,*} Z_{i3}^H Z_{j2}^+ Z_{k2}^+ + 2\sqrt{2}\lambda_U \mu_U^* Z_{i3}^H Z_{j2}^+ Z_{k2}^+ \\
& + 2g_2 M_D^W Z_{i4}^H Z_{j2}^+ Z_{k2}^+ + 2v_T |\Lambda_U|^2 Z_{i4}^H Z_{j2}^+ Z_{k2}^+ + \sqrt{2}\Lambda_U v_s \lambda_U^* Z_{i4}^H Z_{j2}^+ Z_{k2}^+ \\
& + 2\mu_U \Lambda_U^* Z_{i4}^H Z_{j2}^+ Z_{k2}^+ + \sqrt{2}\lambda_U v_s \Lambda_U^* Z_{i4}^H Z_{j2}^+ Z_{k2}^+ + 2g_2 M_D^{W,*} Z_{i4}^H Z_{j2}^+ Z_{k2}^+ \\
& + 2\Lambda_U \mu_U^* Z_{i4}^H Z_{j2}^+ Z_{k2}^+ + 2\Lambda_U v_u \lambda_U^* Z_{i3}^H Z_{j3}^+ Z_{k2}^+ + \sqrt{2}g_2^2 v_u Z_{i4}^H Z_{j3}^+ Z_{k2}^+ \\
& - \sqrt{2}v_u |\Lambda_U|^2 Z_{i4}^H Z_{j3}^+ Z_{k2}^+ + 2\lambda_U v_u \Lambda_U^* Z_{i3}^H Z_{j4}^+ Z_{k2}^+ - \sqrt{2}g_2^2 v_u Z_{i4}^H Z_{j4}^+ Z_{k2}^+ \\
& + \sqrt{2}v_u |\Lambda_U|^2 Z_{i4}^H Z_{j4}^+ Z_{k2}^+ + 2\lambda_D v_d \Lambda_D^* Z_{i3}^H Z_{j1}^+ Z_{k3}^+ + \sqrt{2}g_2^2 v_d Z_{i4}^H Z_{j1}^+ Z_{k3}^+ \\
& - \sqrt{2}v_d |\Lambda_D|^2 Z_{i4}^H Z_{j1}^+ Z_{k3}^+ + 2\lambda_U v_u \Lambda_U^* Z_{i3}^H Z_{j2}^+ Z_{k3}^+ + \sqrt{2}g_2^2 v_u Z_{i4}^H Z_{j2}^+ Z_{k3}^+ \\
& - \sqrt{2}v_u |\Lambda_U|^2 Z_{i4}^H Z_{j2}^+ Z_{k3}^+ + 4g_2^2 v_T Z_{i4}^H Z_{j3}^+ Z_{k3}^+ - 4g_2^2 v_T Z_{i4}^H Z_{j4}^+ Z_{k3}^+ \\
& + 2\Lambda_D v_d \lambda_D^* Z_{i3}^H Z_{j1}^+ Z_{k4}^+ - \sqrt{2}g_2^2 v_d Z_{i4}^H Z_{j1}^+ Z_{k4}^+ + \sqrt{2}v_d |\Lambda_D|^2 Z_{i4}^H Z_{j1}^+ Z_{k4}^+ \\
& + 2\Lambda_U v_u \lambda_U^* Z_{i3}^H Z_{j2}^+ Z_{k4}^+ - \sqrt{2}g_2^2 v_u Z_{i4}^H Z_{j2}^+ Z_{k4}^+ + \sqrt{2}v_u |\Lambda_U|^2 Z_{i4}^H Z_{j2}^+ Z_{k4}^+ \\
& - 4g_2^2 v_T Z_{i4}^H Z_{j3}^+ Z_{k4}^+ + 4g_2^2 v_T Z_{i4}^H Z_{j4}^+ Z_{k4}^+ \\
& + Z_{i1}^H \left( 2\sqrt{2}g_2 M_D^W Z_{j3}^+ Z_{k1}^+ + \sqrt{2}g_2^2 v_T Z_{j3}^+ Z_{k1}^+ - \sqrt{2}v_T |\Lambda_D|^2 Z_{j3}^+ Z_{k1}^+ \right. \\
& + 2\Lambda_D v_s \lambda_D^* Z_{j3}^+ Z_{k1}^+ + 2\sqrt{2}\Lambda_D \mu_D^* Z_{j3}^+ Z_{k1}^+ - \sqrt{2}g_2^2 v_T Z_{j4}^+ Z_{k1}^+ \\
& + \sqrt{2}v_T |\Lambda_D|^2 Z_{j4}^+ Z_{k1}^+ + 2\sqrt{2}\mu_D \Lambda_D^* Z_{j4}^+ Z_{k1}^+ + 2\lambda_D v_s \Lambda_D^* Z_{j4}^+ Z_{k1}^+ \\
& \left. + 2\sqrt{2}g_2 M_D^{W,*} Z_{j4}^+ Z_{k1}^+ + Z_{j2}^+ \left( (-g_1^2 + g_2^2) v_d Z_{k2}^+ + g_2^2 v_u Z_{k1}^+ \right) - 2g_2^2 v_d Z_{j3}^+ Z_{k3}^+ \right)
\end{aligned}$$

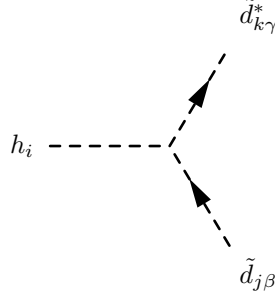
$$\begin{aligned}
& + 4v_d|\Lambda_D|^2 Z_{j3}^+ Z_{k3}^+ + 2g_2^2 v_d Z_{j4}^+ Z_{k4}^+ \\
& + Z_{j1}^+ \left( (g_1^2 + g_2^2) v_d Z_{k1}^+ + g_2^2 v_u Z_{k2}^+ + \sqrt{2}g_2^2 v_T Z_{k3}^+ - \sqrt{2}v_T |\Lambda_D|^2 Z_{k3}^+ + 2\sqrt{2}\mu_D \Lambda_D^* Z_{k3}^+ \right. \\
& + 2\lambda_D v_s \Lambda_D^* Z_{k3}^+ + 2\sqrt{2}g_2 M_D^{W,*} Z_{k3}^+ + 2\sqrt{2}g_2 M_D^W Z_{k4}^+ - \sqrt{2}g_2^2 v_T Z_{k4}^+ + \sqrt{2}v_T |\Lambda_D|^2 Z_{k4}^+ \\
& \left. + 2\Lambda_D v_s \lambda_D^* Z_{k4}^+ + 2\sqrt{2}\Lambda_D \mu_D^* Z_{k4}^+ \right) \\
& + Z_{i2}^H \left( 2\sqrt{2}g_2 M_D^W Z_{j3}^+ Z_{k2}^+ + \sqrt{2}g_2^2 v_T Z_{j3}^+ Z_{k2}^+ - \sqrt{2}v_T |\Lambda_U|^2 Z_{j3}^+ Z_{k2}^+ \right. \\
& + 2\Lambda_U v_s \lambda_U^* Z_{j3}^+ Z_{k2}^+ + 2\sqrt{2}\Lambda_U \mu_U^* Z_{j3}^+ Z_{k2}^+ - \sqrt{2}g_2^2 v_T Z_{j4}^+ Z_{k2}^+ \\
& + \sqrt{2}v_T |\Lambda_U|^2 Z_{j4}^+ Z_{k2}^+ + 2\sqrt{2}\mu_U \Lambda_U^* Z_{j4}^+ Z_{k2}^+ + 2\lambda_U v_s \Lambda_U^* Z_{j4}^+ Z_{k2}^+ \\
& + 2\sqrt{2}g_2 M_D^{W,*} Z_{j4}^+ Z_{k2}^+ + Z_{j1}^+ \left( (-g_1^2 + g_2^2) v_u Z_{k1}^+ + g_2^2 v_d Z_{k2}^+ \right) + 2g_2^2 v_u Z_{j3}^+ Z_{k3}^+ \\
& - 2g_2^2 v_u Z_{j4}^+ Z_{k4}^+ + 4v_u |\Lambda_U|^2 Z_{j4}^+ Z_{k4}^+ \\
& + Z_{j2}^+ \left( g_2^2 v_d Z_{k1}^+ + (g_1^2 + g_2^2) v_u Z_{k2}^+ + \sqrt{2}g_2^2 v_T Z_{k3}^+ - \sqrt{2}v_T |\Lambda_U|^2 Z_{k3}^+ + 2\sqrt{2}\mu_U \Lambda_U^* Z_{k3}^+ \right. \\
& + 2\lambda_U v_s \Lambda_U^* Z_{k3}^+ + 2\sqrt{2}g_2 M_D^{W,*} Z_{k3}^+ + 2\sqrt{2}g_2 M_D^W Z_{k4}^+ - \sqrt{2}g_2^2 v_T Z_{k4}^+ + \sqrt{2}v_T |\Lambda_U|^2 Z_{k4}^+ \\
& \left. + 2\Lambda_U v_s \lambda_U^* Z_{k4}^+ + 2\sqrt{2}\Lambda_U \mu_U^* Z_{k4}^+ \right) \Big) \tag{276}
\end{aligned}$$



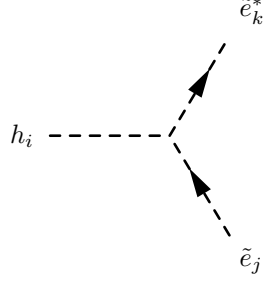
$$\frac{i}{2}\mu \left( \Lambda_U^* \left( -\sqrt{2}Z_{i1}^H Z_{j4}^+ + Z_{i4}^H Z_{j1}^+ \right) + \sqrt{2}\lambda_U^* Z_{i3}^H Z_{j1}^+ \right) \tag{277}$$



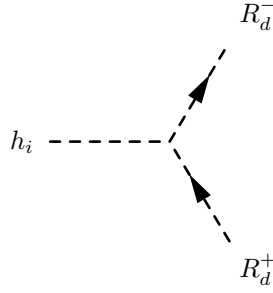
$$\begin{aligned}
& \frac{i}{4} \left( -2g_1 M_D^B Z_{i3}^H Z_{j1}^R Z_{k1}^R - 4v_s |\lambda_D|^2 Z_{i3}^H Z_{j1}^R Z_{k1}^R - 2\sqrt{2}\mu_D \lambda_D^* Z_{i3}^H Z_{j1}^R Z_{k1}^R \right. \\
& - \sqrt{2}\Lambda_D v_T \lambda_D^* Z_{i3}^H Z_{j1}^R Z_{k1}^R - \sqrt{2}\lambda_D v_T \Lambda_D^* Z_{i3}^H Z_{j1}^R Z_{k1}^R - 2g_1 M_D^{B,*} Z_{i3}^H Z_{j1}^R Z_{k1}^R \\
& - 2\sqrt{2}\lambda_D \mu_D^* Z_{i3}^H Z_{j1}^R Z_{k1}^R + 2g_2 M_D^W Z_{i4}^H Z_{j1}^R Z_{k1}^R - 2v_T |\Lambda_D|^2 Z_{i4}^H Z_{j1}^R Z_{k1}^R \\
& - \sqrt{2}\Lambda_D v_s \lambda_D^* Z_{i4}^H Z_{j1}^R Z_{k1}^R - 2\mu_D \Lambda_D^* Z_{i4}^H Z_{j1}^R Z_{k1}^R - \sqrt{2}\lambda_D v_s \Lambda_D^* Z_{i4}^H Z_{j1}^R Z_{k1}^R \\
& + 2g_2 M_D^{W,*} Z_{i4}^H Z_{j1}^R Z_{k1}^R - 2\Lambda_D \mu_D^* Z_{i4}^H Z_{j1}^R Z_{k1}^R + 2g_1 M_D^B Z_{i3}^H Z_{j2}^R Z_{k2}^R \\
& - 4v_s |\lambda_U|^2 Z_{i3}^H Z_{j2}^R Z_{k2}^R - 2\sqrt{2}\mu_U \lambda_U^* Z_{i3}^H Z_{j2}^R Z_{k2}^R + \sqrt{2}\Lambda_U v_T \lambda_U^* Z_{i3}^H Z_{j2}^R Z_{k2}^R \\
& + \sqrt{2}\lambda_U v_T \Lambda_U^* Z_{i3}^H Z_{j2}^R Z_{k2}^R + 2g_1 M_D^{B,*} Z_{i3}^H Z_{j2}^R Z_{k2}^R - 2\sqrt{2}\lambda_U \mu_U^* Z_{i3}^H Z_{j2}^R Z_{k2}^R \\
& - 2g_2 M_D^W Z_{i4}^H Z_{j2}^R Z_{k2}^R - 2v_T |\Lambda_U|^2 Z_{i4}^H Z_{j2}^R Z_{k2}^R + \sqrt{2}\Lambda_U v_s \lambda_U^* Z_{i4}^H Z_{j2}^R Z_{k2}^R \\
& + 2\mu_U \Lambda_U^* Z_{i4}^H Z_{j2}^R Z_{k2}^R + \sqrt{2}\lambda_U v_s \Lambda_U^* Z_{i4}^H Z_{j2}^R Z_{k2}^R - 2g_2 M_D^{W,*} Z_{i4}^H Z_{j2}^R Z_{k2}^R \\
& + 2\Lambda_U \mu_U^* Z_{i4}^H Z_{j2}^R Z_{k2}^R \\
& + Z_{i1}^H \left( Z_{j2}^R \left( 2\lambda_U v_u \lambda_D^* Z_{k1}^R - (g_1^2 + g_2^2) v_d Z_{k2}^R - \Lambda_U v_u \Lambda_D^* Z_{k1}^R \right) \right. \\
& + Z_{j1}^R \left( v_d \left( -2|\Lambda_D|^2 - 4|\lambda_D|^2 + g_1^2 + g_2^2 \right) Z_{k1}^R + v_u \left( 2\lambda_D \lambda_U^* - \Lambda_D \Lambda_U^* \right) Z_{k2}^R \right) \\
& - Z_{i2}^H \left( Z_{j2}^R \left( -2\lambda_U v_d \lambda_D^* Z_{k1}^R + \Lambda_U v_d \Lambda_D^* Z_{k1}^R - v_u \left( -2|\Lambda_U|^2 - 4|\lambda_U|^2 + g_1^2 + g_2^2 \right) Z_{k2}^R \right) \right. \\
& \left. + Z_{j1}^R \left( (g_1^2 + g_2^2) v_u Z_{k1}^R + v_d \left( -2\lambda_D \lambda_U^* + \Lambda_D \Lambda_U^* \right) Z_{k2}^R \right) \right) \left. \right) \tag{278}
\end{aligned}$$



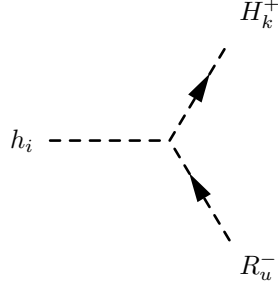
$$\begin{aligned}
& - \frac{i}{12} \delta_{\beta\gamma} \left( 2 \left( 6v_d \sum_{c=1}^3 Z_{j3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{d,ba} Z_{k3+b}^D Z_{i1}^H + 6v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{kc}^D Z_{i1}^H \right) \right. \\
& - 3\sqrt{2}\mu^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D Z_{i2}^H - 3\sqrt{2}\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^D Z_{kb}^D Z_{i2}^H \\
& + g_1 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \left( 2 \left( M_D^B + M_D^{B,*} \right) Z_{i3}^H - g_1 v_d Z_{i1}^H + g_1 v_u Z_{i2}^H \right) \\
& \left. + \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \left( 2 \left( -3g_2 \left( M_D^W + M_D^{W,*} \right) Z_{i4}^H + g_1 \left( M_D^B + M_D^{B,*} \right) Z_{i3}^H \right) - \left( 3g_2^2 + g_1^2 \right) v_d Z_{i1}^H + \left( 3g_2^2 + g_1^2 \right) v_u Z_{i2}^H \right) \right) \tag{279}
\end{aligned}$$



$$\begin{aligned}
& -\frac{i}{4} \left( 4v_d \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ca}^* Y_{e,ba} Z_{k3+b}^E Z_{i1}^H + 4v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{kc}^E Z_{i1}^H \right. \\
& - 2\sqrt{2}\mu^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i2}^H - 2\sqrt{2}\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E Z_{i2}^H \\
& + 2g_1 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E \left( 2(M_D^B + M_D^{B,*}) Z_{i3}^H - g_1 v_d Z_{i1}^H + g_1 v_u Z_{i2}^H \right) \\
& \left. + \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E \left( -2 \left( g_1 (M_D^B + M_D^{B,*}) Z_{i3}^H + g_2 (M_D^W + M_D^{W,*}) Z_{i4}^H \right) + (-g_1^2 + g_2^2) v_u Z_{i2}^H + (-g_2^2 + g_1^2) v_d Z_{i1}^H \right) \right)
\end{aligned} \tag{280}$$

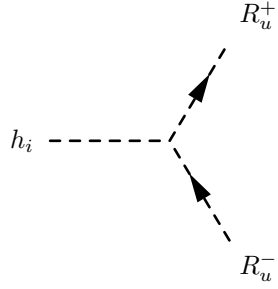


$$\begin{aligned}
& \frac{i}{4} \left( v_d \left( -4|\Lambda_D|^2 - g_2^2 + g_1^2 \right) Z_{i1}^H + \left( -g_1^2 + g_2^2 \right) v_u Z_{i2}^H - 2g_1 M_D^B Z_{i3}^H - 4v_s |\lambda_D|^2 Z_{i3}^H \right. \\
& - 2\sqrt{2}\mu_D \lambda_D^* Z_{i3}^H + \sqrt{2}\Lambda_D v_T \lambda_D^* Z_{i3}^H + \sqrt{2}\lambda_D v_T \Lambda_D^* Z_{i3}^H - 2g_1 M_D^{B,*} Z_{i3}^H - 2\sqrt{2}\lambda_D \mu_D^* Z_{i3}^H \\
& - 2g_2 M_D^W Z_{i4}^H - 2v_T |\Lambda_D|^2 Z_{i4}^H + \sqrt{2}\Lambda_D v_s \lambda_D^* Z_{i4}^H + 2\mu_D \Lambda_D^* Z_{i4}^H + \sqrt{2}\lambda_D v_s \Lambda_D^* Z_{i4}^H \\
& \left. - 2g_2 M_D^{W,*} Z_{i4}^H + 2\Lambda_D \mu_D^* Z_{i4}^H \right)
\end{aligned} \tag{281}$$



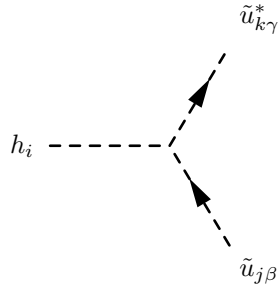
$$\frac{i}{2}\mu^* \left( \Lambda_U Z_{i4}^H Z_{k1}^+ - \sqrt{2}\Lambda_U Z_{i1}^H Z_{k4}^+ + \sqrt{2}\lambda_U Z_{i3}^H Z_{k1}^+ \right) \quad (282)$$


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$$\begin{aligned} & -\frac{i}{4} \left( (-g_2^2 + g_1^2) v_d Z_{i1}^H + v_u (4|\Lambda_U|^2 - g_1^2 + g_2^2) Z_{i2}^H - 2g_1 M_D^B Z_{i3}^H + 4v_s |\lambda_U|^2 Z_{i3}^H \right. \\ & + 2\sqrt{2}\mu_U \lambda_U^* Z_{i3}^H + \sqrt{2}\Lambda_U v_T \lambda_U^* Z_{i3}^H + \sqrt{2}\lambda_U v_T \Lambda_U^* Z_{i3}^H - 2g_1 M_D^{B,*} Z_{i3}^H + 2\sqrt{2}\lambda_U \mu_U^* Z_{i3}^H \\ & - 2g_2 M_D^W Z_{i4}^H + 2v_T |\Lambda_U|^2 Z_{i4}^H + \sqrt{2}\Lambda_U v_s \lambda_U^* Z_{i4}^H + 2\mu_U \Lambda_U^* Z_{i4}^H + \sqrt{2}\lambda_U v_s \Lambda_U^* Z_{i4}^H \\ & \left. - 2g_2 M_D^{W,*} Z_{i4}^H + 2\Lambda_U \mu_U^* Z_{i4}^H \right) \quad (283) \end{aligned}$$

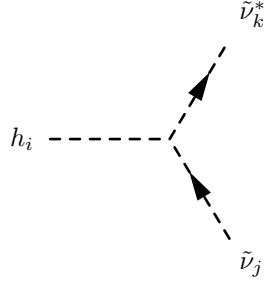

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$$\frac{i}{12} \delta_{\beta\gamma} \left( 6 \left( \sqrt{2}\mu^* \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U Z_{i1}^H + \sqrt{2}\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{kb}^U Z_{i1}^H \right) \right)$$

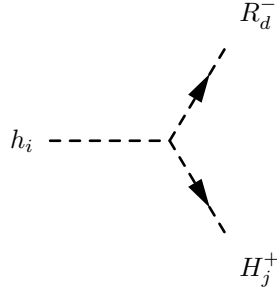
$$\begin{aligned}
& -2v_u \left( \sum_{c=1}^3 Z_{j3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{u,ba} Z_{k3+b}^U + \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{kc}^U \right) Z_{i2}^H \\
& + 4g_1 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \left( 2(M_D^B + M_D^{B,*}) Z_{i3}^H - g_1 v_d Z_{i1}^H + g_1 v_u Z_{i2}^H \right) \\
& + \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \left( -2(3g_2(M_D^W + M_D^{W,*}) Z_{i4}^H + g_1(M_D^B + M_D^{B,*}) Z_{i3}^H) + (-3g_2^2 + g_1^2) v_d Z_{i1}^H - (-3g_2^2 + g_1^2) v_u Z_{i2}^H \right)
\end{aligned} \tag{284}$$


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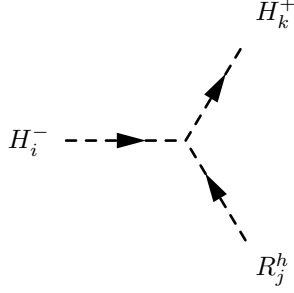
$$\begin{aligned}
& -\frac{i}{4} \delta_{jk} \left( (g_1^2 + g_2^2) v_d Z_{i1}^H - (g_1^2 + g_2^2) v_u Z_{i2}^H - 2g_1 M_D^B Z_{i3}^H - 2g_1 M_D^{B,*} Z_{i3}^H + 2g_2 M_D^W Z_{i4}^H \right. \\
& \left. + 2g_2 M_D^{W,*} Z_{i4}^H \right)
\end{aligned} \tag{285}$$


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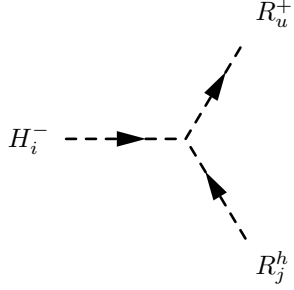
$$-\frac{i}{2} \mu \left( -\Lambda_D^* \left( \sqrt{2} Z_{i2}^H Z_{j3}^+ + Z_{i4}^H Z_{j2}^+ \right) + \sqrt{2} \lambda_D^* Z_{i3}^H Z_{j2}^+ \right) \tag{286}$$


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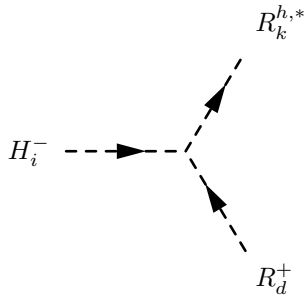
$$-i\mu^* \left( -\Lambda_D Z_{j1}^R Z_{i2}^+ Z_{k4}^+ + \Lambda_U Z_{j2}^R Z_{i3}^+ Z_{k1}^+ \right) \quad (287)$$


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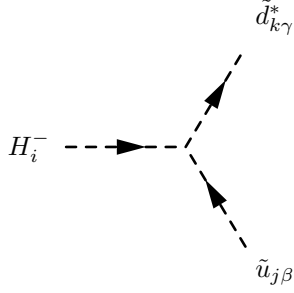
$$\begin{aligned} & -\frac{i}{4} \left( 2\sqrt{2}\lambda_D v_d \lambda_U^* Z_{j1}^R Z_{i2}^+ \right. \\ & + Z_{j2}^R \left( \sqrt{2}g_2^2 v_d Z_{i1}^+ + \sqrt{2}v_u \left( -2|\lambda_U|^2 + g_2^2 \right) Z_{i2}^+ + 4g_2 M_D^W Z_{i3}^+ + 2g_2^2 v_T Z_{i3}^+ \right. \\ & \left. \left. - 2\sqrt{2}\Lambda_U v_s \lambda_U^* Z_{i3}^+ - 4\Lambda_U \mu_U^* Z_{i3}^+ - 2g_2^2 v_T Z_{i4}^+ + 4g_2 M_D^{W,*} Z_{i4}^+ \right) \right. \\ & \left. + \Lambda_U^* \left( \sqrt{2}\Lambda_D Z_{j1}^R \left( 2v_u Z_{i1}^+ + v_d Z_{i2}^+ \right) \right) \right. \\ & \left. + Z_{j2}^R \left( -2 \left( \left( 2\mu_U - \Lambda_U v_T + \sqrt{2}\lambda_U v_s \right) Z_{i4}^+ + \Lambda_U v_T Z_{i3}^+ \right) + \sqrt{2}\Lambda_U v_u Z_{i2}^+ \right) \right) \end{aligned} \quad (288)$$


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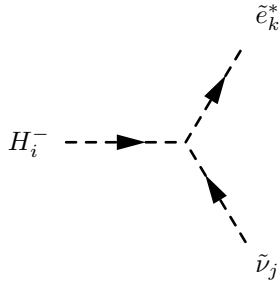
$$\begin{aligned}
& -\frac{i}{4} \left( \sqrt{2} Z_{k2}^R \left( 2\lambda_D v_u \lambda_U^* Z_{i1}^+ + \Lambda_D \Lambda_U^* \left( 2v_d Z_{i2}^+ + v_u Z_{i1}^+ \right) \right) \right. \\
& + Z_{k1}^R \left( \sqrt{2} v_d \left( -2|\lambda_D|^2 + g_2^2 + |\Lambda_D|^2 \right) Z_{i1}^+ + \sqrt{2} g_2^2 v_u Z_{i2}^+ + 4g_2 M_D^W Z_{i3}^+ + 2g_2^2 v_T Z_{i3}^+ \right. \\
& - 2v_T |\Lambda_D|^2 Z_{i3}^+ - 2\sqrt{2} \Lambda_D v_s \lambda_D^* Z_{i3}^+ - 4\Lambda_D \mu_D^* Z_{i3}^+ - 2g_2^2 v_T Z_{i4}^+ + 2v_T |\Lambda_D|^2 Z_{i4}^+ \\
& \left. \left. - 4\mu_D \Lambda_D^* Z_{i4}^+ - 2\sqrt{2} \lambda_D v_s \Lambda_D^* Z_{i4}^+ + 4g_2 M_D^{W,*} Z_{i4}^+ \right) \right) \quad (289)
\end{aligned}$$


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$$\begin{aligned}
& -\frac{i}{4} \delta_{\beta\gamma} \left( -2 \left( 2\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{kb}^D Z_{i1}^+ + \sqrt{2} v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{kc}^D Z_{i1}^+ \right. \right. \\
& + 2\mu^* \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D Z_{i2}^+ + \sqrt{2} v_u \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{kc}^D Z_{i2}^+ \\
& + \sqrt{2} \sum_{c=1}^3 Z_{j3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{d,ba} Z_{k3+b}^D \left( v_d Z_{i2}^+ + v_u Z_{i1}^+ \right) \left. \right) \\
& + g_2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^D \left( 2g_2 v_T Z_{i3}^+ - 2g_2 v_T Z_{i4}^+ + 4M_D^W Z_{i3}^+ + 4M_D^{W,*} Z_{i4}^+ + \sqrt{2} g_2 v_d Z_{i1}^+ + \sqrt{2} g_2 v_u Z_{i2}^+ \right) \quad (290)
\end{aligned}$$


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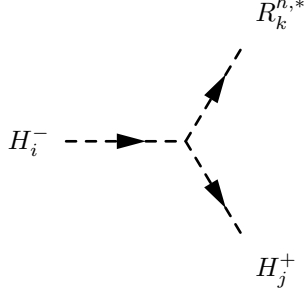


$$-\frac{i}{4} \left( -2 \left( 2\mu^* \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i2}^+ + \sqrt{2} v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{kc}^E Z_{i1}^+ \right) \right)$$



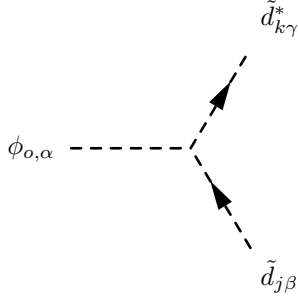
$$+ g_2 \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^E \left( 2g_2 v_T Z_{i3}^+ - 2g_2 v_T Z_{i4}^+ + 4M_D^W Z_{i3}^+ + 4M_D^{W,*} Z_{i4}^+ + \sqrt{2}g_2 v_d Z_{i1}^+ + \sqrt{2}g_2 v_u Z_{i2}^+ \right) \quad (291)$$


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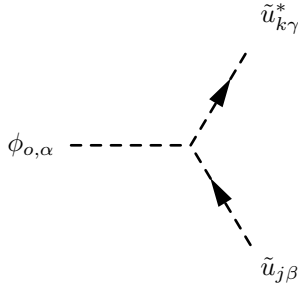
$$i\mu \left( \Lambda_D^* Z_{k1}^R Z_{i4}^+ Z_{j2}^+ - \Lambda_U^* Z_{k2}^R Z_{i1}^+ Z_{j3}^+ \right) \quad (292)$$


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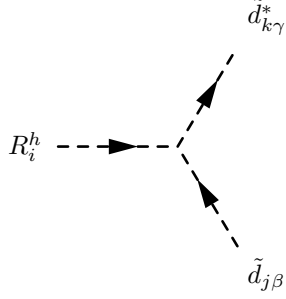
$$- \frac{i}{2} g_3 \left( M_D^O + M_D^{O,*} \right) \lambda_{\gamma,\beta}^\alpha \left( - \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D + \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \right) \quad (293)$$


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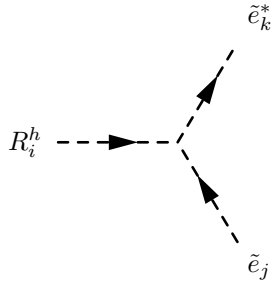
$$- \frac{i}{2} g_3 \left( M_D^O + M_D^{O,*} \right) \lambda_{\gamma,\beta}^\alpha \left( - \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U + \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \right) \quad (294)$$


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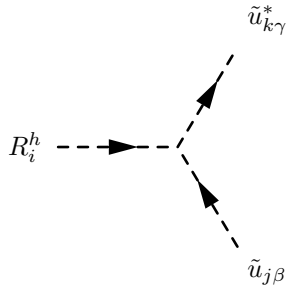
$$\frac{i}{2} \left( 2\mu_D + \Lambda_D v_T + \sqrt{2}\lambda_D v_s \right) \delta_{\beta\gamma} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D Z_{i1}^R \quad (295)$$


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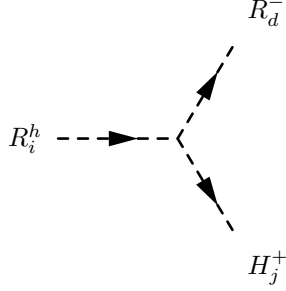
$$\frac{i}{2} \left( 2\mu_D + \Lambda_D v_T + \sqrt{2}\lambda_D v_s \right) \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E Z_{i1}^R \quad (296)$$


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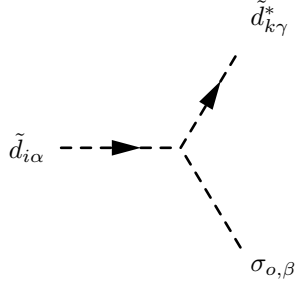
$$-\frac{i}{2} \left( 2\mu_U - \Lambda_U v_T + \sqrt{2}\lambda_U v_s \right) \delta_{\beta\gamma} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{kb}^U Z_{i2}^R \quad (297)$$


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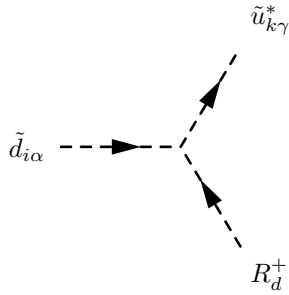
$$\begin{aligned}
& -\frac{i}{4} \left( \sqrt{2} Z_{i2}^R \left( 2\lambda_U v_u \lambda_D^* Z_{j1}^+ + \Lambda_U \Lambda_D^* \left( 2v_d Z_{j2}^+ + v_u Z_{j1}^+ \right) \right) \right. \\
& + Z_{i1}^R \left( \sqrt{2} v_d \left( -2|\lambda_D|^2 + g_2^2 + |\Lambda_D|^2 \right) Z_{j1}^+ + \sqrt{2} g_2^2 v_u Z_{j2}^+ + 2g_2^2 v_T Z_{j3}^+ - 2v_T |\Lambda_D|^2 Z_{j3}^+ \right. \\
& - 4\mu_D \Lambda_D^* Z_{j3}^+ - 2\sqrt{2} \lambda_D v_s \Lambda_D^* Z_{j3}^+ + 4g_2 M_D^{W,*} Z_{j3}^+ + 4g_2 M_D^W Z_{j4}^+ - 2g_2^2 v_T Z_{j4}^+ \\
& \left. \left. + 2v_T |\Lambda_D|^2 Z_{j4}^+ - 2\sqrt{2} \Lambda_D v_s \lambda_D^* Z_{j4}^+ - 4\Lambda_D \mu_D^* Z_{j4}^+ \right) \right) \quad (298)
\end{aligned}$$


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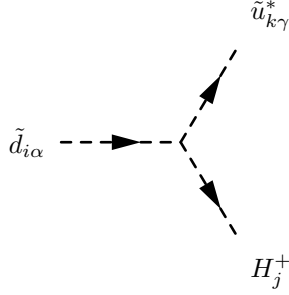
$$\frac{1}{2} g_3 \left( -M_D^{O,*} + M_D^O \right) \lambda_{\gamma,\alpha}^\beta \left( -\sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D + \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \right) \quad (299)$$


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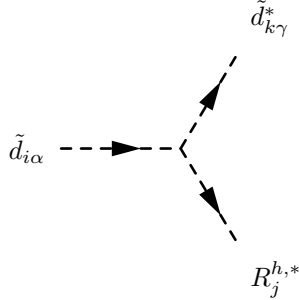
$$\frac{i}{2} \left( 2\mu_D - \Lambda_D v_T + \sqrt{2}\lambda_D v_s \right) \delta_{\alpha\gamma} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{i3+a}^{D,*} Z_{kb}^U \quad (300)$$


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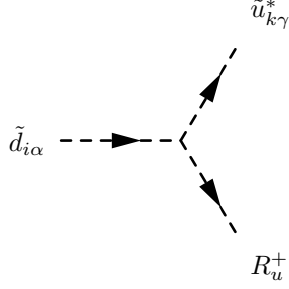
$$\begin{aligned} & -\frac{i}{4} \delta_{\alpha\gamma} \left( -2 \left( 2\mu^* \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U Z_{j1}^+ + \sqrt{2}v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{kc}^U Z_{j1}^+ \right. \right. \\ & + 2\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{i3+a}^{D,*} Z_{kb}^U Z_{j2}^+ + \sqrt{2}v_u \sum_{c=1}^3 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{kc}^U Z_{j2}^+ \\ & + \sqrt{2} \sum_{c=1}^3 Z_{i3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{u,ba} Z_{k3+b}^U \left( v_d Z_{j2}^+ + v_u Z_{j1}^+ \right) \left. \right) \\ & + g_2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^U \left( 2g_2 v_T Z_{j3}^+ - 2g_2 v_T Z_{j4}^+ + 4M_D^{W,*} Z_{j3}^+ + 4M_D^W Z_{j4}^+ + \sqrt{2}g_2 v_d Z_{j1}^+ + \sqrt{2}g_2 v_u Z_{j2}^+ \right) \end{aligned} \quad (301)$$


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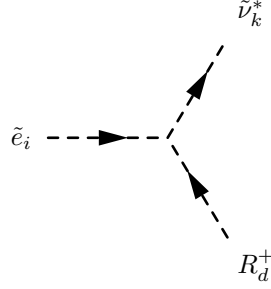
$$\frac{i}{2} \left( 2\mu_D^* + \sqrt{2}v_s \lambda_D^* + v_T \Lambda_D^* \right) \delta_{\alpha\gamma} \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D Z_{j1}^R \quad (302)$$


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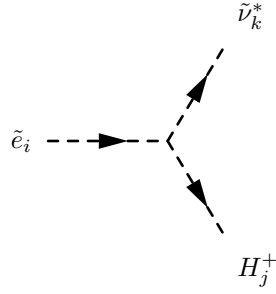
$$-\frac{i}{2} \left( 2\mu_U^* + \sqrt{2}v_s\lambda_U^* + v_T\Lambda_U^* \right) \delta_{\alpha\gamma} \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U \quad (303)$$


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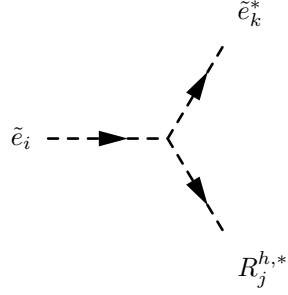
$$\frac{i}{2} \left( 2\mu_D - \Lambda_D v_T + \sqrt{2}\lambda_D v_s \right) \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{i3+a}^{E,*} Z_{kb}^V \quad (304)$$


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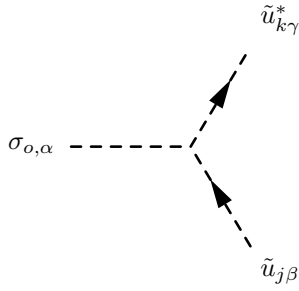
$$-\frac{i}{4} \left( -2 \left( 2\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{i3+a}^{E,*} Z_{kb}^V Z_{j2}^+ + \sqrt{2}v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{kc}^V Z_{j1}^+ \right) \right. \\ \left. + g_2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^V \left( 2g_2 v_T Z_{j3}^+ - 2g_2 v_T Z_{j4}^+ + 4M_D^{W,*} Z_{j3}^+ + 4M_D^W Z_{j4}^+ + \sqrt{2}g_2 v_d Z_{j1}^+ + \sqrt{2}g_2 v_u Z_{j2}^+ \right) \right) \quad (305)$$


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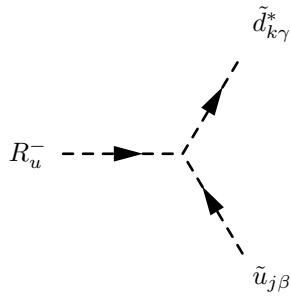
$$\frac{i}{2} \left( 2\mu_D^* + \sqrt{2}v_s\lambda_D^* + v_T\Lambda_D^* \right) \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{j1}^R \quad (306)$$


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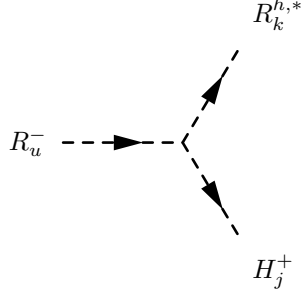
$$\frac{1}{2} g_3 \left( -M_D^{O,*} + M_D^O \right) \lambda_{\gamma,\beta}^\alpha \left( -\sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U + \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \right) \quad (307)$$


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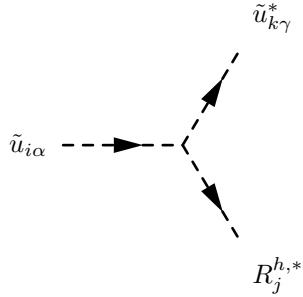
$$-\frac{i}{2} \left( 2\mu_U + \Lambda_U v_T + \sqrt{2}\lambda_U v_s \right) \delta_{\beta\gamma} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{kb}^D \quad (308)$$


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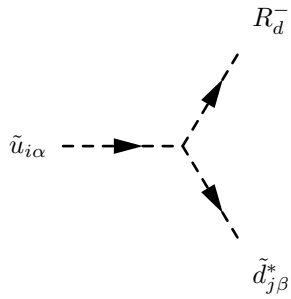
$$\begin{aligned}
& -\frac{i}{4} \left( 2\sqrt{2}\lambda_U v_d \lambda_D^* Z_{k1}^R Z_{j2}^+ + \sqrt{2}\Lambda_U \Lambda_D^* Z_{k1}^R (2v_u Z_{j1}^+ + v_d Z_{j2}^+) \right. \\
& + Z_{k2}^R \left( \sqrt{2}g_2^2 v_d Z_{j1}^+ + \sqrt{2}v_u (-2|\lambda_U|^2 + g_2^2 + |\Lambda_U|^2) Z_{j2}^+ \right. \\
& + 2 \left( - (2\mu_U + \Lambda_U v_T + \sqrt{2}\lambda_U v_s) \Lambda_U^* + g_2 (2M_D^{W,*} + g_2 v_T) \right) Z_{j3}^+ \\
& \left. \left. - \left( -2g_2 M_D^W + 2\Lambda_U \mu_U^* + g_2^2 v_T + \sqrt{2}\Lambda_U v_s \lambda_U^* - v_T |\Lambda_U|^2 \right) Z_{j4}^+ \right) \right) \quad (309)
\end{aligned}$$


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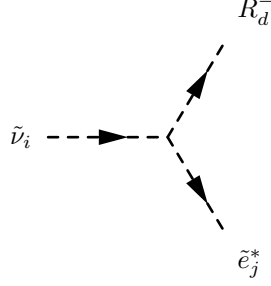
$$-\frac{i}{2} \left( 2\mu_U^* + \sqrt{2}v_s \lambda_U^* - v_T \Lambda_U^* \right) \delta_{\alpha\gamma} \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U Z_{j2}^R \quad (310)$$


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$$\frac{i}{2} \left( 2\mu_D^* + \sqrt{2}v_s\lambda_D^* - v_T\Lambda_D^* \right) \delta_{\alpha\beta} \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{j3+a}^D \quad (311)$$

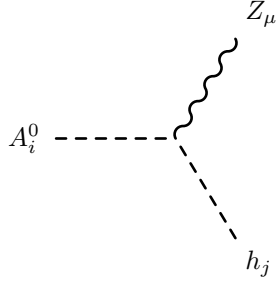

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$$\frac{i}{2} \left( 2\mu_D^* + \sqrt{2}v_s\lambda_D^* - v_T\Lambda_D^* \right) \sum_{b=1}^3 Z_{ib}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{j3+a}^E \quad (312)$$

