Left-Right Symmetric Model
Lagrangian, Rotations and Interactions for eigenstates 'EWSB' including one-loop Self-Energies

SARAH 4.9.1

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1 Fields

1.1 Gauge Fields

Name	$SU(N)$	Coupling	Name
B	$U(1)$	g_B	bminl
W	SU(2)	g_2	left
W_R	SU(2)	g_R	right
g	SU(3)	g_3	color

1.2 Matter Superfields

Name	Spin	Generations	$(U(1) \otimes \mathrm{SU}(2) \otimes \mathrm{SU}(2) \otimes \mathrm{SU}(3))$
Phi	0	1	$(0, \mathbf{2}, \overline{\mathbf{2}}, \mathbf{1})$
deltaR	0	1	$(1, \mathbf{1}, \mathbf{3}, \mathbf{1})$
deltaL	0	1	$(1, \mathbf{3}, \mathbf{1}, \mathbf{1})$
QLbar	$\frac{1}{2}$	3	$(-\frac{1}{6}, \overline{\mathbf{2}}, \mathbf{1}, \overline{\mathbf{3}})$
LLbar	$\frac{1}{2}$	3	$(\frac{1}{2}, \overline{\mathbf{2}}, \mathbf{1}, \mathbf{1})$
QR	$\frac{1}{2}$	3	$(\frac{1}{6}, \mathbf{1}, \mathbf{2}, \mathbf{3})$
LR	$\frac{1}{2}$	3	$(-\frac{1}{2}, \mathbf{1}, \mathbf{2}, \mathbf{1})$

2 Lagrangian

2.1 Input Lagrangian for Eigenstates GaugeES

$$
\begin{aligned}
L = & -4H_1^{-,2}H^{+,2}\lambda_2 + 8H^0H_1^-H^+H'^0\lambda_2 - 4H^{0,2}H'^{0,2}\lambda_2 + 2H_1^-H^+\mu_2^2 - 2H^0H'^0\mu_2^2 - 2\alpha_2 H_1^-H^+|\Delta_{1L0}|^2 \\
& + 2\alpha_2 H^0H'^0|\Delta_{1L0}|^2 + \mu_{LR}^2|\Delta_{1L0}|^2 - 2\alpha_2 H_1^-H^+|\Delta_L^+|^2 + 2\alpha_2 H^0H'^0|\Delta_L^+|^2 + \mu_{LR}^2|\Delta_L^+|^2 \\
& - 2\alpha_2 H_1^-H^+|HL^{++}|^2 + 2\alpha_2 H^0H'^0|HL^{++}|^2 + \mu_{LR}^2|HL^{++}|^2 - 2\alpha_2 H_1^-H^+|\Delta_{1R0}|^2 + 2\alpha_2 H^0H'^0|\Delta_{1R0}|^2 \\
& + \mu_{LR}^2|\Delta_{1R0}|^2 - 2\alpha_2 H_1^-H^+|\Delta_R^+|^2 + 2\alpha_2 H^0H'^0|\Delta_R^+|^2 + \mu_{LR}^2|\Delta_R^+|^2 - 2\alpha_2 H_1^-H^+|HR^{++}|^2 \\
& + 2\alpha_2 H^0H'^0|HR^{++}|^2 + \mu_{LR}^2|HR^{++}|^2 - 2H_1^-H^+\lambda_4|H^0|^2 + \mu|H^0|^2 + 2H^0H'^0\lambda_4|H_1^-|^2 + \mu|H_1^-|^2 \\
& + 2H^0H'^0\lambda_4|H^+|^2 + \mu|H^+|^2 - 2H_1^-H^+\lambda_4|H'^0|^2 + \mu|H'^0|^2 - \beta_3 HR^{++}H_1^{-,2}\Delta_{1L0}^* \\
& + \sqrt{2}\beta_3\Delta_R^+H_1^-H'^0\Delta_{1L0}^* + \beta_3\Delta_{1R0}H'^{0,2}\Delta_{1L0}^* - \Delta_{1L0}^2\rho_1\Delta_{1L0}^{*,2} - \sqrt{2}\beta_3 HR^{++}H^0H_1^-\Delta_L^- \\
& + \beta_3\Delta_R^+H_1^-H^+\Delta_L^- + \beta_3\Delta_R^+H^0H'^0\Delta_L^- + \sqrt{2}\beta_3\Delta_{1R0}H^+H'^0\Delta_L^- - 2\Delta_L^+\rho_1|\Delta_{1L0}|^2\Delta_L^- \\
& - \frac{1}{2}\beta_1\Delta_R^+|H^0|^2\Delta_L^- + \frac{1}{2}\beta_1\Delta_R^+|H_1^-|^2\Delta_L^- + \frac{1}{2}\beta_1\Delta_R^+|H^+|^2\Delta_L^- - \frac{1}{2}\beta_1\Delta_R^+|H'^0|^2\Delta_L^- \\
& - \Delta_L^{+,2}\rho_1\Delta_L^{-,2} - \Delta_L^{+,2}\rho_2\Delta_L^{-,2} - 2\Delta_{1L0}HL^{++}\rho_2\Delta_L^{-,2} - \Delta_R^{+,2}\rho_4\Delta_L^{-,2} - 2\Delta_{1R0}HR^{++}\rho_4\Delta_L^{-,2} \\
& + \beta_3 HR^{++}H^{0,2}HL^{--} - \sqrt{2}\beta_3\Delta_R^+H^0H^+HL^{--} - \beta_3\Delta_{1R0}H^{+,2}HL^{--} - 2HL^{++}\rho_1|\Delta_{1L0}|^2HL^{--}
\end{aligned}
$$

$$
\begin{aligned}
&- 4HL^{++}\rho_2|\Delta_{1L0}|^2HL^{--} - 2HL^{++}\rho_1|\Delta_L^+|^2HL^{--} - 2\Delta_L^{+,2}\rho_2\Delta_{1L0}^*HL^{--} - 2\Delta_R^{+,2}\rho_4\Delta_{1L0}^*HL^{--} \\
&- 4\Delta_{1R0}HR^{++}\rho_4\Delta_{1L0}^*HL^{--} - HL^{++,2}\rho_1HL^{--,2} + \beta_2\Delta_{1L0}H^{0,2}\Delta_{1R0}^* - \sqrt{2}\beta_2\Delta_L^+H^0H_1^-\Delta_{1R0}^* - \beta_2HL^{++}H_1^{-,2}\Delta_{1R0}^* \\
&- \Delta_{1R0}\rho_3|\Delta_{1L0}|^2\Delta_{1R0}^* - \Delta_{1R0}\rho_3|\Delta_L^+|^2\Delta_{1R0}^* - \Delta_{1R0}\rho_3|HL^{++}|^2\Delta_{1R0}^* - \Delta_{1R0}^2\rho_1\Delta_{1R0}^{*,2} \\
&- \sqrt{2}\beta_2\Delta_{1L0}H^0H^+\Delta_R^- + \beta_2\Delta_L^+H_1^-H^+\Delta_R^- + \beta_2\Delta_L^+H^0H'^0\Delta_R^- + \sqrt{2}\beta_2HL^{++}H_1^-H'^0\Delta_R^- \\
&- \Delta_R^+\rho_3|\Delta_{1L0}|^2\Delta_R^- - \Delta_R^+\rho_3|\Delta_L^+|^2\Delta_R^- - \Delta_R^+\rho_3|HL^{++}|^2\Delta_R^- - 2\Delta_R^+\rho_1|\Delta_{1R0}|^2\Delta_R^- \\
&- \frac{1}{2}\beta_1\Delta_L^+|H^0|^2\Delta_R^- + \frac{1}{2}\beta_1\Delta_L^+|H_1^-|^2\Delta_R^- + \frac{1}{2}\beta_1\Delta_L^+|H^+|^2\Delta_R^- - \frac{1}{2}\beta_1\Delta_L^+|H'^0|^2\Delta_R^- \\
&- \Delta_R^{+,2}\rho_1\Delta_R^{-,2} - \Delta_R^{+,2}\rho_2\Delta_R^{-,2} - 2\Delta_{1R0}HR^{++}\rho_2\Delta_R^{-,2} - \Delta_L^{+,2}\rho_4\Delta_R^{-,2} - 2\Delta_{1L0}HL^{++}\rho_4\Delta_R^{-,2} \\
&- \beta_2\Delta_{1L0}H^{+,2}HR^{--} + \sqrt{2}\beta_2\Delta_L^+H^+H'^0HR^{--} + \beta_2HL^{++}H'^{0,2}HR^{--} - HR^{++}\rho_3|\Delta_{1L0}|^2HR^{--} - HR^{++}\rho_3|\Delta_L^+|^2HR^{--} \\
&- HR^{++}\rho_3|HL^{++}|^2HR^{--} - 2HR^{++}\rho_1|\Delta_{1R0}|^2HR^{--} - 4HR^{++}\rho_2|\Delta_{1R0}|^2HR^{--} - 2HR^{++}\rho_1|\Delta_R^+|^2HR^{--} \\
&- 2\Delta_R^{+,2}\rho_2\Delta_{1R0}^*HR^{--} - 2\Delta_L^{+,2}\rho_4\Delta_{1R0}^*HR^{--} - 4\Delta_{1L0}HL^{++}\rho_4\Delta_{1R0}^*HR^{--} - HR^{++,2}\rho_1HR^{--,2} + 2H^{0,2}H'^0\lambda_4H^{0,*} \\
&- \alpha_1H^0|\Delta_{1L0}|^2H^{0,*} - \alpha_1H^0|\Delta_L^+|^2H^{0,*} - \frac{1}{2}\alpha_3H^0|\Delta_L^+|^2H^{0,*} - \alpha_1H^0|HL^{++}|^2H^{0,*} \\
&- \alpha_3H^0|HL^{++}|^2H^{0,*} - \alpha_1H^0|\Delta_{1R0}|^2H^{0,*} - \alpha_1H^0|\Delta_R^+|^2H^{0,*} - \frac{1}{2}\alpha_3H^0|\Delta_R^+|^2H^{0,*} \\
&- \alpha_1H^0|HR^{++}|^2H^{0,*} - \alpha_3H^0|HR^{++}|^2H^{0,*} - \frac{1}{\sqrt{2}}\alpha_3\Delta_L^+H_1^-\Delta_{1L0}^*H^{0,*} - \frac{1}{\sqrt{2}}\beta_1\Delta_R^+H_1^-\Delta_{1L0}^*H^{0,*} \\
&- \beta_1\Delta_{1R0}H'^0\Delta_{1L0}^*H^{0,*} + \frac{1}{\sqrt{2}}\alpha_3HL^{++}H_1^-\Delta_L^-H^{0,*} - \frac{1}{\sqrt{2}}\beta_1\Delta_{1R0}H^+\Delta_L^-H^{0,*} - \frac{1}{\sqrt{2}}\beta_1HL^{++}H_1^-\Delta_R^-H^{0,*} \\
&- \frac{1}{\sqrt{2}}\alpha_3\Delta_{1R0}H^+\Delta_R^-H^{0,*} - \frac{1}{\sqrt{2}}\beta_1\Delta_L^+H^+HR^{--}H^{0,*} + \frac{1}{\sqrt{2}}\alpha_3\Delta_R^+H^+HR^{--}H^{0,*} - \beta_1HL^{++}H'^0HR^{--}H^{0,*} \\
&- H^{0,2}\lambda H^{0,*,2} + \beta_2\Delta_{1R0}\Delta_{1L0}^*H^{0,*,2} + \beta_3HL^{++}HR^{--}H^{0,*,2} - 2H_1^{-,2}H^+\lambda_4H_1^+ - \alpha_1H_1^-|\Delta_{1L0}|^2H_1^+ \\
&- \alpha_3H_1^-|\Delta_{1L0}|^2H_1^+ - \alpha_1H_1^-|\Delta_L^+|^2H_1^+ - \frac{1}{2}\alpha_3H_1^-|\Delta_L^+|^2H_1^+ - \alpha_1H_1^-|HL^{++}|^2H_1^+ \\
&- \alpha_1H_1^-|\Delta_{1R0}|^2H_1^+ - \alpha_1H_1^-|\Delta_R^+|^2H_1^+ - \frac{1}{2}\alpha_3H_1^-|\Delta_R^+|^2H_1^+ - \alpha_1H_1^-|HR^{++}|^2H_1^+ \\
&- \alpha_3H_1^-|HR^{++}|^2H_1^+ - 2H_1^-\lambda|H^0|^2H_1^+ - \frac{1}{\sqrt{2}}\alpha_3\Delta_{1L0}H^0\Delta_L^-H_1^+ + \frac{1}{\sqrt{2}}\beta_1\Delta_{1R0}H'^0\Delta_L^-H_1^+ \\
&+ \frac{1}{\sqrt{2}}\alpha_3\Delta_L^+H^0HL^{--}H_1^+ - \frac{1}{\sqrt{2}}\beta_1\Delta_R^+H^0HL^{--}H_1^+ - \beta_1\Delta_{1R0}H^+HL^{--}H_1^+ - \frac{1}{\sqrt{2}}\beta_1\Delta_{1L0}H^0\Delta_R^-H_1^+ \\
&- \frac{1}{\sqrt{2}}\alpha_3\Delta_{1R0}H'^0\Delta_R^-H_1^+ - \beta_1\Delta_{1L0}H^+HR^{--}H_1^+ + \frac{1}{\sqrt{2}}\beta_1\Delta_L^+H'^0HR^{--}H_1^+ + \frac{1}{\sqrt{2}}\alpha_3\Delta_R^+H'^0HR^{--}H_1^+ \\
&- \sqrt{2}\beta_2\Delta_{1R0}\Delta_L^-H^{0,*}H_1^+ - \sqrt{2}\beta_3\Delta_L^+HR^{--}H^{0,*}H_1^+ - H_1^{-,2}\lambda H_1^{+,2} - \beta_2\Delta_{1R0}HL^{--}H_1^{+,2} \\
&- \beta_3\Delta_{1L0}HR^{--}H_1^{+,2} - 2H_1^-H^{+,2}\lambda_4H^- - \alpha_1H^+|\Delta_{1L0}|^2H^- - \alpha_1H^+|\Delta_L^+|^2H^- \\
&- \frac{1}{2}\alpha_3H^+|\Delta_L^+|^2H^- - \alpha_1H^+|HL^{++}|^2H^- - \alpha_3H^+|HL^{++}|^2H^- - \alpha_1H^+|\Delta_{1R0}|^2H^- \\
&- \alpha_3H^+|\Delta_{1R0}|^2H^- - \alpha_1H^+|\Delta_R^+|^2H^- - \frac{1}{2}\alpha_3H^+|\Delta_R^+|^2H^- - \alpha_1H^+|HR^{++}|^2H^- \\
&- 2H^+\lambda|H^0|^2H^- - 2H^+\lambda|H_1^-|^2H^- - 4H^+\lambda_3|H_1^-|^2H^- - \beta_1HR^{++}H_1^-\Delta_{1L0}^*H^-
\end{aligned}
$$

$$
\begin{aligned}
&- \frac{1}{\sqrt{2}}\alpha_3\Delta_L^+H'^0\Delta_{1L0}^*H^- + \frac{1}{\sqrt{2}}\beta_1\Delta_R^+H'^0\Delta_{1L0}^*H^- - \frac{1}{\sqrt{2}}\beta_1 HR^{++}H^0\Delta_L^-H^- + \frac{1}{\sqrt{2}}\alpha_3 HL^{++}H'^0\Delta_L^-H^- \\
&- \frac{1}{\sqrt{2}}\beta_1\Delta_L^+H^0\Delta_{1R0}^*H^- - \frac{1}{\sqrt{2}}\alpha_3\Delta_R^+H^0\Delta_{1R0}^*H^- - \beta_1 HL^{++}H_1^-\Delta_{1R0}^*H^- + \frac{1}{\sqrt{2}}\alpha_3 HR^{++}H^0\Delta_R^-H^- \\
&+ \frac{1}{\sqrt{2}}\beta_1 HL^{++}H'^0\Delta_R^-H^- - \sqrt{2}\beta_2\Delta_R^+\Delta_{1L0}^*H^{0,*}H^- - \sqrt{2}\beta_3 HL^{++}\Delta_R^-H^{0,*}H^- + 4H^0H'^0\lambda_3H_1^+H^- \\
&+ 2\mu_2^2H_1^+H^- - 2\alpha_2|\Delta_{1L0}|^2H_1^+H^- - 2\alpha_2|\Delta_L^+|^2H_1^+H^- - 2\alpha_2|HL^{++}|^2H_1^+H^- \\
&- 2\alpha_2|\Delta_{1R0}|^2H_1^+H^- - 2\alpha_2|\Delta_R^+|^2H_1^+H^- - 2\alpha_2|HR^{++}|^2H_1^+H^- - 2\lambda_4|H^0|^2H_1^+H^- \\
&- 2\lambda_4|H'^0|^2H_1^+H^- + \beta_2\Delta_R^+\Delta_L^-H_1^+H^- + \beta_3\Delta_L^+\Delta_R^-H_1^+H^- - 2H_1^-\lambda_4H_1^{+,2}H^- \\
&- H^{+,2}\lambda H^{-,2} - \beta_2 HR^{++}\Delta_{1L0}^*H^{-,2} - \beta_3 HL^{++}\Delta_{1R0}^*H^{-,2} - 2H^+\lambda_4H_1^+H^{-,2} - 4\lambda_2H_1^{+,2}H^{-,2} \\
&+ 2H^0H'^{0,2}\lambda_4H'^{0,*} - \alpha_1H'^0|\Delta_{1L0}|^2H'^{0,*} - \alpha_3H'^0|\Delta_{1L0}|^2H'^{0,*} - \alpha_1H'^0|\Delta_L^+|^2H'^{0,*} \\
&- \frac{1}{2}\alpha_3H'^0|\Delta_L^+|^2H'^{0,*} - \alpha_1H'^0|HL^{++}|^2H'^{0,*} - \alpha_1H'^0|\Delta_{1R0}|^2H'^{0,*} - \alpha_3H'^0|\Delta_{1R0}|^2H'^{0,*} \\
&- \alpha_1H'^0|\Delta_R^+|^2H'^{0,*} - \frac{1}{2}\alpha_3H'^0|\Delta_R^+|^2H'^{0,*} - \alpha_1H'^0|HR^{++}|^2H'^{0,*} - 2H'^0\lambda|H^0|^2H'^{0,*} \\
&- 4H'^0\lambda_3|H^0|^2H'^{0,*} - 2H'^0\lambda|H_1^-|^2H'^{0,*} - 2H'^0\lambda|H^+|^2H'^{0,*} + \frac{1}{\sqrt{2}}\beta_1 HR^{++}H_1^-\Delta_L^-H'^{0,*} \\
&- \frac{1}{\sqrt{2}}\alpha_3\Delta_{1L0}H^+\Delta_L^-H'^{0,*} - \beta_1 HR^{++}H^0HL^{--}H'^{0,*} + \frac{1}{\sqrt{2}}\alpha_3\Delta_L^+H^+HL^{--}H'^{0,*} + \frac{1}{\sqrt{2}}\beta_1\Delta_R^+H^+HL^{--}H'^{0,*} \\
&- \beta_1\Delta_{1L0}H^0\Delta_{1R0}^*H'^{0,*} + \frac{1}{\sqrt{2}}\beta_1\Delta_L^+H_1^-\Delta_{1R0}^*H'^{0,*} - \frac{1}{\sqrt{2}}\alpha_3\Delta_R^+H_1^-\Delta_{1R0}^*H'^{0,*} + \frac{1}{\sqrt{2}}\alpha_3 HR^{++}H_1^-\Delta_R^-H'^{0,*} \\
&+ \frac{1}{\sqrt{2}}\beta_1\Delta_{1L0}H^+\Delta_R^-H'^{0,*} + 4H_1^-H^+\lambda_3H^{0,*}H'^{0,*} - 2\mu_2^2H^{0,*}H'^{0,*} + 2\alpha_2|\Delta_{1L0}|^2H^{0,*}H'^{0,*} \\
&+ 2\alpha_2|\Delta_L^+|^2H^{0,*}H'^{0,*} + 2\alpha_2|HL^{++}|^2H^{0,*}H'^{0,*} + 2\alpha_2|\Delta_{1R0}|^2H^{0,*}H'^{0,*} + 2\alpha_2|\Delta_R^+|^2H^{0,*}H'^{0,*} \\
&+ 2\alpha_2|HR^{++}|^2H^{0,*}H'^{0,*} + 2\lambda_4|H_1^-|^2H^{0,*}H'^{0,*} + 2\lambda_4|H^+|^2H^{0,*}H'^{0,*} + \beta_2\Delta_R^+\Delta_L^-H^{0,*}H'^{0,*} \\
&+ \beta_3\Delta_L^+\Delta_R^-H^{0,*}H'^{0,*} + 2H^0\lambda_4H^{0,*,2}H'^{0,*} + \sqrt{2}\beta_2\Delta_R^+HL^{--}H_1^+H'^{0,*} + \sqrt{2}\beta_3\Delta_{1L0}\Delta_R^-H_1^+H'^{0,*} \\
&+ \sqrt{2}\beta_2 HR^{++}\Delta_L^-H^-H'^{0,*} + \sqrt{2}\beta_3\Delta_L^+\Delta_{1R0}^*H^-H'^{0,*} + 8\lambda_2H^{0,*}H_1^+H^-H'^{0,*} - H'^{0,2}\lambda H'^{0,*,2} \\
&+ \beta_2 HR^{++}HL^{--}H'^{0,*,2} + \beta_3\Delta_{1L0}\Delta_{1R0}^*H'^{0,*,2} + 2H'^0\lambda_4H^{0,*}H'^{0,*,2} - 4\lambda_2H^{0,*,2}H'^{0,*,2} + HL^{--}Y_{DL,ik}^*\mathrm{conj}\Big(\mathrm{eL}\Big(\{\mathrm{gt1}\}\Big)\Big(2\Big)\Big)\mathrm{c} \\
&+ HL^{--}Y_{DL,ik}^*\mathrm{conj}\Big(\mathrm{eL}\Big(\{\mathrm{gt1}\}\Big)\Big(1\Big)\Big)\mathrm{conj}\Big(\mathrm{eL}\Big(\{\mathrm{gt3}\}\Big)\Big(2\Big)\Big) + HR^{--}Y_{DR,ik}^*\mathrm{conj}\Big(\mathrm{eR}\Big(\{\mathrm{gt1}\}\Big)\Big(2\Big)\Big)\mathrm{conj}\Big(\mathrm{eR}\Big(\{\mathrm{gt3}\}\Big)\Big(1\Big)\Big) + HR^{-} \\
&+ \frac{1}{\sqrt{2}}\Delta_L^-Y_{DL,ik}^*\mathrm{conj}\Big(\mathrm{eL}\Big(\{\mathrm{gt1}\}\Big)\Big(2\Big)\Big)\mathrm{conj}\Big(\mathrm{nuL}\Big(\{\mathrm{gt3}\}\Big)\Big(1\Big)\Big) - \Delta_{1L0}^*Y_{DL,ik}^*\mathrm{conj}\Big(\mathrm{nuL}\Big(\{\mathrm{gt1}\}\Big)\Big(2\Big)\Big)\mathrm{conj}\Big(\mathrm{nuL}\Big(\{\mathrm{gt3}\}\Big)\Big(1\Big)\Big) + \frac{1}{\sqrt{2}} \\
&+ \frac{1}{\sqrt{2}}\Delta_R^-Y_{DR,ik}^*\mathrm{conj}\Big(\mathrm{eR}\Big(\{\mathrm{gt3}\}\Big)\Big(1\Big)\Big)\mathrm{conj}\Big(\mathrm{nuR}\Big(\{\mathrm{gt1}\}\Big)\Big(2\Big)\Big) + \frac{1}{\sqrt{2}}\Delta_R^-Y_{DR,ik}^*\mathrm{conj}\Big(\mathrm{eR}\Big(\{\mathrm{gt1}\}\Big)\Big(2\Big)\Big)\mathrm{conj}\Big(\mathrm{nuR}\Big(\{\mathrm{gt3}\}\Big)\Big(1\Big)\Big) - \Delta \\
&- H'^{0,*}d_{R,k\gamma}^*Y_{Q1,ik}^*\delta_{\alpha\gamma}d_{L,i\alpha} - H_1^+u_{R,k\gamma}^*Y_{Q1,ik}^*\delta_{\alpha\gamma}d_{L,i\alpha} - H^0d_{R,k\gamma}^*Y_{Q2,ik}^*\delta_{\alpha\gamma}d_{L,i\alpha} \\
&+ H^+u_{R,k\gamma}^*Y_{Q2,ik}^*\delta_{\alpha\gamma}d_{L,i\alpha} - H'^{0,*}e_{R,k}^*Y_{L1,jk}^*e_{L,j} - H_1^+\nu_{R,k}^*Y_{L1,jk}^*e_{L,j} - H^0e_{R,k}^*Y_{L2,jk}^*e_{L,j} \\
&+ H^+\nu_{R,k}^*Y_{L2,jk}^*e_{L,j} - H^-e_{R,k}^*Y_{L1,jk}^*\nu_{L,j} - H^{0,*}\nu_{R,k}^*Y_{L1,jk}^*\nu_{L,j} + H_1^-e_{R,k}^*Y_{L2,jk}^*\nu_{L,j}
\end{aligned}
$$

$$
\begin{aligned}
&- H'^{0}\nu^{*}_{R,k}Y^{*}_{L2,jk}\nu_{L,j} - H^{-}d^{*}_{R,k\gamma}Y^{*}_{Q1,ik}\delta_{\alpha\gamma}u_{L,i\alpha} - H^{0,*}u^{*}_{R,k\gamma}Y^{*}_{Q1,ik}\delta_{\alpha\gamma}u_{L,i\alpha} \\
&+ H_1^{-}d^{*}_{R,k\gamma}Y^{*}_{Q2,ik}\delta_{\alpha\gamma}u_{L,i\alpha} - H'^{0}u^{*}_{R,k\gamma}Y^{*}_{Q2,ik}\delta_{\alpha\gamma}u_{L,i\alpha} - H'^{0}e^{*}_{L,j}e_{R,k}Y_{L1,jk} - H^{+}\nu^{*}_{L,j}e_{R,k}Y_{L1,jk} \\
&- H_1^{-}e^{*}_{L,j}\nu_{R,k}Y_{L1,jk} - H^{0}\nu^{*}_{L,j}\nu_{R,k}Y_{L1,jk} - H^{0,*}e^{*}_{L,j}e_{R,k}Y_{L2,jk} + H_1^{+}\nu^{*}_{L,j}e_{R,k}Y_{L2,jk} \\
&+ H^{-}e^{*}_{L,j}\nu_{R,k}Y_{L2,jk} - H'^{0,*}\nu^{*}_{L,j}\nu_{R,k}Y_{L2,jk} - H'^{0}d^{*}_{L,i\alpha}\delta_{\alpha\gamma}d_{R,k\gamma}Y_{Q1,ik} - H^{+}u^{*}_{L,i\alpha}\delta_{\alpha\gamma}d_{R,k\gamma}Y_{Q1,ik} \\
&- H_1^{-}d^{*}_{L,i\alpha}\delta_{\alpha\gamma}u_{R,k\gamma}Y_{Q1,ik} - H^{0}u^{*}_{L,i\alpha}\delta_{\alpha\gamma}u_{R,k\gamma}Y_{Q1,ik} - H^{0,*}d^{*}_{L,i\alpha}\delta_{\alpha\gamma}d_{R,k\gamma}Y_{Q2,ik} \\
&+ H_1^{+}u^{*}_{L,i\alpha}\delta_{\alpha\gamma}d_{R,k\gamma}Y_{Q2,ik} + H^{-}d^{*}_{L,i\alpha}\delta_{\alpha\gamma}u_{R,k\gamma}Y_{Q2,ik} - H'^{0,*}u^{*}_{L,i\alpha}\delta_{\alpha\gamma}u_{R,k\gamma}Y_{Q2,ik} + HL^{++}Y_{DL,ik}\mathrm{eL}\Big(\{\mathrm{gt1}\}\Big)\Big(2\Big)\mathrm{eL}\Big(\{\mathrm{gt3}\}\Big)\Big(1\Big) \\
&+ HL^{++}Y_{DL,ik}\mathrm{eL}\Big(\{\mathrm{gt1}\}\Big)\Big(1\Big)\mathrm{eL}\Big(\{\mathrm{gt3}\}\Big)\Big(2\Big) + HR^{++}Y_{DR,ik}\mathrm{eR}\Big(\{\mathrm{gt1}\}\Big)\Big(2\Big)\mathrm{eR}\Big(\{\mathrm{gt3}\}\Big)\Big(1\Big) + HR^{++}Y_{DR,ik}\mathrm{eR}\Big(\{\mathrm{gt1}\}\Big)\Big(1\Big)\mathrm{eR}\Big(\{ \\
&- \Delta_{1L0}Y_{DL,ik}\mathrm{nuL}\Big(\{\mathrm{gt1}\}\Big)\Big(2\Big)\mathrm{nuL}\Big(\{\mathrm{gt3}\}\Big)\Big(1\Big) + \frac{1}{\sqrt{2}}\Delta_L^{+}Y_{DL,ik}\mathrm{eL}\Big(\{\mathrm{gt1}\}\Big)\Big(1\Big)\mathrm{nuL}\Big(\{\mathrm{gt3}\}\Big)\Big(2\Big) - \Delta_{1L0}Y_{DL,ik}\mathrm{nuL}\Big(\{\mathrm{gt1}\}\Big)\Big(1\Big)\mathrm{nu} \\
&- \Delta_{1R0}Y_{DR,ik}\mathrm{nuR}\Big(\{\mathrm{gt1}\}\Big)\Big(2\Big)\mathrm{nuR}\Big(\{\mathrm{gt3}\}\Big)\Big(1\Big) + \frac{1}{\sqrt{2}}\Delta_R^{+}Y_{DR,ik}\mathrm{eR}\Big(\{\mathrm{gt1}\}\Big)\Big(1\Big)\mathrm{nuR}\Big(\{\mathrm{gt3}\}\Big)\Big(2\Big) - \Delta_{1R0}Y_{DR,ik}\mathrm{nuR}\Big(\{\mathrm{gt1}\}\Big)\Big(1\Big)\mathrm{n}
\end{aligned}
\tag{1}
$$

2.2 Gauge fixing terms

2.2.1 Gauge fixing terms for eigenstates 'GaugeES'

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

2.2.2 Gauge fixing terms for eigenstates 'EWSB'

$$
\begin{aligned}
L_{GF} = &- \frac{1}{2}|\partial_\mu g|^2\xi_g^{-1} - \frac{1}{2}|\partial_\mu \gamma|^2\xi_\gamma^{-1} \\
&- |\frac{1}{2}\Big(2\partial_\mu W^{-} \\
&- i\xi_{W^-}\Big(g_2H_1^{-}v_d\cos\phi_W - \sqrt{2}g_2v_L\Delta_L^{-}\cos\phi_W - g_2v_uH^{-}\cos\phi_W - g_RH_1^{-}v_u\sin\phi_W \\
&- \sqrt{2}g_Rv_R\Delta_R^{-}\sin\phi_W + g_Rv_dH^{-}\sin\phi_W\Big)\Big)|^2\xi_{W^-}^{-1} \\
&- |\frac{1}{2}\Big(2\partial_\mu W_R^{-} \\
&+ i\xi_{W_R^-}\Big(g_RH_1^{-}v_u\cos\phi_W + \sqrt{2}g_Rv_R\Delta_R^{-}\cos\phi_W + g_2H_1^{-}v_d\sin\phi_W - \sqrt{2}g_2v_L\Delta_L^{-}\sin\phi_W \\
&- H^{-}\Big(g_2v_u\sin\phi_W + g_Rv_d\cos\phi_W\Big)\Big)\Big)|^2\xi_{W_R^-}^{-1} \\
&- \frac{1}{2}|\frac{1}{2}\Big(2\partial_\mu Z \\
&+ \xi_Z\Big(2g_B\Big(\sigma_{L0}v_L + \sigma_{R0}v_R\Big)Z_{12}^{Z} + g_2\Big(-2\sigma_{L0}v_L + \sigma_{H10}v_d - \sigma_{H20}v_u\Big)Z_{22}^{Z} + g_R\Big(-2\sigma_{R0}v_R - \sigma_{H10}v_d + \sigma_{H20}v_u\Big)Z_{32}^{Z}\Big)|^2\xi_Z^{-1} \\
&- \frac{1}{2}|\frac{1}{2}\Big(2\partial_\mu Z'
\end{aligned}
$$

$$+\xi_{Z'}\Big(2g_B\Big(\sigma_{L0}v_L+\sigma_{R0}v_R\Big)Z^Z_{13}+g_2\Big(-2\sigma_{L0}v_L+\sigma_{H10}v_d-\sigma_{H20}v_u\Big)Z^Z_{23}+g_R\Big(-2\sigma_{R0}v_R-\sigma_{H10}v_d+\sigma_{H20}v_u\Big)Z^Z_{33}\Big)\Big)^2\xi^{-1}_{Z'} \tag{3}$$

2.3 Fields integrated out

None

3 Field Rotations

3.1 Rotations in gauge sector for eigenstates 'EWSB'

$$\begin{pmatrix} B_\rho \\ W_{3\rho} \\ W_{R,3\rho} \end{pmatrix} = Z^Z \begin{pmatrix} \gamma_\rho \\ Z_\rho \\ Z'_\rho \end{pmatrix} \tag{4}$$

$$\begin{pmatrix} W_{1\rho} \\ W_{2\rho} \\ W_{R,1\rho} \\ W_{R,2\rho} \end{pmatrix} = Z^W \begin{pmatrix} W^-_\rho \\ W^-_\rho \\ W^-_{R,\rho} \\ W^-_{R,\rho} \end{pmatrix} \tag{5}$$

$$\tag{6}$$

The mixing matrices are parametrized by

$$Z^W = \begin{pmatrix} \frac{1}{\sqrt{2}}\cos\phi_W & \frac{1}{\sqrt{2}}\cos\phi_W & -\frac{1}{\sqrt{2}}\sin\phi_W & -\frac{1}{\sqrt{2}}\sin\phi_W \\ -i\frac{1}{\sqrt{2}}\cos\phi_W & i\frac{1}{\sqrt{2}}\cos\phi_W & i\frac{1}{\sqrt{2}}\sin\phi_W & -i\frac{1}{\sqrt{2}}\sin\phi_W \\ \frac{1}{\sqrt{2}}\sin\phi_W & \frac{1}{\sqrt{2}}\sin\phi_W & \frac{1}{\sqrt{2}}\cos\phi_W & \frac{1}{\sqrt{2}}\cos\phi_W \\ -i\frac{1}{\sqrt{2}}\sin\phi_W & i\frac{1}{\sqrt{2}}\sin\phi_W & -i\frac{1}{\sqrt{2}}\cos\phi_W & i\frac{1}{\sqrt{2}}\cos\phi_W \end{pmatrix} \tag{7}$$

$$\tag{8}$$

3.2 Rotations in Mass sector for eigenstates 'EWSB'

3.2.1 Mass Matrices for Scalars

- **Mass matrix for Higgs**, Basis: $(\phi_{H10},\phi_{H20},\phi_{R0},\phi_{L0}),(\phi_{H10},\phi_{H20},\phi_{R0},\phi_{L0})$

$$m^2_h = \begin{pmatrix} m_{\phi_{H10}\phi_{H10}} & m_{\phi_{H20}\phi_{H10}} & m_{\phi_{R0}\phi_{H10}} & m_{\phi_{L0}\phi_{H10}} \\ m_{\phi_{H10}\phi_{H20}} & m_{\phi_{H20}\phi_{H20}} & m_{\phi_{R0}\phi_{H20}} & m_{\phi_{L0}\phi_{H20}} \\ m_{\phi_{H10}\phi_{R0}} & m_{\phi_{H20}\phi_{R0}} & m_{\phi_{R0}\phi_{R0}} & m_{\phi_{L0}\phi_{R0}} \\ m_{\phi_{H10}\phi_{L0}} & m_{\phi_{H20}\phi_{L0}} & m_{\phi_{R0}\phi_{L0}} & m_{\phi_{L0}\phi_{L0}} \end{pmatrix} \tag{9}$$

$$m_{\phi_{H10}\phi_{H10}} = \frac{1}{2}\Big(-12\lambda_4 v_d v_u + 2\Big(2\lambda_3 + 4\lambda_2 + \lambda\Big)v_u^2 - 2\Big(\beta_2 v_L v_R + \mu\Big) + 6\lambda v_d^2 + \alpha_1\Big(v_L^2 + v_R^2\Big)\Big) \tag{10}$$

$$m_{\phi_{H10}\phi_{H20}} = 2\Big(\Big(2\lambda_3 + 4\lambda_2 + \lambda\Big)v_d v_u + \mu_2^2\Big) - 3\lambda_4\Big(v_d^2 + v_u^2\Big) - \alpha_2\Big(v_L^2 + v_R^2\Big) + \frac{1}{2}\beta_1 v_L v_R \tag{11}$$

$$m_{\phi_{H20}\phi_{H20}} = \frac{1}{2}\Big(-12\lambda_4 v_d v_u + 2\Big(2\lambda_3 + 4\lambda_2 + \lambda\Big)v_d^2 - 2\Big(\beta_3 v_L v_R + \mu\Big) + 6\lambda v_u^2 + \Big(\alpha_1 + \alpha_3\Big)\Big(v_L^2 + v_R^2\Big)\Big) \tag{12}$$

$$m_{\phi_{H10}\phi_{R0}} = \Big(-2\alpha_2 v_u + \alpha_1 v_d\Big)v_R + \Big(-\beta_2 v_d + \frac{1}{2}\beta_1 v_u\Big)v_L \tag{13}$$

$$m_{\phi_{H20}\phi_{R0}} = \Big(-2\alpha_2 v_d + \Big(\alpha_1 + \alpha_3\Big)v_u\Big)v_R + \Big(-\beta_3 v_u + \frac{1}{2}\beta_1 v_d\Big)v_L \tag{14}$$

$$m_{\phi_{R0}\phi_{R0}} = \frac{1}{2}\Big(-2\mu_{LR}^2 - 4\alpha_2 v_d v_u + 6\rho_1 v_R^2 + \Big(\alpha_1 + \alpha_3\Big)v_u^2 + \alpha_1 v_d^2 + \rho_3 v_L^2\Big) \tag{15}$$

$$m_{\phi_{H10}\phi_{L0}} = \Big(-2\alpha_2 v_u + \alpha_1 v_d\Big)v_L + \Big(-\beta_2 v_d + \frac{1}{2}\beta_1 v_u\Big)v_R \tag{16}$$

$$m_{\phi_{H20}\phi_{L0}} = \Big(-2\alpha_2 v_d + \Big(\alpha_1 + \alpha_3\Big)v_u\Big)v_L + \Big(-\beta_3 v_u + \frac{1}{2}\beta_1 v_d\Big)v_R \tag{17}$$

$$m_{\phi_{R0}\phi_{L0}} = \frac{1}{2}\Big(2\rho_3 v_L v_R + \beta_1 v_d v_u - \beta_2 v_d^2 - \beta_3 v_u^2\Big) \tag{18}$$

$$m_{\phi_{L0}\phi_{L0}} = \frac{1}{2}\Big(-2\mu_{LR}^2 - 4\alpha_2 v_d v_u + 6\rho_1 v_L^2 + \Big(\alpha_1 + \alpha_3\Big)v_u^2 + \alpha_1 v_d^2 + \rho_3 v_R^2\Big) \tag{19}$$

This matrix is diagonalized by Z^H:

$$Z^H m_h^2 Z^{H,\dagger} = m_{2,h}^{dia} \tag{20}$$

with

$$\phi_{H10} = \sum_j Z_{j1}^H h_j\,, \qquad \phi_{H20} = \sum_j Z_{j2}^H h_j\,, \qquad \phi_{R0} = \sum_j Z_{j3}^H h_j \tag{21}$$

$$\phi_{L0} = \sum_j Z_{j4}^H h_j \tag{22}$$

- **Mass matrix for Pseudo-Scalar Higgs**, Basis: $(\sigma_{H10}, \sigma_{H20}, \sigma_{R0}, \sigma_{L0})\,, (\sigma_{H10}, \sigma_{H20}, \sigma_{R0}, \sigma_{L0})$

$$m_{A^0}^2 = \begin{pmatrix} m_{\sigma_{H10}\sigma_{H10}} & m_{\sigma_{H20}\sigma_{H10}} & m_{\sigma_{R0}\sigma_{H10}} & \Big(\beta_2 v_d - \frac{1}{2}\beta_1 v_u\Big)v_R \\ m_{\sigma_{H10}\sigma_{H20}} & m_{\sigma_{H20}\sigma_{H20}} & \Big(\beta_3 v_u - \frac{1}{2}\beta_1 v_d\Big)v_L & m_{\sigma_{L0}\sigma_{H20}} \\ m_{\sigma_{H10}\sigma_{R0}} & \Big(\beta_3 v_u - \frac{1}{2}\beta_1 v_d\Big)v_L & m_{\sigma_{R0}\sigma_{R0}} & m_{\sigma_{L0}\sigma_{R0}} \\ \Big(\beta_2 v_d - \frac{1}{2}\beta_1 v_u\Big)v_R & m_{\sigma_{H20}\sigma_{L0}} & m_{\sigma_{R0}\sigma_{L0}} & m_{\sigma_{L0}\sigma_{L0}} \end{pmatrix} + \xi_Z m^2(Z) + \xi_{Z'} m^2(Z') \tag{23}$$

$$m_{\sigma_{H10}\sigma_{H10}} = \Big(2\lambda_3 - 4\lambda_2 + \lambda\Big)v_u^2 - 2\lambda_4 v_d v_u + \frac{1}{2}\Big(2\beta_2 v_L v_R + \alpha_1\Big(v_L^2 + v_R^2\Big)\Big) + \lambda v_d^2 - \mu \tag{24}$$

$$m_{\sigma_{H10}\sigma_{H20}} = -2\mu_2^2 - 8\lambda_2 v_d v_u + \alpha_2\Big(v_L^2 + v_R^2\Big) + \frac{1}{2}\beta_1 v_L v_R + \lambda_4\Big(v_d^2 + v_u^2\Big) \tag{25}$$

$$m_{\sigma_{H20}\sigma_{H20}} = \frac{1}{2}\Big(2\Big(\Big(2\lambda_3 - 4\lambda_2 + \lambda\Big)v_d^2 + \beta_3 v_L v_R + \lambda v_u^2\Big) - 2\mu - 4\lambda_4 v_d v_u + \Big(\alpha_1 + \alpha_3\Big)\Big(v_L^2 + v_R^2\Big)\Big) \tag{26}$$

$$m_{\sigma_{H10}\sigma_{R0}} = \Big(-\beta_2 v_d + \frac{1}{2}\beta_1 v_u\Big) v_L \tag{27}$$

$$m_{\sigma_{R0}\sigma_{R0}} = \frac{1}{2}\Big(-2\mu_{LR}^2 + 2\rho_1 v_R^2 - 4\alpha_2 v_d v_u + \Big(\alpha_1 + \alpha_3\Big) v_u^2 + \alpha_1 v_d^2 + \rho_3 v_L^2\Big) \tag{28}$$

$$m_{\sigma_{H20}\sigma_{L0}} = \frac{1}{2}\Big(-2\beta_3 v_u + \beta_1 v_d\Big) v_R \tag{29}$$

$$m_{\sigma_{R0}\sigma_{L0}} = \frac{1}{2}\Big(-\beta_2 v_d^2 + v_u\Big(\beta_1 v_d - \beta_3 v_u\Big)\Big) \tag{30}$$

$$m_{\sigma_{L0}\sigma_{L0}} = \frac{1}{2}\Big(-2\mu_{LR}^2 + 2\rho_1 v_L^2 - 4\alpha_2 v_d v_u + \Big(\alpha_1 + \alpha_3\Big) v_u^2 + \alpha_1 v_d^2 + \rho_3 v_R^2\Big) \tag{31}$$

Gauge fixing contributions:

$$m^2(\xi_Z) = \begin{pmatrix} m_{\sigma_{H10}\sigma_{H10}} & m_{\sigma_{H20}\sigma_{H10}} & m_{\sigma_{R0}\sigma_{H10}} & m_{\sigma_{L0}\sigma_{H10}} \\ m_{\sigma_{H10}\sigma_{H20}} & m_{\sigma_{H20}\sigma_{H20}} & m_{\sigma_{R0}\sigma_{H20}} & m_{\sigma_{L0}\sigma_{H20}} \\ m_{\sigma_{H10}\sigma_{R0}} & m_{\sigma_{H20}\sigma_{R0}} & m_{\sigma_{R0}\sigma_{R0}} & m_{\sigma_{L0}\sigma_{R0}} \\ m_{\sigma_{H10}\sigma_{L0}} & m_{\sigma_{H20}\sigma_{L0}} & m_{\sigma_{R0}\sigma_{L0}} & m_{\sigma_{L0}\sigma_{L0}} \end{pmatrix} \tag{32}$$

$$m_{\sigma_{H10}\sigma_{H10}} = \frac{1}{4} v_d^2 \Big(g_2 Z_{22}^{Z,*} - g_R Z_{32}^{Z,*}\Big)\Big(g_2 Z_{22}^{Z} - g_R Z_{32}^{Z}\Big) \tag{33}$$

$$m_{\sigma_{H10}\sigma_{H20}} = -\frac{1}{4} v_d v_u \Big(g_2 Z_{22}^{Z,*} - g_R Z_{32}^{Z,*}\Big)\Big(g_2 Z_{22}^{Z} - g_R Z_{32}^{Z}\Big) \tag{34}$$

$$m_{\sigma_{H20}\sigma_{H20}} = \frac{1}{4} v_u^2 \Big(g_2 Z_{22}^{Z,*} - g_R Z_{32}^{Z,*}\Big)\Big(g_2 Z_{22}^{Z} - g_R Z_{32}^{Z}\Big) \tag{35}$$

$$m_{\sigma_{H10}\sigma_{R0}} = \frac{1}{4} v_d v_R \Big(g_2 Z_{22}^{Z,*}\Big(g_B Z_{12}^{Z} - g_R Z_{32}^{Z}\Big) + g_B Z_{12}^{Z,*}\Big(g_2 Z_{22}^{Z} - g_R Z_{32}^{Z}\Big) - g_R Z_{32}^{Z,*}\Big(-2 g_R Z_{32}^{Z} + g_2 Z_{22}^{Z} + g_B Z_{12}^{Z}\Big)\Big) \tag{36}$$

$$m_{\sigma_{H20}\sigma_{R0}} = \frac{1}{4} v_u v_R \Big(g_2 Z_{22}^{Z,*}\Big(-g_B Z_{12}^{Z} + g_R Z_{32}^{Z}\Big) + g_B Z_{12}^{Z,*}\Big(-g_2 Z_{22}^{Z} + g_R Z_{32}^{Z}\Big) + g_R Z_{32}^{Z,*}\Big(-2 g_R Z_{32}^{Z} + g_2 Z_{22}^{Z} + g_B Z_{12}^{Z}\Big)\Big) \tag{37}$$

$$m_{\sigma_{R0}\sigma_{R0}} = v_R^2 \Big(g_B Z_{12}^{Z,*} - g_R Z_{32}^{Z,*}\Big)\Big(g_B Z_{12}^{Z} - g_R Z_{32}^{Z}\Big) \tag{38}$$

$$m_{\sigma_{H10}\sigma_{L0}} = \frac{1}{4} v_d v_L \Big(g_2 Z_{22}^{Z,*}\Big(-2 g_2 Z_{22}^{Z} + g_B Z_{12}^{Z} + g_R Z_{32}^{Z}\Big) + g_B Z_{12}^{Z,*}\Big(g_2 Z_{22}^{Z} - g_R Z_{32}^{Z}\Big) + g_R Z_{32}^{Z,*}\Big(g_2 Z_{22}^{Z} - g_B Z_{12}^{Z}\Big)\Big) \tag{39}$$

$$m_{\sigma_{H20}\sigma_{L0}} = \frac{1}{4} v_u v_L \Big(g_2 Z_{22}^{Z,*}\Big(2 g_2 Z_{22}^{Z} - g_B Z_{12}^{Z} - g_R Z_{32}^{Z}\Big) + g_B Z_{12}^{Z,*}\Big(-g_2 Z_{22}^{Z} + g_R Z_{32}^{Z}\Big) + g_R Z_{32}^{Z,*}\Big(-g_2 Z_{22}^{Z} + g_B Z_{12}^{Z}\Big)\Big) \tag{40}$$

$$m_{\sigma_{R0}\sigma_{L0}} = -\frac{1}{2} v_L v_R \Big(g_2 Z_{22}^{Z,*}\Big(g_B Z_{12}^{Z} - g_R Z_{32}^{Z}\Big) + g_B Z_{12}^{Z,*}\Big(-2 g_B Z_{12}^{Z} + g_2 Z_{22}^{Z} + g_R Z_{32}^{Z}\Big) + g_R Z_{32}^{Z,*}\Big(-g_2 Z_{22}^{Z} + g_B Z_{12}^{Z}\Big)\Big) \tag{41}$$

$$m_{\sigma_{L0}\sigma_{L0}} = v_L^2 \Big(-g_2 Z_{22}^{Z,*} + g_B Z_{12}^{Z,*}\Big)\Big(-g_2 Z_{22}^{Z} + g_B Z_{12}^{Z}\Big) \tag{42}$$

$$m^2(\xi_{Z'}) = \begin{pmatrix} m_{\sigma_{H10}\sigma_{H10}} & m_{\sigma_{H20}\sigma_{H10}} & m_{\sigma_{R0}\sigma_{H10}} & m_{\sigma_{L0}\sigma_{H10}} \\ m_{\sigma_{H10}\sigma_{H20}} & m_{\sigma_{H20}\sigma_{H20}} & m_{\sigma_{R0}\sigma_{H20}} & m_{\sigma_{L0}\sigma_{H20}} \\ m_{\sigma_{H10}\sigma_{R0}} & m_{\sigma_{H20}\sigma_{R0}} & m_{\sigma_{R0}\sigma_{R0}} & m_{\sigma_{L0}\sigma_{R0}} \\ m_{\sigma_{H10}\sigma_{L0}} & m_{\sigma_{H20}\sigma_{L0}} & m_{\sigma_{R0}\sigma_{L0}} & m_{\sigma_{L0}\sigma_{L0}} \end{pmatrix} \tag{43}$$

$$m_{\sigma_{H10}\sigma_{H10}} = \frac{1}{4}v_d^2\Big(g_2 Z_{23}^{Z,*} - g_R Z_{33}^{Z,*}\Big)\Big(g_2 Z_{23}^{Z} - g_R Z_{33}^{Z}\Big) \tag{44}$$

$$m_{\sigma_{H10}\sigma_{H20}} = -\frac{1}{4}v_d v_u\Big(g_2 Z_{23}^{Z,*} - g_R Z_{33}^{Z,*}\Big)\Big(g_2 Z_{23}^{Z} - g_R Z_{33}^{Z}\Big) \tag{45}$$

$$m_{\sigma_{H20}\sigma_{H20}} = \frac{1}{4}v_u^2\Big(g_2 Z_{23}^{Z,*} - g_R Z_{33}^{Z,*}\Big)\Big(g_2 Z_{23}^{Z} - g_R Z_{33}^{Z}\Big) \tag{46}$$

$$m_{\sigma_{H10}\sigma_{R0}} = \frac{1}{4}v_d v_R\Big(g_2 Z_{23}^{Z,*}\Big(g_B Z_{13}^{Z} - g_R Z_{33}^{Z}\Big) + g_B Z_{13}^{Z,*}\Big(g_2 Z_{23}^{Z} - g_R Z_{33}^{Z}\Big) - g_R Z_{33}^{Z,*}\Big(-2g_R Z_{33}^{Z} + g_2 Z_{23}^{Z} + g_B Z_{13}^{Z}\Big)\Big) \tag{47}$$

$$m_{\sigma_{H20}\sigma_{R0}} = \frac{1}{4}v_u v_R\Big(g_2 Z_{23}^{Z,*}\Big(-g_B Z_{13}^{Z} + g_R Z_{33}^{Z}\Big) + g_B Z_{13}^{Z,*}\Big(-g_2 Z_{23}^{Z} + g_R Z_{33}^{Z}\Big) + g_R Z_{33}^{Z,*}\Big(-2g_R Z_{33}^{Z} + g_2 Z_{23}^{Z} + g_B Z_{13}^{Z}\Big)\Big) \tag{48}$$

$$m_{\sigma_{R0}\sigma_{R0}} = v_R^2\Big(g_B Z_{13}^{Z,*} - g_R Z_{33}^{Z,*}\Big)\Big(g_B Z_{13}^{Z} - g_R Z_{33}^{Z}\Big) \tag{49}$$

$$m_{\sigma_{H10}\sigma_{L0}} = \frac{1}{4}v_d v_L\Big(g_2 Z_{23}^{Z,*}\Big(-2g_2 Z_{23}^{Z} + g_B Z_{13}^{Z} + g_R Z_{33}^{Z}\Big) + g_B Z_{13}^{Z,*}\Big(g_2 Z_{23}^{Z} - g_R Z_{33}^{Z}\Big) + g_R Z_{33}^{Z,*}\Big(g_2 Z_{23}^{Z} - g_B Z_{13}^{Z}\Big)\Big) \tag{50}$$

$$m_{\sigma_{H20}\sigma_{L0}} = \frac{1}{4}v_u v_L\Big(g_2 Z_{23}^{Z,*}\Big(2g_2 Z_{23}^{Z} - g_B Z_{13}^{Z} - g_R Z_{33}^{Z}\Big) + g_B Z_{13}^{Z,*}\Big(-g_2 Z_{23}^{Z} + g_R Z_{33}^{Z}\Big) + g_R Z_{33}^{Z,*}\Big(-g_2 Z_{23}^{Z} + g_B Z_{13}^{Z}\Big)\Big) \tag{51}$$

$$m_{\sigma_{R0}\sigma_{L0}} = -\frac{1}{2}v_L v_R\Big(g_2 Z_{23}^{Z,*}\Big(g_B Z_{13}^{Z} - g_R Z_{33}^{Z}\Big) + g_B Z_{13}^{Z,*}\Big(-2g_B Z_{13}^{Z} + g_2 Z_{23}^{Z} + g_R Z_{33}^{Z}\Big) + g_R Z_{33}^{Z,*}\Big(-g_2 Z_{23}^{Z} + g_B Z_{13}^{Z}\Big)\Big) \tag{52}$$

$$m_{\sigma_{L0}\sigma_{L0}} = v_L^2\Big(-g_2 Z_{23}^{Z,*} + g_B Z_{13}^{Z,*}\Big)\Big(-g_2 Z_{23}^{Z} + g_B Z_{13}^{Z}\Big) \tag{53}$$

