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

SARAH 4.2.2

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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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Contents

1 Superfields

1.1 Vector Superfields

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

1.2 Chiral Superfields

SF	Spin 0	Spin $\frac{1}{2}$	Generations	$(U(1) \otimes \mathrm{SU}(2) \otimes \mathrm{SU}(3) \otimes U(1))$
$\hat{q}$	$\tilde{q}$	q	3	$(\frac{1}{6}, \mathbf{2}, \mathbf{3}, 1)$
$\hat{l}$	$\tilde{l}$	l	3	$(-\frac{1}{2}, \mathbf{2}, \mathbf{1}, 2)$
$\hat{H}_d$	H_d	$\tilde{H}_d$	1	$(-\frac{1}{2}, \mathbf{2}, \mathbf{1}, -3)$
$\hat{H}_u$	H_u	$\tilde{H}_u$	1	$(\frac{1}{2}, \mathbf{2}, \mathbf{1}, -2)$
$\hat{d}$	$\tilde{d}_R^*$	d_R^*	3	$(\frac{1}{3}, \mathbf{1}, \overline{\mathbf{3}}, 2)$
$\hat{u}$	$\tilde{u}_R^*$	u_R^*	3	$(-\frac{2}{3}, \mathbf{1}, \overline{\mathbf{3}}, 1)$
$\hat{e}$	$\tilde{e}_R^*$	e_R^*	3	$(1, \mathbf{1}, \mathbf{1}, 1)$
$\hat{s}$	S	$\tilde{S}$	1	$(0, \mathbf{1}, \mathbf{1}, Q_S)$
$\mathrm{SF}\Big(\mathrm{sbar}\Big)$	$\bar{S}_R$	FsbarR	1	$(0, \mathbf{1}, \mathbf{1}, -Q_S)$
$\hat{Dx}$	$\tilde{Dx}_L$	FDxL	3	$(-\frac{1}{3}, \mathbf{1}, \mathbf{3}, -2)$
$\hat{\bar{Dx}}$	$\tilde{Dx}_R^*$	$\mathrm{conj}\Big(\mathrm{FDxbarR}\Big)$	3	$(\frac{1}{3}, \mathbf{1}, \overline{\mathbf{3}}, -3)$
$H\hat{P}R$	HPR	FHp	1	$(-\frac{1}{2}, \mathbf{2}, \mathbf{1}, 2)$
$H\hat{\bar{P}}R$	$H\bar{P}R$	FHpbar	1	$(\frac{1}{2}, \mathbf{2}, \mathbf{1}, -2)$
$\mathrm{SF}\Big(\phi\Big)$	ϕ_R	FphiR	1	$(0, \mathbf{1}, \mathbf{1}, 0)$

2 Superpotential and Lagrangian

2.1 Superpotential

$$W = X\,iF_1\,\mathrm{SF}\Big(\phi\Big) + \mu'\,H\hat{\bar{P}}R\,H\hat{P}R + \frac{1}{2}Mu_{phi}\,\mathrm{SF}\Big(\phi\Big)\,\mathrm{SF}\Big(\phi\Big) - Y_d\,\hat{d}\,\hat{q}\,\hat{H}_d - Y_e\,\hat{e}\,\hat{l}\,\hat{H}_d + \frac{1}{3}\kappa'\,\mathrm{SF}\Big(\phi\Big)\,\mathrm{SF}\Big(\phi\Big)\,\mathrm{SF}\Big(\phi\Big) - \sigma\,\mathrm{SF}\Big(\phi\Big)\,\hat{s}\,\mathrm{SF}\Big($$
$$+ \kappa\,\hat{s}\,\hat{Dx}\,\hat{\bar{Dx}} + \lambda\,\hat{s}\,\hat{H}_u\,\hat{H}_d + Y_u\,\hat{u}\,\hat{q}\,\hat{H}_u \qquad (1)$$

2.2 Softbreaking terms

$$
\begin{aligned}
-L_{SB,W} = &+ \frac{1}{2}\phi_R^2 B_{muphi} - H^{'0}\bar{H}^{'0}B_{\mu'} + H^{'-}\bar{H}^{'+}B_{\mu'} + \phi_R\xi_S + \frac{1}{3}\phi_R^3 T_{\kappa'} - H_d^0 H_u^0 ST_\lambda + H_d^- H_u^+ ST_\lambda - \phi_R \bar{S}_R ST_\sigma \\
&+ H_d^0 \tilde{d}^*_{R,i\alpha}\delta_{\alpha\beta}\delta_{ij}\tilde{d}_{L,j\beta}T_{d,ij} - H_d^- \tilde{d}^*_{R,i\alpha}\delta_{\alpha\beta}\delta_{ij}\tilde{u}_{L,j\beta}T_{d,ij} + H_d^0 \tilde{e}^*_{R,i}\delta_{ij}\tilde{e}_{L,j}T_{e,ij} \\
&- H_d^- \tilde{e}^*_{R,i}\delta_{ij}\tilde{\nu}_{L,j}T_{e,ij} - H_u^+ \tilde{u}^*_{R,i\alpha}\delta_{\alpha\beta}\delta_{ij}\tilde{d}_{L,j\beta}T_{u,ij} + H_u^0 \tilde{u}^*_{R,i\alpha}\delta_{\alpha\beta}\delta_{ij}\tilde{u}_{L,j\beta}T_{u,ij} \\
&+ S\tilde{Dx}^*_{R,k\gamma}\delta_{\beta\gamma}\delta_{jk}\tilde{Dx}_{L,j\beta}T_{\kappa,jk} + \text{h.c.} \qquad (2) \\
-L_{SB,\phi} = &+ m^2_{h_{13}}|H_d^0|^2 + m^2_{h_{13}}|H_d^-|^2 + m^2_{hPr}|H^{'0}|^2 + m^2_{hPr}|H^{'-}|^2 + m^2_{h\bar{P}r}|\bar{H}^{'0}|^2 + m^2_{h\bar{P}r!}|\bar{H}^{'+}|^2 + m^2_{h_{23}}|H_u^0|^2 \\
&+ m^2_{h_{23}}|H_u^+|^2 + m^2_{phi}|\phi_R|^2 + m^2_{sbar_3}|\bar{S}_R|^2 + m^2_{s_3}|S|^2 + \tilde{d}^*_{L,i\alpha}\delta_{\alpha\beta}m^2_{q,ij}\tilde{d}_{L,j\beta} + \tilde{d}^*_{R,i\alpha}\delta_{\alpha\beta}m^2_{d,ij}\tilde{d}_{R,j\beta} \\
&+ \tilde{Dx}^*_{R,i\alpha}\delta_{\alpha\beta}\delta_{ij}m^2_{\bar{X},ij}\tilde{Dx}_{R,j\beta} + \tilde{Dx}^*_{L,i\alpha}\delta_{\alpha\beta}\delta_{ij}m^2_{X,ij}\tilde{Dx}_{L,j\beta} + \tilde{e}^*_{L,i}m^2_{l,ij}\tilde{e}_{L,j} + \tilde{e}^*_{R,i}m^2_{e,ij}\tilde{e}_{R,j} \\
&+ \tilde{u}^*_{L,i\alpha}\delta_{\alpha\beta}m^2_{q,ij}\tilde{u}_{L,j\beta} + \tilde{u}^*_{R,i\alpha}\delta_{\alpha\beta}m^2_{u,ij}\tilde{u}_{R,j\beta} + \tilde{\nu}^*_{L,i}m^2_{l,ij}\tilde{\nu}_{L,j} \qquad (3) \\
-L_{SB,\lambda} = &\frac{1}{2}\Big(\lambda^2_{Bp}M_1' + \lambda^2_{\tilde{B}}M_1 + M_2\lambda^2_{\tilde{W},i} + M_3\lambda_{\tilde{g},\alpha}\lambda_{\tilde{g},\beta} + \text{h.c.}\Big) \qquad (4)
\end{aligned}
$$

2.3 Gauge fixing terms

2.3.1 Gauge fixing terms for eigenstates 'GaugeES'

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

2.3.2 Gauge fixing terms for eigenstates 'EWSB'

$$
\begin{aligned}
L_{GF} = &-\frac{1}{2}|\partial_\mu g|^2\xi_g^{-1} - \frac{1}{2}|\partial_\mu \gamma|^2\xi_\gamma^{-1} - |\,-\frac{i}{2}g_2\Big(H_d^- v_1 - v_2 H_u^{+,*}\Big)\xi_{W^-} + \partial_\mu W^-|^2\xi_{W^-}^{-1} \\
&- \frac{1}{2}|\frac{1}{2}\Big(2\partial_\mu Z \\
&+ \xi_Z\Big(g_2\Big(\sigma_d v_1 - \sigma_u v_2\Big)\cos\Theta_W\cos\Theta'_W + g_1\Big(\sigma_d v_1 - \sigma_u v_2\Big)\cos\Theta'_W\sin\Theta_W \\
&- 2g_1'\Big(2\sigma_u v_2 + 3\sigma_d v_1 - Q_S\sigma_s v_s + Q_S\text{sigmaSbar}vsb\Big)\sin\Theta'_W\Big)\Big)|^2\xi_Z^{-1} \\
&- \frac{1}{2}|\frac{1}{2}\Big(2\partial_\mu Z' \\
&- \xi_{Z'}\Big(2g_1'\Big(2\sigma_u v_2 + 3\sigma_d v_1 - Q_S\sigma_s v_s + Q_S\text{sigmaSbar}vsb\Big)\cos\Theta'_W \\
&+ \Big(\sigma_d v_1 - \sigma_u v_2\Big)\Big(g_1\sin\Theta_W + g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)\Big)|^2\xi_{Z'}^{-1} \qquad (6)
\end{aligned}
$$

2.4 Fields integrated out

None

3 Renormalization Group Equations

3.1 Anomalous Dimensions

$$\gamma_{\hat{q}}^{(1)} = -\frac{1}{60}\Big(160g_3^2 + 2g_1^2 + 3g_{1'}^2 + 90g_2^2\Big)\mathbf{1} + Y_d^\dagger Y_d + Y_u^\dagger Y_u \tag{7}$$

$$\begin{aligned}\gamma_{\hat{q}}^{(2)} = &+\frac{1}{7200}\Big(2024g_1^4 - 8g_1^2\Big(-160g_3^2 + 51g_{1'}^2 - 90g_2^2\Big) + 120g_{1'}^2\Big(16g_3^2 + 9g_2^2\Big) + 200\Big(189g_2^4 + 256g_3^4 + 288g_2^2g_3^2\Big)\\ &+ 9g_{1'}^4\Big(2Q_S^2 + 251\Big)\Big)\mathbf{1}\\ &+ \frac{1}{5}\Big(-10\Big(Y_d^\dagger Y_d Y_d^\dagger Y_d + Y_u^\dagger Y_u Y_u^\dagger Y_u\Big) + Y_d^\dagger Y_d\Big(-15\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 2g_1^2 + 3g_{1'}^2 - 5|\lambda|^2 - 5\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big)\Big)\\ &+ Y_u^\dagger Y_u\Big(-15\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) + 4g_1^2 - 5|\lambda|^2 + g_{1'}^2\Big)\Big)\end{aligned} \tag{8}$$

$$\gamma_{\hat{l}}^{(1)} = -\frac{1}{10}\Big(15g_2^2 + 2g_{1'}^2 + 3g_1^2\Big)\mathbf{1} + Y_e^\dagger Y_e \tag{9}$$

$$\begin{aligned}\gamma_{\hat{l}}^{(2)} = &\frac{1}{200}\Big(\Big(1050g_2^4 + 120g_{1'}^2g_2^2 + 12g_1^2\Big(15g_2^2 + 8g_{1'}^2\Big) + 522g_1^4 + g_{1'}^4\Big(2Q_S^2 + 257\Big)\Big)\mathbf{1}\\ &+ 20\Big(-20Y_e^\dagger Y_e Y_e^\dagger Y_e + Y_e^\dagger Y_e\Big(-10|\lambda|^2 - 10\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + 12g_1^2 - 30\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 3g_{1'}^2\Big)\Big)\Big)\end{aligned} \tag{10}$$

$$\gamma_{\hat{H}_d}^{(1)} = 3\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - \frac{3}{10}g_1^2 - \frac{3}{2}g_2^2 - \frac{9}{20}g_{1'}^2 + |\lambda|^2 + \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) \tag{11}$$

$$\begin{aligned}\gamma_{\hat{H}_d}^{(2)} = &-3\lambda^2\lambda^{*,2} + \frac{1}{20}|\lambda|^2\Big(-20\sigma\sigma'^{,*} - 5g_{1'}^2 - 60\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 60\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) + g_{1'}^2Q_S^2\Big)\\ &+ \frac{1}{800}\Big(-160\Big(2g_1^2 + 3g_{1'}^2 - 80g_3^2\Big)\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 160\Big(6g_1^2 - g_{1'}^2\Big)\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big)\\ &+ 3\Big(696g_1^4 - 72g_1^2g_{1'}^2 + 801g_{1'}^4 + 240g_1^2g_2^2 + 360g_{1'}^2g_2^2 + 1400g_2^4 + 6g_{1'}^4Q_S^2 - 2400\mathrm{Tr}\Big(Y_d Y_d^\dagger Y_d Y_d^\dagger\Big)\\ &- 800\mathrm{Tr}\Big(Y_d Y_u^\dagger Y_u Y_d^\dagger\Big) - 800\mathrm{Tr}\Big(Y_e Y_e^\dagger Y_e Y_e^\dagger\Big)\Big)\Big)\end{aligned} \tag{12}$$

$$\gamma_{\hat{H}_u}^{(1)} = 3\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) - \frac{1}{5}g_{1'}^2 - \frac{3}{10}g_1^2 - \frac{3}{2}g_2^2 + |\lambda|^2 \tag{13}$$

$$\begin{aligned}\gamma_{\hat{H}_u}^{(2)} = &\frac{1}{200}\Big(522g_1^4 + 96g_1^2g_{1'}^2 + 257g_{1'}^4 + 180g_1^2g_2^2 + 120g_{1'}^2g_2^2 + 1050g_2^4 + 2g_{1'}^4Q_S^2 - 600\lambda^2\lambda^{*,2}\\ &+ 20\Big(160g_3^2 - 3g_{1'}^2 + 8g_1^2\Big)\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big)\\ &+ 10|\lambda|^2\Big(-20\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 20\sigma\sigma'^{,*} + 5g_{1'}^2 - 60\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 60\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + g_{1'}^2Q_S^2\Big)\\ &- 600\mathrm{Tr}\Big(Y_d Y_u^\dagger Y_u Y_d^\dagger\Big) - 1800\mathrm{Tr}\Big(Y_u Y_u^\dagger Y_u Y_u^\dagger\Big)\Big)\end{aligned} \tag{14}$$

$$\gamma_{\hat{d}}^{(1)} = \frac{1}{15}\Big(-\Big(2g_1^2 + 3g_{1'}^2 + 40g_3^2\Big)\mathbf{1} + 30Y_d^* Y_d^T\Big) \tag{15}$$

$$\begin{aligned}\gamma_{\hat{d}}^{(2)} = &+\frac{1}{1800}\Big(12800g_3^4 - 16g_1^2\Big(21g_{1'}^2 - 80g_3^2\Big) + 1920g_{1'}^2g_3^2 + 2048g_1^4 + 9g_{1'}^4\Big(2Q_S^2 + 257\Big)\Big)\mathbf{1}\\ &- 2\Big(Y_d^* Y_d^T Y_d^* Y_d^T + Y_d^* Y_u^T Y_u^* Y_d^T\Big)\\ &+ Y_d^* Y_d^T\Big(-2|\lambda|^2 - 2\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + 6g_2^2 - 6\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + \frac{2}{5}g_1^2 + \frac{3}{5}g_{1'}^2\Big)\end{aligned} \tag{16}$$

$$\gamma^{(1)}_{\hat{u}} = 2Y_u^* Y_u^T - \frac{1}{60}\Big(160g_3^2 + 32g_1^2 + 3g_{1'}^2\Big)\mathbf{1} \tag{17}$$

$$\begin{aligned}\gamma^{(2)}_{\hat{u}} = &+\frac{1}{7200}\Big(1920g_{1'}^2 g_3^2 + 34304g_1^4 + 51200g_3^4 + 64g_1^2\Big(320g_3^2 + 33g_{1'}^2\Big) + 9g_{1'}^4\Big(2Q_S^2 + 251\Big)\Big)\mathbf{1}\\ &- \frac{2}{5}\Big(5\Big(Y_u^* Y_d^T Y_d^* Y_u^T + Y_u^* Y_u^T Y_u^* Y_u^T\Big) + Y_u^* Y_u^T\Big(-15g_2^2 + 15\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) + 5|\lambda|^2 - g_{1'}^2 + g_1^2\Big)\Big)\end{aligned} \tag{18}$$

$$\gamma^{(1)}_{\hat{e}} = 2Y_e^* Y_e^T - \frac{1}{20}\Big(24g_1^2 + g_{1'}^2\Big)\mathbf{1} \tag{19}$$

$$\begin{aligned}\gamma^{(2)}_{\hat{e}} = &+\frac{1}{800}\Big(-192g_1^2 g_{1'}^2 + 9216g_1^4 + g_{1'}^4\Big(2Q_S^2 + 251\Big)\Big)\mathbf{1}\\ &- \frac{2}{5}\Big(5Y_e^* Y_e^T Y_e^* Y_e^T + Y_e^* Y_e^T\Big(-15g_2^2 + 15\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 3g_{1'}^2 + 3g_1^2 + 5|\lambda|^2 + 5\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big)\Big)\Big)\end{aligned} \tag{20}$$

$$\gamma^{(1)}_{\hat{s}} = 2|\lambda|^2 + 3\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - \frac{1}{20}g_{1'}^2 Q_S^2 + |\sigma|^2 \tag{21}$$

$$\begin{aligned}\gamma^{(2)}_{\hat{s}} = &+\frac{249}{800}g_{1'}^4 Q_S^2 + \frac{1}{200}g_{1'}^4 Q_S^4 - 4\lambda^2\lambda^{*,2} - 2\sigma|\kappa'|^2\sigma'^{,*} - 2\sigma^2\sigma'^{,*,2}\\ &+ \frac{1}{10}|\lambda|^2\Big(12g_1^2 + 13g_{1'}^2 - 20\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + 60g_2^2 - 60\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 60\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) - g_{1'}^2 Q_S^2\Big)\\ &+ \frac{4}{5}g_1^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + \frac{39}{20}g_{1'}^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 16g_3^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - \frac{3}{20}g_{1'}^2 Q_S^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 6\mathrm{Tr}\Big(\kappa\kappa^\dagger\kappa\kappa^\dagger\Big)\end{aligned} \tag{22}$$

$$\gamma^{(1)}_{\mathrm{SF}\left(\mathrm{sbar}\right)} = -\frac{1}{20}g_{1'}^2 Q_S^2 + |\sigma|^2 \tag{23}$$

$$\gamma^{(2)}_{\mathrm{SF}\left(\mathrm{sbar}\right)} = -2\sigma^2\sigma'^{,*,2} - 2\sigma|\kappa'|^2\sigma'^{,*} - 2\sigma|\lambda|^2\sigma'^{,*} - 3|\sigma|^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + \frac{1}{200}g_{1'}^4 Q_S^4 + \frac{249}{800}g_{1'}^4 Q_S^2 \tag{24}$$

$$\gamma^{(1)}_{\hat{D}x} = -\frac{1}{15}\Big(2g_1^2 + 3g_{1'}^2 + 40g_3^2\Big)\mathbf{1} + \kappa^*\kappa^T \tag{25}$$

$$\begin{aligned}\gamma^{(2)}_{\hat{D}x} = &+\frac{1}{1800}\Big(12800g_3^4 - 16g_1^2\Big(21g_{1'}^2 - 80g_3^2\Big) + 1920g_{1'}^2 g_3^2 + 2048g_1^4 + 9g_{1'}^4\Big(2Q_S^2 + 257\Big)\Big)\mathbf{1} - \kappa^*\kappa^T\kappa^*\kappa^T\\ &+ \kappa^*\kappa^T\Big(-2|\lambda|^2 - 3\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + \frac{1}{20}g_{1'}^2 Q_S^2 + \frac{1}{4}g_{1'}^2 - |\sigma|^2\Big)\end{aligned} \tag{26}$$

$$\gamma^{(1)}_{\hat{D}\hat{x}} = -\frac{1}{60}\Big(160g_3^2 + 27g_{1'}^2 + 8g_1^2\Big)\mathbf{1} + \kappa^\dagger\kappa \tag{27}$$

$$\begin{aligned}\gamma^{(2)}_{\hat{D}\hat{x}} = &+\frac{1}{7200}\Big(128g_1^2\Big(27g_{1'}^2 + 40g_3^2\Big) + 17280g_{1'}^2 g_3^2 + 51200g_3^4 + 8192g_1^4 + 81g_{1'}^4\Big(2Q_S^2 + 267\Big)\Big)\mathbf{1} - \kappa^\dagger\kappa\kappa^\dagger\kappa\\ &+ \kappa^\dagger\kappa\Big(-2|\lambda|^2 - 3\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + \frac{1}{20}g_{1'}^2 Q_S^2 - \frac{1}{4}g_{1'}^2 - |\sigma|^2\Big)\end{aligned} \tag{28}$$

$$\gamma^{(1)}_{H\hat{P}R} = \frac{1}{10}\Big(-15g_2^2 - 2g_{1'}^2 - 3g_1^2\Big) \tag{29}$$

$$\gamma^{(2)}_{H\hat{P}R} = \frac{1}{200}\Big(1050g_2^4 + 120g_{1'}^2 g_2^2 + 12g_1^2\Big(15g_2^2 + 8g_{1'}^2\Big) + 522g_1^4 + g_{1'}^4\Big(2Q_S^2 + 257\Big)\Big) \tag{30}$$

$$\gamma^{(1)}_{H\hat{\hat{P}}R} = \frac{1}{10}\Big(-15g_2^2 - 2g_{1'}^2 - 3g_1^2\Big) \tag{31}$$

$$\gamma^{(2)}_{H\hat{\hat{P}}R} = \frac{1}{200}\Big(1050g_2^4 + 120g_{1'}^2 g_2^2 + 12g_1^2\Big(15g_2^2 + 8g_{1'}^2\Big) + 522g_1^4 + g_{1'}^4\Big(2Q_S^2 + 257\Big)\Big) \tag{32}$$

$$\gamma^{(1)}_{\mathrm{SF}\left(\phi\right)} = 2|\kappa'|^2 + |\sigma|^2 \tag{33}$$

$$\gamma^{(2)}_{\mathrm{SF}\left(\phi\right)} = -4\sigma|\kappa'|^2\sigma'^{,*} - 8\kappa'^{,2}\kappa'^{,*,2} - \frac{1}{10}|\sigma|^2\Big(20\lambda\lambda^* + 20\sigma\sigma'^{,*} + 30\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - g_{1'}^2 Q_S^2\Big) \tag{34}$$

3.2 Gauge Couplings

$$\beta^{(1)}_{g_1} = \frac{42}{5}g_1^3 \tag{35}$$

$$\beta^{(2)}_{g_1} = \frac{1}{50}g_1^3\Big(432g_1^2 + 123g_{1'}^2 + 360g_2^2 + 1200g_3^2 - 60|\lambda|^2 - 140\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 180\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) - 260\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - 40\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)\Big) \tag{36}$$

$$\beta^{(1)}_{g_2} = 2g_2^3 \tag{37}$$

$$\beta^{(2)}_{g_2} = \frac{1}{10}g_2^3\Big(-20|\lambda|^2 - 20\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) + 21g_{1'}^2 + 240g_3^2 + 24g_1^2 + 320g_2^2 - 60\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 60\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)\Big) \tag{38}$$

$$\beta^{(1)}_{g_3} = 0 \tag{39}$$

$$\beta^{(2)}_{g_3} = g_3^3\Big(-2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 3g_{1'}^2 + 3g_1^2 + 48g_3^2 - 4\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 4\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) + 9g_2^2\Big) \tag{40}$$

$$\beta^{(1)}_{g_1'} = \frac{1}{40}g_{1'}^3\Big(2Q_S^2 + 249\Big) \tag{41}$$

$$\beta^{(2)}_{g_1'} = \frac{1}{400}g_{1'}^3\Big(984g_1^2 + 1401g_{1'}^2 + 2520g_2^2 + 9600g_3^2 + 2g_{1'}^2Q_S^4 - 40\Big(13 + Q_S^2\Big)|\lambda|^2 - 40Q_S^2|\sigma|^2 - 1680\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 560\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) - 720\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - 780\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 60Q_S^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)\Big) \tag{42}$$

3.3 Gaugino Mass Parameters

$$\beta^{(1)}_{M_1} = \frac{84}{5}g_1^2M_1 \tag{43}$$

$$\beta^{(2)}_{M_1} = \frac{1}{25}g_1^2\Big(864g_1^2M_1 + 123g_{1'}^2M_1 + 360g_2^2M_1 + 1200g_3^2M_1 + 123g_{1'}^2M_1' + 1200g_3^2M_3 + 360g_2^2M_2 - 60\lambda^*\Big(M_1\lambda - T_\lambda\Big) - 140M_1\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 180M_1\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) - 260M_1\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - 40M_1\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 140\mathrm{Tr}\Big(Y_d^\dagger T_d\Big) + 180\mathrm{Tr}\Big(Y_e^\dagger T_e\Big) + 260\mathrm{Tr}\Big(Y_u^\dagger T_u\Big) + 40\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)\Big) \tag{44}$$

$$\beta^{(1)}_{M_2} = 4g_2^2M_2 \tag{45}$$

$$\beta^{(2)}_{M_2} = \frac{1}{5}g_2^2\Big(24g_1^2M_1 + 21g_{1'}^2M_1' + 240g_3^2M_3 + 24g_1^2M_2 + 21g_{1'}^2M_2 + 640g_2^2M_2 + 240g_3^2M_2 - 20\lambda^*\Big(M_2\lambda - T_\lambda\Big) - 60M_2\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 20M_2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) - 60M_2\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) + 60\mathrm{Tr}\Big(Y_d^\dagger T_d\Big) + 20\mathrm{Tr}\Big(Y_e^\dagger T_e\Big)$$

$$+ 60\mathrm{Tr}\Big(Y_u^\dagger T_u\Big)\Big) \tag{46}$$

$$\beta_{M_3}^{(1)} = 0 \tag{47}$$

$$\begin{aligned}\beta_{M_3}^{(2)} = {} & 2g_3^2\Big(3g_1^2M_1 + 3g_{1'}^2M_1' + 3g_1^2M_3 + 3g_{1'}^2M_3 + 9g_2^2M_3 + 96g_3^2M_3 + 9g_2^2M_2 - 4M_3\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) \\ & - 4M_3\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - 2M_3\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 4\mathrm{Tr}\Big(Y_d^\dagger T_d\Big) + 4\mathrm{Tr}\Big(Y_u^\dagger T_u\Big) + 2\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)\Big)\end{aligned} \tag{48}$$

$$\beta_{M_1'}^{(1)} = \frac{1}{20}g_{1'}^2M_1'\Big(2Q_S^2 + 249\Big) \tag{49}$$

$$\begin{aligned}\beta_{M_1'}^{(2)} = {} & \frac{1}{100}g_{1'}^2\Big(492g_1^2M_1 + 492g_1^2M_1' + 1401g_{1'}^2M_1' + 1260g_2^2M_1' + 4800g_3^2M_1' + 4800g_3^2M_3 + 1260g_2^2M_2 \\ & + 2g_{1'}^2M_1'Q_S^4 - 20\Big(13 + Q_S^2\Big)\lambda^*\Big(M_1'\lambda - T_\lambda\Big) - 20Q_S^2\sigma'^{,*}\Big(M_1'\sigma - T_\sigma\Big) - 840M_1'\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) \\ & - 280M_1'\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) - 360M_1'\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - 390M_1'\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 30M_1'Q_S^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 840\mathrm{Tr}\Big(Y_d^\dagger T_d\Big) \\ & + 280\mathrm{Tr}\Big(Y_e^\dagger T_e\Big) + 360\mathrm{Tr}\Big(Y_u^\dagger T_u\Big) + 390\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) + 30Q_S^2\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)\Big)\end{aligned} \tag{50}$$

3.4 Trilinear Superpotential Parameters

$$\beta_{Y_d}^{(1)} = 3Y_dY_d^\dagger Y_d + Y_d\Big(-3g_2^2 + 3\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - \frac{16}{3}g_3^2 - \frac{7}{10}g_{1'}^2 - \frac{7}{15}g_1^2 + |\lambda|^2 + \mathrm{Tr}\Big(Y_eY_e^\dagger\Big)\Big) + Y_dY_u^\dagger Y_u \tag{51}$$

$$\begin{aligned}\beta_{Y_d}^{(2)} = {} & +\frac{4}{5}g_1^2Y_dY_u^\dagger Y_u + \frac{1}{5}g_{1'}^2Y_dY_u^\dagger Y_u - |\lambda|^2Y_dY_u^\dagger Y_u - 4Y_dY_d^\dagger Y_dY_d^\dagger Y_d \\ & - 2Y_dY_u^\dagger Y_uY_d^\dagger Y_d - 2Y_dY_u^\dagger Y_uY_u^\dagger Y_u \\ & + Y_dY_d^\dagger Y_d\Big(-3|\lambda|^2 - 3\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) + 6g_2^2 - 9\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) + \frac{4}{5}g_1^2 + \frac{6}{5}g_{1'}^2\Big) \\ & - 3Y_dY_u^\dagger Y_u\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) \\ & + Y_d\Big(\frac{1813}{450}g_1^4 - \frac{77}{150}g_1^2g_{1'}^2 + \frac{1841}{400}g_{1'}^4 + g_1^2g_2^2 + \frac{3}{2}g_{1'}^2g_2^2 + \frac{21}{2}g_2^4 + \frac{8}{9}g_1^2g_3^2 + \frac{4}{3}g_{1'}^2g_3^2 + 8g_2^2g_3^2 \\ & + \frac{128}{9}g_3^4 + \frac{7}{200}g_{1'}^4Q_S^2 - 3\lambda^2\lambda^{*,2} - \frac{1}{5}\Big(2g_1^2 + 3g_{1'}^2 - 80g_3^2\Big)\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) + \frac{6}{5}g_1^2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) \\ & - \frac{1}{5}g_{1'}^2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) + \frac{1}{20}|\lambda|^2\Big(-20\sigma\sigma'^{,*} - 5g_{1'}^2 - 60\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 60\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) + g_{1'}^2Q_S^2\Big) \\ & - 9\mathrm{Tr}\Big(Y_dY_d^\dagger Y_dY_d^\dagger\Big) - 3\mathrm{Tr}\Big(Y_dY_u^\dagger Y_uY_d^\dagger\Big) - 3\mathrm{Tr}\Big(Y_eY_e^\dagger Y_eY_e^\dagger\Big)\Big)\end{aligned} \tag{52}$$

$$\beta_{Y_e}^{(1)} = 3Y_eY_e^\dagger Y_e + Y_e\Big(-3g_2^2 + 3\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - \frac{7}{10}g_{1'}^2 - \frac{9}{5}g_1^2 + |\lambda|^2 + \mathrm{Tr}\Big(Y_eY_e^\dagger\Big)\Big) \tag{53}$$

$$\begin{aligned}\beta_{Y_e}^{(2)} = {} & -4Y_eY_e^\dagger Y_eY_e^\dagger Y_e + \frac{3}{2}Y_eY_e^\dagger Y_e\Big(-2|\lambda|^2 - 2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) + 4g_2^2 - 6\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) + g_{1'}^2\Big) \\ & + \frac{1}{400}Y_e\Big(6696g_1^4 - 12g_1^2g_{1'}^2 + 1841g_{1'}^4 + 720g_1^2g_2^2 + 780g_{1'}^2g_2^2 + 4200g_2^4 + 14g_{1'}^4Q_S^2 - 1200\lambda^2\lambda^{*,2} \\ & - 80\Big(2g_1^2 + 3g_{1'}^2 - 80g_3^2\Big)\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) + 480g_1^2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) - 80g_{1'}^2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big)\end{aligned}$$

$$+ 20|\lambda|^2\Big(- 20\sigma\sigma^{\prime,*} - 5g_{1^\prime}^2 - 60\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 60\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) + g_{1^\prime}^2Q_S^2\Big) - 3600\mathrm{Tr}\Big(Y_dY_d^\dagger Y_dY_d^\dagger\Big)$$
$$- 1200\mathrm{Tr}\Big(Y_dY_u^\dagger Y_uY_d^\dagger\Big) - 1200\mathrm{Tr}\Big(Y_eY_e^\dagger Y_eY_e^\dagger\Big)\Big) \tag{54}$$

$$\beta_{\kappa^\prime}^{(1)} = 3\kappa^\prime\Big(2|\kappa^\prime|^2 + |\sigma|^2\Big) \tag{55}$$

$$\beta_{\kappa^\prime}^{(2)} = -\frac{3}{10}\kappa^\prime\Big(40\sigma|\kappa^\prime|^2\sigma^{\prime,*} + 80\kappa^{\prime,2}\kappa^{\prime,*,2} + |\sigma|^2\Big(20\lambda\lambda^* + 20\sigma\sigma^{\prime,*} + 30\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - g_{1^\prime}^2Q_S^2\Big)\Big) \tag{56}$$

$$\beta_\sigma^{(1)} = 2\sigma|\kappa^\prime|^2 + 2\sigma|\lambda|^2 + 3\sigma^2\sigma^{\prime,*} + 3\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - \frac{1}{10}g_{1^\prime}^2Q_S^2\sigma \tag{57}$$

$$\beta_\sigma^{(2)} = -\frac{1}{400}\sigma\Big(- 249g_{1^\prime}^4Q_S^2 - 4g_{1^\prime}^4Q_S^4 - 40g_{1^\prime}^2Q_S^2|\sigma|^2 + 3200\kappa^{\prime,2}\kappa^{\prime,*,2} + 1600\lambda^2\lambda^{*,2} + 3200\sigma|\kappa^\prime|^2\sigma^{\prime,*}$$
$$+ 2400\sigma^2\sigma^{\prime,*,2}$$
$$- 40|\lambda|^2\Big(12g_1^2 + 13g_{1^\prime}^2 - 20\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) - 40\sigma\sigma^{\prime,*} + 60g_2^2 - 60\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 60\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - g_{1^\prime}^2Q_S^2\Big)$$
$$- 320g_1^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 780g_{1^\prime}^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 6400g_3^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 60g_{1^\prime}^2Q_S^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)$$
$$+ 2400|\sigma|^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 2400\mathrm{Tr}\Big(\kappa\kappa^\dagger\kappa\kappa^\dagger\Big)\Big) \tag{58}$$

$$\beta_\kappa^{(1)} = 2\kappa\kappa^\dagger\kappa + \kappa\Big(2|\lambda|^2 + 3\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - \frac{1}{20}g_{1^\prime}^2Q_S^2 - \frac{13}{20}g_{1^\prime}^2 - \frac{16}{3}g_3^2 - \frac{4}{15}g_1^2 + |\sigma|^2\Big) \tag{59}$$

$$\beta_\kappa^{(2)} = -2\kappa\kappa^\dagger\kappa\kappa^\dagger\kappa + \kappa\kappa^\dagger\kappa\Big(- 2|\sigma|^2 - 4|\lambda|^2 - 6\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + \frac{1}{10}g_{1^\prime}^2Q_S^2\Big)$$
$$+ \kappa\Big(\frac{512}{225}g_1^4 + \frac{22}{75}g_1^2g_{1^\prime}^2 + \frac{3431}{800}g_{1^\prime}^4 + \frac{64}{45}g_1^2g_3^2 + \frac{52}{15}g_{1^\prime}^2g_3^2 + \frac{128}{9}g_3^4 + \frac{11}{32}g_{1^\prime}^4Q_S^2 + \frac{1}{200}g_{1^\prime}^4Q_S^4 - 4\lambda^2\lambda^{*,2}$$
$$- 2\sigma|\kappa^\prime|^2\sigma^{\prime,*} - 2\sigma^2\sigma^{\prime,*,2}$$
$$+ \frac{1}{10}|\lambda|^2\Big(12g_1^2 + 13g_{1^\prime}^2 - 20\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) + 60g_2^2 - 60\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 60\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - g_{1^\prime}^2Q_S^2\Big)$$
$$+ \frac{4}{5}g_1^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + \frac{39}{20}g_{1^\prime}^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 16g_3^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - \frac{3}{20}g_{1^\prime}^2Q_S^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 6\mathrm{Tr}\Big(\kappa\kappa^\dagger\kappa\kappa^\dagger\Big)\Big) \tag{60}$$

$$\beta_\lambda^{(1)} = \frac{1}{20}\lambda\Big(- 12g_1^2 - 13g_{1^\prime}^2 - 60g_2^2 - g_{1^\prime}^2Q_S^2 + 80|\lambda|^2 + 20|\sigma|^2 + 60\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) + 20\mathrm{Tr}\Big(Y_eY_e^\dagger\Big)$$
$$+ 60\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) + 60\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)\Big) \tag{61}$$

$$\beta_\lambda^{(2)} = -\frac{1}{800}\lambda\Big(- 4176g_1^4 - 168g_1^2g_{1^\prime}^2 - 3431g_{1^\prime}^4 - 1440g_1^2g_2^2 - 1560g_{1^\prime}^2g_2^2 - 8400g_2^4 - 275g_{1^\prime}^4Q_S^2$$
$$- 4g_{1^\prime}^4Q_S^4 + 8000\lambda^2\lambda^{*,2} + 1600\sigma|\kappa^\prime|^2\sigma^{\prime,*} + 1600\sigma^2\sigma^{\prime,*,2} + 320g_1^2\mathrm{Tr}\Big(Y_dY_d^\dagger\Big)$$
$$+ 480g_{1^\prime}^2\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 12800g_3^2\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 960g_1^2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) + 160g_{1^\prime}^2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big)$$
$$- 640g_1^2\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) + 240g_{1^\prime}^2\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - 12800g_3^2\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)$$
$$- 80|\lambda|^2\Big(12g_1^2 + 13g_{1^\prime}^2 - 20\sigma\sigma^{\prime,*} - 30\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) + 60g_2^2 - 60\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 90\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 90\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)\Big)$$
$$- 640g_1^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 1560g_{1^\prime}^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 12800g_3^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 120g_{1^\prime}^2Q_S^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)$$

$$+ 7200\mathrm{Tr}\Big(Y_d Y_d^\dagger Y_d Y_d^\dagger\Big) + 4800\mathrm{Tr}\Big(Y_d Y_u^\dagger Y_u Y_d^\dagger\Big) + 2400\mathrm{Tr}\Big(Y_e Y_e^\dagger Y_e Y_e^\dagger\Big) + 7200\mathrm{Tr}\Big(Y_u Y_u^\dagger Y_u Y_u^\dagger\Big)$$
$$+ 4800\mathrm{Tr}\Big(\kappa\kappa^\dagger\kappa\kappa^\dagger\Big)\Big) \tag{62}$$

$$\beta^{(1)}_{Y_u} = 3Y_u Y_u^\dagger Y_u - \frac{1}{30}Y_u\Big(160g_3^2 + 26g_1^2 - 30|\lambda|^2 + 90g_2^2 - 90\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) + 9g_{1'}^2\Big) + Y_u Y_d^\dagger Y_d \tag{63}$$

$$\begin{aligned}\beta^{(2)}_{Y_u} =& +\frac{2}{5}g_1^2 Y_u Y_u^\dagger Y_u + \frac{3}{5}g_{1'}^2 Y_u Y_u^\dagger Y_u + 6g_2^2 Y_u Y_u^\dagger Y_u - 3|\lambda|^2 Y_u Y_u^\dagger Y_u \\ & - 2Y_u Y_d^\dagger Y_d Y_d^\dagger Y_d - 2Y_u Y_d^\dagger Y_d Y_u^\dagger Y_u - 4Y_u Y_u^\dagger Y_u Y_u^\dagger Y_u \\ & + \frac{1}{5}Y_u Y_d^\dagger Y_d\Big(-15\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 2g_1^2 + 3g_{1'}^2 - 5|\lambda|^2 - 5\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big)\Big) - 9Y_u Y_u^\dagger Y_u \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) \\ & + Y_u\Big(\frac{689}{90}g_1^4 + \frac{43}{60}g_1^2 g_{1'}^2 + \frac{153}{80}g_{1'}^4 + g_1^2 g_2^2 + \frac{3}{4}g_{1'}^2 g_2^2 + \frac{21}{2}g_2^4 + \frac{136}{45}g_1^2 g_3^2 + \frac{8}{15}g_{1'}^2 g_3^2 + 8g_2^2 g_3^2 \\ & + \frac{128}{9}g_3^4 + \frac{3}{200}g_{1'}^4 Q_S^2 - 3\lambda^2\lambda^{*,2} + \frac{1}{10}\Big(160g_3^2 - 3g_{1'}^2 + 8g_1^2\Big)\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) \\ & + \frac{1}{20}|\lambda|^2\Big(-20\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 20\sigma\sigma^{\prime,*} + 5g_{1'}^2 - 60\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 60\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + g_{1'}^2 Q_S^2\Big) \\ & - 3\mathrm{Tr}\Big(Y_d Y_u^\dagger Y_u Y_d^\dagger\Big) - 9\mathrm{Tr}\Big(Y_u Y_u^\dagger Y_u Y_u^\dagger\Big)\Big)\end{aligned} \tag{64}$$

3.5 Bilinear Superpotential Parameters

$$\beta^{(1)}_{\mu'} = -\frac{1}{5}\Big(15g_2^2 + 2g_{1'}^2 + 3g_1^2\Big)\mu' \tag{65}$$

$$\beta^{(2)}_{\mu'} = \frac{1}{100}\Big(1050g_2^4 + 120g_{1'}^2 g_2^2 + 12g_1^2\Big(15g_2^2 + 8g_{1'}^2\Big) + 522g_1^4 + g_{1'}^4\Big(2Q_S^2 + 257\Big)\Big)\mu' \tag{66}$$

$$\beta^{(1)}_{Mu_{phi}} = 2Mu_{phi}\Big(2|\kappa'|^2 + |\sigma|^2\Big) \tag{67}$$

$$\beta^{(2)}_{Mu_{phi}} = -\frac{1}{5}Mu_{phi}\Big(40\sigma|\kappa'|^2\sigma^{\prime,*} + 80\kappa^{\prime,2}\kappa^{\prime,*,2} + |\sigma|^2\Big(20\lambda\lambda^* + 20\sigma\sigma^{\prime,*} + 30\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - g_{1'}^2 Q_S^2\Big)\Big) \tag{68}$$

3.6 Linear Superpotential Parameters

$$\beta^{(1)}_{XiF_1} = XiF_1\Big(2|\kappa'|^2 + |\sigma|^2\Big) \tag{69}$$

$$\beta^{(2)}_{XiF_1} = -\frac{1}{10}XiF_1\Big(40\sigma|\kappa'|^2\sigma^{\prime,*} + 80\kappa^{\prime,2}\kappa^{\prime,*,2} + |\sigma|^2\Big(20\lambda\lambda^* + 20\sigma\sigma^{\prime,*} + 30\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - g_{1'}^2 Q_S^2\Big)\Big) \tag{70}$$

3.7 Trilinear Soft-Breaking Parameters

$$\beta^{(1)}_{T_d} = +4Y_d Y_d^\dagger T_d + 2Y_d Y_u^\dagger T_u + 5T_d Y_d^\dagger Y_d + T_d Y_u^\dagger Y_u - \frac{7}{15}g_1^2 T_d - \frac{7}{10}g_{1'}^2 T_d - 3g_2^2 T_d$$

$$
\begin{aligned}
&- \frac{16}{3}g_3^2 T_d + |\lambda|^2 T_d + 3T_d \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + T_d \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) \\
&+ Y_d\Big(2\lambda^* T_\lambda + 2\mathrm{Tr}\Big(Y_e^\dagger T_e\Big) + 6g_2^2 M_2 + 6\mathrm{Tr}\Big(Y_d^\dagger T_d\Big) + \frac{14}{15}g_1^2 M_1 + \frac{32}{3}g_3^2 M_3 + \frac{7}{5}g_{1'}^2 M_1'\Big) \qquad (71)\\
\beta_{T_d}^{(2)} &= +\frac{6}{5}g_1^2 Y_d Y_d^\dagger T_d + \frac{9}{5}g_{1'}^2 Y_d Y_d^\dagger T_d + 6g_2^2 Y_d Y_d^\dagger T_d - 4|\lambda|^2 Y_d Y_d^\dagger T_d \\
&- \frac{8}{5}g_1^2 M_1 Y_d Y_u^\dagger Y_u - \frac{2}{5}g_{1'}^2 M_1' Y_d Y_u^\dagger Y_u + \frac{8}{5}g_1^2 Y_d Y_u^\dagger T_u + \frac{2}{5}g_{1'}^2 Y_d Y_u^\dagger T_u \\
&- 2|\lambda|^2 Y_d Y_u^\dagger T_u + \frac{6}{5}g_1^2 T_d Y_d^\dagger Y_d + \frac{9}{5}g_{1'}^2 T_d Y_d^\dagger Y_d + 12 g_2^2 T_d Y_d^\dagger Y_d \\
&- 5|\lambda|^2 T_d Y_d^\dagger Y_d + \frac{4}{5}g_1^2 T_d Y_u^\dagger Y_u + \frac{1}{5}g_{1'}^2 T_d Y_u^\dagger Y_u - |\lambda|^2 T_d Y_u^\dagger Y_u \\
&- 6Y_d Y_d^\dagger Y_d Y_d^\dagger T_d - 8Y_d Y_d^\dagger T_d Y_d^\dagger Y_d - 2Y_d Y_u^\dagger Y_u Y_d^\dagger T_d - 4Y_d Y_u^\dagger Y_u Y_u^\dagger T_u \\
&- 4Y_d Y_u^\dagger T_u Y_d^\dagger Y_d - 4Y_d Y_u^\dagger T_u Y_u^\dagger Y_u - 6T_d Y_d^\dagger Y_d Y_d^\dagger Y_d - 4T_d Y_u^\dagger Y_u Y_d^\dagger Y_d \\
&- 2T_d Y_u^\dagger Y_u Y_u^\dagger Y_u + \frac{1813}{450}g_1^4 T_d + \frac{49}{150}g_1^2 g_{1'}^2 T_d + \frac{1841}{400}g_{1'}^4 T_d + g_1^2 g_2^2 T_d + \frac{3}{2}g_{1'}^2 g_2^2 T_d + \frac{21}{2}g_2^4 T_d \\
&+ \frac{8}{9}g_1^2 g_3^2 T_d + \frac{4}{3}g_{1'}^2 g_3^2 T_d + 8g_2^2 g_3^2 T_d + \frac{128}{9}g_3^4 T_d + \frac{7}{200}g_{1'}^4 Q_S^2 T_d - \frac{1}{4}g_{1'}^2 |\lambda|^2 T_d \\
&+ \frac{1}{20}g_{1'}^2 Q_S^2 |\lambda|^2 T_d - 3\lambda^2 \lambda^{*,2} T_d - \sigma |\lambda|^2 \sigma'^{,*} T_d - 2\lambda^* Y_d Y_u^\dagger Y_u T_\lambda \\
&- 12 Y_d Y_d^\dagger T_d \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 15 T_d Y_d^\dagger Y_d \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - \frac{2}{5}g_1^2 T_d \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) \\
&- \frac{3}{5}g_{1'}^2 T_d \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 16 g_3^2 T_d \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 4 Y_d Y_d^\dagger T_d \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) \\
&- 5 T_d Y_d^\dagger Y_d \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + \frac{6}{5}g_1^2 T_d \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - \frac{1}{5}g_{1'}^2 T_d \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) \\
&- 6 Y_d Y_u^\dagger T_u \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) - 3 T_d Y_u^\dagger Y_u \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) - 3|\lambda|^2 T_d \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) \\
&- 3|\lambda|^2 T_d \mathrm{Tr}\Big(\kappa \kappa^\dagger\Big) \\
&- \frac{2}{5}Y_d Y_d^\dagger Y_d\Big(15\lambda^* T_\lambda + 15\mathrm{Tr}\Big(Y_e^\dagger T_e\Big) + 30 g_2^2 M_2 + 45\mathrm{Tr}\Big(Y_d^\dagger T_d\Big) + 4 g_1^2 M_1 + 6 g_{1'}^2 M_1'\Big) \\
&- 6 Y_d Y_u^\dagger Y_u \mathrm{Tr}\Big(Y_u^\dagger T_u\Big) - 9 T_d \mathrm{Tr}\Big(Y_d Y_d^\dagger Y_d Y_d^\dagger\Big) - 3 T_d \mathrm{Tr}\Big(Y_d Y_u^\dagger Y_u Y_d^\dagger\Big) \\
&- 3 T_d \mathrm{Tr}\Big(Y_e Y_e^\dagger Y_e Y_e^\dagger\Big) \\
&- \frac{1}{900}Y_d\Big(14504 g_1^4 M_1 + 588 g_1^2 g_{1'}^2 M_1 + 1800 g_1^2 g_2^2 M_1 + 1600 g_1^2 g_3^2 M_1 + 588 g_1^2 g_{1'}^2 M_1' + 16569 g_{1'}^4 M_1' \\
&+ 2700 g_{1'}^2 g_2^2 M_1' + 2400 g_{1'}^2 g_3^2 M_1' + 1600 g_1^2 g_3^2 M_3 + 2400 g_{1'}^2 g_3^2 M_3 + 14400 g_2^2 g_3^2 M_3 \\
&+ 51200 g_3^4 M_3 + 1800 g_1^2 g_2^2 M_2 + 2700 g_{1'}^2 g_2^2 M_2 + 37800 g_2^4 M_2 + 14400 g_2^2 g_3^2 M_2 + 126 g_{1'}^4 M_1' Q_S^2 \\
&+ 10800 \lambda \lambda^{*,2} T_\lambda - 360\Big(2 g_1^2 M_1 + 3 g_{1'}^2 M_1' - 80 g_3^2 M_3\Big)\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 2160 g_1^2 M_1 \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) \\
&- 360 g_{1'}^2 M_1' \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + 720 g_1^2 \mathrm{Tr}\Big(Y_d^\dagger T_d\Big) + 1080 g_{1'}^2 \mathrm{Tr}\Big(Y_d^\dagger T_d\Big) - 28800 g_3^2 \mathrm{Tr}\Big(Y_d^\dagger T_d\Big) \\
&- 2160 g_1^2 \mathrm{Tr}\Big(Y_e^\dagger T_e\Big) + 360 g_{1'}^2 \mathrm{Tr}\Big(Y_e^\dagger T_e\Big)
\end{aligned}
$$

$$
\begin{aligned}
&+ 90\lambda^* \Big(T_\lambda \Big(20|\sigma|^2 + 5 g_{1'}^2 + 60 \mathrm{Tr}\Big(\kappa \kappa^\dagger \Big) + 60 \mathrm{Tr}\Big(Y_u Y_u^\dagger \Big) - g_{1'}^2 Q_S^2 \Big) \\
&+ \lambda \Big(20 \sigma'^{,*} T_\sigma - 5 g_{1'}^2 M_1' + 60 \mathrm{Tr}\Big(\kappa^\dagger T_\kappa \Big) + 60 \mathrm{Tr}\Big(Y_u^\dagger T_u \Big) + g_{1'}^2 M_1' Q_S^2 \Big) \Big) \\
&+ 32400 \mathrm{Tr}\Big(Y_d Y_d^\dagger T_d Y_d^\dagger \Big) + 5400 \mathrm{Tr}\Big(Y_d Y_u^\dagger T_u Y_d^\dagger \Big) + 10800 \mathrm{Tr}\Big(Y_e Y_e^\dagger T_e Y_e^\dagger \Big) + 5400 \mathrm{Tr}\Big(Y_u Y_d^\dagger T_d Y_u^\dagger \Big) \Big)
\end{aligned} \tag{72}
$$

$$
\begin{aligned}
\beta_{T_e}^{(1)} = &+ 4 Y_e Y_e^\dagger T_e + 5 T_e Y_e^\dagger Y_e - \frac{9}{5} g_1^2 T_e - \frac{7}{10} g_{1'}^2 T_e - 3 g_2^2 T_e + |\lambda|^2 T_e + 3 T_e \mathrm{Tr}\Big(Y_d Y_d^\dagger \Big) \\
&+ T_e \mathrm{Tr}\Big(Y_e Y_e^\dagger \Big) + Y_e \Big(2 \lambda^* T_\lambda + 2 \mathrm{Tr}\Big(Y_e^\dagger T_e \Big) + 6 g_2^2 M_2 + 6 \mathrm{Tr}\Big(Y_d^\dagger T_d \Big) + \frac{18}{5} g_1^2 M_1 + \frac{7}{5} g_{1'}^2 M_1' \Big)
\end{aligned} \tag{73}
$$

$$
\begin{aligned}
\beta_{T_e}^{(2)} = &+ \frac{6}{5} g_1^2 Y_e Y_e^\dagger T_e + \frac{9}{5} g_{1'}^2 Y_e Y_e^\dagger T_e + 6 g_2^2 Y_e Y_e^\dagger T_e - 4 |\lambda|^2 Y_e Y_e^\dagger T_e \\
&- \frac{6}{5} g_1^2 T_e Y_e^\dagger Y_e + \frac{27}{10} g_{1'}^2 T_e Y_e^\dagger Y_e + 12 g_2^2 T_e Y_e^\dagger Y_e - 5 |\lambda|^2 T_e Y_e^\dagger Y_e \\
&- 6 Y_e Y_e^\dagger Y_e Y_e^\dagger T_e - 8 Y_e Y_e^\dagger T_e Y_e^\dagger Y_e - 6 T_e Y_e^\dagger Y_e Y_e^\dagger Y_e + \frac{837}{50} g_1^4 T_e + \frac{51}{100} g_1^2 g_{1'}^2 T_e + \frac{1841}{400} g_{1'}^4 T_e \\
&+ \frac{9}{5} g_1^2 g_2^2 T_e + \frac{39}{20} g_{1'}^2 g_2^2 T_e + \frac{21}{2} g_2^4 T_e + \frac{7}{200} g_{1'}^4 Q_S^2 T_e - \frac{1}{4} g_{1'}^2 |\lambda|^2 T_e + \frac{1}{20} g_{1'}^2 Q_S^2 |\lambda|^2 T_e \\
&- 3 \lambda^2 \lambda^{*,2} T_e - \sigma |\lambda|^2 \sigma'^{,*} T_e - 12 Y_e Y_e^\dagger T_e \mathrm{Tr}\Big(Y_d Y_d^\dagger \Big) - 15 T_e Y_e^\dagger Y_e \mathrm{Tr}\Big(Y_d Y_d^\dagger \Big) \\
&- \frac{2}{5} g_1^2 T_e \mathrm{Tr}\Big(Y_d Y_d^\dagger \Big) - \frac{3}{5} g_{1'}^2 T_e \mathrm{Tr}\Big(Y_d Y_d^\dagger \Big) + 16 g_3^2 T_e \mathrm{Tr}\Big(Y_d Y_d^\dagger \Big) - 4 Y_e Y_e^\dagger T_e \mathrm{Tr}\Big(Y_e Y_e^\dagger \Big) \\
&- 5 T_e Y_e^\dagger Y_e \mathrm{Tr}\Big(Y_e Y_e^\dagger \Big) + \frac{6}{5} g_1^2 T_e \mathrm{Tr}\Big(Y_e Y_e^\dagger \Big) - \frac{1}{5} g_{1'}^2 T_e \mathrm{Tr}\Big(Y_e Y_e^\dagger \Big) \\
&- 3 |\lambda|^2 T_e \mathrm{Tr}\Big(Y_u Y_u^\dagger \Big) - 3 |\lambda|^2 T_e \mathrm{Tr}\Big(\kappa \kappa^\dagger \Big) \\
&- 3 Y_e Y_e^\dagger Y_e \Big(2 \lambda^* T_\lambda + 2 \mathrm{Tr}\Big(Y_e^\dagger T_e \Big) + 4 g_2^2 M_2 + 6 \mathrm{Tr}\Big(Y_d^\dagger T_d \Big) + g_{1'}^2 M_1' \Big) - 9 T_e \mathrm{Tr}\Big(Y_d Y_d^\dagger Y_d Y_d^\dagger \Big) \\
&- 3 T_e \mathrm{Tr}\Big(Y_d Y_u^\dagger Y_u Y_d^\dagger \Big) - 3 T_e \mathrm{Tr}\Big(Y_e Y_e^\dagger Y_e Y_e^\dagger \Big) \\
&- \frac{1}{100} Y_e \Big(6696 g_1^4 M_1 + 102 g_1^2 g_{1'}^2 M_1 + 360 g_1^2 g_2^2 M_1 + 102 g_1^2 g_{1'}^2 M_1' + 1841 g_{1'}^4 M_1' + 390 g_{1'}^2 g_2^2 M_1' \\
&+ 360 g_1^2 g_2^2 M_2 + 390 g_{1'}^2 g_2^2 M_2 + 4200 g_2^4 M_2 + 14 g_{1'}^4 M_1' Q_S^2 + 1200 \lambda \lambda^{*,2} T_\lambda \\
&- 40 \Big(2 g_1^2 M_1 + 3 g_{1'}^2 M_1' - 80 g_3^2 M_3 \Big) \mathrm{Tr}\Big(Y_d Y_d^\dagger \Big) + 240 g_1^2 M_1 \mathrm{Tr}\Big(Y_e Y_e^\dagger \Big) - 40 g_{1'}^2 M_1' \mathrm{Tr}\Big(Y_e Y_e^\dagger \Big) \\
&+ 80 g_1^2 \mathrm{Tr}\Big(Y_d^\dagger T_d \Big) + 120 g_{1'}^2 \mathrm{Tr}\Big(Y_d^\dagger T_d \Big) - 3200 g_3^2 \mathrm{Tr}\Big(Y_d^\dagger T_d \Big) - 240 g_1^2 \mathrm{Tr}\Big(Y_e^\dagger T_e \Big) \\
&+ 40 g_{1'}^2 \mathrm{Tr}\Big(Y_e^\dagger T_e \Big) \\
&+ 10 \lambda^* \Big(T_\lambda \Big(20 |\sigma|^2 + 5 g_{1'}^2 + 60 \mathrm{Tr}\Big(\kappa \kappa^\dagger \Big) + 60 \mathrm{Tr}\Big(Y_u Y_u^\dagger \Big) - g_{1'}^2 Q_S^2 \Big) \\
&+ \lambda \Big(20 \sigma'^{,*} T_\sigma - 5 g_{1'}^2 M_1' + 60 \mathrm{Tr}\Big(\kappa^\dagger T_\kappa \Big) + 60 \mathrm{Tr}\Big(Y_u^\dagger T_u \Big) + g_{1'}^2 M_1' Q_S^2 \Big) \Big) \\
&+ 3600 \mathrm{Tr}\Big(Y_d Y_d^\dagger T_d Y_d^\dagger \Big) + 600 \mathrm{Tr}\Big(Y_d Y_u^\dagger T_u Y_d^\dagger \Big) + 1200 \mathrm{Tr}\Big(Y_e Y_e^\dagger T_e Y_e^\dagger \Big) + 600 \mathrm{Tr}\Big(Y_u Y_d^\dagger T_d Y_u^\dagger \Big) \Big)
\end{aligned} \tag{74}
$$

$$
\beta_{T_{\kappa'}}^{(1)} = 3 \Big(6 |\kappa'|^2 T_{\kappa'} + \sigma'^{,*} \Big(2 \kappa' T_\sigma + \sigma T_{\kappa'} \Big) \Big) \tag{75}
$$

$$\beta^{(2)}_{T_{\kappa'}} = -\frac{3}{10}\Big(400\kappa'^{,2}\kappa'^{,*,2}T_{\kappa'} + 20\sigma\sigma'^{,*,2}\Big(4\kappa' T_\sigma + \sigma T_{\kappa'}\Big)$$
$$+ \sigma'^{,*}\Big(\sigma T_{\kappa'}\Big(120|\kappa'|^2 + 20|\lambda|^2 + 30\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - g_{1'}^2 Q_S^2\Big)$$
$$+ 2\kappa'\Big(20\lambda^*\Big(\lambda T_\sigma + \sigma T_\lambda\Big) + \sigma\Big(30\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) + g_{1'}^2 M_1' Q_S^2\Big) + T_\sigma\Big(30\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 40|\kappa'|^2 - g_{1'}^2 Q_S^2\Big)\Big)\Big)\Big) \tag{76}$$

$$\beta^{(1)}_{T_\sigma} = +\frac{1}{5}g_{1'}^2 M_1' Q_S^2\sigma - \frac{1}{10}g_{1'}^2 Q_S^2 T_\sigma + 9|\sigma|^2 T_\sigma + 2\kappa'^{,*}\Big(2\sigma T_{\kappa'} + \kappa' T_\sigma\Big) + 2\lambda^*\Big(2\sigma T_\lambda + \lambda T_\sigma\Big)$$
$$+ 3T_\sigma \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 6\sigma\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) \tag{77}$$

$$\beta^{(2)}_{T_\sigma} = -\frac{249}{100}g_{1'}^4 M_1' Q_S^2\sigma - \frac{1}{25}g_{1'}^4 M_1' Q_S^4\sigma - 32\kappa'\sigma\kappa'^{,*,2}T_{\kappa'} + \frac{249}{400}g_{1'}^4 Q_S^2 T_\sigma + \frac{1}{100}g_{1'}^4 Q_S^4 T_\sigma$$
$$- 8\kappa'^{,2}\kappa'^{,*,2}T_\sigma - 30\sigma^2\sigma'^{,*,2}T_\sigma - 4\lambda\lambda^{*,2}\Big(4\sigma T_\lambda + \lambda T_\sigma\Big) - \frac{8}{5}g_1^2 M_1\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)$$
$$- \frac{39}{10}g_{1'}^2 M_1'\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 32g_3^2 M_3\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + \frac{3}{10}g_{1'}^2 M_1' Q_S^2\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)$$
$$+ \frac{4}{5}g_1^2 T_\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + \frac{39}{20}g_{1'}^2 T_\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 16g_3^2 T_\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - \frac{3}{20}g_{1'}^2 Q_S^2 T_\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)$$
$$- \frac{1}{10}\lambda^*\Big(2\sigma T_\lambda\Big(-12g_1^2 - 13g_{1'}^2 + 20\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + 40|\sigma|^2 - 60g_2^2 + 60\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 60\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) + g_{1'}^2 Q_S^2\Big)$$
$$+ \lambda\Big(T_\sigma\Big(120|\sigma|^2 - 12g_1^2 - 13g_{1'}^2 + 20\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 60g_2^2 + 60\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 60\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) + g_{1'}^2 Q_S^2\Big)$$
$$+ 2\sigma\Big(12g_1^2 M_1 + 13g_{1'}^2 M_1' + 20\mathrm{Tr}\Big(Y_e^\dagger T_e\Big) + 60g_2^2 M_2 + 60\mathrm{Tr}\Big(Y_d^\dagger T_d\Big) + 60\mathrm{Tr}\Big(Y_u^\dagger T_u\Big) - g_{1'}^2 M_1' Q_S^2\Big)\Big)\Big)$$
$$+ \frac{8}{5}g_1^2\sigma\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) + \frac{39}{10}g_{1'}^2\sigma\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) + 32g_3^2\sigma\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) - \frac{3}{10}g_{1'}^2 Q_S^2\sigma\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)$$
$$- \frac{1}{10}|\sigma|^2\Big(120\sigma\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) + 180T_\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 2g_{1'}^2 M_1' Q_S^2\sigma - 3g_{1'}^2 Q_S^2 T_\sigma + 80\kappa'^{,*}\Big(2\sigma T_{\kappa'} + 3\kappa' T_\sigma\Big)\Big)$$
$$- 6T_\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger\kappa\kappa^\dagger\Big) - 24\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger T_\kappa\kappa^\dagger\Big) \tag{78}$$

$$\beta^{(1)}_{T_\kappa} = +3\kappa\kappa^\dagger T_\kappa + 3T_\kappa\kappa^\dagger\kappa - \frac{4}{15}g_1^2 T_\kappa - \frac{13}{20}g_{1'}^2 T_\kappa - \frac{16}{3}g_3^2 T_\kappa - \frac{1}{20}g_{1'}^2 Q_S^2 T_\kappa + 2|\lambda|^2 T_\kappa$$
$$+ |\sigma|^2 T_\kappa + 3T_\kappa\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)$$
$$+ \frac{1}{30}\kappa\Big(120\lambda^* T_\lambda + 16g_1^2 M_1 + 180\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) + 320g_3^2 M_3 + 39g_{1'}^2 M_1' + 3g_{1'}^2 M_1' Q_S^2 + 60\sigma'^{,*}T_\sigma\Big) \tag{79}$$

$$\beta^{(2)}_{T_\kappa} = -\frac{1}{4}g_{1'}^2\kappa\kappa^\dagger T_\kappa + \frac{3}{20}g_{1'}^2 Q_S^2\kappa\kappa^\dagger T_\kappa - 6|\lambda|^2\kappa\kappa^\dagger T_\kappa - 3|\sigma|^2\kappa\kappa^\dagger T_\kappa$$
$$+ \frac{1}{4}g_{1'}^2 T_\kappa\kappa^\dagger\kappa + \frac{3}{20}g_{1'}^2 Q_S^2 T_\kappa\kappa^\dagger\kappa - 6|\lambda|^2 T_\kappa\kappa^\dagger\kappa - 3|\sigma|^2 T_\kappa\kappa^\dagger\kappa$$
$$- 3\kappa\kappa^\dagger\kappa\kappa^\dagger T_\kappa - 4\kappa\kappa^\dagger T_\kappa\kappa^\dagger\kappa - 3T_\kappa\kappa^\dagger\kappa\kappa^\dagger\kappa + \frac{512}{225}g_1^4 T_\kappa + \frac{13}{75}g_1^2 g_{1'}^2 T_\kappa + \frac{3431}{800}g_{1'}^4 T_\kappa$$
$$+ \frac{64}{45}g_1^2 g_3^2 T_\kappa + \frac{52}{15}g_{1'}^2 g_3^2 T_\kappa + \frac{128}{9}g_3^4 T_\kappa + \frac{11}{32}g_{1'}^4 Q_S^2 T_\kappa + \frac{1}{200}g_{1'}^4 Q_S^4 T_\kappa + \frac{6}{5}g_1^2|\lambda|^2 T_\kappa$$
$$+ \frac{13}{10}g_{1'}^2|\lambda|^2 T_\kappa + 6g_2^2|\lambda|^2 T_\kappa - \frac{1}{10}g_{1'}^2 Q_S^2|\lambda|^2 T_\kappa - 4\lambda^2\lambda^{*,2}T_\kappa - 2\sigma|\kappa'|^2\sigma'^{,*}T_\kappa$$

$$
\begin{aligned}
&- 2\sigma^2\sigma'^{,*,2}T_\kappa - 6|\lambda|^2 T_\kappa \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 2|\lambda|^2 T_\kappa \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 6|\lambda|^2 T_\kappa \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) \\
&- 9\kappa\kappa^\dagger T_\kappa \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 9 T_\kappa \kappa^\dagger \kappa \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + \frac{4}{5} g_1^2 T_\kappa \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + \frac{39}{20} g_{1'}^2 T_\kappa \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) \\
&+ 16 g_3^2 T_\kappa \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - \frac{3}{20} g_{1'}^2 Q_S^2 T_\kappa \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) \\
&- \frac{1}{5}\kappa\kappa^\dagger\kappa\Big(20\sigma'^{,*}T_\sigma + 40\lambda^* T_\lambda + 60\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) + g_{1'}^2 M_1' Q_S^2\Big) - 6 T_\kappa \mathrm{Tr}\Big(\kappa\kappa^\dagger\kappa\kappa^\dagger\Big) \\
&- \frac{1}{1800}\kappa\Big(16384 g_1^4 M_1 + 624 g_1^2 g_{1'}^2 M_1 + 5120 g_1^2 g_3^2 M_1 + 624 g_1^2 g_{1'}^2 M_1' + 30879 g_{1'}^4 M_1' + 12480 g_{1'}^2 g_3^2 M_1' \\
&+ 5120 g_1^2 g_3^2 M_3 + 12480 g_{1'}^2 g_3^2 M_3 + 102400 g_3^4 M_3 + 2475 g_{1'}^4 M_1' Q_S^2 + 36 g_{1'}^4 M_1' Q_S^4 + 28800\lambda\lambda^{*,2} T_\lambda \\
&+ 14400\sigma\sigma'^{,*,2} T_\sigma + 7200\kappa'^{,*}\sigma'^{,*}\Big(\kappa' T_\sigma + \sigma T_{\kappa'}\Big) + 2880 g_1^2 M_1 \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 7020 g_{1'}^2 M_1' \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) \\
&+ 57600 g_3^2 M_3 \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 540 g_{1'}^2 M_1' Q_S^2 \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) \\
&+ 360\lambda^*\Big(T_\lambda\Big(-12 g_1^2 - 13 g_{1'}^2 + 20\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 60 g_2^2 + 60\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 60\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) + g_{1'}^2 Q_S^2\Big) \\
&+ \lambda\Big(12 g_1^2 M_1 + 13 g_{1'}^2 M_1' + 20\mathrm{Tr}\Big(Y_e^\dagger T_e\Big) + 60 g_2^2 M_2 + 60\mathrm{Tr}\Big(Y_d^\dagger T_d\Big) + 60\mathrm{Tr}\Big(Y_u^\dagger T_u\Big) - g_{1'}^2 M_1' Q_S^2\Big)\Big) \\
&- 2880 g_1^2 \mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) - 7020 g_{1'}^2 \mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) - 57600 g_3^2 \mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) + 540 g_{1'}^2 Q_S^2 \mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) \\
&+ 43200\mathrm{Tr}\Big(\kappa\kappa^\dagger T_\kappa \kappa^\dagger\Big)\Big)
\end{aligned} \tag{80}
$$

$$
\begin{aligned}
\beta_{T_\lambda}^{(1)} = &+ T_\lambda\Big(-\frac{3}{5} g_1^2 - \frac{13}{20} g_{1'}^2 - 3 g_2^2 - \frac{1}{20} g_{1'}^2 Q_S^2 + 12|\lambda|^2 + |\sigma|^2 + 3\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + 3\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) \\
&+ 3\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)\Big) \\
&+ \frac{1}{10}\lambda\Big(12 g_1^2 M_1 + 13 g_{1'}^2 M_1' + 60 g_2^2 M_2 + g_{1'}^2 M_1' Q_S^2 + 20\sigma'^{,*} T_\sigma + 60\mathrm{Tr}\Big(Y_d^\dagger T_d\Big) + 20\mathrm{Tr}\Big(Y_e^\dagger T_e\Big) \\
&+ 60\mathrm{Tr}\Big(Y_u^\dagger T_u\Big) + 60\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)\Big)
\end{aligned} \tag{81}
$$

$$
\begin{aligned}
\beta_{T_\lambda}^{(2)} = &- \frac{522}{25} g_1^4 M_1 \lambda - \frac{39}{50} g_1^2 g_{1'}^2 M_1 \lambda - \frac{18}{5} g_1^2 g_2^2 M_1 \lambda - \frac{39}{50} g_1^2 g_{1'}^2 M_1' \lambda - \frac{3431}{200} g_{1'}^4 M_1' \lambda - \frac{39}{10} g_{1'}^2 g_2^2 M_1' \lambda \\
&- \frac{18}{5} g_1^2 g_2^2 M_2 \lambda - \frac{39}{10} g_{1'}^2 g_2^2 M_2 \lambda - 42 g_2^4 M_2 \lambda - \frac{11}{8} g_{1'}^4 M_1' Q_S^2 \lambda - \frac{1}{50} g_{1'}^4 M_1' Q_S^4 \lambda + \frac{261}{50} g_1^4 T_\lambda \\
&+ \frac{39}{100} g_1^2 g_{1'}^2 T_\lambda + \frac{3431}{800} g_{1'}^4 T_\lambda + \frac{9}{5} g_1^2 g_2^2 T_\lambda + \frac{39}{20} g_{1'}^2 g_2^2 T_\lambda + \frac{21}{2} g_2^4 T_\lambda + \frac{11}{32} g_{1'}^4 Q_S^2 T_\lambda \\
&+ \frac{1}{200} g_{1'}^4 Q_S^4 T_\lambda - 50\lambda^2\lambda^{*,2} T_\lambda - 2\sigma^2\sigma'^{,*,2} T_\lambda - 8\lambda\sigma\sigma'^{,*,2} T_\sigma \\
&- 2\kappa'^{,*}\sigma'^{,*}\Big(2\kappa'\lambda T_\sigma + 2\lambda\sigma T_{\kappa'} + \kappa'\sigma T_\lambda\Big) + \frac{4}{5} g_1^2 M_1 \lambda \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + \frac{6}{5} g_{1'}^2 M_1' \lambda \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) \\
&- 32 g_3^2 M_3 \lambda \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - \frac{2}{5} g_1^2 T_\lambda \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - \frac{3}{5} g_{1'}^2 T_\lambda \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 16 g_3^2 T_\lambda \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) \\
&- \frac{12}{5} g_1^2 M_1 \lambda \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + \frac{2}{5} g_{1'}^2 M_1' \lambda \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + \frac{6}{5} g_1^2 T_\lambda \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - \frac{1}{5} g_{1'}^2 T_\lambda \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) \\
&- \frac{8}{5} g_1^2 M_1 \lambda \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) + \frac{3}{5} g_{1'}^2 M_1' \lambda \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) - 32 g_3^2 M_3 \lambda \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big)
\end{aligned}
$$

$$
\begin{aligned}
&+\frac{4}{5}g_1^2T_\lambda\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)-\frac{3}{10}g_{1'}^2T_\lambda\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)+16g_3^2T_\lambda\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)-\frac{8}{5}g_1^2M_1\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)\\
&-\frac{39}{10}g_{1'}^2M_1'\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)-32g_3^2M_3\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)+\frac{3}{10}g_{1'}^2M_1'Q_S^2\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)+\frac{4}{5}g_1^2T_\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)\\
&+\frac{39}{20}g_{1'}^2T_\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)+16g_3^2T_\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)-\frac{3}{20}g_{1'}^2Q_S^2T_\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)-\frac{4}{5}g_1^2\lambda\mathrm{Tr}\Big(Y_d^\dagger T_d\Big)\\
&-\frac{6}{5}g_{1'}^2\lambda\mathrm{Tr}\Big(Y_d^\dagger T_d\Big)+32g_3^2\lambda\mathrm{Tr}\Big(Y_d^\dagger T_d\Big)+\frac{12}{5}g_1^2\lambda\mathrm{Tr}\Big(Y_e^\dagger T_e\Big)-\frac{2}{5}g_{1'}^2\lambda\mathrm{Tr}\Big(Y_e^\dagger T_e\Big)\\
&+\frac{8}{5}g_1^2\lambda\mathrm{Tr}\Big(Y_u^\dagger T_u\Big)-\frac{3}{5}g_{1'}^2\lambda\mathrm{Tr}\Big(Y_u^\dagger T_u\Big)+32g_3^2\lambda\mathrm{Tr}\Big(Y_u^\dagger T_u\Big)+\frac{8}{5}g_1^2\lambda\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)\\
&+\frac{39}{10}g_{1'}^2\lambda\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)+32g_3^2\lambda\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)-\frac{3}{10}g_{1'}^2Q_S^2\lambda\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)\\
&-\frac{1}{10}|\lambda|^2\Big(-3T_\lambda\Big(12g_1^2+13g_{1'}^2-20\sigma\sigma^{\prime,*}-30\mathrm{Tr}\Big(Y_eY_e^\dagger\Big)+60g_2^2-60\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)-90\mathrm{Tr}\Big(Y_dY_d^\dagger\Big)-90\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)\Big)\\
&+2\lambda\Big(12g_1^2M_1+13g_{1'}^2M_1'+60g_2^2M_2+20\sigma^{\prime,*}T_\sigma+90\mathrm{Tr}\Big(Y_d^\dagger T_d\Big)+30\mathrm{Tr}\Big(Y_e^\dagger T_e\Big)+90\mathrm{Tr}\Big(Y_u^\dagger T_u\Big)\\
&+60\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)\Big)\Big)\\
&-9T_\lambda\mathrm{Tr}\Big(Y_dY_d^\dagger Y_dY_d^\dagger\Big)-36\lambda\mathrm{Tr}\Big(Y_dY_d^\dagger T_dY_d^\dagger\Big)-6T_\lambda\mathrm{Tr}\Big(Y_dY_u^\dagger Y_uY_d^\dagger\Big)-12\lambda\mathrm{Tr}\Big(Y_dY_u^\dagger T_uY_d^\dagger\Big)\\
&-3T_\lambda\mathrm{Tr}\Big(Y_eY_e^\dagger Y_eY_e^\dagger\Big)-12\lambda\mathrm{Tr}\Big(Y_eY_e^\dagger T_eY_e^\dagger\Big)-12\lambda\mathrm{Tr}\Big(Y_uY_d^\dagger T_dY_u^\dagger\Big)-9T_\lambda\mathrm{Tr}\Big(Y_uY_u^\dagger Y_uY_u^\dagger\Big)\\
&-36\lambda\mathrm{Tr}\Big(Y_uY_u^\dagger T_uY_u^\dagger\Big)-6T_\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger\kappa\kappa^\dagger\Big)-24\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger T_\kappa\kappa^\dagger\Big)
\end{aligned}
\tag{82}
$$

$$
\begin{aligned}
\beta_{T_u}^{(1)}=&+2Y_uY_d^\dagger T_d+4Y_uY_u^\dagger T_u+T_uY_d^\dagger Y_d+5T_uY_u^\dagger Y_u-\frac{13}{15}g_1^2T_u-\frac{3}{10}g_{1'}^2T_u-3g_2^2T_u\\
&-\frac{16}{3}g_3^2T_u+|\lambda|^2T_u+3T_u\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)\\
&+Y_u\Big(2\lambda^*T_\lambda+6g_2^2M_2+6\mathrm{Tr}\Big(Y_u^\dagger T_u\Big)+\frac{26}{15}g_1^2M_1+\frac{32}{3}g_3^2M_3+\frac{3}{5}g_{1'}^2M_1'\Big)
\end{aligned}
\tag{83}
$$

$$
\begin{aligned}
\beta_{T_u}^{(2)}=&+\frac{4}{5}g_1^2Y_uY_d^\dagger T_d+\frac{6}{5}g_{1'}^2Y_uY_d^\dagger T_d-2|\lambda|^2Y_uY_d^\dagger T_d-\frac{4}{5}g_1^2M_1Y_uY_u^\dagger Y_u\\
&-\frac{6}{5}g_{1'}^2M_1'Y_uY_u^\dagger Y_u-12g_2^2M_2Y_uY_u^\dagger Y_u+\frac{6}{5}g_1^2Y_uY_u^\dagger T_u+\frac{4}{5}g_{1'}^2Y_uY_u^\dagger T_u\\
&+6g_2^2Y_uY_u^\dagger T_u-4|\lambda|^2Y_uY_u^\dagger T_u+\frac{2}{5}g_1^2T_uY_d^\dagger Y_d+\frac{3}{5}g_{1'}^2T_uY_d^\dagger Y_d\\
&-|\lambda|^2T_uY_d^\dagger Y_d+g_{1'}^2T_uY_u^\dagger Y_u+12g_2^2T_uY_u^\dagger Y_u-5|\lambda|^2T_uY_u^\dagger Y_u\\
&-4Y_uY_d^\dagger Y_dY_d^\dagger T_d-2Y_uY_d^\dagger Y_dY_u^\dagger T_u-4Y_uY_d^\dagger T_dY_d^\dagger Y_d-4Y_uY_d^\dagger T_dY_u^\dagger Y_u\\
&-6Y_uY_u^\dagger Y_uY_u^\dagger T_u-8Y_uY_u^\dagger T_uY_u^\dagger Y_u-2T_uY_d^\dagger Y_dY_d^\dagger Y_d-4T_uY_d^\dagger Y_dY_u^\dagger Y_u\\
&-6T_uY_u^\dagger Y_uY_u^\dagger Y_u+\frac{689}{90}g_1^4T_u+\frac{53}{300}g_1^2g_{1'}^2T_u+\frac{153}{80}g_{1'}^4T_u+g_1^2g_2^2T_u+\frac{3}{4}g_{1'}^2g_2^2T_u+\frac{21}{2}g_2^4T_u\\
&+\frac{136}{45}g_1^2g_3^2T_u+\frac{8}{15}g_{1'}^2g_3^2T_u+8g_2^2g_3^2T_u+\frac{128}{9}g_3^4T_u+\frac{3}{200}g_{1'}^4Q_S^2T_u+\frac{1}{4}g_{1'}^2|\lambda|^2T_u\\
&+\frac{1}{20}g_{1'}^2Q_S^2|\lambda|^2T_u-3\lambda^2\lambda^{*,2}T_u-\sigma|\lambda|^2\sigma^{\prime,*}T_u-6\lambda^*Y_uY_u^\dagger Y_uT_\lambda
\end{aligned}
$$

$$
\begin{aligned}
&- 6Y_uY_d^\dagger T_d\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 3T_uY_d^\dagger Y_d\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 3|\lambda|^2T_u\mathrm{Tr}\Big(Y_dY_d^\dagger\Big)\\
&- 2Y_uY_d^\dagger T_d\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) - T_uY_d^\dagger Y_d\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) - |\lambda|^2T_u\mathrm{Tr}\Big(Y_eY_e^\dagger\Big)\\
&- 12Y_uY_u^\dagger T_u\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - 15T_uY_u^\dagger Y_u\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) + \frac{4}{5}g_1^2T_u\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)\\
&- \frac{3}{10}g_{1'}^2T_u\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) + 16g_3^2T_u\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - 3|\lambda|^2T_u\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)\\
&- \frac{2}{5}Y_uY_d^\dagger Y_d\Big(15\mathrm{Tr}\Big(Y_d^\dagger T_d\Big) + 2g_1^2M_1 + 3g_{1'}^2M_1' + 5\lambda^*T_\lambda + 5\mathrm{Tr}\Big(Y_e^\dagger T_e\Big)\Big)\\
&- 18Y_uY_u^\dagger Y_u\mathrm{Tr}\Big(Y_u^\dagger T_u\Big) - 3T_u\mathrm{Tr}\Big(Y_dY_u^\dagger Y_uY_d^\dagger\Big) - 9T_u\mathrm{Tr}\Big(Y_uY_u^\dagger Y_uY_u^\dagger\Big)\\
&- \frac{1}{900}Y_u\Big(27560g_1^4M_1 + 318g_1^2g_{1'}^2M_1 + 1800g_1^2g_2^2M_1 + 5440g_1^2g_3^2M_1 + 318g_1^2g_{1'}^2M_1' + 6885g_{1'}^4M_1'\\
&+ 1350g_{1'}^2g_2^2M_1' + 960g_{1'}^2g_3^2M_1' + 5440g_1^2g_3^2M_3 + 960g_{1'}^2g_3^2M_3 + 14400g_2^2g_3^2M_3 + 51200g_3^4M_3\\
&+ 1800g_1^2g_2^2M_2 + 1350g_{1'}^2g_2^2M_2 + 37800g_2^4M_2 + 14400g_2^2g_3^2M_2 + 54g_{1'}^4M_1'Q_S^2 + 10800\lambda\lambda^{*,2}T_\lambda\\
&+ 180\Big(160g_3^2M_3 - 3g_{1'}^2M_1' + 8g_1^2M_1\Big)\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - 1440g_1^2\mathrm{Tr}\Big(Y_u^\dagger T_u\Big) + 540g_{1'}^2\mathrm{Tr}\Big(Y_u^\dagger T_u\Big)\\
&- 28800g_3^2\mathrm{Tr}\Big(Y_u^\dagger T_u\Big)\\
&+ 90\lambda^*\Big(T_\lambda\Big(20\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) + 20|\sigma|^2 - 5g_{1'}^2 + 60\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 60\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - g_{1'}^2Q_S^2\Big)\\
&+ \lambda\Big(20\mathrm{Tr}\Big(Y_e^\dagger T_e\Big) + 20\sigma'^{,*}T_\sigma + 5g_{1'}^2M_1' + 60\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) + 60\mathrm{Tr}\Big(Y_d^\dagger T_d\Big) + g_{1'}^2M_1'Q_S^2\Big)\Big)\\
&+ 5400\mathrm{Tr}\Big(Y_dY_u^\dagger T_uY_d^\dagger\Big) + 5400\mathrm{Tr}\Big(Y_uY_d^\dagger T_dY_u^\dagger\Big) + 32400\mathrm{Tr}\Big(Y_uY_u^\dagger T_uY_u^\dagger\Big)\Big)
\end{aligned}
\tag{84}
$$

3.8 Bilinear Soft-Breaking Parameters

$$
\beta_{B_{\mu'}}^{(1)} = \frac{1}{5}\Big(-\Big(15g_2^2 + 2g_{1'}^2 + 3g_1^2\Big)B_{\mu'} + 2\Big(15g_2^2M_2 + 2g_{1'}^2M_1' + 3g_1^2M_1\Big)\mu'\Big) \tag{85}
$$

$$
\begin{aligned}
\beta_{B_{\mu'}}^{(2)} = \frac{1}{100}\Big(&-4\Big(1050g_2^4M_2 + 522g_1^4M_1 + 60g_{1'}^2g_2^2\Big(M_1' + M_2\Big) + 6g_1^2\Big(15g_2^2\Big(M_1 + M_2\Big) + 2g_{1'}^2\Big(M_1 + M_1'\Big)\Big) + g_{1'}^4M_1'\Big(2Q_S^2 + 257\Big)\\
&+ \Big(1050g_2^4 + 120g_{1'}^2g_2^2 + 12g_1^2\Big(15g_2^2 + 2g_{1'}^2\Big) + 522g_1^4 + g_{1'}^4\Big(2Q_S^2 + 257\Big)\Big)B_{\mu'}\Big)
\end{aligned}
\tag{86}
$$

$$
\beta_{B_{muphi}}^{(1)} = 2|\sigma|^2B_{muphi} + 4Mu_{phi}\sigma'^{,*}T_\sigma + 8|\kappa'|^2B_{muphi} + 8Mu_{phi}\kappa'^{,*}T_{\kappa'} \tag{87}
$$

$$
\begin{aligned}
\beta_{B_{muphi}}^{(2)} = &-\frac{1}{5}B_{muphi}\Big(160\kappa'^{,2}\kappa'^{,*,2} + 80\sigma|\kappa'|^2\sigma'^{,*} + |\sigma|^2\Big(20\lambda\lambda^* + 20\sigma\sigma'^{,*} + 30\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - g_{1'}^2Q_S^2\Big)\Big)\\
&- \frac{2}{5}Mu_{phi}\Big(200\kappa'\kappa'^{,*,2}T_{\kappa'} + 40\sigma\sigma'^{,*,2}T_\sigma\\
&+ \sigma'^{,*}\Big(g_{1'}^2M_1'Q_S^2\sigma - g_{1'}^2Q_S^2T_\sigma + 20\kappa'^{,*}\Big(2\sigma T_{\kappa'} + 3\kappa'T_\sigma\Big) + 20\lambda^*\Big(\lambda T_\sigma + \sigma T_\lambda\Big) + 30T_\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)\\
&+ 30\sigma\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)\Big)\Big)
\end{aligned}
\tag{88}
$$

3.9 Linear Soft-Breaking Parameters

$$\beta^{(1)}_{\xi_S} = 2B^*_{muphi}T_{\kappa'} + 2|\kappa'|^2\xi_S + 2Mu_{phi}B_{muphi}\kappa'^{,*} + 2XiF_1\sigma'^{,*}T_\sigma + 4m^2_{phi}\kappa' Mu^*_{phi} + 4XiF_1\kappa'^{,*}T_{\kappa'} + |\sigma|^2\xi_S \quad (89)$$

$$\begin{aligned}\beta^{(2)}_{\xi_S} = &-\frac{1}{5}g^2_{1'}M'_1Q^2_S XiF_1|\sigma|^2 - 4Mu_{phi}\Big(2|\kappa'|^2 + |\sigma|^2\Big)B_{muphi}\kappa'^{,*} + \frac{1}{10}g^2_{1'}Q^2_S|\sigma|^2\xi_S - 8\kappa'^{,2}\kappa'^{,*,2}\xi_S \\ &- 4\sigma|\kappa'|^2\sigma'^{,*}\xi_S - 2\sigma|\lambda|^2\sigma'^{,*}\xi_S - 2\sigma^2\sigma'^{,*,2}\xi_S - 8XiF_1|\sigma|^2\kappa'^{,*}T_{\kappa'} - 8Mu^2_{phi}\kappa'^{,*,2}T_{\kappa'} \\ &- 32\kappa' XiF_1\kappa'^{,*,2}T_{\kappa'} - 16|\kappa'|^2B^*_{muphi}T_{\kappa'} - 4|\sigma|^2B^*_{muphi}T_{\kappa'} \\ &- 4Mu^*_{phi}\Big(10m^2_{phi}\kappa'^{,2}\kappa'^{,*} + \Big(3m^2_{phi} + m^2_{s_3} + m^2_{sbar_3}\Big)\kappa'|\sigma|^2 + 4\kappa'|T_{\kappa'}|^2 + \kappa'|T_\sigma|^2 + \sigma T^*_\sigma T_{\kappa'}\Big) \\ &- 4XiF_1|\sigma|^2\lambda^*T_\lambda + \frac{1}{5}g^2_{1'}Q^2_S XiF_1\sigma'^{,*}T_\sigma - 8XiF_1|\kappa'|^2\sigma'^{,*}T_\sigma - 4XiF_1|\lambda|^2\sigma'^{,*}T_\sigma \\ &- 4Mu^2_{phi}\kappa'^{,*}\sigma'^{,*}T_\sigma - 8XiF_1\sigma\sigma'^{,*,2}T_\sigma - 4\kappa'\sigma'^{,*}B^*_{muphi}T_\sigma - 3|\sigma|^2\xi_S\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) \\ &- 6XiF_1\sigma'^{,*}T_\sigma\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 6XiF_1|\sigma|^2\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)\end{aligned} \quad (90)$$

3.10 Soft-Breaking Scalar Masses

$$\sigma_{1,1} = \sqrt{\frac{3}{5}}g_1\Big(-2\mathrm{Tr}\Big(m^2_u\Big) - \mathrm{Tr}\Big(m^2_l\Big) - \mathrm{Tr}\Big(m^2_X\Big) - m^2_{h_{13}} - m^2_{hPr} + m^2_{h\bar{P}r} + m^2_{h_{23}} + \mathrm{Tr}\Big(m^2_d\Big) + \mathrm{Tr}\Big(m^2_{\bar{X}}\Big) + \mathrm{Tr}\Big(m^2_e\Big) + \mathrm{Tr}\Big(m^2_q\Big)\Big) \quad (91)$$

$$\begin{aligned}\sigma_{1,4} = &\frac{1}{2}\frac{1}{\sqrt{10}}g'_1\Big(-6m^2_{h_{13}} + 4m^2_{hPr} - 4m^2_{h\bar{P}r} - 4m^2_{h_{23}} + m^2_{s_3}Q_S - m^2_{sbar_3}Q_S + 6\mathrm{Tr}\Big(m^2_d\Big) - 6\mathrm{Tr}\Big(m^2_X\Big) - 9\mathrm{Tr}\Big(m^2_{\bar{X}}\Big) + \mathrm{Tr}\Big(m^2_e\Big) + 4\mathrm{T} \\ &+ 6\mathrm{Tr}\Big(m^2_q\Big) + 3\mathrm{Tr}\Big(m^2_u\Big)\Big)\end{aligned} \quad (92)$$

$$\sigma_{2,11} = \frac{1}{10}g^2_1\Big(2\mathrm{Tr}\Big(m^2_{\bar{X}}\Big) + 2\mathrm{Tr}\Big(m^2_d\Big) + 2\mathrm{Tr}\Big(m^2_X\Big) + 3m^2_{h\bar{P}r} + 3\mathrm{Tr}\Big(m^2_l\Big) + 3m^2_{h_{13}} + 3m^2_{hPr} + 3m^2_{h_{23}} + 6\mathrm{Tr}\Big(m^2_e\Big) + 8\mathrm{Tr}\Big(m^2_u\Big) + \mathrm{Tr}\Big(m \quad (93)$$

$$\sigma_{2,14} = \frac{1}{10}\sqrt{\frac{3}{2}}g_1g'_1\Big(-2m^2_{h\bar{P}r} + 2\mathrm{Tr}\Big(m^2_d\Big) - 2\mathrm{Tr}\Big(m^2_l\Big) - 2\mathrm{Tr}\Big(m^2_u\Big) + 2\mathrm{Tr}\Big(m^2_X\Big) - 2m^2_{hPr} - 2m^2_{h_{23}} - 3\mathrm{Tr}\Big(m^2_{\bar{X}}\Big) + 3m^2_{h_{13}} + \mathrm{Tr}\Big(m^2_e\Big) + \quad (94)$$

$$\begin{aligned}\sigma_{3,1} = &\frac{1}{40}\frac{1}{\sqrt{15}}g_1\Big(-18g^2_1m^2_{h_{13}} - 27g^2_{1'}m^2_{h_{13}} - 90g^2_2m^2_{h_{13}} - 18g^2_1m^2_{hPr} - 12g^2_{1'}m^2_{hPr} - 90g^2_2m^2_{hPr} + 18g^2_1m^2_{h\bar{P}r} \\ &+ 12g^2_{1'}m^2_{h\bar{P}r} + 90g^2_2m^2_{h\bar{P}r} + 18g^2_1m^2_{h_{23}} + 12g^2_{1'}m^2_{h_{23}} + 90g^2_2m^2_{h_{23}} + 60\Big(-m^2_{h_{23}} + m^2_{h_{13}}\Big)|\lambda|^2 \\ &+ 4\Big(2g^2_1 + 3g^2_{1'} + 40g^2_3\Big)\mathrm{Tr}\Big(m^2_d\Big) - 8g^2_1\mathrm{Tr}\Big(m^2_X\Big) - 12g^2_{1'}\mathrm{Tr}\Big(m^2_X\Big) - 160g^2_3\mathrm{Tr}\Big(m^2_X\Big) + 8g^2_1\mathrm{Tr}\Big(m^2_{\bar{X}}\Big) \\ &+ 27g^2_{1'}\mathrm{Tr}\Big(m^2_{\bar{X}}\Big) + 160g^2_3\mathrm{Tr}\Big(m^2_{\bar{X}}\Big) + 72g^2_1\mathrm{Tr}\Big(m^2_e\Big) + 3g^2_{1'}\mathrm{Tr}\Big(m^2_e\Big) - 18g^2_1\mathrm{Tr}\Big(m^2_l\Big) - 12g^2_{1'}\mathrm{Tr}\Big(m^2_l\Big) \\ &- 90g^2_2\mathrm{Tr}\Big(m^2_l\Big) + 2g^2_1\mathrm{Tr}\Big(m^2_q\Big) + 3g^2_{1'}\mathrm{Tr}\Big(m^2_q\Big) + 90g^2_2\mathrm{Tr}\Big(m^2_q\Big) + 160g^2_3\mathrm{Tr}\Big(m^2_q\Big) - 64g^2_1\mathrm{Tr}\Big(m^2_u\Big) \\ &- 6g^2_{1'}\mathrm{Tr}\Big(m^2_u\Big) - 320g^2_3\mathrm{Tr}\Big(m^2_u\Big) + 180m^2_{h_{13}}\mathrm{Tr}\Big(Y_dY^\dagger_d\Big) + 60m^2_{h_{13}}\mathrm{Tr}\Big(Y_eY^\dagger_e\Big) - 180m^2_{h_{23}}\mathrm{Tr}\Big(Y_uY^\dagger_u\Big)\end{aligned}$$

$$+ 60\mathrm{Tr}\Big(m_{\bar{X}}^2\kappa\kappa^\dagger\Big) - 60\mathrm{Tr}\Big(m_{\bar{X}}^2\kappa^\dagger\kappa\Big) - 120\mathrm{Tr}\Big(Y_d Y_d^\dagger m_d^{2*}\Big) - 60\mathrm{Tr}\Big(Y_d m_q^{2*} Y_d^\dagger\Big) - 120\mathrm{Tr}\Big(Y_e Y_e^\dagger m_e^{2*}\Big)$$
$$+ 60\mathrm{Tr}\Big(Y_e m_l^{2*} Y_e^\dagger\Big) + 240\mathrm{Tr}\Big(Y_u Y_u^\dagger m_u^{2*}\Big) - 60\mathrm{Tr}\Big(Y_u m_q^{2*} Y_u^\dagger\Big)\Big) \tag{95}$$

$$\sigma_{2,2} = \frac{1}{2}\Big(3\mathrm{Tr}\Big(m_q^2\Big) + m_{h_{13}}^2 + m_{hPr}^2 + m_{h\bar{P}r}^2 + m_{h_{23}}^2 + \mathrm{Tr}\Big(m_l^2\Big)\Big) \tag{96}$$

$$\sigma_{2,3} = \frac{1}{2}\Big(2\mathrm{Tr}\Big(m_q^2\Big) + \mathrm{Tr}\Big(m_d^2\Big) + \mathrm{Tr}\Big(m_X^2\Big) + \mathrm{Tr}\Big(m_{\bar{X}}^2\Big) + \mathrm{Tr}\Big(m_u^2\Big)\Big) \tag{97}$$

$$\sigma_{2,41} = \frac{1}{10}\sqrt{\frac{3}{2}} g_1 g_1'\Big(- 2m_{h\bar{P}r}^2 + 2\mathrm{Tr}\Big(m_d^2\Big) - 2\mathrm{Tr}\Big(m_l^2\Big) - 2\mathrm{Tr}\Big(m_u^2\Big) + 2\mathrm{Tr}\Big(m_X^2\Big) - 2m_{hPr}^2 - 2m_{h_{23}}^2 - 3\mathrm{Tr}\Big(m_{\bar{X}}^2\Big) + 3m_{h_{13}}^2 + \mathrm{Tr}\Big(m_e^2\Big) - \tag{98}$$

$$\sigma_{2,44} = \frac{1}{40} g_{1'}^2\Big(18m_{h_{13}}^2 + 8m_{hPr}^2 + 8m_{h\bar{P}r}^2 + 8m_{h_{23}}^2 + m_{s_3}^2 Q_S^2 + m_{sbar_3}^2 Q_S^2 + 12\mathrm{Tr}\Big(m_d^2\Big) + 12\mathrm{Tr}\Big(m_X^2\Big) + 27\mathrm{Tr}\Big(m_{\bar{X}}^2\Big) + \mathrm{Tr}\Big(m_e^2\Big) + 8\mathrm{Tr}$$
$$+ 6\mathrm{Tr}\Big(m_q^2\Big) + 3\mathrm{Tr}\Big(m_u^2\Big)\Big) \tag{99}$$

$$\sigma_{3,4} = \frac{1}{80}\frac{1}{\sqrt{10}} g_1'\Big(- 36g_1^2 m_{h_{13}}^2 - 54g_{1'}^2 m_{h_{13}}^2 - 180g_2^2 m_{h_{13}}^2 + 24g_1^2 m_{hPr}^2 + 16g_{1'}^2 m_{hPr}^2 + 120g_2^2 m_{hPr}^2 - 24g_1^2 m_{h\bar{P}r}^2$$
$$- 16g_{1'}^2 m_{h\bar{P}r}^2 - 120g_2^2 m_{h\bar{P}r}^2 - 24g_1^2 m_{h_{23}}^2 - 16g_{1'}^2 m_{h_{23}}^2 - 120g_2^2 m_{h_{23}}^2 + g_{1'}^2 m_{s_3}^2 Q_S^3 - g_{1'}^2 m_{sbar_3}^2 Q_S^3$$
$$+ 40\Big(2m_{h_{23}}^2 + 3m_{h_{13}}^2 - m_{s_3}^2 Q_S\Big)|\lambda|^2 - 20\Big(- m_{sbar_3}^2 + m_{s_3}^2\Big)Q_S|\sigma|^2 + 16g_1^2\mathrm{Tr}\Big(m_d^2\Big) + 24g_{1'}^2\mathrm{Tr}\Big(m_d^2\Big)$$
$$+ 320g_3^2\mathrm{Tr}\Big(m_d^2\Big) - 16g_1^2\mathrm{Tr}\Big(m_X^2\Big) - 24g_{1'}^2\mathrm{Tr}\Big(m_X^2\Big) - 320g_3^2\mathrm{Tr}\Big(m_X^2\Big) - 24g_1^2\mathrm{Tr}\Big(m_{\bar{X}}^2\Big) - 81g_{1'}^2\mathrm{Tr}\Big(m_{\bar{X}}^2\Big)$$
$$- 480g_3^2\mathrm{Tr}\Big(m_{\bar{X}}^2\Big) + 24g_1^2\mathrm{Tr}\Big(m_e^2\Big) + g_{1'}^2\mathrm{Tr}\Big(m_e^2\Big) + 24g_1^2\mathrm{Tr}\Big(m_l^2\Big) + 16g_{1'}^2\mathrm{Tr}\Big(m_l^2\Big) + 120g_2^2\mathrm{Tr}\Big(m_l^2\Big)$$
$$+ 4g_1^2\mathrm{Tr}\Big(m_q^2\Big) + 6g_{1'}^2\mathrm{Tr}\Big(m_q^2\Big) + 180g_2^2\mathrm{Tr}\Big(m_q^2\Big) + 320g_3^2\mathrm{Tr}\Big(m_q^2\Big) + 32g_1^2\mathrm{Tr}\Big(m_u^2\Big) + 3g_{1'}^2\mathrm{Tr}\Big(m_u^2\Big)$$
$$+ 160g_3^2\mathrm{Tr}\Big(m_u^2\Big) + 360m_{h_{13}}^2\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 120m_{h_{13}}^2\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + 240m_{h_{23}}^2\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big)$$
$$- 60m_{s_3}^2 Q_S\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 120\mathrm{Tr}\Big(m_{\bar{X}}^2\kappa\kappa^\dagger\Big) + 180\mathrm{Tr}\Big(m_{\bar{X}}^2\kappa^\dagger\kappa\Big) - 240\mathrm{Tr}\Big(Y_d Y_d^\dagger m_d^{2*}\Big)$$
$$- 120\mathrm{Tr}\Big(Y_d m_q^{2*} Y_d^\dagger\Big) - 40\mathrm{Tr}\Big(Y_e Y_e^\dagger m_e^{2*}\Big) - 80\mathrm{Tr}\Big(Y_e m_l^{2*} Y_e^\dagger\Big) - 120\mathrm{Tr}\Big(Y_u Y_u^\dagger m_u^{2*}\Big)$$
$$- 120\mathrm{Tr}\Big(Y_u m_q^{2*} Y_u^\dagger\Big)\Big) \tag{100}$$

$$\beta_{m_q^2}^{(1)} = -\frac{2}{15}g_1^2\mathbf{1}|M_1|^2 - \frac{1}{5}g_{1'}^2\mathbf{1}|M_1'|^2 - \frac{32}{3}g_3^2\mathbf{1}|M_3|^2 - 6g_2^2\mathbf{1}|M_2|^2 + 2m_{h_{13}}^2 Y_d^\dagger Y_d + 2m_{h_{23}}^2 Y_u^\dagger Y_u$$
$$+ 2T_d^\dagger T_d + 2T_u^\dagger T_u + m_q^2 Y_d^\dagger Y_d + m_q^2 Y_u^\dagger Y_u + 2Y_d^\dagger m_d^2 Y_d + Y_d^\dagger Y_d m_q^2$$
$$+ 2Y_u^\dagger m_u^2 Y_u + Y_u^\dagger Y_u m_q^2 + \frac{1}{\sqrt{15}}g_1\mathbf{1}\sigma_{1,1} + \frac{1}{\sqrt{10}}g_1'\mathbf{1}\sigma_{1,4} \tag{101}$$

$$\beta_{m_q^2}^{(2)} = +\frac{32}{45}g_1^2 g_3^2\mathbf{1}|M_3|^2 + \frac{16}{15}g_{1'}^2 g_3^2\mathbf{1}|M_3|^2 + 32g_2^2 g_3^2\mathbf{1}|M_3|^2 + \frac{160}{3}g_3^4\mathbf{1}|M_3|^2 + \frac{2}{5}g_1^2 g_2^2\mathbf{1}|M_2|^2$$
$$+ \frac{3}{5}g_{1'}^2 g_2^2\mathbf{1}|M_2|^2 + 51g_2^4\mathbf{1}|M_2|^2 + 32g_2^2 g_3^2\mathbf{1}|M_2|^2 + \frac{16}{45}g_1^2 g_3^2 M_1\mathbf{1}M_3^* + \frac{8}{15}g_{1'}^2 g_3^2 M_1'\mathbf{1}M_3^*$$
$$+ 16g_2^2 g_3^2 M_2\mathbf{1}M_3^* + \frac{1}{5}g_1^2 g_2^2 M_1\mathbf{1}M_2^* + \frac{3}{10}g_{1'}^2 g_2^2 M_1'\mathbf{1}M_2^* + 16g_2^2 g_3^2 M_3\mathbf{1}M_2^*$$

$$
\begin{aligned}
&+ \frac{4}{5}g_1^2 m_{h_{13}}^2 Y_d^\dagger Y_d + \frac{6}{5}g_{1'}^2 m_{h_{13}}^2 Y_d^\dagger Y_d - 4m_{h_{13}}^2 |\lambda|^2 Y_d^\dagger Y_d - 2m_{h_{23}}^2 |\lambda|^2 Y_d^\dagger Y_d \\
&- 2m_{s_3}^2 |\lambda|^2 Y_d^\dagger Y_d - 2|T_\lambda|^2 Y_d^\dagger Y_d - 2\lambda T_\lambda^* Y_d^\dagger T_d + \frac{8}{5}g_1^2 m_{h_{23}}^2 Y_u^\dagger Y_u \\
&+ \frac{2}{5}g_{1'}^2 m_{h_{23}}^2 Y_u^\dagger Y_u - 2m_{h_{13}}^2 |\lambda|^2 Y_u^\dagger Y_u - 4m_{h_{23}}^2 |\lambda|^2 Y_u^\dagger Y_u \\
&- 2m_{s_3}^2 |\lambda|^2 Y_u^\dagger Y_u - 2|T_\lambda|^2 Y_u^\dagger Y_u \\
&+ \frac{1}{450}g_1^2 M_1^* \Big(\Big(10 \Big(16 g_3^2 \Big(2M_1 + M_3 \Big) + 9 g_2^2 \Big(2M_1 + M_2 \Big) \Big) + 1518 g_1^2 M_1 - 51 g_{1'}^2 \Big(2M_1 + M_1' \Big) \Big) \mathbf{1} \\
&+ 360 \Big(2M_1 Y_d^\dagger Y_d - 2Y_u^\dagger T_u + 4M_1 Y_u^\dagger Y_u - Y_d^\dagger T_d \Big) \Big) \\
&+ \frac{1}{600}g_{1'}^2 M_1'^* \Big(\Big(20 \Big(16 g_3^2 \Big(2M_1' + M_3 \Big) + 9 g_2^2 \Big(2M_1' + M_2 \Big) \Big) - 68 g_1^2 \Big(2M_1' + M_1 \Big) + 9 g_{1'}^2 M_1' \Big(2Q_S^2 + 251 \Big) \Big) \mathbf{1} \\
&+ 240 \Big(2M_1' Y_u^\dagger Y_u - 3Y_d^\dagger T_d + 6M_1' Y_d^\dagger Y_d - Y_u^\dagger T_u \Big) \Big) \\
&- 2\lambda T_\lambda^* Y_u^\dagger T_u - \frac{4}{5}g_1^2 M_1 T_d^\dagger Y_d - \frac{6}{5}g_{1'}^2 M_1' T_d^\dagger Y_d + \frac{4}{5}g_1^2 T_d^\dagger T_d \\
&+ \frac{6}{5}g_{1'}^2 T_d^\dagger T_d - 2|\lambda|^2 T_d^\dagger T_d - \frac{8}{5}g_1^2 M_1 T_u^\dagger Y_u - \frac{2}{5}g_{1'}^2 M_1' T_u^\dagger Y_u \\
&+ \frac{8}{5}g_1^2 T_u^\dagger T_u + \frac{2}{5}g_{1'}^2 T_u^\dagger T_u - 2|\lambda|^2 T_u^\dagger T_u + \frac{2}{5}g_1^2 m_q^2 Y_d^\dagger Y_d \\
&+ \frac{3}{5}g_{1'}^2 m_q^2 Y_d^\dagger Y_d - |\lambda|^2 m_q^2 Y_d^\dagger Y_d + \frac{4}{5}g_1^2 m_q^2 Y_u^\dagger Y_u + \frac{1}{5}g_{1'}^2 m_q^2 Y_u^\dagger Y_u \\
&- |\lambda|^2 m_q^2 Y_u^\dagger Y_u + \frac{4}{5}g_1^2 Y_d^\dagger m_d^2 Y_d + \frac{6}{5}g_{1'}^2 Y_d^\dagger m_d^2 Y_d - 2|\lambda|^2 Y_d^\dagger m_d^2 Y_d \\
&+ \frac{2}{5}g_1^2 Y_d^\dagger Y_d m_q^2 + \frac{3}{5}g_{1'}^2 Y_d^\dagger Y_d m_q^2 - |\lambda|^2 Y_d^\dagger Y_d m_q^2 + \frac{8}{5}g_1^2 Y_u^\dagger m_u^2 Y_u \\
&+ \frac{2}{5}g_{1'}^2 Y_u^\dagger m_u^2 Y_u - 2|\lambda|^2 Y_u^\dagger m_u^2 Y_u + \frac{4}{5}g_1^2 Y_u^\dagger Y_u m_q^2 + \frac{1}{5}g_{1'}^2 Y_u^\dagger Y_u m_q^2 \\
&- |\lambda|^2 Y_u^\dagger Y_u m_q^2 - 8m_{h_{13}}^2 Y_d^\dagger Y_d Y_d^\dagger Y_d - 4Y_d^\dagger Y_d T_d^\dagger T_d - 4Y_d^\dagger T_d T_d^\dagger Y_d \\
&- 8m_{h_{23}}^2 Y_u^\dagger Y_u Y_u^\dagger Y_u - 4Y_u^\dagger Y_u T_u^\dagger T_u - 4Y_u^\dagger T_u T_u^\dagger Y_u - 4T_d^\dagger Y_d Y_d^\dagger T_d \\
&- 4T_d^\dagger T_d Y_d^\dagger Y_d - 4T_u^\dagger Y_u Y_u^\dagger T_u - 4T_u^\dagger T_u Y_u^\dagger Y_u - 2m_q^2 Y_d^\dagger Y_d Y_d^\dagger Y_d \\
&- 2m_q^2 Y_u^\dagger Y_u Y_u^\dagger Y_u - 4Y_d^\dagger m_d^2 Y_d Y_d^\dagger Y_d - 4Y_d^\dagger Y_d m_q^2 Y_d^\dagger Y_d - 4Y_d^\dagger Y_d Y_d^\dagger m_d^2 Y_d \\
&- 2Y_d^\dagger Y_d Y_d^\dagger Y_d m_q^2 - 4Y_u^\dagger m_u^2 Y_u Y_u^\dagger Y_u - 4Y_u^\dagger Y_u m_q^2 Y_u^\dagger Y_u - 4Y_u^\dagger Y_u Y_u^\dagger m_u^2 Y_u \\
&- 2Y_u^\dagger Y_u Y_u^\dagger Y_u m_q^2 - 2\lambda^* T_d^\dagger Y_d T_\lambda - 2\lambda^* T_u^\dagger Y_u T_\lambda + 6 g_2^4 \mathbf{1} \sigma_{2,2} + \frac{32}{3} g_3^4 \mathbf{1} \sigma_{2,3} + \frac{2}{15} g_1^2 \mathbf{1} \sigma_{2,11} \\
&+ \frac{1}{5}\sqrt{\frac{2}{3}} g_1 g_1' \mathbf{1} \sigma_{2,14} + \frac{1}{5}\sqrt{\frac{2}{3}} g_1 g_1' \mathbf{1} \sigma_{2,41} + \frac{1}{5} g_{1'}^2 \mathbf{1} \sigma_{2,44} + 4\frac{1}{\sqrt{15}} g_1 \mathbf{1} \sigma_{3,1} + 2\sqrt{\frac{2}{5}} g_1' \mathbf{1} \sigma_{3,4} \\
&- 12 m_{h_{13}}^2 Y_d^\dagger Y_d \mathrm{Tr}\Big(Y_d Y_d^\dagger \Big) - 6 T_d^\dagger T_d \mathrm{Tr}\Big(Y_d Y_d^\dagger \Big) - 3 m_q^2 Y_d^\dagger Y_d \mathrm{Tr}\Big(Y_d Y_d^\dagger \Big) \\
&- 6 Y_d^\dagger m_d^2 Y_d \mathrm{Tr}\Big(Y_d Y_d^\dagger \Big) - 3 Y_d^\dagger Y_d m_q^2 \mathrm{Tr}\Big(Y_d Y_d^\dagger \Big) - 4 m_{h_{13}}^2 Y_d^\dagger Y_d \mathrm{Tr}\Big(Y_e Y_e^\dagger \Big) \\
&- 2 T_d^\dagger T_d \mathrm{Tr}\Big(Y_e Y_e^\dagger \Big) - m_q^2 Y_d^\dagger Y_d \mathrm{Tr}\Big(Y_e Y_e^\dagger \Big) - 2 Y_d^\dagger m_d^2 Y_d \mathrm{Tr}\Big(Y_e Y_e^\dagger \Big)
\end{aligned}
$$

$$
\begin{aligned}
&- Y_d^\dagger Y_d m_q^2 \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 12 m_{h_{23}}^2 Y_u^\dagger Y_u \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) - 6 T_u^\dagger T_u \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) \\
&- 3 m_q^2 Y_u^\dagger Y_u \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) - 6 Y_u^\dagger m_u^2 Y_u \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) - 3 Y_u^\dagger Y_u m_q^2 \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) \\
&- 6 T_d^\dagger Y_d \mathrm{Tr}\Big(Y_d^\dagger T_d\Big) - 2 T_d^\dagger Y_d \mathrm{Tr}\Big(Y_e^\dagger T_e\Big) - 6 T_u^\dagger Y_u \mathrm{Tr}\Big(Y_u^\dagger T_u\Big) \\
&- 6 Y_d^\dagger T_d \mathrm{Tr}\Big(T_d^* Y_d^T\Big) - 6 Y_d^\dagger Y_d \mathrm{Tr}\Big(T_d^* T_d^T\Big) - 2 Y_d^\dagger T_d \mathrm{Tr}\Big(T_e^* Y_e^T\Big) \\
&- 2 Y_d^\dagger Y_d \mathrm{Tr}\Big(T_e^* T_e^T\Big) - 6 Y_u^\dagger T_u \mathrm{Tr}\Big(T_u^* Y_u^T\Big) - 6 Y_u^\dagger Y_u \mathrm{Tr}\Big(T_u^* T_u^T\Big) \\
&- 6 Y_d^\dagger Y_d \mathrm{Tr}\Big(m_d^2 Y_d Y_d^\dagger\Big) - 2 Y_d^\dagger Y_d \mathrm{Tr}\Big(m_e^2 Y_e Y_e^\dagger\Big) - 2 Y_d^\dagger Y_d \mathrm{Tr}\Big(m_l^2 Y_e^\dagger Y_e\Big) \\
&- 6 Y_d^\dagger Y_d \mathrm{Tr}\Big(m_q^2 Y_d^\dagger Y_d\Big) - 6 Y_u^\dagger Y_u \mathrm{Tr}\Big(m_q^2 Y_u^\dagger Y_u\Big) - 6 Y_u^\dagger Y_u \mathrm{Tr}\Big(m_u^2 Y_u Y_u^\dagger\Big)
\end{aligned} \tag{102}
$$

$$
\begin{aligned}
\beta^{(1)}_{m_l^2} =& -\frac{6}{5} g_1^2 \mathbf{1} |M_1|^2 - \frac{4}{5} g_{1'}^2 \mathbf{1} |M_1'|^2 - 6 g_2^2 \mathbf{1} |M_2|^2 + 2 m_{h_{13}}^2 Y_e^\dagger Y_e + 2 T_e^\dagger T_e + m_l^2 Y_e^\dagger Y_e \\
&+ 2 Y_e^\dagger m_e^2 Y_e + Y_e^\dagger Y_e m_l^2 - \sqrt{\frac{3}{5}} g_1 \mathbf{1} \sigma_{1,1} + \sqrt{\frac{2}{5}} g_1' \mathbf{1} \sigma_{1,4}
\end{aligned} \tag{103}
$$

$$
\begin{aligned}
\beta^{(2)}_{m_l^2} =& + \frac{18}{5} g_1^2 g_2^2 \mathbf{1} |M_2|^2 + \frac{12}{5} g_{1'}^2 g_2^2 \mathbf{1} |M_2|^2 + 51 g_2^4 \mathbf{1} |M_2|^2 + \frac{9}{5} g_1^2 g_2^2 M_1 \mathbf{1} M_2^* + \frac{6}{5} g_{1'}^2 g_2^2 M_1' \mathbf{1} M_2^* \\
&+ \frac{12}{5} g_1^2 m_{h_{13}}^2 Y_e^\dagger Y_e + \frac{3}{5} g_{1'}^2 m_{h_{13}}^2 Y_e^\dagger Y_e - 4 m_{h_{13}}^2 |\lambda|^2 Y_e^\dagger Y_e - 2 m_{h_{23}}^2 |\lambda|^2 Y_e^\dagger Y_e \\
&- 2 m_{s_3}^2 |\lambda|^2 Y_e^\dagger Y_e - 2 |T_\lambda|^2 Y_e^\dagger Y_e \\
&+ \frac{3}{25} g_1^2 M_1^* \Big(\Big(15 g_2^2 \Big(2 M_1 + M_2 \Big) + 261 g_1^2 M_1 + 8 g_{1'}^2 \Big(2 M_1 + M_1' \Big) \Big) \mathbf{1} - 20 Y_e^\dagger T_e + 40 M_1 Y_e^\dagger Y_e \Big) \\
&+ \frac{3}{50} g_{1'}^2 M_1'^* \Big(- 10 Y_e^\dagger T_e + \Big(16 g_1^2 \Big(2 M_1' + M_1 \Big) + 20 g_2^2 \Big(2 M_1' + M_2 \Big) + g_{1'}^2 M_1' \Big(2 Q_S^2 + 257 \Big) \Big) \mathbf{1} + 20 M_1' Y_e^\dagger Y_e \Big) \\
&- 2 \lambda T_\lambda^* Y_e^\dagger T_e - \frac{12}{5} g_1^2 M_1 T_e^\dagger Y_e - \frac{3}{5} g_{1'}^2 M_1' T_e^\dagger Y_e + \frac{12}{5} g_1^2 T_e^\dagger T_e \\
&+ \frac{3}{5} g_{1'}^2 T_e^\dagger T_e - 2 |\lambda|^2 T_e^\dagger T_e + \frac{6}{5} g_1^2 m_l^2 Y_e^\dagger Y_e + \frac{3}{10} g_{1'}^2 m_l^2 Y_e^\dagger Y_e \\
&- |\lambda|^2 m_l^2 Y_e^\dagger Y_e + \frac{12}{5} g_1^2 Y_e^\dagger m_e^2 Y_e + \frac{3}{5} g_{1'}^2 Y_e^\dagger m_e^2 Y_e - 2 |\lambda|^2 Y_e^\dagger m_e^2 Y_e \\
&+ \frac{6}{5} g_1^2 Y_e^\dagger Y_e m_l^2 + \frac{3}{10} g_{1'}^2 Y_e^\dagger Y_e m_l^2 - |\lambda|^2 Y_e^\dagger Y_e m_l^2 - 8 m_{h_{13}}^2 Y_e^\dagger Y_e Y_e^\dagger Y_e \\
&- 4 Y_e^\dagger Y_e T_e^\dagger T_e - 4 Y_e^\dagger T_e T_e^\dagger Y_e - 4 T_e^\dagger Y_e Y_e^\dagger T_e - 4 T_e^\dagger T_e Y_e^\dagger Y_e \\
&- 2 m_l^2 Y_e^\dagger Y_e Y_e^\dagger Y_e - 4 Y_e^\dagger m_e^2 Y_e Y_e^\dagger Y_e - 4 Y_e^\dagger Y_e m_l^2 Y_e^\dagger Y_e - 4 Y_e^\dagger Y_e Y_e^\dagger m_e^2 Y_e \\
&- 2 Y_e^\dagger Y_e Y_e^\dagger Y_e m_l^2 - 2 \lambda^* T_e^\dagger Y_e T_\lambda + 6 g_2^4 \mathbf{1} \sigma_{2,2} + \frac{6}{5} g_1^2 \mathbf{1} \sigma_{2,11} - \frac{2}{5} \sqrt{6} g_1 g_1' \mathbf{1} \sigma_{2,14} - \frac{2}{5} \sqrt{6} g_1 g_1' \mathbf{1} \sigma_{2,41} \\
&+ \frac{4}{5} g_{1'}^2 \mathbf{1} \sigma_{2,44} - 4 \sqrt{\frac{3}{5}} g_1 \mathbf{1} \sigma_{3,1} + 4 \sqrt{\frac{2}{5}} g_1' \mathbf{1} \sigma_{3,4} - 12 m_{h_{13}}^2 Y_e^\dagger Y_e \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 6 T_e^\dagger T_e \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) \\
&- 3 m_l^2 Y_e^\dagger Y_e \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 6 Y_e^\dagger m_e^2 Y_e \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 3 Y_e^\dagger Y_e m_l^2 \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) \\
&- 4 m_{h_{13}}^2 Y_e^\dagger Y_e \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 2 T_e^\dagger T_e \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - m_l^2 Y_e^\dagger Y_e \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big)
\end{aligned}
$$

$$
\begin{aligned}
&- 2Y_e^\dagger m_e^2 Y_e \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - Y_e^\dagger Y_e m_l^2 \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 6T_e^\dagger Y_e \mathrm{Tr}\Big(Y_d^\dagger T_d\Big) \\
&- 2T_e^\dagger Y_e \mathrm{Tr}\Big(Y_e^\dagger T_e\Big) - 6Y_e^\dagger T_e \mathrm{Tr}\Big(T_d^* Y_d^T\Big) - 6Y_e^\dagger Y_e \mathrm{Tr}\Big(T_d^* T_d^T\Big) \\
&- 2Y_e^\dagger T_e \mathrm{Tr}\Big(T_e^* Y_e^T\Big) - 2Y_e^\dagger Y_e \mathrm{Tr}\Big(T_e^* T_e^T\Big) - 6Y_e^\dagger Y_e \mathrm{Tr}\Big(m_d^2 Y_d Y_d^\dagger\Big) \\
&- 2Y_e^\dagger Y_e \mathrm{Tr}\Big(m_e^2 Y_e Y_e^\dagger\Big) - 2Y_e^\dagger Y_e \mathrm{Tr}\Big(m_l^2 Y_e^\dagger Y_e\Big) - 6Y_e^\dagger Y_e \mathrm{Tr}\Big(m_q^2 Y_d^\dagger Y_d\Big) \qquad (104)
\end{aligned}
$$

$$
\begin{aligned}
\beta^{(1)}_{m_{h_{13}}^2} &= -\frac{6}{5} g_1^2 |M_1|^2 - \frac{9}{5} g_{1'}^2 |M_1'|^2 - 6 g_2^2 |M_2|^2 + 2 m_{h_{13}}^2 |\lambda|^2 + 2 m_{h_{23}}^2 |\lambda|^2 + 2 m_{s_3}^2 |\lambda|^2 + 2 |T_\lambda|^2 \\
&- \sqrt{\frac{3}{5}} g_1 \sigma_{1,1} - 3 \frac{1}{\sqrt{10}} g_1' \sigma_{1,4} + 6 m_{h_{13}}^2 \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 2 m_{h_{13}}^2 \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + 6 \mathrm{Tr}\Big(T_d^* T_d^T\Big) + 2 \mathrm{Tr}\Big(T_e^* T_e^T\Big) \\
&+ 6 \mathrm{Tr}\Big(m_d^2 Y_d Y_d^\dagger\Big) + 2 \mathrm{Tr}\Big(m_e^2 Y_e Y_e^\dagger\Big) + 2 \mathrm{Tr}\Big(m_l^2 Y_e^\dagger Y_e\Big) + 6 \mathrm{Tr}\Big(m_q^2 Y_d^\dagger Y_d\Big) \qquad (105)
\end{aligned}
$$

$$
\begin{aligned}
\beta^{(2)}_{m_{h_{13}}^2} &= \frac{1}{200} \Big(4 g_1^2 M_1^* \Big(1566 g_1^2 M_1 - 54 g_{1'}^2 M_1 + 180 g_2^2 M_1 - 27 g_{1'}^2 M_1' + 90 g_2^2 M_2 - 80 M_1 \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 240 M_1 \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) \\
&+ 40 \mathrm{Tr}\Big(Y_d^\dagger T_d\Big) - 120 \mathrm{Tr}\Big(Y_e^\dagger T_e\Big) \Big) \\
&+ g_{1'}^2 M_1'^* \Big(- 108 g_1^2 M_1 - 216 g_1^2 M_1' + 7209 g_{1'}^2 M_1' + 1080 g_2^2 M_1' + 540 g_2^2 M_2 + 54 g_{1'}^2 M_1' Q_S^2 \\
&+ 20 \Big(- 5 + Q_S^2 \Big) \lambda^* \Big(2 M_1' \lambda - T_\lambda \Big) - 480 M_1' \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 160 M_1' \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + 240 \mathrm{Tr}\Big(Y_d^\dagger T_d\Big) + 80 \mathrm{Tr}\Big(Y_e^\dagger T_e\Big) \Big) \\
&+ 20 \Big(- 5 g_{1'}^2 |T_\lambda|^2 + g_{1'}^2 Q_S^2 |T_\lambda|^2 + 3 g_2^2 \Big(170 g_2^2 M_2 + 6 g_1^2 \Big(2 M_2 + M_1 \Big) + 9 g_{1'}^2 \Big(2 M_2 + M_1' \Big) \Big) M_2^* \\
&- 120 \Big(m_{h_{13}}^2 + m_{h_{23}}^2 + m_{s_3}^2 \Big) \lambda^2 \lambda^{*,2} + 5 g_{1'}^2 M_1' \lambda T_\lambda^* - g_{1'}^2 M_1' Q_S^2 \lambda T_\lambda^* - 20 |\sigma|^2 T_\lambda^* T_\lambda \\
&- 20 \lambda \sigma'^{,*} T_\lambda^* T_\sigma + 60 g_2^4 \sigma_{2,2} + 12 g_1^2 \sigma_{2,11} + 6 \sqrt{6} g_1 g_1' \sigma_{2,14} + 6 \sqrt{6} g_1 g_1' \sigma_{2,41} + 18 g_{1'}^2 \sigma_{2,44} \\
&- 8 \sqrt{15} g_1 \sigma_{3,1} - 12 \sqrt{10} g_1' \sigma_{3,4} - 8 g_1^2 m_{h_{13}}^2 \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 12 g_{1'}^2 m_{h_{13}}^2 \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) \\
&+ 320 g_3^2 m_{h_{13}}^2 \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 640 g_3^2 |M_3|^2 \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 24 g_1^2 m_{h_{13}}^2 \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) \\
&- 4 g_{1'}^2 m_{h_{13}}^2 \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 60 |T_\lambda|^2 \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) - 60 |T_\lambda|^2 \mathrm{Tr}\Big(\kappa \kappa^\dagger\Big) - 320 g_3^2 M_3^* \mathrm{Tr}\Big(Y_d^\dagger T_d\Big) \\
&- 60 \lambda T_\lambda^* \mathrm{Tr}\Big(Y_u^\dagger T_u\Big) - 60 \lambda T_\lambda^* \mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) + 8 g_1^2 M_1 \mathrm{Tr}\Big(T_d^* Y_d^T\Big) + 12 g_{1'}^2 M_1' \mathrm{Tr}\Big(T_d^* Y_d^T\Big) \\
&- 320 g_3^2 M_3 \mathrm{Tr}\Big(T_d^* Y_d^T\Big) - 8 g_1^2 \mathrm{Tr}\Big(T_d^* T_d^T\Big) - 12 g_{1'}^2 \mathrm{Tr}\Big(T_d^* T_d^T\Big) + 320 g_3^2 \mathrm{Tr}\Big(T_d^* T_d^T\Big) \\
&- 24 g_1^2 M_1 \mathrm{Tr}\Big(T_e^* Y_e^T\Big) + 4 g_{1'}^2 M_1' \mathrm{Tr}\Big(T_e^* Y_e^T\Big) + 24 g_1^2 \mathrm{Tr}\Big(T_e^* T_e^T\Big) - 4 g_{1'}^2 \mathrm{Tr}\Big(T_e^* T_e^T\Big) \\
&- 8 g_1^2 \mathrm{Tr}\Big(m_d^2 Y_d Y_d^\dagger\Big) - 12 g_{1'}^2 \mathrm{Tr}\Big(m_d^2 Y_d Y_d^\dagger\Big) + 320 g_3^2 \mathrm{Tr}\Big(m_d^2 Y_d Y_d^\dagger\Big) + 24 g_1^2 \mathrm{Tr}\Big(m_e^2 Y_e Y_e^\dagger\Big) \\
&- 4 g_{1'}^2 \mathrm{Tr}\Big(m_e^2 Y_e Y_e^\dagger\Big) + 24 g_1^2 \mathrm{Tr}\Big(m_l^2 Y_e^\dagger Y_e\Big) - 4 g_{1'}^2 \mathrm{Tr}\Big(m_l^2 Y_e^\dagger Y_e\Big) - 8 g_1^2 \mathrm{Tr}\Big(m_q^2 Y_d^\dagger Y_d\Big) \\
&- 12 g_{1'}^2 \mathrm{Tr}\Big(m_q^2 Y_d^\dagger Y_d\Big) + 320 g_3^2 \mathrm{Tr}\Big(m_q^2 Y_d^\dagger Y_d\Big) \Big) \\
&+ \lambda^* \Big(- 5 g_{1'}^2 m_{h_{13}}^2 \lambda - 5 g_{1'}^2 m_{h_{23}}^2 \lambda - 5 g_{1'}^2 m_{s_3}^2 \lambda + g_{1'}^2 m_{h_{13}}^2 Q_S^2 \lambda + g_{1'}^2 m_{h_{23}}^2 Q_S^2 \lambda + g_{1'}^2 m_{s_3}^2 Q_S^2 \lambda \\
&- 20 \Big(2 m_{s_3}^2 + m_{h_{13}}^2 + m_{h_{23}}^2 + m_{phi}^2 + m_{sbar_3}^2 \Big) \lambda |\sigma|^2 - 240 \lambda |T_\lambda|^2 - 20 \lambda |T_\sigma|^2 - 20 \sigma T_\sigma^* T_\lambda
\end{aligned}
$$