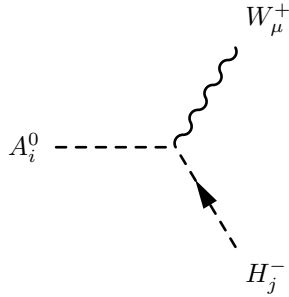

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## 9.2 Two Scalar-One Vector Boson-Interaction



$$\frac{1}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( Z_{i1}^A Z_{j1}^H - Z_{i2}^A Z_{j2}^H \right) \left( -p_\mu^{h_j} + p_\mu^{A_i^0} \right) \quad (313)$$

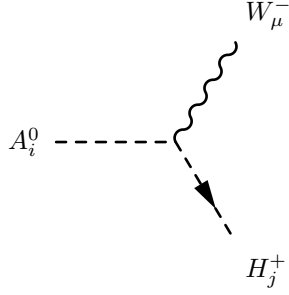

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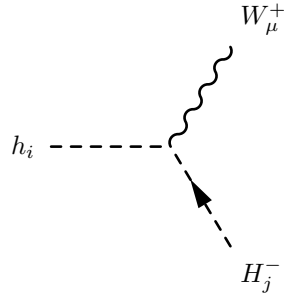
$$\frac{1}{2}g_2\left(\sqrt{2}Z_{i4}^A(-Z_{j4}^+ + Z_{j3}^+) + Z_{i1}^AZ_{j1}^+ + Z_{i2}^AZ_{j2}^+\right)\left(-p_\mu^{H_j^-} + p_\mu^{A_i^0}\right) \quad (314)$$


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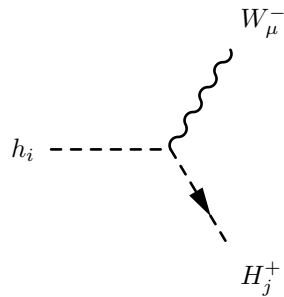
$$\frac{1}{2}g_2\left(\sqrt{2}Z_{i4}^A(-Z_{j4}^+ + Z_{j3}^+) + Z_{i1}^AZ_{j1}^+ + Z_{i2}^AZ_{j2}^+\right)\left(-p_\mu^{H_j^+} + p_\mu^{A_i^0}\right) \quad (315)$$


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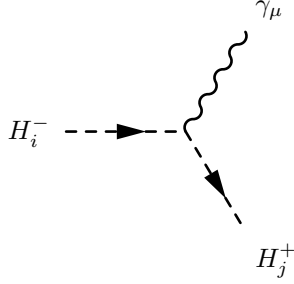
$$\frac{i}{2}g_2\left(\sqrt{2}Z_{i4}^H(Z_{j3}^+ + Z_{j4}^+) + Z_{i1}^HZ_{j1}^+ - Z_{i2}^HZ_{j2}^+\right)\left(-p_\mu^{H_j^-} + p_\mu^{h_i}\right) \quad (316)$$


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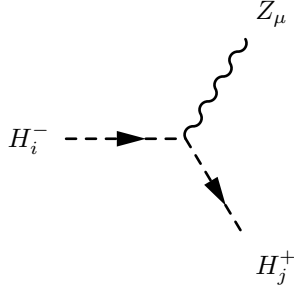
$$-\frac{i}{2}g_2\left(\sqrt{2}Z_{i4}^H(Z_{j3}^+ + Z_{j4}^+) + Z_{i1}^HZ_{j1}^+ - Z_{i2}^HZ_{j2}^+\right)\left(-p_\mu^{H_j^+} + p_\mu^{h_i}\right) \quad (317)$$


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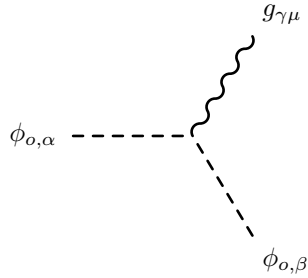
$$\frac{i}{2} \left( (g_1 \cos \Theta_W + g_2 \sin \Theta_W) Z_{i1}^+ Z_{j1}^+ + (g_1 \cos \Theta_W + g_2 \sin \Theta_W) Z_{i2}^+ Z_{j2}^+ \right. \\ \left. + 2g_2 \sin \Theta_W (Z_{i3}^+ Z_{j3}^+ + Z_{i4}^+ Z_{j4}^+) \right) (-p_\mu^{H_j^+} + p_\mu^{H_i^-}) \quad (318)$$


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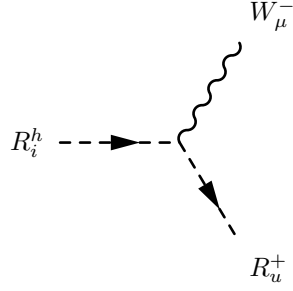
$$\frac{i}{2} \left( (-g_1 \sin \Theta_W + g_2 \cos \Theta_W) Z_{i1}^+ Z_{j1}^+ + (-g_1 \sin \Theta_W + g_2 \cos \Theta_W) Z_{i2}^+ Z_{j2}^+ \right. \\ \left. + 2g_2 \cos \Theta_W (Z_{i3}^+ Z_{j3}^+ + Z_{i4}^+ Z_{j4}^+) \right) (-p_\mu^{H_j^+} + p_\mu^{H_i^-}) \quad (319)$$


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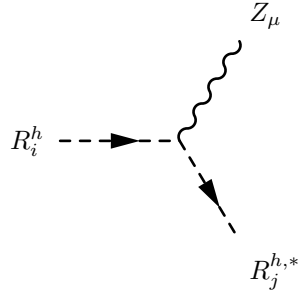
$$g_3 f_{\alpha,\beta,\gamma} (-p_\mu^{\phi_{o,\beta}} + p_\mu^{\phi_{o,\alpha}}) \quad (320)$$


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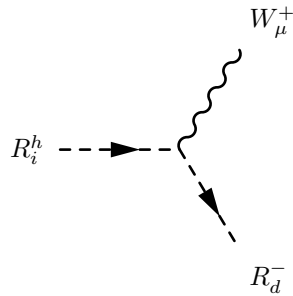
$$-i \frac{1}{\sqrt{2}} g_2 Z_{i2}^R \left( -p_\mu^{R_u^+} + p_\mu^{R_i^h} \right) \quad (321)$$


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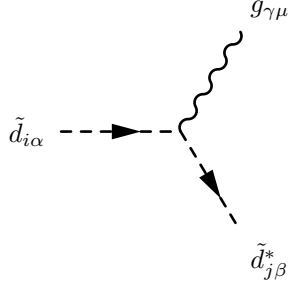
$$\frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( Z_{i1}^R Z_{j1}^R - Z_{i2}^R Z_{j2}^R \right) \left( -p_\mu^{R_j^{h,*}} + p_\mu^{R_i^h} \right) \quad (322)$$


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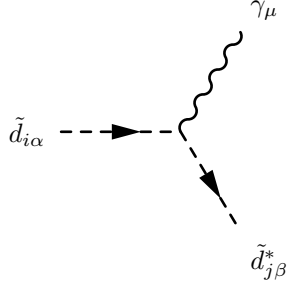
$$-i \frac{1}{\sqrt{2}} g_2 Z_{i1}^R \left( -p_\mu^{R_d^-} + p_\mu^{R_i^h} \right) \quad (323)$$


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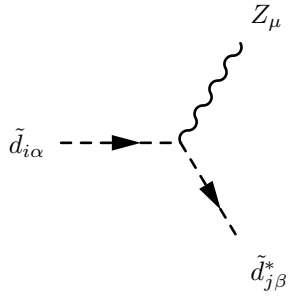
$$-\frac{i}{2}g_3\delta_{ij}\lambda_{\beta,\alpha}^\gamma\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{d}_{i\alpha}}\right) \quad (324)$$


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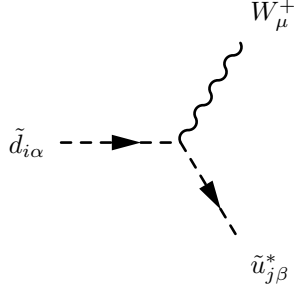
$$-\frac{i}{6}\delta_{\alpha,\beta}\left(-2g_1\cos\Theta_W\sum_{a=1}^3Z_{i3+a}^{D,*}Z_{j3+a}^D+\left(-3g_2\sin\Theta_W+g_1\cos\Theta_W\right)\sum_{a=1}^3Z_{ia}^{D,*}Z_{ja}^D\right)\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{d}_{i\alpha}}\right) \quad (325)$$


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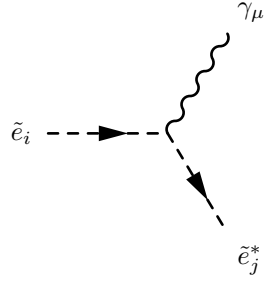
$$\frac{i}{6}\delta_{\alpha,\beta}\left(-2g_1\sin\Theta_W\sum_{a=1}^3Z_{i3+a}^{D,*}Z_{j3+a}^D+\left(3g_2\cos\Theta_W+g_1\sin\Theta_W\right)\sum_{a=1}^3Z_{ia}^{D,*}Z_{ja}^D\right)\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{d}_{i\alpha}}\right) \quad (326)$$


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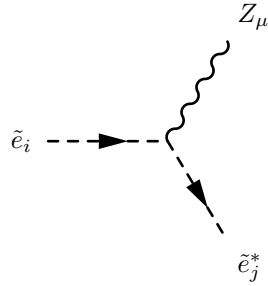
$$-i \frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^U \left( -p_\mu^{\tilde{u}_{j\beta}^*} + p_\mu^{\tilde{d}_{i\alpha}} \right) \quad (327)$$


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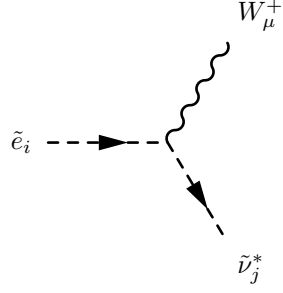
$$\frac{i}{2} \left( 2g_1 \cos \Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E + \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E \right) \left( -p_\mu^{\tilde{e}_j^*} + p_\mu^{\tilde{e}_i} \right) \quad (328)$$


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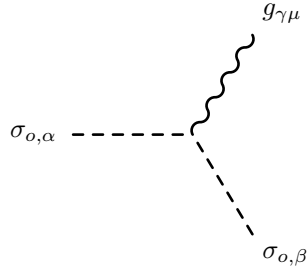
$$\frac{i}{2} \left( -2g_1 \sin \Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E + \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E \right) \left( -p_\mu^{\tilde{e}_j^*} + p_\mu^{\tilde{e}_i} \right) \quad (329)$$


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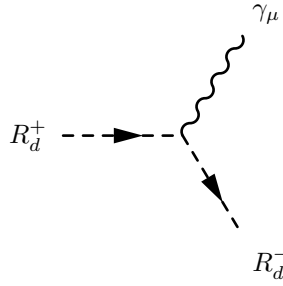
$$-i \frac{1}{\sqrt{2}} g_2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^V \left( -p_\mu^{\tilde{\nu}_j^*} + p_\mu^{\tilde{e}_i} \right) \quad (330)$$


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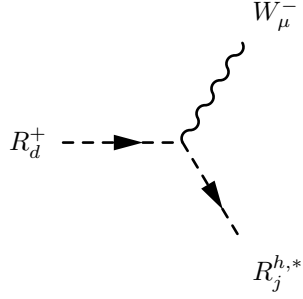
$$g_3 f_{\alpha,\beta,\gamma} \left( -p_\mu^{\sigma_{o,\beta}} + p_\mu^{\sigma_{o,\alpha}} \right) \quad (331)$$


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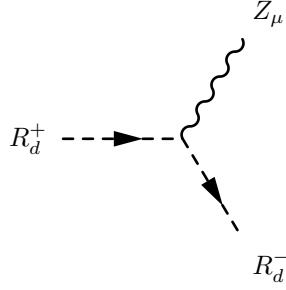
$$-\frac{i}{2} \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) \left( -p_\mu^{R_d^-} + p_\mu^{R_d^+} \right) \quad (332)$$


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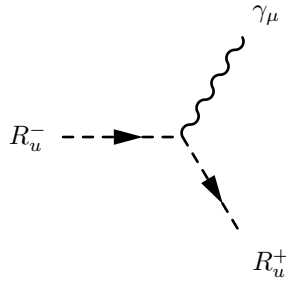
$$-i \frac{1}{\sqrt{2}} g_2 Z_{j1}^R \left( -p_\mu^{R_j^{h,*}} + p_\mu^{R_d^+} \right) \quad (333)$$


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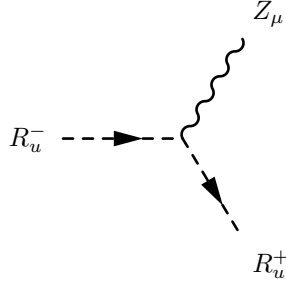
$$-\frac{i}{2} \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( -p_\mu^{R_d^-} + p_\mu^{R_d^+} \right) \quad (334)$$


---



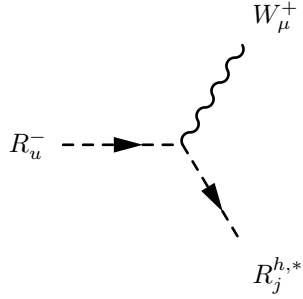
$$\frac{i}{2} \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) \left( -p_\mu^{R_u^+} + p_\mu^{R_u^-} \right) \quad (335)$$


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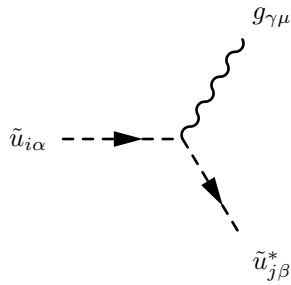
$$\frac{i}{2} \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( -p_\mu^{R_u^+} + p_\mu^{R_u^-} \right) \quad (336)$$


---



$$-i \frac{1}{\sqrt{2}} g_2 Z_{j2}^R \left( -p_\mu^{R_j^{h,*}} + p_\mu^{R_u^-} \right) \quad (337)$$

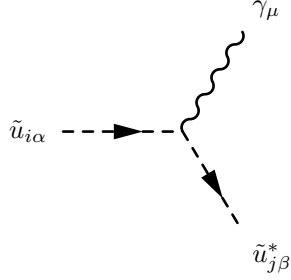

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$$-i \frac{1}{2} g_3 \delta_{ij} \lambda_{\beta,\alpha}^\gamma \left( -p_\mu^{u_{j\beta}^*} + p_\mu^{u_{i\alpha}} \right) \quad (338)$$

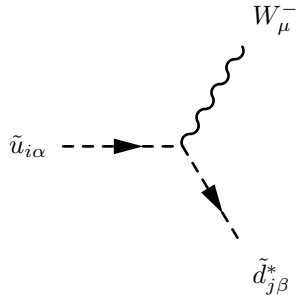

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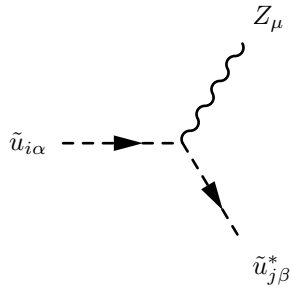
$$-\frac{i}{6}\delta_{\alpha\beta}\left(\left(3g_2\sin\Theta_W+g_1\cos\Theta_W\right)\sum_{a=1}^3Z_{ia}^{U,*}Z_{ja}^U+4g_1\cos\Theta_W\sum_{a=1}^3Z_{i3+a}^{U,*}Z_{j3+a}^U\right)\left(-p_\mu^{\tilde{u}_{j\beta}^*}+p_\mu^{\tilde{u}_{i\alpha}}\right) \quad (339)$$


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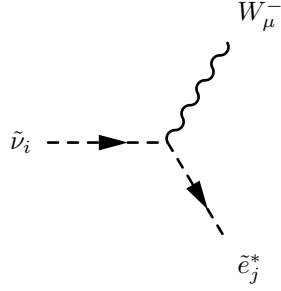
$$-i\frac{1}{\sqrt{2}}g_2\delta_{\alpha\beta}\sum_{a=1}^3Z_{ia}^{U,*}Z_{ja}^D\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{u}_{i\alpha}}\right) \quad (340)$$


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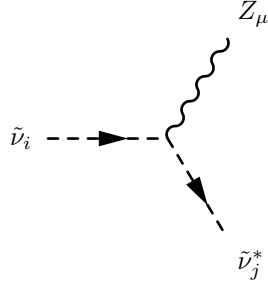
$$-\frac{i}{6}\delta_{\alpha\beta}\left(\left(3g_2\cos\Theta_W-g_1\sin\Theta_W\right)\sum_{a=1}^3Z_{ia}^{U,*}Z_{ja}^U-4g_1\sin\Theta_W\sum_{a=1}^3Z_{i3+a}^{U,*}Z_{j3+a}^U\right)\left(-p_\mu^{\tilde{u}_{j\beta}^*}+p_\mu^{\tilde{u}_{i\alpha}}\right) \quad (341)$$


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$$-i \frac{1}{\sqrt{2}} g_2 \sum_{a=1}^3 Z_{ia}^{V,*} Z_{ja}^E \left( -p_\mu^{\tilde{e}_j^*} + p_\mu^{\tilde{\nu}_i} \right) \quad (342)$$

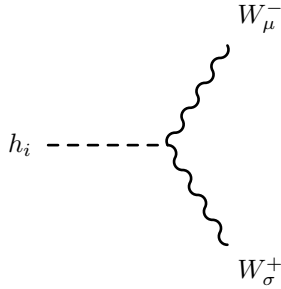

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$$-\frac{i}{2} \delta_{ij} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( -p_\mu^{\tilde{\nu}_j^*} + p_\mu^{\tilde{\nu}_i} \right) \quad (343)$$

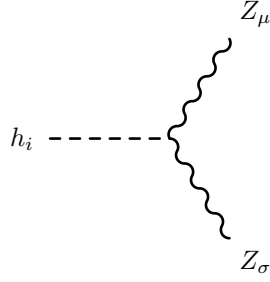

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### 9.3 One Scalar-Two Vector Boson-Interaction



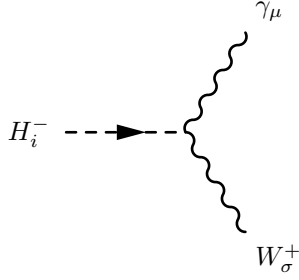
$$\frac{i}{2} g_2^2 \left( 4v_T Z_{i4}^H + v_d Z_{i1}^H + v_u Z_{i2}^H \right) \left( g_{\sigma\mu} \right) \quad (344)$$


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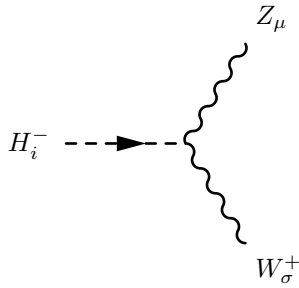
$$\frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right)^2 \left( v_d Z_{i1}^H + v_u Z_{i2}^H \right) \left( g_{\sigma\mu} \right) \quad (345)$$


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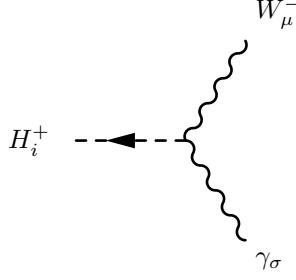
$$-\frac{i}{2} g_2 \left( g_1 v_d \cos \Theta_W Z_{i1}^+ - g_1 v_u \cos \Theta_W Z_{i2}^+ + \sqrt{2} g_2 v_T \sin \Theta_W \left( Z_{i3}^+ + Z_{i4}^+ \right) \right) \left( g_{\sigma\mu} \right) \quad (346)$$


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$$-\frac{i}{2} g_2 \left( -g_1 v_d \sin \Theta_W Z_{i1}^+ + g_1 v_u \sin \Theta_W Z_{i2}^+ + \sqrt{2} g_2 v_T \cos \Theta_W \left( Z_{i3}^+ + Z_{i4}^+ \right) \right) \left( g_{\sigma\mu} \right) \quad (347)$$

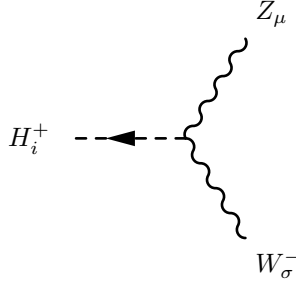

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$$-\frac{i}{2}g_2\left(g_1v_d\cos\Theta_W Z_{i1}^+ - g_1v_u\cos\Theta_W Z_{i2}^+ + \sqrt{2}g_2v_T\sin\Theta_W\left(Z_{i3}^+ + Z_{i4}^+\right)\right)\left(g_{\sigma\mu}\right) \quad (348)$$

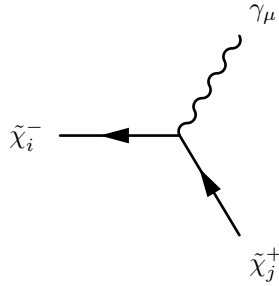

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$$-\frac{i}{2}g_2\left(-g_1v_d\sin\Theta_W Z_{i1}^+ + g_1v_u\sin\Theta_W Z_{i2}^+ + \sqrt{2}g_2v_T\cos\Theta_W\left(Z_{i3}^+ + Z_{i4}^+\right)\right)\left(g_{\sigma\mu}\right) \quad (349)$$


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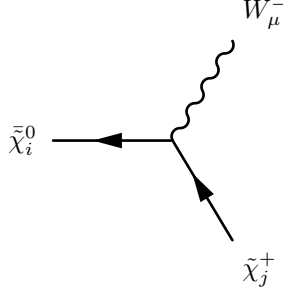
#### 9.4 Two Fermion-One Vector Boson-Interaction



$$-\frac{i}{2}\left(2g_2V_{j1}^{1,*}\sin\Theta_W V_{i1}^1 + V_{j2}^{1,*}\left(g_1\cos\Theta_W + g_2\sin\Theta_W\right)V_{i2}^1\right)\left(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\right) \quad (350)$$

$$+\frac{i}{2}\left(2g_2U_{i1}^{1,*}\sin\Theta_W U_{j1}^1 + U_{i2}^{1,*}\left(g_1\cos\Theta_W + g_2\sin\Theta_W\right)U_{j2}^1\right)\left(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\right) \quad (351)$$

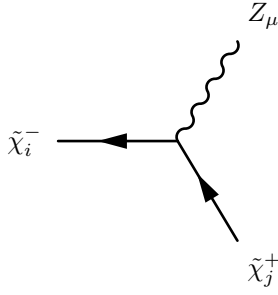

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$$\frac{i}{2}g_2\left(2V_{j1}^{1,*}N_{i2}^1 - \sqrt{2}V_{j2}^{1,*}N_{i3}^1\right)\left(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\right) \quad (352)$$

$$+ \frac{i}{2}g_2\left(2N_{i2}^{2,*}U_{j1}^1 + \sqrt{2}N_{i3}^{2,*}U_{j2}^1\right)\left(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\right) \quad (353)$$

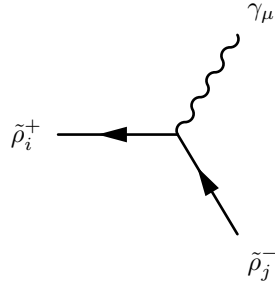

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$$- \frac{i}{2}\left(2g_2V_{j1}^{1,*}\cos\Theta_W V_{i1}^1 + V_{j2}^{1,*}\left(-g_1\sin\Theta_W + g_2\cos\Theta_W\right)V_{i2}^1\right)\left(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\right) \quad (354)$$

$$+ -\frac{i}{2}\left(2g_2U_{i1}^{1,*}\cos\Theta_W U_{j1}^1 + U_{i2}^{1,*}\left(-g_1\sin\Theta_W + g_2\cos\Theta_W\right)U_{j2}^1\right)\left(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\right) \quad (355)$$

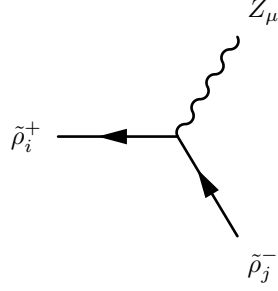

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$$\frac{i}{2}\left(2g_2U_{j1}^{2,*}\sin\Theta_W U_{i1}^2 + U_{j2}^{2,*}\left(g_1\cos\Theta_W + g_2\sin\Theta_W\right)U_{i2}^2\right)\left(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\right) \quad (356)$$

$$+ \frac{i}{2}\left(2g_2V_{i1}^{2,*}\sin\Theta_W V_{j1}^2 + V_{i2}^{2,*}\left(g_1\cos\Theta_W + g_2\sin\Theta_W\right)V_{j2}^2\right)\left(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\right) \quad (357)$$

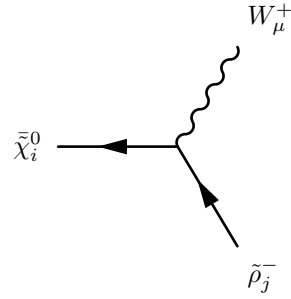

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$$\frac{i}{2} \left( 2g_2 U_{j1}^{2,*} \cos \Theta_W U_{i1}^2 + U_{j2}^{2,*} \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) U_{i2}^2 \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (358)$$

$$+ \frac{i}{2} \left( 2g_2 V_{i1}^{2,*} \cos \Theta_W V_{j1}^2 + V_{i2}^{2,*} \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) V_{j2}^2 \right) \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (359)$$

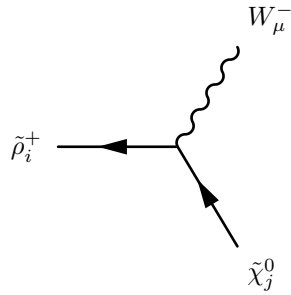

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$$- \frac{i}{2} g_2 \left( 2U_{j1}^{2,*} N_{i2}^1 + \sqrt{2} U_{j2}^{2,*} N_{i4}^1 \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (360)$$

$$+ \left( i \frac{1}{\sqrt{2}} g_2 N_{i4}^{2,*} V_{j2}^2 - i g_2 N_{i2}^{2,*} V_{j1}^2 \right) \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (361)$$

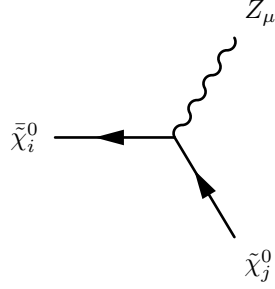

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$$- \frac{i}{2} g_2 \left( 2N_{j2}^{1,*} U_{i1}^2 + \sqrt{2} N_{j4}^{1,*} U_{i2}^2 \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (362)$$

$$+ \left( i \frac{1}{\sqrt{2}} g_2 V_{i2}^{2,*} N_{j4}^2 - i g_2 V_{i1}^{2,*} N_{j2}^2 \right) \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (363)$$

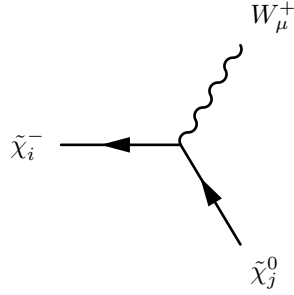

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$$\frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( N_{j3}^{1,*} N_{i3}^1 - N_{j4}^{1,*} N_{i4}^1 \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (364)$$

$$+ \frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( N_{i3}^{2,*} N_{j3}^2 - N_{i4}^{2,*} N_{j4}^2 \right) \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (365)$$

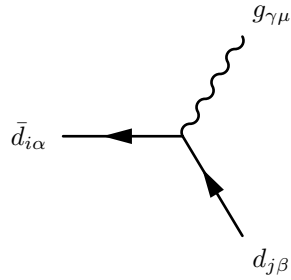

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$$\frac{i}{2} g_2 \left( 2 N_{j2}^{1,*} V_{i1}^1 - \sqrt{2} N_{j3}^{1,*} V_{i2}^1 \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (366)$$

$$+ \frac{i}{2} g_2 \left( 2 U_{i1}^{1,*} N_{j2}^2 + \sqrt{2} U_{i2}^{1,*} N_{j3}^2 \right) \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (367)$$

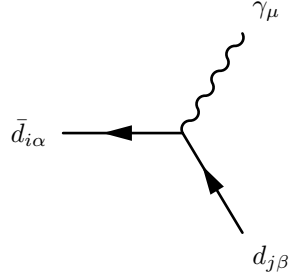

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$$-\frac{i}{2}g_3\delta_{ij}\lambda_{\alpha,\beta}^\gamma\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (368)$$

$$+\frac{i}{2}g_3\delta_{ij}\lambda_{\alpha,\beta}^\gamma\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (369)$$

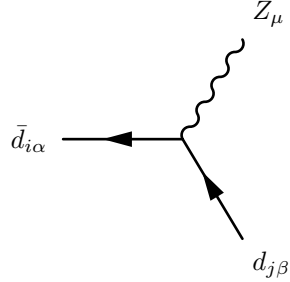

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$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\left(-3g_2\sin\Theta_W+g_1\cos\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (370)$$

$$+\frac{i}{3}g_1\cos\Theta_W\delta_{\alpha\beta}\delta_{ij}\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (371)$$

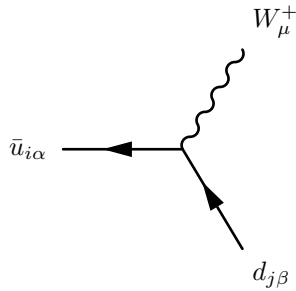

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$$\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\left(3g_2\cos\Theta_W+g_1\sin\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (372)$$

$$+\frac{i}{3}g_1\delta_{\alpha\beta}\delta_{ij}\sin\Theta_W\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (373)$$

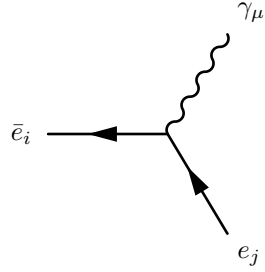

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$$-i \frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \sum_{a=1}^3 U_{L,ja}^{d,*} U_{L,ia}^u \left( \gamma_\mu \cdot \frac{1-\gamma_5}{2} \right) \quad (374)$$

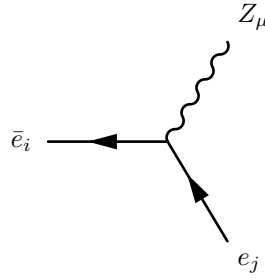

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$$\frac{i}{2} \delta_{ij} \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) \left( \gamma_\mu \cdot \frac{1-\gamma_5}{2} \right) \quad (375)$$

$$+ i g_1 \cos \Theta_W \delta_{ij} \left( \gamma_\mu \cdot \frac{1+\gamma_5}{2} \right) \quad (376)$$

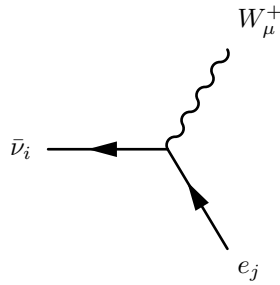

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$$\frac{i}{2} \delta_{ij} \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( \gamma_\mu \cdot \frac{1-\gamma_5}{2} \right) \quad (377)$$

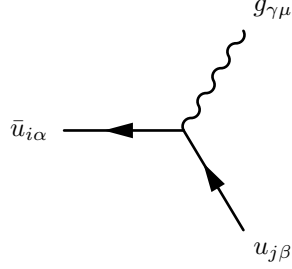
$$+ -i g_1 \delta_{ij} \sin \Theta_W \left( \gamma_\mu \cdot \frac{1+\gamma_5}{2} \right) \quad (378)$$


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$$-i \frac{1}{\sqrt{2}} g_2 U_{L,ji}^{e,*} \Theta_{i,3} \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (379)$$

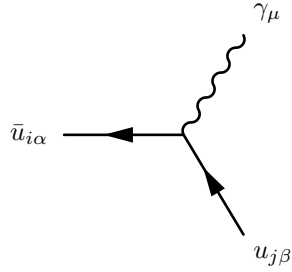

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$$- \frac{i}{2} g_3 \delta_{ij} \lambda_{\alpha,\beta}^\gamma \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (380)$$

$$+ - \frac{i}{2} g_3 \delta_{ij} \lambda_{\alpha,\beta}^\gamma \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (381)$$

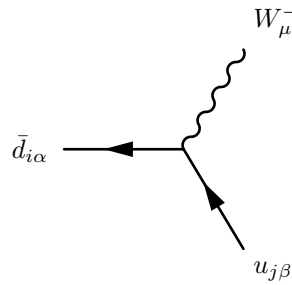

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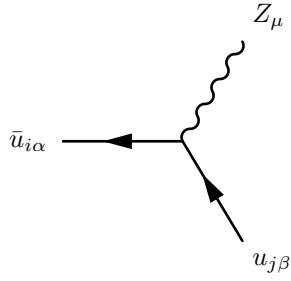
$$- \frac{i}{6} \delta_{\alpha\beta} \delta_{ij} \left( 3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (382)$$

$$+ - \frac{2i}{3} g_1 \cos \Theta_W \delta_{\alpha\beta} \delta_{ij} \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (383)$$


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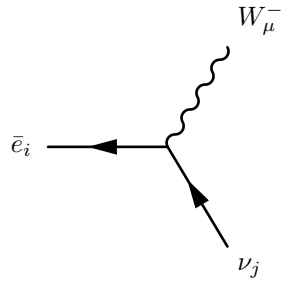


$$-i \frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \sum_{a=1}^3 U_{L,ja}^{u,*} U_{L,ia}^d \left( \gamma_\mu \cdot \frac{1-\gamma_5}{2} \right) \quad (384)$$

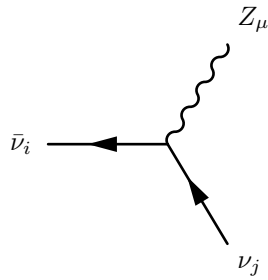


$$-\frac{i}{6} \delta_{\alpha\beta} \delta_{ij} \left( 3g_2 \cos \Theta_W - g_1 \sin \Theta_W \right) \left( \gamma_\mu \cdot \frac{1-\gamma_5}{2} \right) \quad (385)$$

$$+\frac{2i}{3} g_1 \delta_{\alpha\beta} \delta_{ij} \sin \Theta_W \left( \gamma_\mu \cdot \frac{1+\gamma_5}{2} \right) \quad (386)$$

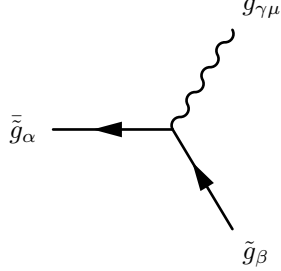


$$-i \frac{1}{\sqrt{2}} g_2 \Theta_{j,3} U_{L,ij}^e \left( \gamma_\mu \cdot \frac{1-\gamma_5}{2} \right) \quad (387)$$



$$-\frac{i}{2}\delta_{ij}\left(g_1\sin\Theta_W+g_2\cos\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (388)$$


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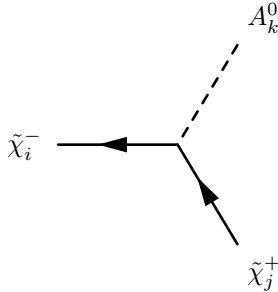


$$-g_3f_{\alpha,\beta,\gamma}\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (389)$$

$$+g_3f_{\alpha,\beta,\gamma}\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (390)$$


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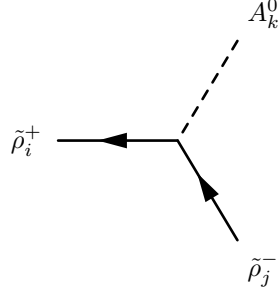
## 9.5 Two Fermion-One Scalar Boson-Interaction



$$\begin{aligned} &\frac{1}{2}\left(U_{i1}^{1,*}\left(-2g_2V_{j1}^{1,*}Z_{k4}^A+\sqrt{2}\Lambda_D V_{j2}^{1,*}Z_{k1}^A\right)\right. \\ &\quad \left.-U_{i2}^{1,*}\left(\sqrt{2}g_2V_{j1}^{1,*}Z_{k1}^A+V_{j2}^{1,*}\left(\Lambda_D Z_{k4}^A-\sqrt{2}\lambda_D Z_{k3}^A\right)\right)\right)\left(\frac{1-\gamma_5}{2}\right) \end{aligned} \quad (391)$$

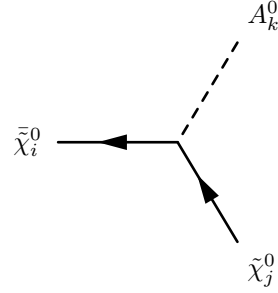
$$\begin{aligned} &+\frac{1}{2}\left(U_{j1}^1\left(2g_2V_{i1}^1Z_{k4}^A-\sqrt{2}\Lambda_D^* V_{i2}^1Z_{k1}^A\right)\right. \\ &\quad \left.+U_{j2}^1\left(\sqrt{2}g_2V_{i1}^1Z_{k1}^A+V_{i2}^1\left(\Lambda_D^* Z_{k4}^A-\sqrt{2}\lambda_D^* Z_{k3}^A\right)\right)\right)\left(\frac{1+\gamma_5}{2}\right) \end{aligned} \quad (392)$$


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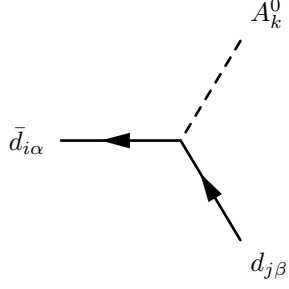
$$\begin{aligned} & \frac{1}{2} \left( g_2 U_{j1}^{2,*} \left( 2V_{i1}^{2,*} Z_{k4}^A - \sqrt{2} V_{i2}^{2,*} Z_{k2}^A \right) \right. \\ & \left. - U_{j2}^{2,*} \left( \sqrt{2} \Lambda_U V_{i1}^{2,*} Z_{k2}^A + V_{i2}^{2,*} \left( \Lambda_U Z_{k4}^A + \sqrt{2} \lambda_U Z_{k3}^A \right) \right) \right) \left( \frac{1-\gamma_5}{2} \right) \end{aligned} \quad (393)$$

$$\begin{aligned} & + \frac{1}{2} \left( \sqrt{2} \lambda_U^* U_{i2}^2 V_{j2}^2 Z_{k3}^A + g_2 U_{i1}^2 \left( -2V_{j1}^2 Z_{k4}^A + \sqrt{2} V_{j2}^2 Z_{k2}^A \right) \right. \\ & \left. + \Lambda_U^* U_{i2}^2 \left( \sqrt{2} V_{j1}^2 Z_{k2}^A + V_{j2}^2 Z_{k4}^A \right) \right) \left( \frac{1+\gamma_5}{2} \right) \end{aligned} \quad (394)$$



$$\begin{aligned} & \frac{1}{2} \left( -g_2 N_{j2}^{1,*} N_{i3}^{2,*} Z_{k1}^A + \sqrt{2} \lambda_U N_{j4}^{1,*} N_{i1}^{2,*} Z_{k2}^A - \Lambda_U N_{j4}^{1,*} N_{i2}^{2,*} Z_{k2}^A + g_2 N_{j2}^{1,*} N_{i4}^{2,*} Z_{k2}^A \right. \\ & \left. + g_1 N_{j1}^{1,*} \left( N_{i3}^{2,*} Z_{k1}^A - N_{i4}^{2,*} Z_{k2}^A \right) + \sqrt{2} \lambda_U N_{j4}^{1,*} N_{i4}^{2,*} Z_{k3}^A - \Lambda_U N_{j4}^{1,*} N_{i4}^{2,*} Z_{k4}^A \right. \\ & \left. - N_{j3}^{1,*} \left( \Lambda_D N_{i2}^{2,*} Z_{k1}^A + N_{i3}^{2,*} \left( \Lambda_D Z_{k4}^A + \sqrt{2} \lambda_D Z_{k3}^A \right) + \sqrt{2} \lambda_D N_{i1}^{2,*} Z_{k1}^A \right) \right) \left( \frac{1-\gamma_5}{2} \right) \end{aligned} \quad (395)$$

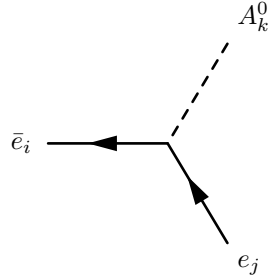
$$\begin{aligned} & + \frac{1}{2} \left( \Lambda_D^* Z_{k1}^A N_{i3}^1 N_{j2}^2 + \Lambda_U^* Z_{k2}^A N_{i4}^1 N_{j2}^2 - g_1 Z_{k1}^A N_{i1}^1 N_{j3}^2 + g_2 Z_{k1}^A N_{i2}^1 N_{j3}^2 \right. \\ & \left. + \Lambda_D^* Z_{k4}^A N_{i3}^1 N_{j3}^2 + \sqrt{2} \lambda_D^* N_{i3}^1 \left( Z_{k1}^A N_{j1}^2 + Z_{k3}^A N_{j3}^2 \right) + g_1 Z_{k2}^A N_{i1}^1 N_{j4}^2 \right. \\ & \left. - g_2 Z_{k2}^A N_{i2}^1 N_{j4}^2 + \Lambda_U^* Z_{k4}^A N_{i4}^1 N_{j4}^2 - \sqrt{2} \lambda_U^* N_{i4}^1 \left( Z_{k2}^A N_{j1}^2 + Z_{k3}^A N_{j4}^2 \right) \right) \left( \frac{1+\gamma_5}{2} \right) \end{aligned} \quad (396)$$



$$\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{b=1}^3U_{L,jb}^{d,*}\sum_{a=1}^3U_{R,ia}^{d,*}Y_{d,ab}Z_{k1}^A\left(\frac{1-\gamma_5}{2}\right) \quad (397)$$

$$+ -\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{b=1}^3\sum_{a=1}^3Y_{d,ab}^*U_{R,ja}^dU_{L,ib}^dZ_{k1}^A\left(\frac{1+\gamma_5}{2}\right) \quad (398)$$

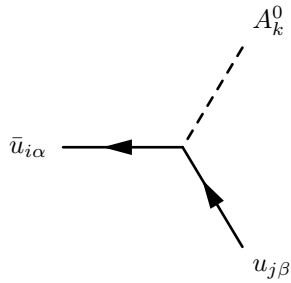

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$$\frac{1}{\sqrt{2}}\sum_{b=1}^3U_{L,jb}^{e,*}\sum_{a=1}^3U_{R,ia}^{e,*}Y_{e,ab}Z_{k1}^A\left(\frac{1-\gamma_5}{2}\right) \quad (399)$$