This matrix is diagonalized by Z^{Ah}:

$$Z^{Ah} m^2_{A^0} Z^{Ah,\dagger} = m^{dia}_{2,A^0} \tag{54}$$

with

$$\sigma_{H10} = \sum_j Z^{Ah}_{j1} A^0_j\,, \qquad \sigma_{H20} = \sum_j Z^{Ah}_{j2} A^0_j\,, \qquad \sigma_{R0} = \sum_j Z^{Ah}_{j3} A^0_j \tag{55}$$

$$\sigma_{L0} = \sum_j Z^{Ah}_{j4} A^0_j \tag{56}$$

- **Mass matrix for Charged Higgs**, Basis: $\left(H_1^-, H^-, \Delta_R^-, \Delta_L^-\right), \left(H_1^+, H^+, \Delta_R^+, \Delta_L^+\right)$

$$m^2_{H^-} = \begin{pmatrix} m_{H_1^- H_1^+} & m^*_{H^- H_1^+} & m^*_{\Delta_R^- H_1^+} & m^*_{\Delta_L^- H_1^+} \\ m_{H_1^- H^+} & m_{H^- H^+} & m^*_{\Delta_R^- H^+} & m^*_{\Delta_L^- H^+} \\ m_{H_1^- \Delta_R^+} & m_{H^- \Delta_R^+} & m_{\Delta_R^- \Delta_R^+} & m^*_{\Delta_L^- \Delta_R^+} \\ m_{H_1^- \Delta_L^+} & m_{H^- \Delta_L^+} & m_{\Delta_R^- \Delta_L^+} & m_{\Delta_L^- \Delta_L^+} \end{pmatrix} + \xi_{W^-} m^2(W^-) + \xi_{W_R^-} m^2(W_R^-) \tag{57}$$

$$m_{H_1^- H_1^+} = \frac{1}{2}\Big(2\lambda\Big(v_d^2 + v_u^2\Big) - 2\mu - 4\lambda_4 v_d v_u + \Big(\alpha_1 + \alpha_3\Big)v_L^2 + \alpha_1 v_R^2\Big) \tag{58}$$

$$m_{H_1^- H^+} = -2\Big(\Big(2\lambda_2 + \lambda_3\Big)v_d v_u + \mu_2^2\Big) + \alpha_2\Big(v_L^2 + v_R^2\Big) + \lambda_4\Big(v_d^2 + v_u^2\Big) \tag{59}$$

$$m_{H^- H^+} = \frac{1}{2}\Big(2\lambda\Big(v_d^2 + v_u^2\Big) - 2\mu - 4\lambda_4 v_d v_u + \Big(\alpha_1 + \alpha_3\Big)v_R^2 + \alpha_1 v_L^2\Big) \tag{60}$$

$$m_{H_1^- \Delta_R^+} = \frac{1}{2}\frac{1}{\sqrt{2}}\Big(\Big(-2\beta_3 v_u + \beta_1 v_d\Big)v_L + \alpha_3 v_u v_R\Big) \tag{61}$$

$$m_{H^- \Delta_R^+} = \frac{1}{2}\frac{1}{\sqrt{2}}\Big(\Big(2\beta_2 v_d - \beta_1 v_u\Big)v_L + \alpha_3 v_d v_R\Big) \tag{62}$$

$$m_{\Delta_R^- \Delta_R^+} = \frac{1}{4}\Big(\Big(2\alpha_1 + \alpha_3\Big)\Big(v_d^2 + v_u^2\Big) + 2\rho_3 v_L^2 - 4\mu_{LR}^2 + 4\rho_1 v_R^2 - 8\alpha_2 v_d v_u\Big) \tag{63}$$

$$m_{H_1^- \Delta_L^+} = \frac{1}{2}\frac{1}{\sqrt{2}}\Big(-\beta_1 v_u v_R + v_d\Big(2\beta_2 v_R + \alpha_3 v_L\Big)\Big) \tag{64}$$

$$m_{H^- \Delta_L^+} = \frac{1}{2}\frac{1}{\sqrt{2}}\Big(\beta_1 v_d v_R + v_u\Big(-2\beta_3 v_R + \alpha_3 v_L\Big)\Big) \tag{65}$$

$$m_{\Delta_R^- \Delta_L^+} = \frac{1}{4}\Big(-2\Big(\beta_2 + \beta_3\Big)v_d v_u + \beta_1\Big(v_d^2 + v_u^2\Big)\Big) \tag{66}$$

$$m_{\Delta_L^- \Delta_L^+} = \frac{1}{4}\Big(\Big(2\alpha_1 + \alpha_3\Big)\Big(v_d^2 + v_u^2\Big) + 2\rho_3 v_R^2 - 4\mu_{LR}^2 + 4\rho_1 v_L^2 - 8\alpha_2 v_d v_u\Big) \tag{67}$$

Gauge fixing contributions:

$$m^2(\xi_{W^-}) = \begin{pmatrix} m_{H_1^- H_1^+} & m^*_{H^- H_1^+} & m^*_{\Delta_R^- H_1^+} & m^*_{\Delta_L^- H_1^+} \\ m_{H_1^- H^+} & m_{H^- H^+} & m^*_{\Delta_R^- H^+} & m^*_{\Delta_L^- H^+} \\ m_{H_1^- \Delta_R^+} & m_{H^- \Delta_R^+} & m_{\Delta_R^- \Delta_R^+} & m^*_{\Delta_L^- \Delta_R^+} \\ m_{H_1^- \Delta_L^+} & m_{H^- \Delta_L^+} & m_{\Delta_R^- \Delta_L^+} & m_{\Delta_L^- \Delta_L^+} \end{pmatrix} \tag{68}$$

$$m_{H_1^- H_1^+} = \frac{1}{4}\Big(g_2 v_d \cos\phi_W - g_R v_u \sin\phi_W\Big)^2 \tag{69}$$

$$m_{H_1^- H^+} = \frac{1}{4}\Big(g_2 v_u \cos\phi_W - g_R v_d \sin\phi_W\Big)\Big(-g_2 v_d \cos\phi_W + g_R v_u \sin\phi_W\Big) \tag{70}$$

$$m_{H^- H^+} = \frac{1}{4}\Big(g_2 v_u \cos\phi_W - g_R v_d \sin\phi_W\Big)^2 \tag{71}$$

$$m_{H_1^- \Delta_R^+} = \frac{1}{2}\frac{1}{\sqrt{2}} g_R v_R \sin\phi_W\Big(-g_2 v_d \cos\phi_W + g_R v_u \sin\phi_W\Big) \tag{72}$$

$$m_{H^-\Delta_R^+} = \frac{1}{2}\frac{1}{\sqrt{2}} g_R v_R \sin\phi_W \Big(g_2 v_u \cos\phi_W - g_R v_d \sin\phi_W \Big) \tag{73}$$

$$m_{\Delta_R^-\Delta_R^+} = \frac{1}{2} g_R^2 v_R^2 \sin\phi_W^2 \tag{74}$$

$$m_{H_1^-\Delta_L^+} = \frac{1}{2}\frac{1}{\sqrt{2}} g_2 v_L \cos\phi_W \Big(- g_2 v_d \cos\phi_W + g_R v_u \sin\phi_W \Big) \tag{75}$$

$$m_{H^-\Delta_L^+} = \frac{1}{2}\frac{1}{\sqrt{2}} g_2 v_L \cos\phi_W \Big(g_2 v_u \cos\phi_W - g_R v_d \sin\phi_W \Big) \tag{76}$$

$$m_{\Delta_R^-\Delta_L^+} = \frac{1}{2} g_2 g_R v_L v_R \cos\phi_W \sin\phi_W \tag{77}$$

$$m_{\Delta_L^-\Delta_L^+} = \frac{1}{2} g_2^2 v_L^2 \cos\phi_W^2 \tag{78}$$

$$m^2(\xi_{W_R^-}) = \begin{pmatrix} m_{H_1^- H_1^+} & m^*_{H^- H_1^+} & m^*_{\Delta_R^- H_1^+} & m^*_{\Delta_L^- H_1^+} \\ m_{H_1^- H^+} & m_{H^- H^+} & m^*_{\Delta_R^- H^+} & m^*_{\Delta_L^- H^+} \\ m_{H_1^-\Delta_R^+} & m_{H^-\Delta_R^+} & m_{\Delta_R^-\Delta_R^+} & m^*_{\Delta_L^-\Delta_R^+} \\ m_{H_1^-\Delta_L^+} & m_{H^-\Delta_L^+} & m_{\Delta_R^-\Delta_L^+} & m_{\Delta_L^-\Delta_L^+} \end{pmatrix} \tag{79}$$

$$m_{H_1^- H_1^+} = \frac{1}{4}\Big(g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W \Big)^2 \tag{80}$$

$$m_{H_1^- H^+} = -\frac{1}{4}\Big(g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W \Big)\Big(g_2 v_u \sin\phi_W + g_R v_d \cos\phi_W \Big) \tag{81}$$

$$m_{H^- H^+} = \frac{1}{4}\Big(g_2 v_u \sin\phi_W + g_R v_d \cos\phi_W \Big)^2 \tag{82}$$

$$m_{H_1^-\Delta_R^+} = \frac{1}{2}\frac{1}{\sqrt{2}} g_R v_R \cos\phi_W \Big(g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W \Big) \tag{83}$$

$$m_{H^-\Delta_R^+} = -\frac{1}{2}\frac{1}{\sqrt{2}} g_R v_R \cos\phi_W \Big(g_2 v_u \sin\phi_W + g_R v_d \cos\phi_W \Big) \tag{84}$$

$$m_{\Delta_R^-\Delta_R^+} = \frac{1}{2} g_R^2 v_R^2 \cos\phi_W^2 \tag{85}$$

$$m_{H_1^-\Delta_L^+} = -\frac{1}{2}\frac{1}{\sqrt{2}} g_2 v_L \sin\phi_W \Big(g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W \Big) \tag{86}$$

$$m_{H^-\Delta_L^+} = \frac{1}{2}\frac{1}{\sqrt{2}} g_2 v_L \sin\phi_W \Big(g_2 v_u \sin\phi_W + g_R v_d \cos\phi_W \Big) \tag{87}$$

$$m_{\Delta_R^-\Delta_L^+} = -\frac{1}{2} g_2 g_R v_L v_R \cos\phi_W \sin\phi_W \tag{88}$$

$$m_{\Delta_L^-\Delta_L^+} = \frac{1}{2} g_2^2 v_L^2 \sin\phi_W^2 \tag{89}$$

This matrix is diagonalized by Z^+:

$$Z^+ m^2_{H^-} Z^{+,\dagger} = m^{dia}_{2,H^-} \tag{90}$$

with

$$H_1^- = \sum_j Z^+_{j1} H_j^- \,, \qquad H^+ = \sum_j Z^+_{j2} H_j^+ \,, \qquad \Delta_R^+ = \sum_j Z^+_{j3} H_j^+ \tag{91}$$

$$\Delta_L^+ = \sum_j Z_{j4}^+ H_j^+ \tag{92}$$

- **Mass matrix for Hppmm**, Basis: $(HR^{--}, HL^{--}), (HR^{++}, HL^{++})$

$$m^2_{\delta^{c--}} = \begin{pmatrix} m_{HR^{--}HR^{++}} & m^*_{HL^{--}HR^{++}} \\ m_{HR^{--}HL^{++}} & m_{HL^{--}HL^{++}} \end{pmatrix} \tag{93}$$

$$m_{HR^{--}HR^{++}} = \frac{1}{2}\Big(2\Big(2\rho_2 + \rho_1\Big)v_R^2 - 2\mu_{LR}^2 - 4\alpha_2 v_d v_u + \Big(\alpha_1 + \alpha_3\Big)v_d^2 + \alpha_1 v_u^2 + \rho_3 v_L^2\Big) \tag{94}$$

$$m_{HR^{--}HL^{++}} = \frac{1}{2}\Big(4\rho_4 v_L v_R + \beta_1 v_d v_u - \beta_2 v_u^2 - \beta_3 v_d^2\Big) \tag{95}$$

$$m_{HL^{--}HL^{++}} = \frac{1}{2}\Big(2\Big(2\rho_2 + \rho_1\Big)v_L^2 - 2\mu_{LR}^2 - 4\alpha_2 v_d v_u + \Big(\alpha_1 + \alpha_3\Big)v_d^2 + \alpha_1 v_u^2 + \rho_3 v_R^2\Big) \tag{96}$$

This matrix is diagonalized by Z^{++}:

$$Z^{++} m^2_{\delta^{c--}} Z^{++,\dagger} = m^{dia}_{2,\delta^{c--}} \tag{97}$$

with

$$HR^{++} = \sum_j Z_{j1}^{++}\delta_j^{c++}, \qquad HL^{++} = \sum_j Z_{j2}^{++}\delta_j^{c++} \tag{98}$$

3.2.2 Mass Matrices for Fermions

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

$$m_d = \Big(\tfrac{1}{\sqrt{2}}\Big(v_d Y^*_{Q2} + v_u Y^*_{Q1}\Big)\delta_{\alpha_1\beta_1} \Big) \tag{99}$$

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

$$U_L^{d,*} m_d U_R^{d,\dagger} = m_d^{dia} \tag{100}$$

with

$$d_{L,i\alpha} = \sum_{t_2} U^{d,*}_{L,ji} D_{L,j\alpha} \tag{101}$$

$$d_{R,i\alpha} = \sum_{t_2} U^{d}_{R,ij} D^*_{R,j\alpha} \tag{102}$$

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

$$m_u = \Big(\tfrac{1}{\sqrt{2}}\Big(v_d Y^*_{Q1} + v_u Y^*_{Q2}\Big)\delta_{\alpha_1\beta_1} \Big) \tag{103}$$

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

$$U_L^{u,*} m_u U_R^{u,\dagger} = m_u^{dia} \tag{104}$$

with

$$u_{L,i\alpha} = \sum_{t_2} U^{u,*}_{L,ji} U_{L,j\alpha} \tag{105}$$

$$u_{R,i\alpha} = \sum_{t_2} U^{u}_{R,ij} U^{*}_{R,j\alpha} \tag{106}$$

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

$$m_e = \left(\begin{array}{c} \frac{1}{\sqrt{2}} \Big(v_d Y^*_{L2} + v_u Y^*_{L1} \Big) \end{array} \right) \tag{107}$$

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

$$U^{e,*}_L m_e U^{e,\dagger}_R = m_e^{dia} \tag{108}$$

with

$$e_{L,i} = \sum_{t_2} U^{e,*}_{L,ji} E_{L,j} \tag{109}$$

$$e_{R,i} = \sum_{t_2} U^{e}_{R,ij} E^*_{R,j} \tag{110}$$

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

$$m_\nu = \left(\begin{array}{cc} \sqrt{2} v_L Y_{DL} & \frac{1}{\sqrt{2}} \Big(v_d Y^*_{L1} + v_u Y^*_{L2} \Big) \\ \frac{1}{\sqrt{2}} \Big(v_d Y^\dagger_{L1} + v_u Y^\dagger_{L2} \Big) & \sqrt{2} v_R Y^*_{DR} \end{array} \right) \tag{111}$$

This matrix is diagonalized by U^V:

$$U^{V,*} m_\nu U^{V,\dagger} = m_\nu^{dia} \tag{112}$$

with

$$\nu_{L,i} = \sum_j U^{V,*}_{ji} \nu_{0,j} \,, \qquad \nu_{R,i} = \sum_j U^V_{ji} \nu^*_{0,j} \tag{113}$$

4 Vacuum Expectation Values

$$H^0 = \frac{1}{\sqrt{2}} \phi_{H10} + \frac{1}{\sqrt{2}} v_d + i \frac{1}{\sqrt{2}} \sigma_{H10} \tag{114}$$

$$H'^0 = \frac{1}{\sqrt{2}} \phi_{H20} + \frac{1}{\sqrt{2}} v_u + i \frac{1}{\sqrt{2}} \sigma_{H20} \tag{115}$$

$$\Delta_{1R0} = \frac{1}{\sqrt{2}} \phi_{R0} + \frac{1}{\sqrt{2}} v_R + i \frac{1}{\sqrt{2}} \sigma_{R0} \tag{116}$$

$$\Delta_{1L0} = \frac{1}{\sqrt{2}} \phi_{L0} + \frac{1}{\sqrt{2}} v_L + i \frac{1}{\sqrt{2}} \sigma_{L0} \tag{117}$$

5 Tadpole Equations

$$\frac{\partial V}{\partial \phi_{H10}} = \frac{1}{2}\Big(-2\Big(\beta_2 v_d v_L v_R + \lambda_4 v_u^3\Big) + v_d\Big(2\lambda\Big(v_d^2 + v_u^2\Big) - 2\mu + \Big(4\lambda_3 + 8\lambda_2\Big)v_u^2 + \alpha_1\Big(v_L^2 + v_R^2\Big)\Big) + v_u\Big(-2\alpha_2\Big(v_L^2 + v_R^2\Big) + 4\mu_2^2 - 6\lambda_4 v_d^2 + \beta_1 v_L v_R\Big)\Big) \tag{118}$$

$$\frac{\partial V}{\partial \phi_{H20}} = \frac{1}{2}\Big(2\lambda v_u^3 + 4\Big(\lambda_3 v_d^2 v_u + \mu_2^2 v_d\Big) + \beta_1 v_d v_L v_R + v_u\Big(-2\Big(\beta_3 v_L v_R + \mu\Big) + \Big(2\lambda + 8\lambda_2\Big)v_d^2 + \Big(\alpha_1 + \alpha_3\Big)\Big(v_L^2 + v_R^2\Big)\Big) - 2\Big(\alpha_2 v_d\Big(v_L^2 + v_R^2\Big) + \lambda_4\Big(3v_d v_u^2 + v_d^3\Big)\Big)\Big) \tag{119}$$

$$\frac{\partial V}{\partial \phi_{R0}} = \frac{1}{2}\Big(\Big(-2\mu_{LR}^2 - 4\alpha_2 v_d v_u + \Big(\alpha_1 + \alpha_3\Big)v_u^2 + \alpha_1 v_d^2 + \rho_3 v_L^2\Big)v_R + 2\rho_1 v_R^3 + \Big(-\beta_2 v_d^2 + v_u\Big(\beta_1 v_d - \beta_3 v_u\Big)\Big)v_L\Big) \tag{120}$$

$$\frac{\partial V}{\partial \phi_{L0}} = \frac{1}{2}\Big(-\Big(\beta_2 v_d^2 + v_u\Big(-\beta_1 v_d + \beta_3 v_u\Big)\Big)v_R + v_L\Big(-2\mu_{LR}^2 + 2\rho_1 v_L^2 - 4\alpha_2 v_d v_u + \Big(\alpha_1 + \alpha_3\Big)v_u^2 + \alpha_1 v_d^2 + \rho_3 v_R^2\Big)\Big) \tag{121}$$

6 Particle content for eigenstates 'EWSB'

Name	Type	complex/real	Generations	Indices
h	Scalar	real	4	generation, 4
A^0	Scalar	real	4	generation, 4
H^-	Scalar	complex	4	generation, 4
δ^{c--}	Scalar	complex	2	generation, 2
d	Fermion	Dirac	3	generation, 3, color, 3
u	Fermion	Dirac	3	generation, 3, color, 3
e	Fermion	Dirac	3	generation, 3
ν	Fermion	Majorana	6	generation, 6
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
W_R^-	Vector	complex	1	lorentz, 4
η^G	Ghost	real	1	color, 8
η^P	Ghost	real	1	
η^Z	Ghost	real	1	
$\eta^{Z'}$	Ghost	real	1	

η_L^-	Ghost	complex	1
η_L^+	Ghost	complex	1
η_R^-	Ghost	complex	1
η_R^+	Ghost	complex	1

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

7.1 One Loop Self-Energy

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

$$
\begin{aligned}
\Pi_{i,j}(p^2) = &+4\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,0,m_Z^2\Big)\Big)\Gamma^*_{\check{h}_j,Z,\gamma}\Gamma_{\check{h}_i,Z,\gamma}+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\\
&+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}+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_{W^-}^2,m_{W^-}^2\Big)\Big)\Gamma^*_{\check{h}_j,W^+,W^-}\Gamma_{\check{h}_i,W^+,W^-}+8\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{W^-}^2,m_{W_R^-}^2\Big)\Big)\Gamma^*_{\check{h}_j,W_R^+,W^-}\Gamma_{\check{h}_i,W_I}\\
&+4\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{W_R^-}^2,m_{W_R^-}^2\Big)\Big)\Gamma^*_{\check{h}_j,W_R^+,W_R^-}\Gamma_{\check{h}_i,W_R^+,W_R^-}-B_0\Big(p^2,m_{\eta_L^-}^2,m_{\eta_L^-}^2\Big)\Gamma_{\check{h}_i,\bar{\eta_L^-},\eta_L^-}\Gamma_{\check{h}_j,\bar{\eta_L^-},\eta_L^-}\\
&-B_0\Big(p^2,m_{\eta_L^+}^2,m_{\eta_L^+}^2\Big)\Gamma_{\check{h}_i,\bar{\eta_L^+},\eta_L^+}\Gamma_{\check{h}_j,\bar{\eta_L^+},\eta_L^+}-2B_0\Big(p^2,m_{\eta_L^-}^2,m_{\eta_R^-}^2\Big)\Gamma_{\check{h}_i,\bar{\eta_R^-},\eta_L^-}\Gamma_{\check{h}_j,\bar{\eta_R^-},\eta_L^-}\\
&-B_0\Big(p^2,m_{\eta_R^-}^2,m_{\eta_R^-}^2\Big)\Gamma_{\check{h}_i,\bar{\eta_R^-},\eta_R^-}\Gamma_{\check{h}_j,\bar{\eta_R^-},\eta_R^-}-2B_0\Big(p^2,m_{\eta_L^+}^2,m_{\eta_R^+}^2\Big)\Gamma_{\check{h}_i,\bar{\eta_R^+},\eta_L^+}\Gamma_{\check{h}_j,\bar{\eta_R^+},\eta_L^+}\\
&-B_0\Big(p^2,m_{\eta_R^+}^2,m_{\eta_R^+}^2\Big)\Gamma_{\check{h}_i,\bar{\eta_R^+},\eta_R^+}\Gamma_{\check{h}_j,\bar{\eta_R^+},\eta_R^+}-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,\bar{\eta^{Z'}},\eta^Z}\Gamma_{\check{h}_j,\bar{\eta^{Z'}},\eta^Z}-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'}}\\
&+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)+4\Gamma_{\check{h}_i,\check{h}_j,W_R^+,W_R^-}\Big(-\frac{1}{2}\mathrm{rMS}m_{W_R^-}^2+A_0\Big(m_{W_R^-}^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_{\delta_a^{c--}}^2\Big)\Gamma_{\check{h}_i,\check{h}_j,\delta_a^{c++},\delta_a^{c--}}\\
&+\sum_{a=1}^{2}\sum_{b=1}^{2}B_0\Big(p^2,m_{\delta_a^{c--}}^2,m_{\delta_b^{c--}}^2\Big)\Gamma^*_{\check{h}_j,\delta_a^{c++},\delta_b^{c--}}\Gamma_{\check{h}_i,\delta_a^{c++},\delta_b^{c--}}\\
&-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)
\end{aligned}
$$

$$
\begin{aligned}
&- 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}^{4} A_0\Big(m_{A_a^0}^2\Big)\Gamma_{\check{h}_i,\check{h}_j,A_a^0,A_a^0} - \sum_{a=1}^{4} 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}^{4} 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}^{4}\sum_{b=1}^{4} 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}^{4}\sum_{b=1}^{4} 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^-} \\
&+ \frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{4} 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}^{6} m_{\nu_a} \sum_{b=1}^{6} B_0\Big(p^2, m_{\nu_a}^2, m_{\nu_b}^2\Big) m_{\nu_b} \Big(\Gamma^{L*}_{\check{h}_j,\nu_a,\nu_b}\Gamma^{R}_{\check{h}_i,\nu_a,\nu_b} + \Gamma^{R*}_{\check{h}_j,\nu_a,\nu_b}\Gamma^{L}_{\check{h}_i,\nu_a,\nu_b}\Big) \\
&+ \frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{6} G_0\Big(p^2, m_{\nu_a}^2, m_{\nu_b}^2\Big)\Big(\Gamma^{L*}_{\check{h}_j,\nu_a,\nu_b}\Gamma^{L}_{\check{h}_i,\nu_a,\nu_b} + \Gamma^{R*}_{\check{h}_j,\nu_a,\nu_b}\Gamma^{R}_{\check{h}_i,\nu_a,\nu_b}\Big) \\
&+ \sum_{b=1}^{4} \Gamma^{*}_{\check{h}_j,\gamma,A_b^0}\Gamma_{\check{h}_i,\gamma,A_b^0} F_0\Big(p^2, m_{A_b^0}^2, 0\Big) + \sum_{b=1}^{4} \Gamma^{*}_{\check{h}_j,Z,A_b^0}\Gamma_{\check{h}_i,Z,A_b^0} F_0\Big(p^2, m_{A_b^0}^2, m_Z^2\Big) \\
&+ \sum_{b=1}^{4} \Gamma^{*}_{\check{h}_j,Z',A_b^0}\Gamma_{\check{h}_i,Z',A_b^0} F_0\Big(p^2, m_{A_b^0}^2, m_{Z'}^2\Big) + 2\sum_{b=1}^{4} \Gamma^{*}_{\check{h}_j,W^+,H_b^-}\Gamma_{\check{h}_i,W^+,H_b^-} F_0\Big(p^2, m_{H_b^-}^2, m_{W^-}^2\Big) \\
&+ 2\sum_{b=1}^{4} \Gamma^{*}_{\check{h}_j,W_R^+,H_b^-}\Gamma_{\check{h}_i,W_R^+,H_b^-} F_0\Big(p^2, m_{H_b^-}^2, m_{W_R^-}^2\Big) \qquad (122)
\end{aligned}
$$

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

$$
\begin{aligned}
\Pi_{i,j}(p^2) = &+8\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m_{W^-}^2, m_{W_R^-}^2\Big)\Big)\Gamma^{*}_{\check{A}_j^0,W_R^+,W^-}\Gamma_{\check{A}_i^0,W_R^+,W^-} - B_0\Big(p^2, m_{\eta_L^-}^2, m_{\eta_L^-}^2\Big)\Gamma_{\check{A}_i^0,\eta_L^-,\eta_L^-}\Gamma_{\check{A}_j^0,\eta_L^-,\eta_L^-} \\
&- B_0\Big(p^2, m_{\eta_L^+}^2, m_{\eta_L^+}^2\Big)\Gamma_{\check{A}_i^0,\eta_L^-,\eta_L^+}\Gamma_{\check{A}_j^0,\eta_L^-,\eta_L^+} - 2B_0\Big(p^2, m_{\eta_L^-}^2, m_{\eta_R^-}^2\Big)\Gamma_{\check{A}_i^0,\eta_R^-,\eta_L^-}\Gamma_{\check{A}_j^0,\eta_R^-,\eta_L^-}
\end{aligned}
$$

$$
\begin{aligned}
&- B_0\Big(p^2, m^2_{\eta^-_R}, m^2_{\eta^-_R}\Big)\Gamma_{\check{A}^0_i,\eta^-_R,\eta^-_R}\Gamma_{\check{A}^0_j,\eta^-_R,\eta^-_R} - 2B_0\Big(p^2, m^2_{\eta^+_L}, m^2_{\eta^+_R}\Big)\Gamma_{\check{A}^0_i,\eta^-_R,\eta^+_L}\Gamma_{\check{A}^0_j,\eta^-_R,\eta^+_L}\\
&- B_0\Big(p^2, m^2_{\eta^+_R}, m^2_{\eta^+_R}\Big)\Gamma_{\check{A}^0_i,\eta^-_R,\eta^+_R}\Gamma_{\check{A}^0_j,\eta^-_R,\eta^+_R} + 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)\\
&+ 4\Gamma_{\check{A}^0_i,\check{A}^0_j,W^+_R,W^-_R}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{W^-_R} + A_0\Big(m^2_{W^-_R}\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_{\delta^{c--}_a}\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,\delta^{c++}_a,\delta^{c--}_a}\\
&+ \sum_{a=1}^{2}\sum_{b=1}^{2} B_0\Big(p^2, m^2_{\delta^{c--}_a}, m^2_{\delta^{c--}_b}\Big)\Gamma^*_{\check{A}^0_j,\delta^{c++}_a,\delta^{c--}_b}\Gamma_{\check{A}^0_i,\delta^{c++}_a,\delta^{c--}_b}\\
&- 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)\\
&- 2\sum_{a=1}^{3} m_{e_a}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{e_a}, m^2_{e_b}\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^2_{e_a}, m^2_{e_b}\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^2_{u_a}, m^2_{u_b}\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^2_{u_a}, m^2_{u_b}\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}^{4} A_0\Big(m^2_{A^0_a}\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,A^0_a,A^0_a} - \sum_{a=1}^{4} A_0\Big(m^2_{H^-_a}\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,H^+_a,H^-_a}\\
&- \frac{1}{2}\sum_{a=1}^{4} A_0\Big(m^2_{h_a}\Big)\Gamma_{\check{A}^0_i,\check{A}^0_j,h_a,h_a} + \sum_{a=1}^{4}\sum_{b=1}^{4} 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}\\
&+ \sum_{a=1}^{4}\sum_{b=1}^{4} B_0\Big(p^2, m^2_{h_a}, m^2_{A^0_b}\Big)\Gamma^*_{\check{A}^0_j,h_a,A^0_b}\Gamma_{\check{A}^0_i,h_a,A^0_b}\\
&- \sum_{a=1}^{6} m_{\nu_a}\sum_{b=1}^{6} B_0\Big(p^2, m^2_{\nu_a}, m^2_{\nu_b}\Big)m_{\nu_b}\Big(\Gamma^{L*}_{\check{A}^0_j,\nu_a,\nu_b}\Gamma^{R}_{\check{A}^0_i,\nu_a,\nu_b} + \Gamma^{R*}_{\check{A}^0_j,\nu_a,\nu_b}\Gamma^{L}_{\check{A}^0_i,\nu_a,\nu_b}\Big)\\
&+ \frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{6} G_0\Big(p^2, m^2_{\nu_a}, m^2_{\nu_b}\Big)\Big(\Gamma^{L*}_{\check{A}^0_j,\nu_a,\nu_b}\Gamma^{L}_{\check{A}^0_i,\nu_a,\nu_b} + \Gamma^{R*}_{\check{A}^0_j,\nu_a,\nu_b}\Gamma^{R}_{\check{A}^0_i,\nu_a,\nu_b}\Big)
\end{aligned}
$$

$$+\sum_{b=1}^{4}\Gamma^{*}_{\check{A}^0_j,\gamma,h_b}\Gamma_{\check{A}^0_i,\gamma,h_b}F_0\Big(p^2,m^2_{h_b},0\Big)+\sum_{b=1}^{4}\Gamma^{*}_{\check{A}^0_j,Z,h_b}\Gamma_{\check{A}^0_i,Z,h_b}F_0\Big(p^2,m^2_{h_b},m^2_Z\Big)$$
$$+\sum_{b=1}^{4}\Gamma^{*}_{\check{A}^0_j,Z',h_b}\Gamma_{\check{A}^0_i,Z',h_b}F_0\Big(p^2,m^2_{h_b},m^2_{Z'}\Big)+2\sum_{b=1}^{4}\Gamma^{*}_{\check{A}^0_j,W^+,H^-_b}\Gamma_{\check{A}^0_i,W^+,H^-_b}F_0\Big(p^2,m^2_{H^-_b},m^2_{W^-}\Big)$$
$$+2\sum_{b=1}^{4}\Gamma^{*}_{\check{A}^0_j,W^+_R,H^-_b}\Gamma_{\check{A}^0_i,W^+_R,H^-_b}F_0\Big(p^2,m^2_{H^-_b},m^2_{W^-_R}\Big) \tag{123}$$

- **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^2_{W^-}\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^2,0,m^2_{W^-_R}\Big)\Big)\Gamma^{*}_{\check{H}^+_j,W^-_R,\gamma}\Gamma_{\check{H}^+_i,W^-_R,\gamma}\\
&+4\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m^2_{W^-},m^2_Z\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^2_{W^-_R},m^2_Z\Big)\Big)\Gamma^{*}_{\check{H}^+_j,Z,W^-_R}\Gamma_{\check{H}^+_i,Z,W^-_R}\\
&+4\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m^2_{W^-},m^2_{Z'}\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^2_{W^-_R},m^2_{Z'}\Big)\Big)\Gamma^{*}_{\check{H}^+_j,Z',W^-_R}\Gamma_{\check{H}^+_i,Z',W^-_R}\\
&-B_0\Big(p^2,m^2_{\eta^Z},m^2_{\eta^+_L}\Big)\Gamma_{\check{H}^+_i,\eta^-_L,\eta^Z}\Gamma_{\check{H}^-_j,\eta^+_L,\eta^{\bar{Z}}}-B_0\Big(p^2,m^2_{\eta^{Z'}},m^2_{\eta^+_L}\Big)\Gamma_{\check{H}^+_i,\eta^-_L,\eta^{Z'}}\Gamma_{\check{H}^-_j,\eta^+_L,\eta^{\bar{Z}'}}\\
&-B_0\Big(p^2,m^2_{\eta^Z},m^2_{\eta^+_R}\Big)\Gamma_{\check{H}^+_i,\eta^-_R,\eta^Z}\Gamma_{\check{H}^-_j,\eta^+_R,\eta^{\bar{Z}}}-B_0\Big(p^2,m^2_{\eta^{Z'}},m^2_{\eta^+_R}\Big)\Gamma_{\check{H}^+_i,\eta^-_R,\eta^{Z'}}\Gamma_{\check{H}^-_j,\eta^+_R,\eta^{\bar{Z}'}}\\
&-B_0\Big(p^2,m^2_{\eta^-_L},m^2_{\eta^Z}\Big)\Gamma_{\check{H}^+_i,\eta^{\bar{Z}},\eta^-_L}\Gamma_{\check{H}^-_j,\eta^Z,\eta^-_L}-B_0\Big(p^2,m^2_{\eta^-_R},m^2_{\eta^Z}\Big)\Gamma_{\check{H}^+_i,\eta^{\bar{Z}},\eta^-_R}\Gamma_{\check{H}^-_j,\eta^Z,\eta^-_R}\\
&-B_0\Big(p^2,m^2_{\eta^-_L},m^2_{\eta^{Z'}}\Big)\Gamma_{\check{H}^+_i,\eta^{\bar{Z}'},\eta^-_L}\Gamma_{\check{H}^-_j,\eta^{Z'},\eta^-_L}-B_0\Big(p^2,m^2_{\eta^-_R},m^2_{\eta^{Z'}}\Big)\Gamma_{\check{H}^+_i,\eta^{\bar{Z}'},\eta^-_R}\Gamma_{\check{H}^-_j,\eta^{Z'},\eta^-_R}\\
&+4\Gamma_{\check{H}^-_i,\check{H}^+_j,W^+,W^-}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{W^-}+A_0\Big(m^2_{W^-}\Big)\Big)+4\Gamma_{\check{H}^-_i,\check{H}^+_j,W^+_R,W^-_R}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{W^-_R}+A_0\Big(m^2_{W^-_R}\Big)\Big)\\
&+2\Gamma_{\check{H}^-_i,\check{H}^+_j,Z,Z}\Big(-\frac{1}{2}\mathrm{rMS}m^2_Z+A_0\Big(m^2_Z\Big)\Big)+2\Gamma_{\check{H}^-_i,\check{H}^+_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_{\delta^{c--}_a}\Big)\Gamma_{\check{H}^-_i,\check{H}^+_j,\delta^{c++}_a,\delta^{c--}_a}\\
&-6\sum_{a=1}^{3}m_{u_a}\sum_{b=1}^{3}B_0\Big(p^2,m^2_{u_a},m^2_{d_b}\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^2_{u_a},m^2_{d_b}\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)\\
&-\frac{1}{2}\sum_{a=1}^{4}A_0\Big(m^2_{A^0_a}\Big)\Gamma_{\check{H}^-_i,\check{H}^+_j,A^0_a,A^0_a}-\sum_{a=1}^{4}A_0\Big(m^2_{H^-_a}\Big)\Gamma_{\check{H}^-_i,\check{H}^+_j,H^+_a,H^-_a}\\
&-\frac{1}{2}\sum_{a=1}^{4}A_0\Big(m^2_{h_a}\Big)\Gamma_{\check{H}^-_i,\check{H}^+_j,h_a,h_a}+\sum_{a=1}^{4}\sum_{b=1}^{2}B_0\Big(p^2,m^2_{H^-_a},m^2_{\delta^{c--}_b}\Big)\Gamma^{*}_{\check{H}^+_j,H^+_a,\delta^{c--}_b}\Gamma_{\check{H}^+_i,H^+_a,\delta^{c--}_b}
\end{aligned}$$

$$
\begin{aligned}
&+\sum_{a=1}^{4}\sum_{b=1}^{4} B_0\Big(p^2, m^2_{H_a^-}, m^2_{A_b^0}\Big)\Gamma^*_{\check{H}_j^+,H_a^-,A_b^0}\Gamma_{\check{H}_i^+,H_a^-,A_b^0}\\
&+\sum_{a=1}^{4}\sum_{b=1}^{4} B_0\Big(p^2, m^2_{H_a^-}, m^2_{h_b}\Big)\Gamma^*_{\check{H}_j^+,H_a^-,h_b}\Gamma_{\check{H}_i^+,H_a^-,h_b}\\
&-2\sum_{a=1}^{6} m_{\nu_a}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{\nu_a}, m^2_{e_b}\Big) m_{e_b}\Big(\Gamma^{L*}_{\check{H}_j^+,\nu_a,e_b}\Gamma^{R}_{\check{H}_i^+,\nu_a,e_b}+\Gamma^{R*}_{\check{H}_j^+,\nu_a,e_b}\Gamma^{L}_{\check{H}_i^+,\nu_a,e_b}\Big)\\
&+\sum_{a=1}^{6}\sum_{b=1}^{3} G_0\Big(p^2, m^2_{\nu_a}, m^2_{e_b}\Big)\Big(\Gamma^{L*}_{\check{H}_j^+,\nu_a,e_b}\Gamma^{L}_{\check{H}_i^+,\nu_a,e_b}+\Gamma^{R*}_{\check{H}_j^+,\nu_a,e_b}\Gamma^{R}_{\check{H}_i^+,\nu_a,e_b}\Big)\\
&+\sum_{b=1}^{2}\Gamma^*_{\check{H}_j^+,W^+,\delta_b^{c--}}\Gamma_{\check{H}_i^+,W^+,\delta_b^{c--}}F_0\Big(p^2, m^2_{\delta_b^{c--}}, m^2_{W^-}\Big)+\sum_{b=1}^{2}\Gamma^*_{\check{H}_j^+,W_R^+,\delta_b^{c--}}\Gamma_{\check{H}_i^+,W_R^+,\delta_b^{c--}}F_0\Big(p^2, m^2_{\delta_b^{c--}}, m^2_{W_R^-}\Big)\\
&+\sum_{b=1}^{4}\Gamma^*_{\check{H}_j^+,W^-,A_b^0}\Gamma_{\check{H}_i^+,W^-,A_b^0}F_0\Big(p^2, m^2_{A_b^0}, m^2_{W^-}\Big)+\sum_{b=1}^{4}\Gamma^*_{\check{H}_j^+,W_R^-,A_b^0}\Gamma_{\check{H}_i^+,W_R^-,A_b^0}F_0\Big(p^2, m^2_{A_b^0}, m^2_{W_R^-}\Big)\\
&+\sum_{b=1}^{4}\Gamma^*_{\check{H}_j^+,W^-,h_b}\Gamma_{\check{H}_i^+,W^-,h_b}F_0\Big(p^2, m^2_{h_b}, m^2_{W^-}\Big)+\sum_{b=1}^{4}\Gamma^*_{\check{H}_j^+,W_R^-,h_b}\Gamma_{\check{H}_i^+,W_R^-,h_b}F_0\Big(p^2, m^2_{h_b}, m^2_{W_R^-}\Big)\\
&+\sum_{b=1}^{4}\Gamma^*_{\check{H}_j^+,\gamma,H_b^-}\Gamma_{\check{H}_i^+,\gamma,H_b^-}F_0\Big(p^2, m^2_{H_b^-}, 0\Big)+\sum_{b=1}^{4}\Gamma^*_{\check{H}_j^+,Z,H_b^-}\Gamma_{\check{H}_i^+,Z,H_b^-}F_0\Big(p^2, m^2_{H_b^-}, m^2_Z\Big)\\
&+\sum_{b=1}^{4}\Gamma^*_{\check{H}_j^+,Z',H_b^-}\Gamma_{\check{H}_i^+,Z',H_b^-}F_0\Big(p^2, m^2_{H_b^-}, m^2_{Z'}\Big) \qquad (124)
\end{aligned}
$$

- **Self-Energy for Hppmm** (δ^{c--})

$$
\begin{aligned}
\Pi_{i,j}(p^2) = &+2\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m^2_{W^-}, m^2_{W^-}\Big)\Big)\Gamma^*_{\check{\delta}_j^{c++},W^-,W^-}\Gamma_{\check{\delta}_i^{c++},W^-,W^-}+4\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m^2_{W^-}, m^2_{W_R^-}\Big)\Big)\Gamma^*_{\check{\delta}_j^{c++},W_R^-,W}\\
&+2\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m^2_{W_R^-}, m^2_{W_R^-}\Big)\Big)\Gamma^*_{\check{\delta}_j^{c++},W_R^-,W_R^-}\Gamma_{\check{\delta}_i^{c++},W_R^-,W_R^-}-B_0\Big(p^2, m^2_{\eta_L^-}, m^2_{\eta_L^+}\Big)\Gamma_{\check{\delta}_i^{c++},\bar{\eta}_L^+,\eta_L^-}\Gamma_{\check{\delta}_j^{c--},\eta_L^+,\bar{\eta}_L^-}\\
&-B_0\Big(p^2, m^2_{\eta_R^-}, m^2_{\eta_L^+}\Big)\Gamma_{\check{\delta}_i^{c++},\bar{\eta}_L^+,\eta_R^-}\Gamma_{\check{\delta}_j^{c--},\eta_L^+,\bar{\eta}_R^-}-B_0\Big(p^2, m^2_{\eta_L^-}, m^2_{\eta_R^+}\Big)\Gamma_{\check{\delta}_i^{c++},\bar{\eta}_R^+,\eta_L^-}\Gamma_{\check{\delta}_j^{c--},\eta_R^+,\bar{\eta}_L^-}\\
&-B_0\Big(p^2, m^2_{\eta_R^-}, m^2_{\eta_R^+}\Big)\Gamma_{\check{\delta}_i^{c++},\bar{\eta}_R^+,\eta_R^-}\Gamma_{\check{\delta}_j^{c--},\eta_R^+,\bar{\eta}_R^-}+4\Gamma_{\check{\delta}_i^{c--},\check{\delta}_j^{c++},W^+,W^-}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{W^-}+A_0\Big(m^2_{W^-}\Big)\Big)\\
&+4\Gamma_{\check{\delta}_i^{c--},\check{\delta}_j^{c++},W_R^+,W_R^-}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{W_R^-}+A_0\Big(m^2_{W_R^-}\Big)\Big)+2\Gamma_{\check{\delta}_i^{c--},\check{\delta}_j^{c++},Z,Z}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{Z}+A_0\Big(m^2_{Z}\Big)\Big)\\
&+2\Gamma_{\check{\delta}_i^{c--},\check{\delta}_j^{c++},Z',Z'}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{Z'}+A_0\Big(m^2_{Z'}\Big)\Big)-\sum_{a=1}^{2}A_0\Big(m^2_{\delta_a^{c--}}\Big)\Gamma_{\check{\delta}_i^{c--},\check{\delta}_j^{c++},\delta_a^{c++},\delta_a^{c--}}\\
&+\sum_{a=1}^{2}\sum_{b=1}^{4} B_0\Big(p^2, m^2_{\delta_a^{c--}}, m^2_{A_b^0}\Big)\Gamma^*_{\check{\delta}_j^{c++},\delta_a^{c--},A_b^0}\Gamma_{\check{\delta}_i^{c++},\delta_a^{c--},A_b^0}
\end{aligned}
$$

$$
\begin{aligned}
&+\sum_{a=1}^{2}\sum_{b=1}^{4} B_0\Big(p^2, m^2_{\delta_a^{c--}}, m^2_{h_b}\Big)\Gamma^{*}_{\check{\delta}_j^{c++},\delta_a^{c--},h_b}\Gamma_{\check{\delta}_i^{c++},\delta_a^{c--},h_b}\\
&-\sum_{a=1}^{3} m_{e_a}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{e_a}, m^2_{e_b}\Big)m_{e_b}\Big(\Gamma^{L*}_{\check{\delta}_j^{c++},e_a,e_b}\Gamma^{R}_{\check{\delta}_i^{c++},e_a,e_b}+\Gamma^{R*}_{\check{\delta}_j^{c++},e_a,e_b}\Gamma^{L}_{\check{\delta}_i^{c++},e_a,e_b}\Big)\\
&+\frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{3} G_0\Big(p^2, m^2_{e_a}, m^2_{e_b}\Big)\Big(\Gamma^{L*}_{\check{\delta}_j^{c++},e_a,e_b}\Gamma^{L}_{\check{\delta}_i^{c++},e_a,e_b}+\Gamma^{R*}_{\check{\delta}_j^{c++},e_a,e_b}\Gamma^{R}_{\check{\delta}_i^{c++},e_a,e_b}\Big)\\
&-\frac{1}{2}\sum_{a=1}^{4} A_0\Big(m^2_{A_a^0}\Big)\Gamma_{\check{\delta}_i^{c--},\check{\delta}_j^{c++},A_a^0,A_a^0}-\sum_{a=1}^{4} A_0\Big(m^2_{H_a^-}\Big)\Gamma_{\check{\delta}_i^{c--},\check{\delta}_j^{c++},H_a^+,H_a^-}\\
&-\frac{1}{2}\sum_{a=1}^{4} A_0\Big(m^2_{h_a}\Big)\Gamma_{\check{\delta}_i^{c--},\check{\delta}_j^{c++},h_a,h_a}+\frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{4} B_0\Big(p^2, m^2_{H_a^-}, m^2_{H_b^-}\Big)\Gamma^{*}_{\check{\delta}_j^{c++},H_a^-,H_b^-}\Gamma_{\check{\delta}_i^{c++},H_a^-,H_b^-}\\
&+\sum_{b=1}^{2}\Gamma^{*}_{\check{\delta}_j^{c++},\gamma,\delta_b^{c--}}\Gamma_{\delta_i^{c++},\gamma,\delta_b^{c--}}F_0\Big(p^2, m^2_{\delta_b^{c--}}, 0\Big)+\sum_{b=1}^{2}\Gamma^{*}_{\check{\delta}_j^{c++},Z,\delta_b^{c--}}\Gamma_{\delta_i^{c++},Z,\delta_b^{c--}}F_0\Big(p^2, m^2_{\delta_b^{c--}}, m^2_{Z}\Big)\\
&+\sum_{b=1}^{2}\Gamma^{*}_{\check{\delta}_j^{c++},Z',\delta_b^{c--}}\Gamma_{\check{\delta}_i^{c++},Z',\delta_b^{c--}}F_0\Big(p^2, m^2_{\delta_b^{c--}}, m^2_{Z'}\Big)+\sum_{b=1}^{4}\Gamma^{*}_{\check{\delta}_j^{c++},W^-,H_b^-}\Gamma_{\check{\delta}_i^{c++},W^-,H_b^-}F_0\Big(p^2, m^2_{H_b^-}, m^2_{W^-}\Big)\\
&+\sum_{b=1}^{4}\Gamma^{*}_{\check{\delta}_j^{c++},W_R^-,H_b^-}\Gamma_{\check{\delta}_i^{c++},W_R^-,H_b^-}F_0\Big(p^2, m^2_{H_b^-}, m^2_{W_R^-}\Big) \qquad (125)
\end{aligned}
$$

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

$$
\begin{aligned}
\Sigma^{S}_{i,j}(p^2) =&+\sum_{a=1}^{3} m_{d_a}\sum_{b=1}^{4} B_0\Big(p^2, m^2_{d_a}, m^2_{A_b^0}\Big)\Gamma^{L*}_{\check{d}_j,d_a,A_b^0}\Gamma^{R}_{\check{d}_i,d_a,A_b^0}\\
&+\sum_{a=1}^{4}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{d_b}, m^2_{h_a}\Big)\Gamma^{L*}_{\check{d}_j,h_a,d_b}m_{d_b}\Gamma^{R}_{\check{d}_i,h_a,d_b}\\
&+\sum_{a=1}^{4}\sum_{b=1}^{3} B_0\Big(p^2, m^2_{u_b}, m^2_{H_a^-}\Big)\Gamma^{L*}_{\check{d}_j,H_a^-,u_b}m_{u_b}\Gamma^{R}_{\check{d}_i,H_a^-,u_b}\\
&-\frac{16}{3}\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m^2_{d_b}, 0\Big)\Big)\Gamma^{R*}_{\check{d}_j,g,d_b}m_{d_b}\Gamma^{L}_{\check{d}_i,g,d_b}-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m^2_{d_b}, 0\Big)\Big)\Gamma^{R*}_{\check{d}_j,\gamma,d_b}m_{d_b}\Gamma^{L}_{\check{d}_i,\gamma,d_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m^2_{u_b}, m^2_{W^-}\Big)\Big)\Gamma^{R*}_{\check{d}_j,W^-,u_b}m_{u_b}\Gamma^{L}_{\check{d}_i,W^-,u_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m^2_{u_b}, m^2_{W_R^-}\Big)\Big)\Gamma^{R*}_{\check{d}_j,W_R^-,u_b}m_{u_b}\Gamma^{L}_{\check{d}_i,W_R^-,u_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m^2_{d_b}, m^2_{Z}\Big)\Big)\Gamma^{R*}_{\check{d}_j,Z,d_b}m_{d_b}\Gamma^{L}_{\check{d}_i,Z,d_b}
\end{aligned}
$$

$$- 4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m_{d_b}^2, m_{Z'}^2\Big)\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,Z',d_b} m_{d_b} \Gamma^{L}_{\tilde{\tilde{d}}_i,Z',d_b} \tag{126}$$

$$\begin{aligned}
\Sigma^R_{i,j}(p^2) = &-\frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{4} B_1\Big(p^2, m_{d_a}^2, m_{A_b^0}^2\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,d_a,A_b^0}\Gamma^{R}_{\tilde{\tilde{d}}_i,d_a,A_b^0} \\
&-\frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_{h_a}^2\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,h_a,d_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,h_a,d_b} \\
&-\frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_{H_a^-}^2\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,H_a^-,u_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,H_a^-,u_b} - \frac{4}{3}\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{d_b}^2, 0\Big)\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,g,d_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,g,d_b} \\
&-\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{d_b}^2, 0\Big)\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,\gamma,d_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,\gamma,d_b} - \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{u_b}^2, m_{W^-}^2\Big)\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,W^-,u_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,W^-,u_b} \\
&-\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{u_b}^2, m_{W_R^-}^2\Big)\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,W_R^-,u_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,W_R^-,u_b} - \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{d_b}^2, m_Z^2\Big)\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,Z,d_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,Z,d_b} \\
&-\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{d_b}^2, m_{Z'}^2\Big)\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,Z',d_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,Z',d_b}
\end{aligned} \tag{127}$$

$$\begin{aligned}
\Sigma^L_{i,j}(p^2) = &-\frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{4} B_1\Big(p^2, m_{d_a}^2, m_{A_b^0}^2\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,d_a,A_b^0}\Gamma^{L}_{\tilde{\tilde{d}}_i,d_a,A_b^0} \\
&-\frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_{h_a}^2\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,h_a,d_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,h_a,d_b} \\
&-\frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_{H_a^-}^2\Big)\Gamma^{L*}_{\tilde{\tilde{d}}_j,H_a^-,u_b}\Gamma^{L}_{\tilde{\tilde{d}}_i,H_a^-,u_b} - \frac{4}{3}\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{d_b}^2, 0\Big)\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,g,d_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,g,d_b} \\
&-\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{d_b}^2, 0\Big)\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,\gamma,d_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,\gamma,d_b} - \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{u_b}^2, m_{W^-}^2\Big)\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,W^-,u_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,W^-,u_b} \\
&-\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{u_b}^2, m_{W_R^-}^2\Big)\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,W_R^-,u_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,W_R^-,u_b} - \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{d_b}^2, m_Z^2\Big)\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,Z,d_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,Z,d_b} \\
&-\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{d_b}^2, m_{Z'}^2\Big)\Big)\Gamma^{R*}_{\tilde{\tilde{d}}_j,Z',d_b}\Gamma^{R}_{\tilde{\tilde{d}}_i,Z',d_b}
\end{aligned} \tag{128}$$

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

$$\Sigma^S_{i,j}(p^2) = +\sum_{a=1}^{3} m_{u_a}\sum_{b=1}^{4} B_0\Big(p^2, m_{u_a}^2, m_{A_b^0}^2\Big)\Gamma^{L*}_{\tilde{u}_j,u_a,A_b^0}\Gamma^{R}_{\tilde{u}_i,u_a,A_b^0}$$

$$
\begin{aligned}
&+\sum_{a=1}^{4}\sum_{b=1}^{3} B_0\Big(p^2, m_{d_b}^2, m_{H_a^-}^2\Big)\Gamma^{L*}_{\breve{u}_j,H_a^+,d_b} m_{d_b}\Gamma^{R}_{\breve{u}_i,H_a^+,d_b}\\
&+\sum_{a=1}^{4}\sum_{b=1}^{3} B_0\Big(p^2, m_{u_b}^2, m_{h_a}^2\Big)\Gamma^{L*}_{\breve{u}_j,h_a,u_b} m_{u_b}\Gamma^{R}_{\breve{u}_i,h_a,u_b}\\
&-\frac{16}{3}\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m_{u_b}^2, 0\Big)\Big)\Gamma^{R*}_{\breve{u}_j,g,u_b} m_{u_b}\Gamma^{L}_{\breve{u}_i,g,u_b} - 4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m_{u_b}^2, 0\Big)\Big)\Gamma^{R*}_{\breve{u}_j,\gamma,u_b} m_{u_b}\Gamma^{L}_{\breve{u}_i,\gamma,u_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m_{u_b}^2, m_Z^2\Big)\Big)\Gamma^{R*}_{\breve{u}_j,Z,u_b} m_{u_b}\Gamma^{L}_{\breve{u}_i,Z,u_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m_{u_b}^2, m_{Z'}^2\Big)\Big)\Gamma^{R*}_{\breve{u}_j,Z',u_b} m_{u_b}\Gamma^{L}_{\breve{u}_i,Z',u_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m_{d_b}^2, m_{W^-}^2\Big)\Big)\Gamma^{R*}_{\breve{u}_j,W^+,d_b} m_{d_b}\Gamma^{L}_{\breve{u}_i,W^+,d_b}\\
&-4\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2, m_{d_b}^2, m_{W_R^-}^2\Big)\Big)\Gamma^{R*}_{\breve{u}_j,W_R^+,d_b} m_{d_b}\Gamma^{L}_{\breve{u}_i,W_R^+,d_b} \qquad (129)\\
\Sigma^R_{i,j}(p^2) =& -\frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{4} B_1\Big(p^2, m_{u_a}^2, m_{A_b^0}^2\Big)\Gamma^{R*}_{\breve{u}_j,u_a,A_b^0}\Gamma^{R}_{\breve{u}_i,u_a,A_b^0}\\
&-\frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_{H_a^-}^2\Big)\Gamma^{R*}_{\breve{u}_j,H_a^+,d_b}\Gamma^{R}_{\breve{u}_i,H_a^+,d_b}\\
&-\frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_{h_a}^2\Big)\Gamma^{R*}_{\breve{u}_j,h_a,u_b}\Gamma^{R}_{\breve{u}_i,h_a,u_b} - \frac{4}{3}\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS}+B_1\Big(p^2, m_{u_b}^2, 0\Big)\Big)\Gamma^{L*}_{\breve{u}_j,g,u_b}\Gamma^{L}_{\breve{u}_i,g,u_b}\\
&-\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS}+B_1\Big(p^2, m_{u_b}^2, 0\Big)\Big)\Gamma^{L*}_{\breve{u}_j,\gamma,u_b}\Gamma^{L}_{\breve{u}_i,\gamma,u_b} - \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS}+B_1\Big(p^2, m_{u_b}^2, m_Z^2\Big)\Big)\Gamma^{L*}_{\breve{u}_j,Z,u_b}\Gamma^{L}_{\breve{u}_i,Z,u_b}\\
&-\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS}+B_1\Big(p^2, m_{u_b}^2, m_{Z'}^2\Big)\Big)\Gamma^{L*}_{\breve{u}_j,Z',u_b}\Gamma^{L}_{\breve{u}_i,Z',u_b} - \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS}+B_1\Big(p^2, m_{d_b}^2, m_{W^-}^2\Big)\Big)\Gamma^{L*}_{\breve{u}_j,W^+,d_b}\Gamma^{L}_{\breve{u}_i,W^+,d_b}\\
&-\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS}+B_1\Big(p^2, m_{d_b}^2, m_{W_R^-}^2\Big)\Big)\Gamma^{L*}_{\breve{u}_j,W_R^+,d_b}\Gamma^{L}_{\breve{u}_i,W_R^+,d_b} \qquad (130)\\
\Sigma^L_{i,j}(p^2) =& -\frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{4} B_1\Big(p^2, m_{u_a}^2, m_{A_b^0}^2\Big)\Gamma^{L*}_{\breve{u}_j,u_a,A_b^0}\Gamma^{L}_{\breve{u}_i,u_a,A_b^0}\\
&-\frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{3} B_1\Big(p^2, m_{d_b}^2, m_{H_a^-}^2\Big)\Gamma^{L*}_{\breve{u}_j,H_a^+,d_b}\Gamma^{L}_{\breve{u}_i,H_a^+,d_b}
\end{aligned}
$$

$$
\begin{aligned}
&- \frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{3} B_1\Big(p^2, m_{u_b}^2, m_{h_a}^2\Big)\Gamma^{L*}_{\check{\bar{u}}_j,h_a,u_b}\Gamma^{L}_{\check{\bar{u}}_i,h_a,u_b} - \frac{4}{3}\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{u_b}^2, 0\Big)\Big)\Gamma^{R*}_{\check{\bar{u}}_j,g,u_b}\Gamma^{R}_{\check{\bar{u}}_i,g,u_b}\\
&- \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{u_b}^2, 0\Big)\Big)\Gamma^{R*}_{\check{\bar{u}}_j,\gamma,u_b}\Gamma^{R}_{\check{\bar{u}}_i,\gamma,u_b} - \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{u_b}^2, m_Z^2\Big)\Big)\Gamma^{R*}_{\check{\bar{u}}_j,Z,u_b}\Gamma^{R}_{\check{\bar{u}}_i,Z,u_b}\\
&- \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{u_b}^2, m_{Z'}^2\Big)\Big)\Gamma^{R*}_{\check{\bar{u}}_j,Z',u_b}\Gamma^{R}_{\check{\bar{u}}_i,Z',u_b} - \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{d_b}^2, m_{W^-}^2\Big)\Big)\Gamma^{R*}_{\check{\bar{u}}_j,W^+,d_b}\Gamma^{R}_{\check{\bar{u}}_i,W^+,d_b}\\
&- \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{d_b}^2, m_{W_R^-}^2\Big)\Big)\Gamma^{R*}_{\check{\bar{u}}_j,W_R^+,d_b}\Gamma^{R}_{\check{\bar{u}}_i,W_R^+,d_b} \qquad (131)
\end{aligned}
$$