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\begin{aligned}
&- 60m_{h_{13}}^2\lambda\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - 120m_{h_{23}}^2\lambda\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - 60m_{s_3}^2\lambda\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - 60m_{h_{13}}^2\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)\\
&- 60m_{h_{23}}^2\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 120m_{s_3}^2\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 60T_\lambda\mathrm{Tr}\Big(T_u^*Y_u^T\Big) - 60\lambda\mathrm{Tr}\Big(T_u^*T_u^T\Big) - 60T_\lambda\mathrm{Tr}\Big(T_\kappa^*\kappa^T\Big)\\
&- 60\lambda\mathrm{Tr}\Big(T_\kappa^*T_\kappa^T\Big) - 60\lambda\mathrm{Tr}\Big(m_q^2Y_u^\dagger Y_u\Big) - 60\lambda\mathrm{Tr}\Big(m_u^2Y_uY_u^\dagger\Big) - 60\lambda\mathrm{Tr}\Big(\kappa\kappa^\dagger m_X^{2*}\Big)\\
&- 60\lambda\mathrm{Tr}\Big(\kappa m_{\bar{X}}^{2*}\kappa^\dagger\Big)\Big)\\
&- 360m_{h_{13}}^2\mathrm{Tr}\Big(Y_dY_d^\dagger Y_dY_d^\dagger\Big) - 360\mathrm{Tr}\Big(Y_dY_d^\dagger T_dT_d^\dagger\Big) - 60m_{h_{13}}^2\mathrm{Tr}\Big(Y_dY_u^\dagger Y_uY_d^\dagger\Big)\\
&- 60m_{h_{23}}^2\mathrm{Tr}\Big(Y_dY_u^\dagger Y_uY_d^\dagger\Big) - 60\mathrm{Tr}\Big(Y_dY_u^\dagger T_uT_d^\dagger\Big) - 360\mathrm{Tr}\Big(Y_dT_d^\dagger T_dY_d^\dagger\Big)\\
&- 60\mathrm{Tr}\Big(Y_dT_u^\dagger T_uY_d^\dagger\Big) - 120m_{h_{13}}^2\mathrm{Tr}\Big(Y_eY_e^\dagger Y_eY_e^\dagger\Big) - 120\mathrm{Tr}\Big(Y_eY_e^\dagger T_eT_e^\dagger\Big)\\
&- 120\mathrm{Tr}\Big(Y_eT_e^\dagger T_eY_e^\dagger\Big) - 60\mathrm{Tr}\Big(Y_uY_d^\dagger T_dT_u^\dagger\Big) - 60\mathrm{Tr}\Big(Y_uT_d^\dagger T_dY_u^\dagger\Big) - 360\mathrm{Tr}\Big(m_d^2Y_dY_d^\dagger Y_dY_d^\dagger\Big)\\
&- 60\mathrm{Tr}\Big(m_d^2Y_dY_u^\dagger Y_uY_d^\dagger\Big) - 120\mathrm{Tr}\Big(m_e^2Y_eY_e^\dagger Y_eY_e^\dagger\Big) - 120\mathrm{Tr}\Big(m_l^2Y_e^\dagger Y_eY_e^\dagger Y_e\Big)\\
&- 360\mathrm{Tr}\Big(m_q^2Y_d^\dagger Y_dY_d^\dagger Y_d\Big) - 60\mathrm{Tr}\Big(m_q^2Y_d^\dagger Y_dY_u^\dagger Y_u\Big) - 60\mathrm{Tr}\Big(m_q^2Y_u^\dagger Y_uY_d^\dagger Y_d\Big)\\
&- 60\mathrm{Tr}\Big(m_u^2Y_uY_d^\dagger Y_dY_u^\dagger\Big)\Big)\Big) \qquad (106)
\end{aligned}
$$

$$
\begin{aligned}
\beta^{(1)}_{m_{h_{23}}^2} &= -\frac{6}{5}g_1^2|M_1|^2 - \frac{4}{5}g_{1'}^2|M_1'|^2 - 6g_2^2|M_2|^2 + 2m_{h_{13}}^2|\lambda|^2 + 2m_{h_{23}}^2|\lambda|^2 + 2m_{s_3}^2|\lambda|^2 + 2|T_\lambda|^2\\
&+ \sqrt{\frac{3}{5}}g_1\sigma_{1,1} - \sqrt{\frac{2}{5}}g_1'\sigma_{1,4} + 6m_{h_{23}}^2\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) + 6\mathrm{Tr}\Big(T_u^*T_u^T\Big) + 6\mathrm{Tr}\Big(m_q^2Y_u^\dagger Y_u\Big) + 6\mathrm{Tr}\Big(m_u^2Y_uY_u^\dagger\Big) \qquad (107)
\end{aligned}
$$

$$
\begin{aligned}
\beta^{(2)}_{m_{h_{23}}^2} &= +\frac{18}{5}g_1^2g_2^2|M_2|^2 + \frac{12}{5}g_{1'}^2g_2^2|M_2|^2 + 51g_2^4|M_2|^2 + \frac{1}{2}g_{1'}^2m_{h_{13}}^2|\lambda|^2 + \frac{1}{2}g_{1'}^2m_{h_{23}}^2|\lambda|^2\\
&+ \frac{1}{2}g_{1'}^2m_{s_3}^2|\lambda|^2 + \frac{1}{10}g_{1'}^2m_{h_{13}}^2Q_S^2|\lambda|^2 + \frac{1}{10}g_{1'}^2m_{h_{23}}^2Q_S^2|\lambda|^2 + \frac{1}{10}g_{1'}^2m_{s_3}^2Q_S^2|\lambda|^2\\
&+ \frac{1}{2}g_{1'}^2|T_\lambda|^2 + \frac{1}{10}g_{1'}^2Q_S^2|T_\lambda|^2 + \frac{9}{5}g_1^2g_2^2M_1M_2^* + \frac{6}{5}g_{1'}^2g_2^2M_1'M_2^* - 12m_{h_{13}}^2\lambda^2\lambda^{*,2}\\
&- 12m_{h_{23}}^2\lambda^2\lambda^{*,2} - 12m_{s_3}^2\lambda^2\lambda^{*,2} - 2m_{h_{13}}^2\sigma|\lambda|^2\sigma'^{,*} - 2m_{h_{23}}^2\sigma|\lambda|^2\sigma'^{,*} - 2m_{phi}^2\sigma|\lambda|^2\sigma'^{,*}\\
&- 4m_{s_3}^2\sigma|\lambda|^2\sigma'^{,*} - 2m_{sbar_3}^2\sigma|\lambda|^2\sigma'^{,*} - \frac{1}{2}g_{1'}^2M_1'\lambda T_\lambda^* - \frac{1}{10}g_{1'}^2M_1'Q_S^2\lambda T_\lambda^*\\
&- 24|\lambda|^2T_\lambda^*T_\lambda - 2|\sigma|^2T_\lambda^*T_\lambda - 2\sigma\lambda^*T_\sigma^*T_\lambda - 2\lambda\sigma'^{,*}T_\lambda^*T_\sigma - 2|\lambda|^2T_\sigma^*T_\sigma + 6g_2^4\sigma_{2,2}\\
&+ \frac{6}{5}g_1^2\sigma_{2,11} - \frac{2}{5}\sqrt{6}g_1g_1'\sigma_{2,14} - \frac{2}{5}\sqrt{6}g_1g_1'\sigma_{2,41} + \frac{4}{5}g_{1'}^2\sigma_{2,44} + 4\sqrt{\frac{3}{5}}g_1\sigma_{3,1} - 4\sqrt{\frac{2}{5}}g_1'\sigma_{3,4} - 12m_{h_{13}}^2|\lambda|^2\mathrm{Tr}\Big(Y_dY_d^\dagger\Big)\\
&- 6m_{h_{23}}^2|\lambda|^2\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 6m_{s_3}^2|\lambda|^2\mathrm{Tr}\Big(Y_dY_d^\dagger\Big) - 6|T_\lambda|^2\mathrm{Tr}\Big(Y_dY_d^\dagger\Big)\\
&- 4m_{h_{13}}^2|\lambda|^2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) - 2m_{h_{23}}^2|\lambda|^2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) - 2m_{s_3}^2|\lambda|^2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big)\\
&- 2|T_\lambda|^2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big) + \frac{8}{5}g_1^2m_{h_{23}}^2\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - \frac{3}{5}g_{1'}^2m_{h_{23}}^2\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) + 32g_3^2m_{h_{23}}^2\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)\\
&+ 64g_3^2|M_3|^2\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) - 6m_{h_{13}}^2|\lambda|^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 6m_{h_{23}}^2|\lambda|^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)
\end{aligned}
$$

$$
\begin{aligned}
&- 12m_{s_3}^2|\lambda|^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 6|T_\lambda|^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 6\lambda T_\lambda^*\mathrm{Tr}\Big(Y_d^\dagger T_d\Big) - 2\lambda T_\lambda^*\mathrm{Tr}\Big(Y_e^\dagger T_e\Big)\\
&+ \frac{1}{25}g_1^2M_1^*\Big(24g_{1'}^2M_1' - 40\mathrm{Tr}\Big(Y_u^\dagger T_u\Big) + 45g_2^2M_2 + 48g_{1'}^2M_1 + 783g_1^2M_1 + 80M_1\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) + 90g_2^2M_1\Big)\\
&- 32g_3^2M_3^*\mathrm{Tr}\Big(Y_u^\dagger T_u\Big)\\
&+ \frac{1}{50}g_{1'}^2M_1'^*\Big(48g_1^2M_1 + 96g_1^2M_1' + 771g_{1'}^2M_1' + 120g_2^2M_1' + 60g_2^2M_2 + 6g_{1'}^2M_1'Q_S^2 + 5\Big(5+Q_S^2\Big)\lambda^*\Big(2M_1'\lambda - T_\lambda\Big)\\
&- 60M_1'\mathrm{Tr}\Big(Y_uY_u^\dagger\Big) + 30\mathrm{Tr}\Big(Y_u^\dagger T_u\Big)\Big)\\
&- 6\lambda T_\lambda^*\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) - 6\lambda^*T_\lambda\mathrm{Tr}\Big(T_d^*Y_d^T\Big) - 6|\lambda|^2\mathrm{Tr}\Big(T_d^*T_d^T\Big) - 2\lambda^*T_\lambda\mathrm{Tr}\Big(T_e^*Y_e^T\Big)\\
&- 2|\lambda|^2\mathrm{Tr}\Big(T_e^*T_e^T\Big) - \frac{8}{5}g_1^2M_1\mathrm{Tr}\Big(T_u^*Y_u^T\Big) + \frac{3}{5}g_{1'}^2M_1'\mathrm{Tr}\Big(T_u^*Y_u^T\Big) - 32g_3^2M_3\mathrm{Tr}\Big(T_u^*Y_u^T\Big)\\
&+ \frac{8}{5}g_1^2\mathrm{Tr}\Big(T_u^*T_u^T\Big) - \frac{3}{5}g_{1'}^2\mathrm{Tr}\Big(T_u^*T_u^T\Big) + 32g_3^2\mathrm{Tr}\Big(T_u^*T_u^T\Big) - 6\lambda^*T_\lambda\mathrm{Tr}\Big(T_\kappa^*\kappa^T\Big)\\
&- 6|\lambda|^2\mathrm{Tr}\Big(T_\kappa^*T_\kappa^T\Big) - 6|\lambda|^2\mathrm{Tr}\Big(m_d^2Y_dY_d^\dagger\Big) - 2|\lambda|^2\mathrm{Tr}\Big(m_e^2Y_eY_e^\dagger\Big) - 2|\lambda|^2\mathrm{Tr}\Big(m_l^2Y_e^\dagger Y_e\Big)\\
&- 6|\lambda|^2\mathrm{Tr}\Big(m_q^2Y_d^\dagger Y_d\Big) + \frac{8}{5}g_1^2\mathrm{Tr}\Big(m_q^2Y_u^\dagger Y_u\Big) - \frac{3}{5}g_{1'}^2\mathrm{Tr}\Big(m_q^2Y_u^\dagger Y_u\Big) + 32g_3^2\mathrm{Tr}\Big(m_q^2Y_u^\dagger Y_u\Big)\\
&+ \frac{8}{5}g_1^2\mathrm{Tr}\Big(m_u^2Y_uY_u^\dagger\Big) - \frac{3}{5}g_{1'}^2\mathrm{Tr}\Big(m_u^2Y_uY_u^\dagger\Big) + 32g_3^2\mathrm{Tr}\Big(m_u^2Y_uY_u^\dagger\Big) - 6|\lambda|^2\mathrm{Tr}\Big(\kappa\kappa^\dagger m_X^{2*}\Big)\\
&- 6|\lambda|^2\mathrm{Tr}\Big(\kappa m_{\bar{X}}^{2*}\kappa^\dagger\Big) - 6m_{h_{13}}^2\mathrm{Tr}\Big(Y_dY_u^\dagger Y_uY_d^\dagger\Big) - 6m_{h_{23}}^2\mathrm{Tr}\Big(Y_dY_u^\dagger Y_uY_d^\dagger\Big)\\
&- 6\mathrm{Tr}\Big(Y_dY_u^\dagger T_uT_d^\dagger\Big) - 6\mathrm{Tr}\Big(Y_dT_u^\dagger T_uY_d^\dagger\Big) - 6\mathrm{Tr}\Big(Y_uY_d^\dagger T_dT_u^\dagger\Big) - 36m_{h_{23}}^2\mathrm{Tr}\Big(Y_uY_u^\dagger Y_uY_u^\dagger\Big)\\
&- 36\mathrm{Tr}\Big(Y_uY_u^\dagger T_uT_u^\dagger\Big) - 6\mathrm{Tr}\Big(Y_uT_d^\dagger T_dY_u^\dagger\Big) - 36\mathrm{Tr}\Big(Y_uT_u^\dagger T_uY_u^\dagger\Big)\\
&- 6\mathrm{Tr}\Big(m_d^2Y_dY_u^\dagger Y_uY_d^\dagger\Big) - 6\mathrm{Tr}\Big(m_q^2Y_d^\dagger Y_dY_u^\dagger Y_u\Big) - 6\mathrm{Tr}\Big(m_q^2Y_u^\dagger Y_uY_d^\dagger Y_d\Big)\\
&- 36\mathrm{Tr}\Big(m_q^2Y_u^\dagger Y_uY_u^\dagger Y_u\Big) - 6\mathrm{Tr}\Big(m_u^2Y_uY_d^\dagger Y_dY_u^\dagger\Big) - 36\mathrm{Tr}\Big(m_u^2Y_uY_u^\dagger Y_uY_u^\dagger\Big)
\end{aligned}
\tag{108}
$$

$$
\begin{aligned}
\beta_{m_d^2}^{(1)} =& -\frac{8}{15}g_1^2\mathbf{1}|M_1|^2 - \frac{4}{5}g_{1'}^2\mathbf{1}|M_1'|^2 - \frac{32}{3}g_3^2\mathbf{1}|M_3|^2 + 4m_{h_{13}}^2Y_dY_d^\dagger + 4T_dT_d^\dagger + 2m_d^2Y_dY_d^\dagger\\
&+ 4Y_dm_q^2Y_d^\dagger + 2Y_dY_d^\dagger m_d^2 + 2\frac{1}{\sqrt{15}}g_1\mathbf{1}\sigma_{1,1} + \sqrt{\frac{2}{5}}g_1'\mathbf{1}\sigma_{1,4}
\end{aligned}
\tag{109}
$$

$$
\begin{aligned}
\beta_{m_d^2}^{(2)} =& +\frac{128}{45}g_1^2g_3^2\mathbf{1}|M_3|^2 + \frac{64}{15}g_{1'}^2g_3^2\mathbf{1}|M_3|^2 + \frac{160}{3}g_3^4\mathbf{1}|M_3|^2 + \frac{64}{45}g_1^2g_3^2M_1\mathbf{1}M_3^* + \frac{32}{15}g_{1'}^2g_3^2M_1'\mathbf{1}M_3^*\\
&+ \frac{4}{5}g_1^2m_{h_{13}}^2Y_dY_d^\dagger + \frac{6}{5}g_{1'}^2m_{h_{13}}^2Y_dY_d^\dagger + 12g_2^2m_{h_{13}}^2Y_dY_d^\dagger + 24g_2^2|M_2|^2Y_dY_d^\dagger\\
&- 8m_{h_{13}}^2|\lambda|^2Y_dY_d^\dagger - 4m_{h_{23}}^2|\lambda|^2Y_dY_d^\dagger - 4m_{s_3}^2|\lambda|^2Y_dY_d^\dagger - 4|T_\lambda|^2Y_dY_d^\dagger\\
&- \frac{4}{5}g_1^2M_1Y_dT_d^\dagger - \frac{6}{5}g_{1'}^2M_1'Y_dT_d^\dagger - 12g_2^2M_2Y_dT_d^\dagger\\
&+ \frac{1}{150}g_{1'}^2M_1'^*\Big(180\Big(2M_1'Y_dY_d^\dagger - T_dY_d^\dagger\Big) + \Big(320g_3^2\Big(2M_1' + M_3\Big) - 56g_1^2\Big(2M_1' + M_1\Big) + 9g_{1'}^2M_1'\Big(2Q_S^2 + 257\Big)\Big)\mathbf{1}\Big)\\
&+ \frac{4}{225}g_1^2M_1^*\Big(\Big(-21g_{1'}^2\Big(2M_1 + M_1'\Big) + 768g_1^2M_1 + 80g_3^2\Big(2M_1 + M_3\Big)\Big)\mathbf{1} - 45T_dY_d^\dagger + 90M_1Y_dY_d^\dagger\Big)
\end{aligned}
$$

$$
\begin{aligned}
&- 12g_2^2 M_2^* T_d Y_d^\dagger - 4\lambda T_\lambda^* T_d Y_d^\dagger + \frac{4}{5} g_1^2 T_d T_d^\dagger + \frac{6}{5} g_{1'}^2 T_d T_d^\dagger \\
&+ 12 g_2^2 T_d T_d^\dagger - 4|\lambda|^2 T_d T_d^\dagger + \frac{2}{5} g_1^2 m_d^2 Y_d Y_d^\dagger + \frac{3}{5} g_{1'}^2 m_d^2 Y_d Y_d^\dagger \\
&+ 6 g_2^2 m_d^2 Y_d Y_d^\dagger - 2|\lambda|^2 m_d^2 Y_d Y_d^\dagger + \frac{4}{5} g_1^2 Y_d m_q^2 Y_d^\dagger + \frac{6}{5} g_{1'}^2 Y_d m_q^2 Y_d^\dagger \\
&+ 12 g_2^2 Y_d m_q^2 Y_d^\dagger - 4|\lambda|^2 Y_d m_q^2 Y_d^\dagger + \frac{2}{5} g_1^2 Y_d Y_d^\dagger m_d^2 + \frac{3}{5} g_{1'}^2 Y_d Y_d^\dagger m_d^2 \\
&+ 6 g_2^2 Y_d Y_d^\dagger m_d^2 - 2|\lambda|^2 Y_d Y_d^\dagger m_d^2 - 8 m_{h_{13}}^2 Y_d Y_d^\dagger Y_d Y_d^\dagger - 4 Y_d Y_d^\dagger T_d T_d^\dagger \\
&- 4 m_{h_{13}}^2 Y_d Y_u^\dagger Y_u Y_d^\dagger - 4 m_{h_{23}}^2 Y_d Y_u^\dagger Y_u Y_d^\dagger - 4 Y_d Y_u^\dagger T_u T_d^\dagger \\
&- 4 Y_d T_d^\dagger T_d Y_d^\dagger - 4 Y_d T_u^\dagger T_u Y_d^\dagger - 4 T_d Y_d^\dagger Y_d T_d^\dagger - 4 T_d Y_u^\dagger Y_u T_d^\dagger \\
&- 4 T_d T_d^\dagger Y_d Y_d^\dagger - 4 T_d T_u^\dagger Y_u Y_d^\dagger - 2 m_d^2 Y_d Y_d^\dagger Y_d Y_d^\dagger - 2 m_d^2 Y_d Y_u^\dagger Y_u Y_d^\dagger \\
&- 4 Y_d m_q^2 Y_d^\dagger Y_d Y_d^\dagger - 4 Y_d m_q^2 Y_u^\dagger Y_u Y_d^\dagger - 4 Y_d Y_d^\dagger m_d^2 Y_d Y_d^\dagger - 4 Y_d Y_d^\dagger Y_d m_q^2 Y_d^\dagger \\
&- 2 Y_d Y_d^\dagger Y_d Y_d^\dagger m_d^2 - 4 Y_d Y_u^\dagger m_u^2 Y_u Y_d^\dagger - 4 Y_d Y_u^\dagger Y_u m_q^2 Y_d^\dagger \\
&- 2 Y_d Y_u^\dagger Y_u Y_d^\dagger m_d^2 - 4\lambda^* Y_d T_d^\dagger T_\lambda + \frac{32}{3} g_3^4 \mathbf{1} \sigma_{2,3} + \frac{8}{15} g_1^2 \mathbf{1} \sigma_{2,11} + \frac{4}{5}\sqrt{\frac{2}{3}} g_1 g_1' \mathbf{1} \sigma_{2,14} + \frac{4}{5}\sqrt{\frac{2}{3}} g_1 g_1' \mathbf{1} \sigma_{2,41} \\
&+ \frac{4}{5} g_{1'}^2 \mathbf{1} \sigma_{2,44} + 8 \frac{1}{\sqrt{15}} g_1 \mathbf{1} \sigma_{3,1} + 4\sqrt{\frac{2}{5}} g_1' \mathbf{1} \sigma_{3,4} - 24 m_{h_{13}}^2 Y_d Y_d^\dagger \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) \\
&- 12 T_d T_d^\dagger \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 6 m_d^2 Y_d Y_d^\dagger \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 12 Y_d m_q^2 Y_d^\dagger \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) \\
&- 6 Y_d Y_d^\dagger m_d^2 \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 8 m_{h_{13}}^2 Y_d Y_d^\dagger \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 4 T_d T_d^\dagger \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) \\
&- 2 m_d^2 Y_d Y_d^\dagger \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 4 Y_d m_q^2 Y_d^\dagger \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 2 Y_d Y_d^\dagger m_d^2 \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) \\
&- 12 Y_d T_d^\dagger \mathrm{Tr}\Big(Y_d^\dagger T_d\Big) - 4 Y_d T_d^\dagger \mathrm{Tr}\Big(Y_e^\dagger T_e\Big) - 12 T_d Y_d^\dagger \mathrm{Tr}\Big(T_d^* Y_d^T\Big) \\
&- 12 Y_d Y_d^\dagger \mathrm{Tr}\Big(T_d^* T_d^T\Big) - 4 T_d Y_d^\dagger \mathrm{Tr}\Big(T_e^* Y_e^T\Big) - 4 Y_d Y_d^\dagger \mathrm{Tr}\Big(T_e^* T_e^T\Big) \\
&- 12 Y_d Y_d^\dagger \mathrm{Tr}\Big(m_d^2 Y_d Y_d^\dagger\Big) - 4 Y_d Y_d^\dagger \mathrm{Tr}\Big(m_e^2 Y_e Y_e^\dagger\Big) - 4 Y_d Y_d^\dagger \mathrm{Tr}\Big(m_l^2 Y_e^\dagger Y_e\Big) \\
&- 12 Y_d Y_d^\dagger \mathrm{Tr}\Big(m_q^2 Y_d^\dagger Y_d\Big)
\end{aligned} \tag{110}
$$

$$
\begin{aligned}
\beta^{(1)}_{m_u^2} = &- \frac{32}{15} g_1^2 \mathbf{1} |M_1|^2 - \frac{1}{5} g_{1'}^2 \mathbf{1} |M_1'|^2 - \frac{32}{3} g_3^2 \mathbf{1} |M_3|^2 + 4 m_{h_{23}}^2 Y_u Y_u^\dagger + 4 T_u T_u^\dagger + 2 m_u^2 Y_u Y_u^\dagger \\
&+ 4 Y_u m_q^2 Y_u^\dagger + 2 Y_u Y_u^\dagger m_u^2 - 4 \frac{1}{\sqrt{15}} g_1 \mathbf{1} \sigma_{1,1} + \frac{1}{\sqrt{10}} g_1' \mathbf{1} \sigma_{1,4}
\end{aligned} \tag{111}
$$

$$
\begin{aligned}
\beta^{(2)}_{m_u^2} = &+ \frac{512}{45} g_1^2 g_3^2 \mathbf{1} |M_3|^2 + \frac{16}{15} g_{1'}^2 g_3^2 \mathbf{1} |M_3|^2 + \frac{160}{3} g_3^4 \mathbf{1} |M_3|^2 + \frac{256}{45} g_1^2 g_3^2 M_1 \mathbf{1} M_3^* + \frac{8}{15} g_{1'}^2 g_3^2 M_1' \mathbf{1} M_3^* \\
&- \frac{4}{5} g_1^2 m_{h_{23}}^2 Y_u Y_u^\dagger + \frac{4}{5} g_{1'}^2 m_{h_{23}}^2 Y_u Y_u^\dagger + 12 g_2^2 m_{h_{23}}^2 Y_u Y_u^\dagger + 24 g_2^2 |M_2|^2 Y_u Y_u^\dagger \\
&- 4 m_{h_{13}}^2 |\lambda|^2 Y_u Y_u^\dagger - 8 m_{h_{23}}^2 |\lambda|^2 Y_u Y_u^\dagger - 4 m_{s_3}^2 |\lambda|^2 Y_u Y_u^\dagger - 4 |T_\lambda|^2 Y_u Y_u^\dagger \\
&+ \frac{4}{5} g_1^2 M_1 Y_u T_u^\dagger - \frac{4}{5} g_{1'}^2 M_1' Y_u T_u^\dagger - 12 g_2^2 M_2 Y_u T_u^\dagger
\end{aligned}
$$

$$
\begin{aligned}
&+\frac{1}{600}g_{1'}^2M_1'^*\Big(\Big(320g_3^2\Big(2M_1'+M_3\Big)+352g_1^2\Big(2M_1'+M_1\Big)+9g_{1'}^2M_1'\Big(2Q_S^2+251\Big)\Big)\mathbf{1}+480\Big(2M_1'Y_uY_u^\dagger-T_uY_u^\dagger\Big)\Big)\\
&-12g_2^2M_2^*T_uY_u^\dagger-4\lambda T_\lambda^*T_uY_u^\dagger\\
&+\frac{4}{225}g_1^2M_1^*\Big(\Big(320g_3^2\Big(2M_1+M_3\Big)+3216g_1^2M_1+33g_{1'}^2\Big(2M_1+M_1'\Big)\Big)\mathbf{1}+45\Big(-2M_1Y_uY_u^\dagger+T_uY_u^\dagger\Big)\Big)\\
&-\frac{4}{5}g_1^2T_uT_u^\dagger+\frac{4}{5}g_{1'}^2T_uT_u^\dagger+12g_2^2T_uT_u^\dagger-4|\lambda|^2T_uT_u^\dagger\\
&-\frac{2}{5}g_1^2m_u^2Y_uY_u^\dagger+\frac{2}{5}g_{1'}^2m_u^2Y_uY_u^\dagger+6g_2^2m_u^2Y_uY_u^\dagger-2|\lambda|^2m_u^2Y_uY_u^\dagger\\
&-\frac{4}{5}g_1^2Y_um_q^2Y_u^\dagger+\frac{4}{5}g_{1'}^2Y_um_q^2Y_u^\dagger+12g_2^2Y_um_q^2Y_u^\dagger-4|\lambda|^2Y_um_q^2Y_u^\dagger\\
&-\frac{2}{5}g_1^2Y_uY_u^\dagger m_u^2+\frac{2}{5}g_{1'}^2Y_uY_u^\dagger m_u^2+6g_2^2Y_uY_u^\dagger m_u^2-2|\lambda|^2Y_uY_u^\dagger m_u^2\\
&-4m_{h_{13}}^2Y_uY_d^\dagger Y_dY_u^\dagger-4m_{h_{23}}^2Y_uY_d^\dagger Y_dY_u^\dagger-4Y_uY_d^\dagger T_dT_u^\dagger\\
&-8m_{h_{23}}^2Y_uY_u^\dagger Y_uY_u^\dagger-4Y_uY_u^\dagger T_uT_u^\dagger-4Y_uT_d^\dagger T_dY_u^\dagger-4Y_uT_u^\dagger T_uY_u^\dagger\\
&-4T_uY_d^\dagger Y_dT_u^\dagger-4T_uY_u^\dagger Y_uT_u^\dagger-4T_uT_d^\dagger Y_dY_u^\dagger-4T_uT_u^\dagger Y_uY_u^\dagger\\
&-2m_u^2Y_uY_d^\dagger Y_dY_u^\dagger-2m_u^2Y_uY_u^\dagger Y_uY_u^\dagger-4Y_um_q^2Y_d^\dagger Y_dY_u^\dagger-4Y_um_q^2Y_u^\dagger Y_uY_u^\dagger\\
&-4Y_uY_d^\dagger m_d^2Y_dY_u^\dagger-4Y_uY_d^\dagger Y_dm_q^2Y_u^\dagger-2Y_uY_d^\dagger Y_dY_u^\dagger m_u^2\\
&-4Y_uY_u^\dagger m_u^2Y_uY_u^\dagger-4Y_uY_u^\dagger Y_um_q^2Y_u^\dagger-2Y_uY_u^\dagger Y_uY_u^\dagger m_u^2-4\lambda^*Y_uT_u^\dagger T_\lambda+\frac{32}{3}g_3^4\mathbf{1}\sigma_{2,3}\\
&+\frac{32}{15}g_1^2\mathbf{1}\sigma_{2,11}-\frac{4}{5}\sqrt{\frac{2}{3}}g_1g_1'\mathbf{1}\sigma_{2,14}-\frac{4}{5}\sqrt{\frac{2}{3}}g_1g_1'\mathbf{1}\sigma_{2,41}+\frac{1}{5}g_{1'}^2\mathbf{1}\sigma_{2,44}-16\frac{1}{\sqrt{15}}g_1\mathbf{1}\sigma_{3,1}+2\sqrt{\frac{2}{5}}g_1'\mathbf{1}\sigma_{3,4}\\
&-24m_{h_{23}}^2Y_uY_u^\dagger\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)-12T_uT_u^\dagger\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)-6m_u^2Y_uY_u^\dagger\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)\\
&-12Y_um_q^2Y_u^\dagger\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)-6Y_uY_u^\dagger m_u^2\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)-12Y_uT_u^\dagger\mathrm{Tr}\Big(Y_u^\dagger T_u\Big)\\
&-12T_uY_u^\dagger\mathrm{Tr}\Big(T_u^*Y_u^T\Big)-12Y_uY_u^\dagger\mathrm{Tr}\Big(T_u^*T_u^T\Big)-12Y_uY_u^\dagger\mathrm{Tr}\Big(m_q^2Y_u^\dagger Y_u\Big)\\
&-12Y_uY_u^\dagger\mathrm{Tr}\Big(m_u^2Y_uY_u^\dagger\Big)
\end{aligned}
\tag{112}
$$

$$
\begin{aligned}
\beta_{m_e^2}^{(1)}=&-\frac{24}{5}g_1^2\mathbf{1}|M_1|^2-\frac{1}{5}g_{1'}^2\mathbf{1}|M_1'|^2+4m_{h_{13}}^2Y_eY_e^\dagger+4T_eT_e^\dagger+2m_e^2Y_eY_e^\dagger+4Y_em_l^2Y_e^\dagger\\
&+2Y_eY_e^\dagger m_e^2+2\sqrt{\frac{3}{5}}g_1\mathbf{1}\sigma_{1,1}+\frac{1}{\sqrt{10}}g_1'\mathbf{1}\sigma_{1,4}
\end{aligned}
\tag{113}
$$

$$
\begin{aligned}
\beta_{m_e^2}^{(2)}=&-\frac{12}{5}g_1^2m_{h_{13}}^2Y_eY_e^\dagger+\frac{12}{5}g_{1'}^2m_{h_{13}}^2Y_eY_e^\dagger+12g_2^2m_{h_{13}}^2Y_eY_e^\dagger+24g_2^2|M_2|^2Y_eY_e^\dagger\\
&-8m_{h_{13}}^2|\lambda|^2Y_eY_e^\dagger-4m_{h_{23}}^2|\lambda|^2Y_eY_e^\dagger-4m_{s_3}^2|\lambda|^2Y_eY_e^\dagger-4|T_\lambda|^2Y_eY_e^\dagger\\
&+\frac{12}{5}g_1^2M_1Y_eT_e^\dagger-\frac{12}{5}g_{1'}^2M_1'Y_eT_e^\dagger-12g_2^2M_2Y_eT_e^\dagger\\
&+\frac{3}{200}g_{1'}^2M_1'^*\Big(160\Big(2M_1'Y_eY_e^\dagger-T_eY_e^\dagger\Big)+\Big(-32g_1^2\Big(2M_1'+M_1\Big)+g_{1'}^2M_1'\Big(2Q_S^2+251\Big)\Big)\mathbf{1}\Big)\\
&-12g_2^2M_2^*T_eY_e^\dagger-4\lambda T_\lambda^*T_eY_e^\dagger
\end{aligned}
$$

$$
\begin{aligned}
&+\frac{12}{25}g_1^2M_1^*\Big(\Big(288g_1^2M_1-g_{1'}^2\Big(2M_1+M_1'\Big)\Big)\mathbf{1}+5\Big(-2M_1Y_eY_e^\dagger+T_eY_e^\dagger\Big)\Big)-\frac{12}{5}g_1^2T_eT_e^\dagger\\
&+\frac{12}{5}g_{1'}^2T_eT_e^\dagger+12g_2^2T_eT_e^\dagger-4|\lambda|^2T_eT_e^\dagger-\frac{6}{5}g_1^2m_e^2Y_eY_e^\dagger\\
&+\frac{6}{5}g_{1'}^2m_e^2Y_eY_e^\dagger+6g_2^2m_e^2Y_eY_e^\dagger-2|\lambda|^2m_e^2Y_eY_e^\dagger-\frac{12}{5}g_1^2Y_em_l^2Y_e^\dagger\\
&+\frac{12}{5}g_{1'}^2Y_em_l^2Y_e^\dagger+12g_2^2Y_em_l^2Y_e^\dagger-4|\lambda|^2Y_em_l^2Y_e^\dagger-\frac{6}{5}g_1^2Y_eY_e^\dagger m_e^2\\
&+\frac{6}{5}g_{1'}^2Y_eY_e^\dagger m_e^2+6g_2^2Y_eY_e^\dagger m_e^2-2|\lambda|^2Y_eY_e^\dagger m_e^2-8m_{h_{13}}^2Y_eY_e^\dagger Y_eY_e^\dagger\\
&-4Y_eY_e^\dagger T_eT_e^\dagger-4Y_eT_e^\dagger T_eY_e^\dagger-4T_eY_e^\dagger Y_eT_e^\dagger-4T_eT_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^2-4\lambda^*Y_eT_e^\dagger T_\lambda+\frac{24}{5}g_1^2\mathbf{1}\sigma_{2,11}+\frac{2}{5}\sqrt{6}g_1g_1'\mathbf{1}\sigma_{2,14}+\frac{2}{5}\sqrt{6}g_1g_1'\mathbf{1}\sigma_{2,41}+\frac{1}{5}g_{1'}^2\mathbf{1}\sigma_{2,44}\\
&+8\sqrt{\frac{3}{5}}g_1\mathbf{1}\sigma_{3,1}+2\sqrt{\frac{2}{5}}g_1'\mathbf{1}\sigma_{3,4}-24m_{h_{13}}^2Y_eY_e^\dagger\mathrm{Tr}\Big(Y_dY_d^\dagger\Big)-12T_eT_e^\dagger\mathrm{Tr}\Big(Y_dY_d^\dagger\Big)\\
&-6m_e^2Y_eY_e^\dagger\mathrm{Tr}\Big(Y_dY_d^\dagger\Big)-12Y_em_l^2Y_e^\dagger\mathrm{Tr}\Big(Y_dY_d^\dagger\Big)-6Y_eY_e^\dagger m_e^2\mathrm{Tr}\Big(Y_dY_d^\dagger\Big)\\
&-8m_{h_{13}}^2Y_eY_e^\dagger\mathrm{Tr}\Big(Y_eY_e^\dagger\Big)-4T_eT_e^\dagger\mathrm{Tr}\Big(Y_eY_e^\dagger\Big)-2m_e^2Y_eY_e^\dagger\mathrm{Tr}\Big(Y_eY_e^\dagger\Big)\\
&-4Y_em_l^2Y_e^\dagger\mathrm{Tr}\Big(Y_eY_e^\dagger\Big)-2Y_eY_e^\dagger m_e^2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big)-12Y_eT_e^\dagger\mathrm{Tr}\Big(Y_d^\dagger T_d\Big)\\
&-4Y_eT_e^\dagger\mathrm{Tr}\Big(Y_e^\dagger T_e\Big)-12T_eY_e^\dagger\mathrm{Tr}\Big(T_d^*Y_d^T\Big)-12Y_eY_e^\dagger\mathrm{Tr}\Big(T_d^*T_d^T\Big)\\
&-4T_eY_e^\dagger\mathrm{Tr}\Big(T_e^*Y_e^T\Big)-4Y_eY_e^\dagger\mathrm{Tr}\Big(T_e^*T_e^T\Big)-12Y_eY_e^\dagger\mathrm{Tr}\Big(m_d^2Y_dY_d^\dagger\Big)\\
&-4Y_eY_e^\dagger\mathrm{Tr}\Big(m_e^2Y_eY_e^\dagger\Big)-4Y_eY_e^\dagger\mathrm{Tr}\Big(m_l^2Y_e^\dagger Y_e\Big)-12Y_eY_e^\dagger\mathrm{Tr}\Big(m_q^2Y_d^\dagger Y_d\Big) \qquad (114)
\end{aligned}
$$

$$
\begin{aligned}
\beta^{(1)}_{m_{s_3}^2} &= -\frac{1}{5}g_{1'}^2Q_S^2|M_1'|^2+4\Big(m_{h_{13}}^2+m_{h_{23}}^2+m_{s_3}^2\Big)|\lambda|^2+2m_{phi}^2|\sigma|^2+2m_{s_3}^2|\sigma|^2+2m_{sbar_3}^2|\sigma|^2+4|T_\lambda|^2\\
&+2|T_\sigma|^2+\frac{1}{\sqrt{10}}g_1'Q_S\sigma_{1,4}+6m_{s_3}^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)+6\mathrm{Tr}\Big(T_\kappa^*T_\kappa^T\Big)+6\mathrm{Tr}\Big(\kappa\kappa^\dagger m_X^{2*}\Big)+6\mathrm{Tr}\Big(\kappa m_X^{2*}\kappa^\dagger\Big) \qquad (115)
\end{aligned}
$$

$$
\begin{aligned}
\beta^{(2)}_{m_{s_3}^2} &= \frac{1}{200}\Big(g_{1'}^2M_1'^*\Big(3\Big(20\Big(-13+Q_S^2\Big)\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)-40M_1'\Big(-13+Q_S^2\Big)\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)+g_{1'}^2M_1'Q_S^2\Big(4Q_S^2+249\Big)\Big)-40\Big(-13+Q_S^2\Big)\lambda^*\\
&+20\Big(24g_1^2|T_\lambda|^2+26g_{1'}^2|T_\lambda|^2+120g_2^2|T_\lambda|^2-2g_{1'}^2Q_S^2|T_\lambda|^2-160\Big(m_{h_{13}}^2+m_{h_{23}}^2+m_{s_3}^2\Big)\lambda^2\lambda^{*,2}\\
&-80m_{phi}^2\sigma^2\sigma'^{,*,2}-80m_{s_3}^2\sigma^2\sigma'^{,*,2}-80m_{sbar_3}^2\sigma^2\sigma'^{,*,2}-24g_1^2M_1\lambda T_\lambda^*-26g_{1'}^2M_1'\lambda T_\lambda^*\\
&-120g_2^2M_2\lambda T_\lambda^*+2g_{1'}^2M_1'Q_S^2\lambda T_\lambda^*-40|\sigma|^2T_{\kappa',*}T_{\kappa'}-40\kappa'\sigma'^{,*}T_{\kappa',*}T_\sigma-160|\sigma|^2T_\sigma^*T_\sigma\\
&-40\kappa'^{,*}\Big(\Big(4m_{phi}^2+m_{s_3}^2+m_{sbar_3}^2\Big)\kappa'|\sigma|^2+T_\sigma^*\Big(\kappa'T_\sigma+\sigma T_{\kappa'}\Big)\Big)+2g_{1'}^2Q_S^2\sigma_{2,44}+4\sqrt{10}g_1'Q_S\sigma_{3,4}\\
&-120|T_\lambda|^2\mathrm{Tr}\Big(Y_dY_d^\dagger\Big)-40|T_\lambda|^2\mathrm{Tr}\Big(Y_eY_e^\dagger\Big)-120|T_\lambda|^2\mathrm{Tr}\Big(Y_uY_u^\dagger\Big)+16g_1^2m_{s_3}^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)\\
&+39g_{1'}^2m_{s_3}^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)+320g_3^2m_{s_3}^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)-3g_{1'}^2m_{s_3}^2Q_S^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)\\
&+32g_1^2|M_1|^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)+640g_3^2|M_3|^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)-120\lambda T_\lambda^*\mathrm{Tr}\Big(Y_d^\dagger T_d\Big)-40\lambda T_\lambda^*\mathrm{Tr}\Big(Y_e^\dagger T_e\Big)
\end{aligned}
$$

$$
\begin{aligned}
&- 120\lambda T_\lambda^* \mathrm{Tr}\Big(Y_u^\dagger T_u\Big) - 16 g_1^2 M_1^* \mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) - 320 g_3^2 M_3^* \mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) - 16 g_1^2 M_1 \mathrm{Tr}\Big(T_\kappa^* \kappa^T\Big) \\
&- 39 g_{1'}^2 M_1' \mathrm{Tr}\Big(T_\kappa^* \kappa^T\Big) - 320 g_3^2 M_3 \mathrm{Tr}\Big(T_\kappa^* \kappa^T\Big) + 3 g_{1'}^2 M_1' Q_S^2 \mathrm{Tr}\Big(T_\kappa^* \kappa^T\Big) + 16 g_1^2 \mathrm{Tr}\Big(T_\kappa^* T_\kappa^T\Big) \\
&+ 39 g_{1'}^2 \mathrm{Tr}\Big(T_\kappa^* T_\kappa^T\Big) + 320 g_3^2 \mathrm{Tr}\Big(T_\kappa^* T_\kappa^T\Big) - 3 g_{1'}^2 Q_S^2 \mathrm{Tr}\Big(T_\kappa^* T_\kappa^T\Big) \\
&+ 2\lambda^* \Big(12 g_1^2 m_{h_{13}}^2 \lambda + 13 g_{1'}^2 m_{h_{13}}^2 \lambda + 60 g_2^2 m_{h_{13}}^2 \lambda + 12 g_1^2 m_{h_{23}}^2 \lambda + 13 g_{1'}^2 m_{h_{23}}^2 \lambda + 60 g_2^2 m_{h_{23}}^2 \lambda \\
&+ 12 g_1^2 m_{s_3}^2 \lambda + 13 g_{1'}^2 m_{s_3}^2 \lambda + 60 g_2^2 m_{s_3}^2 \lambda - g_{1'}^2 m_{h_{13}}^2 Q_S^2 \lambda - g_{1'}^2 m_{h_{23}}^2 Q_S^2 \lambda \\
&- g_{1'}^2 m_{s_3}^2 Q_S^2 \lambda - 160 \lambda |T_\lambda|^2 + 12 g_1^2 M_1^* \Big(2 M_1 \lambda - T_\lambda\Big) + 60 g_2^2 M_2^* \Big(2 M_2 \lambda - T_\lambda\Big) \\
&- 120 m_{h_{13}}^2 \lambda \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 60 m_{h_{23}}^2 \lambda \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 60 m_{s_3}^2 \lambda \mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 40 m_{h_{13}}^2 \lambda \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) \\
&- 20 m_{h_{23}}^2 \lambda \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 20 m_{s_3}^2 \lambda \mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 60 m_{h_{13}}^2 \lambda \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) - 120 m_{h_{23}}^2 \lambda \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) \\
&- 60 m_{s_3}^2 \lambda \mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) - 60 T_\lambda \mathrm{Tr}\Big(T_d^* Y_d^T\Big) - 60 \lambda \mathrm{Tr}\Big(T_d^* T_d^T\Big) - 20 T_\lambda \mathrm{Tr}\Big(T_e^* Y_e^T\Big) - 20 \lambda \mathrm{Tr}\Big(T_e^* T_e^T\Big) \\
&- 60 T_\lambda \mathrm{Tr}\Big(T_u^* Y_u^T\Big) - 60 \lambda \mathrm{Tr}\Big(T_u^* T_u^T\Big) - 60 \lambda \mathrm{Tr}\Big(m_d^2 Y_d Y_d^\dagger\Big) - 20 \lambda \mathrm{Tr}\Big(m_e^2 Y_e Y_e^\dagger\Big) \\
&- 20 \lambda \mathrm{Tr}\Big(m_l^2 Y_e^\dagger Y_e\Big) - 60 \lambda \mathrm{Tr}\Big(m_q^2 Y_d^\dagger Y_d\Big) - 60 \lambda \mathrm{Tr}\Big(m_q^2 Y_u^\dagger Y_u\Big) - 60 \lambda \mathrm{Tr}\Big(m_u^2 Y_u Y_u^\dagger\Big)\Big) \\
&+ 16 g_1^2 \mathrm{Tr}\Big(\kappa \kappa^\dagger m_X^{2*}\Big) + 39 g_{1'}^2 \mathrm{Tr}\Big(\kappa \kappa^\dagger m_X^{2*}\Big) + 320 g_3^2 \mathrm{Tr}\Big(\kappa \kappa^\dagger m_X^{2*}\Big) - 3 g_{1'}^2 Q_S^2 \mathrm{Tr}\Big(\kappa \kappa^\dagger m_X^{2*}\Big) \\
&+ 16 g_1^2 \mathrm{Tr}\Big(\kappa m_{\bar{X}}^{2*} \kappa^\dagger\Big) + 39 g_{1'}^2 \mathrm{Tr}\Big(\kappa m_{\bar{X}}^{2*} \kappa^\dagger\Big) + 320 g_3^2 \mathrm{Tr}\Big(\kappa m_{\bar{X}}^{2*} \kappa^\dagger\Big) - 3 g_{1'}^2 Q_S^2 \mathrm{Tr}\Big(\kappa m_{\bar{X}}^{2*} \kappa^\dagger\Big) \\
&- 240 m_{s_3}^2 \mathrm{Tr}\Big(\kappa \kappa^\dagger \kappa \kappa^\dagger\Big) - 240 \mathrm{Tr}\Big(\kappa \kappa^\dagger T_\kappa T_\kappa^\dagger\Big) - 240 \mathrm{Tr}\Big(\kappa T_\kappa^\dagger T_\kappa \kappa^\dagger\Big) - 120 \mathrm{Tr}\Big(\kappa \kappa^\dagger \kappa \kappa^\dagger m_X^{2*}\Big) \\
&- 120 \mathrm{Tr}\Big(\kappa \kappa^\dagger \kappa m_{\bar{X}}^{2*} \kappa^\dagger\Big) - 120 \mathrm{Tr}\Big(\kappa \kappa^\dagger m_X^{2*} \kappa \kappa^\dagger\Big) - 120 \mathrm{Tr}\Big(\kappa m_{\bar{X}}^{2*} \kappa^\dagger \kappa \kappa^\dagger\Big)\Big)\Big)
\end{aligned} \tag{116}
$$

$$
\beta^{(1)}_{m^2_{sbar_3}} = 2\Big(m_{phi}^2 + m_{s_3}^2 + m_{sbar_3}^2\Big)|\sigma|^2 + 2|T_\sigma|^2 - \frac{1}{5} g_{1'}^2 Q_S^2 |M_1'|^2 - \frac{1}{\sqrt{10}} g_1' Q_S \sigma_{1,4} \tag{117}
$$

$$
\begin{aligned}
\beta^{(2)}_{m^2_{sbar_3}} &= +\frac{3}{200} g_{1'}^4 Q_S^2 \Big(4 Q_S^2 + 249\Big)|M_1'|^2 - 4 m_{h_{13}}^2 \sigma |\lambda|^2 \sigma'^{,*} - 4 m_{h_{23}}^2 \sigma |\lambda|^2 \sigma'^{,*} - 4 m_{phi}^2 \sigma |\lambda|^2 \sigma'^{,*} \\
&- 8 m_{s_3}^2 \sigma |\lambda|^2 \sigma'^{,*} - 4 m_{sbar_3}^2 \sigma |\lambda|^2 \sigma'^{,*} - 8 m_{phi}^2 \sigma^2 \sigma'^{,*,2} - 8 m_{s_3}^2 \sigma^2 \sigma'^{,*,2} - 8 m_{sbar_3}^2 \sigma^2 \sigma'^{,*,2} \\
&- 4|\sigma|^2 T_{\kappa',*} T_{\kappa'} - 4|\sigma|^2 T_\lambda^* T_\lambda - 4\sigma \lambda^* T_\sigma^* T_\lambda - 4\kappa' \sigma'^{,*} T_{\kappa',*} T_\sigma - 4\lambda \sigma'^{,*} T_\lambda^* T_\sigma \\
&- 4|\lambda|^2 T_\sigma^* T_\sigma - 16|\sigma|^2 T_\sigma^* T_\sigma - 4\kappa'^{,*} \Big(\Big(4 m_{phi}^2 + m_{s_3}^2 + m_{sbar_3}^2\Big)\kappa' |\sigma|^2 + T_\sigma^* \Big(\kappa' T_\sigma + \sigma T_{\kappa'}\Big)\Big) \\
&+ \frac{1}{5} g_{1'}^2 Q_S^2 \sigma_{2,44} - 2\sqrt{\frac{2}{5}} g_1' Q_S \sigma_{3,4} - 6 m_{phi}^2 |\sigma|^2 \mathrm{Tr}\Big(\kappa \kappa^\dagger\Big) - 12 m_{s_3}^2 |\sigma|^2 \mathrm{Tr}\Big(\kappa \kappa^\dagger\Big) \\
&- 6 m_{sbar_3}^2 |\sigma|^2 \mathrm{Tr}\Big(\kappa \kappa^\dagger\Big) - 6|T_\sigma|^2 \mathrm{Tr}\Big(\kappa \kappa^\dagger\Big) - 6\sigma T_\sigma^* \mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) - 6\sigma'^{,*} T_\sigma \mathrm{Tr}\Big(T_\kappa^* \kappa^T\Big) \\
&- 6|\sigma|^2 \mathrm{Tr}\Big(T_\kappa^* T_\kappa^T\Big) - 6|\sigma|^2 \mathrm{Tr}\Big(\kappa \kappa^\dagger m_X^{2*}\Big) - 6|\sigma|^2 \mathrm{Tr}\Big(\kappa m_{\bar{X}}^{2*} \kappa^\dagger\Big)
\end{aligned} \tag{118}
$$

$$
\begin{aligned}
\beta^{(1)}_{m_X^2} &= -\frac{8}{15} g_1^2 \mathbf{1} |M_1|^2 - \frac{4}{5} g_{1'}^2 \mathbf{1} |M_1'|^2 - \frac{32}{3} g_3^2 \mathbf{1} |M_3|^2 + 2 m_{s_3}^2 \kappa^* \kappa^T + 2 T_\kappa^* T_\kappa^T + m_X^2 \kappa^* \kappa^T \\
&+ 2\kappa^* m_{\bar{X}}^2 \kappa^T + \kappa^* \kappa^T m_X^2 - 2\frac{1}{\sqrt{15}} g_1 \mathbf{1} \sigma_{1,1} - \sqrt{\frac{2}{5}} g_1' \mathbf{1} \sigma_{1,4}
\end{aligned} \tag{119}
$$

$$
\begin{aligned}
\beta^{(2)}_{m^2_X} =& +\frac{128}{45}g_1^2g_3^2\mathbf{1}|M_3|^2+\frac{64}{15}g_{1'}^2g_3^2\mathbf{1}|M_3|^2+\frac{160}{3}g_3^4\mathbf{1}|M_3|^2\\
&+\frac{4}{225}g_1^2\Big(-21g_{1'}^2\Big(2M_1+M_1'\Big)+768g_1^2M_1+80g_3^2\Big(2M_1+M_3\Big)\Big)\mathbf{1}M_1^*+\frac{64}{45}g_1^2g_3^2M_1\mathbf{1}M_3^*+\frac{32}{15}g_{1'}^2g_3^2M_1'\mathbf{1}M_3^*\\
&+\frac{1}{2}g_{1'}^2m_{s_3}^2\kappa^*\kappa^T+\frac{1}{10}g_{1'}^2m_{s_3}^2Q_S^2\kappa^*\kappa^T-4m_{h_{13}}^2|\lambda|^2\kappa^*\kappa^T-4m_{h_{23}}^2|\lambda|^2\kappa^*\kappa^T\\
&-8m_{s_3}^2|\lambda|^2\kappa^*\kappa^T-2m_{phi}^2|\sigma|^2\kappa^*\kappa^T-4m_{s_3}^2|\sigma|^2\kappa^*\kappa^T-2m_{sbar_3}^2|\sigma|^2\kappa^*\kappa^T\\
&-4|T_\lambda|^2\kappa^*\kappa^T-2|T_\sigma|^2\kappa^*\kappa^T\\
&+\frac{1}{150}g_{1'}^2M_1'^*\Big(15\Big(5+Q_S^2\Big)\Big(2M_1'\kappa^*\kappa^T-\kappa^*T_\kappa^T\Big)+\Big(320g_3^2\Big(2M_1'+M_3\Big)-56g_1^2\Big(2M_1'+M_1\Big)+9g_{1'}^2M_1'\Big(2Q_S^2+257\Big)\Big)\mathbf{1}\Big)\\
&-4\lambda T_\lambda^*\kappa^*T_\kappa^T-2\sigma T_\sigma^*\kappa^*T_\kappa^T-\frac{1}{2}g_{1'}^2M_1'T_\kappa^*\kappa^T-\frac{1}{10}g_{1'}^2M_1'Q_S^2T_\kappa^*\kappa^T\\
&+\frac{1}{2}g_{1'}^2T_\kappa^*T_\kappa^T+\frac{1}{10}g_{1'}^2Q_S^2T_\kappa^*T_\kappa^T-4|\lambda|^2T_\kappa^*T_\kappa^T-2|\sigma|^2T_\kappa^*T_\kappa^T\\
&+\frac{1}{4}g_{1'}^2m_X^2\kappa^*\kappa^T+\frac{1}{20}g_{1'}^2Q_S^2m_X^2\kappa^*\kappa^T-2|\lambda|^2m_X^2\kappa^*\kappa^T-|\sigma|^2m_X^2\kappa^*\kappa^T\\
&+\frac{1}{2}g_{1'}^2\kappa^*m_{\bar{X}}^2\kappa^T+\frac{1}{10}g_{1'}^2Q_S^2\kappa^*m_{\bar{X}}^2\kappa^T-4|\lambda|^2\kappa^*m_{\bar{X}}^2\kappa^T-2|\sigma|^2\kappa^*m_{\bar{X}}^2\kappa^T\\
&+\frac{1}{4}g_{1'}^2\kappa^*\kappa^Tm_X^2+\frac{1}{20}g_{1'}^2Q_S^2\kappa^*\kappa^Tm_X^2-2|\lambda|^2\kappa^*\kappa^Tm_X^2-|\sigma|^2\kappa^*\kappa^Tm_X^2\\
&-4m_{s_3}^2\kappa^*\kappa^T\kappa^*\kappa^T-2\kappa^*\kappa^TT_\kappa^*T_\kappa^T-2\kappa^*T_\kappa^TT_\kappa^*\kappa^T-2T_\kappa^*\kappa^T\kappa^*T_\kappa^T\\
&-2T_\kappa^*T_\kappa^T\kappa^*\kappa^T-m_X^2\kappa^*\kappa^T\kappa^*\kappa^T-2\kappa^*m_{\bar{X}}^2\kappa^T\kappa^*\kappa^T-2\kappa^*\kappa^Tm_X^2\kappa^*\kappa^T\\
&-2\kappa^*\kappa^T\kappa^*m_{\bar{X}}^2\kappa^T-\kappa^*\kappa^T\kappa^*\kappa^Tm_X^2-4\lambda^*T_\kappa^*\kappa^TT_\lambda-2\sigma'^{,*}T_\kappa^*\kappa^TT_\sigma+\frac{32}{3}g_3^4\mathbf{1}\sigma_{2,3}\\
&+\frac{8}{15}g_1^2\mathbf{1}\sigma_{2,11}+\frac{4}{5}\sqrt{\frac{2}{3}}g_1g_1'\mathbf{1}\sigma_{2,14}+\frac{4}{5}\sqrt{\frac{2}{3}}g_1g_1'\mathbf{1}\sigma_{2,41}+\frac{4}{5}g_{1'}^2\mathbf{1}\sigma_{2,44}-8\frac{1}{\sqrt{15}}g_1\mathbf{1}\sigma_{3,1}-4\sqrt{\frac{2}{5}}g_1'\mathbf{1}\sigma_{3,4}\\
&-12m_{s_3}^2\kappa^*\kappa^T\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)-6T_\kappa^*T_\kappa^T\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)-3m_X^2\kappa^*\kappa^T\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)\\
&-6\kappa^*m_{\bar{X}}^2\kappa^T\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)-3\kappa^*\kappa^Tm_X^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big)-6T_\kappa^*\kappa^T\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big)\\
&-6\kappa^*T_\kappa^T\mathrm{Tr}\Big(T_\kappa^*\kappa^T\Big)-6\kappa^*\kappa^T\mathrm{Tr}\Big(T_\kappa^*T_\kappa^T\Big)-6\kappa^*\kappa^T\mathrm{Tr}\Big(\kappa\kappa^\dagger m_X^{2*}\Big)\\
&-6\kappa^*\kappa^T\mathrm{Tr}\Big(\kappa m_{\bar{X}}^{2*}\kappa^\dagger\Big) \qquad (120)\\
\beta^{(1)}_{m^2_{\bar{X}}} =& -\frac{8}{15}g_1^2\mathbf{1}|M_1|^2-\frac{9}{5}g_{1'}^2\mathbf{1}|M_1'|^2-\frac{32}{3}g_3^2\mathbf{1}|M_3|^2+2m_{s_3}^2\kappa^T\kappa^*+2T_\kappa^TT_\kappa^*+m_{\bar{X}}^2\kappa^T\kappa^*\\
&+2\kappa^Tm_{\bar{X}}^2\kappa^*+\kappa^T\kappa^*m_{\bar{X}}^2+2\frac{1}{\sqrt{15}}g_1\mathbf{1}\sigma_{1,1}-3\frac{1}{\sqrt{10}}g_1'\mathbf{1}\sigma_{1,4} \qquad (121)\\
\beta^{(2)}_{m^2_{\bar{X}}} =& +\frac{128}{45}g_1^2g_3^2\mathbf{1}|M_3|^2+\frac{48}{5}g_{1'}^2g_3^2\mathbf{1}|M_3|^2+\frac{160}{3}g_3^4\mathbf{1}|M_3|^2\\
&+\frac{8}{225}g_1^2\Big(27g_{1'}^2\Big(2M_1+M_1'\Big)+384g_1^2M_1+40g_3^2\Big(2M_1+M_3\Big)\Big)\mathbf{1}M_1^*+\frac{64}{45}g_1^2g_3^2M_1\mathbf{1}M_3^*+\frac{24}{5}g_{1'}^2g_3^2M_1'\mathbf{1}M_3^*\\
&-\frac{1}{2}g_{1'}^2m_{s_3}^2\kappa^T\kappa^*+\frac{1}{10}g_{1'}^2m_{s_3}^2Q_S^2\kappa^T\kappa^*-4m_{h_{13}}^2|\lambda|^2\kappa^T\kappa^*-4m_{h_{23}}^2|\lambda|^2\kappa^T\kappa^*
\end{aligned}
$$

$$
\begin{aligned}
&- 8m_{s_3}^2|\lambda|^2\kappa^T\kappa^* - 2m_{phi}^2|\sigma|^2\kappa^T\kappa^* - 4m_{s_3}^2|\sigma|^2\kappa^T\kappa^* - 2m_{sbar_3}^2|\sigma|^2\kappa^T\kappa^* \\
&- 4|T_\lambda|^2\kappa^T\kappa^* - 2|T_\sigma|^2\kappa^T\kappa^* + \frac{1}{2}g_{1'}^2M_1'\kappa^TT_\kappa^* - \frac{1}{10}g_{1'}^2M_1'Q_S^2\kappa^TT_\kappa^* \\
&+ \frac{1}{200}g_{1'}^2M_1'^*\Big(20\Big(-5+Q_S^2\Big)\Big(2M_1'\kappa^T\kappa^* - T_\kappa^T\kappa^*\Big) + 3\Big(320g_3^2\Big(2M_1'+M_3\Big) + 64g_1^2\Big(2M_1'+M_1\Big) + 9g_{1'}^2M_1'\Big(2Q_S^2+267\Big)\Big)\mathbf{1}\Big) \\
&- 4\lambda T_\lambda^*T_\kappa^T\kappa^* - 2\sigma T_\sigma^*T_\kappa^T\kappa^* - \frac{1}{2}g_{1'}^2T_\kappa^TT_\kappa^* + \frac{1}{10}g_{1'}^2Q_S^2T_\kappa^TT_\kappa^* \\
&- 4|\lambda|^2T_\kappa^TT_\kappa^* - 2|\sigma|^2T_\kappa^TT_\kappa^* - \frac{1}{4}g_{1'}^2m_{\bar{X}}^2\kappa^T\kappa^* + \frac{1}{20}g_{1'}^2Q_S^2m_{\bar{X}}^2\kappa^T\kappa^* \\
&- 2|\lambda|^2m_{\bar{X}}^2\kappa^T\kappa^* - |\sigma|^2m_{\bar{X}}^2\kappa^T\kappa^* - \frac{1}{2}g_{1'}^2\kappa^Tm_X^2\kappa^* + \frac{1}{10}g_{1'}^2Q_S^2\kappa^Tm_X^2\kappa^* \\
&- 4|\lambda|^2\kappa^Tm_X^2\kappa^* - 2|\sigma|^2\kappa^Tm_X^2\kappa^* - \frac{1}{4}g_{1'}^2\kappa^T\kappa^*m_{\bar{X}}^2 + \frac{1}{20}g_{1'}^2Q_S^2\kappa^T\kappa^*m_{\bar{X}}^2 \\
&- 2|\lambda|^2\kappa^T\kappa^*m_{\bar{X}}^2 - |\sigma|^2\kappa^T\kappa^*m_{\bar{X}}^2 - 4m_{s_3}^2\kappa^T\kappa^*\kappa^T\kappa^* - 2\kappa^T\kappa^*T_\kappa^TT_\kappa^* \\
&- 2\kappa^TT_\kappa^*T_\kappa^T\kappa^* - 2T_\kappa^T\kappa^*\kappa^TT_\kappa^* - 2T_\kappa^TT_\kappa^*\kappa^T\kappa^* - m_{\bar{X}}^2\kappa^T\kappa^*\kappa^T\kappa^* \\
&- 2\kappa^Tm_X^2\kappa^*\kappa^T\kappa^* - 2\kappa^T\kappa^*m_{\bar{X}}^2\kappa^T\kappa^* - 2\kappa^T\kappa^*\kappa^Tm_X^2\kappa^* - \kappa^T\kappa^*\kappa^T\kappa^*m_{\bar{X}}^2 - 4\lambda^*\kappa^TT_\kappa^*T_\lambda \\
&- 2\sigma'^{,*}\kappa^TT_\kappa^*T_\sigma + \frac{32}{3}g_3^4\mathbf{1}\sigma_{2,3} + \frac{8}{15}g_1^2\mathbf{1}\sigma_{2,11} - \frac{2}{5}\sqrt{6}g_1g_1'\mathbf{1}\sigma_{2,14} - \frac{2}{5}\sqrt{6}g_1g_1'\mathbf{1}\sigma_{2,41} + \frac{9}{5}g_{1'}^2\mathbf{1}\sigma_{2,44} \\
&+ 8\frac{1}{\sqrt{15}}g_1\mathbf{1}\sigma_{3,1} - 6\sqrt{\frac{2}{5}}g_1'\mathbf{1}\sigma_{3,4} - 12m_{s_3}^2\kappa^T\kappa^*\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 6T_\kappa^TT_\kappa^*\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) \\
&- 3m_{\bar{X}}^2\kappa^T\kappa^*\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 6\kappa^Tm_X^2\kappa^*\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 3\kappa^T\kappa^*m_{\bar{X}}^2\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) \\
&- 6\kappa^TT_\kappa^*\mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) - 6T_\kappa^T\kappa^*\mathrm{Tr}\Big(T_\kappa^*\kappa^T\Big) - 6\kappa^T\kappa^*\mathrm{Tr}\Big(T_\kappa^*T_\kappa^T\Big) \\
&- 6\kappa^T\kappa^*\mathrm{Tr}\Big(\kappa\kappa^\dagger m_X^{2*}\Big) - 6\kappa^T\kappa^*\mathrm{Tr}\Big(\kappa m_{\bar{X}}^{2*}\kappa^\dagger\Big)
\end{aligned} \tag{122}
$$

$$
\beta_{m_{h^Pr}^2}^{(1)} = \frac{1}{5}\Big(-30g_2^2|M_2|^2 - 4g_{1'}^2|M_1'|^2 - 6g_1^2|M_1|^2 + \sqrt{10}g_1'\sigma_{1,4} - \sqrt{15}g_1\sigma_{1,1}\Big) \tag{123}
$$

$$
\begin{aligned}
\beta_{m_{h^Pr}^2}^{(2)} &= \frac{1}{50}\Big(6g_1^2\Big(15g_2^2\Big(2M_1+M_2\Big) + 261g_1^2M_1 + 8g_{1'}^2\Big(2M_1+M_1'\Big)\Big)M_1^* \\
&+ 3g_{1'}^2\Big(16g_1^2\Big(2M_1'+M_1\Big) + 20g_2^2\Big(2M_1'+M_2\Big) + g_{1'}^2M_1'\Big(2Q_S^2+257\Big)\Big)M_1'^* \\
&+ 10\Big(3g_2^2\Big(2g_{1'}^2\Big(2M_2+M_1'\Big) + 3g_1^2\Big(2M_2+M_1\Big) + 85g_2^2M_2\Big)M_2^* + 30g_2^4\sigma_{2,2} + 6g_1^2\sigma_{2,11} - 2\sqrt{6}g_1g_1'\sigma_{2,14} \\
&- 2\sqrt{6}g_1g_1'\sigma_{2,41} + 4g_{1'}^2\sigma_{2,44} - 4\sqrt{15}g_1\sigma_{3,1} + 4\sqrt{10}g_1'\sigma_{3,4}\Big)\Big)
\end{aligned} \tag{124}
$$

$$
\beta_{m_{h\bar{P}r}^2}^{(1)} = \frac{1}{5}\Big(-30g_2^2|M_2|^2 - 4g_{1'}^2|M_1'|^2 - 6g_1^2|M_1|^2 - \sqrt{10}g_1'\sigma_{1,4} + \sqrt{15}g_1\sigma_{1,1}\Big) \tag{125}
$$

$$
\begin{aligned}
\beta_{m_{h\bar{P}r}^2}^{(2)} &= \frac{1}{50}\Big(6g_1^2\Big(15g_2^2\Big(2M_1+M_2\Big) + 261g_1^2M_1 + 8g_{1'}^2\Big(2M_1+M_1'\Big)\Big)M_1^* \\
&+ 3g_{1'}^2\Big(16g_1^2\Big(2M_1'+M_1\Big) + 20g_2^2\Big(2M_1'+M_2\Big) + g_{1'}^2M_1'\Big(2Q_S^2+257\Big)\Big)M_1'^* \\
&+ 10\Big(3g_2^2\Big(2g_{1'}^2\Big(2M_2+M_1'\Big) + 3g_1^2\Big(2M_2+M_1\Big) + 85g_2^2M_2\Big)M_2^* + 30g_2^4\sigma_{2,2} + 6g_1^2\sigma_{2,11} - 2\sqrt{6}g_1g_1'\sigma_{2,14}
\end{aligned}
$$

$$- 2\sqrt{6}g_1 g_1' \sigma_{2,41} + 4g_{1'}^2 \sigma_{2,44} + 4\sqrt{15}g_1 \sigma_{3,1} - 4\sqrt{10}g_1' \sigma_{3,4}\Big)\Big) \tag{126}$$

$$\beta^{(1)}_{m^2_{phi}} = 2\Big(2|T_{\kappa'}|^2 + 6m^2_{phi}|\kappa'|^2 + \Big(m^2_{phi} + m^2_{s_3} + m^2_{sbar_3}\Big)|\sigma|^2 + |T_\sigma|^2\Big) \tag{127}$$

$$\begin{aligned}
\beta^{(2)}_{m^2_{phi}} &= -96m^2_{phi}\kappa'^{,2}\kappa'^{,*,2} - 8\Big(m^2_{phi} + m^2_{s_3} + m^2_{sbar_3}\Big)\sigma^2\sigma'^{,*,2} \\
&- 8\kappa'^{,*}\Big(\Big(4m^2_{phi} + m^2_{s_3} + m^2_{sbar_3}\Big)\kappa'|\sigma|^2 + 8\kappa'|T_{\kappa'}|^2 + T^*_\sigma\Big(\kappa' T_\sigma + \sigma T_{\kappa'}\Big)\Big) \\
&- \frac{1}{5}T^*_\sigma\Big(20\lambda^*\Big(\lambda T_\sigma + \sigma T_\lambda\Big) + 30\sigma \mathrm{Tr}\Big(\kappa^\dagger T_\kappa\Big) + 30T_\sigma \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + g^2_{1'}M'_1 Q^2_S\sigma - g^2_{1'}Q^2_S T_\sigma\Big) \\
&+ \frac{1}{5}\sigma'^{,*}\Big(g^2_{1'}m^2_{phi}Q^2_S\sigma + g^2_{1'}m^2_{s_3}Q^2_S\sigma + g^2_{1'}m^2_{sbar_3}Q^2_S\sigma - 20\Big(2m^2_{s_3} + m^2_{h_{13}} + m^2_{h_{23}} + m^2_{phi} + m^2_{sbar_3}\Big)\sigma|\lambda|^2 \\
&- 40\sigma|T_{\kappa'}|^2 - 20\sigma|T_\lambda|^2 - 80\sigma|T_\sigma|^2 + g^2_{1'}Q^2_S M'^*_1\Big(2M'_1\sigma - T_\sigma\Big) - 40\kappa' T_{\kappa',*}T_\sigma \\
&- 20\lambda T^*_\lambda T_\sigma - 30m^2_{phi}\sigma \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 60m^2_{s_3}\sigma \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 30m^2_{sbar_3}\sigma \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 30T_\sigma \mathrm{Tr}\Big(T^*_\kappa \kappa^T\Big) \\
&- 30\sigma \mathrm{Tr}\Big(T^*_\kappa T^T_\kappa\Big) - 30\sigma \mathrm{Tr}\Big(\kappa\kappa^\dagger m^{2*}_X\Big) - 30\sigma \mathrm{Tr}\Big(\kappa m^{2*}_{\bar{X}}\kappa^\dagger\Big)\Big)
\end{aligned} \tag{128}$$

3.11 Vacuum expectation values

$$\beta^{(1)}_{v_1} = \frac{1}{40}v_1\Big(-120\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 30g_2^2 + 30g_2^2\mathrm{Xi} - 40|\lambda|^2 - 40\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + 6g_1^2 + 6g_1^2\mathrm{Xi} + 9g_{1'}^2 + 9g_{1'}^2\mathrm{Xi}\Big) \tag{129}$$

$$\begin{aligned}
\beta^{(2)}_{v_1} &= \frac{1}{1600}v_1\Big(-2088g_1^4 + 216g_1^2g_{1'}^2 - 2403g_{1'}^4 - 720g_1^2g_2^2 - 1080g_{1'}^2g_2^2 - 6000g_2^4 - 18g_{1'}^4Q_S^2 - 36g_1^4\mathrm{Xi} \\
&- 108g_1^2g_{1'}^2\mathrm{Xi} - 81g_{1'}^4\mathrm{Xi} - 360g_1^2g_2^2\mathrm{Xi} - 540g_{1'}^2g_2^2\mathrm{Xi} + 3500g_2^4\mathrm{Xi} + 36g_1^4\mathrm{Xi}^2 + 108g_1^2g_{1'}^2\mathrm{Xi}^2 + 81g_{1'}^4\mathrm{Xi}^2 \\
&+ 360g_1^2g_2^2\mathrm{Xi}^2 + 540g_{1'}^2g_2^2\mathrm{Xi}^2 - 900g_2^4\mathrm{Xi}^2 + 4800\lambda^2\lambda^{*,2} \\
&- 80\Big(2g_1^2\Big(9\mathrm{Xi} - 4\Big) + 320g_3^2 + 3g_{1'}^2\Big(9\mathrm{Xi} - 4\Big) + 90g_2^2\mathrm{Xi}\Big)\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 1920g_1^2\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + 320g_{1'}^2\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) \\
&- 480g_1^2\mathrm{Xi}\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 720g_{1'}^2\mathrm{Xi}\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 2400g_2^2\mathrm{Xi}\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) \\
&- 80|\lambda|^2\Big(-20\sigma\sigma'^{,*} + 30g_2^2\mathrm{Xi} - 5g_{1'}^2 - 60\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 60\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) + 6g_1^2\mathrm{Xi} + 9g_{1'}^2\mathrm{Xi} + g_{1'}^2Q_S^2\Big) \\
&+ 14400\mathrm{Tr}\Big(Y_d Y_d^\dagger Y_d Y_d^\dagger\Big) + 4800\mathrm{Tr}\Big(Y_d Y_u^\dagger Y_u Y_d^\dagger\Big) + 4800\mathrm{Tr}\Big(Y_e Y_e^\dagger Y_e Y_e^\dagger\Big)\Big)
\end{aligned} \tag{130}$$

$$\beta^{(1)}_{v_2} = \frac{1}{20}v_2\Big(\Big(15g_2^2 + 2g_{1'}^2 + 3g_1^2\Big)\Big(1 + \mathrm{Xi}\Big) - 20|\lambda|^2 - 60\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big)\Big) \tag{131}$$

$$\begin{aligned}
\beta^{(2)}_{v_2} &= \frac{1}{400}v_2\Big(-522g_1^4 - 96g_1^2g_{1'}^2 - 257g_{1'}^4 - 180g_1^2g_2^2 - 120g_{1'}^2g_2^2 - 1500g_2^4 - 2g_{1'}^4Q_S^2 - 9g_1^4\mathrm{Xi} \\
&- 12g_1^2g_{1'}^2\mathrm{Xi} - 4g_{1'}^4\mathrm{Xi} - 90g_1^2g_2^2\mathrm{Xi} - 60g_{1'}^2g_2^2\mathrm{Xi} + 875g_2^4\mathrm{Xi} + 9g_1^4\mathrm{Xi}^2 + 12g_1^2g_{1'}^2\mathrm{Xi}^2 + 4g_{1'}^4\mathrm{Xi}^2 \\
&+ 90g_1^2g_2^2\mathrm{Xi}^2 + 60g_{1'}^2g_2^2\mathrm{Xi}^2 - 225g_2^4\mathrm{Xi}^2 + 1200\lambda^2\lambda^{*,2} \\
&- 40\Big(5\Big(32g_3^2 + 9g_2^2\mathrm{Xi}\Big) + g_{1'}^2\Big(6\mathrm{Xi} - 3\Big) + g_1^2\Big(9\mathrm{Xi} + 8\Big)\Big)\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) \\
&- 20|\lambda|^2\Big(-20\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) - 20\sigma\sigma'^{,*} + 30g_2^2\mathrm{Xi} + 4g_{1'}^2\mathrm{Xi} + 5g_{1'}^2 - 60\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 60\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) + 6g_1^2\mathrm{Xi} + g_{1'}^2Q_S^2\Big)
\end{aligned}$$

$$+ 1200\mathrm{Tr}\Big(Y_d Y_u^\dagger Y_u Y_d^\dagger\Big) + 3600\mathrm{Tr}\Big(Y_u Y_u^\dagger Y_u Y_u^\dagger\Big)\Big) \tag{132}$$

$$\beta_{v_s}^{(1)} = \frac{1}{40} v_s \Big(- 120\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 40|\sigma|^2 - 80|\lambda|^2 + g_{1'}^2 Q_S^2 + g_{1'}^2 Q_S^2 \mathrm{Xi}\Big) \tag{133}$$

$$\begin{aligned}\beta_{v_s}^{(2)} = \frac{1}{1600} v_s \Big(& - 249 g_{1'}^4 Q_S^2 - 4 g_{1'}^4 Q_S^4 - g_{1'}^4 Q_S^4 \mathrm{Xi} + g_{1'}^4 Q_S^4 \mathrm{Xi}^2 - 80|\sigma|^2 \Big(- 40\kappa'\kappa'^{,*} + g_{1'}^2 Q_S^2 \mathrm{Xi}\Big) + 6400\lambda^2 \lambda^{*,2} \\ & + 3200\sigma^2 \sigma'^{,*,2} \\ & - 160|\lambda|^2 \Big(12 g_1^2 + 13 g_{1'}^2 - 20\mathrm{Tr}\Big(Y_e Y_e^\dagger\Big) + 60 g_2^2 - 60\mathrm{Tr}\Big(Y_d Y_d^\dagger\Big) - 60\mathrm{Tr}\Big(Y_u Y_u^\dagger\Big) - g_{1'}^2 Q_S^2 + g_{1'}^2 Q_S^2 \mathrm{Xi}\Big) \\ & - 1280 g_1^2 \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 3120 g_{1'}^2 \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - 25600 g_3^2 \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 240 g_{1'}^2 Q_S^2 \mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) \\ & - 240 g_{1'}^2 Q_S^2 \mathrm{Xi}\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + 9600\mathrm{Tr}\Big(\kappa\kappa^\dagger\kappa\kappa^\dagger\Big)\Big)\end{aligned} \tag{134}$$

$$\beta_{vsb}^{(1)} = \frac{1}{40} vsb \Big(- 40|\sigma|^2 + g_{1'}^2 Q_S^2 \Big(1 + \mathrm{Xi}\Big)\Big) \tag{135}$$

$$\beta_{vsb}^{(2)} = \frac{1}{1600} vsb \Big(3200\sigma^2 \sigma'^{,*,2} - 80|\sigma|^2 \Big(- 40\kappa'\kappa'^{,*} - 40\lambda\lambda^* - 60\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) + g_{1'}^2 Q_S^2 \mathrm{Xi}\Big) + g_{1'}^4 Q_S^2 \Big(Q_S^2 \Big(- \mathrm{Xi} - 4 + \mathrm{Xi}^2\Big) - 249\Big)\Big) \tag{136}$$

$$\beta_{vphi}^{(1)} = -vphi \Big(2|\kappa'|^2 + |\sigma|^2\Big) \tag{137}$$

$$\beta_{vphi}^{(2)} = 4 vphi \sigma |\kappa'|^2 \sigma'^{,*} + 8 vphi \kappa'^{,2} \kappa'^{,*,2} + \frac{1}{10} vphi |\sigma|^2 \Big(20\lambda\lambda^* + 20\sigma\sigma'^{,*} + 30\mathrm{Tr}\Big(\kappa\kappa^\dagger\Big) - g_{1'}^2 Q_S^2\Big) \tag{138}$$

4 Field Rotations

4.1 Rotations in gauge sector for eigenstates 'EWSB'

$$\begin{pmatrix} B_\rho \\ W_{3\rho} \\ Bp_\rho \end{pmatrix} = Z^{\gamma Z Z'} \begin{pmatrix} \gamma_\rho \\ Z_\rho \\ Z'_\rho \end{pmatrix} \tag{139}$$

$$\begin{pmatrix} W_{1\rho} \\ W_{2\rho} \end{pmatrix} = Z^W \begin{pmatrix} W_\rho^- \\ W_\rho^- \end{pmatrix} \tag{140}$$

$$\begin{pmatrix} \lambda_{\tilde{W},1} \\ \lambda_{\tilde{W},2} \\ \lambda_{\tilde{W},3} \end{pmatrix} = Z^{\tilde{W}} \begin{pmatrix} \tilde{W}^- \\ \tilde{W}^+ \\ \tilde{W}^0 \end{pmatrix} \tag{141}$$

$$\tag{142}$$

The mixing matrices are parametrized by

$$Z^{\gamma ZZ'} = \begin{pmatrix} \cos\Theta_W & -\cos\Theta'_W \sin\Theta_W & \sin\Theta_W \sin\Theta'_W \\ \sin\Theta_W & \cos\Theta_W \cos\Theta'_W & -\cos\Theta_W \sin\Theta'_W \\ 0 & \sin\Theta'_W & \cos\Theta'_W \end{pmatrix} \tag{143}$$

$$Z^W = \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -i\frac{1}{\sqrt{2}} & i\frac{1}{\sqrt{2}} \end{pmatrix} \tag{144}$$

$$Z^{\tilde{W}} = \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ -i\frac{1}{\sqrt{2}} & i\frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{pmatrix} \tag{145}$$

$$\tag{146}$$

4.2 Rotations in Mass sector for eigenstates 'EWSB'

4.2.1 Mass Matrices for Scalars

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

$$m^2_{\tilde{d}} = \begin{pmatrix} m_{\tilde{d}_L \tilde{d}^*_L} & \frac{1}{2}\text{Delta}\left(\sqrt{2} v_1 T_d^\dagger - v_s v_2 \lambda Y_d^\dagger\right)\delta_{\alpha_1\beta_2} \\ \frac{1}{2}\text{Delta}\delta_{\alpha_2\beta_1}\left(\sqrt{2} v_1 T_d - v_s v_2 Y_d \lambda^*\right) & m_{\tilde{d}_R \tilde{d}^*_R} \end{pmatrix} \tag{147}$$

$$\begin{aligned} m_{\tilde{d}_L \tilde{d}^*_L} &= -\frac{1}{24}\mathbf{1}\Big(3\Big(4g^2_{1'}\Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + g_2^2\Big(-v_2^2 + v_1^2\Big)\Big) + g_1^2\Big(-v_2^2 + v_1^2\Big)\Big)\delta_{\alpha_1\beta_1} \\ &\quad + \frac{1}{2}\Big(2m_q^2 + \mathbf{1} v_1^2 Y_d Y^*_{d,o_1 o_1}\Big)\delta_{\alpha_1\beta_1} \end{aligned} \tag{148}$$

$$m_{\tilde{d}_R \tilde{d}^*_R} = -\frac{1}{12}\mathbf{1}\Big(12g^2_{1'}\Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + g_1^2\Big(-v_2^2 + v_1^2\Big)\Big)\delta_{\alpha_2\beta_2} + \frac{1}{2}\delta_{\alpha_2\beta_2}\Big(2m_d^2 + \mathbf{1} v_1^2 Y_d^\dagger Y_{d,o_2 o_2}\Big) \tag{149}$$

This matrix is diagonalized by Z^D:

$$Z^D m^2_{\tilde{d}} Z^{D,\dagger} = m^{dia}_{2,\tilde{d}} \tag{150}$$

with

$$\tilde{d}_{L,i\alpha} = \sum_j Z^{D,*}_{ji} \tilde{d}_{j\alpha}\,, \qquad \tilde{d}_{R,i\alpha} = \sum_j Z^{D,*}_{ji} \tilde{d}_{j\alpha} \tag{151}$$

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

$$m^2_{\tilde{\nu}} = \Big(\ \tfrac{1}{8}\mathbf{1}\Big(-8g^2_{1'}\Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + \Big(g_1^2 + g_2^2\Big)\Big(-v_2^2 + v_1^2\Big)\Big) + m_l^2\ \Big) \tag{152}$$

This matrix is diagonalized by Z^V:

$$Z^V m^2_{\tilde{\nu}} Z^{V,\dagger} = m^{dia}_{2,\tilde{\nu}} \tag{153}$$

with

$$\tilde{\nu}_{L,i} = \sum_j Z^{V,*}_{ji} \tilde{\nu}_j \tag{154}$$

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

$$m^2_{\tilde{u}} = \begin{pmatrix} m_{\tilde{u}_L \tilde{u}^*_L} & \frac{1}{2}\text{Delta}\Big(\sqrt{2} v_2 T^\dagger_u - v_1 v_s \lambda Y^\dagger_u\Big)\delta_{\alpha_1\beta_2} \\ \frac{1}{2}\text{Delta}\delta_{\alpha_2\beta_1}\Big(\sqrt{2} v_2 T_u - v_1 v_s Y_u \lambda^*\Big) & m_{\tilde{u}_R \tilde{u}^*_R} \end{pmatrix} \tag{155}$$

$$\begin{aligned} m_{\tilde{u}_L \tilde{u}^*_L} &= -\frac{1}{24}\mathbf{1}\Big(3\Big(4 g^2_{1'}\Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + v s b^2\Big)\Big) + g_2^2\Big(-v_1^2 + v_2^2\Big)\Big) + g_1^2\Big(-v_2^2 + v_1^2\Big)\Big)\delta_{\alpha_1\beta_1} \\ &\quad + \frac{1}{2}\Big(2 m_q^2 + \mathbf{1} v_2^2 Y_u Y^*_{u,o_1 o_1}\Big)\delta_{\alpha_1\beta_1} \end{aligned} \tag{156}$$

$$m_{\tilde{u}_R \tilde{u}^*_R} = \frac{1}{2}\delta_{\alpha_2\beta_2}\Big(2 m_u^2 + \mathbf{1} v_2^2 Y^\dagger_u Y_{u,o_2 o_2}\Big) + \frac{1}{6}\mathbf{1}\Big(-3 g^2_{1'}\Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + v s b^2\Big)\Big) + g_1^2\Big(-v_2^2 + v_1^2\Big)\Big)\delta_{\alpha_2\beta_2} \tag{157}$$

This matrix is diagonalized by Z^U:

$$Z^U m^2_{\tilde{u}} Z^{U,\dagger} = m^{dia}_{2,\tilde{u}} \tag{158}$$

with

$$\tilde{u}_{L,i\alpha} = \sum_j Z^{U,*}_{ji} \tilde{u}_{j\alpha}\,, \qquad \tilde{u}_{R,i\alpha} = \sum_j Z^{U,*}_{ji} \tilde{u}_{j\alpha} \tag{159}$$

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

$$m^2_{\tilde{e}} = \begin{pmatrix} m_{\tilde{e}_L \tilde{e}^*_L} & \frac{1}{2}\text{Delta}\Big(\sqrt{2} v_1 T^\dagger_e - v_s v_2 \lambda Y^\dagger_e\Big) \\ \frac{1}{2}\text{Delta}\Big(\sqrt{2} v_1 T_e - v_s v_2 Y_e \lambda^*\Big) & m_{\tilde{e}_R \tilde{e}^*_R} \end{pmatrix} \tag{160}$$

$$m_{\tilde{e}_L \tilde{e}^*_L} = \frac{1}{2}\mathbf{1} v_1^2 Y_e Y^*_{e,o_1 o_1} + \frac{1}{8}\mathbf{1}\Big(-8 g^2_{1'}\Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + v s b^2\Big)\Big) + g_1^2\Big(-v_2^2 + v_1^2\Big) + g_2^2\Big(-v_1^2 + v_2^2\Big)\Big) + m_l^2 \tag{161}$$

$$m_{\tilde{e}_R \tilde{e}^*_R} = \frac{1}{2}\mathbf{1} v_1^2 Y^\dagger_e Y_{e,o_2 o_2} - \frac{1}{4}\mathbf{1}\Big(2 g^2_{1'}\Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + v s b^2\Big)\Big) + g_1^2\Big(-v_2^2 + v_1^2\Big)\Big) + m_e^2 \tag{162}$$

This matrix is diagonalized by Z^E:

$$Z^E m^2_{\tilde{e}} Z^{E,\dagger} = m^{dia}_{2,\tilde{e}} \tag{163}$$

with

$$\tilde{e}_{L,i} = \sum_j Z^{E,*}_{ji} \tilde{e}_j\,, \qquad \tilde{e}_{R,i} = \sum_j Z^{E,*}_{ji} \tilde{e}_j \tag{164}$$

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

$$m^2_{\tilde{x}} = \begin{pmatrix} m_{\tilde{Dx}_L \tilde{Dx}^*_L} & -\frac{1}{2}\mathrm{Delta}\Big(-\sqrt{2} v_s T^*_\kappa + \Big(v_1 v_2 \lambda + vphivsb\sigma\Big)\kappa^*\Big)\delta_{\alpha_1\beta_2} \\ m_{\tilde{Dx}_L \tilde{Dx}^*_R} & m_{\tilde{Dx}_R \tilde{Dx}^*_R} \end{pmatrix} \tag{165}$$

$$m_{\tilde{Dx}_L \tilde{Dx}^*_L} = \frac{1}{12}\mathbf{1}\Big(12 g_{1'}^2\Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + g_1^2\Big(-v_2^2 + v_1^2\Big)\Big)\delta_{\alpha_1\beta_1} + \frac{1}{2}\mathbf{1}\delta_{\alpha_1\beta_1}\Big(2m_X^2 + v_s^2 \kappa^*_{o_1 o_1}\kappa^T\Big) \tag{166}$$

$$m_{\tilde{Dx}_L \tilde{Dx}^*_R} = -\frac{1}{2}\mathrm{Delta}\delta_{\alpha_2\beta_1}\Big(-\sqrt{2} v_s T^T_\kappa + \Big(v_1 v_2 \lambda^* + vphivsb\sigma'^{,*}\Big)\kappa^T\Big) \tag{167}$$

$$m_{\tilde{Dx}_R \tilde{Dx}^*_R} = \frac{1}{12}\mathbf{1}\Big(18 g_{1'}^2\Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + g_1^2\Big(-v_1^2 + v_2^2\Big)\Big)\delta_{\alpha_2\beta_2} + \frac{1}{2}\mathbf{1}\delta_{\alpha_2\beta_2}\Big(2m_X^2 + v_s^2 \kappa^* \kappa_{o_2 o_2}\Big) \tag{168}$$

This matrix is diagonalized by Z^{Dx}:

$$Z^{Dx} m^2_{\tilde{x}} Z^{Dx,\dagger} = m^{dia}_{2,\tilde{x}} \tag{169}$$

with

$$\tilde{Dx}_{L,i\alpha} = \sum_j Z^{Dx,*}_{ji} \tilde{x}_{j\alpha}\,, \qquad \tilde{Dx}_{R,i\alpha} = \sum_j Z^{Dx,*}_{ji} \tilde{x}_{j\alpha} \tag{170}$$

- **Mass matrix for Higgs**, Basis: $(\phi_d, \phi_u, \phi_s, \mathrm{phiSbar}, \mathrm{phiPhi})\,, (\phi_d, \phi_u, \phi_s, \mathrm{phiSbar}, \mathrm{phiPhi})$

$$m_h^2 = \begin{pmatrix} m_{\phi_d\phi_d} & m_{\phi_u\phi_d} & m_{\phi_s\phi_d} & m_{\mathrm{phiSbar}\phi_d} & \frac{1}{2} vsb v_2 \Re\Big(\sigma\lambda^*\Big) \\ m_{\phi_d\phi_u} & m_{\phi_u\phi_u} & m_{\phi_s\phi_u} & m_{\mathrm{phiSbar}\phi_u} & \frac{1}{2} v_1 vsb \Re\Big(\sigma\lambda^*\Big) \\ m_{\phi_d\phi_s} & m_{\phi_u\phi_s} & m_{\phi_s\phi_s} & m_{\mathrm{phiSbar}\phi_s} & m_{\mathrm{phiPhi}\phi_s} \\ m_{\phi_d\mathrm{phiSbar}} & m_{\phi_u\mathrm{phiSbar}} & m_{\phi_s\mathrm{phiSbar}} & m_{\mathrm{phiSbarphiSbar}} & m_{\mathrm{phiPhiphiSbar}} \\ \frac{1}{2} vsb v_2 \Re\Big(\sigma\lambda^*\Big) & \frac{1}{2} v_1 vsb \Re\Big(\sigma\lambda^*\Big) & m_{\phi_s\mathrm{phiPhi}} & m_{\mathrm{phiSbarphiPhi}} & m_{\mathrm{phiPhiphiPhi}} \end{pmatrix} \tag{171}$$

$$m_{\phi_d\phi_d} = \frac{1}{2}\Big(v_s^2 + v_2^2\Big)|\lambda|^2 + \frac{1}{8}\Big(-\Big(-24 g_{1'}^2 + g_1^2 + g_2^2\Big)v_2^2 + 3\Big(4 g_{1'}^2\Big(9v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + \Big(g_1^2 + g_2^2\Big)v_1^2\Big)\Big) + m^2_{h_1} \tag{172}$$

$$m_{\phi_d\phi_u} = -\frac{1}{4}\Big(-24 g_{1'}^2 + g_1^2 + g_2^2\Big)v_1 v_2 + \frac{1}{4}\Big(-2\sqrt{2} v_s \Re\Big(T_\lambda\Big) + \Big(4 v_1 v_2 \lambda + vphivsb\sigma\Big)\lambda^* + vphivsb\lambda\sigma'^{,*}\Big) \tag{173}$$

$$m_{\phi_u\phi_u} = \frac{1}{2}\Big(v_1^2 + v_s^2\Big)|\lambda|^2 + \frac{1}{8}\Big(8 g_{1'}^2\Big(3v_1^2 + 6v_2^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + \Big(-g_1^2 - g_2^2\Big)\Big(-3v_2^2 + v_1^2\Big)\Big) + m^2_{h_{23}} \tag{174}$$

$$m_{\phi_d\phi_s} = -3 g_{1'}^2 Q_S v_1 v_s - \frac{1}{\sqrt{2}} v_2 \Re\Big(T_\lambda\Big) + v_1 v_s |\lambda|^2 \tag{175}$$

$$m_{\phi_u\phi_s} = -2 g_{1'}^2 Q_S v_s v_2 - \frac{1}{\sqrt{2}} v_1 \Re\Big(T_\lambda\Big) + v_s v_2 |\lambda|^2 \tag{176}$$

$$m_{\phi_s\phi_s} = \frac{1}{2}g_{1'}^2 Q_S\Big(-2v_2^2 - 3v_1^2 + Q_S\Big(3v_s^2 - vsb^2\Big)\Big) + \frac{1}{2}\Big(\Big(v_1^2 + v_2^2\Big)|\lambda|^2 + \Big(vphi^2 + vsb^2\Big)|\sigma|^2\Big) + m_{s_3}^2 \tag{177}$$

$$m_{\phi_d\text{phiSbar}} = 3g_{1'}^2 Q_S v_1 vsb + \frac{1}{2}vphiv_2\Re\Big(\sigma\lambda^*\Big) \tag{178}$$

$$m_{\phi_u\text{phiSbar}} = 2g_{1'}^2 Q_S vsbv_2 + \frac{1}{2}v_1 vphi\Re\Big(\sigma\lambda^*\Big) \tag{179}$$

$$m_{\phi_s\text{phiSbar}} = \frac{1}{4}\Big(-2\Big(\Big(-2v_s vsb\sigma + XiF_1\Big)\sigma'^{,*} + \sigma XiF_1^*\Big) - 2vphi^2\Re\Big(\sigma\kappa'^{,*}\Big) - \sqrt{2}vphi\Big(2\Re\Big(\sigma Mu_{phi}^*\Big) + 2\Re\Big(T_\sigma\Big)\Big)\Big) - g_{1'}^2$$

(180)

$$m_{\text{phiSbarphiSbar}} = \frac{1}{2}g_{1'}^2 Q_S\Big(2v_2^2 + 3\Big(Q_S vsb^2 + v_1^2\Big) - Q_S v_s^2\Big) + \frac{1}{2}\Big(vphi^2 + v_s^2\Big)|\sigma|^2 + m_{sbar_3}^2 \tag{181}$$

$$m_{\phi_s\text{phiPhi}} = -\frac{1}{4}vsb\Big(4vphi\Re\Big(\sigma\kappa'^{,*}\Big) + \sqrt{2}\Big(2\Re\Big(\sigma Mu_{phi}^*\Big) + 2\Re\Big(T_\sigma\Big)\Big)\Big) + vphiv_s|\sigma|^2 \tag{182}$$

$$m_{\text{phiSbarphiPhi}} = \frac{1}{4}\Big(2v_1v_2\Re\Big(\sigma\lambda^*\Big) + 4vphivsb|\sigma|^2 - v_s\Big(4vphi\Re\Big(\sigma\kappa'^{,*}\Big) + \sqrt{2}\Big(2\Re\Big(\sigma Mu_{phi}^*\Big) + 2\Re\Big(T_\sigma\Big)\Big)\Big)\Big) \tag{183}$$

$$\begin{aligned} m_{\text{phiPhiphiPhi}} &= +m_{phi}^2 \\ &+ \frac{1}{2}\Big(\Big(v_s^2 + vsb^2\Big)|\sigma|^2 + \Big(2Mu_{phi} + 3\sqrt{2}vphi\kappa'\Big)Mu_{phi}^* + \Big(2XiF_1 + 3\sqrt{2}Mu_{phi}vphi + 6vphi^2\kappa' - v_s vsb\sigma\Big)\kappa'^{,*} - \\ &+ 2\sqrt{2}vphi\Re\Big(T_{\kappa'}\Big)\Big) \end{aligned} \tag{184}$$

This matrix is diagonalized by U_H:

$$U_H m_h^2 U_H^\dagger = m_{2,h}^{dia} \tag{185}$$

with

$$\phi_d = \sum_j U_{H,j1}^* h_j\,, \qquad \phi_u = \sum_j U_{H,j2}^* h_j\,, \qquad \phi_s = \sum_j U_{H,j3}^* h_j \tag{186}$$

$$\text{phiSbar} = \sum_j U_{H,j4}^* h_j\,, \qquad \text{phiPhi} = \sum_j U_{H,j5}^* h_j \tag{187}$$

- **Mass matrix for Pseudo-Scalar Higgs**, Basis: $(\sigma_d, \sigma_u, \sigma_s, \text{sigmaSbar}, \text{sigmaPhi})\,, (\sigma_d, \sigma_u, \sigma_s, \text{sigmaSbar}, \text{sigmaPhi})$

$$m_{A^0}^2 = \begin{pmatrix} m_{\sigma_d\sigma_d} & m_{\sigma_u\sigma_d} & \frac{1}{\sqrt{2}}v_2\Re\Big(T_\lambda\Big) & \frac{1}{2}vphiv_2\Re\Big(\sigma\lambda^*\Big) & \frac{1}{2}vsbv_2\Re\Big(\sigma\lambda^*\Big) \\ m_{\sigma_d\sigma_u} & m_{\sigma_u\sigma_u} & \frac{1}{\sqrt{2}}v_1\Re\Big(T_\lambda\Big) & \frac{1}{2}v_1 vphi\Re\Big(\sigma\lambda^*\Big) & \frac{1}{2}v_1 vsb\Re\Big(\sigma\lambda^*\Big) \\ \frac{1}{\sqrt{2}}v_2\Re\Big(T_\lambda\Big) & \frac{1}{\sqrt{2}}v_1\Re\Big(T_\lambda\Big) & m_{\sigma_s\sigma_s} & m_{\text{sigmaSbar}\sigma_s} & m_{\text{sigmaPhi}\sigma_s} \\ \frac{1}{2}vphiv_2\Re\Big(\sigma\lambda^*\Big) & \frac{1}{2}v_1 vphi\Re\Big(\sigma\lambda^*\Big) & m_{\sigma_s\text{sigmaSbar}} & m_{\text{sigmaSbarsigmaSbar}} & m_{\text{sigmaPhisigmaSbar}} \\ \frac{1}{2}vsbv_2\Re\Big(\sigma\lambda^*\Big) & \frac{1}{2}v_1 vsb\Re\Big(\sigma\lambda^*\Big) & m_{\sigma_s\text{sigmaPhi}} & m_{\text{sigmaSbarsigmaPhi}} & m_{\text{sigmaPhisigmaPhi}} \end{pmatrix} + \xi_Z m^2(Z) + \xi_{Z'} m^2(Z$$

(188)

$$m_{\sigma_d\sigma_d} = \frac{1}{2}\Big(v_s^2 + v_2^2\Big)|\lambda|^2 + \frac{1}{8}\Big(12g_{1'}^2\Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + \Big(g_1^2 + g_2^2\Big)\Big(-v_2^2 + v_1^2\Big)\Big) + m_{h_{13}}^2 \tag{189}$$

$$m_{\sigma_d\sigma_u} = \frac{1}{4}\Big(2\sqrt{2}v_s\Re\Big(T_\lambda\Big) - 2vphivsb\Re\Big(\sigma\lambda^*\Big)\Big) \tag{190}$$

$$m_{\sigma_u\sigma_u} = \frac{1}{2}\Big(v_1^2+v_s^2\Big)|\lambda|^2 + \frac{1}{8}\Big(8g_{1'}^2\Big(2v_2^2+3v_1^2+Q_S\Big(-v_s^2+vsb^2\Big)\Big) + \Big(g_1^2+g_2^2\Big)\Big(-v_1^2+v_2^2\Big)\Big) + m_{h_{23}}^2 \tag{191}$$

$$m_{\sigma_s\sigma_s} = \frac{1}{2}g_{1'}^2Q_S\Big(-2v_2^2-3v_1^2+Q_S\Big(-vsb^2+v_s^2\Big)\Big) + \frac{1}{2}\Big(\Big(v_1^2+v_2^2\Big)|\lambda|^2 + \Big(vphi^2+vsb^2\Big)|\sigma|^2\Big) + m_{s_3}^2 \tag{192}$$

$$m_{\sigma_s\text{sigmaSbar}} = \frac{1}{4}\Big(2vphi^2\Re\Big(\sigma\kappa'^{,*}\Big) + 4\Re\Big(\sigma XiF_1^*\Big) + \sqrt{2}vphi\Big(2\Re\Big(\sigma Mu_{phi}^*\Big) + 2\Re\Big(T_\sigma\Big)\Big)\Big) \tag{193}$$

$$m_{\text{sigmaSbarsigmaSbar}} = \frac{1}{2}g_{1'}^2Q_S\Big(2v_2^2+3v_1^2+Q_S\Big(-v_s^2+vsb^2\Big)\Big) + \frac{1}{2}\Big(vphi^2+v_s^2\Big)|\sigma|^2 + m_{sbar_3}^2 \tag{194}$$

$$m_{\sigma_s\text{sigmaPhi}} = -\frac{1}{4}vsb\Big(4vphi\Re\Big(\sigma\kappa'^{,*}\Big) + \sqrt{2}\Big(2\Re\Big(\sigma Mu_{phi}^*\Big) - 2\Re\Big(T_\sigma\Big)\Big)\Big) \tag{195}$$

$$m_{\text{sigmaSbarsigmaPhi}} = \frac{1}{4}\Big(-2v_1v_2\Re\Big(\sigma\lambda^*\Big) - v_s\Big(4vphi\Re\Big(\sigma\kappa'^{,*}\Big) + \sqrt{2}\Big(-2\Re\Big(T_\sigma\Big) + Mu_{phi}\sigma'^{,*}\Big) + \sqrt{2}\sigma Mu_{phi}^*\Big)\Big) \tag{196}$$

$$\begin{aligned} m_{\text{sigmaPhisigmaPhi}} &= +m_{phi}^2 \\ &+ \frac{1}{2}\Big(\Big(2Mu_{phi}+\sqrt{2}vphi\kappa'\Big)Mu_{phi}^* + \Big(2vphi^2\kappa' - 2XiF_1 + \sqrt{2}Mu_{phi}vphi + v_svsb\sigma\Big)\kappa'^{,*} + \Big(\Big(v_s^2+vsb^2\Big)\sigma \\ &- 2\sqrt{2}vphi\Re\Big(T_{\kappa'}\Big)\Big) \end{aligned} \tag{197}$$

Gauge fixing contributions:

$$m^2(\xi_Z) = \begin{pmatrix} m_{\sigma_d\sigma_d} & m_{\sigma_u\sigma_d} & m_{\sigma_s\sigma_d} & m_{\text{sigmaSbar}\sigma_d} & 0 \\ m_{\sigma_d\sigma_u} & m_{\sigma_u\sigma_u} & m_{\sigma_s\sigma_u} & m_{\text{sigmaSbar}\sigma_u} & 0 \\ m_{\sigma_d\sigma_s} & m_{\sigma_u\sigma_s} & m_{\sigma_s\sigma_s} & m_{\text{sigmaSbar}\sigma_s} & 0 \\ m_{\sigma_d\text{sigmaSbar}} & m_{\sigma_u\text{sigmaSbar}} & m_{\sigma_s\text{sigmaSbar}} & m_{\text{sigmaSbarsigmaSbar}} & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \tag{198}$$

$$m_{\sigma_d\sigma_d} = \frac{1}{4}v_1^2\Big(-6g_1'\sin\Theta'_W + \cos\Theta'_W\Big(g_1\sin\Theta_W + g_2\cos\Theta_W\Big)\Big)^2 \tag{199}$$

$$m_{\sigma_d\sigma_u} = -\frac{1}{4}v_1v_2\Big(-6g_1'\sin\Theta'_W + \cos\Theta'_W\Big(g_1\sin\Theta_W + g_2\cos\Theta_W\Big)\Big)\Big(4g_1'\sin\Theta'_W + \cos\Theta'_W\Big(g_1\sin\Theta_W + g_2\cos \tag{200}$$

$$m_{\sigma_u\sigma_u} = \frac{1}{4}v_2^2\Big(4g_1'\sin\Theta'_W + \cos\Theta'_W\Big(g_1\sin\Theta_W + g_2\cos\Theta_W\Big)\Big)^2 \tag{201}$$

$$m_{\sigma_d\sigma_s} = \frac{1}{2}g_1'Q_Sv_1v_s\sin\Theta'_W\Big(-6g_1'\sin\Theta'_W + \cos\Theta'_W\Big(g_1\sin\Theta_W + g_2\cos\Theta_W\Big)\Big) \tag{202}$$

$$m_{\sigma_u\sigma_s} = -\frac{1}{2}g_1'Q_Sv_sv_2\sin\Theta'_W\Big(4g_1'\sin\Theta'_W + \cos\Theta'_W\Big(g_1\sin\Theta_W + g_2\cos\Theta_W\Big)\Big) \tag{203}$$

$$m_{\sigma_s\sigma_s} = g_{1'}^2Q_S^2v_s^2\sin\Theta'^2_W \tag{204}$$

$$m_{\sigma_d\text{sigmaSbar}} = \frac{1}{2}g_1'Q_Sv_1vsb\sin\Theta'_W\Big(6g_1'\sin\Theta'_W - \cos\Theta'_W\Big(g_1\sin\Theta_W + g_2\cos\Theta_W\Big)\Big) \tag{205}$$

$$m_{\sigma_u \text{sigmaSbar}} = \frac{1}{2} g_1' Q_S vsb v_2 \sin\Theta'_W \Big(4 g_1' \sin\Theta'_W + \cos\Theta'_W \Big(g_1 \sin\Theta_W + g_2 \cos\Theta_W \Big) \Big) \tag{206}$$

$$m_{\sigma_s \text{sigmaSbar}} = -g_{1'}^2 Q_S^2 v_s vsb \sin\Theta'^2_W \tag{207}$$

$$m_{\text{sigmaSbarsigmaSbar}} = g_{1'}^2 Q_S^2 vsb^2 \sin\Theta'^2_W \tag{208}$$

$$m^2(\xi_{Z'}) = \begin{pmatrix} m_{\sigma_d\sigma_d} & m_{\sigma_u\sigma_d} & m_{\sigma_s\sigma_d} & m_{\text{sigmaSbar}\sigma_d} & 0 \\ m_{\sigma_d\sigma_u} & m_{\sigma_u\sigma_u} & m_{\sigma_s\sigma_u} & m_{\text{sigmaSbar}\sigma_u} & 0 \\ m_{\sigma_d\sigma_s} & m_{\sigma_u\sigma_s} & m_{\sigma_s\sigma_s} & m_{\text{sigmaSbar}\sigma_s} & 0 \\ m_{\sigma_d \text{sigmaSbar}} & m_{\sigma_u \text{sigmaSbar}} & m_{\sigma_s \text{sigmaSbar}} & m_{\text{sigmaSbarsigmaSbar}} & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \tag{209}$$

$$m_{\sigma_d\sigma_d} = \frac{1}{4} v_1^2 \Big(6 g_1' \cos\Theta'_W + \Big(g_1 \sin\Theta_W + g_2 \cos\Theta_W \Big) \sin\Theta'_W \Big)^2 \tag{210}$$

$$\begin{aligned} m_{\sigma_d\sigma_u} = \frac{1}{4} v_1 v_2 \Big(& 24 g_{1'}^2 \cos\Theta'^2_W \\ & - \Big(g_1 \sin\Theta_W + g_2 \cos\Theta_W \Big) \Big(g_1' \sin 2\Theta'_W + \Big(g_1 \sin\Theta_W + g_2 \cos\Theta_W \Big) \sin\Theta'^2_W \Big) \Big) \end{aligned} \tag{211}$$

$$m_{\sigma_u\sigma_u} = \frac{1}{4} v_2^2 \Big(-4 g_1' \cos\Theta'_W + \Big(g_1 \sin\Theta_W + g_2 \cos\Theta_W \Big) \sin\Theta'_W \Big)^2 \tag{212}$$

$$m_{\sigma_d\sigma_s} = -\frac{1}{2} g_1' Q_S v_1 v_s \cos\Theta'_W \Big(6 g_1' \cos\Theta'_W + \Big(g_1 \sin\Theta_W + g_2 \cos\Theta_W \Big) \sin\Theta'_W \Big) \tag{213}$$

$$m_{\sigma_u\sigma_s} = \frac{1}{2} g_1' Q_S v_s v_2 \cos\Theta'_W \Big(-4 g_1' \cos\Theta'_W + \Big(g_1 \sin\Theta_W + g_2 \cos\Theta_W \Big) \sin\Theta'_W \Big) \tag{214}$$

$$m_{\sigma_s\sigma_s} = g_{1'}^2 Q_S^2 v_s^2 \cos\Theta'^2_W \tag{215}$$

$$m_{\sigma_d \text{sigmaSbar}} = \frac{1}{2} g_1' Q_S v_1 vsb \cos\Theta'_W \Big(6 g_1' \cos\Theta'_W + \Big(g_1 \sin\Theta_W + g_2 \cos\Theta_W \Big) \sin\Theta'_W \Big) \tag{216}$$

$$m_{\sigma_u \text{sigmaSbar}} = \frac{1}{2} g_1' Q_S vsb v_2 \cos\Theta'_W \Big(4 g_1' \cos\Theta'_W - \Big(g_1 \sin\Theta_W + g_2 \cos\Theta_W \Big) \sin\Theta'_W \Big) \tag{217}$$

$$m_{\sigma_s \text{sigmaSbar}} = -g_{1'}^2 Q_S^2 v_s vsb \cos\Theta'^2_W \tag{218}$$

$$m_{\text{sigmaSbarsigmaSbar}} = g_{1'}^2 Q_S^2 vsb^2 \cos\Theta'^2_W \tag{219}$$

This matrix is diagonalized by U_A:

$$U_A m^2_{A^0} U_A^\dagger = m^{dia}_{2,A^0} \tag{220}$$

with

$$\sigma_d = \sum_j U_{A,j1} A^0_j \,, \qquad \sigma_u = \sum_j U_{A,j2} A^0_j \,, \qquad \sigma_s = \sum_j U_{A,j3} A^0_j \tag{221}$$

$$\text{sigmaSbar} = \sum_j U_{A,j4} A^0_j \,, \qquad \text{sigmaPhi} = \sum_j U_{A,j5} A^0_j \tag{222}$$

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

$$m^2_{H^-} = \begin{pmatrix} m_{H_d^- H_d^{-,*}} & m^*_{H_u^{+,*} H_d^{-,*}} \\ m_{H_d^- H_u^+} & m_{H_u^{+,*} H_u^+} \end{pmatrix} + \xi_{W^-} m^2(W^-) \tag{223}$$

$$m_{H_d^- H_d^{-,*}} = \frac{1}{2} v_s^2 |\lambda|^2 + \frac{1}{8}\Big(12 g_{1'}^2 \Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + g_1^2\Big(-v_2^2 + v_1^2\Big) + g_2^2\Big(v_1^2 + v_2^2\Big)\Big) + m^2_{h_{13}} \tag{224}$$

$$m_{H_d^- H_u^+} = \frac{1}{2}\Big(-\lambda\Big(v_1 v_2 \lambda^* + vphivsb\sigma'^{,*}\Big) + \sqrt{2} v_s T_\lambda\Big) + \frac{1}{4} g_2^2 v_1 v_2 \tag{225}$$

$$m_{H_u^{+,*} H_u^+} = \frac{1}{2} v_s^2 |\lambda|^2 + \frac{1}{8}\Big(8 g_{1'}^2 \Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + g_1^2\Big(-v_1^2 + v_2^2\Big) + g_2^2\Big(v_1^2 + v_2^2\Big)\Big) + m^2_{h_{23}} \tag{226}$$

Gauge fixing contributions:

$$m^2(\xi_{W^-}) = \begin{pmatrix} \frac{1}{4} g_2^2 v_1^2 & -\frac{1}{4} g_2^2 v_1 v_2 \\ -\frac{1}{4} g_2^2 v_1 v_2 & \frac{1}{4} g_2^2 v_2^2 \end{pmatrix} \tag{227}$$

This matrix is diagonalized by U_+:

$$U_+ m^2_{H^-} U_+^\dagger = m^{dia}_{2,H^-} \tag{228}$$

with

$$H_d^- = \sum_j U^*_{+,j1} H_j^- \,, \qquad H_u^+ = \sum_j U_{+,j2} H_j^+ \tag{229}$$

- **Mass matrix for Neutral Prime-Higgs**, Basis: $\Big(H'^0, \bar{H}'^{0,*}\Big), \Big(H'^{0,*}, \bar{H}'^0\Big)$

$$m^2_{H'^0} = \begin{pmatrix} m_{H'^0 H'^{0,*}} & -B^*_{\mu'} \\ -B_{\mu'} & m_{\bar{H}'^{0,*} \bar{H}'^0} \end{pmatrix} \tag{230}$$

$$m_{H'^0 H'^{0,*}} = \frac{1}{8}\Big(-8 g_{1'}^2 \Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + \Big(g_1^2 + g_2^2\Big)\Big(-v_2^2 + v_1^2\Big)\Big) + m^2_{hPr} + |\mu'|^2 \tag{231}$$

$$m_{\bar{H}'^{0,*} \bar{H}'^0} = \frac{1}{8}\Big(8 g_{1'}^2 \Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + \Big(g_1^2 + g_2^2\Big)\Big(-v_1^2 + v_2^2\Big)\Big) + m^2_{h\bar{P}r} + |\mu'|^2 \tag{232}$$

This matrix is diagonalized by $\overset{\circ}{\tilde{h}}'^0$:

$$\overset{\circ}{\tilde{h}}'^0 m^2_{H'^0} \overset{\circ}{\tilde{h}}'^{0,\dagger} = m^{dia}_{2,H'^0} \tag{233}$$

with

$$H'^0 = \sum_j UHp0^*_{j1} H'^0_j \,, \qquad \bar{H}'^0 = \sum_j UHp0_{j2} H'^{0,*}_j \tag{234}$$

- **Mass matrix for Charged Prime-Higgs**, Basis: $\left(H^{'-},\bar{H}^{'+,*}\right),\left(H^{'-,*},\bar{H}^{'+}\right)$

$$m^2_{H'^-}=\begin{pmatrix} m_{H'^-H'^{-,*}} & B^*_{\mu'} \\ B_{\mu'} & m_{\bar{H}'^{+,*}\bar{H}'^{+}} \end{pmatrix} \tag{235}$$

$$m_{H'^-H'^{-,*}}=\frac{1}{8}\Big(-8g_{1'}^2\Big(2v_2^2+3v_1^2+Q_S\Big(-v_s^2+vsb^2\Big)\Big)+g_1^2\Big(-v_2^2+v_1^2\Big)+g_2^2\Big(-v_1^2+v_2^2\Big)\Big)+m^2_{hPr}+|\mu'|^2 \tag{236}$$

$$m_{\bar{H}'^{+,*}\bar{H}'^{+}}=\frac{1}{8}\Big(8g_{1'}^2\Big(2v_2^2+3v_1^2+Q_S\Big(-v_s^2+vsb^2\Big)\Big)+g_1^2\Big(-v_1^2+v_2^2\Big)+g_2^2\Big(-v_2^2+v_1^2\Big)\Big)+m^2_{h\bar{P}r}+|\mu'|^2 \tag{237}$$

This matrix is diagonalized by $UHpp$:

$$UHppm^2_{H'^-}UHpp^\dagger=m^{dia}_{2,H'^-} \tag{238}$$

with

$$H^{'-}=\sum_j UHpp^*_{j1}H_j^{'-}\,,\qquad \bar{H}^{'+}=\sum_j UHpp_{j2}H_j^{'+} \tag{239}$$

4.2.2 Mass Matrices for Fermions

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

$$m_{\tilde{\chi}^0}=\begin{pmatrix} M_1 & 0 & -\frac{1}{2}g_1v_1 & \frac{1}{2}g_1v_2 & 0 & 0 & 0 & 0 \\ 0 & M_2 & \frac{1}{2}g_2v_1 & -\frac{1}{2}g_2v_2 & 0 & 0 & 0 & 0 \\ -\frac{1}{2}g_1v_1 & \frac{1}{2}g_2v_1 & 0 & -\frac{1}{\sqrt{2}}v_s\lambda & -\frac{1}{\sqrt{2}}v_2\lambda & 0 & 0 & -3g_1'v_1 \\ \frac{1}{2}g_1v_2 & -\frac{1}{2}g_2v_2 & -\frac{1}{\sqrt{2}}v_s\lambda & 0 & -\frac{1}{\sqrt{2}}v_1\lambda & 0 & 0 & -2g_1'v_2 \\ 0 & 0 & -\frac{1}{\sqrt{2}}v_2\lambda & -\frac{1}{\sqrt{2}}v_1\lambda & 0 & -\frac{1}{\sqrt{2}}vphi\sigma & -\frac{1}{\sqrt{2}}vsb\sigma & g_1'Q_Sv_s \\ 0 & 0 & 0 & 0 & -\frac{1}{\sqrt{2}}vphi\sigma & 0 & m_{\mathrm{FphiRFsbarR}} & -g_1'Q_Svsb \\ 0 & 0 & 0 & 0 & -\frac{1}{\sqrt{2}}vsb\sigma & m_{\mathrm{FsbarRFphiR}} & m_{\mathrm{FphiRFphiR}} & 0 \\ 0 & 0 & -3g_1'v_1 & -2g_1'v_2 & g_1'Q_Sv_s & -g_1'Q_Svsb & 0 & M_1' \end{pmatrix} \tag{240}$$

$$m_{\mathrm{FsbarRFphiR}}=-\frac{1}{\sqrt{2}}v_s\sigma \tag{241}$$

$$m_{\mathrm{FphiRFphiR}}=\sqrt{2}vphi\kappa'+Mu_{phi} \tag{242}$$

This matrix is diagonalized by N:

$$N^*m_{\tilde{\chi}^0}N^\dagger=m^{dia}_{\tilde{\chi}^0} \tag{243}$$

with

$$\lambda_{\tilde{B}} = \sum_j N^*_{j1}\lambda^0_j\,, \qquad \tilde{W}^0 = \sum_j N^*_{j2}\lambda^0_j\,, \qquad \tilde{H}^0_d = \sum_j N^*_{j3}\lambda^0_j \tag{244}$$

$$\tilde{H}^0_u = \sum_j N^*_{j4}\lambda^0_j\,, \qquad \tilde{S} = \sum_j N^*_{j5}\lambda^0_j\,, \qquad \mathrm{FsbarR} = \sum_j N^*_{j6}\lambda^0_j \tag{245}$$

$$\mathrm{FphiR} = \sum_j N^*_{j7}\lambda^0_j\,, \qquad \lambda_B p = \sum_j N^*_{j8}\lambda^0_j \tag{246}$$

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

$$m_{\tilde{\chi}^-} = \begin{pmatrix} M_2 & \frac{1}{\sqrt{2}} g_2 v_2 \\ \frac{1}{\sqrt{2}} g_2 v_1 & \frac{1}{\sqrt{2}} v_s \lambda \end{pmatrix} \tag{247}$$

This matrix is diagonalized by U and V

$$U^* m_{\tilde{\chi}^-} V^\dagger = m^{dia}_{\tilde{\chi}^-} \tag{248}$$

with

$$\tilde{W}^- = \sum_{t_2} U^*_{j1}\lambda^-_j\,, \qquad \tilde{H}^-_d = \sum_{t_2} U^*_{j2}\lambda^-_j \tag{249}$$

$$\tilde{W}^+ = \sum_{t_2} V^*_{1j}\lambda^+_j\,, \qquad \tilde{H}^+_u = \sum_{t_2} V^*_{2j}\lambda^+_j \tag{250}$$

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

$$m_e = \begin{pmatrix} \frac{1}{\sqrt{2}} \mathbf{1} v_1 Y_e^T \end{pmatrix} \tag{251}$$

This matrix is diagonalized by U^e_L and U^e_R

$$U^{e,*}_L m_e U^{e,\dagger}_R = m^{dia}_e \tag{252}$$

with

$$e_{L,i} = \sum_{t_2} U^{e,*}_{L,ji} E_{L,j} \tag{253}$$

$$e_{R,i} = \sum_{t_2} U^e_{R,ij} E^*_{R,j} \tag{254}$$

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

$$m_d = \begin{pmatrix} \frac{1}{\sqrt{2}} \mathbf{1} v_1 \delta_{\alpha_1\beta_1} Y_d^T \end{pmatrix} \tag{255}$$

This matrix is diagonalized by U^d_L and U^d_R

$$U^{d,*}_L m_d U^{d,\dagger}_R = m^{dia}_d \tag{256}$$

with

$$d_{L,i\alpha} = \sum_{t_2} U^{d,*}_{L,ji} D_{L,j\alpha} \tag{257}$$

$$d_{R,i\alpha} = \sum_{t_2} U^{d}_{R,ij} D^{*}_{R,j\alpha} \tag{258}$$

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

$$m_u = \begin{pmatrix} \frac{1}{\sqrt{2}} \mathbf{1} v_2 \delta_{\alpha_1\beta_1} Y_u^T \end{pmatrix} \tag{259}$$

This matrix is diagonalized by U^u_L and U^u_R

$$U^{u,*}_L m_u U^{u,\dagger}_R = m^{dia}_u \tag{260}$$

with

$$u_{L,i\alpha} = \sum_{t_2} U^{u,*}_{L,ji} U_{L,j\alpha} \tag{261}$$

$$u_{R,i\alpha} = \sum_{t_2} U^{u}_{R,ij} U^{*}_{R,j\alpha} \tag{262}$$

- **Mass matrix for Exotics**, Basis: $\left(\mathrm{FDxL}\left(\{\mathrm{cm1}\}\right)\right), \left(\mathrm{conj}\left(\mathrm{FDxbarR}\left(\{\mathrm{cn1}\}\right)\right)\right)$

$$m_x = \begin{pmatrix} \frac{1}{\sqrt{2}} \mathbf{1} v_s \kappa \delta_{\alpha_1\beta_1} \end{pmatrix} \tag{263}$$