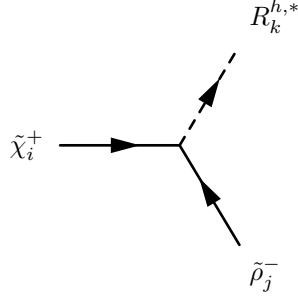
$$+ -\frac{1}{\sqrt{2}}\sum_{b=1}^3\sum_{a=1}^3Y_{e,ab}^*U_{R,ja}^eU_{L,ib}^eZ_{k1}^A\left(\frac{1+\gamma_5}{2}\right) \quad (400)$$


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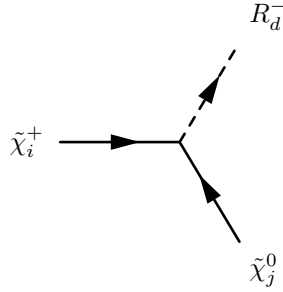
$$\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{b=1}^3U_{L,jb}^{u,*}\sum_{a=1}^3U_{R,ia}^{u,*}Y_{u,ab}Z_{k2}^A\left(\frac{1-\gamma_5}{2}\right) \quad (401)$$

$$+ -\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{b=1}^3\sum_{a=1}^3Y_{u,ab}U_{R,ja}^uU_{L,ib}^uZ_{k2}^A\left(\frac{1+\gamma_5}{2}\right) \quad (402)$$



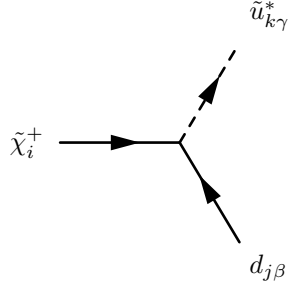
$$-ig_2\left(U_{j1}^{2,*}V_{i2}^{1,*}Z_{k1}^R + U_{j2}^{2,*}V_{i1}^{1,*}Z_{k2}^R\right)\left(\frac{1-\gamma_5}{2}\right) \quad (403)$$

$$+ i\left(\Lambda_D^*U_{i2}^1V_{j1}^2Z_{k1}^R - \Lambda_U^*U_{i1}^1V_{j2}^2Z_{k2}^R\right)\left(\frac{1+\gamma_5}{2}\right) \quad (404)$$



$$-\frac{i}{2}\left(2g_2V_{i1}^{1,*}N_{j3}^{1,*} + \sqrt{2}V_{i2}^{1,*}\left(g_1N_{j1}^{1,*} + g_2N_{j2}^{1,*}\right)\right)\left(\frac{1-\gamma_5}{2}\right) \quad (405)$$

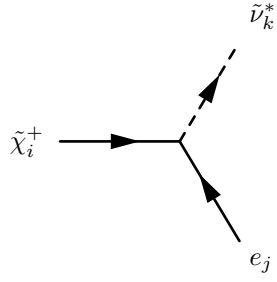
$$+ -\frac{i}{2}\left(2\lambda_D^*U_{i2}^1N_{j1}^2 + \Lambda_D^*\left(2U_{i1}^1N_{j3}^2 - \sqrt{2}U_{i2}^1N_{j2}^2\right)\right)\left(\frac{1+\gamma_5}{2}\right) \quad (406)$$



$$-ig_2 V_{i1}^{1,*} \delta_{\beta\gamma} \sum_{a=1}^3 U_{L,ja}^{d,*} Z_{ka}^U \left( \frac{1-\gamma_5}{2} \right) \quad (407)$$

$$+ i\delta_{\beta\gamma} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* U_{R,ja}^d Z_{kb}^U U_{i2}^1 \left( \frac{1+\gamma_5}{2} \right) \quad (408)$$

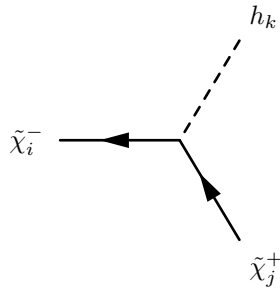

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$$-ig_2 V_{i1}^{1,*} \sum_{a=1}^3 U_{L,ja}^{e,*} Z_{ka}^V \left( \frac{1-\gamma_5}{2} \right) \quad (409)$$

$$+ i \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* U_{R,ja}^e Z_{kb}^V U_{i2}^1 \left( \frac{1+\gamma_5}{2} \right) \quad (410)$$


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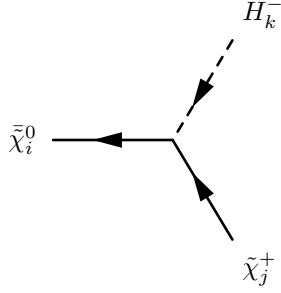




$$\begin{aligned}
& -\frac{i}{2} \left( U_{i1}^{1,*} \left( 2g_2 V_{j1}^{1,*} Z_{k4}^H + \sqrt{2} \Lambda_D V_{j2}^{1,*} Z_{k1}^H \right) \right. \\
& \left. + U_{i2}^{1,*} \left( \sqrt{2} g_2 V_{j1}^{1,*} Z_{k1}^H + V_{j2}^{1,*} \left( -\Lambda_D Z_{k4}^H + \sqrt{2} \lambda_D Z_{k3}^H \right) \right) \right) \left( \frac{1-\gamma_5}{2} \right) \tag{411}
\end{aligned}$$

$$\begin{aligned}
& + \frac{i}{2} \left( U_{j1}^1 \left( 2g_2 V_{i1}^1 Z_{k4}^H + \sqrt{2} \Lambda_D^* V_{i2}^1 Z_{k1}^H \right) \right. \\
& \left. + U_{j2}^1 \left( \sqrt{2} g_2 V_{i1}^1 Z_{k1}^H + V_{i2}^1 \left( -\Lambda_D^* Z_{k4}^H + \sqrt{2} \lambda_D^* Z_{k3}^H \right) \right) \right) \left( \frac{1+\gamma_5}{2} \right) \tag{412}
\end{aligned}$$

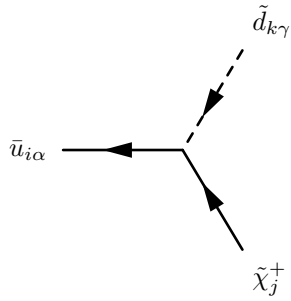

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$$\begin{aligned}
& -\frac{i}{2} \left( V_{j2}^{1,*} \left( 2\lambda_D N_{i1}^{2,*} Z_{k1}^+ + 2\Lambda_D N_{i3}^{2,*} Z_{k3}^+ - \sqrt{2} \Lambda_D N_{i2}^{2,*} Z_{k1}^+ \right) \right. \\
& \left. + 2g_2 V_{j1}^{1,*} \left( N_{i4}^{2,*} Z_{k2}^+ - \sqrt{2} N_{i2}^{2,*} Z_{k4}^+ \right) \right) \left( \frac{1-\gamma_5}{2} \right) \tag{413}
\end{aligned}$$

$$\begin{aligned}
& + \frac{i}{2} \left( 2U_{j1}^1 \left( -\Lambda_U^* N_{i4}^1 Z_{k2}^+ + \sqrt{2} g_2 N_{i2}^1 Z_{k3}^+ \right) \right. \\
& \left. + U_{j2}^1 \left( 2\Lambda_D^* N_{i3}^1 Z_{k4}^+ + \sqrt{2} g_1 N_{i1}^1 Z_{k1}^+ + \sqrt{2} g_2 N_{i2}^1 Z_{k1}^+ \right) \right) \left( \frac{1+\gamma_5}{2} \right) \tag{414}
\end{aligned}$$

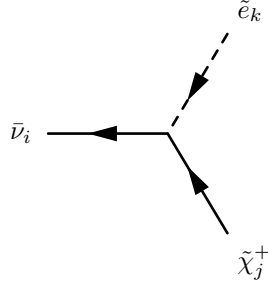

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(415)

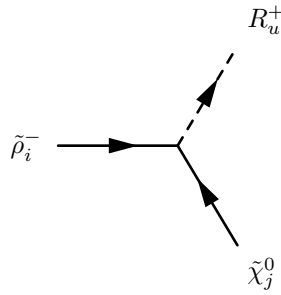
$$+ i\delta_{\alpha\gamma} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} U_{L,ib}^u U_{j2}^1 \left( \frac{1+\gamma_5}{2} \right) \tag{416}$$


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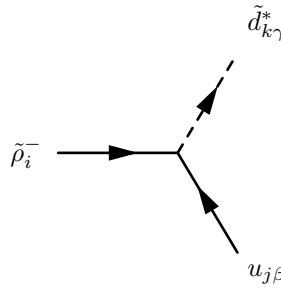
(417)

$$+ i \sum_{a=1}^3 Y_{e,ai}^* Z_{k3+a}^{E_i^*} U_{j2}^1 \left( \frac{1 + \gamma_5}{2} \right) \quad (418)$$



$$\frac{i}{2} \left( -2g_2 U_{i1}^{2,*} N_{j4}^{1,*} + \sqrt{2} U_{i2}^{2,*} (g_1 N_{j1}^{1,*} + g_2 N_{j2}^{1,*}) \right) \left( \frac{1 - \gamma_5}{2} \right) \quad (419)$$

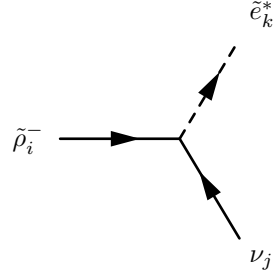
$$+ \frac{i}{2} \left( 2\lambda_U^* V_{i2}^2 N_{j1}^2 + \Lambda_U^* (2V_{i1}^2 N_{j4}^2 + \sqrt{2} V_{i2}^2 N_{j2}^2) \right) \left( \frac{1 + \gamma_5}{2} \right) \quad (420)$$



$$- i g_2 U_{i1}^{2,*} \delta_{\beta\gamma} \sum_{a=1}^3 U_{L,ja}^{u,*} Z_{ka}^D \left( \frac{1 - \gamma_5}{2} \right) \quad (421)$$

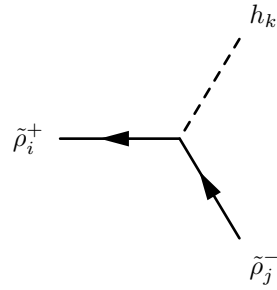
$$+ i\delta_{\beta\gamma} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* U_{R,ja}^u Z_{kb}^D V_{i2}^2 \left( \frac{1+\gamma^5}{2} \right) \quad (422)$$


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$$- ig_2 U_{i1}^{2,*} \Theta_{j,3} Z_{kj}^E \left( \frac{1-\gamma^5}{2} \right) \quad (423)$$

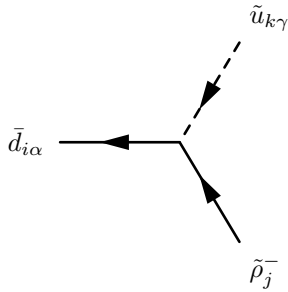

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$$\frac{i}{2} \left( g_2 U_{j1}^{2,*} \left( 2V_{i1}^{2,*} Z_{k4}^H - \sqrt{2} V_{i2}^{2,*} Z_{k2}^H \right) + U_{j2}^{2,*} \left( \sqrt{2} \Lambda_U V_{i1}^{2,*} Z_{k2}^H + V_{i2}^{2,*} \left( \Lambda_U Z_{k4}^H + \sqrt{2} \lambda_U Z_{k3}^H \right) \right) \right) \left( \frac{1-\gamma^5}{2} \right) \quad (424)$$

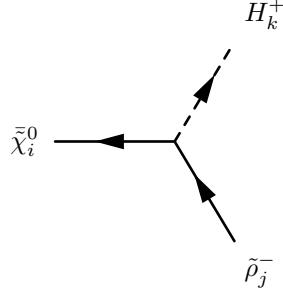
$$+ \frac{i}{2} \left( \sqrt{2} \lambda_U^* U_{i2}^2 V_{j2}^2 Z_{k3}^H + U_{i1}^2 \left( 2g_2 V_{j1}^2 Z_{k4}^H - \sqrt{2} g_2 V_{j2}^2 Z_{k2}^H \right) \right. \\ \left. + \Lambda_U^* U_{i2}^2 \left( \sqrt{2} V_{j1}^2 Z_{k2}^H + V_{j2}^2 Z_{k4}^H \right) \right) \left( \frac{1+\gamma^5}{2} \right) \quad (425)$$


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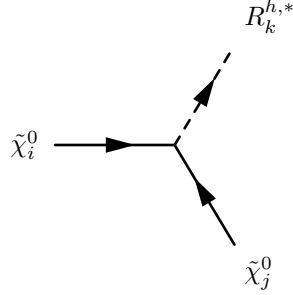
(426)

$$+ i\delta_{\alpha\gamma} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} U_{L,ib}^d V_{j2}^2 \left( \frac{1+\gamma_5}{2} \right) \quad (427)$$



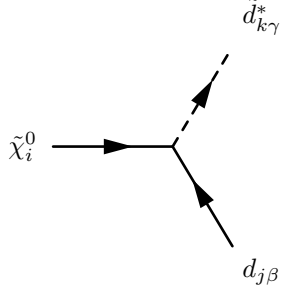
$$- \frac{i}{2} \left( 2g_2 U_{j1}^{2,*} \left( N_{i3}^{2,*} Z_{k1}^+ + \sqrt{2} N_{i2}^{2,*} Z_{k3}^+ \right) - U_{j2}^{2,*} \left( 2\lambda_U N_{i1}^{2,*} Z_{k2}^+ + 2\Lambda_U N_{i4}^{2,*} Z_{k4}^+ + \sqrt{2} \Lambda_U N_{i2}^{2,*} Z_{k2}^+ \right) \right) \left( \frac{1-\gamma_5}{2} \right) \quad (428)$$

$$+ \frac{i}{2} \left( 2\Lambda_D^* V_{j1}^2 N_{i3}^1 Z_{k1}^+ - V_{j2}^2 \left( 2\Lambda_U^* N_{i4}^1 Z_{k3}^+ + \sqrt{2} g_1 N_{i1}^1 Z_{k2}^+ + \sqrt{2} g_2 N_{i2}^1 Z_{k2}^+ \right) - 2\sqrt{2} g_2 V_{j1}^2 N_{i2}^1 Z_{k4}^+ \right) \left( \frac{1+\gamma_5}{2} \right) \quad (429)$$



$$- i \frac{1}{\sqrt{2}} \left( N_{i3}^{1,*} \left( g_1 N_{j1}^{1,*} - g_2 N_{j2}^{1,*} \right) Z_{k1}^R - g_2 N_{i2}^{1,*} N_{j3}^{1,*} Z_{k1}^R - g_1 N_{i4}^{1,*} N_{j1}^{1,*} Z_{k2}^R + g_2 N_{i4}^{1,*} N_{j2}^{1,*} Z_{k2}^R + g_2 N_{i2}^{1,*} N_{j4}^{1,*} Z_{k2}^R + g_1 N_{i1}^{1,*} \left( N_{j3}^{1,*} Z_{k1}^R - N_{j4}^{1,*} Z_{k2}^R \right) \right) \left( \frac{1-\gamma_5}{2} \right) \quad (430)$$

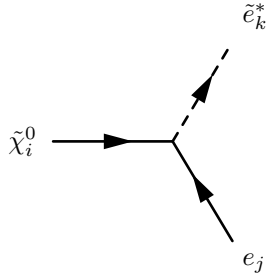
$$+ \frac{i}{2} \left( 2\lambda_D^* Z_{k1}^R \left( N_{i1}^2 N_{j3}^2 + N_{i3}^2 N_{j1}^2 \right) - 2\lambda_U^* Z_{k2}^R \left( N_{i1}^2 N_{j4}^2 + N_{i4}^2 N_{j1}^2 \right) + \sqrt{2} \left( \Lambda_D^* Z_{k1}^R \left( N_{i2}^2 N_{j3}^2 + N_{i3}^2 N_{j2}^2 \right) + \Lambda_U^* Z_{k2}^R \left( N_{i2}^2 N_{j4}^2 + N_{i4}^2 N_{j2}^2 \right) \right) \right) \left( \frac{1+\gamma_5}{2} \right) \quad (431)$$



$$-\frac{i}{3} \frac{1}{\sqrt{2}} \left( -3g_2 N_{i2}^{1,*} + g_1 N_{i1}^{1,*} \right) \delta_{\beta\gamma} \sum_{a=1}^3 U_{L,ja}^{d,*} Z_{ka}^D \left( \frac{1-\gamma_5}{2} \right) \quad (432)$$

$$+ -i \delta_{\beta\gamma} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* U_{R,ja}^d Z_{kb}^D N_{i3}^2 \left( \frac{1+\gamma_5}{2} \right) \quad (433)$$

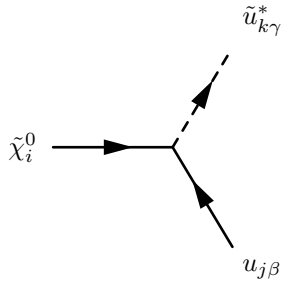

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$$i \frac{1}{\sqrt{2}} \left( g_1 N_{i1}^{1,*} + g_2 N_{i2}^{1,*} \right) \sum_{a=1}^3 U_{L,ja}^{e,*} Z_{ka}^E \left( \frac{1-\gamma_5}{2} \right) \quad (434)$$

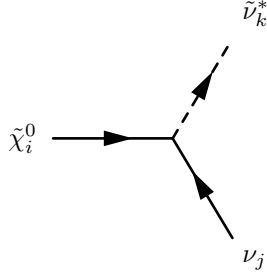
$$+ -i \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* U_{R,ja}^e Z_{kb}^E N_{i3}^2 \left( \frac{1+\gamma_5}{2} \right) \quad (435)$$


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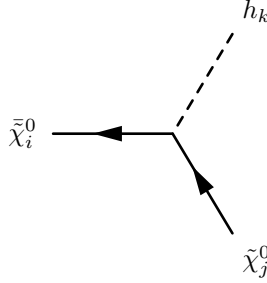


$$-\frac{i}{3}\frac{1}{\sqrt{2}}\left(3g_2N_{i2}^{1,*}+g_1N_{i1}^{1,*}\right)\delta_{\beta\gamma}\sum_{a=1}^3U_{L,ja}^{u,*}Z_{ka}^U\left(\frac{1-\gamma_5}{2}\right) \quad (436)$$

$$+ -i\delta_{\beta\gamma}\sum_{b=1}^3\sum_{a=1}^3Y_{u,ab}^*U_{R,ja}^uZ_{kb}^UN_{i4}^2\left(\frac{1+\gamma_5}{2}\right) \quad (437)$$

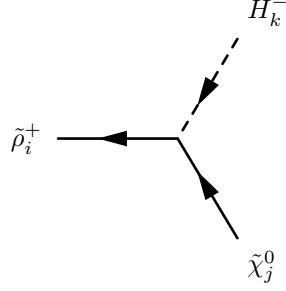


$$i\frac{1}{\sqrt{2}}\left(g_1N_{i1}^{1,*}-g_2N_{i2}^{1,*}\right)\Theta_{j,3}Z_{kj}^V\left(\frac{1-\gamma_5}{2}\right) \quad (438)$$



$$\begin{aligned} & \frac{i}{2}\left(-g_2N_{j2}^{1,*}N_{i3}^{2,*}Z_{k1}^H-\sqrt{2}\lambda_U N_{j4}^{1,*}N_{i1}^{2,*}Z_{k2}^H+\Lambda_U N_{j4}^{1,*}N_{i2}^{2,*}Z_{k2}^H+g_2N_{j2}^{1,*}N_{i4}^{2,*}Z_{k2}^H\right. \\ & +g_1N_{j1}^{1,*}\left(N_{i3}^{2,*}Z_{k1}^H-N_{i4}^{2,*}Z_{k2}^H\right)-\sqrt{2}\lambda_U N_{j4}^{1,*}N_{i4}^{2,*}Z_{k3}^H+\Lambda_U N_{j4}^{1,*}N_{i4}^{2,*}Z_{k4}^H \\ & \left.+N_{j3}^{1,*}\left(\Lambda_D N_{i2}^{2,*}Z_{k1}^H+N_{i3}^{2,*}\left(\Lambda_D Z_{k4}^H+\sqrt{2}\lambda_D Z_{k3}^H\right)+\sqrt{2}\lambda_D N_{i1}^{2,*}Z_{k1}^H\right)\right)\left(\frac{1-\gamma_5}{2}\right) \quad (439) \end{aligned}$$

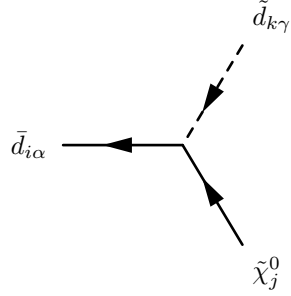
$$\begin{aligned} & +\frac{i}{2}\left(\Lambda_D^* Z_{k1}^H N_{i3}^1 N_{j2}^2+\Lambda_U^* Z_{k2}^H N_{i4}^1 N_{j2}^2+g_1 Z_{k1}^H N_{i1}^1 N_{j3}^2-g_2 Z_{k1}^H N_{i2}^1 N_{j3}^2\right. \\ & +\Lambda_D^* Z_{k4}^H N_{i3}^1 N_{j3}^2+\sqrt{2}\lambda_D^* N_{i3}^1\left(Z_{k1}^H N_{j1}^2+Z_{k3}^H N_{j3}^2\right)-g_1 Z_{k2}^H N_{i1}^1 N_{j4}^2 \\ & \left.+g_2 Z_{k2}^H N_{i2}^1 N_{j4}^2+\Lambda_U^* Z_{k4}^H N_{i4}^1 N_{j4}^2-\sqrt{2}\lambda_U^* N_{i4}^1\left(Z_{k2}^H N_{j1}^2+Z_{k3}^H N_{j4}^2\right)\right)\left(\frac{1+\gamma_5}{2}\right) \quad (440) \end{aligned}$$



$$\begin{aligned}
& -\frac{i}{2} \left( V_{i2}^{2,*} \left( 2\Lambda_U N_{j4}^{1,*} Z_{k3}^+ + \sqrt{2}g_1 N_{j1}^{1,*} Z_{k2}^+ + \sqrt{2}g_2 N_{j2}^{1,*} Z_{k2}^+ \right) \right. \\
& \left. + V_{i1}^{2,*} \left( -2\Lambda_D N_{j3}^{1,*} Z_{k1}^+ + 2\sqrt{2}g_2 N_{j2}^{1,*} Z_{k4}^+ \right) \right) \left( \frac{1-\gamma_5}{2} \right) \quad (441)
\end{aligned}$$

$$\begin{aligned}
& + -\frac{i}{2} \left( 2g_2 U_{i1}^2 \left( N_{j3}^2 Z_{k1}^+ + \sqrt{2}N_{j2}^2 Z_{k3}^+ \right) - U_{i2}^2 \left( 2\lambda_U^* N_{j1}^2 Z_{k2}^+ + \Lambda_U^* \left( 2N_{j4}^2 Z_{k4}^+ + \sqrt{2}N_{j2}^2 Z_{k2}^+ \right) \right) \right) \left( \frac{1+\gamma_5}{2} \right) \quad (442)
\end{aligned}$$

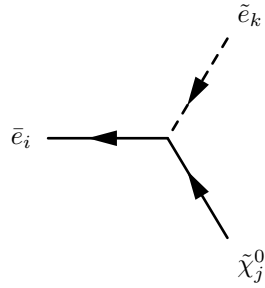

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$$-\frac{i}{3} \sqrt{2}g_1 N_{j1}^{1,*} \delta_{\alpha\gamma} \sum_{a=1}^3 Z_{k3+a}^{D,*} U_{R,ia}^{d,*} \left( \frac{1-\gamma_5}{2} \right) \quad (443)$$

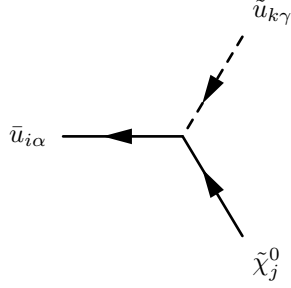
$$\begin{aligned}
& + -i\delta_{\alpha\gamma} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} U_{L,ib}^d N_{j3}^2 \left( \frac{1+\gamma_5}{2} \right) \quad (444)
\end{aligned}$$


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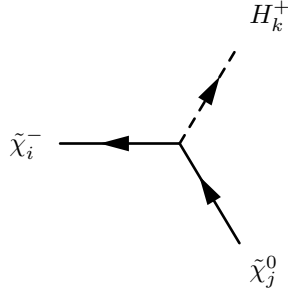
$$-i\sqrt{2}g_1N_{j1}^{1,*}\sum_{a=1}^3Z_{k3+a}^{E,*}U_{R,ia}^{e,*}\left(\frac{1-\gamma_5}{2}\right) \quad (445)$$

$$+ -i\sum_{b=1}^3\sum_{a=1}^3Y_{e,ab}^*Z_{k3+a}^{E,*}U_{L,ib}^eN_{j3}^2\left(\frac{1+\gamma_5}{2}\right) \quad (446)$$



$$\frac{2i}{3}\sqrt{2}g_1N_{j1}^{1,*}\delta_{\alpha\gamma}\sum_{a=1}^3Z_{k3+a}^{U,*}U_{R,ia}^{u,*}\left(\frac{1-\gamma_5}{2}\right) \quad (447)$$

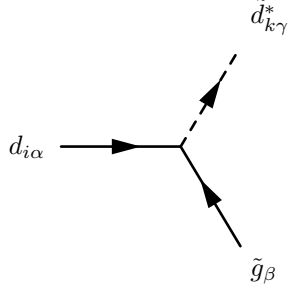
$$+ -i\delta_{\alpha\gamma}\sum_{b=1}^3\sum_{a=1}^3Y_{u,ab}^*Z_{k3+a}^{U,*}U_{L,ib}^uN_{j4}^2\left(\frac{1+\gamma_5}{2}\right) \quad (448)$$



$$\begin{aligned} & \frac{i}{2}\left(2U_{i1}^{1,*}\left(-\Lambda_U N_{j4}^{1,*}Z_{k2}^+ + \sqrt{2}g_2N_{j2}^{1,*}Z_{k3}^+\right) \right. \\ & \left. + U_{i2}^{1,*}\left(2\Lambda_D N_{j3}^{1,*}Z_{k4}^+ + \sqrt{2}g_1N_{j1}^{1,*}Z_{k1}^+ + \sqrt{2}g_2N_{j2}^{1,*}Z_{k1}^+\right)\right)\left(\frac{1-\gamma_5}{2}\right) \quad (449) \end{aligned}$$

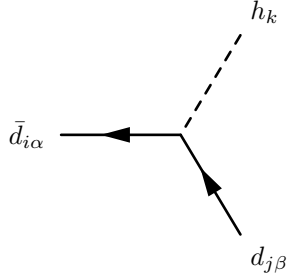
$$\begin{aligned} & + -\frac{i}{2}\left(2\lambda_D^*V_{i2}^1N_{j1}^2Z_{k1}^+ + \Lambda_D^*V_{i2}^1\left(2N_{j3}^2Z_{k3}^+ - \sqrt{2}N_{j2}^2Z_{k1}^+\right) \right. \\ & \left. + 2g_2V_{i1}^1\left(N_{j4}^2Z_{k2}^+ - \sqrt{2}N_{j2}^2Z_{k4}^+\right)\right)\left(\frac{1+\gamma_5}{2}\right) \quad (450) \end{aligned}$$





$$-i \frac{1}{\sqrt{2}} g_3 \lambda_{\gamma,\alpha}^\beta \sum_{a=1}^3 U_{L,ia}^{d,*} Z_{ka}^D \left( \frac{1-\gamma_5}{2} \right) \quad (451)$$

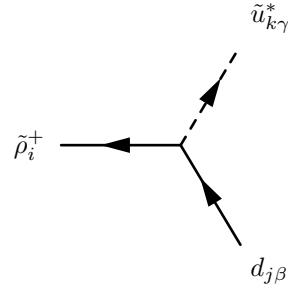

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$$-i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 U_{L,jb}^{d,*} \sum_{a=1}^3 U_{R,ia}^{d,*} Y_{d,ab} Z_{k1}^H \left( \frac{1-\gamma_5}{2} \right) \quad (452)$$

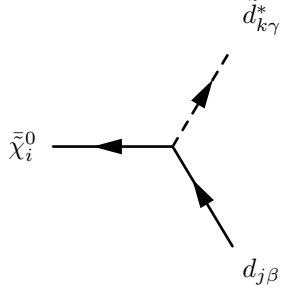
$$+ -i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* U_{R,ja}^d U_{L,ib}^d Z_{k1}^H \left( \frac{1+\gamma_5}{2} \right) \quad (453)$$


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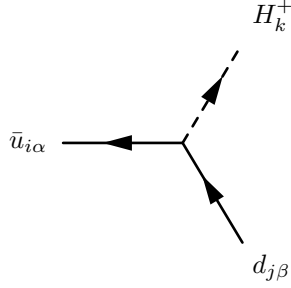
$$i V_{i2}^{2,*} \delta_{\beta\gamma} \sum_{b=1}^3 U_{L,jb}^{d,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U \left( \frac{1-\gamma_5}{2} \right) \quad (454)$$


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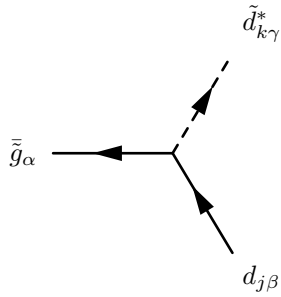
$$-iN_{i3}^{2,*}\delta_{\beta\gamma}\sum_{b=1}^3U_{L,jb}^{d,*}\sum_{a=1}^3Y_{d,ab}Z_{k3+a}^D\left(\frac{1-\gamma_5}{2}\right) \quad (455)$$

$$+ \frac{i}{3}\sqrt{2}g_1\delta_{\beta\gamma}\sum_{a=1}^3Z_{k3+a}^DU_{R,ja}^dN_{i1}^1\left(\frac{1+\gamma_5}{2}\right) \quad (456)$$



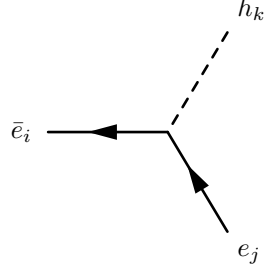
$$i\delta_{\alpha\beta}\sum_{b=1}^3U_{L,jb}^{d,*}\sum_{a=1}^3U_{R,ia}^uY_{u,ab}Z_{k2}^+\left(\frac{1-\gamma_5}{2}\right) \quad (457)$$

$$+ i\delta_{\alpha\beta}\sum_{b=1}^3\sum_{a=1}^3Y_{d,ab}^*U_{R,ja}^dU_{L,ib}^uZ_{k1}^+\left(\frac{1+\gamma_5}{2}\right) \quad (458)$$



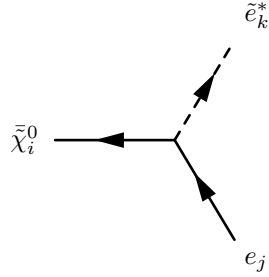
(459)

$$+ i \frac{1}{\sqrt{2}} g_3 \lambda_{\gamma, \beta}^\alpha \sum_{a=1}^3 Z_{k3+a}^D U_{R,ja}^d \left( \frac{1+\gamma_5}{2} \right) \quad (460)$$



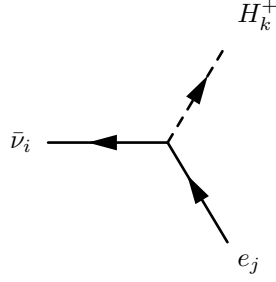
$$- i \frac{1}{\sqrt{2}} \sum_{b=1}^3 U_{L,jb}^{e,*} \sum_{a=1}^3 U_{R,ia}^{e,*} Y_{e,ab} Z_{k1}^H \left( \frac{1-\gamma_5}{2} \right) \quad (461)$$

$$+ -i \frac{1}{\sqrt{2}} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* U_{R,ja}^e U_{L,ib}^e Z_{k1}^H \left( \frac{1+\gamma_5}{2} \right) \quad (462)$$



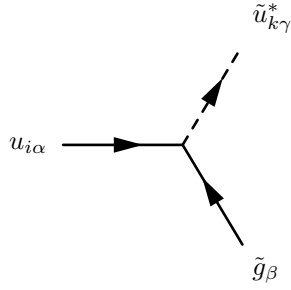
$$- i N_{i3}^{2,*} \sum_{b=1}^3 U_{L,jb}^{e,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \left( \frac{1-\gamma_5}{2} \right) \quad (463)$$

$$+ -i \sqrt{2} g_1 \sum_{a=1}^3 Z_{k3+a}^E U_{R,ja}^e N_{i1}^1 \left( \frac{1+\gamma_5}{2} \right) \quad (464)$$



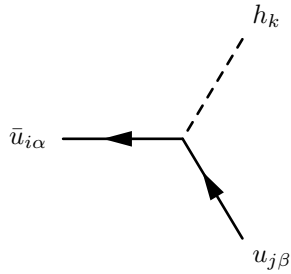
(465)

$$+ i \sum_{a=1}^3 Y_{e,ai}^* U_{R,ja}^e Z_{k1}^+ \left( \frac{1 + \gamma_5}{2} \right) \quad (466)$$



(467)

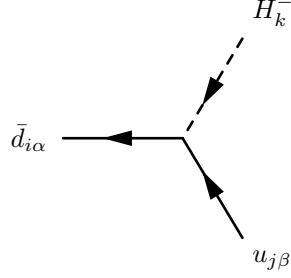
$$- i \frac{1}{\sqrt{2}} g_3 \lambda_{\gamma,\alpha}^\beta \sum_{a=1}^3 U_{L,ia}^{u,*} Z_{ka}^U \left( \frac{1 - \gamma_5}{2} \right) \quad (467)$$



(468)

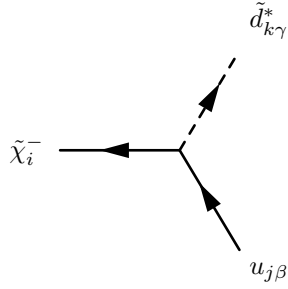
$$- i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 U_{L,jb}^{u,*} \sum_{a=1}^3 U_{R,ia}^{u,*} Y_{u,ab} Z_{k2}^H \left( \frac{1 - \gamma_5}{2} \right) \quad (468)$$

$$+ -i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* U_{R,ja}^u U_{L,ib}^u Z_{k2}^H \left( \frac{1+\gamma_5}{2} \right) \quad (469)$$

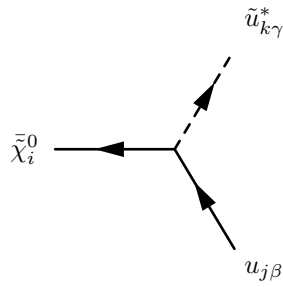


$$i\delta_{\alpha\beta} \sum_{b=1}^3 U_{L,jb}^{u,*} \sum_{a=1}^3 U_{R,ia}^{d,*} Y_{d,ab} Z_{k1}^+ \left( \frac{1-\gamma_5}{2} \right) \quad (470)$$

$$+ i\delta_{\alpha\beta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* U_{R,ja}^u U_{L,ib}^d Z_{k2}^+ \left( \frac{1+\gamma_5}{2} \right) \quad (471)$$



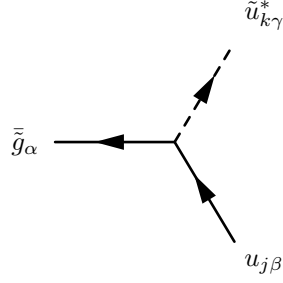
$$iU_{i2}^{1,*} \delta_{\beta\gamma} \sum_{b=1}^3 U_{L,jb}^{u,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \left( \frac{1-\gamma_5}{2} \right) \quad (472)$$



$$-iN_{i4}^{2,*}\delta_{\beta\gamma}\sum_{b=1}^3U_{L,jb}^{u,*}\sum_{a=1}^3Y_{u,ab}Z_{k3+a}^U\left(\frac{1-\gamma_5}{2}\right) \quad (473)$$

$$+\frac{2i}{3}\sqrt{2}g_1\delta_{\beta\gamma}\sum_{a=1}^3Z_{k3+a}^U U_{R,ja}^u N_{i1}^1\left(\frac{1+\gamma_5}{2}\right) \quad (474)$$

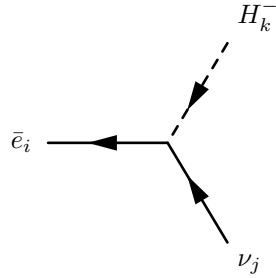

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$$(475)$$

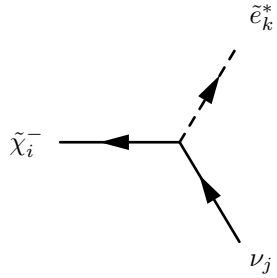
$$+i\frac{1}{\sqrt{2}}g_3\lambda_{\gamma,\beta}^\alpha\sum_{a=1}^3Z_{k3+a}^U U_{R,ja}^u\left(\frac{1+\gamma_5}{2}\right) \quad (476)$$


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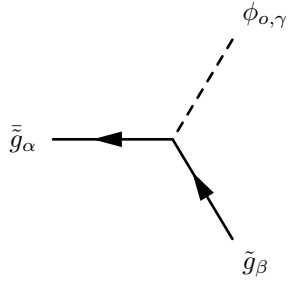
$$i\sum_{a=1}^3U_{R,ia}^{e,*}Y_{e,aj}Z_{k1}^+\left(\frac{1-\gamma_5}{2}\right) \quad (477)$$


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$$iU_{i2}^{1,*} \sum_{a=1}^3 Y_{e,aj} Z_{k3+a}^E \left( \frac{1-\gamma_5}{2} \right) \quad (478)$$

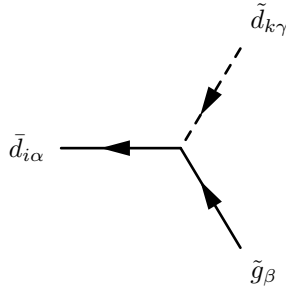

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$$-g_3 f_{\alpha,\beta,\gamma} \left( \frac{1-\gamma_5}{2} \right) \quad (479)$$

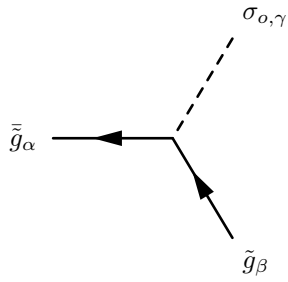
$$+ -g_3 f_{\alpha,\beta,\gamma} \left( \frac{1+\gamma_5}{2} \right) \quad (480)$$


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$$i \frac{1}{\sqrt{2}} g_3 \lambda_{\alpha,\gamma}^\beta \sum_{a=1}^3 Z_{k3+a}^{D,*} U_{R,ia}^{d,*} \left( \frac{1-\gamma_5}{2} \right) \quad (481)$$

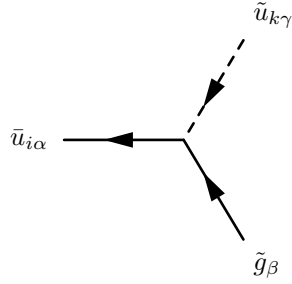

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$$ig_3 f_{\alpha,\beta,\gamma} \left( \frac{1-\gamma_5}{2} \right) \quad (482)$$

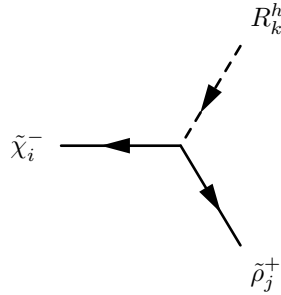
$$+ -ig_3 f_{\alpha,\beta,\gamma} \left( \frac{1+\gamma_5}{2} \right) \quad (483)$$


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$$i \frac{1}{\sqrt{2}} g_3 \lambda_{\alpha,\gamma}^\beta \sum_{a=1}^3 Z_{k3+a}^{U,*} U_{R,ia}^{u,*} \left( \frac{1-\gamma_5}{2} \right) \quad (484)$$

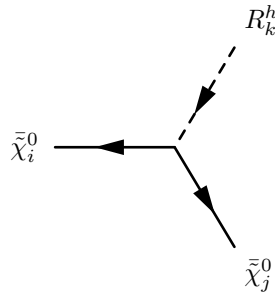

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$$i \left( \Lambda_D U_{i2}^{1,*} V_{j1}^{2,*} Z_{k1}^R - \Lambda_U U_{i1}^{1,*} V_{j2}^{2,*} Z_{k2}^R \right) \left( \frac{1-\gamma_5}{2} \right) \quad (485)$$

$$+ -ig_2 \left( U_{j1}^2 V_{i2}^1 Z_{k1}^R + U_{j2}^2 V_{i1}^1 Z_{k2}^R \right) \left( \frac{1+\gamma_5}{2} \right) \quad (486)$$

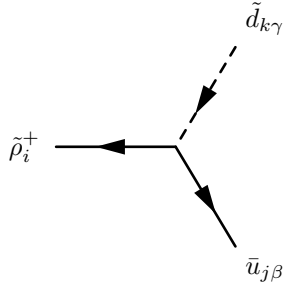

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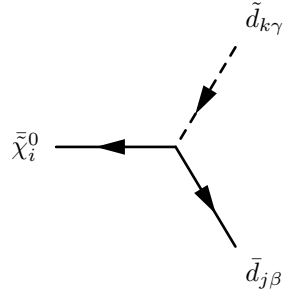
$$\begin{aligned} & \frac{i}{2} \left( N_{i3}^{2,*} \left( 2\lambda_D N_{j1}^{2,*} + \sqrt{2}\Lambda_D N_{j2}^{2,*} \right) Z_{k1}^R + \sqrt{2}\Lambda_D N_{i2}^{2,*} N_{j3}^{2,*} Z_{k1}^R - 2\lambda_U N_{i4}^{2,*} N_{j1}^{2,*} Z_{k2}^R \right. \\ & \left. + \sqrt{2}\Lambda_U N_{i4}^{2,*} N_{j2}^{2,*} Z_{k2}^R + \sqrt{2}\Lambda_U N_{i2}^{2,*} N_{j4}^{2,*} Z_{k2}^R + 2N_{i1}^{2,*} \left( \lambda_D N_{j3}^{2,*} Z_{k1}^R - \lambda_U N_{j4}^{2,*} Z_{k2}^R \right) \right) \left( \frac{1-\gamma_5}{2} \right) \end{aligned} \quad (487)$$

$$\begin{aligned} & + -i \frac{1}{\sqrt{2}} \left( Z_{k1}^R \left( \left( g_1 N_{i1}^1 - g_2 N_{i2}^1 \right) N_{j3}^1 + N_{i3}^1 \left( g_1 N_{j1}^1 - g_2 N_{j2}^1 \right) \right) \right. \\ & \left. + Z_{k2}^R \left( \left( -g_1 N_{i1}^1 + g_2 N_{i2}^1 \right) N_{j4}^1 + N_{i4}^1 \left( -g_1 N_{j1}^1 + g_2 N_{j2}^1 \right) \right) \right) \left( \frac{1+\gamma_5}{2} \right) \end{aligned} \quad (488)$$