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

$$
\begin{aligned}
\Sigma^S_{i,j}(p^2) = &+\sum_{a=1}^{3} m_{e_a}\sum_{b=1}^{2} B_0\Big(p^2, m_{e_a}^2, m_{\delta_b^{c--}}^2\Big)\Gamma^{L*}_{\check{\bar{e}}_j,\bar{e}_a,\delta_b^{c--}}\Gamma^{R}_{\check{\bar{e}}_i,\bar{e}_a,\delta_b^{c--}}\\
&+\sum_{a=1}^{3} m_{e_a}\sum_{b=1}^{4} B_0\Big(p^2, m_{e_a}^2, m_{A_b^0}^2\Big)\Gamma^{L*}_{\check{\bar{e}}_j,e_a,A_b^0}\Gamma^{R}_{\check{\bar{e}}_i,e_a,A_b^0}\\
&+\sum_{a=1}^{4}\sum_{b=1}^{3} B_0\Big(p^2, m_{e_b}^2, m_{h_a}^2\Big)\Gamma^{L*}_{\check{\bar{e}}_j,h_a,e_b} m_{e_b}\Gamma^{R}_{\check{\bar{e}}_i,h_a,e_b}\\
&+\sum_{a=1}^{4}\sum_{b=1}^{6} B_0\Big(p^2, m_{\nu_b}^2, m_{H_a^-}^2\Big)\Gamma^{L*}_{\check{\bar{e}}_j,H_a^-,\nu_b} m_{\nu_b}\Gamma^{R}_{\check{\bar{e}}_i,H_a^-,\nu_b}\\
&- 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{\bar{e}}_j,\gamma,e_b} m_{e_b}\Gamma^{L}_{\check{\bar{e}}_i,\gamma,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{\bar{e}}_j,Z,e_b} m_{e_b}\Gamma^{L}_{\check{\bar{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{\bar{e}}_j,Z',e_b} m_{e_b}\Gamma^{L}_{\check{\bar{e}}_i,Z',e_b}\\
&- 4\sum_{b=1}^{6}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m_{\nu_b}^2, m_{W^-}^2\Big)\Big)\Gamma^{R*}_{\check{\bar{e}}_j,W^-,\nu_b} m_{\nu_b}\Gamma^{L}_{\check{\bar{e}}_i,W^-,\nu_b}\\
&- 4\sum_{b=1}^{6}\Big(-\frac{1}{2}\mathrm{rMS} + B_0\Big(p^2, m_{\nu_b}^2, m_{W_R^-}^2\Big)\Big)\Gamma^{R*}_{\check{\bar{e}}_j,W_R^-,\nu_b} m_{\nu_b}\Gamma^{L}_{\check{\bar{e}}_i,W_R^-,\nu_b} \qquad (132)\\
\Sigma^R_{i,j}(p^2) = &-\frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{2} B_1\Big(p^2, m_{e_a}^2, m_{\delta_b^{c--}}^2\Big)\Gamma^{R*}_{\check{\bar{e}}_j,\bar{e}_a,\delta_b^{c--}}\Gamma^{R}_{\check{\bar{e}}_i,\bar{e}_a,\delta_b^{c--}}\\
&-\frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{4} B_1\Big(p^2, m_{e_a}^2, m_{A_b^0}^2\Big)\Gamma^{R*}_{\check{\bar{e}}_j,e_a,A_b^0}\Gamma^{R}_{\check{\bar{e}}_i,e_a,A_b^0}
\end{aligned}
$$

$$
\begin{aligned}
&- \frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{3} B_1\Big(p^2, m_{e_b}^2, m_{h_a}^2\Big)\Gamma^{R*}_{\check{\bar{e}}_j,h_a,e_b}\Gamma^{R}_{\check{\bar{e}}_i,h_a,e_b} \\
&- \frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{6} B_1\Big(p^2, m_{\nu_b}^2, m_{H_a^-}^2\Big)\Gamma^{R*}_{\check{\bar{e}}_j,H_a^-,\nu_b}\Gamma^{R}_{\check{\bar{e}}_i,H_a^-,\nu_b} - \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{e_b}^2, 0\Big)\Big)\Gamma^{L*}_{\check{\bar{e}}_j,\gamma,e_b}\Gamma^{L}_{\check{\bar{e}}_i,\gamma,e_b} \\
&- \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{e_b}^2, m_Z^2\Big)\Big)\Gamma^{L*}_{\check{\bar{e}}_j,Z,e_b}\Gamma^{L}_{\check{\bar{e}}_i,Z,e_b} - \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{e_b}^2, m_{Z'}^2\Big)\Big)\Gamma^{L*}_{\check{\bar{e}}_j,Z',e_b}\Gamma^{L}_{\check{\bar{e}}_i,Z',e_b} \\
&- \sum_{b=1}^{6}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{\nu_b}^2, m_{W^-}^2\Big)\Big)\Gamma^{L*}_{\check{\bar{e}}_j,W^-,\nu_b}\Gamma^{L}_{\check{\bar{e}}_i,W^-,\nu_b} \\
&- \sum_{b=1}^{6}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{\nu_b}^2, m_{W_R^-}^2\Big)\Big)\Gamma^{L*}_{\check{\bar{e}}_j,W_R^-,\nu_b}\Gamma^{L}_{\check{\bar{e}}_i,W_R^-,\nu_b} \qquad (133)
\end{aligned}
$$

$$
\begin{aligned}
\Sigma^{L}_{i,j}(p^2) = &-\frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{2} B_1\Big(p^2, m_{e_a}^2, m_{\delta_b^{c--}}^2\Big)\Gamma^{L*}_{\check{\bar{e}}_j,\bar{e}_a,\delta_b^{c--}}\Gamma^{L}_{\check{\bar{e}}_i,\bar{e}_a,\delta_b^{c--}} \\
&- \frac{1}{2}\sum_{a=1}^{3}\sum_{b=1}^{4} B_1\Big(p^2, m_{e_a}^2, m_{A_b^0}^2\Big)\Gamma^{L*}_{\check{\bar{e}}_j,e_a,A_b^0}\Gamma^{L}_{\check{\bar{e}}_i,e_a,A_b^0} \\
&- \frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{3} B_1\Big(p^2, m_{e_b}^2, m_{h_a}^2\Big)\Gamma^{L*}_{\check{\bar{e}}_j,h_a,e_b}\Gamma^{L}_{\check{\bar{e}}_i,h_a,e_b} \\
&- \frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{6} B_1\Big(p^2, m_{\nu_b}^2, m_{H_a^-}^2\Big)\Gamma^{L*}_{\check{\bar{e}}_j,H_a^-,\nu_b}\Gamma^{L}_{\check{\bar{e}}_i,H_a^-,\nu_b} - \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{e_b}^2, 0\Big)\Big)\Gamma^{R*}_{\check{\bar{e}}_j,\gamma,e_b}\Gamma^{R}_{\check{\bar{e}}_i,\gamma,e_b} \\
&- \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{e_b}^2, m_Z^2\Big)\Big)\Gamma^{R*}_{\check{\bar{e}}_j,Z,e_b}\Gamma^{R}_{\check{\bar{e}}_i,Z,e_b} - \sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{e_b}^2, m_{Z'}^2\Big)\Big)\Gamma^{R*}_{\check{\bar{e}}_j,Z',e_b}\Gamma^{R}_{\check{\bar{e}}_i,Z',e_b} \\
&- \sum_{b=1}^{6}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{\nu_b}^2, m_{W^-}^2\Big)\Big)\Gamma^{R*}_{\check{\bar{e}}_j,W^-,\nu_b}\Gamma^{R}_{\check{\bar{e}}_i,W^-,\nu_b} \\
&- \sum_{b=1}^{6}\Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m_{\nu_b}^2, m_{W_R^-}^2\Big)\Big)\Gamma^{R*}_{\check{\bar{e}}_j,W_R^-,\nu_b}\Gamma^{R}_{\check{\bar{e}}_i,W_R^-,\nu_b} \qquad (134)
\end{aligned}
$$

- **Self-Energy for Neutrinos** (ν)

$$
\begin{aligned}
\Sigma^{S}_{i,j}(p^2) = &+2\sum_{a=1}^{4}\sum_{b=1}^{3} B_0\Big(p^2, m_{e_b}^2, m_{H_a^-}^2\Big)\Gamma^{L*}_{\check{\nu}_j,H_a^+,e_b} m_{e_b}\Gamma^{R}_{\check{\nu}_i,H_a^+,e_b} \\
&+ \sum_{a=1}^{4}\sum_{b=1}^{6} B_0\Big(p^2, m_{\nu_b}^2, m_{h_a}^2\Big)\Gamma^{L*}_{\check{\nu}_j,h_a,\nu_b} m_{\nu_b}\Gamma^{R}_{\check{\nu}_i,h_a,\nu_b}
\end{aligned}
$$

$$
\begin{aligned}
&+\sum_{a=1}^{6} m_{\nu_a} \sum_{b=1}^{4} B_0\Big(p^2, m_{\nu_a}^2, m_{A_b^0}^2\Big)\Gamma^{L*}_{\check{\nu}_j,\nu_a,A_b^0}\Gamma^{R}_{\check{\nu}_i,\nu_a,A_b^0}\\
&-8\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{e_b}^2,m_{W^-}^2\Big)\Big)\Gamma^{R*}_{\check{\nu}_j,W^+,e_b}m_{e_b}\Gamma^{L}_{\check{\nu}_i,W^+,e_b}\\
&-8\sum_{b=1}^{3}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{e_b}^2,m_{W_R^-}^2\Big)\Big)\Gamma^{R*}_{\check{\nu}_j,W_R^+,e_b}m_{e_b}\Gamma^{L}_{\check{\nu}_i,W_R^+,e_b}\\
&-4\sum_{b=1}^{6}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{\nu_b}^2,0\Big)\Big)\Gamma^{R*}_{\check{\nu}_j,\gamma,\nu_b}m_{\nu_b}\Gamma^{L}_{\check{\nu}_i,\gamma,\nu_b}-4\sum_{b=1}^{6}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{\nu_b}^2,m_Z^2\Big)\Big)\Gamma^{R*}_{\check{\nu}_j,Z,\nu_b}m_{\nu_b}\Gamma^{L}_{\check{\nu}_i,Z,\nu_b}\\
&-4\sum_{b=1}^{6}\Big(-\frac{1}{2}\mathrm{rMS}+B_0\Big(p^2,m_{\nu_b}^2,m_{Z'}^2\Big)\Big)\Gamma^{R*}_{\check{\nu}_j,Z',\nu_b}m_{\nu_b}\Gamma^{L}_{\check{\nu}_i,Z',\nu_b} \qquad (135)\\
\Sigma^R_{i,j}(p^2)=&-\sum_{a=1}^{4}\sum_{b=1}^{3}B_1\Big(p^2,m_{e_b}^2,m_{H_a^-}^2\Big)\Gamma^{R*}_{\check{\nu}_j,H_a^+,e_b}\Gamma^{R}_{\check{\nu}_i,H_a^+,e_b}\\
&-\frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{6}B_1\Big(p^2,m_{\nu_b}^2,m_{h_a}^2\Big)\Gamma^{R*}_{\check{\nu}_j,h_a,\nu_b}\Gamma^{R}_{\check{\nu}_i,h_a,\nu_b}\\
&-\frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{4}B_1\Big(p^2,m_{\nu_a}^2,m_{A_b^0}^2\Big)\Gamma^{R*}_{\check{\nu}_j,\nu_a,A_b^0}\Gamma^{R}_{\check{\nu}_i,\nu_a,A_b^0}\\
&-2\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS}+B_1\Big(p^2,m_{e_b}^2,m_{W^-}^2\Big)\Big)\Gamma^{L*}_{\check{\nu}_j,W^+,e_b}\Gamma^{L}_{\check{\nu}_i,W^+,e_b}-2\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS}+B_1\Big(p^2,m_{e_b}^2,m_{W_R^-}^2\Big)\Big)\Gamma^{L*}_{\check{\nu}_j,W_R^+,e_b}\Gamma^{L}_{\check{\nu}_i,W_R^+,e_b}\\
&-\sum_{b=1}^{6}\Big(\frac{1}{2}\mathrm{rMS}+B_1\Big(p^2,m_{\nu_b}^2,0\Big)\Big)\Gamma^{L*}_{\check{\nu}_j,\gamma,\nu_b}\Gamma^{L}_{\check{\nu}_i,\gamma,\nu_b}-\sum_{b=1}^{6}\Big(\frac{1}{2}\mathrm{rMS}+B_1\Big(p^2,m_{\nu_b}^2,m_Z^2\Big)\Big)\Gamma^{L*}_{\check{\nu}_j,Z,\nu_b}\Gamma^{L}_{\check{\nu}_i,Z,\nu_b}\\
&-\sum_{b=1}^{6}\Big(\frac{1}{2}\mathrm{rMS}+B_1\Big(p^2,m_{\nu_b}^2,m_{Z'}^2\Big)\Big)\Gamma^{L*}_{\check{\nu}_j,Z',\nu_b}\Gamma^{L}_{\check{\nu}_i,Z',\nu_b} \qquad (136)\\
\Sigma^L_{i,j}(p^2)=&-\sum_{a=1}^{4}\sum_{b=1}^{3}B_1\Big(p^2,m_{e_b}^2,m_{H_a^-}^2\Big)\Gamma^{L*}_{\check{\nu}_j,H_a^+,e_b}\Gamma^{L}_{\check{\nu}_i,H_a^+,e_b}\\
&-\frac{1}{2}\sum_{a=1}^{4}\sum_{b=1}^{6}B_1\Big(p^2,m_{\nu_b}^2,m_{h_a}^2\Big)\Gamma^{L*}_{\check{\nu}_j,h_a,\nu_b}\Gamma^{L}_{\check{\nu}_i,h_a,\nu_b}\\
&-\frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{4}B_1\Big(p^2,m_{\nu_a}^2,m_{A_b^0}^2\Big)\Gamma^{L*}_{\check{\nu}_j,\nu_a,A_b^0}\Gamma^{L}_{\check{\nu}_i,\nu_a,A_b^0}\\
&-2\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS}+B_1\Big(p^2,m_{e_b}^2,m_{W^-}^2\Big)\Big)\Gamma^{R*}_{\check{\nu}_j,W^+,e_b}\Gamma^{R}_{\check{\nu}_i,W^+,e_b}-2\sum_{b=1}^{3}\Big(\frac{1}{2}\mathrm{rMS}+B_1\Big(p^2,m_{e_b}^2,m_{W_R^-}^2\Big)\Big)\Gamma^{R*}_{\check{\nu}_j,W_R^+,e_b}\Gamma^{R}_{\check{\nu}_i,W_R^+,e_b}
\end{aligned}
$$

$$
\begin{aligned}
&- \sum_{b=1}^{6} \Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m^2_{\nu_b}, 0\Big)\Big)\Gamma^{R*}_{\check{\nu}_j,\gamma,\nu_b}\Gamma^{R}_{\check{\nu}_i,\gamma,\nu_b} - \sum_{b=1}^{6} \Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m^2_{\nu_b}, m^2_{Z}\Big)\Big)\Gamma^{R*}_{\check{\nu}_j,Z,\nu_b}\Gamma^{R}_{\check{\nu}_i,Z,\nu_b} \\
&- \sum_{b=1}^{6} \Big(\frac{1}{2}\mathrm{rMS} + B_1\Big(p^2, m^2_{\nu_b}, m^2_{Z'}\Big)\Big)\Gamma^{R*}_{\check{\nu}_j,Z',\nu_b}\Gamma^{R}_{\check{\nu}_i,Z',\nu_b} \qquad (137)
\end{aligned}
$$

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

$$
\begin{aligned}
\Pi(p^2) = &+|\Gamma_{Z,\eta^-_L,\eta^-_L}|^2 B_{00}\Big(p^2, m^2_{\eta^-_L}, m^2_{\eta^-_L}\Big) + 2|\Gamma_{Z,\eta^-_R,\eta^-_L}|^2 B_{00}\Big(p^2, m^2_{\eta^-_L}, m^2_{\eta^-_R}\Big) \\
&+ |\Gamma_{Z,\eta^-_L,\eta^+_L}|^2 B_{00}\Big(p^2, m^2_{\eta^+_L}, m^2_{\eta^+_L}\Big) + 2|\Gamma_{Z,\eta^-_R,\eta^+_L}|^2 B_{00}\Big(p^2, m^2_{\eta^+_L}, m^2_{\eta^+_R}\Big) \\
&+ |\Gamma_{Z,\eta^-_R,\eta^-_R}|^2 B_{00}\Big(p^2, m^2_{\eta^-_R}, m^2_{\eta^-_R}\Big) + |\Gamma_{Z,\eta^-_R,\eta^+_R}|^2 B_{00}\Big(p^2, m^2_{\eta^+_R}, m^2_{\eta^+_R}\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\mathrm{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) \\
&- 2|\Gamma_{Z,W^+_R,W^-}|^2\Big(10B_{00}\Big(p^2, m^2_{W^-_R}, m^2_{W^-}\Big) - 2\mathrm{rMS}\Big(-\frac{1}{3}p^2 + m^2_{W^-} + m^2_{W^-_R}\Big) + B_0\Big(p^2, m^2_{W^-_R}, m^2_{W^-}\Big)\Big(4p^2 + m^2_{W^-} + m^2_{W^-_R}\Big)\Big) \\
&- |\Gamma_{Z,W^+_R,W^-_R}|^2\Big(10B_{00}\Big(p^2, m^2_{W^-_R}, m^2_{W^-_R}\Big) + 2A_0\Big(m^2_{W^-_R}\Big) - 2\mathrm{rMS}\Big(2m^2_{W^-_R} - \frac{1}{3}p^2\Big) + B_0\Big(p^2, m^2_{W^-_R}, m^2_{W^-_R}\Big)\Big(2m^2_{W^-_R} + 4p^2\Big)\Big) \\
&+ \sum_{a=1}^{2} A_0\Big(m^2_{\delta^{c--}_a}\Big)\Gamma_{Z,Z,\delta^{c++}_a,\delta^{c--}_a} - 4\sum_{a=1}^{2}\sum_{b=1}^{2}|\Gamma_{Z,\delta^{c++}_a,\delta^{c--}_b}|^2 B_{00}\Big(p^2, m^2_{\delta^{c--}_a}, m^2_{\delta^{c--}_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] \\
&+ \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] \\
&+ \frac{1}{2}\sum_{a=1}^{4} A_0\Big(m^2_{A^0_a}\Big)\Gamma_{Z,Z,A^0_a,A^0_a} + \sum_{a=1}^{4} A_0\Big(m^2_{H^-_a}\Big)\Gamma_{Z,Z,H^+_a,H^-_a} + \frac{1}{2}\sum_{a=1}^{4} A_0\Big(m^2_{h_a}\Big)\Gamma_{Z,Z,h_a,h_a} \\
&- 4\sum_{a=1}^{4}\sum_{b=1}^{4}|\Gamma_{Z,h_a,A^0_b}|^2 B_{00}\Big(p^2, m^2_{A^0_b}, m^2_{h_a}\Big) - 4\sum_{a=1}^{4}\sum_{b=1}^{4}|\Gamma_{Z,H^+_a,H^-_b}|^2 B_{00}\Big(p^2, m^2_{H^-_a}, m^2_{H^-_b}\Big) \\
&+ \frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{6}\Big[\Big(|\Gamma^L_{Z,\nu_a,\nu_b}|^2 + |\Gamma^R_{Z,\nu_a,\nu_b}|^2\Big)H_0\Big(p^2, m^2_{\nu_a}, m^2_{\nu_b}\Big)
\end{aligned}
$$

$$
\begin{aligned}
&+ 4B_0\Big(p^2, m^2_{\nu_a}, m^2_{\nu_b}\Big) m_{\nu_a} m_{\nu_b} \Re\Big(\Gamma^{L*}_{Z,\nu_a,\nu_b}\Gamma^{R}_{Z,\nu_a,\nu_b}\Big)\Big] \\
&+ \sum_{b=1}^{4} |\Gamma_{Z,\gamma,h_b}|^2 B_0\Big(p^2, 0, m^2_{h_b}\Big) + 2\sum_{b=1}^{4} |\Gamma_{Z,W^+,H_b^-}|^2 B_0\Big(p^2, m^2_{W^-}, m^2_{H_b^-}\Big) \\
&+ 2\sum_{b=1}^{4} |\Gamma_{Z,W_R^+,H_b^-}|^2 B_0\Big(p^2, m^2_{W_R^-}, m^2_{H_b^-}\Big) + \sum_{b=1}^{4} |\Gamma_{Z,Z,h_b}|^2 B_0\Big(p^2, m^2_{Z}, m^2_{h_b}\Big) \\
&+ \sum_{b=1}^{4} |\Gamma_{Z,Z',h_b}|^2 B_0\Big(p^2, m^2_{Z'}, m^2_{h_b}\Big) + 2\mathrm{rMS} m^2_{W^-}\Gamma^1_{Z,Z,W^+,W^-} - A_0\Big(m^2_{W^-}\Big)\Big(4\Gamma^1_{Z,Z,W^+,W^-} + \Gamma^2_{Z,Z,W^+,W^-} + \Gamma^3_{Z,Z,W^+,W^-}
\end{aligned}
\tag{138}
$$

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

$$
\begin{aligned}
\Pi(p^2) = &+|\Gamma_{Z',\bar{\eta_L^-},\eta_L^-}|^2 B_{00}\Big(p^2, m^2_{\eta_L^-}, m^2_{\eta_L^-}\Big) + 2|\Gamma_{Z',\bar{\eta_R^-},\eta_L^-}|^2 B_{00}\Big(p^2, m^2_{\eta_L^-}, m^2_{\eta_R^-}\Big) \\
&+ |\Gamma_{Z',\bar{\eta_L^+},\eta_L^+}|^2 B_{00}\Big(p^2, m^2_{\eta_L^+}, m^2_{\eta_L^+}\Big) + 2|\Gamma_{Z',\bar{\eta_R^+},\eta_L^+}|^2 B_{00}\Big(p^2, m^2_{\eta_L^+}, m^2_{\eta_R^+}\Big) \\
&+ |\Gamma_{Z',\bar{\eta_R^-},\eta_R^-}|^2 B_{00}\Big(p^2, m^2_{\eta_R^-}, m^2_{\eta_R^-}\Big) + |\Gamma_{Z',\bar{\eta_R^+},\eta_R^+}|^2 B_{00}\Big(p^2, m^2_{\eta_R^+}, m^2_{\eta_R^+}\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\mathrm{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) \\
&- 2|\Gamma_{Z',W_R^+,W^-}|^2\Big(10B_{00}\Big(p^2, m^2_{W_R^-}, m^2_{W^-}\Big) - 2\mathrm{rMS}\Big(-\frac{1}{3}p^2 + m^2_{W^-} + m^2_{W_R^-}\Big) + B_0\Big(p^2, m^2_{W_R^-}, m^2_{W^-}\Big)\Big(4p^2 + m^2_{W^-} + m^2_{W} \\
&- |\Gamma_{Z',W_R^+,W_R^-}|^2\Big(10B_{00}\Big(p^2, m^2_{W_R^-}, m^2_{W_R^-}\Big) + 2A_0\Big(m^2_{W_R^-}\Big) - 2\mathrm{rMS}\Big(2m^2_{W_R^-} - \frac{1}{3}p^2\Big) + B_0\Big(p^2, m^2_{W_R^-}, m^2_{W_R^-}\Big)\Big(2m^2_{W_R^-} + 4p^2\Big) \\
&+ \sum_{a=1}^{2} A_0\Big(m^2_{\delta_a^{c--}}\Big)\Gamma_{Z',Z',\delta_a^{c++},\delta_a^{c--}} - 4\sum_{a=1}^{2}\sum_{b=1}^{2} |\Gamma_{Z',\delta_a^{c++},\delta_b^{c--}}|^2 B_{00}\Big(p^2, m^2_{\delta_a^{c--}}, m^2_{\delta_b^{c--}}\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] \\
&+ \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] \\
&+ \frac{1}{2}\sum_{a=1}^{4} A_0\Big(m^2_{A_a^0}\Big)\Gamma_{Z',Z',A_a^0,A_a^0} + \sum_{a=1}^{4} A_0\Big(m^2_{H_a^-}\Big)\Gamma_{Z',Z',H_a^+,H_a^-} + \frac{1}{2}\sum_{a=1}^{4} A_0\Big(m^2_{h_a}\Big)\Gamma_{Z',Z',h_a,h_a}
\end{aligned}
$$

$$
\begin{aligned}
&- 4\sum_{a=1}^{4}\sum_{b=1}^{4}|\Gamma_{Z',h_a,A_b^0}|^2 B_{00}\Big(p^2,m_{A_b^0}^2,m_{h_a}^2\Big) - 4\sum_{a=1}^{4}\sum_{b=1}^{4}|\Gamma_{Z',H_a^+,H_b^-}|^2 B_{00}\Big(p^2,m_{H_a^-}^2,m_{H_b^-}^2\Big)\\
&+ \frac{1}{2}\sum_{a=1}^{6}\sum_{b=1}^{6}\Big[\Big(|\Gamma^L_{Z',\nu_a,\nu_b}|^2+|\Gamma^R_{Z',\nu_a,\nu_b}|^2\Big)H_0\Big(p^2,m_{\nu_a}^2,m_{\nu_b}^2\Big)\\
&+ 4B_0\Big(p^2,m_{\nu_a}^2,m_{\nu_b}^2\Big)m_{\nu_a}m_{\nu_b}\Re\Big(\Gamma^{L*}_{Z',\nu_a,\nu_b}\Gamma^R_{Z',\nu_a,\nu_b}\Big)\Big]\\
&+ \sum_{b=1}^{4}|\Gamma_{Z',\gamma,h_b}|^2 B_0\Big(p^2,0,m_{h_b}^2\Big) + 2\sum_{b=1}^{4}|\Gamma_{Z',W^+,H_b^-}|^2 B_0\Big(p^2,m_{W^-}^2,m_{H_b^-}^2\Big)\\
&+ 2\sum_{b=1}^{4}|\Gamma_{Z',W_R^+,H_b^-}|^2 B_0\Big(p^2,m_{W_R^-}^2,m_{H_b^-}^2\Big) + \sum_{b=1}^{4}|\Gamma_{Z',Z,h_b}|^2 B_0\Big(p^2,m_Z^2,m_{h_b}^2\Big)\\
&+ \sum_{b=1}^{4}|\Gamma_{Z',Z',h_b}|^2 B_0\Big(p^2,m_{Z'}^2,m_{h_b}^2\Big) + 2\mathrm{rMS}m_{W^-}^2\Gamma^1_{Z',Z',W^+,W^-} - A_0\Big(m_{W^-}^2\Big)\Big(4\Gamma^1_{Z',Z',W^+,W^-}+\Gamma^2_{Z',Z',W^+,W^-}+\Gamma^3_{Z',Z',W}
\end{aligned}
\tag{139}
$$

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

$$
\begin{aligned}
\Pi(p^2) &= 2\mathrm{rMS}m_{W^-}^2\Gamma^1_{W^-,W^+,W^+,W^-} + 2\mathrm{rMS}m_{W_R^-}^2\Gamma^1_{W^-,W^+,W_R^+,W_R^-} + 3\sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big(|\Gamma^L_{W^+,\bar{u}_a,d_b}|^2+|\Gamma^R_{W^+,\bar{u}_a,d_b}|^2\Big)H_0\Big(p^2,m_{u_a}^2,m_{d_b}^2\\
&+ 4B_0\Big(p^2,m_{u_a}^2,m_{d_b}^2\Big)m_{d_b}m_{u_a}\Re\Big(\Gamma^{L*}_{W^+,\bar{u}_a,d_b}\Gamma^R_{W^+,\bar{u}_a,d_b}\Big)\Big] - 4\sum_{a=1}^{4}\sum_{b=1}^{2}|\Gamma_{W^+,H_a^+,\delta_b^{c--}}|^2 B_{00}\Big(p^2,m_{\delta_b^{c--}}^2,m_{H_a^-}^2\Big) - 4\sum_{a=1}^{4}\sum_{b=1}^{4}|\Gamma_W\\
&+ 4B_0\Big(p^2,m_{\nu_a}^2,m_{e_b}^2\Big)m_{e_b}m_{\nu_a}\Re\Big(\Gamma^{L*}_{W^+,\nu_a,e_b}\Gamma^R_{W^+,\nu_a,e_b}\Big)\Big] + \sum_{b=1}^{2}|\Gamma_{W^+,W^+,\delta_b^{c--}}|^2 B_0\Big(p^2,m_{W^-}^2,m_{\delta_b^{c--}}^2\Big) + \sum_{b=1}^{2}|\Gamma_{W^+,W_R^+,\delta_b^{c--}}|^2
\end{aligned}
\tag{140}
$$

- **Self-Energy for VWRm** (W_R^-)

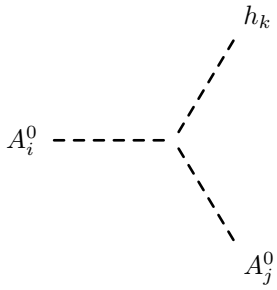
$$
\begin{aligned}
\Pi(p^2) &= 2\mathrm{rMS}m_{W^-}^2\Gamma^1_{W_R^-,W_R^+,W^+,W^-} + 2\mathrm{rMS}m_{W_R^-}^2\Gamma^1_{W_R^-,W_R^+,W_R^+,W_R^-} + 3\sum_{a=1}^{3}\sum_{b=1}^{3}\Big[\Big(|\Gamma^L_{W_R^+,\bar{u}_a,d_b}|^2+|\Gamma^R_{W_R^+,\bar{u}_a,d_b}|^2\Big)H_0\Big(p^2,m_{u_a}^2,m_{d_b}^2\\
&+ 4B_0\Big(p^2,m_{u_a}^2,m_{d_b}^2\Big)m_{d_b}m_{u_a}\Re\Big(\Gamma^{L*}_{W_R^+,\bar{u}_a,d_b}\Gamma^R_{W_R^+,\bar{u}_a,d_b}\Big)\Big] - 4\sum_{a=1}^{4}\sum_{b=1}^{2}|\Gamma_{W_R^+,H_a^+,\delta_b^{c--}}|^2 B_{00}\Big(p^2,m_{\delta_b^{c--}}^2,m_{H_a^-}^2\Big) - 4\sum_{a=1}^{4}\sum_{b=1}^{4}|\Gamma_W\\
&+ 4B_0\Big(p^2,m_{\nu_a}^2,m_{e_b}^2\Big)m_{e_b}m_{\nu_a}\Re\Big(\Gamma^{L*}_{W_R^+,\nu_a,e_b}\Gamma^R_{W_R^+,\nu_a,e_b}\Big)\Big] + \sum_{b=1}^{2}|\Gamma_{W_R^+,W^+,\delta_b^{c--}}|^2 B_0\Big(p^2,m_{W^-}^2,m_{\delta_b^{c--}}^2\Big) + \sum_{b=1}^{2}|\Gamma_{W_R^+,W_R^+,\delta_b^{c--}}|^2
\end{aligned}
\tag{141}
$$

7.2 Tadpoles

$$
\begin{aligned}
\delta t_h^{(1)} = &+ A_0\Big(m^2_{\eta_L^-}\Big)\Gamma_{\check{h}_i,\eta_L^-,\eta_L^-} + A_0\Big(m^2_{\eta_L^+}\Big)\Gamma_{\check{h}_i,\eta_L^-,\eta_L^+} + A_0\Big(m^2_{\eta_R^-}\Big)\Gamma_{\check{h}_i,\eta_R^-,\eta_R^-} \\
&+ A_0\Big(m^2_{\eta_R^+}\Big)\Gamma_{\check{h}_i,\eta_R^-,\eta_R^+} + A_0\Big(m^2_{\eta^Z}\Big)\Gamma_{\check{h}_i,\eta^Z,\eta^Z} + A_0\Big(m^2_{\eta^{Z'}}\Big)\Gamma_{\check{h}_i,\eta^{Z'},\eta^{Z'}} \\
&+ 4\Gamma_{\check{h}_i,W^+,W^-}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{W^-} + A_0\Big(m^2_{W^-}\Big)\Big) + 4\Gamma_{\check{h}_i,W_R^+,W_R^-}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{W_R^-} + A_0\Big(m^2_{W_R^-}\Big)\Big) + 2\Gamma_{\check{h}_i,Z,Z}\Big(-\frac{1}{2}\mathrm{rMS}m^2_Z + A_0\Big(m \\
&+ 2\Gamma_{\check{h}_i,Z',Z'}\Big(-\frac{1}{2}\mathrm{rMS}m^2_{Z'} + A_0\Big(m^2_{Z'}\Big)\Big) - \sum_{a=1}^{2} A_0\Big(m^2_{\delta_a^{c--}}\Big)\Gamma_{\check{h}_i,\delta_a^{c++},\delta_a^{c--}} \\
&+ 6\sum_{a=1}^{3} A_0\Big(m^2_{d_a}\Big)m_{d_a}\Big(\Gamma^L_{\check{h}_i,\bar{d}_a,d_a} + \Gamma^R_{\check{h}_i,\bar{d}_a,d_a}\Big) \\
&+ 2\sum_{a=1}^{3} A_0\Big(m^2_{e_a}\Big)m_{e_a}\Big(\Gamma^L_{\check{h}_i,\bar{e}_a,e_a} + \Gamma^R_{\check{h}_i,\bar{e}_a,e_a}\Big) \\
&+ 6\sum_{a=1}^{3} A_0\Big(m^2_{u_a}\Big)m_{u_a}\Big(\Gamma^L_{\check{h}_i,\bar{u}_a,u_a} + \Gamma^R_{\check{h}_i,\bar{u}_a,u_a}\Big) - \frac{1}{2}\sum_{a=1}^{4} A_0\Big(m^2_{A_a^0}\Big)\Gamma_{\check{h}_i,A_a^0,A_a^0} \\
&- \sum_{a=1}^{4} A_0\Big(m^2_{H_a^-}\Big)\Gamma_{\check{h}_i,H_a^+,H_a^-} - \frac{1}{2}\sum_{a=1}^{4} A_0\Big(m^2_{h_a}\Big)\Gamma_{\check{h}_i,h_a,h_a} \\
&+ \sum_{a=1}^{6} A_0\Big(m^2_{\nu_a}\Big)m_{\nu_a}\Big(\Gamma^L_{\check{h}_i,\nu_a,\nu_a} + \Gamma^R_{\check{h}_i,\nu_a,\nu_a}\Big)
\end{aligned}
\tag{142}
$$

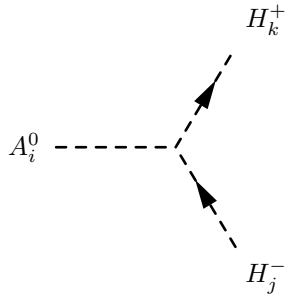
8 Interactions for eigenstates 'EWSB'

8.1 Three Scalar-Interaction

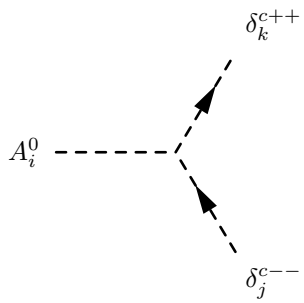


$$
\begin{aligned}
&- \frac{i}{2}\Big(-2\beta_2 v_L Z^{Ah}_{i3} Z^{Ah}_{j1} Z^H_{k1} + 2\beta_2 v_R Z^{Ah}_{i4} Z^{Ah}_{j1} Z^H_{k1} - \beta_1 v_L Z^{Ah}_{i3} Z^{Ah}_{j2} Z^H_{k1} \\
&+ \beta_1 v_R Z^{Ah}_{i4} Z^{Ah}_{j2} Z^H_{k1} + 2\alpha_1 v_d Z^{Ah}_{i3} Z^{Ah}_{j3} Z^H_{k1} - 4\alpha_2 v_u Z^{Ah}_{i3} Z^{Ah}_{j3} Z^H_{k1} \\
&- 2\beta_2 v_d Z^{Ah}_{i4} Z^{Ah}_{j3} Z^H_{k1} + \beta_1 v_u Z^{Ah}_{i4} Z^{Ah}_{j3} Z^H_{k1} - 2\beta_2 v_d Z^{Ah}_{i3} Z^{Ah}_{j4} Z^H_{k1}
\end{aligned}
$$

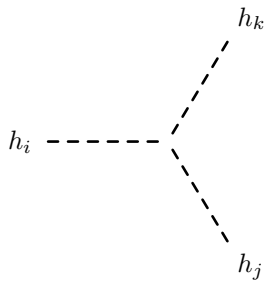
$$
\begin{aligned}
&+ \beta_1 v_u Z^{Ah}_{i3} Z^{Ah}_{j4} Z^{H}_{k1} + 2\alpha_1 v_d Z^{Ah}_{i4} Z^{Ah}_{j4} Z^{H}_{k1} - 4\alpha_2 v_u Z^{Ah}_{i4} Z^{Ah}_{j4} Z^{H}_{k1} \\
&+ \beta_1 v_L Z^{Ah}_{i3} Z^{Ah}_{j1} Z^{H}_{k2} - \beta_1 v_R Z^{Ah}_{i4} Z^{Ah}_{j1} Z^{H}_{k2} + 2\beta_3 v_L Z^{Ah}_{i3} Z^{Ah}_{j2} Z^{H}_{k2} \\
&- 2\beta_3 v_R Z^{Ah}_{i4} Z^{Ah}_{j2} Z^{H}_{k2} - 4\alpha_2 v_d Z^{Ah}_{i3} Z^{Ah}_{j3} Z^{H}_{k2} + 2\alpha_1 v_u Z^{Ah}_{i3} Z^{Ah}_{j3} Z^{H}_{k2} \\
&+ 2\alpha_3 v_u Z^{Ah}_{i3} Z^{Ah}_{j3} Z^{H}_{k2} + \beta_1 v_d Z^{Ah}_{i4} Z^{Ah}_{j3} Z^{H}_{k2} - 2\beta_3 v_u Z^{Ah}_{i4} Z^{Ah}_{j3} Z^{H}_{k2} \\
&+ \beta_1 v_d Z^{Ah}_{i3} Z^{Ah}_{j4} Z^{H}_{k2} - 2\beta_3 v_u Z^{Ah}_{i3} Z^{Ah}_{j4} Z^{H}_{k2} - 4\alpha_2 v_d Z^{Ah}_{i4} Z^{Ah}_{j4} Z^{H}_{k2} \\
&+ 2\alpha_1 v_u Z^{Ah}_{i4} Z^{Ah}_{j4} Z^{H}_{k2} + 2\alpha_3 v_u Z^{Ah}_{i4} Z^{Ah}_{j4} Z^{H}_{k2} + 2\beta_2 v_d Z^{Ah}_{i4} Z^{Ah}_{j1} Z^{H}_{k3} \\
&- \beta_1 v_u Z^{Ah}_{i4} Z^{Ah}_{j1} Z^{H}_{k3} + \beta_1 v_d Z^{Ah}_{i4} Z^{Ah}_{j2} Z^{H}_{k3} - 2\beta_3 v_u Z^{Ah}_{i4} Z^{Ah}_{j2} Z^{H}_{k3} \\
&+ 4\rho_1 v_R Z^{Ah}_{i3} Z^{Ah}_{j3} Z^{H}_{k3} + 2\rho_3 v_R Z^{Ah}_{i4} Z^{Ah}_{j4} Z^{H}_{k3} - 2\beta_2 v_d Z^{Ah}_{i3} Z^{Ah}_{j1} Z^{H}_{k4} \\
&+ \beta_1 v_u Z^{Ah}_{i3} Z^{Ah}_{j1} Z^{H}_{k4} - \beta_1 v_d Z^{Ah}_{i3} Z^{Ah}_{j2} Z^{H}_{k4} + 2\beta_3 v_u Z^{Ah}_{i3} Z^{Ah}_{j2} Z^{H}_{k4} \\
&+ 2\rho_3 v_L Z^{Ah}_{i3} Z^{Ah}_{j3} Z^{H}_{k4} + 4\rho_1 v_L Z^{Ah}_{i4} Z^{Ah}_{j4} Z^{H}_{k4} \\
&+ Z^{Ah}_{i1} \Big(- 2\beta_2 v_L Z^{Ah}_{j3} Z^{H}_{k1} + 2\beta_2 v_R Z^{Ah}_{j4} Z^{H}_{k1} + \beta_1 v_L Z^{Ah}_{j3} Z^{H}_{k2} - \beta_1 v_R Z^{Ah}_{j4} Z^{H}_{k2} \\
&+ 2\beta_2 v_d Z^{Ah}_{j4} Z^{H}_{k3} - \beta_1 v_u Z^{Ah}_{j4} Z^{H}_{k3} - 2\beta_2 v_d Z^{Ah}_{j3} Z^{H}_{k4} + \beta_1 v_u Z^{Ah}_{j3} Z^{H}_{k4} \\
&+ Z^{Ah}_{j2} \Big(4 \Big(- 4\lambda_2 v_u + \lambda_4 v_d \Big) Z^{H}_{k1} + \Big(- 16\lambda_2 v_d + 4\lambda_4 v_u \Big) Z^{H}_{k2} + \beta_1 v_L Z^{H}_{k3} + 4\alpha_2 v_R Z^{H}_{k3} + 4\alpha_2 v_L Z^{H}_{k4} \\
&+ \beta_1 v_R Z^{H}_{k4} \Big) \\
&+ 2 Z^{Ah}_{j1} \Big(2 \Big(- \lambda_4 v_u + \lambda v_d \Big) Z^{H}_{k1} + \Big(2 \Big(2\lambda_3 - 4\lambda_2 + \lambda \Big) v_u - 2\lambda_4 v_d \Big) Z^{H}_{k2} + \beta_2 v_L Z^{H}_{k3} + \alpha_1 v_R Z^{H}_{k3} \\
&+ \alpha_1 v_L Z^{H}_{k4} + \beta_2 v_R Z^{H}_{k4} \Big) \Big) \\
&+ Z^{Ah}_{i2} \Big(- \beta_1 v_L Z^{Ah}_{j3} Z^{H}_{k1} + \beta_1 v_R Z^{Ah}_{j4} Z^{H}_{k1} + 2\beta_3 v_L Z^{Ah}_{j3} Z^{H}_{k2} - 2\beta_3 v_R Z^{Ah}_{j4} Z^{H}_{k2} + \beta_1 v_d Z^{Ah}_{j4} Z^{H}_{k3} \\
&- 2\beta_3 v_u Z^{Ah}_{j4} Z^{H}_{k3} - \beta_1 v_d Z^{Ah}_{j3} Z^{H}_{k4} + 2\beta_3 v_u Z^{Ah}_{j3} Z^{H}_{k4} \\
&+ Z^{Ah}_{j1} \Big(4 \Big(- 4\lambda_2 v_u + \lambda_4 v_d \Big) Z^{H}_{k1} + \Big(- 16\lambda_2 v_d + 4\lambda_4 v_u \Big) Z^{H}_{k2} + \beta_1 v_L Z^{H}_{k3} + 4\alpha_2 v_R Z^{H}_{k3} + 4\alpha_2 v_L Z^{H}_{k4} \\
&+ \beta_1 v_R Z^{H}_{k4} \Big) \\
&+ 2 Z^{Ah}_{j2} \Big(2 \Big(2\lambda_3 v_d - 4\lambda_2 v_d - \lambda_4 v_u + \lambda v_d \Big) Z^{H}_{k1} + \Big(- 2\lambda_4 v_d + 2\lambda v_u \Big) Z^{H}_{k2} + \beta_3 v_L Z^{H}_{k3} + \alpha_1 v_R Z^{H}_{k3} \\
&+ \alpha_3 v_R Z^{H}_{k3} + \alpha_1 v_L Z^{H}_{k4} + \alpha_3 v_L Z^{H}_{k4} + \beta_3 v_R Z^{H}_{k4} \Big) \Big) \Big)
\end{aligned}
\tag{143}
$$



$$\frac{1}{4}\Big(\sqrt{2}\alpha_3 v_L Z^+_{j4}Z^+_{k1}Z^{Ah}_{i1} - 2\sqrt{2}\beta_2 v_R Z^+_{j4}Z^+_{k1}Z^{Ah}_{i1} - 16\lambda_2 v_u Z^+_{j1}Z^+_{k2}Z^{Ah}_{i1}$$
$$+ 8\lambda_3 v_u Z^+_{j1}Z^+_{k2}Z^{Ah}_{i1} - \sqrt{2}\beta_1 v_R Z^+_{j4}Z^+_{k2}Z^{Ah}_{i1} - \sqrt{2}\beta_1 v_L Z^+_{j1}Z^+_{k3}Z^{Ah}_{i1}$$
$$+ 2\beta_2 v_u Z^+_{j4}Z^+_{k3}Z^{Ah}_{i1} - 2\beta_3 v_u Z^+_{j4}Z^+_{k3}Z^{Ah}_{i1} - \sqrt{2}\alpha_3 v_L Z^+_{j1}Z^+_{k4}Z^{Ah}_{i1}$$
$$+ 2\sqrt{2}\beta_2 v_R Z^+_{j1}Z^+_{k4}Z^{Ah}_{i1} - \sqrt{2}\beta_1 v_R Z^+_{j4}Z^+_{k1}Z^{Ah}_{i2} - 16\lambda_2 v_d Z^+_{j1}Z^+_{k2}Z^{Ah}_{i2}$$
$$+ 8\lambda_3 v_d Z^+_{j1}Z^+_{k2}Z^{Ah}_{i2} - \sqrt{2}\alpha_3 v_L Z^+_{j4}Z^+_{k2}Z^{Ah}_{i2} - 2\sqrt{2}\beta_3 v_R Z^+_{j4}Z^+_{k2}Z^{Ah}_{i2}$$
$$- 2\sqrt{2}\beta_3 v_L Z^+_{j1}Z^+_{k3}Z^{Ah}_{i2} - \sqrt{2}\alpha_3 v_R Z^+_{j1}Z^+_{k3}Z^{Ah}_{i2} + 2\beta_2 v_d Z^+_{j4}Z^+_{k3}Z^{Ah}_{i2}$$
$$- 2\beta_3 v_d Z^+_{j4}Z^+_{k3}Z^{Ah}_{i2} + \sqrt{2}\beta_1 v_R Z^+_{j1}Z^+_{k4}Z^{Ah}_{i2} + 2\sqrt{2}\beta_2 v_d Z^+_{j4}Z^+_{k1}Z^{Ah}_{i3}$$
$$- \sqrt{2}\beta_1 v_u Z^+_{j4}Z^+_{k1}Z^{Ah}_{i3} + \sqrt{2}\beta_1 v_d Z^+_{j4}Z^+_{k2}Z^{Ah}_{i3} - 2\sqrt{2}\beta_3 v_u Z^+_{j4}Z^+_{k2}Z^{Ah}_{i3}$$
$$- \sqrt{2}\alpha_3 v_u Z^+_{j1}Z^+_{k3}Z^{Ah}_{i3} - 2\sqrt{2}\beta_2 v_d Z^+_{j1}Z^+_{k4}Z^{Ah}_{i3} + \sqrt{2}\beta_1 v_u Z^+_{j1}Z^+_{k4}Z^{Ah}_{i3}$$
$$+ \sqrt{2}\alpha_3 v_d Z^+_{j4}Z^+_{k1}Z^{Ah}_{i4} + \sqrt{2}\alpha_3 v_u Z^+_{j4}Z^+_{k2}Z^{Ah}_{i4} - \sqrt{2}\beta_1 v_d Z^+_{j1}Z^+_{k3}Z^{Ah}_{i4}$$
$$+ 2\sqrt{2}\beta_3 v_u Z^+_{j1}Z^+_{k3}Z^{Ah}_{i4} - \sqrt{2}\alpha_3 v_d Z^+_{j1}Z^+_{k4}Z^{Ah}_{i4}$$
$$+ Z^+_{j3}\Big(-2\Big(-\beta_3+\beta_2\Big)Z^+_{k4}\Big(v_d Z^{Ah}_{i2} + v_u Z^{Ah}_{i1}\Big)$$
$$+ \sqrt{2}Z^+_{k2}\Big(2\beta_2 v_d Z^{Ah}_{i4} + \Big(2\beta_2 v_L - \alpha_3 v_R\Big)Z^{Ah}_{i1} + \alpha_3 v_d Z^{Ah}_{i3} + \beta_1 v_L Z^{Ah}_{i2} - \beta_1 v_u Z^{Ah}_{i4}\Big)$$
$$+ \sqrt{2}Z^+_{k1}\Big(\Big(2\beta_3 v_L + \alpha_3 v_R\Big)Z^{Ah}_{i2} - 2\beta_3 v_u Z^{Ah}_{i4} + \alpha_3 v_u Z^{Ah}_{i3} + \beta_1 v_d Z^{Ah}_{i4} + \beta_1 v_L Z^{Ah}_{i1}\Big)\Big)$$
$$+ Z^+_{j2}\Big(8\Big(2\lambda_2 - \lambda_3\Big)Z^+_{k1}\Big(v_d Z^{Ah}_{i2} + v_u Z^{Ah}_{i1}\Big)$$
$$+ \sqrt{2}\Big(Z^+_{k4}\Big(\Big(2\beta_3 v_R + \alpha_3 v_L\Big)Z^{Ah}_{i2} + 2\beta_3 v_u Z^{Ah}_{i3} - \alpha_3 v_u Z^{Ah}_{i4} - \beta_1 v_d Z^{Ah}_{i3} + \beta_1 v_R Z^{Ah}_{i1}\Big)$$
$$- Z^+_{k3}\Big(2\beta_2 v_d Z^{Ah}_{i4} + \Big(2\beta_2 v_L - \alpha_3 v_R\Big)Z^{Ah}_{i1} + \alpha_3 v_d Z^{Ah}_{i3} + \beta_1 v_L Z^{Ah}_{i2} - \beta_1 v_u Z^{Ah}_{i4}\Big)\Big)\Big)\Big) \tag{144}$$

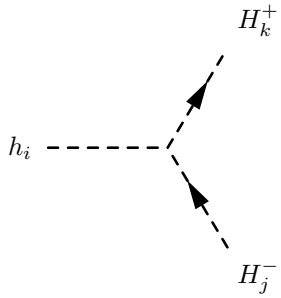


$$-\frac{1}{2}\Big(-Z^{++}_{j1}Z^{++}_{k2} + Z^{++}_{j2}Z^{++}_{k1}\Big)\Big(\Big(-2\beta_2 v_u + \beta_1 v_d\Big)Z^{Ah}_{i2} + \Big(2\beta_3 v_d - \beta_1 v_u\Big)Z^{Ah}_{i1} - 4\rho_4 v_L Z^{Ah}_{i3} + 4\rho_4 v_R Z^{Ah}_{i4}\Big) \tag{145}$$