This matrix is diagonalized by $ZDXL$ and $ZDXR$

$$ZDXL^* m_x ZDXR^\dagger = m^{dia}_x \tag{264}$$

with

$$\mathrm{FDxL}\left(\{\mathrm{gt1}, \mathrm{ct1}\}\right) = \sum_{t_2} ZDXL^*_{ji} X_{L,j\alpha} \tag{265}$$

$$\mathrm{FDxbarR}\left(\{\mathrm{gt1}, \mathrm{ct1}\}\right) = \sum_{t_2} ZDXR_{ij} X^*_{L,j\alpha} \tag{266}$$

- **Mass matrix for Prime Neutralinos**, Basis: $\left(h\tilde{P}r^0, h\tilde{\tilde{P}}r^0\right), \left(h\tilde{P}r^0, h\tilde{\tilde{P}}r^0\right)$

$$m_{\tilde{\chi}'^0} = \begin{pmatrix} 0 & -\mu' \\ -\mu' & 0 \end{pmatrix} \tag{267}$$

This matrix is diagonalized by ZNp:

$$ZNp^* m_{\tilde{\chi}'^0} ZNp^\dagger = m^{dia}_{\tilde{\chi}'^0} \tag{268}$$

with

$$h\tilde{P}r^0 = \sum_j ZNp^*_{j1} \mathrm{L0p}\left(\{\mathrm{gt2}\}\right), \qquad h\tilde{\tilde{P}}r^0 = \sum_j ZNp^*_{j2} \mathrm{L0p}\left(\{\mathrm{gt2}\}\right) \tag{269}$$

5 Vacuum Expectation Values

$$H_d^0 = \frac{1}{\sqrt{2}}\phi_d + \frac{1}{\sqrt{2}}v_1 + i\frac{1}{\sqrt{2}}\sigma_d \tag{270}$$

$$H_u^0 = \frac{1}{\sqrt{2}}\phi_u + \frac{1}{\sqrt{2}}v_2 + i\frac{1}{\sqrt{2}}\sigma_u \tag{271}$$

$$S = \frac{1}{\sqrt{2}}\phi_s + \frac{1}{\sqrt{2}}v_s + i\frac{1}{\sqrt{2}}\sigma_s \tag{272}$$

$$\bar{S}_R = \frac{1}{\sqrt{2}}\text{phiSbar} + \frac{1}{\sqrt{2}}vsb + i\frac{1}{\sqrt{2}}\text{sigmaSbar} \tag{273}$$

$$\phi_R = \frac{1}{\sqrt{2}}\text{phiPhi} + \frac{1}{\sqrt{2}}vphi + i\frac{1}{\sqrt{2}}\text{sigmaPhi} \tag{274}$$

6 Tadpole Equations

$$\begin{aligned}\frac{\partial V}{\partial \phi_d} =& +\frac{1}{8}v_1\Big(12g_{1'}^2\Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + \Big(g_1^2 + g_2^2\Big)\Big(-v_2 + v_1\Big)\Big(v_1 + v_2\Big)\Big)\\ &+ \frac{1}{4}\Big(\Big(2v_1\Big(v_s^2 + v_2^2\Big)\lambda + vphivsbv_2\sigma\Big)\lambda^* + 4m_{h_{13}}^2 v_1 + v_2\Big(-2\sqrt{2}v_s\Re\Big(T_\lambda\Big) + vphivsb\lambda\sigma'^{,*}\Big)\Big)\end{aligned} \tag{275}$$

$$\begin{aligned}\frac{\partial V}{\partial \phi_u} =& +\frac{1}{8}v_2\Big(8g_{1'}^2\Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big) + \Big(g_1^2 + g_2^2\Big)\Big(-v_1^2 + v_2^2\Big)\Big)\\ &+ \frac{1}{4}\Big(\Big(2\Big(v_1^2 + v_s^2\Big)v_2\lambda + v_1 vphivsb\sigma\Big)\lambda^* + 4m_{h_{23}}^2 v_2 + v_1\Big(-2\sqrt{2}v_s\Re\Big(T_\lambda\Big) + vphivsb\lambda\sigma'^{,*}\Big)\Big)\end{aligned} \tag{276}$$

$$\begin{aligned}\frac{\partial V}{\partial \phi_s} =& +\frac{1}{2}g_{1'}^2 Q_S v_s\Big(-2v_2^2 - 3v_1^2 + Q_S\Big(-vsb + v_s\Big)\Big(v_s + vsb\Big)\Big)\\ &+ \frac{1}{4}\Big(-vphi^2\Big(\Big(-2v_s\sigma + vsb\kappa'\Big)\sigma'^{,*} + vsb\sigma\kappa'^{,*}\Big)\\ &+ 2\Big(2m_{s_3}^2 v_s - \sqrt{2}v_1 v_2\Re\Big(T_\lambda\Big) + vsb\Big(-\sigma XiF_1^* + \Big(v_s vsb\sigma - XiF_1\Big)\sigma'^{,*}\Big) + v_s\Big(v_1^2 + v_2^2\Big)|\lambda|^2\Big)\\ &- \sqrt{2}vphivsb\Big(Mu_{phi}\sigma'^{,*} + \sigma Mu_{phi}^* + T_\sigma^* + T_\sigma\Big)\Big)\end{aligned} \tag{277}$$

$$\begin{aligned}\frac{\partial V}{\partial \text{phiSbar}} =& +\frac{1}{2}g_{1'}^2 Q_S vsb\Big(2v_2^2 + 3v_1^2 + Q_S\Big(-v_s^2 + vsb^2\Big)\Big)\\ &+ \frac{1}{4}\Big(4m_{sbar_3}^2 vsb - vphi^2\Big(\Big(-2vsb\sigma + v_s\kappa'\Big)\sigma'^{,*} + v_s\sigma\kappa'^{,*}\Big) + 2v_s\Big(-\sigma XiF_1^* + \Big(v_s vsb\sigma - XiF_1\Big)\sigma'^{,*}\Big)\\ &+ vphi\Big(-\sqrt{2}v_s\Big(2\Re\Big(T_\sigma\Big) + Mu_{phi}\sigma'^{,*} + \sigma Mu_{phi}^*\Big) + v_1 v_2\Big(\lambda\sigma'^{,*} + \sigma\lambda^*\Big)\Big)\Big)\end{aligned} \tag{278}$$

$$\begin{aligned}\frac{\partial V}{\partial \text{phiPhi}} =& \frac{1}{4}\Big(4\Big(m_{phi}^2 vphi + vphi^3|\kappa'|^2\Big) + \Big(4Mu_{phi}vphi + \sqrt{2}\Big(2XiF_1 + 3vphi^2\kappa' - v_s vsb\sigma\Big)\Big)Mu_{phi}^*\\ &+ 2vphi\Big(2\Big(\kappa' XiF_1^* + \Re\Big(B_{muphi}\Big)\Big) + \Big(2XiF_1 - v_s vsb\sigma\Big)\kappa'^{,*} + \Big(\Big(v_s^2 + vsb^2\Big)\sigma - v_s vsb\kappa'\Big)\sigma'^{,*}\Big)\\ &+ \sqrt{2}\Big(2\Big(Mu_{phi}XiF_1^* + \xi_S^* + \xi_S\Big) + vphi^2\Big(3Mu_{phi}\kappa'^{,*} + T_{\kappa',*} + T_{\kappa'}\Big) - v_s vsbT_\sigma^*\Big)\end{aligned}$$

$$+ vsb\Big(\sqrt{2}v_s\Big(- Mu_{phi}\sigma^{\prime,*} - T_\sigma\Big) + v_1\Big(v_2\lambda\sigma^{\prime,*} + v_2\sigma\lambda^*\Big)\Big)\Big) \tag{279}$$

7 Particle content for eigenstates 'EWSB'

Name	Type	complex/real	Generations	Indices
$\tilde{d}$	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
$\tilde{x}$	Scalar	complex	6	generation, 6, color, 3
h	Scalar	real	5	generation, 5
A^0	Scalar	real	5	generation, 5
H^-	Scalar	complex	2	generation, 2
$H^{\prime 0}$	Scalar	complex	2	generation, 2
$H^{\prime -}$	Scalar	complex	2	generation, 2
$\tilde{g}$	Fermion	Majorana	1	color, 8
ν	Fermion	Dirac	3	generation, 3
$\tilde{\chi}^{\prime -}$	Fermion	Dirac	1	
$\tilde{\chi}^0$	Fermion	Majorana	8	generation, 8
$\tilde{\chi}^-$	Fermion	Dirac	2	generation, 2
e	Fermion	Dirac	3	generation, 3
d	Fermion	Dirac	3	generation, 3, color, 3
u	Fermion	Dirac	3	generation, 3, color, 3
x	Fermion	Dirac	3	generation, 3, color, 3
$\tilde{\chi}^{\prime 0}$	Fermion	Majorana	2	generation, 2
g	Vector	real	1	color, 8, lorentz, 4
γ	Vector	real	1	lorentz, 4
Z	Vector	real	1	lorentz, 4
Z'	Vector	real	1	lorentz, 4
W^-	Vector	complex	1	lorentz, 4
η^G	Ghost	real	1	color, 8
η^γ	Ghost	real	1	
η^Z	Ghost	real	1	
$\eta^{Z'}$	Ghost	real	1	
η^-	Ghost	complex	1	

η^+	Ghost	complex	1

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

8.1 One Loop Self-Energy

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

$$
\begin{aligned}
\Pi_{i,j}(p^2) = &+4\Gamma_{\overset{\circ}{\tilde{d}}_i,\overset{\circ}{\tilde{d}}_j^*,W^+,W^-}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{W^-}+A_0\Big(m^2_{W^-}\Big)\Big)+2\Gamma_{\overset{\circ}{\tilde{d}}_i,\overset{\circ}{\tilde{d}}_j^*,Z,Z}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{Z}+A_0\Big(m^2_{Z}\Big)\Big)\\
&+2\Gamma_{\overset{\circ}{\tilde{d}}_i,\overset{\circ}{\tilde{d}}_j^*,Z',Z'}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{Z'}+A_0\Big(m^2_{Z'}\Big)\Big)-\sum_{a=1}^{2}A_0\Big(m^2_{H_a^-}\Big)\Gamma_{\overset{\circ}{\tilde{d}}_i,\overset{\circ}{\tilde{d}}_j^*,H_a^+,H_a^-}\\
&-\sum_{a=1}^{2}A_0\Big(m^2_{H_a'^0}\Big)\Gamma_{\overset{\circ}{\tilde{d}}_i,\overset{\circ}{\tilde{d}}_j^*,H_a'^{0,*},H_a'^0}-\sum_{a=1}^{2}A_0\Big(m^2_{H_a'^-}\Big)\Gamma_{\overset{\circ}{\tilde{d}}_i,\overset{\circ}{\tilde{d}}_j^*,H_a'^+,H_a'^-}\\
&-\sum_{a=1}^{3}A_0\Big(m^2_{\tilde{\nu}_a}\Big)\Gamma_{\overset{\circ}{\tilde{d}}_i,\overset{\circ}{\tilde{d}}_j^*,\tilde{\nu}_a^*,\tilde{\nu}_a}\\
&-2\sum_{a=1}^{3}m_{u_a}\sum_{b=1}^{2}B_0\Big(p^2,m^2_{u_a},m^2_{\tilde{\chi}_b^-}\Big)m_{\tilde{\chi}_b^-}\Big(\Gamma^{L*}_{\overset{\circ}{\tilde{d}}_j^*,u_a,\tilde{\chi}_b^-}\Gamma^{R}_{\overset{\circ}{\tilde{d}}_i^*,u_a,\tilde{\chi}_b^-}+\Gamma^{R*}_{\overset{\circ}{\tilde{d}}_j^*,u_a,\tilde{\chi}_b^-}\Gamma^{L}_{\overset{\circ}{\tilde{d}}_i^*,u_a,\tilde{\chi}_b^-}\Big)\\
&+\sum_{a=1}^{3}\sum_{b=1}^{2}G_0\Big(p^2,m^2_{u_a},m^2_{\tilde{\chi}_b^-}\Big)\Big(\Gamma^{L*}_{\overset{\circ}{\tilde{d}}_j^*,u_a,\tilde{\chi}_b^-}\Gamma^{L}_{\overset{\circ}{\tilde{d}}_i^*,u_a,\tilde{\chi}_b^-}+\Gamma^{R*}_{\overset{\circ}{\tilde{d}}_j^*,u_a,\tilde{\chi}_b^-}\Gamma^{R}_{\overset{\circ}{\tilde{d}}_i^*,u_a,\tilde{\chi}_b^-}\Big)\\
&-2\sum_{a=1}^{3}m_{d_a}\sum_{b=1}^{8}B_0\Big(p^2,m^2_{d_a},m^2_{\tilde{\chi}_b^0}\Big)m_{\tilde{\chi}_b^0}\Big(\Gamma^{L*}_{\overset{\circ}{\tilde{d}}_j^*,d_a,\tilde{\chi}_b^0}\Gamma^{R}_{\overset{\circ}{\tilde{d}}_i^*,d_a,\tilde{\chi}_b^0}+\Gamma^{R*}_{\overset{\circ}{\tilde{d}}_j^*,d_a,\tilde{\chi}_b^0}\Gamma^{L}_{\overset{\circ}{\tilde{d}}_i^*,d_a,\tilde{\chi}_b^0}\Big)\\
&+\sum_{a=1}^{3}\sum_{b=1}^{8}G_0\Big(p^2,m^2_{d_a},m^2_{\tilde{\chi}_b^0}\Big)\Big(\Gamma^{L*}_{\overset{\circ}{\tilde{d}}_j^*,d_a,\tilde{\chi}_b^0}\Gamma^{L}_{\overset{\circ}{\tilde{d}}_i^*,d_a,\tilde{\chi}_b^0}+\Gamma^{R*}_{\overset{\circ}{\tilde{d}}_j^*,d_a,\tilde{\chi}_b^0}\Gamma^{R}_{\overset{\circ}{\tilde{d}}_i^*,d_a,\tilde{\chi}_b^0}\Big)\\
&-\frac{1}{2}\sum_{a=1}^{5}A_0\Big(m^2_{A_a^0}\Big)\Gamma_{\overset{\circ}{\tilde{d}}_i,\overset{\circ}{\tilde{d}}_j^*,A_a^0,A_a^0}-\frac{1}{2}\sum_{a=1}^{5}A_0\Big(m^2_{h_a}\Big)\Gamma_{\overset{\circ}{\tilde{d}}_i,\overset{\circ}{\tilde{d}}_j^*,h_a,h_a}\\
&-C\sum_{a=1}^{6}A_0\Big(m^2_{\tilde{d}_a}\Big)\Gamma_{\overset{\circ}{\tilde{d}}_i,\overset{\circ}{\tilde{d}}_j^*,\tilde{d}_a^*,\tilde{d}_a}-C\sum_{a=1}^{6}A_0\Big(m^2_{\tilde{x}_a}\Big)\Gamma_{\overset{\circ}{\tilde{d}}_i,\overset{\circ}{\tilde{d}}_j^*,\tilde{x}_a^*,\tilde{x}_a}\\
&-\sum_{a=1}^{6}A_0\Big(m^2_{\tilde{e}_a}\Big)\Gamma_{\overset{\circ}{\tilde{d}}_i,\overset{\circ}{\tilde{d}}_j^*,\tilde{e}_a^*,\tilde{e}_a}-C\sum_{a=1}^{6}A_0\Big(m^2_{\tilde{u}_a}\Big)\Gamma_{\overset{\circ}{\tilde{d}}_i,\overset{\circ}{\tilde{d}}_j^*,\tilde{u}_a^*,\tilde{u}_a}\\
&+\sum_{a=1}^{6}\sum_{b=1}^{2}B_0\Big(p^2,m^2_{\tilde{u}_a},m^2_{H_b^-}\Big)\Gamma^{*}_{\overset{\circ}{\tilde{d}}_j^*,\tilde{u}_a,H_b^-}\Gamma_{\overset{\circ}{\tilde{d}}_i^*,\tilde{u}_a,H_b^-}
\end{aligned}
$$

$$
\begin{aligned}
&+\sum_{a=1}^{6}\sum_{b=1}^{5} B_0\Big(p^2, m^2_{\tilde{d}_a}, m^2_{A^0_b}\Big)\Gamma^*_{\tilde{\tilde{d}}^*_j,\tilde{d}_a,A^0_b}\Gamma_{\tilde{\tilde{d}}^*_i,\tilde{d}_a,A^0_b} + \sum_{a=1}^{6}\sum_{b=1}^{5} B_0\Big(p^2, m^2_{\tilde{d}_a}, m^2_{h_b}\Big)\Gamma^*_{\tilde{\tilde{d}}^*_j,\tilde{d}_a,h_b}\Gamma_{\tilde{\tilde{d}}^*_i,\tilde{d}_a,h_b}\\
&-\frac{8}{3}m_{\tilde{g}}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{\tilde{g}}, m^2_{d_b}\Big)m_{d_b}\Big(\Gamma^{L*}_{\tilde{\tilde{d}}^*_j,\tilde{g}_1,d_b}\Gamma^{R}_{\tilde{\tilde{d}}^*_i,\tilde{g}_1,d_b} + \Gamma^{R*}_{\tilde{\tilde{d}}^*_j,\tilde{g}_1,d_b}\Gamma^{L}_{\tilde{\tilde{d}}^*_i,\tilde{g}_1,d_b}\Big)\\
&+\frac{4}{3}\sum_{b=1}^{3} G_0\Big(p^2, m^2_{\tilde{g}}, m^2_{d_b}\Big)\Big(\Gamma^{L*}_{\tilde{\tilde{d}}^*_j,\tilde{g}_1,d_b}\Gamma^{L}_{\tilde{\tilde{d}}^*_i,\tilde{g}_1,d_b} + \Gamma^{R*}_{\tilde{\tilde{d}}^*_j,\tilde{g}_1,d_b}\Gamma^{R}_{\tilde{\tilde{d}}^*_i,\tilde{g}_1,d_b}\Big)\\
&+\frac{4}{3}\sum_{b=1}^{6}\Gamma^*_{\tilde{\tilde{d}}^*_j,g,\tilde{d}_b}\Gamma_{\tilde{\tilde{d}}^*_i,g,\tilde{d}_b}F_0\Big(p^2, m^2_{\tilde{d}_b}, 0\Big) + \sum_{b=1}^{6}\Gamma^*_{\tilde{\tilde{d}}^*_j,\gamma,\tilde{d}_b}\Gamma_{\tilde{\tilde{d}}^*_i,\gamma,\tilde{d}_b}F_0\Big(p^2, m^2_{\tilde{d}_b}, 0\Big)\\
&+\sum_{b=1}^{6}\Gamma^*_{\tilde{\tilde{d}}^*_j,Z,\tilde{d}_b}\Gamma_{\tilde{\tilde{d}}^*_i,Z,\tilde{d}_b}F_0\Big(p^2, m^2_{\tilde{d}_b}, m^2_Z\Big) + \sum_{b=1}^{6}\Gamma^*_{\tilde{\tilde{d}}^*_j,Z',\tilde{d}_b}\Gamma_{\tilde{\tilde{d}}^*_i,Z',\tilde{d}_b}F_0\Big(p^2, m^2_{\tilde{d}_b}, m^2_{Z'}\Big)\\
&+\sum_{b=1}^{6}\Gamma^*_{\tilde{\tilde{d}}^*_j,W^-,\tilde{u}_b}\Gamma_{\tilde{\tilde{d}}^*_i,W^-,\tilde{u}_b}F_0\Big(p^2, m^2_{\tilde{u}_b}, m^2_{W^-}\Big)
\end{aligned}
\tag{280}
$$

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

$$
\begin{aligned}
\Pi_{i,j}(p^2) = &+4\Gamma_{\tilde{\tilde{\nu}}_i,\tilde{\tilde{\nu}}^*_j,W^+,W^-}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{W^-} + A_0\Big(m^2_{W^-}\Big)\Big) + 2\Gamma_{\tilde{\tilde{\nu}}_i,\tilde{\tilde{\nu}}^*_j,Z,Z}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{Z} + A_0\Big(m^2_{Z}\Big)\Big)\\
&+2\Gamma_{\tilde{\tilde{\nu}}_i,\tilde{\tilde{\nu}}^*_j,Z',Z'}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{Z'} + A_0\Big(m^2_{Z'}\Big)\Big) - \sum_{a=1}^{2} A_0\Big(m^2_{H^-_a}\Big)\Gamma_{\tilde{\tilde{\nu}}_i,\tilde{\tilde{\nu}}^*_j,H^+_a,H^-_a}\\
&-\sum_{a=1}^{2} A_0\Big(m^2_{H'^0_a}\Big)\Gamma_{\tilde{\tilde{\nu}}_i,\tilde{\tilde{\nu}}^*_j,H'^{0,*}_a,H'^0_a} - \sum_{a=1}^{2} A_0\Big(m^2_{H'^-_a}\Big)\Gamma_{\tilde{\tilde{\nu}}_i,\tilde{\tilde{\nu}}^*_j,H'^+_a,H'^-_a}\\
&-2\sum_{a=1}^{2} m_{\tilde{\chi}^-_a}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{\tilde{\chi}^-_a}, m^2_{e_b}\Big)m_{e_b}\Big(\Gamma^{L*}_{\tilde{\tilde{\nu}}^*_j,\tilde{\chi}^+_a,e_b}\Gamma^{R}_{\tilde{\tilde{\nu}}^*_i,\tilde{\chi}^+_a,e_b} + \Gamma^{R*}_{\tilde{\tilde{\nu}}^*_j,\tilde{\chi}^+_a,e_b}\Gamma^{L}_{\tilde{\tilde{\nu}}^*_i,\tilde{\chi}^+_a,e_b}\Big)\\
&+\sum_{a=1}^{2}\sum_{b=1}^{3} G_0\Big(p^2, m^2_{\tilde{\chi}^-_a}, m^2_{e_b}\Big)\Big(\Gamma^{L*}_{\tilde{\tilde{\nu}}^*_j,\tilde{\chi}^+_a,e_b}\Gamma^{L}_{\tilde{\tilde{\nu}}^*_i,\tilde{\chi}^+_a,e_b} + \Gamma^{R*}_{\tilde{\tilde{\nu}}^*_j,\tilde{\chi}^+_a,e_b}\Gamma^{R}_{\tilde{\tilde{\nu}}^*_i,\tilde{\chi}^+_a,e_b}\Big)\\
&+\sum_{a=1}^{2}\sum_{b=1}^{6} B_0\Big(p^2, m^2_{H^-_a}, m^2_{\tilde{e}_b}\Big)\Gamma^*_{\tilde{\tilde{\nu}}^*_j,H^+_a,\tilde{e}_b}\Gamma_{\tilde{\tilde{\nu}}^*_i,H^+_a,\tilde{e}_b} - \sum_{a=1}^{3} A_0\Big(m^2_{\tilde{\nu}_a}\Big)\Gamma_{\tilde{\tilde{\nu}}_i,\tilde{\tilde{\nu}}^*_j,\tilde{\nu}^*_a,\tilde{\nu}_a}\\
&+\sum_{a=1}^{3}\sum_{b=1}^{5} B_0\Big(p^2, m^2_{\tilde{\nu}_a}, m^2_{h_b}\Big)\Gamma^*_{\tilde{\tilde{\nu}}^*_j,\tilde{\nu}_a,h_b}\Gamma_{\tilde{\tilde{\nu}}^*_i,\tilde{\nu}_a,h_b}\\
&-2\sum_{a=1}^{3} m_{\nu_a}\sum_{b=1}^{8} B_0\Big(p^2, m^2_{\nu_a}, m^2_{\tilde{\chi}^0_b}\Big)m_{\tilde{\chi}^0_b}\Big(\Gamma^{L*}_{\tilde{\tilde{\nu}}^*_j,\nu_a,\tilde{\chi}^0_b}\Gamma^{R}_{\tilde{\tilde{\nu}}^*_i,\nu_a,\tilde{\chi}^0_b} + \Gamma^{R*}_{\tilde{\tilde{\nu}}^*_j,\nu_a,\tilde{\chi}^0_b}\Gamma^{L}_{\tilde{\tilde{\nu}}^*_i,\nu_a,\tilde{\chi}^0_b}\Big)\\
&+\sum_{a=1}^{3}\sum_{b=1}^{8} G_0\Big(p^2, m^2_{\nu_a}, m^2_{\tilde{\chi}^0_b}\Big)\Big(\Gamma^{L*}_{\tilde{\tilde{\nu}}^*_j,\nu_a,\tilde{\chi}^0_b}\Gamma^{L}_{\tilde{\tilde{\nu}}^*_i,\nu_a,\tilde{\chi}^0_b} + \Gamma^{R*}_{\tilde{\tilde{\nu}}^*_j,\nu_a,\tilde{\chi}^0_b}\Gamma^{R}_{\tilde{\tilde{\nu}}^*_i,\nu_a,\tilde{\chi}^0_b}\Big)
\end{aligned}
$$

$$
\begin{aligned}
&- \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{A^0_a}\Big)\Gamma_{\check{\tilde{\nu}}_i,\check{\tilde{\nu}}^*_j,A^0_a,A^0_a} - \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{h_a}\Big)\Gamma_{\check{\tilde{\nu}}_i,\check{\tilde{\nu}}^*_j,h_a,h_a}\\
&- 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{d}_a}\Big)\Gamma_{\check{\tilde{\nu}}_i,\check{\tilde{\nu}}^*_j,\tilde{d}^*_a,\tilde{d}_a} - 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{x}_a}\Big)\Gamma_{\check{\tilde{\nu}}_i,\check{\tilde{\nu}}^*_j,\tilde{x}^*_a,\tilde{x}_a}\\
&- \sum_{a=1}^{6} A_0\Big(m^2_{\tilde{e}_a}\Big)\Gamma_{\check{\tilde{\nu}}_i,\check{\tilde{\nu}}^*_j,\tilde{e}^*_a,\tilde{e}_a} - 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{u}_a}\Big)\Gamma_{\check{\tilde{\nu}}_i,\check{\tilde{\nu}}^*_j,\tilde{u}^*_a,\tilde{u}_a}\\
&+ \sum_{b=1}^{3}\Gamma^*_{\check{\tilde{\nu}}^*_j,Z,\tilde{\nu}_b}\Gamma_{\check{\tilde{\nu}}^*_i,Z,\tilde{\nu}_b}F_0\Big(p^2,m^2_{\tilde{\nu}_b},m^2_Z\Big) + \sum_{b=1}^{3}\Gamma^*_{\check{\tilde{\nu}}^*_j,Z',\tilde{\nu}_b}\Gamma_{\check{\tilde{\nu}}^*_i,Z',\tilde{\nu}_b}F_0\Big(p^2,m^2_{\tilde{\nu}_b},m^2_{Z'}\Big)\\
&+ \sum_{b=1}^{6}\Gamma^*_{\check{\tilde{\nu}}^*_j,W^+,\tilde{e}_b}\Gamma_{\check{\tilde{\nu}}^*_i,W^+,\tilde{e}_b}F_0\Big(p^2,m^2_{\tilde{e}_b},m^2_{W^-}\Big)
\end{aligned}
\tag{281}
$$

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

$$
\begin{aligned}
\Pi_{i,j}(p^2) = &+4\Gamma_{\check{\tilde{u}}_i,\check{\tilde{u}}^*_j,W^+,W^-}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{W^-} + A_0\Big(m^2_{W^-}\Big)\Big) + 2\Gamma_{\check{\tilde{u}}_i,\check{\tilde{u}}^*_j,Z,Z}\Big(-\frac{1}{2}\mathrm{rMS}m^2_Z + A_0\Big(m^2_Z\Big)\Big)\\
&+ 2\Gamma_{\check{\tilde{u}}_i,\check{\tilde{u}}^*_j,Z',Z'}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{Z'} + A_0\Big(m^2_{Z'}\Big)\Big) - \sum_{a=1}^{2} A_0\Big(m^2_{H^-_a}\Big)\Gamma_{\check{\tilde{u}}_i,\check{\tilde{u}}^*_j,H^+_a,H^-_a}\\
&- \sum_{a=1}^{2} A_0\Big(m^2_{H'^0_a}\Big)\Gamma_{\check{\tilde{u}}_i,\check{\tilde{u}}^*_j,H'^{0,*}_a,H'^0_a} - \sum_{a=1}^{2} A_0\Big(m^2_{H'^-_a}\Big)\Gamma_{\check{\tilde{u}}_i,\check{\tilde{u}}^*_j,H'^+_a,H'^-_a}\\
&- 2\sum_{a=1}^{2} m_{\tilde{\chi}^-_a}\sum_{b=1}^{3} B_0\Big(p^2,m^2_{\tilde{\chi}^-_a},m^2_{d_b}\Big)m_{d_b}\Big(\Gamma^{L*}_{\check{\tilde{u}}^*_j,\tilde{\chi}^+_a,d_b}\Gamma^{R}_{\check{\tilde{u}}^*_i,\tilde{\chi}^+_a,d_b} + \Gamma^{R*}_{\check{\tilde{u}}^*_j,\tilde{\chi}^+_a,d_b}\Gamma^{L}_{\check{\tilde{u}}^*_i,\tilde{\chi}^+_a,d_b}\Big)\\
&+ \sum_{a=1}^{2}\sum_{b=1}^{3} G_0\Big(p^2,m^2_{\tilde{\chi}^-_a},m^2_{d_b}\Big)\Big(\Gamma^{L*}_{\check{\tilde{u}}^*_j,\tilde{\chi}^+_a,d_b}\Gamma^{L}_{\check{\tilde{u}}^*_i,\tilde{\chi}^+_a,d_b} + \Gamma^{R*}_{\check{\tilde{u}}^*_j,\tilde{\chi}^+_a,d_b}\Gamma^{R}_{\check{\tilde{u}}^*_i,\tilde{\chi}^+_a,d_b}\Big)\\
&+ \sum_{a=1}^{2}\sum_{b=1}^{6} B_0\Big(p^2,m^2_{H^-_a},m^2_{\tilde{d}_b}\Big)\Gamma^*_{\check{\tilde{u}}^*_j,H^+_a,\tilde{d}_b}\Gamma_{\check{\tilde{u}}^*_i,H^+_a,\tilde{d}_b} - \sum_{a=1}^{3} A_0\Big(m^2_{\tilde{\nu}_a}\Big)\Gamma_{\check{\tilde{u}}_i,\check{\tilde{u}}^*_j,\tilde{\nu}^*_a,\tilde{\nu}_a}\\
&- 2\sum_{a=1}^{3} m_{u_a}\sum_{b=1}^{8} B_0\Big(p^2,m^2_{u_a},m^2_{\tilde{\chi}^0_b}\Big)m_{\tilde{\chi}^0_b}\Big(\Gamma^{L*}_{\check{\tilde{u}}^*_j,u_a,\tilde{\chi}^0_b}\Gamma^{R}_{\check{\tilde{u}}^*_i,u_a,\tilde{\chi}^0_b} + \Gamma^{R*}_{\check{\tilde{u}}^*_j,u_a,\tilde{\chi}^0_b}\Gamma^{L}_{\check{\tilde{u}}^*_i,u_a,\tilde{\chi}^0_b}\Big)\\
&+ \sum_{a=1}^{3}\sum_{b=1}^{8} G_0\Big(p^2,m^2_{u_a},m^2_{\tilde{\chi}^0_b}\Big)\Big(\Gamma^{L*}_{\check{\tilde{u}}^*_j,u_a,\tilde{\chi}^0_b}\Gamma^{L}_{\check{\tilde{u}}^*_i,u_a,\tilde{\chi}^0_b} + \Gamma^{R*}_{\check{\tilde{u}}^*_j,u_a,\tilde{\chi}^0_b}\Gamma^{R}_{\check{\tilde{u}}^*_i,u_a,\tilde{\chi}^0_b}\Big)\\
&- \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{A^0_a}\Big)\Gamma_{\check{\tilde{u}}_i,\check{\tilde{u}}^*_j,A^0_a,A^0_a} - \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{h_a}\Big)\Gamma_{\check{\tilde{u}}_i,\check{\tilde{u}}^*_j,h_a,h_a}\\
&- C\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{d}_a}\Big)\Gamma_{\check{\tilde{u}}_i,\check{\tilde{u}}^*_j,\tilde{d}^*_a,\tilde{d}_a} - C\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{x}_a}\Big)\Gamma_{\check{\tilde{u}}_i,\check{\tilde{u}}^*_j,\tilde{x}^*_a,\tilde{x}_a}
\end{aligned}
$$

$$
\begin{aligned}
&- \sum_{a=1}^{6} A_0\Big(m^2_{\tilde{e}_a}\Big)\Gamma_{\check{\tilde{u}}_i,\check{\tilde{u}}^*_j,\tilde{e}^*_a,\tilde{e}_a} - C\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{u}_a}\Big)\Gamma_{\check{\tilde{u}}_i,\check{\tilde{u}}^*_j,\tilde{u}^*_a,\tilde{u}_a} \\
&+ \sum_{a=1}^{6}\sum_{b=1}^{5} B_0\Big(p^2, m^2_{\tilde{u}_a}, m^2_{A^0_b}\Big)\Gamma^*_{\check{\tilde{u}}^*_j,\tilde{u}_a,A^0_b}\Gamma_{\check{\tilde{u}}^*_i,\tilde{u}_a,A^0_b} + \sum_{a=1}^{6}\sum_{b=1}^{5} B_0\Big(p^2, m^2_{\tilde{u}_a}, m^2_{h_b}\Big)\Gamma^*_{\check{\tilde{u}}^*_j,\tilde{u}_a,h_b}\Gamma_{\check{\tilde{u}}^*_i,\tilde{u}_a,h_b} \\
&- \frac{8}{3} m_{\tilde{g}} \sum_{b=1}^{3} B_0\Big(p^2, m^2_{\tilde{g}}, m^2_{u_b}\Big) m_{u_b}\Big(\Gamma^{L*}_{\check{\tilde{u}}^*_j,\tilde{g}_1,u_b}\Gamma^{R}_{\check{\tilde{u}}^*_i,\tilde{g}_1,u_b} + \Gamma^{R*}_{\check{\tilde{u}}^*_j,\tilde{g}_1,u_b}\Gamma^{L}_{\check{\tilde{u}}^*_i,\tilde{g}_1,u_b}\Big) \\
&+ \frac{4}{3}\sum_{b=1}^{3} G_0\Big(p^2, m^2_{\tilde{g}}, m^2_{u_b}\Big)\Big(\Gamma^{L*}_{\check{\tilde{u}}^*_j,\tilde{g}_1,u_b}\Gamma^{L}_{\check{\tilde{u}}^*_i,\tilde{g}_1,u_b} + \Gamma^{R*}_{\check{\tilde{u}}^*_j,\tilde{g}_1,u_b}\Gamma^{R}_{\check{\tilde{u}}^*_i,\tilde{g}_1,u_b}\Big) \\
&+ \sum_{b=1}^{6}\Gamma^*_{\check{\tilde{u}}^*_j,W^+,\tilde{d}_b}\Gamma_{\check{\tilde{u}}^*_i,W^+,\tilde{d}_b} F_0\Big(p^2, m^2_{\tilde{d}_b}, m^2_{W^-}\Big) + \frac{4}{3}\sum_{b=1}^{6}\Gamma^*_{\check{\tilde{u}}^*_j,g,\tilde{u}_b}\Gamma_{\check{\tilde{u}}^*_i,g,\tilde{u}_b} F_0\Big(p^2, m^2_{\tilde{u}_b}, 0\Big) \\
&+ \sum_{b=1}^{6}\Gamma^*_{\check{\tilde{u}}^*_j,\gamma,\tilde{u}_b}\Gamma_{\check{\tilde{u}}^*_i,\gamma,\tilde{u}_b} F_0\Big(p^2, m^2_{\tilde{u}_b}, 0\Big) + \sum_{b=1}^{6}\Gamma^*_{\check{\tilde{u}}^*_j,Z,\tilde{u}_b}\Gamma_{\check{\tilde{u}}^*_i,Z,\tilde{u}_b} F_0\Big(p^2, m^2_{\tilde{u}_b}, m^2_{Z}\Big) \\
&+ \sum_{b=1}^{6}\Gamma^*_{\check{\tilde{u}}^*_j,Z',\tilde{u}_b}\Gamma_{\check{\tilde{u}}^*_i,Z',\tilde{u}_b} F_0\Big(p^2, m^2_{\tilde{u}_b}, m^2_{Z'}\Big)
\end{aligned} \tag{282}
$$

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

$$
\begin{aligned}
\Pi_{i,j}(p^2) = &+4\Gamma_{\check{\tilde{e}}_i,\check{\tilde{e}}^*_j,W^+,W^-}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{W^-} + A_0\Big(m^2_{W^-}\Big)\Big) + 2\Gamma_{\check{\tilde{e}}_i,\check{\tilde{e}}^*_j,Z,Z}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{Z} + A_0\Big(m^2_{Z}\Big)\Big) \\
&+ 2\Gamma_{\check{\tilde{e}}_i,\check{\tilde{e}}^*_j,Z',Z'}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{Z'} + A_0\Big(m^2_{Z'}\Big)\Big) - \sum_{a=1}^{2} A_0\Big(m^2_{H^-_a}\Big)\Gamma_{\check{\tilde{e}}_i,\check{\tilde{e}}^*_j,H^+_a,H^-_a} \\
&- \sum_{a=1}^{2} A_0\Big(m^2_{H'^0_a}\Big)\Gamma_{\check{\tilde{e}}_i,\check{\tilde{e}}^*_j,H'^{0,*}_a,H'^0_a} - \sum_{a=1}^{2} A_0\Big(m^2_{H'^-_a}\Big)\Gamma_{\check{\tilde{e}}_i,\check{\tilde{e}}^*_j,H'^+_a,H'^-_a} \\
&- \sum_{a=1}^{3} A_0\Big(m^2_{\tilde{\nu}_a}\Big)\Gamma_{\check{\tilde{e}}_i,\check{\tilde{e}}^*_j,\tilde{\nu}^*_a,\tilde{\nu}_a} + \sum_{a=1}^{3}\sum_{b=1}^{2} B_0\Big(p^2, m^2_{\tilde{\nu}_a}, m^2_{H^-_b}\Big)\Gamma^*_{\check{\tilde{e}}^*_j,\tilde{\nu}_a,H^-_b}\Gamma_{\check{\tilde{e}}^*_i,\tilde{\nu}_a,H^-_b} \\
&- 2\sum_{a=1}^{3} m_{\nu_a}\sum_{b=1}^{2} B_0\Big(p^2, m^2_{\nu_a}, m^2_{\tilde{\chi}^-_b}\Big) m_{\tilde{\chi}^-_b}\Big(\Gamma^{L*}_{\check{\tilde{e}}^*_j,\nu_a,\tilde{\chi}^-_b}\Gamma^{R}_{\check{\tilde{e}}^*_i,\nu_a,\tilde{\chi}^-_b} + \Gamma^{R*}_{\check{\tilde{e}}^*_j,\nu_a,\tilde{\chi}^-_b}\Gamma^{L}_{\check{\tilde{e}}^*_i,\nu_a,\tilde{\chi}^-_b}\Big) \\
&+ \sum_{a=1}^{3}\sum_{b=1}^{2} G_0\Big(p^2, m^2_{\nu_a}, m^2_{\tilde{\chi}^-_b}\Big)\Big(\Gamma^{L*}_{\check{\tilde{e}}^*_j,\nu_a,\tilde{\chi}^-_b}\Gamma^{L}_{\check{\tilde{e}}^*_i,\nu_a,\tilde{\chi}^-_b} + \Gamma^{R*}_{\check{\tilde{e}}^*_j,\nu_a,\tilde{\chi}^-_b}\Gamma^{R}_{\check{\tilde{e}}^*_i,\nu_a,\tilde{\chi}^-_b}\Big) \\
&- 2\sum_{a=1}^{3} m_{e_a}\sum_{b=1}^{8} B_0\Big(p^2, m^2_{e_a}, m^2_{\tilde{\chi}^0_b}\Big) m_{\tilde{\chi}^0_b}\Big(\Gamma^{L*}_{\check{\tilde{e}}^*_j,e_a,\tilde{\chi}^0_b}\Gamma^{R}_{\check{\tilde{e}}^*_i,e_a,\tilde{\chi}^0_b} + \Gamma^{R*}_{\check{\tilde{e}}^*_j,e_a,\tilde{\chi}^0_b}\Gamma^{L}_{\check{\tilde{e}}^*_i,e_a,\tilde{\chi}^0_b}\Big) \\
&+ \sum_{a=1}^{3}\sum_{b=1}^{8} G_0\Big(p^2, m^2_{e_a}, m^2_{\tilde{\chi}^0_b}\Big)\Big(\Gamma^{L*}_{\check{\tilde{e}}^*_j,e_a,\tilde{\chi}^0_b}\Gamma^{L}_{\check{\tilde{e}}^*_i,e_a,\tilde{\chi}^0_b} + \Gamma^{R*}_{\check{\tilde{e}}^*_j,e_a,\tilde{\chi}^0_b}\Gamma^{R}_{\check{\tilde{e}}^*_i,e_a,\tilde{\chi}^0_b}\Big)
\end{aligned}
$$

$$
\begin{aligned}
&- \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{A^0_a}\Big)\Gamma_{\check{\tilde{e}}_i,\check{\tilde{e}}^*_j,A^0_a,A^0_a} - \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{h_a}\Big)\Gamma_{\check{\tilde{e}}_i,\check{\tilde{e}}^*_j,h_a,h_a}\\
&- 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{d}_a}\Big)\Gamma_{\check{\tilde{e}}_i,\check{\tilde{e}}^*_j,\tilde{d}^*_a,\tilde{d}_a} - 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{x}_a}\Big)\Gamma_{\check{\tilde{e}}_i,\check{\tilde{e}}^*_j,\tilde{x}^*_a,\tilde{x}_a}\\
&- \sum_{a=1}^{6} A_0\Big(m^2_{\tilde{e}_a}\Big)\Gamma_{\check{\tilde{e}}_i,\check{\tilde{e}}^*_j,\tilde{e}^*_a,\tilde{e}_a} - 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{u}_a}\Big)\Gamma_{\check{\tilde{e}}_i,\check{\tilde{e}}^*_j,\tilde{u}^*_a,\tilde{u}_a}\\
&+ \sum_{a=1}^{6}\sum_{b=1}^{5} B_0\Big(p^2,m^2_{\tilde{e}_a},m^2_{A^0_b}\Big)\Gamma^*_{\check{\tilde{e}}^*_j,\tilde{e}_a,A^0_b}\Gamma_{\check{\tilde{e}}^*_i,\tilde{e}_a,A^0_b} + \sum_{a=1}^{6}\sum_{b=1}^{5} B_0\Big(p^2,m^2_{\tilde{e}_a},m^2_{h_b}\Big)\Gamma^*_{\check{\tilde{e}}^*_j,\tilde{e}_a,h_b}\Gamma_{\check{\tilde{e}}^*_i,\tilde{e}_a,h_b}\\
&+ \sum_{b=1}^{3}\Gamma^*_{\check{\tilde{e}}^*_j,W^-,\tilde{\nu}_b}\Gamma_{\check{\tilde{e}}^*_i,W^-,\tilde{\nu}_b}F_0\Big(p^2,m^2_{\tilde{\nu}_b},m^2_{W^-}\Big) + \sum_{b=1}^{6}\Gamma^*_{\check{\tilde{e}}^*_j,\gamma,\tilde{e}_b}\Gamma_{\check{\tilde{e}}^*_i,\gamma,\tilde{e}_b}F_0\Big(p^2,m^2_{\tilde{e}_b},0\Big)\\
&+ \sum_{b=1}^{6}\Gamma^*_{\check{\tilde{e}}^*_j,Z,\tilde{e}_b}\Gamma_{\check{\tilde{e}}^*_i,Z,\tilde{e}_b}F_0\Big(p^2,m^2_{\tilde{e}_b},m^2_Z\Big) + \sum_{b=1}^{6}\Gamma^*_{\check{\tilde{e}}^*_j,Z',\tilde{e}_b}\Gamma_{\check{\tilde{e}}^*_i,Z',\tilde{e}_b}F_0\Big(p^2,m^2_{\tilde{e}_b},m^2_{Z'}\Big)
\end{aligned}
\tag{283}
$$

- **Self-Energy for SExotics** $(\tilde{x})$

$$
\begin{aligned}
\Pi_{i,j}(p^2) = &+2\Gamma_{\check{\tilde{x}}_i,\check{\tilde{x}}^*_j,Z,Z}\Big(-\frac{1}{2}\mathrm{rMS}m^2_Z + A_0\Big(m^2_Z\Big)\Big) + 2\Gamma_{\check{\tilde{x}}_i,\check{\tilde{x}}^*_j,Z',Z'}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{Z'} + A_0\Big(m^2_{Z'}\Big)\Big)\\
&- \sum_{a=1}^{2} A_0\Big(m^2_{H^-_a}\Big)\Gamma_{\check{\tilde{x}}_i,\check{\tilde{x}}^*_j,H^+_a,H^-_a} - \sum_{a=1}^{2} A_0\Big(m^2_{H'^0_a}\Big)\Gamma_{\check{\tilde{x}}_i,\check{\tilde{x}}^*_j,H'^{0,*}_a,H'^0_a}\\
&- \sum_{a=1}^{2} A_0\Big(m^2_{H'^-_a}\Big)\Gamma_{\check{\tilde{x}}_i,\check{\tilde{x}}^*_j,H'^+_a,H'^-_a} - \sum_{a=1}^{3} A_0\Big(m^2_{\tilde{\nu}_a}\Big)\Gamma_{\check{\tilde{x}}_i,\check{\tilde{x}}^*_j,\tilde{\nu}^*_a,\tilde{\nu}_a}\\
&- 2\sum_{a=1}^{3} m_{x_a}\sum_{b=1}^{8} B_0\Big(p^2,m^2_{x_a},m^2_{\tilde{\chi}^0_b}\Big)m_{\tilde{\chi}^0_b}\Big(\Gamma^{L*}_{\check{\tilde{x}}^*_j,x_a,\tilde{\chi}^0_b}\Gamma^R_{\check{\tilde{x}}^*_i,x_a,\tilde{\chi}^0_b} + \Gamma^{R*}_{\check{\tilde{x}}^*_j,x_a,\tilde{\chi}^0_b}\Gamma^L_{\check{\tilde{x}}^*_i,x_a,\tilde{\chi}^0_b}\Big)\\
&+ \sum_{a=1}^{3}\sum_{b=1}^{8} G_0\Big(p^2,m^2_{x_a},m^2_{\tilde{\chi}^0_b}\Big)\Big(\Gamma^{L*}_{\check{\tilde{x}}^*_j,x_a,\tilde{\chi}^0_b}\Gamma^L_{\check{\tilde{x}}^*_i,x_a,\tilde{\chi}^0_b} + \Gamma^{R*}_{\check{\tilde{x}}^*_j,x_a,\tilde{\chi}^0_b}\Gamma^R_{\check{\tilde{x}}^*_i,x_a,\tilde{\chi}^0_b}\Big)\\
&- \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{A^0_a}\Big)\Gamma_{\check{\tilde{x}}_i,\check{\tilde{x}}^*_j,A^0_a,A^0_a} - \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{h_a}\Big)\Gamma_{\check{\tilde{x}}_i,\check{\tilde{x}}^*_j,h_a,h_a}\\
&- C\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{d}_a}\Big)\Gamma_{\check{\tilde{x}}_i,\check{\tilde{x}}^*_j,\tilde{d}^*_a,\tilde{d}_a} - C\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{x}_a}\Big)\Gamma_{\check{\tilde{x}}_i,\check{\tilde{x}}^*_j,\tilde{x}^*_a,\tilde{x}_a}\\
&- \sum_{a=1}^{6} A_0\Big(m^2_{\tilde{e}_a}\Big)\Gamma_{\check{\tilde{x}}_i,\check{\tilde{x}}^*_j,\tilde{e}^*_a,\tilde{e}_a} - C\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{u}_a}\Big)\Gamma_{\check{\tilde{x}}_i,\check{\tilde{x}}^*_j,\tilde{u}^*_a,\tilde{u}_a}\\
&+ \sum_{a=1}^{6}\sum_{b=1}^{5} B_0\Big(p^2,m^2_{\tilde{x}_a},m^2_{A^0_b}\Big)\Gamma^*_{\check{\tilde{x}}^*_j,\tilde{x}_a,A^0_b}\Gamma_{\check{\tilde{x}}^*_i,\tilde{x}_a,A^0_b} + \sum_{a=1}^{6}\sum_{b=1}^{5} B_0\Big(p^2,m^2_{\tilde{x}_a},m^2_{h_b}\Big)\Gamma^*_{\check{\tilde{x}}^*_j,\tilde{x}_a,h_b}\Gamma_{\check{\tilde{x}}^*_i,\tilde{x}_a,h_b}
\end{aligned}
$$

$$
\begin{aligned}
&- \frac{8}{3} m_{\tilde{g}} \sum_{b=1}^{3} B_0\Big(p^2, m_{\tilde{g}}^2, m_{x_b}^2\Big) m_{x_b} \Big(\Gamma^{L*}_{\tilde{\check{x}}_j^*, \tilde{g}_1, x_b} \Gamma^{R}_{\tilde{\check{x}}_i^*, \tilde{g}_1, x_b} + \Gamma^{R*}_{\tilde{\check{x}}_j^*, \tilde{g}_1, x_b} \Gamma^{L}_{\tilde{\check{x}}_i^*, \tilde{g}_1, x_b} \Big) \\
&+ \frac{4}{3} \sum_{b=1}^{3} G_0\Big(p^2, m_{\tilde{g}}^2, m_{x_b}^2\Big) \Big(\Gamma^{L*}_{\tilde{\check{x}}_j^*, \tilde{g}_1, x_b} \Gamma^{L}_{\tilde{\check{x}}_i^*, \tilde{g}_1, x_b} + \Gamma^{R*}_{\tilde{\check{x}}_j^*, \tilde{g}_1, x_b} \Gamma^{R}_{\tilde{\check{x}}_i^*, \tilde{g}_1, x_b} \Big) \\
&+ \frac{4}{3} \sum_{b=1}^{6} \Gamma^{*}_{\tilde{\check{x}}_j^*, g, \tilde{x}_b} \Gamma_{\tilde{\check{x}}_i^*, g, \tilde{x}_b} F_0\Big(p^2, m_{\tilde{x}_b}^2, 0\Big) + \sum_{b=1}^{6} \Gamma^{*}_{\tilde{\check{x}}_j^*, \gamma, \tilde{x}_b} \Gamma_{\tilde{\check{x}}_i^*, \gamma, \tilde{x}_b} F_0\Big(p^2, m_{\tilde{x}_b}^2, 0\Big) \\
&+ \sum_{b=1}^{6} \Gamma^{*}_{\tilde{\check{x}}_j^*, Z, \tilde{x}_b} \Gamma_{\tilde{\check{x}}_i^*, Z, \tilde{x}_b} F_0\Big(p^2, m_{\tilde{x}_b}^2, m_Z^2\Big) + \sum_{b=1}^{6} \Gamma^{*}_{\tilde{\check{x}}_j^*, Z', \tilde{x}_b} \Gamma_{\tilde{\check{x}}_i^*, Z', \tilde{x}_b} F_0\Big(p^2, m_{\tilde{x}_b}^2, m_{Z'}^2\Big) \qquad (284)
\end{aligned}
$$

- **Self-Energy for Higgs** (h)

$$
\begin{aligned}
\Pi_{i,j}(p^2) = &+2\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m_Z^2, m_Z^2\Big)\Big) \Gamma^{*}_{\check{h}_j, Z, Z} \Gamma_{\check{h}_i, Z, Z} + 4\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m_Z^2, m_{Z'}^2\Big)\Big) \Gamma^{*}_{\check{h}_j, Z', Z} \Gamma_{\check{h}_i, Z', Z} + 2\Big(-\frac{1}{2}\mathrm{rMS} \\
&+ 4\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m_{W^-}^2, m_{W^-}^2\Big)\Big) \Gamma^{*}_{\check{h}_j, W^+, W^-} \Gamma_{\check{h}_i, W^+, W^-} - B_0\Big(p^2, m_{\eta^-}^2, m_{\eta^-}^2\Big) \Gamma_{\check{h}_i, \bar{\eta^-}, \eta^-} \Gamma_{\check{h}_j, \bar{\eta^-}, \eta^-} \\
&- B_0\Big(p^2, m_{\eta^+}^2, m_{\eta^+}^2\Big) \Gamma_{\check{h}_i, \bar{\eta^+}, \eta^+} \Gamma_{\check{h}_j, \bar{\eta^+}, \eta^+} - B_0\Big(p^2, m_{\eta^Z}^2, m_{\eta^Z}^2\Big) \Gamma_{\check{h}_i, \bar{\eta^Z}, \eta^Z} \Gamma_{\check{h}_j, \bar{\eta^Z}, \eta^Z} \\
&- 2B_0\Big(p^2, m_{\eta^Z}^2, m_{\eta^{Z'}}^2\Big) \Gamma_{\check{h}_i, \eta^{\bar{Z}'}, \eta^Z} \Gamma_{\check{h}_j, \eta^{\bar{Z}'}, \eta^Z} - B_0\Big(p^2, m_{\eta^{Z'}}^2, m_{\eta^{Z'}}^2\Big) \Gamma_{\check{h}_i, \eta^{\bar{Z}'}, \eta^{Z'}} \Gamma_{\check{h}_j, \eta^{\bar{Z}'}, \eta^{Z'}} \\
&+ 4\Gamma_{\check{h}_i, \check{h}_j, W^+, W^-} \Big(-\frac{1}{2}\mathrm{rMS} m_{W^-}^2 + A_0\Big(m_{W^-}^2\Big)\Big) + 2\Gamma_{\check{h}_i, \check{h}_j, Z, Z} \Big(-\frac{1}{2}\mathrm{rMS} m_Z^2 + A_0\Big(m_Z^2\Big)\Big) + 2\Gamma_{\check{h}_i, \check{h}_j, Z', Z'} \Big(-\frac{1}{2}\mathrm{rMS} m_{Z'}^2 \\
&- \sum_{a=1}^{2} A_0\Big(m_{H_a^-}^2\Big) \Gamma_{\check{h}_i, \check{h}_j, H_a^+, H_a^-} - \sum_{a=1}^{2} A_0\Big(m_{H_a'^0}^2\Big) \Gamma_{\check{h}_i, \check{h}_j, H_a'^{0,*}, H_a'^0} \\
&- \sum_{a=1}^{2} A_0\Big(m_{H_a'^-}^2\Big) \Gamma_{\check{h}_i, \check{h}_j, H_a'^+, H_a'^-} + \sum_{a=1}^{2} \sum_{b=1}^{2} B_0\Big(p^2, m_{H_a^-}^2, m_{H_b^-}^2\Big) \Gamma^{*}_{\check{h}_j, H_a^+, H_b^-} \Gamma_{\check{h}_i, H_a^+, H_b^-} \\
&+ \sum_{a=1}^{2} \sum_{b=1}^{2} B_0\Big(p^2, m_{H_a'^0}^2, m_{H_b'^0}^2\Big) \Gamma^{*}_{\check{h}_j, H_a'^{0,*}, H_b'^0} \Gamma_{\check{h}_i, H_a'^{0,*}, H_b'^0} \\
&+ \sum_{a=1}^{2} \sum_{b=1}^{2} B_0\Big(p^2, m_{H_a'^-}^2, m_{H_b'^-}^2\Big) \Gamma^{*}_{\check{h}_j, H_a'^+, H_b'^-} \Gamma_{\check{h}_i, H_a'^+, H_b'^-} \\
&- 2\sum_{a=1}^{2} m_{\tilde{\chi}_a^-} \sum_{b=1}^{2} B_0\Big(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{\chi}_b^-}^2\Big) m_{\tilde{\chi}_b^-} \Big(\Gamma^{L*}_{\check{h}_j, \tilde{\chi}_a^+, \tilde{\chi}_b^-} \Gamma^{R}_{\check{h}_i, \tilde{\chi}_a^+, \tilde{\chi}_b^-} + \Gamma^{R*}_{\check{h}_j, \tilde{\chi}_a^+, \tilde{\chi}_b^-} \Gamma^{L}_{\check{h}_i, \tilde{\chi}_a^+, \tilde{\chi}_b^-} \Big) \\
&+ \sum_{a=1}^{2} \sum_{b=1}^{2} G_0\Big(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{\chi}_b^-}^2\Big) \Big(\Gamma^{L*}_{\check{h}_j, \tilde{\chi}_a^+, \tilde{\chi}_b^-} \Gamma^{L}_{\check{h}_i, \tilde{\chi}_a^+, \tilde{\chi}_b^-} + \Gamma^{R*}_{\check{h}_j, \tilde{\chi}_a^+, \tilde{\chi}_b^-} \Gamma^{R}_{\check{h}_i, \tilde{\chi}_a^+, \tilde{\chi}_b^-} \Big) \\
&- \sum_{a=1}^{3} A_0\Big(m_{\tilde{\nu}_a}^2\Big) \Gamma_{\check{h}_i, \check{h}_j, \tilde{\nu}_a^*, \tilde{\nu}_a} + \sum_{a=1}^{3} \sum_{b=1}^{3} B_0\Big(p^2, m_{\tilde{\nu}_a}^2, m_{\tilde{\nu}_b}^2\Big) \Gamma^{*}_{\check{h}_j, \tilde{\nu}_a^*, \tilde{\nu}_b} \Gamma_{\check{h}_i, \tilde{\nu}_a^*, \tilde{\nu}_b}
\end{aligned}
$$

$$
\begin{aligned}
&- 6\sum_{a=1}^{3} m_{d_a} \sum_{b=1}^{3} B_0\Big(p^2, m_{d_a}^2, m_{d_b}^2\Big) m_{d_b} \Big(\Gamma^{L*}_{\check{h}_j,\bar{d}_a,d_b}\Gamma^{R}_{\check{h}_i,\bar{d}_a,d_b} + \Gamma^{R*}_{\check{h}_j,\bar{d}_a,d_b}\Gamma^{L}_{\check{h}_i,\bar{d}_a,d_b}\Big) \\
&+ 3\sum_{a=1}^{3}\sum_{b=1}^{3} G_0\Big(p^2, m_{d_a}^2, m_{d_b}^2\Big) \Big(\Gamma^{L*}_{\check{h}_j,\bar{d}_a,d_b}\Gamma^{L}_{\check{h}_i,\bar{d}_a,d_b} + \Gamma^{R*}_{\check{h}_j,\bar{d}_a,d_b}\Gamma^{R}_{\check{h}_i,\bar{d}_a,d_b}\Big) \\
&- 6\sum_{a=1}^{3} m_{x_a} \sum_{b=1}^{3} B_0\Big(p^2, m_{x_a}^2, m_{x_b}^2\Big) m_{x_b} \Big(\Gamma^{L*}_{\check{h}_j,\bar{x}_a,x_b}\Gamma^{R}_{\check{h}_i,\bar{x}_a,x_b} + \Gamma^{R*}_{\check{h}_j,\bar{x}_a,x_b}\Gamma^{L}_{\check{h}_i,\bar{x}_a,x_b}\Big) \\
&+ 3\sum_{a=1}^{3}\sum_{b=1}^{3} G_0\Big(p^2, m_{x_a}^2, m_{x_b}^2\Big) \Big(\Gamma^{L*}_{\check{h}_j,\bar{x}_a,x_b}\Gamma^{L}_{\check{h}_i,\bar{x}_a,x_b} + \Gamma^{R*}_{\check{h}_j,\bar{x}_a,x_b}\Gamma^{R}_{\check{h}_i,\bar{x}_a,x_b}\Big) \\
&- 2\sum_{a=1}^{3} m_{e_a} \sum_{b=1}^{3} B_0\Big(p^2, m_{e_a}^2, m_{e_b}^2\Big) m_{e_b} \Big(\Gamma^{L*}_{\check{h}_j,\bar{e}_a,e_b}\Gamma^{R}_{\check{h}_i,\bar{e}_a,e_b} + \Gamma^{R*}_{\check{h}_j,\bar{e}_a,e_b}\Gamma^{L}_{\check{h}_i,\bar{e}_a,e_b}\Big) \\
&+ \sum_{a=1}^{3}\sum_{b=1}^{3} G_0\Big(p^2, m_{e_a}^2, m_{e_b}^2\Big) \Big(\Gamma^{L*}_{\check{h}_j,\bar{e}_a,e_b}\Gamma^{L}_{\check{h}_i,\bar{e}_a,e_b} + \Gamma^{R*}_{\check{h}_j,\bar{e}_a,e_b}\Gamma^{R}_{\check{h}_i,\bar{e}_a,e_b}\Big) \\
&- 6\sum_{a=1}^{3} m_{u_a} \sum_{b=1}^{3} B_0\Big(p^2, m_{u_a}^2, m_{u_b}^2\Big) m_{u_b} \Big(\Gamma^{L*}_{\check{h}_j,\bar{u}_a,u_b}\Gamma^{R}_{\check{h}_i,\bar{u}_a,u_b} + \Gamma^{R*}_{\check{h}_j,\bar{u}_a,u_b}\Gamma^{L}_{\check{h}_i,\bar{u}_a,u_b}\Big) \\
&+ 3\sum_{a=1}^{3}\sum_{b=1}^{3} G_0\Big(p^2, m_{u_a}^2, m_{u_b}^2\Big) \Big(\Gamma^{L*}_{\check{h}_j,\bar{u}_a,u_b}\Gamma^{L}_{\check{h}_i,\bar{u}_a,u_b} + \Gamma^{R*}_{\check{h}_j,\bar{u}_a,u_b}\Gamma^{R}_{\check{h}_i,\bar{u}_a,u_b}\Big) \\
&- \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m_{A_a^0}^2\Big)\Gamma_{\check{h}_i,\check{h}_j,A_a^0,A_a^0} - \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m_{h_a}^2\Big)\Gamma_{\check{h}_i,\check{h}_j,h_a,h_a} \\
&+ \frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{5} B_0\Big(p^2, m_{A_a^0}^2, m_{A_b^0}^2\Big)\Gamma^{*}_{\check{h}_j,A_a^0,A_b^0}\Gamma_{\check{h}_i,A_a^0,A_b^0} \\
&+ \sum_{a=1}^{5}\sum_{b=1}^{5} B_0\Big(p^2, m_{h_a}^2, m_{A_b^0}^2\Big)\Gamma^{*}_{\check{h}_j,h_a,A_b^0}\Gamma_{\check{h}_i,h_a,A_b^0} + \frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{5} B_0\Big(p^2, m_{h_a}^2, m_{h_b}^2\Big)\Gamma^{*}_{\check{h}_j,h_a,h_b}\Gamma_{\check{h}_i,h_a,h_b} \\
&- 3\sum_{a=1}^{6} A_0\Big(m_{\tilde{d}_a}^2\Big)\Gamma_{\check{h}_i,\check{h}_j,\tilde{d}_a^*,\tilde{d}_a} - 3\sum_{a=1}^{6} A_0\Big(m_{\tilde{x}_a}^2\Big)\Gamma_{\check{h}_i,\check{h}_j,\tilde{x}_a^*,\tilde{x}_a} \\
&- \sum_{a=1}^{6} A_0\Big(m_{\tilde{e}_a}^2\Big)\Gamma_{\check{h}_i,\check{h}_j,\tilde{e}_a^*,\tilde{e}_a} - 3\sum_{a=1}^{6} A_0\Big(m_{\tilde{u}_a}^2\Big)\Gamma_{\check{h}_i,\check{h}_j,\tilde{u}_a^*,\tilde{u}_a} \\
&+ 3\sum_{a=1}^{6}\sum_{b=1}^{6} B_0\Big(p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2\Big)\Gamma^{*}_{\check{h}_j,\tilde{d}_a^*,\tilde{d}_b}\Gamma_{\check{h}_i,\tilde{d}_a^*,\tilde{d}_b} \\
&+ 3\sum_{a=1}^{6}\sum_{b=1}^{6} B_0\Big(p^2, m_{\tilde{x}_a}^2, m_{\tilde{x}_b}^2\Big)\Gamma^{*}_{\check{h}_j,\tilde{x}_a^*,\tilde{x}_b}\Gamma_{\check{h}_i,\tilde{x}_a^*,\tilde{x}_b} + \sum_{a=1}^{6}\sum_{b=1}^{6} B_0\Big(p^2, m_{\tilde{e}_a}^2, m_{\tilde{e}_b}^2\Big)\Gamma^{*}_{\check{h}_j,\tilde{e}_a^*,\tilde{e}_b}\Gamma_{\check{h}_i,\tilde{e}_a^*,\tilde{e}_b}
\end{aligned}
$$

$$
\begin{aligned}
&+ 3\sum_{a=1}^{6}\sum_{b=1}^{6} B_0\Big(p^2, m^2_{\tilde{u}_a}, m^2_{\tilde{u}_b}\Big)\Gamma^{*}_{\check{h}_j,\tilde{u}^*_a,\tilde{u}_b}\Gamma_{\check{h}_i,\tilde{u}^*_a,\tilde{u}_b}\\
&- \sum_{a=1}^{8} m_{\tilde{\chi}^0_a}\sum_{b=1}^{8} B_0\Big(p^2, m^2_{\tilde{\chi}^0_a}, m^2_{\tilde{\chi}^0_b}\Big) m_{\tilde{\chi}^0_b}\Big(\Gamma^{L*}_{\check{h}_j,\tilde{\chi}^0_a,\tilde{\chi}^0_b}\Gamma^{R}_{\check{h}_i,\tilde{\chi}^0_a,\tilde{\chi}^0_b} + \Gamma^{R*}_{\check{h}_j,\tilde{\chi}^0_a,\tilde{\chi}^0_b}\Gamma^{L}_{\check{h}_i,\tilde{\chi}^0_a,\tilde{\chi}^0_b}\Big)\\
&+ \frac{1}{2}\sum_{a=1}^{8}\sum_{b=1}^{8} G_0\Big(p^2, m^2_{\tilde{\chi}^0_a}, m^2_{\tilde{\chi}^0_b}\Big)\Big(\Gamma^{L*}_{\check{h}_j,\tilde{\chi}^0_a,\tilde{\chi}^0_b}\Gamma^{L}_{\check{h}_i,\tilde{\chi}^0_a,\tilde{\chi}^0_b} + \Gamma^{R*}_{\check{h}_j,\tilde{\chi}^0_a,\tilde{\chi}^0_b}\Gamma^{R}_{\check{h}_i,\tilde{\chi}^0_a,\tilde{\chi}^0_b}\Big)\\
&+ 2\sum_{b=1}^{2}\Gamma^{*}_{\check{h}_j,W^+,H^-_b}\Gamma_{\check{h}_i,W^+,H^-_b} F_0\Big(p^2, m^2_{H^-_b}, m^2_{W^-}\Big) + \sum_{b=1}^{5}\Gamma^{*}_{\check{h}_j,Z,A^0_b}\Gamma_{\check{h}_i,Z,A^0_b} F_0\Big(p^2, m^2_{A^0_b}, m^2_{Z}\Big)\\
&+ \sum_{b=1}^{5}\Gamma^{*}_{\check{h}_j,Z',A^0_b}\Gamma_{\check{h}_i,Z',A^0_b} F_0\Big(p^2, m^2_{A^0_b}, m^2_{Z'}\Big)
\end{aligned}
\tag{285}
$$

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

$$
\begin{aligned}
\Pi_{i,j}(p^2) = &-B_0\Big(p^2, m^2_{\eta^-}, m^2_{\eta^-}\Big)\Gamma_{\check{A}^0_i,\eta^-,\eta^-}\Gamma_{\check{A}^0_j,\eta^-,\eta^-} - B_0\Big(p^2, m^2_{\eta^+}, m^2_{\eta^+}\Big)\Gamma_{\check{A}^0_i,\eta^+,\eta^+}\Gamma_{\check{A}^0_j,\eta^+,\eta^+}\\
&+ 4\Gamma_{\check{A}^0_i,\check{A}^0_j,W^+,W^-}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{W^-} + A_0\Big(m^2_{W^-}\Big)\Big) + 2\Gamma_{\check{A}^0_i,\check{A}^0_j,Z,Z}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{Z} + A_0\Big(m^2_{Z}\Big)\Big)\\
&+ 2\Gamma_{\check{A}^0_i,\check{A}^0_j,Z',Z'}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{Z'} + A_0\Big(m^2_{Z'}\Big)\Big) - \sum_{a=1}^{2} A_0\Big(m^2_{H^-_a}\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,H^+_a,H^-_a}\\
&- \sum_{a=1}^{2} A_0\Big(m^2_{H'^0_a}\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,H'^{0,*}_a,H'^0_a} - \sum_{a=1}^{2} A_0\Big(m^2_{H'^-_a}\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,H'^+_a,H'^-_a}\\
&+ \sum_{a=1}^{2}\sum_{b=1}^{2} B_0\Big(p^2, m^2_{H^-_a}, m^2_{H^-_b}\Big)\Gamma^{*}_{\check{A}^0_j,H^+_a,H^-_b}\Gamma_{\check{A}^0_i,H^+_a,H^-_b}\\
&- 2\sum_{a=1}^{2} m_{\tilde{\chi}^-_a}\sum_{b=1}^{2} B_0\Big(p^2, m^2_{\tilde{\chi}^-_a}, m^2_{\tilde{\chi}^-_b}\Big) m_{\tilde{\chi}^-_b}\Big(\Gamma^{L*}_{\check{A}^0_j,\tilde{\chi}^+_a,\tilde{\chi}^-_b}\Gamma^{R}_{\check{A}^0_i,\tilde{\chi}^+_a,\tilde{\chi}^-_b} + \Gamma^{R*}_{\check{A}^0_j,\tilde{\chi}^+_a,\tilde{\chi}^-_b}\Gamma^{L}_{\check{A}^0_i,\tilde{\chi}^+_a,\tilde{\chi}^-_b}\Big)\\
&+ \sum_{a=1}^{2}\sum_{b=1}^{2} G_0\Big(p^2, m^2_{\tilde{\chi}^-_a}, m^2_{\tilde{\chi}^-_b}\Big)\Big(\Gamma^{L*}_{\check{A}^0_j,\tilde{\chi}^+_a,\tilde{\chi}^-_b}\Gamma^{L}_{\check{A}^0_i,\tilde{\chi}^+_a,\tilde{\chi}^-_b} + \Gamma^{R*}_{\check{A}^0_j,\tilde{\chi}^+_a,\tilde{\chi}^-_b}\Gamma^{R}_{\check{A}^0_i,\tilde{\chi}^+_a,\tilde{\chi}^-_b}\Big)\\
&- \sum_{a=1}^{3} A_0\Big(m^2_{\tilde{\nu}_a}\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,\tilde{\nu}^*_a,\tilde{\nu}_a}\\
&- 6\sum_{a=1}^{3} m_{d_a}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{d_a}, m^2_{d_b}\Big) m_{d_b}\Big(\Gamma^{L*}_{\check{A}^0_j,\bar{d}_a,d_b}\Gamma^{R}_{\check{A}^0_i,\bar{d}_a,d_b} + \Gamma^{R*}_{\check{A}^0_j,\bar{d}_a,d_b}\Gamma^{L}_{\check{A}^0_i,\bar{d}_a,d_b}\Big)\\
&+ 3\sum_{a=1}^{3}\sum_{b=1}^{3} G_0\Big(p^2, m^2_{d_a}, m^2_{d_b}\Big)\Big(\Gamma^{L*}_{\check{A}^0_j,\bar{d}_a,d_b}\Gamma^{L}_{\check{A}^0_i,\bar{d}_a,d_b} + \Gamma^{R*}_{\check{A}^0_j,\bar{d}_a,d_b}\Gamma^{R}_{\check{A}^0_i,\bar{d}_a,d_b}\Big)
\end{aligned}
$$

$$
\begin{aligned}
&- 6\sum_{a=1}^{3} m_{x_a} \sum_{b=1}^{3} B_0\Big(p^2, m_{x_a}^2, m_{x_b}^2\Big) m_{x_b} \Big(\Gamma^{L*}_{\check{A}^0_j,\bar{x}_a,x_b}\Gamma^{R}_{\check{A}^0_i,\bar{x}_a,x_b} + \Gamma^{R*}_{\check{A}^0_j,\bar{x}_a,x_b}\Gamma^{L}_{\check{A}^0_i,\bar{x}_a,x_b}\Big) \\
&+ 3\sum_{a=1}^{3}\sum_{b=1}^{3} G_0\Big(p^2, m_{x_a}^2, m_{x_b}^2\Big)\Big(\Gamma^{L*}_{\check{A}^0_j,\bar{x}_a,x_b}\Gamma^{L}_{\check{A}^0_i,\bar{x}_a,x_b} + \Gamma^{R*}_{\check{A}^0_j,\bar{x}_a,x_b}\Gamma^{R}_{\check{A}^0_i,\bar{x}_a,x_b}\Big) \\
&- 2\sum_{a=1}^{3} m_{e_a} \sum_{b=1}^{3} B_0\Big(p^2, m_{e_a}^2, m_{e_b}^2\Big) m_{e_b} \Big(\Gamma^{L*}_{\check{A}^0_j,\bar{e}_a,e_b}\Gamma^{R}_{\check{A}^0_i,\bar{e}_a,e_b} + \Gamma^{R*}_{\check{A}^0_j,\bar{e}_a,e_b}\Gamma^{L}_{\check{A}^0_i,\bar{e}_a,e_b}\Big) \\
&+ \sum_{a=1}^{3}\sum_{b=1}^{3} G_0\Big(p^2, m_{e_a}^2, m_{e_b}^2\Big)\Big(\Gamma^{L*}_{\check{A}^0_j,\bar{e}_a,e_b}\Gamma^{L}_{\check{A}^0_i,\bar{e}_a,e_b} + \Gamma^{R*}_{\check{A}^0_j,\bar{e}_a,e_b}\Gamma^{R}_{\check{A}^0_i,\bar{e}_a,e_b}\Big) \\
&- 6\sum_{a=1}^{3} m_{u_a} \sum_{b=1}^{3} B_0\Big(p^2, m_{u_a}^2, m_{u_b}^2\Big) m_{u_b} \Big(\Gamma^{L*}_{\check{A}^0_j,\bar{u}_a,u_b}\Gamma^{R}_{\check{A}^0_i,\bar{u}_a,u_b} + \Gamma^{R*}_{\check{A}^0_j,\bar{u}_a,u_b}\Gamma^{L}_{\check{A}^0_i,\bar{u}_a,u_b}\Big) \\
&+ 3\sum_{a=1}^{3}\sum_{b=1}^{3} G_0\Big(p^2, m_{u_a}^2, m_{u_b}^2\Big)\Big(\Gamma^{L*}_{\check{A}^0_j,\bar{u}_a,u_b}\Gamma^{L}_{\check{A}^0_i,\bar{u}_a,u_b} + \Gamma^{R*}_{\check{A}^0_j,\bar{u}_a,u_b}\Gamma^{R}_{\check{A}^0_i,\bar{u}_a,u_b}\Big) \\
&- \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m_{A^0_a}^2\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,A^0_a,A^0_a} - \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m_{h_a}^2\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,h_a,h_a} \\
&+ \frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{5} B_0\Big(p^2, m_{A^0_a}^2, m_{A^0_b}^2\Big)\Gamma^{*}_{\check{A}^0_j,A^0_a,A^0_b}\Gamma_{\check{A}^0_i,A^0_a,A^0_b} \\
&+ \sum_{a=1}^{5}\sum_{b=1}^{5} B_0\Big(p^2, m_{h_a}^2, m_{A^0_b}^2\Big)\Gamma^{*}_{\check{A}^0_j,h_a,A^0_b}\Gamma_{\check{A}^0_i,h_a,A^0_b} \\
&+ \frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{5} B_0\Big(p^2, m_{h_a}^2, m_{h_b}^2\Big)\Gamma^{*}_{\check{A}^0_j,h_a,h_b}\Gamma_{\check{A}^0_i,h_a,h_b} - 3\sum_{a=1}^{6} A_0\Big(m_{\tilde{d}_a}^2\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,\tilde{d}^*_a,\tilde{d}_a} \\
&- 3\sum_{a=1}^{6} A_0\Big(m_{\tilde{x}_a}^2\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,\tilde{x}^*_a,\tilde{x}_a} - \sum_{a=1}^{6} A_0\Big(m_{\tilde{e}_a}^2\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,\tilde{e}^*_a,\tilde{e}_a} \\
&- 3\sum_{a=1}^{6} A_0\Big(m_{\tilde{u}_a}^2\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,\tilde{u}^*_a,\tilde{u}_a} + 3\sum_{a=1}^{6}\sum_{b=1}^{6} B_0\Big(p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2\Big)\Gamma^{*}_{\check{A}^0_j,\tilde{d}^*_a,\tilde{d}_b}\Gamma_{\check{A}^0_i,\tilde{d}^*_a,\tilde{d}_b} \\
&+ 3\sum_{a=1}^{6}\sum_{b=1}^{6} B_0\Big(p^2, m_{\tilde{x}_a}^2, m_{\tilde{x}_b}^2\Big)\Gamma^{*}_{\check{A}^0_j,\tilde{x}^*_a,\tilde{x}_b}\Gamma_{\check{A}^0_i,\tilde{x}^*_a,\tilde{x}_b} \\
&+ \sum_{a=1}^{6}\sum_{b=1}^{6} B_0\Big(p^2, m_{\tilde{e}_a}^2, m_{\tilde{e}_b}^2\Big)\Gamma^{*}_{\check{A}^0_j,\tilde{e}^*_a,\tilde{e}_b}\Gamma_{\check{A}^0_i,\tilde{e}^*_a,\tilde{e}_b} \\
&+ 3\sum_{a=1}^{6}\sum_{b=1}^{6} B_0\Big(p^2, m_{\tilde{u}_a}^2, m_{\tilde{u}_b}^2\Big)\Gamma^{*}_{\check{A}^0_j,\tilde{u}^*_a,\tilde{u}_b}\Gamma_{\check{A}^0_i,\tilde{u}^*_a,\tilde{u}_b}
\end{aligned}
$$

$$
\begin{aligned}
&- \sum_{a=1}^{8} m_{\tilde{\chi}_a^0} \sum_{b=1}^{8} B_0\Big(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^0}^2\Big) m_{\tilde{\chi}_b^0} \Big(\Gamma^{L*}_{\check{A}_j^0,\tilde{\chi}_a^0,\tilde{\chi}_b^0} \Gamma^{R}_{\check{A}_i^0,\tilde{\chi}_a^0,\tilde{\chi}_b^0} + \Gamma^{R*}_{\check{A}_j^0,\tilde{\chi}_a^0,\tilde{\chi}_b^0} \Gamma^{L}_{\check{A}_i^0,\tilde{\chi}_a^0,\tilde{\chi}_b^0}\Big) \\
&+ \frac{1}{2} \sum_{a=1}^{8} \sum_{b=1}^{8} G_0\Big(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^0}^2\Big) \Big(\Gamma^{L*}_{\check{A}_j^0,\tilde{\chi}_a^0,\tilde{\chi}_b^0} \Gamma^{L}_{\check{A}_i^0,\tilde{\chi}_a^0,\tilde{\chi}_b^0} + \Gamma^{R*}_{\check{A}_j^0,\tilde{\chi}_a^0,\tilde{\chi}_b^0} \Gamma^{R}_{\check{A}_i^0,\tilde{\chi}_a^0,\tilde{\chi}_b^0}\Big) \\
&+ 2 \sum_{b=1}^{2} \Gamma^{*}_{\check{A}_j^0,W^+,H_b^-} \Gamma_{\check{A}_i^0,W^+,H_b^-} F_0\Big(p^2, m_{H_b^-}^2, m_{W^-}^2\Big) + \sum_{b=1}^{5} \Gamma^{*}_{\check{A}_j^0,Z,h_b} \Gamma_{\check{A}_i^0,Z,h_b} F_0\Big(p^2, m_{h_b}^2, m_{Z}^2\Big) \\
&+ \sum_{b=1}^{5} \Gamma^{*}_{\check{A}_j^0,Z',h_b} \Gamma_{\check{A}_i^0,Z',h_b} F_0\Big(p^2, m_{h_b}^2, m_{Z'}^2\Big) \qquad (286)
\end{aligned}
$$

- **Self-Energy for Charged Higgs** (H^-)

$$
\begin{aligned}
\Pi_{i,j}(p^2) = &+4\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, 0, m_{W^-}^2\Big)\Big)\Gamma^{*}_{\check{H}_j^+,W^-,\gamma} \Gamma_{\check{H}_i^+,W^-,\gamma} + 4\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m_{W^-}^2, m_{Z}^2\Big)\Big)\Gamma^{*}_{\check{H}_j^+,Z,W^-} \Gamma_{\check{H}_i^+,Z,W^-} \\
&+ 4\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m_{W^-}^2, m_{Z'}^2\Big)\Big)\Gamma^{*}_{\check{H}_j^+,Z',W^-} \Gamma_{\check{H}_i^+,Z',W^-} - B_0\Big(p^2, m_{\eta^Z}^2, m_{\eta^+}^2\Big) \Gamma_{\check{H}_i^+,\bar{\eta^+},\eta^Z} \Gamma_{\check{H}_j^-,\eta^+,\bar{\eta^Z}} \\
&- B_0\Big(p^2, m_{\eta^{Z'}}^2, m_{\eta^+}^2\Big) \Gamma_{\check{H}_i^+,\bar{\eta^+},\eta^{Z'}} \Gamma_{\check{H}_j^-,\eta^+,\bar{\eta^{Z'}}} - B_0\Big(p^2, m_{\eta^-}^2, m_{\eta^Z}^2\Big) \Gamma_{\check{H}_i^+,\bar{\eta^Z},\eta^-} \Gamma_{\check{H}_j^-,\eta^Z,\bar{\eta^-}} \\
&- B_0\Big(p^2, m_{\eta^-}^2, m_{\eta^{Z'}}^2\Big) \Gamma_{\check{H}_i^+,\bar{\eta^{Z'}},\eta^-} \Gamma_{\check{H}_j^-,\eta^{Z'},\bar{\eta^-}} + 4\Gamma_{\check{H}_i^-,\check{H}_j^+,W^+,W^-} \Big(-\frac{1}{2}\mathrm{rMS} m_{W^-}^2 + A_0\Big(m_{W^-}^2\Big)\Big) \\
&+ 2\Gamma_{\check{H}_i^-,\check{H}_j^+,Z,Z} \Big(-\frac{1}{2}\mathrm{rMS} m_{Z}^2 + A_0\Big(m_{Z}^2\Big)\Big) + 2\Gamma_{\check{H}_i^-,\check{H}_j^+,Z',Z'} \Big(-\frac{1}{2}\mathrm{rMS} m_{Z'}^2 + A_0\Big(m_{Z'}^2\Big)\Big) \\
&- \sum_{a=1}^{2} A_0\Big(m_{H_a^-}^2\Big) \Gamma_{\check{H}_i^-,\check{H}_j^+,H_a^+,H_a^-} - \sum_{a=1}^{2} A_0\Big(m_{H_a'^0}^2\Big) \Gamma_{\check{H}_i^-,\check{H}_j^+,H_a'^{0,*},H_a'^0} \\
&- \sum_{a=1}^{2} A_0\Big(m_{H_a'^-}^2\Big) \Gamma_{\check{H}_i^-,\check{H}_j^+,H_a'^+,H_a'^-} + \sum_{a=1}^{2} \sum_{b=1}^{2} B_0\Big(p^2, m_{H_a'^0}^2, m_{H_b'^-}^2\Big) \Gamma^{*}_{\check{H}_j^+,H_a'^{0,*},H_b'^-} \Gamma_{\check{H}_i^+,H_a'^{0,*},H_b'^-} \\
&+ \sum_{a=1}^{2} \sum_{b=1}^{5} B_0\Big(p^2, m_{H_a^-}^2, m_{A_b^0}^2\Big) \Gamma^{*}_{\check{H}_j^+,H_a^-,A_b^0} \Gamma_{\check{H}_i^+,H_a^-,A_b^0} \\
&+ \sum_{a=1}^{2} \sum_{b=1}^{5} B_0\Big(p^2, m_{H_a^-}^2, m_{h_b}^2\Big) \Gamma^{*}_{\check{H}_j^+,H_a^-,h_b} \Gamma_{\check{H}_i^+,H_a^-,h_b} - \sum_{a=1}^{3} A_0\Big(m_{\tilde{\nu}_a}^2\Big) \Gamma_{\check{H}_i^-,\check{H}_j^+,\tilde{\nu}_a^*,\tilde{\nu}_a} \\
&- 6 \sum_{a=1}^{3} m_{u_a} \sum_{b=1}^{3} B_0\Big(p^2, m_{u_a}^2, m_{d_b}^2\Big) m_{d_b} \Big(\Gamma^{L*}_{\check{H}_j^+,\bar{u}_a,d_b} \Gamma^{R}_{\check{H}_i^+,\bar{u}_a,d_b} + \Gamma^{R*}_{\check{H}_j^+,\bar{u}_a,d_b} \Gamma^{L}_{\check{H}_i^+,\bar{u}_a,d_b}\Big) \\
&+ 3 \sum_{a=1}^{3} \sum_{b=1}^{3} G_0\Big(p^2, m_{u_a}^2, m_{d_b}^2\Big) \Big(\Gamma^{L*}_{\check{H}_j^+,\bar{u}_a,d_b} \Gamma^{L}_{\check{H}_i^+,\bar{u}_a,d_b} + \Gamma^{R*}_{\check{H}_j^+,\bar{u}_a,d_b} \Gamma^{R}_{\check{H}_i^+,\bar{u}_a,d_b}\Big) \\
&- 2 \sum_{a=1}^{3} m_{\nu_a} \sum_{b=1}^{3} B_0\Big(p^2, m_{\nu_a}^2, m_{e_b}^2\Big) m_{e_b} \Big(\Gamma^{L*}_{\check{H}_j^+,\bar{\nu}_a,e_b} \Gamma^{R}_{\check{H}_i^+,\bar{\nu}_a,e_b} + \Gamma^{R*}_{\check{H}_j^+,\bar{\nu}_a,e_b} \Gamma^{L}_{\check{H}_i^+,\bar{\nu}_a,e_b}\Big)
\end{aligned}
$$

$$
\begin{aligned}
&+\sum_{a=1}^{3}\sum_{b=1}^{3} G_0\Big(p^2, m^2_{\nu_a}, m^2_{e_b}\Big)\Big(\Gamma^{L*}_{\check{H}^+_j,\bar{\nu}_a,e_b}\Gamma^{L}_{\check{H}^+_i,\bar{\nu}_a,e_b} + \Gamma^{R*}_{\check{H}^+_j,\bar{\nu}_a,e_b}\Gamma^{R}_{\check{H}^+_i,\bar{\nu}_a,e_b}\Big)\\
&+\sum_{a=1}^{3}\sum_{b=1}^{6} B_0\Big(p^2, m^2_{\tilde{\nu}_a}, m^2_{\tilde{e}_b}\Big)\Gamma^{*}_{\check{H}^+_j,\tilde{\nu}^*_a,\tilde{e}_b}\Gamma_{\check{H}^+_i,\tilde{\nu}^*_a,\tilde{e}_b} - \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{A^0_a}\Big)\Gamma_{\check{H}^-_i,\check{H}^+_j,A^0_a,A^0_a}\\
&-\frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{h_a}\Big)\Gamma_{\check{H}^-_i,\check{H}^+_j,h_a,h_a} - 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{d}_a}\Big)\Gamma_{\check{H}^-_i,\check{H}^+_j,\tilde{d}^*_a,\tilde{d}_a}\\
&-3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{x}_a}\Big)\Gamma_{\check{H}^-_i,\check{H}^+_j,\tilde{x}^*_a,\tilde{x}_a} - \sum_{a=1}^{6} A_0\Big(m^2_{\tilde{e}_a}\Big)\Gamma_{\check{H}^-_i,\check{H}^+_j,\tilde{e}^*_a,\tilde{e}_a}\\
&-3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{u}_a}\Big)\Gamma_{\check{H}^-_i,\check{H}^+_j,\tilde{u}^*_a,\tilde{u}_a} + 3\sum_{a=1}^{6}\sum_{b=1}^{6} B_0\Big(p^2, m^2_{\tilde{u}_a}, m^2_{\tilde{d}_b}\Big)\Gamma^{*}_{\check{H}^+_j,\tilde{u}^*_a,\tilde{d}_b}\Gamma_{\check{H}^+_i,\tilde{u}^*_a,\tilde{d}_b}\\
&-2\sum_{a=1}^{8} m_{\tilde{\chi}^0_a}\sum_{b=1}^{2} B_0\Big(p^2, m^2_{\tilde{\chi}^0_a}, m^2_{\tilde{\chi}^-_b}\Big) m_{\tilde{\chi}^-_b}\Big(\Gamma^{L*}_{\check{H}^+_j,\tilde{\chi}^0_a,\tilde{\chi}^-_b}\Gamma^{R}_{\check{H}^+_i,\tilde{\chi}^0_a,\tilde{\chi}^-_b} + \Gamma^{R*}_{\check{H}^+_j,\tilde{\chi}^0_a,\tilde{\chi}^-_b}\Gamma^{L}_{\check{H}^+_i,\tilde{\chi}^0_a,\tilde{\chi}^-_b}\Big)\\
&+\sum_{a=1}^{8}\sum_{b=1}^{2} G_0\Big(p^2, m^2_{\tilde{\chi}^0_a}, m^2_{\tilde{\chi}^-_b}\Big)\Big(\Gamma^{L*}_{\check{H}^+_j,\tilde{\chi}^0_a,\tilde{\chi}^-_b}\Gamma^{L}_{\check{H}^+_i,\tilde{\chi}^0_a,\tilde{\chi}^-_b} + \Gamma^{R*}_{\check{H}^+_j,\tilde{\chi}^0_a,\tilde{\chi}^-_b}\Gamma^{R}_{\check{H}^+_i,\tilde{\chi}^0_a,\tilde{\chi}^-_b}\Big)\\
&+\sum_{b=1}^{2}\Gamma^{*}_{\check{H}^+_j,\gamma,H^-_b}\Gamma_{\check{H}^+_i,\gamma,H^-_b} F_0\Big(p^2, m^2_{H^-_b}, 0\Big) + \sum_{b=1}^{2}\Gamma^{*}_{\check{H}^+_j,Z,H^-_b}\Gamma_{\check{H}^+_i,Z,H^-_b} F_0\Big(p^2, m^2_{H^-_b}, m^2_Z\Big)\\
&+\sum_{b=1}^{2}\Gamma^{*}_{\check{H}^+_j,Z',H^-_b}\Gamma_{\check{H}^+_i,Z',H^-_b} F_0\Big(p^2, m^2_{H^-_b}, m^2_{Z'}\Big) + \sum_{b=1}^{5}\Gamma^{*}_{\check{H}^+_j,W^-,A^0_b}\Gamma_{\check{H}^+_i,W^-,A^0_b} F_0\Big(p^2, m^2_{A^0_b}, m^2_{W^-}\Big)\\
&+\sum_{b=1}^{5}\Gamma^{*}_{\check{H}^+_j,W^-,h_b}\Gamma_{\check{H}^+_i,W^-,h_b} F_0\Big(p^2, m^2_{h_b}, m^2_{W^-}\Big)
\end{aligned}
\tag{287}
$$

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

$$
\begin{aligned}
\Sigma^S_{i,j}(p^2) = &+2\sum_{a=1}^{2}\sum_{b=1}^{2} B_0\Big(p^2, m^2_{\tilde{\chi}^-_b}, m^2_{H^-_a}\Big)\Gamma^{L*}_{\tilde{\chi}^0_j,H^+_a,\tilde{\chi}^-_b} m_{\tilde{\chi}^-_b}\Gamma^{R}_{\tilde{\chi}^0_i,H^+_a,\tilde{\chi}^-_b}\\
&+2\sum_{a=1}^{2}\sum_{b=1}^{2} B_0\Big(p^2, m^2_{\tilde{\chi}'^0_b}, m^2_{H'^0_a}\Big)\Gamma^{L*}_{\tilde{\chi}^0_j,H'^{0,*}_a,\tilde{\chi}'^0_b} m_{\tilde{\chi}'^0_b}\Gamma^{R}_{\tilde{\chi}^0_i,H'^{0,*}_a,\tilde{\chi}'^0_b}\\
&+2m_{\tilde{\chi}'^-}\sum_{a=1}^{2} B_0\Big(p^2, m^2_{\tilde{\chi}'^-}, m^2_{H'^-_a}\Big)\Gamma^{L*}_{\tilde{\chi}^0_j,H'^+_a,\mathrm{ChaP}\Big(\{1\}\Big)}\Gamma^{R}_{\tilde{\chi}^0_i,H'^+_a,\mathrm{ChaP}\Big(\{1\}\Big)}\\
&+2\sum_{a=1}^{3}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{\nu_b}, m^2_{\tilde{\nu}_a}\Big)\Gamma^{L*}_{\tilde{\chi}^0_j,\tilde{\nu}^*_a,\nu_b} m_{\nu_b}\Gamma^{R}_{\tilde{\chi}^0_i,\tilde{\nu}^*_a,\nu_b}
\end{aligned}
$$

$$
\begin{aligned}
&+\sum_{a=1}^{5}\sum_{b=1}^{8} B_0\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{h_a}\Big)\Gamma^{L*}_{\tilde{\chi}^0_j,h_a,\tilde{\chi}^0_b} m_{\tilde{\chi}^0_b}\Gamma^{R}_{\tilde{\chi}^0_i,h_a,\tilde{\chi}^0_b}\\
&+6\sum_{a=1}^{6}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{d_b}, m^2_{\tilde{d}_a}\Big)\Gamma^{L*}_{\tilde{\chi}^0_j,\tilde{d}^*_a,d_b} m_{d_b}\Gamma^{R}_{\tilde{\chi}^0_i,\tilde{d}^*_a,d_b}\\
&+6\sum_{a=1}^{6}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{x_b}, m^2_{\tilde{x}_a}\Big)\Gamma^{L*}_{\tilde{\chi}^0_j,\tilde{x}^*_a,x_b} m_{x_b}\Gamma^{R}_{\tilde{\chi}^0_i,\tilde{x}^*_a,x_b}\\
&+2\sum_{a=1}^{6}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{e_b}, m^2_{\tilde{e}_a}\Big)\Gamma^{L*}_{\tilde{\chi}^0_j,\tilde{e}^*_a,e_b} m_{e_b}\Gamma^{R}_{\tilde{\chi}^0_i,\tilde{e}^*_a,e_b}\\
&+6\sum_{a=1}^{6}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{u_b}, m^2_{\tilde{u}_a}\Big)\Gamma^{L*}_{\tilde{\chi}^0_j,\tilde{u}^*_a,u_b} m_{u_b}\Gamma^{R}_{\tilde{\chi}^0_i,\tilde{u}^*_a,u_b}\\
&+\sum_{a=1}^{8} m_{\tilde{\chi}^0_a}\sum_{b=1}^{5} B_0\Big(p^2, m^2_{\tilde{\chi}^0_a}, m^2_{A^0_b}\Big)\Gamma^{L*}_{\tilde{\chi}^0_j,\tilde{\chi}^0_a,A^0_b}\Gamma^{R}_{\tilde{\chi}^0_i,\tilde{\chi}^0_a,A^0_b}\\
&-8\sum_{b=1}^{2}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m^2_{\tilde{\chi}^-_b}, m^2_{W^-}\Big)\Big)\Gamma^{R*}_{\tilde{\chi}^0_j,W^+,\tilde{\chi}^-_b} m_{\tilde{\chi}^-_b}\Gamma^{L}_{\tilde{\chi}^0_i,W^+,\tilde{\chi}^-_b}\\
&-4\sum_{b=1}^{8}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{Z}\Big)\Big)\Gamma^{R*}_{\tilde{\chi}^0_j,Z,\tilde{\chi}^0_b} m_{\tilde{\chi}^0_b}\Gamma^{L}_{\tilde{\chi}^0_i,Z,\tilde{\chi}^0_b}\\
&-4\sum_{b=1}^{8}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{Z'}\Big)\Big)\Gamma^{R*}_{\tilde{\chi}^0_j,Z',\tilde{\chi}^0_b} m_{\tilde{\chi}^0_b}\Gamma^{L}_{\tilde{\chi}^0_i,Z',\tilde{\chi}^0_b} \qquad (288)\\
\Sigma^R_{i,j}(p^2) = &-\sum_{a=1}^{2}\sum_{b=1}^{2} B_1\Big(p^2, m^2_{\tilde{\chi}^-_b}, m^2_{H^-_a}\Big)\Gamma^{R*}_{\tilde{\chi}^0_j,H^+_a,\tilde{\chi}^-_b}\Gamma^{R}_{\tilde{\chi}^0_i,H^+_a,\tilde{\chi}^-_b}\\
&-\sum_{a=1}^{2}\sum_{b=1}^{2} B_1\Big(p^2, m^2_{\tilde{\chi}'^0_b}, m^2_{H'^0_a}\Big)\Gamma^{R*}_{\tilde{\chi}^0_j,H'^{0,*}_a,\tilde{\chi}'^0_b}\Gamma^{R}_{\tilde{\chi}^0_i,H'^{0,*}_a,\tilde{\chi}'^0_b}\\
&-\sum_{a=1}^{2} B_1\Big(p^2, m^2_{\tilde{\chi}'^-}, m^2_{H'^-_a}\Big)\Gamma^{R*}_{\tilde{\chi}^0_j,H'^+_a,\mathrm{ChaP}\left(\{1\}\right)}\Gamma^{R}_{\tilde{\chi}^0_i,H'^+_a,\mathrm{ChaP}\left(\{1\}\right)}\\
&-\sum_{a=1}^{3}\sum_{b=1}^{3} B_1\Big(p^2, m^2_{\nu_b}, m^2_{\tilde{\nu}_a}\Big)\Gamma^{R*}_{\tilde{\chi}^0_j,\tilde{\nu}^*_a,\nu_b}\Gamma^{R}_{\tilde{\chi}^0_i,\tilde{\nu}^*_a,\nu_b}\\
&-\frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{8} B_1\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{h_a}\Big)\Gamma^{R*}_{\tilde{\chi}^0_j,h_a,\tilde{\chi}^0_b}\Gamma^{R}_{\tilde{\chi}^0_i,h_a,\tilde{\chi}^0_b}\\
&-3\sum_{a=1}^{6}\sum_{b=1}^{3} B_1\Big(p^2, m^2_{d_b}, m^2_{\tilde{d}_a}\Big)\Gamma^{R*}_{\tilde{\chi}^0_j,\tilde{d}^*_a,d_b}\Gamma^{R}_{\tilde{\chi}^0_i,\tilde{d}^*_a,d_b}
\end{aligned}
$$

$$
\begin{aligned}
&- 3\sum_{a=1}^{6}\sum_{b=1}^{3} B_1\Big(p^2, m_{x_b}^2, m_{\tilde{x}_a}^2\Big)\Gamma^{R*}_{\tilde{\chi}_j^0,\tilde{x}_a^*,x_b}\Gamma^{R}_{\tilde{\chi}_i^0,\tilde{x}_a^*,x_b}\\
&- \sum_{a=1}^{6}\sum_{b=1}^{3} B_1\Big(p^2, m_{e_b}^2, m_{\tilde{e}_a}^2\Big)\Gamma^{R*}_{\tilde{\chi}_j^0,\tilde{e}_a^*,e_b}\Gamma^{R}_{\tilde{\chi}_i^0,\tilde{e}_a^*,e_b}\\
&- 3\sum_{a=1}^{6}\sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_{\tilde{u}_a}^2\Big)\Gamma^{R*}_{\tilde{\chi}_j^0,\tilde{u}_a^*,u_b}\Gamma^{R}_{\tilde{\chi}_i^0,\tilde{u}_a^*,u_b}\\
&- \frac{1}{2}\sum_{a=1}^{8}\sum_{b=1}^{5} B_1\Big(p^2, m_{\tilde{\chi}_a^0}^2, m_{A_b^0}^2\Big)\Gamma^{R*}_{\tilde{\chi}_j^0,\tilde{\chi}_a^0,A_b^0}\Gamma^{R}_{\tilde{\chi}_i^0,\tilde{\chi}_a^0,A_b^0}\\
&- 2\sum_{b=1}^{2} B_1\Big(p^2, m_{\tilde{\chi}_b^-}^2, m_{W^-}^2\Big)\Gamma^{L*}_{\tilde{\chi}_j^0,W^+,\tilde{\chi}_b^-}\Gamma^{L}_{\tilde{\chi}_i^0,W^+,\tilde{\chi}_b^-} - \sum_{b=1}^{8} B_1\Big(p^2, m_{\tilde{\chi}_b^0}^2, m_{Z}^2\Big)\Gamma^{L*}_{\tilde{\chi}_j^0,Z,\tilde{\chi}_b^0}\Gamma^{L}_{\tilde{\chi}_i^0,Z,\tilde{\chi}_b^0}\\
&- \sum_{b=1}^{8} B_1\Big(p^2, m_{\tilde{\chi}_b^0}^2, m_{Z'}^2\Big)\Gamma^{L*}_{\tilde{\chi}_j^0,Z',\tilde{\chi}_b^0}\Gamma^{L}_{\tilde{\chi}_i^0,Z',\tilde{\chi}_b^0}
\end{aligned}
\tag{289}
$$

$$
\begin{aligned}
\Sigma^L_{i,j}(p^2) = &- \sum_{a=1}^{2}\sum_{b=1}^{2} B_1\Big(p^2, m_{\tilde{\chi}_b^-}^2, m_{H_a^-}^2\Big)\Gamma^{L*}_{\tilde{\chi}_j^0,H_a^+,\tilde{\chi}_b^-}\Gamma^{L}_{\tilde{\chi}_i^0,H_a^+,\tilde{\chi}_b^-}\\
&- \sum_{a=1}^{2}\sum_{b=1}^{2} B_1\Big(p^2, m_{\tilde{\chi}_b^{\prime 0}}^2, m_{H_a^{\prime 0}}^2\Big)\Gamma^{L*}_{\tilde{\chi}_j^0,H_a^{\prime 0,*},\tilde{\chi}_b^{\prime 0}}\Gamma^{L}_{\tilde{\chi}_i^0,H_a^{\prime 0,*},\tilde{\chi}_b^{\prime 0}}\\
&- \sum_{a=1}^{2} B_1\Big(p^2, m_{\tilde{\chi}^{\prime -}}^2, m_{H_a^{\prime -}}^2\Big)\Gamma^{L*}_{\tilde{\chi}_j^0,H_a^{\prime +},\mathrm{ChaP}\left(\{1\}\right)}\Gamma^{L}_{\tilde{\chi}_i^0,H_a^{\prime +},\mathrm{ChaP}\left(\{1\}\right)}\\
&- \sum_{a=1}^{3}\sum_{b=1}^{3} B_1\Big(p^2, m_{\nu_b}^2, m_{\tilde{\nu}_a}^2\Big)\Gamma^{L*}_{\tilde{\chi}_j^0,\tilde{\nu}_a^*,\nu_b}\Gamma^{L}_{\tilde{\chi}_i^0,\tilde{\nu}_a^*,\nu_b}\\
&- \frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{8} B_1\Big(p^2, m_{\tilde{\chi}_b^0}^2, m_{h_a}^2\Big)\Gamma^{L*}_{\tilde{\chi}_j^0,h_a,\tilde{\chi}_b^0}\Gamma^{L}_{\tilde{\chi}_i^0,h_a,\tilde{\chi}_b^0}\\
&- 3\sum_{a=1}^{6}\sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_{\tilde{d}_a}^2\Big)\Gamma^{L*}_{\tilde{\chi}_j^0,\tilde{d}_a^*,d_b}\Gamma^{L}_{\tilde{\chi}_i^0,\tilde{d}_a^*,d_b}\\
&- 3\sum_{a=1}^{6}\sum_{b=1}^{3} B_1\Big(p^2, m_{x_b}^2, m_{\tilde{x}_a}^2\Big)\Gamma^{L*}_{\tilde{\chi}_j^0,\tilde{x}_a^*,x_b}\Gamma^{L}_{\tilde{\chi}_i^0,\tilde{x}_a^*,x_b}\\
&- \sum_{a=1}^{6}\sum_{b=1}^{3} B_1\Big(p^2, m_{e_b}^2, m_{\tilde{e}_a}^2\Big)\Gamma^{L*}_{\tilde{\chi}_j^0,\tilde{e}_a^*,e_b}\Gamma^{L}_{\tilde{\chi}_i^0,\tilde{e}_a^*,e_b}\\
&- 3\sum_{a=1}^{6}\sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_{\tilde{u}_a}^2\Big)\Gamma^{L*}_{\tilde{\chi}_j^0,\tilde{u}_a^*,u_b}\Gamma^{L}_{\tilde{\chi}_i^0,\tilde{u}_a^*,u_b}
\end{aligned}
$$

$$
\begin{aligned}
&- \frac{1}{2}\sum_{a=1}^{8}\sum_{b=1}^{5} B_1\Big(p^2, m^2_{\tilde{\chi}^0_a}, m^2_{A^0_b}\Big)\Gamma^{L*}_{\tilde{\chi}^0_j,\tilde{\chi}^0_a,A^0_b}\Gamma^{L}_{\tilde{\chi}^0_i,\tilde{\chi}^0_a,A^0_b}\\
&- 2\sum_{b=1}^{2} B_1\Big(p^2, m^2_{\tilde{\chi}^-_b}, m^2_{W^-}\Big)\Gamma^{R*}_{\tilde{\chi}^0_j,W^+,\tilde{\chi}^-_b}\Gamma^{R}_{\tilde{\chi}^0_i,W^+,\tilde{\chi}^-_b} - \sum_{b=1}^{8} B_1\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{Z}\Big)\Gamma^{R*}_{\tilde{\chi}^0_j,Z,\tilde{\chi}^0_b}\Gamma^{R}_{\tilde{\chi}^0_i,Z,\tilde{\chi}^0_b}\\
&- \sum_{b=1}^{8} B_1\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{Z'}\Big)\Gamma^{R*}_{\tilde{\chi}^0_j,Z',\tilde{\chi}^0_b}\Gamma^{R}_{\tilde{\chi}^0_i,Z',\tilde{\chi}^0_b}
\end{aligned}
\tag{290}
$$

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

$$
\begin{aligned}
\Sigma^S_{i,j}(p^2) = &+\sum_{a=1}^{2}\sum_{b=1}^{2} B_0\Big(p^2, m^2_{\tilde{\chi}'^0_b}, m^2_{H'^-_a}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,H'^-_a,\tilde{\chi}'^0_b} m_{\tilde{\chi}'^0_b}\Gamma^{R}_{\tilde{\chi}^+_i,H'^-_a,\tilde{\chi}'^0_b}\\
&+\sum_{a=1}^{2} m_{\tilde{\chi}^-_a}\sum_{b=1}^{5} B_0\Big(p^2, m^2_{\tilde{\chi}^-_a}, m^2_{A^0_b}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,\tilde{\chi}^-_a,A^0_b}\Gamma^{R}_{\tilde{\chi}^+_i,\tilde{\chi}^-_a,A^0_b}\\
&+\sum_{a=1}^{2}\sum_{b=1}^{8} B_0\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{H^-_a}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,H^-_a,\tilde{\chi}^0_b} m_{\tilde{\chi}^0_b}\Gamma^{R}_{\tilde{\chi}^+_i,H^-_a,\tilde{\chi}^0_b}\\
&+ m_{\tilde{\chi}'^-}\sum_{a=1}^{2} B_0\Big(p^2, m^2_{\tilde{\chi}'^-}, m^2_{H'^0_a}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,H'^{0,*}_a,\mathrm{ChaP}\Big(\{1\}\Big)}\Gamma^{R}_{\tilde{\chi}^+_i,H'^{0,*}_a,\mathrm{ChaP}\Big(\{1\}\Big)}\\
&+\sum_{a=1}^{3}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{e_b}, m^2_{\tilde{\nu}_a}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,\tilde{\nu}^*_a,e_b} m_{e_b}\Gamma^{R}_{\tilde{\chi}^+_i,\tilde{\nu}^*_a,e_b}\\
&+ 3\sum_{a=1}^{3} m_{u_a}\sum_{b=1}^{6} B_0\Big(p^2, m^2_{u_a}, m^2_{\tilde{d}_b}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,\bar{u}_a,\tilde{d}_b}\Gamma^{R}_{\tilde{\chi}^+_i,\bar{u}_a,\tilde{d}_b}\\
&+\sum_{a=1}^{3} m_{\nu_a}\sum_{b=1}^{6} B_0\Big(p^2, m^2_{\nu_a}, m^2_{\tilde{e}_b}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,\bar{\nu}_a,\tilde{e}_b}\Gamma^{R}_{\tilde{\chi}^+_i,\bar{\nu}_a,\tilde{e}_b}\\
&+\sum_{a=1}^{5}\sum_{b=1}^{2} B_0\Big(p^2, m^2_{\tilde{\chi}^-_b}, m^2_{h_a}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,h_a,\tilde{\chi}^-_b} m_{\tilde{\chi}^-_b}\Gamma^{R}_{\tilde{\chi}^+_i,h_a,\tilde{\chi}^-_b}\\
&+ 3\sum_{a=1}^{6}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{d_b}, m^2_{\tilde{u}_a}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,\tilde{u}^*_a,d_b} m_{d_b}\Gamma^{R}_{\tilde{\chi}^+_i,\tilde{u}^*_a,d_b}\\
&- 4\sum_{b=1}^{2}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m^2_{\tilde{\chi}^-_b}, 0\Big)\Big)\Gamma^{R*}_{\tilde{\chi}^+_j,\gamma,\tilde{\chi}^-_b} m_{\tilde{\chi}^-_b}\Gamma^{L}_{\tilde{\chi}^+_i,\gamma,\tilde{\chi}^-_b}\\
&- 4\sum_{b=1}^{2}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m^2_{\tilde{\chi}^-_b}, m^2_{Z}\Big)\Big)\Gamma^{R*}_{\tilde{\chi}^+_j,Z,\tilde{\chi}^-_b} m_{\tilde{\chi}^-_b}\Gamma^{L}_{\tilde{\chi}^+_i,Z,\tilde{\chi}^-_b}
\end{aligned}
$$

$$
\begin{aligned}
&- 4\sum_{b=1}^{2}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m^2_{\tilde{\chi}^-_b},m^2_{Z'}\Big)\Big)\Gamma^{R*}_{\tilde{\chi}^+_j,Z',\tilde{\chi}^-_b}m_{\tilde{\chi}^-_b}\Gamma^{L}_{\tilde{\chi}^+_i,Z',\tilde{\chi}^-_b}\\
&- 4\sum_{b=1}^{8}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m^2_{\tilde{\chi}^0_b},m^2_{W^-}\Big)\Big)\Gamma^{R*}_{\tilde{\chi}^+_j,W^-,\tilde{\chi}^0_b}m_{\tilde{\chi}^0_b}\Gamma^{L}_{\tilde{\chi}^+_i,W^-,\tilde{\chi}^0_b} \qquad (291)\\
\Sigma^R_{i,j}(p^2) &= -\frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{2}B_1\Big(p^2,m^2_{\tilde{\chi}'^0_b},m^2_{H'^-_a}\Big)\Gamma^{R*}_{\tilde{\chi}^+_j,H'^-_a,\tilde{\chi}'^0_b}\Gamma^{R}_{\tilde{\chi}^+_i,H'^-_a,\tilde{\chi}'^0_b}\\
&- \frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{5}B_1\Big(p^2,m^2_{\tilde{\chi}^-_a},m^2_{A^0_b}\Big)\Gamma^{R*}_{\tilde{\chi}^+_j,\tilde{\chi}^-_a,A^0_b}\Gamma^{R}_{\tilde{\chi}^+_i,\tilde{\chi}^-_a,A^0_b}\\
&- \frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{8}B_1\Big(p^2,m^2_{\tilde{\chi}^0_b},m^2_{H^-_a}\Big)\Gamma^{R*}_{\tilde{\chi}^+_j,H^-_a,\tilde{\chi}^0_b}\Gamma^{R}_{\tilde{\chi}^+_i,H^-_a,\tilde{\chi}^0_b}\\
&- \frac{1}{2}\sum_{a=1}^{2}B_1\Big(p^2,m^2_{\tilde{\chi}'^-},m^2_{H'^0_a}\Big)\Gamma^{R*}_{\tilde{\chi}^+_j,H'^{0,*}_a,\mathrm{ChaP}\left(\{1\}\right)}\Gamma^{R}_{\tilde{\chi}^+_i,H'^{0,*}_a,\mathrm{ChaP}\left(\{1\}\right)}\\
&- \frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{3}B_1\Big(p^2,m^2_{e_b},m^2_{\tilde{\nu}_a}\Big)\Gamma^{R*}_{\tilde{\chi}^+_j,\tilde{\nu}^*_a,e_b}\Gamma^{R}_{\tilde{\chi}^+_i,\tilde{\nu}^*_a,e_b}\\
&- \frac{3}{2}\sum_{a=1}^{3}\sum_{b=1}^{6}B_1\Big(p^2,m^2_{u_a},m^2_{\tilde{d}_b}\Big)\Gamma^{R*}_{\tilde{\chi}^+_j,\bar{u}_a,\tilde{d}_b}\Gamma^{R}_{\tilde{\chi}^+_i,\bar{u}_a,\tilde{d}_b}\\
&- \frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{6}B_1\Big(p^2,m^2_{\nu_a},m^2_{\tilde{e}_b}\Big)\Gamma^{R*}_{\tilde{\chi}^+_j,\bar{\nu}_a,\tilde{e}_b}\Gamma^{R}_{\tilde{\chi}^+_i,\bar{\nu}_a,\tilde{e}_b}\\
&- \frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{2}B_1\Big(p^2,m^2_{\tilde{\chi}^-_b},m^2_{h_a}\Big)\Gamma^{R*}_{\tilde{\chi}^+_j,h_a,\tilde{\chi}^-_b}\Gamma^{R}_{\tilde{\chi}^+_i,h_a,\tilde{\chi}^-_b}\\
&- \frac{3}{2}\sum_{a=1}^{6}\sum_{b=1}^{3}B_1\Big(p^2,m^2_{d_b},m^2_{\tilde{u}_a}\Big)\Gamma^{R*}_{\tilde{\chi}^+_j,\tilde{u}^*_a,d_b}\Gamma^{R}_{\tilde{\chi}^+_i,\tilde{u}^*_a,d_b}-\sum_{b=1}^{2}B_1\Big(p^2,m^2_{\tilde{\chi}^-_b},0\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,\gamma,\tilde{\chi}^-_b}\Gamma^{L}_{\tilde{\chi}^+_i,\gamma,\tilde{\chi}^-_b}\\
&- \sum_{b=1}^{2}B_1\Big(p^2,m^2_{\tilde{\chi}^-_b},m^2_{Z}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,Z,\tilde{\chi}^-_b}\Gamma^{L}_{\tilde{\chi}^+_i,Z,\tilde{\chi}^-_b}-\sum_{b=1}^{2}B_1\Big(p^2,m^2_{\tilde{\chi}^-_b},m^2_{Z'}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,Z',\tilde{\chi}^-_b}\Gamma^{L}_{\tilde{\chi}^+_i,Z',\tilde{\chi}^-_b}\\
&- \sum_{b=1}^{8}B_1\Big(p^2,m^2_{\tilde{\chi}^0_b},m^2_{W^-}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,W^-,\tilde{\chi}^0_b}\Gamma^{L}_{\tilde{\chi}^+_i,W^-,\tilde{\chi}^0_b} \qquad (292)\\
\Sigma^L_{i,j}(p^2) &= -\frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{2}B_1\Big(p^2,m^2_{\tilde{\chi}'^0_b},m^2_{H'^-_a}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,H'^-_a,\tilde{\chi}'^0_b}\Gamma^{L}_{\tilde{\chi}^+_i,H'^-_a,\tilde{\chi}'^0_b}\\
&- \frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{5}B_1\Big(p^2,m^2_{\tilde{\chi}^-_a},m^2_{A^0_b}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j,\tilde{\chi}^-_a,A^0_b}\Gamma^{L}_{\tilde{\chi}^+_i,\tilde{\chi}^-_a,A^0_b}
\end{aligned}
$$

$$
\begin{aligned}
&- \frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{8} B_1\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{H^-_a}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j, H^-_a, \tilde{\chi}^0_b}\Gamma^{L}_{\tilde{\chi}^+_i, H^-_a, \tilde{\chi}^0_b} \\
&- \frac{1}{2}\sum_{a=1}^{2} B_1\Big(p^2, m^2_{\tilde{\chi}'^-}, m^2_{H'^0_a}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j, H'^{0,*}_a, \mathrm{ChaP}\left(\{1\}\right)}\Gamma^{L}_{\tilde{\chi}^+_i, H'^{0,*}_a, \mathrm{ChaP}\left(\{1\}\right)} \\
&- \frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{3} B_1\Big(p^2, m^2_{e_b}, m^2_{\tilde{\nu}_a}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j, \tilde{\nu}^*_a, e_b}\Gamma^{L}_{\tilde{\chi}^+_i, \tilde{\nu}^*_a, e_b} \\
&- \frac{3}{2}\sum_{a=1}^{3}\sum_{b=1}^{6} B_1\Big(p^2, m^2_{u_a}, m^2_{\tilde{d}_b}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j, \bar{u}_a, \tilde{d}_b}\Gamma^{L}_{\tilde{\chi}^+_i, \bar{u}_a, \tilde{d}_b} \\
&- \frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{6} B_1\Big(p^2, m^2_{\nu_a}, m^2_{\tilde{e}_b}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j, \bar{\nu}_a, \tilde{e}_b}\Gamma^{L}_{\tilde{\chi}^+_i, \bar{\nu}_a, \tilde{e}_b} \\
&- \frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{2} B_1\Big(p^2, m^2_{\tilde{\chi}^-_b}, m^2_{h_a}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j, h_a, \tilde{\chi}^-_b}\Gamma^{L}_{\tilde{\chi}^+_i, h_a, \tilde{\chi}^-_b} \\
&- \frac{3}{2}\sum_{a=1}^{6}\sum_{b=1}^{3} B_1\Big(p^2, m^2_{d_b}, m^2_{\tilde{u}_a}\Big)\Gamma^{L*}_{\tilde{\chi}^+_j, \tilde{u}^*_a, d_b}\Gamma^{L}_{\tilde{\chi}^+_i, \tilde{u}^*_a, d_b} - \sum_{b=1}^{2} B_1\Big(p^2, m^2_{\tilde{\chi}^-_b}, 0\Big)\Gamma^{R*}_{\tilde{\chi}^+_j, \gamma, \tilde{\chi}^-_b}\Gamma^{R}_{\tilde{\chi}^+_i, \gamma, \tilde{\chi}^-_b} \\
&- \sum_{b=1}^{2} B_1\Big(p^2, m^2_{\tilde{\chi}^-_b}, m^2_{Z}\Big)\Gamma^{R*}_{\tilde{\chi}^+_j, Z, \tilde{\chi}^-_b}\Gamma^{R}_{\tilde{\chi}^+_i, Z, \tilde{\chi}^-_b} - \sum_{b=1}^{2} B_1\Big(p^2, m^2_{\tilde{\chi}^-_b}, m^2_{Z'}\Big)\Gamma^{R*}_{\tilde{\chi}^+_j, Z', \tilde{\chi}^-_b}\Gamma^{R}_{\tilde{\chi}^+_i, Z', \tilde{\chi}^-_b} \\
&- \sum_{b=1}^{8} B_1\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{W^-}\Big)\Gamma^{R*}_{\tilde{\chi}^+_j, W^-, \tilde{\chi}^0_b}\Gamma^{R}_{\tilde{\chi}^+_i, W^-, \tilde{\chi}^0_b}
\end{aligned} \tag{293}
$$

- **Self-Energy for Leptons** (e)

$$
\begin{aligned}
\Sigma^S_{i,j}(p^2) = &+ \sum_{a=1}^{2}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{\nu_b}, m^2_{H^-_a}\Big)\Gamma^{L*}_{\tilde{e}_j, H^-_a, \nu_b} m_{\nu_b}\Gamma^{R}_{\tilde{e}_i, H^-_a, \nu_b} \\
&+ \sum_{a=1}^{3}\sum_{b=1}^{2} B_0\Big(p^2, m^2_{\tilde{\chi}^-_b}, m^2_{\tilde{\nu}_a}\Big)\Gamma^{L*}_{\tilde{e}_j, \tilde{\nu}_a, \tilde{\chi}^-_b} m_{\tilde{\chi}^-_b}\Gamma^{R}_{\tilde{e}_i, \tilde{\nu}_a, \tilde{\chi}^-_b} \\
&+ \sum_{a=1}^{3} m_{e_a}\sum_{b=1}^{5} B_0\Big(p^2, m^2_{e_a}, m^2_{A^0_b}\Big)\Gamma^{L*}_{\tilde{e}_j, e_a, A^0_b}\Gamma^{R}_{\tilde{e}_i, e_a, A^0_b} \\
&+ \sum_{a=1}^{5}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{e_b}, m^2_{h_a}\Big)\Gamma^{L*}_{\tilde{e}_j, h_a, e_b} m_{e_b}\Gamma^{R}_{\tilde{e}_i, h_a, e_b} \\
&+ \sum_{a=1}^{6}\sum_{b=1}^{8} B_0\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{\tilde{e}_a}\Big)\Gamma^{L*}_{\tilde{e}_j, \tilde{e}_a, \tilde{\chi}^0_b} m_{\tilde{\chi}^0_b}\Gamma^{R}_{\tilde{e}_i, \tilde{e}_a, \tilde{\chi}^0_b}
\end{aligned}
$$

$$
\begin{aligned}
&- 4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{e_b}^2,0\Big)\Big)\Gamma^{R*}_{\check{\tilde{e}}_j,\gamma,e_b}m_{e_b}\Gamma^{L}_{\check{\tilde{e}}_i,\gamma,e_b}\\
&- 4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{\nu_b}^2,m_{W^-}^2\Big)\Big)\Gamma^{R*}_{\check{\tilde{e}}_j,W^-,\nu_b}m_{\nu_b}\Gamma^{L}_{\check{\tilde{e}}_i,W^-,\nu_b}\\
&- 4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{e_b}^2,m_{Z}^2\Big)\Big)\Gamma^{R*}_{\check{\tilde{e}}_j,Z,e_b}m_{e_b}\Gamma^{L}_{\check{\tilde{e}}_i,Z,e_b}\\
&- 4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{e_b}^2,m_{Z'}^2\Big)\Big)\Gamma^{R*}_{\check{\tilde{e}}_j,Z',e_b}m_{e_b}\Gamma^{L}_{\check{\tilde{e}}_i,Z',e_b} \qquad (294)\\
\Sigma^R_{i,j}(p^2) =& -\frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{3}B_1\Big(p^2,m_{\nu_b}^2,m_{H_a^-}^2\Big)\Gamma^{R*}_{\check{\tilde{e}}_j,H_a^-,\nu_b}\Gamma^{R}_{\check{\tilde{e}}_i,H_a^-,\nu_b}\\
&- \frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{2}B_1\Big(p^2,m_{\tilde{\chi}_b^-}^2,m_{\tilde{\nu}_a}^2\Big)\Gamma^{R*}_{\check{\tilde{e}}_j,\tilde{\nu}_a,\tilde{\chi}_b^-}\Gamma^{R}_{\check{\tilde{e}}_i,\tilde{\nu}_a,\tilde{\chi}_b^-}\\
&- \frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{5}B_1\Big(p^2,m_{e_a}^2,m_{A_b^0}^2\Big)\Gamma^{R*}_{\check{\tilde{e}}_j,e_a,A_b^0}\Gamma^{R}_{\check{\tilde{e}}_i,e_a,A_b^0}\\
&- \frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{3}B_1\Big(p^2,m_{e_b}^2,m_{h_a}^2\Big)\Gamma^{R*}_{\check{\tilde{e}}_j,h_a,e_b}\Gamma^{R}_{\check{\tilde{e}}_i,h_a,e_b}\\
&- \frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{8}B_1\Big(p^2,m_{\tilde{\chi}_b^0}^2,m_{\tilde{e}_a}^2\Big)\Gamma^{R*}_{\check{\tilde{e}}_j,\tilde{e}_a,\tilde{\chi}_b^0}\Gamma^{R}_{\check{\tilde{e}}_i,\tilde{e}_a,\tilde{\chi}_b^0}-\sum_{b=1}^{3}B_1\Big(p^2,m_{e_b}^2,0\Big)\Gamma^{L*}_{\check{\tilde{e}}_j,\gamma,e_b}\Gamma^{L}_{\check{\tilde{e}}_i,\gamma,e_b}\\
&- \sum_{b=1}^{3}B_1\Big(p^2,m_{\nu_b}^2,m_{W^-}^2\Big)\Gamma^{L*}_{\check{\tilde{e}}_j,W^-,\nu_b}\Gamma^{L}_{\check{\tilde{e}}_i,W^-,\nu_b}-\sum_{b=1}^{3}B_1\Big(p^2,m_{e_b}^2,m_{Z}^2\Big)\Gamma^{L*}_{\check{\tilde{e}}_j,Z,e_b}\Gamma^{L}_{\check{\tilde{e}}_i,Z,e_b}\\
&- \sum_{b=1}^{3}B_1\Big(p^2,m_{e_b}^2,m_{Z'}^2\Big)\Gamma^{L*}_{\check{\tilde{e}}_j,Z',e_b}\Gamma^{L}_{\check{\tilde{e}}_i,Z',e_b} \qquad (295)\\
\Sigma^L_{i,j}(p^2) =& -\frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{3}B_1\Big(p^2,m_{\nu_b}^2,m_{H_a^-}^2\Big)\Gamma^{L*}_{\check{\tilde{e}}_j,H_a^-,\nu_b}\Gamma^{L}_{\check{\tilde{e}}_i,H_a^-,\nu_b}\\
&- \frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{2}B_1\Big(p^2,m_{\tilde{\chi}_b^-}^2,m_{\tilde{\nu}_a}^2\Big)\Gamma^{L*}_{\check{\tilde{e}}_j,\tilde{\nu}_a,\tilde{\chi}_b^-}\Gamma^{L}_{\check{\tilde{e}}_i,\tilde{\nu}_a,\tilde{\chi}_b^-}\\
&- \frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{5}B_1\Big(p^2,m_{e_a}^2,m_{A_b^0}^2\Big)\Gamma^{L*}_{\check{\tilde{e}}_j,e_a,A_b^0}\Gamma^{L}_{\check{\tilde{e}}_i,e_a,A_b^0}\\
&- \frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{3}B_1\Big(p^2,m_{e_b}^2,m_{h_a}^2\Big)\Gamma^{L*}_{\check{\tilde{e}}_j,h_a,e_b}\Gamma^{L}_{\check{\tilde{e}}_i,h_a,e_b}
\end{aligned}
$$

$$
\begin{aligned}
&- \frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{8} B_1\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{\tilde{e}_a}\Big)\Gamma^{L*}_{\check{\tilde{e}}_j,\tilde{e}_a,\tilde{\chi}^0_b}\Gamma^{L}_{\check{\tilde{e}}_i,\tilde{e}_a,\tilde{\chi}^0_b} - \sum_{b=1}^{3} B_1\Big(p^2, m^2_{e_b}, 0\Big)\Gamma^{R*}_{\check{\tilde{e}}_j,\gamma,e_b}\Gamma^{R}_{\check{\tilde{e}}_i,\gamma,e_b}\\
&- \sum_{b=1}^{3} B_1\Big(p^2, m^2_{\nu_b}, m^2_{W^-}\Big)\Gamma^{R*}_{\check{\tilde{e}}_j,W^-,\nu_b}\Gamma^{R}_{\check{\tilde{e}}_i,W^-,\nu_b} - \sum_{b=1}^{3} B_1\Big(p^2, m^2_{e_b}, m^2_{Z}\Big)\Gamma^{R*}_{\check{\tilde{e}}_j,Z,e_b}\Gamma^{R}_{\check{\tilde{e}}_i,Z,e_b}\\
&- \sum_{b=1}^{3} B_1\Big(p^2, m^2_{e_b}, m^2_{Z'}\Big)\Gamma^{R*}_{\check{\tilde{e}}_j,Z',e_b}\Gamma^{R}_{\check{\tilde{e}}_i,Z',e_b}
\end{aligned}
\tag{296}
$$