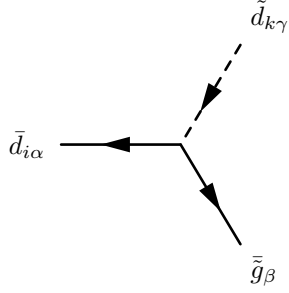
$$iV_{i2}^{2,*} \delta_{\beta\gamma} \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 U_{R,ja}^{u,*} Y_{u,ab} \left( \frac{1-\gamma_5}{2} \right) \quad (489)$$

$$+ -ig_2 \delta_{\beta\gamma} \sum_{a=1}^3 Z_{ka}^{D,*} U_{L,ja}^u U_{i1}^2 \left( \frac{1+\gamma_5}{2} \right) \quad (490)$$



$$-iN_{i3}^{2,*} \delta_{\beta\gamma} \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 U_{R,ja}^{d,*} Y_{d,ab} \left( \frac{1-\gamma_5}{2} \right) \quad (491)$$

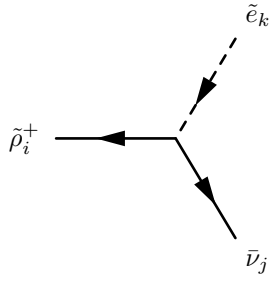
$$+ -\frac{i}{3} \frac{1}{\sqrt{2}} \delta_{\beta\gamma} \sum_{a=1}^3 Z_{ka}^{D,*} U_{L,ja}^d \left( -3g_2 N_{i2}^1 + g_1 N_{i1}^1 \right) \left( \frac{1+\gamma_5}{2} \right) \quad (492)$$



(493)

$$+ -i \frac{1}{\sqrt{2}} g_3 \lambda_{\alpha,\gamma}^\beta \sum_{a=1}^3 Z_{ka}^{D,*} U_{L,ia}^d \left( \frac{1 + \gamma_5}{2} \right) \quad (494)$$

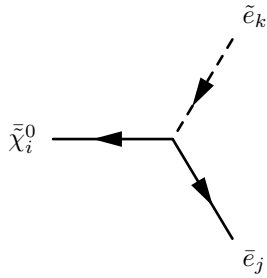

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(495)

$$+ -i g_2 Z_{kj}^{E,*} \Theta_{j,3} U_{i1}^2 \left( \frac{1 + \gamma_5}{2} \right) \quad (496)$$

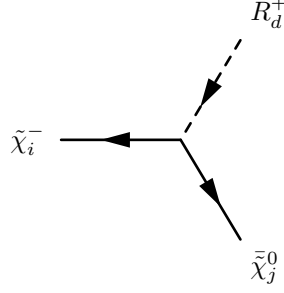

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$$- i N_{i3}^{2,*} \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 U_{R,ja}^{e,*} Y_{e,ab} \left( \frac{1 - \gamma_5}{2} \right) \quad (497)$$

$$+ i \frac{1}{\sqrt{2}} \sum_{a=1}^3 Z_{ka}^{E,*} U_{L,ja}^e (g_1 N_{i1}^1 + g_2 N_{i2}^1) \left( \frac{1+\gamma_5}{2} \right) \quad (498)$$

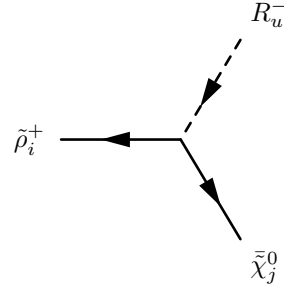

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$$- \frac{i}{2} \left( 2\Lambda_D U_{i1}^{1,*} N_{j3}^{2,*} + U_{i2}^{1,*} \left( 2\lambda_D N_{j1}^{2,*} - \sqrt{2}\Lambda_D N_{j2}^{2,*} \right) \right) \left( \frac{1-\gamma_5}{2} \right) \quad (499)$$

$$+ - \frac{i}{2} \left( 2g_2 V_{i1}^1 N_{j3}^1 + \sqrt{2}V_{i2}^1 \left( g_1 N_{j1}^1 + g_2 N_{j2}^1 \right) \right) \left( \frac{1+\gamma_5}{2} \right) \quad (500)$$

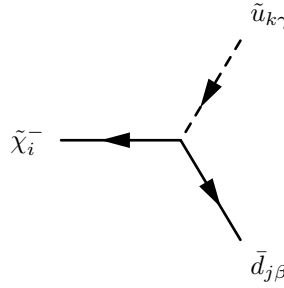

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$$\frac{i}{2} \left( 2\Lambda_U V_{i1}^{2,*} N_{j4}^{2,*} + V_{i2}^{2,*} \left( 2\lambda_U N_{j1}^{2,*} + \sqrt{2}\Lambda_U N_{j2}^{2,*} \right) \right) \left( \frac{1-\gamma_5}{2} \right) \quad (501)$$

$$+ \frac{i}{2} \left( -2g_2 U_{i1}^2 N_{j4}^1 + \sqrt{2}U_{i2}^2 \left( g_1 N_{j1}^1 + g_2 N_{j2}^1 \right) \right) \left( \frac{1+\gamma_5}{2} \right) \quad (502)$$

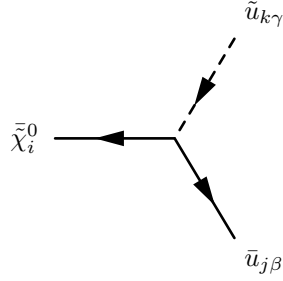

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$$iU_{i2}^{1,*} \delta_{\beta\gamma} \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 U_{R,ja}^{d,*} Y_{d,ab} \left( \frac{1-\gamma_5}{2} \right) \quad (503)$$

$$+ -ig_2 \delta_{\beta\gamma} \sum_{a=1}^3 Z_{ka}^{U,*} U_{L,ja}^d V_{i1}^1 \left( \frac{1+\gamma_5}{2} \right) \quad (504)$$

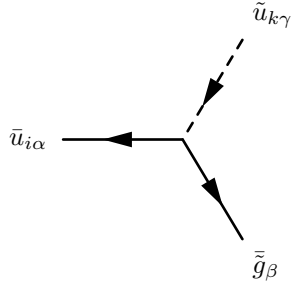

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$$-iN_{i4}^{2,*} \delta_{\beta\gamma} \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 U_{R,ja}^{u,*} Y_{u,ab} \left( \frac{1-\gamma_5}{2} \right) \quad (505)$$

$$+ -\frac{i}{3} \frac{1}{\sqrt{2}} \delta_{\beta\gamma} \sum_{a=1}^3 Z_{ka}^{U,*} U_{L,ja}^u (3g_2 N_{i2}^1 + g_1 N_{i1}^1) \left( \frac{1+\gamma_5}{2} \right) \quad (506)$$

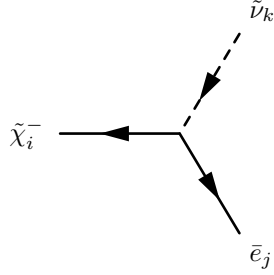

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$$(507)$$

$$+ -i \frac{1}{\sqrt{2}} g_3 \lambda_{\alpha,\gamma}^\beta \sum_{a=1}^3 Z_{ka}^{U,*} U_{L,ia}^u \left( \frac{1+\gamma_5}{2} \right) \quad (508)$$

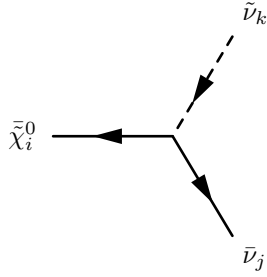

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$$iU_{i2}^{1,*} \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^3 U_{R,ja}^{e,*} Y_{e,ab} \left( \frac{1-\gamma_5}{2} \right) \quad (509)$$

$$+ -ig_2 \sum_{a=1}^3 Z_{ka}^{V,*} U_{L,ja}^e V_{i1}^1 \left( \frac{1+\gamma_5}{2} \right) \quad (510)$$


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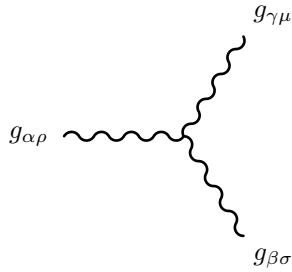


$$(511)$$

$$+ i \frac{1}{\sqrt{2}} Z_{kj}^{V,*} \Theta_{j,3} \left( g_1 N_{i1}^1 - g_2 N_{i2}^1 \right) \left( \frac{1+\gamma_5}{2} \right) \quad (512)$$

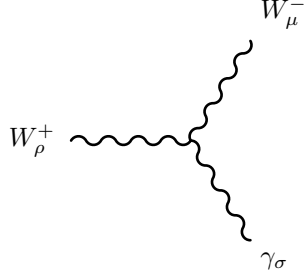

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## 9.6 Three Vector Boson-Interaction



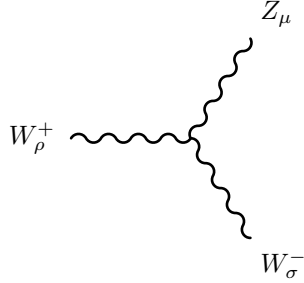
$$g_3 f_{\alpha,\beta,\gamma} \left( g_{\rho\mu} \left( -p_\sigma^{g\gamma\mu} + p_\sigma^{g\alpha\rho} \right) + g_{\rho\sigma} \left( -p_\mu^{g\alpha\rho} + p_\mu^{g\beta\sigma} \right) + g_{\sigma\mu} \left( -p_\rho^{g\beta\sigma} + p_\rho^{g\gamma\mu} \right) \right) \quad (513)$$


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$$ig_2 \sin \Theta_W \left( g_{\rho\mu} \left( -p_\sigma^{W_\mu^-} + p_\sigma^{W_\rho^+} \right) + g_{\rho\sigma} \left( -p_\mu^{W_\rho^+} + p_\mu^{\gamma\sigma} \right) + g_{\sigma\mu} \left( -p_\rho^{\gamma\sigma} + p_\rho^{W_\mu^-} \right) \right) \quad (514)$$

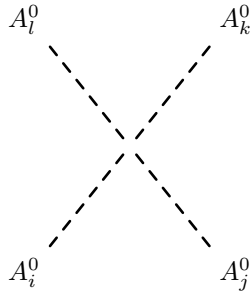

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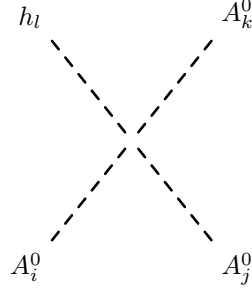
$$-ig_2 \cos \Theta_W \left( g_{\rho\mu} \left( -p_\sigma^{Z_\mu} + p_\sigma^{W_\rho^+} \right) + g_{\rho\sigma} \left( -p_\mu^{W_\rho^+} + p_\mu^{W_\sigma^-} \right) + g_{\sigma\mu} \left( -p_\rho^{W_\sigma^-} + p_\rho^{Z_\mu} \right) \right) \quad (515)$$


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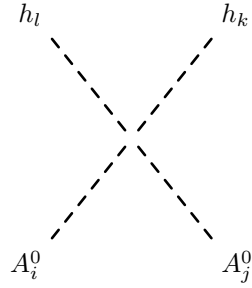
## 9.7 Four Scalar-Interaction



$$\begin{aligned}
& -\frac{i}{4} \left( 4|\lambda_D|^2 Z_{i3}^A Z_{j3}^A Z_{k1}^A Z_{l1}^A + \sqrt{2}\Lambda_D \lambda_D^* Z_{i4}^A Z_{j3}^A Z_{k1}^A Z_{l1}^A + \sqrt{2}\lambda_D \Lambda_D^* Z_{i4}^A Z_{j3}^A Z_{k1}^A Z_{l1}^A \right. \\
& + \sqrt{2}\Lambda_D \lambda_D^* Z_{i3}^A Z_{j4}^A Z_{k1}^A Z_{l1}^A + \sqrt{2}\lambda_D \Lambda_D^* Z_{i3}^A Z_{j4}^A Z_{k1}^A Z_{l1}^A + 2|\Lambda_D|^2 Z_{i4}^A Z_{j4}^A Z_{k1}^A Z_{l1}^A \\
& + 4|\lambda_D|^2 Z_{i3}^A Z_{j1}^A Z_{k3}^A Z_{l1}^A + \sqrt{2}\Lambda_D \lambda_D^* Z_{i4}^A Z_{j1}^A Z_{k3}^A Z_{l1}^A + \sqrt{2}\lambda_D \Lambda_D^* Z_{i4}^A Z_{j1}^A Z_{k3}^A Z_{l1}^A \\
& + \sqrt{2}\Lambda_D \lambda_D^* Z_{i3}^A Z_{j1}^A Z_{k4}^A Z_{l1}^A + \sqrt{2}\lambda_D \Lambda_D^* Z_{i3}^A Z_{j1}^A Z_{k4}^A Z_{l1}^A + 2|\Lambda_D|^2 Z_{i4}^A Z_{j1}^A Z_{k4}^A Z_{l1}^A \\
& + 4|\lambda_U|^2 Z_{i3}^A Z_{j3}^A Z_{k2}^A Z_{l2}^A - \sqrt{2}\Lambda_U \lambda_U^* Z_{i4}^A Z_{j3}^A Z_{k2}^A Z_{l2}^A \\
& - \sqrt{2}\lambda_U \Lambda_U^* Z_{i4}^A Z_{j3}^A Z_{k2}^A Z_{l2}^A - \sqrt{2}\Lambda_U \lambda_U^* Z_{i3}^A Z_{j4}^A Z_{k2}^A Z_{l2}^A \\
& - \sqrt{2}\lambda_U \Lambda_U^* Z_{i3}^A Z_{j4}^A Z_{k2}^A Z_{l2}^A + 2|\Lambda_U|^2 Z_{i4}^A Z_{j4}^A Z_{k2}^A Z_{l2}^A + 4|\lambda_U|^2 Z_{i3}^A Z_{j2}^A Z_{k3}^A Z_{l2}^A \\
& - \sqrt{2}\Lambda_U \lambda_U^* Z_{i4}^A Z_{j2}^A Z_{k3}^A Z_{l2}^A - \sqrt{2}\lambda_U \Lambda_U^* Z_{i4}^A Z_{j2}^A Z_{k3}^A Z_{l2}^A \\
& - \sqrt{2}\Lambda_U \lambda_U^* Z_{i3}^A Z_{j2}^A Z_{k4}^A Z_{l2}^A - \sqrt{2}\lambda_U \Lambda_U^* Z_{i3}^A Z_{j2}^A Z_{k4}^A Z_{l2}^A \\
& + 2|\Lambda_U|^2 Z_{i4}^A Z_{j2}^A Z_{k4}^A Z_{l2}^A + 4|\lambda_D|^2 Z_{i3}^A Z_{j1}^A Z_{k1}^A Z_{l3}^A + \sqrt{2}\Lambda_D \lambda_D^* Z_{i4}^A Z_{j1}^A Z_{k1}^A Z_{l3}^A \\
& + \sqrt{2}\lambda_D \Lambda_D^* Z_{i4}^A Z_{j1}^A Z_{k1}^A Z_{l3}^A + 4|\lambda_U|^2 Z_{i3}^A Z_{j2}^A Z_{k2}^A Z_{l3}^A \\
& - \sqrt{2}\Lambda_U \lambda_U^* Z_{i4}^A Z_{j2}^A Z_{k2}^A Z_{l3}^A - \sqrt{2}\lambda_U \Lambda_U^* Z_{i4}^A Z_{j2}^A Z_{k2}^A Z_{l3}^A \\
& + \sqrt{2}\Lambda_D \lambda_D^* Z_{i3}^A Z_{j1}^A Z_{k1}^A Z_{l4}^A + \sqrt{2}\lambda_D \Lambda_D^* Z_{i3}^A Z_{j1}^A Z_{k1}^A Z_{l4}^A + 2|\Lambda_D|^2 Z_{i4}^A Z_{j1}^A Z_{k1}^A Z_{l4}^A \\
& - \sqrt{2}\Lambda_U \lambda_U^* Z_{i3}^A Z_{j2}^A Z_{k2}^A Z_{l4}^A - \sqrt{2}\lambda_U \Lambda_U^* Z_{i3}^A Z_{j2}^A Z_{k2}^A Z_{l4}^A \\
& + 2|\Lambda_U|^2 Z_{i4}^A Z_{j2}^A Z_{k2}^A Z_{l4}^A \\
& + Z_{i1}^A \left( 4|\lambda_D|^2 Z_{j3}^A Z_{k3}^A Z_{l1}^A + \sqrt{2}\Lambda_D \lambda_D^* Z_{j4}^A Z_{k3}^A Z_{l1}^A + \sqrt{2}\lambda_D \Lambda_D^* Z_{j4}^A Z_{k3}^A Z_{l1}^A \right. \\
& + \sqrt{2}\Lambda_D \lambda_D^* Z_{j3}^A Z_{k4}^A Z_{l1}^A + \sqrt{2}\lambda_D \Lambda_D^* Z_{j3}^A Z_{k4}^A Z_{l1}^A + 2|\Lambda_D|^2 Z_{j4}^A Z_{k4}^A Z_{l1}^A \\
& - \left( g_1^2 + g_2^2 \right) Z_{j2}^A \left( Z_{k1}^A Z_{l2}^A + Z_{k2}^A Z_{l1}^A \right) + 4|\lambda_D|^2 Z_{j3}^A Z_{k1}^A Z_{l3}^A + \sqrt{2}\Lambda_D \lambda_D^* Z_{j4}^A Z_{k1}^A Z_{l3}^A \\
& + \sqrt{2}\lambda_D \Lambda_D^* Z_{j4}^A Z_{k1}^A Z_{l3}^A + \sqrt{2}\Lambda_D \lambda_D^* Z_{j3}^A Z_{k1}^A Z_{l4}^A + \sqrt{2}\lambda_D \Lambda_D^* Z_{j3}^A Z_{k1}^A Z_{l4}^A \\
& + 2|\Lambda_D|^2 Z_{j4}^A Z_{k1}^A Z_{l4}^A \\
& + Z_{j1}^A \left( 3 \left( g_1^2 + g_2^2 \right) Z_{k1}^A Z_{l1}^A - \left( g_1^2 + g_2^2 \right) Z_{k2}^A Z_{l2}^A + 4|\lambda_D|^2 Z_{k3}^A Z_{l3}^A + \sqrt{2}\Lambda_D \lambda_D^* Z_{k4}^A Z_{l3}^A \right. \\
& + \sqrt{2}\lambda_D \Lambda_D^* Z_{k4}^A Z_{l3}^A + \sqrt{2}\Lambda_D \lambda_D^* Z_{k3}^A Z_{l4}^A + \sqrt{2}\lambda_D \Lambda_D^* Z_{k3}^A Z_{l4}^A + 2|\Lambda_D|^2 Z_{k4}^A Z_{l4}^A \left. \right) \\
& - Z_{i2}^A \left( -4|\lambda_U|^2 Z_{j3}^A Z_{k3}^A Z_{l2}^A + \sqrt{2}\Lambda_U \lambda_U^* Z_{j4}^A Z_{k3}^A Z_{l2}^A + \sqrt{2}\lambda_U \Lambda_U^* Z_{j4}^A Z_{k3}^A Z_{l2}^A \right. \\
& + \sqrt{2}\Lambda_U \lambda_U^* Z_{j3}^A Z_{k4}^A Z_{l2}^A + \sqrt{2}\lambda_U \Lambda_U^* Z_{j3}^A Z_{k4}^A Z_{l2}^A - 2|\Lambda_U|^2 Z_{j4}^A Z_{k4}^A Z_{l2}^A \\
& + \left( g_1^2 + g_2^2 \right) Z_{j1}^A \left( Z_{k1}^A Z_{l2}^A + Z_{k2}^A Z_{l1}^A \right) - 4|\lambda_U|^2 Z_{j3}^A Z_{k2}^A Z_{l3}^A + \sqrt{2}\Lambda_U \lambda_U^* Z_{j4}^A Z_{k2}^A Z_{l3}^A \\
& + \sqrt{2}\lambda_U \Lambda_U^* Z_{j4}^A Z_{k2}^A Z_{l3}^A + \sqrt{2}\Lambda_U \lambda_U^* Z_{j3}^A Z_{k2}^A Z_{l4}^A + \sqrt{2}\lambda_U \Lambda_U^* Z_{j3}^A Z_{k2}^A Z_{l4}^A \\
& - 2|\Lambda_U|^2 Z_{j4}^A Z_{k2}^A Z_{l4}^A \\
& + Z_{j2}^A \left( \left( g_1^2 + g_2^2 \right) Z_{k1}^A Z_{l1}^A - 3 \left( g_1^2 + g_2^2 \right) Z_{k2}^A Z_{l2}^A - 4|\lambda_U|^2 Z_{k3}^A Z_{l3}^A + \sqrt{2}\Lambda_U \lambda_U^* Z_{k4}^A Z_{l3}^A \right. \\
& \left. + \sqrt{2}\lambda_U \Lambda_U^* Z_{k4}^A Z_{l3}^A + \sqrt{2}\Lambda_U \lambda_U^* Z_{k3}^A Z_{l4}^A + \sqrt{2}\lambda_U \Lambda_U^* Z_{k3}^A Z_{l4}^A - 2|\Lambda_U|^2 Z_{k4}^A Z_{l4}^A \right) \left. \right) \quad (516)
\end{aligned}$$



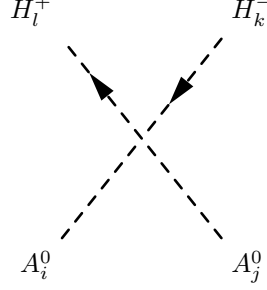
$$\begin{aligned}
& \frac{1}{2} \frac{1}{\sqrt{2}} \left( \Lambda_D \lambda_D^* \left( Z_{i4}^A Z_{j1}^A Z_{k1}^A Z_{l3}^H - Z_{i3}^A Z_{j1}^A Z_{k1}^A Z_{l4}^H \right. \right. \\
& \quad \left. \left. + Z_{i1}^A \left( Z_{j1}^A \left( -Z_{k3}^A Z_{l4}^H + Z_{k4}^A Z_{l3}^H \right) - Z_{j3}^A Z_{k1}^A Z_{l4}^H + Z_{j4}^A Z_{k1}^A Z_{l3}^H \right) \right) \right) \\
& \quad - \left( -\lambda_U \Lambda_U^* + \Lambda_U \lambda_U^* \right) \left( Z_{i4}^A Z_{j2}^A Z_{k2}^A Z_{l3}^H - Z_{i3}^A Z_{j2}^A Z_{k2}^A Z_{l4}^H \right. \\
& \quad \left. + Z_{i2}^A \left( Z_{j2}^A \left( -Z_{k3}^A Z_{l4}^H + Z_{k4}^A Z_{l3}^H \right) - Z_{j3}^A Z_{k2}^A Z_{l4}^H + Z_{j4}^A Z_{k2}^A Z_{l3}^H \right) \right) \\
& \quad + \lambda_D \Lambda_D^* \left( -Z_{i4}^A Z_{j1}^A Z_{k1}^A Z_{l3}^H + Z_{i3}^A Z_{j1}^A Z_{k1}^A Z_{l4}^H \right. \\
& \quad \left. \left. + Z_{i1}^A \left( Z_{j1}^A \left( Z_{k3}^A Z_{l4}^H - Z_{k4}^A Z_{l3}^H \right) + Z_{j3}^A Z_{k1}^A Z_{l4}^H - Z_{j4}^A Z_{k1}^A Z_{l3}^H \right) \right) \right) \quad (517)
\end{aligned}$$



$$\begin{aligned}
& -\frac{i}{4} \left( 4|\lambda_D|^2 Z_{i3}^A Z_{j3}^A Z_{k1}^H Z_{l1}^H + \sqrt{2}\Lambda_D \lambda_D^* Z_{i4}^A Z_{j3}^A Z_{k1}^H Z_{l1}^H + \sqrt{2}\lambda_D \Lambda_D^* Z_{i4}^A Z_{j3}^A Z_{k1}^H Z_{l1}^H \right. \\
& \quad + \sqrt{2}\Lambda_D \lambda_D^* Z_{i3}^A Z_{j4}^A Z_{k1}^H Z_{l1}^H + \sqrt{2}\lambda_D \Lambda_D^* Z_{i3}^A Z_{j4}^A Z_{k1}^H Z_{l1}^H + 2|\Lambda_D|^2 Z_{i4}^A Z_{j4}^A Z_{k1}^H Z_{l1}^H \\
& \quad + 4|\lambda_U|^2 Z_{i3}^A Z_{j3}^A Z_{k2}^H Z_{l2}^H - \sqrt{2}\Lambda_U \lambda_U^* Z_{i4}^A Z_{j3}^A Z_{k2}^H Z_{l2}^H \\
& \quad - \sqrt{2}\lambda_U \Lambda_U^* Z_{i4}^A Z_{j3}^A Z_{k2}^H Z_{l2}^H - \sqrt{2}\Lambda_U \lambda_U^* Z_{i3}^A Z_{j4}^A Z_{k2}^H Z_{l2}^H \\
& \quad \left. - \sqrt{2}\lambda_U \Lambda_U^* Z_{i3}^A Z_{j4}^A Z_{k2}^H Z_{l2}^H + 2|\Lambda_U|^2 Z_{i4}^A Z_{j4}^A Z_{k2}^H Z_{l2}^H \right) \\
& \quad + Z_{i1}^A Z_{j1}^A \left( (g_1^2 + g_2^2) Z_{k1}^H Z_{l1}^H - (g_1^2 + g_2^2) Z_{k2}^H Z_{l2}^H + 4|\lambda_D|^2 Z_{k3}^H Z_{l3}^H + \sqrt{2}\Lambda_D \lambda_D^* Z_{k4}^H Z_{l3}^H \right. \\
& \quad \left. + \sqrt{2}\lambda_D \Lambda_D^* Z_{k4}^H Z_{l3}^H + \sqrt{2}\Lambda_D \lambda_D^* Z_{k3}^H Z_{l4}^H + \sqrt{2}\lambda_D \Lambda_D^* Z_{k3}^H Z_{l4}^H + 2|\Lambda_D|^2 Z_{k4}^H Z_{l4}^H \right)
\end{aligned}$$

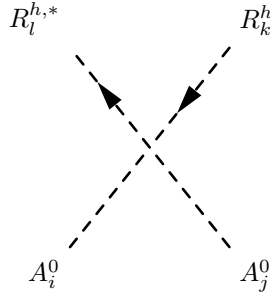


$$\begin{aligned}
& - Z_{i2}^A Z_{j2}^A \left( (g_1^2 + g_2^2) Z_{k1}^H Z_{l1}^H - (g_1^2 + g_2^2) Z_{k2}^H Z_{l2}^H - 4|\lambda_U|^2 Z_{k3}^H Z_{l3}^H + \sqrt{2}\Lambda_U \lambda_U^* Z_{k4}^H Z_{l3}^H \right. \\
& \left. + \sqrt{2}\lambda_U \Lambda_U^* Z_{k4}^H Z_{l3}^H + \sqrt{2}\Lambda_U \lambda_U^* Z_{k3}^H Z_{l4}^H + \sqrt{2}\lambda_U \Lambda_U^* Z_{k3}^H Z_{l4}^H - 2|\Lambda_U|^2 Z_{k4}^H Z_{l4}^H \right) \tag{518}
\end{aligned}$$

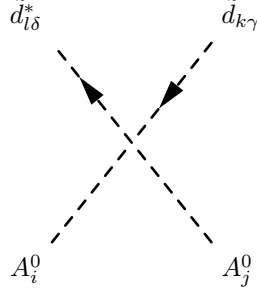


$$\begin{aligned}
& - \frac{i}{4} \left( 4|\lambda_D|^2 Z_{i3}^A Z_{j3}^A Z_{k1}^+ Z_{l1}^+ - \sqrt{2}\Lambda_D \lambda_D^* Z_{i4}^A Z_{j3}^A Z_{k1}^+ Z_{l1}^+ \right. \\
& - \sqrt{2}\lambda_D \Lambda_D^* Z_{i4}^A Z_{j3}^A Z_{k1}^+ Z_{l1}^+ - \sqrt{2}\Lambda_D \lambda_D^* Z_{i3}^A Z_{j4}^A Z_{k1}^+ Z_{l1}^+ \\
& - \sqrt{2}\lambda_D \Lambda_D^* Z_{i3}^A Z_{j4}^A Z_{k1}^+ Z_{l1}^+ + 2|\Lambda_D|^2 Z_{i4}^A Z_{j4}^A Z_{k1}^+ Z_{l1}^+ + 2\Lambda_D \lambda_D^* Z_{i3}^A Z_{j1}^+ Z_{k3}^+ Z_{l1}^+ \\
& + \sqrt{2}g_2^2 Z_{i4}^A Z_{j1}^+ Z_{k3}^+ Z_{l1}^+ - \sqrt{2}|\Lambda_D|^2 Z_{i4}^A Z_{j1}^+ Z_{k3}^+ Z_{l1}^+ - 2\lambda_D \Lambda_D^* Z_{i3}^A Z_{j1}^+ Z_{k4}^+ Z_{l1}^+ \\
& + \sqrt{2}g_2^2 Z_{i4}^A Z_{j1}^+ Z_{k4}^+ Z_{l1}^+ - \sqrt{2}|\Lambda_D|^2 Z_{i4}^A Z_{j1}^+ Z_{k4}^+ Z_{l1}^+ + 4|\lambda_U|^2 Z_{i3}^A Z_{j3}^A Z_{k2}^+ Z_{l2}^+ \\
& + \sqrt{2}\Lambda_U \lambda_U^* Z_{i4}^A Z_{j3}^A Z_{k2}^+ Z_{l2}^+ + \sqrt{2}\lambda_U \Lambda_U^* Z_{i4}^A Z_{j3}^A Z_{k2}^+ Z_{l2}^+ \\
& + \sqrt{2}\Lambda_U \lambda_U^* Z_{i3}^A Z_{j4}^A Z_{k2}^+ Z_{l2}^+ + \sqrt{2}\lambda_U \Lambda_U^* Z_{i3}^A Z_{j4}^A Z_{k2}^+ Z_{l2}^+ + 2|\Lambda_U|^2 Z_{i4}^A Z_{j4}^A Z_{k2}^+ Z_{l2}^+ \\
& - 2\Lambda_U \lambda_U^* Z_{i3}^A Z_{j2}^+ Z_{k3}^+ Z_{l2}^+ - \sqrt{2}g_2^2 Z_{i4}^A Z_{j2}^+ Z_{k3}^+ Z_{l2}^+ + \sqrt{2}|\Lambda_U|^2 Z_{i4}^A Z_{j2}^+ Z_{k3}^+ Z_{l2}^+ \\
& + 2\lambda_U \Lambda_U^* Z_{i3}^A Z_{j2}^+ Z_{k4}^+ Z_{l2}^+ - \sqrt{2}g_2^2 Z_{i4}^A Z_{j2}^+ Z_{k4}^+ Z_{l2}^+ + \sqrt{2}|\Lambda_U|^2 Z_{i4}^A Z_{j2}^+ Z_{k4}^+ Z_{l2}^+ \\
& + 2\lambda_D \Lambda_D^* Z_{i3}^A Z_{j1}^+ Z_{k1}^+ Z_{l3}^+ + \sqrt{2}g_2^2 Z_{i4}^A Z_{j1}^+ Z_{k1}^+ Z_{l3}^+ - \sqrt{2}|\Lambda_D|^2 Z_{i4}^A Z_{j1}^+ Z_{k1}^+ Z_{l3}^+ \\
& - 2\lambda_U \Lambda_U^* Z_{i3}^A Z_{j2}^+ Z_{k2}^+ Z_{l3}^+ - \sqrt{2}g_2^2 Z_{i4}^A Z_{j2}^+ Z_{k2}^+ Z_{l3}^+ + \sqrt{2}|\Lambda_U|^2 Z_{i4}^A Z_{j2}^+ Z_{k2}^+ Z_{l3}^+ \\
& + 4g_2^2 Z_{i4}^A Z_{j4}^A Z_{k3}^+ Z_{l3}^+ + 4g_2^2 Z_{i4}^A Z_{j4}^A Z_{k4}^+ Z_{l3}^+ - 2\Lambda_D \lambda_D^* Z_{i3}^A Z_{j1}^+ Z_{k1}^+ Z_{l4}^+ \\
& + \sqrt{2}g_2^2 Z_{i4}^A Z_{j1}^+ Z_{k1}^+ Z_{l4}^+ - \sqrt{2}|\Lambda_D|^2 Z_{i4}^A Z_{j1}^+ Z_{k1}^+ Z_{l4}^+ + 2\Lambda_U \lambda_U^* Z_{i3}^A Z_{j2}^+ Z_{k2}^+ Z_{l4}^+ \\
& - \sqrt{2}g_2^2 Z_{i4}^A Z_{j2}^+ Z_{k2}^+ Z_{l4}^+ + \sqrt{2}|\Lambda_U|^2 Z_{i4}^A Z_{j2}^+ Z_{k2}^+ Z_{l4}^+ + 4g_2^2 Z_{i4}^A Z_{j4}^A Z_{k3}^+ Z_{l4}^+ \\
& + 4g_2^2 Z_{i4}^A Z_{j4}^A Z_{k4}^+ Z_{l4}^+ \\
& + Z_{i1}^A \left( 2\Lambda_D \lambda_D^* Z_{j3}^A Z_{k3}^+ Z_{l1}^+ + \sqrt{2}g_2^2 Z_{j4}^A Z_{k3}^+ Z_{l1}^+ - \sqrt{2}|\Lambda_D|^2 Z_{j4}^A Z_{k3}^+ Z_{l1}^+ \right. \\
& - 2\lambda_D \Lambda_D^* Z_{j3}^A Z_{k4}^+ Z_{l1}^+ + \sqrt{2}g_2^2 Z_{j4}^A Z_{k4}^+ Z_{l1}^+ - \sqrt{2}|\Lambda_D|^2 Z_{j4}^A Z_{k4}^+ Z_{l1}^+ \\
& - g_2^2 Z_{j2}^A \left( Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) + 2\lambda_D \Lambda_D^* Z_{j3}^A Z_{k1}^+ Z_{l3}^+ + \sqrt{2}g_2^2 Z_{j4}^A Z_{k1}^+ Z_{l3}^+ \\
& - \sqrt{2}|\Lambda_D|^2 Z_{j4}^A Z_{k1}^+ Z_{l3}^+ - 2\Lambda_D \lambda_D^* Z_{j3}^A Z_{k1}^+ Z_{l4}^+ + \sqrt{2}g_2^2 Z_{j4}^A Z_{k1}^+ Z_{l4}^+ \\
& \left. - \sqrt{2}|\Lambda_D|^2 Z_{j4}^A Z_{k1}^+ Z_{l4}^+ \right)
\end{aligned}$$

$$\begin{aligned}
& + Z_{j_1}^A \left( (g_1^2 + g_2^2) Z_{k_1}^+ Z_{l_1}^+ + (-g_1^2 + g_2^2) Z_{k_2}^+ Z_{l_2}^+ - 2g_2^2 Z_{k_3}^+ Z_{l_3}^+ + 4|\Lambda_D|^2 Z_{k_3}^+ Z_{l_3}^+ \right. \\
& \left. + 2g_2^2 Z_{k_4}^+ Z_{l_4}^+ \right) \\
& + Z_{i_2}^A \left( -2\Lambda_U \lambda_U^* Z_{j_3}^A Z_{k_3}^+ Z_{l_2}^+ - \sqrt{2}g_2^2 Z_{j_4}^A Z_{k_3}^+ Z_{l_2}^+ + \sqrt{2}|\Lambda_U|^2 Z_{j_4}^A Z_{k_3}^+ Z_{l_2}^+ \right. \\
& + 2\lambda_U \Lambda_U^* Z_{j_3}^A Z_{k_4}^+ Z_{l_2}^+ - \sqrt{2}g_2^2 Z_{j_4}^A Z_{k_4}^+ Z_{l_2}^+ + \sqrt{2}|\Lambda_U|^2 Z_{j_4}^A Z_{k_4}^+ Z_{l_2}^+ \\
& - g_2^2 Z_{j_1}^A (Z_{k_1}^+ Z_{l_2}^+ + Z_{k_2}^+ Z_{l_1}^+) - 2\lambda_U \Lambda_U^* Z_{j_3}^A Z_{k_2}^+ Z_{l_3}^+ - \sqrt{2}g_2^2 Z_{j_4}^A Z_{k_2}^+ Z_{l_3}^+ \\
& + \sqrt{2}|\Lambda_U|^2 Z_{j_4}^A Z_{k_2}^+ Z_{l_3}^+ + 2\Lambda_U \lambda_U^* Z_{j_3}^A Z_{k_2}^+ Z_{l_4}^+ - \sqrt{2}g_2^2 Z_{j_4}^A Z_{k_2}^+ Z_{l_4}^+ \\
& + \sqrt{2}|\Lambda_U|^2 Z_{j_4}^A Z_{k_2}^+ Z_{l_4}^+ \\
& \left. + Z_{j_2}^A \left( (-g_1^2 + g_2^2) Z_{k_1}^+ Z_{l_1}^+ + (g_1^2 + g_2^2) Z_{k_2}^+ Z_{l_2}^+ + 2g_2^2 Z_{k_3}^+ Z_{l_3}^+ - 2g_2^2 Z_{k_4}^+ Z_{l_4}^+ \right. \right. \\
& \left. \left. + 4|\Lambda_U|^2 Z_{k_4}^+ Z_{l_4}^+ \right) \right) \tag{519}
\end{aligned}$$

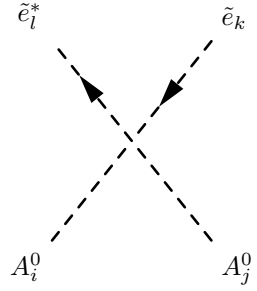


$$\begin{aligned}
& - \frac{i}{4} \left( 4|\lambda_D|^2 Z_{i_3}^A Z_{j_3}^A Z_{k_1}^R Z_{l_1}^R + \sqrt{2}\Lambda_D \lambda_D^* Z_{i_4}^A Z_{j_3}^A Z_{k_1}^R Z_{l_1}^R + \sqrt{2}\lambda_D \Lambda_D^* Z_{i_4}^A Z_{j_3}^A Z_{k_1}^R Z_{l_1}^R \right. \\
& + \sqrt{2}\Lambda_D \lambda_D^* Z_{i_3}^A Z_{j_4}^A Z_{k_1}^R Z_{l_1}^R + \sqrt{2}\lambda_D \Lambda_D^* Z_{i_3}^A Z_{j_4}^A Z_{k_1}^R Z_{l_1}^R + 2|\Lambda_D|^2 Z_{i_4}^A Z_{j_4}^A Z_{k_1}^R Z_{l_1}^R \\
& + 4|\lambda_U|^2 Z_{i_3}^A Z_{j_3}^A Z_{k_2}^R Z_{l_2}^R - \sqrt{2}\Lambda_U \lambda_U^* Z_{i_4}^A Z_{j_3}^A Z_{k_2}^R Z_{l_2}^R \\
& - \sqrt{2}\lambda_U \Lambda_U^* Z_{i_4}^A Z_{j_3}^A Z_{k_2}^R Z_{l_2}^R - \sqrt{2}\Lambda_U \lambda_U^* Z_{i_3}^A Z_{j_4}^A Z_{k_2}^R Z_{l_2}^R \\
& \left. - \sqrt{2}\lambda_U \Lambda_U^* Z_{i_3}^A Z_{j_4}^A Z_{k_2}^R Z_{l_2}^R + 2|\Lambda_U|^2 Z_{i_4}^A Z_{j_4}^A Z_{k_2}^R Z_{l_2}^R \right) \\
& + Z_{i_1}^A \left( Z_{j_2}^A \left( (-2\lambda_D \lambda_U^* + \Lambda_D \Lambda_U^*) Z_{k_1}^R Z_{l_2}^R - 2\lambda_U \lambda_D^* Z_{k_2}^R Z_{l_1}^R + \Lambda_U \Lambda_D^* Z_{k_2}^R Z_{l_1}^R \right) \right. \\
& + Z_{j_1}^A \left( - \left( -2|\Lambda_D|^2 - 4|\lambda_D|^2 + g_1^2 + g_2^2 \right) Z_{k_1}^R Z_{l_1}^R + \left( g_1^2 + g_2^2 \right) Z_{k_2}^R Z_{l_2}^R \right) \\
& + Z_{i_2}^A \left( Z_{j_1}^A \left( (-2\lambda_D \lambda_U^* + \Lambda_D \Lambda_U^*) Z_{k_1}^R Z_{l_2}^R - 2\lambda_U \lambda_D^* Z_{k_2}^R Z_{l_1}^R + \Lambda_U \Lambda_D^* Z_{k_2}^R Z_{l_1}^R \right) \right. \\
& \left. \left. + Z_{j_2}^A \left( - \left( -2|\Lambda_U|^2 - 4|\lambda_U|^2 + g_1^2 + g_2^2 \right) Z_{k_2}^R Z_{l_2}^R + \left( g_1^2 + g_2^2 \right) Z_{k_1}^R Z_{l_1}^R \right) \right) \right) \tag{520}
\end{aligned}$$



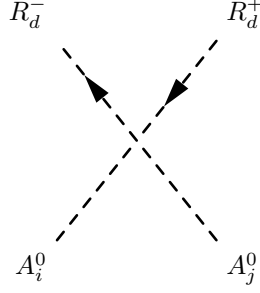
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left( (3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ka}^{D,*} Z_{la}^D (Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A) \right. \\
& + 2 \left( -6 \left( \sum_{c=1}^3 Z_{k3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{d,ba} Z_{l3+b}^D + \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{lc}^D \right) Z_{i1}^A Z_{j1}^A \right. \\
& \left. \left. + g_1^2 \sum_{a=1}^3 Z_{k3+a}^{D,*} Z_{l3+a}^D (Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A) \right) \right) \quad (521)
\end{aligned}$$