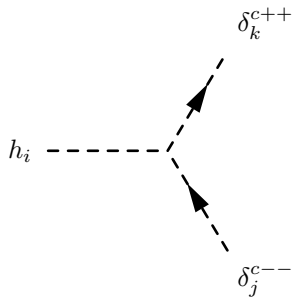
$$
\begin{aligned}
&-\frac{i}{2}\Big(-2\beta_2 v_L Z^H_{i3}Z^H_{j1}Z^H_{k1}+2\alpha_1 v_R Z^H_{i3}Z^H_{j1}Z^H_{k1}+2\alpha_1 v_L Z^H_{i4}Z^H_{j1}Z^H_{k1}\\
&-2\beta_2 v_R Z^H_{i4}Z^H_{j1}Z^H_{k1}+\beta_1 v_L Z^H_{i3}Z^H_{j2}Z^H_{k1}-4\alpha_2 v_R Z^H_{i3}Z^H_{j2}Z^H_{k1}\\
&-4\alpha_2 v_L Z^H_{i4}Z^H_{j2}Z^H_{k1}+\beta_1 v_R Z^H_{i4}Z^H_{j2}Z^H_{k1}+2\alpha_1 v_d Z^H_{i3}Z^H_{j3}Z^H_{k1}\\
&-4\alpha_2 v_u Z^H_{i3}Z^H_{j3}Z^H_{k1}-2\beta_2 v_d Z^H_{i4}Z^H_{j3}Z^H_{k1}+\beta_1 v_u Z^H_{i4}Z^H_{j3}Z^H_{k1}\\
&-2\beta_2 v_d Z^H_{i3}Z^H_{j4}Z^H_{k1}+\beta_1 v_u Z^H_{i3}Z^H_{j4}Z^H_{k1}+2\alpha_1 v_d Z^H_{i4}Z^H_{j4}Z^H_{k1}\\
&-4\alpha_2 v_u Z^H_{i4}Z^H_{j4}Z^H_{k1}+\beta_1 v_L Z^H_{i3}Z^H_{j1}Z^H_{k2}-4\alpha_2 v_R Z^H_{i3}Z^H_{j1}Z^H_{k2}\\
&-4\alpha_2 v_L Z^H_{i4}Z^H_{j1}Z^H_{k2}+\beta_1 v_R Z^H_{i4}Z^H_{j1}Z^H_{k2}-2\beta_3 v_L Z^H_{i3}Z^H_{j2}Z^H_{k2}\\
&+2\alpha_1 v_R Z^H_{i3}Z^H_{j2}Z^H_{k2}+2\alpha_3 v_R Z^H_{i3}Z^H_{j2}Z^H_{k2}+2\alpha_1 v_L Z^H_{i4}Z^H_{j2}Z^H_{k2}\\
&+2\alpha_3 v_L Z^H_{i4}Z^H_{j2}Z^H_{k2}-2\beta_3 v_R Z^H_{i4}Z^H_{j2}Z^H_{k2}-4\alpha_2 v_d Z^H_{i3}Z^H_{j3}Z^H_{k2}\\
&+2\alpha_1 v_u Z^H_{i3}Z^H_{j3}Z^H_{k2}+2\alpha_3 v_u Z^H_{i3}Z^H_{j3}Z^H_{k2}+\beta_1 v_d Z^H_{i4}Z^H_{j3}Z^H_{k2}\\
&-2\beta_3 v_u Z^H_{i4}Z^H_{j3}Z^H_{k2}+\beta_1 v_d Z^H_{i3}Z^H_{j4}Z^H_{k2}-2\beta_3 v_u Z^H_{i3}Z^H_{j4}Z^H_{k2}\\
&-4\alpha_2 v_d Z^H_{i4}Z^H_{j4}Z^H_{k2}+2\alpha_1 v_u Z^H_{i4}Z^H_{j4}Z^H_{k2}+2\alpha_3 v_u Z^H_{i4}Z^H_{j4}Z^H_{k2}\\
&+2\alpha_1 v_d Z^H_{i3}Z^H_{j1}Z^H_{k3}-4\alpha_2 v_u Z^H_{i3}Z^H_{j1}Z^H_{k3}-2\beta_2 v_d Z^H_{i4}Z^H_{j1}Z^H_{k3}\\
&+\beta_1 v_u Z^H_{i4}Z^H_{j1}Z^H_{k3}-4\alpha_2 v_d Z^H_{i3}Z^H_{j2}Z^H_{k3}+2\alpha_1 v_u Z^H_{i3}Z^H_{j2}Z^H_{k3}\\
&+2\alpha_3 v_u Z^H_{i3}Z^H_{j2}Z^H_{k3}+\beta_1 v_d Z^H_{i4}Z^H_{j2}Z^H_{k3}-2\beta_3 v_u Z^H_{i4}Z^H_{j2}Z^H_{k3}\\
&+12\rho_1 v_R Z^H_{i3}Z^H_{j3}Z^H_{k3}+2\rho_3 v_L Z^H_{i4}Z^H_{j3}Z^H_{k3}+2\rho_3 v_L Z^H_{i3}Z^H_{j4}Z^H_{k3}\\
&+2\rho_3 v_R Z^H_{i4}Z^H_{j4}Z^H_{k3}-2\beta_2 v_d Z^H_{i3}Z^H_{j1}Z^H_{k4}+\beta_1 v_u Z^H_{i3}Z^H_{j1}Z^H_{k4}\\
&+2\alpha_1 v_d Z^H_{i4}Z^H_{j1}Z^H_{k4}-4\alpha_2 v_u Z^H_{i4}Z^H_{j1}Z^H_{k4}+\beta_1 v_d Z^H_{i3}Z^H_{j2}Z^H_{k4}\\
&-2\beta_3 v_u Z^H_{i3}Z^H_{j2}Z^H_{k4}-4\alpha_2 v_d Z^H_{i4}Z^H_{j2}Z^H_{k4}+2\alpha_1 v_u Z^H_{i4}Z^H_{j2}Z^H_{k4}\\
&+2\alpha_3 v_u Z^H_{i4}Z^H_{j2}Z^H_{k4}+2\rho_3 v_L Z^H_{i3}Z^H_{j3}Z^H_{k4}+2\rho_3 v_R Z^H_{i4}Z^H_{j3}Z^H_{k4}\\
&+2\rho_3 v_R Z^H_{i3}Z^H_{j4}Z^H_{k4}+12\rho_1 v_L Z^H_{i4}Z^H_{j4}Z^H_{k4}\\
&+Z^H_{i1}\Big(-2\beta_2 v_L Z^H_{j3}Z^H_{k1}+2\alpha_1 v_R Z^H_{j3}Z^H_{k1}+2\alpha_1 v_L Z^H_{j4}Z^H_{k1}-2\beta_2 v_R Z^H_{j4}Z^H_{k1}\\
&+\beta_1 v_L Z^H_{j3}Z^H_{k2}-4\alpha_2 v_R Z^H_{j3}Z^H_{k2}-4\alpha_2 v_L Z^H_{j4}Z^H_{k2}+\beta_1 v_R Z^H_{j4}Z^H_{k2}+2\alpha_1 v_d Z^H_{j3}Z^H_{k3}\\
&-4\alpha_2 v_u Z^H_{j3}Z^H_{k3}-2\beta_2 v_d Z^H_{j4}Z^H_{k3}+\beta_1 v_u Z^H_{j4}Z^H_{k3}-2\beta_2 v_d Z^H_{j3}Z^H_{k4}\\
&+\beta_1 v_u Z^H_{j3}Z^H_{k4}+2\alpha_1 v_d Z^H_{j4}Z^H_{k4}-4\alpha_2 v_u Z^H_{j4}Z^H_{k4}
\end{aligned}
$$

$$
\begin{aligned}
&+ Z^H_{j2}\Big(4\Big(\Big(2\lambda_3 + 4\lambda_2 + \lambda\Big)v_u - 3\lambda_4 v_d\Big)Z^H_{k1} + 4\Big(2\lambda_3 v_d - 3\lambda_4 v_u + 4\lambda_2 v_d + \lambda v_d\Big)Z^H_{k2} + \beta_1 v_L Z^H_{k3} \\
&- 4\alpha_2 v_R Z^H_{k3} - 4\alpha_2 v_L Z^H_{k4} + \beta_1 v_R Z^H_{k4}\Big) \\
&+ 2Z^H_{j1}\Big(6\Big(-\lambda_4 v_u + \lambda v_d\Big)Z^H_{k1} + \Big(2\Big(2\lambda_3 + 4\lambda_2 + \lambda\Big)v_u - 6\lambda_4 v_d\Big)Z^H_{k2} - \beta_2 v_L Z^H_{k3} + \alpha_1 v_R Z^H_{k3} \\
&+ \alpha_1 v_L Z^H_{k4} - \beta_2 v_R Z^H_{k4}\Big)\Big) \\
&+ Z^H_{i2}\Big(\beta_1 v_L Z^H_{j3} Z^H_{k1} - 4\alpha_2 v_R Z^H_{j3} Z^H_{k1} - 4\alpha_2 v_L Z^H_{j4} Z^H_{k1} + \beta_1 v_R Z^H_{j4} Z^H_{k1} \\
&- 2\beta_3 v_L Z^H_{j3} Z^H_{k2} + 2\alpha_1 v_R Z^H_{j3} Z^H_{k2} + 2\alpha_3 v_R Z^H_{j3} Z^H_{k2} + 2\alpha_1 v_L Z^H_{j4} Z^H_{k2} \\
&+ 2\alpha_3 v_L Z^H_{j4} Z^H_{k2} - 2\beta_3 v_R Z^H_{j4} Z^H_{k2} - 4\alpha_2 v_d Z^H_{j3} Z^H_{k3} + 2\alpha_1 v_u Z^H_{j3} Z^H_{k3} \\
&+ 2\alpha_3 v_u Z^H_{j3} Z^H_{k3} + \beta_1 v_d Z^H_{j4} Z^H_{k3} - 2\beta_3 v_u Z^H_{j4} Z^H_{k3} + \beta_1 v_d Z^H_{j3} Z^H_{k4} - 2\beta_3 v_u Z^H_{j3} Z^H_{k4} \\
&- 4\alpha_2 v_d Z^H_{j4} Z^H_{k4} + 2\alpha_1 v_u Z^H_{j4} Z^H_{k4} + 2\alpha_3 v_u Z^H_{j4} Z^H_{k4} \\
&+ Z^H_{j1}\Big(4\Big(\Big(2\lambda_3 + 4\lambda_2 + \lambda\Big)v_u - 3\lambda_4 v_d\Big)Z^H_{k1} + 4\Big(2\lambda_3 v_d - 3\lambda_4 v_u + 4\lambda_2 v_d + \lambda v_d\Big)Z^H_{k2} + \beta_1 v_L Z^H_{k3} \\
&- 4\alpha_2 v_R Z^H_{k3} - 4\alpha_2 v_L Z^H_{k4} + \beta_1 v_R Z^H_{k4}\Big) \\
&+ 2Z^H_{j2}\Big(2\Big(2\lambda_3 v_d - 3\lambda_4 v_u + 4\lambda_2 v_d + \lambda v_d\Big)Z^H_{k1} + \Big(-6\lambda_4 v_d + 6\lambda v_u\Big)Z^H_{k2} - \beta_3 v_L Z^H_{k3} + \alpha_1 v_R Z^H_{k3} \\
&+ \alpha_3 v_R Z^H_{k3} + \alpha_1 v_L Z^H_{k4} + \alpha_3 v_L Z^H_{k4} - \beta_3 v_R Z^H_{k4}\Big)\Big)\Big)
\end{aligned}
\tag{146}
$$



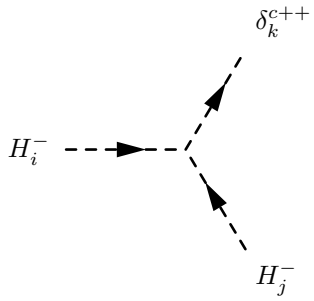
$$
\begin{aligned}
&-\frac{i}{4}\Big(\sqrt{2}\beta_1 v_L Z^+_{j3} Z^+_{k1} Z^H_{i1} + \sqrt{2}\alpha_3 v_L Z^+_{j4} Z^+_{k1} Z^H_{i1} + 2\sqrt{2}\beta_2 v_R Z^+_{j4} Z^+_{k1} Z^H_{i1} \\
&+ 2\sqrt{2}\beta_2 v_L Z^+_{j3} Z^+_{k2} Z^H_{i1} + \sqrt{2}\alpha_3 v_R Z^+_{j3} Z^+_{k2} Z^H_{i1} + \sqrt{2}\beta_1 v_R Z^+_{j4} Z^+_{k2} Z^H_{i1} \\
&+ 4\alpha_1 v_d Z^+_{j3} Z^+_{k3} Z^H_{i1} + 2\alpha_3 v_d Z^+_{j3} Z^+_{k3} Z^H_{i1} - 8\alpha_2 v_u Z^+_{j3} Z^+_{k3} Z^H_{i1} \\
&+ 2\beta_1 v_d Z^+_{j4} Z^+_{k3} Z^H_{i1} - 2\beta_2 v_u Z^+_{j4} Z^+_{k3} Z^H_{i1} - 2\beta_3 v_u Z^+_{j4} Z^+_{k3} Z^H_{i1} \\
&+ 2\beta_1 v_d Z^+_{j3} Z^+_{k4} Z^H_{i1} - 2\beta_2 v_u Z^+_{j3} Z^+_{k4} Z^H_{i1} - 2\beta_3 v_u Z^+_{j3} Z^+_{k4} Z^H_{i1} \\
&+ 4\alpha_1 v_d Z^+_{j4} Z^+_{k4} Z^H_{i1} + 2\alpha_3 v_d Z^+_{j4} Z^+_{k4} Z^H_{i1} - 8\alpha_2 v_u Z^+_{j4} Z^+_{k4} Z^H_{i1} \\
&- 2\sqrt{2}\beta_3 v_L Z^+_{j3} Z^+_{k1} Z^H_{i2} + \sqrt{2}\alpha_3 v_R Z^+_{j3} Z^+_{k1} Z^H_{i2} - \sqrt{2}\beta_1 v_R Z^+_{j4} Z^+_{k1} Z^H_{i2} \\
&- \sqrt{2}\beta_1 v_L Z^+_{j3} Z^+_{k2} Z^H_{i2} + \sqrt{2}\alpha_3 v_L Z^+_{j4} Z^+_{k2} Z^H_{i2} - 2\sqrt{2}\beta_3 v_R Z^+_{j4} Z^+_{k2} Z^H_{i2}
\end{aligned}
$$

$$
\begin{aligned}
&- 8\alpha_2 v_d Z^+_{j3} Z^+_{k3} Z^H_{i2} + 4\alpha_1 v_u Z^+_{j3} Z^+_{k3} Z^H_{i2} + 2\alpha_3 v_u Z^+_{j3} Z^+_{k3} Z^H_{i2} \\
&- 2\beta_2 v_d Z^+_{j4} Z^+_{k3} Z^H_{i2} - 2\beta_3 v_d Z^+_{j4} Z^+_{k3} Z^H_{i2} + 2\beta_1 v_u Z^+_{j4} Z^+_{k3} Z^H_{i2} \\
&- 2\beta_2 v_d Z^+_{j3} Z^+_{k4} Z^H_{i2} - 2\beta_3 v_d Z^+_{j3} Z^+_{k4} Z^H_{i2} + 2\beta_1 v_u Z^+_{j3} Z^+_{k4} Z^H_{i2} \\
&- 8\alpha_2 v_d Z^+_{j4} Z^+_{k4} Z^H_{i2} + 4\alpha_1 v_u Z^+_{j4} Z^+_{k4} Z^H_{i2} + 2\alpha_3 v_u Z^+_{j4} Z^+_{k4} Z^H_{i2} \\
&+ \sqrt{2}\alpha_3 v_u Z^+_{j3} Z^+_{k1} Z^H_{i3} + 2\sqrt{2}\beta_2 v_d Z^+_{j4} Z^+_{k1} Z^H_{i3} - \sqrt{2}\beta_1 v_u Z^+_{j4} Z^+_{k1} Z^H_{i3} \\
&+ \sqrt{2}\alpha_3 v_d Z^+_{j3} Z^+_{k2} Z^H_{i3} + \sqrt{2}\beta_1 v_d Z^+_{j4} Z^+_{k2} Z^H_{i3} - 2\sqrt{2}\beta_3 v_u Z^+_{j4} Z^+_{k2} Z^H_{i3} \\
&+ 8\rho_1 v_R Z^+_{j3} Z^+_{k3} Z^H_{i3} + 4\rho_3 v_R Z^+_{j4} Z^+_{k4} Z^H_{i3} + \sqrt{2}\beta_1 v_d Z^+_{j3} Z^+_{k1} Z^H_{i4} \\
&- 2\sqrt{2}\beta_3 v_u Z^+_{j3} Z^+_{k1} Z^H_{i4} + \sqrt{2}\alpha_3 v_d Z^+_{j4} Z^+_{k1} Z^H_{i4} + 2\sqrt{2}\beta_2 v_d Z^+_{j3} Z^+_{k2} Z^H_{i4} \\
&- \sqrt{2}\beta_1 v_u Z^+_{j3} Z^+_{k2} Z^H_{i4} + \sqrt{2}\alpha_3 v_u Z^+_{j4} Z^+_{k2} Z^H_{i4} + 4\rho_3 v_L Z^+_{j3} Z^+_{k3} Z^H_{i4} \\
&+ 8\rho_1 v_L Z^+_{j4} Z^+_{k4} Z^H_{i4} \\
&+ Z^+_{j2}\Big(4Z^+_{k2}\Big(\Big(-2\lambda_4 v_d + 2\lambda v_u\Big) Z^H_{i2} + 2\Big(-\lambda_4 v_u + \lambda v_d\Big) Z^H_{i1} + \alpha_1 v_L Z^H_{i4} + \alpha_1 v_R Z^H_{i3} + \alpha_3 v_R Z^H_{i3}\Big) \\
&+ \sqrt{2}\Big(Z^+_{k4}\Big(\Big(-2\beta_3 v_R + \alpha_3 v_L\Big) Z^H_{i2} - 2\beta_3 v_u Z^H_{i3} + \alpha_3 v_u Z^H_{i4} + \beta_1 v_d Z^H_{i3} + \beta_1 v_R Z^H_{i1}\Big) \\
&+ Z^+_{k3}\Big(2\beta_2 v_d Z^H_{i4} + \Big(2\beta_2 v_L + \alpha_3 v_R\Big) Z^H_{i1} + \alpha_3 v_d Z^H_{i3} - \beta_1 v_L Z^H_{i2} - \beta_1 v_u Z^H_{i4}\Big)\Big) \\
&+ 8Z^+_{k1}\Big(\Big(-\Big(2\lambda_2 + \lambda_3\Big) v_u + \lambda_4 v_d\Big) Z^H_{i1} + \Big(-2\lambda_2 v_d - \lambda_3 v_d + \lambda_4 v_u\Big) Z^H_{i2} + \alpha_2\Big(v_L Z^H_{i4} + v_R Z^H_{i3}\Big)\Big)\Big) \\
&+ Z^+_{j1}\Big(4Z^+_{k1}\Big(\Big(-2\lambda_4 v_d + 2\lambda v_u\Big) Z^H_{i2} + 2\Big(-\lambda_4 v_u + \lambda v_d\Big) Z^H_{i1} + \alpha_1 v_L Z^H_{i4} + \alpha_1 v_R Z^H_{i3} + \alpha_3 v_L Z^H_{i4}\Big) \\
&+ \sqrt{2}\Big(Z^+_{k4}\Big(2\beta_2 v_d Z^H_{i3} + \Big(2\beta_2 v_R + \alpha_3 v_L\Big) Z^H_{i1} + \alpha_3 v_d Z^H_{i4} - \beta_1 v_R Z^H_{i2} - \beta_1 v_u Z^H_{i3}\Big) \\
&+ Z^+_{k3}\Big(\Big(-2\beta_3 v_L + \alpha_3 v_R\Big) Z^H_{i2} - 2\beta_3 v_u Z^H_{i4} + \alpha_3 v_u Z^H_{i3} + \beta_1 v_d Z^H_{i4} + \beta_1 v_L Z^H_{i1}\Big)\Big) \\
&+ 8Z^+_{k2}\Big(\Big(-\Big(2\lambda_2 + \lambda_3\Big) v_u + \lambda_4 v_d\Big) Z^H_{i1} + \Big(-2\lambda_2 v_d - \lambda_3 v_d + \lambda_4 v_u\Big) Z^H_{i2} + \alpha_2\Big(v_L Z^H_{i4} + v_R Z^H_{i3}\Big)\Big)\Big)\Big)
\end{aligned}
\tag{147}
$$

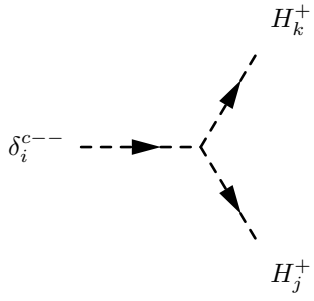


$$
\begin{aligned}
&- \frac{i}{2}\Big(Z^{++}_{j2}\Big(2Z^{++}_{k2}\Big(\Big(-2\alpha_2 v_d + \alpha_1 v_u\Big) Z^H_{i2} + \Big(-2\alpha_2 v_u + \alpha_1 v_d + \alpha_3 v_d\Big) Z^H_{i1} + 2\rho_1 v_L Z^H_{i4} + 4\rho_2 v_L Z^H_{i4} + \rho_3 v_R Z^H_{i3}\Big) \\
&+ Z^{++}_{k1}\Big(\Big(-2\beta_2 v_u + \beta_1 v_d\Big) Z^H_{i2} + \Big(-2\beta_3 v_d + \beta_1 v_u\Big) Z^H_{i1} + 4\rho_4\Big(v_L Z^H_{i3} + v_R Z^H_{i4}\Big)\Big)\Big) \\
&+ Z^{++}_{j1}\Big(2Z^{++}_{k1}\Big(\Big(-2\alpha_2 v_d + \alpha_1 v_u\Big) Z^H_{i2} + \Big(-2\alpha_2 v_u + \alpha_1 v_d + \alpha_3 v_d\Big) Z^H_{i1} + 2\rho_1 v_R Z^H_{i3} + 4\rho_2 v_R Z^H_{i3} + \rho_3 v_L Z^H_{i4}\Big)
\end{aligned}
$$

$$+ Z^{++}_{k2}\Big(\Big(- 2\beta_2 v_u + \beta_1 v_d\Big) Z^H_{i2} + \Big(- 2\beta_3 v_d + \beta_1 v_u\Big) Z^H_{i1} + 4\rho_4\Big(v_L Z^H_{i3} + v_R Z^H_{i4}\Big)\Big)\Big)\Big) \tag{148}$$



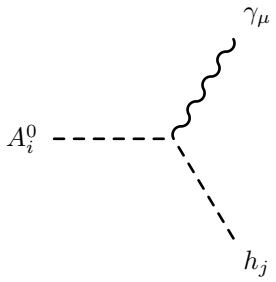
$$\begin{aligned}
&\frac{i}{2}\Big(\alpha_3 v_u Z^+_{i3} Z^+_{j1} Z^{++}_{k1} - 2\beta_3 v_d Z^+_{i4} Z^+_{j1} Z^{++}_{k1} + \beta_1 v_u Z^+_{i4} Z^+_{j1} Z^{++}_{k1} + \alpha_3 v_d Z^+_{i3} Z^+_{j2} Z^{++}_{k1} \\
&- \beta_1 v_d Z^+_{i4} Z^+_{j2} Z^{++}_{k1} + 2\beta_2 v_u Z^+_{i4} Z^+_{j2} Z^{++}_{k1} - 4\sqrt{2}\rho_2 v_R Z^+_{i3} Z^+_{j3} Z^{++}_{k1} \\
&- 4\sqrt{2}\rho_4 v_R Z^+_{i4} Z^+_{j4} Z^{++}_{k1} - \beta_1 v_d Z^+_{i3} Z^+_{j1} Z^{++}_{k2} + 2\beta_2 v_u Z^+_{i3} Z^+_{j1} Z^{++}_{k2} \\
&+ \alpha_3 v_d Z^+_{i4} Z^+_{j1} Z^{++}_{k2} - 2\beta_3 v_d Z^+_{i3} Z^+_{j2} Z^{++}_{k2} + \beta_1 v_u Z^+_{i3} Z^+_{j2} Z^{++}_{k2} + \alpha_3 v_u Z^+_{i4} Z^+_{j2} Z^{++}_{k2} \\
&- 4\sqrt{2}\rho_4 v_L Z^+_{i3} Z^+_{j3} Z^{++}_{k2} - 4\sqrt{2}\rho_2 v_L Z^+_{i4} Z^+_{j4} Z^{++}_{k2} \\
&- Z^+_{i1}\Big(- \alpha_3 v_u Z^+_{j3} Z^{++}_{k1} + 2\beta_3 v_d Z^+_{j4} Z^{++}_{k1} - \beta_1 v_u Z^+_{j4} Z^{++}_{k1} + \beta_1 v_d Z^+_{j3} Z^{++}_{k2} \\
&- 2\beta_2 v_u Z^+_{j3} Z^{++}_{k2} - \alpha_3 v_d Z^+_{j4} Z^{++}_{k2} + \sqrt{2}\beta_1 Z^+_{j2}\Big(v_L Z^{++}_{k1} + v_R Z^{++}_{k2}\Big) \\
&+ 2\sqrt{2} Z^+_{j1}\Big(\beta_2 v_R Z^{++}_{k2} + \beta_3 v_L Z^{++}_{k1}\Big)\Big) \\
&- Z^+_{i2}\Big(- \alpha_3 v_d Z^+_{j3} Z^{++}_{k1} + \beta_1 v_d Z^+_{j4} Z^{++}_{k1} - 2\beta_2 v_u Z^+_{j4} Z^{++}_{k1} + 2\beta_3 v_d Z^+_{j3} Z^{++}_{k2} \\
&- \beta_1 v_u Z^+_{j3} Z^{++}_{k2} - \alpha_3 v_u Z^+_{j4} Z^{++}_{k2} + \sqrt{2}\beta_1 Z^+_{j1}\Big(v_L Z^{++}_{k1} + v_R Z^{++}_{k2}\Big) \\
&+ 2\sqrt{2} Z^+_{j2}\Big(\beta_2 v_L Z^{++}_{k1} + \beta_3 v_R Z^{++}_{k2}\Big)\Big)\Big)
\end{aligned} \tag{149}$$



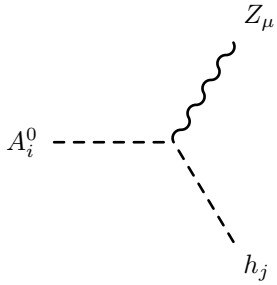
$$\frac{i}{2}\Big(\alpha_3 v_u Z^+_{j3} Z^+_{k1} Z^{++}_{i1} - 2\beta_3 v_d Z^+_{j4} Z^+_{k1} Z^{++}_{i1} + \beta_1 v_u Z^+_{j4} Z^+_{k1} Z^{++}_{i1} + \alpha_3 v_d Z^+_{j3} Z^+_{k2} Z^{++}_{i1}$$

$$
\begin{aligned}
&- \beta_1 v_d Z^+_{j4} Z^+_{k2} Z^{++}_{i1} + 2\beta_2 v_u Z^+_{j4} Z^+_{k2} Z^{++}_{i1} - 4\sqrt{2}\rho_2 v_R Z^+_{j3} Z^+_{k3} Z^{++}_{i1} \\
&- 4\sqrt{2}\rho_4 v_R Z^+_{j4} Z^+_{k4} Z^{++}_{i1} - \beta_1 v_d Z^+_{j3} Z^+_{k1} Z^{++}_{i2} + 2\beta_2 v_u Z^+_{j3} Z^+_{k1} Z^{++}_{i2} \\
&+ \alpha_3 v_d Z^+_{j4} Z^+_{k1} Z^{++}_{i2} - 2\beta_3 v_d Z^+_{j3} Z^+_{k2} Z^{++}_{i2} + \beta_1 v_u Z^+_{j3} Z^+_{k2} Z^{++}_{i2} + \alpha_3 v_u Z^+_{j4} Z^+_{k2} Z^{++}_{i2} \\
&- 4\sqrt{2}\rho_4 v_L Z^+_{j3} Z^+_{k3} Z^{++}_{i2} - 4\sqrt{2}\rho_2 v_L Z^+_{j4} Z^+_{k4} Z^{++}_{i2} \\
&- Z^+_{j1}\Big(- \alpha_3 v_u Z^+_{k3} Z^{++}_{i1} + 2\beta_3 v_d Z^+_{k4} Z^{++}_{i1} - \beta_1 v_u Z^+_{k4} Z^{++}_{i1} + \beta_1 v_d Z^+_{k3} Z^{++}_{i2} \\
&- 2\beta_2 v_u Z^+_{k3} Z^{++}_{i2} - \alpha_3 v_d Z^+_{k4} Z^{++}_{i2} + \sqrt{2}\beta_1 Z^+_{k2}\Big(v_L Z^{++}_{i1} + v_R Z^{++}_{i2}\Big) \\
&+ 2\sqrt{2} Z^+_{k1}\Big(\beta_2 v_R Z^{++}_{i2} + \beta_3 v_L Z^{++}_{i1}\Big)\Big) \\
&- Z^+_{j2}\Big(- \alpha_3 v_d Z^+_{k3} Z^{++}_{i1} + \beta_1 v_d Z^+_{k4} Z^{++}_{i1} - 2\beta_2 v_u Z^+_{k4} Z^{++}_{i1} + 2\beta_3 v_d Z^+_{k3} Z^{++}_{i2} \\
&- \beta_1 v_u Z^+_{k3} Z^{++}_{i2} - \alpha_3 v_u Z^+_{k4} Z^{++}_{i2} + \sqrt{2}\beta_1 Z^+_{k1}\Big(v_L Z^{++}_{i1} + v_R Z^{++}_{i2}\Big) \\
&+ 2\sqrt{2} Z^+_{k2}\Big(\beta_2 v_L Z^{++}_{i1} + \beta_3 v_R Z^{++}_{i2}\Big)\Big)\Big)
\end{aligned} \tag{150}
$$

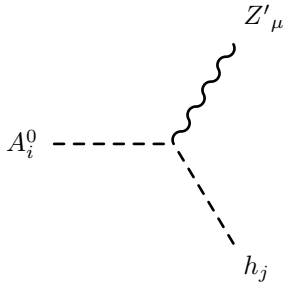
8.2 Two Scalar-One Vector Boson-Interaction



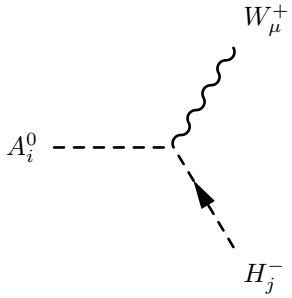
$$
\begin{aligned}
&\frac{1}{2}\Big(2 Z^{Ah}_{i4} Z^H_{j4}\Big(- g_2 Z^Z_{21} + g_B Z^Z_{11}\Big) + 2 Z^{Ah}_{i3} Z^H_{j3}\Big(g_B Z^Z_{11} - g_R Z^Z_{31}\Big) \\
&+ \Big(Z^{Ah}_{i1} Z^H_{j1} - Z^{Ah}_{i2} Z^H_{j2}\Big)\Big(g_2 Z^Z_{21} - g_R Z^Z_{31}\Big)\Big)\Big(- p^{h_j}_\mu + p^{A^0_i}_\mu\Big)
\end{aligned} \tag{151}
$$



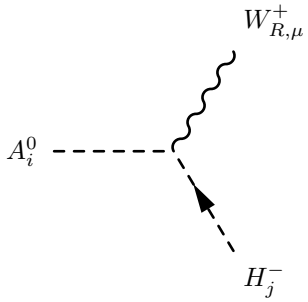
$$\frac{1}{2}\Big(2Z_{i4}^{Ah}Z_{j4}^{H}\Big(-g_2Z_{22}^{Z}+g_BZ_{12}^{Z}\Big)+2Z_{i3}^{Ah}Z_{j3}^{H}\Big(g_BZ_{12}^{Z}-g_RZ_{32}^{Z}\Big)$$
$$+\Big(Z_{i1}^{Ah}Z_{j1}^{H}-Z_{i2}^{Ah}Z_{j2}^{H}\Big)\Big(g_2Z_{22}^{Z}-g_RZ_{32}^{Z}\Big)\Big)\Big(-p_{\mu}^{h_j}+p_{\mu}^{A_i^0}\Big) \tag{152}$$



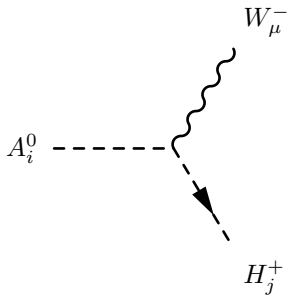
$$\frac{1}{2}\Big(2Z_{i4}^{Ah}Z_{j4}^{H}\Big(-g_2Z_{23}^{Z}+g_BZ_{13}^{Z}\Big)+2Z_{i3}^{Ah}Z_{j3}^{H}\Big(g_BZ_{13}^{Z}-g_RZ_{33}^{Z}\Big)$$
$$+\Big(Z_{i1}^{Ah}Z_{j1}^{H}-Z_{i2}^{Ah}Z_{j2}^{H}\Big)\Big(g_2Z_{23}^{Z}-g_RZ_{33}^{Z}\Big)\Big)\Big(-p_{\mu}^{h_j}+p_{\mu}^{A_i^0}\Big) \tag{153}$$



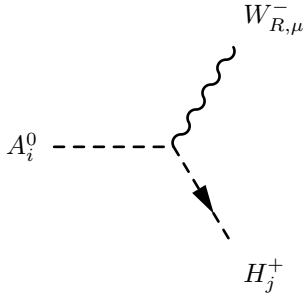
$$\frac{1}{2}\Big(Z_{j2}^{+}\Big(g_2\cos\phi_WZ_{i2}^{Ah}-g_R\sin\phi_WZ_{i1}^{Ah}\Big)+Z_{j1}^{+}\Big(g_2\cos\phi_WZ_{i1}^{Ah}-g_R\sin\phi_WZ_{i2}^{Ah}\Big)$$
$$+\sqrt{2}\Big(g_2\cos\phi_WZ_{j4}^{+}Z_{i4}^{Ah}+g_R\sin\phi_WZ_{j3}^{+}Z_{i3}^{Ah}\Big)\Big)\Big(-p_{\mu}^{H_j^-}+p_{\mu}^{A_i^0}\Big) \tag{154}$$



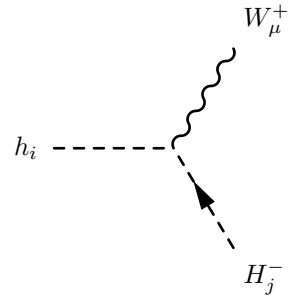
$$\frac{1}{2}\Big(- Z^{+}_{j1}\Big(g_2 \sin\phi_W Z^{Ah}_{i1} + g_R \cos\phi_W Z^{Ah}_{i2}\Big) - Z^{+}_{j2}\Big(g_2 \sin\phi_W Z^{Ah}_{i2} + g_R \cos\phi_W Z^{Ah}_{i1}\Big)$$
$$+ \sqrt{2}\Big(- g_2 \sin\phi_W Z^{+}_{j4} Z^{Ah}_{i4} + g_R \cos\phi_W Z^{+}_{j3} Z^{Ah}_{i3}\Big)\Big)\Big(- p_\mu^{H_j^-} + p_\mu^{A_i^0}\Big) \tag{155}$$



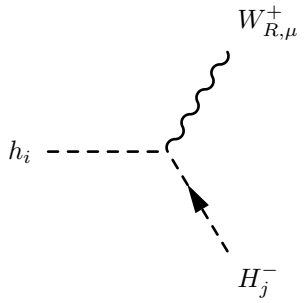
$$\frac{1}{2}\Big(Z^{+}_{j2}\Big(g_2 \cos\phi_W Z^{Ah}_{i2} - g_R \sin\phi_W Z^{Ah}_{i1}\Big) + Z^{+}_{j1}\Big(g_2 \cos\phi_W Z^{Ah}_{i1} - g_R \sin\phi_W Z^{Ah}_{i2}\Big)$$
$$+ \sqrt{2}\Big(g_2 \cos\phi_W Z^{+}_{j4} Z^{Ah}_{i4} + g_R \sin\phi_W Z^{+}_{j3} Z^{Ah}_{i3}\Big)\Big)\Big(- p_\mu^{H_j^+} + p_\mu^{A_i^0}\Big) \tag{156}$$



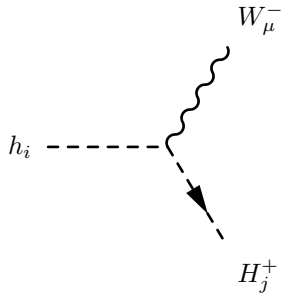
$$\frac{1}{2}\Big(- Z^{+}_{j1}\Big(g_2 \sin\phi_W Z^{Ah}_{i1} + g_R \cos\phi_W Z^{Ah}_{i2}\Big) - Z^{+}_{j2}\Big(g_2 \sin\phi_W Z^{Ah}_{i2} + g_R \cos\phi_W Z^{Ah}_{i1}\Big)$$
$$+ \sqrt{2}\Big(- g_2 \sin\phi_W Z^{+}_{j4} Z^{Ah}_{i4} + g_R \cos\phi_W Z^{+}_{j3} Z^{Ah}_{i3}\Big)\Big)\Big(- p_\mu^{H_j^+} + p_\mu^{A_i^0}\Big) \tag{157}$$



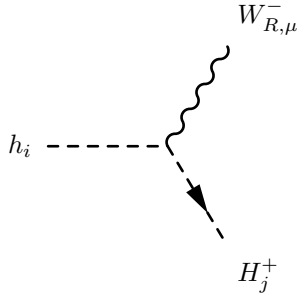
$$\frac{i}{2}\Big(Z^+_{j2}\Big(-g_2\cos\phi_W Z^H_{i2}+g_R\sin\phi_W Z^H_{i1}\Big)+Z^+_{j1}\Big(g_2\cos\phi_W Z^H_{i1}-g_R\sin\phi_W Z^H_{i2}\Big)$$
$$-\sqrt{2}\Big(g_2\cos\phi_W Z^+_{j4}Z^H_{i4}+g_R\sin\phi_W Z^+_{j3}Z^H_{i3}\Big)\Big)\Big(-p_\mu^{H_j^-}+p_\mu^{h_i}\Big) \tag{158}$$



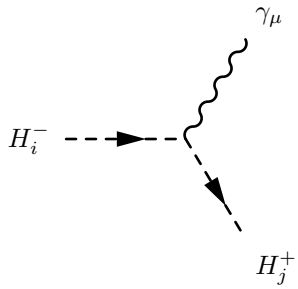
$$-\frac{i}{2}\Big(Z^+_{j1}\Big(g_2\sin\phi_W Z^H_{i1}+g_R\cos\phi_W Z^H_{i2}\Big)-Z^+_{j2}\Big(g_2\sin\phi_W Z^H_{i2}+g_R\cos\phi_W Z^H_{i1}\Big)$$
$$+\sqrt{2}\Big(-g_2\sin\phi_W Z^+_{j4}Z^H_{i4}+g_R\cos\phi_W Z^+_{j3}Z^H_{i3}\Big)\Big)\Big(-p_\mu^{H_j^-}+p_\mu^{h_i}\Big) \tag{159}$$



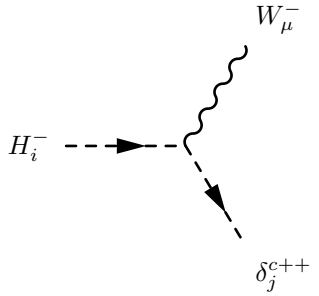
$$-\frac{i}{2}\Big(Z^+_{j2}\Big(-g_2\cos\phi_W Z^H_{i2}+g_R\sin\phi_W Z^H_{i1}\Big)+Z^+_{j1}\Big(g_2\cos\phi_W Z^H_{i1}-g_R\sin\phi_W Z^H_{i2}\Big)$$
$$-\sqrt{2}\Big(g_2\cos\phi_W Z^+_{j4}Z^H_{i4}+g_R\sin\phi_W Z^+_{j3}Z^H_{i3}\Big)\Big)\Big(-p_\mu^{H_j^+}+p_\mu^{h_i}\Big) \tag{160}$$



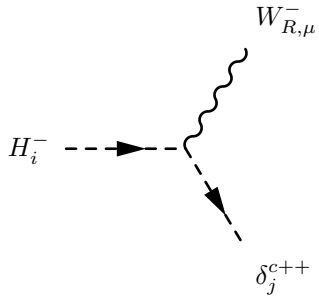
$$\frac{i}{2}\Big(Z^+_{j1}\Big(g_2\sin\phi_W Z^H_{i1}+g_R\cos\phi_W Z^H_{i2}\Big)-Z^+_{j2}\Big(g_2\sin\phi_W Z^H_{i2}+g_R\cos\phi_W Z^H_{i1}\Big)$$
$$+\sqrt{2}\Big(-g_2\sin\phi_W Z^+_{j4}Z^H_{i4}+g_R\cos\phi_W Z^+_{j3}Z^H_{i3}\Big)\Big)\Big(-p_\mu^{H^+_j}+p_\mu^{h_i}\Big) \tag{161}$$



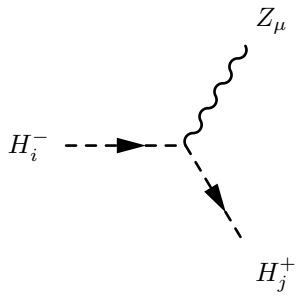
$$\frac{i}{2}\Big(2g_B Z^+_{i3}Z^+_{j3}Z^Z_{11}+2g_B Z^+_{i4}Z^+_{j4}Z^Z_{11}+\Big(Z^+_{i1}Z^+_{j1}+Z^+_{i2}Z^+_{j2}\Big)\Big(g_2Z^Z_{21}+g_RZ^Z_{31}\Big)\Big)\Big(-p_\mu^{H^+_j}+p_\mu^{H^-_i}\Big) \tag{162}$$



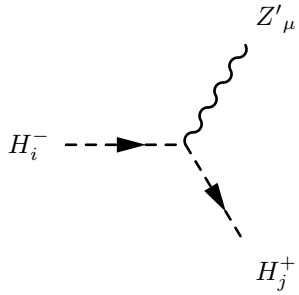
$$-i\Big(g_2\cos\phi_W Z^+_{i4}Z^{++}_{j2}+g_R\sin\phi_W Z^+_{i3}Z^{++}_{j1}\Big)\Big(-p_\mu^{\delta^{c++}_j}+p_\mu^{H^-_i}\Big) \tag{163}$$



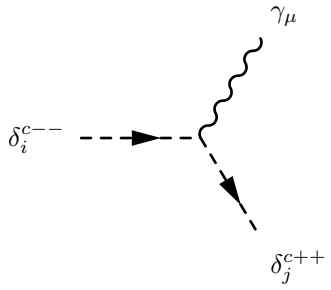
$$\Big(ig_2\sin\phi_W Z^+_{i4}Z^{++}_{j2}-ig_R\cos\phi_W Z^+_{i3}Z^{++}_{j1}\Big)\Big(-p_\mu^{\delta^{c++}_j}+p_\mu^{H^-_i}\Big) \tag{164}$$



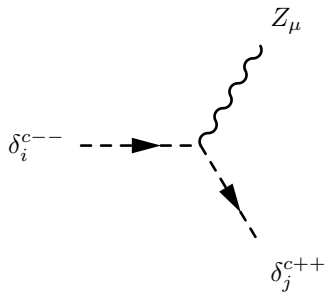
$$\frac{i}{2}\Big(2g_B Z^+_{i3} Z^+_{j3} Z^Z_{12} + 2g_B Z^+_{i4} Z^+_{j4} Z^Z_{12} + \Big(Z^+_{i1} Z^+_{j1} + Z^+_{i2} Z^+_{j2}\Big)\Big(g_2 Z^Z_{22} + g_R Z^Z_{32}\Big)\Big)\Big(-p_\mu^{H_j^+} + p_\mu^{H_i^-}\Big) \tag{165}$$



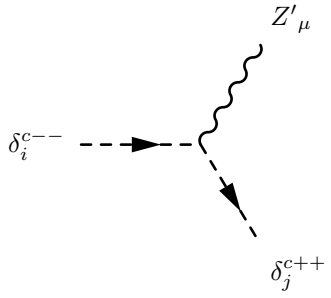
$$\frac{i}{2}\Big(2g_B Z^+_{i3} Z^+_{j3} Z^Z_{13} + 2g_B Z^+_{i4} Z^+_{j4} Z^Z_{13} + \Big(Z^+_{i1} Z^+_{j1} + Z^+_{i2} Z^+_{j2}\Big)\Big(g_2 Z^Z_{23} + g_R Z^Z_{33}\Big)\Big)\Big(-p_\mu^{H_j^+} + p_\mu^{H_i^-}\Big) \tag{166}$$



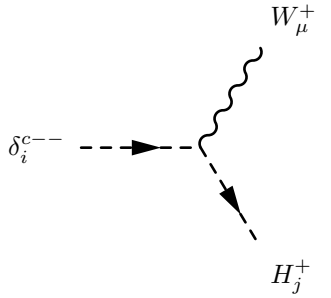
$$i\Big(Z^{++}_{i1} Z^{++}_{j1}\Big(g_B Z^Z_{11} + g_R Z^Z_{31}\Big) + Z^{++}_{i2} Z^{++}_{j2}\Big(g_2 Z^Z_{21} + g_B Z^Z_{11}\Big)\Big)\Big(-p_\mu^{\delta_j^{c++}} + p_\mu^{\delta_i^{c--}}\Big) \tag{167}$$



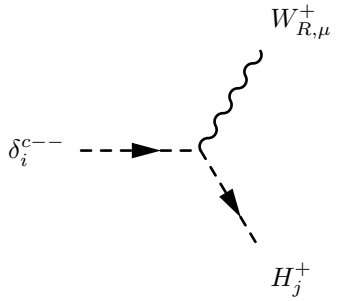
$$i\Big(Z_{i1}^{++}Z_{j1}^{++}\Big(g_B Z_{12}^Z + g_R Z_{32}^Z\Big) + Z_{i2}^{++}Z_{j2}^{++}\Big(g_2 Z_{22}^Z + g_B Z_{12}^Z\Big)\Big)\Big(-p_\mu^{\delta_j^{c++}} + p_\mu^{\delta_i^{c--}}\Big) \tag{168}$$



$$i\Big(Z_{i1}^{++}Z_{j1}^{++}\Big(g_B Z_{13}^Z + g_R Z_{33}^Z\Big) + Z_{i2}^{++}Z_{j2}^{++}\Big(g_2 Z_{23}^Z + g_B Z_{13}^Z\Big)\Big)\Big(-p_\mu^{\delta_j^{c++}} + p_\mu^{\delta_i^{c--}}\Big) \tag{169}$$

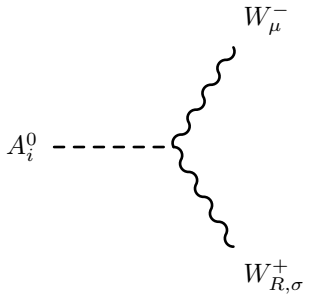


$$-i\Big(g_2\cos\phi_W Z_{j4}^+ Z_{i2}^{++} + g_R\sin\phi_W Z_{j3}^+ Z_{i1}^{++}\Big)\Big(-p_\mu^{H_j^+} + p_\mu^{\delta_i^{c--}}\Big) \tag{170}$$

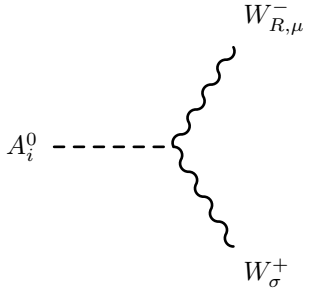


$$\Big(ig_2 \sin\phi_W Z^+_{j4} Z^{++}_{i2} - ig_R \cos\phi_W Z^+_{j3} Z^{++}_{i1}\Big)\Big(- p_\mu^{H^+_j} + p_\mu^{\delta^{c--}_i}\Big) \tag{171}$$

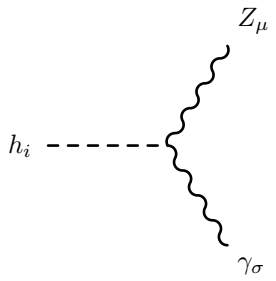
8.3 One Scalar-Two Vector Boson-Interaction



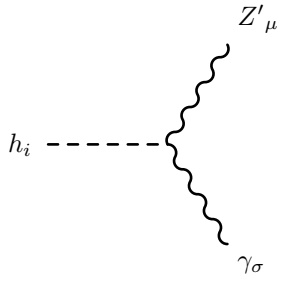
$$\frac{1}{2} g_2 g_R \Big(- v_d Z^{Ah}_{i2} + v_u Z^{Ah}_{i1}\Big)\Big(g_{\sigma\mu}\Big) \tag{172}$$



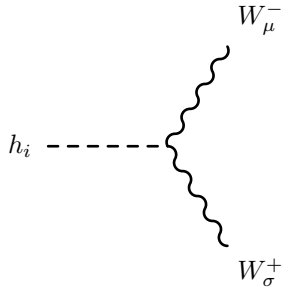
$$\frac{1}{2} g_2 g_R \Big(v_d Z^{Ah}_{i2} - v_u Z^{Ah}_{i1}\Big)\Big(g_{\sigma\mu}\Big) \tag{173}$$



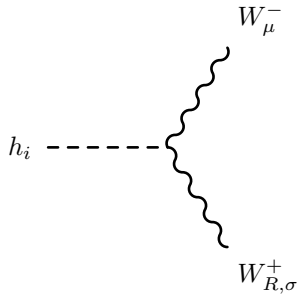
$$\frac{i}{2}\Big(4v_L Z^H_{i4}\Big(-g_2 Z^Z_{21}+g_B Z^Z_{11}\Big)\Big(-g_2 Z^Z_{22}+g_B Z^Z_{12}\Big) + 4v_R Z^H_{i3}\Big(g_B Z^Z_{11}-g_R Z^Z_{31}\Big)\Big(g_B Z^Z_{12}-g_R Z^Z_{32}\Big) + \Big(v_d Z^H_{i1}+v_u Z^H_{i2}\Big)\Big(g_2 Z^Z_{21}-g_R Z^Z_{31}\Big)\Big(g_2 Z^Z_{22}-g_R Z^Z_{32}\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{174}$$



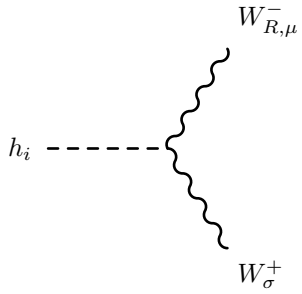
$$\frac{i}{2}\Big(4v_L Z^H_{i4}\Big(-g_2 Z^Z_{21}+g_B Z^Z_{11}\Big)\Big(-g_2 Z^Z_{23}+g_B Z^Z_{13}\Big) + 4v_R Z^H_{i3}\Big(g_B Z^Z_{11}-g_R Z^Z_{31}\Big)\Big(g_B Z^Z_{13}-g_R Z^Z_{33}\Big) + \Big(v_d Z^H_{i1}+v_u Z^H_{i2}\Big)\Big(g_2 Z^Z_{21}-g_R Z^Z_{31}\Big)\Big(g_2 Z^Z_{23}-g_R Z^Z_{33}\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{175}$$



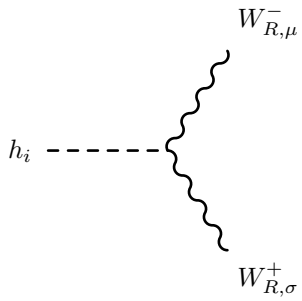
$$\frac{i}{2}\Big(\Big(-2g_2g_Rv_u\cos\phi_W\sin\phi_W+g_2^2v_d\cos\phi_W^2+g_R^2v_d\sin\phi_W^2\Big)Z_{i1}^H$$
$$+\Big(-2g_2g_Rv_d\cos\phi_W\sin\phi_W+g_2^2v_u\cos\phi_W^2+g_R^2v_u\sin\phi_W^2\Big)Z_{i2}^H$$
$$+2\Big(g_2^2v_L\cos\phi_W^2Z_{i4}^H+g_R^2v_R\sin\phi_W^2Z_{i3}^H\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{176}$$



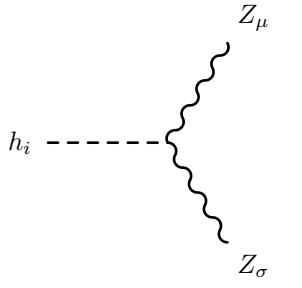
$$-\frac{i}{4}\Big(\Big(2g_2g_Rv_u\cos2\phi_W+\Big(-g_R^2+g_2^2\Big)v_d\sin2\phi_W\Big)Z_{i1}^H$$
$$+\Big(2g_2g_Rv_d\cos2\phi_W+\Big(-g_R^2+g_2^2\Big)v_u\sin2\phi_W\Big)Z_{i2}^H$$
$$+2\sin2\phi_W\Big(g_2^2v_LZ_{i4}^H-g_R^2v_RZ_{i3}^H\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{177}$$



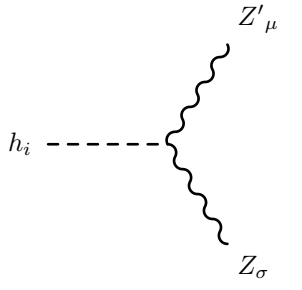
$$-\frac{i}{4}\Big(\Big(2g_2g_Rv_u\cos2\phi_W+\Big(-g_R^2+g_2^2\Big)v_d\sin2\phi_W\Big)Z_{i1}^H$$
$$+\Big(2g_2g_Rv_d\cos2\phi_W+\Big(-g_R^2+g_2^2\Big)v_u\sin2\phi_W\Big)Z_{i2}^H$$
$$+2\sin2\phi_W\Big(g_2^2v_LZ_{i4}^H-g_R^2v_RZ_{i3}^H\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{178}$$



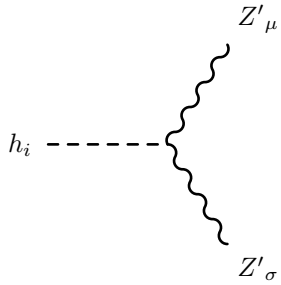
$$\frac{i}{2}\Big(\Big(g_2\sin\phi_W\Big(2g_Rv_u\cos\phi_W+g_2v_d\sin\phi_W\Big)+g_R^2v_d\cos\phi_W^2\Big)Z_{i1}^H + \Big(g_2\sin\phi_W\Big(2g_Rv_d\cos\phi_W+g_2v_u\sin\phi_W\Big)+g_R^2v_u\cos\phi_W^2\Big)Z_{i2}^H + 2\Big(g_2^2v_L\sin\phi_W^2Z_{i4}^H+g_R^2v_R\cos\phi_W^2Z_{i3}^H\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{179}$$



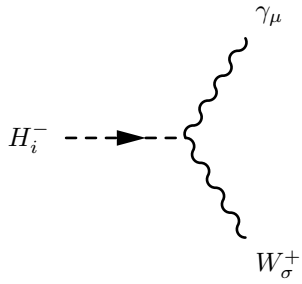
$$\frac{i}{2}\Big(4v_LZ_{i4}^H\Big(-g_2Z_{22}^Z+g_BZ_{12}^Z\Big)^2+4v_RZ_{i3}^H\Big(g_BZ_{12}^Z-g_RZ_{32}^Z\Big)^2 + \Big(v_dZ_{i1}^H+v_uZ_{i2}^H\Big)\Big(g_2Z_{22}^Z-g_RZ_{32}^Z\Big)^2\Big)\Big(g_{\sigma\mu}\Big) \tag{180}$$



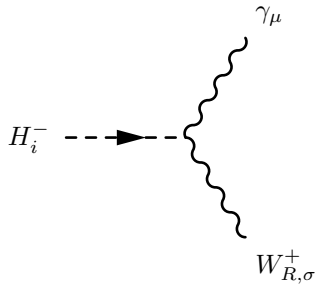
$$\frac{i}{2}\Big(4v_L Z^H_{i4}\Big(-g_2 Z^Z_{22}+g_B Z^Z_{12}\Big)\Big(-g_2 Z^Z_{23}+g_B Z^Z_{13}\Big)$$
$$+4v_R Z^H_{i3}\Big(g_B Z^Z_{12}-g_R Z^Z_{32}\Big)\Big(g_B Z^Z_{13}-g_R Z^Z_{33}\Big)$$
$$+\Big(v_d Z^H_{i1}+v_u Z^H_{i2}\Big)\Big(g_2 Z^Z_{22}-g_R Z^Z_{32}\Big)\Big(g_2 Z^Z_{23}-g_R Z^Z_{33}\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{181}$$