- **Self-Energy for Down-Quarks** (d)

$$
\begin{aligned}
\Sigma^S_{i,j}(p^2) = &+\sum_{a=1}^{2}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{u_b}, m^2_{H^-_a}\Big)\Gamma^{L*}_{\check{\tilde{d}}_j,H^-_a,u_b} m_{u_b}\Gamma^{R}_{\check{\tilde{d}}_i,H^-_a,u_b}\\
&+\sum_{a=1}^{3} m_{d_a}\sum_{b=1}^{5} B_0\Big(p^2, m^2_{d_a}, m^2_{A^0_b}\Big)\Gamma^{L*}_{\check{\tilde{d}}_j,d_a,A^0_b}\Gamma^{R}_{\check{\tilde{d}}_i,d_a,A^0_b}\\
&+\sum_{a=1}^{5}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{d_b}, m^2_{h_a}\Big)\Gamma^{L*}_{\check{\tilde{d}}_j,h_a,d_b} m_{d_b}\Gamma^{R}_{\check{\tilde{d}}_i,h_a,d_b}\\
&+\sum_{a=1}^{6}\sum_{b=1}^{2} B_0\Big(p^2, m^2_{\tilde{\chi}^-_b}, m^2_{\tilde{u}_a}\Big)\Gamma^{L*}_{\check{\tilde{d}}_j,\tilde{u}_a,\tilde{\chi}^-_b} m_{\tilde{\chi}^-_b}\Gamma^{R}_{\check{\tilde{d}}_i,\tilde{u}_a,\tilde{\chi}^-_b}\\
&+\sum_{a=1}^{6}\sum_{b=1}^{8} B_0\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{\tilde{d}_a}\Big)\Gamma^{L*}_{\check{\tilde{d}}_j,\tilde{d}_a,\tilde{\chi}^0_b} m_{\tilde{\chi}^0_b}\Gamma^{R}_{\check{\tilde{d}}_i,\tilde{d}_a,\tilde{\chi}^0_b}\\
&+\frac{4}{3} m_{\tilde{g}}\sum_{a=1}^{6} B_0\Big(p^2, m^2_{\tilde{g}}, m^2_{\tilde{d}_a}\Big)\Gamma^{L*}_{\check{\tilde{d}}_j,\tilde{d}_a,\tilde{g}_1}\Gamma^{R}_{\check{\tilde{d}}_i,\tilde{d}_a,\tilde{g}_1} - \frac{16}{3}\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m^2_{d_b}, 0\Big)\Big)\Gamma^{R*}_{\check{\tilde{d}}_j,g,d_b} m_{d_b}\Gamma^{L}_{\check{\tilde{d}}_i,g,d_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m^2_{d_b}, 0\Big)\Big)\Gamma^{R*}_{\check{\tilde{d}}_j,\gamma,d_b} m_{d_b}\Gamma^{L}_{\check{\tilde{d}}_i,\gamma,d_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m^2_{u_b}, m^2_{W^-}\Big)\Big)\Gamma^{R*}_{\check{\tilde{d}}_j,W^-,u_b} m_{u_b}\Gamma^{L}_{\check{\tilde{d}}_i,W^-,u_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m^2_{d_b}, m^2_{Z}\Big)\Big)\Gamma^{R*}_{\check{\tilde{d}}_j,Z,d_b} m_{d_b}\Gamma^{L}_{\check{\tilde{d}}_i,Z,d_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m^2_{d_b}, m^2_{Z'}\Big)\Big)\Gamma^{R*}_{\check{\tilde{d}}_j,Z',d_b} m_{d_b}\Gamma^{L}_{\check{\tilde{d}}_i,Z',d_b}
\end{aligned}
\tag{297}
$$

$$
\Sigma^R_{i,j}(p^2) = -\frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{3} B_1\Big(p^2, m^2_{u_b}, m^2_{H^-_a}\Big)\Gamma^{R*}_{\check{\tilde{d}}_j,H^-_a,u_b}\Gamma^{R}_{\check{\tilde{d}}_i,H^-_a,u_b}
$$

$$
\begin{aligned}
&- \frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{5} B_1\Big(p^2, m_{d_a}^2, m_{A_b^0}^2\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,d_a,A_b^0}\Gamma^{R}_{\tilde{\tilde{d}}_i,d_a,A_b^0}\\
&- \frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_{h_a}^2\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,h_a,d_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,h_a,d_b}\\
&- \frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{2} B_1\Big(p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{u}_a}^2\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,\tilde{u}_a,\tilde{\chi}_b^-}\Gamma^{R}_{\tilde{\tilde{d}}_i,\tilde{u}_a,\tilde{\chi}_b^-}\\
&- \frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{8} B_1\Big(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{d}_a}^2\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,\tilde{d}_a,\tilde{\chi}_b^0}\Gamma^{R}_{\tilde{\tilde{d}}_i,\tilde{d}_a,\tilde{\chi}_b^0}\\
&- \frac{2}{3}\sum_{a=1}^{6} B_1\Big(p^2, m_{\tilde{g}}^2, m_{\tilde{d}_a}^2\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,\tilde{d}_a,\tilde{g}_1}\Gamma^{R}_{\tilde{\tilde{d}}_i,\tilde{d}_a,\tilde{g}_1} - \frac{4}{3}\sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, 0\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,g,d_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,g,d_b}\\
&- \sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, 0\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,\gamma,d_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,\gamma,d_b} - \sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_{W^-}^2\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,W^-,u_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,W^-,u_b}\\
&- \sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_Z^2\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,Z,d_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,Z,d_b} - \sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_{Z'}^2\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,Z',d_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,Z',d_b}
\end{aligned}
\tag{298}
$$

$$
\begin{aligned}
\Sigma^L_{i,j}(p^2) = &- \frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_{H_a^-}^2\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,H_a^-,u_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,H_a^-,u_b}\\
&- \frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{5} B_1\Big(p^2, m_{d_a}^2, m_{A_b^0}^2\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,d_a,A_b^0}\Gamma^{L}_{\tilde{\tilde{d}}_i,d_a,A_b^0}\\
&- \frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_{h_a}^2\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,h_a,d_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,h_a,d_b}\\
&- \frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{2} B_1\Big(p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{u}_a}^2\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,\tilde{u}_a,\tilde{\chi}_b^-}\Gamma^{L}_{\tilde{\tilde{d}}_i,\tilde{u}_a,\tilde{\chi}_b^-}\\
&- \frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{8} B_1\Big(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{d}_a}^2\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,\tilde{d}_a,\tilde{\chi}_b^0}\Gamma^{L}_{\tilde{\tilde{d}}_i,\tilde{d}_a,\tilde{\chi}_b^0}\\
&- \frac{2}{3}\sum_{a=1}^{6} B_1\Big(p^2, m_{\tilde{g}}^2, m_{\tilde{d}_a}^2\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,\tilde{d}_a,\tilde{g}_1}\Gamma^{L}_{\tilde{\tilde{d}}_i,\tilde{d}_a,\tilde{g}_1} - \frac{4}{3}\sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, 0\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,g,d_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,g,d_b}\\
&- \sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, 0\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,\gamma,d_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,\gamma,d_b} - \sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_{W^-}^2\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,W^-,u_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,W^-,u_b}\\
&- \sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_Z^2\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,Z,d_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,Z,d_b} - \sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_{Z'}^2\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,Z',d_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,Z',d_b}
\end{aligned}
\tag{299}
$$

- **Self-Energy for Up-Quarks** (u)

$$
\begin{aligned}
\Sigma^S_{i,j}(p^2) = &+\sum_{a=1}^{2}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{d_b}, m^2_{H^-_a}\Big)\Gamma^{L*}_{\check{u}_j,H^+_a,d_b} m_{d_b}\Gamma^{R}_{\check{u}_i,H^+_a,d_b}\\
&+\sum_{a=1}^{2} m_{\tilde{\chi}^-_a}\sum_{b=1}^{6} B_0\Big(p^2, m^2_{\tilde{\chi}^-_a}, m^2_{\tilde{d}_b}\Big)\Gamma^{L*}_{\check{u}_j,\tilde{\chi}^+_a,\tilde{d}_b}\Gamma^{R}_{\check{u}_i,\tilde{\chi}^+_a,\tilde{d}_b}\\
&+\sum_{a=1}^{3} m_{u_a}\sum_{b=1}^{5} B_0\Big(p^2, m^2_{u_a}, m^2_{A^0_b}\Big)\Gamma^{L*}_{\check{u}_j,u_a,A^0_b}\Gamma^{R}_{\check{u}_i,u_a,A^0_b}\\
&+\sum_{a=1}^{5}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{u_b}, m^2_{h_a}\Big)\Gamma^{L*}_{\check{u}_j,h_a,u_b} m_{u_b}\Gamma^{R}_{\check{u}_i,h_a,u_b}\\
&+\sum_{a=1}^{6}\sum_{b=1}^{8} B_0\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{\tilde{u}_a}\Big)\Gamma^{L*}_{\check{u}_j,\tilde{u}_a,\tilde{\chi}^0_b} m_{\tilde{\chi}^0_b}\Gamma^{R}_{\check{u}_i,\tilde{u}_a,\tilde{\chi}^0_b}\\
&+\frac{4}{3} m_{\tilde{g}}\sum_{a=1}^{6} B_0\Big(p^2, m^2_{\tilde{g}}, m^2_{\tilde{u}_a}\Big)\Gamma^{L*}_{\check{u}_j,\tilde{u}_a,\tilde{g}_1}\Gamma^{R}_{\check{u}_i,\tilde{u}_a,\tilde{g}_1} - \frac{16}{3}\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m^2_{u_b}, 0\Big)\Big)\Gamma^{R*}_{\check{u}_j,g,u_b} m_{u_b}\Gamma^{L}_{\check{u}_i,g,u_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m^2_{u_b}, 0\Big)\Big)\Gamma^{R*}_{\check{u}_j,\gamma,u_b} m_{u_b}\Gamma^{L}_{\check{u}_i,\gamma,u_b} - 4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m^2_{u_b}, m^2_{Z}\Big)\Big)\Gamma^{R*}_{\check{u}_j,Z,u_b} m_{u_b}\Gamma^{L}_{\check{u}_i,Z,u_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m^2_{u_b}, m^2_{Z'}\Big)\Big)\Gamma^{R*}_{\check{u}_j,Z',u_b} m_{u_b}\Gamma^{L}_{\check{u}_i,Z',u_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m^2_{d_b}, m^2_{W^-}\Big)\Big)\Gamma^{R*}_{\check{u}_j,W^+,d_b} m_{d_b}\Gamma^{L}_{\check{u}_i,W^+,d_b}
\end{aligned}
\tag{300}
$$

$$
\begin{aligned}
\Sigma^R_{i,j}(p^2) = &-\frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{3} B_1\Big(p^2, m^2_{d_b}, m^2_{H^-_a}\Big)\Gamma^{R*}_{\check{u}_j,H^+_a,d_b}\Gamma^{R}_{\check{u}_i,H^+_a,d_b}\\
&-\frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{6} B_1\Big(p^2, m^2_{\tilde{\chi}^-_a}, m^2_{\tilde{d}_b}\Big)\Gamma^{R*}_{\check{u}_j,\tilde{\chi}^+_a,\tilde{d}_b}\Gamma^{R}_{\check{u}_i,\tilde{\chi}^+_a,\tilde{d}_b}\\
&-\frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{5} B_1\Big(p^2, m^2_{u_a}, m^2_{A^0_b}\Big)\Gamma^{R*}_{\check{u}_j,u_a,A^0_b}\Gamma^{R}_{\check{u}_i,u_a,A^0_b}\\
&-\frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{3} B_1\Big(p^2, m^2_{u_b}, m^2_{h_a}\Big)\Gamma^{R*}_{\check{u}_j,h_a,u_b}\Gamma^{R}_{\check{u}_i,h_a,u_b}\\
&-\frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{8} B_1\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{\tilde{u}_a}\Big)\Gamma^{R*}_{\check{u}_j,\tilde{u}_a,\tilde{\chi}^0_b}\Gamma^{R}_{\check{u}_i,\tilde{u}_a,\tilde{\chi}^0_b}\\
&-\frac{2}{3}\sum_{a=1}^{6} B_1\Big(p^2, m^2_{\tilde{g}}, m^2_{\tilde{u}_a}\Big)\Gamma^{R*}_{\check{u}_j,\tilde{u}_a,\tilde{g}_1}\Gamma^{R}_{\check{u}_i,\tilde{u}_a,\tilde{g}_1} - \frac{4}{3}\sum_{b=1}^{3} B_1\Big(p^2, m^2_{u_b}, 0\Big)\Gamma^{L*}_{\check{u}_j,g,u_b}\Gamma^{L}_{\check{u}_i,g,u_b}
\end{aligned}
$$

$$
\begin{aligned}
&- \sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, 0\Big)\Gamma^{L*}_{\check{\tilde{u}}_j,\gamma,u_b}\Gamma^{L}_{\check{\tilde{u}}_i,\gamma,u_b} - \sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_Z^2\Big)\Gamma^{L*}_{\check{\tilde{u}}_j,Z,u_b}\Gamma^{L}_{\check{\tilde{u}}_i,Z,u_b} \\
&- \sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_{Z'}^2\Big)\Gamma^{L*}_{\check{\tilde{u}}_j,Z',u_b}\Gamma^{L}_{\check{\tilde{u}}_i,Z',u_b} - \sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_{W^-}^2\Big)\Gamma^{L*}_{\check{\tilde{u}}_j,W^+,d_b}\Gamma^{L}_{\check{\tilde{u}}_i,W^+,d_b} \qquad (301)
\end{aligned}
$$

$$
\begin{aligned}
\Sigma^{L}_{i,j}(p^2) = &-\frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_{H_a^-}^2\Big)\Gamma^{L*}_{\check{\tilde{u}}_j,H_a^+,d_b}\Gamma^{L}_{\check{\tilde{u}}_i,H_a^+,d_b} \\
&- \frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{6} B_1\Big(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{d}_b}^2\Big)\Gamma^{L*}_{\check{\tilde{u}}_j,\tilde{\chi}_a^+,\tilde{d}_b}\Gamma^{L}_{\check{\tilde{u}}_i,\tilde{\chi}_a^+,\tilde{d}_b} \\
&- \frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{5} B_1\Big(p^2, m_{u_a}^2, m_{A_b^0}^2\Big)\Gamma^{L*}_{\check{\tilde{u}}_j,u_a,A_b^0}\Gamma^{L}_{\check{\tilde{u}}_i,u_a,A_b^0} \\
&- \frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_{h_a}^2\Big)\Gamma^{L*}_{\check{\tilde{u}}_j,h_a,u_b}\Gamma^{L}_{\check{\tilde{u}}_i,h_a,u_b} \\
&- \frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{8} B_1\Big(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{u}_a}^2\Big)\Gamma^{L*}_{\check{\tilde{u}}_j,\tilde{u}_a,\tilde{\chi}_b^0}\Gamma^{L}_{\check{\tilde{u}}_i,\tilde{u}_a,\tilde{\chi}_b^0} \\
&- \frac{2}{3}\sum_{a=1}^{6} B_1\Big(p^2, m_{\tilde{g}}^2, m_{\tilde{u}_a}^2\Big)\Gamma^{L*}_{\check{\tilde{u}}_j,\tilde{u}_a,\tilde{g}_1}\Gamma^{L}_{\check{\tilde{u}}_i,\tilde{u}_a,\tilde{g}_1} - \frac{4}{3}\sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, 0\Big)\Gamma^{R*}_{\check{\tilde{u}}_j,g,u_b}\Gamma^{R}_{\check{\tilde{u}}_i,g,u_b} \\
&- \sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, 0\Big)\Gamma^{R*}_{\check{\tilde{u}}_j,\gamma,u_b}\Gamma^{R}_{\check{\tilde{u}}_i,\gamma,u_b} - \sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_Z^2\Big)\Gamma^{R*}_{\check{\tilde{u}}_j,Z,u_b}\Gamma^{R}_{\check{\tilde{u}}_i,Z,u_b} \\
&- \sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_{Z'}^2\Big)\Gamma^{R*}_{\check{\tilde{u}}_j,Z',u_b}\Gamma^{R}_{\check{\tilde{u}}_i,Z',u_b} - \sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_{W^-}^2\Big)\Gamma^{R*}_{\check{\tilde{u}}_j,W^+,d_b}\Gamma^{R}_{\check{\tilde{u}}_i,W^+,d_b} \qquad (302)
\end{aligned}
$$

- **Self-Energy for Exotics** (x)

$$
\begin{aligned}
\Sigma^{S}_{i,j}(p^2) = &+ \sum_{a=1}^{3} m_{x_a}\sum_{b=1}^{5} B_0\Big(p^2, m_{x_a}^2, m_{A_b^0}^2\Big)\Gamma^{L*}_{\check{\tilde{x}}_j,x_a,A_b^0}\Gamma^{R}_{\check{\tilde{x}}_i,x_a,A_b^0} \\
&+ \sum_{a=1}^{5}\sum_{b=1}^{3} B_0\Big(p^2, m_{x_b}^2, m_{h_a}^2\Big)\Gamma^{L*}_{\check{\tilde{x}}_j,h_a,x_b} m_{x_b}\Gamma^{R}_{\check{\tilde{x}}_i,h_a,x_b} \\
&+ \sum_{a=1}^{6}\sum_{b=1}^{8} B_0\Big(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{x}_a}^2\Big)\Gamma^{L*}_{\check{\tilde{x}}_j,\tilde{x}_a,\tilde{\chi}_b^0} m_{\tilde{\chi}_b^0}\Gamma^{R}_{\check{\tilde{x}}_i,\tilde{x}_a,\tilde{\chi}_b^0} \\
&+ \frac{4}{3} m_{\tilde{g}}\sum_{a=1}^{6} B_0\Big(p^2, m_{\tilde{g}}^2, m_{\tilde{x}_a}^2\Big)\Gamma^{L*}_{\check{\tilde{x}}_j,\tilde{x}_a,\tilde{g}_1}\Gamma^{R}_{\check{\tilde{x}}_i,\tilde{x}_a,\tilde{g}_1} - \frac{16}{3}\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m_{x_b}^2, 0\Big)\Big)\Gamma^{R*}_{\check{\tilde{x}}_j,g,x_b} m_{x_b}\Gamma^{L}_{\check{\tilde{x}}_i,g,x_b}
\end{aligned}
$$

$$
\begin{aligned}
&- 4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{x_b}^2,0\Big)\Big)\Gamma^{R*}_{\check{\tilde{x}}_j,\gamma,x_b}m_{x_b}\Gamma^{L}_{\check{\tilde{x}}_i,\gamma,x_b}-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{x_b}^2,m_Z^2\Big)\Big)\Gamma^{R*}_{\check{\tilde{x}}_j,Z,x_b}m_{x_b}\Gamma^{L}_{\check{\tilde{x}}_i,Z,x_b}\\
&- 4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{x_b}^2,m_{Z'}^2\Big)\Big)\Gamma^{R*}_{\check{\tilde{x}}_j,Z',x_b}m_{x_b}\Gamma^{L}_{\check{\tilde{x}}_i,Z',x_b} \qquad (303)\\
\Sigma^R_{i,j}(p^2)=&-\frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{5}B_1\Big(p^2,m_{x_a}^2,m_{A_b^0}^2\Big)\Gamma^{R*}_{\check{\tilde{x}}_j,x_a,A_b^0}\Gamma^{R}_{\check{\tilde{x}}_i,x_a,A_b^0}\\
&-\frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{3}B_1\Big(p^2,m_{x_b}^2,m_{h_a}^2\Big)\Gamma^{R*}_{\check{\tilde{x}}_j,h_a,x_b}\Gamma^{R}_{\check{\tilde{x}}_i,h_a,x_b}\\
&-\frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{8}B_1\Big(p^2,m_{\tilde{\chi}_b^0}^2,m_{\tilde{x}_a}^2\Big)\Gamma^{R*}_{\check{\tilde{x}}_j,\tilde{x}_a,\tilde{\chi}_b^0}\Gamma^{R}_{\check{\tilde{x}}_i,\tilde{x}_a,\tilde{\chi}_b^0}\\
&-\frac{2}{3}\sum_{a=1}^{6}B_1\Big(p^2,m_{\tilde{g}}^2,m_{\tilde{x}_a}^2\Big)\Gamma^{R*}_{\check{\tilde{x}}_j,\tilde{x}_a,\tilde{g}_1}\Gamma^{R}_{\check{\tilde{x}}_i,\tilde{x}_a,\tilde{g}_1}-\frac{4}{3}\sum_{b=1}^{3}B_1\Big(p^2,m_{x_b}^2,0\Big)\Gamma^{L*}_{\check{\tilde{x}}_j,g,x_b}\Gamma^{L}_{\check{\tilde{x}}_i,g,x_b}\\
&-\sum_{b=1}^{3}B_1\Big(p^2,m_{x_b}^2,0\Big)\Gamma^{L*}_{\check{\tilde{x}}_j,\gamma,x_b}\Gamma^{L}_{\check{\tilde{x}}_i,\gamma,x_b}-\sum_{b=1}^{3}B_1\Big(p^2,m_{x_b}^2,m_Z^2\Big)\Gamma^{L*}_{\check{\tilde{x}}_j,Z,x_b}\Gamma^{L}_{\check{\tilde{x}}_i,Z,x_b}\\
&-\sum_{b=1}^{3}B_1\Big(p^2,m_{x_b}^2,m_{Z'}^2\Big)\Gamma^{L*}_{\check{\tilde{x}}_j,Z',x_b}\Gamma^{L}_{\check{\tilde{x}}_i,Z',x_b} \qquad (304)\\
\Sigma^L_{i,j}(p^2)=&-\frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{5}B_1\Big(p^2,m_{x_a}^2,m_{A_b^0}^2\Big)\Gamma^{L*}_{\check{\tilde{x}}_j,x_a,A_b^0}\Gamma^{L}_{\check{\tilde{x}}_i,x_a,A_b^0}\\
&-\frac{1}{2}\sum_{a=1}^{5}\sum_{b=1}^{3}B_1\Big(p^2,m_{x_b}^2,m_{h_a}^2\Big)\Gamma^{L*}_{\check{\tilde{x}}_j,h_a,x_b}\Gamma^{L}_{\check{\tilde{x}}_i,h_a,x_b}\\
&-\frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{8}B_1\Big(p^2,m_{\tilde{\chi}_b^0}^2,m_{\tilde{x}_a}^2\Big)\Gamma^{L*}_{\check{\tilde{x}}_j,\tilde{x}_a,\tilde{\chi}_b^0}\Gamma^{L}_{\check{\tilde{x}}_i,\tilde{x}_a,\tilde{\chi}_b^0}\\
&-\frac{2}{3}\sum_{a=1}^{6}B_1\Big(p^2,m_{\tilde{g}}^2,m_{\tilde{x}_a}^2\Big)\Gamma^{L*}_{\check{\tilde{x}}_j,\tilde{x}_a,\tilde{g}_1}\Gamma^{L}_{\check{\tilde{x}}_i,\tilde{x}_a,\tilde{g}_1}-\frac{4}{3}\sum_{b=1}^{3}B_1\Big(p^2,m_{x_b}^2,0\Big)\Gamma^{R*}_{\check{\tilde{x}}_j,g,x_b}\Gamma^{R}_{\check{\tilde{x}}_i,g,x_b}\\
&-\sum_{b=1}^{3}B_1\Big(p^2,m_{x_b}^2,0\Big)\Gamma^{R*}_{\check{\tilde{x}}_j,\gamma,x_b}\Gamma^{R}_{\check{\tilde{x}}_i,\gamma,x_b}-\sum_{b=1}^{3}B_1\Big(p^2,m_{x_b}^2,m_Z^2\Big)\Gamma^{R*}_{\check{\tilde{x}}_j,Z,x_b}\Gamma^{R}_{\check{\tilde{x}}_i,Z,x_b}\\
&-\sum_{b=1}^{3}B_1\Big(p^2,m_{x_b}^2,m_{Z'}^2\Big)\Gamma^{R*}_{\check{\tilde{x}}_j,Z',x_b}\Gamma^{R}_{\check{\tilde{x}}_i,Z',x_b} \qquad (305)
\end{aligned}
$$

- **Self-Energy for Neutral Prime-Higgs** $(H^{'0})$

$$
\Pi_{i,j}(p^2)=+4\Gamma_{\check{H}_i^{'0},\check{H}_j^{'0,*},W^+,W^-}\Big(-\frac{1}{2}\mathrm{rMS}m_{W^-}^2+A_0\Big(m_{W^-}^2\Big)\Big)+2\Gamma_{\check{H}_i^{'0},\check{H}_j^{'0,*},Z,Z}\Big(-\frac{1}{2}\mathrm{rMS}m_Z^2+A_0\Big(m_Z^2\Big)\Big)
$$

$$
\begin{aligned}
&+2\Gamma_{\check{H}_i^{\prime 0},\check{H}_j^{\prime 0,*},Z^\prime,Z^\prime}\Big(-\frac{1}{2}\mathrm{rMS}m_{Z^\prime}^2+A_0\Big(m_{Z^\prime}^2\Big)\Big)-\sum_{a=1}^{2}A_0\Big(m_{H_a^-}^2\Big)\Gamma_{\check{H}_i^{\prime 0},\check{H}_j^{\prime 0,*},H_a^+,H_a^-}\\
&-\sum_{a=1}^{2}A_0\Big(m_{H_a^{\prime 0}}^2\Big)\Gamma_{\check{H}_i^{\prime 0},\check{H}_j^{\prime 0,*},H_a^{\prime 0,*},H_a^{\prime 0}}-\sum_{a=1}^{2}A_0\Big(m_{H_a^{\prime -}}^2\Big)\Gamma_{\check{H}_i^{\prime 0},\check{H}_j^{\prime 0,*},H_a^{\prime +},H_a^{\prime -}}\\
&+\sum_{a=1}^{2}\sum_{b=1}^{2}B_0\Big(p^2,m_{H_a^-}^2,m_{H_b^{\prime -}}^2\Big)\Gamma^*_{\check{H}_j^{\prime 0,*},H_a^+,H_b^{\prime -}}\Gamma_{\check{H}_i^{\prime 0,*},H_a^+,H_b^{\prime -}}\\
&+\sum_{a=1}^{2}\sum_{b=1}^{5}B_0\Big(p^2,m_{H_a^{\prime 0}}^2,m_{h_b}^2\Big)\Gamma^*_{\check{H}_j^{\prime 0,*},H_a^{\prime 0},h_b}\Gamma_{\check{H}_i^{\prime 0,*},H_a^{\prime 0},h_b}\\
&-\sum_{a=1}^{2}m_{\tilde{\chi}_a^{\prime 0}}\sum_{b=1}^{8}B_0\Big(p^2,m_{\tilde{\chi}_a^{\prime 0}}^2,m_{\tilde{\chi}_b^0}^2\Big)m_{\tilde{\chi}_b^0}\Big(\Gamma^{L*}_{\check{H}_j^{\prime 0,*},\tilde{\chi}_a^{\prime 0},\tilde{\chi}_b^0}\Gamma^{R}_{\check{H}_i^{\prime 0,*},\tilde{\chi}_a^{\prime 0},\tilde{\chi}_b^0}+\Gamma^{R*}_{\check{H}_j^{\prime 0,*},\tilde{\chi}_a^{\prime 0},\tilde{\chi}_b^0}\Gamma^{L}_{\check{H}_i^{\prime 0,*},\tilde{\chi}_a^{\prime 0},\tilde{\chi}_b^0}\Big)\\
&+\frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{8}G_0\Big(p^2,m_{\tilde{\chi}_a^{\prime 0}}^2,m_{\tilde{\chi}_b^0}^2\Big)\Big(\Gamma^{L*}_{\check{H}_j^{\prime 0,*},\tilde{\chi}_a^{\prime 0},\tilde{\chi}_b^0}\Gamma^{L}_{\check{H}_i^{\prime 0,*},\tilde{\chi}_a^{\prime 0},\tilde{\chi}_b^0}+\Gamma^{R*}_{\check{H}_j^{\prime 0,*},\tilde{\chi}_a^{\prime 0},\tilde{\chi}_b^0}\Gamma^{R}_{\check{H}_i^{\prime 0,*},\tilde{\chi}_a^{\prime 0},\tilde{\chi}_b^0}\Big)\\
&-2m_{\tilde{\chi}^{\prime -}}\sum_{a=1}^{2}B_0\Big(p^2,m_{\tilde{\chi}_a^-}^2,m_{\tilde{\chi}^{\prime -}}^2\Big)m_{\tilde{\chi}_a^-}\Big(\Gamma^{L*}_{\check{H}_j^{\prime 0,*},\tilde{\chi}_a^+,\mathrm{ChaP}\left(\{1\}\right)}\Gamma^{R}_{\check{H}_i^{\prime 0,*},\tilde{\chi}_a^+,\mathrm{ChaP}\left(\{1\}\right)}+\Gamma^{R*}_{\check{H}_j^{\prime 0,*},\tilde{\chi}_a^+,\mathrm{ChaP}\left(\{1\}\right)}\Gamma^{L}_{\check{H}_i^{\prime 0,*},\tilde{\chi}_a^+,\mathrm{ChaP}\left(\{1\}\right.}\\
&+\sum_{a=1}^{2}G_0\Big(p^2,m_{\tilde{\chi}_a^-}^2,m_{\tilde{\chi}^{\prime -}}^2\Big)\Big(\Gamma^{L*}_{\check{H}_j^{\prime 0,*},\tilde{\chi}_a^+,\mathrm{ChaP}\left(\{1\}\right)}\Gamma^{L}_{\check{H}_i^{\prime 0,*},\tilde{\chi}_a^+,\mathrm{ChaP}\left(\{1\}\right)}+\Gamma^{R*}_{\check{H}_j^{\prime 0,*},\tilde{\chi}_a^+,\mathrm{ChaP}\left(\{1\}\right)}\Gamma^{R}_{\check{H}_i^{\prime 0,*},\tilde{\chi}_a^+,\mathrm{ChaP}\left(\{1\}\right)}\Big)\\
&-\sum_{a=1}^{3}A_0\Big(m_{\tilde{\nu}_a}^2\Big)\Gamma_{\check{H}_i^{\prime 0},\check{H}_j^{\prime 0,*},\tilde{\nu}_a^*,\tilde{\nu}_a}-\frac{1}{2}\sum_{a=1}^{5}A_0\Big(m_{A_a^0}^2\Big)\Gamma_{\check{H}_i^{\prime 0},\check{H}_j^{\prime 0,*},A_a^0,A_a^0}\\
&-\frac{1}{2}\sum_{a=1}^{5}A_0\Big(m_{h_a}^2\Big)\Gamma_{\check{H}_i^{\prime 0},\check{H}_j^{\prime 0,*},h_a,h_a}-3\sum_{a=1}^{6}A_0\Big(m_{\tilde{d}_a}^2\Big)\Gamma_{\check{H}_i^{\prime 0},\check{H}_j^{\prime 0,*},\tilde{d}_a^*,\tilde{d}_a}\\
&-3\sum_{a=1}^{6}A_0\Big(m_{\tilde{x}_a}^2\Big)\Gamma_{\check{H}_i^{\prime 0},\check{H}_j^{\prime 0,*},\tilde{x}_a^*,\tilde{x}_a}-\sum_{a=1}^{6}A_0\Big(m_{\tilde{e}_a}^2\Big)\Gamma_{\check{H}_i^{\prime 0},\check{H}_j^{\prime 0,*},\tilde{e}_a^*,\tilde{e}_a}\\
&-3\sum_{a=1}^{6}A_0\Big(m_{\tilde{u}_a}^2\Big)\Gamma_{\check{H}_i^{\prime 0},\check{H}_j^{\prime 0,*},\tilde{u}_a^*,\tilde{u}_a}+\sum_{b=1}^{2}\Gamma^*_{\check{H}_j^{\prime 0,*},Z,H_b^{\prime 0}}\Gamma_{\check{H}_i^{\prime 0,*},Z,H_b^{\prime 0}}F_0\Big(p^2,m_{H_b^{\prime 0}}^2,m_Z^2\Big)\\
&+\sum_{b=1}^{2}\Gamma^*_{\check{H}_j^{\prime 0,*},Z^\prime,H_b^{\prime 0}}\Gamma_{\check{H}_i^{\prime 0,*},Z^\prime,H_b^{\prime 0}}F_0\Big(p^2,m_{H_b^{\prime 0}}^2,m_{Z^\prime}^2\Big)+\sum_{b=1}^{2}\Gamma^*_{\check{H}_j^{\prime 0,*},W^+,H_b^{\prime -}}\Gamma_{\check{H}_i^{\prime 0,*},W^+,H_b^{\prime -}}F_0\Big(p^2,m_{H_b^{\prime -}}^2,m_{W^-}^2\Big)
\end{aligned}
\tag{306}
$$

- **Self-Energy for Charged Prime-Higgs** $(H^{\prime -})$

$$
\Pi_{i,j}(p^2)=+4\Gamma_{\check{H}_i^{\prime -},\check{H}_j^{\prime +},W^+,W^-}\Big(-\frac{1}{2}\mathrm{rMS}m_{W^-}^2+A_0\Big(m_{W^-}^2\Big)\Big)+2\Gamma_{\check{H}_i^{\prime -},\check{H}_j^{\prime +},Z,Z}\Big(-\frac{1}{2}\mathrm{rMS}m_Z^2+A_0\Big(m_Z^2\Big)\Big)
$$

$$
\begin{aligned}
&+2\Gamma_{\check{H}_i'^-,\check{H}_j'^+,Z',Z'}\Big(-\frac{1}{2}\mathrm{rMS}m_{Z'}^2+A_0\Big(m_{Z'}^2\Big)\Big)-\sum_{a=1}^{2}A_0\Big(m_{H_a^-}^2\Big)\Gamma_{\check{H}_i'^-,\check{H}_j'^+,H_a^+,H_a^-}\\
&-\sum_{a=1}^{2}A_0\Big(m_{H_a'^0}^2\Big)\Gamma_{\check{H}_i'^-,\check{H}_j'^+,H_a'^{0,*},H_a'^0}-\sum_{a=1}^{2}A_0\Big(m_{H_a'^-}^2\Big)\Gamma_{\check{H}_i'^-,\check{H}_j'^+,H_a'^+,H_a'^-}\\
&+\sum_{a=1}^{2}\sum_{b=1}^{2}B_0\Big(p^2,m_{H_a'^0}^2,m_{H_b^-}^2\Big)\Gamma^*_{\check{H}_j'^+,H_a'^0,H_b^-}\Gamma_{\check{H}_i'^+,H_a'^0,H_b^-}\\
&-2\sum_{a=1}^{2}m_{\tilde{\chi}_a'^0}\sum_{b=1}^{2}B_0\Big(p^2,m_{\tilde{\chi}_a'^0}^2,m_{\tilde{\chi}_b^-}^2\Big)m_{\tilde{\chi}_b^-}\Big(\Gamma^{L*}_{\check{H}_j'^+,\tilde{\chi}_a'^0,\tilde{\chi}_b^-}\Gamma^{R}_{\check{H}_i'^+,\tilde{\chi}_a'^0,\tilde{\chi}_b^-}+\Gamma^{R*}_{\check{H}_j'^+,\tilde{\chi}_a'^0,\tilde{\chi}_b^-}\Gamma^{L}_{\check{H}_i'^+,\tilde{\chi}_a'^0,\tilde{\chi}_b^-}\Big)\\
&+\sum_{a=1}^{2}\sum_{b=1}^{2}G_0\Big(p^2,m_{\tilde{\chi}_a'^0}^2,m_{\tilde{\chi}_b^-}^2\Big)\Big(\Gamma^{L*}_{\check{H}_j'^+,\tilde{\chi}_a'^0,\tilde{\chi}_b^-}\Gamma^{L}_{\check{H}_i'^+,\tilde{\chi}_a'^0,\tilde{\chi}_b^-}+\Gamma^{R*}_{\check{H}_j'^+,\tilde{\chi}_a'^0,\tilde{\chi}_b^-}\Gamma^{R}_{\check{H}_i'^+,\tilde{\chi}_a'^0,\tilde{\chi}_b^-}\Big)\\
&+\sum_{a=1}^{2}\sum_{b=1}^{5}B_0\Big(p^2,m_{H_a'^-}^2,m_{h_b}^2\Big)\Gamma^*_{\check{H}_j'^+,H_a'^-,h_b}\Gamma_{\check{H}_i'^+,H_a'^-,h_b}-\sum_{a=1}^{3}A_0\Big(m_{\tilde{\nu}_a}^2\Big)\Gamma_{\check{H}_i'^-,\check{H}_j'^+,\tilde{\nu}_a^*,\tilde{\nu}_a}\\
&-\frac{1}{2}\sum_{a=1}^{5}A_0\Big(m_{A_a^0}^2\Big)\Gamma_{\check{H}_i'^-,\check{H}_j'^+,A_a^0,A_a^0}-\frac{1}{2}\sum_{a=1}^{5}A_0\Big(m_{h_a}^2\Big)\Gamma_{\check{H}_i'^-,\check{H}_j'^+,h_a,h_a}\\
&-3\sum_{a=1}^{6}A_0\Big(m_{\tilde{d}_a}^2\Big)\Gamma_{\check{H}_i'^-,\check{H}_j'^+,\tilde{d}_a^*,\tilde{d}_a}-3\sum_{a=1}^{6}A_0\Big(m_{\tilde{x}_a}^2\Big)\Gamma_{\check{H}_i'^-,\check{H}_j'^+,\tilde{x}_a^*,\tilde{x}_a}\\
&-\sum_{a=1}^{6}A_0\Big(m_{\tilde{e}_a}^2\Big)\Gamma_{\check{H}_i'^-,\check{H}_j'^+,\tilde{e}_a^*,\tilde{e}_a}-3\sum_{a=1}^{6}A_0\Big(m_{\tilde{u}_a}^2\Big)\Gamma_{\check{H}_i'^-,\check{H}_j'^+,\tilde{u}_a^*,\tilde{u}_a}\\
&-2m_{\tilde{\chi}'^-}\sum_{a=1}^{8}B_0\Big(p^2,m_{\tilde{\chi}_a^0}^2,m_{\tilde{\chi}'^-}^2\Big)m_{\tilde{\chi}_a^0}\Big(\Gamma^{L*}_{\check{H}_j'^+,\tilde{\chi}_a^0,\mathrm{ChaP}\left(\{1\}\right)}\Gamma^{R}_{\check{H}_i'^+,\tilde{\chi}_a^0,\mathrm{ChaP}\left(\{1\}\right)}+\Gamma^{R*}_{\check{H}_j'^+,\tilde{\chi}_a^0,\mathrm{ChaP}\left(\{1\}\right)}\Gamma^{L}_{\check{H}_i'^+,\tilde{\chi}_a^0,\mathrm{ChaP}\left(\{1\}\right)}\Big)\\
&+\sum_{a=1}^{8}G_0\Big(p^2,m_{\tilde{\chi}_a^0}^2,m_{\tilde{\chi}'^-}^2\Big)\Big(\Gamma^{L*}_{\check{H}_j'^+,\tilde{\chi}_a^0,\mathrm{ChaP}\left(\{1\}\right)}\Gamma^{L}_{\check{H}_i'^+,\tilde{\chi}_a^0,\mathrm{ChaP}\left(\{1\}\right)}+\Gamma^{R*}_{\check{H}_j'^+,\tilde{\chi}_a^0,\mathrm{ChaP}\left(\{1\}\right)}\Gamma^{R}_{\check{H}_i'^+,\tilde{\chi}_a^0,\mathrm{ChaP}\left(\{1\}\right)}\Big)\\
&+\sum_{b=1}^{2}\Gamma^*_{\check{H}_j'^+,W^-,H_b'^0}\Gamma_{\check{H}_i'^+,W^-,H_b'^0}F_0\Big(p^2,m_{H_b'^0}^2,m_{W^-}^2\Big)+\sum_{b=1}^{2}\Gamma^*_{\check{H}_j'^+,\gamma,H_b'^-}\Gamma_{\check{H}_i'^+,\gamma,H_b'^-}F_0\Big(p^2,m_{H_b'^-}^2,0\Big)\\
&+\sum_{b=1}^{2}\Gamma^*_{\check{H}_j'^+,Z,H_b'^-}\Gamma_{\check{H}_i'^+,Z,H_b'^-}F_0\Big(p^2,m_{H_b'^-}^2,m_Z^2\Big)+\sum_{b=1}^{2}\Gamma^*_{\check{H}_j'^+,Z',H_b'^-}\Gamma_{\check{H}_i'^+,Z',H_b'^-}F_0\Big(p^2,m_{H_b'^-}^2,m_{Z'}^2\Big)
\end{aligned}
\tag{307}
$$

- **Self-Energy for Prime Neutralinos** $(\tilde{\chi}'^0)$

$$
\Sigma^S_{i,j}(p^2)=+2\sum_{a=1}^{2}\sum_{b=1}^{2}B_0\Big(p^2,m_{\tilde{\chi}_b^-}^2,m_{H_a'^-}^2\Big)\Gamma^{L*}_{\check{\tilde{\chi}}_j'^0,H_a'^+,\tilde{\chi}_b^-}m_{\tilde{\chi}_b^-}\Gamma^{R}_{\check{\tilde{\chi}}_i'^0,H_a'^+,\tilde{\chi}_b^-}
$$

$$
\begin{aligned}
&+2\sum_{a=1}^{2}\sum_{b=1}^{8}B_0\Big(p^2,m^2_{\tilde{\chi}^0_b},m^2_{H'^0_a}\Big)\Gamma^{L*}_{\tilde{\chi}'^0_j,H'^{0,*}_a,\tilde{\chi}^0_b}m_{\tilde{\chi}^0_b}\Gamma^{R}_{\tilde{\chi}'^0_i,H'^{0,*}_a,\tilde{\chi}^0_b}\\
&-4\sum_{b=1}^{2}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m^2_{\tilde{\chi}'^0_b},m^2_Z\Big)\Big)\Gamma^{R*}_{\tilde{\chi}'^0_j,Z,\tilde{\chi}'^0_b}m_{\tilde{\chi}'^0_b}\Gamma^{L}_{\tilde{\chi}'^0_i,Z,\tilde{\chi}'^0_b}\\
&-4\sum_{b=1}^{2}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m^2_{\tilde{\chi}'^0_b},m^2_{Z'}\Big)\Big)\Gamma^{R*}_{\tilde{\chi}'^0_j,Z',\tilde{\chi}'^0_b}m_{\tilde{\chi}'^0_b}\Gamma^{L}_{\tilde{\chi}'^0_i,Z',\tilde{\chi}'^0_b}\\
&-8\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m^2_{\tilde{\chi}'^-},m^2_{W^-}\Big)\Big)\Gamma^{R*}_{\tilde{\chi}'^0_j,W^+,\mathrm{ChaP}\Big(\{1\}\Big)}m_{\tilde{\chi}'^-}\Gamma^{L}_{\tilde{\chi}'^0_i,W^+,\mathrm{ChaP}\Big(\{1\}\Big)}
\end{aligned}
\tag{308}
$$

$$
\begin{aligned}
\Sigma^R_{i,j}(p^2)=&-\sum_{a=1}^{2}\sum_{b=1}^{2}B_1\Big(p^2,m^2_{\tilde{\chi}^-_b},m^2_{H'^-_a}\Big)\Gamma^{R*}_{\tilde{\chi}'^0_j,H'^+_a,\tilde{\chi}^-_b}\Gamma^{R}_{\tilde{\chi}'^0_i,H'^+_a,\tilde{\chi}^-_b}\\
&-\sum_{a=1}^{2}\sum_{b=1}^{8}B_1\Big(p^2,m^2_{\tilde{\chi}^0_b},m^2_{H'^0_a}\Big)\Gamma^{R*}_{\tilde{\chi}'^0_j,H'^{0,*}_a,\tilde{\chi}^0_b}\Gamma^{R}_{\tilde{\chi}'^0_i,H'^{0,*}_a,\tilde{\chi}^0_b}\\
&-\sum_{b=1}^{2}B_1\Big(p^2,m^2_{\tilde{\chi}'^0_b},m^2_Z\Big)\Gamma^{L*}_{\tilde{\chi}'^0_j,Z,\tilde{\chi}'^0_b}\Gamma^{L}_{\tilde{\chi}'^0_i,Z,\tilde{\chi}'^0_b}-\sum_{b=1}^{2}B_1\Big(p^2,m^2_{\tilde{\chi}'^0_b},m^2_{Z'}\Big)\Gamma^{L*}_{\tilde{\chi}'^0_j,Z',\tilde{\chi}'^0_b}\Gamma^{L}_{\tilde{\chi}'^0_i,Z',\tilde{\chi}'^0_b}\\
&-2B_1\Big(p^2,m^2_{\tilde{\chi}'^-},m^2_{W^-}\Big)\Gamma^{L*}_{\tilde{\chi}'^0_j,W^+,\mathrm{ChaP}\Big(\{1\}\Big)}\Gamma^{L}_{\tilde{\chi}'^0_i,W^+,\mathrm{ChaP}\Big(\{1\}\Big)}
\end{aligned}
\tag{309}
$$

$$
\begin{aligned}
\Sigma^L_{i,j}(p^2)=&-\sum_{a=1}^{2}\sum_{b=1}^{2}B_1\Big(p^2,m^2_{\tilde{\chi}^-_b},m^2_{H'^-_a}\Big)\Gamma^{L*}_{\tilde{\chi}'^0_j,H'^+_a,\tilde{\chi}^-_b}\Gamma^{L}_{\tilde{\chi}'^0_i,H'^+_a,\tilde{\chi}^-_b}\\
&-\sum_{a=1}^{2}\sum_{b=1}^{8}B_1\Big(p^2,m^2_{\tilde{\chi}^0_b},m^2_{H'^0_a}\Big)\Gamma^{L*}_{\tilde{\chi}'^0_j,H'^{0,*}_a,\tilde{\chi}^0_b}\Gamma^{L}_{\tilde{\chi}'^0_i,H'^{0,*}_a,\tilde{\chi}^0_b}\\
&-\sum_{b=1}^{2}B_1\Big(p^2,m^2_{\tilde{\chi}'^0_b},m^2_Z\Big)\Gamma^{R*}_{\tilde{\chi}'^0_j,Z,\tilde{\chi}'^0_b}\Gamma^{R}_{\tilde{\chi}'^0_i,Z,\tilde{\chi}'^0_b}-\sum_{b=1}^{2}B_1\Big(p^2,m^2_{\tilde{\chi}'^0_b},m^2_{Z'}\Big)\Gamma^{R*}_{\tilde{\chi}'^0_j,Z',\tilde{\chi}'^0_b}\Gamma^{R}_{\tilde{\chi}'^0_i,Z',\tilde{\chi}'^0_b}\\
&-2B_1\Big(p^2,m^2_{\tilde{\chi}'^-},m^2_{W^-}\Big)\Gamma^{R*}_{\tilde{\chi}'^0_j,W^+,\mathrm{ChaP}\Big(\{1\}\Big)}\Gamma^{R}_{\tilde{\chi}'^0_i,W^+,\mathrm{ChaP}\Big(\{1\}\Big)}
\end{aligned}
\tag{310}
$$

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

$$
\begin{aligned}
\Sigma^S(p^2)=&+\sum_{a=1}^{6}\sum_{b=1}^{3}B_0\Big(p^2,m^2_{d_b},m^2_{\tilde{d}_a}\Big)\Gamma^{L*}_{\tilde{g}_j,\tilde{d}^*_a,d_b}m_{d_b}\Gamma^{R}_{\tilde{g}_i,\tilde{d}^*_a,d_b}\\
&+\sum_{a=1}^{6}\sum_{b=1}^{3}B_0\Big(p^2,m^2_{x_b},m^2_{\tilde{x}_a}\Big)\Gamma^{L*}_{\tilde{g}_j,\tilde{x}^*_a,x_b}m_{x_b}\Gamma^{R}_{\tilde{g}_i,\tilde{x}^*_a,x_b}
\end{aligned}
$$

$$+\sum_{a=1}^{6}\sum_{b=1}^{3}B_0\Big(p^2,m_{u_b}^2,m_{\tilde{u}_a}^2\Big)\Gamma^{L*}_{\tilde{g}_j,\tilde{u}_a^*,u_b}m_{u_b}\Gamma^{R}_{\tilde{g}_i,\tilde{u}_a^*,u_b}-12\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{\tilde{g}}^2,0\Big)\Big)\Gamma^{R*}_{\tilde{g}_j,g,\tilde{g}_1}m_{\tilde{g}}\Gamma^{L}_{\tilde{g}_i,g,\tilde{g}_1} \tag{311}$$

$$\begin{aligned}\Sigma^R(p^2)=&-\frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{3}B_1\Big(p^2,m_{d_b}^2,m_{\tilde{d}_a}^2\Big)\Gamma^{R*}_{\tilde{g}_j,\tilde{d}_a^*,d_b}\Gamma^{R}_{\tilde{g}_i,\tilde{d}_a^*,d_b}\\&-\frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{3}B_1\Big(p^2,m_{x_b}^2,m_{\tilde{x}_a}^2\Big)\Gamma^{R*}_{\tilde{g}_j,\tilde{x}_a^*,x_b}\Gamma^{R}_{\tilde{g}_i,\tilde{x}_a^*,x_b}\\&-\frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{3}B_1\Big(p^2,m_{u_b}^2,m_{\tilde{u}_a}^2\Big)\Gamma^{R*}_{\tilde{g}_j,\tilde{u}_a^*,u_b}\Gamma^{R}_{\tilde{g}_i,\tilde{u}_a^*,u_b}-3B_1\Big(p^2,m_{\tilde{g}}^2,0\Big)\Gamma^{L*}_{\tilde{g}_j,g,\tilde{g}_1}\Gamma^{L}_{\tilde{g}_i,g,\tilde{g}_1}\end{aligned} \tag{312}$$

$$\begin{aligned}\Sigma^L(p^2)=&-\frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{3}B_1\Big(p^2,m_{d_b}^2,m_{\tilde{d}_a}^2\Big)\Gamma^{L*}_{\tilde{g}_j,\tilde{d}_a^*,d_b}\Gamma^{L}_{\tilde{g}_i,\tilde{d}_a^*,d_b}\\&-\frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{3}B_1\Big(p^2,m_{x_b}^2,m_{\tilde{x}_a}^2\Big)\Gamma^{L*}_{\tilde{g}_j,\tilde{x}_a^*,x_b}\Gamma^{L}_{\tilde{g}_i,\tilde{x}_a^*,x_b}\\&-\frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{3}B_1\Big(p^2,m_{u_b}^2,m_{\tilde{u}_a}^2\Big)\Gamma^{L*}_{\tilde{g}_j,\tilde{u}_a^*,u_b}\Gamma^{L}_{\tilde{g}_i,\tilde{u}_a^*,u_b}-3B_1\Big(p^2,m_{\tilde{g}}^2,0\Big)\Gamma^{R*}_{\tilde{g}_j,g,\tilde{g}_1}\Gamma^{R}_{\tilde{g}_i,g,\tilde{g}_1}\end{aligned} \tag{313}$$

- **Self-Energy for Prime Chargino** $(\tilde{\chi}^{'-})$

$$\begin{aligned}\Sigma^S(p^2)=&+\sum_{a=1}^{2}\sum_{b=1}^{2}B_0\Big(p^2,m_{\tilde{\chi}_b^-}^2,m_{H_a^{'0}}^2\Big)\Gamma^{L*}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO2}\}}\right),H_a^{'0},\tilde{\chi}_b^-}m_{\tilde{\chi}_b^-}\Gamma^{R}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO1}\}}\right),H_a^{'0},\tilde{\chi}_b^-}\\&+\sum_{a=1}^{2}\sum_{b=1}^{8}B_0\Big(p^2,m_{\tilde{\chi}_b^0}^2,m_{H_a^{'-}}^2\Big)\Gamma^{L*}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO2}\}}\right),H_a^{'-},\tilde{\chi}_b^0}m_{\tilde{\chi}_b^0}\Gamma^{R}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO1}\}}\right),H_a^{'-},\tilde{\chi}_b^0}\\&-4\sum_{b=1}^{2}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{\tilde{\chi}_b^{'0}}^2,m_{W^-}^2\Big)\Big)\Gamma^{R*}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO2}\}}\right),W^-,\tilde{\chi}_b^{'0}}m_{\tilde{\chi}_b^{'0}}\Gamma^{L}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO1}\}}\right),W^-,\tilde{\chi}_b^{'0}}\\&-4\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{\tilde{\chi}^{'-}}^2,0\Big)\Big)\Gamma^{R*}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO2}\}}\right),\gamma,\mathrm{ChaP}\left(\{1\}\right)}m_{\tilde{\chi}^{'-}}\Gamma^{L}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO1}\}}\right),\gamma,\mathrm{ChaP}\left(\{1\}\right)}\\&-4\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{\tilde{\chi}^{'-}}^2,m_Z^2\Big)\Big)\Gamma^{R*}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO2}\}}\right),Z,\mathrm{ChaP}\left(\{1\}\right)}m_{\tilde{\chi}^{'-}}\Gamma^{L}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO1}\}}\right),Z,\mathrm{ChaP}\left(\{1\}\right)}\\&-4\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{\tilde{\chi}^{'-}}^2,m_{Z'}^2\Big)\Big)\Gamma^{R*}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO2}\}}\right),Z',\mathrm{ChaP}\left(\{1\}\right)}m_{\tilde{\chi}^{'-}}\Gamma^{L}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO1}\}}\right),Z',\mathrm{ChaP}\left(\{1\}\right)}\end{aligned} \tag{314}$$

$$\Sigma^R(p^2)=-\frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{2}B_1\Big(p^2,m_{\tilde{\chi}_b^-}^2,m_{H_a^{'0}}^2\Big)\Gamma^{R*}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO2}\}}\right),H_a^{'0},\tilde{\chi}_b^-}\Gamma^{R}_{\mathrm{ChaP}\left(\bar{\{\mathrm{gO1}\}}\right),H_a^{'0},\tilde{\chi}_b^-}$$

$$
\begin{aligned}
&- \frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{8} B_1\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{H'^-_a}\Big)\Gamma^{R*}_{\text{ChaP}\left(\bar{\{\text{gO2}\}}\right),H'^-_a,\tilde{\chi}^0_b}\Gamma^{R}_{\text{ChaP}\left(\bar{\{\text{gO1}\}}\right),H'^-_a,\tilde{\chi}^0_b}\\
&- \sum_{b=1}^{2} B_1\Big(p^2, m^2_{\tilde{\chi}'^0_b}, m^2_{W^-}\Big)\Gamma^{L*}_{\text{ChaP}\left(\bar{\{\text{gO2}\}}\right),W^-,\tilde{\chi}'^0_b}\Gamma^{L}_{\text{ChaP}\left(\bar{\{\text{gO1}\}}\right),W^-,\tilde{\chi}'^0_b} - B_1\Big(p^2, m^2_{\tilde{\chi}'^-}, 0\Big)\Gamma^{L*}_{\text{ChaP}\left(\bar{\{\text{gO2}\}}\right),\gamma,\text{ChaP}\left(\{1\}\right)}\Gamma^{L}_{\text{Ch}}\\
&- B_1\Big(p^2, m^2_{\tilde{\chi}'^-}, m^2_{Z}\Big)\Gamma^{L*}_{\text{ChaP}\left(\bar{\{\text{gO2}\}}\right),Z,\text{ChaP}\left(\{1\}\right)}\Gamma^{L}_{\text{ChaP}\left(\bar{\{\text{gO1}\}}\right),Z,\text{ChaP}\left(\{1\}\right)} - B_1\Big(p^2, m^2_{\tilde{\chi}'^-}, m^2_{Z'}\Big)\Gamma^{L*}_{\text{ChaP}\left(\bar{\{\text{gO2}\}}\right),Z',\text{ChaP}}
\end{aligned}
\tag{315}
$$

$$
\begin{aligned}
\Sigma^L(p^2) = &-\frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{2} B_1\Big(p^2, m^2_{\tilde{\chi}^-_b}, m^2_{H'^0_a}\Big)\Gamma^{L*}_{\text{ChaP}\left(\bar{\{\text{gO2}\}}\right),H'^0_a,\tilde{\chi}^-_b}\Gamma^{L}_{\text{ChaP}\left(\bar{\{\text{gO1}\}}\right),H'^0_a,\tilde{\chi}^-_b}\\
&- \frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{8} B_1\Big(p^2, m^2_{\tilde{\chi}^0_b}, m^2_{H'^-_a}\Big)\Gamma^{L*}_{\text{ChaP}\left(\bar{\{\text{gO2}\}}\right),H'^-_a,\tilde{\chi}^0_b}\Gamma^{L}_{\text{ChaP}\left(\bar{\{\text{gO1}\}}\right),H'^-_a,\tilde{\chi}^0_b}\\
&- \sum_{b=1}^{2} B_1\Big(p^2, m^2_{\tilde{\chi}'^0_b}, m^2_{W^-}\Big)\Gamma^{R*}_{\text{ChaP}\left(\bar{\{\text{gO2}\}}\right),W^-,\tilde{\chi}'^0_b}\Gamma^{R}_{\text{ChaP}\left(\bar{\{\text{gO1}\}}\right),W^-,\tilde{\chi}'^0_b} - B_1\Big(p^2, m^2_{\tilde{\chi}'^-}, 0\Big)\Gamma^{R*}_{\text{ChaP}\left(\bar{\{\text{gO2}\}}\right),\gamma,\text{ChaP}\left(\{1\}\right)}\Gamma^{R}_{\text{Ch}}\\
&- B_1\Big(p^2, m^2_{\tilde{\chi}'^-}, m^2_{Z}\Big)\Gamma^{R*}_{\text{ChaP}\left(\bar{\{\text{gO2}\}}\right),Z,\text{ChaP}\left(\{1\}\right)}\Gamma^{R}_{\text{ChaP}\left(\bar{\{\text{gO1}\}}\right),Z,\text{ChaP}\left(\{1\}\right)} - B_1\Big(p^2, m^2_{\tilde{\chi}'^-}, m^2_{Z'}\Big)\Gamma^{R*}_{\text{ChaP}\left(\bar{\{\text{gO2}\}}\right),Z',\text{ChaP}}
\end{aligned}
\tag{316}
$$

- **Self-Energy for Z-Boson** (Z)

$$
\begin{aligned}
\Pi(p^2) = &+|\Gamma_{Z,\bar{\eta^-},\eta^-}|^2 B_{00}\Big(p^2, m^2_{\eta^-}, m^2_{\eta^-}\Big) + |\Gamma_{Z,\bar{\eta^+},\eta^+}|^2 B_{00}\Big(p^2, m^2_{\eta^+}, m^2_{\eta^+}\Big)\\
&+ \Big(|\Gamma^{L}_{Z,\text{ChaP}\left(\bar{\{1\}}\right),\text{ChaP}\left(\{1\}\right)}|^2 + |\Gamma^{R}_{Z,\text{ChaP}\left(\bar{\{1\}}\right),\text{ChaP}\left(\{1\}\right)}|^2\Big) H_0\Big(p^2, m^2_{\tilde{\chi}'^-}, m^2_{\tilde{\chi}'^-}\Big)\\
&- |\Gamma_{Z,W^+,W^-}|^2\Big(10B_{00}\Big(p^2, m^2_{W^-}, m^2_{W^-}\Big) + 2A_0\Big(m^2_{W^-}\Big) - 2\text{rMS}\Big(2m^2_{W^-} - \frac{1}{3}p^2\Big) + B_0\Big(p^2, m^2_{W^-}, m^2_{W^-}\Big)\Big(2m^2_{W^-} + 4p^2\Big)\Big)\\
&+ 4B_0\Big(p^2, m^2_{\tilde{\chi}'^-}, m^2_{\tilde{\chi}'^-}\Big) m^2_{\tilde{\chi}'^-}\Re\Big(\Gamma^{L*}_{Z,\text{ChaP}\left(\bar{\{1\}}\right),\text{ChaP}\left(\{1\}\right)}\Gamma^{R}_{Z,\text{ChaP}\left(\bar{\{1\}}\right),\text{ChaP}\left(\{1\}\right)}\Big) + \sum_{a=1}^{2} A_0\Big(m^2_{H^-_a}\Big)\Gamma_{Z,Z,H^+_a,H^-_a} + \sum_{a=1}^{2} A_0\\
&+ \sum_{a=1}^{2} A_0\Big(m^2_{H'^-_a}\Big)\Gamma_{Z,Z,H'^+_a,H'^-_a} - 4\sum_{a=1}^{2}\sum_{b=1}^{2}|\Gamma_{Z,H^+_a,H^-_b}|^2 B_{00}\Big(p^2, m^2_{H^-_a}, m^2_{H^-_b}\Big)\\
&- 4\sum_{a=1}^{2}\sum_{b=1}^{2}|\Gamma_{Z,H'^{0,*}_a,H'^0_b}|^2 B_{00}\Big(p^2, m^2_{H'^0_a}, m^2_{H'^0_b}\Big)\\
&- 4\sum_{a=1}^{2}\sum_{b=1}^{2}|\Gamma_{Z,H'^+_a,H'^-_b}|^2 B_{00}\Big(p^2, m^2_{H'^-_a}, m^2_{H'^-_b}\Big)
\end{aligned}
$$

$$
\begin{aligned}
&+ \sum_{a=1}^{2}\sum_{b=1}^{2}\Big[\Big(|\Gamma^L_{Z,\tilde{\chi}_a^+,\tilde{\chi}_b^-}|^2 + |\Gamma^R_{Z,\tilde{\chi}_a^+,\tilde{\chi}_b^-}|^2\Big)H_0\Big(p^2, m^2_{\tilde{\chi}_a^-}, m^2_{\tilde{\chi}_b^-}\Big) \\
&+ 4B_0\Big(p^2, m^2_{\tilde{\chi}_a^-}, m^2_{\tilde{\chi}_b^-}\Big)m_{\tilde{\chi}_a^-}m_{\tilde{\chi}_b^-}\Re\Big(\Gamma^{L*}_{Z,\tilde{\chi}_a^+,\tilde{\chi}_b^-}\Gamma^R_{Z,\tilde{\chi}_a^+,\tilde{\chi}_b^-}\Big)\Big] \\
&+ \frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{2}\Big[\Big(|\Gamma^L_{Z,\tilde{\chi}_a'^0,\tilde{\chi}_b'^0}|^2 + |\Gamma^R_{Z,\tilde{\chi}_a'^0,\tilde{\chi}_b'^0}|^2\Big)H_0\Big(p^2, m^2_{\tilde{\chi}_a'^0}, m^2_{\tilde{\chi}_b'^0}\Big) \\
&+ 4B_0\Big(p^2, m^2_{\tilde{\chi}_a'^0}, m^2_{\tilde{\chi}_b'^0}\Big)m_{\tilde{\chi}_a'^0}m_{\tilde{\chi}_b'^0}\Re\Big(\Gamma^{L*}_{Z,\tilde{\chi}_a'^0,\tilde{\chi}_b'^0}\Gamma^R_{Z,\tilde{\chi}_a'^0,\tilde{\chi}_b'^0}\Big)\Big] \\
&+ \sum_{a=1}^{3}A_0\Big(m^2_{\tilde{\nu}_a}\Big)\Gamma_{Z,Z,\tilde{\nu}_a^*,\tilde{\nu}_a} - 4\sum_{a=1}^{3}\sum_{b=1}^{3}|\Gamma_{Z,\tilde{\nu}_a^*,\tilde{\nu}_b}|^2 B_{00}\Big(p^2, m^2_{\tilde{\nu}_a}, m^2_{\tilde{\nu}_b}\Big) \\
&+ 3\sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big(|\Gamma^L_{Z,\bar{d}_a,d_b}|^2 + |\Gamma^R_{Z,\bar{d}_a,d_b}|^2\Big)H_0\Big(p^2, m^2_{d_a}, m^2_{d_b}\Big) \\
&+ 4B_0\Big(p^2, m^2_{d_a}, m^2_{d_b}\Big)m_{d_a}m_{d_b}\Re\Big(\Gamma^{L*}_{Z,\bar{d}_a,d_b}\Gamma^R_{Z,\bar{d}_a,d_b}\Big)\Big] \\
&+ 3\sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big(|\Gamma^L_{Z,\bar{x}_a,x_b}|^2 + |\Gamma^R_{Z,\bar{x}_a,x_b}|^2\Big)H_0\Big(p^2, m^2_{x_a}, m^2_{x_b}\Big) \\
&+ 4B_0\Big(p^2, m^2_{x_a}, m^2_{x_b}\Big)m_{x_a}m_{x_b}\Re\Big(\Gamma^{L*}_{Z,\bar{x}_a,x_b}\Gamma^R_{Z,\bar{x}_a,x_b}\Big)\Big] \\
&+ \sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big(|\Gamma^L_{Z,\bar{e}_a,e_b}|^2 + |\Gamma^R_{Z,\bar{e}_a,e_b}|^2\Big)H_0\Big(p^2, m^2_{e_a}, m^2_{e_b}\Big) \\
&+ 4B_0\Big(p^2, m^2_{e_a}, m^2_{e_b}\Big)m_{e_a}m_{e_b}\Re\Big(\Gamma^{L*}_{Z,\bar{e}_a,e_b}\Gamma^R_{Z,\bar{e}_a,e_b}\Big)\Big] \\
&+ 3\sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big(|\Gamma^L_{Z,\bar{u}_a,u_b}|^2 + |\Gamma^R_{Z,\bar{u}_a,u_b}|^2\Big)H_0\Big(p^2, m^2_{u_a}, m^2_{u_b}\Big) \\
&+ 4B_0\Big(p^2, m^2_{u_a}, m^2_{u_b}\Big)m_{u_a}m_{u_b}\Re\Big(\Gamma^{L*}_{Z,\bar{u}_a,u_b}\Gamma^R_{Z,\bar{u}_a,u_b}\Big)\Big] \\
&+ \sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big(|\Gamma^L_{Z,\bar{\nu}_a,\nu_b}|^2 + |\Gamma^R_{Z,\bar{\nu}_a,\nu_b}|^2\Big)H_0\Big(p^2, m^2_{\nu_a}, m^2_{\nu_b}\Big) \\
&+ 4B_0\Big(p^2, m^2_{\nu_a}, m^2_{\nu_b}\Big)m_{\nu_a}m_{\nu_b}\Re\Big(\Gamma^{L*}_{Z,\bar{\nu}_a,\nu_b}\Gamma^R_{Z,\bar{\nu}_a,\nu_b}\Big)\Big] \\
&+ \frac{1}{2}\sum_{a=1}^{5}A_0\Big(m^2_{A_a^0}\Big)\Gamma_{Z,Z,A_a^0,A_a^0} + \frac{1}{2}\sum_{a=1}^{5}A_0\Big(m^2_{h_a}\Big)\Gamma_{Z,Z,h_a,h_a} \\
&- 4\sum_{a=1}^{5}\sum_{b=1}^{5}|\Gamma_{Z,h_a,A_b^0}|^2 B_{00}\Big(p^2, m^2_{A_b^0}, m^2_{h_a}\Big) + 3\sum_{a=1}^{6}A_0\Big(m^2_{\tilde{d}_a}\Big)\Gamma_{Z,Z,\tilde{d}_a^*,\tilde{d}_a} \\
&+ 3\sum_{a=1}^{6}A_0\Big(m^2_{\tilde{x}_a}\Big)\Gamma_{Z,Z,\tilde{x}_a^*,\tilde{x}_a} + \sum_{a=1}^{6}A_0\Big(m^2_{\tilde{e}_a}\Big)\Gamma_{Z,Z,\tilde{e}_a^*,\tilde{e}_a} + 3\sum_{a=1}^{6}A_0\Big(m^2_{\tilde{u}_a}\Big)\Gamma_{Z,Z,\tilde{u}_a^*,\tilde{u}_a}
\end{aligned}
$$

$$
\begin{aligned}
&- 12\sum_{a=1}^{6}\sum_{b=1}^{6}|\Gamma_{Z,\tilde{d}_a^*,\tilde{d}_b}|^2 B_{00}\Big(p^2,m_{\tilde{d}_a}^2,m_{\tilde{d}_b}^2\Big) - 12\sum_{a=1}^{6}\sum_{b=1}^{6}|\Gamma_{Z,\tilde{x}_a^*,\tilde{x}_b}|^2 B_{00}\Big(p^2,m_{\tilde{x}_a}^2,m_{\tilde{x}_b}^2\Big)\\
&- 4\sum_{a=1}^{6}\sum_{b=1}^{6}|\Gamma_{Z,\tilde{e}_a^*,\tilde{e}_b}|^2 B_{00}\Big(p^2,m_{\tilde{e}_a}^2,m_{\tilde{e}_b}^2\Big) - 12\sum_{a=1}^{6}\sum_{b=1}^{6}|\Gamma_{Z,\tilde{u}_a^*,\tilde{u}_b}|^2 B_{00}\Big(p^2,m_{\tilde{u}_a}^2,m_{\tilde{u}_b}^2\Big)\\
&+ \frac{1}{2}\sum_{a=1}^{8}\sum_{b=1}^{8}\Big[\Big(|\Gamma^L_{Z,\tilde{\chi}_a^0,\tilde{\chi}_b^0}|^2+|\Gamma^R_{Z,\tilde{\chi}_a^0,\tilde{\chi}_b^0}|^2\Big)H_0\Big(p^2,m_{\tilde{\chi}_a^0}^2,m_{\tilde{\chi}_b^0}^2\Big)\\
&+ 4B_0\Big(p^2,m_{\tilde{\chi}_a^0}^2,m_{\tilde{\chi}_b^0}^2\Big)m_{\tilde{\chi}_a^0}m_{\tilde{\chi}_b^0}\Re\Big(\Gamma^{L*}_{Z,\tilde{\chi}_a^0,\tilde{\chi}_b^0}\Gamma^R_{Z,\tilde{\chi}_a^0,\tilde{\chi}_b^0}\Big)\Big]\\
&+ 2\sum_{b=1}^{2}|\Gamma_{Z,W^+,H_b^-}|^2 B_0\Big(p^2,m_{W^-}^2,m_{H_b^-}^2\Big) + \sum_{b=1}^{5}|\Gamma_{Z,Z,h_b}|^2 B_0\Big(p^2,m_Z^2,m_{h_b}^2\Big)\\
&+ \sum_{b=1}^{5}|\Gamma_{Z,Z',h_b}|^2 B_0\Big(p^2,m_{Z'}^2,m_{h_b}^2\Big) + 2\mathrm{rMS}m_{W^-}^2\Gamma^1_{Z,Z,W^+,W^-} - A_0\Big(m_{W^-}^2\Big)\Big(4\Gamma^1_{Z,Z,W^+,W^-}+\Gamma^2_{Z,Z,W^+,W^-}+\Gamma^3_{Z,Z,W^+,W^-}
\end{aligned}
\tag{317}
$$

- **Self-Energy for Z'-Boson** (Z')

$$
\begin{aligned}
\Pi(p^2) = &+|\Gamma_{Z',\bar{\eta^-},\eta^-}|^2 B_{00}\Big(p^2,m_{\eta^-}^2,m_{\eta^-}^2\Big) + |\Gamma_{Z',\bar{\eta^+},\eta^+}|^2 B_{00}\Big(p^2,m_{\eta^+}^2,m_{\eta^+}^2\Big)\\
&+ \Big(|\Gamma^L_{Z',\mathrm{ChaP}\left(\bar{\{1\}}\right),\mathrm{ChaP}\left(\{1\}\right)}|^2 + |\Gamma^R_{Z',\mathrm{ChaP}\left(\bar{\{1\}}\right),\mathrm{ChaP}\left(\{1\}\right)}|^2\Big)H_0\Big(p^2,m_{\tilde{\chi}'^-}^2,m_{\tilde{\chi}'^-}^2\Big)\\
&- |\Gamma_{Z',W^+,W^-}|^2\Big(10B_{00}\Big(p^2,m_{W^-}^2,m_{W^-}^2\Big)+2A_0\Big(m_{W^-}^2\Big)-2\mathrm{rMS}\Big(2m_{W^-}^2-\frac{1}{3}p^2\Big)+B_0\Big(p^2,m_{W^-}^2,m_{W^-}^2\Big)\Big(2m_{W^-}^2+4p^2\Big)\\
&+ 4B_0\Big(p^2,m_{\tilde{\chi}'^-}^2,m_{\tilde{\chi}'^-}^2\Big)m_{\tilde{\chi}'^-}^2\Re\Big(\Gamma^{L*}_{Z',\mathrm{ChaP}\left(\bar{\{1\}}\right),\mathrm{ChaP}\left(\{1\}\right)}\Gamma^R_{Z',\mathrm{ChaP}\left(\bar{\{1\}}\right),\mathrm{ChaP}\left(\{1\}\right)}\Big) + \sum_{a=1}^{2}A_0\Big(m_{H_a^-}^2\Big)\Gamma_{Z',Z',H_a^+,H_a^-} + \sum_{a=1}^{2}\\
&+ \sum_{a=1}^{2}A_0\Big(m_{H_a'^-}^2\Big)\Gamma_{Z',Z',H_a'^+,H_a'^-} - 4\sum_{a=1}^{2}\sum_{b=1}^{2}|\Gamma_{Z',H_a^+,H_b^-}|^2 B_{00}\Big(p^2,m_{H_a^-}^2,m_{H_b^-}^2\Big)\\
&- 4\sum_{a=1}^{2}\sum_{b=1}^{2}|\Gamma_{Z',H_a'^{0,*},H_b'^0}|^2 B_{00}\Big(p^2,m_{H_a'^0}^2,m_{H_b'^0}^2\Big)\\
&- 4\sum_{a=1}^{2}\sum_{b=1}^{2}|\Gamma_{Z',H_a'^+,H_b'^-}|^2 B_{00}\Big(p^2,m_{H_a'^-}^2,m_{H_b'^-}^2\Big)\\
&+ \sum_{a=1}^{2}\sum_{b=1}^{2}\Big[\Big(|\Gamma^L_{Z',\tilde{\chi}_a^+,\tilde{\chi}_b^-}|^2+|\Gamma^R_{Z',\tilde{\chi}_a^+,\tilde{\chi}_b^-}|^2\Big)H_0\Big(p^2,m_{\tilde{\chi}_a^-}^2,m_{\tilde{\chi}_b^-}^2\Big)\\
&+ 4B_0\Big(p^2,m_{\tilde{\chi}_a^-}^2,m_{\tilde{\chi}_b^-}^2\Big)m_{\tilde{\chi}_a^-}m_{\tilde{\chi}_b^-}\Re\Big(\Gamma^{L*}_{Z',\tilde{\chi}_a^+,\tilde{\chi}_b^-}\Gamma^R_{Z',\tilde{\chi}_a^+,\tilde{\chi}_b^-}\Big)\Big]\\
&+ \frac{1}{2}\sum_{a=1}^{2}\sum_{b=1}^{2}\Big[\Big(|\Gamma^L_{Z',\tilde{\chi}_a'^0,\tilde{\chi}_b'^0}|^2+|\Gamma^R_{Z',\tilde{\chi}_a'^0,\tilde{\chi}_b'^0}|^2\Big)H_0\Big(p^2,m_{\tilde{\chi}_a'^0}^2,m_{\tilde{\chi}_b'^0}^2\Big)
\end{aligned}
$$

$$
\begin{aligned}
&+ 4B_0\Big(p^2, m^2_{\tilde{\chi}^{\prime 0}_a}, m^2_{\tilde{\chi}^{\prime 0}_b}\Big) m_{\tilde{\chi}^{\prime 0}_a} m_{\tilde{\chi}^{\prime 0}_b} \Re\Big(\Gamma^{L*}_{Z^\prime,\tilde{\chi}^{\prime 0}_a,\tilde{\chi}^{\prime 0}_b} \Gamma^{R}_{Z^\prime,\tilde{\chi}^{\prime 0}_a,\tilde{\chi}^{\prime 0}_b}\Big)\Big] \\
&+ \sum_{a=1}^{3} A_0\Big(m^2_{\tilde{\nu}_a}\Big) \Gamma_{Z^\prime,Z^\prime,\tilde{\nu}^*_a,\tilde{\nu}_a} - 4\sum_{a=1}^{3}\sum_{b=1}^{3} |\Gamma_{Z^\prime,\tilde{\nu}^*_a,\tilde{\nu}_b}|^2 B_{00}\Big(p^2, m^2_{\tilde{\nu}_a}, m^2_{\tilde{\nu}_b}\Big) \\
&+ 3\sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big(|\Gamma^{L}_{Z^\prime,\bar{d}_a,d_b}|^2 + |\Gamma^{R}_{Z^\prime,\bar{d}_a,d_b}|^2\Big) H_0\Big(p^2, m^2_{d_a}, m^2_{d_b}\Big) \\
&+ 4B_0\Big(p^2, m^2_{d_a}, m^2_{d_b}\Big) m_{d_a} m_{d_b} \Re\Big(\Gamma^{L*}_{Z^\prime,\bar{d}_a,d_b} \Gamma^{R}_{Z^\prime,\bar{d}_a,d_b}\Big)\Big] \\
&+ 3\sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big(|\Gamma^{L}_{Z^\prime,\bar{x}_a,x_b}|^2 + |\Gamma^{R}_{Z^\prime,\bar{x}_a,x_b}|^2\Big) H_0\Big(p^2, m^2_{x_a}, m^2_{x_b}\Big) \\
&+ 4B_0\Big(p^2, m^2_{x_a}, m^2_{x_b}\Big) m_{x_a} m_{x_b} \Re\Big(\Gamma^{L*}_{Z^\prime,\bar{x}_a,x_b} \Gamma^{R}_{Z^\prime,\bar{x}_a,x_b}\Big)\Big] \\
&+ \sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big(|\Gamma^{L}_{Z^\prime,\bar{e}_a,e_b}|^2 + |\Gamma^{R}_{Z^\prime,\bar{e}_a,e_b}|^2\Big) H_0\Big(p^2, m^2_{e_a}, m^2_{e_b}\Big) \\
&+ 4B_0\Big(p^2, m^2_{e_a}, m^2_{e_b}\Big) m_{e_a} m_{e_b} \Re\Big(\Gamma^{L*}_{Z^\prime,\bar{e}_a,e_b} \Gamma^{R}_{Z^\prime,\bar{e}_a,e_b}\Big)\Big] \\
&+ 3\sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big(|\Gamma^{L}_{Z^\prime,\bar{u}_a,u_b}|^2 + |\Gamma^{R}_{Z^\prime,\bar{u}_a,u_b}|^2\Big) H_0\Big(p^2, m^2_{u_a}, m^2_{u_b}\Big) \\
&+ 4B_0\Big(p^2, m^2_{u_a}, m^2_{u_b}\Big) m_{u_a} m_{u_b} \Re\Big(\Gamma^{L*}_{Z^\prime,\bar{u}_a,u_b} \Gamma^{R}_{Z^\prime,\bar{u}_a,u_b}\Big)\Big] \\
&+ \sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big(|\Gamma^{L}_{Z^\prime,\bar{\nu}_a,\nu_b}|^2 + |\Gamma^{R}_{Z^\prime,\bar{\nu}_a,\nu_b}|^2\Big) H_0\Big(p^2, m^2_{\nu_a}, m^2_{\nu_b}\Big) \\
&+ 4B_0\Big(p^2, m^2_{\nu_a}, m^2_{\nu_b}\Big) m_{\nu_a} m_{\nu_b} \Re\Big(\Gamma^{L*}_{Z^\prime,\bar{\nu}_a,\nu_b} \Gamma^{R}_{Z^\prime,\bar{\nu}_a,\nu_b}\Big)\Big] \\
&+ \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{A^0_a}\Big) \Gamma_{Z^\prime,Z^\prime,A^0_a,A^0_a} + \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{h_a}\Big) \Gamma_{Z^\prime,Z^\prime,h_a,h_a} \\
&- 4\sum_{a=1}^{5}\sum_{b=1}^{5} |\Gamma_{Z^\prime,h_a,A^0_b}|^2 B_{00}\Big(p^2, m^2_{A^0_b}, m^2_{h_a}\Big) + 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{d}_a}\Big) \Gamma_{Z^\prime,Z^\prime,\tilde{d}^*_a,\tilde{d}_a} \\
&+ 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{x}_a}\Big) \Gamma_{Z^\prime,Z^\prime,\tilde{x}^*_a,\tilde{x}_a} + \sum_{a=1}^{6} A_0\Big(m^2_{\tilde{e}_a}\Big) \Gamma_{Z^\prime,Z^\prime,\tilde{e}^*_a,\tilde{e}_a} + 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{u}_a}\Big) \Gamma_{Z^\prime,Z^\prime,\tilde{u}^*_a,\tilde{u}_a} \\
&- 12\sum_{a=1}^{6}\sum_{b=1}^{6} |\Gamma_{Z^\prime,\tilde{d}^*_a,\tilde{d}_b}|^2 B_{00}\Big(p^2, m^2_{\tilde{d}_a}, m^2_{\tilde{d}_b}\Big) - 12\sum_{a=1}^{6}\sum_{b=1}^{6} |\Gamma_{Z^\prime,\tilde{x}^*_a,\tilde{x}_b}|^2 B_{00}\Big(p^2, m^2_{\tilde{x}_a}, m^2_{\tilde{x}_b}\Big) \\
&- 4\sum_{a=1}^{6}\sum_{b=1}^{6} |\Gamma_{Z^\prime,\tilde{e}^*_a,\tilde{e}_b}|^2 B_{00}\Big(p^2, m^2_{\tilde{e}_a}, m^2_{\tilde{e}_b}\Big) - 12\sum_{a=1}^{6}\sum_{b=1}^{6} |\Gamma_{Z^\prime,\tilde{u}^*_a,\tilde{u}_b}|^2 B_{00}\Big(p^2, m^2_{\tilde{u}_a}, m^2_{\tilde{u}_b}\Big) \\
&+ \frac{1}{2}\sum_{a=1}^{8}\sum_{b=1}^{8}\Big[\Big(|\Gamma^{L}_{Z^\prime,\tilde{\chi}^0_a,\tilde{\chi}^0_b}|^2 + |\Gamma^{R}_{Z^\prime,\tilde{\chi}^0_a,\tilde{\chi}^0_b}|^2\Big) H_0\Big(p^2, m^2_{\tilde{\chi}^0_a}, m^2_{\tilde{\chi}^0_b}\Big)
\end{aligned}
$$

$$+ 4B_0\Big(p^2, m^2_{\tilde{\chi}^0_a}, m^2_{\tilde{\chi}^0_b}\Big) m_{\tilde{\chi}^0_a} m_{\tilde{\chi}^0_b} \Re\Big(\Gamma^{L*}_{Z',\tilde{\chi}^0_a,\tilde{\chi}^0_b} \Gamma^{R}_{Z',\tilde{\chi}^0_a,\tilde{\chi}^0_b}\Big)\Big]$$
$$+ 2\sum_{b=1}^{2} |\Gamma_{Z',W^+,H^-_b}|^2 B_0\Big(p^2, m^2_{W^-}, m^2_{H^-_b}\Big) + \sum_{b=1}^{5} |\Gamma_{Z',Z,h_b}|^2 B_0\Big(p^2, m^2_Z, m^2_{h_b}\Big)$$
$$+ \sum_{b=1}^{5} |\Gamma_{Z',Z',h_b}|^2 B_0\Big(p^2, m^2_{Z'}, m^2_{h_b}\Big) + 2\mathrm{rMS} m^2_{W^-} \Gamma^1_{Z',Z',W^+,W^-} - A_0\Big(m^2_{W^-}\Big)\Big(4\Gamma^1_{Z',Z',W^+,W^-} + \Gamma^2_{Z',Z',W^+,W^-} + \Gamma^3_{Z',Z',W} \tag{318}$$

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

$$\Pi(p^2) = -12\sum_{a=1}^{6}\sum_{b=1}^{6} |\Gamma_{W^+,\tilde{u}^*_a,\tilde{d}_b}|^2 B_{00}\Big(p^2, m^2_{\tilde{d}_b}, m^2_{\tilde{u}_a}\Big) + 2\mathrm{rMS} m^2_{W^-} \Gamma^1_{W^-,W^+,W^+,W^-} + 3\sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big(|\Gamma^L_{W^+,\bar{u}_a,d_b}|^2 + |\Gamma^R_{W^+,\bar{u}_a,d_b}|^2\Big) B$$
$$+ 4B_0\Big(p^2, m^2_{u_a}, m^2_{d_b}\Big) m_{d_b} m_{u_a} \Re\Big(\Gamma^{L*}_{W^+,\bar{u}_a,d_b} \Gamma^{R}_{W^+,\bar{u}_a,d_b}\Big)\Big] + 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{d}_a}\Big)\Gamma_{W^-,W^+,\tilde{d}^*_a,\tilde{d}_a} + 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{u}_a}\Big)\Gamma_{W^-,W^+,\tilde{u}^*_a,\tilde{u}_a} +$$
$$+ 4B_0\Big(p^2, m^2_{\tilde{\chi}'^0_a}, m^2_{\tilde{\chi}'^-}\Big) m_{\tilde{\chi}'^-} m_{\tilde{\chi}'^0_a} \Re\Big(\Gamma^{L*}_{W^+,\tilde{\chi}'^0_a,\mathrm{ChaP}\left(\{1\}\right)} \Gamma^{R}_{W^+,\tilde{\chi}'^0_a,\mathrm{ChaP}\left(\{1\}\right)}\Big)\Big] + \sum_{a=1}^{3} A_0\Big(m^2_{\tilde{\nu}_a}\Big)\Gamma_{W^-,W^+,\tilde{\nu}^*_a,\tilde{\nu}_a} + \sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big($$
$$+ 4B_0\Big(p^2, m^2_{\nu_a}, m^2_{e_b}\Big) m_{e_b} m_{\nu_a} \Re\Big(\Gamma^{L*}_{W^+,\bar{\nu}_a,e_b} \Gamma^{R}_{W^+,\bar{\nu}_a,e_b}\Big)\Big] + \sum_{a=1}^{6} A_0\Big(m^2_{\tilde{e}_a}\Big)\Gamma_{W^-,W^+,\tilde{e}^*_a,\tilde{e}_a} + \sum_{a=1}^{8}\sum_{b=1}^{2}\Big[\Big(|\Gamma^L_{W^+,\tilde{\chi}^0_a,\tilde{\chi}^-_b}|^2 + |\Gamma^R_{W^+,\tilde{\chi}^0_a}$$
$$+ 4B_0\Big(p^2, m^2_{\tilde{\chi}^0_a}, m^2_{\tilde{\chi}^-_b}\Big) m_{\tilde{\chi}^-_b} m_{\tilde{\chi}^0_a} \Re\Big(\Gamma^{L*}_{W^+,\tilde{\chi}^0_a,\tilde{\chi}^-_b} \Gamma^{R}_{W^+,\tilde{\chi}^0_a,\tilde{\chi}^-_b}\Big)\Big] + \sum_{b=1}^{2} |\Gamma_{W^+,\gamma,H^-_b}|^2 B_0\Big(p^2, 0, m^2_{H^-_b}\Big) + \sum_{b=1}^{2} |\Gamma_{W^+,Z,H^-_b}|^2 B_0\Big(p^2, $$
(319)

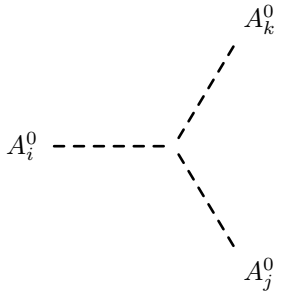
8.2 Tadpoles

$$\delta t^{(1)}_h = + A_0\Big(m^2_{\eta^-}\Big)\Gamma_{\check{h}_i,\eta^-,\eta^-} + A_0\Big(m^2_{\eta^+}\Big)\Gamma_{\check{h}_i,\eta^+,\eta^+} + A_0\Big(m^2_{\eta^Z}\Big)\Gamma_{\check{h}_i,\eta^Z,\eta^Z}$$
$$+ A_0\Big(m^2_{\eta^{Z'}}\Big)\Gamma_{\check{h}_i,\eta^{\bar{Z}'},\eta^{Z'}} + 4\Gamma_{\check{h}_i,W^+,W^-}\Big(-\frac{1}{2}\mathrm{rMS} m^2_{W^-} + A_0\Big(m^2_{W^-}\Big)\Big) + 2\Gamma_{\check{h}_i,Z,Z}\Big(-\frac{1}{2}\mathrm{rMS} m^2_Z + A_0\Big(m^2_Z\Big)\Big)$$
$$+ 2\Gamma_{\check{h}_i,Z',Z'}\Big(-\frac{1}{2}\mathrm{rMS} m^2_{Z'} + A_0\Big(m^2_{Z'}\Big)\Big) - \sum_{a=1}^{2} A_0\Big(m^2_{H^-_a}\Big)\Gamma_{\check{h}_i,H^+_a,H^-_a} - \sum_{a=1}^{2} A_0\Big(m^2_{H'^0_a}\Big)\Gamma_{\check{h}_i,H'^{0,*}_a,H'^0_a}$$
$$- \sum_{a=1}^{2} A_0\Big(m^2_{H'^-_a}\Big)\Gamma_{\check{h}_i,H'^+_a,H'^-_a} + 2\sum_{a=1}^{2} A_0\Big(m^2_{\tilde{\chi}^-_a}\Big) m_{\tilde{\chi}^-_a}\Big(\Gamma^L_{\check{h}_i,\tilde{\chi}^+_a,\tilde{\chi}^-_a} + \Gamma^R_{\check{h}_i,\tilde{\chi}^+_a,\tilde{\chi}^-_a}\Big)$$
$$- \sum_{a=1}^{3} A_0\Big(m^2_{\tilde{\nu}_a}\Big)\Gamma_{\check{h}_i,\tilde{\nu}^*_a,\tilde{\nu}_a} + 6\sum_{a=1}^{3} A_0\Big(m^2_{d_a}\Big) m_{d_a}\Big(\Gamma^L_{\check{h}_i,\bar{d}_a,d_a} + \Gamma^R_{\check{h}_i,\bar{d}_a,d_a}\Big)$$
$$+ 6\sum_{a=1}^{3} A_0\Big(m^2_{x_a}\Big) m_{x_a}\Big(\Gamma^L_{\check{h}_i,\bar{x}_a,x_a} + \Gamma^R_{\check{h}_i,\bar{x}_a,x_a}\Big)$$

$$
\begin{aligned}
&+ 2\sum_{a=1}^{3} A_0\Big(m_{e_a}^2\Big) m_{e_a}\Big(\Gamma^L_{\check{h}_i,\bar{e}_a,e_a} + \Gamma^R_{\check{h}_i,\bar{e}_a,e_a}\Big) \\
&+ 6\sum_{a=1}^{3} A_0\Big(m_{u_a}^2\Big) m_{u_a}\Big(\Gamma^L_{\check{h}_i,\bar{u}_a,u_a} + \Gamma^R_{\check{h}_i,\bar{u}_a,u_a}\Big) - \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{A^0_a}\Big)\Gamma_{\check{h}_i,A^0_a,A^0_a} \\
&- \frac{1}{2}\sum_{a=1}^{5} A_0\Big(m^2_{h_a}\Big)\Gamma_{\check{h}_i,h_a,h_a} - 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{d}_a}\Big)\Gamma_{\check{h}_i,\tilde{d}^*_a,\tilde{d}_a} - 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{x}_a}\Big)\Gamma_{\check{h}_i,\tilde{x}^*_a,\tilde{x}_a} \\
&- \sum_{a=1}^{6} A_0\Big(m^2_{\tilde{e}_a}\Big)\Gamma_{\check{h}_i,\tilde{e}^*_a,\tilde{e}_a} - 3\sum_{a=1}^{6} A_0\Big(m^2_{\tilde{u}_a}\Big)\Gamma_{\check{h}_i,\tilde{u}^*_a,\tilde{u}_a} \\
&+ \sum_{a=1}^{8} A_0\Big(m^2_{\tilde{\chi}^0_a}\Big) m_{\tilde{\chi}^0_a}\Big(\Gamma^L_{\check{h}_i,\tilde{\chi}^0_a,\tilde{\chi}^0_a} + \Gamma^R_{\check{h}_i,\tilde{\chi}^0_a,\tilde{\chi}^0_a}\Big)
\end{aligned} \tag{320}
$$

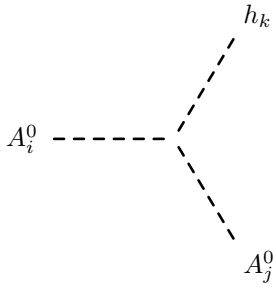
9 Interactions for eigenstates 'EWSB'

9.1 Three Scalar-Interaction



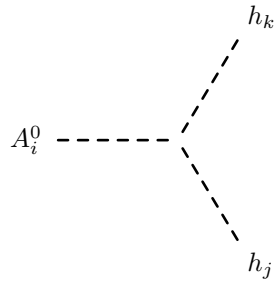
$$
\begin{aligned}
&\frac{1}{4}\Big(- vphi\sigma\lambda^* U_{A,i4}U_{A,j2}U_{A,k1} + vphi\lambda\sigma'^{,*}U_{A,i4}U_{A,j2}U_{A,k1} - vsb\sigma\lambda^* U_{A,i5}U_{A,j2}U_{A,k1} \\
&+ vsb\lambda\sigma'^{,*}U_{A,i5}U_{A,j2}U_{A,k1} - vphi\sigma\lambda^* U_{A,i2}U_{A,j4}U_{A,k1} + vphi\lambda\sigma'^{,*}U_{A,i2}U_{A,j4}U_{A,k1} \\
&+ v_2\sigma\lambda^* U_{A,i5}U_{A,j4}U_{A,k1} - v_2\lambda\sigma'^{,*}U_{A,i5}U_{A,j4}U_{A,k1} - vsb\sigma\lambda^* U_{A,i2}U_{A,j5}U_{A,k1} \\
&+ vsb\lambda\sigma'^{,*}U_{A,i2}U_{A,j5}U_{A,k1} + v_2\sigma\lambda^* U_{A,i4}U_{A,j5}U_{A,k1} - v_2\lambda\sigma'^{,*}U_{A,i4}U_{A,j5}U_{A,k1} \\
&- vphi\sigma\lambda^* U_{A,i4}U_{A,j1}U_{A,k2} + vphi\lambda\sigma'^{,*}U_{A,i4}U_{A,j1}U_{A,k2} - vsb\sigma\lambda^* U_{A,i5}U_{A,j1}U_{A,k2} \\
&+ vsb\lambda\sigma'^{,*}U_{A,i5}U_{A,j1}U_{A,k2} - vphi\sigma\lambda^* U_{A,i1}U_{A,j4}U_{A,k2} + vphi\lambda\sigma'^{,*}U_{A,i1}U_{A,j4}U_{A,k2} \\
&+ v_1\sigma\lambda^* U_{A,i5}U_{A,j4}U_{A,k2} - v_1\lambda\sigma'^{,*}U_{A,i5}U_{A,j4}U_{A,k2} - vsb\sigma\lambda^* U_{A,i1}U_{A,j5}U_{A,k2} \\
&+ vsb\lambda\sigma'^{,*}U_{A,i1}U_{A,j5}U_{A,k2} + v_1\sigma\lambda^* U_{A,i4}U_{A,j5}U_{A,k2} - v_1\lambda\sigma'^{,*}U_{A,i4}U_{A,j5}U_{A,k2} \\
&- \sqrt{2}\sigma Mu^*_{phi}U_{A,i5}U_{A,j4}U_{A,k3} - 2vphi\sigma\kappa'^{,*}U_{A,i5}U_{A,j4}U_{A,k3} + \sqrt{2}Mu_{phi}\sigma'^{,*}U_{A,i5}U_{A,j4}U_{A,k3} \\
&+ 2vphi\kappa'\sigma'^{,*}U_{A,i5}U_{A,j4}U_{A,k3} - \sqrt{2}T^*_\sigma U_{A,i5}U_{A,j4}U_{A,k3} + \sqrt{2}T_\sigma U_{A,i5}U_{A,j4}U_{A,k3} \\
&- \sqrt{2}\sigma Mu^*_{phi}U_{A,i4}U_{A,j5}U_{A,k3} - 2vphi\sigma\kappa'^{,*}U_{A,i4}U_{A,j5}U_{A,k3} + \sqrt{2}Mu_{phi}\sigma'^{,*}U_{A,i4}U_{A,j5}U_{A,k3} \\
&+ 2vphi\kappa'\sigma'^{,*}U_{A,i4}U_{A,j5}U_{A,k3} - \sqrt{2}T^*_\sigma U_{A,i4}U_{A,j5}U_{A,k3} + \sqrt{2}T_\sigma U_{A,i4}U_{A,j5}U_{A,k3}
\end{aligned}
$$

$$
\begin{aligned}
&+ 2vsb\sigma\kappa^{\prime,*}U_{A,i5}U_{A,j5}U_{A,k3} - 2vsb\kappa^{\prime}\sigma^{\prime,*}U_{A,i5}U_{A,j5}U_{A,k3} \\
&- \sqrt{2}T_{\lambda}^{*}\Big(U_{A,i1}\Big(U_{A,j2}U_{A,k3} + U_{A,j3}U_{A,k2}\Big) + U_{A,i2}\Big(U_{A,j1}U_{A,k3} + U_{A,j3}U_{A,k1}\Big) + U_{A,i3}\Big(U_{A,j1}U_{A,k2} + U_{A,j2}U_{A,k1}\Big)\Big) \\
&+ \sqrt{2}T_{\lambda}\Big(U_{A,i1}\Big(U_{A,j2}U_{A,k3} + U_{A,j3}U_{A,k2}\Big) + U_{A,i2}\Big(U_{A,j1}U_{A,k3} + U_{A,j3}U_{A,k1}\Big) + U_{A,i3}\Big(U_{A,j1}U_{A,k2} + U_{A,j2}U_{A,k1}\Big)\Big) \\
&- vphi\sigma\lambda^{*}U_{A,i2}U_{A,j1}U_{A,k4} + vphi\lambda\sigma^{\prime,*}U_{A,i2}U_{A,j1}U_{A,k4} + v_2\sigma\lambda^{*}U_{A,i5}U_{A,j1}U_{A,k4} \\
&- v_2\lambda\sigma^{\prime,*}U_{A,i5}U_{A,j1}U_{A,k4} - vphi\sigma\lambda^{*}U_{A,i1}U_{A,j2}U_{A,k4} + vphi\lambda\sigma^{\prime,*}U_{A,i1}U_{A,j2}U_{A,k4} \\
&+ v_1\sigma\lambda^{*}U_{A,i5}U_{A,j2}U_{A,k4} - v_1\lambda\sigma^{\prime,*}U_{A,i5}U_{A,j2}U_{A,k4} - \sqrt{2}\sigma Mu_{phi}^{*}U_{A,i5}U_{A,j3}U_{A,k4} \\
&- 2vphi\sigma\kappa^{\prime,*}U_{A,i5}U_{A,j3}U_{A,k4} + \sqrt{2}Mu_{phi}\sigma^{\prime,*}U_{A,i5}U_{A,j3}U_{A,k4} + 2vphi\kappa^{\prime}\sigma^{\prime,*}U_{A,i5}U_{A,j3}U_{A,k4} \\
&- \sqrt{2}T_{\sigma}^{*}U_{A,i5}U_{A,j3}U_{A,k4} + \sqrt{2}T_{\sigma}U_{A,i5}U_{A,j3}U_{A,k4} + v_2\sigma\lambda^{*}U_{A,i1}U_{A,j5}U_{A,k4} \\
&- v_2\lambda\sigma^{\prime,*}U_{A,i1}U_{A,j5}U_{A,k4} + v_1\sigma\lambda^{*}U_{A,i2}U_{A,j5}U_{A,k4} - v_1\lambda\sigma^{\prime,*}U_{A,i2}U_{A,j5}U_{A,k4} \\
&- \sqrt{2}\sigma Mu_{phi}^{*}U_{A,i3}U_{A,j5}U_{A,k4} - 2vphi\sigma\kappa^{\prime,*}U_{A,i3}U_{A,j5}U_{A,k4} + \sqrt{2}Mu_{phi}\sigma^{\prime,*}U_{A,i3}U_{A,j5}U_{A,k4} \\
&+ 2vphi\kappa^{\prime}\sigma^{\prime,*}U_{A,i3}U_{A,j5}U_{A,k4} - \sqrt{2}T_{\sigma}^{*}U_{A,i3}U_{A,j5}U_{A,k4} + \sqrt{2}T_{\sigma}U_{A,i3}U_{A,j5}U_{A,k4} \\
&+ 2v_s\sigma\kappa^{\prime,*}U_{A,i5}U_{A,j5}U_{A,k4} - 2v_s\kappa^{\prime}\sigma^{\prime,*}U_{A,i5}U_{A,j5}U_{A,k4} - vsb\sigma\lambda^{*}U_{A,i2}U_{A,j1}U_{A,k5} \\
&+ vsb\lambda\sigma^{\prime,*}U_{A,i2}U_{A,j1}U_{A,k5} + v_2\sigma\lambda^{*}U_{A,i4}U_{A,j1}U_{A,k5} - v_2\lambda\sigma^{\prime,*}U_{A,i4}U_{A,j1}U_{A,k5} \\
&- vsb\sigma\lambda^{*}U_{A,i1}U_{A,j2}U_{A,k5} + vsb\lambda\sigma^{\prime,*}U_{A,i1}U_{A,j2}U_{A,k5} + v_1\sigma\lambda^{*}U_{A,i4}U_{A,j2}U_{A,k5} \\
&- v_1\lambda\sigma^{\prime,*}U_{A,i4}U_{A,j2}U_{A,k5} - \sqrt{2}\sigma Mu_{phi}^{*}U_{A,i4}U_{A,j3}U_{A,k5} - 2vphi\sigma\kappa^{\prime,*}U_{A,i4}U_{A,j3}U_{A,k5} \\
&+ \sqrt{2}Mu_{phi}\sigma^{\prime,*}U_{A,i4}U_{A,j3}U_{A,k5} + 2vphi\kappa^{\prime}\sigma^{\prime,*}U_{A,i4}U_{A,j3}U_{A,k5} - \sqrt{2}T_{\sigma}^{*}U_{A,i4}U_{A,j3}U_{A,k5} \\
&+ \sqrt{2}T_{\sigma}U_{A,i4}U_{A,j3}U_{A,k5} + 2vsb\sigma\kappa^{\prime,*}U_{A,i5}U_{A,j3}U_{A,k5} - 2vsb\kappa^{\prime}\sigma^{\prime,*}U_{A,i5}U_{A,j3}U_{A,k5} \\
&+ v_2\sigma\lambda^{*}U_{A,i1}U_{A,j4}U_{A,k5} - v_2\lambda\sigma^{\prime,*}U_{A,i1}U_{A,j4}U_{A,k5} + v_1\sigma\lambda^{*}U_{A,i2}U_{A,j4}U_{A,k5} \\
&- v_1\lambda\sigma^{\prime,*}U_{A,i2}U_{A,j4}U_{A,k5} - \sqrt{2}\sigma Mu_{phi}^{*}U_{A,i3}U_{A,j4}U_{A,k5} - 2vphi\sigma\kappa^{\prime,*}U_{A,i3}U_{A,j4}U_{A,k5} \\
&+ \sqrt{2}Mu_{phi}\sigma^{\prime,*}U_{A,i3}U_{A,j4}U_{A,k5} + 2vphi\kappa^{\prime}\sigma^{\prime,*}U_{A,i3}U_{A,j4}U_{A,k5} - \sqrt{2}T_{\sigma}^{*}U_{A,i3}U_{A,j4}U_{A,k5} \\
&+ \sqrt{2}T_{\sigma}U_{A,i3}U_{A,j4}U_{A,k5} + 2v_s\sigma\kappa^{\prime,*}U_{A,i5}U_{A,j4}U_{A,k5} - 2v_s\kappa^{\prime}\sigma^{\prime,*}U_{A,i5}U_{A,j4}U_{A,k5} \\
&+ 2vsb\sigma\kappa^{\prime,*}U_{A,i3}U_{A,j5}U_{A,k5} - 2vsb\kappa^{\prime}\sigma^{\prime,*}U_{A,i3}U_{A,j5}U_{A,k5} + 2v_s\sigma\kappa^{\prime,*}U_{A,i4}U_{A,j5}U_{A,k5} \\
&- 2v_s\kappa^{\prime}\sigma^{\prime,*}U_{A,i4}U_{A,j5}U_{A,k5} + 6\sqrt{2}\kappa^{\prime}Mu_{phi}^{*}U_{A,i5}U_{A,j5}U_{A,k5} - 6\sqrt{2}Mu_{phi}\kappa^{\prime,*}U_{A,i5}U_{A,j5}U_{A,k5} \\
&+ 2\sqrt{2}T_{\kappa^{\prime},*}U_{A,i5}U_{A,j5}U_{A,k5} - 2\sqrt{2}T_{\kappa^{\prime}}U_{A,i5}U_{A,j5}U_{A,k5}\Big)
\end{aligned}
\tag{321}
$$



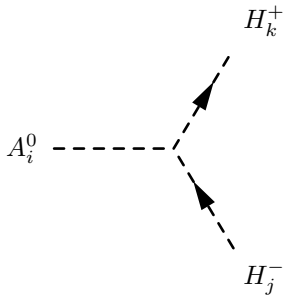
$$
\begin{aligned}
&\frac{i}{4}\Big(12g_{1'}^2 Q_S v_s U_{H,k3}^* U_{A,i1} U_{A,j1} - 4v_s|\lambda|^2 U_{H,k3}^* U_{A,i1} U_{A,j1} - 12g_{1'}^2 Q_S vsb U_{H,k4}^* U_{A,i1} U_{A,j1} \\
&- \sqrt{2} T_\lambda^* U_{H,k3}^* U_{A,i2} U_{A,j1} + vphi\sigma\lambda^* U_{H,k4}^* U_{A,i2} U_{A,j1} + vphi\lambda\sigma'^{,*} U_{H,k4}^* U_{A,i2} U_{A,j1} \\
&+ vsb\sigma\lambda^* U_{H,k5}^* U_{A,i2} U_{A,j1} + vsb\lambda\sigma'^{,*} U_{H,k5}^* U_{A,i2} U_{A,j1} - \sqrt{2} U_{H,k3}^* T_\lambda U_{A,i2} U_{A,j1} \\
&- v_2\sigma\lambda^* U_{H,k5}^* U_{A,i4} U_{A,j1} - v_2\lambda\sigma'^{,*} U_{H,k5}^* U_{A,i4} U_{A,j1} - v_2\sigma\lambda^* U_{H,k4}^* U_{A,i5} U_{A,j1} \\
&- v_2\lambda\sigma'^{,*} U_{H,k4}^* U_{A,i5} U_{A,j1} - \sqrt{2} T_\lambda^* U_{H,k3}^* U_{A,i1} U_{A,j2} + vphi\sigma\lambda^* U_{H,k4}^* U_{A,i1} U_{A,j2} \\
&+ vphi\lambda\sigma'^{,*} U_{H,k4}^* U_{A,i1} U_{A,j2} + vsb\sigma\lambda^* U_{H,k5}^* U_{A,i1} U_{A,j2} + vsb\lambda\sigma'^{,*} U_{H,k5}^* U_{A,i1} U_{A,j2} \\
&- \sqrt{2} U_{H,k3}^* T_\lambda U_{A,i1} U_{A,j2} + 8g_{1'}^2 Q_S v_s U_{H,k3}^* U_{A,i2} U_{A,j2} - 4v_s|\lambda|^2 U_{H,k3}^* U_{A,i2} U_{A,j2} \\
&- 8g_{1'}^2 Q_S vsb U_{H,k4}^* U_{A,i2} U_{A,j2} - v_1\sigma\lambda^* U_{H,k5}^* U_{A,i4} U_{A,j2} - v_1\lambda\sigma'^{,*} U_{H,k5}^* U_{A,i4} U_{A,j2} \\
&- v_1\sigma\lambda^* U_{H,k4}^* U_{A,i5} U_{A,j2} - v_1\lambda\sigma'^{,*} U_{H,k4}^* U_{A,i5} U_{A,j2} - 4g_{1'}^2 Q_S^2 v_s U_{H,k3}^* U_{A,i3} U_{A,j3} \\
&+ 4g_{1'}^2 Q_S^2 vsb U_{H,k4}^* U_{A,i3} U_{A,j3} - 4vsb|\sigma|^2 U_{H,k4}^* U_{A,i3} U_{A,j3} - 4vphi|\sigma|^2 U_{H,k5}^* U_{A,i3} U_{A,j3} \\
&- \sqrt{2}\sigma M u_{phi}^* U_{H,k5}^* U_{A,i4} U_{A,j3} - 2vphi\sigma\kappa'^{,*} U_{H,k5}^* U_{A,i4} U_{A,j3} - \sqrt{2} M u_{phi}\sigma'^{,*} U_{H,k5}^* U_{A,i4} U_{A,j3} \\
&- 2vphi\kappa'\sigma'^{,*} U_{H,k5}^* U_{A,i4} U_{A,j3} - \sqrt{2} T_\sigma^* U_{H,k5}^* U_{A,i4} U_{A,j3} - \sqrt{2} U_{H,k5}^* T_\sigma U_{A,i4} U_{A,j3} \\
&+ \sqrt{2}\sigma M u_{phi}^* U_{H,k4}^* U_{A,i5} U_{A,j3} + 2vphi\sigma\kappa'^{,*} U_{H,k4}^* U_{A,i5} U_{A,j3} + \sqrt{2} M u_{phi}\sigma'^{,*} U_{H,k4}^* U_{A,i5} U_{A,j3} \\
&+ 2vphi\kappa'\sigma'^{,*} U_{H,k4}^* U_{A,i5} U_{A,j3} - \sqrt{2} T_\sigma^* U_{H,k4}^* U_{A,i5} U_{A,j3} + 2vsb\sigma\kappa'^{,*} U_{H,k5}^* U_{A,i5} U_{A,j3} \\
&+ 2vsb\kappa'\sigma'^{,*} U_{H,k5}^* U_{A,i5} U_{A,j3} - \sqrt{2} U_{H,k4}^* T_\sigma U_{A,i5} U_{A,j3} - v_2\sigma\lambda^* U_{H,k5}^* U_{A,i1} U_{A,j4} \\
&- v_2\lambda\sigma'^{,*} U_{H,k5}^* U_{A,i1} U_{A,j4} - v_1\sigma\lambda^* U_{H,k5}^* U_{A,i2} U_{A,j4} - v_1\lambda\sigma'^{,*} U_{H,k5}^* U_{A,i2} U_{A,j4} \\
&- \sqrt{2}\sigma M u_{phi}^* U_{H,k5}^* U_{A,i3} U_{A,j4} - 2vphi\sigma\kappa'^{,*} U_{H,k5}^* U_{A,i3} U_{A,j4} - \sqrt{2} M u_{phi}\sigma'^{,*} U_{H,k5}^* U_{A,i3} U_{A,j4} \\
&- 2vphi\kappa'\sigma'^{,*} U_{H,k5}^* U_{A,i3} U_{A,j4} - \sqrt{2} T_\sigma^* U_{H,k5}^* U_{A,i3} U_{A,j4} - \sqrt{2} U_{H,k5}^* T_\sigma U_{A,i3} U_{A,j4} \\
&+ 4g_{1'}^2 Q_S^2 v_s U_{H,k3}^* U_{A,i4} U_{A,j4} - 4v_s|\sigma|^2 U_{H,k3}^* U_{A,i4} U_{A,j4} - 4g_{1'}^2 Q_S^2 vsb U_{H,k4}^* U_{A,i4} U_{A,j4} \\
&- 4vphi|\sigma|^2 U_{H,k5}^* U_{A,i4} U_{A,j4} + \sqrt{2}\sigma M u_{phi}^* U_{H,k3}^* U_{A,i5} U_{A,j4} + 2vphi\sigma\kappa'^{,*} U_{H,k3}^* U_{A,i5} U_{A,j4} \\
&+ \sqrt{2} M u_{phi}\sigma'^{,*} U_{H,k3}^* U_{A,i5} U_{A,j4} + 2vphi\kappa'\sigma'^{,*} U_{H,k3}^* U_{A,i5} U_{A,j4} - \sqrt{2} T_\sigma^* U_{H,k3}^* U_{A,i5} U_{A,j4} \\
&+ 2v_s\sigma\kappa'^{,*} U_{H,k5}^* U_{A,i5} U_{A,j4} + 2v_s\kappa'\sigma'^{,*} U_{H,k5}^* U_{A,i5} U_{A,j4} - \sqrt{2} U_{H,k3}^* T_\sigma U_{A,i5} U_{A,j4} \\
&- v_2\sigma\lambda^* U_{H,k4}^* U_{A,i1} U_{A,j5} - v_2\lambda\sigma'^{,*} U_{H,k4}^* U_{A,i1} U_{A,j5} - v_1\sigma\lambda^* U_{H,k4}^* U_{A,i2} U_{A,j5} \\
&- v_1\lambda\sigma'^{,*} U_{H,k4}^* U_{A,i2} U_{A,j5} + \sqrt{2}\sigma M u_{phi}^* U_{H,k4}^* U_{A,i3} U_{A,j5} + 2vphi\sigma\kappa'^{,*} U_{H,k4}^* U_{A,i3} U_{A,j5} \\
&+ \sqrt{2} M u_{phi}\sigma'^{,*} U_{H,k4}^* U_{A,i3} U_{A,j5} + 2vphi\kappa'\sigma'^{,*} U_{H,k4}^* U_{A,i3} U_{A,j5} - \sqrt{2} T_\sigma^* U_{H,k4}^* U_{A,i3} U_{A,j5} \\
&+ 2vsb\sigma\kappa'^{,*} U_{H,k5}^* U_{A,i3} U_{A,j5} + 2vsb\kappa'\sigma'^{,*} U_{H,k5}^* U_{A,i3} U_{A,j5} - \sqrt{2} U_{H,k4}^* T_\sigma U_{A,i3} U_{A,j5} \\
&+ \sqrt{2}\sigma M u_{phi}^* U_{H,k3}^* U_{A,i4} U_{A,j5} + 2vphi\sigma\kappa'^{,*} U_{H,k3}^* U_{A,i4} U_{A,j5} + \sqrt{2} M u_{phi}\sigma'^{,*} U_{H,k3}^* U_{A,i4} U_{A,j5} \\
&+ 2vphi\kappa'\sigma'^{,*} U_{H,k3}^* U_{A,i4} U_{A,j5} - \sqrt{2} T_\sigma^* U_{H,k3}^* U_{A,i4} U_{A,j5} + 2v_s\sigma\kappa'^{,*} U_{H,k5}^* U_{A,i4} U_{A,j5} \\
&+ 2v_s\kappa'\sigma'^{,*} U_{H,k5}^* U_{A,i4} U_{A,j5} - \sqrt{2} U_{H,k3}^* T_\sigma U_{A,i4} U_{A,j5} - 4v_s|\sigma|^2 U_{H,k3}^* U_{A,i5} U_{A,j5} \\
&- 2vsb\sigma\kappa'^{,*} U_{H,k3}^* U_{A,i5} U_{A,j5} - 2vsb\kappa'\sigma'^{,*} U_{H,k3}^* U_{A,i5} U_{A,j5} - 4vsb|\sigma|^2 U_{H,k4}^* U_{A,i5} U_{A,j5} \\
&- 2v_s\sigma\kappa'^{,*} U_{H,k4}^* U_{A,i5} U_{A,j5} - 2v_s\kappa'\sigma'^{,*} U_{H,k4}^* U_{A,i5} U_{A,j5} - 8vphi|\kappa'|^2 U_{H,k5}^* U_{A,i5} U_{A,j5} \\
&- 2\sqrt{2}\kappa' M u_{phi}^* U_{H,k5}^* U_{A,i5} U_{A,j5} - 2\sqrt{2} M u_{phi}\kappa'^{,*} U_{H,k5}^* U_{A,i5} U_{A,j5} + 2\sqrt{2} T_{\kappa',*} U_{H,k5}^* U_{A,i5} U_{A,j5}
\end{aligned}
$$

$$
\begin{aligned}
&+ 2\sqrt{2}U^{*}_{H,k5}T_{\kappa'}U_{A,i5}U_{A,j5} \\
&+ U^{*}_{H,k2}\Big(- \sqrt{2}T^{*}_{\lambda}U_{A,i3}U_{A,j1} - \sqrt{2}T_{\lambda}U_{A,i3}U_{A,j1} - vphi\sigma\lambda^{*}U_{A,i4}U_{A,j1} - vphi\lambda\sigma^{\prime,*}U_{A,i4}U_{A,j1} \\
&- vsb\sigma\lambda^{*}U_{A,i5}U_{A,j1} - vsb\lambda\sigma^{\prime,*}U_{A,i5}U_{A,j1} - g_1^2v_2U_{A,i2}U_{A,j2} - 16g_{1^{\prime}}^2v_2U_{A,i2}U_{A,j2} \\
&- g_2^2v_2U_{A,i2}U_{A,j2} + 8g_{1^{\prime}}^2Q_Sv_2U_{A,i3}U_{A,j3} - 4v_2|\lambda|^2U_{A,i3}U_{A,j3} - 8g_{1^{\prime}}^2Q_Sv_2U_{A,i4}U_{A,j4} \\
&+ v_1\sigma\lambda^{*}U_{A,i5}U_{A,j4} + v_1\lambda\sigma^{\prime,*}U_{A,i5}U_{A,j4} + v_1\sigma\lambda^{*}U_{A,i4}U_{A,j5} + v_1\lambda\sigma^{\prime,*}U_{A,i4}U_{A,j5} \\
&+ U_{A,i1}\Big(v_2\Big(- 24g_{1^{\prime}}^2 - 4|\lambda|^2 + g_1^2 + g_2^2\Big)U_{A,j1} - \sqrt{2}T^{*}_{\lambda}U_{A,j3} - \sqrt{2}T_{\lambda}U_{A,j3} - vphi\sigma\lambda^{*}U_{A,j4} \\
&- vphi\lambda\sigma^{\prime,*}U_{A,j4} - vsb\sigma\lambda^{*}U_{A,j5} - vsb\lambda\sigma^{\prime,*}U_{A,j5}\Big)\Big) \\
&- U^{*}_{H,k1}\Big(\Big(36g_{1^{\prime}}^2 + g_1^2 + g_2^2\Big)v_1U_{A,i1}U_{A,j1} + \sqrt{2}T^{*}_{\lambda}U_{A,i3}U_{A,j2} + \sqrt{2}T_{\lambda}U_{A,i3}U_{A,j2} + vphi\sigma\lambda^{*}U_{A,i4}U_{A,j2} \\
&+ vphi\lambda\sigma^{\prime,*}U_{A,i4}U_{A,j2} + vsb\sigma\lambda^{*}U_{A,i5}U_{A,j2} + vsb\lambda\sigma^{\prime,*}U_{A,i5}U_{A,j2} - 12g_{1^{\prime}}^2Q_Sv_1U_{A,i3}U_{A,j3} \\
&+ 4v_1|\lambda|^2U_{A,i3}U_{A,j3} + 12g_{1^{\prime}}^2Q_Sv_1U_{A,i4}U_{A,j4} - v_2\sigma\lambda^{*}U_{A,i5}U_{A,j4} - v_2\lambda\sigma^{\prime,*}U_{A,i5}U_{A,j4} \\
&- v_2\sigma\lambda^{*}U_{A,i4}U_{A,j5} - v_2\lambda\sigma^{\prime,*}U_{A,i4}U_{A,j5} \\
&+ U_{A,i2}\Big(- v_1\Big(- 24g_{1^{\prime}}^2 - 4|\lambda|^2 + g_1^2 + g_2^2\Big)U_{A,j2} + \sqrt{2}T^{*}_{\lambda}U_{A,j3} + \sqrt{2}T_{\lambda}U_{A,j3} + vphi\sigma\lambda^{*}U_{A,j4} + vphi\lambda\sigma^{\prime,*}U_{A,j4} \\
&+ vsb\sigma\lambda^{*}U_{A,j5} + vsb\lambda\sigma^{\prime,*}U_{A,j5}\Big)\Big)\Big)
\end{aligned}
\tag{322}
$$

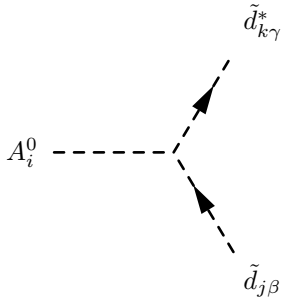


$$
\begin{aligned}
&\frac{1}{4}\Big(vphi\lambda\sigma^{\prime,*}U^{*}_{H,j4}U^{*}_{H,k2}U_{A,i1} + vsb\lambda\sigma^{\prime,*}U^{*}_{H,j5}U^{*}_{H,k2}U_{A,i1} + vphi\lambda\sigma^{\prime,*}U^{*}_{H,j2}U^{*}_{H,k4}U_{A,i1} \\
&+ v_2\lambda\sigma^{\prime,*}U^{*}_{H,j5}U^{*}_{H,k4}U_{A,i1} + vsb\lambda\sigma^{\prime,*}U^{*}_{H,j2}U^{*}_{H,k5}U_{A,i1} + v_2\lambda\sigma^{\prime,*}U^{*}_{H,j4}U^{*}_{H,k5}U_{A,i1} \\
&- \sqrt{2}U^{*}_{H,j3}U^{*}_{H,k2}T_{\lambda}U_{A,i1} - \sqrt{2}U^{*}_{H,j2}U^{*}_{H,k3}T_{\lambda}U_{A,i1} + vphi\lambda\sigma^{\prime,*}U^{*}_{H,j4}U^{*}_{H,k1}U_{A,i2} \\
&+ vsb\lambda\sigma^{\prime,*}U^{*}_{H,j5}U^{*}_{H,k1}U_{A,i2} + vphi\lambda\sigma^{\prime,*}U^{*}_{H,j1}U^{*}_{H,k4}U_{A,i2} + v_1\lambda\sigma^{\prime,*}U^{*}_{H,j5}U^{*}_{H,k4}U_{A,i2} \\
&+ vsb\lambda\sigma^{\prime,*}U^{*}_{H,j1}U^{*}_{H,k5}U_{A,i2} + v_1\lambda\sigma^{\prime,*}U^{*}_{H,j4}U^{*}_{H,k5}U_{A,i2} - \sqrt{2}U^{*}_{H,j3}U^{*}_{H,k1}T_{\lambda}U_{A,i2} \\
&- \sqrt{2}U^{*}_{H,j1}U^{*}_{H,k3}T_{\lambda}U_{A,i2} - \sqrt{2}\sigma Mu^{*}_{phi}U^{*}_{H,j5}U^{*}_{H,k4}U_{A,i3} - 2vphi\sigma\kappa^{\prime,*}U^{*}_{H,j5}U^{*}_{H,k4}U_{A,i3} \\
&+ \sqrt{2}Mu_{phi}\sigma^{\prime,*}U^{*}_{H,j5}U^{*}_{H,k4}U_{A,i3} + 2vphi\kappa^{\prime}\sigma^{\prime,*}U^{*}_{H,j5}U^{*}_{H,k4}U_{A,i3} + \sqrt{2}T^{*}_{\sigma}U^{*}_{H,j5}U^{*}_{H,k4}U_{A,i3} \\
&- \sqrt{2}\sigma Mu^{*}_{phi}U^{*}_{H,j4}U^{*}_{H,k5}U_{A,i3} - 2vphi\sigma\kappa^{\prime,*}U^{*}_{H,j4}U^{*}_{H,k5}U_{A,i3} + \sqrt{2}Mu_{phi}\sigma^{\prime,*}U^{*}_{H,j4}U^{*}_{H,k5}U_{A,i3} \\
&+ 2vphi\kappa^{\prime}\sigma^{\prime,*}U^{*}_{H,j4}U^{*}_{H,k5}U_{A,i3} + \sqrt{2}T^{*}_{\sigma}U^{*}_{H,j4}U^{*}_{H,k5}U_{A,i3} - 2vsb\sigma\kappa^{\prime,*}U^{*}_{H,j5}U^{*}_{H,k5}U_{A,i3}
\end{aligned}
$$