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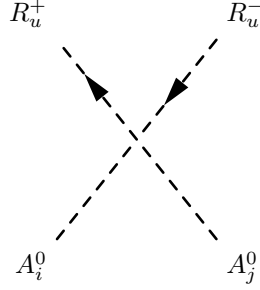
$$\begin{aligned}
& -\frac{i}{4} \left( 4 \left( \sum_{c=1}^3 Z_{k3+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ca}^* Y_{e,ba} Z_{l3+b}^E + \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^E \right) Z_{i1}^A Z_{j1}^A \right. \\
& + \left( -g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ka}^{E,*} Z_{la}^E (Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A) \\
& \left. + 2g_1^2 \sum_{a=1}^3 Z_{k3+a}^{E,*} Z_{l3+a}^E (-Z_{i1}^A Z_{j1}^A + Z_{i2}^A Z_{j2}^A) \right) \quad (522)
\end{aligned}$$


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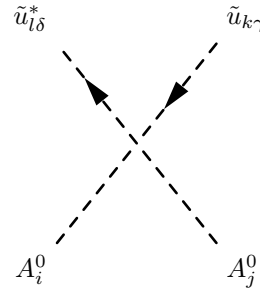
$$\begin{aligned}
& \frac{i}{4} \left( (-4|\Lambda_D|^2 - g_2^2 + g_1^2) Z_{i1}^A Z_{j1}^A + (-g_1^2 + g_2^2) Z_{i2}^A Z_{j2}^A - 4|\lambda_D|^2 Z_{i3}^A Z_{j3}^A \right. \\
& + \sqrt{2}\Lambda_D \lambda_D^* Z_{i4}^A Z_{j3}^A + \sqrt{2}\lambda_D \Lambda_D^* Z_{i4}^A Z_{j3}^A + \sqrt{2}\Lambda_D \lambda_D^* Z_{i3}^A Z_{j4}^A + \sqrt{2}\lambda_D \Lambda_D^* Z_{i3}^A Z_{j4}^A \\
& \left. - 2|\Lambda_D|^2 Z_{i4}^A Z_{j4}^A \right) \tag{523}
\end{aligned}$$


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$$\begin{aligned}
& -\frac{i}{4} \left( (-g_2^2 + g_1^2) Z_{i1}^A Z_{j1}^A + (4|\Lambda_U|^2 - g_1^2 + g_2^2) Z_{i2}^A Z_{j2}^A + 4|\lambda_U|^2 Z_{i3}^A Z_{j3}^A \right. \\
& + \sqrt{2}\Lambda_U \lambda_U^* Z_{i4}^A Z_{j3}^A + \sqrt{2}\lambda_U \Lambda_U^* Z_{i4}^A Z_{j3}^A + \sqrt{2}\Lambda_U \lambda_U^* Z_{i3}^A Z_{j4}^A + \sqrt{2}\lambda_U \Lambda_U^* Z_{i3}^A Z_{j4}^A \\
& \left. + 2|\Lambda_U|^2 Z_{i4}^A Z_{j4}^A \right) \tag{524}
\end{aligned}$$


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$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left( \left( -3g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ka}^{U,*} Z_{la}^U \left( Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A \right) \right. \\
& - 4 \left( 3 \left( \sum_{c=1}^3 Z_{k3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{u,ba} Z_{l3+b}^U + \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{lc}^U \right) Z_{i2}^A Z_{j2}^A \right. \\
& \left. \left. + g_1^2 \sum_{a=1}^3 Z_{k3+a}^{U,*} Z_{l3+a}^U \left( Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A \right) \right) \right) \tag{525}
\end{aligned}$$

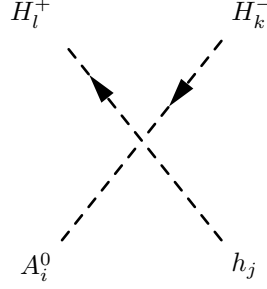

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$$- \frac{i}{4} \left( g_1^2 + g_2^2 \right) \delta_{kl} \left( Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A \right) \tag{526}$$

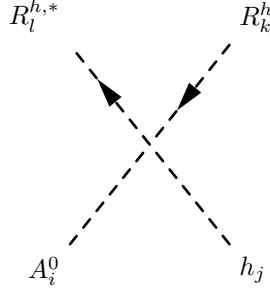

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$$\begin{aligned}
& \frac{1}{2} \frac{1}{\sqrt{2}} \left( \Lambda_D \lambda_D^* \left( Z_{i4}^A \left( Z_{j1}^H \left( Z_{k1}^H Z_{l3}^H + Z_{k3}^H Z_{l1}^H \right) + Z_{j3}^H Z_{k1}^H Z_{l1}^H \right) \right. \right. \\
& - Z_{i3}^A \left( Z_{j1}^H \left( Z_{k1}^H Z_{l4}^H + Z_{k4}^H Z_{l1}^H \right) + Z_{j4}^H Z_{k1}^H Z_{l1}^H \right) \left. \right) \\
& + \lambda_D \Lambda_D^* \left( -Z_{i4}^A \left( Z_{j1}^H \left( Z_{k1}^H Z_{l3}^H + Z_{k3}^H Z_{l1}^H \right) + Z_{j3}^H Z_{k1}^H Z_{l1}^H \right) \right. \\
& + Z_{i3}^A \left( Z_{j1}^H \left( Z_{k1}^H Z_{l4}^H + Z_{k4}^H Z_{l1}^H \right) + Z_{j4}^H Z_{k1}^H Z_{l1}^H \right) \left. \right) \\
& - \left( -\lambda_U \Lambda_U^* + \Lambda_U \lambda_U^* \right) \left( Z_{i4}^A \left( Z_{j2}^H \left( Z_{k2}^H Z_{l3}^H + Z_{k3}^H Z_{l2}^H \right) + Z_{j3}^H Z_{k2}^H Z_{l2}^H \right) \right. \\
& \left. \left. - Z_{i3}^A \left( Z_{j2}^H \left( Z_{k2}^H Z_{l4}^H + Z_{k4}^H Z_{l2}^H \right) + Z_{j4}^H Z_{k2}^H Z_{l2}^H \right) \right) \right) \tag{527}
\end{aligned}$$


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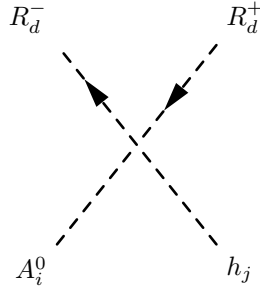


$$\begin{aligned}
& \frac{1}{4} \left( g_2^2 Z_{i2}^A Z_{j1}^H Z_{k2}^+ Z_{l1}^+ + g_2^2 Z_{i1}^A Z_{j2}^H Z_{k2}^+ Z_{l1}^+ - \sqrt{2} g_2^2 Z_{i4}^A Z_{j1}^H Z_{k3}^+ Z_{l1}^+ \right. \\
& + \sqrt{2} g_2^2 Z_{i1}^A Z_{j4}^H Z_{k3}^+ Z_{l1}^+ - \sqrt{2} g_2^2 Z_{i4}^A Z_{j1}^H Z_{k4}^+ Z_{l1}^+ - \sqrt{2} g_2^2 Z_{i1}^A Z_{j4}^H Z_{k4}^+ Z_{l1}^+ \\
& - g_2^2 Z_{i2}^A Z_{j1}^H Z_{k1}^+ Z_{l2}^+ - g_2^2 Z_{i1}^A Z_{j2}^H Z_{k1}^+ Z_{l2}^+ + \sqrt{2} \Lambda_U \lambda_U^* Z_{i4}^A Z_{j3}^H Z_{k2}^+ Z_{l2}^+ \\
& - \sqrt{2} \Lambda_U \Lambda_U^* Z_{i4}^A Z_{j3}^H Z_{k2}^+ Z_{l2}^+ - \sqrt{2} \Lambda_U \lambda_U^* Z_{i3}^A Z_{j4}^H Z_{k2}^+ Z_{l2}^+ \\
& + \sqrt{2} \lambda_U \Lambda_U^* Z_{i3}^A Z_{j4}^H Z_{k2}^+ Z_{l2}^+ - 2 \Lambda_U \lambda_U^* Z_{i3}^A Z_{j2}^H Z_{k3}^+ Z_{l2}^+ - \sqrt{2} g_2^2 Z_{i4}^A Z_{j2}^H Z_{k3}^+ Z_{l2}^+ \\
& + \sqrt{2} |\Lambda_U|^2 Z_{i4}^A Z_{j2}^H Z_{k3}^+ Z_{l2}^+ - 2 \Lambda_U \lambda_U^* Z_{i2}^A Z_{j3}^H Z_{k3}^+ Z_{l2}^+ - \sqrt{2} g_2^2 Z_{i2}^A Z_{j4}^H Z_{k3}^+ Z_{l2}^+ \\
& + \sqrt{2} |\Lambda_U|^2 Z_{i2}^A Z_{j4}^H Z_{k3}^+ Z_{l2}^+ + 2 \lambda_U \Lambda_U^* Z_{i3}^A Z_{j2}^H Z_{k4}^+ Z_{l2}^+ - \sqrt{2} g_2^2 Z_{i4}^A Z_{j2}^H Z_{k4}^+ Z_{l2}^+ \\
& + \sqrt{2} |\Lambda_U|^2 Z_{i4}^A Z_{j2}^H Z_{k4}^+ Z_{l2}^+ - 2 \lambda_U \Lambda_U^* Z_{i2}^A Z_{j3}^H Z_{k4}^+ Z_{l2}^+ + \sqrt{2} g_2^2 Z_{i2}^A Z_{j4}^H Z_{k4}^+ Z_{l2}^+ \\
& - \sqrt{2} |\Lambda_U|^2 Z_{i2}^A Z_{j4}^H Z_{k4}^+ Z_{l2}^+ + \sqrt{2} g_2^2 Z_{i4}^A Z_{j1}^H Z_{k1}^+ Z_{l3}^+ \\
& - \sqrt{2} g_2^2 Z_{i1}^A Z_{j4}^H Z_{k1}^+ Z_{l3}^+ + 2 \lambda_U \Lambda_U^* Z_{i3}^A Z_{j2}^H Z_{k2}^+ Z_{l3}^+ + \sqrt{2} g_2^2 Z_{i4}^A Z_{j2}^H Z_{k2}^+ Z_{l3}^+ \\
& - \sqrt{2} |\Lambda_U|^2 Z_{i4}^A Z_{j2}^H Z_{k2}^+ Z_{l3}^+ + 2 \lambda_U \Lambda_U^* Z_{i2}^A Z_{j3}^H Z_{k2}^+ Z_{l3}^+ + \sqrt{2} g_2^2 Z_{i2}^A Z_{j4}^H Z_{k2}^+ Z_{l3}^+ \\
& - \sqrt{2} |\Lambda_U|^2 Z_{i2}^A Z_{j4}^H Z_{k2}^+ Z_{l3}^+ - 4 g_2^2 Z_{i4}^A Z_{j4}^H Z_{k4}^+ Z_{l3}^+ + \sqrt{2} g_2^2 Z_{i4}^A Z_{j1}^H Z_{k1}^+ Z_{l4}^+ \\
& + \sqrt{2} g_2^2 Z_{i1}^A Z_{j4}^H Z_{k1}^+ Z_{l4}^+ - 2 \Lambda_U \lambda_U^* Z_{i3}^A Z_{j2}^H Z_{k2}^+ Z_{l4}^+ + \sqrt{2} g_2^2 Z_{i4}^A Z_{j2}^H Z_{k2}^+ Z_{l4}^+ \\
& - \sqrt{2} |\Lambda_U|^2 Z_{i4}^A Z_{j2}^H Z_{k2}^+ Z_{l4}^+ + 2 \Lambda_U \lambda_U^* Z_{i2}^A Z_{j3}^H Z_{k2}^+ Z_{l4}^+ \\
& - \sqrt{2} g_2^2 Z_{i2}^A Z_{j4}^H Z_{k2}^+ Z_{l4}^+ + \sqrt{2} |\Lambda_U|^2 Z_{i2}^A Z_{j4}^H Z_{k2}^+ Z_{l4}^+ + 4 g_2^2 Z_{i4}^A Z_{j4}^H Z_{k3}^+ Z_{l4}^+ \\
& - \Lambda_D \lambda_D^* \left( \sqrt{2} Z_{i4}^A Z_{j3}^H Z_{k1}^+ Z_{l1}^+ + 2 Z_{i1}^A Z_{j3}^H \left( Z_{k1}^+ Z_{l4}^+ - Z_{k3}^+ Z_{l1}^+ \right) \right. \\
& + Z_{i3}^A \left( 2 Z_{j1}^H \left( Z_{k1}^+ Z_{l4}^+ + Z_{k3}^+ Z_{l1}^+ \right) - \sqrt{2} Z_{j4}^H Z_{k1}^+ Z_{l1}^+ \right) \\
& + \Lambda_D^* \left( \lambda_D Z_{i3}^A \left( 2 Z_{j1}^H \left( Z_{k1}^+ Z_{l3}^+ + Z_{k4}^+ Z_{l1}^+ \right) - \sqrt{2} Z_{j4}^H Z_{k1}^+ Z_{l1}^+ \right) \right. \\
& + Z_{i1}^A \left( 2 \lambda_D Z_{j3}^H \left( - Z_{k1}^+ Z_{l3}^+ + Z_{k4}^+ Z_{l1}^+ \right) + \sqrt{2} \Lambda_D Z_{j4}^H \left( Z_{k1}^+ \left( - Z_{l4}^+ + Z_{l3}^+ \right) - Z_{k3}^+ Z_{l1}^+ + Z_{k4}^+ Z_{l1}^+ \right) \right) \\
& \left. + \sqrt{2} Z_{i4}^A \left( \Lambda_D Z_{j1}^H \left( - Z_{k1}^+ \left( Z_{l3}^+ + Z_{l4}^+ \right) + Z_{k3}^+ Z_{l1}^+ + Z_{k4}^+ Z_{l1}^+ \right) + \lambda_D Z_{j3}^H Z_{k1}^+ Z_{l1}^+ \right) \right) \right) \quad (528)
\end{aligned}$$



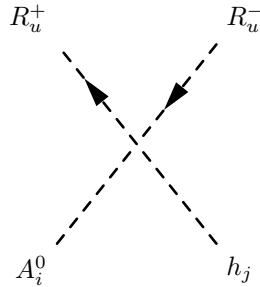
$$\begin{aligned}
& \frac{1}{4} \left( \Lambda_D^* \left( \Lambda_U \left( -Z_{i1}^A Z_{j2}^H + Z_{i2}^A Z_{j1}^H \right) Z_{k2}^R + \sqrt{2} \lambda_D Z_{i3}^A Z_{j4}^H Z_{k1}^R - \sqrt{2} \lambda_D Z_{i4}^A Z_{j3}^H Z_{k1}^R \right) Z_{l1}^R \right. \\
& + \lambda_D^* \left( 2\lambda_U \left( Z_{i1}^A Z_{j2}^H - Z_{i2}^A Z_{j1}^H \right) Z_{k2}^R - \sqrt{2} \Lambda_D Z_{i3}^A Z_{j4}^H Z_{k1}^R + \sqrt{2} \Lambda_D Z_{i4}^A Z_{j3}^H Z_{k1}^R \right) Z_{l1}^R \\
& + \left( \Lambda_U^* \left( \Lambda_D Z_{i1}^A Z_{j2}^H Z_{k1}^R - \Lambda_D Z_{i2}^A Z_{j1}^H Z_{k1}^R + \sqrt{2} \lambda_U \left( -Z_{i3}^A Z_{j4}^H + Z_{i4}^A Z_{j3}^H \right) Z_{k2}^R \right) \right. \\
& \left. \left. + \lambda_U^* \left( -2\lambda_D Z_{i1}^A Z_{j2}^H Z_{k1}^R + 2\lambda_D Z_{i2}^A Z_{j1}^H Z_{k1}^R + \sqrt{2} \Lambda_U \left( Z_{i3}^A Z_{j4}^H - Z_{i4}^A Z_{j3}^H \right) Z_{k2}^R \right) \right) Z_{l2}^R \right) \quad (529)
\end{aligned}$$


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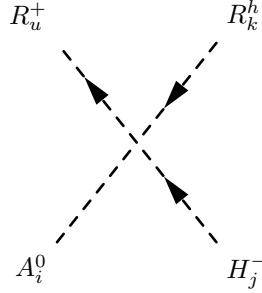
$$-\frac{1}{2} \frac{1}{\sqrt{2}} \left( -\lambda_D \Lambda_D^* + \Lambda_D \lambda_D^* \right) \left( -Z_{i3}^A Z_{j4}^H + Z_{i4}^A Z_{j3}^H \right) \quad (530)$$


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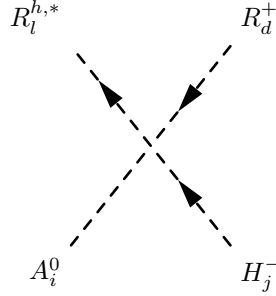
$$\frac{1}{2} \frac{1}{\sqrt{2}} \left( -\lambda_U \Lambda_U^* + \Lambda_U \lambda_U^* \right) \left( -Z_{i3}^A Z_{j4}^H + Z_{i4}^A Z_{j3}^H \right) \quad (531)$$


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$$\begin{aligned} & \frac{1}{4} \left( \sqrt{2} Z_{i1}^A \left( 2\lambda_D \lambda_U^* Z_{k1}^R Z_{j2}^+ - g_2^2 Z_{k2}^R Z_{j1}^+ \right) \right. \\ & + Z_{k2}^R \left( -2g_2^2 Z_{i4}^A \left( Z_{j3}^+ + Z_{j4}^+ \right) + 2\sqrt{2} \Lambda_U \lambda_U^* Z_{i3}^A Z_{j3}^+ + \sqrt{2} \left( -2|\lambda_U|^2 + g_2^2 \right) Z_{i2}^A Z_{j2}^+ \right) \\ & + \Lambda_U^* \left( \sqrt{2} \Lambda_D Z_{i1}^A Z_{k1}^R Z_{j2}^+ + \sqrt{2} Z_{i2}^A \left( -2\Lambda_D Z_{k1}^R Z_{j1}^+ + \Lambda_U Z_{k2}^R Z_{j2}^+ \right) \right. \\ & \left. \left. + 2Z_{k2}^R \left( \Lambda_U Z_{i4}^A \left( Z_{j3}^+ + Z_{j4}^+ \right) - \sqrt{2} \lambda_U Z_{i3}^A Z_{j4}^+ \right) \right) \right) \quad (532) \end{aligned}$$

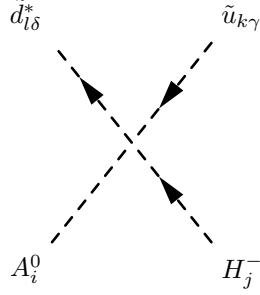

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$$\begin{aligned} & \frac{1}{4} \left( -2\sqrt{2} \lambda_D \lambda_U^* Z_{i2}^A Z_{i2}^R Z_{j1}^+ - \sqrt{2} \Lambda_D \Lambda_U^* Z_{i2}^A Z_{i2}^R Z_{j1}^+ + \sqrt{2} g_2^2 Z_{i2}^A Z_{i1}^R Z_{j2}^+ \right. \\ & - \sqrt{2} Z_{i1}^A \left( \left( -2|\lambda_D|^2 + g_2^2 + |\Lambda_D|^2 \right) Z_{i1}^R Z_{j1}^+ - 2\Lambda_D \Lambda_U^* Z_{i2}^R Z_{j2}^+ \right) + 2\sqrt{2} \Lambda_D \lambda_D^* Z_{i3}^A Z_{i1}^R Z_{j3}^+ \\ & - 2g_2^2 Z_{i4}^A Z_{i1}^R Z_{j3}^+ + 2|\Lambda_D|^2 Z_{i4}^A Z_{i1}^R Z_{j3}^+ - 2\sqrt{2} \lambda_D \Lambda_D^* Z_{i3}^A Z_{i1}^R Z_{j4}^+ \\ & \left. - 2g_2^2 Z_{i4}^A Z_{i1}^R Z_{j4}^+ + 2|\Lambda_D|^2 Z_{i4}^A Z_{i1}^R Z_{j4}^+ \right) \quad (533) \end{aligned}$$

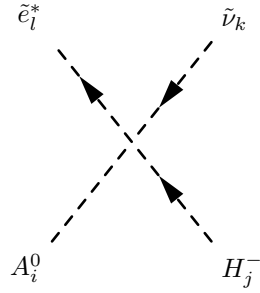

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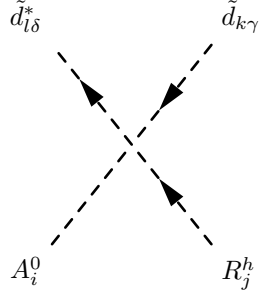
$$\begin{aligned}
& -\frac{1}{4}\delta_{\gamma\delta}\left(2\sqrt{2}\left(-\sum_{c=1}^3\sum_{b=1}^3Z_{kb}^{U,*}\sum_{a=1}^3Y_{d,ac}^*Y_{d,ab}Z_{lc}^DZ_{i1}^AZ_{j1}^+\right)+\sum_{c=1}^3\sum_{b=1}^3Z_{kb}^{U,*}\sum_{a=1}^3Y_{u,ac}^*Y_{u,ab}Z_{lc}^DZ_{i2}^AZ_{j2}^+\right) \\
& +\sum_{c=1}^3Z_{k3+c}^{U,*}\sum_{b=1}^3\sum_{a=1}^3Y_{u,ca}^*Y_{d,ba}Z_{l3+b}^D\left(Z_{i1}^AZ_{j2}^+-Z_{i2}^AZ_{j1}^+\right) \\
& +g_2^2\sum_{a=1}^3Z_{ka}^{U,*}Z_{la}^D\left(2Z_{i4}^A\left(Z_{j3}^++Z_{j4}^+\right)+\sqrt{2}Z_{i1}^AZ_{j1}^+-\sqrt{2}Z_{i2}^AZ_{j2}^+\right)
\end{aligned} \tag{534}$$


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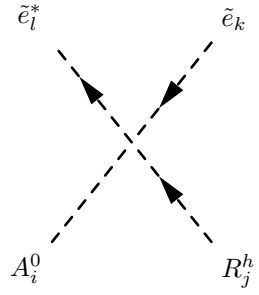
$$\begin{aligned}
& \frac{1}{4}\left(2\sqrt{2}\sum_{c=1}^3\sum_{b=1}^3Z_{kb}^{V,*}\sum_{a=1}^3Y_{e,ac}^*Y_{e,ab}Z_{lc}^EZ_{i1}^AZ_{j1}^+\right) \\
& -g_2^2\sum_{a=1}^3Z_{ka}^{V,*}Z_{la}^E\left(2Z_{i4}^A\left(Z_{j3}^++Z_{j4}^+\right)+\sqrt{2}Z_{i1}^AZ_{j1}^+-\sqrt{2}Z_{i2}^AZ_{j2}^+\right)
\end{aligned} \tag{535}$$


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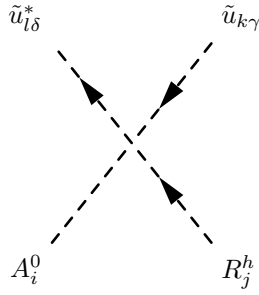
$$-\frac{1}{2}\delta_{\gamma\delta}\sum_{b=1}^3\sum_{a=1}^3Y_{d,ab}^*Z_{k3+a}^{D,*}Z_{lb}^D\left(\Lambda_D Z_{i4}^A+\sqrt{2}\lambda_D Z_{i3}^A\right)Z_{j1}^R \quad (536)$$


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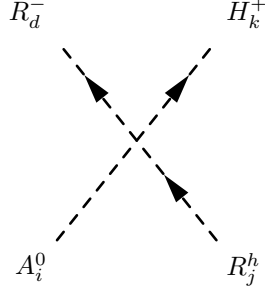
$$-\frac{1}{2}\sum_{b=1}^3\sum_{a=1}^3Y_{e,ab}^*Z_{k3+a}^{E,*}Z_{lb}^E\left(\Lambda_D Z_{i4}^A+\sqrt{2}\lambda_D Z_{i3}^A\right)Z_{j1}^R \quad (537)$$


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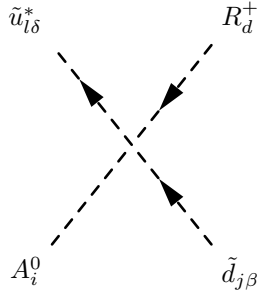
$$\frac{1}{2}\delta_{\gamma\delta}\sum_{b=1}^3\sum_{a=1}^3Y_{u,ab}^*Z_{k3+a}^{U,*}Z_{lb}^U\left(-\Lambda_U Z_{i4}^A+\sqrt{2}\lambda_U Z_{i3}^A\right)Z_{j2}^R \quad (538)$$


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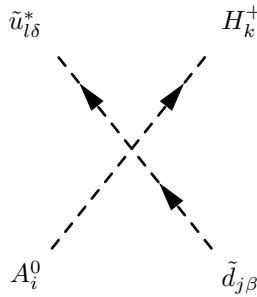
$$\begin{aligned}
& \frac{1}{4} \left( \sqrt{2} \Lambda_U \Lambda_D^* Z_{i2}^A Z_{j2}^R Z_{k1}^+ - \sqrt{2} g_2^2 Z_{i2}^A Z_{j1}^R Z_{k2}^+ \right. \\
& + \sqrt{2} Z_{i1}^A \left( (-2|\lambda_D|^2 + g_2^2 + |\Lambda_D|^2) Z_{j1}^R Z_{k1}^+ - 2\Lambda_U \Lambda_D^* Z_{j2}^R Z_{k2}^+ \right) - 2\sqrt{2} \lambda_D \Lambda_D^* Z_{i3}^A Z_{j1}^R Z_{k3}^+ \\
& + 2g_2^2 Z_{i4}^A Z_{j1}^R Z_{k3}^+ - 2|\Lambda_D|^2 Z_{i4}^A Z_{j1}^R Z_{k3}^+ + 2g_2^2 Z_{i4}^A Z_{j1}^R Z_{k4}^+ \\
& \left. - 2|\Lambda_D|^2 Z_{i4}^A Z_{j1}^R Z_{k4}^+ + 2\sqrt{2} \lambda_D^* \left( \Lambda_D Z_{i3}^A Z_{j1}^R Z_{k4}^+ + \lambda_U Z_{i2}^A Z_{j2}^R Z_{k1}^+ \right) \right) \quad (539)
\end{aligned}$$


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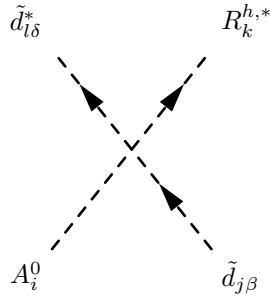
$$\frac{1}{2} \delta_{\beta\delta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{lb}^U \left( \Lambda_D Z_{i4}^A - \sqrt{2} \lambda_D Z_{i3}^A \right) \quad (540)$$


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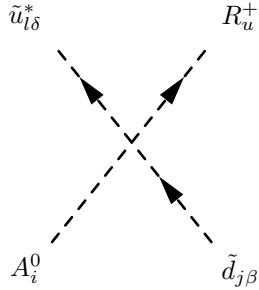
$$\begin{aligned}
& \frac{1}{4}\delta_{\beta\delta}\left(2\sqrt{2}\left(-\sum_{c=1}^3\sum_{b=1}^3Z_{jb}^{D,*}\sum_{a=1}^3Y_{d,ac}^*Y_{d,ab}Z_{lc}^UZ_{i1}^AZ_{k1}^++\sum_{c=1}^3\sum_{b=1}^3Z_{jb}^{D,*}\sum_{a=1}^3Y_{u,ac}^*Y_{u,ab}Z_{lc}^UZ_{i2}^AZ_{k2}^+\right.\right. \\
& +\left.\sum_{c=1}^3Z_{j3+c}^{D,*}\sum_{b=1}^3\sum_{a=1}^3Y_{d,ca}^*Y_{u,ba}Z_{l3+b}^U\left(Z_{i1}^AZ_{k2}^+-Z_{i2}^AZ_{k1}^+\right)\right) \\
& +g_2^2\sum_{a=1}^3Z_{ja}^{D,*}Z_{la}^U\left(2Z_{i4}^A\left(Z_{k3}^++Z_{k4}^+\right)+\sqrt{2}Z_{i1}^AZ_{k1}^+-\sqrt{2}Z_{i2}^AZ_{k2}^+\right)
\end{aligned} \tag{541}$$


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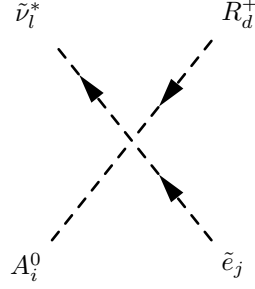
$$\frac{1}{2}\delta_{\beta\delta}\sum_{b=1}^3Z_{jb}^{D,*}\sum_{a=1}^3Y_{d,ab}Z_{l3+a}^D\left(\Lambda_D^*Z_{i4}^A+\sqrt{2}\lambda_D^*Z_{i3}^A\right)Z_{k1}^R \tag{542}$$


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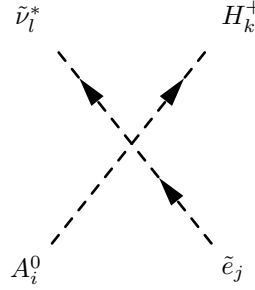
$$-\frac{1}{2}\delta_{\beta\delta}\sum_{b=1}^3Z_{jb}^{D,*}\sum_{a=1}^3Y_{u,ab}Z_{l3+a}^U\left(\Lambda_U^*Z_{i4}^A+\sqrt{2}\lambda_U^*Z_{i3}^A\right) \tag{543}$$


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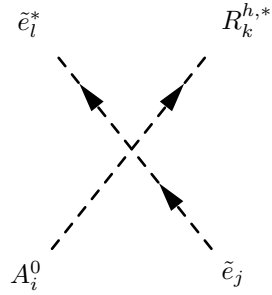
$$\frac{1}{2} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{lb}^V \left( \Lambda_D Z_{i4}^A - \sqrt{2} \lambda_D Z_{i3}^A \right) \quad (544)$$


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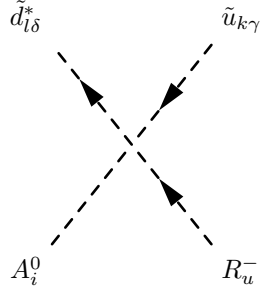
$$\begin{aligned} & \frac{1}{4} \left( -2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^V Z_{i1}^A Z_{k1}^+ \right. \\ & \left. + g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^V \left( 2Z_{i4}^A (Z_{k3}^+ + Z_{k4}^+) + \sqrt{2} Z_{i1}^A Z_{k1}^+ - \sqrt{2} Z_{i2}^A Z_{k2}^+ \right) \right) \quad (545) \end{aligned}$$


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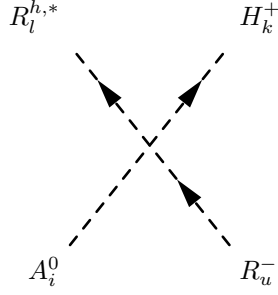
$$\frac{1}{2} \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \left( \Lambda_D^* Z_{i4}^A + \sqrt{2} \lambda_D^* Z_{i3}^A \right) Z_{k1}^R \quad (546)$$


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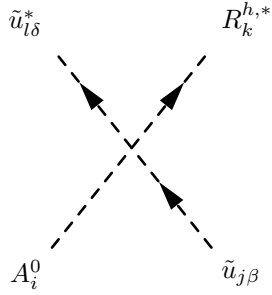
$$\frac{1}{2}\delta_{\gamma\delta}\sum_{b=1}^3\sum_{a=1}^3Y_{u,ab}^*Z_{k3+a}^{U,*}Z_{lb}^D\left(\Lambda_U Z_{i4}^A+\sqrt{2}\lambda_U Z_{i3}^A\right) \quad (547)$$


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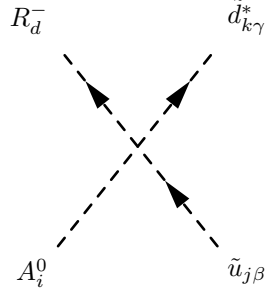
$$\begin{aligned} & \frac{1}{4}\left(\sqrt{2}\Lambda_U\Lambda_D^*Z_{l1}^R\left(2Z_{i2}^AZ_{k1}^+-Z_{i1}^AZ_{k2}^+\right)+\sqrt{2}Z_{i1}^A\left(-2\lambda_U\lambda_D^*Z_{l1}^RZ_{k2}^++g_2^2Z_{l2}^RZ_{k1}^+\right)\right. \\ & -Z_{l2}^R\left(\sqrt{2}\left(-2|\lambda_U|^2+g_2^2+|\Lambda_U|^2\right)Z_{i2}^AZ_{k2}^+\right. \\ & \left.\left.+2\left(-g_2^2Z_{i4}^A\left(Z_{k3}^++Z_{k4}^+\right)+\Lambda_U^*\left(\Lambda_U Z_{i4}^A\left(Z_{k3}^++Z_{k4}^+\right)+\sqrt{2}\lambda_U Z_{i3}^AZ_{k3}^+\right)-\sqrt{2}\Lambda_U\lambda_U^*Z_{i3}^AZ_{k4}^+\right)\right)\right) \end{aligned} \quad (548)$$


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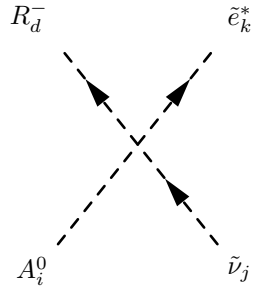
$$\frac{1}{2}\delta_{\beta\delta}\sum_{b=1}^3Z_{jb}^{U,*}\sum_{a=1}^3Y_{u,ab}Z_{l3+a}^U\left(\Lambda_U^*Z_{i4}^A-\sqrt{2}\lambda_U^*Z_{i3}^A\right)Z_{k2}^R \quad (549)$$


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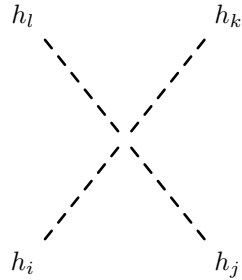
$$\frac{1}{2} \delta_{\beta\gamma} \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \left( -\Lambda_D^* Z_{i4}^A + \sqrt{2} \lambda_D^* Z_{i3}^A \right) \quad (550)$$


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$$\frac{1}{2} \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \left( -\Lambda_D^* Z_{i4}^A + \sqrt{2} \lambda_D^* Z_{i3}^A \right) \quad (551)$$

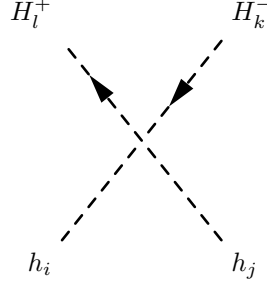

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$$\begin{aligned} & -\frac{i}{4} \left( 4|\lambda_D|^2 Z_{i3}^H Z_{j3}^H Z_{k1}^H Z_{l1}^H + \sqrt{2} \Lambda_D \lambda_D^* Z_{i4}^H Z_{j3}^H Z_{k1}^H Z_{l1}^H + \sqrt{2} \lambda_D \Lambda_D^* Z_{i4}^H Z_{j3}^H Z_{k1}^H Z_{l1}^H \right. \\ & \left. + \sqrt{2} \Lambda_D \lambda_D^* Z_{i3}^H Z_{j4}^H Z_{k1}^H Z_{l1}^H + \sqrt{2} \lambda_D \Lambda_D^* Z_{i3}^H Z_{j4}^H Z_{k1}^H Z_{l1}^H + 2|\Lambda_D|^2 Z_{i4}^H Z_{j4}^H Z_{k1}^H Z_{l1}^H \right) \end{aligned}$$

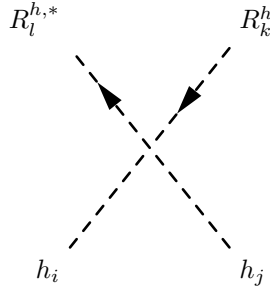
$$\begin{aligned}
& + 4|\lambda_D|^2 Z_{i3}^H Z_{j1}^H Z_{k3}^H Z_{l1}^H + \sqrt{2}\Lambda_D \lambda_D^* Z_{i4}^H Z_{j1}^H Z_{k3}^H Z_{l1}^H + \sqrt{2}\lambda_D \Lambda_D^* Z_{i4}^H Z_{j1}^H Z_{k3}^H Z_{l1}^H \\
& + \sqrt{2}\Lambda_D \lambda_D^* Z_{i3}^H Z_{j1}^H Z_{k4}^H Z_{l1}^H + \sqrt{2}\lambda_D \Lambda_D^* Z_{i3}^H Z_{j1}^H Z_{k4}^H Z_{l1}^H + 2|\Lambda_D|^2 Z_{i4}^H Z_{j1}^H Z_{k4}^H Z_{l1}^H \\
& + 4|\lambda_U|^2 Z_{i3}^H Z_{j3}^H Z_{k2}^H Z_{l2}^H - \sqrt{2}\Lambda_U \lambda_U^* Z_{i4}^H Z_{j3}^H Z_{k2}^H Z_{l2}^H \\
& - \sqrt{2}\lambda_U \Lambda_U^* Z_{i4}^H Z_{j3}^H Z_{k2}^H Z_{l2}^H - \sqrt{2}\Lambda_U \lambda_U^* Z_{i3}^H Z_{j4}^H Z_{k2}^H Z_{l2}^H \\
& - \sqrt{2}\lambda_U \Lambda_U^* Z_{i3}^H Z_{j4}^H Z_{k2}^H Z_{l2}^H + 2|\Lambda_U|^2 Z_{i4}^H Z_{j4}^H Z_{k2}^H Z_{l2}^H + 4|\lambda_U|^2 Z_{i3}^H Z_{j2}^H Z_{k3}^H Z_{l2}^H \\
& - \sqrt{2}\Lambda_U \lambda_U^* Z_{i4}^H Z_{j2}^H Z_{k3}^H Z_{l2}^H - \sqrt{2}\lambda_U \Lambda_U^* Z_{i4}^H Z_{j2}^H Z_{k3}^H Z_{l2}^H \\
& - \sqrt{2}\Lambda_U \lambda_U^* Z_{i3}^H Z_{j2}^H Z_{k4}^H Z_{l2}^H - \sqrt{2}\lambda_U \Lambda_U^* Z_{i3}^H Z_{j2}^H Z_{k4}^H Z_{l2}^H \\
& + 2|\Lambda_U|^2 Z_{i4}^H Z_{j2}^H Z_{k4}^H Z_{l2}^H + 4|\lambda_D|^2 Z_{i3}^H Z_{j1}^H Z_{k1}^H Z_{l3}^H + \sqrt{2}\Lambda_D \lambda_D^* Z_{i4}^H Z_{j1}^H Z_{k1}^H Z_{l3}^H \\
& + \sqrt{2}\lambda_D \Lambda_D^* Z_{i4}^H Z_{j1}^H Z_{k1}^H Z_{l3}^H + 4|\lambda_U|^2 Z_{i3}^H Z_{j2}^H Z_{k2}^H Z_{l3}^H \\
& - \sqrt{2}\Lambda_U \lambda_U^* Z_{i4}^H Z_{j2}^H Z_{k2}^H Z_{l3}^H - \sqrt{2}\lambda_U \Lambda_U^* Z_{i4}^H Z_{j2}^H Z_{k2}^H Z_{l3}^H \\
& + \sqrt{2}\Lambda_D \lambda_D^* Z_{i3}^H Z_{j1}^H Z_{k1}^H Z_{l4}^H + \sqrt{2}\lambda_D \Lambda_D^* Z_{i3}^H Z_{j1}^H Z_{k1}^H Z_{l4}^H + 2|\Lambda_D|^2 Z_{i4}^H Z_{j1}^H Z_{k1}^H Z_{l4}^H \\
& - \sqrt{2}\Lambda_U \lambda_U^* Z_{i3}^H Z_{j2}^H Z_{k2}^H Z_{l4}^H - \sqrt{2}\lambda_U \Lambda_U^* Z_{i3}^H Z_{j2}^H Z_{k2}^H Z_{l4}^H \\
& + 2|\Lambda_U|^2 Z_{i4}^H Z_{j2}^H Z_{k2}^H Z_{l4}^H \\
& + Z_{i1}^H \left( 4|\lambda_D|^2 Z_{j3}^H Z_{k3}^H Z_{l1}^H + \sqrt{2}\Lambda_D \lambda_D^* Z_{j4}^H Z_{k3}^H Z_{l1}^H + \sqrt{2}\lambda_D \Lambda_D^* Z_{j4}^H Z_{k3}^H Z_{l1}^H \right. \\
& + \sqrt{2}\Lambda_D \lambda_D^* Z_{j3}^H Z_{k4}^H Z_{l1}^H + \sqrt{2}\lambda_D \Lambda_D^* Z_{j3}^H Z_{k4}^H Z_{l1}^H + 2|\Lambda_D|^2 Z_{j4}^H Z_{k4}^H Z_{l1}^H \\
& - \left( g_1^2 + g_2^2 \right) Z_{j2}^H \left( Z_{k1}^H Z_{l2}^H + Z_{k2}^H Z_{l1}^H \right) + 4|\lambda_D|^2 Z_{j3}^H Z_{k1}^H Z_{l3}^H + \sqrt{2}\Lambda_D \lambda_D^* Z_{j4}^H Z_{k1}^H Z_{l3}^H \\
& + \sqrt{2}\lambda_D \Lambda_D^* Z_{j4}^H Z_{k1}^H Z_{l3}^H + \sqrt{2}\Lambda_D \lambda_D^* Z_{j3}^H Z_{k1}^H Z_{l4}^H + \sqrt{2}\lambda_D \Lambda_D^* Z_{j3}^H Z_{k1}^H Z_{l4}^H \\
& \left. + 2|\Lambda_D|^2 Z_{j4}^H Z_{k1}^H Z_{l4}^H \right. \\
& + Z_{j1}^H \left( 3 \left( g_1^2 + g_2^2 \right) Z_{k1}^H Z_{l1}^H - \left( g_1^2 + g_2^2 \right) Z_{k2}^H Z_{l2}^H + 4|\lambda_D|^2 Z_{k3}^H Z_{l3}^H + \sqrt{2}\Lambda_D \lambda_D^* Z_{k4}^H Z_{l3}^H \right. \\
& + \sqrt{2}\lambda_D \Lambda_D^* Z_{k4}^H Z_{l3}^H + \sqrt{2}\Lambda_D \lambda_D^* Z_{k3}^H Z_{l4}^H + \sqrt{2}\lambda_D \Lambda_D^* Z_{k3}^H Z_{l4}^H + 2|\Lambda_D|^2 Z_{k4}^H Z_{l4}^H \left. \right) \\
& - Z_{i2}^H \left( -4|\lambda_U|^2 Z_{j3}^H Z_{k3}^H Z_{l2}^H + \sqrt{2}\Lambda_U \lambda_U^* Z_{j4}^H Z_{k3}^H Z_{l2}^H + \sqrt{2}\lambda_U \Lambda_U^* Z_{j4}^H Z_{k3}^H Z_{l2}^H \right. \\
& + \sqrt{2}\Lambda_U \lambda_U^* Z_{j3}^H Z_{k4}^H Z_{l2}^H + \sqrt{2}\lambda_U \Lambda_U^* Z_{j3}^H Z_{k4}^H Z_{l2}^H - 2|\Lambda_U|^2 Z_{j4}^H Z_{k4}^H Z_{l2}^H \\
& + \left( g_1^2 + g_2^2 \right) Z_{j1}^H \left( Z_{k1}^H Z_{l2}^H + Z_{k2}^H Z_{l1}^H \right) - 4|\lambda_U|^2 Z_{j3}^H Z_{k2}^H Z_{l3}^H + \sqrt{2}\Lambda_U \lambda_U^* Z_{j4}^H Z_{k2}^H Z_{l3}^H \\
& + \sqrt{2}\lambda_U \Lambda_U^* Z_{j4}^H Z_{k2}^H Z_{l3}^H + \sqrt{2}\Lambda_U \lambda_U^* Z_{j3}^H Z_{k2}^H Z_{l4}^H + \sqrt{2}\lambda_U \Lambda_U^* Z_{j3}^H Z_{k2}^H Z_{l4}^H \\
& \left. - 2|\Lambda_U|^2 Z_{j4}^H Z_{k2}^H Z_{l4}^H \right. \\
& + Z_{j2}^H \left( \left( g_1^2 + g_2^2 \right) Z_{k1}^H Z_{l1}^H - 3 \left( g_1^2 + g_2^2 \right) Z_{k2}^H Z_{l2}^H - 4|\lambda_U|^2 Z_{k3}^H Z_{l3}^H + \sqrt{2}\Lambda_U \lambda_U^* Z_{k4}^H Z_{l3}^H \right. \\
& \left. \left. + \sqrt{2}\lambda_U \Lambda_U^* Z_{k4}^H Z_{l3}^H + \sqrt{2}\Lambda_U \lambda_U^* Z_{k3}^H Z_{l4}^H + \sqrt{2}\lambda_U \Lambda_U^* Z_{k3}^H Z_{l4}^H - 2|\Lambda_U|^2 Z_{k4}^H Z_{l4}^H \right) \right) \tag{552}
\end{aligned}$$