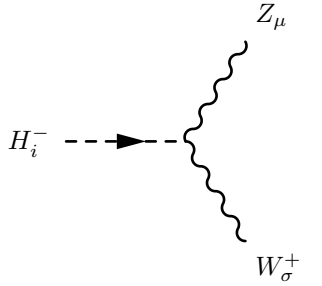
$$\frac{i}{2}\Big(4v_L Z^H_{i4}\Big(-g_2 Z^Z_{23}+g_B Z^Z_{13}\Big)^2+4v_R Z^H_{i3}\Big(g_B Z^Z_{13}-g_R Z^Z_{33}\Big)^2$$
$$+\Big(v_d Z^H_{i1}+v_u Z^H_{i2}\Big)\Big(g_2 Z^Z_{23}-g_R Z^Z_{33}\Big)^2\Big)\Big(g_{\sigma\mu}\Big) \tag{182}$$



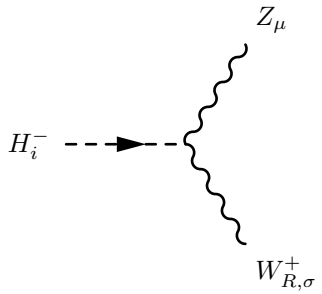
$$\frac{i}{2}\Big(\sqrt{2}g_R v_R \sin\phi_W Z^+_{i3}\Big(2g_B Z^Z_{11}-g_R Z^Z_{31}\Big)$$
$$+g_2\Big(\sqrt{2}v_L\cos\phi_W Z^+_{i4}\Big(2g_B Z^Z_{11}-g_2 Z^Z_{21}\Big)$$
$$+g_R\Big(Z^+_{i1}\Big(-v_d\cos\phi_W Z^Z_{31}+v_u\sin\phi_W Z^Z_{21}\Big)+Z^+_{i2}\Big(-v_d\sin\phi_W Z^Z_{21}+v_u\cos\phi_W Z^Z_{31}\Big)\Big)\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{183}$$



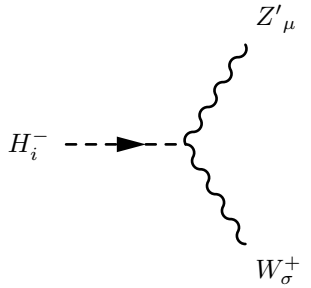
$$\frac{i}{2}\Big(\sqrt{2}g_R v_R \cos\phi_W Z_{i3}^+\Big(2g_B Z_{11}^Z - g_R Z_{31}^Z\Big) + g_2\Big(-\sqrt{2}v_L \sin\phi_W Z_{i4}^+\Big(2g_B Z_{11}^Z - g_2 Z_{21}^Z\Big) + g_R\Big(Z_{i1}^+\Big(v_d \sin\phi_W Z_{31}^Z + v_u \cos\phi_W Z_{21}^Z\Big) - Z_{i2}^+\Big(v_d \cos\phi_W Z_{21}^Z + v_u \sin\phi_W Z_{31}^Z\Big)\Big)\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{184}$$



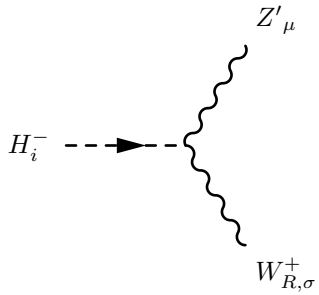
$$\frac{i}{2}\Big(\sqrt{2}g_R v_R \sin\phi_W Z_{i3}^+\Big(2g_B Z_{12}^Z - g_R Z_{32}^Z\Big) + g_2\Big(\sqrt{2}v_L \cos\phi_W Z_{i4}^+\Big(2g_B Z_{12}^Z - g_2 Z_{22}^Z\Big) + g_R\Big(Z_{i1}^+\Big(-v_d \cos\phi_W Z_{32}^Z + v_u \sin\phi_W Z_{22}^Z\Big) + Z_{i2}^+\Big(-v_d \sin\phi_W Z_{22}^Z + v_u \cos\phi_W Z_{32}^Z\Big)\Big)\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{185}$$



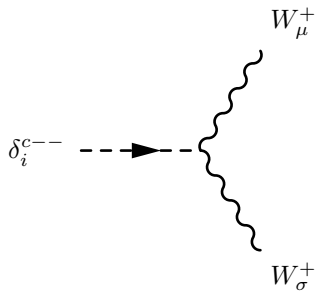
$$\frac{i}{2}\Big(\sqrt{2}g_R v_R \cos\phi_W Z^+_{i3}\Big(2g_B Z^Z_{12} - g_R Z^Z_{32}\Big)$$
$$+ g_2\Big(-\sqrt{2}v_L \sin\phi_W Z^+_{i4}\Big(2g_B Z^Z_{12} - g_2 Z^Z_{22}\Big)$$
$$+ g_R\Big(Z^+_{i1}\Big(v_d \sin\phi_W Z^Z_{32} + v_u \cos\phi_W Z^Z_{22}\Big) - Z^+_{i2}\Big(v_d \cos\phi_W Z^Z_{22} + v_u \sin\phi_W Z^Z_{32}\Big)\Big)\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{186}$$



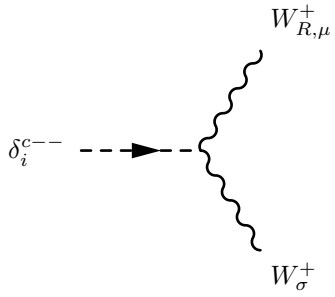
$$\frac{i}{2}\Big(\sqrt{2}g_R v_R \sin\phi_W Z^+_{i3}\Big(2g_B Z^Z_{13} - g_R Z^Z_{33}\Big)$$
$$+ g_2\Big(\sqrt{2}v_L \cos\phi_W Z^+_{i4}\Big(2g_B Z^Z_{13} - g_2 Z^Z_{23}\Big)$$
$$+ g_R\Big(Z^+_{i1}\Big(-v_d \cos\phi_W Z^Z_{33} + v_u \sin\phi_W Z^Z_{23}\Big) + Z^+_{i2}\Big(-v_d \sin\phi_W Z^Z_{23} + v_u \cos\phi_W Z^Z_{33}\Big)\Big)\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{187}$$



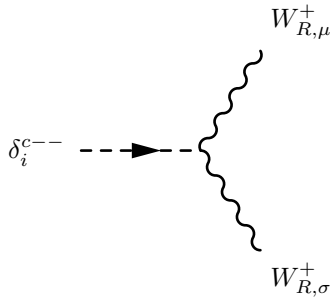
$$\frac{i}{2}\Big(\sqrt{2}g_R v_R \cos\phi_W Z^+_{i3}\Big(2g_B Z^Z_{13} - g_R Z^Z_{33}\Big)$$
$$+ g_2\Big(-\sqrt{2}v_L \sin\phi_W Z^+_{i4}\Big(2g_B Z^Z_{13} - g_2 Z^Z_{23}\Big)$$
$$+ g_R\Big(Z^+_{i1}\Big(v_d \sin\phi_W Z^Z_{33} + v_u \cos\phi_W Z^Z_{23}\Big) - Z^+_{i2}\Big(v_d \cos\phi_W Z^Z_{23} + v_u \sin\phi_W Z^Z_{33}\Big)\Big)\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{188}$$



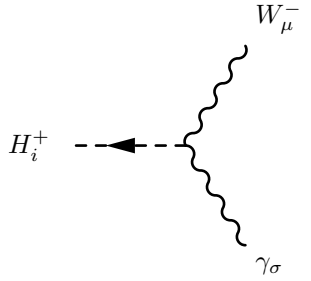
$$-i\sqrt{2}\Big(g_2^2 v_L \cos\phi_W^2 Z_{i2}^{++} + g_R^2 v_R \sin\phi_W^2 Z_{i1}^{++}\Big)\Big(g_{\sigma\mu}\Big) \tag{189}$$



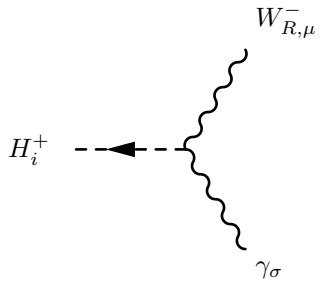
$$-i\sqrt{2}\cos\phi_W \sin\phi_W\Big(-g_2^2 v_L Z_{i2}^{++} + g_R^2 v_R Z_{i1}^{++}\Big)\Big(g_{\sigma\mu}\Big) \tag{190}$$



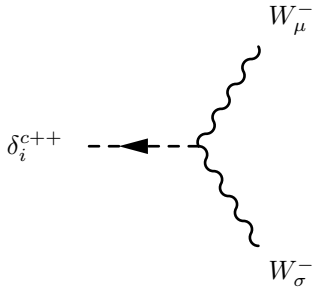
$$-i\sqrt{2}\Big(g_2^2 v_L \sin\phi_W^2 Z_{i2}^{++} + g_R^2 v_R \cos\phi_W^2 Z_{i1}^{++}\Big)\Big(g_{\sigma\mu}\Big) \tag{191}$$



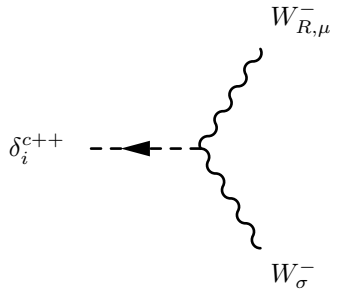
$$\frac{i}{2}\Big(\sqrt{2}g_R v_R \sin\phi_W Z^+_{i3}\Big(2g_B Z^Z_{11} - g_R Z^Z_{31}\Big) + g_2\Big(\sqrt{2}v_L \cos\phi_W Z^+_{i4}\Big(2g_B Z^Z_{11} - g_2 Z^Z_{21}\Big) + g_R\Big(Z^+_{i1}\Big(-v_d \cos\phi_W Z^Z_{31} + v_u \sin\phi_W Z^Z_{21}\Big) + Z^+_{i2}\Big(-v_d \sin\phi_W Z^Z_{21} + v_u \cos\phi_W Z^Z_{31}\Big)\Big)\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{192}$$



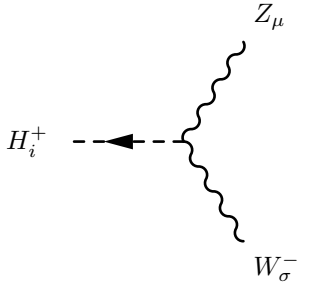
$$\frac{i}{2}\Big(\sqrt{2}g_R v_R \cos\phi_W Z^+_{i3}\Big(2g_B Z^Z_{11} - g_R Z^Z_{31}\Big) + g_2\Big(-\sqrt{2}v_L \sin\phi_W Z^+_{i4}\Big(2g_B Z^Z_{11} - g_2 Z^Z_{21}\Big) + g_R\Big(Z^+_{i1}\Big(v_d \sin\phi_W Z^Z_{31} + v_u \cos\phi_W Z^Z_{21}\Big) - Z^+_{i2}\Big(v_d \cos\phi_W Z^Z_{21} + v_u \sin\phi_W Z^Z_{31}\Big)\Big)\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{193}$$



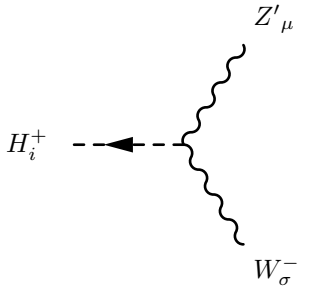
$$- i\sqrt{2}\Big(g_2^2 v_L \cos\phi_W^2 Z_{i2}^{++} + g_R^2 v_R \sin\phi_W^2 Z_{i1}^{++}\Big)\Big(g_{\sigma\mu}\Big) \tag{194}$$



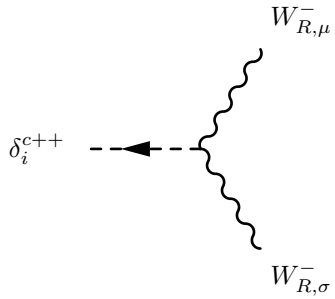
$$- i\sqrt{2}\cos\phi_W \sin\phi_W \Big(- g_2^2 v_L Z_{i2}^{++} + g_R^2 v_R Z_{i1}^{++}\Big)\Big(g_{\sigma\mu}\Big) \tag{195}$$



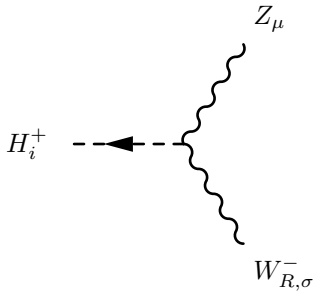
$$\begin{aligned}
&\frac{i}{2}\Big(\sqrt{2} g_R v_R \sin\phi_W Z_{i3}^+\Big(2 g_B Z_{12}^Z - g_R Z_{32}^Z\Big) \\
&+ g_2\Big(\sqrt{2} v_L \cos\phi_W Z_{i4}^+\Big(2 g_B Z_{12}^Z - g_2 Z_{22}^Z\Big) \\
&+ g_R\Big(Z_{i1}^+\Big(- v_d \cos\phi_W Z_{32}^Z + v_u \sin\phi_W Z_{22}^Z\Big) + Z_{i2}^+\Big(- v_d \sin\phi_W Z_{22}^Z + v_u \cos\phi_W Z_{32}^Z\Big)\Big)\Big)\Big)\Big(g_{\sigma\mu}\Big)
\end{aligned} \tag{196}$$



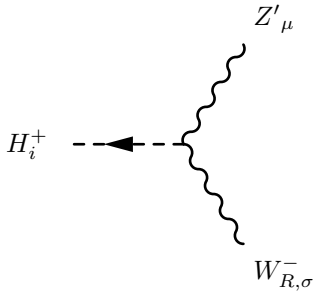
$$\frac{i}{2}\Big(\sqrt{2}g_R v_R \sin\phi_W Z^+_{i3}\Big(2g_B Z^Z_{13} - g_R Z^Z_{33}\Big)$$
$$+ g_2\Big(\sqrt{2}v_L \cos\phi_W Z^+_{i4}\Big(2g_B Z^Z_{13} - g_2 Z^Z_{23}\Big)$$
$$+ g_R\Big(Z^+_{i1}\Big(-v_d \cos\phi_W Z^Z_{33} + v_u \sin\phi_W Z^Z_{23}\Big) + Z^+_{i2}\Big(-v_d \sin\phi_W Z^Z_{23} + v_u \cos\phi_W Z^Z_{33}\Big)\Big)\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{197}$$



$$-i\sqrt{2}\Big(g_2^2 v_L \sin\phi_W^2 Z^{++}_{i2} + g_R^2 v_R \cos\phi_W^2 Z^{++}_{i1}\Big)\Big(g_{\sigma\mu}\Big) \tag{198}$$

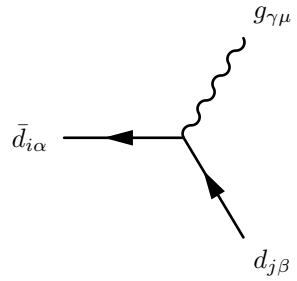


$$\frac{i}{2}\Big(\sqrt{2}g_R v_R \cos\phi_W Z^+_{i3}\Big(2g_B Z^Z_{12} - g_R Z^Z_{32}\Big)$$
$$+ g_2\Big(-\sqrt{2}v_L \sin\phi_W Z^+_{i4}\Big(2g_B Z^Z_{12} - g_2 Z^Z_{22}\Big)$$
$$+ g_R\Big(Z^+_{i1}\Big(v_d \sin\phi_W Z^Z_{32} + v_u \cos\phi_W Z^Z_{22}\Big) - Z^+_{i2}\Big(v_d \cos\phi_W Z^Z_{22} + v_u \sin\phi_W Z^Z_{32}\Big)\Big)\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{199}$$

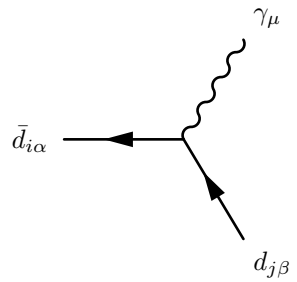


$$\frac{i}{2}\Big(\sqrt{2}g_R v_R \cos\phi_W Z^+_{i3}\Big(2g_B Z^Z_{13} - g_R Z^Z_{33}\Big)$$
$$+ g_2\Big(-\sqrt{2}v_L \sin\phi_W Z^+_{i4}\Big(2g_B Z^Z_{13} - g_2 Z^Z_{23}\Big)$$
$$+ g_R\Big(Z^+_{i1}\Big(v_d \sin\phi_W Z^Z_{33} + v_u \cos\phi_W Z^Z_{23}\Big) - Z^+_{i2}\Big(v_d \cos\phi_W Z^Z_{23} + v_u \sin\phi_W Z^Z_{33}\Big)\Big)\Big)\Big)\Big(g_{\sigma\mu}\Big) \tag{200}$$

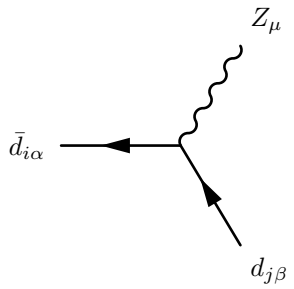
8.4 Two Fermion-One Vector Boson-Interaction



$$-\frac{i}{2}g_3\delta_{ij}\lambda^\gamma_{\alpha,\beta}\Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{201}$$
$$+\ -\frac{i}{2}g_3\delta_{ij}\lambda^\gamma_{\alpha,\beta}\Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{202}$$

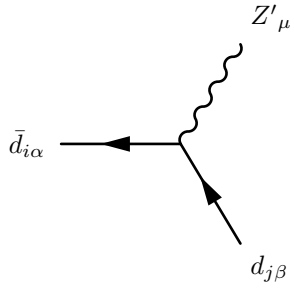


$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(-3g_2 Z^Z_{21} + g_B Z^Z_{11}\Big)\Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{203}$$
$$+\ -\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(-3g_R Z^Z_{31} + g_B Z^Z_{11}\Big)\Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{204}$$



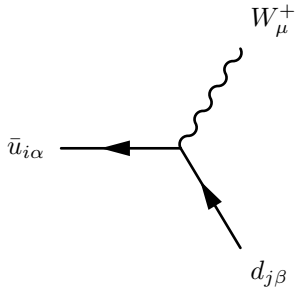
$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(-3g_2 Z_{22}^Z + g_B Z_{12}^Z\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{205}$$

$$+\ -\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(-3g_R Z_{32}^Z + g_B Z_{12}^Z\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{206}$$



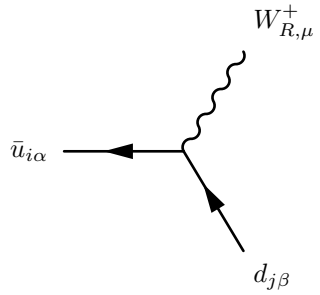
$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(-3g_2 Z_{23}^Z + g_B Z_{13}^Z\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{207}$$

$$+\ -\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(-3g_R Z_{33}^Z + g_B Z_{13}^Z\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{208}$$



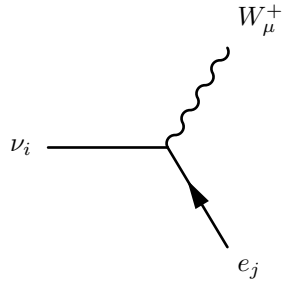
$$-i\frac{1}{\sqrt{2}}g_2\cos\phi_W\delta_{\alpha\beta}\sum_{a=1}^{3}U_{L,ja}^{d,*}U_{L,ia}^{u}\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{209}$$

$$+\ -i\frac{1}{\sqrt{2}}g_R\delta_{\alpha\beta}\sin\phi_W\sum_{a=1}^{3}U^{u,*}_{R,ia}U^{d}_{R,ja}\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{210}$$



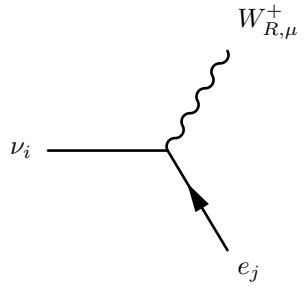
$$i\frac{1}{\sqrt{2}}g_2\delta_{\alpha\beta}\sin\phi_W\sum_{a=1}^{3}U^{d,*}_{L,ja}U^{u}_{L,ia}\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{211}$$

$$+\ -i\frac{1}{\sqrt{2}}g_R\cos\phi_W\delta_{\alpha\beta}\sum_{a=1}^{3}U^{u,*}_{R,ia}U^{d}_{R,ja}\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{212}$$



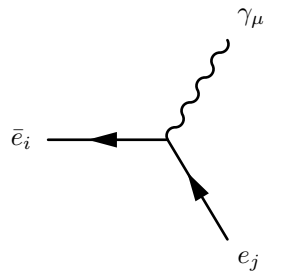
$$-\ i\frac{1}{\sqrt{2}}g_2\cos\phi_W\sum_{a=1}^{3}U^{e,*}_{L,ja}U^{V}_{ia}\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{213}$$

$$+\ -i\frac{1}{\sqrt{2}}g_R\sin\phi_W\sum_{a=1}^{3}U^{V,*}_{i3+a}U^{e}_{R,ja}\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{214}$$



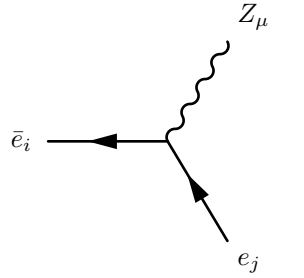
$$i\frac{1}{\sqrt{2}}g_2 \sin\phi_W \sum_{a=1}^{3} U^{e,*}_{L,ja} U^{V}_{ia} \Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{215}$$

$$+\ -i\frac{1}{\sqrt{2}}g_R \cos\phi_W \sum_{a=1}^{3} U^{V,*}_{i3+a} U^{e}_{R,ja} \Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{216}$$



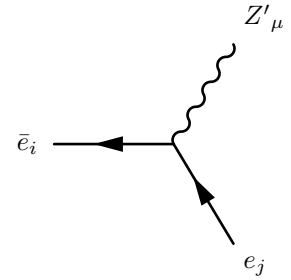
$$\frac{i}{2}\delta_{ij}\Big(g_2 Z^Z_{21} + g_B Z^Z_{11}\Big)\Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{217}$$

$$+\ \frac{i}{2}\delta_{ij}\Big(g_B Z^Z_{11} + g_R Z^Z_{31}\Big)\Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{218}$$



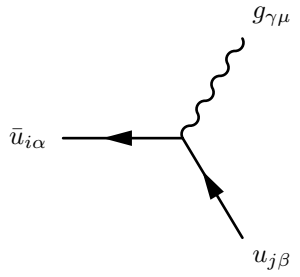
$$\frac{i}{2}\delta_{ij}\Big(g_2 Z_{22}^Z + g_B Z_{12}^Z\Big)\Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{219}$$

$$+\ \frac{i}{2}\delta_{ij}\Big(g_B Z_{12}^Z + g_R Z_{32}^Z\Big)\Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{220}$$



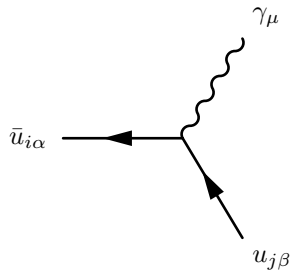
$$\frac{i}{2}\delta_{ij}\Big(g_2 Z_{23}^Z + g_B Z_{13}^Z\Big)\Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{221}$$

$$+\ \frac{i}{2}\delta_{ij}\Big(g_B Z_{13}^Z + g_R Z_{33}^Z\Big)\Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{222}$$



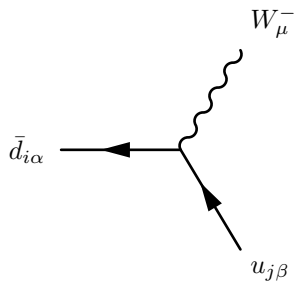
$$-\frac{i}{2}g_3\delta_{ij}\lambda^\gamma_{\alpha,\beta}\Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{223}$$

$$+\ -\frac{i}{2}g_3\delta_{ij}\lambda^\gamma_{\alpha,\beta}\Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{224}$$



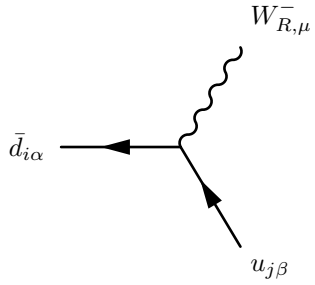
$$- \frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(3g_2 Z_{21}^Z + g_B Z_{11}^Z\Big)\Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{225}$$

$$+ \ -\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(3g_R Z_{31}^Z + g_B Z_{11}^Z\Big)\Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{226}$$



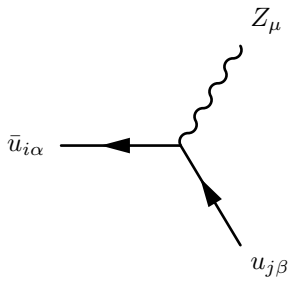
$$- \, i\frac{1}{\sqrt{2}} g_2 \cos\phi_W \delta_{\alpha\beta} \sum_{a=1}^{3} U_{L,ja}^{u,*} U_{L,ia}^{d} \Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{227}$$

$$+ \ -i\frac{1}{\sqrt{2}} g_R \delta_{\alpha\beta} \sin\phi_W \sum_{a=1}^{3} U_{R,ia}^{d,*} U_{R,ja}^{u} \Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{228}$$



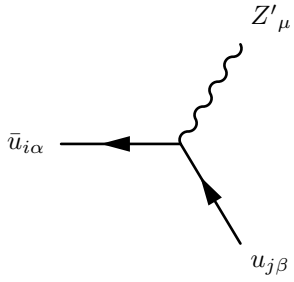
$$i\frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \sin\phi_W \sum_{a=1}^{3} U_{L,ja}^{u,*} U_{L,ia}^{d} \Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{229}$$

$$+ \ -i\frac{1}{\sqrt{2}} g_R \cos\phi_W \delta_{\alpha\beta} \sum_{a=1}^{3} U_{R,ia}^{d,*} U_{R,ja}^{u} \Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{230}$$



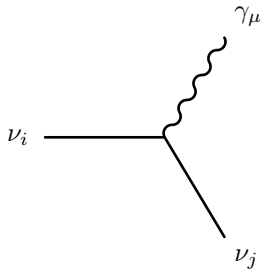
$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(3g_2Z_{22}^Z+g_BZ_{12}^Z\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{231}$$

$$+\ -\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(3g_RZ_{32}^Z+g_BZ_{12}^Z\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{232}$$



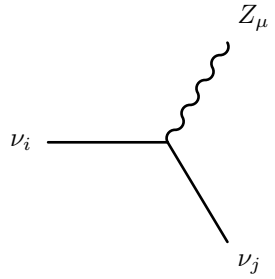
$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(3g_2Z_{23}^Z+g_BZ_{13}^Z\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{233}$$

$$+\ -\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\Big(3g_RZ_{33}^Z+g_BZ_{13}^Z\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{234}$$



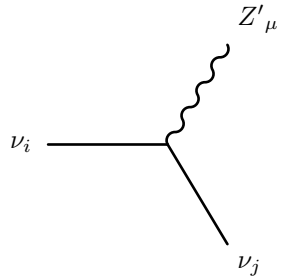
$$\frac{i}{2}\Big(\sum_{a=1}^{3}U_{j3+a}^{V,*}U_{i3+a}^{V}\Big(-g_BZ_{11}^Z+g_RZ_{31}^Z\Big)+\sum_{a=1}^{3}U_{ja}^{V,*}U_{ia}^{V}\Big(-g_2Z_{21}^Z+g_BZ_{11}^Z\Big)\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{235}$$

$$+\ -\frac{i}{2}\Big(\sum_{a=1}^{3} U^{V,*}_{i3+a}U^{V}_{j3+a}\Big(-g_B Z^Z_{11}+g_R Z^Z_{31}\Big)+\sum_{a=1}^{3} U^{V,*}_{ia}U^{V}_{ja}\Big(-g_2 Z^Z_{21}+g_B Z^Z_{11}\Big)\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{236}$$



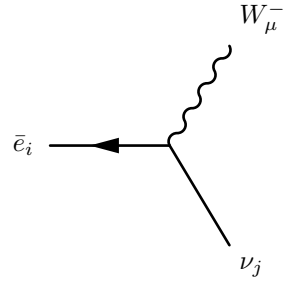
$$\frac{i}{2}\Big(\sum_{a=1}^{3} U^{V,*}_{j3+a}U^{V}_{i3+a}\Big(-g_B Z^Z_{12}+g_R Z^Z_{32}\Big)+\sum_{a=1}^{3} U^{V,*}_{ja}U^{V}_{ia}\Big(-g_2 Z^Z_{22}+g_B Z^Z_{12}\Big)\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{237}$$

$$+\ -\frac{i}{2}\Big(\sum_{a=1}^{3} U^{V,*}_{i3+a}U^{V}_{j3+a}\Big(-g_B Z^Z_{12}+g_R Z^Z_{32}\Big)+\sum_{a=1}^{3} U^{V,*}_{ia}U^{V}_{ja}\Big(-g_2 Z^Z_{22}+g_B Z^Z_{12}\Big)\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{238}$$



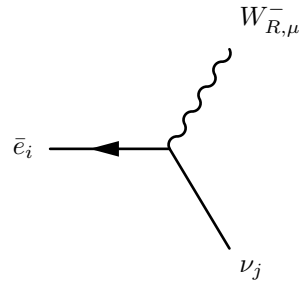
$$\frac{i}{2}\Big(\sum_{a=1}^{3} U^{V,*}_{j3+a}U^{V}_{i3+a}\Big(-g_B Z^Z_{13}+g_R Z^Z_{33}\Big)+\sum_{a=1}^{3} U^{V,*}_{ja}U^{V}_{ia}\Big(-g_2 Z^Z_{23}+g_B Z^Z_{13}\Big)\Big)\Big(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\Big) \tag{239}$$

$$+\ -\frac{i}{2}\Big(\sum_{a=1}^{3} U^{V,*}_{i3+a}U^{V}_{j3+a}\Big(-g_B Z^Z_{13}+g_R Z^Z_{33}\Big)+\sum_{a=1}^{3} U^{V,*}_{ia}U^{V}_{ja}\Big(-g_2 Z^Z_{23}+g_B Z^Z_{13}\Big)\Big)\Big(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\Big) \tag{240}$$



$$- i\frac{1}{\sqrt{2}} g_2 \cos\phi_W \sum_{a=1}^{3} U_{ja}^{V,*} U_{L,ia}^{e} \Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{241}$$

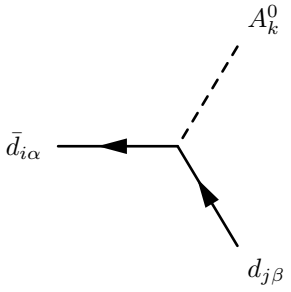
$$+ \; -i\frac{1}{\sqrt{2}} g_R \sin\phi_W \sum_{a=1}^{3} U_{R,ia}^{e,*} U_{j3+a}^{V} \Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{242}$$



$$i\frac{1}{\sqrt{2}} g_2 \sin\phi_W \sum_{a=1}^{3} U_{ja}^{V,*} U_{L,ia}^{e} \Big(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\Big) \tag{243}$$

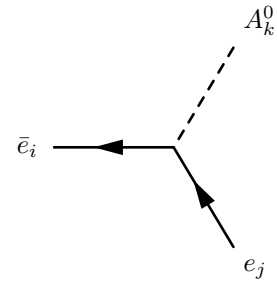
$$+ \; -i\frac{1}{\sqrt{2}} g_R \cos\phi_W \sum_{a=1}^{3} U_{R,ia}^{e,*} U_{j3+a}^{V} \Big(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\Big) \tag{244}$$

8.5 Two Fermion-One Scalar Boson-Interaction



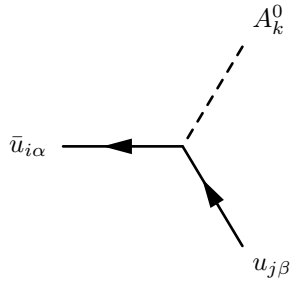
$$\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\Big(-\sum_{b=1}^{3}U^{d,*}_{R,ib}\sum_{a=1}^{3}U^{d,*}_{L,ja}Y^{*}_{Q1,ab}Z^{Ah}_{k2}+\sum_{b=1}^{3}U^{d,*}_{R,ib}\sum_{a=1}^{3}U^{d,*}_{L,ja}Y^{*}_{Q2,ab}Z^{Ah}_{k1}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{245}$$

$$+\ \frac{1}{\sqrt{2}}\delta_{\alpha\beta}\Big(\sum_{b=1}^{3}\sum_{a=1}^{3}U^{d}_{L,ia}Y_{Q1,ab}U^{d}_{R,jb}Z^{Ah}_{k2}-\sum_{b=1}^{3}\sum_{a=1}^{3}U^{d}_{L,ia}Y_{Q2,ab}U^{d}_{R,jb}Z^{Ah}_{k1}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{246}$$



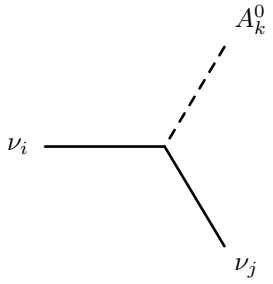
$$\frac{1}{\sqrt{2}}\Big(-\sum_{b=1}^{3}U^{e,*}_{R,ib}\sum_{a=1}^{3}U^{e,*}_{L,ja}Y^{*}_{L1,ab}Z^{Ah}_{k2}+\sum_{b=1}^{3}U^{e,*}_{R,ib}\sum_{a=1}^{3}U^{e,*}_{L,ja}Y^{*}_{L2,ab}Z^{Ah}_{k1}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{247}$$

$$+\ \frac{1}{\sqrt{2}}\Big(\sum_{b=1}^{3}\sum_{a=1}^{3}U^{e}_{L,ia}Y_{L1,ab}U^{e}_{R,jb}Z^{Ah}_{k2}-\sum_{b=1}^{3}\sum_{a=1}^{3}U^{e}_{L,ia}Y_{L2,ab}U^{e}_{R,jb}Z^{Ah}_{k1}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{248}$$



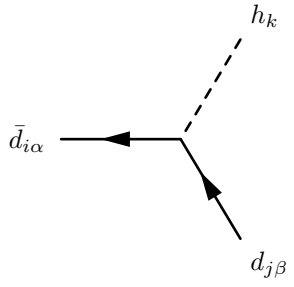
$$\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\Big(-\sum_{b=1}^{3}U^{u,*}_{R,ib}\sum_{a=1}^{3}U^{u,*}_{L,ja}Y^{*}_{Q1,ab}Z^{Ah}_{k1}+\sum_{b=1}^{3}U^{u,*}_{R,ib}\sum_{a=1}^{3}U^{u,*}_{L,ja}Y^{*}_{Q2,ab}Z^{Ah}_{k2}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{249}$$

$$+\ \frac{1}{\sqrt{2}}\delta_{\alpha\beta}\Big(\sum_{b=1}^{3}\sum_{a=1}^{3}U^{u}_{L,ia}Y_{Q1,ab}U^{u}_{R,jb}Z^{Ah}_{k1}-\sum_{b=1}^{3}\sum_{a=1}^{3}U^{u}_{L,ia}Y_{Q2,ab}U^{u}_{R,jb}Z^{Ah}_{k2}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{250}$$



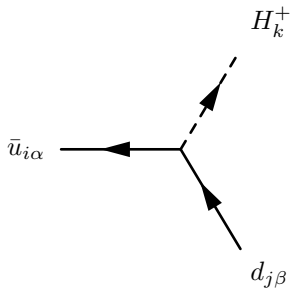
$$
\begin{aligned}
&\frac{1}{\sqrt{2}}\Big(-\sum_{b=1}^{3} U_{j3+b}^{V,*} \sum_{a=1}^{3} U_{ia}^{V,*} Y_{L1,ab}^{*} Z_{k1}^{Ah} - \sum_{b=1}^{3} U_{i3+b}^{V,*} \sum_{a=1}^{3} U_{ja}^{V,*} Y_{L1,ab}^{*} Z_{k1}^{Ah} \\
&+ \sum_{b=1}^{3} U_{j3+b}^{V,*} \sum_{a=1}^{3} U_{ia}^{V,*} Y_{L2,ab}^{*} Z_{k2}^{Ah} + \sum_{b=1}^{3} U_{i3+b}^{V,*} \sum_{a=1}^{3} U_{ja}^{V,*} Y_{L2,ab}^{*} Z_{k2}^{Ah} \\
&- \sum_{b=1}^{3} U_{j3+b}^{V,*} \sum_{a=1}^{3} U_{i3+a}^{V,*} Y_{DR,ab}^{*} Z_{k3}^{Ah} - \sum_{b=1}^{3} U_{i3+b}^{V,*} \sum_{a=1}^{3} U_{j3+a}^{V,*} Y_{DR,ab}^{*} Z_{k3}^{Ah} \\
&+ \sum_{b=1}^{3} U_{jb}^{V,*} \sum_{a=1}^{3} U_{ia}^{V,*} Y_{DL,ab} Z_{k4}^{Ah} + \sum_{b=1}^{3} U_{ib}^{V,*} \sum_{a=1}^{3} U_{ja}^{V,*} Y_{DL,ab} Z_{k4}^{Ah} \Big) \Big(\frac{1-\gamma_5}{2} \Big)
\end{aligned} \tag{251}
$$

$$
\begin{aligned}
&+ \frac{1}{\sqrt{2}}\Big(\sum_{b=1}^{3} U_{j3+b}^{V} \sum_{a=1}^{3} U_{ia}^{V} Y_{L1,ab} Z_{k1}^{Ah} + \sum_{b=1}^{3} U_{i3+b}^{V} \sum_{a=1}^{3} U_{ja}^{V} Y_{L1,ab} Z_{k1}^{Ah} - \sum_{b=1}^{3} U_{j3+b}^{V} \sum_{a=1}^{3} U_{ia}^{V} Y_{L2,ab} Z_{k2}^{Ah} \\
&- \sum_{b=1}^{3} U_{i3+b}^{V} \sum_{a=1}^{3} U_{ja}^{V} Y_{L2,ab} Z_{k2}^{Ah} + \sum_{b=1}^{3} U_{j3+b}^{V} \sum_{a=1}^{3} U_{i3+a}^{V} Y_{DR,ab} Z_{k3}^{Ah} \\
&+ \sum_{b=1}^{3} U_{i3+b}^{V} \sum_{a=1}^{3} U_{j3+a}^{V} Y_{DR,ab} Z_{k3}^{Ah} - \sum_{b=1}^{3} U_{jb}^{V} \sum_{a=1}^{3} Y_{DL,ab}^{*} U_{ia}^{V} Z_{k4}^{Ah} \\
&- \sum_{b=1}^{3} U_{ib}^{V} \sum_{a=1}^{3} Y_{DL,ab}^{*} U_{ja}^{V} Z_{k4}^{Ah} \Big) \Big(\frac{1+\gamma_5}{2} \Big)
\end{aligned} \tag{252}
$$



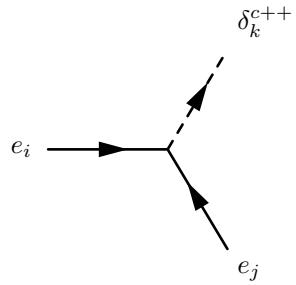
$$- i\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\Big(\sum_{b=1}^{3}U^{d,*}_{R,ib}\sum_{a=1}^{3}U^{d,*}_{L,ja}Y^{*}_{Q1,ab}Z^{H}_{k2}+\sum_{b=1}^{3}U^{d,*}_{R,ib}\sum_{a=1}^{3}U^{d,*}_{L,ja}Y^{*}_{Q2,ab}Z^{H}_{k1}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{253}$$

$$+\ -i\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\Big(\sum_{b=1}^{3}\sum_{a=1}^{3}U^{d}_{L,ia}Y_{Q1,ab}U^{d}_{R,jb}Z^{H}_{k2}+\sum_{b=1}^{3}\sum_{a=1}^{3}U^{d}_{L,ia}Y_{Q2,ab}U^{d}_{R,jb}Z^{H}_{k1}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{254}$$



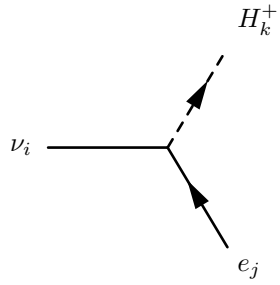
$$- i\delta_{\alpha\beta}\Big(\sum_{b=1}^{3}U^{u,*}_{R,ib}\sum_{a=1}^{3}U^{d,*}_{L,ja}Y^{*}_{Q1,ab}Z^{+}_{k1}-\sum_{b=1}^{3}U^{u,*}_{R,ib}\sum_{a=1}^{3}U^{d,*}_{L,ja}Y^{*}_{Q2,ab}Z^{+}_{k2}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{255}$$

$$+\ i\delta_{\alpha\beta}\Big(-\sum_{b=1}^{3}\sum_{a=1}^{3}U^{u}_{L,ia}Y_{Q1,ab}U^{d}_{R,jb}Z^{+}_{k2}+\sum_{b=1}^{3}\sum_{a=1}^{3}U^{u}_{L,ia}Y_{Q2,ab}U^{d}_{R,jb}Z^{+}_{k1}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{256}$$

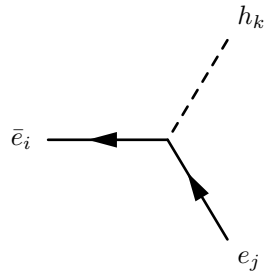


$$i\Big(\sum_{b=1}^{3}U^{e,*}_{L,jb}\sum_{a=1}^{3}U^{e,*}_{L,ia}Y_{DL,ab}+\sum_{b=1}^{3}U^{e,*}_{L,ib}\sum_{a=1}^{3}U^{e,*}_{L,ja}Y_{DL,ab}\Big)Z^{++}_{k2}\Big(\frac{1-\gamma_5}{2}\Big) \tag{257}$$

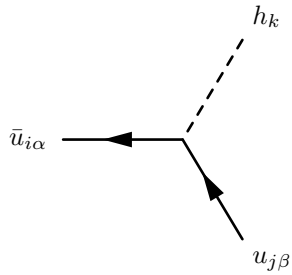
$$+\ i\Big(\sum_{b=1}^{3}\sum_{a=1}^{3}U^{e}_{R,ja}Y_{DR,ab}U^{e}_{R,ib}+\sum_{b=1}^{3}\sum_{a=1}^{3}U^{e}_{R,ia}Y_{DR,ab}U^{e}_{R,jb}\Big)Z^{++}_{k1}\Big(\frac{1+\gamma_5}{2}\Big) \tag{258}$$



$$
\begin{aligned}
&-\frac{i}{2}\Big(2\sum_{b=1}^{3}U_{i3+b}^{V,*}\sum_{a=1}^{3}U_{L,ja}^{e,*}Y_{L1,ab}^{*}Z_{k1}^{+}-2\sum_{b=1}^{3}U_{i3+b}^{V,*}\sum_{a=1}^{3}U_{L,ja}^{e,*}Y_{L2,ab}^{*}Z_{k2}^{+}\\
&-\sqrt{2}\Big(\sum_{b=1}^{3}U_{L,jb}^{e,*}\sum_{a=1}^{3}U_{ia}^{V,*}Y_{DL,ab}+\sum_{b=1}^{3}U_{ib}^{V,*}\sum_{a=1}^{3}U_{L,ja}^{e,*}Y_{DL,ab}\Big)Z_{k4}^{+}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \qquad (259)\\
&+\frac{i}{2}\Big(2\sum_{b=1}^{3}\sum_{a=1}^{3}U_{ia}^{V}Y_{L2,ab}U_{R,jb}^{e}Z_{k1}^{+}-2\sum_{b=1}^{3}\sum_{a=1}^{3}U_{ia}^{V}Y_{L1,ab}U_{R,jb}^{e}Z_{k2}^{+}\\
&+\sqrt{2}\Big(\sum_{b=1}^{3}U_{i3+b}^{V}\sum_{a=1}^{3}U_{R,ja}^{e}Y_{DR,ab}+\sum_{b=1}^{3}\sum_{a=1}^{3}U_{i3+a}^{V}Y_{DR,ab}U_{R,jb}^{e}\Big)Z_{k3}^{+}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \qquad (260)
\end{aligned}
$$

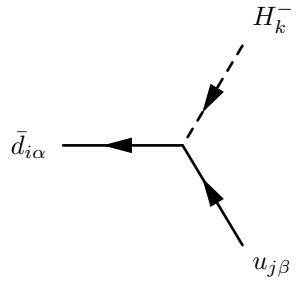


$$
\begin{aligned}
&-i\frac{1}{\sqrt{2}}\Big(\sum_{b=1}^{3}U_{R,ib}^{e,*}\sum_{a=1}^{3}U_{L,ja}^{e,*}Y_{L1,ab}^{*}Z_{k2}^{H}+\sum_{b=1}^{3}U_{R,ib}^{e,*}\sum_{a=1}^{3}U_{L,ja}^{e,*}Y_{L2,ab}^{*}Z_{k1}^{H}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \qquad (261)\\
&+\ -i\frac{1}{\sqrt{2}}\Big(\sum_{b=1}^{3}\sum_{a=1}^{3}U_{L,ia}^{e}Y_{L1,ab}U_{R,jb}^{e}Z_{k2}^{H}+\sum_{b=1}^{3}\sum_{a=1}^{3}U_{L,ia}^{e}Y_{L2,ab}U_{R,jb}^{e}Z_{k1}^{H}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \qquad (262)
\end{aligned}
$$



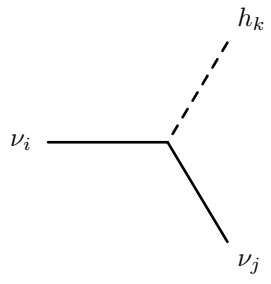
$$-i\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\Big(\sum_{b=1}^{3}U^{u,*}_{R,ib}\sum_{a=1}^{3}U^{u,*}_{L,ja}Y^{*}_{Q1,ab}Z^{H}_{k1}+\sum_{b=1}^{3}U^{u,*}_{R,ib}\sum_{a=1}^{3}U^{u,*}_{L,ja}Y^{*}_{Q2,ab}Z^{H}_{k2}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{263}$$

$$+\ -i\frac{1}{\sqrt{2}}\delta_{\alpha\beta}\Big(\sum_{b=1}^{3}\sum_{a=1}^{3}U^{u}_{L,ia}Y_{Q1,ab}U^{u}_{R,jb}Z^{H}_{k1}+\sum_{b=1}^{3}\sum_{a=1}^{3}U^{u}_{L,ia}Y_{Q2,ab}U^{u}_{R,jb}Z^{H}_{k2}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{264}$$



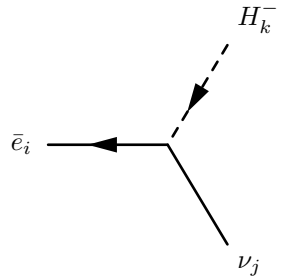
$$i\delta_{\alpha\beta}\Big(-\sum_{b=1}^{3}U^{d,*}_{R,ib}\sum_{a=1}^{3}U^{u,*}_{L,ja}Y^{*}_{Q1,ab}Z^{+}_{k2}+\sum_{b=1}^{3}U^{d,*}_{R,ib}\sum_{a=1}^{3}U^{u,*}_{L,ja}Y^{*}_{Q2,ab}Z^{+}_{k1}\Big)\Big(\frac{1-\gamma_5}{2}\Big) \tag{265}$$

$$+\ -i\delta_{\alpha\beta}\Big(\sum_{b=1}^{3}\sum_{a=1}^{3}U^{d}_{L,ia}Y_{Q1,ab}U^{u}_{R,jb}Z^{+}_{k1}-\sum_{b=1}^{3}\sum_{a=1}^{3}U^{d}_{L,ia}Y_{Q2,ab}U^{u}_{R,jb}Z^{+}_{k2}\Big)\Big(\frac{1+\gamma_5}{2}\Big) \tag{266}$$



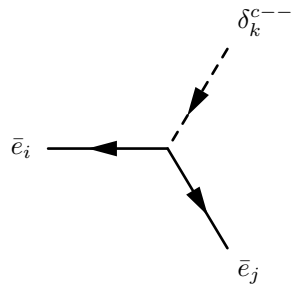
$$
\begin{aligned}
&-i\frac{1}{\sqrt{2}}\Big(\sum_{b=1}^{3}U^{V,*}_{j3+b}\sum_{a=1}^{3}U^{V,*}_{ia}Y^{*}_{L1,ab}Z^{H}_{k1}+\sum_{b=1}^{3}U^{V,*}_{i3+b}\sum_{a=1}^{3}U^{V,*}_{ja}Y^{*}_{L1,ab}Z^{H}_{k1}\\
&+\sum_{b=1}^{3}U^{V,*}_{j3+b}\sum_{a=1}^{3}U^{V,*}_{ia}Y^{*}_{L2,ab}Z^{H}_{k2}+\sum_{b=1}^{3}U^{V,*}_{i3+b}\sum_{a=1}^{3}U^{V,*}_{ja}Y^{*}_{L2,ab}Z^{H}_{k2}\\
&+\sum_{b=1}^{3}U^{V,*}_{j3+b}\sum_{a=1}^{3}U^{V,*}_{i3+a}Y^{*}_{DR,ab}Z^{H}_{k3}+\sum_{b=1}^{3}U^{V,*}_{i3+b}\sum_{a=1}^{3}U^{V,*}_{j3+a}Y^{*}_{DR,ab}Z^{H}_{k3}\\
&+\sum_{b=1}^{3}U^{V,*}_{jb}\sum_{a=1}^{3}U^{V,*}_{ia}Y_{DL,ab}Z^{H}_{k4}+\sum_{b=1}^{3}U^{V,*}_{ib}\sum_{a=1}^{3}U^{V,*}_{ja}Y_{DL,ab}Z^{H}_{k4}\Big)\Big(\frac{1-\gamma_5}{2}\Big)
\end{aligned}
\tag{267}
$$

$$
\begin{aligned}
&+\ -i\frac{1}{\sqrt{2}}\Big(\sum_{b=1}^{3}U^{V}_{j3+b}\sum_{a=1}^{3}U^{V}_{ia}Y_{L1,ab}Z^{H}_{k1}+\sum_{b=1}^{3}U^{V}_{i3+b}\sum_{a=1}^{3}U^{V}_{ja}Y_{L1,ab}Z^{H}_{k1}+\sum_{b=1}^{3}U^{V}_{j3+b}\sum_{a=1}^{3}U^{V}_{ia}Y_{L2,ab}Z^{H}_{k2}\\
&+\sum_{b=1}^{3}U^{V}_{i3+b}\sum_{a=1}^{3}U^{V}_{ja}Y_{L2,ab}Z^{H}_{k2}+\sum_{b=1}^{3}U^{V}_{j3+b}\sum_{a=1}^{3}U^{V}_{i3+a}Y_{DR,ab}Z^{H}_{k3}+\sum_{b=1}^{3}U^{V}_{i3+b}\sum_{a=1}^{3}U^{V}_{j3+a}Y_{DR,ab}Z^{H}_{k3}\\
&+\sum_{b=1}^{3}U^{V}_{jb}\sum_{a=1}^{3}Y^{*}_{DL,ab}U^{V}_{ia}Z^{H}_{k4}+\sum_{b=1}^{3}U^{V}_{ib}\sum_{a=1}^{3}Y^{*}_{DL,ab}U^{V}_{ja}Z^{H}_{k4}\Big)\Big(\frac{1+\gamma_5}{2}\Big)
\end{aligned}
\tag{268}
$$



$$
\begin{aligned}
&\frac{i}{2}\Big(2\sum_{b=1}^{3}U^{e,*}_{R,ib}\sum_{a=1}^{3}U^{V,*}_{ja}Y^{*}_{L2,ab}Z^{+}_{k1}-2\sum_{b=1}^{3}U^{e,*}_{R,ib}\sum_{a=1}^{3}U^{V,*}_{ja}Y^{*}_{L1,ab}Z^{+}_{k2}\\
&+\sqrt{2}\Big(\sum_{b=1}^{3}U^{e,*}_{R,ib}\sum_{a=1}^{3}U^{V,*}_{j3+a}Y^{*}_{DR,ab}+\sum_{b=1}^{3}U^{V,*}_{j3+b}\sum_{a=1}^{3}U^{e,*}_{R,ia}Y^{*}_{DR,ab}\Big)Z^{+}_{k3}\Big)\Big(\frac{1-\gamma_5}{2}\Big)
\end{aligned}
\tag{269}
$$

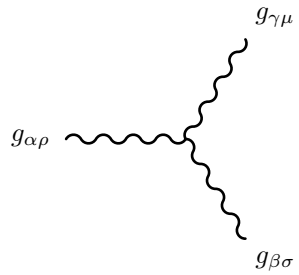
$$
\begin{aligned}
&+\ -\frac{i}{2}\Big(2\sum_{b=1}^{3}U^{V}_{j3+b}\sum_{a=1}^{3}U^{e}_{L,ia}Y_{L1,ab}Z^{+}_{k1}-2\sum_{b=1}^{3}U^{V}_{j3+b}\sum_{a=1}^{3}U^{e}_{L,ia}Y_{L2,ab}Z^{+}_{k2}\\
&-\sqrt{2}\Big(\sum_{b=1}^{3}U^{V}_{jb}\sum_{a=1}^{3}Y^{*}_{DL,ab}U^{e}_{L,ia}+\sum_{b=1}^{3}\sum_{a=1}^{3}Y^{*}_{DL,ab}U^{V}_{ja}U^{e}_{L,ib}\Big)Z^{+}_{k4}\Big)\Big(\frac{1+\gamma_5}{2}\Big)
\end{aligned}
\tag{270}
$$



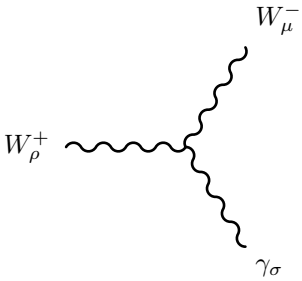
$$i\Big(\sum_{b=1}^{3} U_{R,jb}^{e,*} \sum_{a=1}^{3} U_{R,ia}^{e,*} Y_{DR,ab}^{*} + \sum_{b=1}^{3} U_{R,ib}^{e,*} \sum_{a=1}^{3} U_{R,ja}^{e,*} Y_{DR,ab}^{*}\Big) Z_{k1}^{++} \Big(\frac{1-\gamma_5}{2}\Big) \tag{271}$$

$$+\ i\Big(\sum_{b=1}^{3}\sum_{a=1}^{3} Y_{DL,ab}^{*} U_{L,ja}^{e} U_{L,ib}^{e} + \sum_{b=1}^{3}\sum_{a=1}^{3} Y_{DL,ab}^{*} U_{L,ia}^{e} U_{L,jb}^{e}\Big) Z_{k2}^{++} \Big(\frac{1+\gamma_5}{2}\Big) \tag{272}$$