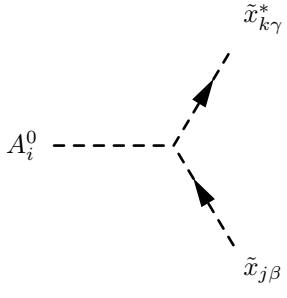
$$
\begin{aligned}
&+ 2vsb\kappa'\sigma'^{,*}U^*_{H,j5}U^*_{H,k5}U_{A,i3} - \sqrt{2}U^*_{H,j2}U^*_{H,k1}T_\lambda U_{A,i3} - \sqrt{2}U^*_{H,j1}U^*_{H,k2}T_\lambda U_{A,i3}\\
&- \sqrt{2}U^*_{H,j5}U^*_{H,k4}T_\sigma U_{A,i3} - \sqrt{2}U^*_{H,j4}U^*_{H,k5}T_\sigma U_{A,i3}\\
&+ \sqrt{2}T^*_\lambda\Big(U^*_{H,j1}\Big(U^*_{H,k2}U_{A,i3} + U^*_{H,k3}U_{A,i2}\Big) + U^*_{H,j2}\Big(U^*_{H,k1}U_{A,i3} + U^*_{H,k3}U_{A,i1}\Big) + U^*_{H,j3}\Big(U^*_{H,k1}U_{A,i2} + U^*_{H,k2}U_{A,i1}\Big)\Big)\\
&- vphi\lambda\sigma'^{,*}U^*_{H,j2}U^*_{H,k1}U_{A,i4} - v_2\lambda\sigma'^{,*}U^*_{H,j5}U^*_{H,k1}U_{A,i4} - vphi\lambda\sigma'^{,*}U^*_{H,j1}U^*_{H,k2}U_{A,i4}\\
&- v_1\lambda\sigma'^{,*}U^*_{H,j5}U^*_{H,k2}U_{A,i4} - \sqrt{2}\sigma Mu^*_{phi}U^*_{H,j5}U^*_{H,k3}U_{A,i4} - 2vphi\sigma\kappa'^{,*}U^*_{H,j5}U^*_{H,k3}U_{A,i4}\\
&+ \sqrt{2}Mu_{phi}\sigma'^{,*}U^*_{H,j5}U^*_{H,k3}U_{A,i4} + 2vphi\kappa'\sigma'^{,*}U^*_{H,j5}U^*_{H,k3}U_{A,i4} + \sqrt{2}T^*_\sigma U^*_{H,j5}U^*_{H,k3}U_{A,i4}\\
&- v_2\lambda\sigma'^{,*}U^*_{H,j1}U^*_{H,k5}U_{A,i4} - v_1\lambda\sigma'^{,*}U^*_{H,j2}U^*_{H,k5}U_{A,i4} - \sqrt{2}\sigma Mu^*_{phi}U^*_{H,j3}U^*_{H,k5}U_{A,i4}\\
&- 2vphi\sigma\kappa'^{,*}U^*_{H,j3}U^*_{H,k5}U_{A,i4} + \sqrt{2}Mu_{phi}\sigma'^{,*}U^*_{H,j3}U^*_{H,k5}U_{A,i4} + 2vphi\kappa'\sigma'^{,*}U^*_{H,j3}U^*_{H,k5}U_{A,i4}\\
&+ \sqrt{2}T^*_\sigma U^*_{H,j3}U^*_{H,k5}U_{A,i4} - 2v_s\sigma\kappa'^{,*}U^*_{H,j5}U^*_{H,k5}U_{A,i4} + 2v_s\kappa'\sigma'^{,*}U^*_{H,j5}U^*_{H,k5}U_{A,i4}\\
&- \sqrt{2}U^*_{H,j5}U^*_{H,k3}T_\sigma U_{A,i4} - \sqrt{2}U^*_{H,j3}U^*_{H,k5}T_\sigma U_{A,i4} - vsb\lambda\sigma'^{,*}U^*_{H,j2}U^*_{H,k1}U_{A,i5}\\
&- v_2\lambda\sigma'^{,*}U^*_{H,j4}U^*_{H,k1}U_{A,i5} - vsb\lambda\sigma'^{,*}U^*_{H,j1}U^*_{H,k2}U_{A,i5} - v_1\lambda\sigma'^{,*}U^*_{H,j4}U^*_{H,k2}U_{A,i5}\\
&+ \sqrt{2}\sigma Mu^*_{phi}U^*_{H,j4}U^*_{H,k3}U_{A,i5} + 2vphi\sigma\kappa'^{,*}U^*_{H,j4}U^*_{H,k3}U_{A,i5} - \sqrt{2}Mu_{phi}\sigma'^{,*}U^*_{H,j4}U^*_{H,k3}U_{A,i5}\\
&- 2vphi\kappa'\sigma'^{,*}U^*_{H,j4}U^*_{H,k3}U_{A,i5} + \sqrt{2}T^*_\sigma U^*_{H,j4}U^*_{H,k3}U_{A,i5} + 2vsb\sigma\kappa'^{,*}U^*_{H,j5}U^*_{H,k3}U_{A,i5}\\
&- 2vsb\kappa'\sigma'^{,*}U^*_{H,j5}U^*_{H,k3}U_{A,i5} - v_2\lambda\sigma'^{,*}U^*_{H,j1}U^*_{H,k4}U_{A,i5} - v_1\lambda\sigma'^{,*}U^*_{H,j2}U^*_{H,k4}U_{A,i5}\\
&+ \sqrt{2}\sigma Mu^*_{phi}U^*_{H,j3}U^*_{H,k4}U_{A,i5} + 2vphi\sigma\kappa'^{,*}U^*_{H,j3}U^*_{H,k4}U_{A,i5} - \sqrt{2}Mu_{phi}\sigma'^{,*}U^*_{H,j3}U^*_{H,k4}U_{A,i5}\\
&- 2vphi\kappa'\sigma'^{,*}U^*_{H,j3}U^*_{H,k4}U_{A,i5} + \sqrt{2}T^*_\sigma U^*_{H,j3}U^*_{H,k4}U_{A,i5} + 2v_s\sigma\kappa'^{,*}U^*_{H,j5}U^*_{H,k4}U_{A,i5}\\
&- 2v_s\kappa'\sigma'^{,*}U^*_{H,j5}U^*_{H,k4}U_{A,i5} + 2vsb\sigma\kappa'^{,*}U^*_{H,j3}U^*_{H,k5}U_{A,i5} - 2vsb\kappa'\sigma'^{,*}U^*_{H,j3}U^*_{H,k5}U_{A,i5}\\
&+ 2v_s\sigma\kappa'^{,*}U^*_{H,j4}U^*_{H,k5}U_{A,i5} - 2v_s\kappa'\sigma'^{,*}U^*_{H,j4}U^*_{H,k5}U_{A,i5} + 2\sqrt{2}\kappa' Mu^*_{phi}U^*_{H,j5}U^*_{H,k5}U_{A,i5}\\
&- 2\sqrt{2}Mu_{phi}\kappa'^{,*}U^*_{H,j5}U^*_{H,k5}U_{A,i5} - 2\sqrt{2}T_{\kappa',*}U^*_{H,j5}U^*_{H,k5}U_{A,i5} + 2\sqrt{2}U^*_{H,j5}U^*_{H,k5}T_{\kappa'}U_{A,i5}\\
&- \sqrt{2}U^*_{H,j4}U^*_{H,k3}T_\sigma U_{A,i5} - \sqrt{2}U^*_{H,j3}U^*_{H,k4}T_\sigma U_{A,i5}\\
&+ \sigma\lambda^*\Big(- vphiU^*_{H,j2}U^*_{H,k4}U_{A,i1} - vsbU^*_{H,j2}U^*_{H,k5}U_{A,i1} - vphiU^*_{H,j1}U^*_{H,k4}U_{A,i2} - vsbU^*_{H,j1}U^*_{H,k5}U_{A,i2}\\
&+ vphiU^*_{H,j2}U^*_{H,k1}U_{A,i4} + vphiU^*_{H,j1}U^*_{H,k2}U_{A,i4} + v_2U^*_{H,j1}U^*_{H,k5}U_{A,i4} + v_1U^*_{H,j2}U^*_{H,k5}U_{A,i4}\\
&- U^*_{H,j5}\Big(U^*_{H,k1}\Big(- v_2U_{A,i4} + vsbU_{A,i2}\Big) + U^*_{H,k2}\Big(- v_1U_{A,i4} + vsbU_{A,i1}\Big) + U^*_{H,k4}\Big(v_1U_{A,i2} + v_2U_{A,i1}\Big)\Big)\\
&+ vsbU^*_{H,j2}U^*_{H,k1}U_{A,i5} + vsbU^*_{H,j1}U^*_{H,k2}U_{A,i5} + v_2U^*_{H,j1}U^*_{H,k4}U_{A,i5} + v_1U^*_{H,j2}U^*_{H,k4}U_{A,i5}\\
&- U^*_{H,j4}\Big(U^*_{H,k1}\Big(- v_2U_{A,i5} + vphiU_{A,i2}\Big) + U^*_{H,k2}\Big(- v_1U_{A,i5} + vphiU_{A,i1}\Big) + U^*_{H,k5}\Big(v_1U_{A,i2} + v_2U_{A,i1}\Big)\Big)\Big)\Big) \qquad (323)
\end{aligned}
$$



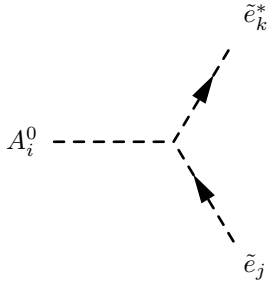
$$\frac{1}{4}\Big(U^*_{+,j2}\Big(-2\Big(\sigma\lambda^*\Big(vphiU_{A,i4}+vsbU_{A,i5}\Big)+\sqrt{2}T^*_\lambda U_{A,i3}\Big)+v_1\Big(-2|\lambda|^2+g_2^2\Big)U_{A,i2}+v_2\Big(-2|\lambda|^2+g_2^2\Big)U_{A,i1}\Big)U_{+,k1}$$
$$+U^*_{+,j1}\Big(2\Big(\lambda\sigma'^{,*}\Big(vphiU_{A,i4}+vsbU_{A,i5}\Big)+\sqrt{2}T_\lambda U_{A,i3}\Big)-v_1\Big(-2|\lambda|^2+g_2^2\Big)U_{A,i2}-v_2\Big(-2|\lambda|^2+g_2^2\Big)U_{A,i1}\Big)U_{+,k2}\Big) \tag{324}$$



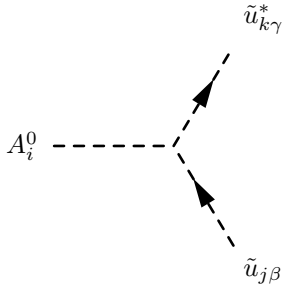
$$-\frac{1}{2}\delta_{\beta\gamma}\Big(\sqrt{2}\sum_{a=1}^{3}Z^{D,*}_{j3+a}T^*_{d,aa}Z^D_{ka}U_{A,i1}-\sqrt{2}\sum_{a=1}^{3}Z^{D,*}_{ja}Z^D_{k3+a}T_{d,aa}U_{A,i1}$$
$$+\Big(\lambda\sum_{a=1}^{3}Y^*_{d,aa}Z^{D,*}_{j3+a}Z^D_{ka}-\lambda^*\sum_{a=1}^{3}Z^{D,*}_{ja}Y_{d,aa}Z^D_{k3+a}\Big)\Big(v_2U_{A,i3}+v_sU_{A,i2}\Big)\Big) \tag{325}$$



$$
\begin{aligned}
&-\frac{1}{2}\delta_{\beta\gamma}\Big(-\lambda^*\sum_{a=1}^{3}Z_{ja}^{Dx,*}Z_{k3+a}^{Dx}\kappa_{aa}\Big(v_1U_{A,i2}+v_2U_{A,i1}\Big)+\sqrt{2}\sum_{a=1}^{3}Z_{j3+a}^{Dx,*}T_{\kappa,aa}^{*}Z_{ka}^{Dx}U_{A,i3}\\
&-\sqrt{2}\sum_{a=1}^{3}Z_{ja}^{Dx,*}Z_{k3+a}^{Dx}T_{\kappa,aa}U_{A,i3}-vphi\sigma'^{,*}\sum_{a=1}^{3}Z_{ja}^{Dx,*}Z_{k3+a}^{Dx}\kappa_{aa}U_{A,i4}\\
&-vsb\sigma'^{,*}\sum_{a=1}^{3}Z_{ja}^{Dx,*}Z_{k3+a}^{Dx}\kappa_{aa}U_{A,i5}\\
&+\sum_{a=1}^{3}Z_{j3+a}^{Dx,*}\kappa_{aa}^{*}Z_{ka}^{Dx}\Big(v_1\lambda U_{A,i2}+v_2\lambda U_{A,i1}+vphi\sigma U_{A,i4}+vsb\sigma U_{A,i5}\Big)\Big)
\end{aligned}
\tag{326}
$$

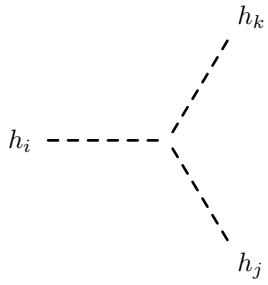


$$
\begin{aligned}
&\frac{1}{2}\Big(-\sqrt{2}\sum_{a=1}^{3}Z_{j3+a}^{E,*}T_{e,aa}^{*}Z_{ka}^{E}U_{A,i1}+\sqrt{2}\sum_{a=1}^{3}Z_{ja}^{E,*}Z_{k3+a}^{E}T_{e,aa}U_{A,i1}\\
&-\Big(\lambda\sum_{a=1}^{3}Y_{e,aa}^{*}Z_{j3+a}^{E,*}Z_{ka}^{E}-\lambda^*\sum_{a=1}^{3}Z_{ja}^{E,*}Y_{e,aa}Z_{k3+a}^{E}\Big)\Big(v_2U_{A,i3}+v_sU_{A,i2}\Big)\Big)
\end{aligned}
\tag{327}
$$



$$
-\frac{1}{2}\delta_{\beta\gamma}\Big(\sqrt{2}\Big(-\sum_{a=1}^{3}Z_{ja}^{U,*}Z_{k3+a}^{U}T_{u,aa}+\sum_{a=1}^{3}Z_{j3+a}^{U,*}T_{u,aa}^{*}Z_{ka}^{U}\Big)U_{A,i2}
$$

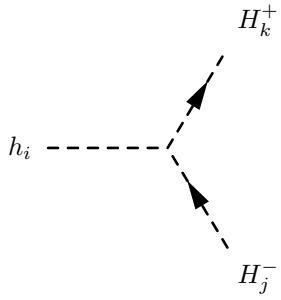
$$+\lambda\sum_{a=1}^{3}Y^{*}_{u,aa}Z^{U,*}_{j3+a}Z^{U}_{ka}\Big(v_1U_{A,i3}+v_sU_{A,i1}\Big)-\lambda^{*}\sum_{a=1}^{3}Z^{U,*}_{ja}Y_{u,aa}Z^{U}_{k3+a}\Big(v_1U_{A,i3}+v_sU_{A,i1}\Big)\Big) \tag{328}$$



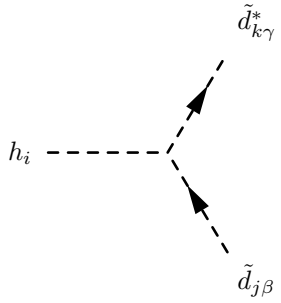
$$\frac{i}{4}\Big(12g_{1'}^{2}Q_Sv_sU^{*}_{H,i3}U^{*}_{H,j1}U^{*}_{H,k1}-4v_s|\lambda|^{2}U^{*}_{H,i3}U^{*}_{H,j1}U^{*}_{H,k1}-12g_{1'}^{2}Q_SvsbU^{*}_{H,i4}U^{*}_{H,j1}U^{*}_{H,k1}$$
$$+\sqrt{2}T^{*}_{\lambda}U^{*}_{H,i3}U^{*}_{H,j2}U^{*}_{H,k1}-vphi\sigma\lambda^{*}U^{*}_{H,i4}U^{*}_{H,j2}U^{*}_{H,k1}-vphi\lambda\sigma^{\prime,*}U^{*}_{H,i4}U^{*}_{H,j2}U^{*}_{H,k1}$$
$$-vsb\sigma\lambda^{*}U^{*}_{H,i5}U^{*}_{H,j2}U^{*}_{H,k1}-vsb\lambda\sigma^{\prime,*}U^{*}_{H,i5}U^{*}_{H,j2}U^{*}_{H,k1}+12g_{1'}^{2}Q_Sv_1U^{*}_{H,i3}U^{*}_{H,j3}U^{*}_{H,k1}$$
$$-4v_1|\lambda|^{2}U^{*}_{H,i3}U^{*}_{H,j3}U^{*}_{H,k1}-12g_{1'}^{2}Q_Sv_1U^{*}_{H,i4}U^{*}_{H,j4}U^{*}_{H,k1}$$
$$-v_2\sigma\lambda^{*}U^{*}_{H,i5}U^{*}_{H,j4}U^{*}_{H,k1}-v_2\lambda\sigma^{\prime,*}U^{*}_{H,i5}U^{*}_{H,j4}U^{*}_{H,k1}-v_2\sigma\lambda^{*}U^{*}_{H,i4}U^{*}_{H,j5}U^{*}_{H,k1}$$
$$-v_2\lambda\sigma^{\prime,*}U^{*}_{H,i4}U^{*}_{H,j5}U^{*}_{H,k1}+\sqrt{2}T^{*}_{\lambda}U^{*}_{H,i3}U^{*}_{H,j1}U^{*}_{H,k2}-vphi\sigma\lambda^{*}U^{*}_{H,i4}U^{*}_{H,j1}U^{*}_{H,k2}$$
$$-vphi\lambda\sigma^{\prime,*}U^{*}_{H,i4}U^{*}_{H,j1}U^{*}_{H,k2}-vsb\sigma\lambda^{*}U^{*}_{H,i5}U^{*}_{H,j1}U^{*}_{H,k2}-vsb\lambda\sigma^{\prime,*}U^{*}_{H,i5}U^{*}_{H,j1}U^{*}_{H,k2}$$
$$+8g_{1'}^{2}Q_Sv_sU^{*}_{H,i3}U^{*}_{H,j2}U^{*}_{H,k2}-4v_s|\lambda|^{2}U^{*}_{H,i3}U^{*}_{H,j2}U^{*}_{H,k2}-8g_{1'}^{2}Q_SvsbU^{*}_{H,i4}U^{*}_{H,j2}U^{*}_{H,k2}$$
$$+8g_{1'}^{2}Q_Sv_2U^{*}_{H,i3}U^{*}_{H,j3}U^{*}_{H,k2}-4v_2|\lambda|^{2}U^{*}_{H,i3}U^{*}_{H,j3}U^{*}_{H,k2}$$
$$-8g_{1'}^{2}Q_Sv_2U^{*}_{H,i4}U^{*}_{H,j4}U^{*}_{H,k2}-v_1\sigma\lambda^{*}U^{*}_{H,i5}U^{*}_{H,j4}U^{*}_{H,k2}-v_1\lambda\sigma^{\prime,*}U^{*}_{H,i5}U^{*}_{H,j4}U^{*}_{H,k2}$$
$$-v_1\sigma\lambda^{*}U^{*}_{H,i4}U^{*}_{H,j5}U^{*}_{H,k2}-v_1\lambda\sigma^{\prime,*}U^{*}_{H,i4}U^{*}_{H,j5}U^{*}_{H,k2}+12g_{1'}^{2}Q_Sv_1U^{*}_{H,i3}U^{*}_{H,j1}U^{*}_{H,k3}$$
$$-4v_1|\lambda|^{2}U^{*}_{H,i3}U^{*}_{H,j1}U^{*}_{H,k3}+8g_{1'}^{2}Q_Sv_2U^{*}_{H,i3}U^{*}_{H,j2}U^{*}_{H,k3}-4v_2|\lambda|^{2}U^{*}_{H,i3}U^{*}_{H,j2}U^{*}_{H,k3}$$
$$-12g_{1'}^{2}Q_S^{2}v_sU^{*}_{H,i3}U^{*}_{H,j3}U^{*}_{H,k3}+4g_{1'}^{2}Q_S^{2}vsbU^{*}_{H,i4}U^{*}_{H,j3}U^{*}_{H,k3}$$
$$-4vsb|\sigma|^{2}U^{*}_{H,i4}U^{*}_{H,j3}U^{*}_{H,k3}-4vphi|\sigma|^{2}U^{*}_{H,i5}U^{*}_{H,j3}U^{*}_{H,k3}+4g_{1'}^{2}Q_S^{2}vsbU^{*}_{H,i3}U^{*}_{H,j4}U^{*}_{H,k3}$$
$$-4vsb|\sigma|^{2}U^{*}_{H,i3}U^{*}_{H,j4}U^{*}_{H,k3}+4g_{1'}^{2}Q_S^{2}v_sU^{*}_{H,i4}U^{*}_{H,j4}U^{*}_{H,k3}-4v_s|\sigma|^{2}U^{*}_{H,i4}U^{*}_{H,j4}U^{*}_{H,k3}$$
$$+\sqrt{2}\sigma Mu^{*}_{phi}U^{*}_{H,i5}U^{*}_{H,j4}U^{*}_{H,k3}+2vphi\sigma\kappa^{\prime,*}U^{*}_{H,i5}U^{*}_{H,j4}U^{*}_{H,k3}+\sqrt{2}Mu_{phi}\sigma^{\prime,*}U^{*}_{H,i5}U^{*}_{H,j4}U^{*}_{H,k3}$$
$$+2vphi\kappa^{\prime}\sigma^{\prime,*}U^{*}_{H,i5}U^{*}_{H,j4}U^{*}_{H,k3}+\sqrt{2}T^{*}_{\sigma}U^{*}_{H,i5}U^{*}_{H,j4}U^{*}_{H,k3}-4vphi|\sigma|^{2}U^{*}_{H,i3}U^{*}_{H,j5}U^{*}_{H,k3}$$
$$+\sqrt{2}\sigma Mu^{*}_{phi}U^{*}_{H,i4}U^{*}_{H,j5}U^{*}_{H,k3}+2vphi\sigma\kappa^{\prime,*}U^{*}_{H,i4}U^{*}_{H,j5}U^{*}_{H,k3}+\sqrt{2}Mu_{phi}\sigma^{\prime,*}U^{*}_{H,i4}U^{*}_{H,j5}U^{*}_{H,k3}$$
$$+2vphi\kappa^{\prime}\sigma^{\prime,*}U^{*}_{H,i4}U^{*}_{H,j5}U^{*}_{H,k3}+\sqrt{2}T^{*}_{\sigma}U^{*}_{H,i4}U^{*}_{H,j5}U^{*}_{H,k3}-4v_s|\sigma|^{2}U^{*}_{H,i5}U^{*}_{H,j5}U^{*}_{H,k3}$$
$$+2vsb\sigma\kappa^{\prime,*}U^{*}_{H,i5}U^{*}_{H,j5}U^{*}_{H,k3}+2vsb\kappa^{\prime}\sigma^{\prime,*}U^{*}_{H,i5}U^{*}_{H,j5}U^{*}_{H,k3}-12g_{1'}^{2}Q_Sv_1U^{*}_{H,i4}U^{*}_{H,j1}U^{*}_{H,k4}$$
$$-v_2\sigma\lambda^{*}U^{*}_{H,i5}U^{*}_{H,j1}U^{*}_{H,k4}-v_2\lambda\sigma^{\prime,*}U^{*}_{H,i5}U^{*}_{H,j1}U^{*}_{H,k4}-8g_{1'}^{2}Q_Sv_2U^{*}_{H,i4}U^{*}_{H,j2}U^{*}_{H,k4}$$
$$-v_1\sigma\lambda^{*}U^{*}_{H,i5}U^{*}_{H,j2}U^{*}_{H,k4}-v_1\lambda\sigma^{\prime,*}U^{*}_{H,i5}U^{*}_{H,j2}U^{*}_{H,k4}+4g_{1'}^{2}Q_S^{2}vsbU^{*}_{H,i3}U^{*}_{H,j3}U^{*}_{H,k4}$$

$$
\begin{aligned}
&- 4vsb|\sigma|^2U^*_{H,i3}U^*_{H,j3}U^*_{H,k4} + 4g^2_{1'}Q^2_S v_s U^*_{H,i4}U^*_{H,j3}U^*_{H,k4} - 4v_s|\sigma|^2U^*_{H,i4}U^*_{H,j3}U^*_{H,k4}\\
&+ \sqrt{2}\sigma M u^*_{phi}U^*_{H,i5}U^*_{H,j3}U^*_{H,k4} + 2vphi\sigma\kappa'^{,*}U^*_{H,i5}U^*_{H,j3}U^*_{H,k4} + \sqrt{2}Mu_{phi}\sigma'^{,*}U^*_{H,i5}U^*_{H,j3}U^*_{H,k4}\\
&+ 2vphi\kappa'\sigma'^{,*}U^*_{H,i5}U^*_{H,j3}U^*_{H,k4} + \sqrt{2}T^*_\sigma U^*_{H,i5}U^*_{H,j3}U^*_{H,k4} + 4g^2_{1'}Q^2_S v_s U^*_{H,i3}U^*_{H,j4}U^*_{H,k4}\\
&- 4v_s|\sigma|^2U^*_{H,i3}U^*_{H,j4}U^*_{H,k4} - 12g^2_{1'}Q^2_S vsbU^*_{H,i4}U^*_{H,j4}U^*_{H,k4} - 4vphi|\sigma|^2U^*_{H,i5}U^*_{H,j4}U^*_{H,k4}\\
&+ \sqrt{2}\sigma M u^*_{phi}U^*_{H,i3}U^*_{H,j5}U^*_{H,k4} + 2vphi\sigma\kappa'^{,*}U^*_{H,i3}U^*_{H,j5}U^*_{H,k4} + \sqrt{2}Mu_{phi}\sigma'^{,*}U^*_{H,i3}U^*_{H,j5}U^*_{H,k4}\\
&+ 2vphi\kappa'\sigma'^{,*}U^*_{H,i3}U^*_{H,j5}U^*_{H,k4} + \sqrt{2}T^*_\sigma U^*_{H,i3}U^*_{H,j5}U^*_{H,k4} - 4vphi|\sigma|^2U^*_{H,i4}U^*_{H,j5}U^*_{H,k4}\\
&- 4vsb|\sigma|^2U^*_{H,i5}U^*_{H,j5}U^*_{H,k4} + 2v_s\sigma\kappa'^{,*}U^*_{H,i5}U^*_{H,j5}U^*_{H,k4} + 2v_s\kappa'\sigma'^{,*}U^*_{H,i5}U^*_{H,j5}U^*_{H,k4}\\
&- v_2\sigma\lambda^*U^*_{H,i4}U^*_{H,j1}U^*_{H,k5} - v_2\lambda\sigma'^{,*}U^*_{H,i4}U^*_{H,j1}U^*_{H,k5} - v_1\sigma\lambda^*U^*_{H,i4}U^*_{H,j2}U^*_{H,k5}\\
&- v_1\lambda\sigma'^{,*}U^*_{H,i4}U^*_{H,j2}U^*_{H,k5} - 4vphi|\sigma|^2U^*_{H,i3}U^*_{H,j3}U^*_{H,k5} + \sqrt{2}\sigma M u^*_{phi}U^*_{H,i4}U^*_{H,j3}U^*_{H,k5}\\
&+ 2vphi\sigma\kappa'^{,*}U^*_{H,i4}U^*_{H,j3}U^*_{H,k5} + \sqrt{2}Mu_{phi}\sigma'^{,*}U^*_{H,i4}U^*_{H,j3}U^*_{H,k5} + 2vphi\kappa'\sigma'^{,*}U^*_{H,i4}U^*_{H,j3}U^*_{H,k5}\\
&+ \sqrt{2}T^*_\sigma U^*_{H,i4}U^*_{H,j3}U^*_{H,k5} - 4v_s|\sigma|^2U^*_{H,i5}U^*_{H,j3}U^*_{H,k5} + 2vsb\sigma\kappa'^{,*}U^*_{H,i5}U^*_{H,j3}U^*_{H,k5}\\
&+ 2vsb\kappa'\sigma'^{,*}U^*_{H,i5}U^*_{H,j3}U^*_{H,k5} + \sqrt{2}\sigma M u^*_{phi}U^*_{H,i3}U^*_{H,j4}U^*_{H,k5} + 2vphi\sigma\kappa'^{,*}U^*_{H,i3}U^*_{H,j4}U^*_{H,k5}\\
&+ \sqrt{2}Mu_{phi}\sigma'^{,*}U^*_{H,i3}U^*_{H,j4}U^*_{H,k5} + 2vphi\kappa'\sigma'^{,*}U^*_{H,i3}U^*_{H,j4}U^*_{H,k5} + \sqrt{2}T^*_\sigma U^*_{H,i3}U^*_{H,j4}U^*_{H,k5}\\
&- 4vphi|\sigma|^2U^*_{H,i4}U^*_{H,j4}U^*_{H,k5} - 4vsb|\sigma|^2U^*_{H,i5}U^*_{H,j4}U^*_{H,k5} + 2v_s\sigma\kappa'^{,*}U^*_{H,i5}U^*_{H,j4}U^*_{H,k5}\\
&+ 2v_s\kappa'\sigma'^{,*}U^*_{H,i5}U^*_{H,j4}U^*_{H,k5} - 4v_s|\sigma|^2U^*_{H,i3}U^*_{H,j5}U^*_{H,k5} + 2vsb\sigma\kappa'^{,*}U^*_{H,i3}U^*_{H,j5}U^*_{H,k5}\\
&+ 2vsb\kappa'\sigma'^{,*}U^*_{H,i3}U^*_{H,j5}U^*_{H,k5} - 4vsb|\sigma|^2U^*_{H,i4}U^*_{H,j5}U^*_{H,k5} + 2v_s\sigma\kappa'^{,*}U^*_{H,i4}U^*_{H,j5}U^*_{H,k5}\\
&+ 2v_s\kappa'\sigma'^{,*}U^*_{H,i4}U^*_{H,j5}U^*_{H,k5} - 24vphi|\kappa'|^2U^*_{H,i5}U^*_{H,j5}U^*_{H,k5} - 6\sqrt{2}\kappa' M u^*_{phi}U^*_{H,i5}U^*_{H,j5}U^*_{H,k5}\\
&- 6\sqrt{2}Mu_{phi}\kappa'^{,*}U^*_{H,i5}U^*_{H,j5}U^*_{H,k5} - 2\sqrt{2}T_{\kappa',*}U^*_{H,i5}U^*_{H,j5}U^*_{H,k5} - 2\sqrt{2}U^*_{H,i5}U^*_{H,j5}U^*_{H,k5}T_{\kappa'}\\
&+ \sqrt{2}U^*_{H,i3}U^*_{H,j2}U^*_{H,k1}T_\lambda + \sqrt{2}U^*_{H,i3}U^*_{H,j1}U^*_{H,k2}T_\lambda\\
&- U^*_{H,i1}\Big(- 12g^2_{1'}Q_S v_s U^*_{H,j3}U^*_{H,k1} + 4v_s|\lambda|^2U^*_{H,j3}U^*_{H,k1} + 12g^2_{1'}Q_S vsbU^*_{H,j4}U^*_{H,k1}\\
&- \sqrt{2}T^*_\lambda U^*_{H,j3}U^*_{H,k2} + vphi\sigma\lambda^*U^*_{H,j4}U^*_{H,k2} + vphi\lambda\sigma'^{,*}U^*_{H,j4}U^*_{H,k2} + vsb\sigma\lambda^*U^*_{H,j5}U^*_{H,k2}\\
&+ vsb\lambda\sigma'^{,*}U^*_{H,j5}U^*_{H,k2} - 12g^2_{1'}Q_S v_1 U^*_{H,j3}U^*_{H,k3} + 4v_1|\lambda|^2U^*_{H,j3}U^*_{H,k3}\\
&+ 12g^2_{1'}Q_S v_1 U^*_{H,j4}U^*_{H,k4} + v_2\sigma\lambda^*U^*_{H,j5}U^*_{H,k4} + v_2\lambda\sigma'^{,*}U^*_{H,j5}U^*_{H,k4}\\
&+ U^*_{H,j1}\Big(3\Big(36g^2_{1'} + g^2_1 + g^2_2\Big)v_1U^*_{H,k1} - v_2\Big(- 24g^2_{1'} - 4|\lambda|^2 + g^2_1 + g^2_2\Big)U^*_{H,k2}\\
&+ 4\Big(3g^2_{1'}Q_S vsbU^*_{H,k4} + \Big(- 3g^2_{1'}Q_S v_s + v_s|\lambda|^2\Big)U^*_{H,k3}\Big)\Big)\\
&+ v_2\sigma\lambda^*U^*_{H,j4}U^*_{H,k5} + v_2\lambda\sigma'^{,*}U^*_{H,j4}U^*_{H,k5} - \sqrt{2}U^*_{H,j3}U^*_{H,k2}T_\lambda\\
&+ U^*_{H,j2}\Big(- v_2\Big(- 24g^2_{1'} - 4|\lambda|^2 + g^2_1 + g^2_2\Big)U^*_{H,k1} - v_1\Big(- 24g^2_{1'} - 4|\lambda|^2 + g^2_1 + g^2_2\Big)U^*_{H,k2}\\
&- \sqrt{2}T^*_\lambda U^*_{H,k3} + vphi\sigma\lambda^*U^*_{H,k4} + vphi\lambda\sigma'^{,*}U^*_{H,k4} + vsb\sigma\lambda^*U^*_{H,k5} + vsb\lambda\sigma'^{,*}U^*_{H,k5} - \sqrt{2}U^*_{H,k3}T_\lambda\Big)\Big)\\
&+ U^*_{H,i2}\Big(\sqrt{2}T^*_\lambda U^*_{H,j3}U^*_{H,k1} - vphi\sigma\lambda^*U^*_{H,j4}U^*_{H,k1} - vphi\lambda\sigma'^{,*}U^*_{H,j4}U^*_{H,k1} - vsb\sigma\lambda^*U^*_{H,j5}U^*_{H,k1}\\
&- vsb\lambda\sigma'^{,*}U^*_{H,j5}U^*_{H,k1} + 8g^2_{1'}Q_S v_s U^*_{H,j3}U^*_{H,k2} - 4v_s|\lambda|^2U^*_{H,j3}U^*_{H,k2}
\end{aligned}
$$

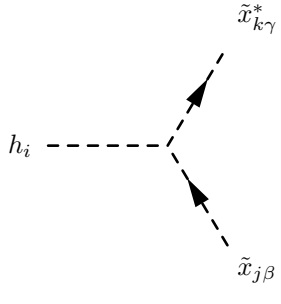
$$
\begin{aligned}
&- 8g_{1'}^2 Q_S vsb U_{H,j4}^* U_{H,k2}^* + 8g_{1'}^2 Q_S v_2 U_{H,j3}^* U_{H,k3}^* - 4v_2|\lambda|^2 U_{H,j3}^* U_{H,k3}^* \\
&- 8g_{1'}^2 Q_S v_2 U_{H,j4}^* U_{H,k4}^* - v_1\sigma\lambda^* U_{H,j5}^* U_{H,k4}^* - v_1\lambda\sigma'^{,*} U_{H,j5}^* U_{H,k4}^* \\
&+ U_{H,j2}^*\Big(v_1\Big(-24g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2\Big)U_{H,k1}^* - 3\Big(16g_{1'}^2 + g_1^2 + g_2^2\Big)v_2 U_{H,k2}^* + 8g_{1'}^2 Q_S v_s U_{H,k3}^* \\
&- 4v_s|\lambda|^2 U_{H,k3}^* - 8g_{1'}^2 Q_S vsb U_{H,k4}^*\Big) \\
&- v_1\sigma\lambda^* U_{H,j4}^* U_{H,k5}^* - v_1\lambda\sigma'^{,*} U_{H,j4}^* U_{H,k5}^* + \sqrt{2}U_{H,j3}^* U_{H,k1}^* T_\lambda \\
&+ U_{H,j1}^*\Big(v_2\Big(-24g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2\Big)U_{H,k1}^* + v_1\Big(-24g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2\Big)U_{H,k2}^* + \sqrt{2}T_\lambda^* U_{H,k3}^* \\
&- vphi\sigma\lambda^* U_{H,k4}^* - vphi\lambda\sigma'^{,*} U_{H,k4}^* - vsb\sigma\lambda^* U_{H,k5}^* - vsb\lambda\sigma'^{,*} U_{H,k5}^* + \sqrt{2}U_{H,k3}^* T_\lambda\Big)\Big) \\
&+ \sqrt{2}U_{H,i5}^* U_{H,j4}^* U_{H,k3}^* T_\sigma + \sqrt{2}U_{H,i4}^* U_{H,j5}^* U_{H,k3}^* T_\sigma + \sqrt{2}U_{H,i5}^* U_{H,j3}^* U_{H,k4}^* T_\sigma \\
&+ \sqrt{2}U_{H,i3}^* U_{H,j5}^* U_{H,k4}^* T_\sigma + \sqrt{2}U_{H,i4}^* U_{H,j3}^* U_{H,k5}^* T_\sigma + \sqrt{2}U_{H,i3}^* U_{H,j4}^* U_{H,k5}^* T_\sigma\Big)
\end{aligned}
\tag{329}
$$



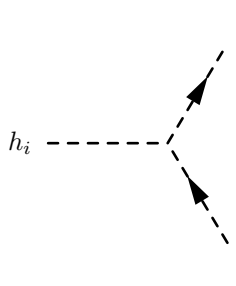
$$
\begin{aligned}
&\frac{i}{4}\Big(U_{H,i2}^*\Big(-U_{+,j2}^*\Big(\Big(16g_{1'}^2 + g_1^2 + g_2^2\Big)v_2 U_{+,k2} + v_1\Big(-2|\lambda|^2 + g_2^2\Big)U_{+,k1}\Big) \\
&+ U_{+,j1}^*\Big(\Big(-24g_{1'}^2 - g_2^2 + g_1^2\Big)v_2 U_{+,k1} - v_1\Big(-2|\lambda|^2 + g_2^2\Big)U_{+,k2}\Big)\Big) \\
&- U_{H,i1}^*\Big(U_{+,j2}^*\Big(\Big(24g_{1'}^2 - g_1^2 + g_2^2\Big)v_1 U_{+,k2} + v_2\Big(-2|\lambda|^2 + g_2^2\Big)U_{+,k1}\Big) \\
&+ U_{+,j1}^*\Big(\Big(36g_{1'}^2 + g_1^2 + g_2^2\Big)v_1 U_{+,k1} + v_2\Big(-2|\lambda|^2 + g_2^2\Big)U_{+,k2}\Big)\Big) \\
&+ 2\Big(vsb U_{H,i5}^*\Big(\lambda\sigma'^{,*} U_{+,j1}^* U_{+,k2} + \sigma\lambda^* U_{+,j2}^* U_{+,k1}\Big) \\
&+ U_{H,i4}^*\Big(U_{+,j1}^*\Big(-6g_{1'}^2 Q_S vsb U_{+,k1} + vphi\lambda\sigma'^{,*} U_{+,k2}\Big) + U_{+,j2}^*\Big(-4g_{1'}^2 Q_S vsb U_{+,k2} + vphi\sigma\lambda^* U_{+,k1}\Big)\Big) \\
&+ U_{H,i3}^*\Big(-U_{+,j2}^*\Big(2v_s\Big(-2g_{1'}^2 Q_S + |\lambda|^2\Big)U_{+,k2} + \sqrt{2}T_\lambda^* U_{+,k1}\Big) \\
&+ U_{+,j1}^*\Big(\Big(-2v_s|\lambda|^2 + 6g_{1'}^2 Q_S v_s\Big)U_{+,k1} - \sqrt{2}T_\lambda U_{+,k2}\Big)\Big)\Big)\Big)
\end{aligned}
\tag{330}
$$



$$
\begin{aligned}
&\frac{i}{12}\delta_{\beta\gamma}\Big(U^*_{H,i2}\Big(-\Big(3\Big(-8g^2_{1'}+g^2_2\Big)+g^2_1\Big)v_2\sum_{a=1}^{3}Z^{D,*}_{ja}Z^D_{ka}+6v_s\lambda\sum_{a=1}^{3}Y^*_{d,aa}Z^{D,*}_{j3+a}Z^D_{ka}\\
&-2g^2_1v_2\sum_{a=1}^{3}Z^{D,*}_{j3+a}Z^D_{k3+a}+48g^2_{1'}v_2\sum_{a=1}^{3}Z^{D,*}_{j3+a}Z^D_{k3+a}+6v_s\lambda^*\sum_{a=1}^{3}Z^{D,*}_{ja}Y_{d,aa}Z^D_{k3+a}\Big)\\
&+6\Big(2g^2_{1'}Q_SvsbU^*_{H,i4}\Big(2\sum_{a=1}^{3}Z^{D,*}_{j3+a}Z^D_{k3+a}+\sum_{a=1}^{3}Z^{D,*}_{ja}Z^D_{ka}\Big)\\
&+U^*_{H,i3}\Big(-2g^2_{1'}Q_Sv_s\sum_{a=1}^{3}Z^{D,*}_{ja}Z^D_{ka}+v_2\lambda\sum_{a=1}^{3}Y^*_{d,aa}Z^{D,*}_{j3+a}Z^D_{ka}-4g^2_{1'}Q_Sv_s\sum_{a=1}^{3}Z^{D,*}_{j3+a}Z^D_{k3+a}\\
&+v_2\lambda^*\sum_{a=1}^{3}Z^{D,*}_{ja}Y_{d,aa}Z^D_{k3+a}\Big)\Big)\\
&+U^*_{H,i1}\Big(\Big(\Big(36g^2_{1'}+3g^2_2+g^2_1\Big)v_1\sum_{a=1}^{3}Z^{D,*}_{ja}Z^D_{ka}\\
&-2\Big(3\sqrt{2}\sum_{a=1}^{3}Z^{D,*}_{j3+a}T^*_{d,aa}Z^D_{ka}-\Big(36g^2_{1'}+g^2_1\Big)v_1\sum_{a=1}^{3}Z^{D,*}_{j3+a}Z^D_{k3+a}+3\sqrt{2}\sum_{a=1}^{3}Z^{D,*}_{ja}Z^D_{k3+a}T_{d,aa}\\
&+6v_1\sum_{b=1}^{3}|Y_{d,bb}|^2Z^{D,*}_{jb}Z^D_{kb}+6v_1\sum_{b=1}^{3}|Y_{d,bb}|^2Z^{D,*}_{j3+b}Z^D_{k3+b}\Big)\Big)\Big)
\end{aligned}
\tag{331}
$$

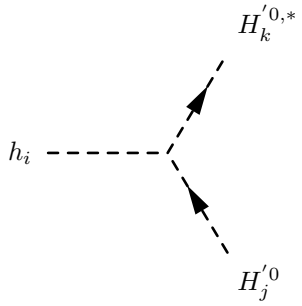


$$\frac{i}{6}\delta_{\beta\gamma}\Big(U^*_{H,i2}\Big(\Big(-24g^2_{1'}+g^2_1\Big)v_2\sum_{a=1}^{3}Z^{Dx,*}_{ja}Z^{Dx}_{ka}+3v_1\lambda\sum_{a=1}^{3}Z^{Dx,*}_{j3+a}\kappa^*_{aa}Z^{Dx}_{ka}-g^2_1v_2\sum_{a=1}^{3}Z^{Dx,*}_{j3+a}Z^{Dx}_{k3+a}$$
$$-36g^2_{1'}v_2\sum_{a=1}^{3}Z^{Dx,*}_{j3+a}Z^{Dx}_{k3+a}+3v_1\lambda^*\sum_{a=1}^{3}Z^{Dx,*}_{ja}Z^{Dx}_{k3+a}\kappa_{aa}\Big)$$
$$+U^*_{H,i1}\Big(-\Big(36g^2_{1'}+g^2_1\Big)v_1\sum_{a=1}^{3}Z^{Dx,*}_{ja}Z^{Dx}_{ka}+3v_2\lambda\sum_{a=1}^{3}Z^{Dx,*}_{j3+a}\kappa^*_{aa}Z^{Dx}_{ka}+g^2_1v_1\sum_{a=1}^{3}Z^{Dx,*}_{j3+a}Z^{Dx}_{k3+a}$$
$$-54g^2_{1'}v_1\sum_{a=1}^{3}Z^{Dx,*}_{j3+a}Z^{Dx}_{k3+a}+3v_2\lambda^*\sum_{a=1}^{3}Z^{Dx,*}_{ja}Z^{Dx}_{k3+a}\kappa_{aa}\Big)$$
$$+3\Big(vsbU^*_{H,i5}\Big(\sigma'^{,*}\sum_{a=1}^{3}Z^{Dx,*}_{ja}Z^{Dx}_{k3+a}\kappa_{aa}+\sigma\sum_{a=1}^{3}Z^{Dx,*}_{j3+a}\kappa^*_{aa}Z^{Dx}_{ka}\Big)$$
$$+U^*_{H,i4}\Big(-4g^2_{1'}Q_SvsbZ^{Dx,*}_{ja}Z^{Dx}_{ka}+vphi\sigma\sum_{a=1}^{3}Z^{Dx,*}_{j3+a}\kappa^*_{aa}Z^{Dx}_{ka}-6g^2_{1'}Q_SvsbZ^{Dx,*}_{j3+a}Z^{Dx}_{k3+a}$$
$$+vphi\sigma'^{,*}\sum_{a=1}^{3}Z^{Dx,*}_{ja}Z^{Dx}_{k3+a}\kappa_{aa}\Big)$$
$$+U^*_{H,i3}\Big(4g^2_{1'}Q_Sv_s\sum_{a=1}^{3}Z^{Dx,*}_{ja}Z^{Dx}_{ka}-\sqrt{2}\sum_{a=1}^{3}Z^{Dx,*}_{j3+a}T^*_{\kappa,aa}Z^{Dx}_{ka}+6g^2_{1'}Q_Sv_s\sum_{a=1}^{3}Z^{Dx,*}_{j3+a}Z^{Dx}_{k3+a}$$
$$-\sqrt{2}\sum_{a=1}^{3}Z^{Dx,*}_{ja}Z^{Dx}_{k3+a}T_{\kappa,aa}-2v_s\sum_{b=1}^{3}|\kappa_{bb}|^2Z^{Dx,*}_{jb}Z^{Dx}_{kb}-2v_s\sum_{b=1}^{3}|\kappa_{bb}|^2Z^{Dx,*}_{j3+b}Z^{Dx}_{k3+b}\Big)\Big)\Big) \tag{332}$$

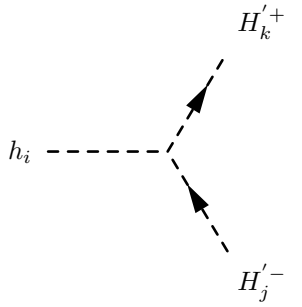


$$\frac{i}{4}\Big(-8g^2_{1'}Q_Sv_sU^*_{H,i3}\sum_{a=1}^{3}Z^{E,*}_{ja}Z^{E}_{ka}+8g^2_{1'}Q_SvsbU^*_{H,i4}\sum_{a=1}^{3}Z^{E,*}_{ja}Z^{E}_{ka}$$
$$+2v_2\lambda U^*_{H,i3}\sum_{a=1}^{3}Y^*_{e,aa}Z^{E,*}_{j3+a}Z^{E}_{ka}-4g^2_{1'}Q_Sv_sU^*_{H,i3}\sum_{a=1}^{3}Z^{E,*}_{j3+a}Z^{E}_{k3+a}$$
$$+4g^2_{1'}Q_SvsbU^*_{H,i4}\sum_{a=1}^{3}Z^{E,*}_{j3+a}Z^{E}_{k3+a}+2v_2\lambda^*U^*_{H,i3}\sum_{a=1}^{3}Z^{E,*}_{ja}Y_{e,aa}Z^{E}_{k3+a}$$

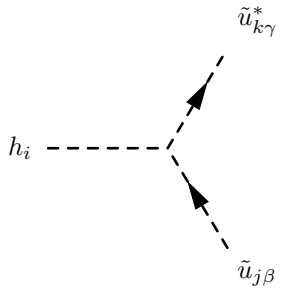
$$
\begin{aligned}
&+ U^{*}_{H,i2}\Big(\Big(16g^{2}_{1'} - g^{2}_{2} + g^{2}_{1}\Big)v_{2}\sum_{a=1}^{3} Z^{E,*}_{ja}Z^{E}_{ka} \\
&+ 2\Big(v_{s}\lambda\sum_{a=1}^{3} Y^{*}_{e,aa}Z^{E,*}_{j3+a}Z^{E}_{ka} - \Big(-4g^{2}_{1'} + g^{2}_{1}\Big)v_{2}\sum_{a=1}^{3} Z^{E,*}_{j3+a}Z^{E}_{k3+a} \\
&+ v_{s}\lambda^{*}\sum_{a=1}^{3} Z^{E,*}_{ja}Y_{e,aa}Z^{E}_{k3+a}\Big)\Big) \\
&+ U^{*}_{H,i1}\Big(\Big(24g^{2}_{1'} - g^{2}_{1} + g^{2}_{2}\Big)v_{1}\sum_{a=1}^{3} Z^{E,*}_{ja}Z^{E}_{ka} \\
&- 2\Big(\sqrt{2}\sum_{a=1}^{3} Z^{E,*}_{j3+a}T^{*}_{e,aa}Z^{E}_{ka} - \Big(6g^{2}_{1'} + g^{2}_{1}\Big)v_{1}\sum_{a=1}^{3} Z^{E,*}_{j3+a}Z^{E}_{k3+a} + \sqrt{2}\sum_{a=1}^{3} Z^{E,*}_{ja}Z^{E}_{k3+a}T_{e,aa} \\
&+ 2v_{1}\sum_{b=1}^{3} |Y_{e,bb}|^{2}Z^{E,*}_{jb}Z^{E}_{kb} + 2v_{1}\sum_{b=1}^{3} |Y_{e,bb}|^{2}Z^{E,*}_{j3+b}Z^{E}_{k3+b}\Big)\Big)\Big)
\end{aligned}
\tag{333}
$$



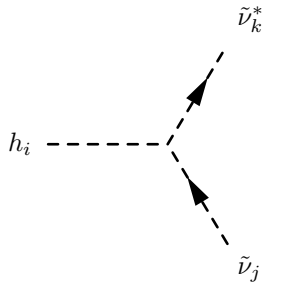
$$
-\frac{i}{4}\Big(-\Big(16g^{2}_{1'} + g^{2}_{1} + g^{2}_{2}\Big)v_{2}U^{*}_{H,i2} + \Big(-24g^{2}_{1'} + g^{2}_{1} + g^{2}_{2}\Big)v_{1}U^{*}_{H,i1} + 8g^{2}_{1'}Q_{S}\Big(-vsbU^{*}_{H,i4} + v_{s}U^{*}_{H,i3}\Big)\Big)\Big(UHp0^{*}_{j1}UHp0_{k1} - UHp0^{*}_{j2}U
\tag{334}
$$



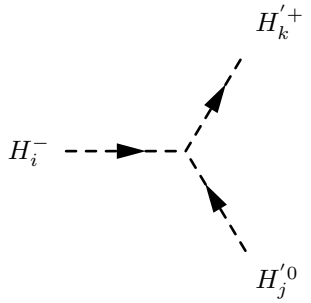
$$
-\frac{i}{4}\Big(\Big(-16g^{2}_{1'} - g^{2}_{1} + g^{2}_{2}\Big)v_{2}U^{*}_{H,i2} + \Big(-24g^{2}_{1'} - g^{2}_{2} + g^{2}_{1}\Big)v_{1}U^{*}_{H,i1} + 8g^{2}_{1'}Q_{S}\Big(-vsbU^{*}_{H,i4} + v_{s}U^{*}_{H,i3}\Big)\Big)\Big(UHpp^{*}_{j1}UHpp_{k1} - UHpp^{*}_{j2}U
\tag{335}
$$



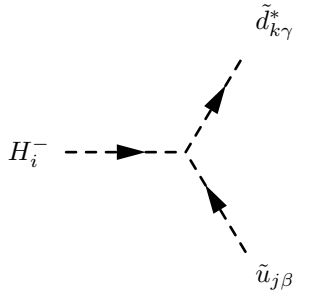
$$
\begin{aligned}
&\frac{i}{12}\delta_{\beta\gamma}\Big(U^*_{H,i1}\Big(\Big(36g_{1'}^2-3g_2^2+g_1^2\Big)v_1\sum_{a=1}^{3}Z^{U,*}_{ja}Z^U_{ka}+6v_s\lambda\sum_{a=1}^{3}Y^*_{u,aa}Z^{U,*}_{j3+a}Z^U_{ka}\\
&-4g_1^2v_1\sum_{a=1}^{3}Z^{U,*}_{j3+a}Z^U_{k3+a}+36g_{1'}^2v_1\sum_{a=1}^{3}Z^{U,*}_{j3+a}Z^U_{k3+a}+6v_s\lambda^*\sum_{a=1}^{3}Z^{U,*}_{ja}Y_{u,aa}Z^U_{k3+a}\Big)\\
&+6\Big(2g_{1'}^2Q_SvsbU^*_{H,i4}\delta_{jk}\\
&+U^*_{H,i3}\Big(-2g_{1'}^2Q_Sv_s\sum_{a=1}^{3}Z^{U,*}_{ja}Z^U_{ka}+v_1\lambda\sum_{a=1}^{3}Y^*_{u,aa}Z^{U,*}_{j3+a}Z^U_{ka}-2g_{1'}^2Q_Sv_s\sum_{a=1}^{3}Z^{U,*}_{j3+a}Z^U_{k3+a}\\
&+v_1\lambda^*\sum_{a=1}^{3}Z^{U,*}_{ja}Y_{u,aa}Z^U_{k3+a}\Big)\Big)\\
&-U^*_{H,i2}\Big(\Big(-3\Big(8g_{1'}^2+g_2^2\Big)+g_1^2\Big)v_2\sum_{a=1}^{3}Z^{U,*}_{ja}Z^U_{ka}\\
&+2\Big(3\sqrt{2}\sum_{a=1}^{3}Z^{U,*}_{j3+a}T^*_{u,aa}Z^U_{ka}-2\Big(6g_{1'}^2+g_1^2\Big)v_2\sum_{a=1}^{3}Z^{U,*}_{j3+a}Z^U_{k3+a}+3\sqrt{2}\sum_{a=1}^{3}Z^{U,*}_{ja}Z^U_{k3+a}T_{u,aa}\\
&+6v_2\sum_{b=1}^{3}|Y_{u,bb}|^2Z^{U,*}_{jb}Z^U_{kb}+6v_2\sum_{b=1}^{3}|Y_{u,bb}|^2Z^{U,*}_{j3+b}Z^U_{k3+b}\Big)\Big)\Big)
\end{aligned}
\tag{336}
$$



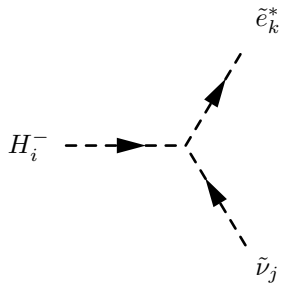
$$\frac{i}{4}\Big(\Big(16g_{1'}^2+g_1^2+g_2^2\Big)v_2U_{H,i2}^*-\Big(-24g_{1'}^2+g_1^2+g_2^2\Big)v_1U_{H,i1}^*+8g_{1'}^2Q_S\Big(vsbU_{H,i4}^*-v_sU_{H,i3}^*\Big)\Big)\delta_{jk} \tag{337}$$



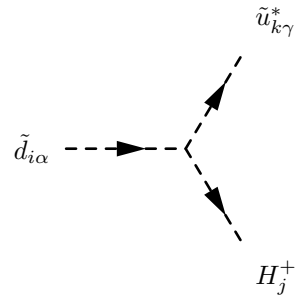
$$-\frac{i}{2}\frac{1}{\sqrt{2}}g_2^2\Big(v_1U_{+,i1}^*+v_2U_{+,i2}^*\Big)\Big(UHp0_{j1}^*UHpp_{k1}+UHp0_{j2}^*UHpp_{k2}\Big) \tag{338}$$



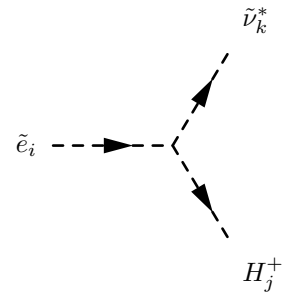
$$\begin{aligned}
&-\frac{i}{4}\delta_{\beta\gamma}\Big(U_{+,i2}^*\Big(\sqrt{2}g_2^2v_2\sum_{a=1}^{3}Z_{ja}^{U,*}Z_{ka}^D\\
&-2\Big(2\sum_{a=1}^{3}Z_{j3+a}^{U,*}T_{u,aa}^*Z_{ka}^D\\
&+\sqrt{2}\Big(v_1\sum_{b=1}^{3}Y_{u,bb}^*Z_{j3+b}^{U,*}Y_{d,bb}Z_{k3+b}^D+v_2\sum_{b=1}^{3}|Y_{u,bb}|^2Z_{jb}^{U,*}Z_{kb}^D+v_s\lambda^*\sum_{a=1}^{3}Z_{ja}^{U,*}Y_{d,aa}Z_{k3+a}^D\Big)\Big)\Big)\\
&+U_{+,i1}^*\Big(\sqrt{2}g_2^2v_1\sum_{a=1}^{3}Z_{ja}^{U,*}Z_{ka}^D\\
&-2\Big(\sqrt{2}v_s\lambda\sum_{a=1}^{3}Y_{u,aa}^*Z_{j3+a}^{U,*}Z_{ka}^D+2\sum_{a=1}^{3}Z_{ja}^{U,*}Z_{k3+a}^DT_{d,aa}\\
&+\sqrt{2}\Big(v_1\sum_{b=1}^{3}|Y_{d,bb}|^2Z_{jb}^{U,*}Z_{kb}^D+v_2\sum_{b=1}^{3}Y_{u,bb}^*Z_{j3+b}^{U,*}Y_{d,bb}Z_{k3+b}^D\Big)\Big)\Big)\Big)
\end{aligned} \tag{339}$$



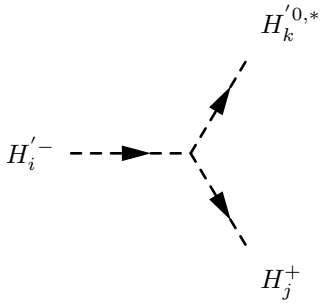
$$\frac{i}{4}\Big(\sqrt{2}U_{+,i2}^*\Big(2v_s\lambda^*\sum_{a=1}^{3}Z_{ja}^{V,*}Y_{e,aa}Z_{k3+a}^{E}-g_2^2v_2\sum_{a=1}^{3}Z_{ja}^{V,*}Z_{ka}^{E}\Big)$$
$$+U_{+,i1}^*\Big(2\sqrt{2}v_1\sum_{b=1}^{3}|Y_{e,bb}|^2Z_{jb}^{V,*}Z_{kb}^{E}+4\sum_{a=1}^{3}Z_{ja}^{V,*}Z_{k3+a}^{E}T_{e,aa}-\sqrt{2}g_2^2v_1\sum_{a=1}^{3}Z_{ja}^{V,*}Z_{ka}^{E}\Big)\Big) \tag{340}$$



$$-\frac{i}{4}\delta_{\alpha\gamma}\Big(\sqrt{2}g_2^2\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ka}^{U}\Big(v_1U_{+,j1}+v_2U_{+,j2}\Big)$$
$$-2\Big(2\sum_{a=1}^{3}Z_{i3+a}^{D,*}T_{d,aa}^{*}Z_{ka}^{U}U_{+,j1}+\sqrt{2}v_s\lambda^*\sum_{a=1}^{3}Z_{ia}^{D,*}Y_{u,aa}Z_{k3+a}^{U}U_{+,j1}$$
$$+\sqrt{2}v_1\sum_{b=1}^{3}|Y_{d,bb}|^2Z_{ib}^{D,*}Z_{kb}^{U}U_{+,j1}+\sqrt{2}v_2\sum_{b=1}^{3}Y_{d,bb}^{*}Z_{i3+b}^{D,*}Y_{u,bb}Z_{k3+b}^{U}U_{+,j1}$$
$$+\sqrt{2}v_s\lambda\sum_{a=1}^{3}Y_{d,aa}^{*}Z_{i3+a}^{D,*}Z_{ka}^{U}U_{+,j2}+2\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{k3+a}^{U}T_{u,aa}U_{+,j2}$$
$$+\sqrt{2}v_2\sum_{b=1}^{3}|Y_{u,bb}|^2Z_{ib}^{D,*}Z_{kb}^{U}U_{+,j2}+\sqrt{2}v_1\sum_{b=1}^{3}Y_{d,bb}^{*}Z_{i3+b}^{D,*}Y_{u,bb}Z_{k3+b}^{U}U_{+,j2}\Big)\Big) \tag{341}$$

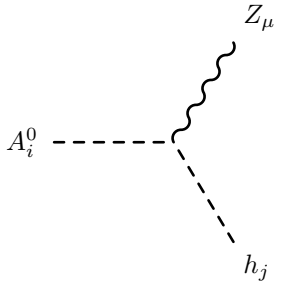


$$\frac{i}{4}\Big(-\sqrt{2}g_2^2\sum_{a=1}^{3}Z_{ia}^{E,*}Z_{ka}^{V}\Big(v_1U_{+,j1}+v_2U_{+,j2}\Big)$$
$$+2\Big(2\sum_{a=1}^{3}Z_{i3+a}^{E,*}T_{e,aa}^{*}Z_{ka}^{V}U_{+,j1}$$
$$+\sqrt{2}\Big(v_1\sum_{b=1}^{3}|Y_{e,bb}|^2Z_{ib}^{E,*}Z_{kb}^{V}U_{+,j1}+v_s\lambda\sum_{a=1}^{3}Y_{e,aa}^{*}Z_{i3+a}^{E,*}Z_{ka}^{V}U_{+,j2}\Big)\Big)\Big) \tag{342}$$

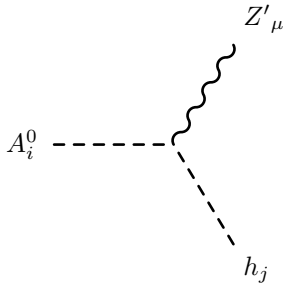


$$-\frac{i}{2}\frac{1}{\sqrt{2}}g_2^2\Big(UHpp_{i1}^{*}UHp0_{k1}+UHpp_{i2}^{*}UHp0_{k2}\Big)\Big(v_1U_{+,j1}+v_2U_{+,j2}\Big) \tag{343}$$

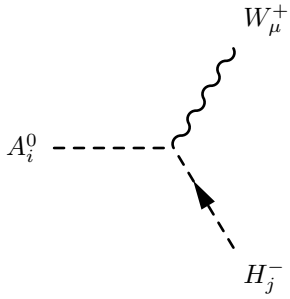
9.2 Two Scalar-One Vector Boson-Interaction



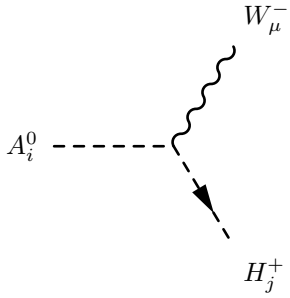
$$\frac{1}{2}\Big(U^*_{H,j1}\Big(-6g'_1\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)U_{A,i1}$$
$$-U^*_{H,j2}\Big(4g'_1\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)U_{A,i2}$$
$$+2g'_1Q_S\sin\Theta'_W\Big(U^*_{H,j3}U_{A,i3}-U^*_{H,j4}U_{A,i4}\Big)\Big)\Big(-p_\mu^{h_j}+p_\mu^{A^0_i}\Big) \tag{344}$$



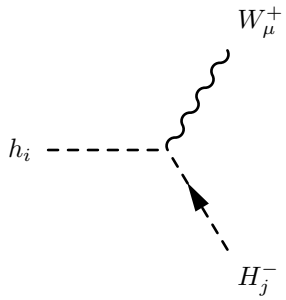
$$\frac{1}{2}\Big(-U^*_{H,j1}\Big(6g'_1\cos\Theta'_W+\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)U_{A,i1}$$
$$-U^*_{H,j2}\Big(4g'_1\cos\Theta'_W-\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)U_{A,i2}$$
$$-2g'_1Q_S\cos\Theta'_W\Big(-U^*_{H,j3}U_{A,i3}+U^*_{H,j4}U_{A,i4}\Big)\Big)\Big(-p_\mu^{h_j}+p_\mu^{A^0_i}\Big) \tag{345}$$



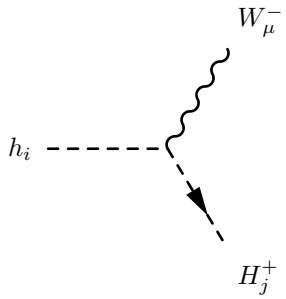
$$\frac{1}{2}g_2\Big(U^*_{+,j1}U_{A,i1}+U^*_{+,j2}U_{A,i2}\Big)\Big(-p_\mu^{H^-_j}+p_\mu^{A^0_i}\Big) \tag{346}$$



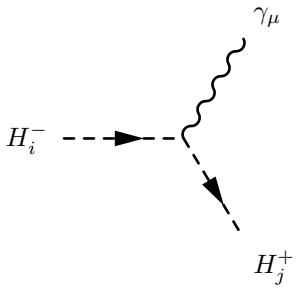
$$\frac{1}{2}g_2\Big(U_{A,i1}U_{+,j1}+U_{A,i2}U_{+,j2}\Big)\Big(-p_\mu^{H_j^+}+p_\mu^{A_i^0}\Big) \tag{347}$$



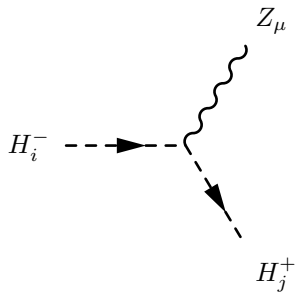
$$\frac{i}{2}g_2\Big(U^*_{H,i1}U^*_{+,j1}-U^*_{H,i2}U^*_{+,j2}\Big)\Big(-p_\mu^{H_j^-}+p_\mu^{h_i}\Big) \tag{348}$$



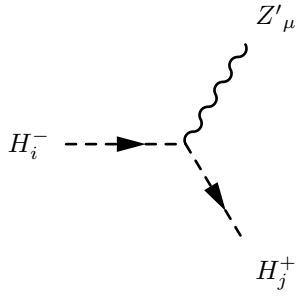
$$-\frac{i}{2}g_2\Big(U^*_{H,i1}U_{+,j1}-U^*_{H,i2}U_{+,j2}\Big)\Big(-p_\mu^{H_j^+}+p_\mu^{h_i}\Big) \tag{349}$$



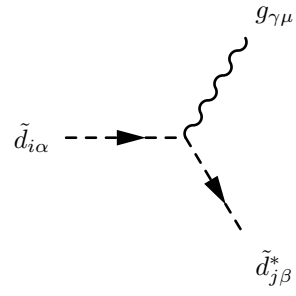
$$\frac{i}{2}\delta_{ij}\Big(g_1\cos\Theta_W+g_2\sin\Theta_W\Big)\Big(-p_\mu^{H_j^+}+p_\mu^{H_i^-}\Big) \tag{350}$$



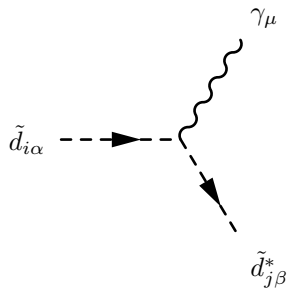
$$\frac{i}{2}\Big(U^*_{+,i1}\Big(6g'_1\sin\Theta'_W - g_1\cos\Theta'_W\sin\Theta_W + g_2\cos\Theta_W\cos\Theta'_W\Big)U_{+,j1}$$
$$+ U^*_{+,i2}\Big(-4g'_1\sin\Theta'_W - g_1\cos\Theta'_W\sin\Theta_W + g_2\cos\Theta_W\cos\Theta'_W\Big)U_{+,j2}\Big)\Big(-p_\mu^{H_j^+} + p_\mu^{H_i^-}\Big) \tag{351}$$



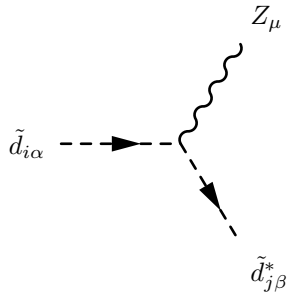
$$\frac{i}{2}\Big(U^*_{+,i1}\Big(6g'_1\cos\Theta'_W + \Big(g_1\sin\Theta_W - g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)U_{+,j1}$$
$$+ U^*_{+,i2}\Big(-4g'_1\cos\Theta'_W + \Big(g_1\sin\Theta_W - g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)U_{+,j2}\Big)\Big(-p_\mu^{H_j^+} + p_\mu^{H_i^-}\Big) \tag{352}$$



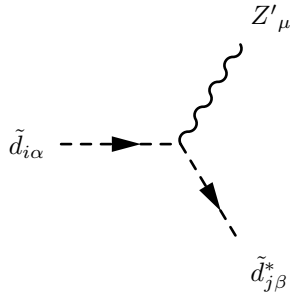
$$-\frac{i}{2}g_3\delta_{ij}\lambda^\gamma_{\beta,\alpha}\Big(-p_\mu^{\tilde{d}^*_{j\beta}} + p_\mu^{\tilde{d}_{i\alpha}}\Big) \tag{353}$$



$$-\frac{i}{6}\delta_{\alpha\beta}\Big(-2g_1\cos\Theta_W\sum_{a=1}^{3}Z^{D,*}_{i3+a}Z^{D}_{j3+a}+\Big(-3g_2\sin\Theta_W+g_1\cos\Theta_W\Big)\sum_{a=1}^{3}Z^{D,*}_{ia}Z^{D}_{ja}\Big)\Big(-p_\mu^{\tilde{d}^*_{j\beta}}+p_\mu^{\tilde{d}_{i\alpha}}\Big) \tag{354}$$

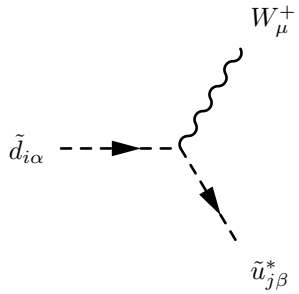


$$\begin{aligned}&\frac{i}{6}\delta_{\alpha\beta}\Big(\Big(3g_2\cos\Theta_W\cos\Theta'_W-6g'_1\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W\Big)\sum_{a=1}^{3}Z^{D,*}_{ia}Z^{D}_{ja}\\&-2\Big(-6g'_1\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W\Big)\sum_{a=1}^{3}Z^{D,*}_{i3+a}Z^{D}_{j3+a}\Big)\Big(-p_\mu^{\tilde{d}^*_{j\beta}}+p_\mu^{\tilde{d}_{i\alpha}}\Big)\end{aligned} \tag{355}$$

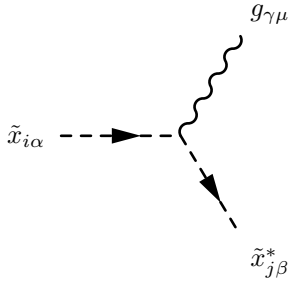


$$-\frac{i}{6}\delta_{\alpha\beta}\Big(\Big(\Big(3g_2\cos\Theta_W+g_1\sin\Theta_W\Big)\sin\Theta'_W+6g'_1\cos\Theta'_W\Big)\sum_{a=1}^{3}Z^{D,*}_{ia}Z^{D}_{ja}$$

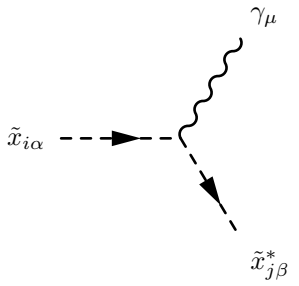
$$- 2\Big(6g_1' \cos\Theta'_W + g_1 \sin\Theta_W \sin\Theta'_W\Big) \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{j3+a} \Big) \Big(- p_\mu^{\tilde{d}^*_{j\beta}} + p_\mu^{\tilde{d}_{i\alpha}} \Big) \tag{356}$$



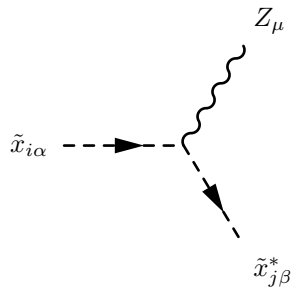
$$- i \frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{U}_{ja} \Big(- p_\mu^{\tilde{u}^*_{j\beta}} + p_\mu^{\tilde{d}_{i\alpha}} \Big) \tag{357}$$



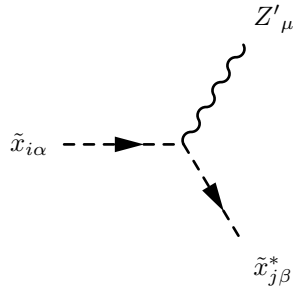
$$- \frac{i}{2} g_3 \delta_{ij} \lambda^{\gamma}_{\beta,\alpha} \Big(- p_\mu^{\tilde{x}^*_{j\beta}} + p_\mu^{\tilde{x}_{i\alpha}} \Big) \tag{358}$$



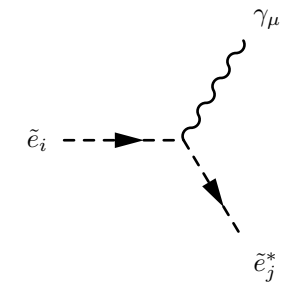
$$\frac{i}{3} g_1 \cos\Theta_W \delta_{\alpha\beta} \delta_{ij} \Big(- p_\mu^{\tilde{x}^*_{j\beta}} + p_\mu^{\tilde{x}_{i\alpha}} \Big) \tag{359}$$



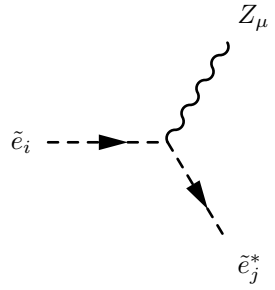
$$
\begin{aligned}
&-\frac{i}{3}\delta_{\alpha\beta}\Big(\Big(-6g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W\Big)\sum_{a=1}^{3}Z_{ia}^{Dx,*}Z_{ja}^{Dx}\\
&+\Big(9g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W\Big)\sum_{a=1}^{3}Z_{i3+a}^{Dx,*}Z_{j3+a}^{Dx}\Big)\Big(-p_\mu^{\tilde{x}^*_{j\beta}}+p_\mu^{\tilde{x}_{i\alpha}}\Big)
\end{aligned}
\tag{360}
$$



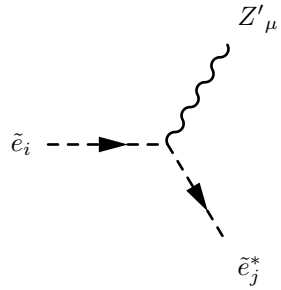
$$
\begin{aligned}
&\frac{i}{3}\delta_{\alpha\beta}\Big(\Big(6g_1'\cos\Theta'_W+g_1\sin\Theta_W\sin\Theta'_W\Big)\sum_{a=1}^{3}Z_{ia}^{Dx,*}Z_{ja}^{Dx}\\
&+\Big(-9g_1'\cos\Theta'_W+g_1\sin\Theta_W\sin\Theta'_W\Big)\sum_{a=1}^{3}Z_{i3+a}^{Dx,*}Z_{j3+a}^{Dx}\Big)\Big(-p_\mu^{\tilde{x}^*_{j\beta}}+p_\mu^{\tilde{x}_{i\alpha}}\Big)
\end{aligned}
\tag{361}
$$



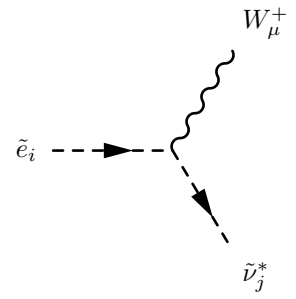
$$\frac{i}{2}\Big(2g_1\cos\Theta_W\sum_{a=1}^{3}Z^{E,*}_{i3+a}Z^{E}_{j3+a}+\Big(g_1\cos\Theta_W+g_2\sin\Theta_W\Big)\sum_{a=1}^{3}Z^{E,*}_{ia}Z^{E}_{ja}\Big)\Big(-p_\mu^{\tilde{e}_j^*}+p_\mu^{\tilde{e}_i}\Big) \tag{362}$$



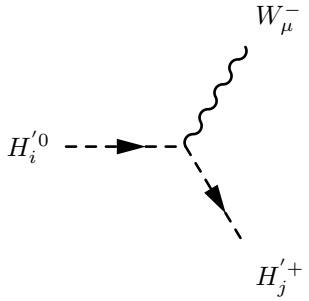
$$\begin{aligned}&\frac{i}{2}\Big(\Big(-4g_1'\sin\Theta'_W-g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)\sum_{a=1}^{3}Z^{E,*}_{ia}Z^{E}_{ja}\\&+2\Big(-g_1\cos\Theta'_W\sin\Theta_W+g_1'\sin\Theta'_W\Big)\sum_{a=1}^{3}Z^{E,*}_{i3+a}Z^{E}_{j3+a}\Big)\Big(-p_\mu^{\tilde{e}_j^*}+p_\mu^{\tilde{e}_i}\Big)\end{aligned} \tag{363}$$



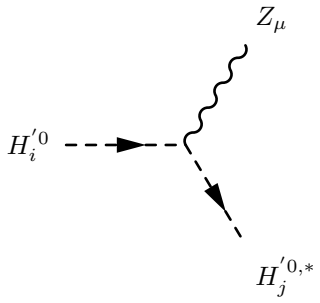
$$\begin{aligned}&-\frac{i}{2}\Big(\Big(4g_1'\cos\Theta'_W+\Big(-g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)\sum_{a=1}^{3}Z^{E,*}_{ia}Z^{E}_{ja}\\&-2\Big(g_1'\cos\Theta'_W+g_1\sin\Theta_W\sin\Theta'_W\Big)\sum_{a=1}^{3}Z^{E,*}_{i3+a}Z^{E}_{j3+a}\Big)\Big(-p_\mu^{\tilde{e}_j^*}+p_\mu^{\tilde{e}_i}\Big)\end{aligned} \tag{364}$$



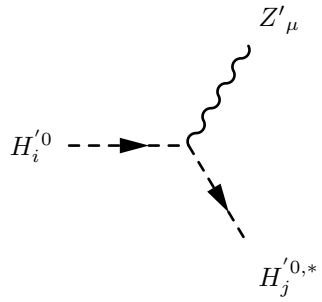
$$- i\frac{1}{\sqrt{2}}g_2 \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{V} \Big(- p_\mu^{\tilde{\nu}_j^*} + p_\mu^{\tilde{e}_i} \Big) \tag{365}$$



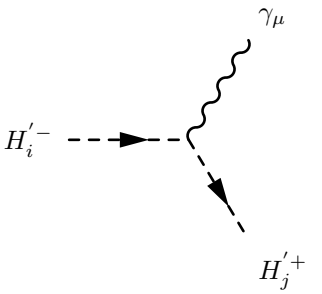
$$- i\frac{1}{\sqrt{2}}g_2 \Big(UHp0_{i1}^* UHpp_{j1} - UHp0_{i2}^* UHpp_{j2} \Big) \Big(- p_\mu^{H_j^{'+}} + p_\mu^{H_i^{'0}} \Big) \tag{366}$$



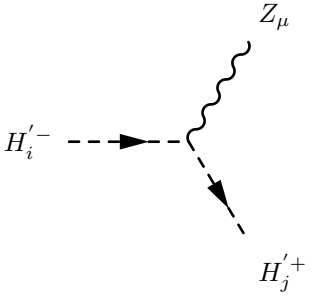
$$- \frac{i}{2}\delta_{ij} \Big(4g_1' \sin\Theta'_W + g_1 \cos\Theta'_W \sin\Theta_W + g_2 \cos\Theta_W \cos\Theta'_W \Big) \Big(- p_\mu^{H_j^{'0,*}} + p_\mu^{H_i^{'0}} \Big) \tag{367}$$



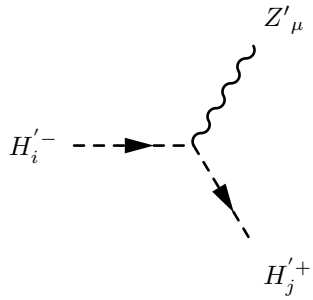
$$-\frac{i}{2}\delta_{ij}\Big(4g_1'\cos\Theta'_W-\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)\Big(-p_\mu^{H_j^{'0,*}}+p_\mu^{H_i^{'0}}\Big) \tag{368}$$



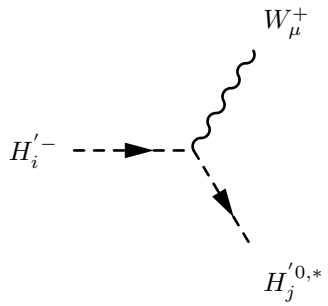
$$\frac{i}{2}\delta_{ij}\Big(g_1\cos\Theta_W+g_2\sin\Theta_W\Big)\Big(-p_\mu^{H_j^{'+}}+p_\mu^{H_i^{'-}}\Big) \tag{369}$$



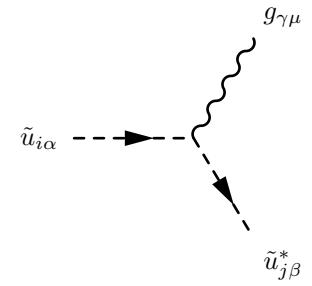
$$\frac{i}{2}\delta_{ij}\Big(-4g_1'\sin\Theta'_W-g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)\Big(-p_\mu^{H_j^{'+}}+p_\mu^{H_i^{'-}}\Big) \tag{370}$$



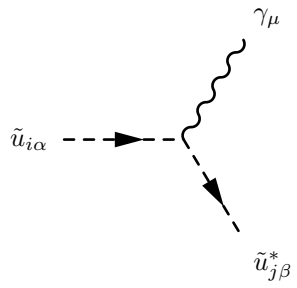
$$-\frac{i}{2}\delta_{ij}\Big(4g_1'\cos\Theta'_W+\Big(-g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)\Big(-p_\mu^{H_j^{'+}}+p_\mu^{H_i^{'-}}\Big) \tag{371}$$



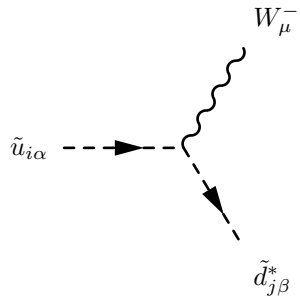
$$-i\frac{1}{\sqrt{2}}g_2\Big(UHpp_{i1}^*UHp0_{j1}-UHpp_{i2}^*UHp0_{j2}\Big)\Big(-p_\mu^{H_j^{'0,*}}+p_\mu^{H_i^{'-}}\Big) \tag{372}$$



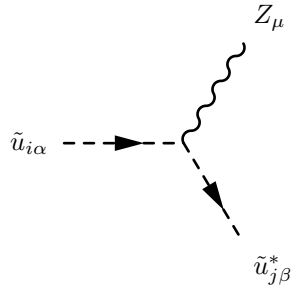
$$-\frac{i}{2}g_3\delta_{ij}\lambda^\gamma_{\beta,\alpha}\Big(-p_\mu^{\tilde{u}^*_{j\beta}}+p_\mu^{\tilde{u}_{i\alpha}}\Big) \tag{373}$$



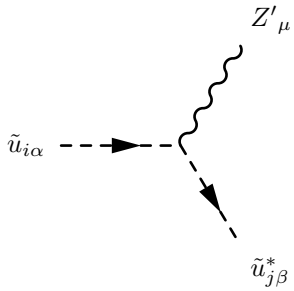
$$-\frac{i}{6}\delta_{\alpha\beta}\Big(\Big(3g_2\sin\Theta_W+g_1\cos\Theta_W\Big)\sum_{a=1}^{3}Z^{U,*}_{ia}Z^{U}_{ja}+4g_1\cos\Theta_W\sum_{a=1}^{3}Z^{U,*}_{i3+a}Z^{U}_{j3+a}\Big)\Big(-p_\mu^{\tilde{u}^*_{j\beta}}+p_\mu^{\tilde{u}_{i\alpha}}\Big) \tag{374}$$



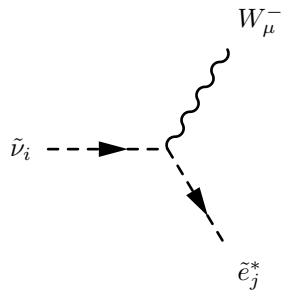
$$-i\frac{1}{\sqrt{2}}g_2\delta_{\alpha\beta}\sum_{a=1}^{3}Z^{U,*}_{ia}Z^{D}_{ja}\Big(-p_\mu^{\tilde{d}^*_{j\beta}}+p_\mu^{\tilde{u}_{i\alpha}}\Big) \tag{375}$$



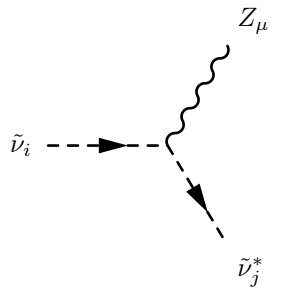
$$\begin{aligned}&-\frac{i}{6}\delta_{\alpha\beta}\Big(\Big(3g_2\cos\Theta_W\cos\Theta'_W+6g'_1\sin\Theta'_W-g_1\cos\Theta'_W\sin\Theta_W\Big)\sum_{a=1}^{3}Z^{U,*}_{ia}Z^{U}_{ja}\\&-2\Big(2g_1\cos\Theta'_W\sin\Theta_W+3g'_1\sin\Theta'_W\Big)\sum_{a=1}^{3}Z^{U,*}_{i3+a}Z^{U}_{j3+a}\Big)\Big(-p_\mu^{\tilde{u}^*_{j\beta}}+p_\mu^{\tilde{u}_{i\alpha}}\Big)\end{aligned} \tag{376}$$



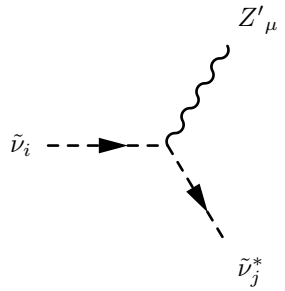
$$-\frac{i}{6}\delta_{\alpha\beta}\Big(\Big(\Big(-3g_2\cos\Theta_W+g_1\sin\Theta_W\Big)\sin\Theta'_W+6g'_1\cos\Theta'_W\Big)\sum_{a=1}^{3}Z^{U,*}_{ia}Z^{U}_{ja}$$
$$+2\Big(2g_1\sin\Theta_W\sin\Theta'_W-3g'_1\cos\Theta'_W\Big)\sum_{a=1}^{3}Z^{U,*}_{i3+a}Z^{U}_{j3+a}\Big)\Big(-p_\mu^{\tilde{u}^*_{j\beta}}+p_\mu^{\tilde{u}_{i\alpha}}\Big) \tag{377}$$



$$-i\frac{1}{\sqrt{2}}g_2\sum_{a=1}^{3}Z^{V,*}_{ia}Z^{E}_{ja}\Big(-p_\mu^{\tilde{e}^*_j}+p_\mu^{\tilde{\nu}_i}\Big) \tag{378}$$

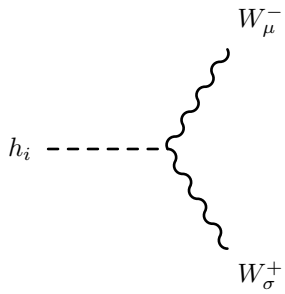


$$-\frac{i}{2}\delta_{ij}\Big(4g'_1\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)\Big(-p_\mu^{\tilde{\nu}^*_j}+p_\mu^{\tilde{\nu}_i}\Big) \tag{379}$$

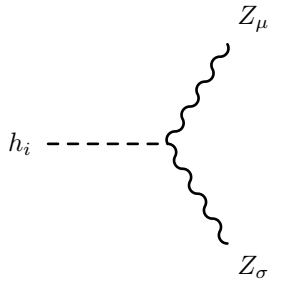


$$-\frac{i}{2}\delta_{ij}\Big(4g_1'\cos\Theta'_W-\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)\Big(-p_\mu^{\tilde{\nu}_j^*}+p_\mu^{\tilde{\nu}_i}\Big) \tag{380}$$

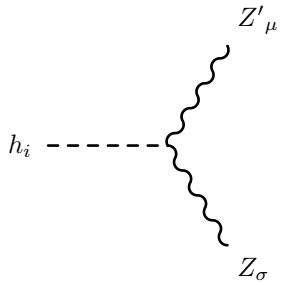
9.3 One Scalar-Two Vector Boson-Interaction



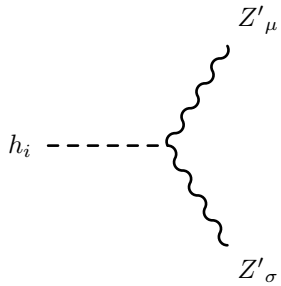
$$\frac{i}{2}g_2^2\Big(v_1U_{H,i1}^*+v_2U_{H,i2}^*\Big)\Big(g_{\sigma\mu}\Big) \tag{381}$$



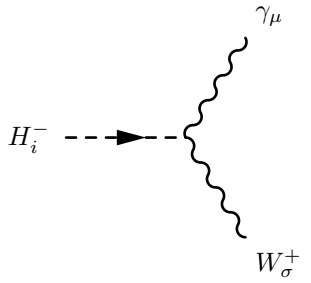
$$\begin{aligned}&\frac{i}{2}\Big(4g_{1'}^2Q_S^2\Big(vsbU_{H,i4}^*+v_sU_{H,i3}^*\Big)\sin\Theta'^2_W\\&+v_1U_{H,i1}^*\Big(-6g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)^2\\&+v_2U_{H,i2}^*\Big(4g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)^2\Big)\Big(g_{\sigma\mu}\Big)\end{aligned} \tag{382}$$



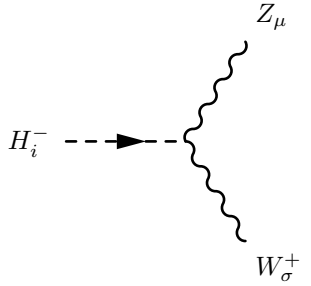
$$\frac{i}{2}\Big(- v_1 U^*_{H,i1}\Big(6g_1 g'_1 \cos\Theta'^2_W \sin\Theta_W + g_2^2 \cos\Theta^2_W \cos\Theta'_W \sin\Theta'_W$$
$$+ \cos\Theta'_W\Big(- 36 g'^2_1 + g_1^2 \sin\Theta^2_W\Big)\sin\Theta'_W - 6 g_1 g'_1 \sin\Theta_W \sin\Theta'^2_W$$
$$+ 2 g_2 \cos\Theta_W\Big(3 g'_1 \cos\Theta'^2_W - 3 g'_1 \sin\Theta'^2_W + g_1 \cos\Theta'_W \sin\Theta_W \sin\Theta'_W\Big)\Big)$$
$$+ 2 g'^2_1 Q_S^2\Big(vsb U^*_{H,i4} + v_s U^*_{H,i3}\Big)\sin 2\Theta'_W$$
$$- v_2 U^*_{H,i2}\Big(- 4 g_1 g'_1 \cos\Theta'^2_W \sin\Theta_W + g_2^2 \cos\Theta^2_W \cos\Theta'_W \sin\Theta'_W$$
$$+ g_1^2 \cos\Theta'_W \sin\Theta^2_W \sin\Theta'_W$$
$$+ 2 g_2 \cos\Theta_W\Big(- 2 g'_1 \cos\Theta'^2_W + 2 g'_1 \sin\Theta'^2_W + g_1 \cos\Theta'_W \sin\Theta_W \sin\Theta'_W\Big)$$
$$+ 4 g'_1\Big(- 2 g'_1 \sin 2\Theta'_W + g_1 \sin\Theta_W \sin\Theta'^2_W\Big)\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{383}$$



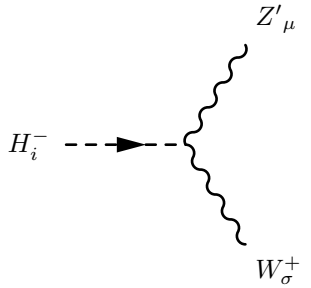
$$\frac{i}{2}\Big(4 g'^2_1 Q_S^2\Big(vsb U^*_{H,i4} + v_s U^*_{H,i3}\Big)\cos\Theta'^2_W$$
$$+ v_2 U^*_{H,i2}\Big(- 4 g'_1 \cos\Theta'_W + \Big(g_1 \sin\Theta_W + g_2 \cos\Theta_W\Big)\sin\Theta'_W\Big)^2$$
$$+ v_1 U^*_{H,i1}\Big(6 g'_1 \cos\Theta'_W + \Big(g_1 \sin\Theta_W + g_2 \cos\Theta_W\Big)\sin\Theta'_W\Big)^2\Big)\Big(g_{\sigma\mu}\Big) \tag{384}$$



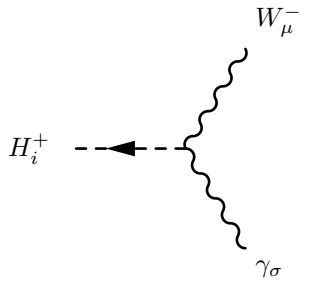
$$-\frac{i}{2}g_1g_2\Big(v_1U^*_{+,i1}-v_2U^*_{+,i2}\Big)\cos\Theta_W\Big(g_{\sigma\mu}\Big) \tag{385}$$



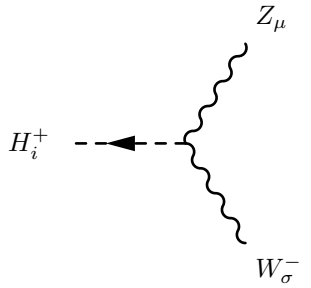
$$\begin{aligned}&\frac{i}{2}g_2\Big(v_1U^*_{+,i1}\Big(-6g'_1\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W\Big)\\&-v_2U^*_{+,i2}\Big(4g'_1\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W\Big)\Big)\Big(g_{\sigma\mu}\Big)\end{aligned} \tag{386}$$



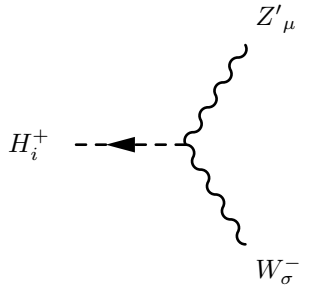
$$\begin{aligned}&-\frac{i}{2}g_2\Big(v_2U^*_{+,i2}\Big(4g'_1\cos\Theta'_W-g_1\sin\Theta_W\sin\Theta'_W\Big)\\&+v_1U^*_{+,i1}\Big(6g'_1\cos\Theta'_W+g_1\sin\Theta_W\sin\Theta'_W\Big)\Big)\Big(g_{\sigma\mu}\Big)\end{aligned} \tag{387}$$



$$-\frac{i}{2}g_1g_2\cos\Theta_W\Big(v_1U_{+,i1}-v_2U_{+,i2}\Big)\Big(g_{\sigma\mu}\Big) \tag{388}$$

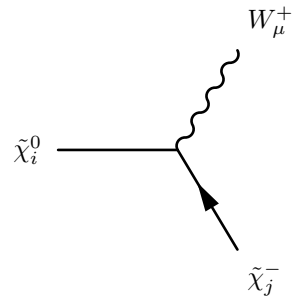


$$\begin{aligned}&\frac{i}{2}g_2\Big(v_1\Big(-6g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W\Big)U_{+,i1}\\&-v_2\Big(4g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W\Big)U_{+,i2}\Big)\Big(g_{\sigma\mu}\Big)\end{aligned} \tag{389}$$



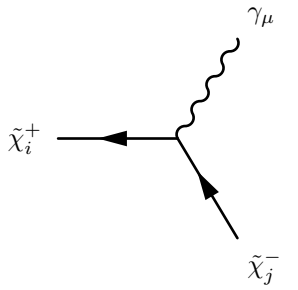
$$\begin{aligned}&-\frac{i}{2}g_2\Big(v_1\Big(6g_1'\cos\Theta'_W+g_1\sin\Theta_W\sin\Theta'_W\Big)U_{+,i1}\\&+v_2\Big(4g_1'\cos\Theta'_W-g_1\sin\Theta_W\sin\Theta'_W\Big)U_{+,i2}\Big)\Big(g_{\sigma\mu}\Big)\end{aligned} \tag{390}$$

9.4 Two Fermion-One Vector Boson-Interaction



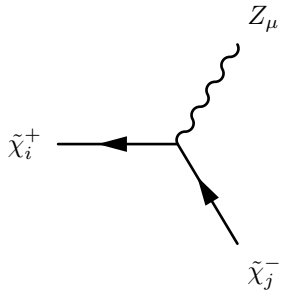
$$-\frac{i}{2}g_2\Big(2U_{j1}^*N_{i2}+\sqrt{2}U_{j2}^*N_{i3}\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{391}$$

$$+\ -\frac{i}{2}g_2\Big(2N_{i2}^*V_{j1}-\sqrt{2}N_{i4}^*V_{j2}\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{392}$$

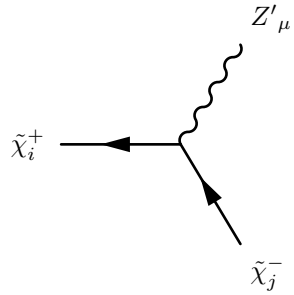


$$\frac{i}{2}\Big(2g_2U_{j1}^*\sin\Theta_WU_{i1}+U_{j2}^*\Big(g_1\cos\Theta_W+g_2\sin\Theta_W\Big)U_{i2}\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{393}$$

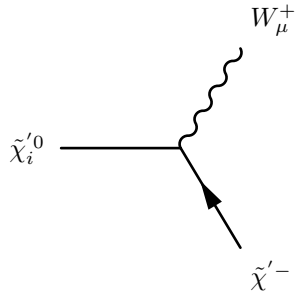
$$+\ \frac{i}{2}\Big(2g_2V_{i1}^*\sin\Theta_WV_{j1}+V_{i2}^*\Big(g_1\cos\Theta_W+g_2\sin\Theta_W\Big)V_{j2}\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{394}$$



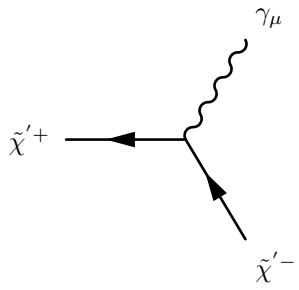
$$\frac{i}{2}\Big(2g_2U^*_{j1}\cos\Theta_W\cos\Theta'_W U_{i1}$$
$$+\,U^*_{j2}\Big(6g'_1\sin\Theta'_W-g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)U_{i2}\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{395}$$
$$+\;\frac{i}{2}\Big(2g_2V^*_{i1}\cos\Theta_W\cos\Theta'_W V_{j1}$$
$$+\,V^*_{i2}\Big(-4g'_1\sin\Theta'_W-g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)V_{j2}\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{396}$$



$$-\frac{i}{2}\Big(2g_2U^*_{j1}\cos\Theta_W\sin\Theta'_W U_{i1}$$
$$+\,U^*_{j2}\Big(-6g'_1\cos\Theta'_W+\Big(-g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)U_{i2}\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{397}$$
$$+\;-\frac{i}{2}\Big(2g_2V^*_{i1}\cos\Theta_W\sin\Theta'_W V_{j1}$$
$$+\,V^*_{i2}\Big(4g'_1\cos\Theta'_W+\Big(-g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)V_{j2}\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{398}$$

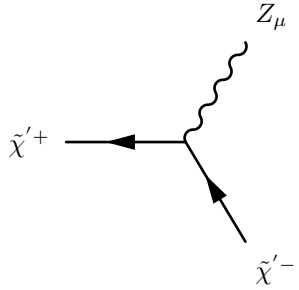


$$-\,i\frac{1}{\sqrt{2}}g_2ZNp_{i1}\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{399}$$
$$+\;i\frac{1}{\sqrt{2}}g_2ZNp^*_{i2}\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{400}$$



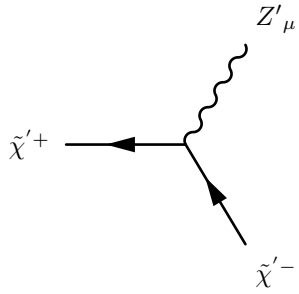
$$\frac{i}{2}\Big(g_1 \cos\Theta_W + g_2 \sin\Theta_W\Big)\Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{401}$$

$$+\ \frac{i}{2}\Big(g_1 \cos\Theta_W + g_2 \sin\Theta_W\Big)\Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{402}$$



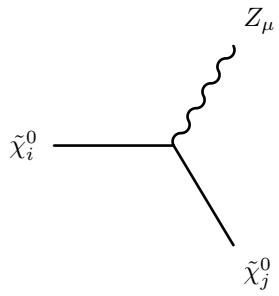
$$\frac{i}{2}\Big(-4g_1' \sin\Theta'_W - g_1 \cos\Theta'_W \sin\Theta_W + g_2 \cos\Theta_W \cos\Theta'_W\Big)\Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{403}$$

$$+\ \frac{i}{2}\Big(-4g_1' \sin\Theta'_W - g_1 \cos\Theta'_W \sin\Theta_W + g_2 \cos\Theta_W \cos\Theta'_W\Big)\Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{404}$$

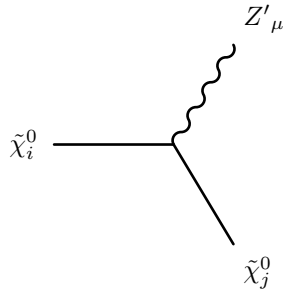


$$-\frac{i}{2}\Big(4g_1' \cos\Theta'_W + \Big(-g_1 \sin\Theta_W + g_2 \cos\Theta_W\Big)\sin\Theta'_W\Big)\Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{405}$$

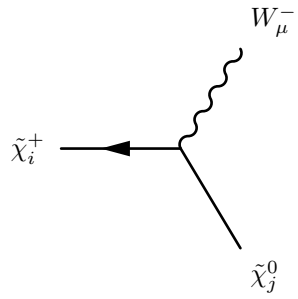
$$+\ -\frac{i}{2}\Big(4g_1' \cos\Theta'_W + \Big(-g_1 \sin\Theta_W + g_2 \cos\Theta_W\Big)\sin\Theta'_W\Big)\Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{406}$$



$$
\begin{aligned}
&-\frac{i}{2}\Big(N_{j3}^*\Big(-6g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)N_{i3}\\
&-N_{j4}^*\Big(4g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)N_{i4}\\
&+2g_1'Q_S\sin\Theta'_W\Big(N_{j5}^*N_{i5}-N_{j6}^*N_{i6}\Big)\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \qquad (407)\\
&+\frac{i}{2}\Big(N_{i3}^*\Big(-6g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)N_{j3}\\
&-N_{i4}^*\Big(4g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)N_{j4}\\
&+2g_1'Q_S\sin\Theta'_W\Big(N_{i5}^*N_{j5}-N_{i6}^*N_{j6}\Big)\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \qquad (408)
\end{aligned}
$$

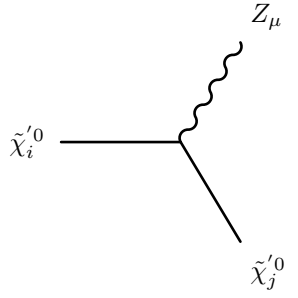


$$
\begin{aligned}
&\frac{i}{2}\Big(N_{j3}^*\Big(6g_1'\cos\Theta'_W+\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)N_{i3}\\
&+N_{j4}^*\Big(4g_1'\cos\Theta'_W-\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)N_{i4}\\
&+2g_1'Q_S\cos\Theta'_W\Big(-N_{j5}^*N_{i5}+N_{j6}^*N_{i6}\Big)\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \qquad (409)\\
&+-\frac{i}{2}\Big(N_{i3}^*\Big(6g_1'\cos\Theta'_W+\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)N_{j3}\\
&+N_{i4}^*\Big(4g_1'\cos\Theta'_W-\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)N_{j4}\\
&+2g_1'Q_S\cos\Theta'_W\Big(-N_{i5}^*N_{j5}+N_{i6}^*N_{j6}\Big)\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \qquad (410)
\end{aligned}
$$



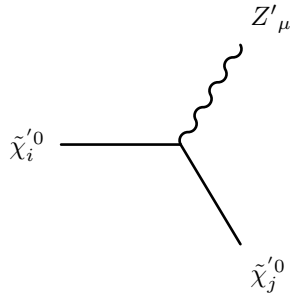
$$-\frac{i}{2}g_2\Big(2N_{j2}^*U_{i1}+\sqrt{2}N_{j3}^*U_{i2}\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{411}$$

$$+\ -\frac{i}{2}g_2\Big(2V_{i1}^*N_{j2}-\sqrt{2}V_{i2}^*N_{j4}\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{412}$$



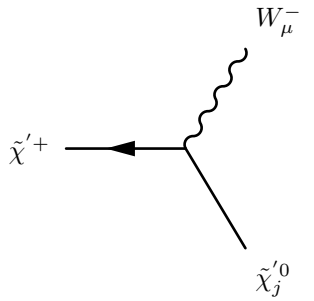
$$-\frac{i}{2}\Big(4g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)\Big(ZNp_{j1}^*ZNp_{i1}-ZNp_{j2}^*ZNp_{i2}\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{413}$$

$$+\ \frac{i}{2}\Big(4g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)\Big(ZNp_{i1}^*ZNp_{j1}-ZNp_{i2}^*ZNp_{j2}\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{414}$$



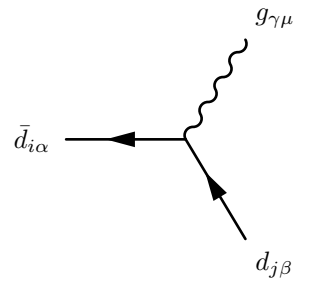
$$\frac{i}{4}\Big(2\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W-8g_1'\cos\Theta'_W\Big)\Big(ZNp_{j1}^*ZNp_{i1}-ZNp_{j2}^*ZNp_{i2}\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{415}$$

$$+\ \frac{i}{2}\Big(4g_1'\cos\Theta'_W-\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)\Big(ZNp_{i1}^*ZNp_{j1}-ZNp_{i2}^*ZNp_{j2}\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{416}$$



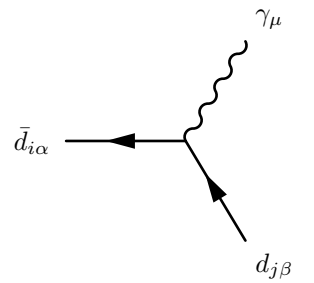
$$- i\frac{1}{\sqrt{2}}g_2 ZN p^*_{j1}\Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{417}$$

$$+ i\frac{1}{\sqrt{2}}g_2 ZN p_{j2}\Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{418}$$



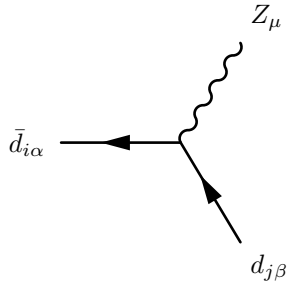
$$- \frac{i}{2}g_3\delta_{ij}\lambda^\gamma_{\alpha,\beta}\Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{419}$$

$$+ -\frac{i}{2}g_3\delta_{ij}\lambda^\gamma_{\alpha,\beta}\Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{420}$$



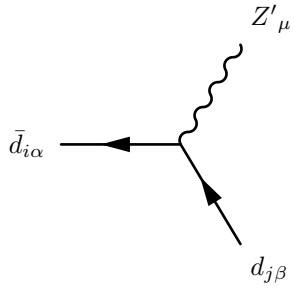
$$- \frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(- 3g_2 \sin\Theta_W + g_1 \cos\Theta_W\Big)\Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{421}$$

$$+\ \frac{i}{3}g_1\cos\Theta_W\delta_{\alpha\beta}\delta_{ij}\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{422}$$



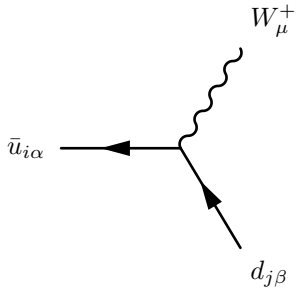
$$\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(3g_2\cos\Theta_W\cos\Theta'_W-6g'_1\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{423}$$

$$+\ -\frac{i}{3}\delta_{\alpha\beta}\delta_{ij}\Big(-6g'_1\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{424}$$

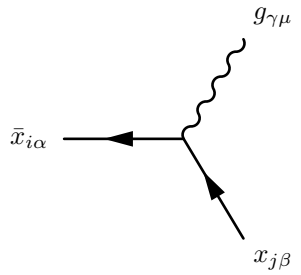


$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(\Big(3g_2\cos\Theta_W+g_1\sin\Theta_W\Big)\sin\Theta'_W+6g'_1\cos\Theta'_W\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{425}$$

$$+\ \frac{i}{3}\delta_{\alpha\beta}\delta_{ij}\Big(6g'_1\cos\Theta'_W+g_1\sin\Theta_W\sin\Theta'_W\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{426}$$

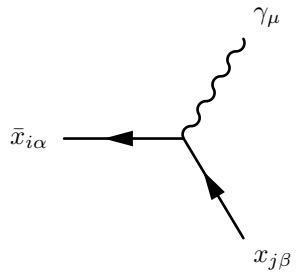


$$- i\frac{1}{\sqrt{2}}g_2\delta_{\alpha\beta}\sum_{a=1}^{3}U^{d,*}_{L,ja}U^{u}_{L,ia}\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{427}$$



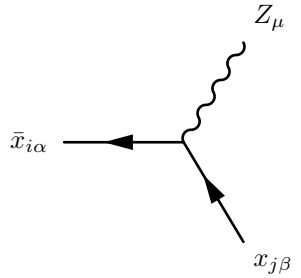
$$- \frac{i}{2}g_3\delta_{ij}\lambda^{\gamma}_{\alpha,\beta}\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{428}$$

$$+ \; -\frac{i}{2}g_3\delta_{ij}\lambda^{\gamma}_{\alpha,\beta}\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{429}$$



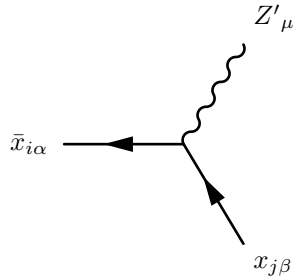
$$\frac{i}{3}g_1\cos\Theta_W\delta_{\alpha\beta}\delta_{ij}\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{430}$$

$$+ \; \frac{i}{3}g_1\cos\Theta_W\delta_{\alpha\beta}\delta_{ij}\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{431}$$



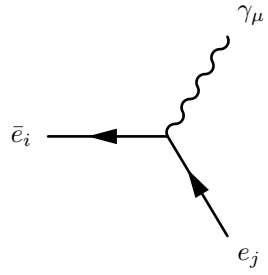
$$-\frac{i}{3}\delta_{\alpha\beta}\delta_{ij}\Big(-6g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{432}$$

$$+\ -\frac{i}{3}\delta_{\alpha\beta}\delta_{ij}\Big(9g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{433}$$



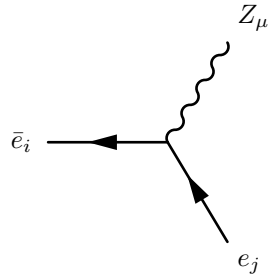
$$\frac{i}{3}\delta_{\alpha\beta}\delta_{ij}\Big(6g_1'\cos\Theta'_W+g_1\sin\Theta_W\sin\Theta'_W\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{434}$$

$$+\ -\frac{i}{3}\delta_{\alpha\beta}\delta_{ij}\Big(9g_1'\cos\Theta'_W-g_1\sin\Theta_W\sin\Theta'_W\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{435}$$



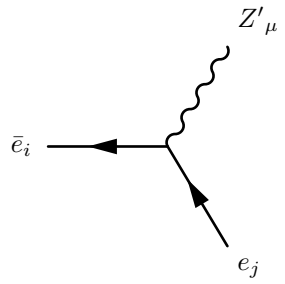
$$\frac{i}{2}\delta_{ij}\Big(g_1\cos\Theta_W+g_2\sin\Theta_W\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{436}$$

$$+\ ig_1\cos\Theta_W\delta_{ij}\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{437}$$



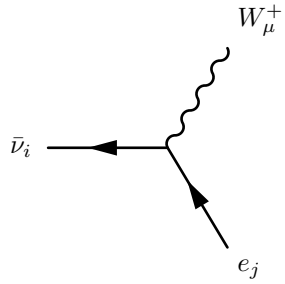
$$\frac{i}{2}\delta_{ij}\Big(-4g_1'\sin\Theta'_W - g_1\cos\Theta'_W\sin\Theta_W + g_2\cos\Theta_W\cos\Theta'_W\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{438}$$

$$+\ -i\delta_{ij}\Big(g_1\cos\Theta'_W\sin\Theta_W - g_1'\sin\Theta'_W\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{439}$$

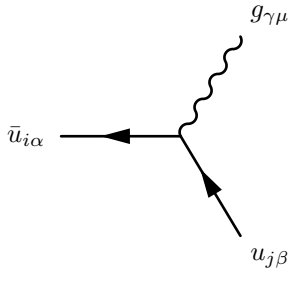


$$-\frac{i}{2}\delta_{ij}\Big(4g_1'\cos\Theta'_W + \Big(-g_1\sin\Theta_W + g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{440}$$

$$+\ i\delta_{ij}\Big(g_1'\cos\Theta'_W + g_1\sin\Theta_W\sin\Theta'_W\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{441}$$

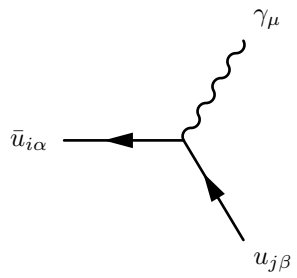


$$-i\frac{1}{\sqrt{2}}g_2U^{e,*}_{L,ji}\Theta_{i,3}\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{442}$$



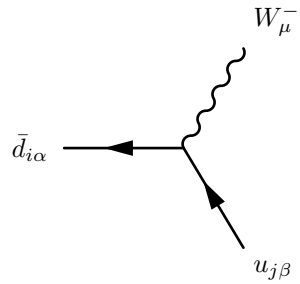
$$- \frac{i}{2} g_3 \delta_{ij} \lambda^{\gamma}_{\alpha,\beta} \Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2} \Big) \tag{443}$$

$$+ \; - \frac{i}{2} g_3 \delta_{ij} \lambda^{\gamma}_{\alpha,\beta} \Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2} \Big) \tag{444}$$

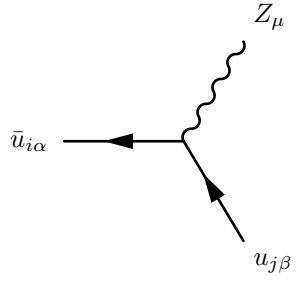


$$- \frac{i}{6} \delta_{\alpha\beta} \delta_{ij} \Big(3 g_2 \sin\Theta_W + g_1 \cos\Theta_W \Big) \Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2} \Big) \tag{445}$$

$$+ \; - \frac{2i}{3} g_1 \cos\Theta_W \delta_{\alpha\beta} \delta_{ij} \Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2} \Big) \tag{446}$$

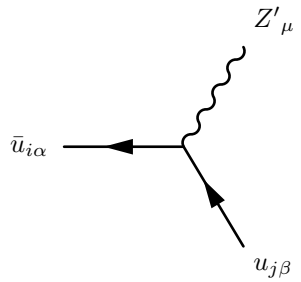


$$- \, i \frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \sum_{a=1}^{3} U^{u,*}_{L,ja} U^{d}_{L,ia} \Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2} \Big) \tag{447}$$



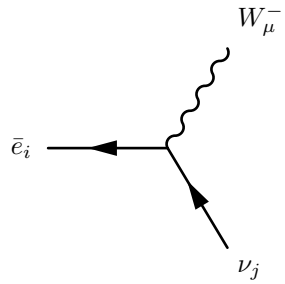
$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(3g_2\cos\Theta_W\cos\Theta'_W+6g'_1\sin\Theta'_W-g_1\cos\Theta'_W\sin\Theta_W\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{448}$$

$$+\frac{i}{3}\delta_{\alpha\beta}\delta_{ij}\Big(2g_1\cos\Theta'_W\sin\Theta_W+3g'_1\sin\Theta'_W\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{449}$$

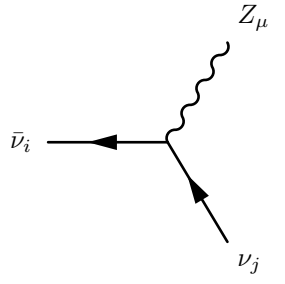


$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(\Big(-3g_2\cos\Theta_W+g_1\sin\Theta_W\Big)\sin\Theta'_W+6g'_1\cos\Theta'_W\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{450}$$

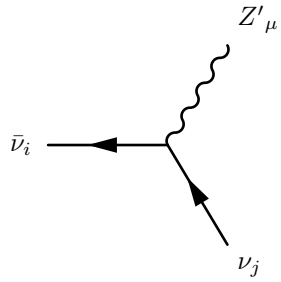
$$+\frac{i}{3}\delta_{\alpha\beta}\delta_{ij}\Big(-2g_1\sin\Theta_W\sin\Theta'_W+3g'_1\cos\Theta'_W\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{451}$$



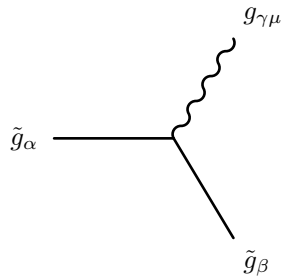
$$-i\frac{1}{\sqrt{2}}g_2\Theta_{j,3}U^e_{L,ij}\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{452}$$



$$-\frac{i}{2}\delta_{ij}\Big(4g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{453}$$



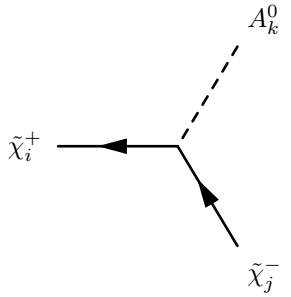
$$-\frac{i}{2}\delta_{ij}\Big(4g_1'\cos\Theta'_W-\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{454}$$



$$-g_3|\phi_{\tilde{g}}|^2 f_{\alpha,\beta,\gamma}\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{455}$$

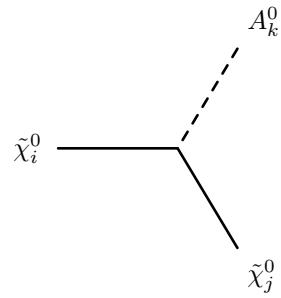
$$+\ -g_3|\phi_{\tilde{g}}|^2 f_{\alpha,\beta,\gamma}\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{456}$$

9.5 Two Fermion-One Scalar Boson-Interaction



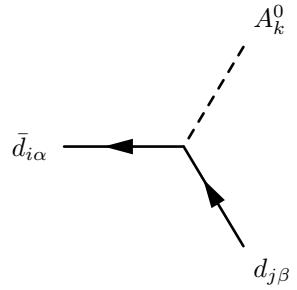
$$- \frac{1}{\sqrt{2}}\Big(g_2 U^*_{j1} V^*_{i2} U_{A,k2} + U^*_{j2}\Big(g_2 V^*_{i1} U_{A,k1} - \lambda V^*_{i2} U_{A,k3}\Big)\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{457}$$

$$+ \frac{1}{\sqrt{2}}\Big(g_2 U_{i1} V_{j2} U_{A,k2} + U_{i2}\Big(g_2 V_{j1} U_{A,k1} - \lambda^* V_{j2} U_{A,k3}\Big)\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{458}$$



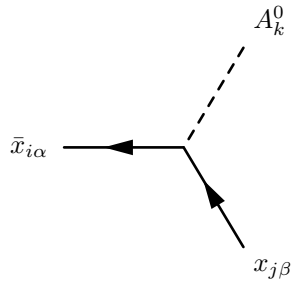
$$\begin{aligned}
&\frac{1}{2}\Big(- g_2 N^*_{i2} N^*_{j3} U_{A,k1} + 6 g'_1 N^*_{i8} N^*_{j3} U_{A,k1} - \sqrt{2}\lambda N^*_{i5} N^*_{j4} U_{A,k1} - \sqrt{2}\lambda N^*_{i4} N^*_{j5} U_{A,k1} \\
&- g_1 N^*_{i4} N^*_{j1} U_{A,k2} + g_2 N^*_{i4} N^*_{j2} U_{A,k2} - \sqrt{2}\lambda N^*_{i5} N^*_{j3} U_{A,k2} + g_2 N^*_{i2} N^*_{j4} U_{A,k2} \\
&+ 4 g'_1 N^*_{i8} N^*_{j4} U_{A,k2} + 4 g'_1 N^*_{i4} N^*_{j8} U_{A,k2} - N^*_{i1}\Big(- g_1 N^*_{j3} U_{A,k1} + g_1 N^*_{j4} U_{A,k2}\Big) \\
&- \sqrt{2}\lambda N^*_{i4} N^*_{j3} U_{A,k3} - 2 g'_1 Q_S N^*_{i8} N^*_{j5} U_{A,k3} - \sqrt{2}\sigma N^*_{i7} N^*_{j6} U_{A,k3} \\
&- \sqrt{2}\sigma N^*_{i6} N^*_{j7} U_{A,k3} - 2 g'_1 Q_S N^*_{i5} N^*_{j8} U_{A,k3} \\
&- N^*_{i3}\Big(- 6 g'_1 N^*_{j8} U_{A,k1} - g_1 N^*_{j1} U_{A,k1} + g_2 N^*_{j2} U_{A,k1} + \sqrt{2}\lambda N^*_{j4} U_{A,k3} + \sqrt{2}\lambda N^*_{j5} U_{A,k2}\Big) \\
&- \sqrt{2}\sigma N^*_{i7} N^*_{j5} U_{A,k4} + 2 g'_1 Q_S N^*_{i8} N^*_{j6} U_{A,k4} - \sqrt{2}\sigma N^*_{i5} N^*_{j7} U_{A,k4} \\
&+ 2 g'_1 Q_S N^*_{i6} N^*_{j8} U_{A,k4} - \sqrt{2}\sigma N^*_{i6} N^*_{j5} U_{A,k5} - \sqrt{2}\sigma N^*_{i5} N^*_{j6} U_{A,k5} \\
&+ 2\sqrt{2}\kappa' N^*_{i7} N^*_{j7} U_{A,k5}\Big)\Big(\frac{1-\gamma_5}{2}\Big)
\end{aligned} \tag{459}$$

$$\begin{aligned}
&+ \frac{1}{2}\Big(\sqrt{2}\lambda^* U_{A,k3} N_{i4} N_{j3} + \sqrt{2}\lambda^* U_{A,k3} N_{i3} N_{j4} + \sqrt{2}\sigma'^{,*} U_{A,k5} N_{i6} N_{j5} + \sqrt{2}\sigma'^{,*} U_{A,k4} N_{i7} N_{j5} \\
&+ 2 g'_1 Q_S U_{A,k3} N_{i8} N_{j5} + \sqrt{2}\sigma'^{,*} U_{A,k5} N_{i5} N_{j6} + \sqrt{2}\sigma'^{,*} U_{A,k3} N_{i7} N_{j6} - 2 g'_1 Q_S U_{A,k4} N_{i8} N_{j6} \\
&+ \sqrt{2}\sigma'^{,*} U_{A,k4} N_{i5} N_{j7} + \sqrt{2}\sigma'^{,*} U_{A,k3} N_{i6} N_{j7} - 2\sqrt{2}\kappa'^{,*} U_{A,k5} N_{i7} N_{j7} + 2 g'_1 Q_S U_{A,k3} N_{i5} N_{j8} \\
&- 2 g'_1 Q_S U_{A,k4} N_{i6} N_{j8} \\
&+ U_{A,k1}\Big(- g_1 N_{i1} N_{j3} + g_2 N_{i2} N_{j3} - 6 g'_1 N_{i8} N_{j3} + \sqrt{2}\lambda^* N_{i5} N_{j4} + \sqrt{2}\lambda^* N_{i4} N_{j5} \\
&+ N_{i3}\Big(- 6 g'_1 N_{j8} - g_1 N_{j1} + g_2 N_{j2}\Big)\Big) \\
&+ U_{A,k2}\Big(\Big(- 4 g'_1 N_{i8} + g_1 N_{i1} - g_2 N_{i2}\Big) N_{j4} + \sqrt{2}\lambda^*\Big(N_{i3} N_{j5} + N_{i5} N_{j3}\Big) \\
&+ N_{i4}\Big(- 4 g'_1 N_{j8} + g_1 N_{j1} - g_2 N_{j2}\Big)\Big)\Big)\Big(\frac{1+\gamma_5}{2}\Big)
\end{aligned} \tag{460}$$



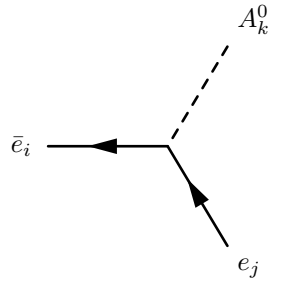
$$\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{a=1}^{3} U_{L,ja}^{d,*} U_{R,ia}^{d,*} Y_{d,aa} U_{A,k1}\Big(\frac{1-\gamma_5}{2}\Big) \tag{461}$$

$$+\ -\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{a=1}^{3} Y_{d,aa}^{*} U_{L,ia}^{d} U_{R,ja}^{d} U_{A,k1}\Big(\frac{1+\gamma_5}{2}\Big) \tag{462}$$



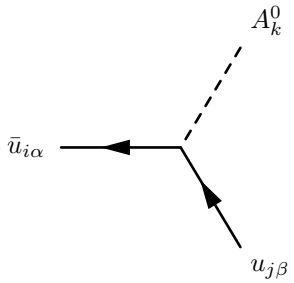
$$\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{a=1}^{3} ZDXL_{ja}^{*} ZDXR_{ia}^{*} \kappa_{aa} U_{A,k3}\Big(\frac{1-\gamma_5}{2}\Big) \tag{463}$$

$$+\ -\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{a=1}^{3} \kappa_{aa}^{*} ZDXL_{ia} ZDXR_{ja} U_{A,k3}\Big(\frac{1+\gamma_5}{2}\Big) \tag{464}$$



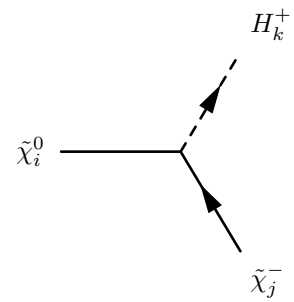
$$\frac{1}{\sqrt{2}}\sum_{a=1}^{3} U_{L,ja}^{e,*} U_{R,ia}^{e,*} Y_{e,aa} U_{A,k1}\Big(\frac{1-\gamma_5}{2}\Big) \tag{465}$$

$$+\ -\frac{1}{\sqrt{2}}\sum_{a=1}^{3} Y_{e,aa}^{*} U_{L,ia}^{e} U_{R,ja}^{e} U_{A,k1}\Big(\frac{1+\gamma_5}{2}\Big) \tag{466}$$



$$\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{a=1}^{3} U_{L,ja}^{u,*} U_{R,ia}^{u,*} Y_{u,aa} U_{A,k2}\Big(\frac{1-\gamma_5}{2}\Big) \tag{467}$$

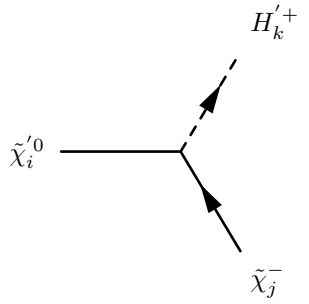
$$+\ -\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\sum_{a=1}^{3} Y_{u,aa}^{*} U_{L,ia}^{u} U_{R,ja}^{u} U_{A,k2}\Big(\frac{1+\gamma_5}{2}\Big) \tag{468}$$



$$i\Big(-g_2 U_{j1}^{*} N_{i3}^{*} U_{+,k1}$$

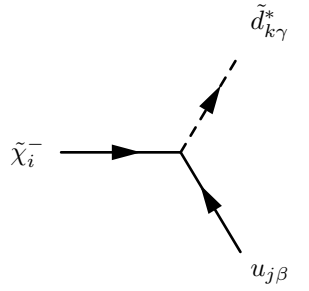
$$+ U_{j2}^{*}\Big(3\sqrt{2}g_1' N_{i8}^{*} U_{+,k1} + \frac{1}{\sqrt{2}} g_1 N_{i1}^{*} U_{+,k1} + \frac{1}{\sqrt{2}} g_2 N_{i2}^{*} U_{+,k1} - \lambda N_{i5}^{*} U_{+,k2}\Big)\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{469}$$

$$+\ i\Big(-\frac{1}{2}\Big(2g_2 V_{j1} N_{i4} + \sqrt{2} V_{j2}\Big(-4g_1' N_{i8} + g_1 N_{i1} + g_2 N_{i2}\Big)\Big) U_{+,k2} - \lambda^{*} V_{j2} N_{i5} U_{+,k1}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{470}$$