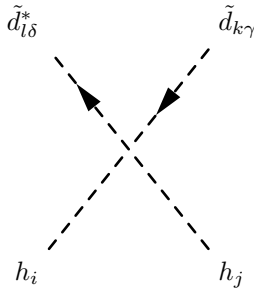


$$\begin{aligned}
& -\frac{i}{4} \left( 4|\lambda_D|^2 Z_{i3}^H Z_{j3}^H Z_{k1}^+ Z_{l1}^+ - \sqrt{2}\Lambda_D \lambda_D^* Z_{i4}^H Z_{j3}^H Z_{k1}^+ Z_{l1}^+ \right. \\
& - \sqrt{2}\lambda_D \Lambda_D^* Z_{i4}^H Z_{j3}^H Z_{k1}^+ Z_{l1}^+ - \sqrt{2}\Lambda_D \lambda_D^* Z_{i3}^H Z_{j4}^H Z_{k1}^+ Z_{l1}^+ \\
& - \sqrt{2}\lambda_D \Lambda_D^* Z_{i3}^H Z_{j4}^H Z_{k1}^+ Z_{l1}^+ + 2|\Lambda_D|^2 Z_{i4}^H Z_{j4}^H Z_{k1}^+ Z_{l1}^+ + 2\Lambda_D \lambda_D^* Z_{i3}^H Z_{j1}^H Z_{k3}^+ Z_{l1}^+ \\
& + \sqrt{2}g_2^2 Z_{i4}^H Z_{j1}^H Z_{k3}^+ Z_{l1}^+ - \sqrt{2}|\Lambda_D|^2 Z_{i4}^H Z_{j1}^H Z_{k3}^+ Z_{l1}^+ + 2\lambda_D \Lambda_D^* Z_{i3}^H Z_{j1}^H Z_{k4}^+ Z_{l1}^+ \\
& - \sqrt{2}g_2^2 Z_{i4}^H Z_{j1}^H Z_{k4}^+ Z_{l1}^+ + \sqrt{2}|\Lambda_D|^2 Z_{i4}^H Z_{j1}^H Z_{k4}^+ Z_{l1}^+ + 4|\lambda_U|^2 Z_{i3}^H Z_{j3}^H Z_{k2}^+ Z_{l2}^+ \\
& + \sqrt{2}\Lambda_U \lambda_U^* Z_{i4}^H Z_{j3}^H Z_{k2}^+ Z_{l2}^+ + \sqrt{2}\lambda_U \Lambda_U^* Z_{i4}^H Z_{j3}^H Z_{k2}^+ Z_{l2}^+ \\
& + \sqrt{2}\Lambda_U \lambda_U^* Z_{i3}^H Z_{j4}^H Z_{k2}^+ Z_{l2}^+ + \sqrt{2}\lambda_U \Lambda_U^* Z_{i3}^H Z_{j4}^H Z_{k2}^+ Z_{l2}^+ + 2|\Lambda_U|^2 Z_{i4}^H Z_{j4}^H Z_{k2}^+ Z_{l2}^+ \\
& + 2\Lambda_U \lambda_U^* Z_{i3}^H Z_{j2}^H Z_{k3}^+ Z_{l2}^+ + \sqrt{2}g_2^2 Z_{i4}^H Z_{j2}^H Z_{k3}^+ Z_{l2}^+ - \sqrt{2}|\Lambda_U|^2 Z_{i4}^H Z_{j2}^H Z_{k3}^+ Z_{l2}^+ \\
& + 2\lambda_U \Lambda_U^* Z_{i3}^H Z_{j2}^H Z_{k4}^+ Z_{l2}^+ - \sqrt{2}g_2^2 Z_{i4}^H Z_{j2}^H Z_{k4}^+ Z_{l2}^+ + \sqrt{2}|\Lambda_U|^2 Z_{i4}^H Z_{j2}^H Z_{k4}^+ Z_{l2}^+ \\
& + 2\lambda_D \Lambda_D^* Z_{i3}^H Z_{j1}^H Z_{k1}^+ Z_{l3}^+ + \sqrt{2}g_2^2 Z_{i4}^H Z_{j1}^H Z_{k1}^+ Z_{l3}^+ - \sqrt{2}|\Lambda_D|^2 Z_{i4}^H Z_{j1}^H Z_{k1}^+ Z_{l3}^+ \\
& + 2\lambda_U \Lambda_U^* Z_{i3}^H Z_{j2}^H Z_{k2}^+ Z_{l3}^+ + \sqrt{2}g_2^2 Z_{i4}^H Z_{j2}^H Z_{k2}^+ Z_{l3}^+ - \sqrt{2}|\Lambda_U|^2 Z_{i4}^H Z_{j2}^H Z_{k2}^+ Z_{l3}^+ \\
& + 4g_2^2 Z_{i4}^H Z_{j4}^H Z_{k3}^+ Z_{l3}^+ - 4g_2^2 Z_{i4}^H Z_{j4}^H Z_{k4}^+ Z_{l3}^+ + 2\Lambda_D \lambda_D^* Z_{i3}^H Z_{j1}^H Z_{k1}^+ Z_{l4}^+ \\
& - \sqrt{2}g_2^2 Z_{i4}^H Z_{j1}^H Z_{k1}^+ Z_{l4}^+ + \sqrt{2}|\Lambda_D|^2 Z_{i4}^H Z_{j1}^H Z_{k1}^+ Z_{l4}^+ + 2\Lambda_U \lambda_U^* Z_{i3}^H Z_{j2}^H Z_{k2}^+ Z_{l4}^+ \\
& - \sqrt{2}g_2^2 Z_{i4}^H Z_{j2}^H Z_{k2}^+ Z_{l4}^+ + \sqrt{2}|\Lambda_U|^2 Z_{i4}^H Z_{j2}^H Z_{k2}^+ Z_{l4}^+ - 4g_2^2 Z_{i4}^H Z_{j4}^H Z_{k3}^+ Z_{l4}^+ \\
& + 4g_2^2 Z_{i4}^H Z_{j4}^H Z_{k4}^+ Z_{l4}^+ \\
& + Z_{i1}^H \left( g_2^2 Z_{j2}^+ Z_{k2}^+ Z_{l1}^+ + 2\Lambda_D \lambda_D^* Z_{j3}^+ Z_{k3}^+ Z_{l1}^+ + \sqrt{2}g_2^2 Z_{j4}^+ Z_{k3}^+ Z_{l1}^+ \right. \\
& - \sqrt{2}|\Lambda_D|^2 Z_{j4}^+ Z_{k3}^+ Z_{l1}^+ + 2\lambda_D \Lambda_D^* Z_{j3}^+ Z_{k4}^+ Z_{l1}^+ - \sqrt{2}g_2^2 Z_{j4}^+ Z_{k4}^+ Z_{l1}^+ \\
& + \sqrt{2}|\Lambda_D|^2 Z_{j4}^+ Z_{k4}^+ Z_{l1}^+ + g_2^2 Z_{j2}^+ Z_{k1}^+ Z_{l2}^+ + 2\lambda_D \Lambda_D^* Z_{j3}^+ Z_{k1}^+ Z_{l3}^+ \\
& + \sqrt{2}g_2^2 Z_{j4}^+ Z_{k1}^+ Z_{l3}^+ - \sqrt{2}|\Lambda_D|^2 Z_{j4}^+ Z_{k1}^+ Z_{l3}^+ + 2\Lambda_D \lambda_D^* Z_{j3}^+ Z_{k1}^+ Z_{l4}^+ \\
& - \sqrt{2}g_2^2 Z_{j4}^+ Z_{k1}^+ Z_{l4}^+ + \sqrt{2}|\Lambda_D|^2 Z_{j4}^+ Z_{k1}^+ Z_{l4}^+ \\
& \left. + Z_{j1}^H \left( (g_1^2 + g_2^2) Z_{k1}^+ Z_{l1}^+ + (-g_1^2 + g_2^2) Z_{k2}^+ Z_{l2}^+ - 2g_2^2 Z_{k3}^+ Z_{l3}^+ + 4|\Lambda_D|^2 Z_{k3}^+ Z_{l3}^+ \right. \right. \\
& \left. \left. + 2g_2^2 Z_{k4}^+ Z_{l4}^+ \right) \right) \\
& + Z_{i2}^H \left( g_2^2 Z_{j1}^+ Z_{k2}^+ Z_{l1}^+ + g_2^2 Z_{j1}^+ Z_{k1}^+ Z_{l2}^+ + 2\Lambda_U \lambda_U^* Z_{j3}^+ Z_{k3}^+ Z_{l2}^+ + \sqrt{2}g_2^2 Z_{j4}^+ Z_{k3}^+ Z_{l2}^+ \right.
\end{aligned}$$

$$\begin{aligned}
& -\sqrt{2}|\Lambda_U|^2 Z_{j_4}^H Z_{k_3}^+ Z_{l_2}^+ + 2\lambda_U \Lambda_U^* Z_{j_3}^H Z_{k_4}^+ Z_{l_2}^+ - \sqrt{2}g_2^2 Z_{j_4}^H Z_{k_4}^+ Z_{l_2}^+ \\
& + \sqrt{2}|\Lambda_U|^2 Z_{j_4}^H Z_{k_4}^+ Z_{l_2}^+ + 2\lambda_U \Lambda_U^* Z_{j_3}^H Z_{k_2}^+ Z_{l_3}^+ + \sqrt{2}g_2^2 Z_{j_4}^H Z_{k_2}^+ Z_{l_3}^+ \\
& - \sqrt{2}|\Lambda_U|^2 Z_{j_4}^H Z_{k_2}^+ Z_{l_3}^+ + 2\Lambda_U \lambda_U^* Z_{j_3}^H Z_{k_2}^+ Z_{l_4}^+ - \sqrt{2}g_2^2 Z_{j_4}^H Z_{k_2}^+ Z_{l_4}^+ \\
& + \sqrt{2}|\Lambda_U|^2 Z_{j_4}^H Z_{k_2}^+ Z_{l_4}^+ \\
& + Z_{j_2}^H \left( \left( -g_1^2 + g_2^2 \right) Z_{k_1}^+ Z_{l_1}^+ + \left( g_1^2 + g_2^2 \right) Z_{k_2}^+ Z_{l_2}^+ + 2g_2^2 Z_{k_3}^+ Z_{l_3}^+ - 2g_2^2 Z_{k_4}^+ Z_{l_4}^+ \right. \\
& \left. + 4|\Lambda_U|^2 Z_{k_4}^+ Z_{l_4}^+ \right) \tag{553}
\end{aligned}$$

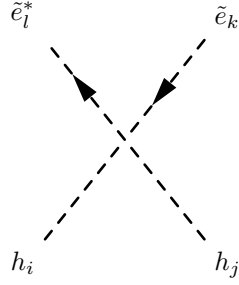


$$\begin{aligned}
& -\frac{i}{4} \left( 4|\lambda_D|^2 Z_{i_3}^H Z_{j_3}^H Z_{k_1}^R Z_{l_1}^R + \sqrt{2}\Lambda_D \lambda_D^* Z_{i_4}^H Z_{j_3}^H Z_{k_1}^R Z_{l_1}^R + \sqrt{2}\lambda_D \Lambda_D^* Z_{i_4}^H Z_{j_3}^H Z_{k_1}^R Z_{l_1}^R \right. \\
& + \sqrt{2}\Lambda_D \lambda_D^* Z_{i_3}^H Z_{j_4}^H Z_{k_1}^R Z_{l_1}^R + \sqrt{2}\lambda_D \Lambda_D^* Z_{i_3}^H Z_{j_4}^H Z_{k_1}^R Z_{l_1}^R + 2|\Lambda_D|^2 Z_{i_4}^H Z_{j_4}^H Z_{k_1}^R Z_{l_1}^R \\
& + 4|\lambda_U|^2 Z_{i_3}^H Z_{j_3}^H Z_{k_2}^R Z_{l_2}^R - \sqrt{2}\Lambda_U \lambda_U^* Z_{i_4}^H Z_{j_3}^H Z_{k_2}^R Z_{l_2}^R \\
& - \sqrt{2}\lambda_U \Lambda_U^* Z_{i_4}^H Z_{j_3}^H Z_{k_2}^R Z_{l_2}^R - \sqrt{2}\Lambda_U \lambda_U^* Z_{i_3}^H Z_{j_4}^H Z_{k_2}^R Z_{l_2}^R \\
& - \sqrt{2}\lambda_U \Lambda_U^* Z_{i_3}^H Z_{j_4}^H Z_{k_2}^R Z_{l_2}^R + 2|\Lambda_U|^2 Z_{i_4}^H Z_{j_4}^H Z_{k_2}^R Z_{l_2}^R \\
& + Z_{i_1}^H \left( Z_{j_2}^H \left( \left( -2\lambda_D \lambda_U^* + \Lambda_D \Lambda_U^* \right) Z_{k_1}^R Z_{l_2}^R - 2\lambda_U \lambda_D^* Z_{k_2}^R Z_{l_1}^R + \Lambda_U \Lambda_D^* Z_{k_2}^R Z_{l_1}^R \right) \right. \\
& + Z_{j_1}^H \left( - \left( -2|\Lambda_D|^2 - 4|\lambda_D|^2 + g_1^2 + g_2^2 \right) Z_{k_1}^R Z_{l_1}^R + \left( g_1^2 + g_2^2 \right) Z_{k_2}^R Z_{l_2}^R \right) \\
& + Z_{i_2}^H \left( Z_{j_1}^H \left( \left( -2\lambda_D \lambda_U^* + \Lambda_D \Lambda_U^* \right) Z_{k_1}^R Z_{l_2}^R - 2\lambda_U \lambda_D^* Z_{k_2}^R Z_{l_1}^R + \Lambda_U \Lambda_D^* Z_{k_2}^R Z_{l_1}^R \right) \right. \\
& \left. \left. + Z_{j_2}^H \left( - \left( -2|\Lambda_U|^2 - 4|\lambda_U|^2 + g_1^2 + g_2^2 \right) Z_{k_2}^R Z_{l_2}^R + \left( g_1^2 + g_2^2 \right) Z_{k_1}^R Z_{l_1}^R \right) \right) \right) \tag{554}
\end{aligned}$$



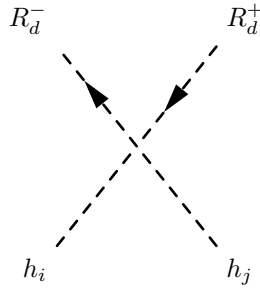
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left( (3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ka}^{D,*} Z_{la}^D (Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \right. \\
& + 2 \left( -6 \left( \sum_{c=1}^3 Z_{k3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{d,ba} Z_{l3+b}^D + \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{lc}^D \right) Z_{i1}^H Z_{j1}^H \right. \\
& \left. \left. + g_1^2 \sum_{a=1}^3 Z_{k3+a}^{D,*} Z_{l3+a}^D (Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \right) \right) \tag{555}
\end{aligned}$$


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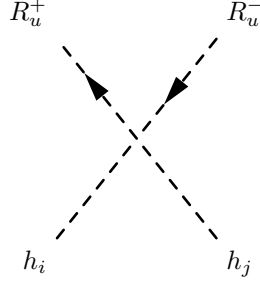
$$\begin{aligned}
& -\frac{i}{4} \left( 4 \left( \sum_{c=1}^3 Z_{k3+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ca}^* Y_{e,ba} Z_{l3+b}^E + \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^E \right) Z_{i1}^H Z_{j1}^H \right. \\
& + \left( -g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ka}^{E,*} Z_{la}^E (Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \\
& \left. + 2g_1^2 \sum_{a=1}^3 Z_{k3+a}^{E,*} Z_{l3+a}^E (-Z_{i1}^H Z_{j1}^H + Z_{i2}^H Z_{j2}^H) \right) \tag{556}
\end{aligned}$$


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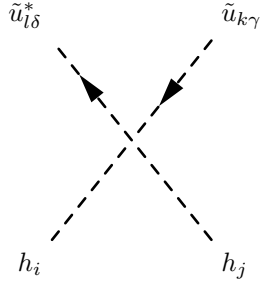
$$\begin{aligned}
& \frac{i}{4} \left( (-4|\Lambda_D|^2 - g_2^2 + g_1^2) Z_{i1}^H Z_{j1}^H + (-g_1^2 + g_2^2) Z_{i2}^H Z_{j2}^H - 4|\lambda_D|^2 Z_{i3}^H Z_{j3}^H \right. \\
& + \sqrt{2}\Lambda_D \lambda_D^* Z_{i4}^H Z_{j3}^H + \sqrt{2}\lambda_D \Lambda_D^* Z_{i4}^H Z_{j3}^H + \sqrt{2}\Lambda_D \lambda_D^* Z_{i3}^H Z_{j4}^H + \sqrt{2}\lambda_D \Lambda_D^* Z_{i3}^H Z_{j4}^H \\
& \left. - 2|\Lambda_D|^2 Z_{i4}^H Z_{j4}^H \right) \tag{557}
\end{aligned}$$


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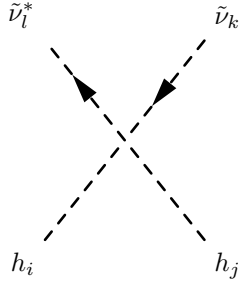
$$\begin{aligned}
& -\frac{i}{4} \left( (-g_2^2 + g_1^2) Z_{i1}^H Z_{j1}^H + (4|\Lambda_U|^2 - g_1^2 + g_2^2) Z_{i2}^H Z_{j2}^H + 4|\lambda_U|^2 Z_{i3}^H Z_{j3}^H \right. \\
& + \sqrt{2}\Lambda_U \lambda_U^* Z_{i4}^H Z_{j3}^H + \sqrt{2}\lambda_U \Lambda_U^* Z_{i4}^H Z_{j3}^H + \sqrt{2}\Lambda_U \lambda_U^* Z_{i3}^H Z_{j4}^H + \sqrt{2}\lambda_U \Lambda_U^* Z_{i3}^H Z_{j4}^H \\
& \left. + 2|\Lambda_U|^2 Z_{i4}^H Z_{j4}^H \right) \tag{558}
\end{aligned}$$


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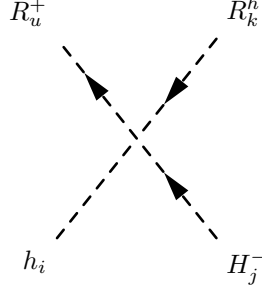
$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left( (-3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ka}^{U,*} Z_{la}^U (Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \right. \\
& - 4 \left( 3 \left( \sum_{c=1}^3 Z_{k3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{u,ba} Z_{l3+b}^U + \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{lc}^U \right) Z_{i2}^H Z_{j2}^H \right. \\
& \left. \left. + g_1^2 \sum_{a=1}^3 Z_{k3+a}^{U,*} Z_{l3+a}^U (Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \right) \right) \tag{559}
\end{aligned}$$


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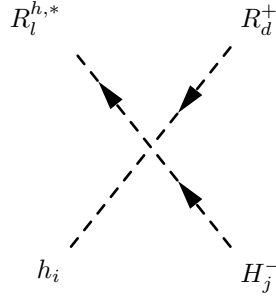
$$-\frac{i}{4}(g_1^2 + g_2^2)\delta_{kl}\left(Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H\right) \quad (560)$$


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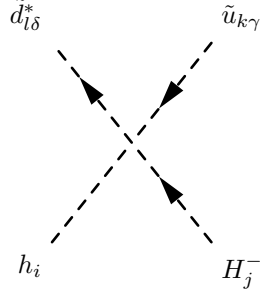
$$\begin{aligned} & -\frac{i}{4}\left(\sqrt{2}Z_{i1}^H\left(2\lambda_D\lambda_U^*Z_{k1}^R Z_{j2}^+ + g_2^2 Z_{k2}^R Z_{j1}^+\right)\right. \\ & + \Lambda_U^*\left(\sqrt{2}\Lambda_D Z_{i1}^H Z_{k1}^R Z_{j2}^+ + \sqrt{2}Z_{i2}^H\left(2\Lambda_D Z_{k1}^R Z_{j1}^+ + \Lambda_U Z_{k2}^R Z_{j2}^+\right)\right. \\ & \left. - 2Z_{k2}^R\left(\Lambda_U Z_{i4}^H\left(-Z_{j4}^+ + Z_{j3}^+\right) + \sqrt{2}\lambda_U Z_{i3}^H Z_{j4}^+\right)\right) \\ & \left. + Z_{k2}^R\left(-2\left(g_2^2 Z_{i4}^H\left(-Z_{j3}^+ + Z_{j4}^+\right) + \sqrt{2}\Lambda_U\lambda_U^* Z_{i3}^H Z_{j3}^+\right) + \sqrt{2}\left(-2|\lambda_U|^2 + g_2^2\right)Z_{i2}^H Z_{j2}^+\right)\right) \end{aligned} \quad (561)$$


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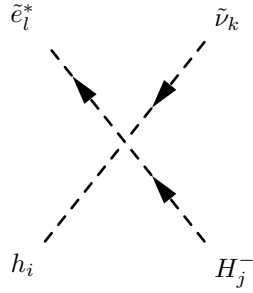
$$\begin{aligned} & -\frac{i}{4}\left(2\sqrt{2}\lambda_D\lambda_U^*Z_{i2}^H Z_{l2}^R Z_{j1}^+ + \sqrt{2}\Lambda_D\Lambda_U^*Z_{i2}^H Z_{l2}^R Z_{j1}^+ + \sqrt{2}g_2^2 Z_{i2}^H Z_{l1}^R Z_{j2}^+\right. \\ & + \sqrt{2}Z_{i1}^H\left(\left(-2|\lambda_D|^2 + g_2^2 + |\Lambda_D|^2\right)Z_{l1}^R Z_{j1}^+ + 2\Lambda_D\Lambda_U^*Z_{l2}^R Z_{j2}^+\right) - 2\sqrt{2}\Lambda_D\lambda_D^*Z_{i3}^H Z_{l1}^R Z_{j3}^+ \\ & + 2g_2^2 Z_{i4}^H Z_{l1}^R Z_{j3}^+ - 2|\Lambda_D|^2 Z_{i4}^H Z_{l1}^R Z_{j3}^+ - 2\sqrt{2}\lambda_D\Lambda_D^*Z_{i3}^H Z_{l1}^R Z_{j4}^+ \\ & \left. - 2g_2^2 Z_{i4}^H Z_{l1}^R Z_{j4}^+ + 2|\Lambda_D|^2 Z_{i4}^H Z_{l1}^R Z_{j4}^+\right) \end{aligned} \quad (562)$$


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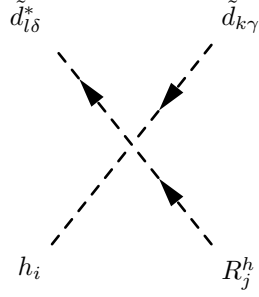
$$\begin{aligned}
& -\frac{i}{4}\delta_{\gamma\delta}\left(-2\sqrt{2}\left(\sum_{c=1}^3\sum_{b=1}^3Z_{kb}^{U,*}\sum_{a=1}^3Y_{d,ac}^*Y_{d,ab}Z_{lc}^DZ_{i1}^HZ_{j1}^+\right)+\sum_{c=1}^3\sum_{b=1}^3Z_{kb}^{U,*}\sum_{a=1}^3Y_{u,ac}^*Y_{u,ab}Z_{lc}^DZ_{i2}^HZ_{j2}^+\right. \\
& +\sum_{c=1}^3Z_{k3+c}^{U,*}\sum_{b=1}^3\sum_{a=1}^3Y_{u,ca}^*Y_{d,ba}Z_{l3+b}^D\left(Z_{i1}^HZ_{j2}^++Z_{i2}^HZ_{j1}^+\right)\left. \right) \\
& +g_2^2\sum_{a=1}^3Z_{ka}^{U,*}Z_{la}^D\left(2Z_{i4}^H\left(-Z_{j4}^++Z_{j3}^+\right)+\sqrt{2}Z_{i1}^HZ_{j1}^++\sqrt{2}Z_{i2}^HZ_{j2}^+\right)
\end{aligned} \tag{563}$$


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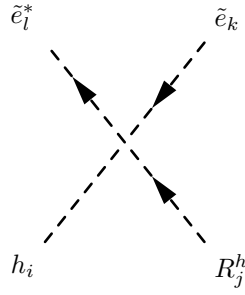
$$\begin{aligned}
& -\frac{i}{4}\left(-2\sqrt{2}\sum_{c=1}^3\sum_{b=1}^3Z_{kb}^{V,*}\sum_{a=1}^3Y_{e,ac}^*Y_{e,ab}Z_{lc}^EZ_{i1}^HZ_{j1}^+\right. \\
& +g_2^2\sum_{a=1}^3Z_{ka}^{V,*}Z_{la}^E\left(2Z_{i4}^H\left(-Z_{j4}^++Z_{j3}^+\right)+\sqrt{2}Z_{i1}^HZ_{j1}^++\sqrt{2}Z_{i2}^HZ_{j2}^+\right)\left. \right)
\end{aligned} \tag{564}$$


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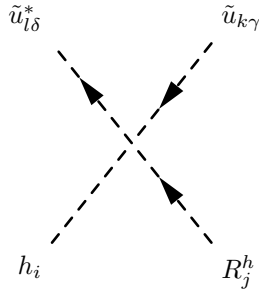
$$\frac{i}{2} \delta_{\gamma\delta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} Z_{lb}^D \left( \Lambda_D Z_{i4}^H + \sqrt{2} \lambda_D Z_{i3}^H \right) Z_{j1}^R \quad (565)$$


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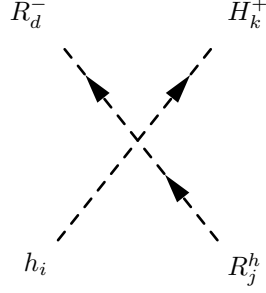
$$\frac{i}{2} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} Z_{lb}^E \left( \Lambda_D Z_{i4}^H + \sqrt{2} \lambda_D Z_{i3}^H \right) Z_{j1}^R \quad (566)$$


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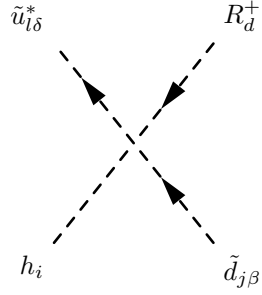
$$-\frac{i}{2} \delta_{\gamma\delta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} Z_{lb}^U \left( -\Lambda_U Z_{i4}^H + \sqrt{2} \lambda_U Z_{i3}^H \right) Z_{j2}^R \quad (567)$$


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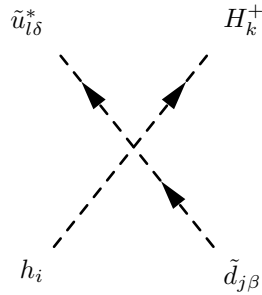
$$\begin{aligned}
& -\frac{i}{4} \left( \sqrt{2} \Lambda_U \Lambda_D^* Z_{i2}^H Z_{j2}^R Z_{k1}^+ + \sqrt{2} g_2^2 Z_{i2}^H Z_{j1}^R Z_{k2}^+ \right. \\
& + \sqrt{2} Z_{i1}^H \left( (-2|\lambda_D|^2 + g_2^2 + |\Lambda_D|^2) Z_{j1}^R Z_{k1}^+ + 2\Lambda_U \Lambda_D^* Z_{j2}^R Z_{k2}^+ \right) - 2\sqrt{2} \lambda_D \Lambda_D^* Z_{i3}^H Z_{j1}^R Z_{k3}^+ \\
& + 2g_2^2 Z_{i4}^H Z_{j1}^R Z_{k3}^+ - 2|\Lambda_D|^2 Z_{i4}^H Z_{j1}^R Z_{k3}^+ - 2g_2^2 Z_{i4}^H Z_{j1}^R Z_{k4}^+ \\
& \left. + 2|\Lambda_D|^2 Z_{i4}^H Z_{j1}^R Z_{k4}^+ + 2\sqrt{2} \lambda_D^* \left( -\Lambda_D Z_{i3}^H Z_{j1}^R Z_{k4}^+ + \lambda_U Z_{i2}^H Z_{j2}^R Z_{k1}^+ \right) \right) \quad (568)
\end{aligned}$$


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$$\frac{i}{2} \delta_{\beta\delta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{lb}^U \left( -\Lambda_D Z_{i4}^H + \sqrt{2} \lambda_D Z_{i3}^H \right) \quad (569)$$

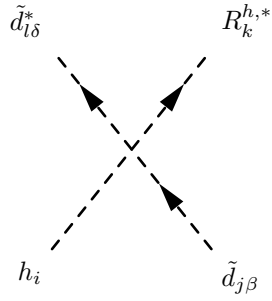

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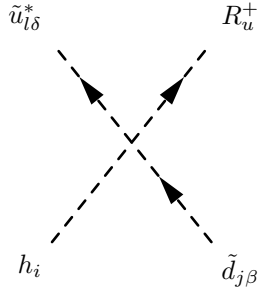
$$\begin{aligned}
& -\frac{i}{4}\delta_{\beta\delta}\left(-2\sqrt{2}\left(\sum_{c=1}^3\sum_{b=1}^3Z_{jb}^{D,*}\sum_{a=1}^3Y_{d,ac}^*Y_{d,ab}Z_{lc}^UZ_{i1}^HZ_{k1}^+\right)+\sum_{c=1}^3\sum_{b=1}^3Z_{jb}^{D,*}\sum_{a=1}^3Y_{u,ac}^*Y_{u,ab}Z_{lc}^UZ_{i2}^HZ_{k2}^+\right) \\
& +\sum_{c=1}^3Z_{j3+c}^{D,*}\sum_{b=1}^3\sum_{a=1}^3Y_{d,ca}^*Y_{u,ba}Z_{l3+b}^U\left(Z_{i1}^HZ_{k2}^++Z_{i2}^HZ_{k1}^+\right) \\
& +g_2^2\sum_{a=1}^3Z_{ja}^{D,*}Z_{la}^U\left(2Z_{i4}^H\left(-Z_{k4}^++Z_{k3}^+\right)+\sqrt{2}Z_{i1}^HZ_{k1}^++\sqrt{2}Z_{i2}^HZ_{k2}^+\right)
\end{aligned} \tag{570}$$


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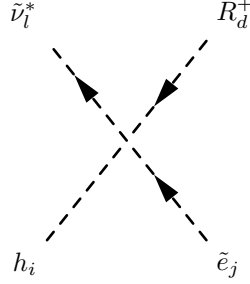
$$\frac{i}{2}\delta_{\beta\delta}\sum_{b=1}^3Z_{jb}^{D,*}\sum_{a=1}^3Y_{d,ab}Z_{l3+a}^D\left(\Lambda_D^*Z_{i4}^H+\sqrt{2}\lambda_D^*Z_{i3}^H\right)Z_{k1}^R \tag{571}$$


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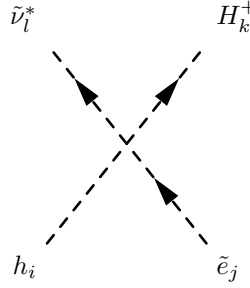
$$-\frac{i}{2}\delta_{\beta\delta}\sum_{b=1}^3Z_{jb}^{D,*}\sum_{a=1}^3Y_{u,ab}Z_{l3+a}^U\left(\Lambda_U^*Z_{i4}^H+\sqrt{2}\lambda_U^*Z_{i3}^H\right) \tag{572}$$


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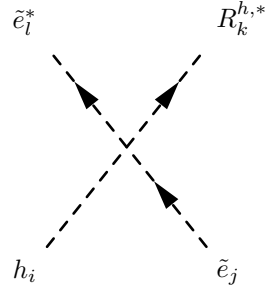
$$\frac{i}{2} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{lb}^V \left( -\Lambda_D Z_{i4}^H + \sqrt{2} \lambda_D Z_{i3}^H \right) \quad (573)$$


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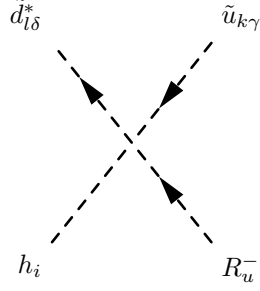
$$\begin{aligned} & -\frac{i}{4} \left( -2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^V Z_{i1}^H Z_{k1}^+ \right. \\ & \left. + g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^V \left( 2Z_{i4}^H \left( -Z_{k4}^+ + Z_{k3}^+ \right) + \sqrt{2} Z_{i1}^H Z_{k1}^+ + \sqrt{2} Z_{i2}^H Z_{k2}^+ \right) \right) \quad (574) \end{aligned}$$


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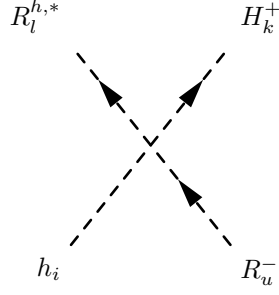
$$\frac{i}{2} \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \left( \Lambda_D^* Z_{i4}^H + \sqrt{2} \lambda_D^* Z_{i3}^H \right) Z_{k1}^R \quad (575)$$


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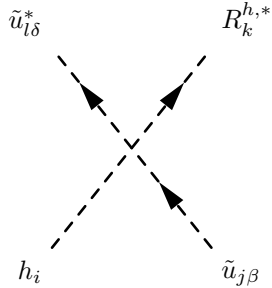
$$-\frac{i}{2}\delta_{\gamma\delta}\sum_{b=1}^3\sum_{a=1}^3Y_{u,ab}Z_{k3+a}^{U,*}Z_{lb}^D\left(\Lambda_U Z_{i4}^H+\sqrt{2}\lambda_U Z_{i3}^H\right) \quad (576)$$


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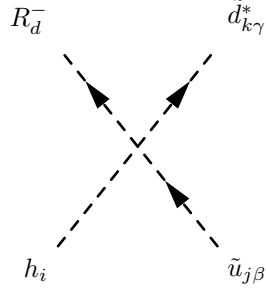
$$\begin{aligned} &-\frac{i}{4}\left(\sqrt{2}\Lambda_U\Lambda_D^*Z_{l1}^R\left(2Z_{i2}^HZ_{k1}^++Z_{i1}^HZ_{k2}^+\right)+\sqrt{2}Z_{i1}^H\left(2\lambda_U\lambda_D^*Z_{l1}^RZ_{k2}^++g_2^2Z_{l2}^RZ_{k1}^+\right)\right. \\ &+Z_{l2}^R\left(\sqrt{2}\left(-2|\lambda_U|^2+g_2^2+|\Lambda_U|^2\right)Z_{i2}^HZ_{k2}^+\right. \\ &\left.\left.-2\left(g_2^2Z_{i4}^H\left(-Z_{k3}^++Z_{k4}^+\right)+\Lambda_U^*\left(\Lambda_U Z_{i4}^H\left(-Z_{k4}^++Z_{k3}^+\right)+\sqrt{2}\lambda_U Z_{i3}^HZ_{k3}^+\right)+\sqrt{2}\Lambda_U\lambda_U^*Z_{i3}^HZ_{k4}^+\right)\right)\right) \quad (577) \end{aligned}$$


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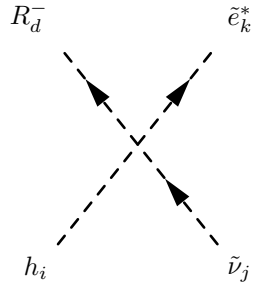
$$-\frac{i}{2}\delta_{\beta\delta}\sum_{b=1}^3Z_{jb}^{U,*}\sum_{a=1}^3Y_{u,ab}Z_{l3+a}^U\left(-\Lambda_U^*Z_{i4}^H+\sqrt{2}\lambda_U^*Z_{i3}^H\right)Z_{k2}^R \quad (578)$$


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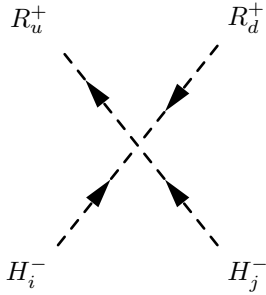
$$\frac{i}{2} \delta_{\beta\gamma} \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \left( -\Lambda_D^* Z_{i4}^H + \sqrt{2} \lambda_D^* Z_{i3}^H \right) \quad (579)$$


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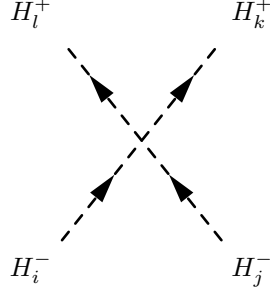
$$\frac{i}{2} \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \left( -\Lambda_D^* Z_{i4}^H + \sqrt{2} \lambda_D^* Z_{i3}^H \right) \quad (580)$$


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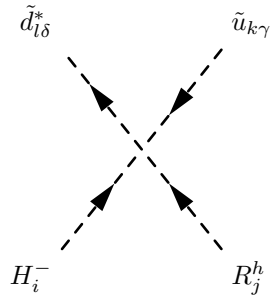


$$\frac{i}{2} \left( 2\lambda_D \lambda_U^* - \Lambda_D \Lambda_U^* \right) \left( Z_{i1}^+ Z_{j2}^+ + Z_{i2}^+ Z_{j1}^+ \right) \quad (581)$$

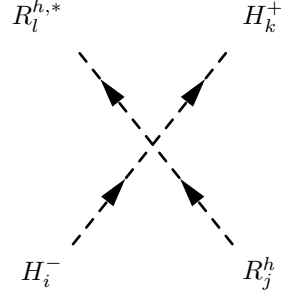

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$$\begin{aligned}
& -\frac{i}{4} \left( Z_{i1}^+ \left( 2(g_1^2 + g_2^2) Z_{j1}^+ Z_{k1}^+ Z_{l1}^+ - (g_1^2 + g_2^2) Z_{j2}^+ (Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+) \right) \right. \\
& + 2 \left( - \left( -2|\Lambda_D|^2 + g_2^2 \right) Z_{j4}^+ (Z_{k1}^+ Z_{l4}^+ + Z_{k4}^+ Z_{l1}^+) + g_2^2 Z_{j3}^+ (Z_{k1}^+ Z_{l3}^+ + Z_{k3}^+ Z_{l1}^+) \right) \Big) \\
& - Z_{i2}^+ \left( (g_1^2 + g_2^2) Z_{j1}^+ (Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+) \right) \\
& - 2 \left( (g_1^2 + g_2^2) Z_{j2}^+ Z_{k2}^+ Z_{l2}^+ - \left( -2|\Lambda_U|^2 + g_2^2 \right) Z_{j3}^+ (Z_{k2}^+ Z_{l3}^+ + Z_{k3}^+ Z_{l2}^+) \right. \\
& \left. + g_2^2 Z_{j4}^+ (Z_{k2}^+ Z_{l4}^+ + Z_{k4}^+ Z_{l2}^+) \right) \\
& + 2 \left( Z_{i3}^+ \left( g_2^2 Z_{j1}^+ (Z_{k1}^+ Z_{l3}^+ + Z_{k3}^+ Z_{l1}^+) - \left( -2|\Lambda_U|^2 + g_2^2 \right) Z_{j2}^+ (Z_{k2}^+ Z_{l3}^+ + Z_{k3}^+ Z_{l2}^+) \right) \right. \\
& \left. + 2g_2^2 \left( 2Z_{j3}^+ Z_{k3}^+ Z_{l3}^+ - Z_{j4}^+ (Z_{k3}^+ Z_{l4}^+ + Z_{k4}^+ Z_{l3}^+) \right) \right) \\
& + Z_{i4}^+ \left( - \left( -2|\Lambda_D|^2 + g_2^2 \right) Z_{j1}^+ (Z_{k1}^+ Z_{l4}^+ + Z_{k4}^+ Z_{l1}^+) \right) \\
& \left. + g_2^2 \left( -2 \left( -2Z_{j4}^+ Z_{k4}^+ Z_{l4}^+ + Z_{j3}^+ (Z_{k3}^+ Z_{l4}^+ + Z_{k4}^+ Z_{l3}^+) \right) + Z_{j2}^+ (Z_{k2}^+ Z_{l4}^+ + Z_{k4}^+ Z_{l2}^+) \right) \right) \Big) \quad (582)
\end{aligned}$$