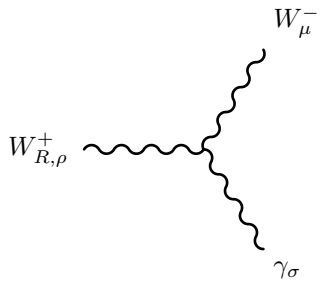
8.6 Three Vector Boson-Interaction



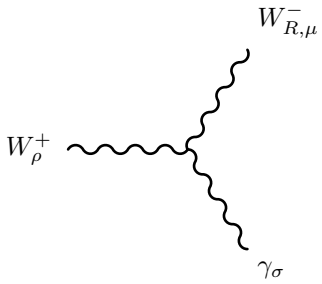
$$g_3 f_{\alpha,\beta,\gamma}\Big(g_{\rho\mu}\Big(-p_\sigma^{g_{\gamma\mu}} + p_\sigma^{g_{\alpha\rho}}\Big) + g_{\rho\sigma}\Big(-p_\mu^{g_{\alpha\rho}} + p_\mu^{g_{\beta\sigma}}\Big) + g_{\sigma\mu}\Big(-p_\rho^{g_{\beta\sigma}} + p_\rho^{g_{\gamma\mu}}\Big)\Big) \tag{273}$$



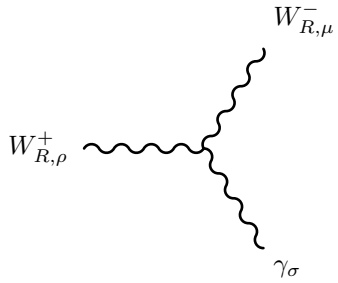
$$\frac{i}{2}\Big(\cos 2\phi_W\Big(g_2 Z_{21}^Z - g_R Z_{31}^Z\Big) + g_2 Z_{21}^Z + g_R Z_{31}^Z\Big)\Big(g_{\rho\mu}\Big(-p_\sigma^{W_\mu^-} + p_\sigma^{W_\rho^+}\Big) + g_{\rho\sigma}\Big(-p_\mu^{W_\rho^+} + p_\mu^{\gamma_\sigma}\Big) + g_{\sigma\mu}\Big(-p_\rho^{\gamma_\sigma} + p_\rho^{W_\mu^-}\Big)\Big) \tag{274}$$



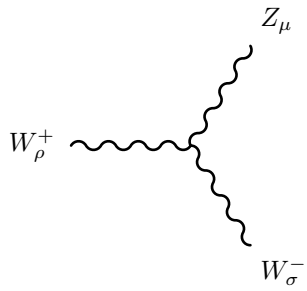
$$-i\cos\phi_W \sin\phi_W\Big(g_2 Z_{21}^Z - g_R Z_{31}^Z\Big)\Big(g_{\rho\mu}\Big(-p_\sigma^{W_\mu^-} + p_\sigma^{W_{R,\rho}^+}\Big) + g_{\rho\sigma}\Big(-p_\mu^{W_{R,\rho}^+} + p_\mu^{\gamma_\sigma}\Big) + g_{\sigma\mu}\Big(-p_\rho^{\gamma_\sigma} + p_\rho^{W_\mu^-}\Big)\Big) \tag{275}$$



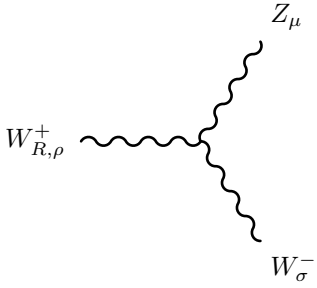
$$-i\cos\phi_W \sin\phi_W\Big(g_2 Z_{21}^Z - g_R Z_{31}^Z\Big)\Big(g_{\rho\mu}\Big(-p_\sigma^{W_{R,\mu}^-} + p_\sigma^{W_\rho^+}\Big) + g_{\rho\sigma}\Big(-p_\mu^{W_\rho^+} + p_\mu^{\gamma_\sigma}\Big) + g_{\sigma\mu}\Big(-p_\rho^{\gamma_\sigma} + p_\rho^{W_{R,\mu}^-}\Big)\Big) \tag{276}$$



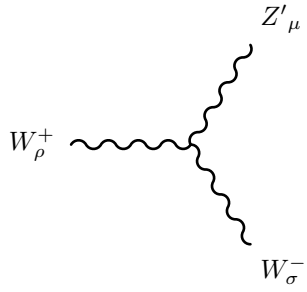
$$-\frac{i}{2}\Big(\cos 2\phi_W\Big(g_2 Z_{21}^Z - g_R Z_{31}^Z\Big) - g_2 Z_{21}^Z - g_R Z_{31}^Z\Big)\Big(g_{\rho\mu}\Big(-p_\sigma^{W_{R,\mu}^-} + p_\sigma^{W_{R,\rho}^+}\Big) + g_{\rho\sigma}\Big(-p_\mu^{W_{R,\rho}^+} + p_\mu^{\gamma_\sigma}\Big) + g_{\sigma\mu}\Big(-p_\rho^{\gamma_\sigma} + p_\rho^{W_{R,\mu}^-}\Big)\Big) \tag{277}$$



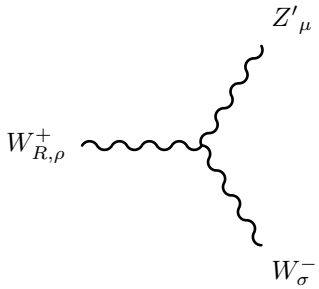
$$-\frac{i}{2}\Big(\cos 2\phi_W\Big(g_2 Z_{22}^Z - g_R Z_{32}^Z\Big) + g_2 Z_{22}^Z + g_R Z_{32}^Z\Big)\Big(g_{\rho\mu}\Big(-p_\sigma^{Z_\mu} + p_\sigma^{W_\rho^+}\Big) + g_{\rho\sigma}\Big(-p_\mu^{W_\rho^+} + p_\mu^{W_\sigma^-}\Big) + g_{\sigma\mu}\Big(-p_\rho^{W_\sigma^-} + p_\rho^{Z_\mu}\Big)\Big) \tag{278}$$



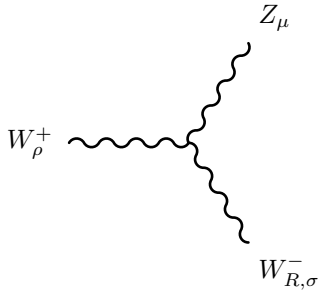
$$i\cos\phi_W \sin\phi_W\Big(g_2 Z_{22}^Z - g_R Z_{32}^Z\Big)\Big(g_{\rho\mu}\Big(-p_\sigma^{Z_\mu} + p_\sigma^{W_{R,\rho}^+}\Big) + g_{\rho\sigma}\Big(-p_\mu^{W_{R,\rho}^+} + p_\mu^{W_\sigma^-}\Big) + g_{\sigma\mu}\Big(-p_\rho^{W_\sigma^-} + p_\rho^{Z_\mu}\Big)\Big) \tag{279}$$



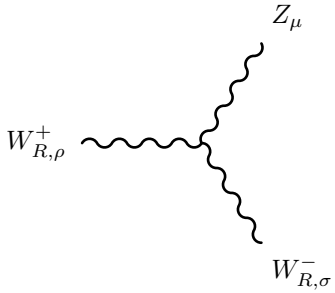
$$-\frac{i}{2}\Big(\cos 2\phi_W\Big(g_2 Z_{23}^Z - g_R Z_{33}^Z\Big) + g_2 Z_{23}^Z + g_R Z_{33}^Z\Big)\Big(g_{\rho\mu}\Big(-p_\sigma^{Z'_\mu} + p_\sigma^{W_\rho^+}\Big) + g_{\rho\sigma}\Big(-p_\mu^{W_\rho^+} + p_\mu^{W_\sigma^-}\Big) + g_{\sigma\mu}\Big(-p_\rho^{W_\sigma^-} + p_\rho^{Z'_\mu}\Big)\Big) \tag{280}$$



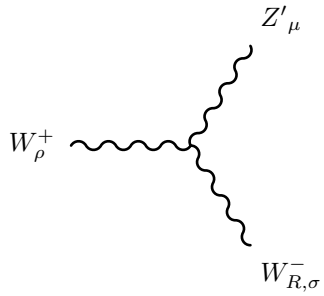
$$i\cos\phi_W\sin\phi_W\Big(g_2Z^Z_{23}-g_RZ^Z_{33}\Big)\Big(g_{\rho\mu}\Big(-p^{Z'_\mu}_\sigma+p^{W^+_{R,\rho}}_\sigma\Big)+g_{\rho\sigma}\Big(-p^{W^+_{R,\rho}}_\mu+p^{W^-_\sigma}_\mu\Big)+g_{\sigma\mu}\Big(-p^{W^-_\sigma}_\rho+p^{Z'_\mu}_\rho\Big)\Big) \tag{281}$$



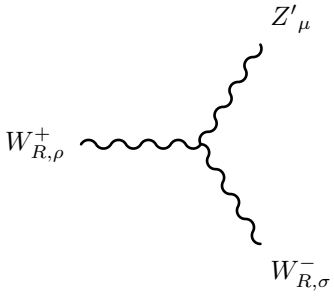
$$i\cos\phi_W\sin\phi_W\Big(g_2Z^Z_{22}-g_RZ^Z_{32}\Big)\Big(g_{\rho\mu}\Big(-p^{Z_\mu}_\sigma+p^{W^+_\rho}_\sigma\Big)+g_{\rho\sigma}\Big(-p^{W^+_\rho}_\mu+p^{W^-_{R,\sigma}}_\mu\Big)+g_{\sigma\mu}\Big(-p^{W^-_{R,\sigma}}_\rho+p^{Z_\mu}_\rho\Big)\Big) \tag{282}$$



$$\frac{i}{2}\Big(\cos 2\phi_W\Big(g_2Z^Z_{22}-g_RZ^Z_{32}\Big)-g_2Z^Z_{22}-g_RZ^Z_{32}\Big)\Big(g_{\rho\mu}\Big(-p^{Z_\mu}_\sigma+p^{W^+_{R,\rho}}_\sigma\Big)+g_{\rho\sigma}\Big(-p^{W^+_{R,\rho}}_\mu+p^{W^-_{R,\sigma}}_\mu\Big)+g_{\sigma\mu}\Big(-p^{W^-_{R,\sigma}}_\rho+p^{Z_\mu}_\rho\Big)\Big) \tag{283}$$

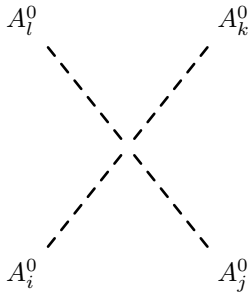


$$i\cos\phi_W \sin\phi_W \Big(g_2 Z_{23}^Z - g_R Z_{33}^Z\Big)\Big(g_{\rho\mu}\Big(-p_\sigma^{Z'_\mu} + p_\sigma^{W^+_\rho}\Big) + g_{\rho\sigma}\Big(-p_\mu^{W^+_\rho} + p_\mu^{W^-_{R,\sigma}}\Big) + g_{\sigma\mu}\Big(-p_\rho^{W^-_{R,\sigma}} + p_\rho^{Z'_\mu}\Big)\Big) \tag{284}$$



$$\frac{i}{2}\Big(\cos 2\phi_W \Big(g_2 Z_{23}^Z - g_R Z_{33}^Z\Big) - g_2 Z_{23}^Z - g_R Z_{33}^Z\Big)\Big(g_{\rho\mu}\Big(-p_\sigma^{Z'_\mu} + p_\sigma^{W^+_{R,\rho}}\Big) + g_{\rho\sigma}\Big(-p_\mu^{W^+_{R,\rho}} + p_\mu^{W^-_{R,\sigma}}\Big) + g_{\sigma\mu}\Big(-p_\rho^{W^-_{R,\sigma}} + p_\rho^{Z'_\mu}\Big)\Big) \tag{285}$$

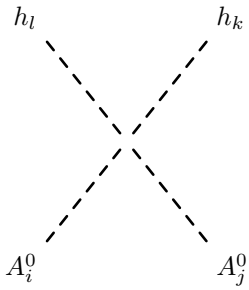
8.7 Four Scalar-Interaction



$$-\frac{i}{2}\Big(2\alpha_1 Z_{i3}^{Ah} Z_{j3}^{Ah} Z_{k1}^{Ah} Z_{l1}^{Ah} + 2\beta_2 Z_{i4}^{Ah} Z_{j3}^{Ah} Z_{k1}^{Ah} Z_{l1}^{Ah} + 2\beta_2 Z_{i3}^{Ah} Z_{j4}^{Ah} Z_{k1}^{Ah} Z_{l1}^{Ah}$$
$$+ 2\alpha_1 Z_{i4}^{Ah} Z_{j4}^{Ah} Z_{k1}^{Ah} Z_{l1}^{Ah} + 4\alpha_2 Z_{i3}^{Ah} Z_{j3}^{Ah} Z_{k2}^{Ah} Z_{l1}^{Ah} + \beta_1 Z_{i4}^{Ah} Z_{j3}^{Ah} Z_{k2}^{Ah} Z_{l1}^{Ah}$$

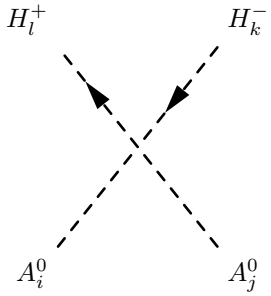
$$
\begin{aligned}
&+ \beta_1 Z^{Ah}_{i3} Z^{Ah}_{j4} Z^{Ah}_{k2} Z^{Ah}_{l1} + 4\alpha_2 Z^{Ah}_{i4} Z^{Ah}_{j4} Z^{Ah}_{k2} Z^{Ah}_{l1} + 2\alpha_1 Z^{Ah}_{i3} Z^{Ah}_{j1} Z^{Ah}_{k3} Z^{Ah}_{l1} \\
&+ 2\beta_2 Z^{Ah}_{i4} Z^{Ah}_{j1} Z^{Ah}_{k3} Z^{Ah}_{l1} + 4\alpha_2 Z^{Ah}_{i3} Z^{Ah}_{j2} Z^{Ah}_{k3} Z^{Ah}_{l1} + \beta_1 Z^{Ah}_{i4} Z^{Ah}_{j2} Z^{Ah}_{k3} Z^{Ah}_{l1} \\
&+ 2\beta_2 Z^{Ah}_{i3} Z^{Ah}_{j1} Z^{Ah}_{k4} Z^{Ah}_{l1} + 2\alpha_1 Z^{Ah}_{i4} Z^{Ah}_{j1} Z^{Ah}_{k4} Z^{Ah}_{l1} + \beta_1 Z^{Ah}_{i3} Z^{Ah}_{j2} Z^{Ah}_{k4} Z^{Ah}_{l1} \\
&+ 4\alpha_2 Z^{Ah}_{i4} Z^{Ah}_{j2} Z^{Ah}_{k4} Z^{Ah}_{l1} + 4\alpha_2 Z^{Ah}_{i3} Z^{Ah}_{j3} Z^{Ah}_{k1} Z^{Ah}_{l2} + \beta_1 Z^{Ah}_{i4} Z^{Ah}_{j3} Z^{Ah}_{k1} Z^{Ah}_{l2} \\
&+ \beta_1 Z^{Ah}_{i3} Z^{Ah}_{j4} Z^{Ah}_{k1} Z^{Ah}_{l2} + 4\alpha_2 Z^{Ah}_{i4} Z^{Ah}_{j4} Z^{Ah}_{k1} Z^{Ah}_{l2} + 2\alpha_1 Z^{Ah}_{i3} Z^{Ah}_{j3} Z^{Ah}_{k2} Z^{Ah}_{l2} \\
&+ 2\alpha_3 Z^{Ah}_{i3} Z^{Ah}_{j3} Z^{Ah}_{k2} Z^{Ah}_{l2} + 2\beta_3 Z^{Ah}_{i4} Z^{Ah}_{j3} Z^{Ah}_{k2} Z^{Ah}_{l2} + 2\beta_3 Z^{Ah}_{i3} Z^{Ah}_{j4} Z^{Ah}_{k2} Z^{Ah}_{l2} \\
&+ 2\alpha_1 Z^{Ah}_{i4} Z^{Ah}_{j4} Z^{Ah}_{k2} Z^{Ah}_{l2} + 2\alpha_3 Z^{Ah}_{i4} Z^{Ah}_{j4} Z^{Ah}_{k2} Z^{Ah}_{l2} + 4\alpha_2 Z^{Ah}_{i3} Z^{Ah}_{j1} Z^{Ah}_{k3} Z^{Ah}_{l2} \\
&+ \beta_1 Z^{Ah}_{i4} Z^{Ah}_{j1} Z^{Ah}_{k3} Z^{Ah}_{l2} + 2\alpha_1 Z^{Ah}_{i3} Z^{Ah}_{j2} Z^{Ah}_{k3} Z^{Ah}_{l2} + 2\alpha_3 Z^{Ah}_{i3} Z^{Ah}_{j2} Z^{Ah}_{k3} Z^{Ah}_{l2} \\
&+ 2\beta_3 Z^{Ah}_{i4} Z^{Ah}_{j2} Z^{Ah}_{k3} Z^{Ah}_{l2} + \beta_1 Z^{Ah}_{i3} Z^{Ah}_{j1} Z^{Ah}_{k4} Z^{Ah}_{l2} + 4\alpha_2 Z^{Ah}_{i4} Z^{Ah}_{j1} Z^{Ah}_{k4} Z^{Ah}_{l2} \\
&+ 2\beta_3 Z^{Ah}_{i3} Z^{Ah}_{j2} Z^{Ah}_{k4} Z^{Ah}_{l2} + 2\alpha_1 Z^{Ah}_{i4} Z^{Ah}_{j2} Z^{Ah}_{k4} Z^{Ah}_{l2} + 2\alpha_3 Z^{Ah}_{i4} Z^{Ah}_{j2} Z^{Ah}_{k4} Z^{Ah}_{l2} \\
&+ 2\alpha_1 Z^{Ah}_{i3} Z^{Ah}_{j1} Z^{Ah}_{k1} Z^{Ah}_{l3} + 2\beta_2 Z^{Ah}_{i4} Z^{Ah}_{j1} Z^{Ah}_{k1} Z^{Ah}_{l3} + 4\alpha_2 Z^{Ah}_{i3} Z^{Ah}_{j2} Z^{Ah}_{k1} Z^{Ah}_{l3} \\
&+ \beta_1 Z^{Ah}_{i4} Z^{Ah}_{j2} Z^{Ah}_{k1} Z^{Ah}_{l3} + 4\alpha_2 Z^{Ah}_{i3} Z^{Ah}_{j1} Z^{Ah}_{k2} Z^{Ah}_{l3} + \beta_1 Z^{Ah}_{i4} Z^{Ah}_{j1} Z^{Ah}_{k2} Z^{Ah}_{l3} \\
&+ 2\alpha_1 Z^{Ah}_{i3} Z^{Ah}_{j2} Z^{Ah}_{k2} Z^{Ah}_{l3} + 2\alpha_3 Z^{Ah}_{i3} Z^{Ah}_{j2} Z^{Ah}_{k2} Z^{Ah}_{l3} + 2\beta_3 Z^{Ah}_{i4} Z^{Ah}_{j2} Z^{Ah}_{k2} Z^{Ah}_{l3} \\
&+ 12\rho_1 Z^{Ah}_{i3} Z^{Ah}_{j3} Z^{Ah}_{k3} Z^{Ah}_{l3} + 2\rho_3 Z^{Ah}_{i4} Z^{Ah}_{j4} Z^{Ah}_{k3} Z^{Ah}_{l3} + 2\rho_3 Z^{Ah}_{i4} Z^{Ah}_{j3} Z^{Ah}_{k4} Z^{Ah}_{l3} \\
&+ 2\rho_3 Z^{Ah}_{i3} Z^{Ah}_{j4} Z^{Ah}_{k4} Z^{Ah}_{l3} + 2\beta_2 Z^{Ah}_{i3} Z^{Ah}_{j1} Z^{Ah}_{k1} Z^{Ah}_{l4} + 2\alpha_1 Z^{Ah}_{i4} Z^{Ah}_{j1} Z^{Ah}_{k1} Z^{Ah}_{l4} \\
&+ \beta_1 Z^{Ah}_{i3} Z^{Ah}_{j2} Z^{Ah}_{k1} Z^{Ah}_{l4} + 4\alpha_2 Z^{Ah}_{i4} Z^{Ah}_{j2} Z^{Ah}_{k1} Z^{Ah}_{l4} + \beta_1 Z^{Ah}_{i3} Z^{Ah}_{j1} Z^{Ah}_{k2} Z^{Ah}_{l4} \\
&+ 4\alpha_2 Z^{Ah}_{i4} Z^{Ah}_{j1} Z^{Ah}_{k2} Z^{Ah}_{l4} + 2\beta_3 Z^{Ah}_{i3} Z^{Ah}_{j2} Z^{Ah}_{k2} Z^{Ah}_{l4} + 2\alpha_1 Z^{Ah}_{i4} Z^{Ah}_{j2} Z^{Ah}_{k2} Z^{Ah}_{l4} \\
&+ 2\alpha_3 Z^{Ah}_{i4} Z^{Ah}_{j2} Z^{Ah}_{k2} Z^{Ah}_{l4} + 2\rho_3 Z^{Ah}_{i4} Z^{Ah}_{j3} Z^{Ah}_{k3} Z^{Ah}_{l4} + 2\rho_3 Z^{Ah}_{i3} Z^{Ah}_{j4} Z^{Ah}_{k3} Z^{Ah}_{l4} \\
&+ 2\rho_3 Z^{Ah}_{i3} Z^{Ah}_{j3} Z^{Ah}_{k4} Z^{Ah}_{l4} + 12\rho_1 Z^{Ah}_{i4} Z^{Ah}_{j4} Z^{Ah}_{k4} Z^{Ah}_{l4} \\
&+ Z^{Ah}_{i1} \Big(2\alpha_1 Z^{Ah}_{j3} Z^{Ah}_{k3} Z^{Ah}_{l1} + 2\beta_2 Z^{Ah}_{j4} Z^{Ah}_{k3} Z^{Ah}_{l1} + 2\beta_2 Z^{Ah}_{j3} Z^{Ah}_{k4} Z^{Ah}_{l1} + 2\alpha_1 Z^{Ah}_{j4} Z^{Ah}_{k4} Z^{Ah}_{l1} \\
&+ 4\alpha_2 Z^{Ah}_{j3} Z^{Ah}_{k3} Z^{Ah}_{l2} + \beta_1 Z^{Ah}_{j4} Z^{Ah}_{k3} Z^{Ah}_{l2} + \beta_1 Z^{Ah}_{j3} Z^{Ah}_{k4} Z^{Ah}_{l2} + 4\alpha_2 Z^{Ah}_{j4} Z^{Ah}_{k4} Z^{Ah}_{l2} \\
&+ 2\alpha_1 Z^{Ah}_{j3} Z^{Ah}_{k1} Z^{Ah}_{l3} + 2\beta_2 Z^{Ah}_{j4} Z^{Ah}_{k1} Z^{Ah}_{l3} + 4\alpha_2 Z^{Ah}_{j3} Z^{Ah}_{k2} Z^{Ah}_{l3} + \beta_1 Z^{Ah}_{j4} Z^{Ah}_{k2} Z^{Ah}_{l3} \\
&+ 2\beta_2 Z^{Ah}_{j3} Z^{Ah}_{k1} Z^{Ah}_{l4} + 2\alpha_1 Z^{Ah}_{j4} Z^{Ah}_{k1} Z^{Ah}_{l4} + \beta_1 Z^{Ah}_{j3} Z^{Ah}_{k2} Z^{Ah}_{l4} + 4\alpha_2 Z^{Ah}_{j4} Z^{Ah}_{k2} Z^{Ah}_{l4} \\
&+ 2Z^{Ah}_{j1} \Big(2Z^{Ah}_{k2} \Big(\Big(2\lambda_3 + 4\lambda_2 + \lambda \Big) Z^{Ah}_{l2} + 3\lambda_4 Z^{Ah}_{l1} \Big) + 6Z^{Ah}_{k1} \Big(\lambda_4 Z^{Ah}_{l2} + \lambda Z^{Ah}_{l1} \Big) + \alpha_1 Z^{Ah}_{k3} Z^{Ah}_{l3} + \beta_2 Z^{Ah}_{k4} Z^{Ah}_{l3} \\
&+ \beta_2 Z^{Ah}_{k3} Z^{Ah}_{l4} + \alpha_1 Z^{Ah}_{k4} Z^{Ah}_{l4} \Big) \\
&+ Z^{Ah}_{j2} \Big(4Z^{Ah}_{k1} \Big(\Big(2\lambda_3 + 4\lambda_2 + \lambda \Big) Z^{Ah}_{l2} + 3\lambda_4 Z^{Ah}_{l1} \Big) + 4Z^{Ah}_{k2} \Big(\Big(2\lambda_3 + 4\lambda_2 + \lambda \Big) Z^{Ah}_{l1} + 3\lambda_4 Z^{Ah}_{l2} \Big) + 4\alpha_2 Z^{Ah}_{k3} Z^{Ah}_{l3} \\
&+ \beta_1 Z^{Ah}_{k4} Z^{Ah}_{l3} + \beta_1 Z^{Ah}_{k3} Z^{Ah}_{l4} + 4\alpha_2 Z^{Ah}_{k4} Z^{Ah}_{l4} \Big) \Big) \\
&+ Z^{Ah}_{i2} \Big(4\alpha_2 Z^{Ah}_{j3} Z^{Ah}_{k3} Z^{Ah}_{l1} + \beta_1 Z^{Ah}_{j4} Z^{Ah}_{k3} Z^{Ah}_{l1} + \beta_1 Z^{Ah}_{j3} Z^{Ah}_{k4} Z^{Ah}_{l1} + 4\alpha_2 Z^{Ah}_{j4} Z^{Ah}_{k4} Z^{Ah}_{l1} \\
&+ 2\alpha_1 Z^{Ah}_{j3} Z^{Ah}_{k3} Z^{Ah}_{l2} + 2\alpha_3 Z^{Ah}_{j3} Z^{Ah}_{k3} Z^{Ah}_{l2} + 2\beta_3 Z^{Ah}_{j4} Z^{Ah}_{k3} Z^{Ah}_{l2} + 2\beta_3 Z^{Ah}_{j3} Z^{Ah}_{k4} Z^{Ah}_{l2} \\
&+ 2\alpha_1 Z^{Ah}_{j4} Z^{Ah}_{k4} Z^{Ah}_{l2} + 2\alpha_3 Z^{Ah}_{j4} Z^{Ah}_{k4} Z^{Ah}_{l2} + 4\alpha_2 Z^{Ah}_{j3} Z^{Ah}_{k1} Z^{Ah}_{l3} + \beta_1 Z^{Ah}_{j4} Z^{Ah}_{k1} Z^{Ah}_{l3} \\
&+ 2\alpha_1 Z^{Ah}_{j3} Z^{Ah}_{k2} Z^{Ah}_{l3} + 2\alpha_3 Z^{Ah}_{j3} Z^{Ah}_{k2} Z^{Ah}_{l3} + 2\beta_3 Z^{Ah}_{j4} Z^{Ah}_{k2} Z^{Ah}_{l3} + \beta_1 Z^{Ah}_{j3} Z^{Ah}_{k1} Z^{Ah}_{l4}
\end{aligned}
$$

$$
\begin{aligned}
&+ 4\alpha_2 Z_{j4}^{Ah} Z_{k1}^{Ah} Z_{l4}^{Ah} + 2\beta_3 Z_{j3}^{Ah} Z_{k2}^{Ah} Z_{l4}^{Ah} + 2\alpha_1 Z_{j4}^{Ah} Z_{k2}^{Ah} Z_{l4}^{Ah} + 2\alpha_3 Z_{j4}^{Ah} Z_{k2}^{Ah} Z_{l4}^{Ah} \\
&+ Z_{j1}^{Ah}\Big(4Z_{k1}^{Ah}\Big(\Big(2\lambda_3 + 4\lambda_2 + \lambda\Big) Z_{l2}^{Ah} + 3\lambda_4 Z_{l1}^{Ah}\Big) + 4Z_{k2}^{Ah}\Big(\Big(2\lambda_3 + 4\lambda_2 + \lambda\Big) Z_{l1}^{Ah} + 3\lambda_4 Z_{l2}^{Ah}\Big) + 4\alpha_2 Z_{k3}^{Ah} Z_{l3}^{Ah} \\
&+ \beta_1 Z_{k4}^{Ah} Z_{l3}^{Ah} + \beta_1 Z_{k3}^{Ah} Z_{l4}^{Ah} + 4\alpha_2 Z_{k4}^{Ah} Z_{l4}^{Ah}\Big) \\
&+ 2Z_{j2}^{Ah}\Big(6Z_{k2}^{Ah}\Big(\lambda_4 Z_{l1}^{Ah} + \lambda Z_{l2}^{Ah}\Big) + 2Z_{k1}^{Ah}\Big(\Big(2\lambda_3 + 4\lambda_2 + \lambda\Big) Z_{l1}^{Ah} + 3\lambda_4 Z_{l2}^{Ah}\Big) + \alpha_1 Z_{k3}^{Ah} Z_{l3}^{Ah} + \alpha_3 Z_{k3}^{Ah} Z_{l3}^{Ah} \\
&+ \beta_3 Z_{k4}^{Ah} Z_{l3}^{Ah} + \beta_3 Z_{k3}^{Ah} Z_{l4}^{Ah} + \alpha_1 Z_{k4}^{Ah} Z_{l4}^{Ah} + \alpha_3 Z_{k4}^{Ah} Z_{l4}^{Ah}\Big)\Big)\Big)
\end{aligned} \tag{286}
$$



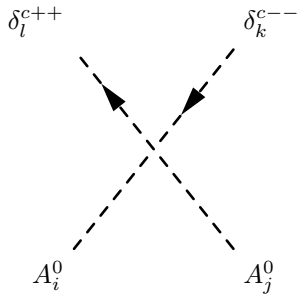
$$
\begin{aligned}
&- \frac{i}{2}\Big(2\alpha_1 Z_{i3}^{Ah} Z_{j3}^{Ah} Z_{k1}^{H} Z_{l1}^{H} - 2\beta_2 Z_{i4}^{Ah} Z_{j3}^{Ah} Z_{k1}^{H} Z_{l1}^{H} - 2\beta_2 Z_{i3}^{Ah} Z_{j4}^{Ah} Z_{k1}^{H} Z_{l1}^{H} \\
&+ 2\alpha_1 Z_{i4}^{Ah} Z_{j4}^{Ah} Z_{k1}^{H} Z_{l1}^{H} - 4\alpha_2 Z_{i3}^{Ah} Z_{j3}^{Ah} Z_{k2}^{H} Z_{l1}^{H} + \beta_1 Z_{i4}^{Ah} Z_{j3}^{Ah} Z_{k2}^{H} Z_{l1}^{H} \\
&+ \beta_1 Z_{i3}^{Ah} Z_{j4}^{Ah} Z_{k2}^{H} Z_{l1}^{H} - 4\alpha_2 Z_{i4}^{Ah} Z_{j4}^{Ah} Z_{k2}^{H} Z_{l1}^{H} + 2\beta_2 Z_{i4}^{Ah} Z_{j1}^{Ah} Z_{k3}^{H} Z_{l1}^{H} \\
&+ \beta_1 Z_{i4}^{Ah} Z_{j2}^{Ah} Z_{k3}^{H} Z_{l1}^{H} - 2\beta_2 Z_{i3}^{Ah} Z_{j1}^{Ah} Z_{k4}^{H} Z_{l1}^{H} - \beta_1 Z_{i3}^{Ah} Z_{j2}^{Ah} Z_{k4}^{H} Z_{l1}^{H} \\
&- 4\alpha_2 Z_{i3}^{Ah} Z_{j3}^{Ah} Z_{k1}^{H} Z_{l2}^{H} + \beta_1 Z_{i4}^{Ah} Z_{j3}^{Ah} Z_{k1}^{H} Z_{l2}^{H} + \beta_1 Z_{i3}^{Ah} Z_{j4}^{Ah} Z_{k1}^{H} Z_{l2}^{H} \\
&- 4\alpha_2 Z_{i4}^{Ah} Z_{j4}^{Ah} Z_{k1}^{H} Z_{l2}^{H} + 2\alpha_1 Z_{i3}^{Ah} Z_{j3}^{Ah} Z_{k2}^{H} Z_{l2}^{H} + 2\alpha_3 Z_{i3}^{Ah} Z_{j3}^{Ah} Z_{k2}^{H} Z_{l2}^{H} \\
&- 2\beta_3 Z_{i4}^{Ah} Z_{j3}^{Ah} Z_{k2}^{H} Z_{l2}^{H} - 2\beta_3 Z_{i3}^{Ah} Z_{j4}^{Ah} Z_{k2}^{H} Z_{l2}^{H} + 2\alpha_1 Z_{i4}^{Ah} Z_{j4}^{Ah} Z_{k2}^{H} Z_{l2}^{H} \\
&+ 2\alpha_3 Z_{i4}^{Ah} Z_{j4}^{Ah} Z_{k2}^{H} Z_{l2}^{H} - \beta_1 Z_{i4}^{Ah} Z_{j1}^{Ah} Z_{k3}^{H} Z_{l2}^{H} - 2\beta_3 Z_{i4}^{Ah} Z_{j2}^{Ah} Z_{k3}^{H} Z_{l2}^{H} \\
&+ \beta_1 Z_{i3}^{Ah} Z_{j1}^{Ah} Z_{k4}^{H} Z_{l2}^{H} + 2\beta_3 Z_{i3}^{Ah} Z_{j2}^{Ah} Z_{k4}^{H} Z_{l2}^{H} + 2\beta_2 Z_{i4}^{Ah} Z_{j1}^{Ah} Z_{k1}^{H} Z_{l3}^{H} \\
&+ \beta_1 Z_{i4}^{Ah} Z_{j2}^{Ah} Z_{k1}^{H} Z_{l3}^{H} - \beta_1 Z_{i4}^{Ah} Z_{j1}^{Ah} Z_{k2}^{H} Z_{l3}^{H} - 2\beta_3 Z_{i4}^{Ah} Z_{j2}^{Ah} Z_{k2}^{H} Z_{l3}^{H} \\
&+ 4\rho_1 Z_{i3}^{Ah} Z_{j3}^{Ah} Z_{k3}^{H} Z_{l3}^{H} + 2\rho_3 Z_{i4}^{Ah} Z_{j4}^{Ah} Z_{k3}^{H} Z_{l3}^{H} - 2\beta_2 Z_{i3}^{Ah} Z_{j1}^{Ah} Z_{k1}^{H} Z_{l4}^{H} \\
&- \beta_1 Z_{i3}^{Ah} Z_{j2}^{Ah} Z_{k1}^{H} Z_{l4}^{H} + \beta_1 Z_{i3}^{Ah} Z_{j1}^{Ah} Z_{k2}^{H} Z_{l4}^{H} + 2\beta_3 Z_{i3}^{Ah} Z_{j2}^{Ah} Z_{k2}^{H} Z_{l4}^{H} \\
&+ 2\rho_3 Z_{i3}^{Ah} Z_{j3}^{Ah} Z_{k4}^{H} Z_{l4}^{H} + 4\rho_1 Z_{i4}^{Ah} Z_{j4}^{Ah} Z_{k4}^{H} Z_{l4}^{H} \\
&+ Z_{i1}^{Ah}\Big(2\beta_2 Z_{j4}^{Ah} Z_{k3}^{H} Z_{l1}^{H} - 2\beta_2 Z_{j3}^{Ah} Z_{k4}^{H} Z_{l1}^{H} - \beta_1 Z_{j4}^{Ah} Z_{k3}^{H} Z_{l2}^{H} + \beta_1 Z_{j3}^{Ah} Z_{k4}^{H} Z_{l2}^{H} \\
&+ 2\beta_2 Z_{j4}^{Ah} Z_{k1}^{H} Z_{l3}^{H} - \beta_1 Z_{j4}^{Ah} Z_{k2}^{H} Z_{l3}^{H} - 2\beta_2 Z_{j3}^{Ah} Z_{k1}^{H} Z_{l4}^{H} + \beta_1 Z_{j3}^{Ah} Z_{k2}^{H} Z_{l4}^{H} \\
&+ 2Z_{j1}^{Ah}\Big(Z_{k2}^{H}\Big(2\Big(2\lambda_3 - 4\lambda_2 + \lambda\Big) Z_{l2}^{H} - 2\lambda_4 Z_{l1}^{H}\Big) + 2Z_{k1}^{H}\Big(-\lambda_4 Z_{l2}^{H} + \lambda Z_{l1}^{H}\Big) + \alpha_1 Z_{k3}^{H} Z_{l3}^{H} + \beta_2 Z_{k4}^{H} Z_{l3}^{H} \\
&+ \beta_2 Z_{k3}^{H} Z_{l4}^{H} + \alpha_1 Z_{k4}^{H} Z_{l4}^{H}\Big)
\end{aligned}
$$

$$
\begin{aligned}
&+ Z^{Ah}_{j2}\Big(4Z^{H}_{k1}\Big(-4\lambda_2 Z^{H}_{l2}+\lambda_4 Z^{H}_{l1}\Big)+Z^{H}_{k2}\Big(-16\lambda_2 Z^{H}_{l1}+4\lambda_4 Z^{H}_{l2}\Big)+4\alpha_2 Z^{H}_{k3}Z^{H}_{l3}+\beta_1 Z^{H}_{k4}Z^{H}_{l3}\\
&+\beta_1 Z^{H}_{k3}Z^{H}_{l4}+4\alpha_2 Z^{H}_{k4}Z^{H}_{l4}\Big)\Big)\\
&+ Z^{Ah}_{i2}\Big(\beta_1 Z^{Ah}_{j4}Z^{H}_{k3}Z^{H}_{l1}-\beta_1 Z^{Ah}_{j3}Z^{H}_{k4}Z^{H}_{l1}-2\beta_3 Z^{Ah}_{j4}Z^{H}_{k3}Z^{H}_{l2}+2\beta_3 Z^{Ah}_{j3}Z^{H}_{k4}Z^{H}_{l2}\\
&+\beta_1 Z^{Ah}_{j4}Z^{H}_{k1}Z^{H}_{l3}-2\beta_3 Z^{Ah}_{j4}Z^{H}_{k2}Z^{H}_{l3}-\beta_1 Z^{Ah}_{j3}Z^{H}_{k1}Z^{H}_{l4}+2\beta_3 Z^{Ah}_{j3}Z^{H}_{k2}Z^{H}_{l4}\\
&+ Z^{Ah}_{j1}\Big(4Z^{H}_{k1}\Big(-4\lambda_2 Z^{H}_{l2}+\lambda_4 Z^{H}_{l1}\Big)+Z^{H}_{k2}\Big(-16\lambda_2 Z^{H}_{l1}+4\lambda_4 Z^{H}_{l2}\Big)+4\alpha_2 Z^{H}_{k3}Z^{H}_{l3}+\beta_1 Z^{H}_{k4}Z^{H}_{l3}\\
&+\beta_1 Z^{H}_{k3}Z^{H}_{l4}+4\alpha_2 Z^{H}_{k4}Z^{H}_{l4}\Big)\\
&+2Z^{Ah}_{j2}\Big(Z^{H}_{k2}\Big(-2\lambda_4 Z^{H}_{l1}+2\lambda Z^{H}_{l2}\Big)+2Z^{H}_{k1}\Big(\Big(2\lambda_3-4\lambda_2+\lambda\Big)Z^{H}_{l1}-\lambda_4 Z^{H}_{l2}\Big)+\alpha_1 Z^{H}_{k3}Z^{H}_{l3}+\alpha_3 Z^{H}_{k3}Z^{H}_{l3}\\
&+\beta_3 Z^{H}_{k4}Z^{H}_{l3}+\beta_3 Z^{H}_{k3}Z^{H}_{l4}+\alpha_1 Z^{H}_{k4}Z^{H}_{l4}+\alpha_3 Z^{H}_{k4}Z^{H}_{l4}\Big)\Big)\Big)
\end{aligned}
\tag{287}
$$

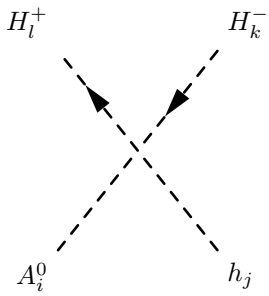


$$
\begin{aligned}
&-\frac{i}{4}\Big(4\alpha_1 Z^{+}_{k3}Z^{+}_{l3}Z^{Ah}_{i1}Z^{Ah}_{j1}+2\alpha_3 Z^{+}_{k3}Z^{+}_{l3}Z^{Ah}_{i1}Z^{Ah}_{j1}+2\beta_1 Z^{+}_{k4}Z^{+}_{l3}Z^{Ah}_{i1}Z^{Ah}_{j1}\\
&+2\beta_1 Z^{+}_{k3}Z^{+}_{l4}Z^{Ah}_{i1}Z^{Ah}_{j1}+4\alpha_1 Z^{+}_{k4}Z^{+}_{l4}Z^{Ah}_{i1}Z^{Ah}_{j1}+2\alpha_3 Z^{+}_{k4}Z^{+}_{l4}Z^{Ah}_{i1}Z^{Ah}_{j1}\\
&+8\alpha_2 Z^{+}_{k3}Z^{+}_{l3}Z^{Ah}_{i2}Z^{Ah}_{j1}+2\beta_2 Z^{+}_{k4}Z^{+}_{l3}Z^{Ah}_{i2}Z^{Ah}_{j1}+2\beta_3 Z^{+}_{k4}Z^{+}_{l3}Z^{Ah}_{i2}Z^{Ah}_{j1}\\
&+2\beta_2 Z^{+}_{k3}Z^{+}_{l4}Z^{Ah}_{i2}Z^{Ah}_{j1}+2\beta_3 Z^{+}_{k3}Z^{+}_{l4}Z^{Ah}_{i2}Z^{Ah}_{j1}+8\alpha_2 Z^{+}_{k4}Z^{+}_{l4}Z^{Ah}_{i2}Z^{Ah}_{j1}\\
&+2\sqrt{2}\beta_2 Z^{+}_{k4}Z^{+}_{l1}Z^{Ah}_{i3}Z^{Ah}_{j1}+\sqrt{2}\alpha_3 Z^{+}_{k3}Z^{+}_{l2}Z^{Ah}_{i3}Z^{Ah}_{j1}+\sqrt{2}\beta_1 Z^{+}_{k4}Z^{+}_{l2}Z^{Ah}_{i3}Z^{Ah}_{j1}\\
&-\sqrt{2}\beta_1 Z^{+}_{k3}Z^{+}_{l1}Z^{Ah}_{i4}Z^{Ah}_{j1}-\sqrt{2}\alpha_3 Z^{+}_{k4}Z^{+}_{l1}Z^{Ah}_{i4}Z^{Ah}_{j1}-2\sqrt{2}\beta_2 Z^{+}_{k3}Z^{+}_{l2}Z^{Ah}_{i4}Z^{Ah}_{j1}\\
&+8\alpha_2 Z^{+}_{k3}Z^{+}_{l3}Z^{Ah}_{i1}Z^{Ah}_{j2}+2\beta_2 Z^{+}_{k4}Z^{+}_{l3}Z^{Ah}_{i1}Z^{Ah}_{j2}+2\beta_3 Z^{+}_{k4}Z^{+}_{l3}Z^{Ah}_{i1}Z^{Ah}_{j2}\\
&+2\beta_2 Z^{+}_{k3}Z^{+}_{l4}Z^{Ah}_{i1}Z^{Ah}_{j2}+2\beta_3 Z^{+}_{k3}Z^{+}_{l4}Z^{Ah}_{i1}Z^{Ah}_{j2}+8\alpha_2 Z^{+}_{k4}Z^{+}_{l4}Z^{Ah}_{i1}Z^{Ah}_{j2}\\
&+4\alpha_1 Z^{+}_{k3}Z^{+}_{l3}Z^{Ah}_{i2}Z^{Ah}_{j2}+2\alpha_3 Z^{+}_{k3}Z^{+}_{l3}Z^{Ah}_{i2}Z^{Ah}_{j2}+2\beta_1 Z^{+}_{k4}Z^{+}_{l3}Z^{Ah}_{i2}Z^{Ah}_{j2}\\
&+2\beta_1 Z^{+}_{k3}Z^{+}_{l4}Z^{Ah}_{i2}Z^{Ah}_{j2}+4\alpha_1 Z^{+}_{k4}Z^{+}_{l4}Z^{Ah}_{i2}Z^{Ah}_{j2}+2\alpha_3 Z^{+}_{k4}Z^{+}_{l4}Z^{Ah}_{i2}Z^{Ah}_{j2}\\
&-\sqrt{2}\alpha_3 Z^{+}_{k3}Z^{+}_{l1}Z^{Ah}_{i3}Z^{Ah}_{j2}+\sqrt{2}\beta_1 Z^{+}_{k4}Z^{+}_{l1}Z^{Ah}_{i3}Z^{Ah}_{j2}+2\sqrt{2}\beta_3 Z^{+}_{k4}Z^{+}_{l2}Z^{Ah}_{i3}Z^{Ah}_{j2}\\
&-2\sqrt{2}\beta_3 Z^{+}_{k3}Z^{+}_{l1}Z^{Ah}_{i4}Z^{Ah}_{j2}-\sqrt{2}\beta_1 Z^{+}_{k3}Z^{+}_{l2}Z^{Ah}_{i4}Z^{Ah}_{j2}+\sqrt{2}\alpha_3 Z^{+}_{k4}Z^{+}_{l2}Z^{Ah}_{i4}Z^{Ah}_{j2}\\
&+2\sqrt{2}\beta_2 Z^{+}_{k4}Z^{+}_{l1}Z^{Ah}_{i1}Z^{Ah}_{j3}+\sqrt{2}\alpha_3 Z^{+}_{k3}Z^{+}_{l2}Z^{Ah}_{i1}Z^{Ah}_{j3}+\sqrt{2}\beta_1 Z^{+}_{k4}Z^{+}_{l2}Z^{Ah}_{i1}Z^{Ah}_{j3}
\end{aligned}
$$

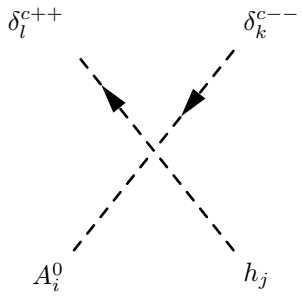
$$
\begin{aligned}
&- \sqrt{2}\alpha_3 Z^+_{k3} Z^+_{l1} Z^{Ah}_{i2} Z^{Ah}_{j3} + \sqrt{2}\beta_1 Z^+_{k4} Z^+_{l1} Z^{Ah}_{i2} Z^{Ah}_{j3} + 2\sqrt{2}\beta_3 Z^+_{k4} Z^+_{l2} Z^{Ah}_{i2} Z^{Ah}_{j3} \\
&+ 8\rho_1 Z^+_{k3} Z^+_{l3} Z^{Ah}_{i3} Z^{Ah}_{j3} + 4\rho_3 Z^+_{k4} Z^+_{l4} Z^{Ah}_{i3} Z^{Ah}_{j3} - \sqrt{2}\beta_1 Z^+_{k3} Z^+_{l1} Z^{Ah}_{i1} Z^{Ah}_{j4} \\
&- \sqrt{2}\alpha_3 Z^+_{k4} Z^+_{l1} Z^{Ah}_{i1} Z^{Ah}_{j4} - 2\sqrt{2}\beta_2 Z^+_{k3} Z^+_{l2} Z^{Ah}_{i1} Z^{Ah}_{j4} - 2\sqrt{2}\beta_3 Z^+_{k3} Z^+_{l1} Z^{Ah}_{i2} Z^{Ah}_{j4} \\
&- \sqrt{2}\beta_1 Z^+_{k3} Z^+_{l2} Z^{Ah}_{i2} Z^{Ah}_{j4} + \sqrt{2}\alpha_3 Z^+_{k4} Z^+_{l2} Z^{Ah}_{i2} Z^{Ah}_{j4} + 4\rho_3 Z^+_{k3} Z^+_{l3} Z^{Ah}_{i4} Z^{Ah}_{j4} \\
&+ 8\rho_1 Z^+_{k4} Z^+_{l4} Z^{Ah}_{i4} Z^{Ah}_{j4} \\
&+ Z^+_{k2}\Big(4Z^+_{l2}\Big(2Z^{Ah}_{i1}\Big(\lambda_4 Z^{Ah}_{j2} + \lambda Z^{Ah}_{j1}\Big) + 2Z^{Ah}_{i2}\Big(\lambda_4 Z^{Ah}_{j1} + \lambda Z^{Ah}_{j2}\Big) + \alpha_1 Z^{Ah}_{i3} Z^{Ah}_{j3} + \alpha_1 Z^{Ah}_{i4} Z^{Ah}_{j4} + \alpha_3 Z^{Ah}_{i3} Z^{Ah}_{j3}\Big) \\
&+ \sqrt{2}\Big(Z^+_{l4}\Big(2\beta_3 Z^{Ah}_{i2} Z^{Ah}_{j3} + \alpha_3 Z^{Ah}_{i2} Z^{Ah}_{j4} + \alpha_3 Z^{Ah}_{i4} Z^{Ah}_{j2} + \beta_1 Z^{Ah}_{i1} Z^{Ah}_{j3} + Z^{Ah}_{i3}\Big(2\beta_3 Z^{Ah}_{j2} + \beta_1 Z^{Ah}_{j1}\Big)\Big) \\
&+ Z^+_{l3}\Big(-2\beta_2 Z^{Ah}_{i1} Z^{Ah}_{j4} + \alpha_3 Z^{Ah}_{i1} Z^{Ah}_{j3} + \alpha_3 Z^{Ah}_{i3} Z^{Ah}_{j1} - \beta_1 Z^{Ah}_{i2} Z^{Ah}_{j4} - Z^{Ah}_{i4}\Big(2\beta_2 Z^{Ah}_{j1} + \beta_1 Z^{Ah}_{j2}\Big)\Big)\Big) \\
&+ 8Z^+_{l1}\Big(\alpha_2\Big(Z^{Ah}_{i3} Z^{Ah}_{j3} + Z^{Ah}_{i4} Z^{Ah}_{j4}\Big) + Z^{Ah}_{i1}\Big(\Big(2\lambda_2 + \lambda_3\Big)Z^{Ah}_{j2} + \lambda_4 Z^{Ah}_{j1}\Big) + Z^{Ah}_{i2}\Big(\Big(2\lambda_2 + \lambda_3\Big)Z^{Ah}_{j1} + \lambda_4 Z^{Ah}_{j2}\Big)\Big)\Big) \\
&+ Z^+_{k1}\Big(4Z^+_{l1}\Big(2Z^{Ah}_{i1}\Big(\lambda_4 Z^{Ah}_{j2} + \lambda Z^{Ah}_{j1}\Big) + 2Z^{Ah}_{i2}\Big(\lambda_4 Z^{Ah}_{j1} + \lambda Z^{Ah}_{j2}\Big) + \alpha_1 Z^{Ah}_{i3} Z^{Ah}_{j3} + \alpha_1 Z^{Ah}_{i4} Z^{Ah}_{j4} + \alpha_3 Z^{Ah}_{i4} Z^{Ah}_{j4}\Big) \\
&+ \sqrt{2}\Big(Z^+_{l4}\Big(2\beta_2 Z^{Ah}_{i1} Z^{Ah}_{j3} - \alpha_3 Z^{Ah}_{i1} Z^{Ah}_{j4} - \alpha_3 Z^{Ah}_{i4} Z^{Ah}_{j1} + \beta_1 Z^{Ah}_{i2} Z^{Ah}_{j3} + Z^{Ah}_{i3}\Big(2\beta_2 Z^{Ah}_{j1} + \beta_1 Z^{Ah}_{j2}\Big)\Big) \\
&- Z^+_{l3}\Big(2\beta_3 Z^{Ah}_{i2} Z^{Ah}_{j4} + \alpha_3 Z^{Ah}_{i2} Z^{Ah}_{j3} + \alpha_3 Z^{Ah}_{i3} Z^{Ah}_{j2} + \beta_1 Z^{Ah}_{i1} Z^{Ah}_{j4} + Z^{Ah}_{i4}\Big(2\beta_3 Z^{Ah}_{j2} + \beta_1 Z^{Ah}_{j1}\Big)\Big)\Big) \\
&+ 8Z^+_{l2}\Big(\alpha_2\Big(Z^{Ah}_{i3} Z^{Ah}_{j3} + Z^{Ah}_{i4} Z^{Ah}_{j4}\Big) + Z^{Ah}_{i1}\Big(\Big(2\lambda_2 + \lambda_3\Big)Z^{Ah}_{j2} + \lambda_4 Z^{Ah}_{j1}\Big) + Z^{Ah}_{i2}\Big(\Big(2\lambda_2 + \lambda_3\Big)Z^{Ah}_{j1} + \lambda_4 Z^{Ah}_{j2}\Big)\Big)\Big)\Big)
\end{aligned}
\tag{288}
$$



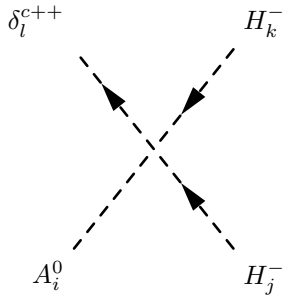
$$
\begin{aligned}
&- \frac{i}{2}\Big(Z^{++}_{k2}\Big(2Z^{++}_{l2}\Big(Z^{Ah}_{i2}\Big(2\alpha_2 Z^{Ah}_{j1} + \alpha_1 Z^{Ah}_{j2}\Big) + Z^{Ah}_{i1}\Big(2\alpha_2 Z^{Ah}_{j2} + \Big(\alpha_1 + \alpha_3\Big)Z^{Ah}_{j1}\Big) + \rho_3 Z^{Ah}_{i3} Z^{Ah}_{j3} + 2\rho_1 Z^{Ah}_{i4} Z^{Ah}_{j4} \\
&+ 4\rho_2 Z^{Ah}_{i4} Z^{Ah}_{j4}\Big) \\
&+ Z^{++}_{l1}\Big(4\rho_4\Big(Z^{Ah}_{i3} Z^{Ah}_{j4} + Z^{Ah}_{i4} Z^{Ah}_{j3}\Big) + Z^{Ah}_{i1}\Big(2\beta_3 Z^{Ah}_{j1} + \beta_1 Z^{Ah}_{j2}\Big) + Z^{Ah}_{i2}\Big(2\beta_2 Z^{Ah}_{j2} + \beta_1 Z^{Ah}_{j1}\Big)\Big)\Big) \\
&+ Z^{++}_{k1}\Big(2Z^{++}_{l1}\Big(Z^{Ah}_{i2}\Big(2\alpha_2 Z^{Ah}_{j1} + \alpha_1 Z^{Ah}_{j2}\Big) + Z^{Ah}_{i1}\Big(2\alpha_2 Z^{Ah}_{j2} + \Big(\alpha_1 + \alpha_3\Big)Z^{Ah}_{j1}\Big) + 2\rho_1 Z^{Ah}_{i3} Z^{Ah}_{j3} + 4\rho_2 Z^{Ah}_{i3} Z^{Ah}_{j3} \\
&+ \rho_3 Z^{Ah}_{i4} Z^{Ah}_{j4}\Big) \\
&+ Z^{++}_{l2}\Big(4\rho_4\Big(Z^{Ah}_{i3} Z^{Ah}_{j4} + Z^{Ah}_{i4} Z^{Ah}_{j3}\Big) + Z^{Ah}_{i1}\Big(2\beta_3 Z^{Ah}_{j1} + \beta_1 Z^{Ah}_{j2}\Big) + Z^{Ah}_{i2}\Big(2\beta_2 Z^{Ah}_{j2} + \beta_1 Z^{Ah}_{j1}\Big)\Big)\Big)\Big)
\end{aligned}
\tag{289}
$$