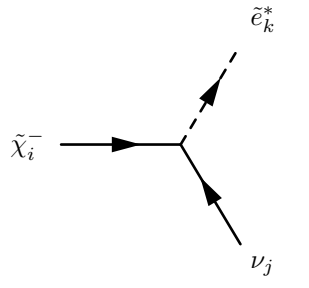
$$- ig_2 U^*_{j1} ZNp^*_{i1} UHpp_{k1} \Big(\frac{1-\gamma_5}{2}\Big) \tag{471}$$

$$+ \; -ig_2 UHpp_{k2} V_{j1} ZNp_{i2} \Big(\frac{1+\gamma_5}{2}\Big) \tag{472}$$

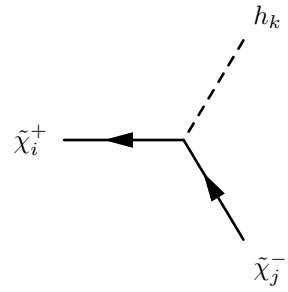


$$i\delta_{\beta\gamma} \Big(- g_2 U^*_{i1} \sum_{a=1}^{3} U^{u,*}_{L,ja} Z^D_{ka} + U^*_{i2} \sum_{a=1}^{3} U^{u,*}_{L,ja} Y_{d,aa} Z^D_{k3+a} \Big) \Big(\frac{1-\gamma_5}{2}\Big) \tag{473}$$

$$+ \; i\delta_{\beta\gamma} \sum_{a=1}^{3} Y^*_{u,aa} Z^D_{ka} U^u_{R,ja} V_{i2} \Big(\frac{1+\gamma_5}{2}\Big) \tag{474}$$

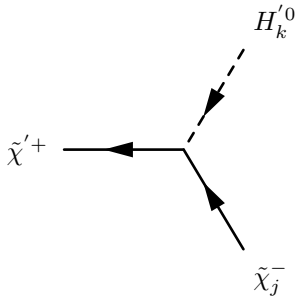


$$i\Theta_{j,3}\Big(- g_2 U_{i1}^* Z_{kj}^E + U_{i2}^* Y_{e,jj} Z_{k3+j}^E \Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{475}$$



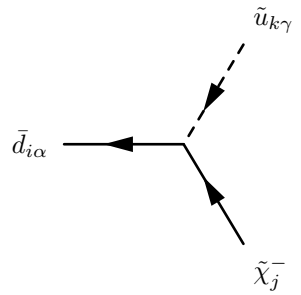
$$- i\frac{1}{\sqrt{2}}\Big(g_2 U_{j1}^* V_{i2}^* U_{H,k2}^* + U_{j2}^*\Big(g_2 V_{i1}^* U_{H,k1}^* + \lambda V_{i2}^* U_{H,k3}^*\Big)\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{476}$$

$$+ \; -i\frac{1}{\sqrt{2}}\Big(g_2 U_{H,k1}^* U_{i2} V_{j1} + \Big(g_2 U_{H,k2}^* U_{i1} + \lambda^* U_{H,k3}^* U_{i2}\Big) V_{j2}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{477}$$



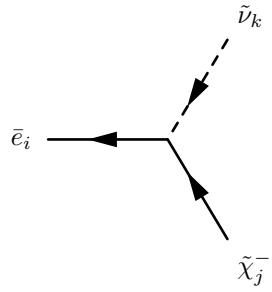
$$- ig_2 UHp0_{k2}^* U_{j1}^*\Big(\frac{1-\gamma_5}{2}\Big) \tag{478}$$

$$+ \; -ig_2 UHp0_{k1}^* V_{j1}\Big(\frac{1+\gamma_5}{2}\Big) \tag{479}$$



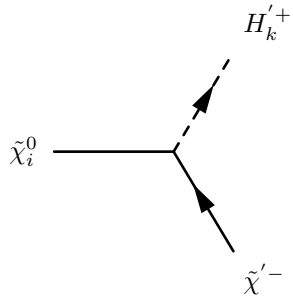
$$iU^*_{j2}\delta_{\alpha\gamma}\sum_{a=1}^{3}U^{d,*}_{R,ia}Z^{U,*}_{ka}Y_{d,aa}\Big(\frac{1-\gamma_5}{2}\Big) \tag{480}$$

$$+\ i\delta_{\alpha\gamma}\Big(-g_2\sum_{a=1}^{3}Z^{U,*}_{ka}U^{d}_{L,ia}V_{j1}+\sum_{a=1}^{3}Y^*_{u,aa}Z^{U,*}_{k3+a}U^{d}_{L,ia}V_{j2}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{481}$$



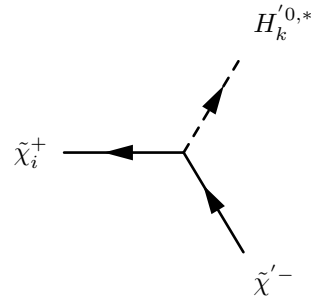
$$iU^*_{j2}\sum_{a=1}^{3}U^{e,*}_{R,ia}Z^{V,*}_{ka}Y_{e,aa}\Big(\frac{1-\gamma_5}{2}\Big) \tag{482}$$

$$+\ -ig_2\sum_{a=1}^{3}Z^{V,*}_{ka}U^{e}_{L,ia}V_{j1}\Big(\frac{1+\gamma_5}{2}\Big) \tag{483}$$



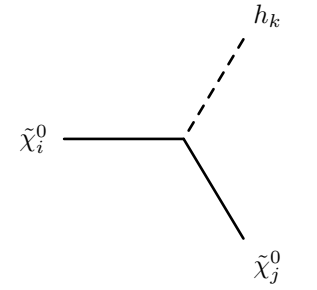
$$i\frac{1}{\sqrt{2}}\Big(-4g_1'N^*_{i8}+g_1N^*_{i1}+g_2N^*_{i2}\Big)UHpp_{k1}\Big(\frac{1-\gamma_5}{2}\Big) \tag{484}$$

$$+\ -i\frac{1}{\sqrt{2}}UHpp_{k2}\Big(-4g_1'N_{i8}+g_1N_{i1}+g_2N_{i2}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{485}$$



$$- ig_2 V_{i1}^* UHp0_{k1}\Big(\frac{1-\gamma_5}{2}\Big) \tag{486}$$

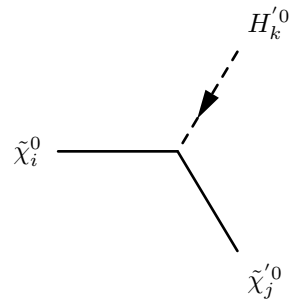
$$+ \; -ig_2 UHp0_{k2} U_{i1}\Big(\frac{1+\gamma_5}{2}\Big) \tag{487}$$



$$\begin{aligned}
&\frac{i}{2}\Big(\sqrt{2}\lambda U_{H,k3}^* N_{i4}^* N_{j3}^* + \sqrt{2}\lambda U_{H,k3}^* N_{i3}^* N_{j4}^* + \sqrt{2}\sigma U_{H,k5}^* N_{i6}^* N_{j5}^* + \sqrt{2}\sigma U_{H,k4}^* N_{i7}^* N_{j5}^* \\
&- 2g_1' Q_S U_{H,k3}^* N_{i8}^* N_{j5}^* + \sqrt{2}\sigma U_{H,k5}^* N_{i5}^* N_{j6}^* + \sqrt{2}\sigma U_{H,k3}^* N_{i7}^* N_{j6}^* \\
&+ 2g_1' Q_S U_{H,k4}^* N_{i8}^* N_{j6}^* + \sqrt{2}\sigma U_{H,k4}^* N_{i5}^* N_{j7}^* + \sqrt{2}\sigma U_{H,k3}^* N_{i6}^* N_{j7}^* \\
&- 2\sqrt{2}\kappa' U_{H,k5}^* N_{i7}^* N_{j7}^* - 2g_1' Q_S U_{H,k3}^* N_{i5}^* N_{j8}^* + 2g_1' Q_S U_{H,k4}^* N_{i6}^* N_{j8}^* \\
&+ U_{H,k2}^*\Big(\sqrt{2}\lambda N_{i5}^* N_{j3}^* - g_1 N_{i1}^* N_{j4}^* + g_2 N_{i2}^* N_{j4}^* + 4g_1' N_{i8}^* N_{j4}^* + \sqrt{2}\lambda N_{i3}^* N_{j5}^* \\
&+ N_{i4}^*\Big(4g_1' N_{j8}^* - g_1 N_{j1}^* + g_2 N_{j2}^*\Big)\Big) \\
&+ U_{H,k1}^*\Big(g_1 N_{i1}^* N_{j3}^* - g_2 N_{i2}^* N_{j3}^* + 6g_1' N_{i8}^* N_{j3}^* + \sqrt{2}\lambda N_{i5}^* N_{j4}^* + \sqrt{2}\lambda N_{i4}^* N_{j5}^* \\
&+ N_{i3}^*\Big(6g_1' N_{j8}^* + g_1 N_{j1}^* - g_2 N_{j2}^*\Big)\Big)\Big)\Big(\frac{1-\gamma_5}{2}\Big)
\end{aligned} \tag{488}$$

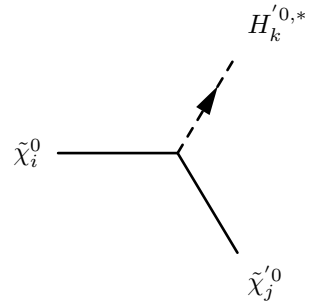
$$\begin{aligned}
&+ \; \frac{i}{2}\Big(\sqrt{2}\lambda^* U_{H,k3}^* N_{i4} N_{j3} + \sqrt{2}\lambda^* U_{H,k3}^* N_{i3} N_{j4} + \sqrt{2}\sigma'^{,*} U_{H,k5}^* N_{i6} N_{j5} + \sqrt{2}\sigma'^{,*} U_{H,k4}^* N_{i7} N_{j5} \\
&- 2g_1' Q_S U_{H,k3}^* N_{i8} N_{j5} + \sqrt{2}\sigma'^{,*} U_{H,k5}^* N_{i5} N_{j6} + \sqrt{2}\sigma'^{,*} U_{H,k3}^* N_{i7} N_{j6} + 2g_1' Q_S U_{H,k4}^* N_{i8} N_{j6} \\
&+ \sqrt{2}\sigma'^{,*} U_{H,k4}^* N_{i5} N_{j7} + \sqrt{2}\sigma'^{,*} U_{H,k3}^* N_{i6} N_{j7} - 2\sqrt{2}\kappa'^{,*} U_{H,k5}^* N_{i7} N_{j7} - 2g_1' Q_S U_{H,k3}^* N_{i5} N_{j8}
\end{aligned}$$

$$
\begin{aligned}
&+ 2g_1' Q_S U^*_{H,k4} N_{i6} N_{j8} \\
&+ U^*_{H,k2}\Big(\Big(4g_1' N_{i8} - g_1 N_{i1} + g_2 N_{i2}\Big) N_{j4} + N_{i4}\Big(4g_1' N_{j8} - g_1 N_{j1} + g_2 N_{j2}\Big) + \sqrt{2}\lambda^*\Big(N_{i3} N_{j5} + N_{i5} N_{j3}\Big)\Big) \\
&+ U^*_{H,k1}\Big(g_1 N_{i1} N_{j3} - g_2 N_{i2} N_{j3} + 6g_1' N_{i8} N_{j3} + \sqrt{2}\lambda^* N_{i5} N_{j4} + \sqrt{2}\lambda^* N_{i4} N_{j5} \\
&+ N_{i3}\Big(6g_1' N_{j8} + g_1 N_{j1} - g_2 N_{j2}\Big)\Big)\Big)\Big(\frac{1+\gamma_5}{2}\Big)
\end{aligned} \tag{489}
$$



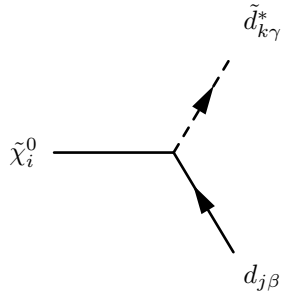
$$
i\frac{1}{\sqrt{2}} UHp0^*_{k2}\Big(4g_1' N^*_{i8} - g_1 N^*_{i1} + g_2 N^*_{i2}\Big) ZNp^*_{j2}\Big(\frac{1-\gamma_5}{2}\Big) \tag{490}
$$

$$
+\ i\frac{1}{\sqrt{2}} UHp0^*_{k1}\Big(-4g_1' N_{i8} + g_1 N_{i1} - g_2 N_{i2}\Big) ZNp_{j1}\Big(\frac{1+\gamma_5}{2}\Big) \tag{491}
$$



$$
i\frac{1}{\sqrt{2}}\Big(-4g_1' N^*_{i8} + g_1 N^*_{i1} - g_2 N^*_{i2}\Big) ZNp^*_{j1} UHp0_{k1}\Big(\frac{1-\gamma_5}{2}\Big) \tag{492}
$$

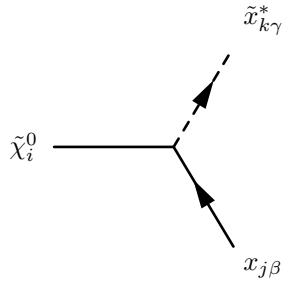
$$
+\ i\frac{1}{\sqrt{2}} UHp0_{k2}\Big(4g_1' N_{i8} - g_1 N_{i1} + g_2 N_{i2}\Big) ZNp_{j2}\Big(\frac{1+\gamma_5}{2}\Big) \tag{493}
$$



$$- \frac{i}{6}\delta_{\beta\gamma}\Big(\sqrt{2}g_1 N^*_{i1}\sum_{a=1}^{3} U^{d,*}_{L,ja} Z^D_{ka} - 3\sqrt{2}g_2 N^*_{i2}\sum_{a=1}^{3} U^{d,*}_{L,ja} Z^D_{ka} + 6\sqrt{2}g'_1 N^*_{i8}\sum_{a=1}^{3} U^{d,*}_{L,ja} Z^D_{ka}$$

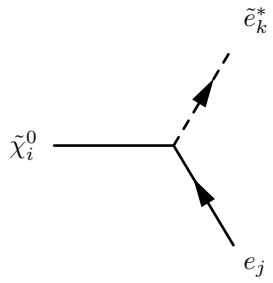
$$+ 6N^*_{i3}\sum_{a=1}^{3} U^{d,*}_{L,ja} Y_{d,aa} Z^D_{k3+a}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{494}$$

$$+ \; -\frac{i}{3}\delta_{\beta\gamma}\Big(3\sum_{a=1}^{3} Y^*_{d,aa} Z^D_{ka} U^d_{R,ja} N_{i3} + \sqrt{2}\sum_{a=1}^{3} Z^D_{k3+a} U^d_{R,ja}\Big(6g'_1 N_{i8} + g_1 N_{i1}\Big)\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{495}$$

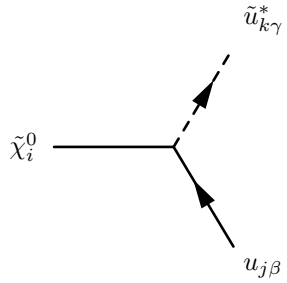


$$\frac{i}{3}\delta_{\beta\gamma}\Big(-3N^*_{i5}\sum_{a=1}^{3} ZDXL^*_{ja} Z^{Dx}_{k3+a}\kappa_{aa} + 6\sqrt{2}g'_1 N^*_{i8}\sum_{a=1}^{3} ZDXL^*_{ja} Z^{Dx}_{ka} + \sqrt{2}g_1 N^*_{i1}\sum_{a=1}^{3} ZDXL^*_{ja} Z^{Dx}_{ka}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{496}$$

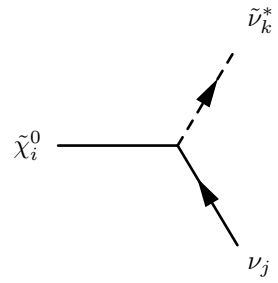
$$+ \; -\frac{i}{3}\delta_{\beta\gamma}\Big(3\sum_{a=1}^{3}\kappa^*_{aa} Z^{Dx}_{ka} ZDXR_{ja} N_{i5} + \sqrt{2}\sum_{a=1}^{3} Z^{Dx}_{k3+a} ZDXR_{ja}\Big(-9g'_1 N_{i8} + g_1 N_{i1}\Big)\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{497}$$



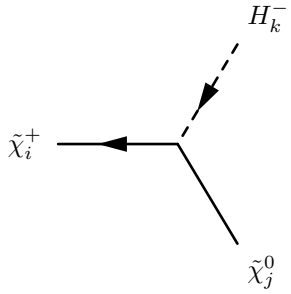
$$i\Big(\frac{1}{\sqrt{2}}g_1 N_{i1}^* \sum_{a=1}^{3} U_{L,ja}^{e,*} Z_{ka}^E + \frac{1}{\sqrt{2}} g_2 N_{i2}^* \sum_{a=1}^{3} U_{L,ja}^{e,*} Z_{ka}^E - 2\sqrt{2} g_1' N_{i8}^* \sum_{a=1}^{3} U_{L,ja}^{e,*} Z_{ka}^E$$
$$- N_{i3}^* \sum_{a=1}^{3} U_{L,ja}^{e,*} Y_{e,aa} Z_{k3+a}^E \Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{498}$$
$$+ i\Big(- \sqrt{2} \sum_{a=1}^{3} Z_{k3+a}^E U_{R,ja}^e \Big(g_1 N_{i1} + g_1' N_{i8}\Big) - \sum_{a=1}^{3} Y_{e,aa}^* Z_{ka}^E U_{R,ja}^e N_{i3}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{499}$$



$$- \frac{i}{6}\delta_{\beta\gamma}\Big(\sqrt{2} g_1 N_{i1}^* \sum_{a=1}^{3} U_{L,ja}^{u,*} Z_{ka}^U + 3\sqrt{2} g_2 N_{i2}^* \sum_{a=1}^{3} U_{L,ja}^{u,*} Z_{ka}^U + 6\sqrt{2} g_1' N_{i8}^* \sum_{a=1}^{3} U_{L,ja}^{u,*} Z_{ka}^U$$
$$+ 6 N_{i4}^* \sum_{a=1}^{3} U_{L,ja}^{u,*} Y_{u,aa} Z_{k3+a}^U \Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{500}$$
$$+ \frac{i}{3}\delta_{\beta\gamma}\Big(- 3 \sum_{a=1}^{3} Y_{u,aa}^* Z_{ka}^U U_{R,ja}^u N_{i4} + \sqrt{2} \sum_{a=1}^{3} Z_{k3+a}^U U_{R,ja}^u \Big(2 g_1 N_{i1} - 3 g_1' N_{i8}\Big)\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{501}$$

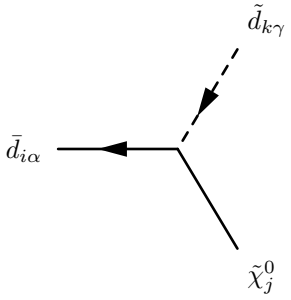


$$i\frac{1}{\sqrt{2}}\Big(-4g_1'N_{i8}^* + g_1N_{i1}^* - g_2N_{i2}^*\Big)\Theta_{j,3}Z_{kj}^V\Big(\frac{1-\gamma_5}{2}\Big) \tag{502}$$



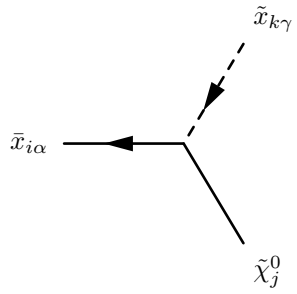
$$i\Big(-\frac{1}{2}V_{i2}^*\Big(2\lambda N_{j5}^*U_{+,k1}^* + \sqrt{2}\Big(-4g_1'N_{j8}^* + g_1N_{j1}^* + g_2N_{j2}^*\Big)U_{+,k2}^*\Big) - g_2V_{i1}^*N_{j4}^*U_{+,k2}^*\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{503}$$

$$+\ i\Big(\frac{1}{2}U_{+,k1}^*\Big(-2g_2U_{i1}N_{j3} + \sqrt{2}U_{i2}\Big(6g_1'N_{j8} + g_1N_{j1} + g_2N_{j2}\Big)\Big) - \lambda^*U_{+,k2}^*U_{i2}N_{j5}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{504}$$



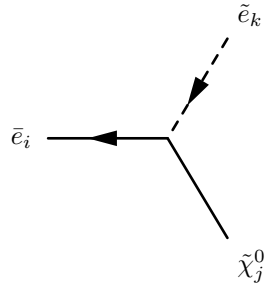
$$-\frac{i}{3}\delta_{\alpha\gamma}\Big(3N_{j3}^*\sum_{a=1}^{3}Z_{ka}^{D,*}U_{R,ia}^{d,*}Y_{d,aa} + 6\sqrt{2}g_1'N_{j8}^*\sum_{a=1}^{3}Z_{k3+a}^{D,*}U_{R,ia}^{d,*} + \sqrt{2}g_1N_{j1}^*\sum_{a=1}^{3}Z_{k3+a}^{D,*}U_{R,ia}^{d,*}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{505}$$

$$+\ -\frac{i}{6}\delta_{\alpha\gamma}\Big(6\sum_{a=1}^{3}Y_{d,aa}^*Z_{k3+a}^{D,*}U_{L,ia}^dN_{j3} + \sqrt{2}\sum_{a=1}^{3}Z_{ka}^{D,*}U_{L,ia}^d\Big(-3g_2N_{j2} + 6g_1'N_{j8} + g_1N_{j1}\Big)\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{506}$$



$$-\frac{i}{3}\delta_{\alpha\gamma}\Big(3N_{j5}^{*}\sum_{a=1}^{3}Z_{ka}^{Dx,*}ZDXR_{ia}^{*}\kappa_{aa}-9\sqrt{2}g_1'N_{j8}^{*}\sum_{a=1}^{3}Z_{k3+a}^{Dx,*}ZDXR_{ia}^{*}+\sqrt{2}g_1N_{j1}^{*}\sum_{a=1}^{3}Z_{k3+a}^{Dx,*}ZDXR_{ia}^{*}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{507}$$

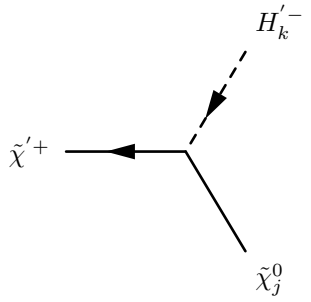
$$+\frac{i}{3}\delta_{\alpha\gamma}\Big(-3\sum_{a=1}^{3}Z_{k3+a}^{Dx,*}\kappa_{aa}^{*}ZDXL_{ia}N_{j5}+\sqrt{2}\sum_{a=1}^{3}Z_{ka}^{Dx,*}ZDXL_{ia}\Big(6g_1'N_{j8}+g_1N_{j1}\Big)\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{508}$$



$$i\Big(-\sqrt{2}g_1N_{j1}^{*}\sum_{a=1}^{3}Z_{k3+a}^{E,*}U_{R,ia}^{e,*}-\sqrt{2}g_1'N_{j8}^{*}\sum_{a=1}^{3}Z_{k3+a}^{E,*}U_{R,ia}^{e,*}$$

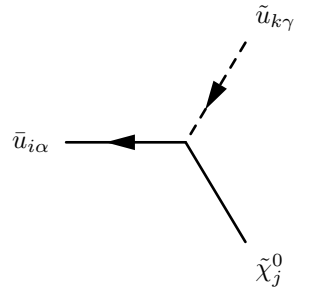
$$-N_{j3}^{*}\sum_{a=1}^{3}Z_{ka}^{E,*}U_{R,ia}^{e,*}Y_{e,aa}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{509}$$

$$+\ i\Big(\frac{1}{\sqrt{2}}\sum_{a=1}^{3}Z_{ka}^{E,*}U_{L,ia}^{e}\Big(-4g_1'N_{j8}+g_1N_{j1}+g_2N_{j2}\Big)-\sum_{a=1}^{3}Y_{e,aa}^{*}Z_{k3+a}^{E,*}U_{L,ia}^{e}N_{j3}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{510}$$



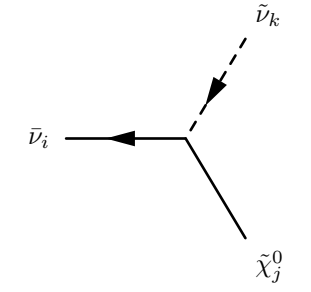
$$- i\frac{1}{\sqrt{2}}UHpp^*_{k2}\Big(- 4g_1' N^*_{j8} + g_1 N^*_{j1} + g_2 N^*_{j2}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{511}$$

$$+ \ i\frac{1}{\sqrt{2}}UHpp^*_{k1}\Big(- 4g_1' N_{j8} + g_1 N_{j1} + g_2 N_{j2}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{512}$$



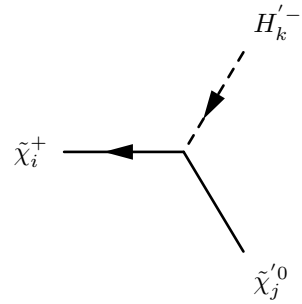
$$\frac{i}{3}\delta_{\alpha\gamma}\Big(2\sqrt{2}g_1 N^*_{j1}\sum_{a=1}^{3} Z^{U,*}_{k3+a}U^{u,*}_{R,ia} - 3\Big(N^*_{j4}\sum_{a=1}^{3} Z^{U,*}_{ka}U^{u,*}_{R,ia}Y_{u,aa} + \sqrt{2}g_1' N^*_{j8}\sum_{a=1}^{3} Z^{U,*}_{k3+a}U^{u,*}_{R,ia}\Big)\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{513}$$

$$+ \ -\frac{i}{6}\delta_{\alpha\gamma}\Big(6\sum_{a=1}^{3} Y^*_{u,aa}Z^{U,*}_{k3+a}U^{u}_{L,ia}N_{j4} + \sqrt{2}\sum_{a=1}^{3} Z^{U,*}_{ka}U^{u}_{L,ia}\Big(3g_2 N_{j2} + 6g_1' N_{j8} + g_1 N_{j1}\Big)\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{514}$$



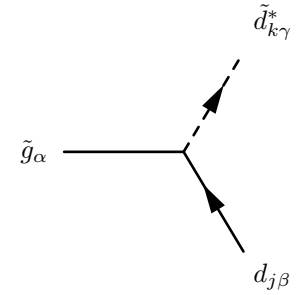
$$(515)$$

$$+\ i\frac{1}{\sqrt{2}}Z^{V,*}_{ki}\Theta_{i,3}\Big(-4g'_1N_{j8}+g_1N_{j1}-g_2N_{j2}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{516}$$



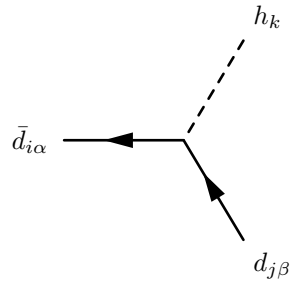
$$-\ ig_2UHpp^*_{k2}V^*_{i1}ZNp^*_{j2}\Big(\frac{1-\gamma_5}{2}\Big) \tag{517}$$

$$+\ -ig_2UHpp^*_{k1}U_{i1}ZNp_{j1}\Big(\frac{1+\gamma_5}{2}\Big) \tag{518}$$



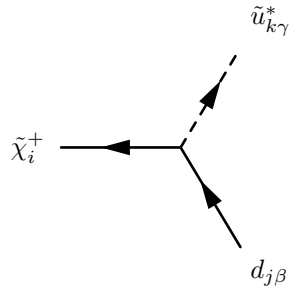
$$-\ i\frac{1}{\sqrt{2}}g_3\phi_{\tilde{g}}\lambda^\alpha_{\gamma,\beta}\sum_{a=1}^{3}U^{d,*}_{L,ja}Z^D_{ka}\Big(\frac{1-\gamma_5}{2}\Big) \tag{519}$$

$$+\ i\frac{1}{\sqrt{2}}g_3\phi^*_{\tilde{g}}\lambda^\alpha_{\gamma,\beta}\sum_{a=1}^{3}Z^D_{k3+a}U^d_{R,ja}\Big(\frac{1+\gamma_5}{2}\Big) \tag{520}$$



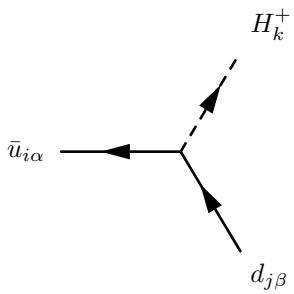
$$- i\frac{1}{\sqrt{2}}U^{*}_{H,k1}\delta_{\alpha\beta}\sum_{a=1}^{3}U^{d,*}_{L,ja}U^{d,*}_{R,ia}Y_{d,aa}\Big(\frac{1-\gamma_5}{2}\Big) \tag{521}$$

$$+\ -i\frac{1}{\sqrt{2}}U^{*}_{H,k1}\delta_{\alpha\beta}\sum_{a=1}^{3}Y^{*}_{d,aa}U^{d}_{L,ia}U^{d}_{R,ja}\Big(\frac{1+\gamma_5}{2}\Big) \tag{522}$$



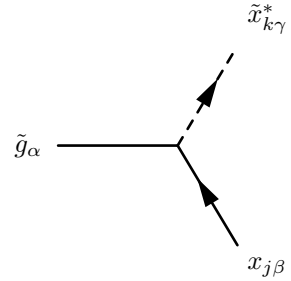
$$i\delta_{\beta\gamma}\Big(-g_2V^{*}_{i1}\sum_{a=1}^{3}U^{d,*}_{L,ja}Z^{U}_{ka}+V^{*}_{i2}\sum_{a=1}^{3}U^{d,*}_{L,ja}Y_{u,aa}Z^{U}_{k3+a}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{523}$$

$$+\ i\delta_{\beta\gamma}\sum_{a=1}^{3}Y^{*}_{d,aa}U^{d}_{R,ja}Z^{U}_{ka}U_{i2}\Big(\frac{1+\gamma_5}{2}\Big) \tag{524}$$



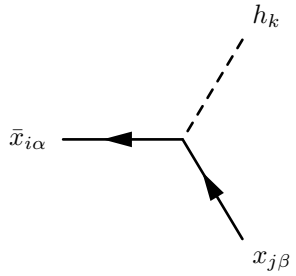
$$i\delta_{\alpha\beta}\sum_{a=1}^{3}U^{d,*}_{L,ja}U^{u,*}_{R,ia}Y_{u,aa}U_{+,k2}\Big(\frac{1-\gamma_5}{2}\Big) \tag{525}$$

$$+\ i\delta_{\alpha\beta}\sum_{a=1}^{3}Y^{*}_{d,aa}U^{d}_{R,ja}U^{u}_{L,ia}U_{+,k1}\Big(\frac{1+\gamma_5}{2}\Big) \tag{526}$$



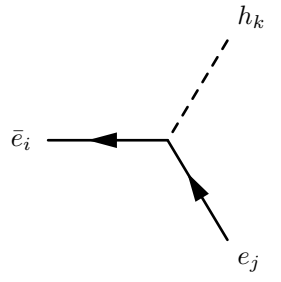
$$-i\frac{1}{\sqrt{2}}g_3\phi_{\tilde{g}}\lambda^{\alpha}_{\gamma,\beta}\sum_{a=1}^{3}ZDXL^*_{ja}Z^{Dx}_{ka}\Big(\frac{1-\gamma_5}{2}\Big) \tag{527}$$

$$+\ i\frac{1}{\sqrt{2}}g_3\phi^*_{\tilde{g}}\lambda^{\alpha}_{\gamma,\beta}\sum_{a=1}^{3}Z^{Dx}_{k3+a}ZDXR_{ja}\Big(\frac{1+\gamma_5}{2}\Big) \tag{528}$$



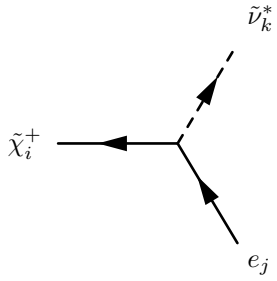
$$-i\frac{1}{\sqrt{2}}U^*_{H,k3}\delta_{\alpha\beta}\sum_{a=1}^{3}ZDXL^*_{ja}ZDXR^*_{ia}\kappa_{aa}\Big(\frac{1-\gamma_5}{2}\Big) \tag{529}$$

$$+\ -i\frac{1}{\sqrt{2}}U^*_{H,k3}\delta_{\alpha\beta}\sum_{a=1}^{3}\kappa^*_{aa}ZDXL_{ia}ZDXR_{ja}\Big(\frac{1+\gamma_5}{2}\Big) \tag{530}$$



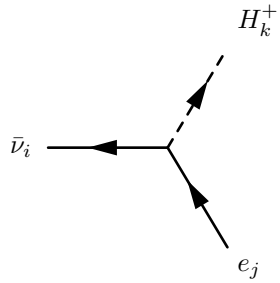
$$- i\frac{1}{\sqrt{2}}U^{*}_{H,k1}\sum_{a=1}^{3}U^{e,*}_{L,ja}U^{e,*}_{R,ia}Y_{e,aa}\Big(\frac{1-\gamma_5}{2}\Big) \tag{531}$$

$$+ -i\frac{1}{\sqrt{2}}U^{*}_{H,k1}\sum_{a=1}^{3}Y^{*}_{e,aa}U^{e}_{L,ia}U^{e}_{R,ja}\Big(\frac{1+\gamma_5}{2}\Big) \tag{532}$$



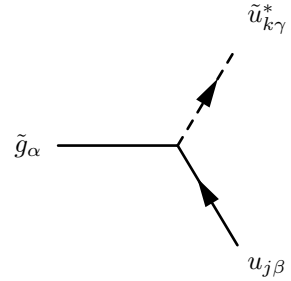
$$- ig_2V^{*}_{i1}\sum_{a=1}^{3}U^{e,*}_{L,ja}Z^{V}_{ka}\Big(\frac{1-\gamma_5}{2}\Big) \tag{533}$$

$$+ i\sum_{a=1}^{3}Y^{*}_{e,aa}U^{e}_{R,ja}Z^{V}_{ka}U_{i2}\Big(\frac{1+\gamma_5}{2}\Big) \tag{534}$$



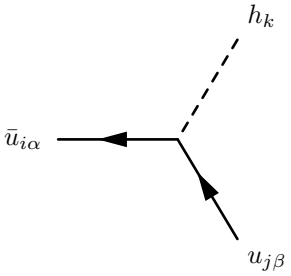
(535)

$$+ iY^{*}_{e,ii}\Theta_{i,3}U^{e}_{R,ji}U_{+,k1}\Big(\frac{1+\gamma_5}{2}\Big) \tag{536}$$



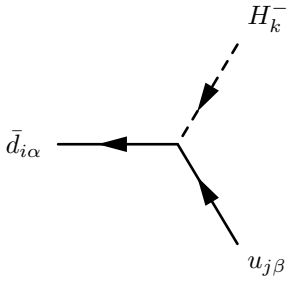
$$- i\frac{1}{\sqrt{2}} g_3 \phi_{\tilde{g}} \lambda^{\alpha}_{\gamma,\beta} \sum_{a=1}^{3} U^{u,*}_{L,ja} Z^{U}_{ka} \Big(\frac{1-\gamma_5}{2} \Big) \tag{537}$$

$$+ \ i\frac{1}{\sqrt{2}} g_3 \phi^*_{\tilde{g}} \lambda^{\alpha}_{\gamma,\beta} \sum_{a=1}^{3} Z^{U}_{k3+a} U^{u}_{R,ja} \Big(\frac{1+\gamma_5}{2} \Big) \tag{538}$$



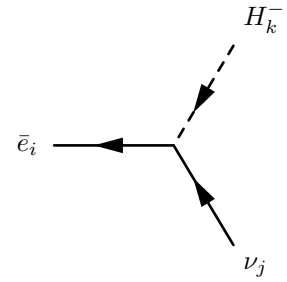
$$- i\frac{1}{\sqrt{2}} U^{*}_{H,k2} \delta_{\alpha\beta} \sum_{a=1}^{3} U^{u,*}_{L,ja} U^{u,*}_{R,ia} Y_{u,aa} \Big(\frac{1-\gamma_5}{2} \Big) \tag{539}$$

$$+ \ -i\frac{1}{\sqrt{2}} U^{*}_{H,k2} \delta_{\alpha\beta} \sum_{a=1}^{3} Y^{*}_{u,aa} U^{u}_{L,ia} U^{u}_{R,ja} \Big(\frac{1+\gamma_5}{2} \Big) \tag{540}$$

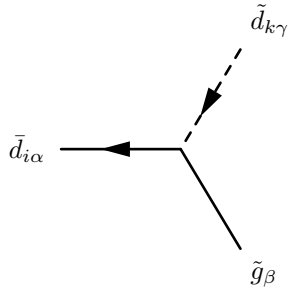


$$iU^{*}_{+,k1}\delta_{\alpha\beta}\sum_{a=1}^{3}U^{d,*}_{R,ia}U^{u,*}_{L,ja}Y_{d,aa}\Big(\frac{1-\gamma_5}{2}\Big) \tag{541}$$

$$+\ iU^{*}_{+,k2}\delta_{\alpha\beta}\sum_{a=1}^{3}Y^{*}_{u,aa}U^{d}_{L,ia}U^{u}_{R,ja}\Big(\frac{1+\gamma_5}{2}\Big) \tag{542}$$

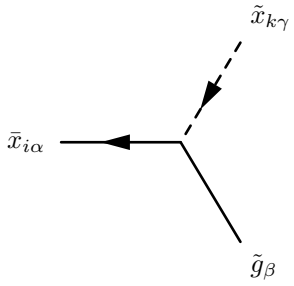


$$iU^{e,*}_{R,ij}U^{*}_{+,k1}\Theta_{j,3}Y_{e,jj}\Big(\frac{1-\gamma_5}{2}\Big) \tag{543}$$



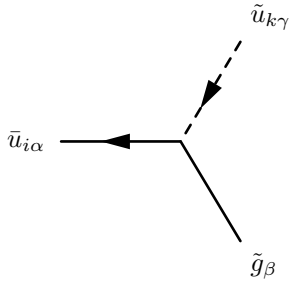
$$i\frac{1}{\sqrt{2}}g_3\phi_{\tilde{g}}\lambda^{\beta}_{\alpha,\gamma}\sum_{a=1}^{3}Z^{D,*}_{k3+a}U^{d,*}_{R,ia}\Big(\frac{1-\gamma_5}{2}\Big) \tag{544}$$

$$+\ -i\frac{1}{\sqrt{2}}g_3\phi^{*}_{\tilde{g}}\lambda^{\beta}_{\alpha,\gamma}\sum_{a=1}^{3}Z^{D,*}_{ka}U^{d}_{L,ia}\Big(\frac{1+\gamma_5}{2}\Big) \tag{545}$$



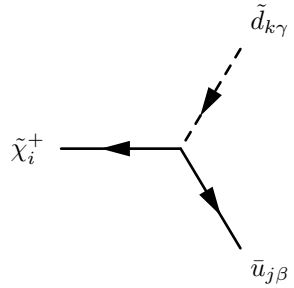
$$i\frac{1}{\sqrt{2}}g_3\phi_{\tilde{g}}\lambda^{\beta}_{\alpha,\gamma}\sum_{a=1}^{3}Z^{Dx,*}_{k3+a}ZDXR^{*}_{ia}\Big(\frac{1-\gamma_5}{2}\Big) \tag{546}$$

$$+\ -i\frac{1}{\sqrt{2}}g_3\phi^{*}_{\tilde{g}}\lambda^{\beta}_{\alpha,\gamma}\sum_{a=1}^{3}Z^{Dx,*}_{ka}ZDXL_{ia}\Big(\frac{1+\gamma_5}{2}\Big) \tag{547}$$



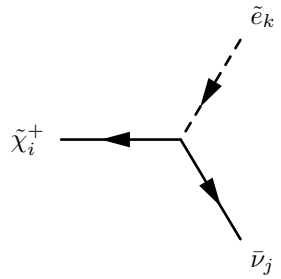
$$i\frac{1}{\sqrt{2}}g_3\phi_{\tilde{g}}\lambda^{\beta}_{\alpha,\gamma}\sum_{a=1}^{3}Z^{U,*}_{k3+a}U^{u,*}_{R,ia}\Big(\frac{1-\gamma_5}{2}\Big) \tag{548}$$

$$+\ -i\frac{1}{\sqrt{2}}g_3\phi^{*}_{\tilde{g}}\lambda^{\beta}_{\alpha,\gamma}\sum_{a=1}^{3}Z^{U,*}_{ka}U^{u}_{L,ia}\Big(\frac{1+\gamma_5}{2}\Big) \tag{549}$$



$$iV^{*}_{i2}\delta_{\beta\gamma}\sum_{a=1}^{3}Z^{D,*}_{ka}U^{u,*}_{R,ja}Y_{u,aa}\Big(\frac{1-\gamma_5}{2}\Big) \tag{550}$$

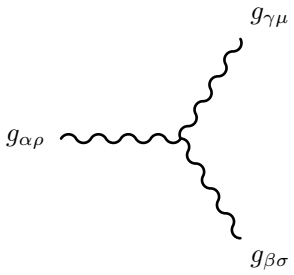
$$+\ i\delta_{\beta\gamma}\Big(-g_2\sum_{a=1}^{3}Z^{D,*}_{ka}U^{u}_{L,ja}U_{i1}+\sum_{a=1}^{3}Y^{*}_{d,aa}Z^{D,*}_{k3+a}U^{u}_{L,ja}U_{i2}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{551}$$



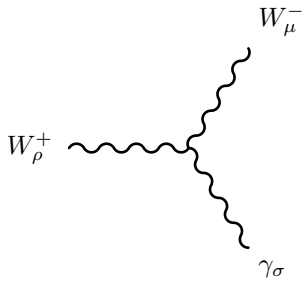
(552)

$$+\ i\Theta_{j,3}\Big(-g_2 Z^{E,*}_{kj} U_{i1} + Y^*_{e,jj} Z^{E,*}_{k3+j} U_{i2}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{553}$$

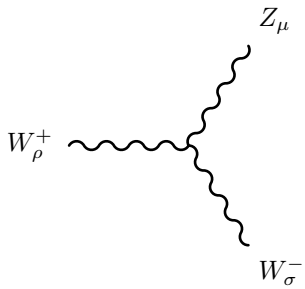
9.6 Three Vector Boson-Interaction



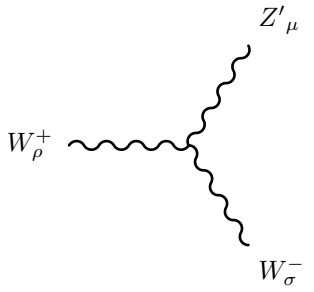
$$g_3 f_{\alpha,\beta,\gamma}\Big(g_{\rho\mu}\Big(-p_\sigma^{g_{\gamma\mu}} + p_\sigma^{g_{\alpha\rho}}\Big) + g_{\rho\sigma}\Big(-p_\mu^{g_{\alpha\rho}} + p_\mu^{g_{\beta\sigma}}\Big) + g_{\sigma\mu}\Big(-p_\rho^{g_{\beta\sigma}} + p_\rho^{g_{\gamma\mu}}\Big)\Big) \tag{554}$$



$$ig_2 \sin\Theta_W\Big(g_{\rho\mu}\Big(-p_\sigma^{W_\mu^-} + p_\sigma^{W_\rho^+}\Big) + g_{\rho\sigma}\Big(-p_\mu^{W_\rho^+} + p_\mu^{\gamma_\sigma}\Big) + g_{\sigma\mu}\Big(-p_\rho^{\gamma_\sigma} + p_\rho^{W_\mu^-}\Big)\Big) \tag{555}$$

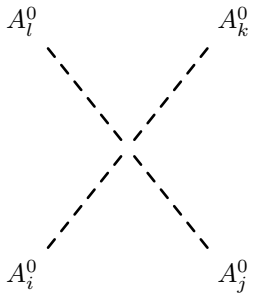


$$-ig_2\cos\Theta_W\cos\Theta'_W\Big(g_{\rho\mu}\Big(-p_\sigma^{Z_\mu}+p_\sigma^{W^+_\rho}\Big)+g_{\rho\sigma}\Big(-p_\mu^{W^+_\rho}+p_\mu^{W^-_\sigma}\Big)+g_{\sigma\mu}\Big(-p_\rho^{W^-_\sigma}+p_\rho^{Z_\mu}\Big)\Big) \tag{556}$$



$$ig_2\cos\Theta_W\sin\Theta'_W\Big(g_{\rho\mu}\Big(-p_\sigma^{Z'_\mu}+p_\sigma^{W^+_\rho}\Big)+g_{\rho\sigma}\Big(-p_\mu^{W^+_\rho}+p_\mu^{W^-_\sigma}\Big)+g_{\sigma\mu}\Big(-p_\rho^{W^-_\sigma}+p_\rho^{Z'_\mu}\Big)\Big) \tag{557}$$

9.7 Four Scalar-Interaction



$$\begin{aligned}&\frac{i}{4}\Big(12g_{1'}^2Q_SU_{A,i3}U_{A,j3}U_{A,k1}U_{A,l1}-4|\lambda|^2U_{A,i3}U_{A,j3}U_{A,k1}U_{A,l1}-12g_{1'}^2Q_SU_{A,i4}U_{A,j4}U_{A,k1}U_{A,l1}\\&-\sigma\lambda^*U_{A,i5}U_{A,j4}U_{A,k2}U_{A,l1}-\lambda\sigma'^{,*}U_{A,i5}U_{A,j4}U_{A,k2}U_{A,l1}-\sigma\lambda^*U_{A,i4}U_{A,j5}U_{A,k2}U_{A,l1}\\&-\lambda\sigma'^{,*}U_{A,i4}U_{A,j5}U_{A,k2}U_{A,l1}+12g_{1'}^2Q_SU_{A,i3}U_{A,j1}U_{A,k3}U_{A,l1}-4|\lambda|^2U_{A,i3}U_{A,j1}U_{A,k3}U_{A,l1}\end{aligned}$$

$$
\begin{aligned}
&- 12g_{1'}^2 Q_S U_{A,i4}U_{A,j1}U_{A,k4}U_{A,l1} - \sigma\lambda^* U_{A,i5}U_{A,j2}U_{A,k4}U_{A,l1} - \lambda\sigma'^{,*} U_{A,i5}U_{A,j2}U_{A,k4}U_{A,l1}\\
&- \sigma\lambda^* U_{A,i4}U_{A,j2}U_{A,k5}U_{A,l1} - \lambda\sigma'^{,*} U_{A,i4}U_{A,j2}U_{A,k5}U_{A,l1} - \sigma\lambda^* U_{A,i5}U_{A,j4}U_{A,k1}U_{A,l2}\\
&- \lambda\sigma'^{,*} U_{A,i5}U_{A,j4}U_{A,k1}U_{A,l2} - \sigma\lambda^* U_{A,i4}U_{A,j5}U_{A,k1}U_{A,l2} - \lambda\sigma'^{,*} U_{A,i4}U_{A,j5}U_{A,k1}U_{A,l2}\\
&+ 8g_{1'}^2 Q_S U_{A,i3}U_{A,j3}U_{A,k2}U_{A,l2} - 4|\lambda|^2 U_{A,i3}U_{A,j3}U_{A,k2}U_{A,l2} - 8g_{1'}^2 Q_S U_{A,i4}U_{A,j4}U_{A,k2}U_{A,l2}\\
&+ 8g_{1'}^2 Q_S U_{A,i3}U_{A,j2}U_{A,k3}U_{A,l2} - 4|\lambda|^2 U_{A,i3}U_{A,j2}U_{A,k3}U_{A,l2} - \sigma\lambda^* U_{A,i5}U_{A,j1}U_{A,k4}U_{A,l2}\\
&- \lambda\sigma'^{,*} U_{A,i5}U_{A,j1}U_{A,k4}U_{A,l2} - 8g_{1'}^2 Q_S U_{A,i4}U_{A,j2}U_{A,k4}U_{A,l2} - \sigma\lambda^* U_{A,i4}U_{A,j1}U_{A,k5}U_{A,l2}\\
&- \lambda\sigma'^{,*} U_{A,i4}U_{A,j1}U_{A,k5}U_{A,l2} + 12g_{1'}^2 Q_S U_{A,i3}U_{A,j1}U_{A,k1}U_{A,l3} - 4|\lambda|^2 U_{A,i3}U_{A,j1}U_{A,k1}U_{A,l3}\\
&+ 8g_{1'}^2 Q_S U_{A,i3}U_{A,j2}U_{A,k2}U_{A,l3} - 4|\lambda|^2 U_{A,i3}U_{A,j2}U_{A,k2}U_{A,l3}\\
&- 12g_{1'}^2 Q_S^2 U_{A,i3}U_{A,j3}U_{A,k3}U_{A,l3} + 4g_{1'}^2 Q_S^2 U_{A,i4}U_{A,j4}U_{A,k3}U_{A,l3}\\
&- 4|\sigma|^2 U_{A,i4}U_{A,j4}U_{A,k3}U_{A,l3} - 4|\sigma|^2 U_{A,i5}U_{A,j5}U_{A,k3}U_{A,l3} + 4g_{1'}^2 Q_S^2 U_{A,i4}U_{A,j3}U_{A,k4}U_{A,l3}\\
&- 4|\sigma|^2 U_{A,i4}U_{A,j3}U_{A,k4}U_{A,l3} + 4g_{1'}^2 Q_S^2 U_{A,i3}U_{A,j4}U_{A,k4}U_{A,l3} - 4|\sigma|^2 U_{A,i3}U_{A,j4}U_{A,k4}U_{A,l3}\\
&+ 2\sigma\kappa'^{,*} U_{A,i5}U_{A,j5}U_{A,k4}U_{A,l3} + 2\kappa'\sigma'^{,*} U_{A,i5}U_{A,j5}U_{A,k4}U_{A,l3} - 4|\sigma|^2 U_{A,i5}U_{A,j3}U_{A,k5}U_{A,l3}\\
&+ 2\sigma\kappa'^{,*} U_{A,i5}U_{A,j4}U_{A,k5}U_{A,l3} + 2\kappa'\sigma'^{,*} U_{A,i5}U_{A,j4}U_{A,k5}U_{A,l3} - 4|\sigma|^2 U_{A,i3}U_{A,j5}U_{A,k5}U_{A,l3}\\
&+ 2\sigma\kappa'^{,*} U_{A,i4}U_{A,j5}U_{A,k5}U_{A,l3} + 2\kappa'\sigma'^{,*} U_{A,i4}U_{A,j5}U_{A,k5}U_{A,l3} - 12g_{1'}^2 Q_S U_{A,i4}U_{A,j1}U_{A,k1}U_{A,l4}\\
&- \sigma\lambda^* U_{A,i5}U_{A,j2}U_{A,k1}U_{A,l4} - \lambda\sigma'^{,*} U_{A,i5}U_{A,j2}U_{A,k1}U_{A,l4} - \sigma\lambda^* U_{A,i5}U_{A,j1}U_{A,k2}U_{A,l4}\\
&- \lambda\sigma'^{,*} U_{A,i5}U_{A,j1}U_{A,k2}U_{A,l4} - 8g_{1'}^2 Q_S U_{A,i4}U_{A,j2}U_{A,k2}U_{A,l4} + 4g_{1'}^2 Q_S^2 U_{A,i4}U_{A,j3}U_{A,k3}U_{A,l4}\\
&- 4|\sigma|^2 U_{A,i4}U_{A,j3}U_{A,k3}U_{A,l4} + 4g_{1'}^2 Q_S^2 U_{A,i3}U_{A,j4}U_{A,k3}U_{A,l4} - 4|\sigma|^2 U_{A,i3}U_{A,j4}U_{A,k3}U_{A,l4}\\
&+ 2\sigma\kappa'^{,*} U_{A,i5}U_{A,j5}U_{A,k3}U_{A,l4} + 2\kappa'\sigma'^{,*} U_{A,i5}U_{A,j5}U_{A,k3}U_{A,l4} + 4g_{1'}^2 Q_S^2 U_{A,i3}U_{A,j3}U_{A,k4}U_{A,l4}\\
&- 4|\sigma|^2 U_{A,i3}U_{A,j3}U_{A,k4}U_{A,l4} - 12g_{1'}^2 Q_S^2 U_{A,i4}U_{A,j4}U_{A,k4}U_{A,l4}\\
&- 4|\sigma|^2 U_{A,i5}U_{A,j5}U_{A,k4}U_{A,l4} + 2\sigma\kappa'^{,*} U_{A,i5}U_{A,j3}U_{A,k5}U_{A,l4} + 2\kappa'\sigma'^{,*} U_{A,i5}U_{A,j3}U_{A,k5}U_{A,l4}\\
&- 4|\sigma|^2 U_{A,i5}U_{A,j4}U_{A,k5}U_{A,l4} + 2\sigma\kappa'^{,*} U_{A,i3}U_{A,j5}U_{A,k5}U_{A,l4} + 2\kappa'\sigma'^{,*} U_{A,i3}U_{A,j5}U_{A,k5}U_{A,l4}\\
&- 4|\sigma|^2 U_{A,i4}U_{A,j5}U_{A,k5}U_{A,l4} - \sigma\lambda^* U_{A,i4}U_{A,j2}U_{A,k1}U_{A,l5} - \lambda\sigma'^{,*} U_{A,i4}U_{A,j2}U_{A,k1}U_{A,l5}\\
&- \sigma\lambda^* U_{A,i4}U_{A,j1}U_{A,k2}U_{A,l5} - \lambda\sigma'^{,*} U_{A,i4}U_{A,j1}U_{A,k2}U_{A,l5} - 4|\sigma|^2 U_{A,i5}U_{A,j3}U_{A,k3}U_{A,l5}\\
&+ 2\sigma\kappa'^{,*} U_{A,i5}U_{A,j4}U_{A,k3}U_{A,l5} + 2\kappa'\sigma'^{,*} U_{A,i5}U_{A,j4}U_{A,k3}U_{A,l5} - 4|\sigma|^2 U_{A,i3}U_{A,j5}U_{A,k3}U_{A,l5}\\
&+ 2\sigma\kappa'^{,*} U_{A,i4}U_{A,j5}U_{A,k3}U_{A,l5} + 2\kappa'\sigma'^{,*} U_{A,i4}U_{A,j5}U_{A,k3}U_{A,l5} + 2\sigma\kappa'^{,*} U_{A,i5}U_{A,j3}U_{A,k4}U_{A,l5}\\
&+ 2\kappa'\sigma'^{,*} U_{A,i5}U_{A,j3}U_{A,k4}U_{A,l5} - 4|\sigma|^2 U_{A,i5}U_{A,j4}U_{A,k4}U_{A,l5} + 2\sigma\kappa'^{,*} U_{A,i3}U_{A,j5}U_{A,k4}U_{A,l5}\\
&+ 2\kappa'\sigma'^{,*} U_{A,i3}U_{A,j5}U_{A,k4}U_{A,l5} - 4|\sigma|^2 U_{A,i4}U_{A,j5}U_{A,k4}U_{A,l5} - 4|\sigma|^2 U_{A,i3}U_{A,j3}U_{A,k5}U_{A,l5}\\
&+ 2\sigma\kappa'^{,*} U_{A,i4}U_{A,j3}U_{A,k5}U_{A,l5} + 2\kappa'\sigma'^{,*} U_{A,i4}U_{A,j3}U_{A,k5}U_{A,l5} + 2\sigma\kappa'^{,*} U_{A,i3}U_{A,j4}U_{A,k5}U_{A,l5}\\
&+ 2\kappa'\sigma'^{,*} U_{A,i3}U_{A,j4}U_{A,k5}U_{A,l5} - 4|\sigma|^2 U_{A,i4}U_{A,j4}U_{A,k5}U_{A,l5} - 24|\kappa'|^2 U_{A,i5}U_{A,j5}U_{A,k5}U_{A,l5}\\
&+ U_{A,i2}\Big(- \sigma\lambda^* U_{A,j5}U_{A,k4}U_{A,l1} - \lambda\sigma'^{,*} U_{A,j5}U_{A,k4}U_{A,l1} - \sigma\lambda^* U_{A,j4}U_{A,k5}U_{A,l1}\\
&- \lambda\sigma'^{,*} U_{A,j4}U_{A,k5}U_{A,l1} + 8g_{1'}^2 Q_S U_{A,j3}U_{A,k3}U_{A,l2} - 4|\lambda|^2 U_{A,j3}U_{A,k3}U_{A,l2}\\
&- 8g_{1'}^2 Q_S U_{A,j4}U_{A,k4}U_{A,l2} + 8g_{1'}^2 Q_S U_{A,j3}U_{A,k2}U_{A,l3} - 4|\lambda|^2 U_{A,j3}U_{A,k2}U_{A,l3}\\
&- \sigma\lambda^* U_{A,j5}U_{A,k1}U_{A,l4} - \lambda\sigma'^{,*} U_{A,j5}U_{A,k1}U_{A,l4} - 8g_{1'}^2 Q_S U_{A,j4}U_{A,k2}U_{A,l4}\\
&+ U_{A,j2}\Big(\Big(- 24g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2\Big)U_{A,k1}U_{A,l1} - 3\Big(16g_{1'}^2 + g_1^2 + g_2^2\Big)U_{A,k2}U_{A,l2} + 8g_{1'}^2 Q_S U_{A,k3}U_{A,l3}
\end{aligned}
$$

$$
\begin{aligned}
&- 4|\lambda|^2 U_{A,k3} U_{A,l3} - 8 g_{1'}^2 Q_S U_{A,k4} U_{A,l4} \Big) \\
&- \sigma \lambda^* U_{A,j4} U_{A,k1} U_{A,l5} - \lambda \sigma'^{,*} U_{A,j4} U_{A,k1} U_{A,l5} \\
&+ U_{A,j1} \Big(\Big(- 24 g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \Big) U_{A,k2} U_{A,l1} + \Big(- 24 g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \Big) U_{A,k1} U_{A,l2} \\
&- \Big(\lambda \sigma'^{,*} + \sigma \lambda^* \Big) \Big(U_{A,k4} U_{A,l5} + U_{A,k5} U_{A,l4} \Big) \Big) \Big) \\
&- U_{A,i1} \Big(- 12 g_{1'}^2 Q_S U_{A,j3} U_{A,k3} U_{A,l1} + 4|\lambda|^2 U_{A,j3} U_{A,k3} U_{A,l1} + 12 g_{1'}^2 Q_S U_{A,j4} U_{A,k4} U_{A,l1} \\
&+ \sigma \lambda^* U_{A,j5} U_{A,k4} U_{A,l2} + \lambda \sigma'^{,*} U_{A,j5} U_{A,k4} U_{A,l2} + \sigma \lambda^* U_{A,j4} U_{A,k5} U_{A,l2} + \lambda \sigma'^{,*} U_{A,j4} U_{A,k5} U_{A,l2} \\
&- 12 g_{1'}^2 Q_S U_{A,j3} U_{A,k1} U_{A,l3} + 4|\lambda|^2 U_{A,j3} U_{A,k1} U_{A,l3} + 12 g_{1'}^2 Q_S U_{A,j4} U_{A,k1} U_{A,l4} \\
&+ \sigma \lambda^* U_{A,j5} U_{A,k2} U_{A,l4} + \lambda \sigma'^{,*} U_{A,j5} U_{A,k2} U_{A,l4} \\
&+ U_{A,j1} \Big(3 \Big(36 g_{1'}^2 + g_1^2 + g_2^2 \Big) U_{A,k1} U_{A,l1} - \Big(- 24 g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \Big) U_{A,k2} U_{A,l2} \\
&+ 4 \Big(\Big(- 3 g_{1'}^2 Q_S + |\lambda|^2 \Big) U_{A,k3} U_{A,l3} + 3 g_{1'}^2 Q_S U_{A,k4} U_{A,l4} \Big) \Big) \\
&+ \sigma \lambda^* U_{A,j4} U_{A,k2} U_{A,l5} + \lambda \sigma'^{,*} U_{A,j4} U_{A,k2} U_{A,l5} \\
&+ U_{A,j2} \Big(- \Big(- 24 g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \Big) U_{A,k2} U_{A,l1} - \Big(- 24 g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \Big) U_{A,k1} U_{A,l2} \\
&+ \Big(\lambda \sigma'^{,*} + \sigma \lambda^* \Big) \Big(U_{A,k4} U_{A,l5} + U_{A,k5} U_{A,l4} \Big) \Big) \Big) \Big)
\end{aligned} \tag{558}
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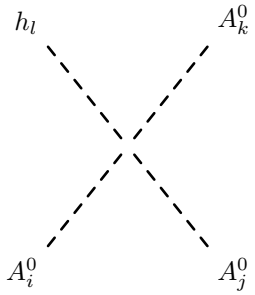
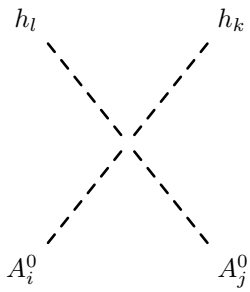


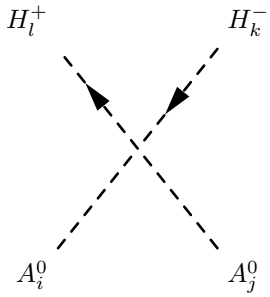
$$
\begin{aligned}
&\frac{1}{4} \Big(- \sigma \lambda^* \Big(- U_{H,l2}^* U_{A,i5} U_{A,j4} U_{A,k1} - U_{H,l2}^* U_{A,i4} U_{A,j5} U_{A,k1} - U_{H,l1}^* U_{A,i5} U_{A,j4} U_{A,k2} \\
&- U_{H,l1}^* U_{A,i4} U_{A,j5} U_{A,k2} - U_{H,l2}^* U_{A,i5} U_{A,j1} U_{A,k4} - U_{H,l1}^* U_{A,i5} U_{A,j2} U_{A,k4} \\
&- U_{H,l2}^* U_{A,i1} U_{A,j5} U_{A,k4} - U_{H,l1}^* U_{A,i2} U_{A,j5} U_{A,k4} \\
&+ U_{H,l5}^* \Big(U_{A,i1} \Big(U_{A,j2} U_{A,k4} + U_{A,j4} U_{A,k2} \Big) + U_{A,i2} \Big(U_{A,j1} U_{A,k4} + U_{A,j4} U_{A,k1} \Big) + U_{A,i4} \Big(U_{A,j1} U_{A,k2} + U_{A,j2} U_{A,k1} \Big) \Big) \\
&- U_{H,l2}^* U_{A,i4} U_{A,j1} U_{A,k5} - U_{H,l1}^* U_{A,i4} U_{A,j2} U_{A,k5} - U_{H,l2}^* U_{A,i1} U_{A,j4} U_{A,k5} \\
&- U_{H,l1}^* U_{A,i2} U_{A,j4} U_{A,k5} \\
&+ U_{H,l4}^* \Big(U_{A,i1} \Big(U_{A,j2} U_{A,k5} + U_{A,j5} U_{A,k2} \Big) + U_{A,i2} \Big(U_{A,j1} U_{A,k5} + U_{A,j5} U_{A,k1} \Big) + U_{A,i5} \Big(U_{A,j1} U_{A,k2} + U_{A,j2} U_{A,k1} \Big) \Big) \Big) \\
&- 2 \sigma \kappa'^{,*} \Big(- U_{H,l4}^* \Big(U_{A,i3} U_{A,j5} U_{A,k5} + U_{A,i5} \Big(U_{A,j3} U_{A,k5} + U_{A,j5} U_{A,k3} \Big) \Big)
\end{aligned}
$$

$$
\begin{aligned}
&+ U^*_{H,l5}\Big(U_{A,i3}\Big(U_{A,j4}U_{A,k5} + U_{A,j5}U_{A,k4}\Big) + U_{A,i4}\Big(U_{A,j3}U_{A,k5} + U_{A,j5}U_{A,k3}\Big) + U_{A,i5}\Big(U_{A,j3}U_{A,k4} + U_{A,j4}U_{A,k3}\Big)\Big)\\
&- U^*_{H,l3}\Big(U_{A,i4}U_{A,j5}U_{A,k5} + U_{A,i5}\Big(U_{A,j4}U_{A,k5} + U_{A,j5}U_{A,k4}\Big)\Big)\Big)\\
&- \sigma'^{,*}\Big(\lambda U^*_{H,l2}U_{A,i5}U_{A,j4}U_{A,k1} + \lambda U^*_{H,l2}U_{A,i4}U_{A,j5}U_{A,k1} + \lambda U^*_{H,l1}U_{A,i5}U_{A,j4}U_{A,k2}\\
&+ \lambda U^*_{H,l1}U_{A,i4}U_{A,j5}U_{A,k2} + \lambda U^*_{H,l2}U_{A,i5}U_{A,j1}U_{A,k4} + \lambda U^*_{H,l1}U_{A,i5}U_{A,j2}U_{A,k4}\\
&+ \lambda U^*_{H,l2}U_{A,i1}U_{A,j5}U_{A,k4} + \lambda U^*_{H,l1}U_{A,i2}U_{A,j5}U_{A,k4} + 2\kappa' U^*_{H,l3}U_{A,i5}U_{A,j5}U_{A,k4}\\
&+ \lambda U^*_{H,l2}U_{A,i4}U_{A,j1}U_{A,k5} + \lambda U^*_{H,l1}U_{A,i4}U_{A,j2}U_{A,k5} + \lambda U^*_{H,l2}U_{A,i1}U_{A,j4}U_{A,k5}\\
&+ \lambda U^*_{H,l1}U_{A,i2}U_{A,j4}U_{A,k5} + 2\kappa' U^*_{H,l3}U_{A,i5}U_{A,j4}U_{A,k5} + 2\kappa' U^*_{H,l3}U_{A,i4}U_{A,j5}U_{A,k5}\\
&- U^*_{H,l5}\Big(\lambda U_{A,i1}U_{A,j4}U_{A,k2} + 2\kappa' U_{A,i5}U_{A,j4}U_{A,k3} + \lambda U_{A,i1}U_{A,j2}U_{A,k4} + 2\kappa' U_{A,i5}U_{A,j3}U_{A,k4}\\
&+ 2\kappa' U_{A,i3}U_{A,j5}U_{A,k4} + \lambda U_{A,i2}\Big(U_{A,j1}U_{A,k4} + U_{A,j4}U_{A,k1}\Big) + 2\kappa' U_{A,i3}U_{A,j4}U_{A,k5}\\
&+ U_{A,i4}\Big(2\kappa' U_{A,j3}U_{A,k5} + 2\kappa' U_{A,j5}U_{A,k3} + \lambda U_{A,j1}U_{A,k2} + \lambda U_{A,j2}U_{A,k1}\Big)\Big)\\
&- U^*_{H,l4}\Big(\lambda U_{A,i1}U_{A,j5}U_{A,k2} + \lambda U_{A,i1}U_{A,j2}U_{A,k5} - 2\kappa' U_{A,i3}U_{A,j5}U_{A,k5} + \lambda U_{A,i2}\Big(U_{A,j1}U_{A,k5} + U_{A,j5}U_{A,k1}\Big)\\
&+ U_{A,i5}\Big(-2\kappa'\Big(U_{A,j3}U_{A,k5} + U_{A,j5}U_{A,k3}\Big) + \lambda U_{A,j1}U_{A,k2} + \lambda U_{A,j2}U_{A,k1}\Big)\Big)\Big)\Big)
\end{aligned}
\tag{559}
$$

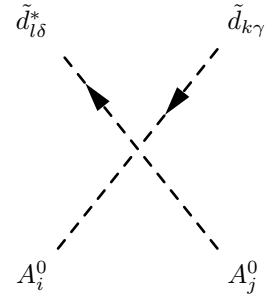


$$
\begin{aligned}
&\frac{i}{4}\Big(12g^2_{1'}Q_S U^*_{H,k3}U^*_{H,l3}U_{A,i1}U_{A,j1} - 4|\lambda|^2 U^*_{H,k3}U^*_{H,l3}U_{A,i1}U_{A,j1}\\
&- 12g^2_{1'}Q_S U^*_{H,k4}U^*_{H,l4}U_{A,i1}U_{A,j1} + \sigma\lambda^* U^*_{H,k5}U^*_{H,l4}U_{A,i2}U_{A,j1} + \lambda\sigma'^{,*}U^*_{H,k5}U^*_{H,l4}U_{A,i2}U_{A,j1}\\
&+ \sigma\lambda^* U^*_{H,k4}U^*_{H,l5}U_{A,i2}U_{A,j1} + \lambda\sigma'^{,*}U^*_{H,k4}U^*_{H,l5}U_{A,i2}U_{A,j1} - \sigma\lambda^* U^*_{H,k5}U^*_{H,l2}U_{A,i4}U_{A,j1}\\
&- \lambda\sigma'^{,*}U^*_{H,k5}U^*_{H,l2}U_{A,i4}U_{A,j1} - \sigma\lambda^* U^*_{H,k4}U^*_{H,l2}U_{A,i5}U_{A,j1}\\
&- \lambda\sigma'^{,*}U^*_{H,k4}U^*_{H,l2}U_{A,i5}U_{A,j1} + \sigma\lambda^* U^*_{H,k5}U^*_{H,l4}U_{A,i1}U_{A,j2} + \lambda\sigma'^{,*}U^*_{H,k5}U^*_{H,l4}U_{A,i1}U_{A,j2}\\
&+ \sigma\lambda^* U^*_{H,k4}U^*_{H,l5}U_{A,i1}U_{A,j2} + \lambda\sigma'^{,*}U^*_{H,k4}U^*_{H,l5}U_{A,i1}U_{A,j2} + 8g^2_{1'}Q_S U^*_{H,k3}U^*_{H,l3}U_{A,i2}U_{A,j2}\\
&- 4|\lambda|^2 U^*_{H,k3}U^*_{H,l3}U_{A,i2}U_{A,j2} - 8g^2_{1'}Q_S U^*_{H,k4}U^*_{H,l4}U_{A,i2}U_{A,j2}\\
&- \sigma\lambda^* U^*_{H,k5}U^*_{H,l1}U_{A,i4}U_{A,j2} - \lambda\sigma'^{,*}U^*_{H,k5}U^*_{H,l1}U_{A,i4}U_{A,j2}\\
&- \sigma\lambda^* U^*_{H,k4}U^*_{H,l1}U_{A,i5}U_{A,j2} - \lambda\sigma'^{,*}U^*_{H,k4}U^*_{H,l1}U_{A,i5}U_{A,j2}\\
&- 4g^2_{1'}Q^2_S U^*_{H,k3}U^*_{H,l3}U_{A,i3}U_{A,j3} + 4g^2_{1'}Q^2_S U^*_{H,k4}U^*_{H,l4}U_{A,i3}U_{A,j3}
\end{aligned}
$$

$$
\begin{aligned}
&- 4|\sigma|^2 U^*_{H,k4} U^*_{H,l4} U_{A,i3} U_{A,j3} - 4|\sigma|^2 U^*_{H,k5} U^*_{H,l5} U_{A,i3} U_{A,j3} \\
&- 2\sigma\kappa'^{,*} U^*_{H,k5} U^*_{H,l5} U_{A,i4} U_{A,j3} - 2\kappa'\sigma'^{,*} U^*_{H,k5} U^*_{H,l5} U_{A,i4} U_{A,j3} \\
&+ 2\sigma\kappa'^{,*} U^*_{H,k5} U^*_{H,l4} U_{A,i5} U_{A,j3} + 2\kappa'\sigma'^{,*} U^*_{H,k5} U^*_{H,l4} U_{A,i5} U_{A,j3} \\
&+ 2\sigma\kappa'^{,*} U^*_{H,k4} U^*_{H,l5} U_{A,i5} U_{A,j3} + 2\kappa'\sigma'^{,*} U^*_{H,k4} U^*_{H,l5} U_{A,i5} U_{A,j3} \\
&- \sigma\lambda^* U^*_{H,k5} U^*_{H,l2} U_{A,i1} U_{A,j4} - \lambda\sigma'^{,*} U^*_{H,k5} U^*_{H,l2} U_{A,i1} U_{A,j4} \\
&- \sigma\lambda^* U^*_{H,k5} U^*_{H,l1} U_{A,i2} U_{A,j4} - \lambda\sigma'^{,*} U^*_{H,k5} U^*_{H,l1} U_{A,i2} U_{A,j4} \\
&- 2\sigma\kappa'^{,*} U^*_{H,k5} U^*_{H,l5} U_{A,i3} U_{A,j4} - 2\kappa'\sigma'^{,*} U^*_{H,k5} U^*_{H,l5} U_{A,i3} U_{A,j4} \\
&+ 4g_{1'}^2 Q_S^2 U^*_{H,k3} U^*_{H,l3} U_{A,i4} U_{A,j4} - 4|\sigma|^2 U^*_{H,k3} U^*_{H,l3} U_{A,i4} U_{A,j4} \\
&- 4g_{1'}^2 Q_S^2 U^*_{H,k4} U^*_{H,l4} U_{A,i4} U_{A,j4} - 4|\sigma|^2 U^*_{H,k5} U^*_{H,l5} U_{A,i4} U_{A,j4} \\
&+ 2\sigma\kappa'^{,*} U^*_{H,k5} U^*_{H,l3} U_{A,i5} U_{A,j4} + 2\kappa'\sigma'^{,*} U^*_{H,k5} U^*_{H,l3} U_{A,i5} U_{A,j4} \\
&+ 2\sigma\kappa'^{,*} U^*_{H,k3} U^*_{H,l5} U_{A,i5} U_{A,j4} + 2\kappa'\sigma'^{,*} U^*_{H,k3} U^*_{H,l5} U_{A,i5} U_{A,j4} \\
&- \sigma\lambda^* U^*_{H,k4} U^*_{H,l2} U_{A,i1} U_{A,j5} - \lambda\sigma'^{,*} U^*_{H,k4} U^*_{H,l2} U_{A,i1} U_{A,j5} \\
&- \sigma\lambda^* U^*_{H,k4} U^*_{H,l1} U_{A,i2} U_{A,j5} - \lambda\sigma'^{,*} U^*_{H,k4} U^*_{H,l1} U_{A,i2} U_{A,j5} \\
&+ 2\sigma\kappa'^{,*} U^*_{H,k5} U^*_{H,l4} U_{A,i3} U_{A,j5} + 2\kappa'\sigma'^{,*} U^*_{H,k5} U^*_{H,l4} U_{A,i3} U_{A,j5} \\
&+ 2\sigma\kappa'^{,*} U^*_{H,k4} U^*_{H,l5} U_{A,i3} U_{A,j5} + 2\kappa'\sigma'^{,*} U^*_{H,k4} U^*_{H,l5} U_{A,i3} U_{A,j5} \\
&+ 2\sigma\kappa'^{,*} U^*_{H,k5} U^*_{H,l3} U_{A,i4} U_{A,j5} + 2\kappa'\sigma'^{,*} U^*_{H,k5} U^*_{H,l3} U_{A,i4} U_{A,j5} \\
&+ 2\sigma\kappa'^{,*} U^*_{H,k3} U^*_{H,l5} U_{A,i4} U_{A,j5} + 2\kappa'\sigma'^{,*} U^*_{H,k3} U^*_{H,l5} U_{A,i4} U_{A,j5} \\
&- 4|\sigma|^2 U^*_{H,k3} U^*_{H,l3} U_{A,i5} U_{A,j5} - 2\sigma\kappa'^{,*} U^*_{H,k4} U^*_{H,l3} U_{A,i5} U_{A,j5} \\
&- 2\kappa'\sigma'^{,*} U^*_{H,k4} U^*_{H,l3} U_{A,i5} U_{A,j5} - 2\sigma\kappa'^{,*} U^*_{H,k3} U^*_{H,l4} U_{A,i5} U_{A,j5} \\
&- 2\kappa'\sigma'^{,*} U^*_{H,k3} U^*_{H,l4} U_{A,i5} U_{A,j5} - 4|\sigma|^2 U^*_{H,k4} U^*_{H,l4} U_{A,i5} U_{A,j5} \\
&- 8|\kappa'|^2 U^*_{H,k5} U^*_{H,l5} U_{A,i5} U_{A,j5} \\
&+ U^*_{H,k2} \Big(U^*_{H,l2} \Big(\Big(-24 g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \Big) U_{A,i1} U_{A,j1} - \Big(16 g_{1'}^2 + g_1^2 + g_2^2 \Big) U_{A,i2} U_{A,j2} + 8 g_{1'}^2 Q_S U_{A,i3} U_{A,j3} \\
&- 4|\lambda|^2 U_{A,i3} U_{A,j3} - 8 g_{1'}^2 Q_S U_{A,i4} U_{A,j4} \Big) \\
&- \Big(\lambda\sigma'^{,*} + \sigma\lambda^* \Big) \Big(- U^*_{H,l1} \Big(U_{A,i4} U_{A,j5} + U_{A,i5} U_{A,j4} \Big) + U^*_{H,l4} \Big(U_{A,i1} U_{A,j5} + U_{A,i5} U_{A,j1} \Big) + U^*_{H,l5} \Big(U_{A,i1} U_{A,j4} + U_{A,i4} U_{A,j1} \Big) \Big) \Big) \\
&- U^*_{H,k1} \Big(U^*_{H,l1} \Big(\Big(36 g_{1'}^2 + g_1^2 + g_2^2 \Big) U_{A,i1} U_{A,j1} - \Big(-24 g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \Big) U_{A,i2} U_{A,j2} \\
&+ 4 \Big(\Big(-3 g_{1'}^2 Q_S + |\lambda|^2 \Big) U_{A,i3} U_{A,j3} + 3 g_{1'}^2 Q_S U_{A,i4} U_{A,j4} \Big) \Big) \\
&+ \Big(\lambda\sigma'^{,*} + \sigma\lambda^* \Big) \Big(- U^*_{H,l2} \Big(U_{A,i4} U_{A,j5} + U_{A,i5} U_{A,j4} \Big) + U^*_{H,l4} \Big(U_{A,i2} U_{A,j5} + U_{A,i5} U_{A,j2} \Big) + U^*_{H,l5} \Big(U_{A,i2} U_{A,j4} + U_{A,i4} U_{A,j2} \Big) \Big) \Big) \Big)
\end{aligned}
\tag{560}
$$

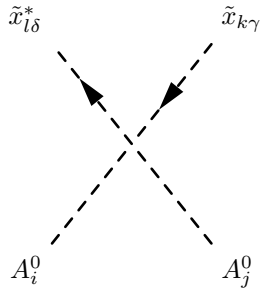


$$\frac{i}{4}\Big(U_{+,k2}^*\Big(U_{A,i1}\Big(\Big(-24g_{1'}^2-g_2^2+g_1^2\Big)U_{A,j1}U_{+,l2}+\Big(-2|\lambda|^2+g_2^2\Big)U_{A,j2}U_{+,l1}\Big)$$
$$+U_{A,i2}\Big(-\Big(16g_{1'}^2+g_1^2+g_2^2\Big)U_{A,j2}U_{+,l2}+\Big(-2|\lambda|^2+g_2^2\Big)U_{A,j1}U_{+,l1}\Big)$$
$$-2\Big(4g_{1'}^2Q_S\Big(-U_{A,i3}U_{A,j3}+U_{A,i4}U_{A,j4}\Big)U_{+,l2}$$
$$+\lambda^*\Big(2\lambda U_{A,i3}U_{A,j3}U_{+,l2}+\sigma U_{A,i4}U_{A,j5}U_{+,l1}+\sigma U_{A,i5}U_{A,j4}U_{+,l1}\Big)\Big)\Big)$$
$$-U_{+,k1}^*\Big(U_{A,i2}\Big(\Big(24g_{1'}^2-g_1^2+g_2^2\Big)U_{A,j2}U_{+,l1}-\Big(-2|\lambda|^2+g_2^2\Big)U_{A,j1}U_{+,l2}\Big)$$
$$+U_{A,i1}\Big(-\Big(-2|\lambda|^2+g_2^2\Big)U_{A,j2}U_{+,l2}+\Big(36g_{1'}^2+g_1^2+g_2^2\Big)U_{A,j1}U_{+,l1}\Big)$$
$$+2\Big(2\Big(-3g_{1'}^2Q_S+|\lambda|^2\Big)U_{A,i3}U_{A,j3}U_{+,l1}+\lambda\sigma'^{,*}U_{A,i5}U_{A,j4}U_{+,l2}$$
$$+U_{A,i4}\Big(6g_{1'}^2Q_SU_{A,j4}U_{+,l1}+\lambda\sigma'^{,*}U_{A,j5}U_{+,l2}\Big)\Big)\Big)\Big)\Big) \tag{561}$$

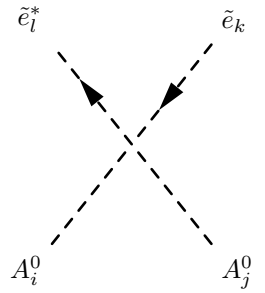


$$\frac{i}{12}\delta_{\gamma\delta}\Big(\sum_{a=1}^{3}Z_{ka}^{D,*}Z_{la}^D\Big(\Big(36g_{1'}^2+3g_2^2+g_1^2\Big)U_{A,i1}U_{A,j1}-\Big(-24g_{1'}^2+3g_2^2+g_1^2\Big)U_{A,i2}U_{A,j2}$$
$$+12g_{1'}^2Q_S\Big(-U_{A,i3}U_{A,j3}+U_{A,i4}U_{A,j4}\Big)\Big)$$
$$+2\Big(-3\Big(2\sum_{b=1}^{3}|Y_{d,bb}|^2Z_{kb}^{D,*}Z_{lb}^DU_{A,i1}U_{A,j1}+2\sum_{b=1}^{3}|Y_{d,bb}|^2Z_{k3+b}^{D,*}Z_{l3+b}^DU_{A,i1}U_{A,j1}$$

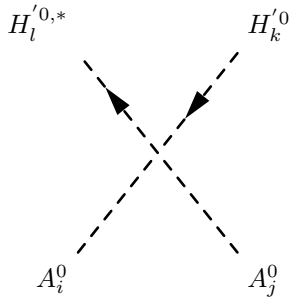
$$+\Big(\lambda\sum_{a=1}^{3}Y^{*}_{d,aa}Z^{D,*}_{k3+a}Z^{D}_{la}+\lambda^{*}\sum_{a=1}^{3}Z^{D,*}_{ka}Y_{d,aa}Z^{D}_{l3+a}\Big)\Big(U_{A,i2}U_{A,j3}+U_{A,i3}U_{A,j2}\Big)\Big)$$
$$+\sum_{a=1}^{3}Z^{D,*}_{k3+a}Z^{D}_{l3+a}\Big(12g^{2}_{1'}Q_{S}\Big(-U_{A,i3}U_{A,j3}+U_{A,i4}U_{A,j4}\Big)-\Big(-24g^{2}_{1'}+g^{2}_{1}\Big)U_{A,i2}U_{A,j2}+\Big(36g^{2}_{1'}+g^{2}_{1}\Big)U_{A,i1}U_{A,j1}\Big)\Big)\Big) \tag{562}$$



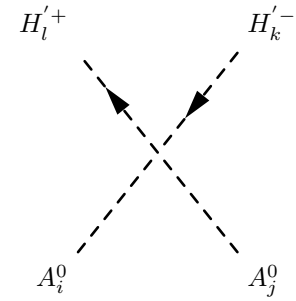
$$-\frac{i}{6}\delta_{\gamma\delta}\Big(\sum_{a=1}^{3}Z^{Dx,*}_{ka}Z^{Dx}_{la}\Big(12g^{2}_{1'}Q_{S}\Big(-U_{A,i3}U_{A,j3}+U_{A,i4}U_{A,j4}\Big)-\Big(-24g^{2}_{1'}+g^{2}_{1}\Big)U_{A,i2}U_{A,j2}+\Big(36g^{2}_{1'}+g^{2}_{1}\Big)U_{A,i1}U_{A,j1}\Big)$$
$$+\sum_{a=1}^{3}Z^{Dx,*}_{k3+a}Z^{Dx}_{l3+a}\Big(18g^{2}_{1'}Q_{S}\Big(-U_{A,i3}U_{A,j3}+U_{A,i4}U_{A,j4}\Big)+\Big(36g^{2}_{1'}+g^{2}_{1}\Big)U_{A,i2}U_{A,j2}-\Big(-54g^{2}_{1'}+g^{2}_{1}\Big)U_{A,i1}U_{A,j1}\Big)$$
$$+3\Big(\lambda^{*}\sum_{a=1}^{3}Z^{Dx,*}_{ka}Z^{Dx}_{l3+a}\kappa_{aa}\Big(U_{A,i1}U_{A,j2}+U_{A,i2}U_{A,j1}\Big)+2\sum_{b=1}^{3}|\kappa_{bb}|^{2}Z^{Dx,*}_{kb}Z^{Dx}_{lb}U_{A,i3}U_{A,j3}$$
$$+2\sum_{b=1}^{3}|\kappa_{bb}|^{2}Z^{Dx,*}_{k3+b}Z^{Dx}_{l3+b}U_{A,i3}U_{A,j3}+\sigma'^{,*}\sum_{a=1}^{3}Z^{Dx,*}_{ka}Z^{Dx}_{l3+a}\kappa_{aa}U_{A,i5}U_{A,j4}$$
$$+\sigma'^{,*}\sum_{a=1}^{3}Z^{Dx,*}_{ka}Z^{Dx}_{l3+a}\kappa_{aa}U_{A,i4}U_{A,j5}$$
$$+\sum_{a=1}^{3}Z^{Dx,*}_{k3+a}\kappa^{*}_{aa}Z^{Dx}_{la}\Big(\lambda U_{A,i1}U_{A,j2}+\lambda U_{A,i2}U_{A,j1}+\sigma U_{A,i4}U_{A,j5}+\sigma U_{A,i5}U_{A,j4}\Big)\Big)\Big) \tag{563}$$



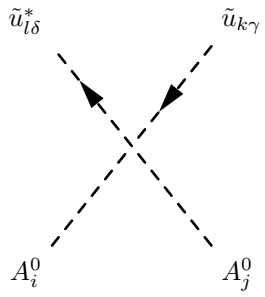
$$\frac{i}{4}\Big(\sum_{a=1}^{3} Z_{ka}^{E,*} Z_{la}^{E}\Big(\Big(24g_{1'}^2 - g_1^2 + g_2^2\Big)U_{A,i1}U_{A,j1} + \Big(16g_{1'}^2 - g_2^2 + g_1^2\Big)U_{A,i2}U_{A,j2}$$
$$+ 8g_{1'}^2 Q_S\Big(- U_{A,i3}U_{A,j3} + U_{A,i4}U_{A,j4}\Big)\Big)$$
$$+ 2\Big(- 2\sum_{b=1}^{3} |Y_{e,bb}|^2 Z_{kb}^{E,*} Z_{lb}^{E} U_{A,i1}U_{A,j1} - 2\sum_{b=1}^{3} |Y_{e,bb}|^2 Z_{k3+b}^{E,*} Z_{l3+b}^{E} U_{A,i1}U_{A,j1}$$
$$- \lambda\sum_{a=1}^{3} Y_{e,aa}^{*} Z_{k3+a}^{E,*} Z_{la}^{E} U_{A,i3}U_{A,j2} - \lambda^{*}\sum_{a=1}^{3} Z_{ka}^{E,*} Y_{e,aa} Z_{l3+a}^{E} U_{A,i3}U_{A,j2}$$
$$- \lambda\sum_{a=1}^{3} Y_{e,aa}^{*} Z_{k3+a}^{E,*} Z_{la}^{E} U_{A,i2}U_{A,j3} - \lambda^{*}\sum_{a=1}^{3} Z_{ka}^{E,*} Y_{e,aa} Z_{l3+a}^{E} U_{A,i2}U_{A,j3}$$
$$+ \sum_{a=1}^{3} Z_{k3+a}^{E,*} Z_{l3+a}^{E}\Big(2g_{1'}^2 Q_S\Big(- U_{A,i3}U_{A,j3} + U_{A,i4}U_{A,j4}\Big) - \Big(- 4g_{1'}^2 + g_1^2\Big)U_{A,i2}U_{A,j2} + \Big(6g_{1'}^2 + g_1^2\Big)U_{A,i1}U_{A,j1}\Big)\Big)\Big) \tag{564}$$



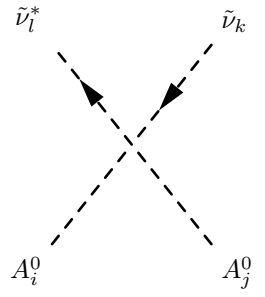
$$- \frac{i}{4}\Big(UHp0_{k1}^{*} UHp0_{l1} - UHp0_{k2}^{*} UHp0_{l2}\Big)\Big(\Big(- 24g_{1'}^2 + g_1^2 + g_2^2\Big)U_{A,i1}U_{A,j1} - \Big(16g_{1'}^2 + g_1^2 + g_2^2\Big)U_{A,i2}U_{A,j2}$$
$$+ 8g_{1'}^2 Q_S\Big(U_{A,i3}U_{A,j3} - U_{A,i4}U_{A,j4}\Big)\Big) \tag{565}$$



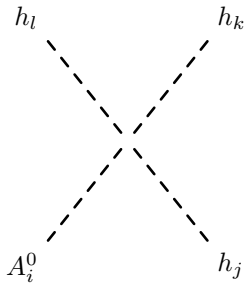
$$- \frac{i}{4}\Big(UHpp^{*}_{k1}UHpp_{l1} - UHpp^{*}_{k2}UHpp_{l2}\Big)\Big(\Big(- 24g^2_{1'} - g^2_2 + g^2_1\Big)U_{A,i1}U_{A,j1} + \Big(- 16g^2_{1'} - g^2_1 + g^2_2\Big)U_{A,i2}U_{A,j2}$$
$$+ 8g^2_{1'}Q_S\Big(U_{A,i3}U_{A,j3} - U_{A,i4}U_{A,j4}\Big)\Big) \tag{566}$$



$$\frac{i}{12}\delta_{\gamma\delta}\Big(\sum_{a=1}^{3} Z^{U,*}_{ka}Z^{U}_{la}\Big(\Big(36g^2_{1'} - 3g^2_2 + g^2_1\Big)U_{A,i1}U_{A,j1} + \Big(24g^2_{1'} + 3g^2_2 - g^2_1\Big)U_{A,i2}U_{A,j2}$$
$$+ 12g^2_{1'}Q_S\Big(- U_{A,i3}U_{A,j3} + U_{A,i4}U_{A,j4}\Big)\Big)$$
$$- 2\Big(3\Big(2\Big(\sum_{b=1}^{3}|Y_{u,bb}|^2 Z^{U,*}_{kb}Z^{U}_{lb} + \sum_{b=1}^{3}|Y_{u,bb}|^2 Z^{U,*}_{k3+b}Z^{U}_{l3+b}\Big)U_{A,i2}U_{A,j2}$$
$$+ \lambda\sum_{a=1}^{3} Y^{*}_{u,aa}Z^{U,*}_{k3+a}Z^{U}_{la}\Big(U_{A,i1}U_{A,j3} + U_{A,i3}U_{A,j1}\Big)$$
$$+ \lambda^{*}\sum_{a=1}^{3} Z^{U,*}_{ka}Y_{u,aa}Z^{U}_{l3+a}\Big(U_{A,i1}U_{A,j3} + U_{A,i3}U_{A,j1}\Big)\Big)$$
$$+ 2\sum_{a=1}^{3} Z^{U,*}_{k3+a}Z^{U}_{l3+a}\Big(3g^2_{1'}Q_S\Big(U_{A,i3}U_{A,j3} - U_{A,i4}U_{A,j4}\Big) - \Big(6g^2_{1'} + g^2_1\Big)U_{A,i2}U_{A,j2} + \Big(- 9g^2_{1'} + g^2_1\Big)U_{A,i1}U_{A,j1}\Big)\Big)\Big) \tag{567}$$

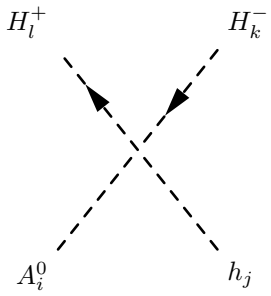


$$\frac{i}{4}\delta_{kl}\Big(-\Big(-24g_{1'}^2+g_1^2+g_2^2\Big)U_{A,i1}U_{A,j1}+\Big(16g_{1'}^2+g_1^2+g_2^2\Big)U_{A,i2}U_{A,j2}$$
$$+8g_{1'}^2Q_S\Big(-U_{A,i3}U_{A,j3}+U_{A,i4}U_{A,j4}\Big)\Big) \tag{568}$$

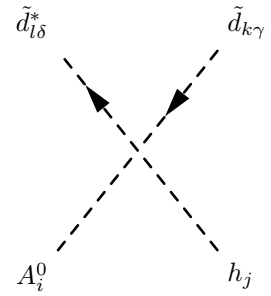


$$\frac{1}{4}\Big(-\sigma\lambda^*\Big(U_{H,j2}^*U_{H,k5}^*U_{H,l4}^*U_{A,i1}+U_{H,j2}^*U_{H,k4}^*U_{H,l5}^*U_{A,i1}+U_{H,j1}^*U_{H,k5}^*U_{H,l4}^*U_{A,i2}$$
$$+U_{H,j1}^*U_{H,k4}^*U_{H,l5}^*U_{A,i2}-U_{H,j2}^*U_{H,k5}^*U_{H,l1}^*U_{A,i4}-U_{H,j1}^*U_{H,k5}^*U_{H,l2}^*U_{A,i4}$$
$$-U_{H,j2}^*U_{H,k1}^*U_{H,l5}^*U_{A,i4}-U_{H,j1}^*U_{H,k2}^*U_{H,l5}^*U_{A,i4}$$
$$+U_{H,j5}^*\Big(U_{H,k4}^*\Big(U_{H,l1}^*U_{A,i2}+U_{H,l2}^*U_{A,i1}\Big)+U_{H,k2}^*\Big(-U_{H,l1}^*U_{A,i4}+U_{H,l4}^*U_{A,i1}\Big)$$
$$+U_{H,k1}^*\Big(-U_{H,l2}^*U_{A,i4}+U_{H,l4}^*U_{A,i2}\Big)\Big)$$
$$-U_{H,j2}^*U_{H,k4}^*U_{H,l1}^*U_{A,i5}-U_{H,j1}^*U_{H,k4}^*U_{H,l2}^*U_{A,i5}-U_{H,j2}^*U_{H,k1}^*U_{H,l4}^*U_{A,i5}$$
$$-U_{H,j1}^*U_{H,k2}^*U_{H,l4}^*U_{A,i5}$$
$$+U_{H,j4}^*\Big(U_{H,k5}^*\Big(U_{H,l1}^*U_{A,i2}+U_{H,l2}^*U_{A,i1}\Big)+U_{H,k2}^*\Big(-U_{H,l1}^*U_{A,i5}+U_{H,l5}^*U_{A,i1}\Big)$$
$$+U_{H,k1}^*\Big(-U_{H,l2}^*U_{A,i5}+U_{H,l5}^*U_{A,i2}\Big)\Big)\Big)$$
$$-\sigma'^{,*}\Big(-\lambda U_{H,j2}^*U_{H,k5}^*U_{H,l4}^*U_{A,i1}-\lambda U_{H,j2}^*U_{H,k4}^*U_{H,l5}^*U_{A,i1}-\lambda U_{H,j1}^*U_{H,k5}^*U_{H,l4}^*U_{A,i2}$$
$$-\lambda U_{H,j1}^*U_{H,k4}^*U_{H,l5}^*U_{A,i2}+\lambda U_{H,j2}^*U_{H,k5}^*U_{H,l1}^*U_{A,i4}+\lambda U_{H,j1}^*U_{H,k5}^*U_{H,l2}^*U_{A,i4}$$
$$+\lambda U_{H,j2}^*U_{H,k1}^*U_{H,l5}^*U_{A,i4}+\lambda U_{H,j1}^*U_{H,k2}^*U_{H,l5}^*U_{A,i4}-2\kappa' U_{H,j3}^*U_{H,k5}^*U_{H,l5}^*U_{A,i4}$$
$$+\lambda U_{H,j2}^*U_{H,k4}^*U_{H,l1}^*U_{A,i5}+\lambda U_{H,j1}^*U_{H,k4}^*U_{H,l2}^*U_{A,i5}+\lambda U_{H,j2}^*U_{H,k1}^*U_{H,l4}^*U_{A,i5}$$
$$+\lambda U_{H,j1}^*U_{H,k2}^*U_{H,l4}^*U_{A,i5}+2\kappa' U_{H,j3}^*U_{H,k5}^*U_{H,l4}^*U_{A,i5}+2\kappa' U_{H,j3}^*U_{H,k4}^*U_{H,l5}^*U_{A,i5}$$
$$-U_{H,j5}^*\Big(\lambda U_{H,k1}^*U_{H,l4}^*U_{A,i2}+2\kappa' U_{H,k5}^*U_{H,l4}^*U_{A,i3}-\lambda U_{H,k1}^*U_{H,l2}^*U_{A,i4}+2\kappa' U_{H,k5}^*U_{H,l3}^*U_{A,i4}$$
$$+2\kappa' U_{H,k3}^*U_{H,l5}^*U_{A,i4}+\lambda U_{H,k2}^*\Big(-U_{H,l1}^*U_{A,i4}+U_{H,l4}^*U_{A,i1}\Big)-2\kappa' U_{H,k3}^*U_{H,l4}^*U_{A,i5}$$
$$+U_{H,k4}^*\Big(-2\kappa' U_{H,l3}^*U_{A,i5}+2\kappa' U_{H,l5}^*U_{A,i3}+\lambda U_{H,l1}^*U_{A,i2}+\lambda U_{H,l2}^*U_{A,i1}\Big)\Big)$$
$$-U_{H,j4}^*\Big(\lambda U_{H,k1}^*U_{H,l5}^*U_{A,i2}-\lambda U_{H,k1}^*U_{H,l2}^*U_{A,i5}-2\kappa' U_{H,k3}^*U_{H,l5}^*U_{A,i5}$$

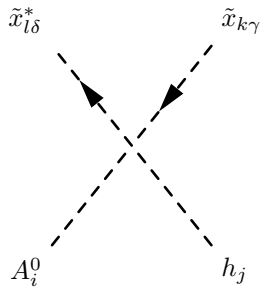
$$
\begin{aligned}
&+ \lambda U^*_{H,k2}\Big(- U^*_{H,l1}U_{A,i5} + U^*_{H,l5}U_{A,i1}\Big)\\
&+ U^*_{H,k5}\Big(- 2\kappa' U^*_{H,l3}U_{A,i5} + 2\kappa' U^*_{H,l5}U_{A,i3} + \lambda U^*_{H,l1}U_{A,i2} + \lambda U^*_{H,l2}U_{A,i1}\Big)\Big)\Big)\\
&- 2\sigma\kappa'^{,*}\Big(U^*_{H,j4}\Big(- U^*_{H,k3}U^*_{H,l5}U_{A,i5} + U^*_{H,k5}\Big(- U^*_{H,l3}U_{A,i5} + U^*_{H,l5}U_{A,i3}\Big)\Big)\\
&+ U^*_{H,j5}\Big(U^*_{H,k5}\Big(U^*_{H,l3}U_{A,i4} + U^*_{H,l4}U_{A,i3}\Big) + U^*_{H,k4}\Big(- U^*_{H,l3}U_{A,i5} + U^*_{H,l5}U_{A,i3}\Big)\\
&+ U^*_{H,k3}\Big(- U^*_{H,l4}U_{A,i5} + U^*_{H,l5}U_{A,i4}\Big)\Big)\\
&+ U^*_{H,j3}\Big(- U^*_{H,k4}U^*_{H,l5}U_{A,i5} + U^*_{H,k5}\Big(- U^*_{H,l4}U_{A,i5} + U^*_{H,l5}U_{A,i4}\Big)\Big)\Big)\Big)
\end{aligned}
\tag{569}
$$



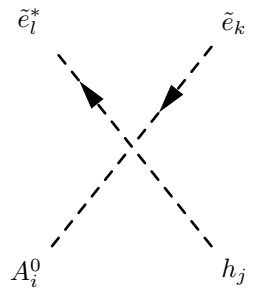
$$
\begin{aligned}
&\frac{1}{4}\Big(\Big(- 2|\lambda|^2 + g_2^2\Big)U^*_{H,j2}U_{A,i1}\Big(- U^*_{+,k1}U_{+,l2} + U^*_{+,k2}U_{+,l1}\Big)\\
&+ \Big(- 2|\lambda|^2 + g_2^2\Big)U^*_{H,j1}U_{A,i2}\Big(- U^*_{+,k1}U_{+,l2} + U^*_{+,k2}U_{+,l1}\Big)\\
&- 2\Big(U^*_{H,j4}U_{A,i5} + U^*_{H,j5}U_{A,i4}\Big)\Big(- \lambda\sigma'^{,*}U^*_{+,k1}U_{+,l2} + \sigma\lambda^* U^*_{+,k2}U_{+,l1}\Big)\Big)
\end{aligned}
\tag{570}
$$



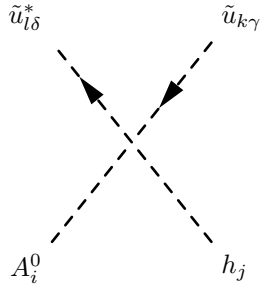
$$
- \frac{1}{2}\delta_{\gamma\delta}\Big(\lambda\sum_{a=1}^{3} Y^*_{d,aa}Z^{D,*}_{k3+a}Z^D_{la} - \lambda^*\sum_{a=1}^{3} Z^{D,*}_{ka}Y_{d,aa}Z^D_{l3+a}\Big)\Big(U^*_{H,j2}U_{A,i3} + U^*_{H,j3}U_{A,i2}\Big) \tag{571}
$$



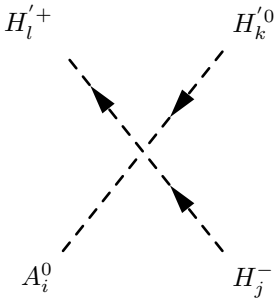
$$
\begin{aligned}
&-\frac{1}{2}\delta_{\gamma\delta}\Big(U^*_{H,j2}\Big(\lambda\sum_{a=1}^{3}Z^{Dx,*}_{k3+a}\kappa^*_{aa}Z^{Dx}_{la}-\lambda^*\sum_{a=1}^{3}Z^{Dx,*}_{ka}Z^{Dx}_{l3+a}\kappa_{aa}\Big)U_{A,i1}\\
&+U^*_{H,j1}\Big(\lambda\sum_{a=1}^{3}Z^{Dx,*}_{k3+a}\kappa^*_{aa}Z^{Dx}_{la}-\lambda^*\sum_{a=1}^{3}Z^{Dx,*}_{ka}Z^{Dx}_{l3+a}\kappa_{aa}\Big)U_{A,i2}\\
&+\Big(-\sigma'^{,*}\sum_{a=1}^{3}Z^{Dx,*}_{ka}Z^{Dx}_{l3+a}\kappa_{aa}+\sigma\sum_{a=1}^{3}Z^{Dx,*}_{k3+a}\kappa^*_{aa}Z^{Dx}_{la}\Big)\Big(U^*_{H,j4}U_{A,i5}+U^*_{H,j5}U_{A,i4}\Big)\Big)
\end{aligned}
\tag{572}
$$



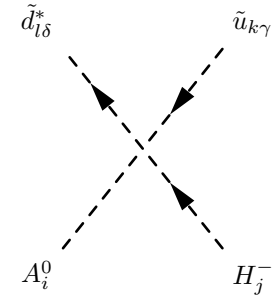
$$
-\frac{1}{2}\Big(\lambda\sum_{a=1}^{3}Y^*_{e,aa}Z^{E,*}_{k3+a}Z^{E}_{la}-\lambda^*\sum_{a=1}^{3}Z^{E,*}_{ka}Y_{e,aa}Z^{E}_{l3+a}\Big)\Big(U^*_{H,j2}U_{A,i3}+U^*_{H,j3}U_{A,i2}\Big) \tag{573}
$$



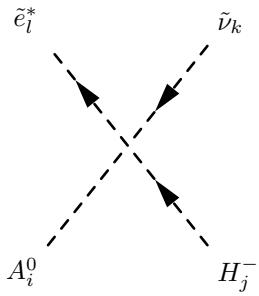
$$-\frac{1}{2}\delta_{\gamma\delta}\Big(\lambda\sum_{a=1}^{3}Y^{*}_{u,aa}Z^{U,*}_{k3+a}Z^{U}_{la}-\lambda^{*}\sum_{a=1}^{3}Z^{U,*}_{ka}Y_{u,aa}Z^{U}_{l3+a}\Big)\Big(U^{*}_{H,j1}U_{A,i3}+U^{*}_{H,j3}U_{A,i1}\Big) \tag{574}$$



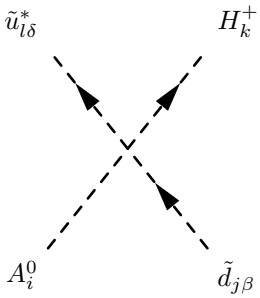
$$-\frac{1}{2}\frac{1}{\sqrt{2}}g_2^2\Big(UHp0^{*}_{k1}UHpp_{l1}+UHp0^{*}_{k2}UHpp_{l2}\Big)\Big(U^{*}_{+,j1}U_{A,i1}-U^{*}_{+,j2}U_{A,i2}\Big) \tag{575}$$



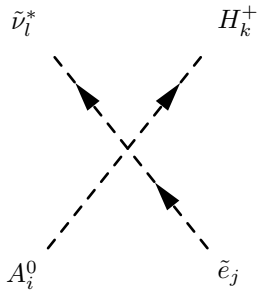
$$\begin{aligned}
&-\frac{1}{2}\frac{1}{\sqrt{2}}\delta_{\gamma\delta}\Big(U^{*}_{+,j1}\Big(g_2^2\sum_{a=1}^{3}Z^{U,*}_{ka}Z^{D}_{la}U_{A,i1}-2\sum_{b=1}^{3}|Y_{d,bb}|^2Z^{U,*}_{kb}Z^{D}_{lb}U_{A,i1}\\
&-2\sum_{b=1}^{3}Y^{*}_{u,bb}Z^{U,*}_{k3+b}Y_{d,bb}Z^{D}_{l3+b}U_{A,i2}+2\lambda\sum_{a=1}^{3}Y^{*}_{u,aa}Z^{U,*}_{k3+a}Z^{D}_{la}U_{A,i3}\Big)\\
&+U^{*}_{+,j2}\Big(2\sum_{b=1}^{3}Y^{*}_{u,bb}Z^{U,*}_{k3+b}Y_{d,bb}Z^{D}_{l3+b}U_{A,i1}-g_2^2\sum_{a=1}^{3}Z^{U,*}_{ka}Z^{D}_{la}U_{A,i2}\\
&+2\sum_{b=1}^{3}|Y_{u,bb}|^2Z^{U,*}_{kb}Z^{D}_{lb}U_{A,i2}-2\lambda^{*}\sum_{a=1}^{3}Z^{U,*}_{ka}Y_{d,aa}Z^{D}_{l3+a}U_{A,i3}\Big)\Big)
\end{aligned} \tag{576}$$



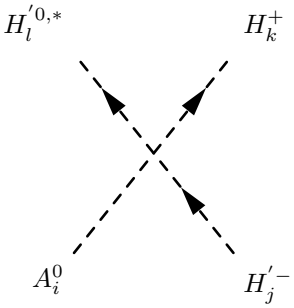
$$
\begin{aligned}
&-\frac{1}{2}\frac{1}{\sqrt{2}}\Big(U_{+,j1}^*\Big(-2\sum_{b=1}^{3}|Y_{e,bb}|^2 Z_{kb}^{V,*}Z_{lb}^{E}+g_2^2\sum_{a=1}^{3}Z_{ka}^{V,*}Z_{la}^{E}\Big)U_{A,i1}\\
&-U_{+,j2}^*\Big(2\lambda^*\sum_{a=1}^{3}Z_{ka}^{V,*}Y_{e,aa}Z_{l3+a}^{E}U_{A,i3}+g_2^2\sum_{a=1}^{3}Z_{ka}^{V,*}Z_{la}^{E}U_{A,i2}\Big)\Big)
\end{aligned}
\tag{577}
$$



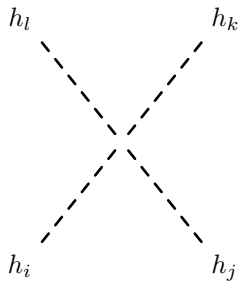
$$
\begin{aligned}
&\frac{1}{2}\frac{1}{\sqrt{2}}\delta_{\beta\delta}\Big(g_2^2\sum_{a=1}^{3}Z_{ja}^{D,*}Z_{la}^{U}\Big(U_{A,i1}U_{+,k1}-U_{A,i2}U_{+,k2}\Big)\\
&+2\Big(-\sum_{b=1}^{3}|Y_{d,bb}|^2 Z_{jb}^{D,*}Z_{lb}^{U}U_{A,i1}U_{+,k1}+\lambda^*\sum_{a=1}^{3}Z_{ja}^{D,*}Y_{u,aa}Z_{l3+a}^{U}U_{A,i3}U_{+,k1}\\
&+\sum_{b=1}^{3}|Y_{u,bb}|^2 Z_{jb}^{D,*}Z_{lb}^{U}U_{A,i2}U_{+,k2}-\lambda\sum_{a=1}^{3}Y_{d,aa}^{*}Z_{j3+a}^{D,*}Z_{la}^{U}U_{A,i3}U_{+,k2}\\
&+\sum_{b=1}^{3}Y_{d,bb}^{*}Z_{j3+b}^{D,*}Y_{u,bb}Z_{l3+b}^{U}\Big(U_{A,i1}U_{+,k2}-U_{A,i2}U_{+,k1}\Big)\Big)\Big)
\end{aligned}
\tag{578}
$$



$$\frac{1}{2}\frac{1}{\sqrt{2}}\Big(g_2^2\sum_{a=1}^{3}Z_{ja}^{E,*}Z_{la}^{V}\Big(U_{A,i1}U_{+,k1}-U_{A,i2}U_{+,k2}\Big)$$
$$-2\Big(\lambda\sum_{a=1}^{3}Y_{e,aa}^{*}Z_{j3+a}^{E,*}Z_{la}^{V}U_{A,i3}U_{+,k2}+\sum_{b=1}^{3}|Y_{e,bb}|^2Z_{jb}^{E,*}Z_{lb}^{V}U_{A,i1}U_{+,k1}\Big)\Big) \tag{579}$$



$$\frac{1}{2}\frac{1}{\sqrt{2}}g_2^2\Big(UHpp_{j1}^{*}UHp0_{l1}+UHpp_{j2}^{*}UHp0_{l2}\Big)\Big(U_{A,i1}U_{+,k1}-U_{A,i2}U_{+,k2}\Big) \tag{580}$$

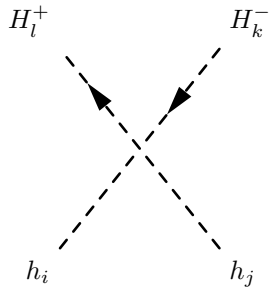


$$\frac{i}{4}\Big(12g_{1'}^2Q_SU_{H,i3}^{*}U_{H,j3}^{*}U_{H,k1}^{*}U_{H,l1}^{*}-4|\lambda|^2U_{H,i3}^{*}U_{H,j3}^{*}U_{H,k1}^{*}U_{H,l1}^{*}$$

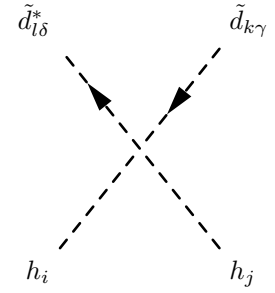
$$
\begin{aligned}
&- 12g_{1'}^2 Q_S U_{H,i4}^* U_{H,j4}^* U_{H,k1}^* U_{H,l1}^* - \sigma\lambda^* U_{H,i5}^* U_{H,j4}^* U_{H,k2}^* U_{H,l1}^* \\
&- \lambda\sigma'^{,*} U_{H,i5}^* U_{H,j4}^* U_{H,k2}^* U_{H,l1}^* - \sigma\lambda^* U_{H,i4}^* U_{H,j5}^* U_{H,k2}^* U_{H,l1}^* \\
&- \lambda\sigma'^{,*} U_{H,i4}^* U_{H,j5}^* U_{H,k2}^* U_{H,l1}^* + 12g_{1'}^2 Q_S U_{H,i3}^* U_{H,j1}^* U_{H,k3}^* U_{H,l1}^* \\
&- 4|\lambda|^2 U_{H,i3}^* U_{H,j1}^* U_{H,k3}^* U_{H,l1}^* - 12g_{1'}^2 Q_S U_{H,i4}^* U_{H,j1}^* U_{H,k4}^* U_{H,l1}^* \\
&- \sigma\lambda^* U_{H,i5}^* U_{H,j2}^* U_{H,k4}^* U_{H,l1}^* - \lambda\sigma'^{,*} U_{H,i5}^* U_{H,j2}^* U_{H,k4}^* U_{H,l1}^* \\
&- \sigma\lambda^* U_{H,i4}^* U_{H,j2}^* U_{H,k5}^* U_{H,l1}^* - \lambda\sigma'^{,*} U_{H,i4}^* U_{H,j2}^* U_{H,k5}^* U_{H,l1}^* \\
&- \sigma\lambda^* U_{H,i5}^* U_{H,j4}^* U_{H,k1}^* U_{H,l2}^* - \lambda\sigma'^{,*} U_{H,i5}^* U_{H,j4}^* U_{H,k1}^* U_{H,l2}^* \\
&- \sigma\lambda^* U_{H,i4}^* U_{H,j5}^* U_{H,k1}^* U_{H,l2}^* - \lambda\sigma'^{,*} U_{H,i4}^* U_{H,j5}^* U_{H,k1}^* U_{H,l2}^* \\
&+ 8g_{1'}^2 Q_S U_{H,i3}^* U_{H,j3}^* U_{H,k2}^* U_{H,l2}^* - 4|\lambda|^2 U_{H,i3}^* U_{H,j3}^* U_{H,k2}^* U_{H,l2}^* \\
&- 8g_{1'}^2 Q_S U_{H,i4}^* U_{H,j4}^* U_{H,k2}^* U_{H,l2}^* + 8g_{1'}^2 Q_S U_{H,i3}^* U_{H,j2}^* U_{H,k3}^* U_{H,l2}^* \\
&- 4|\lambda|^2 U_{H,i3}^* U_{H,j2}^* U_{H,k3}^* U_{H,l2}^* - \sigma\lambda^* U_{H,i5}^* U_{H,j1}^* U_{H,k4}^* U_{H,l2}^* \\
&- \lambda\sigma'^{,*} U_{H,i5}^* U_{H,j1}^* U_{H,k4}^* U_{H,l2}^* - 8g_{1'}^2 Q_S U_{H,i4}^* U_{H,j2}^* U_{H,k4}^* U_{H,l2}^* \\
&- \sigma\lambda^* U_{H,i4}^* U_{H,j1}^* U_{H,k5}^* U_{H,l2}^* - \lambda\sigma'^{,*} U_{H,i4}^* U_{H,j1}^* U_{H,k5}^* U_{H,l2}^* \\
&+ 12g_{1'}^2 Q_S U_{H,i3}^* U_{H,j1}^* U_{H,k1}^* U_{H,l3}^* - 4|\lambda|^2 U_{H,i3}^* U_{H,j1}^* U_{H,k1}^* U_{H,l3}^* \\
&+ 8g_{1'}^2 Q_S U_{H,i3}^* U_{H,j2}^* U_{H,k2}^* U_{H,l3}^* - 4|\lambda|^2 U_{H,i3}^* U_{H,j2}^* U_{H,k2}^* U_{H,l3}^* \\
&- 12g_{1'}^2 Q_S^2 U_{H,i3}^* U_{H,j3}^* U_{H,k3}^* U_{H,l3}^* + 4g_{1'}^2 Q_S^2 U_{H,i4}^* U_{H,j4}^* U_{H,k3}^* U_{H,l3}^* \\
&- 4|\sigma|^2 U_{H,i4}^* U_{H,j4}^* U_{H,k3}^* U_{H,l3}^* - 4|\sigma|^2 U_{H,i5}^* U_{H,j5}^* U_{H,k3}^* U_{H,l3}^* \\
&+ 4g_{1'}^2 Q_S^2 U_{H,i4}^* U_{H,j3}^* U_{H,k4}^* U_{H,l3}^* - 4|\sigma|^2 U_{H,i4}^* U_{H,j3}^* U_{H,k4}^* U_{H,l3}^* \\
&+ 4g_{1'}^2 Q_S^2 U_{H,i3}^* U_{H,j4}^* U_{H,k4}^* U_{H,l3}^* - 4|\sigma|^2 U_{H,i3}^* U_{H,j4}^* U_{H,k4}^* U_{H,l3}^* \\
&+ 2\sigma\kappa'^{,*} U_{H,i5}^* U_{H,j5}^* U_{H,k4}^* U_{H,l3}^* + 2\kappa'\sigma'^{,*} U_{H,i5}^* U_{H,j5}^* U_{H,k4}^* U_{H,l3}^* \\
&- 4|\sigma|^2 U_{H,i5}^* U_{H,j3}^* U_{H,k5}^* U_{H,l3}^* + 2\sigma\kappa'^{,*} U_{H,i5}^* U_{H,j4}^* U_{H,k5}^* U_{H,l3}^* \\
&+ 2\kappa'\sigma'^{,*} U_{H,i5}^* U_{H,j4}^* U_{H,k5}^* U_{H,l3}^* - 4|\sigma|^2 U_{H,i3}^* U_{H,j5}^* U_{H,k5}^* U_{H,l3}^* \\
&+ 2\sigma\kappa'^{,*} U_{H,i4}^* U_{H,j5}^* U_{H,k5}^* U_{H,l3}^* + 2\kappa'\sigma'^{,*} U_{H,i4}^* U_{H,j5}^* U_{H,k5}^* U_{H,l3}^* \\
&- 12g_{1'}^2 Q_S U_{H,i4}^* U_{H,j1}^* U_{H,k1}^* U_{H,l4}^* - \sigma\lambda^* U_{H,i5}^* U_{H,j2}^* U_{H,k1}^* U_{H,l4}^* \\
&- \lambda\sigma'^{,*} U_{H,i5}^* U_{H,j2}^* U_{H,k1}^* U_{H,l4}^* - \sigma\lambda^* U_{H,i5}^* U_{H,j1}^* U_{H,k2}^* U_{H,l4}^* \\
&- \lambda\sigma'^{,*} U_{H,i5}^* U_{H,j1}^* U_{H,k2}^* U_{H,l4}^* - 8g_{1'}^2 Q_S U_{H,i4}^* U_{H,j2}^* U_{H,k2}^* U_{H,l4}^* \\
&+ 4g_{1'}^2 Q_S^2 U_{H,i4}^* U_{H,j3}^* U_{H,k3}^* U_{H,l4}^* - 4|\sigma|^2 U_{H,i4}^* U_{H,j3}^* U_{H,k3}^* U_{H,l4}^* \\
&+ 4g_{1'}^2 Q_S^2 U_{H,i3}^* U_{H,j4}^* U_{H,k3}^* U_{H,l4}^* - 4|\sigma|^2 U_{H,i3}^* U_{H,j4}^* U_{H,k3}^* U_{H,l4}^* \\
&+ 2\sigma\kappa'^{,*} U_{H,i5}^* U_{H,j5}^* U_{H,k3}^* U_{H,l4}^* + 2\kappa'\sigma'^{,*} U_{H,i5}^* U_{H,j5}^* U_{H,k3}^* U_{H,l4}^* \\
&+ 4g_{1'}^2 Q_S^2 U_{H,i3}^* U_{H,j3}^* U_{H,k4}^* U_{H,l4}^* - 4|\sigma|^2 U_{H,i3}^* U_{H,j3}^* U_{H,k4}^* U_{H,l4}^* \\
&- 12g_{1'}^2 Q_S^2 U_{H,i4}^* U_{H,j4}^* U_{H,k4}^* U_{H,l4}^* - 4|\sigma|^2 U_{H,i5}^* U_{H,j5}^* U_{H,k4}^* U_{H,l4}^* \\
&+ 2\sigma\kappa'^{,*} U_{H,i5}^* U_{H,j3}^* U_{H,k5}^* U_{H,l4}^* + 2\kappa'\sigma'^{,*} U_{H,i5}^* U_{H,j3}^* U_{H,k5}^* U_{H,l4}^* \\
&- 4|\sigma|^2 U_{H,i5}^* U_{H,j4}^* U_{H,k5}^* U_{H,l4}^* + 2\sigma\kappa'^{,*} U_{H,i3}^* U_{H,j5}^* U_{H,k5}^* U_{H,l4}^*
\end{aligned}
$$

$$
\begin{aligned}
&+ 2\kappa'\sigma'^{,*}U^*_{H,i3}U^*_{H,j5}U^*_{H,k5}U^*_{H,l4} - 4|\sigma|^2U^*_{H,i4}U^*_{H,j5}U^*_{H,k5}U^*_{H,l4}\\
&- \sigma\lambda^*U^*_{H,i4}U^*_{H,j2}U^*_{H,k1}U^*_{H,l5} - \lambda\sigma'^{,*}U^*_{H,i4}U^*_{H,j2}U^*_{H,k1}U^*_{H,l5}\\
&- \sigma\lambda^*U^*_{H,i4}U^*_{H,j1}U^*_{H,k2}U^*_{H,l5} - \lambda\sigma'^{,*}U^*_{H,i4}U^*_{H,j1}U^*_{H,k2}U^*_{H,l5}\\
&- 4|\sigma|^2U^*_{H,i5}U^*_{H,j3}U^*_{H,k3}U^*_{H,l5} + 2\sigma\kappa'^{,*}U^*_{H,i5}U^*_{H,j4}U^*_{H,k3}U^*_{H,l5}\\
&+ 2\kappa'\sigma'^{,*}U^*_{H,i5}U^*_{H,j4}U^*_{H,k3}U^*_{H,l5} - 4|\sigma|^2U^*_{H,i3}U^*_{H,j5}U^*_{H,k3}U^*_{H,l5}\\
&+ 2\sigma\kappa'^{,*}U^*_{H,i4}U^*_{H,j5}U^*_{H,k3}U^*_{H,l5} + 2\kappa'\sigma'^{,*}U^*_{H,i4}U^*_{H,j5}U^*_{H,k3}U^*_{H,l5}\\
&+ 2\sigma\kappa'^{,*}U^*_{H,i5}U^*_{H,j3}U^*_{H,k4}U^*_{H,l5} + 2\kappa'\sigma'^{,*}U^*_{H,i5}U^*_{H,j3}U^*_{H,k4}U^*_{H,l5}\\
&- 4|\sigma|^2U^*_{H,i5}U^*_{H,j4}U^*_{H,k4}U^*_{H,l5} + 2\sigma\kappa'^{,*}U^*_{H,i3}U^*_{H,j5}U^*_{H,k4}U^*_{H,l5}\\
&+ 2\kappa'\sigma'^{,*}U^*_{H,i3}U^*_{H,j5}U^*_{H,k4}U^*_{H,l5} - 4|\sigma|^2U^*_{H,i4}U^*_{H,j5}U^*_{H,k4}U^*_{H,l5}\\
&- 4|\sigma|^2U^*_{H,i3}U^*_{H,j3}U^*_{H,k5}U^*_{H,l5} + 2\sigma\kappa'^{,*}U^*_{H,i4}U^*_{H,j3}U^*_{H,k5}U^*_{H,l5}\\
&+ 2\kappa'\sigma'^{,*}U^*_{H,i4}U^*_{H,j3}U^*_{H,k5}U^*_{H,l5} + 2\sigma\kappa'^{,*}U^*_{H,i3}U^*_{H,j4}U^*_{H,k5}U^*_{H,l5}\\
&+ 2\kappa'\sigma'^{,*}U^*_{H,i3}U^*_{H,j4}U^*_{H,k5}U^*_{H,l5} - 4|\sigma|^2U^*_{H,i4}U^*_{H,j4}U^*_{H,k5}U^*_{H,l5}\\
&- 24|\kappa'|^2U^*_{H,i5}U^*_{H,j5}U^*_{H,k5}U^*_{H,l5}\\
&+ U^*_{H,i2}\Big(- \sigma\lambda^*U^*_{H,j5}U^*_{H,k4}U^*_{H,l1} - \lambda\sigma'^{,*}U^*_{H,j5}U^*_{H,k4}U^*_{H,l1} - \sigma\lambda^*U^*_{H,j4}U^*_{H,k5}U^*_{H,l1}\\
&- \lambda\sigma'^{,*}U^*_{H,j4}U^*_{H,k5}U^*_{H,l1} + 8g_{1'}^2Q_SU^*_{H,j3}U^*_{H,k3}U^*_{H,l2} - 4|\lambda|^2U^*_{H,j3}U^*_{H,k3}U^*_{H,l2}\\
&- 8g_{1'}^2Q_SU^*_{H,j4}U^*_{H,k4}U^*_{H,l2} + 8g_{1'}^2Q_SU^*_{H,j3}U^*_{H,k2}U^*_{H,l3} - 4|\lambda|^2U^*_{H,j3}U^*_{H,k2}U^*_{H,l3}\\
&- \sigma\lambda^*U^*_{H,j5}U^*_{H,k1}U^*_{H,l4} - \lambda\sigma'^{,*}U^*_{H,j5}U^*_{H,k1}U^*_{H,l4} - 8g_{1'}^2Q_SU^*_{H,j4}U^*_{H,k2}U^*_{H,l4}\\
&+ U^*_{H,j2}\Big(\Big(- 24g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2\Big)U^*_{H,k1}U^*_{H,l1} - 3\Big(16g_{1'}^2 + g_1^2 + g_2^2\Big)U^*_{H,k2}U^*_{H,l2}\\
&+ 8g_{1'}^2Q_SU^*_{H,k3}U^*_{H,l3} - 4|\lambda|^2U^*_{H,k3}U^*_{H,l3} - 8g_{1'}^2Q_SU^*_{H,k4}U^*_{H,l4}\Big)\\
&- \sigma\lambda^*U^*_{H,j4}U^*_{H,k1}U^*_{H,l5} - \lambda\sigma'^{,*}U^*_{H,j4}U^*_{H,k1}U^*_{H,l5}\\
&+ U^*_{H,j1}\Big(\Big(- 24g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2\Big)U^*_{H,k2}U^*_{H,l1} + \Big(- 24g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2\Big)U^*_{H,k1}U^*_{H,l2}\\
&- \Big(\lambda\sigma'^{,*} + \sigma\lambda^*\Big)\Big(U^*_{H,k4}U^*_{H,l5} + U^*_{H,k5}U^*_{H,l4}\Big)\Big)\Big)\\
&- U^*_{H,i1}\Big(- 12g_{1'}^2Q_SU^*_{H,j3}U^*_{H,k3}U^*_{H,l1} + 4|\lambda|^2U^*_{H,j3}U^*_{H,k3}U^*_{H,l1} + 12g_{1'}^2Q_SU^*_{H,j4}U^*_{H,k4}U^*_{H,l1}\\
&+ \sigma\lambda^*U^*_{H,j5}U^*_{H,k4}U^*_{H,l2} + \lambda\sigma'^{,*}U^*_{H,j5}U^*_{H,k4}U^*_{H,l2} + \sigma\lambda^*U^*_{H,j4}U^*_{H,k5}U^*_{H,l2}\\
&+ \lambda\sigma'^{,*}U^*_{H,j4}U^*_{H,k5}U^*_{H,l2} - 12g_{1'}^2Q_SU^*_{H,j3}U^*_{H,k1}U^*_{H,l3} + 4|\lambda|^2U^*_{H,j3}U^*_{H,k1}U^*_{H,l3}\\
&+ 12g_{1'}^2Q_SU^*_{H,j4}U^*_{H,k1}U^*_{H,l4} + \sigma\lambda^*U^*_{H,j5}U^*_{H,k2}U^*_{H,l4} + \lambda\sigma'^{,*}U^*_{H,j5}U^*_{H,k2}U^*_{H,l4}\\
&+ U^*_{H,j1}\Big(3\Big(36g_{1'}^2 + g_1^2 + g_2^2\Big)U^*_{H,k1}U^*_{H,l1} - \Big(- 24g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2\Big)U^*_{H,k2}U^*_{H,l2}\\
&+ 4\Big(\Big(- 3g_{1'}^2Q_S + |\lambda|^2\Big)U^*_{H,k3}U^*_{H,l3} + 3g_{1'}^2Q_SU^*_{H,k4}U^*_{H,l4}\Big)\Big)\\
&+ \sigma\lambda^*U^*_{H,j4}U^*_{H,k2}U^*_{H,l5} + \lambda\sigma'^{,*}U^*_{H,j4}U^*_{H,k2}U^*_{H,l5}\\
&+ U^*_{H,j2}\Big(- \Big(- 24g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2\Big)U^*_{H,k2}U^*_{H,l1} - \Big(- 24g_{1'}^2 - 4|\lambda|^2 + g_1^2 + g_2^2\Big)U^*_{H,k1}U^*_{H,l2}
\end{aligned}
$$

$$+\Big(\lambda\sigma'^{,*}+\sigma\lambda^*\Big)\Big(U^*_{H,k4}U^*_{H,l5}+U^*_{H,k5}U^*_{H,l4}\Big)\Big)\Big)\Big) \tag{581}$$