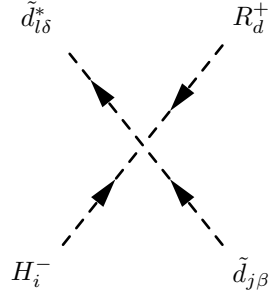


$$i\Lambda_U \delta_{\gamma\delta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} Z_{lb}^D Z_{j2}^R Z_{i3}^+ \quad (583)$$



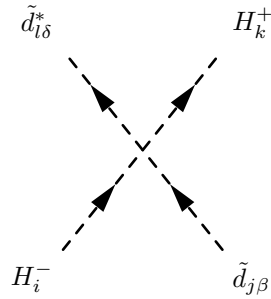
$$\begin{aligned}
& -\frac{i}{4} \left( Z_{j2}^R Z_{l2}^R \left( (-g_2^2 + g_1^2) Z_{i1}^+ Z_{k1}^+ + (4|\Lambda_U|^2 - g_1^2 + g_2^2) Z_{i2}^+ Z_{k2}^+ - 2g_2^2 Z_{i3}^+ Z_{k3}^+ \right. \right. \\
& \left. \left. + 4|\Lambda_U|^2 Z_{i3}^+ Z_{k3}^+ + 2g_2^2 Z_{i4}^+ Z_{k4}^+ \right) \right. \\
& \left. + Z_{j1}^R Z_{i1}^R \left( (4|\Lambda_D|^2 - g_1^2 + g_2^2) Z_{i1}^+ Z_{k1}^+ + (-g_2^2 + g_1^2) Z_{i2}^+ Z_{k2}^+ + 2g_2^2 Z_{i3}^+ Z_{k3}^+ - 2g_2^2 Z_{i4}^+ Z_{k4}^+ \right. \right. \\
& \left. \left. + 4|\Lambda_D|^2 Z_{i4}^+ Z_{k4}^+ \right) \right) \tag{584}
\end{aligned}$$


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$$-i\Lambda_D \delta_{\beta\delta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{lb}^D Z_{i3}^+ \tag{585}$$


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$$\begin{aligned}
& \frac{i}{12} \delta_{\beta\delta} \left( 2 \left( g_1^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{l3+a}^D \left( Z_{i1}^+ Z_{k1}^+ - Z_{i2}^+ Z_{k2}^+ \right) \right. \right. \\
& - 6 \left( \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{lc}^D Z_{i2}^+ Z_{k2}^+ + \sum_{c=1}^3 Z_{j3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{d,ba} Z_{l3+b}^D Z_{i1}^+ Z_{k1}^+ \right) \\
& \left. \left. + \sum_{a=1}^3 Z_{ja}^{D,*} Z_{la}^D \left( \left( -3g_2^2 + g_1^2 \right) Z_{i1}^+ Z_{k1}^+ - \left( -3g_2^2 + g_1^2 \right) Z_{i2}^+ Z_{k2}^+ + 6g_2^2 \left( -Z_{i3}^+ Z_{k3}^+ + Z_{i4}^+ Z_{k4}^+ \right) \right) \right) \right) \quad (586)
\end{aligned}$$

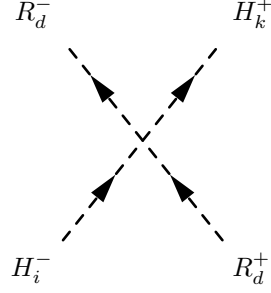

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$$- i\Lambda_D \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{lb}^E Z_{i3}^+ \quad (587)$$


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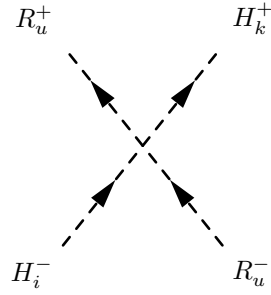
$$\begin{aligned}
& -\frac{i}{4} \left( 4 \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ca}^* Y_{e,ba} Z_{l3+b}^E Z_{i1}^+ Z_{k1}^+ \right. \\
& + 2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E \left( -Z_{i1}^+ Z_{k1}^+ + Z_{i2}^+ Z_{k2}^+ \right) \\
& \left. + \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E \left( 2g_2^2 \left( Z_{i3}^+ Z_{k3}^+ - Z_{i4}^+ Z_{k4}^+ \right) + \left( g_1^2 + g_2^2 \right) Z_{i1}^+ Z_{k1}^+ - \left( g_1^2 + g_2^2 \right) Z_{i2}^+ Z_{k2}^+ \right) \right) \quad (588)
\end{aligned}$$


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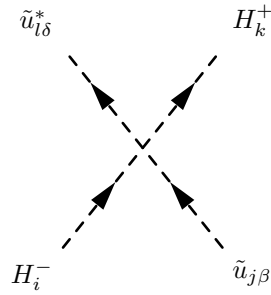
$$\frac{i}{4} \left( (-2|\Lambda_D|^2 - 4|\lambda_D|^2 + g_1^2 + g_2^2) Z_{i1}^+ Z_{k1}^+ - (g_1^2 + g_2^2) Z_{i2}^+ Z_{k2}^+ + 2g_2^2 Z_{i3}^+ Z_{k3}^+ - 4|\Lambda_D|^2 Z_{i3}^+ Z_{k3}^+ - 2g_2^2 Z_{i4}^+ Z_{k4}^+ \right) \quad (589)$$


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$$-\frac{i}{4} \left( (g_1^2 + g_2^2) Z_{i1}^+ Z_{k1}^+ - (-2|\Lambda_U|^2 - 4|\lambda_U|^2 + g_1^2 + g_2^2) Z_{i2}^+ Z_{k2}^+ + 2g_2^2 Z_{i3}^+ Z_{k3}^+ - 2g_2^2 Z_{i4}^+ Z_{k4}^+ + 4|\Lambda_U|^2 Z_{i4}^+ Z_{k4}^+ \right) \quad (590)$$


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$$\frac{i}{12} \delta_{\beta\delta} \left( -4 \left( g_1^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \left( Z_{i1}^+ Z_{k1}^+ - Z_{i2}^+ Z_{k2}^+ \right) \right) \right)$$



$$\begin{aligned}
& + 3 \left( \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{lc}^U Z_{i1}^+ Z_{k1}^+ + \sum_{c=1}^3 Z_{j3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{u,ba} Z_{l3+b}^U Z_{i2}^+ Z_{k2}^+ \right) \\
& + \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( (3g_2^2 + g_1^2) Z_{i1}^+ Z_{k1}^+ - (3g_2^2 + g_1^2) Z_{i2}^+ Z_{k2}^+ + 6g_2^2 (Z_{i3}^+ Z_{k3}^+ - Z_{i4}^+ Z_{k4}^+) \right)
\end{aligned} \tag{591}$$


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$$- i\Lambda_D^* \delta_{\beta\delta} \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{k1}^R Z_{i4}^+ \tag{592}$$

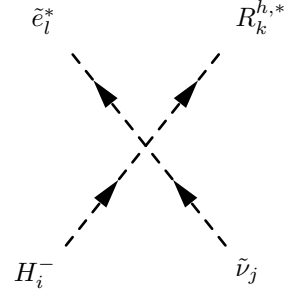

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$$i\Lambda_U^* \delta_{\beta\delta} \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U Z_{i4}^+ \tag{593}$$


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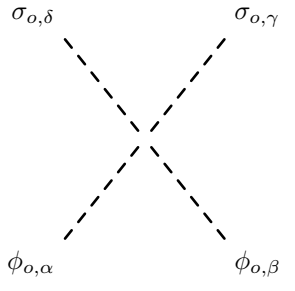
$$\begin{aligned}
& -\frac{i}{4} \left( 4 \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^V Z_{i1}^+ Z_{k1}^+ \right. \\
& \left. + \delta_{jl} \left( 2g_2^2 \left( -Z_{i3}^+ Z_{k3}^+ + Z_{i4}^+ Z_{k4}^+ \right) + \left( -g_1^2 + g_2^2 \right) Z_{i2}^+ Z_{k2}^+ + \left( -g_2^2 + g_1^2 \right) Z_{i1}^+ Z_{k1}^+ \right) \right) \quad (594)
\end{aligned}$$


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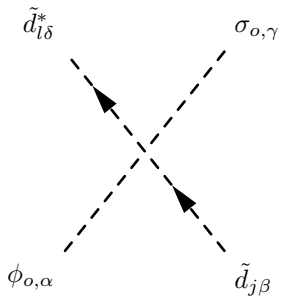
$$-i\Lambda_D^* \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{k1}^R Z_{i4}^+ \quad (595)$$


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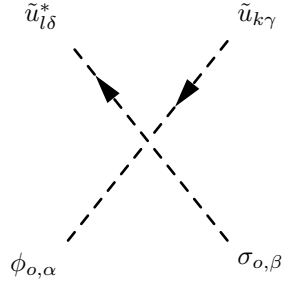
$$-i g_3^2 \left( \sum_{a=1}^8 f_{\alpha,\delta,a} f_{\beta,\gamma,a} + \sum_{a=1}^8 f_{\alpha,\gamma,a} f_{\beta,\delta,a} \right) \quad (596)$$


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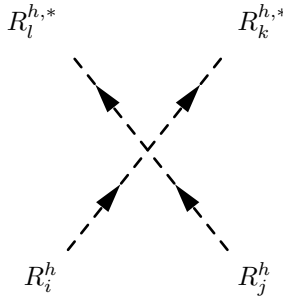
$$-\frac{i}{2}g_3^2\left(-\sum_{a=1}^3 Z_{j_{3+a}}^{D,*} Z_{l_{3+a}}^D + \sum_{a=1}^3 Z_{j_a}^{D,*} Z_{l_a}^D\right) \sum_{b=1}^8 f_{\alpha,\gamma,b} \lambda_{\delta,\beta}^b \quad (597)$$


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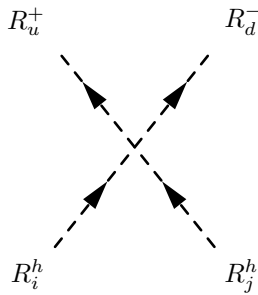
$$-\frac{i}{2}g_3^2\left(-\sum_{a=1}^3 Z_{k_{3+a}}^{U,*} Z_{l_{3+a}}^U + \sum_{a=1}^3 Z_{k_a}^{U,*} Z_{l_a}^U\right) \sum_{b=1}^8 f_{\alpha,\beta,b} \lambda_{\delta,\gamma}^b \quad (598)$$


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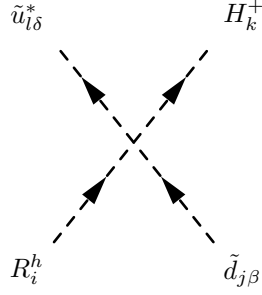
$$\begin{aligned} &-\frac{i}{4}(g_1^2 + g_2^2) \left( -Z_{i2}^R \left( -2Z_{j2}^R Z_{k2}^R Z_{l2}^R + Z_{j1}^R (Z_{k1}^R Z_{l2}^R + Z_{k2}^R Z_{l1}^R) \right) \right. \\ &+ \left. Z_{i1}^R (2Z_{j1}^R Z_{k1}^R Z_{l1}^R - Z_{j2}^R (Z_{k1}^R Z_{l2}^R + Z_{k2}^R Z_{l1}^R)) \right) \quad (599) \end{aligned}$$


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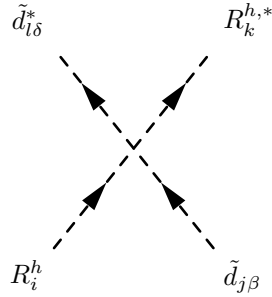
$$-\frac{i}{2}g_2^2\left(Z_{i1}^R Z_{j2}^R + Z_{i2}^R Z_{j1}^R\right) \quad (600)$$


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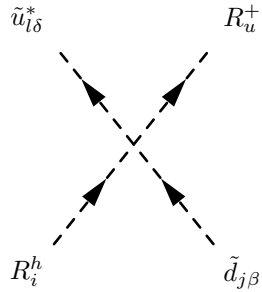
$$-i\Lambda_D\delta_{\beta\delta}\sum_{b=1}^3\sum_{a=1}^3Y_{d,ab}^*Z_{j3+a}^{D,*}Z_{lb}^U Z_{i1}^R Z_{k4}^+ \quad (601)$$


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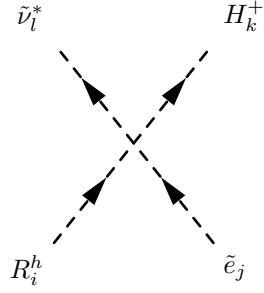
$$-\frac{i}{12}\delta_{\beta\delta}\left(2g_1^2\sum_{a=1}^3Z_{j3+a}^{D,*}Z_{l3+a}^D + (3g_2^2 + g_1^2)\sum_{a=1}^3Z_{ja}^{D,*}Z_{la}^D\right)\left(Z_{i1}^R Z_{k1}^R - Z_{i2}^R Z_{k2}^R\right) \quad (602)$$


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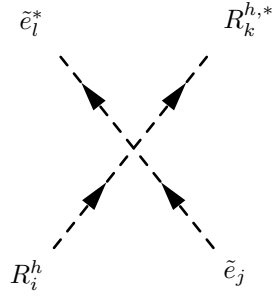
$$-\frac{i}{2}g_2^2\delta_{\beta\delta}\sum_{a=1}^3Z_{ja}^{D,*}Z_{la}^UZ_{i2}^R \quad (603)$$


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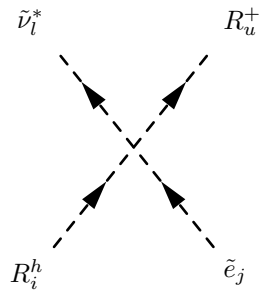
$$-i\Lambda_D\sum_{b=1}^3\sum_{a=1}^3Y_{e,ab}^*Z_{j3+a}^{E,*}Z_{lb}^VZ_{i1}^RZ_{k4}^+ \quad (604)$$


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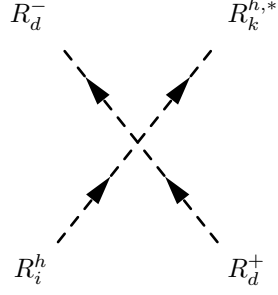
$$\frac{i}{4}\left(-2g_1^2\sum_{a=1}^3Z_{j3+a}^{E,*}Z_{l3+a}^E+\left(-g_2^2+g_1^2\right)\sum_{a=1}^3Z_{ja}^{E,*}Z_{la}^E\right)\left(Z_{i1}^RZ_{k1}^R-Z_{i2}^RZ_{k2}^R\right) \quad (605)$$


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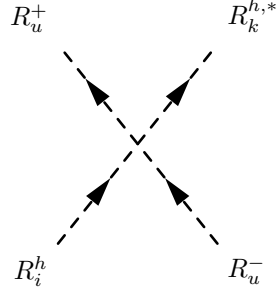
$$-\frac{i}{2}g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^V Z_{i2}^R \quad (606)$$


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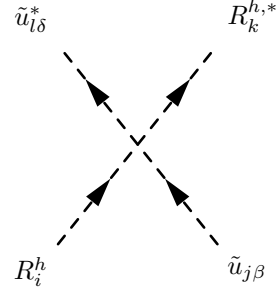
$$-\frac{i}{4} \left( (g_1^2 + g_2^2) Z_{i1}^R Z_{k1}^R + (-g_1^2 + g_2^2) Z_{i2}^R Z_{k2}^R \right) \quad (607)$$


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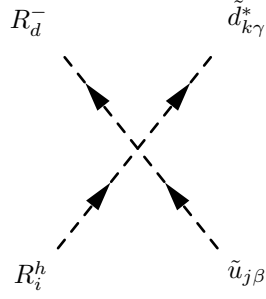
$$\frac{i}{4} \left( -(g_1^2 + g_2^2) Z_{i2}^R Z_{k2}^R + (-g_2^2 + g_1^2) Z_{i1}^R Z_{k1}^R \right) \quad (608)$$


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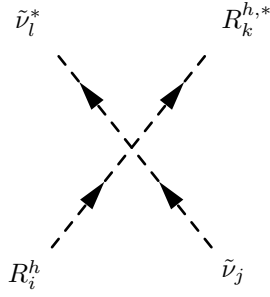
$$-\frac{i}{12} \delta_{\beta\delta} \left( (-3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U - 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \right) (Z_{i1}^R Z_{k1}^R - Z_{i2}^R Z_{k2}^R) \quad (609)$$


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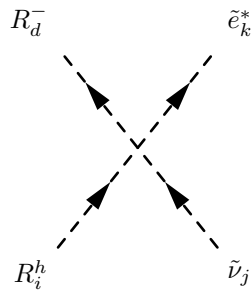
$$-\frac{i}{2}g_2^2\delta_{\beta\gamma}\sum_{a=1}^3Z_{ja}^{U,*}Z_{ka}^DZ_{i1}^R \quad (610)$$


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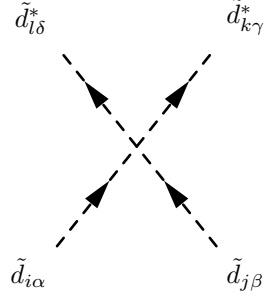
$$\frac{i}{4}(g_1^2 + g_2^2)\delta_{jl}(Z_{i1}^R Z_{k1}^R - Z_{i2}^R Z_{k2}^R) \quad (611)$$


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$$-\frac{i}{2}g_2^2\sum_{a=1}^3Z_{ja}^{V,*}Z_{ka}^EZ_{i1}^R \quad (612)$$


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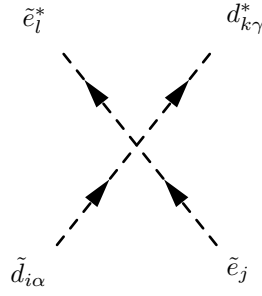
$$\begin{aligned}
& -\frac{i}{72} \left( \delta_{\alpha\delta} \delta_{\beta\gamma} \left( g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D + 9g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D \right. \right. \\
& - 6g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*}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



$$\begin{aligned}
& -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. \\
& + 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
\end{aligned}$$

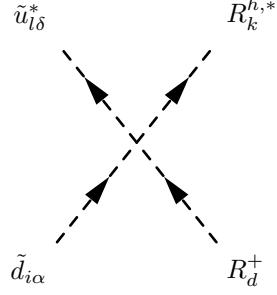
$$\begin{aligned}
& + 72 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{i3+c}^{D,*} Z_{kd}^D \\
& + 72 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{j3+c}^{D,*} Z_{ld}^D \Big) \tag{613}
\end{aligned}$$


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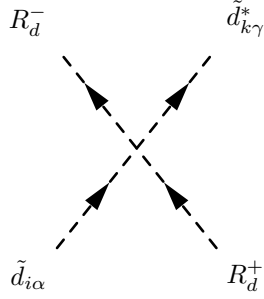
$$\begin{aligned}
& \frac{i}{24} \delta_{\alpha\gamma} \left( -2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E \left( 2 \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \right. \\
& + \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E \left( 2g_1^2 \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + \left( -3g_2^2 + g_1^2 \right) \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \\
& + g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E - 3g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E \\
& + 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E - 2g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E \\
& - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E \\
& - 24 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{i3+c}^{D,*} Z_{kd}^D \\
& \left. - 24 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{j3+c}^{E,*} Z_{ld}^E \right) \tag{614}
\end{aligned}$$


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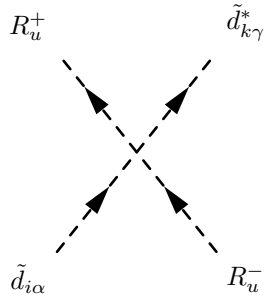
$$-\frac{i}{2}g_2^2\delta_{\alpha\delta}\sum_{a=1}^3Z_{ia}^{D,*}Z_{la}^UZ_{k1}^R \quad (615)$$


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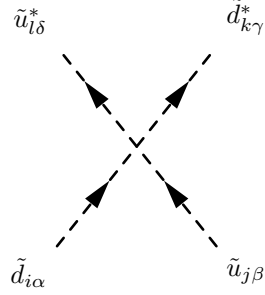
$$-\frac{i}{12}\delta_{\alpha\gamma}\left(2g_1^2\sum_{a=1}^3Z_{i3+a}^{D,*}Z_{k3+a}^D + \left(-3g_2^2 + g_1^2\right)\sum_{a=1}^3Z_{ia}^{D,*}Z_{ka}^D\right) \quad (616)$$


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$$\frac{i}{12}\delta_{\alpha\gamma}\left(2g_1^2\sum_{a=1}^3Z_{i3+a}^{D,*}Z_{k3+a}^D + \left(-3g_2^2 + g_1^2\right)\sum_{a=1}^3Z_{ia}^{D,*}Z_{ka}^D\right) \quad (617)$$

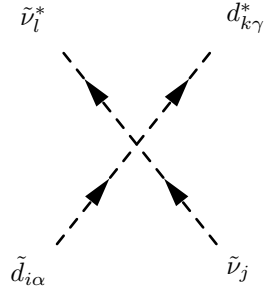

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$$\begin{aligned}
& -\frac{i}{72} \left( \delta_{\alpha\gamma} \delta_{\beta\delta} \left( \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( 2 \left( 3g_3^2 + g_1^2 \right) \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + \left( -6g_3^2 - 9g_2^2 + g_1^2 \right) \sum_{b=1}^3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

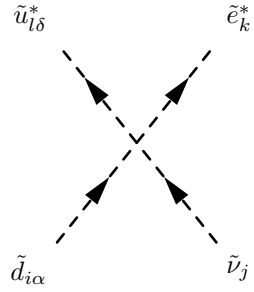
$$+ 4 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{i3+c}^{D,*} Z_{ld}^U \Big) \quad (618)$$


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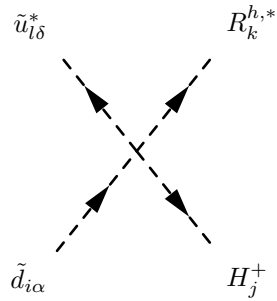
$$\frac{i}{12} \delta_{\alpha\gamma} \delta_{jl} \left( 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D + (3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \right) \quad (619)$$


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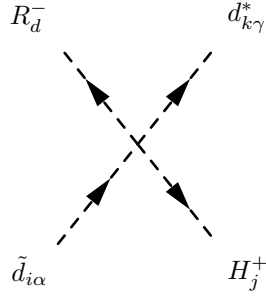
$$\begin{aligned} & - \frac{i}{4} \delta_{\alpha\delta} \left( g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{V,*} Z_{kb}^E + g_2^2 \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^E \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^U \right. \\ & \left. + 4 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{i3+c}^{D,*} Z_{ld}^U \right) \quad (620) \end{aligned}$$


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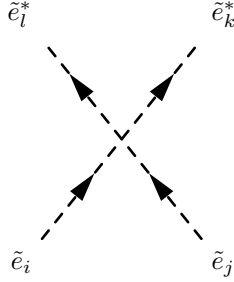
$$i\Lambda_U^* \delta_{\alpha\delta} \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U Z_{k2}^R Z_{j3}^+ \quad (621)$$


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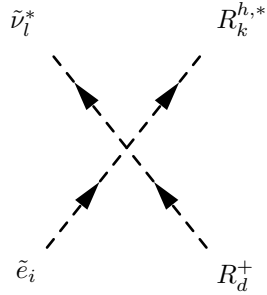
$$-i\Lambda_D^* \delta_{\alpha\gamma} \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D Z_{j3}^+ \quad (622)$$


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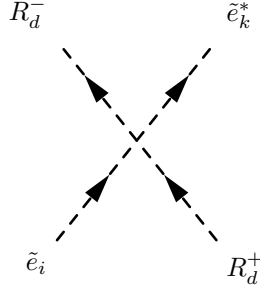


$$\begin{aligned} & -\frac{i}{8} \left( g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{kb}^E + g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{kb}^E \right) \\ & - 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{kb}^E \\ & - 2g_1^2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

$$\begin{aligned}
& + g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E + g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E + g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E \\
& + g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E - 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{l3+b}^E + 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{l3+b}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E + 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E \\
& + 8 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd} Z_{i3+c}^{E,*} Z_{kd}^E \\
& + 8 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd} Z_{j3+c}^{E,*} Z_{kd}^E \\
& + 8 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd} Z_{i3+c}^{E,*} Z_{ld}^E \\
& + 8 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd} Z_{j3+c}^{E,*} Z_{ld}^E
\end{aligned} \tag{623}$$

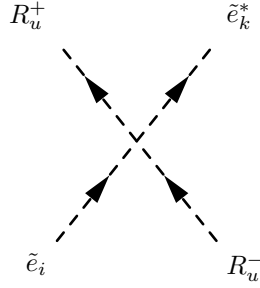


$$- \frac{i}{2} g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^V Z_{k1}^R \tag{624}$$



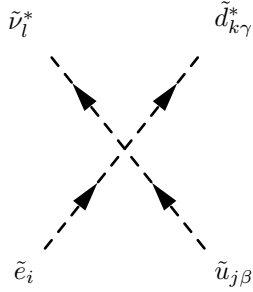
$$\frac{i}{4} \left( -2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E + (g_1^2 + g_2^2) \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \right) \quad (625)$$


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$$-\frac{i}{4} \left( -2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E + (g_1^2 + g_2^2) \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \right) \quad (626)$$

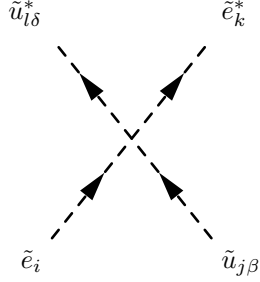

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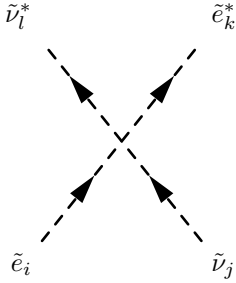
$$\begin{aligned} & -\frac{i}{4} \delta_{\beta\gamma} \left( g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^V \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^D + g_2^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^D \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^V \right. \\ & \left. + 4 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd} Z_{i3+c}^{E,*} Z_{ld}^V \right) \quad (627) \end{aligned}$$


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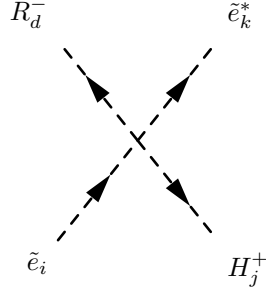




$$\begin{aligned}
& \frac{i}{24} \delta_{\beta\delta} \left( -4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \left( -2 \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{k3+b}^E + \sum_{b=1}^3 Z_{ib}^{E,*} Z_{kb}^E \right) \right. \\
& + \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( -2g_1^2 \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{k3+b}^E + (3g_2^2 + g_1^2) \sum_{b=1}^3 Z_{ib}^{E,*} Z_{kb}^E \right) \\
& + g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U + 3g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& - 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 4g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& \left. + 8g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \right) \tag{628}
\end{aligned}$$

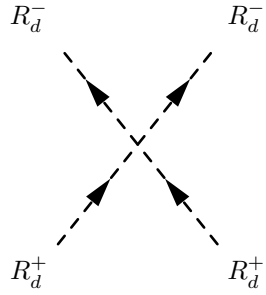


$$\begin{aligned}
& -\frac{i}{4} \left( \delta_{jl} \left( -2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E + (-g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \right) \right. \\
& + g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^V \sum_{b=1}^3 Z_{jb}^{V,*} Z_{kb}^E + g_2^2 \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^V \\
& \left. + 4 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{i3+c}^{E,*} Z_{ld}^V \right) \tag{629}
\end{aligned}$$



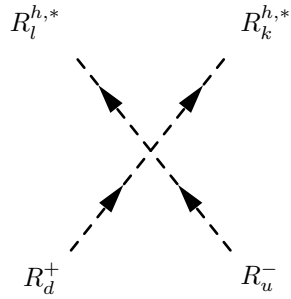
$$-i\Lambda_D^* \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{j3}^+ \quad (630)$$


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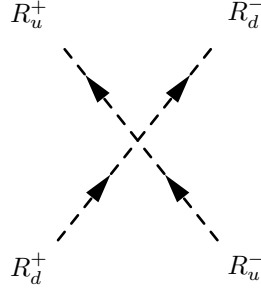
$$-\frac{i}{2}(g_1^2 + g_2^2) \quad (631)$$


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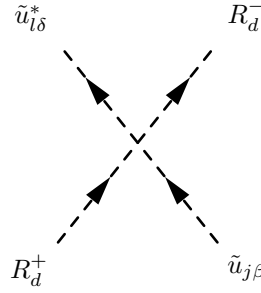
$$-\frac{i}{2}g_2^2 (Z_{k1}^R Z_{l2}^R + Z_{k2}^R Z_{l1}^R) \quad (632)$$


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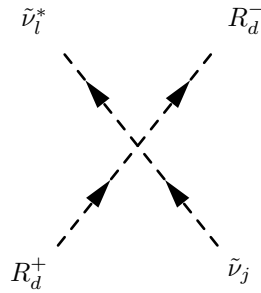
$$\frac{i}{4}(g_1^2 + g_2^2) \tag{633}$$


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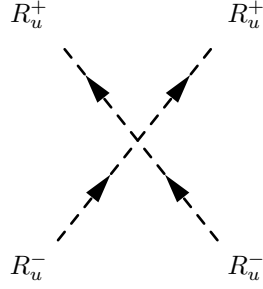
$$-\frac{i}{12}\delta_{\beta\delta}\left(\left(3g_2^2 + g_1^2\right)\sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U - 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U\right) \tag{634}$$


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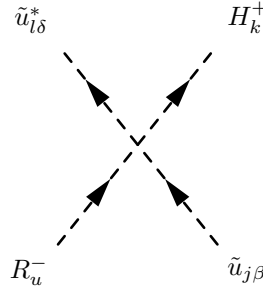
$$\frac{i}{4}\left(-g_2^2 + g_1^2\right)\delta_{jl} \tag{635}$$


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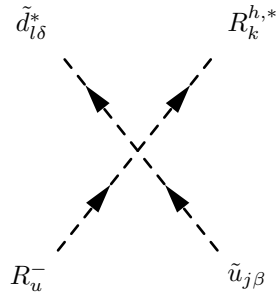
$$-\frac{i}{2}(g_1^2 + g_2^2) \quad (636)$$


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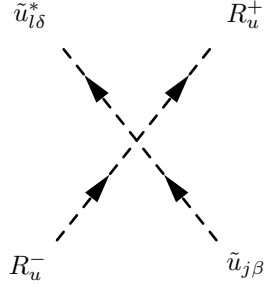
$$i\Lambda_U \delta_{\beta\delta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{lb}^U Z_{k4}^+ \quad (637)$$


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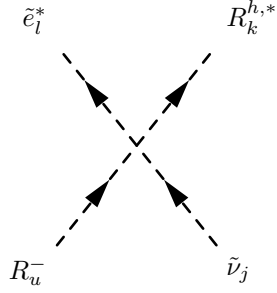
$$-\frac{i}{2} g_2^2 \delta_{\beta\delta} \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^D Z_{k2}^R \quad (638)$$


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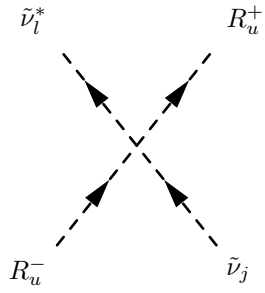
$$\frac{i}{12} \delta_{\beta\delta} \left( (3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U - 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \right) \quad (639)$$


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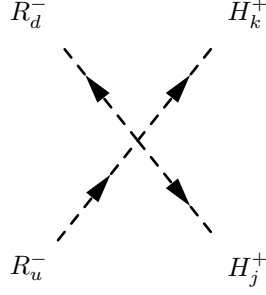
$$-\frac{i}{2} g_2^2 \sum_{a=1}^3 Z_{ja}^{V,*} Z_{la}^E Z_{k2}^R \quad (640)$$


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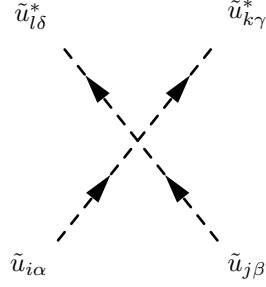


$$-\frac{i}{4} (-g_2^2 + g_1^2) \delta_{jl} \quad (641)$$


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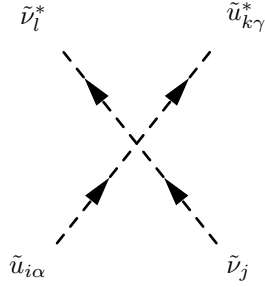
$$\frac{i}{2} \left( 2\lambda_U \lambda_D^* - \Lambda_U \Lambda_D^* \right) \left( Z_{j1}^+ Z_{k2}^+ + Z_{j2}^+ Z_{k1}^+ \right) \quad (642)$$



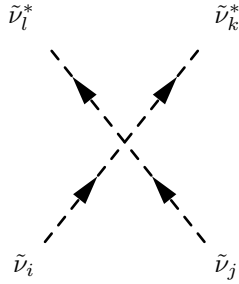
$$\begin{aligned} & - \frac{i}{72} \left( \delta_{\alpha\delta} \delta_{\beta\gamma} \left( g_1^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U + 9g_2^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U \right. \right. \\ & - 6g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U \\ & + 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U \\ & + 18g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( - \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{k3+b}^U + \sum_{b=1}^3 Z_{ib}^{U,*} Z_{kb}^U \right) \\ & - 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \left( - \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{k3+b}^U + \sum_{b=1}^3 Z_{ib}^{U,*} Z_{kb}^U \right) \\ & - 4g_1^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U + 6g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U \\ & \left. + 16g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U - 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U \right) \end{aligned}$$

$$\begin{aligned}
& + 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. \\
& + \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
\end{aligned}$$

$$\begin{aligned}
& -6g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& + 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 18g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U \\
& + 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U - 4g_1^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& + 6g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U + 16g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& - 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& + 72 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{u,cd} Z_{i3+c}^{U,*} Z_{kd}^U \\
& + 72 \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{u,cd} Z_{j3+c}^{U,*} Z_{ld}^U \Big) \tag{643}
\end{aligned}$$



$$\frac{i}{12} \delta_{\alpha\gamma} \delta_{jl} \left( \left( -3g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \right) \tag{644}$$

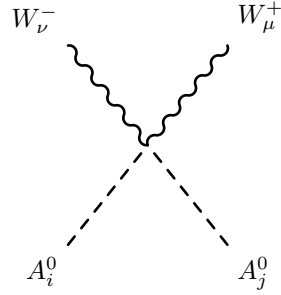




$$-\frac{i}{4}(g_1^2 + g_2^2)(\delta_{ik}\delta_{jl} + \delta_{il}\delta_{jk}) \quad (645)$$

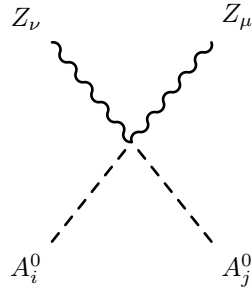

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## 9.8 Two Scalar-Two Vector Boson-Interaction



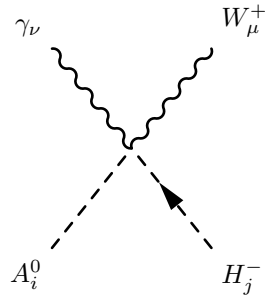
$$\frac{i}{2}g_2^2(4Z_{i4}^AZ_{j4}^A + Z_{i1}^AZ_{j1}^A + Z_{i2}^AZ_{j2}^A)(g_{\mu\nu}) \quad (646)$$


---



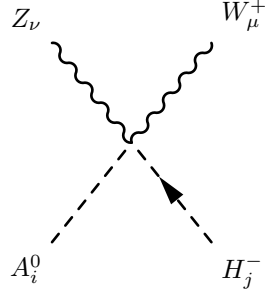
$$\frac{i}{2}(g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2(Z_{i1}^AZ_{j1}^A + Z_{i2}^AZ_{j2}^A)(g_{\mu\nu}) \quad (647)$$


---



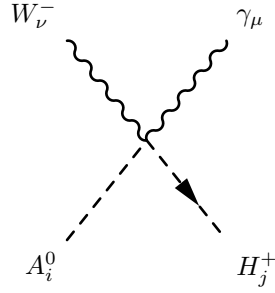
$$-\frac{1}{2}g_2(g_1 \cos \Theta_W Z_{i1}^AZ_{j1}^+ + g_1 \cos \Theta_W Z_{i2}^AZ_{j2}^+ + \sqrt{2}g_2 \sin \Theta_W Z_{i4}^A(-Z_{j4}^+ + Z_{j3}^+))(g_{\mu\nu}) \quad (648)$$


---



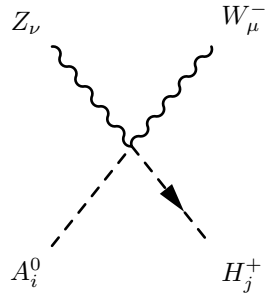
$$\frac{1}{2}g_2 \left( g_1 \sin \Theta_W Z_{i1}^A Z_{j1}^+ + g_1 \sin \Theta_W Z_{i2}^A Z_{j2}^+ + \sqrt{2}g_2 \cos \Theta_W Z_{i4}^A (-Z_{j3}^+ + Z_{j4}^+) \right) (g_{\mu\nu}) \quad (649)$$


---



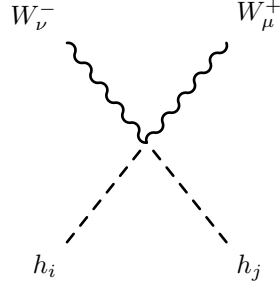
$$\frac{1}{2}g_2 \left( g_1 \cos \Theta_W Z_{i1}^A Z_{j1}^+ + g_1 \cos \Theta_W Z_{i2}^A Z_{j2}^+ + \sqrt{2}g_2 \sin \Theta_W Z_{i4}^A (-Z_{j4}^+ + Z_{j3}^+) \right) (g_{\mu\nu}) \quad (650)$$


---



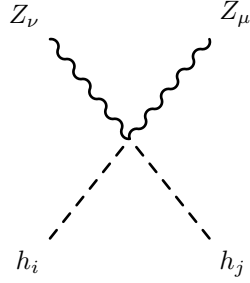
$$\frac{1}{2}g_2 \left( -g_1 \sin \Theta_W Z_{i1}^A Z_{j1}^+ - g_1 \sin \Theta_W Z_{i2}^A Z_{j2}^+ + \sqrt{2}g_2 \cos \Theta_W Z_{i4}^A (-Z_{j4}^+ + Z_{j3}^+) \right) (g_{\mu\nu}) \quad (651)$$


---



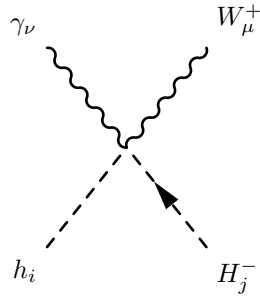
$$\frac{i}{2}g_2^2\left(4Z_{i4}^HZ_{j4}^H+Z_{i1}^HZ_{j1}^H+Z_{i2}^HZ_{j2}^H\right)\left(g_{\mu\nu}\right) \quad (652)$$


---



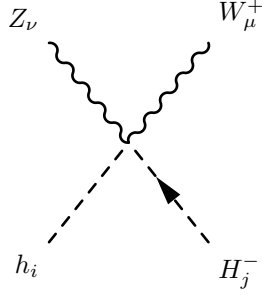
$$\frac{i}{2}\left(g_1\sin\Theta_W+g_2\cos\Theta_W\right)^2\left(Z_{i1}^HZ_{j1}^H+Z_{i2}^HZ_{j2}^H\right)\left(g_{\mu\nu}\right) \quad (653)$$


---



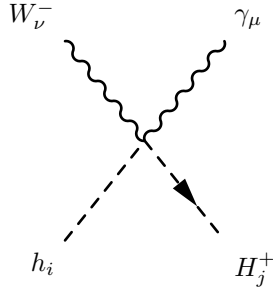
$$-\frac{i}{2}g_2\left(g_1\cos\Theta_W Z_{i1}^H Z_{j1}^+-g_1\cos\Theta_W Z_{i2}^H Z_{j2}^++\sqrt{2}g_2\sin\Theta_W Z_{i4}^H\left(Z_{j3}^++Z_{j4}^+\right)\right)\left(g_{\mu\nu}\right) \quad (654)$$


---



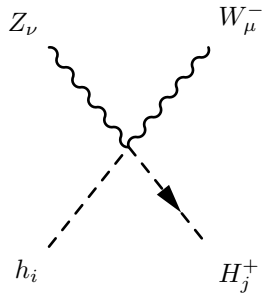
$$-\frac{i}{2}g_2\left(-g_1\sin\Theta_W Z_{i1}^H Z_{j1}^+ + g_1\sin\Theta_W Z_{i2}^H Z_{j2}^+ + \sqrt{2}g_2\cos\Theta_W Z_{i4}^H(Z_{j3}^+ + Z_{j4}^+)\right)(g_{\mu\nu}) \quad (655)$$


---



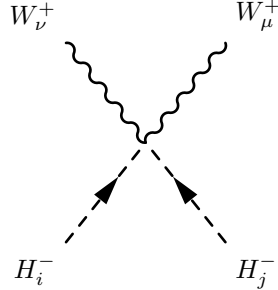
$$-\frac{i}{2}g_2\left(g_1\cos\Theta_W Z_{i1}^H Z_{j1}^+ - g_1\cos\Theta_W Z_{i2}^H Z_{j2}^+ + \sqrt{2}g_2\sin\Theta_W Z_{i4}^H(Z_{j3}^+ + Z_{j4}^+)\right)(g_{\mu\nu}) \quad (656)$$


---



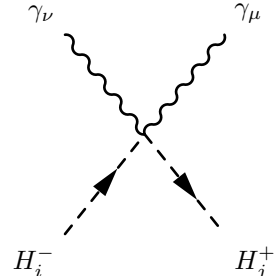
$$-\frac{i}{2}g_2\left(-g_1\sin\Theta_W Z_{i1}^H Z_{j1}^+ + g_1\sin\Theta_W Z_{i2}^H Z_{j2}^+ + \sqrt{2}g_2\cos\Theta_W Z_{i4}^H(Z_{j3}^+ + Z_{j4}^+)\right)(g_{\mu\nu}) \quad (657)$$