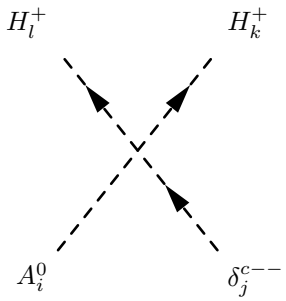
$$
\begin{aligned}
&\frac{1}{4}\Big(2\beta_2 Z^+_{k4}Z^+_{l3}Z^{Ah}_{i2}Z^H_{j1} - 2\beta_3 Z^+_{k4}Z^+_{l3}Z^{Ah}_{i2}Z^H_{j1} - 2\beta_2 Z^+_{k3}Z^+_{l4}Z^{Ah}_{i2}Z^H_{j1}\\
&+ 2\beta_3 Z^+_{k3}Z^+_{l4}Z^{Ah}_{i2}Z^H_{j1} + 2\sqrt{2}\beta_2 Z^+_{k4}Z^+_{l1}Z^{Ah}_{i3}Z^H_{j1} + \sqrt{2}\alpha_3 Z^+_{k3}Z^+_{l2}Z^{Ah}_{i3}Z^H_{j1}\\
&+ \sqrt{2}\beta_1 Z^+_{k4}Z^+_{l2}Z^{Ah}_{i3}Z^H_{j1} + \sqrt{2}\beta_1 Z^+_{k3}Z^+_{l1}Z^{Ah}_{i4}Z^H_{j1} + \sqrt{2}\alpha_3 Z^+_{k4}Z^+_{l1}Z^{Ah}_{i4}Z^H_{j1}\\
&+ 2\sqrt{2}\beta_2 Z^+_{k3}Z^+_{l2}Z^{Ah}_{i4}Z^H_{j1} + 2\beta_2 Z^+_{k4}Z^+_{l3}Z^{Ah}_{i1}Z^H_{j2} - 2\beta_3 Z^+_{k4}Z^+_{l3}Z^{Ah}_{i1}Z^H_{j2}\\
&- 2\beta_2 Z^+_{k3}Z^+_{l4}Z^{Ah}_{i1}Z^H_{j2} + 2\beta_3 Z^+_{k3}Z^+_{l4}Z^{Ah}_{i1}Z^H_{j2} + \sqrt{2}\alpha_3 Z^+_{k3}Z^+_{l1}Z^{Ah}_{i3}Z^H_{j2}\\
&- \sqrt{2}\beta_1 Z^+_{k4}Z^+_{l1}Z^{Ah}_{i3}Z^H_{j2} - 2\sqrt{2}\beta_3 Z^+_{k4}Z^+_{l2}Z^{Ah}_{i3}Z^H_{j2} - 2\sqrt{2}\beta_3 Z^+_{k3}Z^+_{l1}Z^{Ah}_{i4}Z^H_{j2}\\
&- \sqrt{2}\beta_1 Z^+_{k3}Z^+_{l2}Z^{Ah}_{i4}Z^H_{j2} + \sqrt{2}\alpha_3 Z^+_{k4}Z^+_{l2}Z^{Ah}_{i4}Z^H_{j2} - 2\sqrt{2}\beta_2 Z^+_{k4}Z^+_{l1}Z^{Ah}_{i1}Z^H_{j3}\\
&- \sqrt{2}\alpha_3 Z^+_{k3}Z^+_{l2}Z^{Ah}_{i1}Z^H_{j3} - \sqrt{2}\beta_1 Z^+_{k4}Z^+_{l2}Z^{Ah}_{i1}Z^H_{j3} + \sqrt{2}\alpha_3 Z^+_{k3}Z^+_{l1}Z^{Ah}_{i2}Z^H_{j3}\\
&- \sqrt{2}\beta_1 Z^+_{k4}Z^+_{l1}Z^{Ah}_{i2}Z^H_{j3} - 2\sqrt{2}\beta_3 Z^+_{k4}Z^+_{l2}Z^{Ah}_{i2}Z^H_{j3} + \sqrt{2}\beta_1 Z^+_{k3}Z^+_{l1}Z^{Ah}_{i1}Z^H_{j4}\\
&+ \sqrt{2}\alpha_3 Z^+_{k4}Z^+_{l1}Z^{Ah}_{i1}Z^H_{j4} + 2\sqrt{2}\beta_2 Z^+_{k3}Z^+_{l2}Z^{Ah}_{i1}Z^H_{j4} + 2\sqrt{2}\beta_3 Z^+_{k3}Z^+_{l1}Z^{Ah}_{i2}Z^H_{j4}\\
&+ \sqrt{2}\beta_1 Z^+_{k3}Z^+_{l2}Z^{Ah}_{i2}Z^H_{j4} - \sqrt{2}\alpha_3 Z^+_{k4}Z^+_{l2}Z^{Ah}_{i2}Z^H_{j4}\\
&+ Z^+_{k2}\Big(8\Big(2\lambda_2 - \lambda_3\Big)Z^+_{l1}\Big(Z^{Ah}_{i1}Z^H_{j2} + Z^{Ah}_{i2}Z^H_{j1}\Big)\\
&+ \sqrt{2}\Big(Z^+_{l4}\Big(2\beta_3 Z^{Ah}_{i2}Z^H_{j3} + \alpha_3 Z^{Ah}_{i2}Z^H_{j4} - \alpha_3 Z^{Ah}_{i4}Z^H_{j2} + \beta_1 Z^{Ah}_{i1}Z^H_{j3} + Z^{Ah}_{i3}\Big(2\beta_3 Z^H_{j2} - \beta_1 Z^H_{j1}\Big)\Big)\\
&- Z^+_{l3}\Big(2\beta_2 Z^{Ah}_{i1}Z^H_{j4} - \alpha_3 Z^{Ah}_{i1}Z^H_{j3} + \alpha_3 Z^{Ah}_{i3}Z^H_{j1} + \beta_1 Z^{Ah}_{i2}Z^H_{j4} + Z^{Ah}_{i4}\Big(2\beta_2 Z^H_{j1} - \beta_1 Z^H_{j2}\Big)\Big)\Big)\Big)\\
&- Z^+_{k1}\Big(8\Big(2\lambda_2 - \lambda_3\Big)Z^+_{l2}\Big(Z^{Ah}_{i1}Z^H_{j2} + Z^{Ah}_{i2}Z^H_{j1}\Big)\\
&+ \sqrt{2}\Big(Z^+_{l4}\Big(-2\beta_2 Z^{Ah}_{i1}Z^H_{j3} + \alpha_3 Z^{Ah}_{i1}Z^H_{j4} + \alpha_3 Z^{Ah}_{i4}Z^H_{j1} - \beta_1 Z^{Ah}_{i2}Z^H_{j3} + Z^{Ah}_{i3}\Big(2\beta_2 Z^H_{j1} - \beta_1 Z^H_{j2}\Big)\Big)\\
&+ Z^+_{l3}\Big(2\beta_3 Z^{Ah}_{i2}Z^H_{j4} + \alpha_3 Z^{Ah}_{i2}Z^H_{j3} + \alpha_3 Z^{Ah}_{i3}Z^H_{j2} + \beta_1 Z^{Ah}_{i1}Z^H_{j4} + Z^{Ah}_{i4}\Big(-2\beta_3 Z^H_{j2} + \beta_1 Z^H_{j1}\Big)\Big)\Big)\Big)\Big)
\end{aligned}
\tag{290}
$$



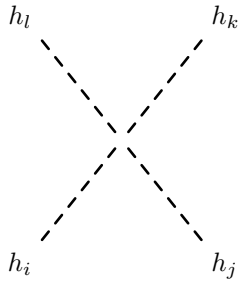
$$-\frac{1}{2}\Big(-Z_{k1}^{++}Z_{l2}^{++}+Z_{k2}^{++}Z_{l1}^{++}\Big)\Big(4\rho_4\Big(-Z_{i3}^{Ah}Z_{j4}^{H}+Z_{i4}^{Ah}Z_{j3}^{H}\Big)+Z_{i1}^{Ah}\Big(2\beta_3Z_{j1}^{H}-\beta_1Z_{j2}^{H}\Big)+Z_{i2}^{Ah}\Big(-2\beta_2Z_{j2}^{H}+\beta_1Z_{j1}^{H}\Big)\Big) \tag{291}$$



$$\begin{aligned}
&\frac{1}{2}\Big(-\alpha_3Z_{j2}^{+}Z_{k3}^{+}Z_{l1}^{++}Z_{i1}^{Ah}+2\beta_3Z_{j1}^{+}Z_{k4}^{+}Z_{l1}^{++}Z_{i1}^{Ah}+\beta_1Z_{j2}^{+}Z_{k4}^{+}Z_{l1}^{++}Z_{i1}^{Ah}\\
&-\beta_1Z_{j1}^{+}Z_{k3}^{+}Z_{l2}^{++}Z_{i1}^{Ah}-2\beta_3Z_{j2}^{+}Z_{k3}^{+}Z_{l2}^{++}Z_{i1}^{Ah}+\alpha_3Z_{j1}^{+}Z_{k4}^{+}Z_{l2}^{++}Z_{i1}^{Ah}\\
&+\alpha_3Z_{j1}^{+}Z_{k3}^{+}Z_{l1}^{++}Z_{i2}^{Ah}+\beta_1Z_{j1}^{+}Z_{k4}^{+}Z_{l1}^{++}Z_{i2}^{Ah}+2\beta_2Z_{j2}^{+}Z_{k4}^{+}Z_{l1}^{++}Z_{i2}^{Ah}\\
&-2\beta_2Z_{j1}^{+}Z_{k3}^{+}Z_{l2}^{++}Z_{i2}^{Ah}-\beta_1Z_{j2}^{+}Z_{k3}^{+}Z_{l2}^{++}Z_{i2}^{Ah}-\alpha_3Z_{j2}^{+}Z_{k4}^{+}Z_{l2}^{++}Z_{i2}^{Ah}\\
&-2\sqrt{2}\beta_2Z_{j1}^{+}Z_{k1}^{+}Z_{l2}^{++}Z_{i3}^{Ah}-\sqrt{2}\beta_1Z_{j2}^{+}Z_{k1}^{+}Z_{l2}^{++}Z_{i3}^{Ah}-\sqrt{2}\beta_1Z_{j1}^{+}Z_{k2}^{+}Z_{l2}^{++}Z_{i3}^{Ah}\\
&-2\sqrt{2}\beta_3Z_{j2}^{+}Z_{k2}^{+}Z_{l2}^{++}Z_{i3}^{Ah}-2\sqrt{2}\beta_3Z_{j1}^{+}Z_{k1}^{+}Z_{l1}^{++}Z_{i4}^{Ah}-\sqrt{2}\beta_1Z_{j2}^{+}Z_{k1}^{+}Z_{l1}^{++}Z_{i4}^{Ah}\\
&-\sqrt{2}\beta_1Z_{j1}^{+}Z_{k2}^{+}Z_{l1}^{++}Z_{i4}^{Ah}-2\sqrt{2}\beta_2Z_{j2}^{+}Z_{k2}^{+}Z_{l1}^{++}Z_{i4}^{Ah}\\
&+Z_{j4}^{+}\Big(Z_{k1}^{+}\Big(\alpha_3Z_{l2}^{++}Z_{i1}^{Ah}+Z_{l1}^{++}\Big(2\beta_3Z_{i1}^{Ah}+\beta_1Z_{i2}^{Ah}\Big)\Big)+Z_{k2}^{+}\Big(-\alpha_3Z_{l2}^{++}Z_{i2}^{Ah}+Z_{l1}^{++}\Big(2\beta_2Z_{i2}^{Ah}+\beta_1Z_{i1}^{Ah}\Big)\Big)\\
&+4\sqrt{2}Z_{k4}^{+}\Big(\rho_2Z_{l2}^{++}Z_{i4}^{Ah}+\rho_4Z_{l1}^{++}Z_{i3}^{Ah}\Big)\Big)\\
&-Z_{j3}^{+}\Big(Z_{k2}^{+}\Big(\alpha_3Z_{l1}^{++}Z_{i1}^{Ah}+Z_{l2}^{++}\Big(2\beta_3Z_{i1}^{Ah}+\beta_1Z_{i2}^{Ah}\Big)\Big)+Z_{k1}^{+}\Big(-\alpha_3Z_{l1}^{++}Z_{i2}^{Ah}+Z_{l2}^{++}\Big(2\beta_2Z_{i2}^{Ah}+\beta_1Z_{i1}^{Ah}\Big)\Big)\\
&-4\sqrt{2}Z_{k3}^{+}\Big(\rho_2Z_{l1}^{++}Z_{i3}^{Ah}+\rho_4Z_{l2}^{++}Z_{i4}^{Ah}\Big)\Big)\Big)
\end{aligned} \tag{292}$$



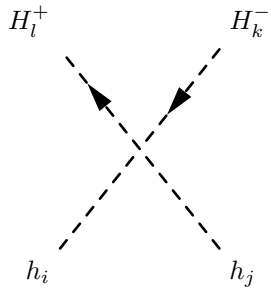
$$
\begin{aligned}
&\frac{1}{2}\Big(\alpha_3 Z^+_{k2} Z^+_{l3} Z^{++}_{j1} Z^{Ah}_{i1} - 2\beta_3 Z^+_{k1} Z^+_{l4} Z^{++}_{j1} Z^{Ah}_{i1} - \beta_1 Z^+_{k2} Z^+_{l4} Z^{++}_{j1} Z^{Ah}_{i1} \\
&+ \beta_1 Z^+_{k1} Z^+_{l3} Z^{++}_{j2} Z^{Ah}_{i1} + 2\beta_3 Z^+_{k2} Z^+_{l3} Z^{++}_{j2} Z^{Ah}_{i1} - \alpha_3 Z^+_{k1} Z^+_{l4} Z^{++}_{j2} Z^{Ah}_{i1} \\
&- \alpha_3 Z^+_{k1} Z^+_{l3} Z^{++}_{j1} Z^{Ah}_{i2} - \beta_1 Z^+_{k1} Z^+_{l4} Z^{++}_{j1} Z^{Ah}_{i2} - 2\beta_2 Z^+_{k2} Z^+_{l4} Z^{++}_{j1} Z^{Ah}_{i2} \\
&+ 2\beta_2 Z^+_{k1} Z^+_{l3} Z^{++}_{j2} Z^{Ah}_{i2} + \beta_1 Z^+_{k2} Z^+_{l3} Z^{++}_{j2} Z^{Ah}_{i2} + \alpha_3 Z^+_{k2} Z^+_{l4} Z^{++}_{j2} Z^{Ah}_{i2} \\
&+ 2\sqrt{2}\beta_2 Z^+_{k1} Z^+_{l1} Z^{++}_{j2} Z^{Ah}_{i3} + \sqrt{2}\beta_1 Z^+_{k2} Z^+_{l1} Z^{++}_{j2} Z^{Ah}_{i3} + \sqrt{2}\beta_1 Z^+_{k1} Z^+_{l2} Z^{++}_{j2} Z^{Ah}_{i3} \\
&+ 2\sqrt{2}\beta_3 Z^+_{k2} Z^+_{l2} Z^{++}_{j2} Z^{Ah}_{i3} + 2\sqrt{2}\beta_3 Z^+_{k1} Z^+_{l1} Z^{++}_{j1} Z^{Ah}_{i4} + \sqrt{2}\beta_1 Z^+_{k2} Z^+_{l1} Z^{++}_{j1} Z^{Ah}_{i4} \\
&+ \sqrt{2}\beta_1 Z^+_{k1} Z^+_{l2} Z^{++}_{j1} Z^{Ah}_{i4} + 2\sqrt{2}\beta_2 Z^+_{k2} Z^+_{l2} Z^{++}_{j1} Z^{Ah}_{i4} \\
&- Z^+_{k4}\Big(Z^+_{l1}\Big(\alpha_3 Z^{++}_{j2} Z^{Ah}_{i1} + Z^{++}_{j1}\Big(2\beta_3 Z^{Ah}_{i1} + \beta_1 Z^{Ah}_{i2}\Big)\Big) + Z^+_{l2}\Big(-\alpha_3 Z^{++}_{j2} Z^{Ah}_{i2} + Z^{++}_{j1}\Big(2\beta_2 Z^{Ah}_{i2} + \beta_1 Z^{Ah}_{i1}\Big)\Big) \\
&+ 4\sqrt{2} Z^+_{l4}\Big(\rho_2 Z^{++}_{j2} Z^{Ah}_{i4} + \rho_4 Z^{++}_{j1} Z^{Ah}_{i3}\Big)\Big) \\
&+ Z^+_{k3}\Big(Z^+_{l2}\Big(\alpha_3 Z^{++}_{j1} Z^{Ah}_{i1} + Z^{++}_{j2}\Big(2\beta_3 Z^{Ah}_{i1} + \beta_1 Z^{Ah}_{i2}\Big)\Big) + Z^+_{l1}\Big(-\alpha_3 Z^{++}_{j1} Z^{Ah}_{i2} + Z^{++}_{j2}\Big(2\beta_2 Z^{Ah}_{i2} + \beta_1 Z^{Ah}_{i1}\Big)\Big) \\
&- 4\sqrt{2} Z^+_{l3}\Big(\rho_2 Z^{++}_{j1} Z^{Ah}_{i3} + \rho_4 Z^{++}_{j2} Z^{Ah}_{i4}\Big)\Big)\Big)
\end{aligned}
\tag{293}
$$



$$
\begin{aligned}
&-\frac{i}{2}\Big(2\alpha_1 Z^H_{i3} Z^H_{j3} Z^H_{k1} Z^H_{l1} - 2\beta_2 Z^H_{i4} Z^H_{j3} Z^H_{k1} Z^H_{l1} - 2\beta_2 Z^H_{i3} Z^H_{j4} Z^H_{k1} Z^H_{l1} \\
&+ 2\alpha_1 Z^H_{i4} Z^H_{j4} Z^H_{k1} Z^H_{l1} - 4\alpha_2 Z^H_{i3} Z^H_{j3} Z^H_{k2} Z^H_{l1} + \beta_1 Z^H_{i4} Z^H_{j3} Z^H_{k2} Z^H_{l1} \\
&+ \beta_1 Z^H_{i3} Z^H_{j4} Z^H_{k2} Z^H_{l1} - 4\alpha_2 Z^H_{i4} Z^H_{j4} Z^H_{k2} Z^H_{l1} + 2\alpha_1 Z^H_{i3} Z^H_{j1} Z^H_{k3} Z^H_{l1}
\end{aligned}
$$

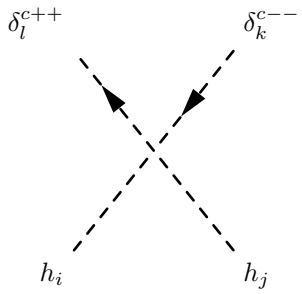
$$
\begin{aligned}
&- 2\beta_2 Z_{i4}^H Z_{j1}^H Z_{k3}^H Z_{l1}^H - 4\alpha_2 Z_{i3}^H Z_{j2}^H Z_{k3}^H Z_{l1}^H + \beta_1 Z_{i4}^H Z_{j2}^H Z_{k3}^H Z_{l1}^H \\
&- 2\beta_2 Z_{i3}^H Z_{j1}^H Z_{k4}^H Z_{l1}^H + 2\alpha_1 Z_{i4}^H Z_{j1}^H Z_{k4}^H Z_{l1}^H + \beta_1 Z_{i3}^H Z_{j2}^H Z_{k4}^H Z_{l1}^H \\
&- 4\alpha_2 Z_{i4}^H Z_{j2}^H Z_{k4}^H Z_{l1}^H - 4\alpha_2 Z_{i3}^H Z_{j3}^H Z_{k1}^H Z_{l2}^H + \beta_1 Z_{i4}^H Z_{j3}^H Z_{k1}^H Z_{l2}^H \\
&+ \beta_1 Z_{i3}^H Z_{j4}^H Z_{k1}^H Z_{l2}^H - 4\alpha_2 Z_{i4}^H Z_{j4}^H Z_{k1}^H Z_{l2}^H + 2\alpha_1 Z_{i3}^H Z_{j3}^H Z_{k2}^H Z_{l2}^H \\
&+ 2\alpha_3 Z_{i3}^H Z_{j3}^H Z_{k2}^H Z_{l2}^H - 2\beta_3 Z_{i4}^H Z_{j3}^H Z_{k2}^H Z_{l2}^H - 2\beta_3 Z_{i3}^H Z_{j4}^H Z_{k2}^H Z_{l2}^H \\
&+ 2\alpha_1 Z_{i4}^H Z_{j4}^H Z_{k2}^H Z_{l2}^H + 2\alpha_3 Z_{i4}^H Z_{j4}^H Z_{k2}^H Z_{l2}^H - 4\alpha_2 Z_{i3}^H Z_{j1}^H Z_{k3}^H Z_{l2}^H \\
&+ \beta_1 Z_{i4}^H Z_{j1}^H Z_{k3}^H Z_{l2}^H + 2\alpha_1 Z_{i3}^H Z_{j2}^H Z_{k3}^H Z_{l2}^H + 2\alpha_3 Z_{i3}^H Z_{j2}^H Z_{k3}^H Z_{l2}^H \\
&- 2\beta_3 Z_{i4}^H Z_{j2}^H Z_{k3}^H Z_{l2}^H + \beta_1 Z_{i3}^H Z_{j1}^H Z_{k4}^H Z_{l2}^H - 4\alpha_2 Z_{i4}^H Z_{j1}^H Z_{k4}^H Z_{l2}^H \\
&- 2\beta_3 Z_{i3}^H Z_{j2}^H Z_{k4}^H Z_{l2}^H + 2\alpha_1 Z_{i4}^H Z_{j2}^H Z_{k4}^H Z_{l2}^H + 2\alpha_3 Z_{i4}^H Z_{j2}^H Z_{k4}^H Z_{l2}^H \\
&+ 2\alpha_1 Z_{i3}^H Z_{j1}^H Z_{k1}^H Z_{l3}^H - 2\beta_2 Z_{i4}^H Z_{j1}^H Z_{k1}^H Z_{l3}^H - 4\alpha_2 Z_{i3}^H Z_{j2}^H Z_{k1}^H Z_{l3}^H \\
&+ \beta_1 Z_{i4}^H Z_{j2}^H Z_{k1}^H Z_{l3}^H - 4\alpha_2 Z_{i3}^H Z_{j1}^H Z_{k2}^H Z_{l3}^H + \beta_1 Z_{i4}^H Z_{j1}^H Z_{k2}^H Z_{l3}^H \\
&+ 2\alpha_1 Z_{i3}^H Z_{j2}^H Z_{k2}^H Z_{l3}^H + 2\alpha_3 Z_{i3}^H Z_{j2}^H Z_{k2}^H Z_{l3}^H - 2\beta_3 Z_{i4}^H Z_{j2}^H Z_{k2}^H Z_{l3}^H \\
&+ 12\rho_1 Z_{i3}^H Z_{j3}^H Z_{k3}^H Z_{l3}^H + 2\rho_3 Z_{i4}^H Z_{j4}^H Z_{k3}^H Z_{l3}^H + 2\rho_3 Z_{i4}^H Z_{j3}^H Z_{k4}^H Z_{l3}^H \\
&+ 2\rho_3 Z_{i3}^H Z_{j4}^H Z_{k4}^H Z_{l3}^H - 2\beta_2 Z_{i3}^H Z_{j1}^H Z_{k1}^H Z_{l4}^H + 2\alpha_1 Z_{i4}^H Z_{j1}^H Z_{k1}^H Z_{l4}^H \\
&+ \beta_1 Z_{i3}^H Z_{j2}^H Z_{k1}^H Z_{l4}^H - 4\alpha_2 Z_{i4}^H Z_{j2}^H Z_{k1}^H Z_{l4}^H + \beta_1 Z_{i3}^H Z_{j1}^H Z_{k2}^H Z_{l4}^H \\
&- 4\alpha_2 Z_{i4}^H Z_{j1}^H Z_{k2}^H Z_{l4}^H - 2\beta_3 Z_{i3}^H Z_{j2}^H Z_{k2}^H Z_{l4}^H + 2\alpha_1 Z_{i4}^H Z_{j2}^H Z_{k2}^H Z_{l4}^H \\
&+ 2\alpha_3 Z_{i4}^H Z_{j2}^H Z_{k2}^H Z_{l4}^H + 2\rho_3 Z_{i4}^H Z_{j3}^H Z_{k3}^H Z_{l4}^H + 2\rho_3 Z_{i3}^H Z_{j4}^H Z_{k3}^H Z_{l4}^H \\
&+ 2\rho_3 Z_{i3}^H Z_{j3}^H Z_{k4}^H Z_{l4}^H + 12\rho_1 Z_{i4}^H Z_{j4}^H Z_{k4}^H Z_{l4}^H \\
&+ Z_{i1}^H \Big(2\alpha_1 Z_{j3}^H Z_{k3}^H Z_{l1}^H - 2\beta_2 Z_{j4}^H Z_{k3}^H Z_{l1}^H - 2\beta_2 Z_{j3}^H Z_{k4}^H Z_{l1}^H + 2\alpha_1 Z_{j4}^H Z_{k4}^H Z_{l1}^H \\
&- 4\alpha_2 Z_{j3}^H Z_{k3}^H Z_{l2}^H + \beta_1 Z_{j4}^H Z_{k3}^H Z_{l2}^H + \beta_1 Z_{j3}^H Z_{k4}^H Z_{l2}^H - 4\alpha_2 Z_{j4}^H Z_{k4}^H Z_{l2}^H \\
&+ 2\alpha_1 Z_{j3}^H Z_{k1}^H Z_{l3}^H - 2\beta_2 Z_{j4}^H Z_{k1}^H Z_{l3}^H - 4\alpha_2 Z_{j3}^H Z_{k2}^H Z_{l3}^H + \beta_1 Z_{j4}^H Z_{k2}^H Z_{l3}^H \\
&- 2\beta_2 Z_{j3}^H Z_{k1}^H Z_{l4}^H + 2\alpha_1 Z_{j4}^H Z_{k1}^H Z_{l4}^H + \beta_1 Z_{j3}^H Z_{k2}^H Z_{l4}^H - 4\alpha_2 Z_{j4}^H Z_{k2}^H Z_{l4}^H \\
&+ 2 Z_{j1}^H \Big(Z_{k2}^H \Big(2 \Big(2\lambda_3 + 4\lambda_2 + \lambda \Big) Z_{l2}^H - 6\lambda_4 Z_{l1}^H \Big) + 6 Z_{k1}^H \Big(- \lambda_4 Z_{l2}^H + \lambda Z_{l1}^H \Big) + \alpha_1 Z_{k3}^H Z_{l3}^H - \beta_2 Z_{k4}^H Z_{l3}^H \\
&- \beta_2 Z_{k3}^H Z_{l4}^H + \alpha_1 Z_{k4}^H Z_{l4}^H \Big) \\
&+ Z_{j2}^H \Big(4 Z_{k1}^H \Big(\Big(2\lambda_3 + 4\lambda_2 + \lambda \Big) Z_{l2}^H - 3\lambda_4 Z_{l1}^H \Big) + 4 Z_{k2}^H \Big(\Big(2\lambda_3 + 4\lambda_2 + \lambda \Big) Z_{l1}^H - 3\lambda_4 Z_{l2}^H \Big) - 4\alpha_2 Z_{k3}^H Z_{l3}^H \\
&+ \beta_1 Z_{k4}^H Z_{l3}^H + \beta_1 Z_{k3}^H Z_{l4}^H - 4\alpha_2 Z_{k4}^H Z_{l4}^H \Big) \Big) \\
&+ Z_{i2}^H \Big(- 4\alpha_2 Z_{j3}^H Z_{k3}^H Z_{l1}^H + \beta_1 Z_{j4}^H Z_{k3}^H Z_{l1}^H + \beta_1 Z_{j3}^H Z_{k4}^H Z_{l1}^H - 4\alpha_2 Z_{j4}^H Z_{k4}^H Z_{l1}^H \\
&+ 2\alpha_1 Z_{j3}^H Z_{k3}^H Z_{l2}^H + 2\alpha_3 Z_{j3}^H Z_{k3}^H Z_{l2}^H - 2\beta_3 Z_{j4}^H Z_{k3}^H Z_{l2}^H - 2\beta_3 Z_{j3}^H Z_{k4}^H Z_{l2}^H \\
&+ 2\alpha_1 Z_{j4}^H Z_{k4}^H Z_{l2}^H + 2\alpha_3 Z_{j4}^H Z_{k4}^H Z_{l2}^H - 4\alpha_2 Z_{j3}^H Z_{k1}^H Z_{l3}^H + \beta_1 Z_{j4}^H Z_{k1}^H Z_{l3}^H \\
&+ 2\alpha_1 Z_{j3}^H Z_{k2}^H Z_{l3}^H + 2\alpha_3 Z_{j3}^H Z_{k2}^H Z_{l3}^H - 2\beta_3 Z_{j4}^H Z_{k2}^H Z_{l3}^H + \beta_1 Z_{j3}^H Z_{k1}^H Z_{l4}^H \\
&- 4\alpha_2 Z_{j4}^H Z_{k1}^H Z_{l4}^H - 2\beta_3 Z_{j3}^H Z_{k2}^H Z_{l4}^H + 2\alpha_1 Z_{j4}^H Z_{k2}^H Z_{l4}^H + 2\alpha_3 Z_{j4}^H Z_{k2}^H Z_{l4}^H
\end{aligned}
$$

$$
\begin{aligned}
&+ Z_{j1}^{H}\Big(4Z_{k1}^{H}\Big(\Big(2\lambda_3+4\lambda_2+\lambda\Big)Z_{l2}^{H}-3\lambda_4 Z_{l1}^{H}\Big)+4Z_{k2}^{H}\Big(\Big(2\lambda_3+4\lambda_2+\lambda\Big)Z_{l1}^{H}-3\lambda_4 Z_{l2}^{H}\Big)-4\alpha_2 Z_{k3}^{H}Z_{l3}^{H}\\
&+\beta_1 Z_{k4}^{H}Z_{l3}^{H}+\beta_1 Z_{k3}^{H}Z_{l4}^{H}-4\alpha_2 Z_{k4}^{H}Z_{l4}^{H}\Big)\\
&+2Z_{j2}^{H}\Big(Z_{k2}^{H}\Big(-6\lambda_4 Z_{l1}^{H}+6\lambda Z_{l2}^{H}\Big)+2Z_{k1}^{H}\Big(\Big(2\lambda_3+4\lambda_2+\lambda\Big)Z_{l1}^{H}-3\lambda_4 Z_{l2}^{H}\Big)+\alpha_1 Z_{k3}^{H}Z_{l3}^{H}+\alpha_3 Z_{k3}^{H}Z_{l3}^{H}\\
&-\beta_3 Z_{k4}^{H}Z_{l3}^{H}-\beta_3 Z_{k3}^{H}Z_{l4}^{H}+\alpha_1 Z_{k4}^{H}Z_{l4}^{H}+\alpha_3 Z_{k4}^{H}Z_{l4}^{H}\Big)\Big)
\end{aligned}
\tag{294}
$$

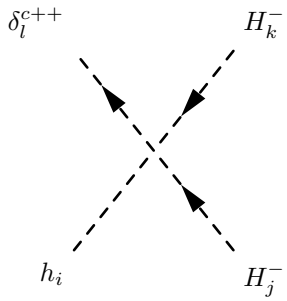


$$
\begin{aligned}
&-\frac{i}{4}\Big(4\alpha_1 Z_{k3}^{+}Z_{l3}^{+}Z_{i1}^{H}Z_{j1}^{H}+2\alpha_3 Z_{k3}^{+}Z_{l3}^{+}Z_{i1}^{H}Z_{j1}^{H}+2\beta_1 Z_{k4}^{+}Z_{l3}^{+}Z_{i1}^{H}Z_{j1}^{H}\\
&+2\beta_1 Z_{k3}^{+}Z_{l4}^{+}Z_{i1}^{H}Z_{j1}^{H}+4\alpha_1 Z_{k4}^{+}Z_{l4}^{+}Z_{i1}^{H}Z_{j1}^{H}+2\alpha_3 Z_{k4}^{+}Z_{l4}^{+}Z_{i1}^{H}Z_{j1}^{H}\\
&-8\alpha_2 Z_{k3}^{+}Z_{l3}^{+}Z_{i2}^{H}Z_{j1}^{H}-2\beta_2 Z_{k4}^{+}Z_{l3}^{+}Z_{i2}^{H}Z_{j1}^{H}-2\beta_3 Z_{k4}^{+}Z_{l3}^{+}Z_{i2}^{H}Z_{j1}^{H}\\
&-2\beta_2 Z_{k3}^{+}Z_{l4}^{+}Z_{i2}^{H}Z_{j1}^{H}-2\beta_3 Z_{k3}^{+}Z_{l4}^{+}Z_{i2}^{H}Z_{j1}^{H}-8\alpha_2 Z_{k4}^{+}Z_{l4}^{+}Z_{i2}^{H}Z_{j1}^{H}\\
&+2\sqrt{2}\beta_2 Z_{k4}^{+}Z_{l1}^{+}Z_{i3}^{H}Z_{j1}^{H}+\sqrt{2}\alpha_3 Z_{k3}^{+}Z_{l2}^{+}Z_{i3}^{H}Z_{j1}^{H}+\sqrt{2}\beta_1 Z_{k4}^{+}Z_{l2}^{+}Z_{i3}^{H}Z_{j1}^{H}\\
&+\sqrt{2}\beta_1 Z_{k3}^{+}Z_{l1}^{+}Z_{i4}^{H}Z_{j1}^{H}+\sqrt{2}\alpha_3 Z_{k4}^{+}Z_{l1}^{+}Z_{i4}^{H}Z_{j1}^{H}+2\sqrt{2}\beta_2 Z_{k3}^{+}Z_{l2}^{+}Z_{i4}^{H}Z_{j1}^{H}\\
&-8\alpha_2 Z_{k3}^{+}Z_{l3}^{+}Z_{i1}^{H}Z_{j2}^{H}-2\beta_2 Z_{k4}^{+}Z_{l3}^{+}Z_{i1}^{H}Z_{j2}^{H}-2\beta_3 Z_{k4}^{+}Z_{l3}^{+}Z_{i1}^{H}Z_{j2}^{H}\\
&-2\beta_2 Z_{k3}^{+}Z_{l4}^{+}Z_{i1}^{H}Z_{j2}^{H}-2\beta_3 Z_{k3}^{+}Z_{l4}^{+}Z_{i1}^{H}Z_{j2}^{H}-8\alpha_2 Z_{k4}^{+}Z_{l4}^{+}Z_{i1}^{H}Z_{j2}^{H}\\
&+4\alpha_1 Z_{k3}^{+}Z_{l3}^{+}Z_{i2}^{H}Z_{j2}^{H}+2\alpha_3 Z_{k3}^{+}Z_{l3}^{+}Z_{i2}^{H}Z_{j2}^{H}+2\beta_1 Z_{k4}^{+}Z_{l3}^{+}Z_{i2}^{H}Z_{j2}^{H}\\
&+2\beta_1 Z_{k3}^{+}Z_{l4}^{+}Z_{i2}^{H}Z_{j2}^{H}+4\alpha_1 Z_{k4}^{+}Z_{l4}^{+}Z_{i2}^{H}Z_{j2}^{H}+2\alpha_3 Z_{k4}^{+}Z_{l4}^{+}Z_{i2}^{H}Z_{j2}^{H}\\
&+\sqrt{2}\alpha_3 Z_{k3}^{+}Z_{l1}^{+}Z_{i3}^{H}Z_{j2}^{H}-\sqrt{2}\beta_1 Z_{k4}^{+}Z_{l1}^{+}Z_{i3}^{H}Z_{j2}^{H}-2\sqrt{2}\beta_3 Z_{k4}^{+}Z_{l2}^{+}Z_{i3}^{H}Z_{j2}^{H}\\
&-2\sqrt{2}\beta_3 Z_{k3}^{+}Z_{l1}^{+}Z_{i4}^{H}Z_{j2}^{H}-\sqrt{2}\beta_1 Z_{k3}^{+}Z_{l2}^{+}Z_{i4}^{H}Z_{j2}^{H}+\sqrt{2}\alpha_3 Z_{k4}^{+}Z_{l2}^{+}Z_{i4}^{H}Z_{j2}^{H}\\
&+2\sqrt{2}\beta_2 Z_{k4}^{+}Z_{l1}^{+}Z_{i1}^{H}Z_{j3}^{H}+\sqrt{2}\alpha_3 Z_{k3}^{+}Z_{l2}^{+}Z_{i1}^{H}Z_{j3}^{H}+\sqrt{2}\beta_1 Z_{k4}^{+}Z_{l2}^{+}Z_{i1}^{H}Z_{j3}^{H}\\
&+\sqrt{2}\alpha_3 Z_{k3}^{+}Z_{l1}^{+}Z_{i2}^{H}Z_{j3}^{H}-\sqrt{2}\beta_1 Z_{k4}^{+}Z_{l1}^{+}Z_{i2}^{H}Z_{j3}^{H}-2\sqrt{2}\beta_3 Z_{k4}^{+}Z_{l2}^{+}Z_{i2}^{H}Z_{j3}^{H}\\
&+8\rho_1 Z_{k3}^{+}Z_{l3}^{+}Z_{i3}^{H}Z_{j3}^{H}+4\rho_3 Z_{k4}^{+}Z_{l4}^{+}Z_{i3}^{H}Z_{j3}^{H}+\sqrt{2}\beta_1 Z_{k3}^{+}Z_{l1}^{+}Z_{i1}^{H}Z_{j4}^{H}\\
&+\sqrt{2}\alpha_3 Z_{k4}^{+}Z_{l1}^{+}Z_{i1}^{H}Z_{j4}^{H}+2\sqrt{2}\beta_2 Z_{k3}^{+}Z_{l2}^{+}Z_{i1}^{H}Z_{j4}^{H}-2\sqrt{2}\beta_3 Z_{k3}^{+}Z_{l1}^{+}Z_{i2}^{H}Z_{j4}^{H}\\
&-\sqrt{2}\beta_1 Z_{k3}^{+}Z_{l2}^{+}Z_{i2}^{H}Z_{j4}^{H}+\sqrt{2}\alpha_3 Z_{k4}^{+}Z_{l2}^{+}Z_{i2}^{H}Z_{j4}^{H}+4\rho_3 Z_{k3}^{+}Z_{l3}^{+}Z_{i4}^{H}Z_{j4}^{H}\\
&+8\rho_1 Z_{k4}^{+}Z_{l4}^{+}Z_{i4}^{H}Z_{j4}^{H}
\end{aligned}
$$

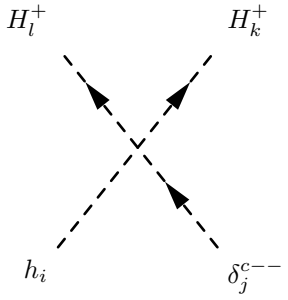
$$
\begin{aligned}
&+ Z^{+}_{k2}\Big(4Z^{+}_{l2}\Big(Z^{H}_{i2}\Big(-2\lambda_4 Z^{H}_{j1}+2\lambda Z^{H}_{j2}\Big)+2Z^{H}_{i1}\Big(-\lambda_4 Z^{H}_{j2}+\lambda Z^{H}_{j1}\Big)+\alpha_1 Z^{H}_{i3}Z^{H}_{j3}+\alpha_3 Z^{H}_{i3}Z^{H}_{j3}\\
&+\alpha_1 Z^{H}_{i4}Z^{H}_{j4}\Big)\\
&+\sqrt{2}\Big(Z^{+}_{l4}\Big(-2\beta_3 Z^{H}_{i2}Z^{H}_{j3}+\alpha_3 Z^{H}_{i2}Z^{H}_{j4}+\alpha_3 Z^{H}_{i4}Z^{H}_{j2}+\beta_1 Z^{H}_{i1}Z^{H}_{j3}+Z^{H}_{i3}\Big(-2\beta_3 Z^{H}_{j2}+\beta_1 Z^{H}_{j1}\Big)\Big)\\
&+Z^{+}_{l3}\Big(2\beta_2 Z^{H}_{i1}Z^{H}_{j4}+\alpha_3 Z^{H}_{i1}Z^{H}_{j3}+\alpha_3 Z^{H}_{i3}Z^{H}_{j1}-\beta_1 Z^{H}_{i2}Z^{H}_{j4}+Z^{H}_{i4}\Big(2\beta_2 Z^{H}_{j1}-\beta_1 Z^{H}_{j2}\Big)\Big)\Big)\\
&+8Z^{+}_{l1}\Big(\alpha_2\Big(Z^{H}_{i3}Z^{H}_{j3}+Z^{H}_{i4}Z^{H}_{j4}\Big)+Z^{H}_{i1}\Big(-\Big(2\lambda_2+\lambda_3\Big)Z^{H}_{j2}+\lambda_4 Z^{H}_{j1}\Big)+Z^{H}_{i2}\Big(-\Big(2\lambda_2+\lambda_3\Big)Z^{H}_{j1}+\lambda_4 Z^{H}_{j2}\Big)\Big)\Big)\\
&+Z^{+}_{k1}\Big(4Z^{+}_{l1}\Big(Z^{H}_{i2}\Big(-2\lambda_4 Z^{H}_{j1}+2\lambda Z^{H}_{j2}\Big)+2Z^{H}_{i1}\Big(-\lambda_4 Z^{H}_{j2}+\lambda Z^{H}_{j1}\Big)+\alpha_1 Z^{H}_{i3}Z^{H}_{j3}+\alpha_1 Z^{H}_{i4}Z^{H}_{j4}\\
&+\alpha_3 Z^{H}_{i4}Z^{H}_{j4}\Big)\\
&+\sqrt{2}\Big(Z^{+}_{l4}\Big(2\beta_2 Z^{H}_{i1}Z^{H}_{j3}+\alpha_3 Z^{H}_{i1}Z^{H}_{j4}+\alpha_3 Z^{H}_{i4}Z^{H}_{j1}-\beta_1 Z^{H}_{i2}Z^{H}_{j3}+Z^{H}_{i3}\Big(2\beta_2 Z^{H}_{j1}-\beta_1 Z^{H}_{j2}\Big)\Big)\\
&+Z^{+}_{l3}\Big(-2\beta_3 Z^{H}_{i2}Z^{H}_{j4}+\alpha_3 Z^{H}_{i2}Z^{H}_{j3}+\alpha_3 Z^{H}_{i3}Z^{H}_{j2}+\beta_1 Z^{H}_{i1}Z^{H}_{j4}+Z^{H}_{i4}\Big(-2\beta_3 Z^{H}_{j2}+\beta_1 Z^{H}_{j1}\Big)\Big)\Big)\\
&+8Z^{+}_{l2}\Big(\alpha_2\Big(Z^{H}_{i3}Z^{H}_{j3}+Z^{H}_{i4}Z^{H}_{j4}\Big)+Z^{H}_{i1}\Big(-\Big(2\lambda_2+\lambda_3\Big)Z^{H}_{j2}+\lambda_4 Z^{H}_{j1}\Big)+Z^{H}_{i2}\Big(-\Big(2\lambda_2+\lambda_3\Big)Z^{H}_{j1}+\lambda_4 Z^{H}_{j2}\Big)\Big)\Big)\Big)
\end{aligned}
\tag{295}
$$



$$
\begin{aligned}
&-\frac{i}{2}\Big(Z^{++}_{k2}\Big(2Z^{++}_{l2}\Big(Z^{H}_{i2}\Big(-2\alpha_2 Z^{H}_{j1}+\alpha_1 Z^{H}_{j2}\Big)+Z^{H}_{i1}\Big(-2\alpha_2 Z^{H}_{j2}+\Big(\alpha_1+\alpha_3\Big)Z^{H}_{j1}\Big)+\rho_3 Z^{H}_{i3}Z^{H}_{j3}+2\rho_1 Z^{H}_{i4}Z^{H}_{j4}\\
&+4\rho_2 Z^{H}_{i4}Z^{H}_{j4}\Big)\\
&+Z^{++}_{l1}\Big(4\rho_4\Big(Z^{H}_{i3}Z^{H}_{j4}+Z^{H}_{i4}Z^{H}_{j3}\Big)+Z^{H}_{i1}\Big(-2\beta_3 Z^{H}_{j1}+\beta_1 Z^{H}_{j2}\Big)+Z^{H}_{i2}\Big(-2\beta_2 Z^{H}_{j2}+\beta_1 Z^{H}_{j1}\Big)\Big)\Big)\\
&+Z^{++}_{k1}\Big(2Z^{++}_{l1}\Big(Z^{H}_{i2}\Big(-2\alpha_2 Z^{H}_{j1}+\alpha_1 Z^{H}_{j2}\Big)+Z^{H}_{i1}\Big(-2\alpha_2 Z^{H}_{j2}+\Big(\alpha_1+\alpha_3\Big)Z^{H}_{j1}\Big)+2\rho_1 Z^{H}_{i3}Z^{H}_{j3}+4\rho_2 Z^{H}_{i3}Z^{H}_{j3}\\
&+\rho_3 Z^{H}_{i4}Z^{H}_{j4}\Big)\\
&+Z^{++}_{l2}\Big(4\rho_4\Big(Z^{H}_{i3}Z^{H}_{j4}+Z^{H}_{i4}Z^{H}_{j3}\Big)+Z^{H}_{i1}\Big(-2\beta_3 Z^{H}_{j1}+\beta_1 Z^{H}_{j2}\Big)+Z^{H}_{i2}\Big(-2\beta_2 Z^{H}_{j2}+\beta_1 Z^{H}_{j1}\Big)\Big)\Big)\Big)
\end{aligned}
\tag{296}
$$

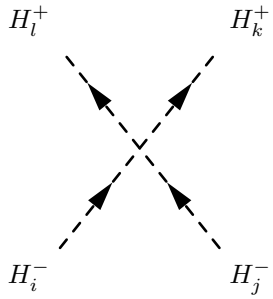


$$
\begin{aligned}
&\frac{i}{2}\Big(\alpha_3 Z^+_{j2}Z^+_{k3}Z^{++}_{l1}Z^H_{i1} - 2\beta_3 Z^+_{j1}Z^+_{k4}Z^{++}_{l1}Z^H_{i1} - \beta_1 Z^+_{j2}Z^+_{k4}Z^{++}_{l1}Z^H_{i1}\\
&- \beta_1 Z^+_{j1}Z^+_{k3}Z^{++}_{l2}Z^H_{i1} - 2\beta_3 Z^+_{j2}Z^+_{k3}Z^{++}_{l2}Z^H_{i1} + \alpha_3 Z^+_{j1}Z^+_{k4}Z^{++}_{l2}Z^H_{i1}\\
&+ \alpha_3 Z^+_{j1}Z^+_{k3}Z^{++}_{l1}Z^H_{i2} + \beta_1 Z^+_{j1}Z^+_{k4}Z^{++}_{l1}Z^H_{i2} + 2\beta_2 Z^+_{j2}Z^+_{k4}Z^{++}_{l1}Z^H_{i2}\\
&+ 2\beta_2 Z^+_{j1}Z^+_{k3}Z^{++}_{l2}Z^H_{i2} + \beta_1 Z^+_{j2}Z^+_{k3}Z^{++}_{l2}Z^H_{i2} + \alpha_3 Z^+_{j2}Z^+_{k4}Z^{++}_{l2}Z^H_{i2}\\
&- 2\sqrt{2}\beta_2 Z^+_{j1}Z^+_{k1}Z^{++}_{l2}Z^H_{i3} - \sqrt{2}\beta_1 Z^+_{j2}Z^+_{k1}Z^{++}_{l2}Z^H_{i3} - \sqrt{2}\beta_1 Z^+_{j1}Z^+_{k2}Z^{++}_{l2}Z^H_{i3}\\
&- 2\sqrt{2}\beta_3 Z^+_{j2}Z^+_{k2}Z^{++}_{l2}Z^H_{i3} - 2\sqrt{2}\beta_3 Z^+_{j1}Z^+_{k1}Z^{++}_{l1}Z^H_{i4} - \sqrt{2}\beta_1 Z^+_{j2}Z^+_{k1}Z^{++}_{l1}Z^H_{i4}\\
&- \sqrt{2}\beta_1 Z^+_{j1}Z^+_{k2}Z^{++}_{l1}Z^H_{i4} - 2\sqrt{2}\beta_2 Z^+_{j2}Z^+_{k2}Z^{++}_{l1}Z^H_{i4}\\
&+ Z^+_{j4}\Big(Z^+_{k1}\Big(\alpha_3 Z^{++}_{l2}Z^H_{i1} + Z^{++}_{l1}\Big(-2\beta_3 Z^H_{i1} + \beta_1 Z^H_{i2}\Big)\Big)\\
&+ Z^+_{k2}\Big(\alpha_3 Z^{++}_{l2}Z^H_{i2} + Z^{++}_{l1}\Big(2\beta_2 Z^H_{i2} - \beta_1 Z^H_{i1}\Big)\Big) - 4\sqrt{2}Z^+_{k4}\Big(\rho_2 Z^{++}_{l2}Z^H_{i4} + \rho_4 Z^{++}_{l1}Z^H_{i3}\Big)\Big)\\
&+ Z^+_{j3}\Big(Z^+_{k2}\Big(\alpha_3 Z^{++}_{l1}Z^H_{i1} + Z^{++}_{l2}\Big(-2\beta_3 Z^H_{i1} + \beta_1 Z^H_{i2}\Big)\Big)\\
&+ Z^+_{k1}\Big(\alpha_3 Z^{++}_{l1}Z^H_{i2} + Z^{++}_{l2}\Big(2\beta_2 Z^H_{i2} - \beta_1 Z^H_{i1}\Big)\Big) - 4\sqrt{2}Z^+_{k3}\Big(\rho_2 Z^{++}_{l1}Z^H_{i3} + \rho_4 Z^{++}_{l2}Z^H_{i4}\Big)\Big)\Big)
\end{aligned}
\tag{297}
$$



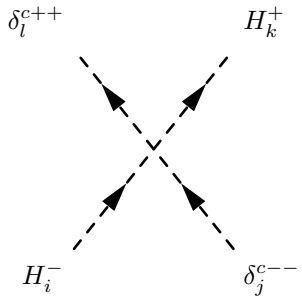
$$
\begin{aligned}
&\frac{i}{2}\Big(\alpha_3 Z^+_{k2}Z^+_{l3}Z^{++}_{j1}Z^H_{i1} - 2\beta_3 Z^+_{k1}Z^+_{l4}Z^{++}_{j1}Z^H_{i1} - \beta_1 Z^+_{k2}Z^+_{l4}Z^{++}_{j1}Z^H_{i1}\\
&- \beta_1 Z^+_{k1}Z^+_{l3}Z^{++}_{j2}Z^H_{i1} - 2\beta_3 Z^+_{k2}Z^+_{l3}Z^{++}_{j2}Z^H_{i1} + \alpha_3 Z^+_{k1}Z^+_{l4}Z^{++}_{j2}Z^H_{i1}\\
&+ \alpha_3 Z^+_{k1}Z^+_{l3}Z^{++}_{j1}Z^H_{i2} + \beta_1 Z^+_{k1}Z^+_{l4}Z^{++}_{j1}Z^H_{i2} + 2\beta_2 Z^+_{k2}Z^+_{l4}Z^{++}_{j1}Z^H_{i2}
\end{aligned}
$$

$$
\begin{aligned}
&+ 2\beta_2 Z^+_{k1} Z^+_{l3} Z^{++}_{j2} Z^H_{i2} + \beta_1 Z^+_{k2} Z^+_{l3} Z^{++}_{j2} Z^H_{i2} + \alpha_3 Z^+_{k2} Z^+_{l4} Z^{++}_{j2} Z^H_{i2} \\
&- 2\sqrt{2}\beta_2 Z^+_{k1} Z^+_{l1} Z^{++}_{j2} Z^H_{i3} - \sqrt{2}\beta_1 Z^+_{k2} Z^+_{l1} Z^{++}_{j2} Z^H_{i3} - \sqrt{2}\beta_1 Z^+_{k1} Z^+_{l2} Z^{++}_{j2} Z^H_{i3} \\
&- 2\sqrt{2}\beta_3 Z^+_{k2} Z^+_{l2} Z^{++}_{j2} Z^H_{i3} - 2\sqrt{2}\beta_3 Z^+_{k1} Z^+_{l1} Z^{++}_{j1} Z^H_{i4} - \sqrt{2}\beta_1 Z^+_{k2} Z^+_{l1} Z^{++}_{j1} Z^H_{i4} \\
&- \sqrt{2}\beta_1 Z^+_{k1} Z^+_{l2} Z^{++}_{j1} Z^H_{i4} - 2\sqrt{2}\beta_2 Z^+_{k2} Z^+_{l2} Z^{++}_{j1} Z^H_{i4} \\
&+ Z^+_{k4}\Big(Z^+_{l1}\Big(\alpha_3 Z^{++}_{j2} Z^H_{i1} + Z^{++}_{j1}\Big(-2\beta_3 Z^H_{i1} + \beta_1 Z^H_{i2}\Big)\Big) \\
&+ Z^+_{l2}\Big(\alpha_3 Z^{++}_{j2} Z^H_{i2} + Z^{++}_{j1}\Big(2\beta_2 Z^H_{i2} - \beta_1 Z^H_{i1}\Big)\Big) - 4\sqrt{2} Z^+_{l4}\Big(\rho_2 Z^{++}_{j2} Z^H_{i4} + \rho_4 Z^{++}_{j1} Z^H_{i3}\Big)\Big) \\
&+ Z^+_{k3}\Big(Z^+_{l2}\Big(\alpha_3 Z^{++}_{j1} Z^H_{i1} + Z^{++}_{j2}\Big(-2\beta_3 Z^H_{i1} + \beta_1 Z^H_{i2}\Big)\Big) \\
&+ Z^+_{l1}\Big(\alpha_3 Z^{++}_{j1} Z^H_{i2} + Z^{++}_{j2}\Big(2\beta_2 Z^H_{i2} - \beta_1 Z^H_{i1}\Big)\Big) - 4\sqrt{2} Z^+_{l3}\Big(\rho_2 Z^{++}_{j1} Z^H_{i3} + \rho_4 Z^{++}_{j2} Z^H_{i4}\Big)\Big)\Big)
\end{aligned}
\tag{298}
$$