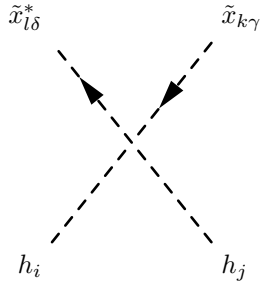


$$\begin{aligned}
&\frac{i}{4}\Big(U^*_{H,i2}\Big(-\Big(-2|\lambda|^2+g_2^2\Big)U^*_{H,j1}\Big(U^*_{+,k1}U_{+,l2}+U^*_{+,k2}U_{+,l1}\Big)\\
&+U^*_{H,j2}\Big(-\Big(16g_{1'}^2+g_1^2+g_2^2\Big)U^*_{+,k2}U_{+,l2}+\Big(-24g_{1'}^2-g_2^2+g_1^2\Big)U^*_{+,k1}U_{+,l1}\Big)\Big)\\
&-U^*_{H,i1}\Big(\Big(-2|\lambda|^2+g_2^2\Big)U^*_{H,j2}\Big(U^*_{+,k1}U_{+,l2}+U^*_{+,k2}U_{+,l1}\Big)\\
&+U^*_{H,j1}\Big(\Big(24g_{1'}^2-g_1^2+g_2^2\Big)U^*_{+,k2}U_{+,l2}+\Big(36g_{1'}^2+g_1^2+g_2^2\Big)U^*_{+,k1}U_{+,l1}\Big)\Big)\\
&+2\Big(U^*_{H,i5}U^*_{H,j4}\Big(\lambda\sigma'^{,*}U^*_{+,k1}U_{+,l2}+\sigma\lambda^*U^*_{+,k2}U_{+,l1}\Big)\\
&+2U^*_{H,i3}U^*_{H,j3}\Big(\Big(2g_{1'}^2Q_S-|\lambda|^2\Big)U^*_{+,k2}U_{+,l2}+\Big(3g_{1'}^2Q_S-|\lambda|^2\Big)U^*_{+,k1}U_{+,l1}\Big)\\
&+U^*_{H,i4}\Big(-2g_{1'}^2Q_SU^*_{H,j4}\Big(2U^*_{+,k2}U_{+,l2}+3U^*_{+,k1}U_{+,l1}\Big)+U^*_{H,j5}\Big(\lambda\sigma'^{,*}U^*_{+,k1}U_{+,l2}+\sigma\lambda^*U^*_{+,k2}U_{+,l1}\Big)\Big)\Big)\Big)
\end{aligned} \tag{582}$$



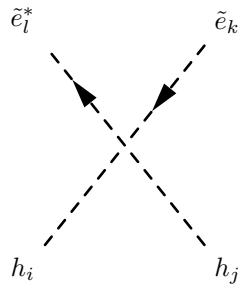
$$\begin{aligned}
&\frac{i}{12}\delta_{\gamma\delta}\Big(U^*_{H,i2}\Big(-U^*_{H,j2}\Big(2\Big(-24g_{1'}^2+g_1^2\Big)\sum_{a=1}^{3}Z^{D,*}_{k3+a}Z^D_{l3+a}+\Big(-24g_{1'}^2+3g_2^2+g_1^2\Big)\sum_{a=1}^{3}Z^{D,*}_{ka}Z^D_{la}\Big)\\
&+6U^*_{H,j3}\Big(\lambda\sum_{a=1}^{3}Y^*_{d,aa}Z^{D,*}_{k3+a}Z^D_{la}+\lambda^*\sum_{a=1}^{3}Z^{D,*}_{ka}Y_{d,aa}Z^D_{l3+a}\Big)\Big)
\end{aligned}$$

$$
\begin{aligned}
&+ 6\Big(2g_{1'}^2 Q_S U_{H,i4}^* U_{H,j4}^* \Big(2\sum_{a=1}^{3} Z_{k3+a}^{D,*} Z_{l3+a}^{D} + \sum_{a=1}^{3} Z_{ka}^{D,*} Z_{la}^{D}\Big) \\
&+ U_{H,i3}^* \Big(- 2g_{1'}^2 Q_S U_{H,j3}^* \Big(2\sum_{a=1}^{3} Z_{k3+a}^{D,*} Z_{l3+a}^{D} + \sum_{a=1}^{3} Z_{ka}^{D,*} Z_{la}^{D}\Big) \\
&+ U_{H,j2}^* \Big(\lambda \sum_{a=1}^{3} Y_{d,aa}^* Z_{k3+a}^{D,*} Z_{la}^{D} + \lambda^* \sum_{a=1}^{3} Z_{ka}^{D,*} Y_{d,aa} Z_{l3+a}^{D}\Big)\Big)\Big) \\
&+ U_{H,i1}^* U_{H,j1}^* \Big(\Big(36g_{1'}^2 + 3g_2^2 + g_1^2\Big) \sum_{a=1}^{3} Z_{ka}^{D,*} Z_{la}^{D} \\
&+ 2\Big(\Big(36g_{1'}^2 + g_1^2\Big) \sum_{a=1}^{3} Z_{k3+a}^{D,*} Z_{l3+a}^{D} - 6\Big(\sum_{b=1}^{3} |Y_{d,bb}|^2 Z_{kb}^{D,*} Z_{lb}^{D} + \sum_{b=1}^{3} |Y_{d,bb}|^2 Z_{k3+b}^{D,*} Z_{l3+b}^{D}\Big)\Big)\Big)\Big)
\end{aligned}
\tag{583}
$$

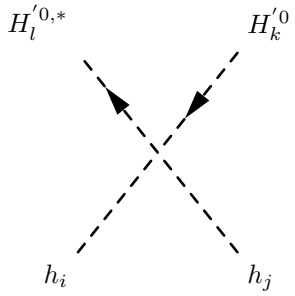


$$
\begin{aligned}
&\frac{i}{6}\delta_{\gamma\delta}\Big(U_{H,i2}^* \Big(U_{H,j2}^* \Big(\Big(- 24g_{1'}^2 + g_1^2\Big) \sum_{a=1}^{3} Z_{ka}^{Dx,*} Z_{la}^{Dx} - \Big(36g_{1'}^2 + g_1^2\Big) \sum_{a=1}^{3} Z_{k3+a}^{Dx,*} Z_{l3+a}^{Dx}\Big) \\
&+ 3U_{H,j1}^* \Big(\lambda \sum_{a=1}^{3} Z_{k3+a}^{Dx,*} \kappa_{aa}^* Z_{la}^{Dx} + \lambda^* \sum_{a=1}^{3} Z_{ka}^{Dx,*} Z_{l3+a}^{Dx} \kappa_{aa}\Big)\Big) \\
&+ U_{H,i1}^* \Big(- U_{H,j1}^* \Big(\Big(36g_{1'}^2 + g_1^2\Big) \sum_{a=1}^{3} Z_{ka}^{Dx,*} Z_{la}^{Dx} - \Big(- 54g_{1'}^2 + g_1^2\Big) \sum_{a=1}^{3} Z_{k3+a}^{Dx,*} Z_{l3+a}^{Dx}\Big) \\
&+ 3U_{H,j2}^* \Big(\lambda \sum_{a=1}^{3} Z_{k3+a}^{Dx,*} \kappa_{aa}^* Z_{la}^{Dx} + \lambda^* \sum_{a=1}^{3} Z_{ka}^{Dx,*} Z_{l3+a}^{Dx} \kappa_{aa}\Big)\Big) \\
&+ 3\Big(U_{H,i5}^* U_{H,j4}^* \Big(\sigma'^{,*} \sum_{a=1}^{3} Z_{ka}^{Dx,*} Z_{l3+a}^{Dx} \kappa_{aa} + \sigma \sum_{a=1}^{3} Z_{k3+a}^{Dx,*} \kappa_{aa}^* Z_{la}^{Dx}\Big) \\
&+ U_{H,i4}^* \Big(- 2g_{1'}^2 Q_S U_{H,j4}^* \Big(2\sum_{a=1}^{3} Z_{ka}^{Dx,*} Z_{la}^{Dx} + 3\sum_{a=1}^{3} Z_{k3+a}^{Dx,*} Z_{l3+a}^{Dx}\Big) \\
&+ U_{H,j5}^* \Big(\sigma'^{,*} \sum_{a=1}^{3} Z_{ka}^{Dx,*} Z_{l3+a}^{Dx} \kappa_{aa} + \sigma \sum_{a=1}^{3} Z_{k3+a}^{Dx,*} \kappa_{aa}^* Z_{la}^{Dx}\Big)\Big)
\end{aligned}
$$

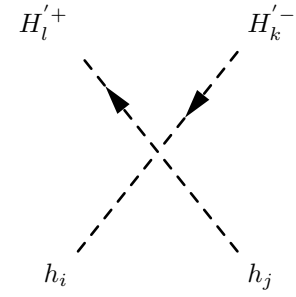
$$+ 2U_{H,i3}^{*}U_{H,j3}^{*}\Big(2g_{1'}^{2}Q_S\sum_{a=1}^{3}Z_{ka}^{Dx,*}Z_{la}^{Dx} + 3g_{1'}^{2}Q_S\sum_{a=1}^{3}Z_{k3+a}^{Dx,*}Z_{l3+a}^{Dx} - \sum_{b=1}^{3}|\kappa_{bb}|^2 Z_{kb}^{Dx,*}Z_{lb}^{Dx}$$
$$- \sum_{b=1}^{3}|\kappa_{bb}|^2 Z_{k3+b}^{Dx,*}Z_{l3+b}^{Dx}\Big)\Big) \tag{584}$$



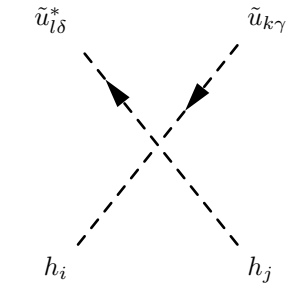
$$\frac{i}{4}\Big(- 8g_{1'}^{2}Q_S U_{H,i3}^{*}U_{H,j3}^{*}\sum_{a=1}^{3}Z_{ka}^{E,*}Z_{la}^{E} + 8g_{1'}^{2}Q_S U_{H,i4}^{*}U_{H,j4}^{*}\sum_{a=1}^{3}Z_{ka}^{E,*}Z_{la}^{E}$$
$$+ 2\lambda U_{H,i3}^{*}U_{H,j2}^{*}\sum_{a=1}^{3}Y_{e,aa}^{*}Z_{k3+a}^{E,*}Z_{la}^{E} - 4g_{1'}^{2}Q_S U_{H,i3}^{*}U_{H,j3}^{*}\sum_{a=1}^{3}Z_{k3+a}^{E,*}Z_{l3+a}^{E}$$
$$+ 4g_{1'}^{2}Q_S U_{H,i4}^{*}U_{H,j4}^{*}\sum_{a=1}^{3}Z_{k3+a}^{E,*}Z_{l3+a}^{E} + 2\lambda^{*}U_{H,i3}^{*}U_{H,j2}^{*}\sum_{a=1}^{3}Z_{ka}^{E,*}Y_{e,aa}Z_{l3+a}^{E}$$
$$+ U_{H,i2}^{*}\Big(U_{H,j2}^{*}\Big(\Big(16g_{1'}^{2} - g_2^2 + g_1^2\Big)\sum_{a=1}^{3}Z_{ka}^{E,*}Z_{la}^{E} - 2\Big(- 4g_{1'}^{2} + g_1^2\Big)\sum_{a=1}^{3}Z_{k3+a}^{E,*}Z_{l3+a}^{E}\Big)$$
$$+ 2U_{H,j3}^{*}\Big(\lambda\sum_{a=1}^{3}Y_{e,aa}^{*}Z_{k3+a}^{E,*}Z_{la}^{E} + \lambda^{*}\sum_{a=1}^{3}Z_{ka}^{E,*}Y_{e,aa}Z_{l3+a}^{E}\Big)\Big)$$
$$+ U_{H,i1}^{*}U_{H,j1}^{*}\Big(\Big(24g_{1'}^{2} - g_1^2 + g_2^2\Big)\sum_{a=1}^{3}Z_{ka}^{E,*}Z_{la}^{E}$$
$$+ 2\Big(- 2\Big(\sum_{b=1}^{3}|Y_{e,bb}|^2 Z_{kb}^{E,*}Z_{lb}^{E} + \sum_{b=1}^{3}|Y_{e,bb}|^2 Z_{k3+b}^{E,*}Z_{l3+b}^{E}\Big) + \Big(6g_{1'}^{2} + g_1^2\Big)\sum_{a=1}^{3}Z_{k3+a}^{E,*}Z_{l3+a}^{E}\Big)\Big)\Big) \tag{585}$$



$$-\frac{i}{4}\Big(\Big(-24g_{1'}^2+g_1^2+g_2^2\Big)U_{H,i1}^*U_{H,j1}^*-\Big(16g_{1'}^2+g_1^2+g_2^2\Big)U_{H,i2}^*U_{H,j2}^*$$
$$+8g_{1'}^2Q_S\Big(U_{H,i3}^*U_{H,j3}^*-U_{H,i4}^*U_{H,j4}^*\Big)\Big)\Big(UHp0_{k1}^*UHp0_{l1}-UHp0_{k2}^*UHp0_{l2}\Big) \tag{586}$$

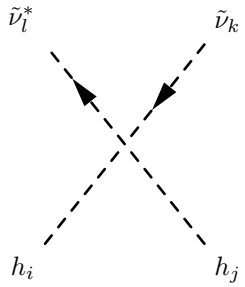


$$-\frac{i}{4}\Big(\Big(-24g_{1'}^2-g_2^2+g_1^2\Big)U_{H,i1}^*U_{H,j1}^*+\Big(-16g_{1'}^2-g_1^2+g_2^2\Big)U_{H,i2}^*U_{H,j2}^*$$
$$+8g_{1'}^2Q_S\Big(U_{H,i3}^*U_{H,j3}^*-U_{H,i4}^*U_{H,j4}^*\Big)\Big)\Big(UHpp_{k1}^*UHpp_{l1}-UHpp_{k2}^*UHpp_{l2}\Big) \tag{587}$$

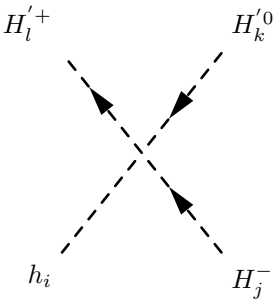


$$\frac{i}{12}\delta_{\gamma\delta}\Big(U_{H,i1}^*\Big(U_{H,j1}^*\Big(\Big(36g_{1'}^2-3g_2^2+g_1^2\Big)\sum_{a=1}^{3}Z_{ka}^{U,*}Z_{la}^U-4\Big(-9g_{1'}^2+g_1^2\Big)\sum_{a=1}^{3}Z_{k3+a}^{U,*}Z_{l3+a}^U\Big)$$

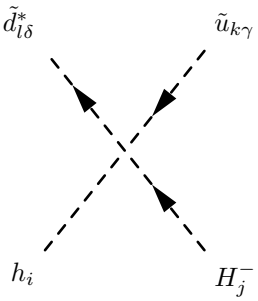
$$
\begin{aligned}
&+ 6U^{*}_{H,j3}\Big(\lambda\sum_{a=1}^{3}Y^{*}_{u,aa}Z^{U,*}_{k3+a}Z^{U}_{la} + \lambda^{*}\sum_{a=1}^{3}Z^{U,*}_{ka}Y_{u,aa}Z^{U}_{l3+a}\Big)\Big)\\
&+ 6\Big(2g^{2}_{1'}Q_{S}U^{*}_{H,i4}U^{*}_{H,j4}\delta_{kl}\\
&+ U^{*}_{H,i3}\Big(-2g^{2}_{1'}Q_{S}U^{*}_{H,j3}\delta_{kl} + U^{*}_{H,j1}\Big(\lambda\sum_{a=1}^{3}Y^{*}_{u,aa}Z^{U,*}_{k3+a}Z^{U}_{la} + \lambda^{*}\sum_{a=1}^{3}Z^{U,*}_{ka}Y_{u,aa}Z^{U}_{l3+a}\Big)\Big)\Big)\\
&+ U^{*}_{H,i2}U^{*}_{H,j2}\Big(\Big(3\Big(8g^{2}_{1'}+g^{2}_{2}\Big)-g^{2}_{1}\Big)\sum_{a=1}^{3}Z^{U,*}_{ka}Z^{U}_{la}\\
&+ 4\Big(-3\Big(\sum_{b=1}^{3}|Y_{u,bb}|^{2}Z^{U,*}_{kb}Z^{U}_{lb} + \sum_{b=1}^{3}|Y_{u,bb}|^{2}Z^{U,*}_{k3+b}Z^{U}_{l3+b}\Big) + \Big(6g^{2}_{1'}+g^{2}_{1}\Big)\sum_{a=1}^{3}Z^{U,*}_{k3+a}Z^{U}_{l3+a}\Big)\Big)\Big)
\end{aligned}
\tag{588}
$$



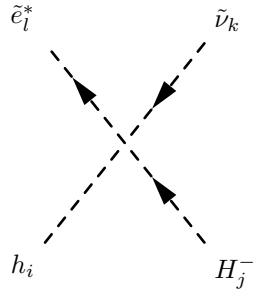
$$
\begin{aligned}
&\frac{i}{4}\Big(-\Big(-24g^{2}_{1'}+g^{2}_{1}+g^{2}_{2}\Big)U^{*}_{H,i1}U^{*}_{H,j1} + \Big(16g^{2}_{1'}+g^{2}_{1}+g^{2}_{2}\Big)U^{*}_{H,i2}U^{*}_{H,j2}\\
&+ 8g^{2}_{1'}Q_{S}\Big(-U^{*}_{H,i3}U^{*}_{H,j3} + U^{*}_{H,i4}U^{*}_{H,j4}\Big)\Big)\delta_{kl}
\end{aligned}
\tag{589}
$$



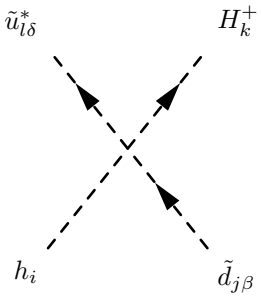
$$
-\frac{i}{2}\frac{1}{\sqrt{2}}g^{2}_{2}\Big(U^{*}_{H,i1}U^{*}_{+,j1} + U^{*}_{H,i2}U^{*}_{+,j2}\Big)\Big(UHp0^{*}_{k1}UHpp_{l1} + UHp0^{*}_{k2}UHpp_{l2}\Big) \tag{590}
$$



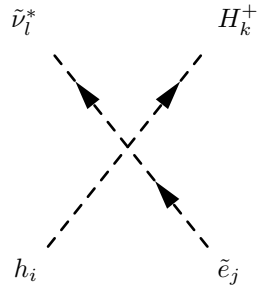
$$\frac{i}{2}\frac{1}{\sqrt{2}}\delta_{\gamma\delta}\Big(2U^*_{H,i3}\Big(\lambda U^*_{+,j1}\sum_{a=1}^{3}Y^*_{u,aa}Z^{U,*}_{k3+a}Z^D_{la}+\lambda^*U^*_{+,j2}\sum_{a=1}^{3}Z^{U,*}_{ka}Y_{d,aa}Z^D_{l3+a}\Big)$$
$$+U^*_{H,i2}\Big(U^*_{+,j2}\Big(2\sum_{b=1}^{3}|Y_{u,bb}|^2Z^{U,*}_{kb}Z^D_{lb}-g_2^2\sum_{a=1}^{3}Z^{U,*}_{ka}Z^D_{la}\Big)$$
$$+2U^*_{+,j1}\sum_{b=1}^{3}Y^*_{u,bb}Z^{U,*}_{k3+b}Y_{d,bb}Z^D_{l3+b}\Big)$$
$$+U^*_{H,i1}\Big(U^*_{+,j1}\Big(2\sum_{b=1}^{3}|Y_{d,bb}|^2Z^{U,*}_{kb}Z^D_{lb}-g_2^2\sum_{a=1}^{3}Z^{U,*}_{ka}Z^D_{la}\Big)$$
$$+2U^*_{+,j2}\sum_{b=1}^{3}Y^*_{u,bb}Z^{U,*}_{k3+b}Y_{d,bb}Z^D_{l3+b}\Big)\Big) \tag{591}$$



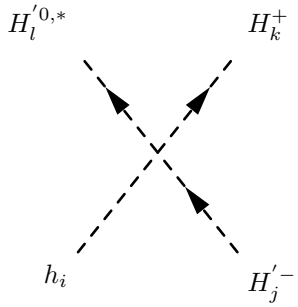
$$-\frac{i}{2}\frac{1}{\sqrt{2}}\Big(U^*_{+,j2}\Big(-2\lambda^*U^*_{H,i3}\sum_{a=1}^{3}Z^{V,*}_{ka}Y_{e,aa}Z^E_{l3+a}+g_2^2U^*_{H,i2}\sum_{a=1}^{3}Z^{V,*}_{ka}Z^E_{la}\Big)$$
$$+U^*_{H,i1}U^*_{+,j1}\Big(-2\sum_{b=1}^{3}|Y_{e,bb}|^2Z^{V,*}_{kb}Z^E_{lb}+g_2^2\sum_{a=1}^{3}Z^{V,*}_{ka}Z^E_{la}\Big)\Big) \tag{592}$$



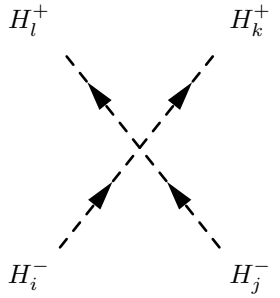
$$\frac{i}{2}\frac{1}{\sqrt{2}}\delta_{\beta\delta}\Big(2\lambda^* U^*_{H,i3}\sum_{a=1}^{3} Z^{D,*}_{ja} Y_{u,aa} Z^U_{l3+a} U_{+,k1} + 2U^*_{H,i2}\sum_{b=1}^{3} Y^*_{d,bb} Z^{D,*}_{j3+b} Y_{u,bb} Z^U_{l3+b} U_{+,k1}$$
$$- g_2^2 U^*_{H,i2}\sum_{a=1}^{3} Z^{D,*}_{ja} Z^U_{la} U_{+,k2} + 2\lambda U^*_{H,i3}\sum_{a=1}^{3} Y^*_{d,aa} Z^{D,*}_{j3+a} Z^U_{la} U_{+,k2}$$
$$+ 2U^*_{H,i2}\sum_{b=1}^{3} |Y_{u,bb}|^2 Z^{D,*}_{jb} Z^U_{lb} U_{+,k2}$$
$$+ U^*_{H,i1}\Big(-g_2^2\sum_{a=1}^{3} Z^{D,*}_{ja} Z^U_{la} U_{+,k1} + 2\sum_{b=1}^{3} |Y_{d,bb}|^2 Z^{D,*}_{jb} Z^U_{lb} U_{+,k1}$$
$$+ 2\sum_{b=1}^{3} Y^*_{d,bb} Z^{D,*}_{j3+b} Y_{u,bb} Z^U_{l3+b} U_{+,k2}\Big)\Big) \tag{593}$$



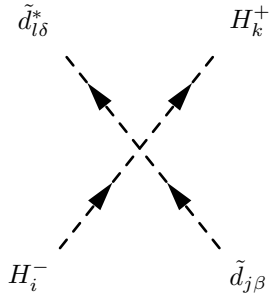
$$-\frac{i}{2}\frac{1}{\sqrt{2}}\Big(U^*_{H,i1}\Big(-2\sum_{b=1}^{3} |Y_{e,bb}|^2 Z^{E,*}_{jb} Z^V_{lb} + g_2^2\sum_{a=1}^{3} Z^{E,*}_{ja} Z^V_{la}\Big) U_{+,k1}$$
$$+\Big(-2\lambda U^*_{H,i3}\sum_{a=1}^{3} Y^*_{e,aa} Z^{E,*}_{j3+a} Z^V_{la} + g_2^2 U^*_{H,i2}\sum_{a=1}^{3} Z^{E,*}_{ja} Z^V_{la}\Big) U_{+,k2}\Big) \tag{594}$$



$$-\frac{i}{2}\frac{1}{\sqrt{2}}g_2^2\Big(UHpp_{j1}^*UHp0_{l1}+UHpp_{j2}^*UHp0_{l2}\Big)\Big(U_{H,i1}^*U_{+,k1}+U_{H,i2}^*U_{+,k2}\Big) \tag{595}$$

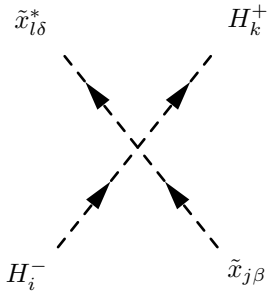


$$\begin{aligned}&\frac{i}{4}\Big(U_{+,i2}^*\Big(-2\Big(16g_{1'}^2+g_1^2+g_2^2\Big)U_{+,j2}^*U_{+,k2}U_{+,l2}+\Big(-24g_{1'}^2-4|\lambda|^2+g_1^2+g_2^2\Big)U_{+,j1}^*\Big(U_{+,k1}U_{+,l2}+U_{+,k2}U_{+,l1}\Big)\Big)\\&+U_{+,i1}^*\Big(-2\Big(36g_{1'}^2+g_1^2+g_2^2\Big)U_{+,j1}^*U_{+,k1}U_{+,l1}+\Big(-24g_{1'}^2-4|\lambda|^2+g_1^2+g_2^2\Big)U_{+,j2}^*\Big(U_{+,k1}U_{+,l2}+U_{+,k2}U_{+,l1}\Big)\Big)\Big)\end{aligned} \tag{596}$$

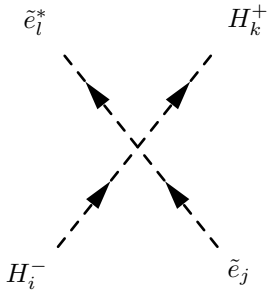


$$\frac{i}{12}\delta_{\beta\delta}\Big(U_{+,i1}^*\Big(\Big(36g_{1'}^2-3g_2^2+g_1^2\Big)\sum_{a=1}^{3}Z_{ja}^{D,*}Z_{la}^D$$

$$+ 2\Big(\Big(36g_{1'}^2 + g_1^2\Big)\sum_{a=1}^{3} Z_{j3+a}^{D,*} Z_{l3+a}^{D} - 6\sum_{b=1}^{3} |Y_{d,bb}|^2 Z_{j3+b}^{D,*} Z_{l3+b}^{D}\Big)\Big) U_{+,k1}$$
$$+ U_{+,i2}^{*}\Big(\Big(3\Big(8g_{1'}^2 + g_2^2\Big) - g_1^2\Big)\sum_{a=1}^{3} Z_{ja}^{D,*} Z_{la}^{D}$$
$$- 2\Big(\Big(-24g_{1'}^2 + g_1^2\Big)\sum_{a=1}^{3} Z_{j3+a}^{D,*} Z_{l3+a}^{D} + 6\sum_{b=1}^{3} |Y_{u,bb}|^2 Z_{jb}^{D,*} Z_{lb}^{D}\Big)\Big) U_{+,k2}\Big) \tag{597}$$

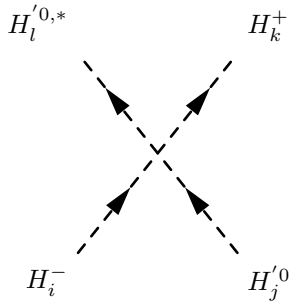


$$-\frac{i}{6}\delta_{\beta\delta}\Big(U_{+,i1}^{*}\Big(\Big(36g_{1'}^2 + g_1^2\Big)\sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{la}^{Dx} U_{+,k1} - \Big(-54g_{1'}^2 + g_1^2\Big)\sum_{a=1}^{3} Z_{j3+a}^{Dx,*} Z_{l3+a}^{Dx} U_{+,k1}$$
$$+ 6\lambda\sum_{a=1}^{3} Z_{j3+a}^{Dx,*}\kappa_{aa}^{*} Z_{la}^{Dx} U_{+,k2}\Big)$$
$$+ U_{+,i2}^{*}\Big(6\lambda^{*}\sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{l3+a}^{Dx}\kappa_{aa} U_{+,k1}$$
$$+ \Big(-\Big(-24g_{1'}^2 + g_1^2\Big)\sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{la}^{Dx} + \Big(36g_{1'}^2 + g_1^2\Big)\sum_{a=1}^{3} Z_{j3+a}^{Dx,*} Z_{l3+a}^{Dx}\Big) U_{+,k2}\Big)\Big) \tag{598}$$

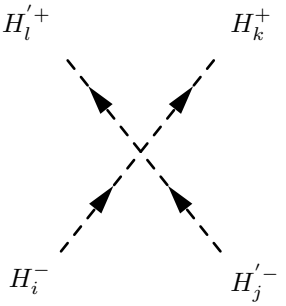


$$\frac{i}{4}\Big(-U_{+,i1}^{*}\Big(\Big(-24g_{1'}^2 + g_1^2 + g_2^2\Big)\sum_{a=1}^{3} Z_{ja}^{E,*} Z_{la}^{E}$$

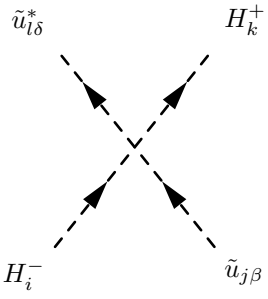
$$- 2\Big(- 2\sum_{b=1}^{3}|Y_{e,bb}|^2 Z^{E,*}_{j3+b}Z^{E}_{l3+b} + \Big(6g^2_{1'} + g^2_1\Big)\sum_{a=1}^{3} Z^{E,*}_{j3+a}Z^{E}_{l3+a}\Big)\Big)U_{+,k1}$$
$$+ U^*_{+,i2}\Big(\Big(16g^2_{1'} + g^2_1 + g^2_2\Big)\sum_{a=1}^{3} Z^{E,*}_{ja}Z^{E}_{la} - 2\Big(- 4g^2_{1'} + g^2_1\Big)\sum_{a=1}^{3} Z^{E,*}_{j3+a}Z^{E}_{l3+a}\Big)U_{+,k2}\Big) \tag{599}$$



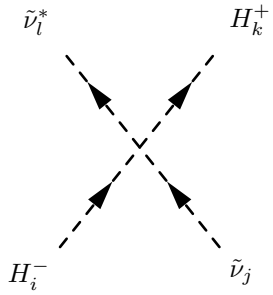
$$- \frac{i}{4}\Big(UHp0^*_{j1}UHp0_{l1} - UHp0^*_{j2}UHp0_{l2}\Big)\Big(\Big(- 16g^2_{1'} - g^2_1 + g^2_2\Big)U^*_{+,i2}U_{+,k2} + \Big(- 24g^2_{1'} - g^2_2 + g^2_1\Big)U^*_{+,i1}U_{+,k1}\Big) \tag{600}$$



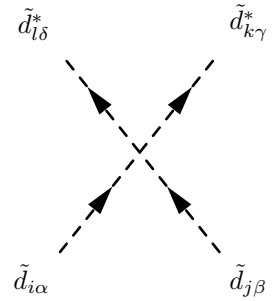
$$- \frac{i}{4}\Big(UHpp^*_{j1}UHpp_{l1} - UHpp^*_{j2}UHpp_{l2}\Big)\Big(- \Big(16g^2_{1'} + g^2_1 + g^2_2\Big)U^*_{+,i2}U_{+,k2} + \Big(- 24g^2_{1'} + g^2_1 + g^2_2\Big)U^*_{+,i1}U_{+,k1}\Big) \tag{601}$$



$$\frac{i}{12}\delta_{\beta\delta}\Big(U^*_{+,i1}\Big(\Big(36g^2_{1'}+3g^2_2+g^2_1\Big)\sum_{a=1}^{3}Z^{U,*}_{ja}Z^U_{la}$$
$$-4\Big(3\sum_{b=1}^{3}|Y_{d,bb}|^2Z^{U,*}_{jb}Z^U_{lb}+\Big(-9g^2_{1'}+g^2_1\Big)\sum_{a=1}^{3}Z^{U,*}_{j3+a}Z^U_{l3+a}\Big)\Big)U_{+,k1}$$
$$+U^*_{+,i2}\Big(-\Big(3\Big(-8g^2_{1'}+g^2_2\Big)+g^2_1\Big)\sum_{a=1}^{3}Z^{U,*}_{ja}Z^U_{la}$$
$$+4\Big(-3\sum_{b=1}^{3}|Y_{u,bb}|^2Z^{U,*}_{j3+b}Z^U_{l3+b}+\Big(6g^2_{1'}+g^2_1\Big)\sum_{a=1}^{3}Z^{U,*}_{j3+a}Z^U_{l3+a}\Big)\Big)U_{+,k2}\Big) \tag{602}$$



$$\frac{i}{4}\Big(U^*_{+,i1}\Big(\Big(24g^2_{1'}-g^2_1+g^2_2\Big)\delta_{jl}-4\sum_{b=1}^{3}|Y_{e,bb}|^2Z^{V,*}_{jb}Z^V_{lb}\Big)U_{+,k1}$$
$$+\Big(16g^2_{1'}-g^2_2+g^2_1\Big)U^*_{+,i2}\delta_{jl}U_{+,k2}\Big) \tag{603}$$



$$\frac{i}{72}\Big(-\delta_{\alpha\gamma}\delta_{\beta\delta}\Big(72\sum_{a=1}^{3}Z^{D,*}_{ja}Y_{d,aa}Z^D_{l3+a}\sum_{b=1}^{3}Y^*_{d,bb}Z^{D,*}_{i3+b}Z^D_{kb}+18g^2_3\sum_{a=1}^{3}Z^{D,*}_{ia}Z^D_{la}\sum_{b=1}^{3}Z^{D,*}_{jb}Z^D_{kb}$$
$$-18g^2_3\sum_{a=1}^{3}Z^{D,*}_{i3+a}Z^D_{l3+a}\sum_{b=1}^{3}Z^{D,*}_{jb}Z^D_{kb}$$

$$
+ 2\sum_{a=1}^{3} Z^{D,*}_{j3+a} Z^{D}_{l3+a} \Big(\Big(2g_1^2 - 3g_3^2 + 72g_{1'}^2 \Big) \sum_{b=1}^{3} Z^{D,*}_{i3+b} Z^{D}_{k3+b} + \Big(36g_{1'}^2 + 3g_3^2 + g_1^2 \Big) \sum_{b=1}^{3} Z^{D,*}_{ib} Z^{D}_{kb} \Big)
$$

$$
+ \sum_{a=1}^{3} Z^{D,*}_{ja} Z^{D}_{la} \Big(2\Big(36g_{1'}^2 + 3g_3^2 + g_1^2 \Big) \sum_{b=1}^{3} Z^{D,*}_{i3+b} Z^{D}_{k3+b} + \Big(36g_{1'}^2 - 6g_3^2 + 9g_2^2 + g_1^2 \Big) \sum_{b=1}^{3} Z^{D,*}_{ib} Z^{D}_{kb} \Big)
$$

$$
- 18g_3^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{la} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{k3+b} + 18g_3^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{l3+a} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{k3+b}
$$

$$
+ 18g_3^2 \sum_{a=1}^{3} Z^{D,*}_{ja} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{ib} Z^{D}_{lb} - 18g_3^2 \sum_{a=1}^{3} Z^{D,*}_{j3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{ib} Z^{D}_{lb}
$$

$$
+ g_1^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{lb} + 36g_{1'}^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{lb}
$$

$$
+ 9g_2^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{lb} - 6g_3^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{lb}
$$

$$
+ 2g_1^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{lb} + 72g_{1'}^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{lb}
$$

$$
+ 6g_3^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{lb} + 72 \sum_{a=1}^{3} Z^{D,*}_{ia} Y_{d,aa} Z^{D}_{k3+a} \sum_{b=1}^{3} Y^{*}_{d,bb} Z^{D,*}_{j3+b} Z^{D}_{lb}
$$

$$
- 18g_3^2 \sum_{a=1}^{3} Z^{D,*}_{ja} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{i3+b} Z^{D}_{l3+b} + 18g_3^2 \sum_{a=1}^{3} Z^{D,*}_{j3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{i3+b} Z^{D}_{l3+b}
$$

$$
+ 2g_1^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{l3+b} + 72g_{1'}^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{l3+b}
$$

$$
+ 6g_3^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{l3+b} + 4g_1^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{l3+b}
$$

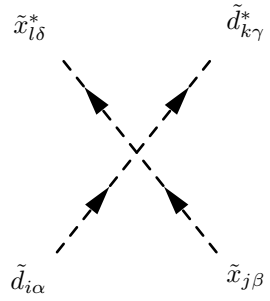
$$
+ 144g_{1'}^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{l3+b} - 6g_3^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{l3+b} \Big)
$$

$$
- \delta_{\alpha\delta}\delta_{\beta\gamma} \Big(g_1^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{la} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{kb} + 36g_{1'}^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{la} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{kb}
$$

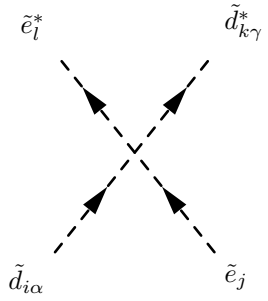
$$
+ 9g_2^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{la} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{kb} - 6g_3^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{la} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{kb}
$$

$$
+ 2g_1^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{l3+a} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{kb} + 72g_{1'}^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{l3+a} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{kb}
$$

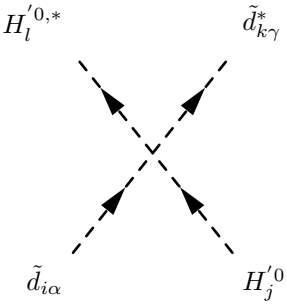
$$
\begin{aligned}
&+ 6g_3^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{l3+a} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{kb} + 72 \sum_{a=1}^{3} Z^{D,*}_{ia} Y_{d,aa} Z^{D}_{l3+a} \sum_{b=1}^{3} Y^{*}_{d,bb} Z^{D,*}_{j3+b} Z^{D}_{kb} \\
&+ 18g_3^2 \sum_{a=1}^{3} Z^{D,*}_{ja} Z^{D}_{la} \Big(- \sum_{b=1}^{3} Z^{D,*}_{i3+b} Z^{D}_{k3+b} + \sum_{b=1}^{3} Z^{D,*}_{ib} Z^{D}_{kb} \Big) \\
&- 18g_3^2 \sum_{a=1}^{3} Z^{D,*}_{j3+a} Z^{D}_{l3+a} \Big(- \sum_{b=1}^{3} Z^{D,*}_{i3+b} Z^{D}_{k3+b} + \sum_{b=1}^{3} Z^{D,*}_{ib} Z^{D}_{kb} \Big) \\
&+ 2g_1^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{la} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{k3+b} + 72 g_{1'}^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{la} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{k3+b} \\
&+ 6g_3^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{la} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{k3+b} + 4g_1^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{l3+a} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{k3+b} \\
&+ 144 g_{1'}^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{l3+a} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{k3+b} - 6g_3^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{l3+a} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{k3+b} \\
&+ g_1^2 \sum_{a=1}^{3} Z^{D,*}_{ja} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{ib} Z^{D}_{lb} + 36 g_{1'}^2 \sum_{a=1}^{3} Z^{D,*}_{ja} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{ib} Z^{D}_{lb} \\
&+ 9g_2^2 \sum_{a=1}^{3} Z^{D,*}_{ja} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{ib} Z^{D}_{lb} - 6g_3^2 \sum_{a=1}^{3} Z^{D,*}_{ja} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{ib} Z^{D}_{lb} \\
&+ 2g_1^2 \sum_{a=1}^{3} Z^{D,*}_{j3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{ib} Z^{D}_{lb} + 72 g_{1'}^2 \sum_{a=1}^{3} Z^{D,*}_{j3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{ib} Z^{D}_{lb} \\
&+ 6g_3^2 \sum_{a=1}^{3} Z^{D,*}_{j3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{ib} Z^{D}_{lb} + 72 \sum_{a=1}^{3} Z^{D,*}_{ja} Y_{d,aa} Z^{D}_{k3+a} \sum_{b=1}^{3} Y^{*}_{d,bb} Z^{D,*}_{i3+b} Z^{D}_{lb} \\
&+ 18g_3^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{lb} - 18g_3^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{jb} Z^{D}_{lb} \\
&+ 2g_1^2 \sum_{a=1}^{3} Z^{D,*}_{ja} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{i3+b} Z^{D}_{l3+b} + 72 g_{1'}^2 \sum_{a=1}^{3} Z^{D,*}_{ja} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{i3+b} Z^{D}_{l3+b} \\
&+ 6g_3^2 \sum_{a=1}^{3} Z^{D,*}_{ja} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{i3+b} Z^{D}_{l3+b} + 4g_1^2 \sum_{a=1}^{3} Z^{D,*}_{j3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{i3+b} Z^{D}_{l3+b} \\
&+ 144 g_{1'}^2 \sum_{a=1}^{3} Z^{D,*}_{j3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{i3+b} Z^{D}_{l3+b} - 6g_3^2 \sum_{a=1}^{3} Z^{D,*}_{j3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{i3+b} Z^{D}_{l3+b} \\
&- 18g_3^2 \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ka} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{l3+b} + 18g_3^2 \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{k3+a} \sum_{b=1}^{3} Z^{D,*}_{j3+b} Z^{D}_{l3+b} \Big) \Big)
\end{aligned}
\tag{604}
$$



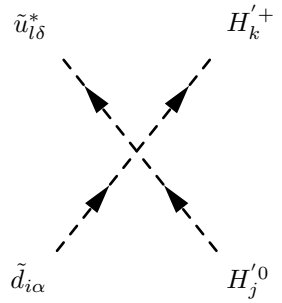
$$
\begin{aligned}
&\frac{i}{36}\Big(- 9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\Big(\sum_{a=1}^{3} Z_{ja}^{Dx,*}Z_{la}^{Dx}\Big(- \sum_{b=1}^{3} Z_{i3+b}^{D,*}Z_{k3+b}^{D} + \sum_{b=1}^{3} Z_{ib}^{D,*}Z_{kb}^{D}\Big)\\
&+ \sum_{a=1}^{3} Z_{j3+a}^{Dx,*}Z_{l3+a}^{Dx}\Big(- \sum_{b=1}^{3} Z_{ib}^{D,*}Z_{kb}^{D} + \sum_{b=1}^{3} Z_{i3+b}^{D,*}Z_{k3+b}^{D}\Big)\\
&+ \Big(- \sum_{a=1}^{3} Z_{i3+a}^{D,*}Z_{k3+a}^{D} + \sum_{a=1}^{3} Z_{ia}^{D,*}Z_{ka}^{D}\Big)\Big(- \sum_{b=1}^{3} Z_{j3+b}^{Dx,*}Z_{l3+b}^{Dx} + \sum_{b=1}^{3} Z_{jb}^{Dx,*}Z_{lb}^{Dx}\Big)\Big)\\
&+ \delta_{\alpha\gamma}\delta_{\beta\delta}\Big(\sum_{a=1}^{3} Z_{ja}^{Dx,*}Z_{la}^{Dx}\Big(\Big(2g_1^2 - 3g_3^2 + 72g_{1'}^2\Big)\sum_{b=1}^{3} Z_{i3+b}^{D,*}Z_{k3+b}^{D} + \Big(36g_{1'}^2 + 3g_3^2 + g_1^2\Big)\sum_{b=1}^{3} Z_{ib}^{D,*}Z_{kb}^{D}\Big)\\
&+ \sum_{a=1}^{3} Z_{j3+a}^{Dx,*}Z_{l3+a}^{Dx}\Big(\Big(108g_{1'}^2 - 2g_1^2 + 3g_3^2\Big)\sum_{b=1}^{3} Z_{i3+b}^{D,*}Z_{k3+b}^{D} - \Big(3g_3^2 - 54g_{1'}^2 + g_1^2\Big)\sum_{b=1}^{3} Z_{ib}^{D,*}Z_{kb}^{D}\Big)\\
&+ g_1^2\sum_{a=1}^{3} Z_{ia}^{D,*}Z_{ka}^{D}\sum_{b=1}^{3} Z_{jb}^{Dx,*}Z_{lb}^{Dx} + 36g_{1'}^2\sum_{a=1}^{3} Z_{ia}^{D,*}Z_{ka}^{D}\sum_{b=1}^{3} Z_{jb}^{Dx,*}Z_{lb}^{Dx}\\
&+ 3g_3^2\sum_{a=1}^{3} Z_{ia}^{D,*}Z_{ka}^{D}\sum_{b=1}^{3} Z_{jb}^{Dx,*}Z_{lb}^{Dx} + 2g_1^2\sum_{a=1}^{3} Z_{i3+a}^{D,*}Z_{k3+a}^{D}\sum_{b=1}^{3} Z_{jb}^{Dx,*}Z_{lb}^{Dx}\\
&+ 72g_{1'}^2\sum_{a=1}^{3} Z_{i3+a}^{D,*}Z_{k3+a}^{D}\sum_{b=1}^{3} Z_{jb}^{Dx,*}Z_{lb}^{Dx} - 3g_3^2\sum_{a=1}^{3} Z_{i3+a}^{D,*}Z_{k3+a}^{D}\sum_{b=1}^{3} Z_{jb}^{Dx,*}Z_{lb}^{Dx}\\
&- g_1^2\sum_{a=1}^{3} Z_{ia}^{D,*}Z_{ka}^{D}\sum_{b=1}^{3} Z_{j3+b}^{Dx,*}Z_{l3+b}^{Dx} + 54g_{1'}^2\sum_{a=1}^{3} Z_{ia}^{D,*}Z_{ka}^{D}\sum_{b=1}^{3} Z_{j3+b}^{Dx,*}Z_{l3+b}^{Dx}\\
&- 3g_3^2\sum_{a=1}^{3} Z_{ia}^{D,*}Z_{ka}^{D}\sum_{b=1}^{3} Z_{j3+b}^{Dx,*}Z_{l3+b}^{Dx} - 2g_1^2\sum_{a=1}^{3} Z_{i3+a}^{D,*}Z_{k3+a}^{D}\sum_{b=1}^{3} Z_{j3+b}^{Dx,*}Z_{l3+b}^{Dx}\\
&+ 108g_{1'}^2\sum_{a=1}^{3} Z_{i3+a}^{D,*}Z_{k3+a}^{D}\sum_{b=1}^{3} Z_{j3+b}^{Dx,*}Z_{l3+b}^{Dx} + 3g_3^2\sum_{a=1}^{3} Z_{i3+a}^{D,*}Z_{k3+a}^{D}\sum_{b=1}^{3} Z_{j3+b}^{Dx,*}Z_{l3+b}^{Dx}\Big)\Big)
\end{aligned}
\tag{605}
$$



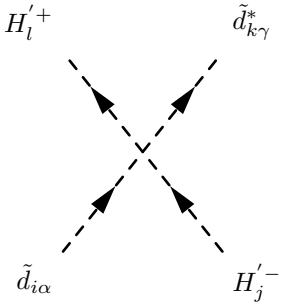
$$
\begin{aligned}
&-\frac{i}{24}\delta_{\alpha\gamma}\Big(24\sum_{a=1}^{3}Z_{ja}^{E,*}Y_{e,aa}Z_{l3+a}^{E}\sum_{b=1}^{3}Y_{d,bb}^{*}Z_{i3+b}^{D,*}Z_{kb}^{D}\\
&+2\Big(6g_{1'}^{2}+g_{1}^{2}\Big)\sum_{a=1}^{3}Z_{j3+a}^{E,*}Z_{l3+a}^{E}\Big(2\sum_{b=1}^{3}Z_{i3+b}^{D,*}Z_{k3+b}^{D}+\sum_{b=1}^{3}Z_{ib}^{D,*}Z_{kb}^{D}\Big)\\
&+\sum_{a=1}^{3}Z_{ja}^{E,*}Z_{la}^{E}\Big(-2\Big(-24g_{1'}^{2}+g_{1}^{2}\Big)\sum_{b=1}^{3}Z_{i3+b}^{D,*}Z_{k3+b}^{D}+\Big(24g_{1'}^{2}+3g_{2}^{2}-g_{1}^{2}\Big)\sum_{b=1}^{3}Z_{ib}^{D,*}Z_{kb}^{D}\Big)\\
&-g_{1}^{2}\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ka}^{D}\sum_{b=1}^{3}Z_{jb}^{E,*}Z_{lb}^{E}+24g_{1'}^{2}\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ka}^{D}\sum_{b=1}^{3}Z_{jb}^{E,*}Z_{lb}^{E}\\
&+3g_{2}^{2}\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ka}^{D}\sum_{b=1}^{3}Z_{jb}^{E,*}Z_{lb}^{E}-2g_{1}^{2}\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{k3+a}^{D}\sum_{b=1}^{3}Z_{jb}^{E,*}Z_{lb}^{E}\\
&+48g_{1'}^{2}\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{k3+a}^{D}\sum_{b=1}^{3}Z_{jb}^{E,*}Z_{lb}^{E}+24\sum_{a=1}^{3}Z_{ia}^{D,*}Y_{d,aa}Z_{k3+a}^{D}\sum_{b=1}^{3}Y_{e,bb}^{*}Z_{j3+b}^{E,*}Z_{lb}^{E}\\
&+2g_{1}^{2}\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ka}^{D}\sum_{b=1}^{3}Z_{j3+b}^{E,*}Z_{l3+b}^{E}+12g_{1'}^{2}\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ka}^{D}\sum_{b=1}^{3}Z_{j3+b}^{E,*}Z_{l3+b}^{E}\\
&+4g_{1}^{2}\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{k3+a}^{D}\sum_{b=1}^{3}Z_{j3+b}^{E,*}Z_{l3+b}^{E}+24g_{1'}^{2}\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{k3+a}^{D}\sum_{b=1}^{3}Z_{j3+b}^{E,*}Z_{l3+b}^{E}\Big)
\end{aligned}
\tag{606}
$$



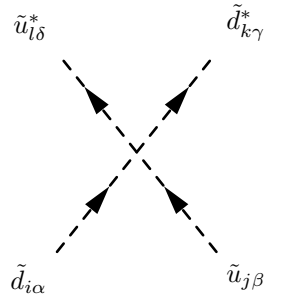
$$\frac{i}{12}\delta_{\alpha\gamma}\Big(2\Big(-24g_{1'}^2+g_1^2\Big)\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{k3+a}^{D}+\Big(3\Big(-8g_{1'}^2+g_2^2\Big)+g_1^2\Big)\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ka}^{D}\Big)\Big(UHp0_{j1}^{*}UHp0_{l1}-UHp0_{j2}^{*}UHp0_{l2}\Big) \tag{607}$$



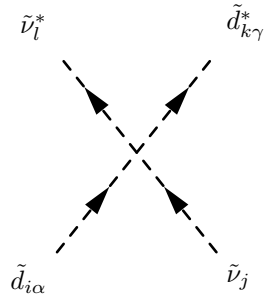
$$-\frac{i}{2}g_2^2\delta_{\alpha\delta}\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{la}^{U}\Big(UHp0_{j1}^{*}UHpp_{k1}+UHp0_{j2}^{*}UHpp_{k2}\Big) \tag{608}$$



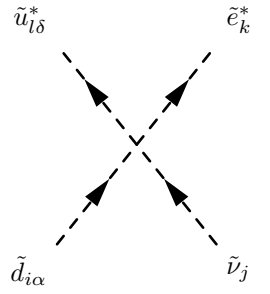
$$\frac{i}{12}\delta_{\alpha\gamma}\Big(2\Big(-24g_{1'}^2+g_1^2\Big)\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{k3+a}^{D}+\Big(-3\Big(8g_{1'}^2+g_2^2\Big)+g_1^2\Big)\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ka}^{D}\Big)\Big(UHpp_{j1}^{*}UHpp_{l1}-UHpp_{j2}^{*}UHpp_{l2}\Big) \tag{609}$$



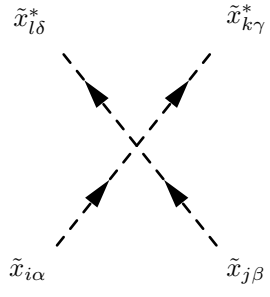
$$\frac{i}{72}\Big(- \delta_{\alpha\gamma}\delta_{\beta\delta}\Big(\sum_{a=1}^{3} Z_{j3+a}^{U,*} Z_{l3+a}^{U}\Big(- 2\Big(- 36g_{1'}^2 + 3g_3^2 + 4g_1^2\Big) \sum_{b=1}^{3} Z_{i3+b}^{D,*} Z_{k3+b}^{D} + \Big(36g_{1'}^2 - 4g_1^2 + 6g_3^2\Big) \sum_{b=1}^{3} Z_{ib}^{D,*} Z_{kb}^{D}\Big)$$
$$+ \sum_{a=1}^{3} Z_{ja}^{U,*} Z_{la}^{U}\Big(2\Big(36g_{1'}^2 + 3g_3^2 + g_1^2\Big) \sum_{b=1}^{3} Z_{i3+b}^{D,*} Z_{k3+b}^{D} + \Big(36g_{1'}^2 - 6g_3^2 - 9g_2^2 + g_1^2\Big) \sum_{b=1}^{3} Z_{ib}^{D,*} Z_{kb}^{D}\Big)$$
$$+ g_1^2 \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ka}^{D} \sum_{b=1}^{3} Z_{jb}^{U,*} Z_{lb}^{U} + 36g_{1'}^2 \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ka}^{D} \sum_{b=1}^{3} Z_{jb}^{U,*} Z_{lb}^{U}$$
$$- 9g_2^2 \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ka}^{D} \sum_{b=1}^{3} Z_{jb}^{U,*} Z_{lb}^{U} - 6g_3^2 \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ka}^{D} \sum_{b=1}^{3} Z_{jb}^{U,*} Z_{lb}^{U}$$
$$+ 2g_1^2 \sum_{a=1}^{3} Z_{i3+a}^{D,*} Z_{k3+a}^{D} \sum_{b=1}^{3} Z_{jb}^{U,*} Z_{lb}^{U} + 72g_{1'}^2 \sum_{a=1}^{3} Z_{i3+a}^{D,*} Z_{k3+a}^{D} \sum_{b=1}^{3} Z_{jb}^{U,*} Z_{lb}^{U}$$
$$+ 6g_3^2 \sum_{a=1}^{3} Z_{i3+a}^{D,*} Z_{k3+a}^{D} \sum_{b=1}^{3} Z_{jb}^{U,*} Z_{lb}^{U} - 4g_1^2 \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ka}^{D} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U}$$
$$+ 36g_{1'}^2 \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ka}^{D} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U} + 6g_3^2 \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ka}^{D} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U}$$
$$- 8g_1^2 \sum_{a=1}^{3} Z_{i3+a}^{D,*} Z_{k3+a}^{D} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U} + 72g_{1'}^2 \sum_{a=1}^{3} Z_{i3+a}^{D,*} Z_{k3+a}^{D} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U}$$
$$- 6g_3^2 \sum_{a=1}^{3} Z_{i3+a}^{D,*} Z_{k3+a}^{D} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U}\Big)$$
$$- 18\delta_{\alpha\delta}\delta_{\beta\gamma}\Big(g_2^2 \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{la}^{U} \sum_{b=1}^{3} Z_{jb}^{U,*} Z_{kb}^{D} + 4 \sum_{a=1}^{3} Z_{ia}^{D,*} Y_{u,aa} Z_{l3+a}^{U} \sum_{b=1}^{3} Y_{u,bb}^{*} Z_{j3+b}^{U,*} Z_{kb}^{D}$$
$$+ g_3^2 \sum_{a=1}^{3} Z_{ja}^{U,*} Z_{la}^{U}\Big(- \sum_{b=1}^{3} Z_{i3+b}^{D,*} Z_{k3+b}^{D} + \sum_{b=1}^{3} Z_{ib}^{D,*} Z_{kb}^{D}\Big)$$
$$+ g_3^2 \sum_{a=1}^{3} Z_{j3+a}^{U,*} Z_{l3+a}^{U}\Big(- \sum_{b=1}^{3} Z_{ib}^{D,*} Z_{kb}^{D} + \sum_{b=1}^{3} Z_{i3+b}^{D,*} Z_{k3+b}^{D}\Big)$$
$$+ g_2^2 \sum_{a=1}^{3} Z_{ja}^{U,*} Z_{ka}^{D} \sum_{b=1}^{3} Z_{ib}^{D,*} Z_{lb}^{U} + 4 \sum_{a=1}^{3} Z_{ja}^{U,*} Y_{d,aa} Z_{k3+a}^{D} \sum_{b=1}^{3} Y_{d,bb}^{*} Z_{i3+b}^{D,*} Z_{lb}^{U}$$
$$+ g_3^2 \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ka}^{D} \sum_{b=1}^{3} Z_{jb}^{U,*} Z_{lb}^{U} - g_3^2 \sum_{a=1}^{3} Z_{i3+a}^{D,*} Z_{k3+a}^{D} \sum_{b=1}^{3} Z_{jb}^{U,*} Z_{lb}^{U}$$
$$- g_3^2 \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ka}^{D} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U} + g_3^2 \sum_{a=1}^{3} Z_{i3+a}^{D,*} Z_{k3+a}^{D} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U}\Big)\Big) \tag{610}$$



$$\frac{i}{12}\delta_{\alpha\gamma}\delta_{jl}\Big(2\Big(-24g_{1'}^2+g_1^2\Big)\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{k3+a}^{D}+\Big(3\Big(-8g_{1'}^2+g_2^2\Big)+g_1^2\Big)\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ka}^{D}\Big) \tag{611}$$



$$\begin{aligned}&-\frac{i}{4}\delta_{\alpha\delta}\Big(g_2^2\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{la}^{U}\sum_{b=1}^{3}Z_{jb}^{V,*}Z_{kb}^{E}+g_2^2\sum_{a=1}^{3}Z_{ja}^{V,*}Z_{ka}^{E}\sum_{b=1}^{3}Z_{ib}^{D,*}Z_{lb}^{U}\\&+4\sum_{a=1}^{3}Z_{ja}^{V,*}Y_{e,aa}Z_{k3+a}^{E}\sum_{b=1}^{3}Y_{d,bb}^{*}Z_{i3+b}^{D,*}Z_{lb}^{U}\Big)\end{aligned} \tag{612}$$



$$\frac{i}{36}\Big(-\delta_{\alpha\gamma}\delta_{\beta\delta}\Big(9g_3^2\sum_{a=1}^{3}Z_{ia}^{Dx,*}Z_{la}^{Dx}\sum_{b=1}^{3}Z_{jb}^{Dx,*}Z_{kb}^{Dx}-9g_3^2\sum_{a=1}^{3}Z_{i3+a}^{Dx,*}Z_{l3+a}^{Dx}\sum_{b=1}^{3}Z_{jb}^{Dx,*}Z_{kb}^{Dx}$$

$$
\begin{aligned}
&+ 36 \sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{l3+a}^{Dx} \kappa_{aa} \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} \kappa_{bb}^{*} Z_{kb}^{Dx} \\
&+ \sum_{a=1}^{3} Z_{j3+a}^{Dx,*} Z_{l3+a}^{Dx} \Big(\Big(108 g_{1'}^{2} - 2 g_{1}^{2} + 3 g_{3}^{2} \Big) \sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{kb}^{Dx} + \Big(162 g_{1'}^{2} + 2 g_{1}^{2} - 3 g_{3}^{2} \Big) \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{k3+b}^{Dx} \Big) \\
&+ \sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{la}^{Dx} \Big(\Big(108 g_{1'}^{2} - 2 g_{1}^{2} + 3 g_{3}^{2} \Big) \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{k3+b}^{Dx} + \Big(2 g_{1}^{2} - 3 g_{3}^{2} + 72 g_{1'}^{2} \Big) \sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{kb}^{Dx} \Big) \\
&- 9 g_{3}^{2} \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{la}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{k3+b}^{Dx} + 9 g_{3}^{2} \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{l3+a}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{k3+b}^{Dx} \\
&+ 9 g_{3}^{2} \sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{lb}^{Dx} - 9 g_{3}^{2} \sum_{a=1}^{3} Z_{j3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{lb}^{Dx} \\
&+ 2 g_{1}^{2} \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{lb}^{Dx} + 72 g_{1'}^{2} \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{lb}^{Dx} \\
&- 3 g_{3}^{2} \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{lb}^{Dx} - 2 g_{1}^{2} \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{lb}^{Dx} \\
&+ 108 g_{1'}^{2} \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{lb}^{Dx} + 3 g_{3}^{2} \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{lb}^{Dx} \\
&+ 36 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{k3+a}^{Dx} \kappa_{aa} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} \kappa_{bb}^{*} Z_{lb}^{Dx} - 9 g_{3}^{2} \sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{l3+b}^{Dx} \\
&+ 9 g_{3}^{2} \sum_{a=1}^{3} Z_{j3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{l3+b}^{Dx} - 2 g_{1}^{2} \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{l3+b}^{Dx} \\
&+ 108 g_{1'}^{2} \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{l3+b}^{Dx} + 3 g_{3}^{2} \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{l3+b}^{Dx} \\
&+ 2 g_{1}^{2} \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{l3+b}^{Dx} + 162 g_{1'}^{2} \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{l3+b}^{Dx} \\
&- 3 g_{3}^{2} \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{l3+b}^{Dx} \Big) \\
&- \delta_{\alpha\delta} \delta_{\beta\gamma} \Big(2 g_{1}^{2} \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{la}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{kb}^{Dx} + 72 g_{1'}^{2} \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{la}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{kb}^{Dx} \\
&- 3 g_{3}^{2} \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{la}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{kb}^{Dx} - 2 g_{1}^{2} \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{l3+a}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{kb}^{Dx}
\end{aligned}
$$

$$
+ 108 g_{1'}^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{l3+a}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{kb}^{Dx} + 3 g_3^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{l3+a}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{kb}^{Dx}
$$

$$
+ 36 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{l3+a}^{Dx} \kappa_{aa} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} \kappa_{bb}^{*} Z_{kb}^{Dx}
$$

$$
+ 9 g_3^2 \sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{la}^{Dx} \Big(- \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{k3+b}^{Dx} + \sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{kb}^{Dx} \Big)
$$

$$
+ 9 g_3^2 \sum_{a=1}^{3} Z_{j3+a}^{Dx,*} Z_{l3+a}^{Dx} \Big(- \sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{kb}^{Dx} + \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{k3+b}^{Dx} \Big)
$$

$$
- 2 g_1^2 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{la}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{k3+b}^{Dx} + 108 g_{1'}^2 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{la}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{k3+b}^{Dx}
$$

$$
+ 3 g_3^2 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{la}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{k3+b}^{Dx} + 2 g_1^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{l3+a}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{k3+b}^{Dx}
$$

$$
+ 162 g_{1'}^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{l3+a}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{k3+b}^{Dx} - 3 g_3^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{l3+a}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{k3+b}^{Dx}
$$

$$
+ 2 g_1^2 \sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{lb}^{Dx} + 72 g_{1'}^2 \sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{lb}^{Dx}
$$

$$
- 3 g_3^2 \sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{lb}^{Dx} - 2 g_1^2 \sum_{a=1}^{3} Z_{j3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{lb}^{Dx}
$$

$$
+ 108 g_{1'}^2 \sum_{a=1}^{3} Z_{j3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{lb}^{Dx} + 3 g_3^2 \sum_{a=1}^{3} Z_{j3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{lb}^{Dx}
$$

$$
+ 9 g_3^2 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{lb}^{Dx} - 9 g_3^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{jb}^{Dx,*} Z_{lb}^{Dx}
$$

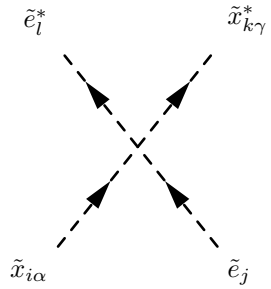
$$
+ 36 \sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{k3+a}^{Dx} \kappa_{aa} \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} \kappa_{bb}^{*} Z_{lb}^{Dx} - 2 g_1^2 \sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{l3+b}^{Dx}
$$

$$
+ 108 g_{1'}^2 \sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{l3+b}^{Dx} + 3 g_3^2 \sum_{a=1}^{3} Z_{ja}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{l3+b}^{Dx}
$$

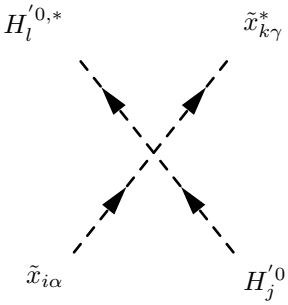
$$
+ 2 g_1^2 \sum_{a=1}^{3} Z_{j3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{l3+b}^{Dx} + 162 g_{1'}^2 \sum_{a=1}^{3} Z_{j3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{l3+b}^{Dx}
$$

$$
- 3 g_3^2 \sum_{a=1}^{3} Z_{j3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{l3+b}^{Dx} - 9 g_3^2 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{l3+b}^{Dx}
$$

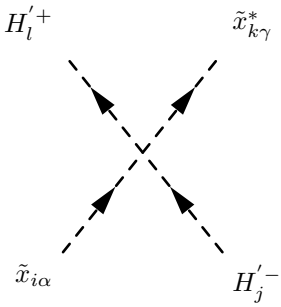
$$+ 9g_3^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{Dx,*} Z_{l3+b}^{Dx} \Big) \Big) \tag{613}$$



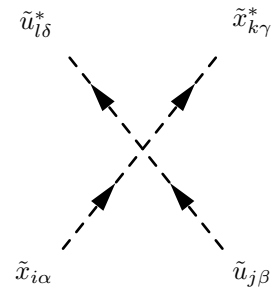
$$\begin{aligned}
&\frac{i}{12}\delta_{\alpha\gamma}\Big(2\sum_{a=1}^{3} Z_{j3+a}^{E,*} Z_{l3+a}^{E}\Big(\Big(6g_{1'}^2 + g_1^2\Big)\sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{kb}^{Dx} - \Big(-9g_{1'}^2 + g_1^2\Big)\sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{k3+b}^{Dx}\Big) \\
&+ \sum_{a=1}^{3} Z_{ja}^{E,*} Z_{la}^{E}\Big(-\Big(-24g_{1'}^2 + g_1^2\Big)\sum_{b=1}^{3} Z_{ib}^{Dx,*} Z_{kb}^{Dx} + \Big(36g_{1'}^2 + g_1^2\Big)\sum_{b=1}^{3} Z_{i3+b}^{Dx,*} Z_{k3+b}^{Dx}\Big) \\
&- g_1^2 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{jb}^{E,*} Z_{lb}^{E} + 24g_{1'}^2 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{jb}^{E,*} Z_{lb}^{E} \\
&+ g_1^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{jb}^{E,*} Z_{lb}^{E} + 36g_{1'}^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{jb}^{E,*} Z_{lb}^{E} \\
&+ 2g_1^2 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{E,*} Z_{l3+b}^{E} + 12g_{1'}^2 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{E,*} Z_{l3+b}^{E} \\
&- 2g_1^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{E,*} Z_{l3+b}^{E} + 18g_{1'}^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{E,*} Z_{l3+b}^{E}\Big)
\end{aligned} \tag{614}$$



$$-\frac{i}{6}\delta_{\alpha\gamma}\Big(\Big(-24g_{1'}^2 + g_1^2\Big)\sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} - \Big(36g_{1'}^2 + g_1^2\Big)\sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx}\Big)\Big(UHp0_{j1}^* UHp0_{l1} - UHp0_{j2}^* UHp0_{l2}\Big) \tag{615}$$

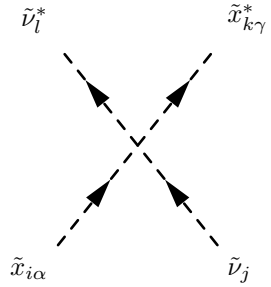


$$-\frac{i}{6}\delta_{\alpha\gamma}\Big(\Big(-24g_{1'}^2+g_1^2\Big)\sum_{a=1}^{3}Z_{ia}^{Dx,*}Z_{ka}^{Dx}-\Big(36g_{1'}^2+g_1^2\Big)\sum_{a=1}^{3}Z_{i3+a}^{Dx,*}Z_{k3+a}^{Dx}\Big)\Big(UHpp_{j1}^{*}UHpp_{l1}-UHpp_{j2}^{*}UHpp_{l2}\Big) \quad (616)$$

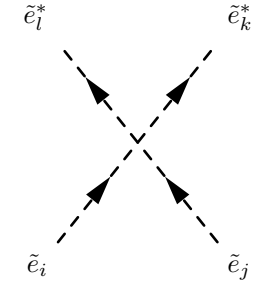


$$\begin{aligned}
&\frac{i}{36}\Big(-9g_3^2\delta_{\alpha\delta}\delta_{\beta\gamma}\Big(\sum_{a=1}^{3}Z_{ja}^{U,*}Z_{la}^{U}\Big(-\sum_{b=1}^{3}Z_{i3+b}^{Dx,*}Z_{k3+b}^{Dx}+\sum_{b=1}^{3}Z_{ib}^{Dx,*}Z_{kb}^{Dx}\Big)\\
&+\sum_{a=1}^{3}Z_{j3+a}^{U,*}Z_{l3+a}^{U}\Big(-\sum_{b=1}^{3}Z_{ib}^{Dx,*}Z_{kb}^{Dx}+\sum_{b=1}^{3}Z_{i3+b}^{Dx,*}Z_{k3+b}^{Dx}\Big)\\
&+\Big(-\sum_{a=1}^{3}Z_{i3+a}^{Dx,*}Z_{k3+a}^{Dx}+\sum_{a=1}^{3}Z_{ia}^{Dx,*}Z_{ka}^{Dx}\Big)\Big(-\sum_{b=1}^{3}Z_{j3+b}^{U,*}Z_{l3+b}^{U}+\sum_{b=1}^{3}Z_{jb}^{U,*}Z_{lb}^{U}\Big)\Big)\\
&+\delta_{\alpha\gamma}\delta_{\beta\delta}\Big(\sum_{a=1}^{3}Z_{ja}^{U,*}Z_{la}^{U}\Big(\Big(36g_{1'}^2+3g_3^2+g_1^2\Big)\sum_{b=1}^{3}Z_{ib}^{Dx,*}Z_{kb}^{Dx}-\Big(3g_3^2-54g_{1'}^2+g_1^2\Big)\sum_{b=1}^{3}Z_{i3+b}^{Dx,*}Z_{k3+b}^{Dx}\Big)\\
&+\sum_{a=1}^{3}Z_{j3+a}^{U,*}Z_{l3+a}^{U}\Big(\Big(36g_{1'}^2-3g_3^2-4g_1^2\Big)\sum_{b=1}^{3}Z_{ib}^{Dx,*}Z_{kb}^{Dx}+\Big(3g_3^2+4g_1^2+54g_{1'}^2\Big)\sum_{b=1}^{3}Z_{i3+b}^{Dx,*}Z_{k3+b}^{Dx}\Big)\\
&+g_1^2\sum_{a=1}^{3}Z_{ia}^{Dx,*}Z_{ka}^{Dx}\sum_{b=1}^{3}Z_{jb}^{U,*}Z_{lb}^{U}+36g_{1'}^2\sum_{a=1}^{3}Z_{ia}^{Dx,*}Z_{ka}^{Dx}\sum_{b=1}^{3}Z_{jb}^{U,*}Z_{lb}^{U}\\
&+3g_3^2\sum_{a=1}^{3}Z_{ia}^{Dx,*}Z_{ka}^{Dx}\sum_{b=1}^{3}Z_{jb}^{U,*}Z_{lb}^{U}-g_1^2\sum_{a=1}^{3}Z_{i3+a}^{Dx,*}Z_{k3+a}^{Dx}\sum_{b=1}^{3}Z_{jb}^{U,*}Z_{lb}^{U}
\end{aligned}$$

$$+ 54g_{1'}^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{jb}^{U,*} Z_{lb}^{U} - 3g_3^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{jb}^{U,*} Z_{lb}^{U}$$
$$- 4g_1^2 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U} + 36g_{1'}^2 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U}$$
$$- 3g_3^2 \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U} + 4g_1^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U}$$
$$+ 54g_{1'}^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U} + 3g_3^2 \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U} \Big) \Big) \tag{617}$$



$$- \frac{i}{6}\delta_{\alpha\gamma}\delta_{jl}\Big(\Big(-24g_{1'}^2 + g_1^2 \Big) \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ka}^{Dx} - \Big(36g_{1'}^2 + g_1^2 \Big) \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{k3+a}^{Dx} \Big) \tag{618}$$



$$\frac{i}{8}\Big(-8 \sum_{a=1}^{3} Z_{ja}^{E,*} Y_{e,aa} Z_{l3+a}^{E} \sum_{b=1}^{3} Y_{e,bb}^{*} Z_{i3+b}^{E,*} Z_{kb}^{E} - g_1^2 \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{la}^{E} \sum_{b=1}^{3} Z_{jb}^{E,*} Z_{kb}^{E}$$
$$- 16g_{1'}^2 \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{la}^{E} \sum_{b=1}^{3} Z_{jb}^{E,*} Z_{kb}^{E} - g_2^2 \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{la}^{E} \sum_{b=1}^{3} Z_{jb}^{E,*} Z_{kb}^{E}$$

$$+ 2g_1^2 \sum_{a=1}^{3} Z^{E,*}_{i3+a} Z^{E}_{l3+a} \sum_{b=1}^{3} Z^{E,*}_{jb} Z^{E}_{kb} - 8g_{1'}^2 \sum_{a=1}^{3} Z^{E,*}_{i3+a} Z^{E}_{l3+a} \sum_{b=1}^{3} Z^{E,*}_{jb} Z^{E}_{kb}$$

$$- 8 \sum_{a=1}^{3} Z^{E,*}_{ia} Y_{e,aa} Z^{E}_{l3+a} \sum_{b=1}^{3} Y^{*}_{e,bb} Z^{E,*}_{j3+b} Z^{E}_{kb}$$

$$- \sum_{a=1}^{3} Z^{E,*}_{ja} Z^{E}_{la} \Big(\Big(16g_{1'}^2 + g_1^2 + g_2^2 \Big) \sum_{b=1}^{3} Z^{E,*}_{ib} Z^{E}_{kb} - 2 \Big(-4g_{1'}^2 + g_1^2 \Big) \sum_{b=1}^{3} Z^{E,*}_{i3+b} Z^{E}_{k3+b} \Big)$$

$$+ 2 \sum_{a=1}^{3} Z^{E,*}_{j3+a} Z^{E}_{l3+a} \Big(-2 \Big(g_1^2 + g_{1'}^2 \Big) \sum_{b=1}^{3} Z^{E,*}_{i3+b} Z^{E}_{k3+b} + \Big(-4g_{1'}^2 + g_1^2 \Big) \sum_{b=1}^{3} Z^{E,*}_{ib} Z^{E}_{kb} \Big)$$

$$+ 2g_1^2 \sum_{a=1}^{3} Z^{E,*}_{ia} Z^{E}_{la} \sum_{b=1}^{3} Z^{E,*}_{j3+b} Z^{E}_{k3+b} - 8g_{1'}^2 \sum_{a=1}^{3} Z^{E,*}_{ia} Z^{E}_{la} \sum_{b=1}^{3} Z^{E,*}_{j3+b} Z^{E}_{k3+b}$$

$$- 4g_1^2 \sum_{a=1}^{3} Z^{E,*}_{i3+a} Z^{E}_{l3+a} \sum_{b=1}^{3} Z^{E,*}_{j3+b} Z^{E}_{k3+b} - 4g_{1'}^2 \sum_{a=1}^{3} Z^{E,*}_{i3+a} Z^{E}_{l3+a} \sum_{b=1}^{3} Z^{E,*}_{j3+b} Z^{E}_{k3+b}$$

$$- g_1^2 \sum_{a=1}^{3} Z^{E,*}_{ja} Z^{E}_{ka} \sum_{b=1}^{3} Z^{E,*}_{ib} Z^{E}_{lb} - 16g_{1'}^2 \sum_{a=1}^{3} Z^{E,*}_{ja} Z^{E}_{ka} \sum_{b=1}^{3} Z^{E,*}_{ib} Z^{E}_{lb}$$

$$- g_2^2 \sum_{a=1}^{3} Z^{E,*}_{ja} Z^{E}_{ka} \sum_{b=1}^{3} Z^{E,*}_{ib} Z^{E}_{lb} + 2g_1^2 \sum_{a=1}^{3} Z^{E,*}_{j3+a} Z^{E}_{k3+a} \sum_{b=1}^{3} Z^{E,*}_{ib} Z^{E}_{lb}$$

$$- 8g_{1'}^2 \sum_{a=1}^{3} Z^{E,*}_{j3+a} Z^{E}_{k3+a} \sum_{b=1}^{3} Z^{E,*}_{ib} Z^{E}_{lb} - 8 \sum_{a=1}^{3} Z^{E,*}_{ja} Y_{e,aa} Z^{E}_{k3+a} \sum_{b=1}^{3} Y^{*}_{e,bb} Z^{E,*}_{i3+b} Z^{E}_{lb}$$

$$- g_1^2 \sum_{a=1}^{3} Z^{E,*}_{ia} Z^{E}_{ka} \sum_{b=1}^{3} Z^{E,*}_{jb} Z^{E}_{lb} - 16g_{1'}^2 \sum_{a=1}^{3} Z^{E,*}_{ia} Z^{E}_{ka} \sum_{b=1}^{3} Z^{E,*}_{jb} Z^{E}_{lb}$$

$$- g_2^2 \sum_{a=1}^{3} Z^{E,*}_{ia} Z^{E}_{ka} \sum_{b=1}^{3} Z^{E,*}_{jb} Z^{E}_{lb} + 2g_1^2 \sum_{a=1}^{3} Z^{E,*}_{i3+a} Z^{E}_{k3+a} \sum_{b=1}^{3} Z^{E,*}_{jb} Z^{E}_{lb}$$

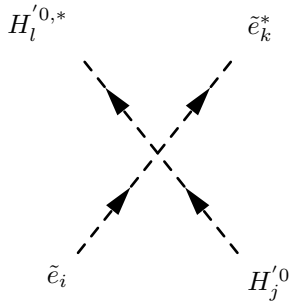
$$- 8g_{1'}^2 \sum_{a=1}^{3} Z^{E,*}_{i3+a} Z^{E}_{k3+a} \sum_{b=1}^{3} Z^{E,*}_{jb} Z^{E}_{lb} - 8 \sum_{a=1}^{3} Z^{E,*}_{ia} Y_{e,aa} Z^{E}_{k3+a} \sum_{b=1}^{3} Y^{*}_{e,bb} Z^{E,*}_{j3+b} Z^{E}_{lb}$$

$$+ 2g_1^2 \sum_{a=1}^{3} Z^{E,*}_{ja} Z^{E}_{ka} \sum_{b=1}^{3} Z^{E,*}_{i3+b} Z^{E}_{l3+b} - 8g_{1'}^2 \sum_{a=1}^{3} Z^{E,*}_{ja} Z^{E}_{ka} \sum_{b=1}^{3} Z^{E,*}_{i3+b} Z^{E}_{l3+b}$$

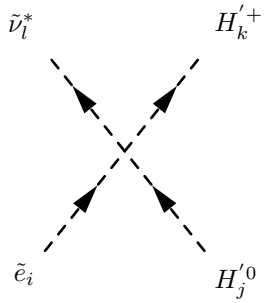
$$- 4g_1^2 \sum_{a=1}^{3} Z^{E,*}_{j3+a} Z^{E}_{k3+a} \sum_{b=1}^{3} Z^{E,*}_{i3+b} Z^{E}_{l3+b} - 4g_{1'}^2 \sum_{a=1}^{3} Z^{E,*}_{j3+a} Z^{E}_{k3+a} \sum_{b=1}^{3} Z^{E,*}_{i3+b} Z^{E}_{l3+b}$$

$$+ 2g_1^2 \sum_{a=1}^{3} Z^{E,*}_{ia} Z^{E}_{ka} \sum_{b=1}^{3} Z^{E,*}_{j3+b} Z^{E}_{l3+b} - 8g_{1'}^2 \sum_{a=1}^{3} Z^{E,*}_{ia} Z^{E}_{ka} \sum_{b=1}^{3} Z^{E,*}_{j3+b} Z^{E}_{l3+b}$$

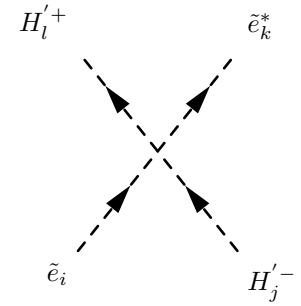
$$- 4g_1^2 \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{k3+a}^{E} \sum_{b=1}^{3} Z_{j3+b}^{E,*} Z_{l3+b}^{E} - 4g_{1'}^2 \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{k3+a}^{E} \sum_{b=1}^{3} Z_{j3+b}^{E,*} Z_{l3+b}^{E} \Big) \tag{619}$$



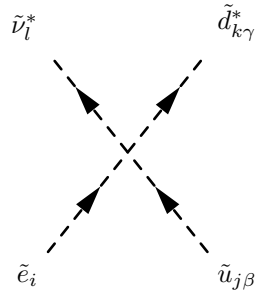
$$- \frac{i}{4} \Big(\Big(16 g_{1'}^2 - g_2^2 + g_1^2 \Big) \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ka}^{E} - 2 \Big(- 4 g_{1'}^2 + g_1^2 \Big) \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{k3+a}^{E} \Big) \Big(UHp0_{j1}^* UHp0_{l1} - UHp0_{j2}^* UHp0_{l2} \Big) \tag{620}$$



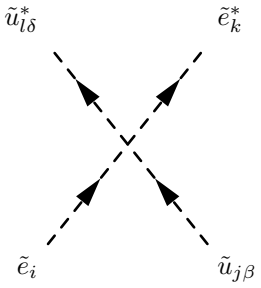
$$- \frac{i}{2} g_2^2 \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{la}^{V} \Big(UHp0_{j1}^* UHpp_{k1} + UHp0_{j2}^* UHpp_{k2} \Big) \tag{621}$$



$$-\frac{i}{4}\Big(\Big(16g_{1'}^2+g_1^2+g_2^2\Big)\sum_{a=1}^{3}Z_{ia}^{E,*}Z_{ka}^{E}-2\Big(-4g_{1'}^2+g_1^2\Big)\sum_{a=1}^{3}Z_{i3+a}^{E,*}Z_{k3+a}^{E}\Big)\Big(UHpp_{j1}^{*}UHpp_{l1}-UHpp_{j2}^{*}UHpp_{l2}\Big) \quad (622)$$

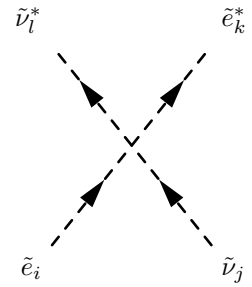


$$-\frac{i}{4}\delta_{\beta\gamma}\Big(g_2^2\sum_{a=1}^{3}Z_{ia}^{E,*}Z_{la}^{V}\sum_{b=1}^{3}Z_{jb}^{U,*}Z_{kb}^{D}+g_2^2\sum_{a=1}^{3}Z_{ja}^{U,*}Z_{ka}^{D}\sum_{b=1}^{3}Z_{ib}^{E,*}Z_{lb}^{V}$$
$$+4\sum_{a=1}^{3}Z_{ja}^{U,*}Y_{d,aa}Z_{k3+a}^{D}\sum_{b=1}^{3}Y_{e,bb}^{*}Z_{i3+b}^{E,*}Z_{lb}^{V}\Big) \quad (623)$$

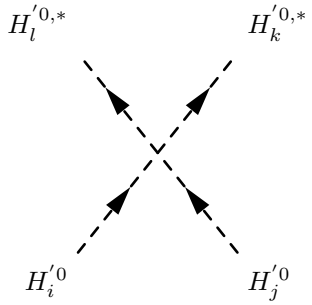


$$-\frac{i}{24}\delta_{\beta\delta}\Big(4\sum_{a=1}^{3}Z_{j3+a}^{U,*}Z_{l3+a}^{U}\Big(\Big(-2g_1^2+3g_{1'}^2\Big)\sum_{b=1}^{3}Z_{i3+b}^{E,*}Z_{k3+b}^{E}+\Big(6g_{1'}^2+g_1^2\Big)\sum_{b=1}^{3}Z_{ib}^{E,*}Z_{kb}^{E}\Big)$$
$$+\sum_{a=1}^{3}Z_{ja}^{U,*}Z_{la}^{U}\Big(-\Big(-24g_{1'}^2+3g_2^2+g_1^2\Big)\sum_{b=1}^{3}Z_{ib}^{E,*}Z_{kb}^{E}+2\Big(6g_{1'}^2+g_1^2\Big)\sum_{b=1}^{3}Z_{i3+b}^{E,*}Z_{k3+b}^{E}\Big)$$
$$-g_1^2\sum_{a=1}^{3}Z_{ia}^{E,*}Z_{ka}^{E}\sum_{b=1}^{3}Z_{jb}^{U,*}Z_{lb}^{U}+24g_{1'}^2\sum_{a=1}^{3}Z_{ia}^{E,*}Z_{ka}^{E}\sum_{b=1}^{3}Z_{jb}^{U,*}Z_{lb}^{U}$$
$$-3g_2^2\sum_{a=1}^{3}Z_{ia}^{E,*}Z_{ka}^{E}\sum_{b=1}^{3}Z_{jb}^{U,*}Z_{lb}^{U}+2g_1^2\sum_{a=1}^{3}Z_{i3+a}^{E,*}Z_{k3+a}^{E}\sum_{b=1}^{3}Z_{jb}^{U,*}Z_{lb}^{U}$$

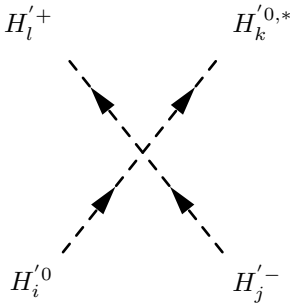
$$+ 12g_{1'}^2 \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{k3+a}^{E} \sum_{b=1}^{3} Z_{jb}^{U,*} Z_{lb}^{U} + 4g_1^2 \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ka}^{E} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U}$$
$$+ 24g_{1'}^2 \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ka}^{E} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U} - 8g_1^2 \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{k3+a}^{E} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U}$$
$$+ 12g_{1'}^2 \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{k3+a}^{E} \sum_{b=1}^{3} Z_{j3+b}^{U,*} Z_{l3+b}^{U}\Big) \tag{624}$$



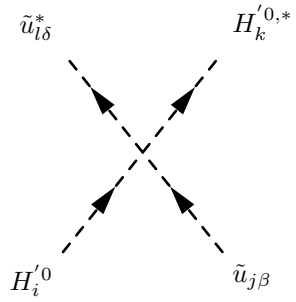
$$\frac{i}{4}\Big(\delta_{jl}\Big(\Big(-16g_{1'}^2 - g_1^2 + g_2^2\Big)\sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ka}^{E} + 2\Big(-4g_{1'}^2 + g_1^2\Big)\sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{k3+a}^{E}\Big)$$
$$- g_2^2 \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{la}^{V} \sum_{b=1}^{3} Z_{jb}^{V,*} Z_{kb}^{E} - g_2^2 \sum_{a=1}^{3} Z_{ja}^{V,*} Z_{ka}^{E} \sum_{b=1}^{3} Z_{ib}^{E,*} Z_{lb}^{V}$$
$$- 4\sum_{a=1}^{3} Z_{ja}^{V,*} Y_{e,aa} Z_{k3+a}^{E} \sum_{b=1}^{3} Y_{e,bb}^{*} Z_{i3+b}^{E,*} Z_{lb}^{V}\Big) \tag{625}$$



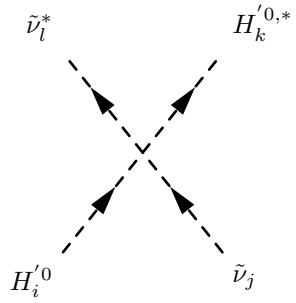
$$-\frac{i}{4}\Big(16g_{1'}^2 + g_1^2 + g_2^2\Big)\Big(UHp0_{i1}^{*}\Big(2UHp0_{j1}^{*}UHp0_{k1}UHp0_{l1} - UHp0_{j2}^{*}\Big(UHp0_{k1}UHp0_{l2} + UHp0_{k2}UHp0_{l1}\Big)\Big) - UHp0_{i2}^{*}\Big(-2UHp0_{j}$$
(626)



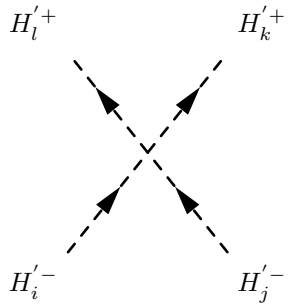
$$\frac{i}{4}\Big(UHp0^*_{i2}\Big(-\Big(16g^2_{1'}+g^2_1+g^2_2\Big)UHpp^*_{j2}UHp0_{k2}UHpp_{l2}+UHpp^*_{j1}\Big(\Big(16g^2_{1'}-g^2_2+g^2_1\Big)UHp0_{k2}UHpp_{l1}-2g^2_2UHp0_{k1}UHpp_{l2}\Big)\Big)$$
$$-UHp0^*_{i1}\Big(\Big(16g^2_{1'}+g^2_1+g^2_2\Big)UHpp^*_{j1}UHp0_{k1}UHpp_{l1}+UHpp^*_{j2}\Big(\Big(-16g^2_{1'}-g^2_1+g^2_2\Big)UHp0_{k1}UHpp_{l2}+2g^2_2UHp0_{k2}UHpp_{l1}\Big)\Big)\Big) \tag{627}$$



$$\frac{i}{12}\delta_{\beta\delta}\Big(\Big(-3\Big(8g^2_{1'}+g^2_2\Big)+g^2_1\Big)\sum_{a=1}^{3}Z^{U,*}_{ja}Z^U_{la}-4\Big(6g^2_{1'}+g^2_1\Big)\sum_{a=1}^{3}Z^{U,*}_{j3+a}Z^U_{l3+a}\Big)\Big(UHp0^*_{i1}UHp0_{k1}-UHp0^*_{i2}UHp0_{k2}\Big) \tag{628}$$

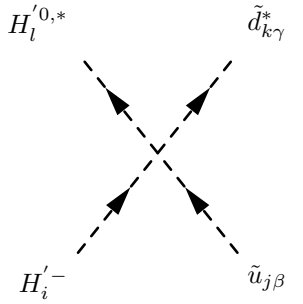


$$-\frac{i}{4}\Big(16g^2_{1'}+g^2_1+g^2_2\Big)\delta_{jl}\Big(UHp0^*_{i1}UHp0_{k1}-UHp0^*_{i2}UHp0_{k2}\Big) \tag{629}$$

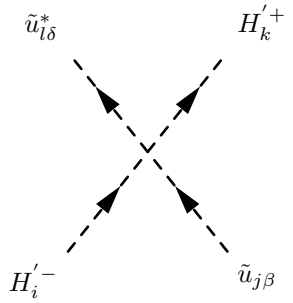


$$-\frac{i}{4}\Big(16g_{1'}^2+g_1^2+g_2^2\Big)\Big(UHpp_{i1}^*\Big(2UHpp_{j1}^*UHpp_{k1}UHpp_{l1}-UHpp_{j2}^*\Big(UHpp_{k1}UHpp_{l2}+UHpp_{k2}UHpp_{l1}\Big)\Big)-UHpp_{i2}^*\Big(-2UHpp_{j}$$

(630)

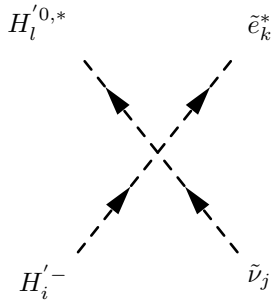


$$-\frac{i}{2}g_2^2\delta_{\beta\gamma}\sum_{a=1}^{3}Z_{ja}^{U,*}Z_{ka}^{D}\Big(UHpp_{i1}^*UHp0_{l1}+UHpp_{i2}^*UHp0_{l2}\Big) \tag{631}$$

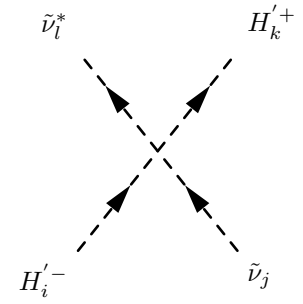


$$\frac{i}{12}\delta_{\beta\delta}\Big(\Big(3\Big(-8g_{1'}^2+g_2^2\Big)+g_1^2\Big)\sum_{a=1}^{3}Z_{ja}^{U,*}Z_{la}^{U}-4\Big(6g_{1'}^2+g_1^2\Big)\sum_{a=1}^{3}Z_{j3+a}^{U,*}Z_{l3+a}^{U}\Big)\Big(UHpp_{i1}^*UHpp_{k1}-UHpp_{i2}^*UHpp_{k2}\Big)$$

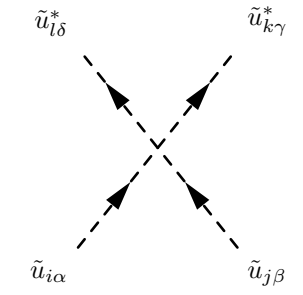
(632)



$$-\frac{i}{2}g_2^2\sum_{a=1}^{3}Z_{ja}^{V,*}Z_{ka}^{E}\Big(UHpp_{i1}^{*}UHp0_{l1}+UHpp_{i2}^{*}UHp0_{l2}\Big) \tag{633}$$



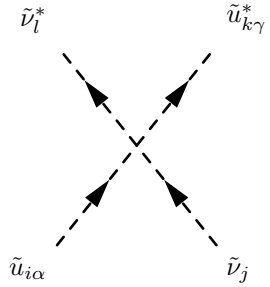
$$-\frac{i}{4}\Big(16g_{1'}^2-g_2^2+g_1^2\Big)\delta_{jl}\Big(UHpp_{i1}^{*}UHpp_{k1}-UHpp_{i2}^{*}UHpp_{k2}\Big) \tag{634}$$



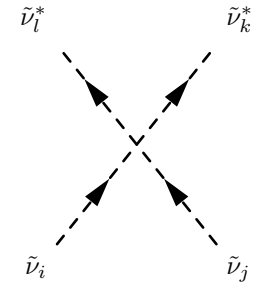
$$\frac{i}{72}\Big(-\delta_{\alpha\gamma}\delta_{\beta\delta}\Big(72\sum_{a=1}^{3}Z_{ja}^{U,*}Y_{u,aa}Z_{l3+a}^{U}\sum_{b=1}^{3}Y_{u,bb}^{*}Z_{i3+b}^{U,*}Z_{kb}^{U}+18g_3^2\sum_{a=1}^{3}Z_{ia}^{U,*}Z_{la}^{U}\sum_{b=1}^{3}Z_{jb}^{U,*}Z_{kb}^{U}$$
$$-18g_3^2\sum_{a=1}^{3}Z_{i3+a}^{U,*}Z_{l3+a}^{U}\sum_{b=1}^{3}Z_{jb}^{U,*}Z_{kb}^{U}$$

$$
\begin{aligned}
&+\sum_{a=1}^{3} Z^{U,*}_{j3+a} Z^{U}_{l3+a}\Big(2\Big(18g_{1'}^2-3g_3^2+8g_1^2\Big)\sum_{b=1}^{3} Z^{U,*}_{i3+b} Z^{U}_{k3+b}+\Big(36g_{1'}^2-4g_1^2+6g_3^2\Big)\sum_{b=1}^{3} Z^{U,*}_{ib} Z^{U}_{kb}\Big)\\
&+\sum_{a=1}^{3} Z^{U,*}_{ja} Z^{U}_{la}\Big(2\Big(18g_{1'}^2-2g_1^2+3g_3^2\Big)\sum_{b=1}^{3} Z^{U,*}_{i3+b} Z^{U}_{k3+b}+\Big(36g_{1'}^2-6g_3^2+9g_2^2+g_1^2\Big)\sum_{b=1}^{3} Z^{U,*}_{ib} Z^{U}_{kb}\Big)\\
&-18g_3^2\sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{la}\sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{k3+b}+18g_3^2\sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{l3+a}\sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{k3+b}\\
&+18g_3^2\sum_{a=1}^{3} Z^{U,*}_{ja} Z^{U}_{ka}\sum_{b=1}^{3} Z^{U,*}_{ib} Z^{U}_{lb}-18g_3^2\sum_{a=1}^{3} Z^{U,*}_{j3+a} Z^{U}_{k3+a}\sum_{b=1}^{3} Z^{U,*}_{ib} Z^{U}_{lb}\\
&+g_1^2\sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ka}\sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{lb}+36g_{1'}^2\sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ka}\sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{lb}\\
&+9g_2^2\sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ka}\sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{lb}-6g_3^2\sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ka}\sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{lb}\\
&-4g_1^2\sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{k3+a}\sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{lb}+36g_{1'}^2\sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{k3+a}\sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{lb}\\
&+6g_3^2\sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{k3+a}\sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{lb}+72\sum_{a=1}^{3} Z^{U,*}_{ia} Y_{u,aa} Z^{U}_{k3+a}\sum_{b=1}^{3} Y^{*}_{u,bb} Z^{U,*}_{j3+b} Z^{U}_{lb}\\
&-18g_3^2\sum_{a=1}^{3} Z^{U,*}_{ja} Z^{U}_{ka}\sum_{b=1}^{3} Z^{U,*}_{i3+b} Z^{U}_{l3+b}+18g_3^2\sum_{a=1}^{3} Z^{U,*}_{j3+a} Z^{U}_{k3+a}\sum_{b=1}^{3} Z^{U,*}_{i3+b} Z^{U}_{l3+b}\\
&-4g_1^2\sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ka}\sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{l3+b}+36g_{1'}^2\sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ka}\sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{l3+b}\\
&+6g_3^2\sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ka}\sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{l3+b}+16g_1^2\sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{k3+a}\sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{l3+b}\\
&+36g_{1'}^2\sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{k3+a}\sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{l3+b}-6g_3^2\sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{k3+a}\sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{l3+b}\Big)\\
&-\delta_{\alpha\delta}\delta_{\beta\gamma}\Big(g_1^2\sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{la}\sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{kb}+36g_{1'}^2\sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{la}\sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{kb}\\
&+9g_2^2\sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{la}\sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{kb}-6g_3^2\sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{la}\sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{kb}\\
&-4g_1^2\sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{l3+a}\sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{kb}+36g_{1'}^2\sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{l3+a}\sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{kb}
\end{aligned}
$$

$$+ 6 g_3^2 \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{l3+a} \sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{kb} + 72 \sum_{a=1}^{3} Z^{U,*}_{ia} Y_{u,aa} Z^{U}_{l3+a} \sum_{b=1}^{3} Y^{*}_{u,bb} Z^{U,*}_{j3+b} Z^{U}_{kb}$$
$$+ 18 g_3^2 \sum_{a=1}^{3} Z^{U,*}_{ja} Z^{U}_{la} \Big(- \sum_{b=1}^{3} Z^{U,*}_{i3+b} Z^{U}_{k3+b} + \sum_{b=1}^{3} Z^{U,*}_{ib} Z^{U}_{kb} \Big)$$
$$- 18 g_3^2 \sum_{a=1}^{3} Z^{U,*}_{j3+a} Z^{U}_{l3+a} \Big(- \sum_{b=1}^{3} Z^{U,*}_{i3+b} Z^{U}_{k3+b} + \sum_{b=1}^{3} Z^{U,*}_{ib} Z^{U}_{kb} \Big)$$
$$- 4 g_1^2 \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{la} \sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{k3+b} + 36 g_{1'}^2 \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{la} \sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{k3+b}$$
$$+ 6 g_3^2 \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{la} \sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{k3+b} + 16 g_1^2 \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{l3+a} \sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{k3+b}$$
$$+ 36 g_{1'}^2 \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{l3+a} \sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{k3+b} - 6 g_3^2 \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{l3+a} \sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{k3+b}$$
$$+ g_1^2 \sum_{a=1}^{3} Z^{U,*}_{ja} Z^{U}_{ka} \sum_{b=1}^{3} Z^{U,*}_{ib} Z^{U}_{lb} + 36 g_{1'}^2 \sum_{a=1}^{3} Z^{U,*}_{ja} Z^{U}_{ka} \sum_{b=1}^{3} Z^{U,*}_{ib} Z^{U}_{lb}$$
$$+ 9 g_2^2 \sum_{a=1}^{3} Z^{U,*}_{ja} Z^{U}_{ka} \sum_{b=1}^{3} Z^{U,*}_{ib} Z^{U}_{lb} - 6 g_3^2 \sum_{a=1}^{3} Z^{U,*}_{ja} Z^{U}_{ka} \sum_{b=1}^{3} Z^{U,*}_{ib} Z^{U}_{lb}$$
$$- 4 g_1^2 \sum_{a=1}^{3} Z^{U,*}_{j3+a} Z^{U}_{k3+a} \sum_{b=1}^{3} Z^{U,*}_{ib} Z^{U}_{lb} + 36 g_{1'}^2 \sum_{a=1}^{3} Z^{U,*}_{j3+a} Z^{U}_{k3+a} \sum_{b=1}^{3} Z^{U,*}_{ib} Z^{U}_{lb}$$
$$+ 6 g_3^2 \sum_{a=1}^{3} Z^{U,*}_{j3+a} Z^{U}_{k3+a} \sum_{b=1}^{3} Z^{U,*}_{ib} Z^{U}_{lb} + 72 \sum_{a=1}^{3} Z^{U,*}_{ja} Y_{u,aa} Z^{U}_{k3+a} \sum_{b=1}^{3} Y^{*}_{u,bb} Z^{U,*}_{i3+b} Z^{U}_{lb}$$
$$+ 18 g_3^2 \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ka} \sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{lb} - 18 g_3^2 \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{k3+a} \sum_{b=1}^{3} Z^{U,*}_{jb} Z^{U}_{lb}$$
$$- 4 g_1^2 \sum_{a=1}^{3} Z^{U,*}_{ja} Z^{U}_{ka} \sum_{b=1}^{3} Z^{U,*}_{i3+b} Z^{U}_{l3+b} + 36 g_{1'}^2 \sum_{a=1}^{3} Z^{U,*}_{ja} Z^{U}_{ka} \sum_{b=1}^{3} Z^{U,*}_{i3+b} Z^{U}_{l3+b}$$
$$+ 6 g_3^2 \sum_{a=1}^{3} Z^{U,*}_{ja} Z^{U}_{ka} \sum_{b=1}^{3} Z^{U,*}_{i3+b} Z^{U}_{l3+b} + 16 g_1^2 \sum_{a=1}^{3} Z^{U,*}_{j3+a} Z^{U}_{k3+a} \sum_{b=1}^{3} Z^{U,*}_{i3+b} Z^{U}_{l3+b}$$
$$+ 36 g_{1'}^2 \sum_{a=1}^{3} Z^{U,*}_{j3+a} Z^{U}_{k3+a} \sum_{b=1}^{3} Z^{U,*}_{i3+b} Z^{U}_{l3+b} - 6 g_3^2 \sum_{a=1}^{3} Z^{U,*}_{j3+a} Z^{U}_{k3+a} \sum_{b=1}^{3} Z^{U,*}_{i3+b} Z^{U}_{l3+b}$$
$$- 18 g_3^2 \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ka} \sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{l3+b} + 18 g_3^2 \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{k3+a} \sum_{b=1}^{3} Z^{U,*}_{j3+b} Z^{U}_{l3+b} \Big) \Big) \tag{635}$$

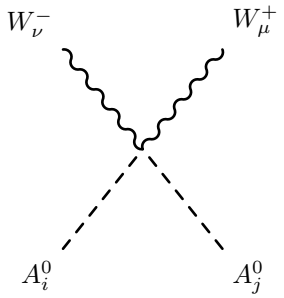


$$\frac{i}{12}\delta_{\alpha\gamma}\delta_{jl}\Big(\Big(-3\Big(8g_{1'}^2+g_2^2\Big)+g_1^2\Big)\sum_{a=1}^{3}Z_{ia}^{U,*}Z_{ka}^{U}-4\Big(6g_{1'}^2+g_1^2\Big)\sum_{a=1}^{3}Z_{i3+a}^{U,*}Z_{k3+a}^{U}\Big) \tag{636}$$

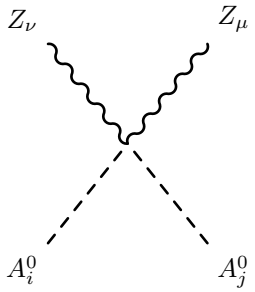


$$-\frac{i}{4}\Big(16g_{1'}^2+g_1^2+g_2^2\Big)\Big(\delta_{ik}\delta_{jl}+\delta_{il}\delta_{jk}\Big) \tag{637}$$

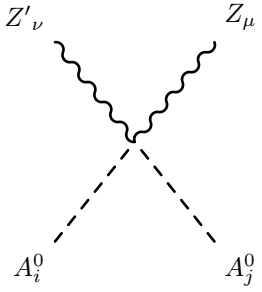
9.8 Two Scalar-Two Vector Boson-Interaction



$$\Big(\frac{i}{2}g_2^2U_{A,i1}U_{A,j1}+\frac{i}{2}g_2^2U_{A,i2}U_{A,j2}\Big)\Big(g_{\mu\nu}\Big) \tag{638}$$

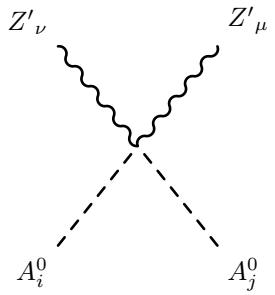


$$\Big(+ \frac{i}{2} g_2^2 \cos\Theta_W^2 \cos\Theta'^2_W U_{A,i1} U_{A,j1} + i g_1 g_2 \cos\Theta_W \cos\Theta'^2_W \sin\Theta_W U_{A,i1} U_{A,j1}$$
$$+ \frac{i}{2} g_1^2 \cos\Theta'^2_W \sin\Theta_W^2 U_{A,i1} U_{A,j1} - 6 i g_1' g_2 \cos\Theta_W \cos\Theta'_W \sin\Theta'_W U_{A,i1} U_{A,j1}$$
$$- 6 i g_1 g_1' \cos\Theta'_W \sin\Theta_W \sin\Theta'_W U_{A,i1} U_{A,j1} + 18 i g_{1'}^2 \sin\Theta'^2_W U_{A,i1} U_{A,j1}$$
$$+ \frac{i}{2} g_2^2 \cos\Theta_W^2 \cos\Theta'^2_W U_{A,i2} U_{A,j2} + i g_1 g_2 \cos\Theta_W \cos\Theta'^2_W \sin\Theta_W U_{A,i2} U_{A,j2}$$
$$+ \frac{i}{2} g_1^2 \cos\Theta'^2_W \sin\Theta_W^2 U_{A,i2} U_{A,j2} + 4 i g_1' g_2 \cos\Theta_W \cos\Theta'_W \sin\Theta'_W U_{A,i2} U_{A,j2}$$
$$+ 4 i g_1 g_1' \cos\Theta'_W \sin\Theta_W \sin\Theta'_W U_{A,i2} U_{A,j2} + 8 i g_{1'}^2 \sin\Theta'^2_W U_{A,i2} U_{A,j2}$$
$$+ 2 i g_{1'}^2 Q_S^2 \sin\Theta'^2_W U_{A,i3} U_{A,j3} + 2 i g_{1'}^2 Q_S^2 \sin\Theta'^2_W U_{A,i4} U_{A,j4} \Big) \Big(g_{\mu\nu} \Big) \tag{639}$$

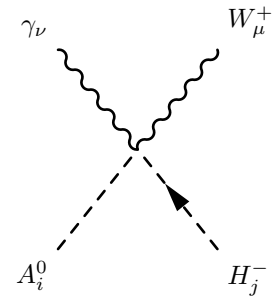


$$\Big(- 3 i g_1' g_2 \cos\Theta_W \cos\Theta'^2_W U_{A,i1} U_{A,j1} - 3 i g_1 g_1' \cos\Theta'^2_W \sin\Theta_W U_{A,i1} U_{A,j1}$$
$$+ 18 i g_{1'}^2 \cos\Theta'_W \sin\Theta'_W U_{A,i1} U_{A,j1} - \frac{i}{2} g_2^2 \cos\Theta_W^2 \cos\Theta'_W \sin\Theta'_W U_{A,i1} U_{A,j1}$$
$$- i g_1 g_2 \cos\Theta_W \cos\Theta'_W \sin\Theta_W \sin\Theta'_W U_{A,i1} U_{A,j1}$$
$$- \frac{i}{2} g_1^2 \cos\Theta'_W \sin\Theta_W^2 \sin\Theta'_W U_{A,i1} U_{A,j1} + 3 i g_1' g_2 \cos\Theta_W \sin\Theta'^2_W U_{A,i1} U_{A,j1}$$
$$+ 3 i g_1 g_1' \sin\Theta_W \sin\Theta'^2_W U_{A,i1} U_{A,j1} + 2 i g_1' g_2 \cos\Theta_W \cos\Theta'^2_W U_{A,i2} U_{A,j2}$$
$$+ 2 i g_1 g_1' \cos\Theta'^2_W \sin\Theta_W U_{A,i2} U_{A,j2} - \frac{i}{2} g_2^2 \cos\Theta_W^2 \cos\Theta'_W \sin\Theta'_W U_{A,i2} U_{A,j2}$$

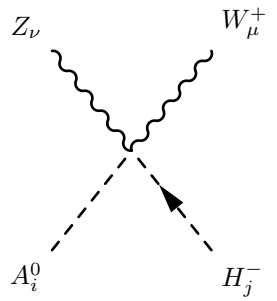
$$
\begin{aligned}
&- ig_1 g_2 \cos\Theta_W \cos\Theta'_W \sin\Theta_W \sin\Theta'_W U_{A,i2} U_{A,j2} \\
&- \frac{i}{2} g_1^2 \cos\Theta'_W \sin\Theta_W^2 \sin\Theta'_W U_{A,i2} U_{A,j2} - 2ig'_1 g_2 \cos\Theta_W \sin\Theta'^2_W U_{A,i2} U_{A,j2} \\
&- 2ig_1 g'_1 \sin\Theta_W \sin\Theta'^2_W U_{A,i2} U_{A,j2} + 4ig'^2_{1'} \sin 2\Theta'_W U_{A,i2} U_{A,j2} \\
&+ ig'^2_{1'} Q_S^2 \sin 2\Theta'_W U_{A,i3} U_{A,j3} + ig'^2_{1'} Q_S^2 \sin 2\Theta'_W U_{A,i4} U_{A,j4} \Big) \Big(g_{\mu\nu} \Big)
\end{aligned} \tag{640}
$$



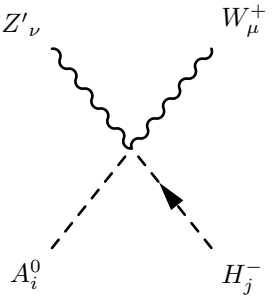
$$
\begin{aligned}
&\Big(+ 18ig'^2_{1'} \cos\Theta'^2_W U_{A,i1} U_{A,j1} + 6ig'_1 g_2 \cos\Theta_W \cos\Theta'_W \sin\Theta'_W U_{A,i1} U_{A,j1} \\
&+ 6ig_1 g'_1 \cos\Theta'_W \sin\Theta_W \sin\Theta'_W U_{A,i1} U_{A,j1} + \frac{i}{2} g_2^2 \cos\Theta_W^2 \sin\Theta'^2_W U_{A,i1} U_{A,j1} \\
&+ ig_1 g_2 \cos\Theta_W \sin\Theta_W \sin\Theta'^2_W U_{A,i1} U_{A,j1} + \frac{i}{2} g_1^2 \sin\Theta_W^2 \sin\Theta'^2_W U_{A,i1} U_{A,j1} \\
&+ 8ig'^2_{1'} \cos\Theta'^2_W U_{A,i2} U_{A,j2} - 4ig'_1 g_2 \cos\Theta_W \cos\Theta'_W \sin\Theta'_W U_{A,i2} U_{A,j2} \\
&- 4ig_1 g'_1 \cos\Theta'_W \sin\Theta_W \sin\Theta'_W U_{A,i2} U_{A,j2} + \frac{i}{2} g_2^2 \cos\Theta_W^2 \sin\Theta'^2_W U_{A,i2} U_{A,j2} \\
&+ ig_1 g_2 \cos\Theta_W \sin\Theta_W \sin\Theta'^2_W U_{A,i2} U_{A,j2} + \frac{i}{2} g_1^2 \sin\Theta_W^2 \sin\Theta'^2_W U_{A,i2} U_{A,j2} \\
&+ 2ig'^2_{1'} Q_S^2 \cos\Theta'^2_W U_{A,i3} U_{A,j3} + 2ig'^2_{1'} Q_S^2 \cos\Theta'^2_W U_{A,i4} U_{A,j4} \Big) \Big(g_{\mu\nu} \Big)
\end{aligned} \tag{641}
$$



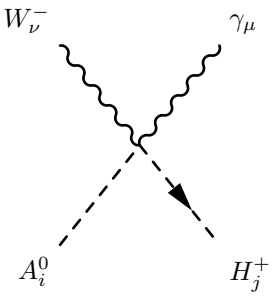
$$
\Big(- \frac{1}{2} g_1 g_2 U^*_{+,j1} \cos\Theta_W U_{A,i1} - \frac{1}{2} g_1 g_2 U^*_{+,j2} \cos\Theta_W U_{A,i2} \Big) \Big(g_{\mu\nu} \Big) \tag{642}
$$



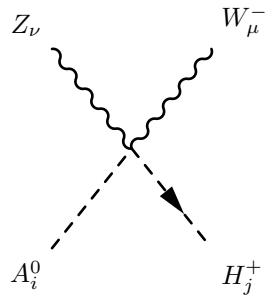
$$\Big(+ \frac{1}{2} g_1 g_2 U^*_{+,j1} \cos\Theta'_W \sin\Theta_W U_{A,i1} - 3 g'_1 g_2 U^*_{+,j1} \sin\Theta'_W U_{A,i1} + \frac{1}{2} g_1 g_2 U^*_{+,j2} \cos\Theta'_W \sin\Theta_W U_{A,i2} + 2 g'_1 g_2 U^*_{+,j2} \sin\Theta'_W U_{A,i2} \Big) \Big(g_{\mu\nu} \Big) \tag{643}$$



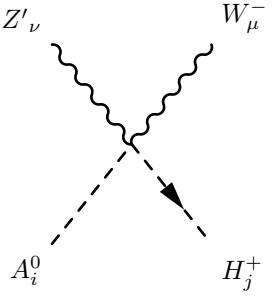
$$\Big(- 3 g'_1 g_2 U^*_{+,j1} \cos\Theta'_W U_{A,i1} - \frac{1}{2} g_1 g_2 U^*_{+,j1} \sin\Theta_W \sin\Theta'_W U_{A,i1} + 2 g'_1 g_2 U^*_{+,j2} \cos\Theta'_W U_{A,i2} - \frac{1}{2} g_1 g_2 U^*_{+,j2} \sin\Theta_W \sin\Theta'_W U_{A,i2} \Big) \Big(g_{\mu\nu} \Big) \tag{644}$$



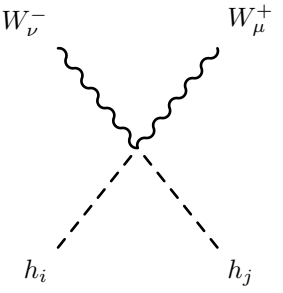
$$\Big(\frac{1}{2} g_1 g_2 \cos\Theta_W U_{A,i1} U_{+,j1} + \frac{1}{2} g_1 g_2 \cos\Theta_W U_{A,i2} U_{+,j2} \Big) \Big(g_{\mu\nu} \Big) \tag{645}$$



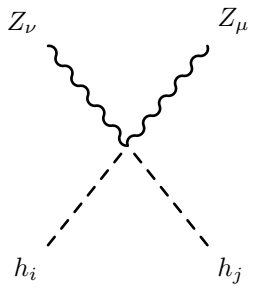
$$\Big(-\frac{1}{2} g_1 g_2 \cos\Theta'_W \sin\Theta_W U_{A,i1} U_{+,j1} + 3 g'_1 g_2 \sin\Theta'_W U_{A,i1} U_{+,j1} - \frac{1}{2} g_1 g_2 \cos\Theta'_W \sin\Theta_W U_{A,i2} U_{+,j2} - 2 g'_1 g_2 \sin\Theta'_W U_{A,i2} U_{+,j2} \Big) \Big(g_{\mu\nu} \Big) \tag{646}$$



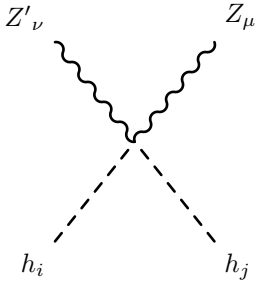
$$\Big(+3 g'_1 g_2 \cos\Theta'_W U_{A,i1} U_{+,j1} + \frac{1}{2} g_1 g_2 \sin\Theta_W \sin\Theta'_W U_{A,i1} U_{+,j1} - 2 g'_1 g_2 \cos\Theta'_W U_{A,i2} U_{+,j2} + \frac{1}{2} g_1 g_2 \sin\Theta_W \sin\Theta'_W U_{A,i2} U_{+,j2} \Big) \Big(g_{\mu\nu} \Big) \tag{647}$$



$$\Big(\frac{i}{2} g_2^2 U^*_{H,i1} U^*_{H,j1} + \frac{i}{2} g_2^2 U^*_{H,i2} U^*_{H,j2} \Big) \Big(g_{\mu\nu} \Big) \tag{648}$$

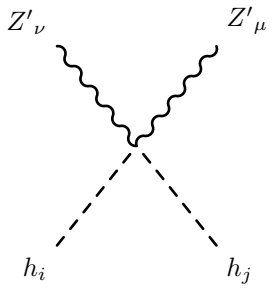


$$\Big(+ \frac{i}{2} g_2^2 U_{H,i1}^* U_{H,j1}^* \cos\Theta_W^2 \cos{\Theta'}_W^2 + \frac{i}{2} g_2^2 U_{H,i2}^* U_{H,j2}^* \cos\Theta_W^2 \cos{\Theta'}_W^2$$
$$+ i g_1 g_2 U_{H,i1}^* U_{H,j1}^* \cos\Theta_W \cos{\Theta'}_W^2 \sin\Theta_W$$
$$+ i g_1 g_2 U_{H,i2}^* U_{H,j2}^* \cos\Theta_W \cos{\Theta'}_W^2 \sin\Theta_W + \frac{i}{2} g_1^2 U_{H,i1}^* U_{H,j1}^* \cos{\Theta'}_W^2 \sin\Theta_W^2$$
$$+ \frac{i}{2} g_1^2 U_{H,i2}^* U_{H,j2}^* \cos{\Theta'}_W^2 \sin\Theta_W^2 - 6 i g_1' g_2 U_{H,i1}^* U_{H,j1}^* \cos\Theta_W \cos{\Theta'}_W \sin{\Theta'}_W$$
$$+ 4 i g_1' g_2 U_{H,i2}^* U_{H,j2}^* \cos\Theta_W \cos{\Theta'}_W \sin{\Theta'}_W$$
$$- 6 i g_1 g_1' U_{H,i1}^* U_{H,j1}^* \cos{\Theta'}_W \sin\Theta_W \sin{\Theta'}_W$$
$$+ 4 i g_1 g_1' U_{H,i2}^* U_{H,j2}^* \cos{\Theta'}_W \sin\Theta_W \sin{\Theta'}_W + 18 i g_{1'}^2 U_{H,i1}^* U_{H,j1}^* \sin{\Theta'}_W^2$$
$$+ 8 i g_{1'}^2 U_{H,i2}^* U_{H,j2}^* \sin{\Theta'}_W^2 + 2 i g_{1'}^2 Q_S^2 U_{H,i3}^* U_{H,j3}^* \sin{\Theta'}_W^2$$
$$+ 2 i g_{1'}^2 Q_S^2 U_{H,i4}^* U_{H,j4}^* \sin{\Theta'}_W^2 \Big) \Big(g_{\mu\nu} \Big) \tag{649}$$

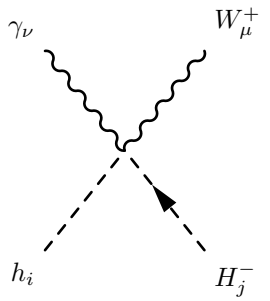


$$\Big(- 3 i g_1' g_2 U_{H,i1}^* U_{H,j1}^* \cos\Theta_W \cos{\Theta'}_W^2 + 2 i g_1' g_2 U_{H,i2}^* U_{H,j2}^* \cos\Theta_W \cos{\Theta'}_W^2$$
$$- 3 i g_1 g_1' U_{H,i1}^* U_{H,j1}^* \cos{\Theta'}_W^2 \sin\Theta_W + 2 i g_1 g_1' U_{H,i2}^* U_{H,j2}^* \cos{\Theta'}_W^2 \sin\Theta_W$$
$$+ 18 i g_{1'}^2 U_{H,i1}^* U_{H,j1}^* \cos{\Theta'}_W \sin{\Theta'}_W - \frac{i}{2} g_2^2 U_{H,i1}^* U_{H,j1}^* \cos\Theta_W^2 \cos{\Theta'}_W \sin{\Theta'}_W$$
$$- \frac{i}{2} g_2^2 U_{H,i2}^* U_{H,j2}^* \cos\Theta_W^2 \cos{\Theta'}_W \sin{\Theta'}_W$$

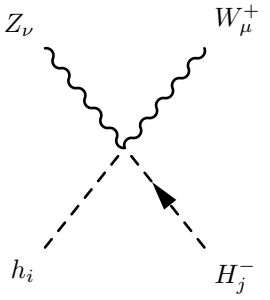
$$
\begin{aligned}
&- ig_1 g_2 U^*_{H,i1} U^*_{H,j1} \cos\Theta_W \cos\Theta'_W \sin\Theta_W \sin\Theta'_W \\
&- ig_1 g_2 U^*_{H,i2} U^*_{H,j2} \cos\Theta_W \cos\Theta'_W \sin\Theta_W \sin\Theta'_W \\
&- \frac{i}{2} g_1^2 U^*_{H,i1} U^*_{H,j1} \cos\Theta'_W \sin\Theta^2_W \sin\Theta'_W \\
&- \frac{i}{2} g_1^2 U^*_{H,i2} U^*_{H,j2} \cos\Theta'_W \sin\Theta^2_W \sin\Theta'_W + 3ig'_1 g_2 U^*_{H,i1} U^*_{H,j1} \cos\Theta_W \sin{\Theta'}^2_W \\
&- 2ig'_1 g_2 U^*_{H,i2} U^*_{H,j2} \cos\Theta_W \sin{\Theta'}^2_W + 3ig_1 g'_1 U^*_{H,i1} U^*_{H,j1} \sin\Theta_W \sin{\Theta'}^2_W \\
&- 2ig_1 g'_1 U^*_{H,i2} U^*_{H,j2} \sin\Theta_W \sin{\Theta'}^2_W + 4ig^2_{1'} U^*_{H,i2} U^*_{H,j2} \sin 2\Theta'_W \\
&+ ig^2_{1'} Q^2_S U^*_{H,i3} U^*_{H,j3} \sin 2\Theta'_W + ig^2_{1'} Q^2_S U^*_{H,i4} U^*_{H,j4} \sin 2\Theta'_W \Big) \Big(g_{\mu\nu} \Big)
\end{aligned} \tag{650}
$$



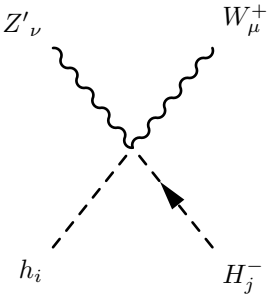
$$
\begin{aligned}
&\Big(+ 18ig^2_{1'} U^*_{H,i1} U^*_{H,j1} \cos{\Theta'}^2_W + 8ig^2_{1'} U^*_{H,i2} U^*_{H,j2} \cos{\Theta'}^2_W \\
&+ 2ig^2_{1'} Q^2_S U^*_{H,i3} U^*_{H,j3} \cos{\Theta'}^2_W + 2ig^2_{1'} Q^2_S U^*_{H,i4} U^*_{H,j4} \cos{\Theta'}^2_W \\
&+ 6ig'_1 g_2 U^*_{H,i1} U^*_{H,j1} \cos\Theta_W \cos\Theta'_W \sin\Theta'_W \\
&- 4ig'_1 g_2 U^*_{H,i2} U^*_{H,j2} \cos\Theta_W \cos\Theta'_W \sin\Theta'_W \\
&+ 6ig_1 g'_1 U^*_{H,i1} U^*_{H,j1} \cos\Theta'_W \sin\Theta_W \sin\Theta'_W \\
&- 4ig_1 g'_1 U^*_{H,i2} U^*_{H,j2} \cos\Theta'_W \sin\Theta_W \sin\Theta'_W + \frac{i}{2} g_2^2 U^*_{H,i1} U^*_{H,j1} \cos\Theta^2_W \sin{\Theta'}^2_W \\
&+ \frac{i}{2} g_2^2 U^*_{H,i2} U^*_{H,j2} \cos\Theta^2_W \sin{\Theta'}^2_W + ig_1 g_2 U^*_{H,i1} U^*_{H,j1} \cos\Theta_W \sin\Theta_W \sin{\Theta'}^2_W \\
&+ ig_1 g_2 U^*_{H,i2} U^*_{H,j2} \cos\Theta_W \sin\Theta_W \sin{\Theta'}^2_W + \frac{i}{2} g_1^2 U^*_{H,i1} U^*_{H,j1} \sin\Theta^2_W \sin{\Theta'}^2_W \\
&+ \frac{i}{2} g_1^2 U^*_{H,i2} U^*_{H,j2} \sin\Theta^2_W \sin{\Theta'}^2_W \Big) \Big(g_{\mu\nu} \Big)
\end{aligned} \tag{651}
$$