---



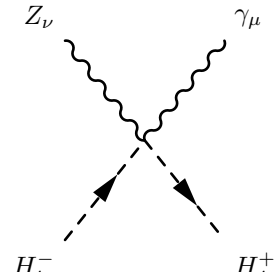
$$- 2ig_2^2 \left( Z_{i3}^+ Z_{j4}^+ + Z_{i4}^+ Z_{j3}^+ \right) (g_{\mu\nu}) \quad (658)$$


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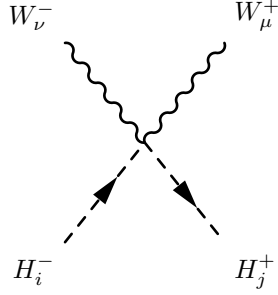
$$\frac{i}{2} \left( \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right)^2 Z_{i1}^+ Z_{j1}^+ + \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right)^2 Z_{i2}^+ Z_{j2}^+ \right. \\ \left. + 4g_2^2 \sin^2 \Theta_W \left( Z_{i3}^+ Z_{j3}^+ + Z_{i4}^+ Z_{j4}^+ \right) \right) (g_{\mu\nu}) \quad (659)$$


---



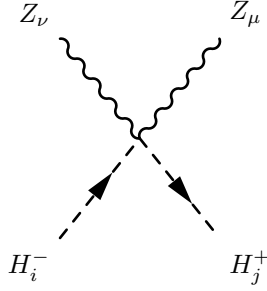
$$- \frac{i}{4} \left( \left( -2g_1 g_2 \cos 2\Theta_W + \left( -g_2^2 + g_1^2 \right) \sin 2\Theta_W \right) Z_{i1}^+ Z_{j1}^+ \right. \\ \left. + \left( -2g_1 g_2 \cos 2\Theta_W + \left( -g_2^2 + g_1^2 \right) \sin 2\Theta_W \right) Z_{i2}^+ Z_{j2}^+ \right. \\ \left. - 4g_2^2 \sin 2\Theta_W \left( Z_{i3}^+ Z_{j3}^+ + Z_{i4}^+ Z_{j4}^+ \right) \right) (g_{\mu\nu}) \quad (660)$$


---



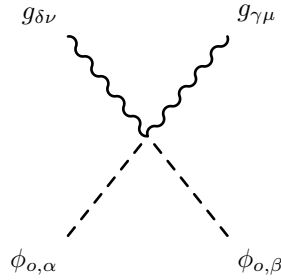
$$\frac{i}{2} g_2^2 \left( 2Z_{i3}^+ Z_{j3}^+ + 2Z_{i4}^+ Z_{j4}^+ + Z_{i1}^+ Z_{j1}^+ + Z_{i2}^+ Z_{j2}^+ \right) (g_{\mu\nu}) \quad (661)$$


---



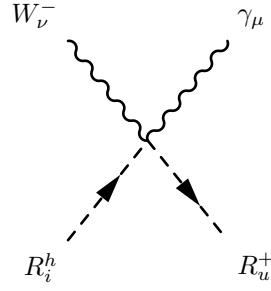
$$\begin{aligned} & \frac{i}{2} \left( \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right)^2 Z_{i1}^+ Z_{j1}^+ + \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right)^2 Z_{i2}^+ Z_{j2}^+ \right. \\ & \left. + 4g_2^2 \cos^2 \Theta_W \left( Z_{i3}^+ Z_{j3}^+ + Z_{i4}^+ Z_{j4}^+ \right) \right) (g_{\mu\nu}) \quad (662) \end{aligned}$$


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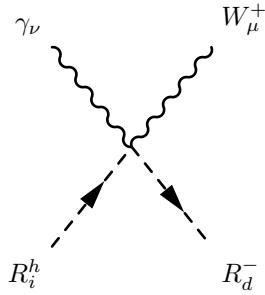
$$i g_3^2 \left( \sum_{a=1}^8 f_{\alpha,\delta,a} f_{\beta,\gamma,a} + \sum_{a=1}^8 f_{\alpha,\gamma,a} f_{\beta,\delta,a} \right) (g_{\mu\nu}) \quad (663)$$


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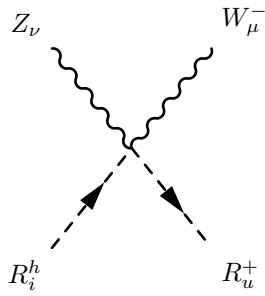
$$-i \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W Z_{i2}^R (g_{\mu\nu}) \quad (664)$$


---



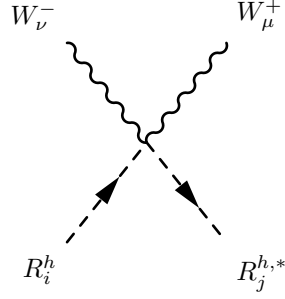
$$i \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W Z_{i1}^R (g_{\mu\nu}) \quad (665)$$


---



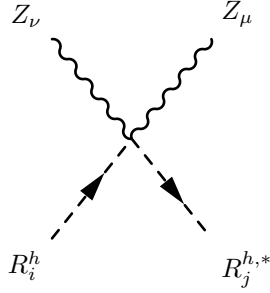
$$i \frac{1}{\sqrt{2}} g_1 g_2 \sin \Theta_W Z_{i2}^R (g_{\mu\nu}) \quad (666)$$


---



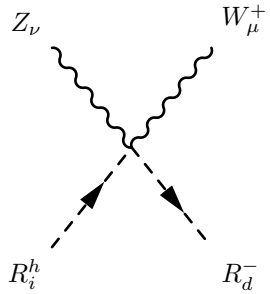
$$\frac{i}{2}g_2^2 \left( Z_{i1}^R Z_{j1}^R + Z_{i2}^R Z_{j2}^R \right) (g_{\mu\nu}) \quad (667)$$


---



$$\frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right)^2 \left( Z_{i1}^R Z_{j1}^R + Z_{i2}^R Z_{j2}^R \right) (g_{\mu\nu}) \quad (668)$$

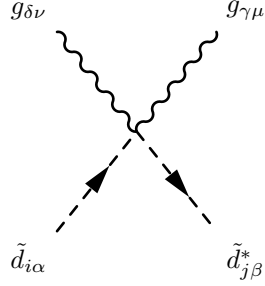

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$$-i \frac{1}{\sqrt{2}} g_1 g_2 \sin \Theta_W Z_{i1}^R (g_{\mu\nu}) \quad (669)$$

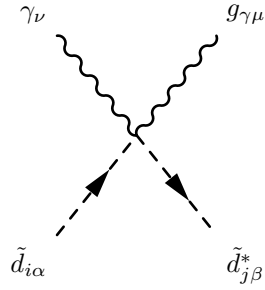

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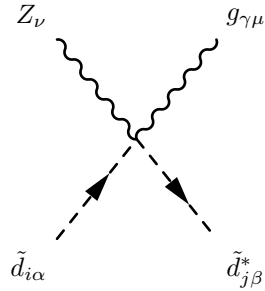
$$\frac{i}{4} g_3^2 \delta_{ij} \left( \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta + \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta \right) (g_{\mu\nu}) \quad (670)$$


---



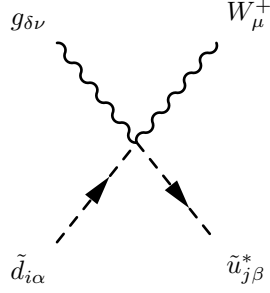
$$\frac{i}{6} g_3 \lambda_{\beta,\alpha}^\gamma \left( -2g_1 \cos \Theta_W \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{j3+a}^D + \left( -3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D \right) (g_{\mu\nu}) \quad (671)$$


---



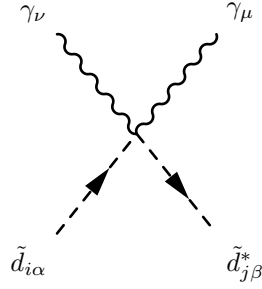
$$-\frac{i}{6} g_3 \lambda_{\beta,\alpha}^\gamma \left( -2g_1 \sin \Theta_W \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{j3+a}^D + \left( 3g_2 \cos \Theta_W + g_1 \sin \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D \right) (g_{\mu\nu}) \quad (672)$$


---



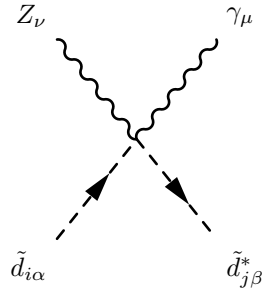
$$i \frac{1}{\sqrt{2}} g_2 g_3 \lambda_{\beta,\alpha}^{\delta} \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^U (g_{\mu\nu}) \quad (673)$$


---



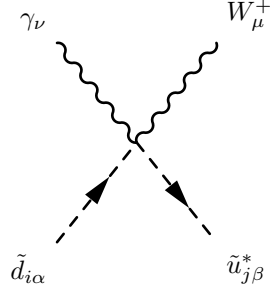
$$\frac{i}{18} \delta_{\alpha\beta} \left( (-3g_2 \sin \Theta_W + g_1 \cos \Theta_W)^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D + 4g_1^2 \cos^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{j3+a}^D \right) (g_{\mu\nu}) \quad (674)$$


---



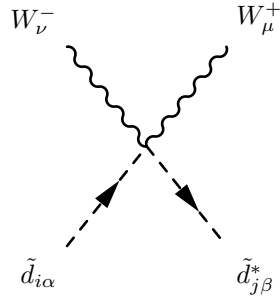
$$- \frac{i}{36} \delta_{\alpha\beta} \left( (6g_1 g_2 \cos 2\Theta_W + (-9g_2^2 + g_1^2) \sin 2\Theta_W) \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D + 4g_1^2 \sin 2\Theta_W \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{j3+a}^D \right) (g_{\mu\nu}) \quad (675)$$


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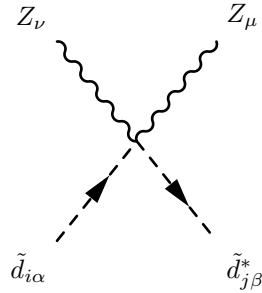
$$\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W \delta_{\alpha\beta} \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^U (g_{\mu\nu}) \quad (676)$$


---



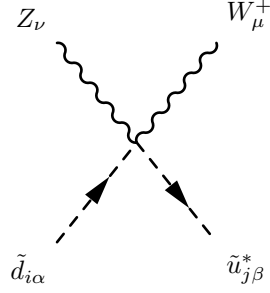
$$\frac{i}{2} g_2^2 \delta_{\alpha\beta} \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D (g_{\mu\nu}) \quad (677)$$


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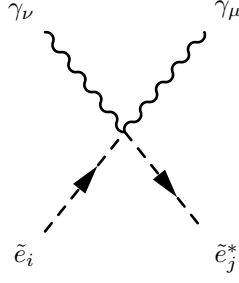
$$\frac{i}{18} \delta_{\alpha\beta} \left( (3g_2 \cos \Theta_W + g_1 \sin \Theta_W)^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D + 4g_1^2 \sin^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{j3+a}^D \right) (g_{\mu\nu}) \quad (678)$$


---



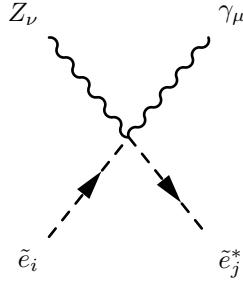
$$-\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 \delta_{\alpha\beta} \sin \Theta_W \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^U (g_{\mu\nu}) \quad (679)$$


---



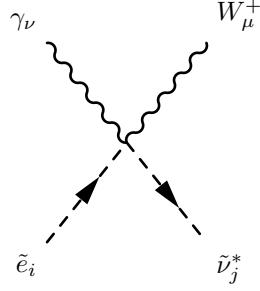
$$\frac{i}{2} \left( 4g_1^2 \cos^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E + (g_1 \cos \Theta_W + g_2 \sin \Theta_W)^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E \right) (g_{\mu\nu}) \quad (680)$$


---



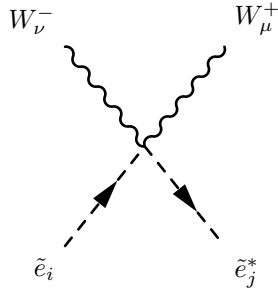
$$-\frac{i}{4} \left( (-2g_1 g_2 \cos 2\Theta_W + (-g_2^2 + g_1^2) \sin 2\Theta_W) \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E + 4g_1^2 \sin 2\Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E \right) (g_{\mu\nu}) \quad (681)$$


---



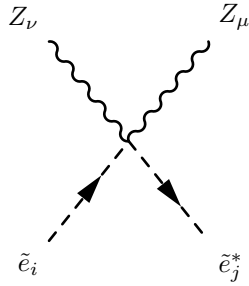
$$-i \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^V (g_{\mu\nu}) \quad (682)$$


---



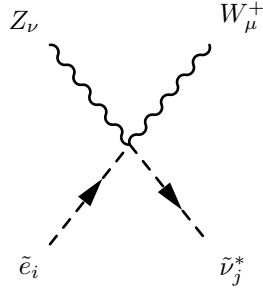
$$\frac{i}{2} g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E (g_{\mu\nu}) \quad (683)$$


---



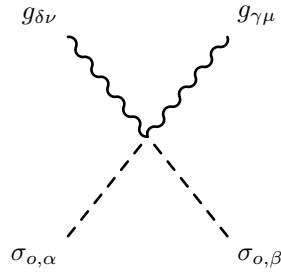
$$\frac{i}{2} \left( 4g_1^2 \sin^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E + \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right)^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E \right) (g_{\mu\nu}) \quad (684)$$


---



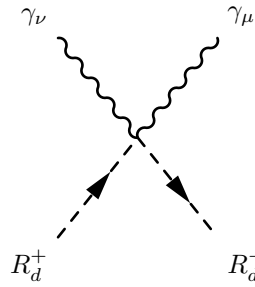
$$i \frac{1}{\sqrt{2}} g_1 g_2 \sin \Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^V (g_{\mu\nu}) \quad (685)$$


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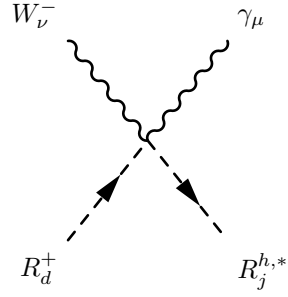
$$i g_3^2 \left( \sum_{a=1}^8 f_{\alpha,\delta,a} f_{\beta,\gamma,a} + \sum_{a=1}^8 f_{\alpha,\gamma,a} f_{\beta,\delta,a} \right) (g_{\mu\nu}) \quad (686)$$


---



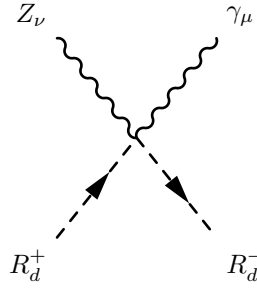
$$\frac{i}{2} (g_1 \cos \Theta_W + g_2 \sin \Theta_W)^2 (g_{\mu\nu}) \quad (687)$$


---



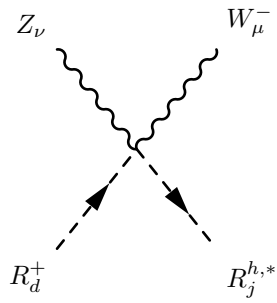
$$i \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W Z_{j1}^R (g_{\mu\nu}) \quad (688)$$


---



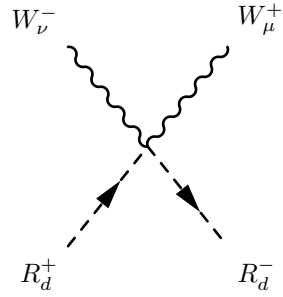
$$-\frac{i}{4} \left( -2g_1 g_2 \cos 2\Theta_W + (-g_2^2 + g_1^2) \sin 2\Theta_W \right) (g_{\mu\nu}) \quad (689)$$


---



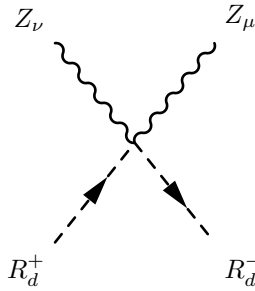
$$-i \frac{1}{\sqrt{2}} g_1 g_2 \sin \Theta_W Z_{j1}^R (g_{\mu\nu}) \quad (690)$$


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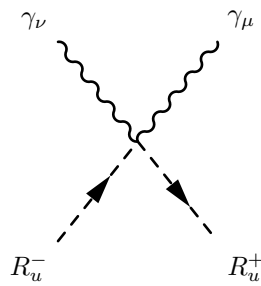
$$\frac{i}{2}g_2^2(g_{\mu\nu}) \tag{691}$$


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$$\frac{i}{2}\left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W\right)^2(g_{\mu\nu}) \tag{692}$$

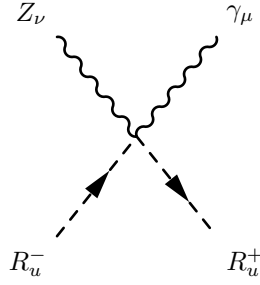

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$$\frac{i}{2}\left(g_1 \cos \Theta_W + g_2 \sin \Theta_W\right)^2(g_{\mu\nu}) \tag{693}$$

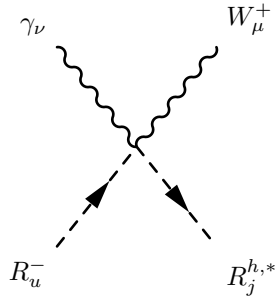

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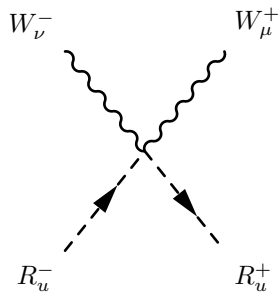
$$-\frac{i}{4} \left( -2g_1 g_2 \cos 2\Theta_W + (-g_2^2 + g_1^2) \sin 2\Theta_W \right) (g_{\mu\nu}) \quad (694)$$


---



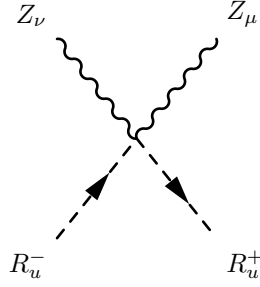
$$-i \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W Z_{j2}^R (g_{\mu\nu}) \quad (695)$$


---



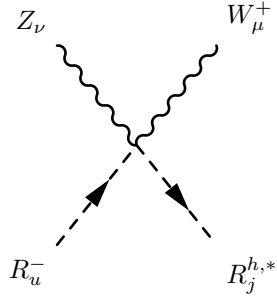
$$\frac{i}{2} g_2^2 (g_{\mu\nu}) \quad (696)$$


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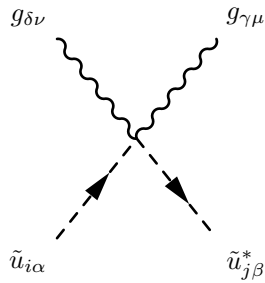
$$\frac{i}{2} \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right)^2 (g_{\mu\nu}) \quad (697)$$


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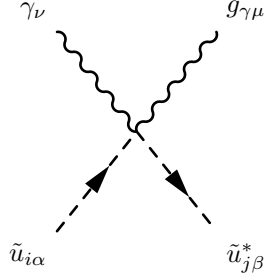
$$i \frac{1}{\sqrt{2}} g_1 g_2 \sin \Theta_W Z_{j2}^R (g_{\mu\nu}) \quad (698)$$


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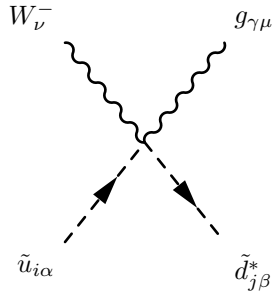
$$\frac{i}{4} g_3^2 \delta_{ij} \left( \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta + \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta \right) (g_{\mu\nu}) \quad (699)$$


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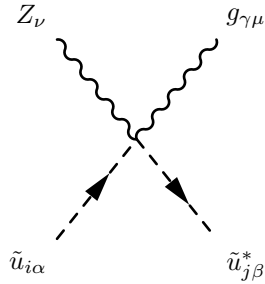
$$\frac{i}{6} g_3 \lambda_{\beta, \alpha}^{\gamma} \left( \left( 3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U + 4g_1 \cos \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U \right) (g_{\mu\nu}) \quad (700)$$


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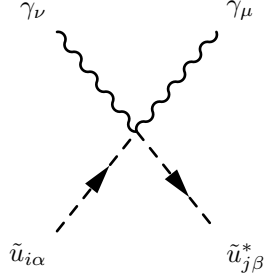
$$i \frac{1}{\sqrt{2}} g_2 g_3 \lambda_{\beta, \alpha}^{\gamma} \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^D (g_{\mu\nu}) \quad (701)$$


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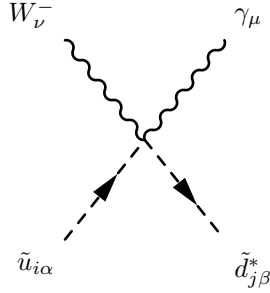
$$\frac{i}{6} g_3 \lambda_{\beta, \alpha}^{\gamma} \left( \left( 3g_2 \cos \Theta_W - g_1 \sin \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U - 4g_1 \sin \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U \right) (g_{\mu\nu}) \quad (702)$$


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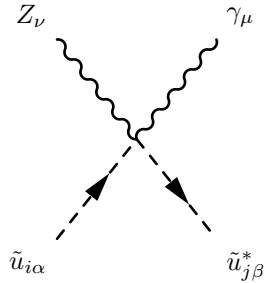
$$\frac{i}{18} \delta_{\alpha\beta} \left( 16g_1^2 \cos^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U + \left( 3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right)^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U \right) (g_{\mu\nu}) \quad (703)$$


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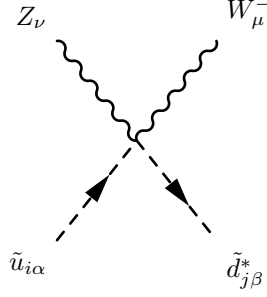
$$\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W \delta_{\alpha\beta} \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^D (g_{\mu\nu}) \quad (704)$$


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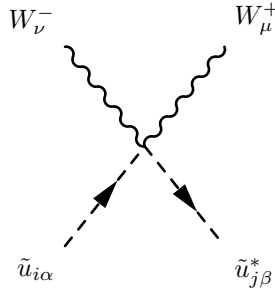
$$\begin{aligned} & - \frac{i}{36} \delta_{\alpha\beta} \left( -6g_1 g_2 \cos 2\Theta_W + \left( -9g_2^2 + g_1^2 \right) \sin 2\Theta_W \right) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U \\ & + 16g_1^2 \sin 2\Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U (g_{\mu\nu}) \end{aligned} \quad (705)$$


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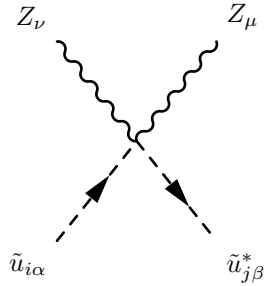
$$-\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 \delta_{\alpha\beta} \sin \Theta_W \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^D (g_{\mu\nu}) \quad (706)$$


---



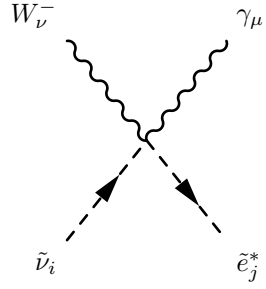
$$\frac{i}{2} g_2^2 \delta_{\alpha\beta} \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U (g_{\mu\nu}) \quad (707)$$


---



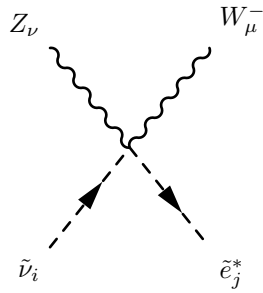
$$\frac{i}{18} \delta_{\alpha\beta} \left( 16g_1^2 \sin^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U + \left( -3g_2 \cos \Theta_W + g_1 \sin \Theta_W \right)^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U \right) (g_{\mu\nu}) \quad (708)$$


---



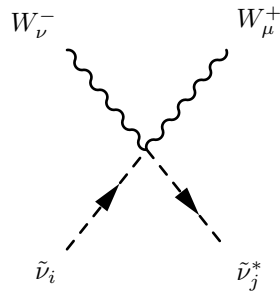
$$-i \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W \sum_{a=1}^3 Z_{ia}^{V,*} Z_{ja}^E (g_{\mu\nu}) \quad (709)$$


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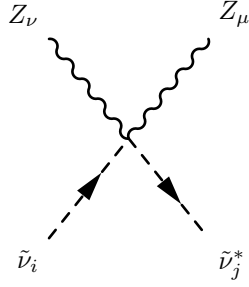
$$i \frac{1}{\sqrt{2}} g_1 g_2 \sin \Theta_W \sum_{a=1}^3 Z_{ia}^{V,*} Z_{ja}^E (g_{\mu\nu}) \quad (710)$$


---



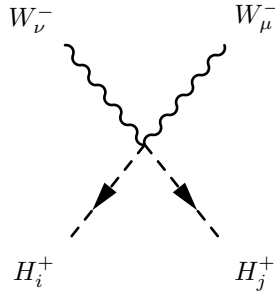
$$\frac{i}{2} g_2^2 \delta_{ij} (g_{\mu\nu}) \quad (711)$$


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$$\frac{i}{2} \delta_{ij} (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 (g_{\mu\nu}) \quad (712)$$

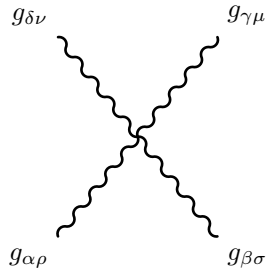

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$$-2ig_2^2 (Z_{i3}^+ Z_{j4}^+ + Z_{i4}^+ Z_{j3}^+) (g_{\mu\nu}) \quad (713)$$


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## 9.9 Four Vector Boson-Interaction

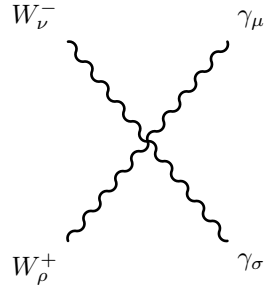


$$-ig_3^2 \left( \sum_{a=1}^8 f_{\alpha,\delta,a} f_{\beta,\gamma,a} + \sum_{a=1}^8 f_{\alpha,\gamma,a} f_{\beta,\delta,a} \right) (g_{\rho\sigma} g_{\mu\nu}) \quad (714)$$

$$+ ig_3^2 \left( - \sum_{a=1}^8 f_{\alpha,\beta,a} f_{\gamma,\delta,a} + \sum_{a=1}^8 f_{\alpha,\delta,a} f_{\beta,\gamma,a} \right) (g_{\rho\mu} g_{\sigma\nu}) \quad (715)$$

$$+ ig_3^2 \left( \sum_{a=1}^8 f_{\alpha,\gamma,a} f_{\beta,\delta,a} + \sum_{a=1}^8 f_{\alpha,\beta,a} f_{\gamma,\delta,a} \right) (g_{\rho\nu} g_{\sigma\mu}) \quad (716)$$


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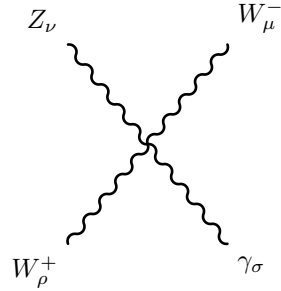


$$ig_2^2 \sin^2 \Theta_W (g_{\rho\sigma} g_{\mu\nu}) \quad (717)$$

$$+ ig_2^2 \sin^2 \Theta_W (g_{\rho\mu} g_{\sigma\nu}) \quad (718)$$

$$+ -2ig_2^2 \sin^2 \Theta_W (g_{\rho\nu} g_{\sigma\mu}) \quad (719)$$


---



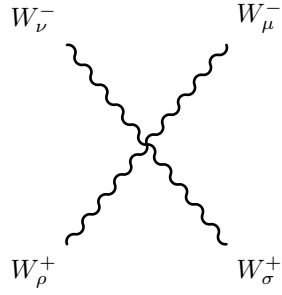
$$ig_2^2 \cos \Theta_W \sin \Theta_W (g_{\rho\sigma} g_{\mu\nu}) \quad (720)$$

$$+ -ig_2^2 \sin 2\Theta_W (g_{\rho\mu} g_{\sigma\nu}) \quad (721)$$

$$+ ig_2^2 \cos \Theta_W \sin \Theta_W (g_{\rho\nu} g_{\sigma\mu}) \quad (722)$$


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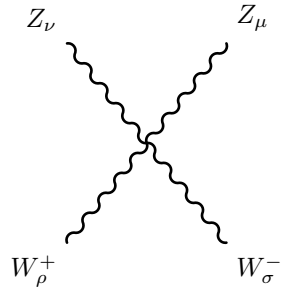




$$2ig_2^2(g_{\rho\sigma}g_{\mu\nu}) \quad (723)$$

$$+ -ig_2^2(g_{\rho\mu}g_{\sigma\nu}) \quad (724)$$

$$+ -ig_2^2(g_{\rho\nu}g_{\sigma\mu}) \quad (725)$$

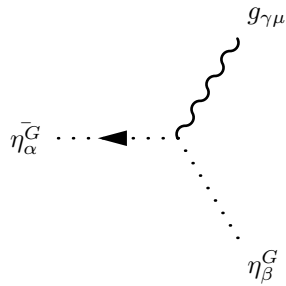


$$- 2ig_2^2 \cos^2 \Theta_W^2 (g_{\rho\sigma}g_{\mu\nu}) \quad (726)$$

$$+ ig_2^2 \cos^2 \Theta_W^2 (g_{\rho\mu}g_{\sigma\nu}) \quad (727)$$

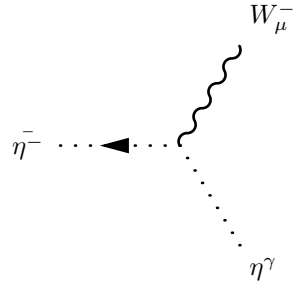
$$+ ig_2^2 \cos^2 \Theta_W^2 (g_{\rho\nu}g_{\sigma\mu}) \quad (728)$$

## 9.10 Two Ghosts-One Vector Boson-Interaction



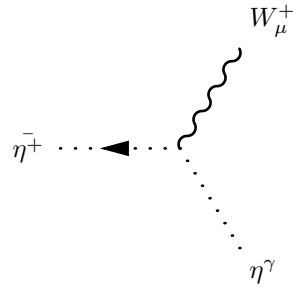
$$g_3 f_{\alpha,\beta,\gamma} \left( p_\mu^{\eta_\beta^G} \right) \quad (729)$$


---



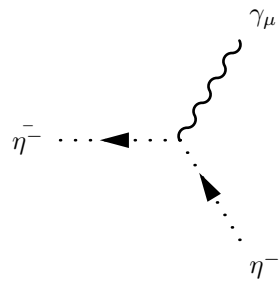
$$i g_2 \sin \Theta_W \left( p_\mu^{\eta^\gamma} \right) \quad (730)$$


---



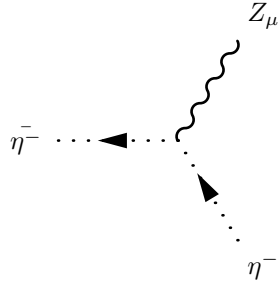
$$- i g_2 \sin \Theta_W \left( p_\mu^{\eta^\gamma} \right) \quad (731)$$


---



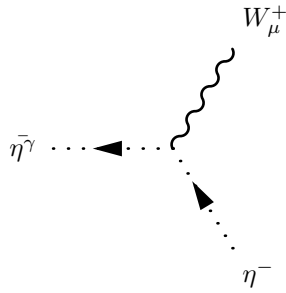
$$- i g_2 \sin \Theta_W \left( p_\mu^{\eta^-} \right) \quad (732)$$


---



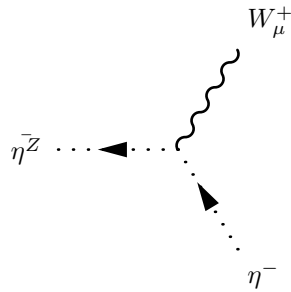
$$-ig_2 \cos \Theta_W (p_\mu^{\eta^-}) \quad (733)$$


---



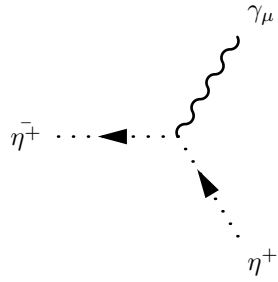
$$ig_2 \sin \Theta_W (p_\mu^{\eta^-}) \quad (734)$$


---



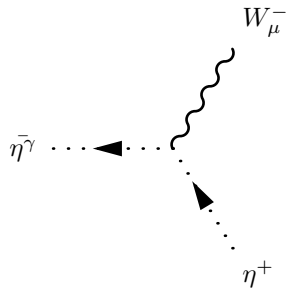
$$ig_2 \cos \Theta_W (p_\mu^{\eta^-}) \quad (735)$$


---



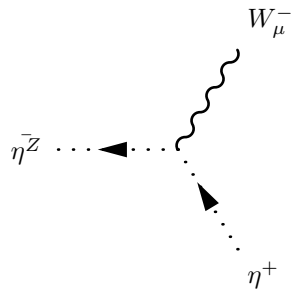
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$$ig_2 \sin \Theta_W (p_\mu^{\eta^+}) \quad (736)$$



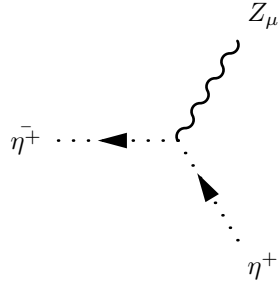
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$$-ig_2 \sin \Theta_W (p_\mu^{\eta^+}) \quad (737)$$



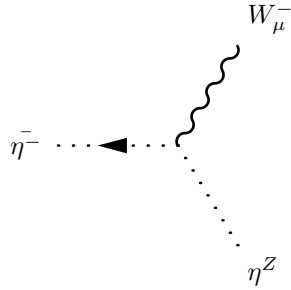
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$$-ig_2 \cos \Theta_W (p_\mu^{\eta^+}) \quad (738)$$



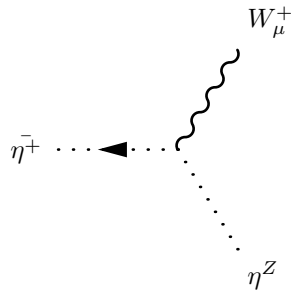
$$ig_2 \cos \Theta_W (p_\mu^{\eta^+}) \quad (739)$$


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$$ig_2 \cos \Theta_W (p_\mu^{\eta^Z}) \quad (740)$$

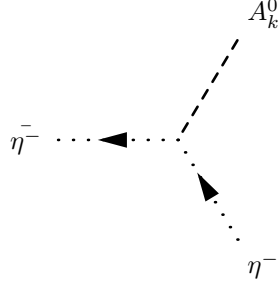

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$$-ig_2 \cos \Theta_W (p_\mu^{\eta^Z}) \quad (741)$$

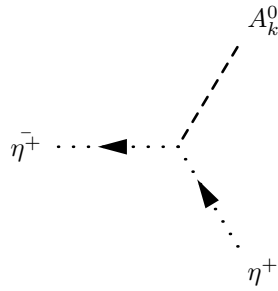

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### 9.11 Two Ghosts-One Scalar-Interaction



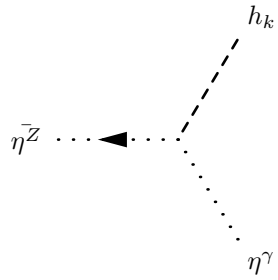
$$\frac{1}{4}g_2^2\xi_{W^-}\left(v_dZ_{k1}^A - v_uZ_{k2}^A\right) \quad (742)$$


---



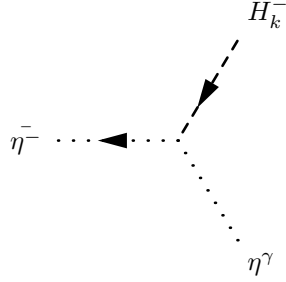
$$\frac{1}{4}g_2^2\xi_{W^-}\left(-v_dZ_{k1}^A + v_uZ_{k2}^A\right) \quad (743)$$


---



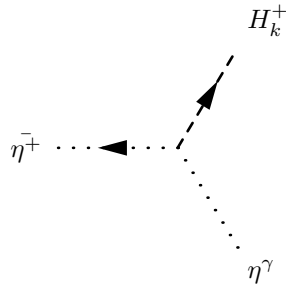
$$\frac{i}{8}\xi_Z\left(2g_1g_2\cos 2\Theta_W + \left(-g_2^2 + g_1^2\right)\sin 2\Theta_W\right)\left(v_dZ_{k1}^H + v_uZ_{k2}^H\right) \quad (744)$$


---



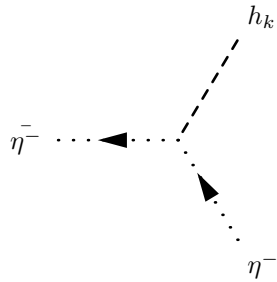
$$\begin{aligned} & \frac{i}{4} g_2 \xi_{W^-} \left( v_d \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) Z_{k1}^+ - v_u \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) Z_{k2}^+ \right. \\ & \left. + 2\sqrt{2} g_2 v_T \sin \Theta_W \left( Z_{k3}^+ + Z_{k4}^+ \right) \right) \end{aligned} \quad (745)$$


---



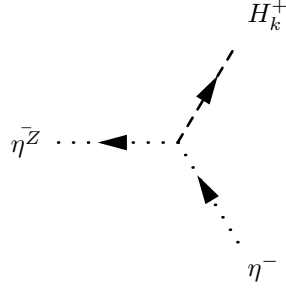
$$\begin{aligned} & \frac{i}{4} g_2 \xi_{W^-} \left( v_d \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) Z_{k1}^+ - v_u \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) Z_{k2}^+ \right. \\ & \left. + 2\sqrt{2} g_2 v_T \sin \Theta_W \left( Z_{k3}^+ + Z_{k4}^+ \right) \right) \end{aligned} \quad (746)$$


---



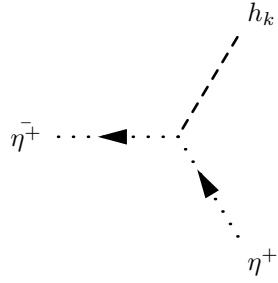
$$-\frac{i}{4} g_2^2 \xi_{W^-} \left( 4v_T Z_{k4}^H + v_d Z_{k1}^H + v_u Z_{k2}^H \right) \quad (747)$$


---



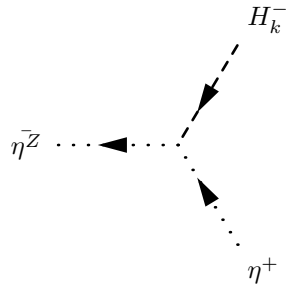
$$-\frac{i}{4}g_2\xi_Z(g_1\sin\Theta_W+g_2\cos\Theta_W)(v_dZ_{k1}^+-v_uZ_{k2}^+) \quad (748)$$


---



$$-\frac{i}{4}g_2^2\xi_{W^-}(4v_TZ_{k4}^H+v_dZ_{k1}^H+v_uZ_{k2}^H) \quad (749)$$

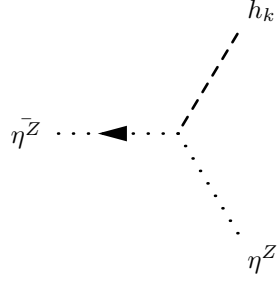

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$$-\frac{i}{4}g_2\xi_Z(g_1\sin\Theta_W+g_2\cos\Theta_W)(v_dZ_{k1}^+-v_uZ_{k2}^+) \quad (750)$$

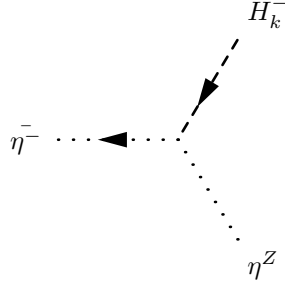

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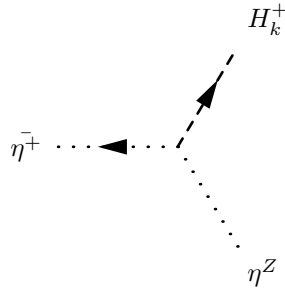
$$-\frac{i}{4}\xi_Z\left(g_1\sin\Theta_W+g_2\cos\Theta_W\right)^2\left(v_dZ_{k1}^H+v_uZ_{k2}^H\right) \quad (751)$$


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$$\begin{aligned} &\frac{i}{4}g_2\xi_{W^-}\left(v_d\left(-g_1\sin\Theta_W+g_2\cos\Theta_W\right)Z_{k1}^++\left(g_1v_u\sin\Theta_W-g_2v_u\cos\Theta_W\right)Z_{k2}^+ \right. \\ &\left.+2\sqrt{2}g_2v_T\cos\Theta_W\left(Z_{k3}^++Z_{k4}^+\right)\right) \quad (752) \end{aligned}$$


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$$\begin{aligned} &\frac{i}{4}g_2\xi_{W^+}\left(v_d\left(-g_1\sin\Theta_W+g_2\cos\Theta_W\right)Z_{k1}^++\left(g_1v_u\sin\Theta_W-g_2v_u\cos\Theta_W\right)Z_{k2}^+ \right. \\ &\left.+2\sqrt{2}g_2v_T\cos\Theta_W\left(Z_{k3}^++Z_{k4}^+\right)\right) \quad (753) \end{aligned}$$


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## 10 Clebsch-Gordan Coefficients

- : Gauge group:SU[2], Dynkin labels: (-2),(2)

$$K_{a,b}^{SU[2],-1 \times 3} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}_{ab} \quad (754)$$

- : Gauge group:SU[2], Dynkin labels: (1),(2),(1)

$$K_{1,a,b}^{SU[2],2 \times 3 \times 2} = \begin{pmatrix} 0 & 0 \\ 0 & \frac{1}{\sqrt{2}} \\ -1 & 0 \end{pmatrix}_{ab} \quad (755)$$

$$K_{2,a,b}^{SU[2],2 \times 3 \times 2} = \begin{pmatrix} 0 & -1 \\ \frac{1}{\sqrt{2}} & 0 \\ 0 & 0 \end{pmatrix}_{ab} \quad (756)$$

(757)