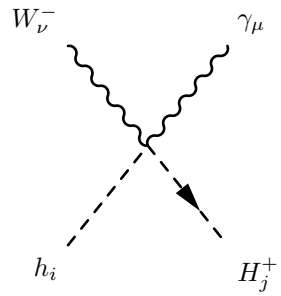
$$\Big(- \frac{i}{2} g_1 g_2 U^*_{H,i1} U^*_{+,j1} \cos\Theta_W + \frac{i}{2} g_1 g_2 U^*_{H,i2} U^*_{+,j2} \cos\Theta_W \Big) \Big(g_{\mu\nu} \Big) \tag{652}$$



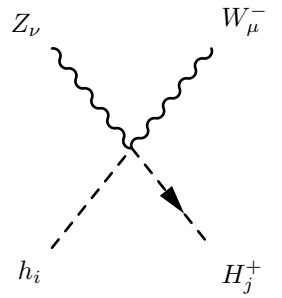
$$\begin{aligned} &\Big(+ \frac{i}{2} g_1 g_2 U^*_{H,i1} U^*_{+,j1} \cos\Theta'_W \sin\Theta_W - \frac{i}{2} g_1 g_2 U^*_{H,i2} U^*_{+,j2} \cos\Theta'_W \sin\Theta_W \\ &- 3 i g'_1 g_2 U^*_{H,i1} U^*_{+,j1} \sin\Theta'_W - 2 i g'_1 g_2 U^*_{H,i2} U^*_{+,j2} \sin\Theta'_W \Big) \Big(g_{\mu\nu} \Big) \end{aligned} \tag{653}$$



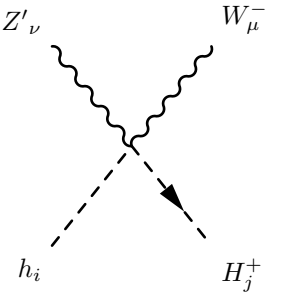
$$\begin{aligned} &\Big(- 3 i g'_1 g_2 U^*_{H,i1} U^*_{+,j1} \cos\Theta'_W - 2 i g'_1 g_2 U^*_{H,i2} U^*_{+,j2} \cos\Theta'_W \\ &- \frac{i}{2} g_1 g_2 U^*_{H,i1} U^*_{+,j1} \sin\Theta_W \sin\Theta'_W + \frac{i}{2} g_1 g_2 U^*_{H,i2} U^*_{+,j2} \sin\Theta_W \sin\Theta'_W \Big) \Big(g_{\mu\nu} \Big) \end{aligned} \tag{654}$$



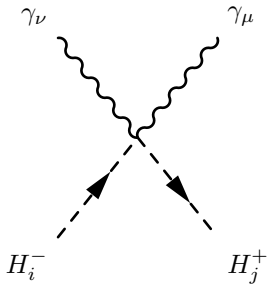
$$\Big(-\frac{i}{2} g_1 g_2 U^*_{H,i1} \cos\Theta_W U_{+,j1} + \frac{i}{2} g_1 g_2 U^*_{H,i2} \cos\Theta_W U_{+,j2} \Big) \Big(g_{\mu\nu} \Big) \tag{655}$$



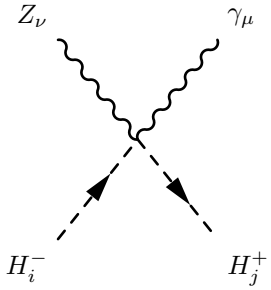
$$\begin{aligned} &\Big(+\frac{i}{2} g_1 g_2 U^*_{H,i1} \cos\Theta'_W \sin\Theta_W U_{+,j1} - 3 i g'_1 g_2 U^*_{H,i1} \sin\Theta'_W U_{+,j1} \\ &-\frac{i}{2} g_1 g_2 U^*_{H,i2} \cos\Theta'_W \sin\Theta_W U_{+,j2} - 2 i g'_1 g_2 U^*_{H,i2} \sin\Theta'_W U_{+,j2} \Big) \Big(g_{\mu\nu} \Big) \end{aligned} \tag{656}$$



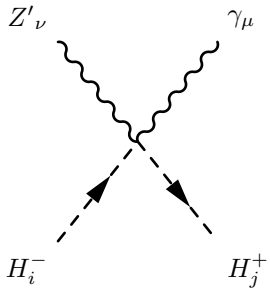
$$\begin{aligned} &\Big(-3 i g'_1 g_2 U^*_{H,i1} \cos\Theta'_W U_{+,j1} - \frac{i}{2} g_1 g_2 U^*_{H,i1} \sin\Theta_W \sin\Theta'_W U_{+,j1} \\ &-2 i g'_1 g_2 U^*_{H,i2} \cos\Theta'_W U_{+,j2} + \frac{i}{2} g_1 g_2 U^*_{H,i2} \sin\Theta_W \sin\Theta'_W U_{+,j2} \Big) \Big(g_{\mu\nu} \Big) \end{aligned} \tag{657}$$



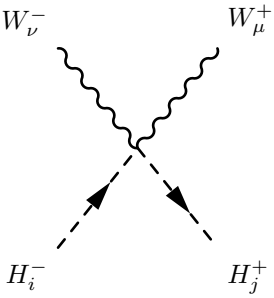
$$\Big(+ \frac{i}{2} g_1^2 U_{+,i1}^* \cos\Theta_W^2 U_{+,j1} + i g_1 g_2 U_{+,i1}^* \cos\Theta_W \sin\Theta_W U_{+,j1}$$
$$+ \frac{i}{2} g_2^2 U_{+,i1}^* \sin\Theta_W^2 U_{+,j1} + \frac{i}{2} g_1^2 U_{+,i2}^* \cos\Theta_W^2 U_{+,j2}$$
$$+ i g_1 g_2 U_{+,i2}^* \cos\Theta_W \sin\Theta_W U_{+,j2} + \frac{i}{2} g_2^2 U_{+,i2}^* \sin\Theta_W^2 U_{+,j2} \Big) \Big(g_{\mu\nu} \Big) \tag{658}$$



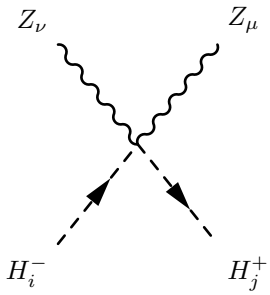
$$\Big(+ \frac{i}{2} g_1 g_2 U_{+,i1}^* \cos\Theta_W^2 \cos\Theta'_W U_{+,j1} - \frac{i}{2} g_1^2 U_{+,i1}^* \cos\Theta_W \cos\Theta'_W \sin\Theta_W U_{+,j1}$$
$$+ \frac{i}{2} g_2^2 U_{+,i1}^* \cos\Theta_W \cos\Theta'_W \sin\Theta_W U_{+,j1} - \frac{i}{2} g_1 g_2 U_{+,i1}^* \cos\Theta'_W \sin\Theta_W^2 U_{+,j1}$$
$$+ 3 i g_1 g'_1 U_{+,i1}^* \cos\Theta_W \sin\Theta'_W U_{+,j1} + 3 i g'_1 g_2 U_{+,i1}^* \sin\Theta_W \sin\Theta'_W U_{+,j1}$$
$$+ \frac{i}{2} g_1 g_2 U_{+,i2}^* \cos\Theta_W^2 \cos\Theta'_W U_{+,j2} - \frac{i}{2} g_1^2 U_{+,i2}^* \cos\Theta_W \cos\Theta'_W \sin\Theta_W U_{+,j2}$$
$$+ \frac{i}{2} g_2^2 U_{+,i2}^* \cos\Theta_W \cos\Theta'_W \sin\Theta_W U_{+,j2} - \frac{i}{2} g_1 g_2 U_{+,i2}^* \cos\Theta'_W \sin\Theta_W^2 U_{+,j2}$$
$$- 2 i g_1 g'_1 U_{+,i2}^* \cos\Theta_W \sin\Theta'_W U_{+,j2} - 2 i g'_1 g_2 U_{+,i2}^* \sin\Theta_W \sin\Theta'_W U_{+,j2} \Big) \Big(g_{\mu\nu} \Big) \tag{659}$$



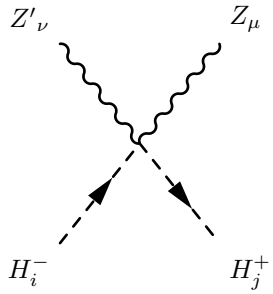
$$\Big(+ 3ig_1 g_1' U_{+,i1}^* \cos\Theta_W \cos\Theta'_W U_{+,j1} + 3ig_1' g_2 U_{+,i1}^* \cos\Theta'_W \sin\Theta_W U_{+,j1}$$
$$- \frac{i}{2} g_1 g_2 U_{+,i1}^* \cos\Theta_W^2 \sin\Theta'_W U_{+,j1} + \frac{i}{2} g_1^2 U_{+,i1}^* \cos\Theta_W \sin\Theta_W \sin\Theta'_W U_{+,j1}$$
$$- \frac{i}{2} g_2^2 U_{+,i1}^* \cos\Theta_W \sin\Theta_W \sin\Theta'_W U_{+,j1} + \frac{i}{2} g_1 g_2 U_{+,i1}^* \sin\Theta_W^2 \sin\Theta'_W U_{+,j1}$$
$$- 2ig_1 g_1' U_{+,i2}^* \cos\Theta_W \cos\Theta'_W U_{+,j2} - 2ig_1' g_2 U_{+,i2}^* \cos\Theta'_W \sin\Theta_W U_{+,j2}$$
$$- \frac{i}{2} g_1 g_2 U_{+,i2}^* \cos\Theta_W^2 \sin\Theta'_W U_{+,j2} + \frac{i}{2} g_1^2 U_{+,i2}^* \cos\Theta_W \sin\Theta_W \sin\Theta'_W U_{+,j2}$$
$$- \frac{i}{2} g_2^2 U_{+,i2}^* \cos\Theta_W \sin\Theta_W \sin\Theta'_W U_{+,j2} + \frac{i}{2} g_1 g_2 U_{+,i2}^* \sin\Theta_W^2 \sin\Theta'_W U_{+,j2} \Big) \Big(g_{\mu\nu} \Big) \tag{660}$$



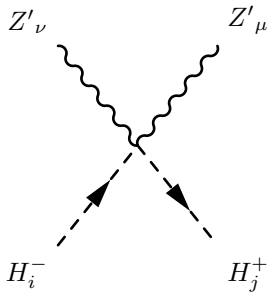
$$\Big(\frac{i}{2} g_2^2 U_{+,i1}^* U_{+,j1} + \frac{i}{2} g_2^2 U_{+,i2}^* U_{+,j2} \Big) \Big(g_{\mu\nu} \Big) \tag{661}$$



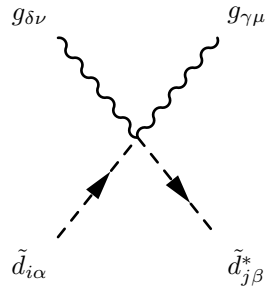
$$\Big(+ \frac{i}{2} g_2^2 U_{+,i1}^* \cos\Theta_W^2 \cos\Theta'^2_W U_{+,j1} - i g_1 g_2 U_{+,i1}^* \cos\Theta_W \cos\Theta'^2_W \sin\Theta_W U_{+,j1}$$
$$+ \frac{i}{2} g_1^2 U_{+,i1}^* \cos\Theta'^2_W \sin\Theta_W^2 U_{+,j1} + 6 i g_1' g_2 U_{+,i1}^* \cos\Theta_W \cos\Theta'_W \sin\Theta'_W U_{+,j1}$$
$$- 6 i g_1 g_1' U_{+,i1}^* \cos\Theta'_W \sin\Theta_W \sin\Theta'_W U_{+,j1} + 18 i g_{1'}^2 U_{+,i1}^* \sin\Theta'^2_W U_{+,j1}$$
$$+ \frac{i}{2} g_2^2 U_{+,i2}^* \cos\Theta_W^2 \cos\Theta'^2_W U_{+,j2} - i g_1 g_2 U_{+,i2}^* \cos\Theta_W \cos\Theta'^2_W \sin\Theta_W U_{+,j2}$$
$$+ \frac{i}{2} g_1^2 U_{+,i2}^* \cos\Theta'^2_W \sin\Theta_W^2 U_{+,j2} - 4 i g_1' g_2 U_{+,i2}^* \cos\Theta_W \cos\Theta'_W \sin\Theta'_W U_{+,j2}$$
$$+ 4 i g_1 g_1' U_{+,i2}^* \cos\Theta'_W \sin\Theta_W \sin\Theta'_W U_{+,j2} + 8 i g_{1'}^2 U_{+,i2}^* \sin\Theta'^2_W U_{+,j2} \Big) \Big(g_{\mu\nu} \Big) \tag{662}$$



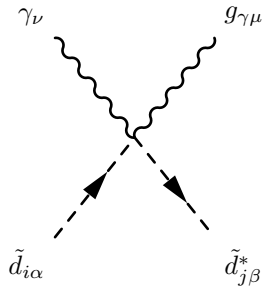
$$\Big(+ 3 i g_1' g_2 U_{+,i1}^* \cos\Theta_W \cos\Theta'^2_W U_{+,j1} - 3 i g_1 g_1' U_{+,i1}^* \cos\Theta'^2_W \sin\Theta_W U_{+,j1}$$
$$+ 18 i g_{1'}^2 U_{+,i1}^* \cos\Theta'_W \sin\Theta'_W U_{+,j1} - \frac{i}{2} g_2^2 U_{+,i1}^* \cos\Theta_W^2 \cos\Theta'_W \sin\Theta'_W U_{+,j1}$$
$$+ i g_1 g_2 U_{+,i1}^* \cos\Theta_W \cos\Theta'_W \sin\Theta_W \sin\Theta'_W U_{+,j1}$$
$$- \frac{i}{2} g_1^2 U_{+,i1}^* \cos\Theta'_W \sin\Theta_W^2 \sin\Theta'_W U_{+,j1} - 3 i g_1' g_2 U_{+,i1}^* \cos\Theta_W \sin\Theta'^2_W U_{+,j1}$$
$$+ 3 i g_1 g_1' U_{+,i1}^* \sin\Theta_W \sin\Theta'^2_W U_{+,j1} - 2 i g_1' g_2 U_{+,i2}^* \cos\Theta_W \cos\Theta'^2_W U_{+,j2}$$
$$+ 2 i g_1 g_1' U_{+,i2}^* \cos\Theta'^2_W \sin\Theta_W U_{+,j2} - \frac{i}{2} g_2^2 U_{+,i2}^* \cos\Theta_W^2 \cos\Theta'_W \sin\Theta'_W U_{+,j2}$$
$$+ i g_1 g_2 U_{+,i2}^* \cos\Theta_W \cos\Theta'_W \sin\Theta_W \sin\Theta'_W U_{+,j2}$$
$$- \frac{i}{2} g_1^2 U_{+,i2}^* \cos\Theta'_W \sin\Theta_W^2 \sin\Theta'_W U_{+,j2} + 2 i g_1' g_2 U_{+,i2}^* \cos\Theta_W \sin\Theta'^2_W U_{+,j2}$$
$$- 2 i g_1 g_1' U_{+,i2}^* \sin\Theta_W \sin\Theta'^2_W U_{+,j2} + 4 i g_{1'}^2 U_{+,i2}^* \sin 2\Theta'_W U_{+,j2} \Big) \Big(g_{\mu\nu} \Big) \tag{663}$$



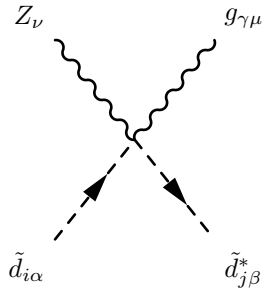
$$\Big(+ 18ig_{1'}^2 U_{+,i1}^* \cos\Theta'^2_W U_{+,j1} - 6ig_1' g_2 U_{+,i1}^* \cos\Theta_W \cos\Theta'_W \sin\Theta'_W U_{+,j1}$$
$$+ 6ig_1 g_1' U_{+,i1}^* \cos\Theta'_W \sin\Theta_W \sin\Theta'_W U_{+,j1} + \frac{i}{2} g_2^2 U_{+,i1}^* \cos\Theta_W^2 \sin\Theta'^2_W U_{+,j1}$$
$$- ig_1 g_2 U_{+,i1}^* \cos\Theta_W \sin\Theta_W \sin\Theta'^2_W U_{+,j1} + \frac{i}{2} g_1^2 U_{+,i1}^* \sin\Theta_W^2 \sin\Theta'^2_W U_{+,j1}$$
$$+ 8ig_{1'}^2 U_{+,i2}^* \cos\Theta'^2_W U_{+,j2} + 4ig_1' g_2 U_{+,i2}^* \cos\Theta_W \cos\Theta'_W \sin\Theta'_W U_{+,j2}$$
$$- 4ig_1 g_1' U_{+,i2}^* \cos\Theta'_W \sin\Theta_W \sin\Theta'_W U_{+,j2} + \frac{i}{2} g_2^2 U_{+,i2}^* \cos\Theta_W^2 \sin\Theta'^2_W U_{+,j2}$$
$$- ig_1 g_2 U_{+,i2}^* \cos\Theta_W \sin\Theta_W \sin\Theta'^2_W U_{+,j2} + \frac{i}{2} g_1^2 U_{+,i2}^* \sin\Theta_W^2 \sin\Theta'^2_W U_{+,j2} \Big) \Big(g_{\mu\nu} \Big) \tag{664}$$



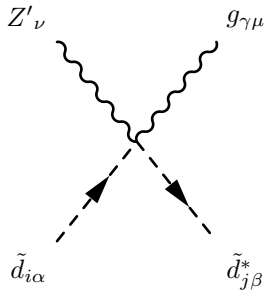
$$\Big(\frac{i}{4} g_3^2 \delta_{ij} \sum_{a=1}^{3} \lambda^\gamma_{a,\alpha} \lambda^\delta_{\beta,a} + \frac{i}{4} g_3^2 \delta_{ij} \sum_{a=1}^{3} \lambda^\gamma_{\beta,a} \lambda^\delta_{a,\alpha} \Big) \Big(g_{\mu\nu} \Big) \tag{665}$$



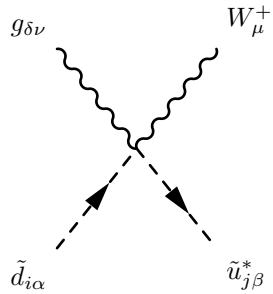
$$\Big(+ \frac{i}{6} g_1 g_3 \cos\Theta_W \lambda^\gamma_{\beta,\alpha} \sum_{a=1}^{3} Z^{D,*}_{ia} Z^D_{ja} - \frac{i}{2} g_2 g_3 \lambda^\gamma_{\beta,\alpha} \sin\Theta_W \sum_{a=1}^{3} Z^{D,*}_{ia} Z^D_{ja}$$
$$- \frac{i}{3} g_1 g_3 \cos\Theta_W \lambda^\gamma_{\beta,\alpha} \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^D_{j3+a} \Big) \Big(g_{\mu\nu} \Big) \tag{666}$$



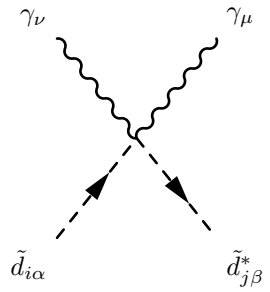
$$\Big(- \frac{i}{2} g_2 g_3 \cos\Theta_W \cos\Theta'_W \lambda^\gamma_{\beta,\alpha} \sum_{a=1}^{3} Z^{D,*}_{ia} Z^D_{ja}$$
$$- \frac{i}{6} g_1 g_3 \cos\Theta'_W \lambda^\gamma_{\beta,\alpha} \sin\Theta_W \sum_{a=1}^{3} Z^{D,*}_{ia} Z^D_{ja} + i g'_1 g_3 \lambda^\gamma_{\beta,\alpha} \sin\Theta'_W \sum_{a=1}^{3} Z^{D,*}_{ia} Z^D_{ja}$$
$$+ \frac{i}{3} g_1 g_3 \cos\Theta'_W \lambda^\gamma_{\beta,\alpha} \sin\Theta_W \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^D_{j3+a} - 2 i g'_1 g_3 \lambda^\gamma_{\beta,\alpha} \sin\Theta'_W \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^D_{j3+a} \Big) \Big(g_{\mu\nu} \Big) \tag{667}$$



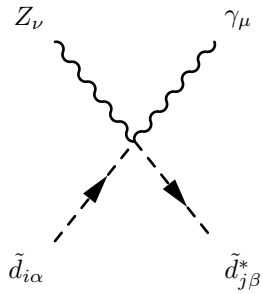
$$\Big(+ ig_1' g_3 \cos\Theta'_W \lambda^\gamma_{\beta,\alpha} \sum_{a=1}^{3} Z^{D,*}_{ia} Z^D_{ja} + \frac{i}{2} g_2 g_3 \cos\Theta_W \lambda^\gamma_{\beta,\alpha} \sin\Theta'_W \sum_{a=1}^{3} Z^{D,*}_{ia} Z^D_{ja}$$
$$+ \frac{i}{6} g_1 g_3 \lambda^\gamma_{\beta,\alpha} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{D,*}_{ia} Z^D_{ja} - 2ig_1' g_3 \cos\Theta'_W \lambda^\gamma_{\beta,\alpha} \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^D_{j3+a}$$
$$- \frac{i}{3} g_1 g_3 \lambda^\gamma_{\beta,\alpha} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^D_{j3+a} \Big) \Big(g_{\mu\nu} \Big) \tag{668}$$



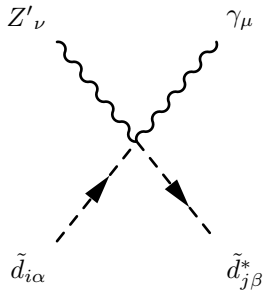
$$i \frac{1}{\sqrt{2}} g_2 g_3 \lambda^\delta_{\beta,\alpha} \sum_{a=1}^{3} Z^{D,*}_{ia} Z^U_{ja} \Big(g_{\mu\nu} \Big) \tag{669}$$



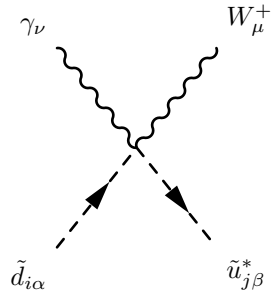
$$\Big(+ \frac{i}{18} g_1^2 \cos\Theta_W^2 \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D} - \frac{i}{3} g_1 g_2 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}$$
$$+ \frac{i}{2} g_2^2 \delta_{\alpha\beta} \sin\Theta_W^2 \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D} + \frac{2i}{9} g_1^2 \cos\Theta_W^2 \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{i3+a}^{D,*} Z_{j3+a}^{D} \Big) \Big(g_{\mu\nu} \Big) \tag{670}$$



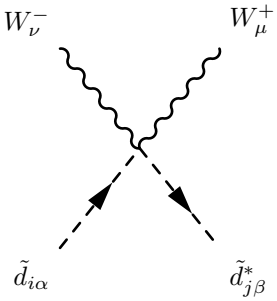
$$\Big(- \frac{i}{6} g_1 g_2 \cos\Theta_W^2 \cos\Theta'_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}$$
$$- \frac{i}{18} g_1^2 \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}$$
$$+ \frac{i}{2} g_2^2 \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}$$
$$+ \frac{i}{6} g_1 g_2 \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W^2 \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}$$
$$+ \frac{i}{3} g_1 g'_1 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}$$
$$- i g'_1 g_2 \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}$$
$$- \frac{2i}{9} g_1^2 \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z_{i3+a}^{D,*} Z_{j3+a}^{D}$$
$$+ \frac{4i}{3} g_1 g'_1 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z_{i3+a}^{D,*} Z_{j3+a}^{D} \Big) \Big(g_{\mu\nu} \Big) \tag{671}$$



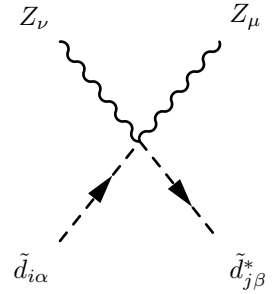
$$\Big(+ \frac{i}{3} g_1 g_1' \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}$$
$$- i g_1' g_2 \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}$$
$$+ \frac{i}{6} g_1 g_2 \cos\Theta_W^2 \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}$$
$$+ \frac{i}{18} g_1^2 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}$$
$$- \frac{i}{2} g_2^2 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}$$
$$- \frac{i}{6} g_1 g_2 \delta_{\alpha\beta} \sin\Theta_W^2 \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}$$
$$+ \frac{4i}{3} g_1 g_1' \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{i3+a}^{D,*} Z_{j3+a}^{D}$$
$$+ \frac{2i}{9} g_1^2 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{i3+a}^{D,*} Z_{j3+a}^{D} \Big) \Big(g_{\mu\nu} \Big) \tag{672}$$



$$\frac{i}{3}\frac{1}{\sqrt{2}}g_1 g_2 \cos\Theta_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{U} \Big(g_{\mu\nu} \Big) \tag{673}$$

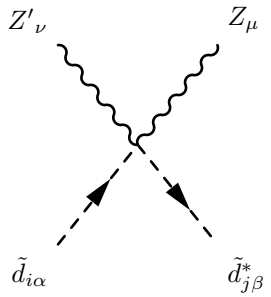


$$\frac{i}{2}g_2^2 \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D} \Big(g_{\mu\nu} \Big) \tag{674}$$



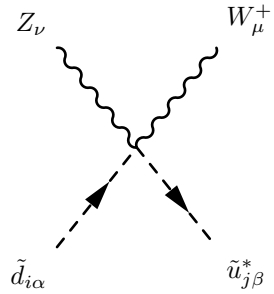
$$\begin{aligned}
\Big(&+ \frac{i}{2}g_2^2 \cos\Theta_W^2 \cos{\Theta'}_W^2 \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D} \\
&+ \frac{i}{3}g_1 g_2 \cos\Theta_W \cos{\Theta'}_W^2 \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D} \\
&+ \frac{i}{18}g_1^2 \cos{\Theta'}_W^2 \delta_{\alpha\beta} \sin\Theta_W^2 \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D} \\
&- 2ig_1' g_2 \cos\Theta_W \cos{\Theta'}_W \delta_{\alpha\beta} \sin{\Theta'}_W \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D} \\
&- \frac{2i}{3}g_1 g_1' \cos{\Theta'}_W \delta_{\alpha\beta} \sin\Theta_W \sin{\Theta'}_W \sum_{a=1}^{3} Z_{ia}^{D,*} Z_{ja}^{D}
\end{aligned}$$

$$+ 2ig_{1'}^2\delta_{\alpha\beta}\sin\Theta'^2_W\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ja}^{D} + \frac{2i}{9}g_1^2\cos\Theta'^2_W\delta_{\alpha\beta}\sin\Theta_W^2\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{j3+a}^{D}$$
$$- \frac{8i}{3}g_1g_1'\cos\Theta'_W\delta_{\alpha\beta}\sin\Theta_W\sin\Theta'_W\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{j3+a}^{D}$$
$$+ 8ig_{1'}^2\delta_{\alpha\beta}\sin\Theta'^2_W\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{j3+a}^{D}\Big)\Big(g_{\mu\nu}\Big) \tag{675}$$

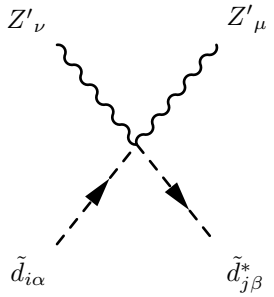


$$\Big(-ig_1'g_2\cos\Theta_W\cos\Theta'^2_W\delta_{\alpha\beta}\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ja}^{D}$$
$$- \frac{i}{3}g_1g_1'\cos\Theta'^2_W\delta_{\alpha\beta}\sin\Theta_W\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ja}^{D}$$
$$+ 2ig_{1'}^2\cos\Theta'_W\delta_{\alpha\beta}\sin\Theta'_W\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ja}^{D}$$
$$- \frac{i}{2}g_2^2\cos\Theta_W^2\cos\Theta'_W\delta_{\alpha\beta}\sin\Theta'_W\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ja}^{D}$$
$$- \frac{i}{3}g_1g_2\cos\Theta_W\cos\Theta'_W\delta_{\alpha\beta}\sin\Theta_W\sin\Theta'_W\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ja}^{D}$$
$$- \frac{i}{18}g_1^2\cos\Theta'_W\delta_{\alpha\beta}\sin\Theta_W^2\sin\Theta'_W\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ja}^{D}$$
$$+ ig_1'g_2\cos\Theta_W\delta_{\alpha\beta}\sin\Theta'^2_W\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ja}^{D}$$
$$+ \frac{i}{3}g_1g_1'\delta_{\alpha\beta}\sin\Theta_W\sin\Theta'^2_W\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ja}^{D}$$
$$- \frac{4i}{3}g_1g_1'\cos\Theta'^2_W\delta_{\alpha\beta}\sin\Theta_W\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{j3+a}^{D}$$

$$- \frac{2i}{9} g_1^2 \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W^2 \sin\Theta'_W \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{j3+a}$$
$$+ \frac{4i}{3} g_1 g_1' \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'^2_W \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{j3+a} + 4i g_{1'}^2 \delta_{\alpha\beta} \sin 2\Theta'_W \sum_{a=1}^{3} Z^{D,*}_{i3+a} Z^{D}_{j3+a} \Big) \Big(g_{\mu\nu} \Big) \tag{676}$$

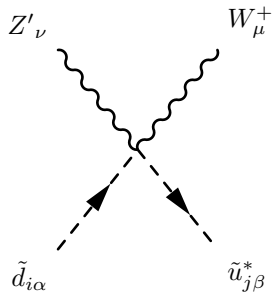


$$\Big(- \frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{U}_{ja} + i\sqrt{2} g_1' g_2 \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{U}_{ja} \Big) \Big(g_{\mu\nu} \Big) \tag{677}$$

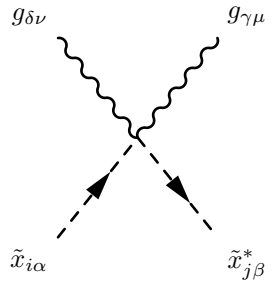


$$\Big(+ 2i g_{1'}^2 \cos\Theta'^2_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ja} + 2i g_1' g_2 \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ja}$$
$$+ \frac{2i}{3} g_1 g_1' \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ja}$$
$$+ \frac{i}{2} g_2^2 \cos\Theta_W^2 \delta_{\alpha\beta} \sin\Theta'^2_W \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ja}$$
$$+ \frac{i}{3} g_1 g_2 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'^2_W \sum_{a=1}^{3} Z^{D,*}_{ia} Z^{D}_{ja}$$

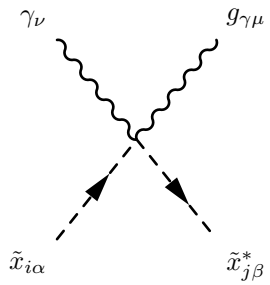
$$+\frac{i}{18}g_1^2\delta_{\alpha\beta}\sin\Theta_W^2\sin\Theta'^2_W\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ja}^{D}+8ig_{1'}^2\cos\Theta'^2_W\delta_{\alpha\beta}\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{j3+a}^{D}$$
$$+\frac{8i}{3}g_1g_1'\cos\Theta'_W\delta_{\alpha\beta}\sin\Theta_W\sin\Theta'_W\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{j3+a}^{D}$$
$$+\frac{2i}{9}g_1^2\delta_{\alpha\beta}\sin\Theta_W^2\sin\Theta'^2_W\sum_{a=1}^{3}Z_{i3+a}^{D,*}Z_{j3+a}^{D}\Big)\Big(g_{\mu\nu}\Big) \tag{678}$$



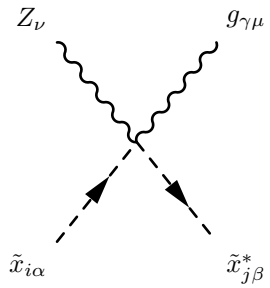
$$\Big(\frac{i}{3}\frac{1}{\sqrt{2}}g_1g_2\delta_{\alpha\beta}\sin\Theta_W\sin\Theta'_W\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ja}^{U}+i\sqrt{2}g_1'g_2\cos\Theta'_W\delta_{\alpha\beta}\sum_{a=1}^{3}Z_{ia}^{D,*}Z_{ja}^{U}\Big)\Big(g_{\mu\nu}\Big) \tag{679}$$



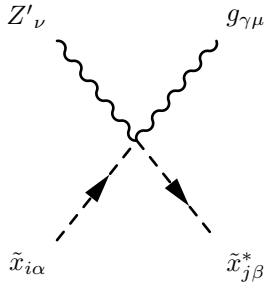
$$\Big(\frac{i}{4}g_3^2\delta_{ij}\sum_{a=1}^{3}\lambda^{\gamma}_{a,\alpha}\lambda^{\delta}_{\beta,a}+\frac{i}{4}g_3^2\delta_{ij}\sum_{a=1}^{3}\lambda^{\gamma}_{\beta,a}\lambda^{\delta}_{a,\alpha}\Big)\Big(g_{\mu\nu}\Big) \tag{680}$$



$$-\frac{i}{3}g_1 g_3 \cos\Theta_W \delta_{ij} \lambda^{\gamma}_{\beta,\alpha}\Big(g_{\mu\nu}\Big) \tag{681}$$

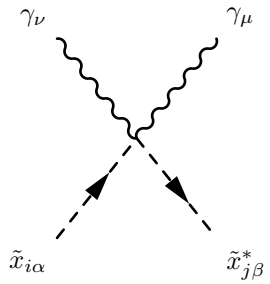


$$\begin{aligned}\Big(&+\frac{i}{3}g_1 g_3 \cos\Theta'_W \lambda^{\gamma}_{\beta,\alpha} \sin\Theta_W \sum_{a=1}^{3} Z^{Dx,*}_{ia} Z^{Dx}_{ja} - 2ig'_1 g_3 \lambda^{\gamma}_{\beta,\alpha} \sin\Theta'_W \sum_{a=1}^{3} Z^{Dx,*}_{ia} Z^{Dx}_{ja} \\ &+\frac{i}{3}g_1 g_3 \cos\Theta'_W \lambda^{\gamma}_{\beta,\alpha} \sin\Theta_W \sum_{a=1}^{3} Z^{Dx,*}_{i3+a} Z^{Dx}_{j3+a} + 3ig'_1 g_3 \lambda^{\gamma}_{\beta,\alpha} \sin\Theta'_W \sum_{a=1}^{3} Z^{Dx,*}_{i3+a} Z^{Dx}_{j3+a}\Big)\Big(g_{\mu\nu}\Big)\end{aligned} \tag{682}$$

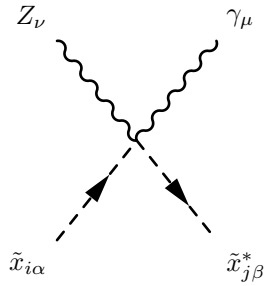


$$\Big(-2ig'_1 g_3 \cos\Theta'_W \lambda^{\gamma}_{\beta,\alpha} \sum_{a=1}^{3} Z^{Dx,*}_{ia} Z^{Dx}_{ja} - \frac{i}{3}g_1 g_3 \lambda^{\gamma}_{\beta,\alpha} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{Dx,*}_{ia} Z^{Dx}_{ja}$$

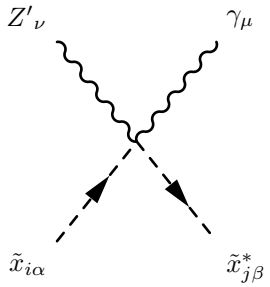
$$+ 3ig_1' g_3 \cos\Theta'_W \lambda^{\gamma}_{\beta,\alpha} \sum_{a=1}^{3} Z^{Dx,*}_{i3+a} Z^{Dx}_{j3+a} - \frac{i}{3} g_1 g_3 \lambda^{\gamma}_{\beta,\alpha} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{Dx,*}_{i3+a} Z^{Dx}_{j3+a} \Big) \Big(g_{\mu\nu} \Big) \tag{683}$$



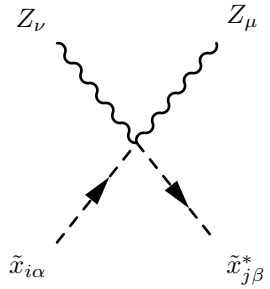
$$\frac{2i}{9} g_1^2 \cos\Theta_W^2 \delta_{\alpha\beta} \delta_{ij} \Big(g_{\mu\nu} \Big) \tag{684}$$



$$\begin{aligned}
&\Big(- \frac{2i}{9} g_1^2 \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z^{Dx,*}_{ia} Z^{Dx}_{ja} \\
&+ \frac{4i}{3} g_1 g_1' \cos\Theta_W \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z^{Dx,*}_{ia} Z^{Dx}_{ja} \\
&- \frac{2i}{9} g_1^2 \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z^{Dx,*}_{i3+a} Z^{Dx}_{j3+a} \\
&- 2ig_1 g_1' \cos\Theta_W \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z^{Dx,*}_{i3+a} Z^{Dx}_{j3+a} \Big) \Big(g_{\mu\nu} \Big)
\end{aligned} \tag{685}$$

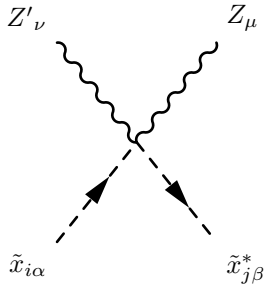


$$\Big(+ \frac{4i}{3} g_1 g_1' \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ja}^{Dx}$$
$$+ \frac{2i}{9} g_1^2 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ja}^{Dx}$$
$$- 2i g_1 g_1' \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{j3+a}^{Dx}$$
$$+ \frac{2i}{9} g_1^2 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{j3+a}^{Dx} \Big) \Big(g_{\mu\nu} \Big) \tag{686}$$

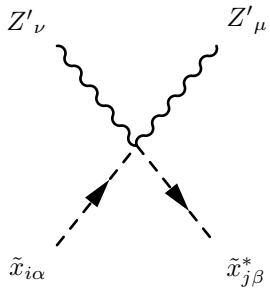


$$\Big(+ \frac{2i}{9} g_1^2 \cos\Theta'^2_W \delta_{\alpha\beta} \sin\Theta^2_W \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ja}^{Dx}$$
$$- \frac{8i}{3} g_1 g_1' \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ja}^{Dx}$$
$$+ 8i g_{1'}^2 \delta_{\alpha\beta} \sin\Theta'^2_W \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ja}^{Dx} + \frac{2i}{9} g_1^2 \cos\Theta'^2_W \delta_{\alpha\beta} \sin\Theta^2_W \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{j3+a}^{Dx}$$
$$+ 4i g_1 g_1' \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{j3+a}^{Dx}$$

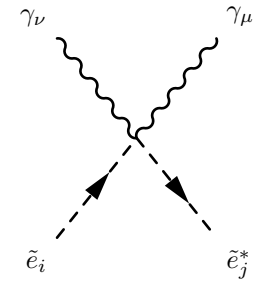
$$+ 18ig_{1'}^2\delta_{\alpha\beta}\sin\Theta'^2_W\sum_{a=1}^{3}Z^{Dx,*}_{i3+a}Z^{Dx}_{j3+a}\Big)\Big(g_{\mu\nu}\Big) \tag{687}$$



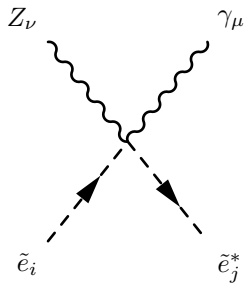
$$\Big(-\frac{4i}{3}g_1g'_1\cos\Theta'^2_W\delta_{\alpha\beta}\sin\Theta_W\sum_{a=1}^{3}Z^{Dx,*}_{ia}Z^{Dx}_{ja}$$
$$+ 8ig_{1'}^2\cos\Theta'_W\delta_{\alpha\beta}\sin\Theta'_W\sum_{a=1}^{3}Z^{Dx,*}_{ia}Z^{Dx}_{ja}$$
$$-\frac{2i}{9}g_1^2\cos\Theta'_W\delta_{\alpha\beta}\sin\Theta^2_W\sin\Theta'_W\sum_{a=1}^{3}Z^{Dx,*}_{ia}Z^{Dx}_{ja}$$
$$+\frac{4i}{3}g_1g'_1\delta_{\alpha\beta}\sin\Theta_W\sin\Theta'^2_W\sum_{a=1}^{3}Z^{Dx,*}_{ia}Z^{Dx}_{ja}$$
$$+ 2ig_1g'_1\cos\Theta'^2_W\delta_{\alpha\beta}\sin\Theta_W\sum_{a=1}^{3}Z^{Dx,*}_{i3+a}Z^{Dx}_{j3+a}$$
$$+ 18ig_{1'}^2\cos\Theta'_W\delta_{\alpha\beta}\sin\Theta'_W\sum_{a=1}^{3}Z^{Dx,*}_{i3+a}Z^{Dx}_{j3+a}$$
$$-\frac{2i}{9}g_1^2\cos\Theta'_W\delta_{\alpha\beta}\sin\Theta^2_W\sin\Theta'_W\sum_{a=1}^{3}Z^{Dx,*}_{i3+a}Z^{Dx}_{j3+a}$$
$$- 2ig_1g'_1\delta_{\alpha\beta}\sin\Theta_W\sin\Theta'^2_W\sum_{a=1}^{3}Z^{Dx,*}_{i3+a}Z^{Dx}_{j3+a}\Big)\Big(g_{\mu\nu}\Big) \tag{688}$$



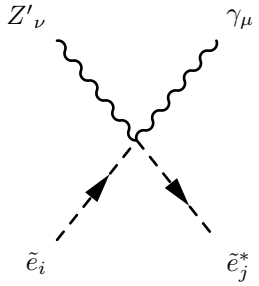
$$\Big(+ 8ig_{1'}^2 \cos\Theta'^2_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ja}^{Dx} + \frac{8i}{3} g_1 g'_1 \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ja}^{Dx}$$
$$+ \frac{2i}{9} g_1^2 \delta_{\alpha\beta} \sin\Theta_W^2 \sin\Theta'^2_W \sum_{a=1}^{3} Z_{ia}^{Dx,*} Z_{ja}^{Dx} + 18ig_{1'}^2 \cos\Theta'^2_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{j3+a}^{Dx}$$
$$- 4ig_1 g'_1 \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{j3+a}^{Dx}$$
$$+ \frac{2i}{9} g_1^2 \delta_{\alpha\beta} \sin\Theta_W^2 \sin\Theta'^2_W \sum_{a=1}^{3} Z_{i3+a}^{Dx,*} Z_{j3+a}^{Dx} \Big) \Big(g_{\mu\nu} \Big) \tag{689}$$



$$\Big(+ \frac{i}{2} g_1^2 \cos\Theta_W^2 \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} + ig_1 g_2 \cos\Theta_W \sin\Theta_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E}$$
$$+ \frac{i}{2} g_2^2 \sin\Theta_W^2 \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} + 2ig_1^2 \cos\Theta_W^2 \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{j3+a}^{E} \Big) \Big(g_{\mu\nu} \Big) \tag{690}$$

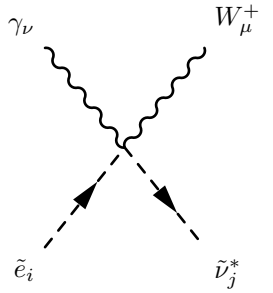


$$\Big(+ \frac{i}{2} g_1 g_2 \cos\Theta_W^2 \cos\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E}$$
$$- \frac{i}{2} g_1^2 \cos\Theta_W \cos\Theta'_W \sin\Theta_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E}$$
$$+ \frac{i}{2} g_2^2 \cos\Theta_W \cos\Theta'_W \sin\Theta_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E}$$
$$- \frac{i}{2} g_1 g_2 \cos\Theta'_W \sin\Theta_W^2 \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} - 2i g_1 g'_1 \cos\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E}$$
$$- 2i g'_1 g_2 \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E}$$
$$- 2i g_1^2 \cos\Theta_W \cos\Theta'_W \sin\Theta_W \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{j3+a}^{E}$$
$$+ 2i g_1 g'_1 \cos\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{j3+a}^{E} \Big) \Big(g_{\mu\nu} \Big) \tag{691}$$

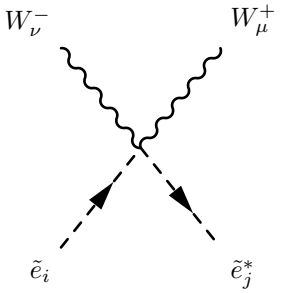


$$\Big(- 2i g_1 g'_1 \cos\Theta_W \cos\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} - 2i g'_1 g_2 \cos\Theta'_W \sin\Theta_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E}$$

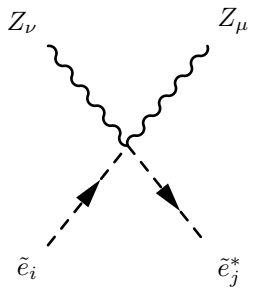
$$
\begin{aligned}
&- \frac{i}{2} g_1 g_2 \cos\Theta_W^2 \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} \\
&+ \frac{i}{2} g_1^2 \cos\Theta_W \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} \\
&- \frac{i}{2} g_2^2 \cos\Theta_W \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} \\
&+ \frac{i}{2} g_1 g_2 \sin\Theta_W^2 \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} + 2i g_1 g_1' \cos\Theta_W \cos\Theta'_W \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{j3+a}^{E} \\
&+ 2i g_1^2 \cos\Theta_W \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{j3+a}^{E} \Big) \Big(g_{\mu\nu} \Big)
\end{aligned}
\tag{692}
$$



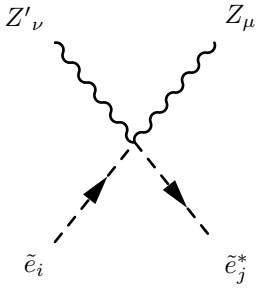
$$
- i \frac{1}{\sqrt{2}} g_1 g_2 \cos\Theta_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{V} \Big(g_{\mu\nu} \Big)
\tag{693}
$$



$$
\frac{i}{2} g_2^2 \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} \Big(g_{\mu\nu} \Big)
\tag{694}
$$

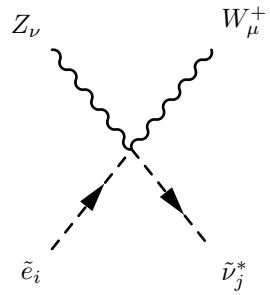


$$\Big(+ \frac{i}{2} g_2^2 \cos\Theta_W^2 \cos\Theta'^2_W \sum_{a=1}^{3} Z^{E,*}_{ia} Z^E_{ja}$$
$$- i g_1 g_2 \cos\Theta_W \cos\Theta'^2_W \sin\Theta_W \sum_{a=1}^{3} Z^{E,*}_{ia} Z^E_{ja}$$
$$+ \frac{i}{2} g_1^2 \cos\Theta'^2_W \sin\Theta_W^2 \sum_{a=1}^{3} Z^{E,*}_{ia} Z^E_{ja}$$
$$- 4 i g_1' g_2 \cos\Theta_W \cos\Theta'_W \sin\Theta'_W \sum_{a=1}^{3} Z^{E,*}_{ia} Z^E_{ja}$$
$$+ 4 i g_1 g_1' \cos\Theta'_W \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{E,*}_{ia} Z^E_{ja} + 8 i g_{1'}^2 \sin\Theta'^2_W \sum_{a=1}^{3} Z^{E,*}_{ia} Z^E_{ja}$$
$$+ 2 i g_1^2 \cos\Theta'^2_W \sin\Theta_W^2 \sum_{a=1}^{3} Z^{E,*}_{i3+a} Z^E_{j3+a}$$
$$- 4 i g_1 g_1' \cos\Theta'_W \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{E,*}_{i3+a} Z^E_{j3+a} + 2 i g_{1'}^2 \sin\Theta'^2_W \sum_{a=1}^{3} Z^{E,*}_{i3+a} Z^E_{j3+a} \Big) \Big(g_{\mu\nu} \Big) \tag{695}$$

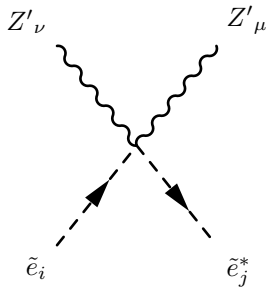


$$\Big(- 2 i g_1' g_2 \cos\Theta_W \cos\Theta'^2_W \sum_{a=1}^{3} Z^{E,*}_{ia} Z^E_{ja} + 2 i g_1 g_1' \cos\Theta'^2_W \sin\Theta_W \sum_{a=1}^{3} Z^{E,*}_{ia} Z^E_{ja}$$

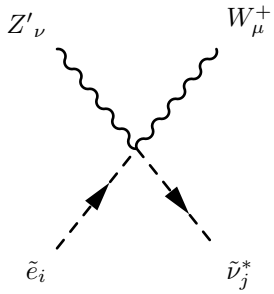
$$
\begin{aligned}
&- \frac{i}{2} g_2^2 \cos\Theta_W^2 \cos\Theta'_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} \\
&+ i g_1 g_2 \cos\Theta_W \cos\Theta'_W \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} \\
&- \frac{i}{2} g_1^2 \cos\Theta'_W \sin\Theta_W^2 \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} \\
&+ 2 i g_1' g_2 \cos\Theta_W \sin\Theta'^2_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} - 2 i g_1 g_1' \sin\Theta_W \sin\Theta'^2_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} \\
&+ 4 i g_{1'}^2 \sin 2\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} - 2 i g_1 g_1' \cos\Theta'^2_W \sin\Theta_W \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{j3+a}^{E} \\
&+ 2 i g_{1'}^2 \cos\Theta'_W \sin\Theta'_W \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{j3+a}^{E} \\
&- 2 i g_1^2 \cos\Theta'_W \sin\Theta_W^2 \sin\Theta'_W \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{j3+a}^{E} \\
&+ 2 i g_1 g_1' \sin\Theta_W \sin\Theta'^2_W \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{j3+a}^{E} \Big) \Big(g_{\mu\nu} \Big)
\end{aligned}
\tag{696}
$$



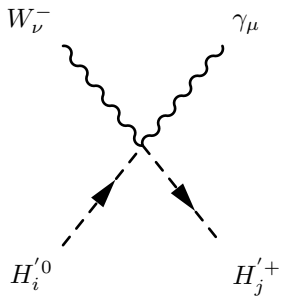
$$
\Big(2 i \sqrt{2} g_1' g_2 \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{V} + i \frac{1}{\sqrt{2}} g_1 g_2 \cos\Theta'_W \sin\Theta_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{V} \Big) \Big(g_{\mu\nu} \Big) \tag{697}
$$



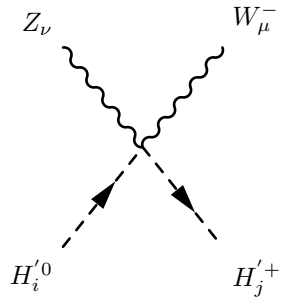
$$\Big(+ 8ig_{1'}^2 \cos\Theta'^2_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} + 4ig_1' g_2 \cos\Theta_W \cos\Theta'_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E}$$
$$- 4ig_1 g_1' \cos\Theta'_W \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E}$$
$$+ \frac{i}{2} g_2^2 \cos\Theta_W^2 \sin\Theta'^2_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E}$$
$$- ig_1 g_2 \cos\Theta_W \sin\Theta_W \sin\Theta'^2_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E}$$
$$+ \frac{i}{2} g_1^2 \sin\Theta_W^2 \sin\Theta'^2_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{E} + 2ig_{1'}^2 \cos\Theta'^2_W \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{j3+a}^{E}$$
$$+ 4ig_1 g_1' \cos\Theta'_W \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{j3+a}^{E}$$
$$+ 2ig_1^2 \sin\Theta_W^2 \sin\Theta'^2_W \sum_{a=1}^{3} Z_{i3+a}^{E,*} Z_{j3+a}^{E} \Big) \Big(g_{\mu\nu} \Big) \tag{698}$$



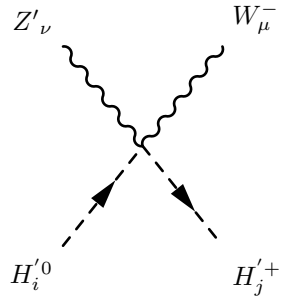
$$\Big(2i\sqrt{2} g_1' g_2 \cos\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{V} - i\frac{1}{\sqrt{2}} g_1 g_2 \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{E,*} Z_{ja}^{V} \Big) \Big(g_{\mu\nu} \Big) \tag{699}$$



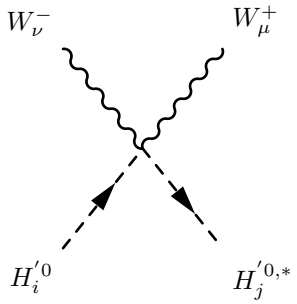
$$\Big(-i\frac{1}{\sqrt{2}} g_1 g_2 UHp0^*_{i1} \cos\Theta_W UHpp_{j1} + i\frac{1}{\sqrt{2}} g_1 g_2 UHp0^*_{i2} \cos\Theta_W UHpp_{j2} \Big) \Big(g_{\mu\nu} \Big) \tag{700}$$



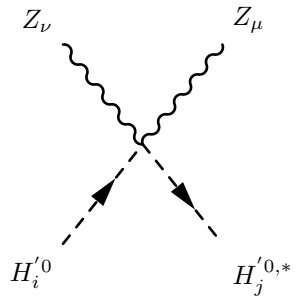
$$\begin{aligned}\Big(&+ i\frac{1}{\sqrt{2}} g_1 g_2 UHp0^*_{i1} \cos\Theta'_W \sin\Theta_W UHpp_{j1} + 2i\sqrt{2} g'_1 g_2 UHp0^*_{i1} \sin\Theta'_W UHpp_{j1} \\ &- i\frac{1}{\sqrt{2}} g_1 g_2 UHp0^*_{i2} \cos\Theta'_W \sin\Theta_W UHpp_{j2} - 2i\sqrt{2} g'_1 g_2 UHp0^*_{i2} \sin\Theta'_W UHpp_{j2} \Big) \Big(g_{\mu\nu} \Big)\end{aligned} \tag{701}$$



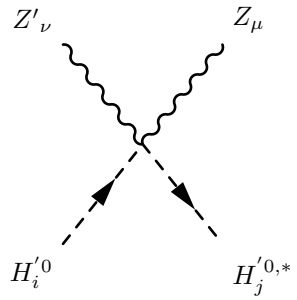
$$\begin{aligned}\Big(&+ 2i\sqrt{2} g'_1 g_2 UHp0^*_{i1} \cos\Theta'_W UHpp_{j1} - i\frac{1}{\sqrt{2}} g_1 g_2 UHp0^*_{i1} \sin\Theta_W \sin\Theta'_W UHpp_{j1} \\ &- 2i\sqrt{2} g'_1 g_2 UHp0^*_{i2} \cos\Theta'_W UHpp_{j2} + i\frac{1}{\sqrt{2}} g_1 g_2 UHp0^*_{i2} \sin\Theta_W \sin\Theta'_W UHpp_{j2} \Big) \Big(g_{\mu\nu} \Big)\end{aligned} \tag{702}$$



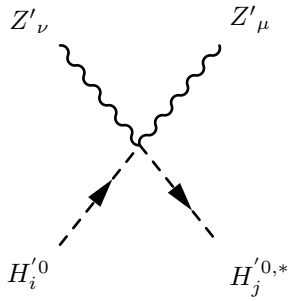
$$\Big(\frac{i}{2}g_2^2 UHp0^*_{i1} UHp0_{j1} + \frac{i}{2}g_2^2 UHp0^*_{i2} UHp0_{j2}\Big)\Big(g_{\mu\nu}\Big) \tag{703}$$



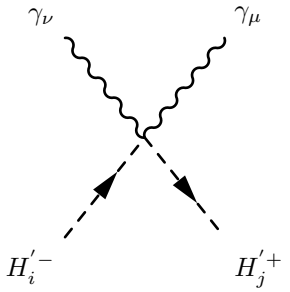
$$\begin{aligned}
&\Big(+ \frac{i}{2}g_2^2 UHp0^*_{i1} \cos\Theta_W^2 \cos\Theta'^2_W UHp0_{j1} + ig_1 g_2 UHp0^*_{i1} \cos\Theta_W \cos\Theta'^2_W \sin\Theta_W UHp0_{j1} \\
&+ \frac{i}{2}g_1^2 UHp0^*_{i1} \cos\Theta'^2_W \sin\Theta_W^2 UHp0_{j1} + 4ig_1' g_2 UHp0^*_{i1} \cos\Theta_W \cos\Theta'_W \sin\Theta'_W UHp0_{j1} \\
&+ 4ig_1 g_1' UHp0^*_{i1} \cos\Theta'_W \sin\Theta_W \sin\Theta'_W UHp0_{j1} + 8ig_{1'}^2 UHp0^*_{i1} \sin\Theta'^2_W UHp0_{j1} \\
&+ \frac{i}{2}g_2^2 UHp0^*_{i2} \cos\Theta_W^2 \cos\Theta'^2_W UHp0_{j2} + ig_1 g_2 UHp0^*_{i2} \cos\Theta_W \cos\Theta'^2_W \sin\Theta_W UHp0_{j2} \\
&+ \frac{i}{2}g_1^2 UHp0^*_{i2} \cos\Theta'^2_W \sin\Theta_W^2 UHp0_{j2} + 4ig_1' g_2 UHp0^*_{i2} \cos\Theta_W \cos\Theta'_W \sin\Theta'_W UHp0_{j2} \\
&+ 4ig_1 g_1' UHp0^*_{i2} \cos\Theta'_W \sin\Theta_W \sin\Theta'_W UHp0_{j2} + 8ig_{1'}^2 UHp0^*_{i2} \sin\Theta'^2_W UHp0_{j2}\Big)\Big(g_{\mu\nu}\Big)
\end{aligned} \tag{704}$$



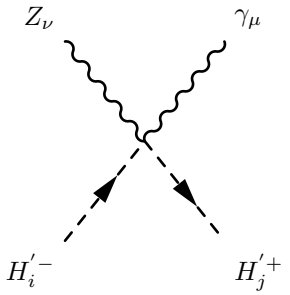
$$\Big(+ 2ig_1' g_2 UHp0_{i1}^* \cos\Theta_W \cos\Theta'^2_W UHp0_{j1} + 2ig_1 g_1' UHp0_{i1}^* \cos\Theta'^2_W \sin\Theta_W UHp0_{j1}$$
$$+ \frac{i}{4} g_1^2 UHp0_{i1}^* \cos\Theta_W^2 \cos\Theta'_W \sin\Theta'_W UHp0_{j1} - \frac{i}{4} g_2^2 UHp0_{i1}^* \cos\Theta_W^2 \cos\Theta'_W \sin\Theta'_W UHp0_{j1}$$
$$- ig_1 g_2 UHp0_{i1}^* \cos\Theta_W \cos\Theta'_W \sin\Theta_W \sin\Theta'_W UHp0_{j1} - 2ig_1' g_2 UHp0_{i1}^* \cos\Theta_W \sin\Theta'^2_W UHp0_{j1}$$
$$- 2ig_1 g_1' UHp0_{i1}^* \sin\Theta_W \sin\Theta'^2_W UHp0_{j1} - \frac{3i}{16} g_1^2 UHp0_{i1}^* \sin 2\Theta'_W UHp0_{j1} + 4ig_{1'}^2 UHp0_{i1}^* \sin 2\Theta'_W UHp0_{j1}$$
$$- \frac{i}{16} g_2^2 UHp0_{i1}^* \sin 2\Theta'_W UHp0_{j1} + \frac{i}{16} g_1^2 UHp0_{i1}^* \cos 2\Theta_W \sin 2\Theta'_W UHp0_{j1}$$
$$- \frac{i}{16} g_2^2 UHp0_{i1}^* \cos 2\Theta_W \sin 2\Theta'_W UHp0_{j1} + 2ig_1' g_2 UHp0_{i2}^* \cos\Theta_W \cos\Theta'^2_W UHp0_{j2}$$
$$+ 2ig_1 g_1' UHp0_{i2}^* \cos\Theta'^2_W \sin\Theta_W UHp0_{j2} + \frac{i}{4} g_1^2 UHp0_{i2}^* \cos\Theta_W^2 \cos\Theta'_W \sin\Theta'_W UHp0_{j2}$$
$$- \frac{i}{4} g_2^2 UHp0_{i2}^* \cos\Theta_W^2 \cos\Theta'_W \sin\Theta'_W UHp0_{j2}$$
$$- ig_1 g_2 UHp0_{i2}^* \cos\Theta_W \cos\Theta'_W \sin\Theta_W \sin\Theta'_W UHp0_{j2} - 2ig_1' g_2 UHp0_{i2}^* \cos\Theta_W \sin\Theta'^2_W UHp0_{j2}$$
$$- 2ig_1 g_1' UHp0_{i2}^* \sin\Theta_W \sin\Theta'^2_W UHp0_{j2} - \frac{3i}{16} g_1^2 UHp0_{i2}^* \sin 2\Theta'_W UHp0_{j2} + 4ig_{1'}^2 UHp0_{i2}^* \sin 2\Theta'_W UHp0_{j2}$$
$$- \frac{i}{16} g_2^2 UHp0_{i2}^* \sin 2\Theta'_W UHp0_{j2} + \frac{i}{16} g_1^2 UHp0_{i2}^* \cos 2\Theta_W \sin 2\Theta'_W UHp0_{j2}$$
$$- \frac{i}{16} g_2^2 UHp0_{i2}^* \cos 2\Theta_W \sin 2\Theta'_W UHp0_{j2} \Big) \Big(g_{\mu\nu} \Big) \tag{705}$$



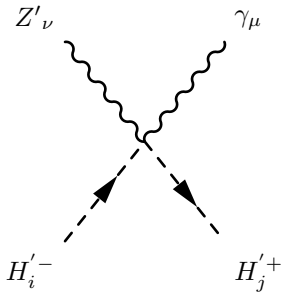
$$\Big(+ 8ig_{1'}^2 UHp0_{i1}^* \cos\Theta'^2_W UHp0_{j1} - 4ig_1' g_2 UHp0_{i1}^* \cos\Theta_W \cos\Theta'_W \sin\Theta'_W UHp0_{j1}$$
$$- 4ig_1 g_1' UHp0_{i1}^* \cos\Theta'_W \sin\Theta_W \sin\Theta'_W UHp0_{j1} + \frac{i}{2} g_2^2 UHp0_{i1}^* \cos\Theta_W^2 \sin\Theta'^2_W UHp0_{j1}$$
$$+ ig_1 g_2 UHp0_{i1}^* \cos\Theta_W \sin\Theta_W \sin\Theta'^2_W UHp0_{j1} + \frac{i}{2} g_1^2 UHp0_{i1}^* \sin\Theta_W^2 \sin\Theta'^2_W UHp0_{j1}$$
$$+ 8ig_{1'}^2 UHp0_{i2}^* \cos\Theta'^2_W UHp0_{j2} - 4ig_1' g_2 UHp0_{i2}^* \cos\Theta_W \cos\Theta'_W \sin\Theta'_W UHp0_{j2}$$
$$- 4ig_1 g_1' UHp0_{i2}^* \cos\Theta'_W \sin\Theta_W \sin\Theta'_W UHp0_{j2} + \frac{i}{2} g_2^2 UHp0_{i2}^* \cos\Theta_W^2 \sin\Theta'^2_W UHp0_{j2}$$
$$+ ig_1 g_2 UHp0_{i2}^* \cos\Theta_W \sin\Theta_W \sin\Theta'^2_W UHp0_{j2} + \frac{i}{2} g_1^2 UHp0_{i2}^* \sin\Theta_W^2 \sin\Theta'^2_W UHp0_{j2} \Big) \Big(g_{\mu\nu} \Big) \tag{706}$$



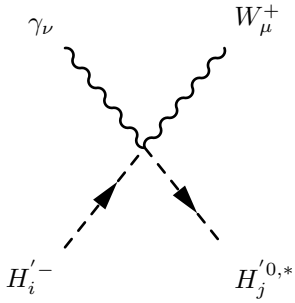
$$\Big(+ \frac{i}{2} g_1^2 UHpp_{i1}^* \cos\Theta_W^2 UHpp_{j1} + i g_1 g_2 UHpp_{i1}^* \cos\Theta_W \sin\Theta_W UHpp_{j1} + \frac{i}{2} g_2^2 UHpp_{i1}^* \sin\Theta_W^2 UHpp_{j1}$$
$$+ \frac{i}{2} g_1^2 UHpp_{i2}^* \cos\Theta_W^2 UHpp_{j2} + i g_1 g_2 UHpp_{i2}^* \cos\Theta_W \sin\Theta_W UHpp_{j2} + \frac{i}{2} g_2^2 UHpp_{i2}^* \sin\Theta_W^2 UHpp_{j2} \Big) \Big(g_{\mu\nu} \Big) \quad (707)$$



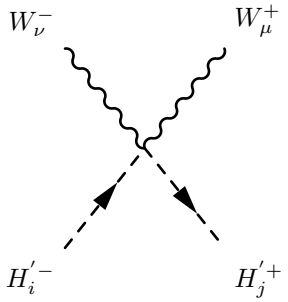
$$\Big(+ \frac{i}{2} g_1 g_2 UHpp_{i1}^* \cos\Theta_W^2 \cos\Theta'_W UHpp_{j1} - \frac{i}{2} g_1^2 UHpp_{i1}^* \cos\Theta_W \cos\Theta'_W \sin\Theta_W UHpp_{j1}$$
$$+ \frac{i}{2} g_2^2 UHpp_{i1}^* \cos\Theta_W \cos\Theta'_W \sin\Theta_W UHpp_{j1} - \frac{i}{2} g_1 g_2 UHpp_{i1}^* \cos\Theta'_W \sin\Theta_W^2 UHpp_{j1}$$
$$- 2i g_1 g'_1 UHpp_{i1}^* \cos\Theta_W \sin\Theta'_W UHpp_{j1} - 2i g'_1 g_2 UHpp_{i1}^* \sin\Theta_W \sin\Theta'_W UHpp_{j1}$$
$$+ \frac{i}{2} g_1 g_2 UHpp_{i2}^* \cos\Theta_W^2 \cos\Theta'_W UHpp_{j2} - \frac{i}{2} g_1^2 UHpp_{i2}^* \cos\Theta_W \cos\Theta'_W \sin\Theta_W UHpp_{j2}$$
$$+ \frac{i}{2} g_2^2 UHpp_{i2}^* \cos\Theta_W \cos\Theta'_W \sin\Theta_W UHpp_{j2} - \frac{i}{2} g_1 g_2 UHpp_{i2}^* \cos\Theta'_W \sin\Theta_W^2 UHpp_{j2}$$
$$- 2i g_1 g'_1 UHpp_{i2}^* \cos\Theta_W \sin\Theta'_W UHpp_{j2} - 2i g'_1 g_2 UHpp_{i2}^* \sin\Theta_W \sin\Theta'_W UHpp_{j2} \Big) \Big(g_{\mu\nu} \Big) \quad (708)$$



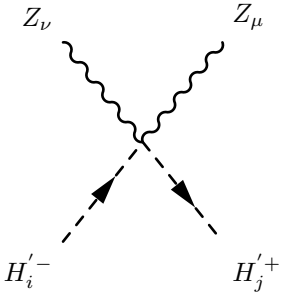
$$\Big(-2ig_1g_1'UHpp_{i1}^*\cos\Theta_W\cos\Theta'_WUHpp_{j1} - 2ig_1'g_2UHpp_{i1}^*\cos\Theta'_W\sin\Theta_WUHpp_{j1}$$
$$-\frac{i}{2}g_1g_2UHpp_{i1}^*\cos\Theta_W^2\sin\Theta'_WUHpp_{j1} + \frac{i}{2}g_1^2UHpp_{i1}^*\cos\Theta_W\sin\Theta_W\sin\Theta'_WUHpp_{j1}$$
$$-\frac{i}{2}g_2^2UHpp_{i1}^*\cos\Theta_W\sin\Theta_W\sin\Theta'_WUHpp_{j1} + \frac{i}{2}g_1g_2UHpp_{i1}^*\sin\Theta_W^2\sin\Theta'_WUHpp_{j1}$$
$$-2ig_1g_1'UHpp_{i2}^*\cos\Theta_W\cos\Theta'_WUHpp_{j2} - 2ig_1'g_2UHpp_{i2}^*\cos\Theta'_W\sin\Theta_WUHpp_{j2}$$
$$-\frac{i}{2}g_1g_2UHpp_{i2}^*\cos\Theta_W^2\sin\Theta'_WUHpp_{j2} + \frac{i}{2}g_1^2UHpp_{i2}^*\cos\Theta_W\sin\Theta_W\sin\Theta'_WUHpp_{j2}$$
$$-\frac{i}{2}g_2^2UHpp_{i2}^*\cos\Theta_W\sin\Theta_W\sin\Theta'_WUHpp_{j2} + \frac{i}{2}g_1g_2UHpp_{i2}^*\sin\Theta_W^2\sin\Theta'_WUHpp_{j2}\Big)\Big(g_{\mu\nu}\Big) \tag{709}$$



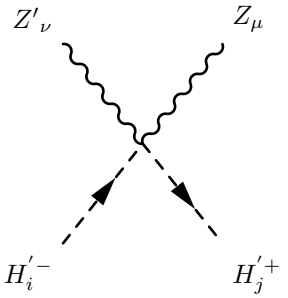
$$\Big(-i\frac{1}{\sqrt{2}}g_1g_2UHpp_{i1}^*\cos\Theta_WUHp0_{j1} + i\frac{1}{\sqrt{2}}g_1g_2UHpp_{i2}^*\cos\Theta_WUHp0_{j2}\Big)\Big(g_{\mu\nu}\Big) \tag{710}$$



$$\Big(\frac{i}{2}g_2^2 UHpp^*_{i1}UHpp_{j1} + \frac{i}{2}g_2^2 UHpp^*_{i2}UHpp_{j2}\Big)\Big(g_{\mu\nu}\Big) \tag{711}$$

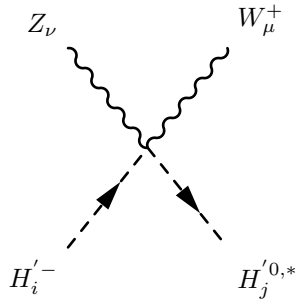


$$\begin{aligned}
&\Big(+ \frac{i}{2}g_2^2 UHpp^*_{i1}\cos\Theta_W^2\cos{\Theta'}^2_W UHpp_{j1} - ig_1g_2 UHpp^*_{i1}\cos\Theta_W\cos{\Theta'}^2_W\sin\Theta_W UHpp_{j1}\\
&+ \frac{i}{2}g_1^2 UHpp^*_{i1}\cos{\Theta'}^2_W\sin\Theta_W^2 UHpp_{j1} - 4ig_1'g_2 UHpp^*_{i1}\cos\Theta_W\cos\Theta'_W\sin\Theta'_W UHpp_{j1}\\
&+ 4ig_1g_1' UHpp^*_{i1}\cos\Theta'_W\sin\Theta_W\sin\Theta'_W UHpp_{j1} + 8ig_{1'}^2 UHpp^*_{i1}\sin{\Theta'}^2_W UHpp_{j1}\\
&+ \frac{i}{2}g_2^2 UHpp^*_{i2}\cos\Theta_W^2\cos{\Theta'}^2_W UHpp_{j2} - ig_1g_2 UHpp^*_{i2}\cos\Theta_W\cos{\Theta'}^2_W\sin\Theta_W UHpp_{j2}\\
&+ \frac{i}{2}g_1^2 UHpp^*_{i2}\cos{\Theta'}^2_W\sin\Theta_W^2 UHpp_{j2} - 4ig_1'g_2 UHpp^*_{i2}\cos\Theta_W\cos\Theta'_W\sin\Theta'_W UHpp_{j2}\\
&+ 4ig_1g_1' UHpp^*_{i2}\cos\Theta'_W\sin\Theta_W\sin\Theta'_W UHpp_{j2} + 8ig_{1'}^2 UHpp^*_{i2}\sin{\Theta'}^2_W UHpp_{j2}\Big)\Big(g_{\mu\nu}\Big)
\end{aligned} \tag{712}$$

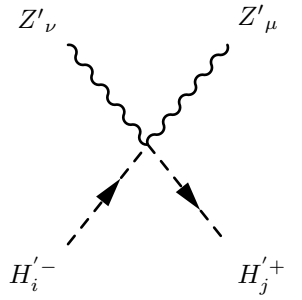


$$\begin{aligned}
&\Big(- 2ig_1'g_2 UHpp^*_{i1}\cos\Theta_W\cos2\Theta'_W UHpp_{j1} + 2ig_1g_1' UHpp^*_{i1}\cos{\Theta'}^2_W\sin\Theta_W UHpp_{j1}\\
&+ \frac{i}{4}g_1^2 UHpp^*_{i1}\cos\Theta_W^2\cos\Theta'_W\sin\Theta'_W UHpp_{j1} - \frac{i}{4}g_2^2 UHpp^*_{i1}\cos\Theta_W^2\cos\Theta'_W\sin\Theta'_W UHpp_{j1}\\
&- 2ig_1g_1' UHpp^*_{i1}\sin\Theta_W\sin{\Theta'}^2_W UHpp_{j1} - \frac{3i}{16}g_1^2 UHpp^*_{i1}\sin2\Theta'_W UHpp_{j1} + 4ig_{1'}^2 UHpp^*_{i1}\sin2\Theta'_W UHpp_{j1}\\
&- \frac{i}{16}g_2^2 UHpp^*_{i1}\sin2\Theta'_W UHpp_{j1} + \frac{i}{16}g_1^2 UHpp^*_{i1}\cos2\Theta_W\sin2\Theta'_W UHpp_{j1}
\end{aligned}$$

$$
\begin{aligned}
&- \frac{i}{16} g_2^2 UHpp_{i1}^* \cos 2\Theta_W \sin 2\Theta'_W UHpp_{j1} + \frac{i}{4} g_1 g_2 UHpp_{i1}^* \sin 2\Theta_W \sin 2\Theta'_W UHpp_{j1} \\
&- 2ig'_1 g_2 UHpp_{i2}^* \cos\Theta_W \cos 2\Theta'_W UHpp_{j2} + 2ig_1 g'_1 UHpp_{i2}^* \cos {\Theta'}_W^2 \sin\Theta_W UHpp_{j2} \\
&+ \frac{i}{4} g_1^2 UHpp_{i2}^* \cos\Theta_W^2 \cos\Theta'_W \sin\Theta'_W UHpp_{j2} - \frac{i}{4} g_2^2 UHpp_{i2}^* \cos\Theta_W^2 \cos\Theta'_W \sin\Theta'_W UHpp_{j2} \\
&- 2ig_1 g'_1 UHpp_{i2}^* \sin\Theta_W \sin {\Theta'}_W^2 UHpp_{j2} - \frac{3i}{16} g_1^2 UHpp_{i2}^* \sin 2\Theta'_W UHpp_{j2} + 4ig_{1'}^2 UHpp_{i2}^* \sin 2\Theta'_W UHpp_{j2} \\
&- \frac{i}{16} g_2^2 UHpp_{i2}^* \sin 2\Theta'_W UHpp_{j2} + \frac{i}{16} g_1^2 UHpp_{i2}^* \cos 2\Theta_W \sin 2\Theta'_W UHpp_{j2} \\
&- \frac{i}{16} g_2^2 UHpp_{i2}^* \cos 2\Theta_W \sin 2\Theta'_W UHpp_{j2} + \frac{i}{4} g_1 g_2 UHpp_{i2}^* \sin 2\Theta_W \sin 2\Theta'_W UHpp_{j2} \Big) \Big(g_{\mu\nu} \Big)
\end{aligned} \tag{713}
$$

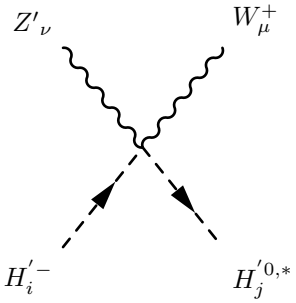


$$
\begin{aligned}
&\Big(+ i\frac{1}{\sqrt{2}} g_1 g_2 UHpp_{i1}^* \cos\Theta'_W \sin\Theta_W UHp0_{j1} + 2i\sqrt{2} g'_1 g_2 UHpp_{i1}^* \sin\Theta'_W UHp0_{j1} \\
&- i\frac{1}{\sqrt{2}} g_1 g_2 UHpp_{i2}^* \cos\Theta'_W \sin\Theta_W UHp0_{j2} - 2i\sqrt{2} g'_1 g_2 UHpp_{i2}^* \sin\Theta'_W UHp0_{j2} \Big) \Big(g_{\mu\nu} \Big)
\end{aligned} \tag{714}
$$

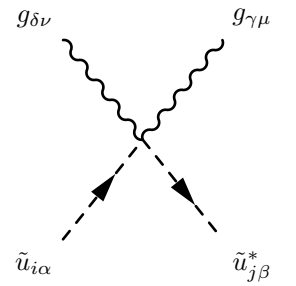


$$
\begin{aligned}
&\Big(+ 8ig_{1'}^2 UHpp_{i1}^* \cos {\Theta'}_W^2 UHpp_{j1} + 4ig'_1 g_2 UHpp_{i1}^* \cos\Theta_W \cos\Theta'_W \sin\Theta'_W UHpp_{j1} \\
&- 4ig_1 g'_1 UHpp_{i1}^* \cos\Theta'_W \sin\Theta_W \sin\Theta'_W UHpp_{j1} + \frac{i}{2} g_2^2 UHpp_{i1}^* \cos\Theta_W^2 \sin {\Theta'}_W^2 UHpp_{j1} \\
&- ig_1 g_2 UHpp_{i1}^* \cos\Theta_W \sin\Theta_W \sin {\Theta'}_W^2 UHpp_{j1} + \frac{i}{2} g_1^2 UHpp_{i1}^* \sin\Theta_W^2 \sin {\Theta'}_W^2 UHpp_{j1}
\end{aligned}
$$

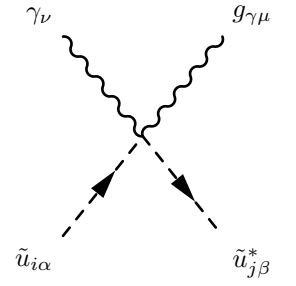
$$+ 8ig_1^2{}'UHpp_{i2}^*\cos\Theta'^2_W UHpp_{j2} + 4ig_1'g_2UHpp_{i2}^*\cos\Theta_W\cos\Theta'_W\sin\Theta'_W UHpp_{j2}$$
$$- 4ig_1g_1'UHpp_{i2}^*\cos\Theta'_W\sin\Theta_W\sin\Theta'_W UHpp_{j2} + \frac{i}{2}g_2^2UHpp_{i2}^*\cos\Theta_W^2\sin\Theta'^2_W UHpp_{j2}$$
$$- ig_1g_2UHpp_{i2}^*\cos\Theta_W\sin\Theta_W\sin\Theta'^2_W UHpp_{j2} + \frac{i}{2}g_1^2UHpp_{i2}^*\sin\Theta_W^2\sin\Theta'^2_W UHpp_{j2}\Big)\Big(g_{\mu\nu}\Big) \tag{715}$$



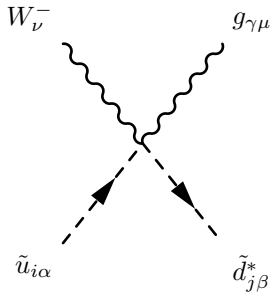
$$\Big(+ 2i\sqrt{2}g_1'g_2UHpp_{i1}^*\cos\Theta'_W UHp0_{j1} - i\frac{1}{\sqrt{2}}g_1g_2UHpp_{i1}^*\sin\Theta_W\sin\Theta'_W UHp0_{j1}$$
$$- 2i\sqrt{2}g_1'g_2UHpp_{i2}^*\cos\Theta'_W UHp0_{j2} + i\frac{1}{\sqrt{2}}g_1g_2UHpp_{i2}^*\sin\Theta_W\sin\Theta'_W UHp0_{j2}\Big)\Big(g_{\mu\nu}\Big) \tag{716}$$



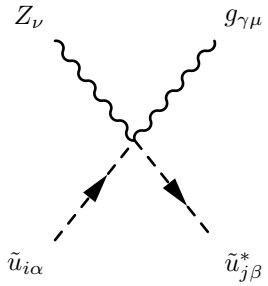
$$\Big(\frac{i}{4}g_3^2\delta_{ij}\sum_{a=1}^{3}\lambda^\gamma_{a,\alpha}\lambda^\delta_{\beta,a} + \frac{i}{4}g_3^2\delta_{ij}\sum_{a=1}^{3}\lambda^\gamma_{\beta,a}\lambda^\delta_{a,\alpha}\Big)\Big(g_{\mu\nu}\Big) \tag{717}$$



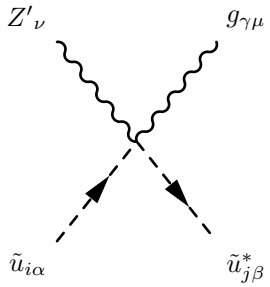
$$\Big(+ \frac{i}{6} g_1 g_3 \cos\Theta_W \lambda^{\gamma}_{\beta,\alpha} \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja} + \frac{i}{2} g_2 g_3 \lambda^{\gamma}_{\beta,\alpha} \sin\Theta_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja}$$
$$+ \frac{2i}{3} g_1 g_3 \cos\Theta_W \lambda^{\gamma}_{\beta,\alpha} \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{j3+a} \Big) \Big(g_{\mu\nu} \Big) \tag{718}$$



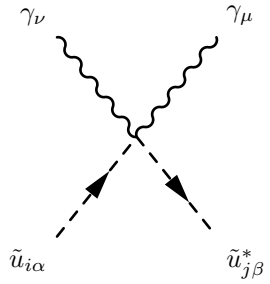
$$i \frac{1}{\sqrt{2}} g_2 g_3 \lambda^{\gamma}_{\beta,\alpha} \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{D}_{ja} \Big(g_{\mu\nu} \Big) \tag{719}$$



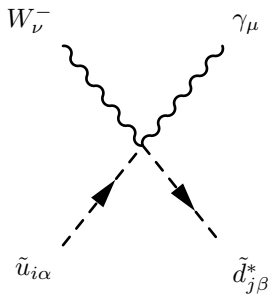
$$\Big(+ \frac{i}{2} g_2 g_3 \cos\Theta_W \cos\Theta'_W \lambda^{\gamma}_{\beta,\alpha} \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja} - \frac{i}{6} g_1 g_3 \cos\Theta'_W \lambda^{\gamma}_{\beta,\alpha} \sin\Theta_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja}$$
$$+ i g'_1 g_3 \lambda^{\gamma}_{\beta,\alpha} \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja} - \frac{2i}{3} g_1 g_3 \cos\Theta'_W \lambda^{\gamma}_{\beta,\alpha} \sin\Theta_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{j3+a}$$
$$- i g'_1 g_3 \lambda^{\gamma}_{\beta,\alpha} \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{j3+a} \Big) \Big(g_{\mu\nu} \Big) \tag{720}$$



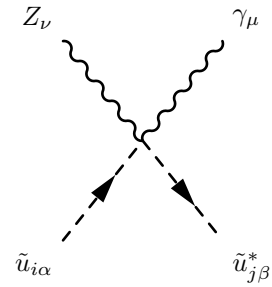
$$\Big(+ ig_1' g_3 \cos\Theta'_W \lambda^\gamma_{\beta,\alpha} \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} - \frac{i}{2} g_2 g_3 \cos\Theta_W \lambda^\gamma_{\beta,\alpha} \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja}$$
$$+ \frac{i}{6} g_1 g_3 \lambda^\gamma_{\beta,\alpha} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} - ig_1' g_3 \cos\Theta'_W \lambda^\gamma_{\beta,\alpha} \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^U_{j3+a}$$
$$+ \frac{2i}{3} g_1 g_3 \lambda^\gamma_{\beta,\alpha} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^U_{j3+a} \Big) \Big(g_{\mu\nu} \Big) \tag{721}$$



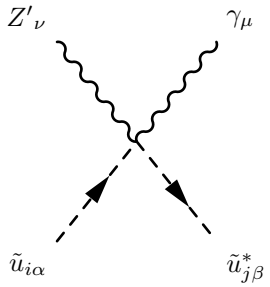
$$\Big(+ \frac{i}{18} g_1^2 \cos\Theta_W^2 \delta_{\alpha\beta} \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} + \frac{i}{3} g_1 g_2 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja}$$
$$+ \frac{i}{2} g_2^2 \delta_{\alpha\beta} \sin\Theta_W^2 \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} + \frac{8i}{9} g_1^2 \cos\Theta_W^2 \delta_{\alpha\beta} \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^U_{j3+a} \Big) \Big(g_{\mu\nu} \Big) \tag{722}$$



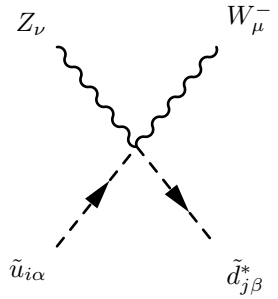
$$\frac{i}{3}\frac{1}{\sqrt{2}}g_1 g_2 \cos\Theta_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{D}_{ja} \Big(g_{\mu\nu} \Big) \tag{723}$$



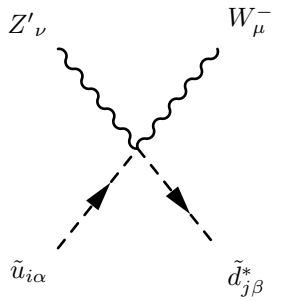
$$\begin{aligned}
&\Big(+ \frac{i}{6} g_1 g_2 \cos\Theta_W^2 \cos\Theta'_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja} \\
&- \frac{i}{18} g_1^2 \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja} \\
&+ \frac{i}{2} g_2^2 \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja} \\
&- \frac{i}{6} g_1 g_2 \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W^2 \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja} \\
&+ \frac{i}{3} g_1 g'_1 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja} + i g'_1 g_2 \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja} \\
&- \frac{8i}{9} g_1^2 \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{j3+a} \\
&- \frac{4i}{3} g_1 g'_1 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{j3+a} \Big) \Big(g_{\mu\nu} \Big)
\end{aligned} \tag{724}$$



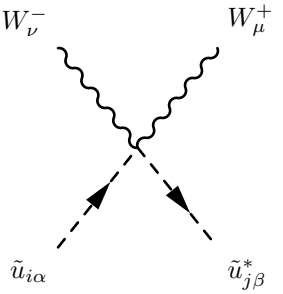
$$\Big(+ \frac{i}{3} g_1 g_1' \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{ia}^{U,*} Z_{ja}^{U} + i g_1' g_2 \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z_{ia}^{U,*} Z_{ja}^{U}$$
$$- \frac{i}{6} g_1 g_2 \cos\Theta_W^2 \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{U,*} Z_{ja}^{U}$$
$$+ \frac{i}{18} g_1^2 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{U,*} Z_{ja}^{U}$$
$$- \frac{i}{2} g_2^2 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{U,*} Z_{ja}^{U}$$
$$+ \frac{i}{6} g_1 g_2 \delta_{\alpha\beta} \sin\Theta_W^2 \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{U,*} Z_{ja}^{U}$$
$$- \frac{4i}{3} g_1 g_1' \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z_{i3+a}^{U,*} Z_{j3+a}^{U}$$
$$+ \frac{4i}{9} g_1^2 \delta_{\alpha\beta} \sin 2\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{i3+a}^{U,*} Z_{j3+a}^{U} \Big) \Big(g_{\mu\nu} \Big) \tag{725}$$



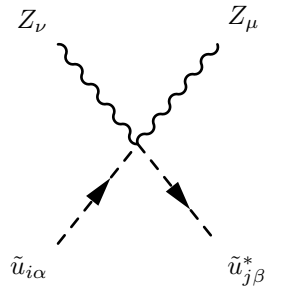
$$\Big(- \frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z_{ia}^{U,*} Z_{ja}^{D} + i\sqrt{2} g_1' g_2 \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{U,*} Z_{ja}^{D} \Big) \Big(g_{\mu\nu} \Big) \tag{726}$$



$$\Big(\frac{i}{3}\frac{1}{\sqrt{2}}g_1 g_2 \delta_{\alpha\beta}\sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{D}_{ja} + i\sqrt{2} g'_1 g_2 \cos\Theta'_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{D}_{ja}\Big)\Big(g_{\mu\nu}\Big) \tag{727}$$



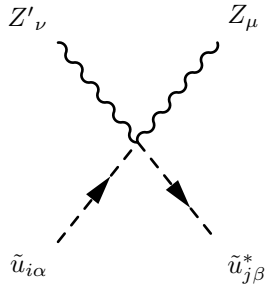
$$\frac{i}{2} g_2^2 \delta_{\alpha\beta} \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja}\Big(g_{\mu\nu}\Big) \tag{728}$$



$$\Big(+ \frac{i}{2} g_2^2 \cos\Theta_W^2 \cos\Theta'^2_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja}$$

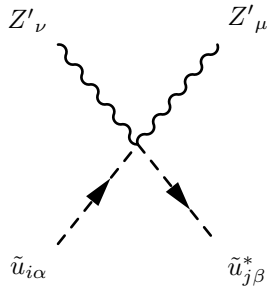
$$- \frac{i}{3} g_1 g_2 \cos\Theta_W \cos\Theta'^2_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^{U}_{ja}$$

$$
\begin{aligned}
&+ \frac{i}{18} g_1^2 \cos\Theta'^2_W \delta_{\alpha\beta} \sin\Theta^2_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&+ 2i g_1' g_2 \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&- \frac{2i}{3} g_1 g_1' \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&+ 2i g_{1'}^2 \delta_{\alpha\beta} \sin\Theta'^2_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} + \frac{8i}{9} g_1^2 \cos\Theta'^2_W \delta_{\alpha\beta} \sin\Theta^2_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^U_{j3+a} \\
&+ \frac{8i}{3} g_1 g_1' \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^U_{j3+a} \\
&+ 2i g_{1'}^2 \delta_{\alpha\beta} \sin\Theta'^2_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^U_{j3+a} \Big) \Big(g_{\mu\nu} \Big)
\end{aligned} \tag{729}
$$



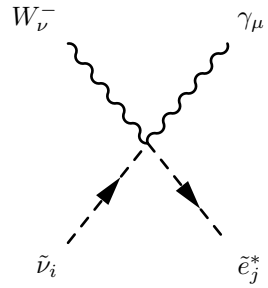
$$
\begin{aligned}
&\Big(+ i g_1' g_2 \cos\Theta_W \cos\Theta'^2_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&- \frac{i}{3} g_1 g_1' \cos\Theta'^2_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&+ 2i g_{1'}^2 \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&- \frac{i}{2} g_2^2 \cos\Theta^2_W \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&+ \frac{i}{3} g_1 g_2 \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&- \frac{i}{18} g_1^2 \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta^2_W \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja}
\end{aligned}
$$

$$
\begin{aligned}
&- ig_1' g_2 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta'^2_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&+ \frac{i}{3} g_1 g_1' \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'^2_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&+ \frac{4i}{3} g_1 g_1' \cos\Theta'^2_W \delta_{\alpha\beta} \sin\Theta_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^U_{j3+a} \\
&+ 2ig_{1'}^2 \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^U_{j3+a} \\
&- \frac{4i}{3} g_1 g_1' \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'^2_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^U_{j3+a} \\
&- \frac{4i}{9} g_1^2 \delta_{\alpha\beta} \sin\Theta^2_W \sin 2\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^U_{j3+a} \Big) \Big(g_{\mu\nu} \Big)
\end{aligned} \tag{730}
$$

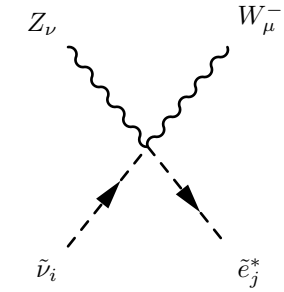


$$
\begin{aligned}
&\Big(+ 2ig_{1'}^2 \cos\Theta'^2_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&- 2ig_1' g_2 \cos\Theta_W \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&+ \frac{2i}{3} g_1 g_1' \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&+ \frac{i}{2} g_2^2 \cos\Theta^2_W \delta_{\alpha\beta} \sin\Theta'^2_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&- \frac{i}{3} g_1 g_2 \cos\Theta_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'^2_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} \\
&+ \frac{i}{18} g_1^2 \delta_{\alpha\beta} \sin\Theta^2_W \sin\Theta'^2_W \sum_{a=1}^{3} Z^{U,*}_{ia} Z^U_{ja} + 2ig_{1'}^2 \cos\Theta'^2_W \delta_{\alpha\beta} \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^U_{j3+a}
\end{aligned}
$$

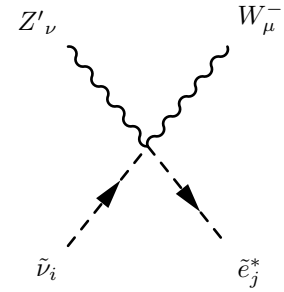
$$- \frac{8i}{3} g_1 g_1' \cos\Theta'_W \delta_{\alpha\beta} \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{j3+a}$$
$$+ \frac{8i}{9} g_1^2 \delta_{\alpha\beta} \sin\Theta^2_W \sin\Theta'^2_W \sum_{a=1}^{3} Z^{U,*}_{i3+a} Z^{U}_{j3+a} \Big) \Big(g_{\mu\nu} \Big) \tag{731}$$



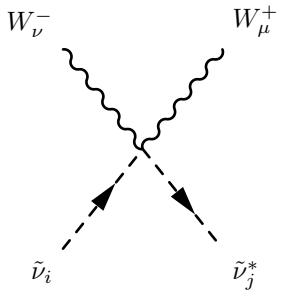
$$- i \frac{1}{\sqrt{2}} g_1 g_2 \cos\Theta_W \sum_{a=1}^{3} Z^{V,*}_{ia} Z^{E}_{ja} \Big(g_{\mu\nu} \Big) \tag{732}$$



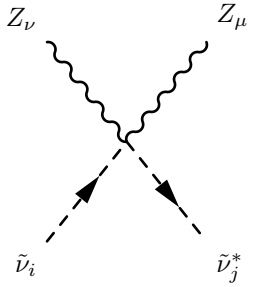
$$\Big(2i\sqrt{2} g_1' g_2 \sin\Theta'_W \sum_{a=1}^{3} Z^{V,*}_{ia} Z^{E}_{ja} + i \frac{1}{\sqrt{2}} g_1 g_2 \cos\Theta'_W \sin\Theta_W \sum_{a=1}^{3} Z^{V,*}_{ia} Z^{E}_{ja} \Big) \Big(g_{\mu\nu} \Big) \tag{733}$$



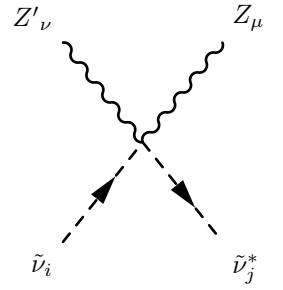
$$\Big(2i\sqrt{2}g_1' g_2 \cos\Theta'_W \sum_{a=1}^{3} Z_{ia}^{V,*} Z_{ja}^{E} - i\frac{1}{\sqrt{2}} g_1 g_2 \sin\Theta_W \sin\Theta'_W \sum_{a=1}^{3} Z_{ia}^{V,*} Z_{ja}^{E}\Big)\Big(g_{\mu\nu}\Big) \tag{734}$$



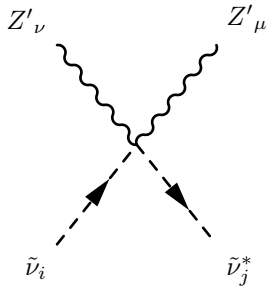
$$\frac{i}{2} g_2^2 \delta_{ij}\Big(g_{\mu\nu}\Big) \tag{735}$$



$$\begin{aligned}&\Big(+ \frac{i}{2} g_2^2 \cos\Theta_W^2 \cos\Theta'^2_W \delta_{ij} + i g_1 g_2 \cos\Theta_W \cos\Theta'^2_W \delta_{ij} \sin\Theta_W \\ &+ \frac{i}{2} g_1^2 \cos\Theta'^2_W \delta_{ij} \sin\Theta_W^2 + 4i g_1' g_2 \cos\Theta_W \cos\Theta'_W \delta_{ij} \sin\Theta'_W \\ &+ 4i g_1 g_1' \cos\Theta'_W \delta_{ij} \sin\Theta_W \sin\Theta'_W + 8i g_{1'}^2 \delta_{ij} \sin\Theta'^2_W\Big)\Big(g_{\mu\nu}\Big)\end{aligned} \tag{736}$$

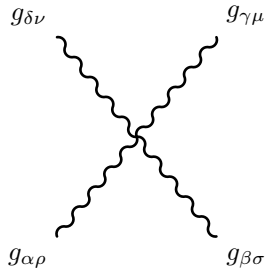


$$\Big(+ 2ig_1' g_2 \cos\Theta_W \cos {\Theta'}^2_W \delta_{ij} + 2ig_1 g_1' \cos {\Theta'}^2_W \delta_{ij} \sin\Theta_W$$
$$- \frac{i}{2} g_2^2 \cos\Theta_W^2 \cos {\Theta'}_W \delta_{ij} \sin {\Theta'}_W - ig_1 g_2 \cos\Theta_W \cos {\Theta'}_W \delta_{ij} \sin\Theta_W \sin {\Theta'}_W$$
$$- \frac{i}{2} g_1^2 \cos {\Theta'}_W \delta_{ij} \sin\Theta_W^2 \sin {\Theta'}_W - 2ig_1' g_2 \cos\Theta_W \delta_{ij} \sin {\Theta'}^2_W$$
$$- 2ig_1 g_1' \delta_{ij} \sin\Theta_W \sin {\Theta'}^2_W + 4ig_{1'}^2 \delta_{ij} \sin 2{\Theta'}_W \Big) \Big(g_{\mu\nu} \Big) \tag{737}$$



$$\Big(+ 8ig_{1'}^2 \cos {\Theta'}^2_W \delta_{ij} - 4ig_1' g_2 \cos\Theta_W \cos {\Theta'}_W \delta_{ij} \sin {\Theta'}_W$$
$$- 4ig_1 g_1' \cos {\Theta'}_W \delta_{ij} \sin\Theta_W \sin {\Theta'}_W + \frac{i}{2} g_2^2 \cos\Theta_W^2 \delta_{ij} \sin {\Theta'}^2_W$$
$$+ ig_1 g_2 \cos\Theta_W \delta_{ij} \sin\Theta_W \sin {\Theta'}^2_W + \frac{i}{2} g_1^2 \delta_{ij} \sin\Theta_W^2 \sin {\Theta'}^2_W \Big) \Big(g_{\mu\nu} \Big) \tag{738}$$

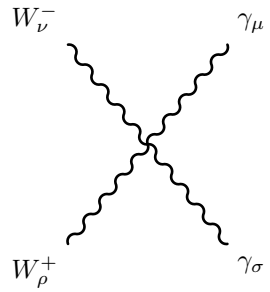
9.9 Four Vector Boson-Interaction



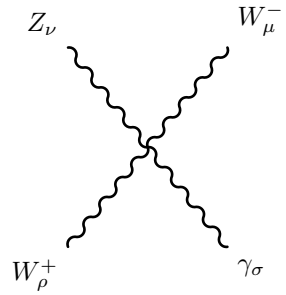
$$ig_3^2 \Big(- \sum_{a=1}^{8} f_{\alpha,\delta,a} f_{\beta,\gamma,a} - \sum_{a=1}^{8} f_{\alpha,\gamma,a} f_{\beta,\delta,a} \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{739}$$

$$+ \; ig_3^2 \Big(- \sum_{a=1}^{8} f_{\alpha,\beta,a} f_{\gamma,\delta,a} + \sum_{a=1}^{8} f_{\alpha,\delta,a} f_{\beta,\gamma,a} \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{740}$$

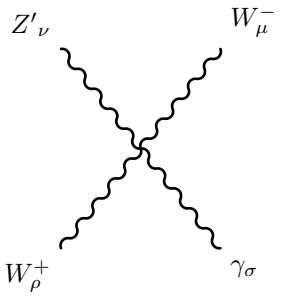
$$+\ ig_3^2\Big(\sum_{a=1}^{8} f_{\alpha,\gamma,a}f_{\beta,\delta,a} + \sum_{a=1}^{8} f_{\alpha,\beta,a}f_{\gamma,\delta,a}\Big)\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{741}$$



$$ig_2^2 \sin\Theta_W^2\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{742}$$
$$+\ ig_2^2 \sin\Theta_W^2\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{743}$$
$$+\ -2ig_2^2 \sin\Theta_W^2\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{744}$$



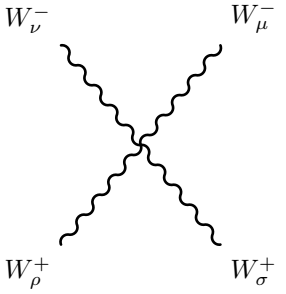
$$\frac{i}{2}g_2^2 \cos\Theta'_W \sin 2\Theta_W\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{745}$$
$$+\ -ig_2^2 \cos\Theta'_W \sin 2\Theta_W\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{746}$$
$$+\ \frac{i}{2}g_2^2 \cos\Theta'_W \sin 2\Theta_W\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{747}$$



$$-\frac{i}{2}g_2^2 \sin 2\Theta_W \sin \Theta'_W \Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{748}$$

$$+\ ig_2^2 \sin 2\Theta_W \sin \Theta'_W \Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{749}$$

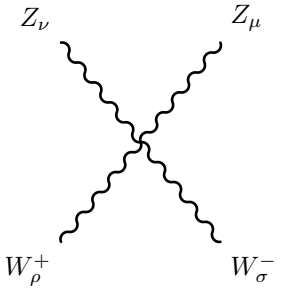
$$+\ -\frac{i}{2}g_2^2 \sin 2\Theta_W \sin \Theta'_W \Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{750}$$



$$2ig_2^2\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{751}$$

$$+\ -ig_2^2\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{752}$$

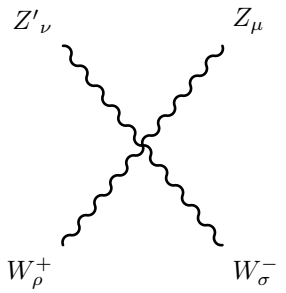
$$+\ -ig_2^2\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{753}$$



$$- 2ig_2^2 \cos\Theta_W^2 \cos\Theta'^2_W \Big(g_{\rho\sigma} g_{\mu\nu}\Big) \tag{754}$$

$$+ ig_2^2 \cos\Theta_W^2 \cos\Theta'^2_W \Big(g_{\rho\mu} g_{\sigma\nu}\Big) \tag{755}$$

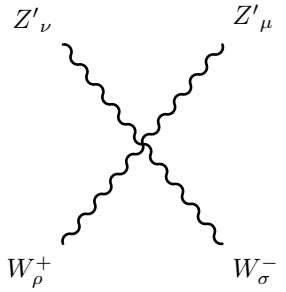
$$+ ig_2^2 \cos\Theta_W^2 \cos\Theta'^2_W \Big(g_{\rho\nu} g_{\sigma\mu}\Big) \tag{756}$$



$$ig_2^2 \cos\Theta_W^2 \sin 2\Theta'_W \Big(g_{\rho\sigma} g_{\mu\nu}\Big) \tag{757}$$

$$+ -\frac{i}{2} g_2^2 \cos\Theta_W^2 \sin 2\Theta'_W \Big(g_{\rho\mu} g_{\sigma\nu}\Big) \tag{758}$$

$$+ -\frac{i}{2} g_2^2 \cos\Theta_W^2 \sin 2\Theta'_W \Big(g_{\rho\nu} g_{\sigma\mu}\Big) \tag{759}$$

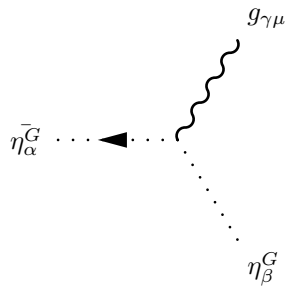


$$- 2ig_2^2 \cos\Theta_W^2 \sin\Theta'^2_W \Big(g_{\rho\sigma} g_{\mu\nu}\Big) \tag{760}$$

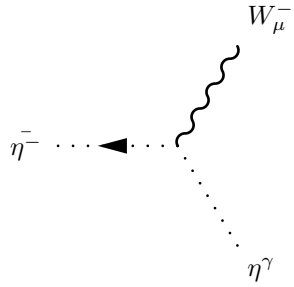
$$+ ig_2^2 \cos\Theta_W^2 \sin\Theta'^2_W \Big(g_{\rho\mu} g_{\sigma\nu}\Big) \tag{761}$$

$$+ ig_2^2 \cos\Theta_W^2 \sin\Theta'^2_W \Big(g_{\rho\nu} g_{\sigma\mu}\Big) \tag{762}$$

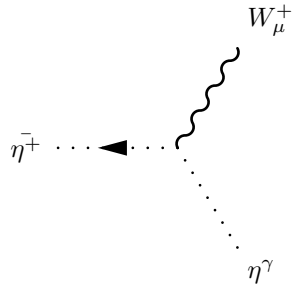
9.10 Two Ghosts-One Vector Boson-Interaction



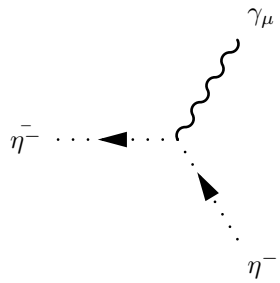
$$g_3 f_{\alpha,\beta,\gamma}\left(p_\mu^{\eta_\beta^G}\right) \tag{763}$$



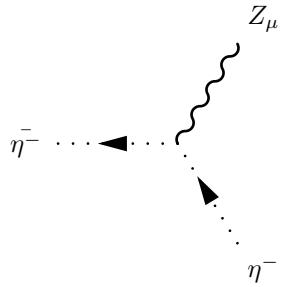
$$ig_2 \sin\Theta_W\left(p_\mu^{\eta^\gamma}\right) \tag{764}$$



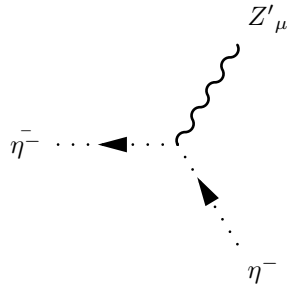
$$-ig_2 \sin\Theta_W\left(p_\mu^{\eta^\gamma}\right) \tag{765}$$



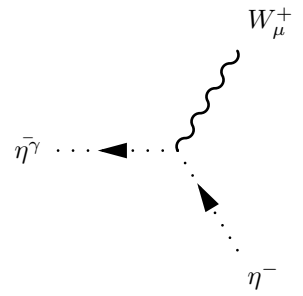
$$-ig_2 \sin\Theta_W \left(p_\mu^{\eta^-}\right) \tag{766}$$



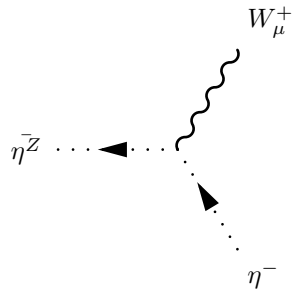
$$-ig_2 \cos\Theta_W \cos\Theta'_W \left(p_\mu^{\eta^-}\right) \tag{767}$$



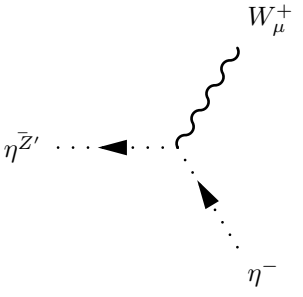
$$ig_2 \cos\Theta_W \sin\Theta'_W \left(p_\mu^{\eta^-}\right) \tag{768}$$



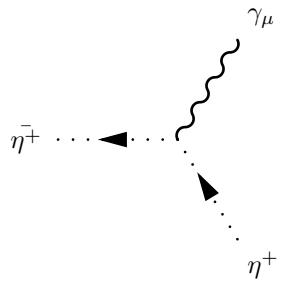
$$ig_2 \sin\Theta_W \left(p_\mu^{\eta^-}\right) \tag{769}$$



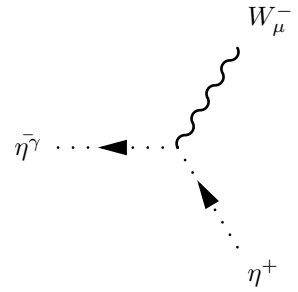
$$ig_2 \cos\Theta_W \cos\Theta'_W \left(p_\mu^{\eta^-}\right) \tag{770}$$



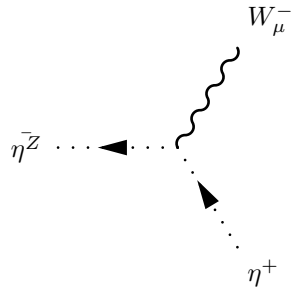
$$-ig_2 \cos\Theta_W \sin\Theta'_W \left(p_\mu^{\eta^-}\right) \tag{771}$$



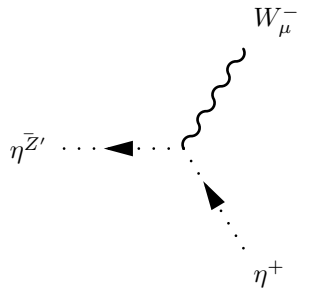
$$ig_2 \sin\Theta_W \left(p_\mu^{\eta^+}\right) \tag{772}$$



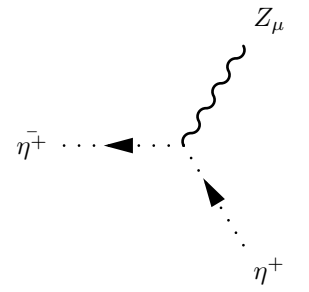
$$-ig_2 \sin\Theta_W \left(p_\mu^{\eta^+}\right) \tag{773}$$



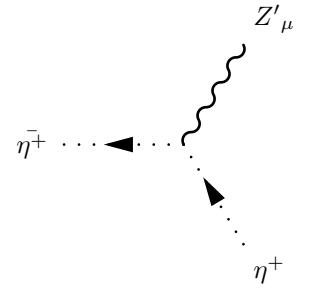
$$-ig_2 \cos\Theta_W \cos\Theta'_W \left(p_\mu^{\eta^+}\right) \tag{774}$$



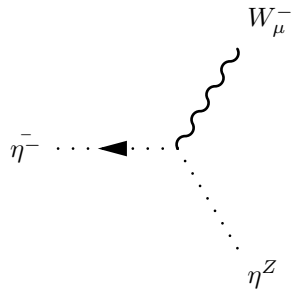
$$ig_2 \cos\Theta_W \sin\Theta'_W \left(p_\mu^{\eta^+}\right) \tag{775}$$



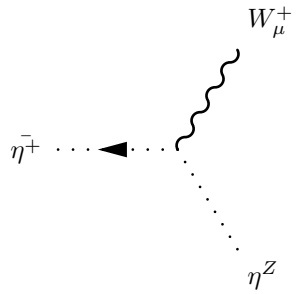
$$ig_2 \cos\Theta_W \cos\Theta'_W \left(p_\mu^{\eta^+}\right) \tag{776}$$



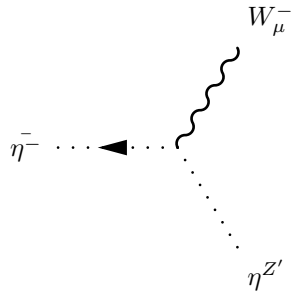
$$-ig_2 \cos\Theta_W \sin\Theta'_W \left(p_\mu^{\eta^+}\right) \tag{777}$$



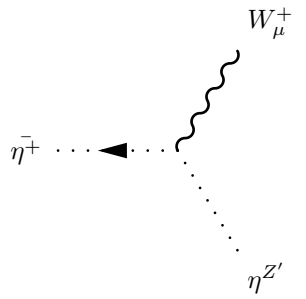
$$ig_2 \cos\Theta_W \cos\Theta'_W \left(p_\mu^{\eta^Z}\right) \tag{778}$$



$$-ig_2 \cos\Theta_W \cos\Theta'_W \left(p_\mu^{\eta^Z}\right) \tag{779}$$

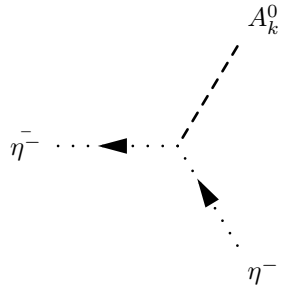


$$-ig_2 \cos\Theta_W \sin\Theta'_W \left(p_\mu^{\eta^{Z'}}\right) \tag{780}$$

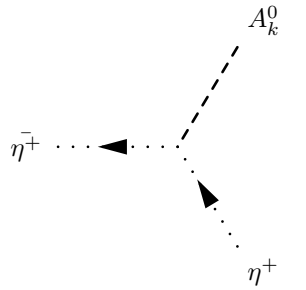


$$ig_2 \cos\Theta_W \sin\Theta'_W \left(p_\mu^{\eta^{Z'}}\right) \tag{781}$$

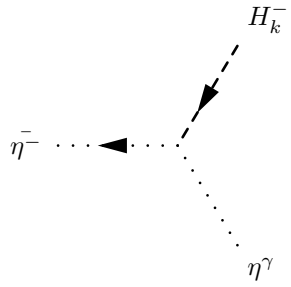
9.11 Two Ghosts-One Scalar-Interaction



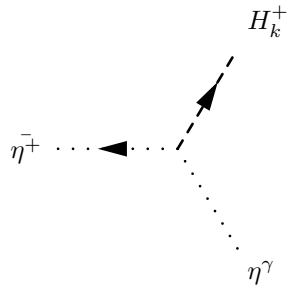
$$\frac{1}{4} g_2^2 \xi_{W^-} \left(v_1 U_{A,k1} - v_2 U_{A,k2}\right) \tag{782}$$



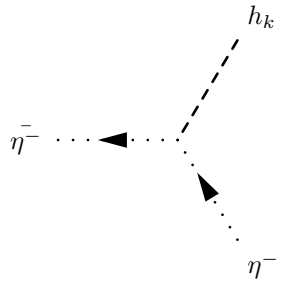
$$-\frac{1}{4} g_2^2 \xi_{W^-} \left(v_1 U_{A,k1} - v_2 U_{A,k2}\right) \tag{783}$$



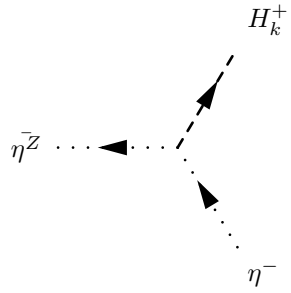
$$\frac{i}{4}g_2\Big(v_1U^*_{+,k1} - v_2U^*_{+,k2}\Big)\xi_{W^-}\Big(g_1\cos\Theta_W + g_2\sin\Theta_W\Big) \tag{784}$$



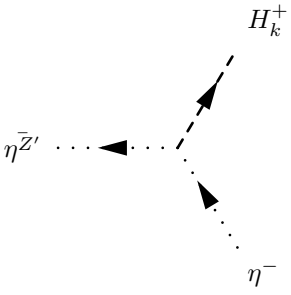
$$\frac{i}{4}g_2\xi_{W^-}\Big(g_1\cos\Theta_W + g_2\sin\Theta_W\Big)\Big(v_1U_{+,k1} - v_2U_{+,k2}\Big) \tag{785}$$



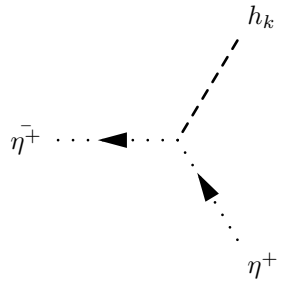
$$-\frac{i}{4}g_2^2\Big(v_1U^*_{H,k1} + v_2U^*_{H,k2}\Big)\xi_{W^-} \tag{786}$$



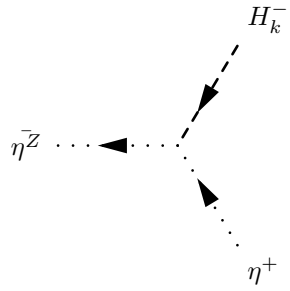
$$\frac{i}{4}g_2\xi_Z\Big(-v_1\Big(-6g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)U_{+,k1}$$
$$+v_2\Big(4g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)U_{+,k2}\Big) \tag{787}$$



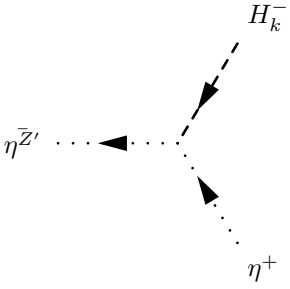
$$\frac{i}{4}g_2\xi_{Z'}\Big(v_1\Big(6g_1'\cos\Theta'_W+\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)U_{+,k1}$$
$$+v_2\Big(4g_1'\cos\Theta'_W-\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)U_{+,k2}\Big) \tag{788}$$



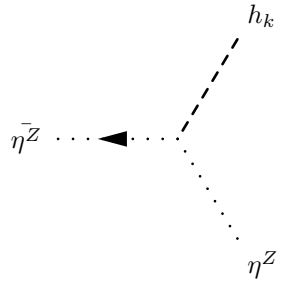
$$-\frac{i}{4}g_2^2\Big(v_1U^*_{H,k1}+v_2U^*_{H,k2}\Big)\xi_{W^-} \tag{789}$$



$$\frac{i}{4}g_2\xi_Z\Big(-v_1U^*_{+,k1}\Big(-6g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)$$
$$+v_2U^*_{+,k2}\Big(4g_1'\sin\Theta'_W+g_1\cos\Theta'_W\sin\Theta_W+g_2\cos\Theta_W\cos\Theta'_W\Big)\Big) \tag{790}$$

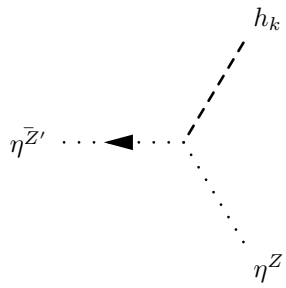


$$\frac{i}{4}g_2\xi_{Z'}\Big(v_2U^*_{+,k2}\Big(4g_1'\cos\Theta'_W-\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)$$
$$+v_1U^*_{+,k1}\Big(6g_1'\cos\Theta'_W+\Big(g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)\Big) \tag{791}$$

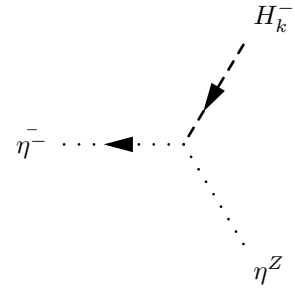


$$-\frac{i}{4}\xi_Z\Big(4g_{1'}^2Q_S^2\Big(vsbU^*_{H,k4}+v_sU^*_{H,k3}\Big)\sin\Theta'^2_W$$

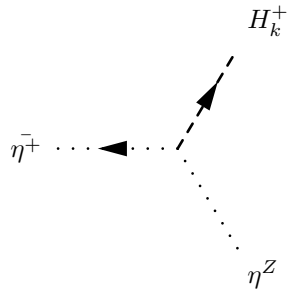
$$+ v_1 U^*_{H,k1}\Big(- 6g'_1 \sin\Theta'_W + g_1 \cos\Theta'_W \sin\Theta_W + g_2 \cos\Theta_W \cos\Theta'_W\Big)^2$$
$$+ v_2 U^*_{H,k2}\Big(4g'_1 \sin\Theta'_W + g_1 \cos\Theta'_W \sin\Theta_W + g_2 \cos\Theta_W \cos\Theta'_W\Big)^2\Big) \tag{792}$$



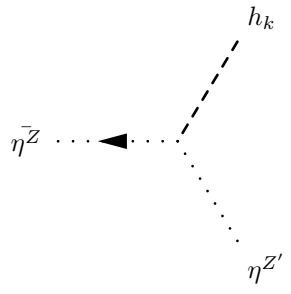
$$\frac{i}{4}\xi_{Z'}\Big(v_1 U^*_{H,k1}\Big(6g_1 g'_1 \cos\Theta'^2_W \sin\Theta_W + g_2^2 \cos\Theta^2_W \cos\Theta'_W \sin\Theta'_W$$
$$+ \cos\Theta'_W\Big(- 36g^2_{1'} + g_1^2 \sin\Theta^2_W\Big)\sin\Theta'_W - 6g_1 g'_1 \sin\Theta_W \sin\Theta'^2_W$$
$$+ 2g_2 \cos\Theta_W\Big(3g'_1 \cos\Theta'^2_W - 3g'_1 \sin\Theta'^2_W + g_1 \cos\Theta'_W \sin\Theta_W \sin\Theta'_W\Big)\Big)$$
$$- 2g^2_{1'} Q^2_S\Big(vsbU^*_{H,k4} + v_s U^*_{H,k3}\Big)\sin 2\Theta'_W$$
$$+ v_2 U^*_{H,k2}\Big(- 4g_1 g'_1 \cos\Theta'^2_W \sin\Theta_W + g_2^2 \cos\Theta^2_W \cos\Theta'_W \sin\Theta'_W$$
$$+ g_1^2 \cos\Theta'_W \sin\Theta^2_W \sin\Theta'_W$$
$$+ 2g_2 \cos\Theta_W\Big(- 2g'_1 \cos\Theta'^2_W + 2g'_1 \sin\Theta'^2_W + g_1 \cos\Theta'_W \sin\Theta_W \sin\Theta'_W\Big)$$
$$+ 4g'_1\Big(- 2g'_1 \sin 2\Theta'_W + g_1 \sin\Theta_W \sin\Theta'^2_W\Big)\Big)\Big) \tag{793}$$



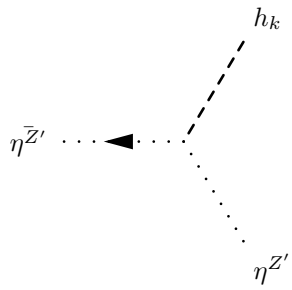
$$\frac{i}{4}g_2\xi_{W^-}\Big(v_2 U^*_{+,k2}\Big(4g'_1 \sin\Theta'_W + g_1 \cos\Theta'_W \sin\Theta_W - g_2 \cos\Theta_W \cos\Theta'_W\Big)$$
$$+ v_1 U^*_{+,k1}\Big(6g'_1 \sin\Theta'_W - g_1 \cos\Theta'_W \sin\Theta_W + g_2 \cos\Theta_W \cos\Theta'_W\Big)\Big) \tag{794}$$



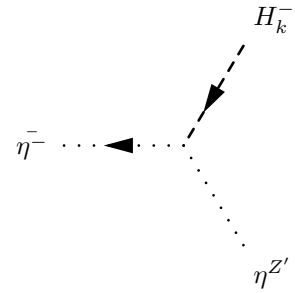
$$\frac{i}{4}g_2\xi_{W^-}\Big(v_1\Big(6g_1'\sin\Theta'_W - g_1\cos\Theta'_W\sin\Theta_W + g_2\cos\Theta_W\cos\Theta'_W\Big)U_{+,k1} + v_2\Big(4g_1'\sin\Theta'_W + g_1\cos\Theta'_W\sin\Theta_W - g_2\cos\Theta_W\cos\Theta'_W\Big)U_{+,k2}\Big) \tag{795}$$



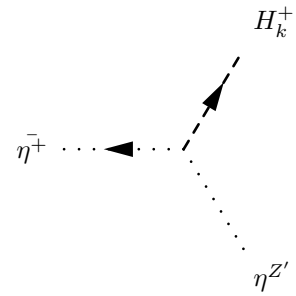
$$\begin{aligned}&\frac{i}{4}\xi_Z\Big(v_1U^*_{H,k1}\Big(6g_1g_1'\cos\Theta'^2_W\sin\Theta_W + g_2^2\cos\Theta_W^2\cos\Theta'_W\sin\Theta'_W \\ &+ \cos\Theta'_W\Big(-36g_{1'}^2 + g_1^2\sin\Theta_W^2\Big)\sin\Theta'_W - 6g_1g_1'\sin\Theta_W\sin\Theta'^2_W \\ &+ 2g_2\cos\Theta_W\Big(3g_1'\cos\Theta'^2_W - 3g_1'\sin\Theta'^2_W + g_1\cos\Theta'_W\sin\Theta_W\sin\Theta'_W\Big)\Big) \\ &- 2g_{1'}^2Q_S^2\Big(vsbU^*_{H,k4} + v_sU^*_{H,k3}\Big)\sin 2\Theta'_W \\ &+ v_2U^*_{H,k2}\Big(-4g_1g_1'\cos\Theta'^2_W\sin\Theta_W + g_2^2\cos\Theta_W^2\cos\Theta'_W\sin\Theta'_W \\ &+ g_1^2\cos\Theta'_W\sin\Theta_W^2\sin\Theta'_W \\ &+ 2g_2\cos\Theta_W\Big(-2g_1'\cos\Theta'^2_W + 2g_1'\sin\Theta'^2_W + g_1\cos\Theta'_W\sin\Theta_W\sin\Theta'_W\Big) \\ &+ 4g_1'\Big(-2g_1'\sin 2\Theta'_W + g_1\sin\Theta_W\sin\Theta'^2_W\Big)\Big)\Big)\end{aligned} \tag{796}$$



$$
\begin{aligned}
&-\frac{i}{4}\xi_{Z'}\Big(4g_{1'}^2Q_S^2\Big(vsbU_{H,k4}^* + v_sU_{H,k3}^*\Big)\cos\Theta'^2_W \\
&+ v_2U_{H,k2}^*\Big(-4g_1'\cos\Theta'_W + \Big(g_1\sin\Theta_W + g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)^2 \\
&+ v_1U_{H,k1}^*\Big(6g_1'\cos\Theta'_W + \Big(g_1\sin\Theta_W + g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)^2\Big)
\end{aligned}
\tag{797}
$$



$$
\begin{aligned}
&\frac{i}{4}g_2\xi_{W^-}\Big(v_2U_{+,k2}^*\Big(4g_1'\cos\Theta'_W + \Big(-g_1\sin\Theta_W + g_2\cos\Theta_W\Big)\sin\Theta'_W\Big) \\
&+ v_1U_{+,k1}^*\Big(6g_1'\cos\Theta'_W + \Big(g_1\sin\Theta_W - g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)\Big)
\end{aligned}
\tag{798}
$$



$$\frac{i}{4}g_2\xi_{W^-}\Big(v_1\Big(6g_1'\cos\Theta'_W+\Big(g_1\sin\Theta_W-g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)U_{+,k1}$$
$$+v_2\Big(4g_1'\cos\Theta'_W+\Big(-g_1\sin\Theta_W+g_2\cos\Theta_W\Big)\sin\Theta'_W\Big)U_{+,k2}\Big) \tag{799}$$

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10 Clebsch-Gordan Coefficients