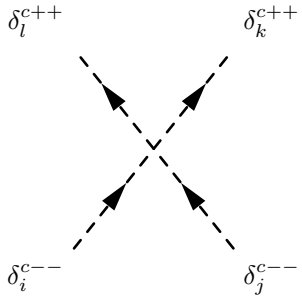
$$
\begin{aligned}
&- \frac{i}{2}\Big(2\alpha_1 Z^+_{i3} Z^+_{j1} Z^+_{k3} Z^+_{l1} + \alpha_3 Z^+_{i3} Z^+_{j1} Z^+_{k3} Z^+_{l1} - \beta_1 Z^+_{i4} Z^+_{j1} Z^+_{k3} Z^+_{l1} \\
&+ 4\alpha_2 Z^+_{i3} Z^+_{j2} Z^+_{k3} Z^+_{l1} - 2\beta_2 Z^+_{i4} Z^+_{j2} Z^+_{k3} Z^+_{l1} - \beta_1 Z^+_{i3} Z^+_{j1} Z^+_{k4} Z^+_{l1} \\
&+ 2\alpha_1 Z^+_{i4} Z^+_{j1} Z^+_{k4} Z^+_{l1} + \alpha_3 Z^+_{i4} Z^+_{j1} Z^+_{k4} Z^+_{l1} - 2\beta_3 Z^+_{i3} Z^+_{j2} Z^+_{k4} Z^+_{l1} \\
&+ 4\alpha_2 Z^+_{i4} Z^+_{j2} Z^+_{k4} Z^+_{l1} + 4\alpha_2 Z^+_{i3} Z^+_{j1} Z^+_{k3} Z^+_{l2} - 2\beta_3 Z^+_{i4} Z^+_{j1} Z^+_{k3} Z^+_{l2} \\
&+ 2\alpha_1 Z^+_{i3} Z^+_{j2} Z^+_{k3} Z^+_{l2} + \alpha_3 Z^+_{i3} Z^+_{j2} Z^+_{k3} Z^+_{l2} - \beta_1 Z^+_{i4} Z^+_{j2} Z^+_{k3} Z^+_{l2} \\
&- 2\beta_2 Z^+_{i3} Z^+_{j1} Z^+_{k4} Z^+_{l2} + 4\alpha_2 Z^+_{i4} Z^+_{j1} Z^+_{k4} Z^+_{l2} - \beta_1 Z^+_{i3} Z^+_{j2} Z^+_{k4} Z^+_{l2} \\
&+ 2\alpha_1 Z^+_{i4} Z^+_{j2} Z^+_{k4} Z^+_{l2} + \alpha_3 Z^+_{i4} Z^+_{j2} Z^+_{k4} Z^+_{l2} + 2\alpha_1 Z^+_{i3} Z^+_{j1} Z^+_{k1} Z^+_{l3} \\
&+ \alpha_3 Z^+_{i3} Z^+_{j1} Z^+_{k1} Z^+_{l3} - \beta_1 Z^+_{i4} Z^+_{j1} Z^+_{k1} Z^+_{l3} + 4\alpha_2 Z^+_{i3} Z^+_{j2} Z^+_{k1} Z^+_{l3} \\
&- 2\beta_2 Z^+_{i4} Z^+_{j2} Z^+_{k1} Z^+_{l3} + 4\alpha_2 Z^+_{i3} Z^+_{j1} Z^+_{k2} Z^+_{l3} - 2\beta_3 Z^+_{i4} Z^+_{j1} Z^+_{k2} Z^+_{l3} \\
&+ 2\alpha_1 Z^+_{i3} Z^+_{j2} Z^+_{k2} Z^+_{l3} + \alpha_3 Z^+_{i3} Z^+_{j2} Z^+_{k2} Z^+_{l3} - \beta_1 Z^+_{i4} Z^+_{j2} Z^+_{k2} Z^+_{l3} \\
&+ 8\rho_1 Z^+_{i3} Z^+_{j3} Z^+_{k3} Z^+_{l3} + 8\rho_2 Z^+_{i3} Z^+_{j3} Z^+_{k3} Z^+_{l3} + 8\rho_4 Z^+_{i4} Z^+_{j4} Z^+_{k3} Z^+_{l3} \\
&+ 2\rho_3 Z^+_{i4} Z^+_{j3} Z^+_{k4} Z^+_{l3} + 2\rho_3 Z^+_{i3} Z^+_{j4} Z^+_{k4} Z^+_{l3} - \beta_1 Z^+_{i3} Z^+_{j1} Z^+_{k1} Z^+_{l4} \\
&+ 2\alpha_1 Z^+_{i4} Z^+_{j1} Z^+_{k1} Z^+_{l4} + \alpha_3 Z^+_{i4} Z^+_{j1} Z^+_{k1} Z^+_{l4} - 2\beta_3 Z^+_{i3} Z^+_{j2} Z^+_{k1} Z^+_{l4} \\
&+ 4\alpha_2 Z^+_{i4} Z^+_{j2} Z^+_{k1} Z^+_{l4} - 2\beta_2 Z^+_{i3} Z^+_{j1} Z^+_{k2} Z^+_{l4} + 4\alpha_2 Z^+_{i4} Z^+_{j1} Z^+_{k2} Z^+_{l4}
\end{aligned}
$$

$$
\begin{aligned}
&- \beta_1 Z_{i3}^+ Z_{j2}^+ Z_{k2}^+ Z_{l4}^+ + 2\alpha_1 Z_{i4}^+ Z_{j2}^+ Z_{k2}^+ Z_{l4}^+ + \alpha_3 Z_{i4}^+ Z_{j2}^+ Z_{k2}^+ Z_{l4}^+ \\
&+ 2\rho_3 Z_{i4}^+ Z_{j3}^+ Z_{k3}^+ Z_{l4}^+ + 2\rho_3 Z_{i3}^+ Z_{j4}^+ Z_{k3}^+ Z_{l4}^+ + 8\rho_4 Z_{i3}^+ Z_{j3}^+ Z_{k4}^+ Z_{l4}^+ \\
&+ 8\rho_1 Z_{i4}^+ Z_{j4}^+ Z_{k4}^+ Z_{l4}^+ + 8\rho_2 Z_{i4}^+ Z_{j4}^+ Z_{k4}^+ Z_{l4}^+ \\
&+ Z_{i1}^+ \Big(2\alpha_1 Z_{j3}^+ Z_{k3}^+ Z_{l1}^+ + \alpha_3 Z_{j3}^+ Z_{k3}^+ Z_{l1}^+ - \beta_1 Z_{j4}^+ Z_{k3}^+ Z_{l1}^+ - \beta_1 Z_{j3}^+ Z_{k4}^+ Z_{l1}^+ \\
&+ 2\alpha_1 Z_{j4}^+ Z_{k4}^+ Z_{l1}^+ + \alpha_3 Z_{j4}^+ Z_{k4}^+ Z_{l1}^+ + 4\alpha_2 Z_{j3}^+ Z_{k3}^+ Z_{l2}^+ - 2\beta_3 Z_{j4}^+ Z_{k3}^+ Z_{l2}^+ \\
&- 2\beta_2 Z_{j3}^+ Z_{k4}^+ Z_{l2}^+ + 4\alpha_2 Z_{j4}^+ Z_{k4}^+ Z_{l2}^+ \\
&+ 8 Z_{j1}^+ \Big(Z_{k1}^+ \Big(\lambda_4 Z_{l2}^+ + \lambda Z_{l1}^+ \Big) + Z_{k2}^+ \Big(4\lambda_2 Z_{l2}^+ + \lambda_4 Z_{l1}^+ \Big) \Big) \\
&+ 4 Z_{j2}^+ \Big(Z_{k1}^+ \Big(\Big(2\lambda_3 + \lambda \Big) Z_{l2}^+ + 2\lambda_4 Z_{l1}^+ \Big) + Z_{k2}^+ \Big(\Big(2\lambda_3 + \lambda \Big) Z_{l1}^+ + 2\lambda_4 Z_{l2}^+ \Big) \Big) + 2\alpha_1 Z_{j3}^+ Z_{k1}^+ Z_{l3}^+ \\
&+ \alpha_3 Z_{j3}^+ Z_{k1}^+ Z_{l3}^+ - \beta_1 Z_{j4}^+ Z_{k1}^+ Z_{l3}^+ + 4\alpha_2 Z_{j3}^+ Z_{k2}^+ Z_{l3}^+ - 2\beta_3 Z_{j4}^+ Z_{k2}^+ Z_{l3}^+ \\
&- \beta_1 Z_{j3}^+ Z_{k1}^+ Z_{l4}^+ + 2\alpha_1 Z_{j4}^+ Z_{k1}^+ Z_{l4}^+ + \alpha_3 Z_{j4}^+ Z_{k1}^+ Z_{l4}^+ - 2\beta_2 Z_{j3}^+ Z_{k2}^+ Z_{l4}^+ \\
&+ 4\alpha_2 Z_{j4}^+ Z_{k2}^+ Z_{l4}^+ \Big) \\
&+ Z_{i2}^+ \Big(4\alpha_2 Z_{j3}^+ Z_{k3}^+ Z_{l1}^+ - 2\beta_2 Z_{j4}^+ Z_{k3}^+ Z_{l1}^+ - 2\beta_3 Z_{j3}^+ Z_{k4}^+ Z_{l1}^+ + 4\alpha_2 Z_{j4}^+ Z_{k4}^+ Z_{l1}^+ \\
&+ 2\alpha_1 Z_{j3}^+ Z_{k3}^+ Z_{l2}^+ + \alpha_3 Z_{j3}^+ Z_{k3}^+ Z_{l2}^+ - \beta_1 Z_{j4}^+ Z_{k3}^+ Z_{l2}^+ - \beta_1 Z_{j3}^+ Z_{k4}^+ Z_{l2}^+ \\
&+ 2\alpha_1 Z_{j4}^+ Z_{k4}^+ Z_{l2}^+ + \alpha_3 Z_{j4}^+ Z_{k4}^+ Z_{l2}^+ \\
&+ 8 Z_{j2}^+ \Big(Z_{k1}^+ \Big(4\lambda_2 Z_{l1}^+ + \lambda_4 Z_{l2}^+ \Big) + Z_{k2}^+ \Big(\lambda_4 Z_{l1}^+ + \lambda Z_{l2}^+ \Big) \Big) \\
&+ 4 Z_{j1}^+ \Big(Z_{k1}^+ \Big(\Big(2\lambda_3 + \lambda \Big) Z_{l2}^+ + 2\lambda_4 Z_{l1}^+ \Big) + Z_{k2}^+ \Big(\Big(2\lambda_3 + \lambda \Big) Z_{l1}^+ + 2\lambda_4 Z_{l2}^+ \Big) \Big) + 4\alpha_2 Z_{j3}^+ Z_{k1}^+ Z_{l3}^+ \\
&- 2\beta_2 Z_{j4}^+ Z_{k1}^+ Z_{l3}^+ + 2\alpha_1 Z_{j3}^+ Z_{k2}^+ Z_{l3}^+ + \alpha_3 Z_{j3}^+ Z_{k2}^+ Z_{l3}^+ - \beta_1 Z_{j4}^+ Z_{k2}^+ Z_{l3}^+ \\
&- 2\beta_3 Z_{j3}^+ Z_{k1}^+ Z_{l4}^+ + 4\alpha_2 Z_{j4}^+ Z_{k1}^+ Z_{l4}^+ - \beta_1 Z_{j3}^+ Z_{k2}^+ Z_{l4}^+ + 2\alpha_1 Z_{j4}^+ Z_{k2}^+ Z_{l4}^+ \\
&+ \alpha_3 Z_{j4}^+ Z_{k2}^+ Z_{l4}^+ \Big) \Big)
\end{aligned}
\tag{299}
$$



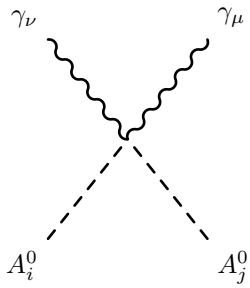
$$
\begin{aligned}
&- i \Big(2\rho_1 Z_{i3}^+ Z_{k3}^+ Z_{j1}^{++} Z_{l1}^{++} + \rho_3 Z_{i4}^+ Z_{k4}^+ Z_{j1}^{++} Z_{l1}^{++} + \rho_3 Z_{i3}^+ Z_{k3}^+ Z_{j2}^{++} Z_{l2}^{++} \\
&+ 2\rho_1 Z_{i4}^+ Z_{k4}^+ Z_{j2}^{++} Z_{l2}^{++}
\end{aligned}
$$

$$+ Z_{i1}^{+}\Big(2\alpha_2 Z_{k2}^{+}\Big(Z_{j1}^{++}Z_{l1}^{++} + Z_{j2}^{++}Z_{l2}^{++}\Big) + Z_{k1}^{+}\Big(\Big(\alpha_1+\alpha_3\Big)Z_{j1}^{++}Z_{l1}^{++} + \alpha_1 Z_{j2}^{++}Z_{l2}^{++}\Big)\Big)$$
$$+ Z_{i2}^{+}\Big(2\alpha_2 Z_{k1}^{+}\Big(Z_{j1}^{++}Z_{l1}^{++} + Z_{j2}^{++}Z_{l2}^{++}\Big) + Z_{k2}^{+}\Big(\Big(\alpha_1+\alpha_3\Big)Z_{j2}^{++}Z_{l2}^{++} + \alpha_1 Z_{j1}^{++}Z_{l1}^{++}\Big)\Big)\Big) \tag{300}$$

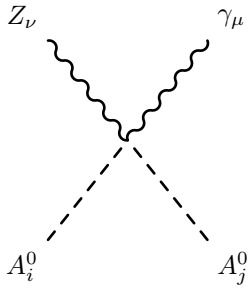


$$-i\Big(Z_{i2}^{++}\Big(4\rho_1 Z_{j2}^{++}Z_{k2}^{++}Z_{l2}^{++} + \rho_3 Z_{j1}^{++}\Big(Z_{k1}^{++}Z_{l2}^{++} + Z_{k2}^{++}Z_{l1}^{++}\Big)\Big)$$
$$+ Z_{i1}^{++}\Big(4\rho_1 Z_{j1}^{++}Z_{k1}^{++}Z_{l1}^{++} + \rho_3 Z_{j2}^{++}\Big(Z_{k1}^{++}Z_{l2}^{++} + Z_{k2}^{++}Z_{l1}^{++}\Big)\Big)\Big) \tag{301}$$

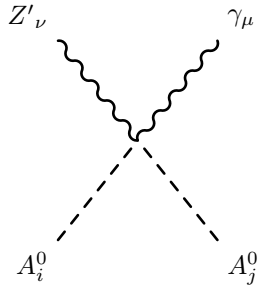
8.8 Two Scalar-Two Vector Boson-Interaction



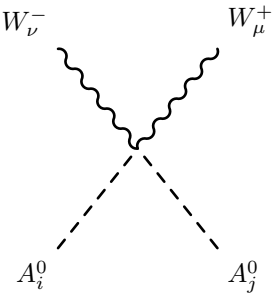
$$\frac{i}{2}\Big(4Z_{i4}^{Ah}Z_{j4}^{Ah}\Big(-g_2 Z_{21}^{Z} + g_B Z_{11}^{Z}\Big)^2 + 4Z_{i3}^{Ah}Z_{j3}^{Ah}\Big(g_B Z_{11}^{Z} - g_R Z_{31}^{Z}\Big)^2$$
$$+ \Big(Z_{i1}^{Ah}Z_{j1}^{Ah} + Z_{i2}^{Ah}Z_{j2}^{Ah}\Big)\Big(g_2 Z_{21}^{Z} - g_R Z_{31}^{Z}\Big)^2\Big)\Big(g_{\mu\nu}\Big) \tag{302}$$



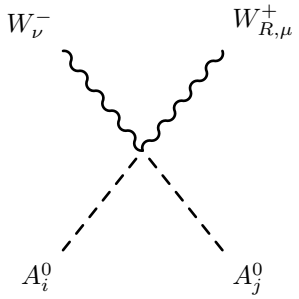
$$\frac{i}{2}\Big(4Z_{i4}^{Ah}Z_{j4}^{Ah}\Big(-g_2Z_{21}^{Z}+g_BZ_{11}^{Z}\Big)\Big(-g_2Z_{22}^{Z}+g_BZ_{12}^{Z}\Big)$$
$$+4Z_{i3}^{Ah}Z_{j3}^{Ah}\Big(g_BZ_{11}^{Z}-g_RZ_{31}^{Z}\Big)\Big(g_BZ_{12}^{Z}-g_RZ_{32}^{Z}\Big)$$
$$+\Big(Z_{i1}^{Ah}Z_{j1}^{Ah}+Z_{i2}^{Ah}Z_{j2}^{Ah}\Big)\Big(g_2Z_{21}^{Z}-g_RZ_{31}^{Z}\Big)\Big(g_2Z_{22}^{Z}-g_RZ_{32}^{Z}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{303}$$



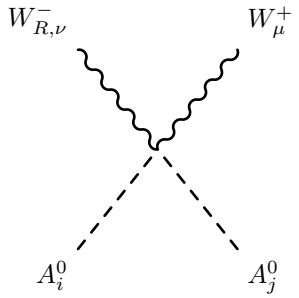
$$\frac{i}{2}\Big(4Z_{i4}^{Ah}Z_{j4}^{Ah}\Big(-g_2Z_{21}^{Z}+g_BZ_{11}^{Z}\Big)\Big(-g_2Z_{23}^{Z}+g_BZ_{13}^{Z}\Big)$$
$$+4Z_{i3}^{Ah}Z_{j3}^{Ah}\Big(g_BZ_{11}^{Z}-g_RZ_{31}^{Z}\Big)\Big(g_BZ_{13}^{Z}-g_RZ_{33}^{Z}\Big)$$
$$+\Big(Z_{i1}^{Ah}Z_{j1}^{Ah}+Z_{i2}^{Ah}Z_{j2}^{Ah}\Big)\Big(g_2Z_{21}^{Z}-g_RZ_{31}^{Z}\Big)\Big(g_2Z_{23}^{Z}-g_RZ_{33}^{Z}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{304}$$



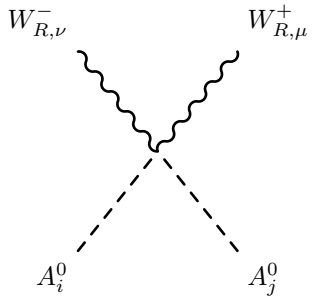
$$\frac{i}{2}\Big(Z_{i1}^{Ah}\Big(-2g_2g_R\cos\phi_W\sin\phi_WZ_{j2}^{Ah}+\Big(g_2^2\cos\phi_W^2+g_R^2\sin\phi_W^2\Big)Z_{j1}^{Ah}\Big)$$
$$+Z_{i2}^{Ah}\Big(-2g_2g_R\cos\phi_W\sin\phi_WZ_{j1}^{Ah}+\Big(g_2^2\cos\phi_W^2+g_R^2\sin\phi_W^2\Big)Z_{j2}^{Ah}\Big)$$
$$+2\Big(g_2^2\cos\phi_W^2Z_{i4}^{Ah}Z_{j4}^{Ah}+g_R^2\sin\phi_W^2Z_{i3}^{Ah}Z_{j3}^{Ah}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{305}$$



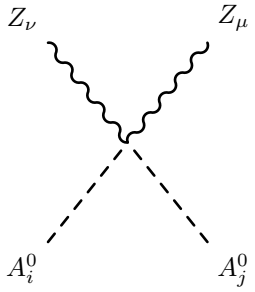
$$
\begin{aligned}
&-\frac{i}{4}\Big(Z_{i1}^{Ah}\Big(2g_2g_R\cos 2\phi_W Z_{j2}^{Ah}+\Big(-g_R^2+g_2^2\Big)\sin 2\phi_W Z_{j1}^{Ah}\Big)\\
&+Z_{i2}^{Ah}\Big(2g_2g_R\cos 2\phi_W Z_{j1}^{Ah}+\Big(-g_R^2+g_2^2\Big)\sin 2\phi_W Z_{j2}^{Ah}\Big)\\
&+2\sin 2\phi_W\Big(g_2^2Z_{i4}^{Ah}Z_{j4}^{Ah}-g_R^2Z_{i3}^{Ah}Z_{j3}^{Ah}\Big)\Big)\Big(g_{\mu\nu}\Big)
\end{aligned}
\tag{306}
$$



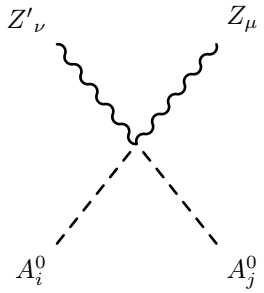
$$
\begin{aligned}
&-\frac{i}{4}\Big(Z_{i1}^{Ah}\Big(2g_2g_R\cos 2\phi_W Z_{j2}^{Ah}+\Big(-g_R^2+g_2^2\Big)\sin 2\phi_W Z_{j1}^{Ah}\Big)\\
&+Z_{i2}^{Ah}\Big(2g_2g_R\cos 2\phi_W Z_{j1}^{Ah}+\Big(-g_R^2+g_2^2\Big)\sin 2\phi_W Z_{j2}^{Ah}\Big)\\
&+2\sin 2\phi_W\Big(g_2^2Z_{i4}^{Ah}Z_{j4}^{Ah}-g_R^2Z_{i3}^{Ah}Z_{j3}^{Ah}\Big)\Big)\Big(g_{\mu\nu}\Big)
\end{aligned}
\tag{307}
$$



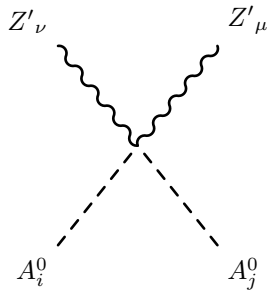
$$\frac{i}{2}\Big(Z_{i2}^{Ah}\Big(\Big(g_2^2\sin\phi_W^2+g_R^2\cos\phi_W^2\Big)Z_{j2}^{Ah}+g_2g_R\sin 2\phi_W Z_{j1}^{Ah}\Big)$$
$$+Z_{i1}^{Ah}\Big(\Big(g_2^2\sin\phi_W^2+g_R^2\cos\phi_W^2\Big)Z_{j1}^{Ah}+g_2g_R\sin 2\phi_W Z_{j2}^{Ah}\Big)$$
$$+2\Big(g_2^2\sin\phi_W^2Z_{i4}^{Ah}Z_{j4}^{Ah}+g_R^2\cos\phi_W^2Z_{i3}^{Ah}Z_{j3}^{Ah}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{308}$$



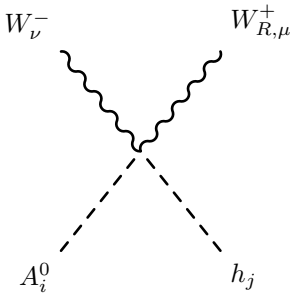
$$\frac{i}{2}\Big(4Z_{i4}^{Ah}Z_{j4}^{Ah}\Big(-g_2Z_{22}^Z+g_BZ_{12}^Z\Big)^2+4Z_{i3}^{Ah}Z_{j3}^{Ah}\Big(g_BZ_{12}^Z-g_RZ_{32}^Z\Big)^2$$
$$+\Big(Z_{i1}^{Ah}Z_{j1}^{Ah}+Z_{i2}^{Ah}Z_{j2}^{Ah}\Big)\Big(g_2Z_{22}^Z-g_RZ_{32}^Z\Big)^2\Big)\Big(g_{\mu\nu}\Big) \tag{309}$$



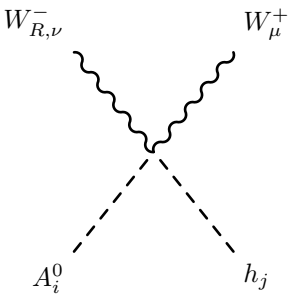
$$\frac{i}{2}\Big(4Z_{i4}^{Ah}Z_{j4}^{Ah}\Big(-g_2Z_{22}^Z+g_BZ_{12}^Z\Big)\Big(-g_2Z_{23}^Z+g_BZ_{13}^Z\Big)$$
$$+4Z_{i3}^{Ah}Z_{j3}^{Ah}\Big(g_BZ_{12}^Z-g_RZ_{32}^Z\Big)\Big(g_BZ_{13}^Z-g_RZ_{33}^Z\Big)$$
$$+\Big(Z_{i1}^{Ah}Z_{j1}^{Ah}+Z_{i2}^{Ah}Z_{j2}^{Ah}\Big)\Big(g_2Z_{22}^Z-g_RZ_{32}^Z\Big)\Big(g_2Z_{23}^Z-g_RZ_{33}^Z\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{310}$$



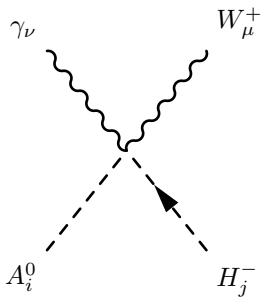
$$\frac{i}{2}\Big(4Z_{i4}^{Ah}Z_{j4}^{Ah}\Big(-g_2Z_{23}^{Z}+g_BZ_{13}^{Z}\Big)^2+4Z_{i3}^{Ah}Z_{j3}^{Ah}\Big(g_BZ_{13}^{Z}-g_RZ_{33}^{Z}\Big)^2 + \Big(Z_{i1}^{Ah}Z_{j1}^{Ah}+Z_{i2}^{Ah}Z_{j2}^{Ah}\Big)\Big(g_2Z_{23}^{Z}-g_RZ_{33}^{Z}\Big)^2\Big)\Big(g_{\mu\nu}\Big) \tag{311}$$



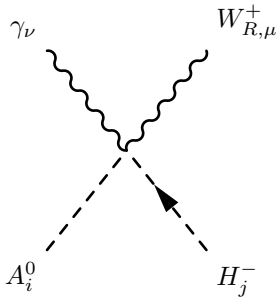
$$\frac{1}{2}g_2g_R\Big(Z_{i1}^{Ah}Z_{j2}^{H}-Z_{i2}^{Ah}Z_{j1}^{H}\Big)\Big(g_{\mu\nu}\Big) \tag{312}$$



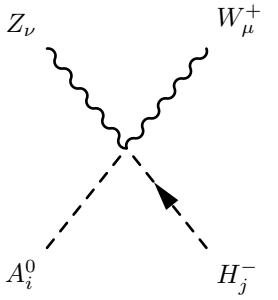
$$\frac{1}{2}g_2g_R\Big(-Z_{i1}^{Ah}Z_{j2}^{H}+Z_{i2}^{Ah}Z_{j1}^{H}\Big)\Big(g_{\mu\nu}\Big) \tag{313}$$



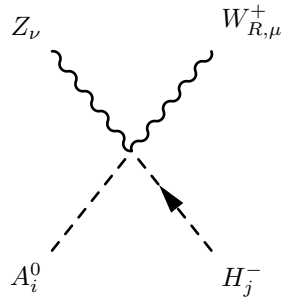
$$\frac{1}{2}\Big(\sqrt{2}g_R\sin\phi_W Z_{j3}^{+}Z_{i3}^{Ah}\Big(-2g_B Z_{11}^{Z}+g_R Z_{31}^{Z}\Big)$$
$$+g_2\Big(-\sqrt{2}\cos\phi_W Z_{j4}^{+}Z_{i4}^{Ah}\Big(2g_B Z_{11}^{Z}-g_2 Z_{21}^{Z}\Big)$$
$$+g_R\Big(Z_{j1}^{+}\Big(-\cos\phi_W Z_{i1}^{Ah}Z_{31}^{Z}+\sin\phi_W Z_{i2}^{Ah}Z_{21}^{Z}\Big)+Z_{j2}^{+}\Big(-\cos\phi_W Z_{i2}^{Ah}Z_{31}^{Z}+\sin\phi_W Z_{i1}^{Ah}Z_{21}^{Z}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{314}$$



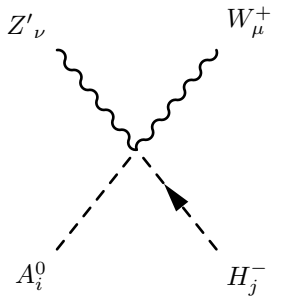
$$\frac{1}{2}\Big(\sqrt{2}g_R\cos\phi_W Z_{j3}^{+}Z_{i3}^{Ah}\Big(-2g_B Z_{11}^{Z}+g_R Z_{31}^{Z}\Big)$$
$$+g_2\Big(\sqrt{2}\sin\phi_W Z_{j4}^{+}Z_{i4}^{Ah}\Big(2g_B Z_{11}^{Z}-g_2 Z_{21}^{Z}\Big)$$
$$+g_R\Big(Z_{j1}^{+}\Big(\cos\phi_W Z_{i2}^{Ah}Z_{21}^{Z}+\sin\phi_W Z_{i1}^{Ah}Z_{31}^{Z}\Big)+Z_{j2}^{+}\Big(\cos\phi_W Z_{i1}^{Ah}Z_{21}^{Z}+\sin\phi_W Z_{i2}^{Ah}Z_{31}^{Z}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{315}$$



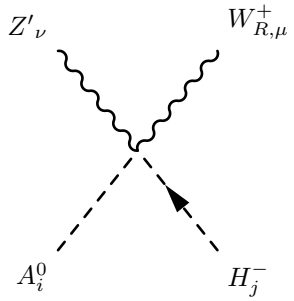
$$\frac{1}{2}\Big(\sqrt{2}g_R\sin\phi_W Z^+_{j3}Z^{Ah}_{i3}\Big(-2g_BZ^Z_{12}+g_RZ^Z_{32}\Big)$$
$$+g_2\Big(-\sqrt{2}\cos\phi_W Z^+_{j4}Z^{Ah}_{i4}\Big(2g_BZ^Z_{12}-g_2Z^Z_{22}\Big)$$
$$+g_R\Big(Z^+_{j1}\Big(-\cos\phi_W Z^{Ah}_{i1}Z^Z_{32}+\sin\phi_W Z^{Ah}_{i2}Z^Z_{22}\Big)+Z^+_{j2}\Big(-\cos\phi_W Z^{Ah}_{i2}Z^Z_{32}+\sin\phi_W Z^{Ah}_{i1}Z^Z_{22}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{316}$$



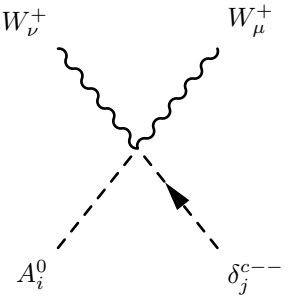
$$\frac{1}{2}\Big(\sqrt{2}g_R\cos\phi_W Z^+_{j3}Z^{Ah}_{i3}\Big(-2g_BZ^Z_{12}+g_RZ^Z_{32}\Big)$$
$$+g_2\Big(\sqrt{2}\sin\phi_W Z^+_{j4}Z^{Ah}_{i4}\Big(2g_BZ^Z_{12}-g_2Z^Z_{22}\Big)$$
$$+g_R\Big(Z^+_{j1}\Big(\cos\phi_W Z^{Ah}_{i2}Z^Z_{22}+\sin\phi_W Z^{Ah}_{i1}Z^Z_{32}\Big)+Z^+_{j2}\Big(\cos\phi_W Z^{Ah}_{i1}Z^Z_{22}+\sin\phi_W Z^{Ah}_{i2}Z^Z_{32}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{317}$$



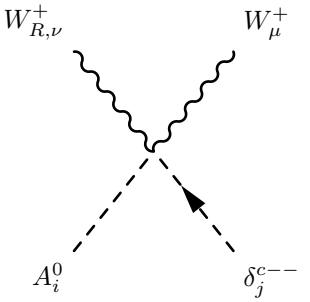
$$\frac{1}{2}\Big(\sqrt{2}g_R\sin\phi_W Z^+_{j3}Z^{Ah}_{i3}\Big(-2g_BZ^Z_{13}+g_RZ^Z_{33}\Big)$$
$$+g_2\Big(-\sqrt{2}\cos\phi_W Z^+_{j4}Z^{Ah}_{i4}\Big(2g_BZ^Z_{13}-g_2Z^Z_{23}\Big)$$
$$+g_R\Big(Z^+_{j1}\Big(-\cos\phi_W Z^{Ah}_{i1}Z^Z_{33}+\sin\phi_W Z^{Ah}_{i2}Z^Z_{23}\Big)+Z^+_{j2}\Big(-\cos\phi_W Z^{Ah}_{i2}Z^Z_{33}+\sin\phi_W Z^{Ah}_{i1}Z^Z_{23}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{318}$$



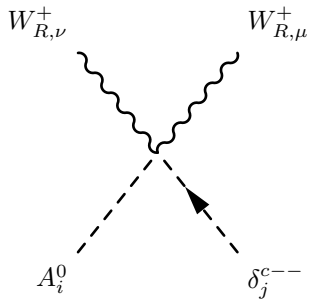
$$\frac{1}{2}\Big(\sqrt{2}g_R\cos\phi_W Z^+_{j3}Z^{Ah}_{i3}\Big(-2g_B Z^Z_{13}+g_R Z^Z_{33}\Big)$$
$$+\,g_2\Big(\sqrt{2}\sin\phi_W Z^+_{j4}Z^{Ah}_{i4}\Big(2g_B Z^Z_{13}-g_2 Z^Z_{23}\Big)$$
$$+\,g_R\Big(Z^+_{j1}\Big(\cos\phi_W Z^{Ah}_{i2}Z^Z_{23}+\sin\phi_W Z^{Ah}_{i1}Z^Z_{33}\Big)+Z^+_{j2}\Big(\cos\phi_W Z^{Ah}_{i1}Z^Z_{23}+\sin\phi_W Z^{Ah}_{i2}Z^Z_{33}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{319}$$



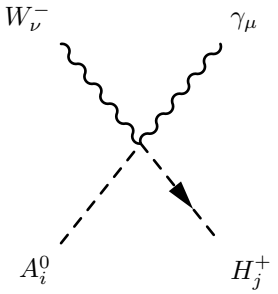
$$\sqrt{2}\Big(g_2^2\cos\phi_W^2 Z^{++}_{j2}Z^{Ah}_{i4}+g_R^2\sin\phi_W^2 Z^{++}_{j1}Z^{Ah}_{i3}\Big)\Big(g_{\mu\nu}\Big) \tag{320}$$



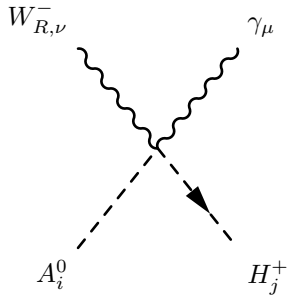
$$\sqrt{2}\cos\phi_W\sin\phi_W\Big(-g_2^2 Z^{++}_{j2}Z^{Ah}_{i4}+g_R^2 Z^{++}_{j1}Z^{Ah}_{i3}\Big)\Big(g_{\mu\nu}\Big) \tag{321}$$



$$\sqrt{2}\Big(g_2^2 \sin\phi_W^2 Z_{j2}^{++} Z_{i4}^{Ah} + g_R^2 \cos\phi_W^2 Z_{j1}^{++} Z_{i3}^{Ah}\Big)\Big(g_{\mu\nu}\Big) \tag{322}$$

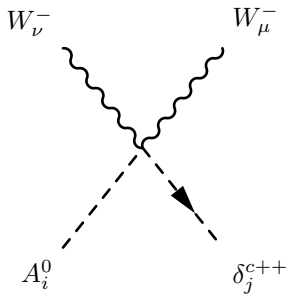


$$\begin{aligned}
&\frac{1}{2}\Big(\sqrt{2} g_R \sin\phi_W Z_{j3}^{+} Z_{i3}^{Ah}\Big(2 g_B Z_{11}^{Z} - g_R Z_{31}^{Z}\Big) \\
&+ g_2\Big(\sqrt{2}\cos\phi_W Z_{j4}^{+} Z_{i4}^{Ah}\Big(2 g_B Z_{11}^{Z} - g_2 Z_{21}^{Z}\Big) \\
&+ g_R\Big(Z_{j1}^{+}\Big(\cos\phi_W Z_{i1}^{Ah} Z_{31}^{Z} - \sin\phi_W Z_{i2}^{Ah} Z_{21}^{Z}\Big) + Z_{j2}^{+}\Big(\cos\phi_W Z_{i2}^{Ah} Z_{31}^{Z} - \sin\phi_W Z_{i1}^{Ah} Z_{21}^{Z}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big)
\end{aligned} \tag{323}$$

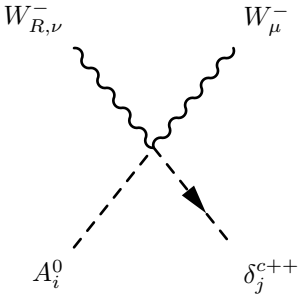


$$\frac{1}{2}\Big(\sqrt{2} g_R \cos\phi_W Z_{j3}^{+} Z_{i3}^{Ah}\Big(2 g_B Z_{11}^{Z} - g_R Z_{31}^{Z}\Big)$$

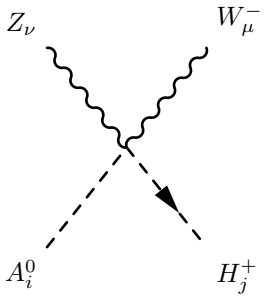
$$+ g_2\Big(- \sqrt{2}\sin\phi_W Z^+_{j4} Z^{Ah}_{i4}\Big(2g_B Z^Z_{11} - g_2 Z^Z_{21}\Big)$$
$$- g_R\Big(Z^+_{j1}\Big(\cos\phi_W Z^{Ah}_{i2} Z^Z_{21} + \sin\phi_W Z^{Ah}_{i1} Z^Z_{31}\Big) + Z^+_{j2}\Big(\cos\phi_W Z^{Ah}_{i1} Z^Z_{21} + \sin\phi_W Z^{Ah}_{i2} Z^Z_{31}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{324}$$



$$-\sqrt{2}\Big(g_2^2\cos\phi_W^2 Z^{++}_{j2} Z^{Ah}_{i4} + g_R^2\sin\phi_W^2 Z^{++}_{j1} Z^{Ah}_{i3}\Big)\Big(g_{\mu\nu}\Big) \tag{325}$$

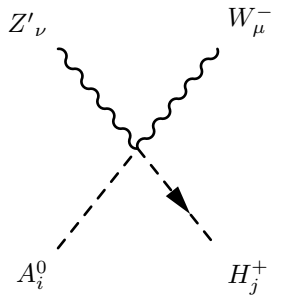


$$\sqrt{2}\cos\phi_W\sin\phi_W\Big(g_2^2 Z^{++}_{j2} Z^{Ah}_{i4} - g_R^2 Z^{++}_{j1} Z^{Ah}_{i3}\Big)\Big(g_{\mu\nu}\Big) \tag{326}$$

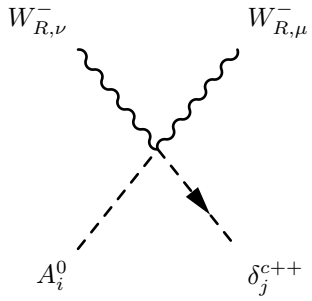


$$\frac{1}{2}\Big(\sqrt{2}g_R\sin\phi_W Z^+_{j3} Z^{Ah}_{i3}\Big(2g_B Z^Z_{12} - g_R Z^Z_{32}\Big)$$

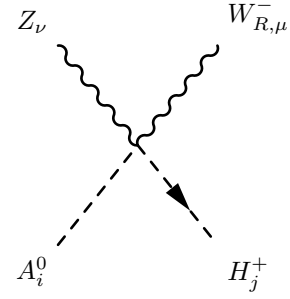
$$+ g_2\Big(\sqrt{2}\cos\phi_W Z^+_{j4} Z^{Ah}_{i4}\Big(2g_B Z^Z_{12} - g_2 Z^Z_{22}\Big)$$
$$+ g_R\Big(Z^+_{j1}\Big(\cos\phi_W Z^{Ah}_{i1} Z^Z_{32} - \sin\phi_W Z^{Ah}_{i2} Z^Z_{22}\Big) + Z^+_{j2}\Big(\cos\phi_W Z^{Ah}_{i2} Z^Z_{32} - \sin\phi_W Z^{Ah}_{i1} Z^Z_{22}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{327}$$



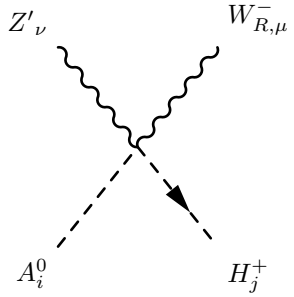
$$\frac{1}{2}\Big(\sqrt{2} g_R \sin\phi_W Z^+_{j3} Z^{Ah}_{i3}\Big(2g_B Z^Z_{13} - g_R Z^Z_{33}\Big)$$
$$+ g_2\Big(\sqrt{2}\cos\phi_W Z^+_{j4} Z^{Ah}_{i4}\Big(2g_B Z^Z_{13} - g_2 Z^Z_{23}\Big)$$
$$+ g_R\Big(Z^+_{j1}\Big(\cos\phi_W Z^{Ah}_{i1} Z^Z_{33} - \sin\phi_W Z^{Ah}_{i2} Z^Z_{23}\Big) + Z^+_{j2}\Big(\cos\phi_W Z^{Ah}_{i2} Z^Z_{33} - \sin\phi_W Z^{Ah}_{i1} Z^Z_{23}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{328}$$



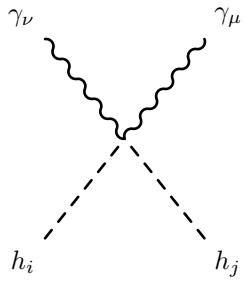
$$-\sqrt{2}\Big(g_2^2 \sin\phi_W^2 Z^{++}_{j2} Z^{Ah}_{i4} + g_R^2 \cos\phi_W^2 Z^{++}_{j1} Z^{Ah}_{i3}\Big)\Big(g_{\mu\nu}\Big) \tag{329}$$



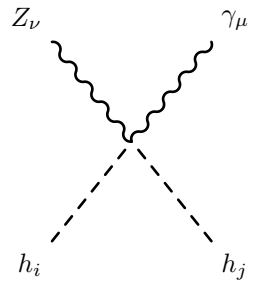
$$\frac{1}{2}\Big(\sqrt{2}g_R\cos\phi_W Z^+_{j3}Z^{Ah}_{i3}\Big(2g_B Z^Z_{12}-g_R Z^Z_{32}\Big)$$
$$+g_2\Big(-\sqrt{2}\sin\phi_W Z^+_{j4}Z^{Ah}_{i4}\Big(2g_B Z^Z_{12}-g_2 Z^Z_{22}\Big)$$
$$-g_R\Big(Z^+_{j1}\Big(\cos\phi_W Z^{Ah}_{i2}Z^Z_{22}+\sin\phi_W Z^{Ah}_{i1}Z^Z_{32}\Big)+Z^+_{j2}\Big(\cos\phi_W Z^{Ah}_{i1}Z^Z_{22}+\sin\phi_W Z^{Ah}_{i2}Z^Z_{32}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{330}$$



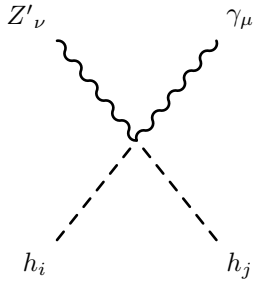
$$\frac{1}{2}\Big(\sqrt{2}g_R\cos\phi_W Z^+_{j3}Z^{Ah}_{i3}\Big(2g_B Z^Z_{13}-g_R Z^Z_{33}\Big)$$
$$+g_2\Big(-\sqrt{2}\sin\phi_W Z^+_{j4}Z^{Ah}_{i4}\Big(2g_B Z^Z_{13}-g_2 Z^Z_{23}\Big)$$
$$-g_R\Big(Z^+_{j1}\Big(\cos\phi_W Z^{Ah}_{i2}Z^Z_{23}+\sin\phi_W Z^{Ah}_{i1}Z^Z_{33}\Big)+Z^+_{j2}\Big(\cos\phi_W Z^{Ah}_{i1}Z^Z_{23}+\sin\phi_W Z^{Ah}_{i2}Z^Z_{33}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{331}$$



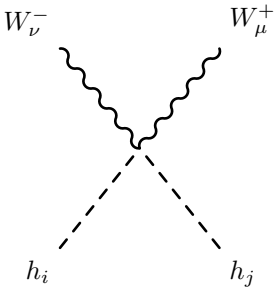
$$\frac{i}{2}\Big(4Z^H_{i4}Z^H_{j4}\Big(-g_2Z^Z_{21}+g_BZ^Z_{11}\Big)^2+4Z^H_{i3}Z^H_{j3}\Big(g_BZ^Z_{11}-g_RZ^Z_{31}\Big)^2$$
$$+\Big(Z^H_{i1}Z^H_{j1}+Z^H_{i2}Z^H_{j2}\Big)\Big(g_2Z^Z_{21}-g_RZ^Z_{31}\Big)^2\Big)\Big(g_{\mu\nu}\Big) \tag{332}$$



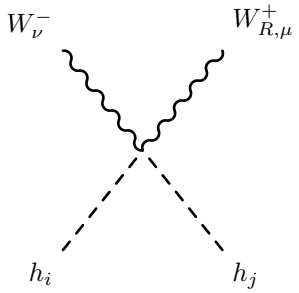
$$\frac{i}{2}\Big(4Z^H_{i4}Z^H_{j4}\Big(-g_2Z^Z_{21}+g_BZ^Z_{11}\Big)\Big(-g_2Z^Z_{22}+g_BZ^Z_{12}\Big)$$
$$+4Z^H_{i3}Z^H_{j3}\Big(g_BZ^Z_{11}-g_RZ^Z_{31}\Big)\Big(g_BZ^Z_{12}-g_RZ^Z_{32}\Big)$$
$$+\Big(Z^H_{i1}Z^H_{j1}+Z^H_{i2}Z^H_{j2}\Big)\Big(g_2Z^Z_{21}-g_RZ^Z_{31}\Big)\Big(g_2Z^Z_{22}-g_RZ^Z_{32}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{333}$$



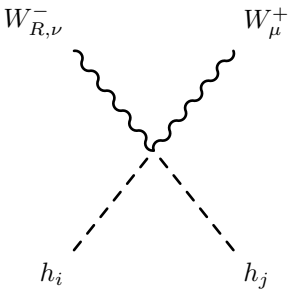
$$\frac{i}{2}\Big(4Z^H_{i4}Z^H_{j4}\Big(-g_2Z^Z_{21}+g_BZ^Z_{11}\Big)\Big(-g_2Z^Z_{23}+g_BZ^Z_{13}\Big)$$
$$+4Z^H_{i3}Z^H_{j3}\Big(g_BZ^Z_{11}-g_RZ^Z_{31}\Big)\Big(g_BZ^Z_{13}-g_RZ^Z_{33}\Big)$$
$$+\Big(Z^H_{i1}Z^H_{j1}+Z^H_{i2}Z^H_{j2}\Big)\Big(g_2Z^Z_{21}-g_RZ^Z_{31}\Big)\Big(g_2Z^Z_{23}-g_RZ^Z_{33}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{334}$$



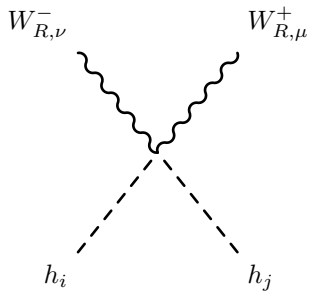
$$\frac{i}{2}\Big(Z^H_{i1}\Big(-2g_2g_R\cos\phi_W\sin\phi_W Z^H_{j2}+\Big(g_2^2\cos\phi_W^2+g_R^2\sin\phi_W^2\Big)Z^H_{j1}\Big)$$
$$+Z^H_{i2}\Big(-2g_2g_R\cos\phi_W\sin\phi_W Z^H_{j1}+\Big(g_2^2\cos\phi_W^2+g_R^2\sin\phi_W^2\Big)Z^H_{j2}\Big)$$
$$+2\Big(g_2^2\cos\phi_W^2 Z^H_{i4}Z^H_{j4}+g_R^2\sin\phi_W^2 Z^H_{i3}Z^H_{j3}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{335}$$



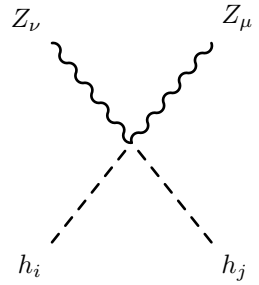
$$-\frac{i}{4}\Big(Z^H_{i1}\Big(2g_2g_R\cos 2\phi_W Z^H_{j2}+\Big(-g_R^2+g_2^2\Big)\sin 2\phi_W Z^H_{j1}\Big)$$
$$+Z^H_{i2}\Big(2g_2g_R\cos 2\phi_W Z^H_{j1}+\Big(-g_R^2+g_2^2\Big)\sin 2\phi_W Z^H_{j2}\Big)$$
$$+2\sin 2\phi_W\Big(g_2^2 Z^H_{i4}Z^H_{j4}-g_R^2 Z^H_{i3}Z^H_{j3}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{336}$$



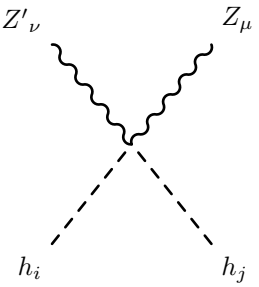
$$-\frac{i}{4}\Big(Z^H_{i1}\Big(2g_2g_R\cos 2\phi_W Z^H_{j2}+\Big(-g_R^2+g_2^2\Big)\sin 2\phi_W Z^H_{j1}\Big)$$
$$+Z^H_{i2}\Big(2g_2g_R\cos 2\phi_W Z^H_{j1}+\Big(-g_R^2+g_2^2\Big)\sin 2\phi_W Z^H_{j2}\Big)$$
$$+2\sin 2\phi_W\Big(g_2^2 Z^H_{i4}Z^H_{j4}-g_R^2 Z^H_{i3}Z^H_{j3}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{337}$$



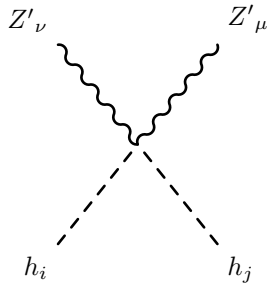
$$\frac{i}{2}\Big(Z^H_{i2}\Big(\Big(g_2^2\sin\phi_W^2+g_R^2\cos\phi_W^2\Big)Z^H_{j2}+g_2g_R\sin 2\phi_W Z^H_{j1}\Big) + Z^H_{i1}\Big(\Big(g_2^2\sin\phi_W^2+g_R^2\cos\phi_W^2\Big)Z^H_{j1}+g_2g_R\sin 2\phi_W Z^H_{j2}\Big) + 2\Big(g_2^2\sin\phi_W^2 Z^H_{i4}Z^H_{j4}+g_R^2\cos\phi_W^2 Z^H_{i3}Z^H_{j3}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{338}$$



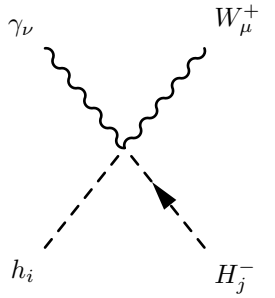
$$\frac{i}{2}\Big(4Z^H_{i4}Z^H_{j4}\Big(-g_2Z^Z_{22}+g_BZ^Z_{12}\Big)^2+4Z^H_{i3}Z^H_{j3}\Big(g_BZ^Z_{12}-g_RZ^Z_{32}\Big)^2 + \Big(Z^H_{i1}Z^H_{j1}+Z^H_{i2}Z^H_{j2}\Big)\Big(g_2Z^Z_{22}-g_RZ^Z_{32}\Big)^2\Big)\Big(g_{\mu\nu}\Big) \tag{339}$$



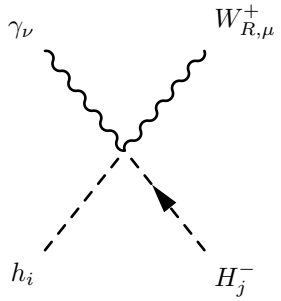
$$\frac{i}{2}\Big(4Z_{i4}^{H}Z_{j4}^{H}\Big(-g_2Z_{22}^{Z}+g_BZ_{12}^{Z}\Big)\Big(-g_2Z_{23}^{Z}+g_BZ_{13}^{Z}\Big)$$
$$+4Z_{i3}^{H}Z_{j3}^{H}\Big(g_BZ_{12}^{Z}-g_RZ_{32}^{Z}\Big)\Big(g_BZ_{13}^{Z}-g_RZ_{33}^{Z}\Big)$$
$$+\Big(Z_{i1}^{H}Z_{j1}^{H}+Z_{i2}^{H}Z_{j2}^{H}\Big)\Big(g_2Z_{22}^{Z}-g_RZ_{32}^{Z}\Big)\Big(g_2Z_{23}^{Z}-g_RZ_{33}^{Z}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{340}$$



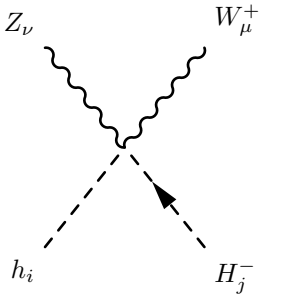
$$\frac{i}{2}\Big(4Z_{i4}^{H}Z_{j4}^{H}\Big(-g_2Z_{23}^{Z}+g_BZ_{13}^{Z}\Big)^2+4Z_{i3}^{H}Z_{j3}^{H}\Big(g_BZ_{13}^{Z}-g_RZ_{33}^{Z}\Big)^2$$
$$+\Big(Z_{i1}^{H}Z_{j1}^{H}+Z_{i2}^{H}Z_{j2}^{H}\Big)\Big(g_2Z_{23}^{Z}-g_RZ_{33}^{Z}\Big)^2\Big)\Big(g_{\mu\nu}\Big) \tag{341}$$



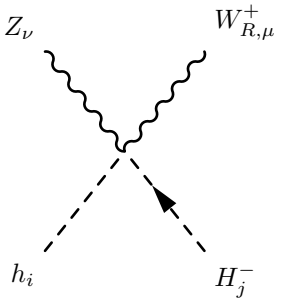
$$\frac{i}{2}\Big(\sqrt{2}g_R\sin\phi_W Z_{j3}^{+}Z_{i3}^{H}\Big(2g_BZ_{11}^{Z}-g_RZ_{31}^{Z}\Big)$$
$$+g_2\Big(\sqrt{2}\cos\phi_W Z_{j4}^{+}Z_{i4}^{H}\Big(2g_BZ_{11}^{Z}-g_2Z_{21}^{Z}\Big)$$
$$+g_R\Big(Z_{j1}^{+}\Big(-\cos\phi_W Z_{i1}^{H}Z_{31}^{Z}+\sin\phi_W Z_{i2}^{H}Z_{21}^{Z}\Big)+Z_{j2}^{+}\Big(\cos\phi_W Z_{i2}^{H}Z_{31}^{Z}-\sin\phi_W Z_{i1}^{H}Z_{21}^{Z}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{342}$$



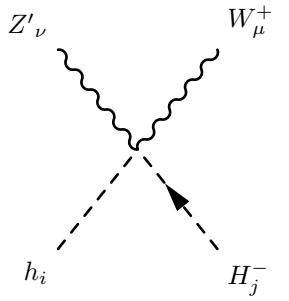
$$\frac{i}{2}\Big(\sqrt{2}g_R\cos\phi_W Z^+_{j3}Z^H_{i3}\Big(2g_B Z^Z_{11}-g_R Z^Z_{31}\Big) + g_2\Big(-\sqrt{2}\sin\phi_W Z^+_{j4}Z^H_{i4}\Big(2g_B Z^Z_{11}-g_2 Z^Z_{21}\Big) + g_R\Big(Z^+_{j1}\Big(\cos\phi_W Z^H_{i2}Z^Z_{21}+\sin\phi_W Z^H_{i1}Z^Z_{31}\Big)-Z^+_{j2}\Big(\cos\phi_W Z^H_{i1}Z^Z_{21}+\sin\phi_W Z^H_{i2}Z^Z_{31}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{343}$$



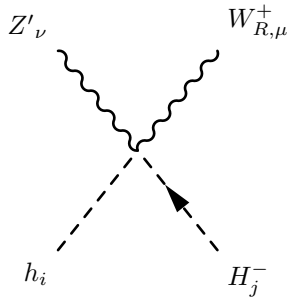
$$\frac{i}{2}\Big(\sqrt{2}g_R\sin\phi_W Z^+_{j3}Z^H_{i3}\Big(2g_B Z^Z_{12}-g_R Z^Z_{32}\Big) + g_2\Big(\sqrt{2}\cos\phi_W Z^+_{j4}Z^H_{i4}\Big(2g_B Z^Z_{12}-g_2 Z^Z_{22}\Big) + g_R\Big(Z^+_{j1}\Big(-\cos\phi_W Z^H_{i1}Z^Z_{32}+\sin\phi_W Z^H_{i2}Z^Z_{22}\Big)+Z^+_{j2}\Big(\cos\phi_W Z^H_{i2}Z^Z_{32}-\sin\phi_W Z^H_{i1}Z^Z_{22}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{344}$$



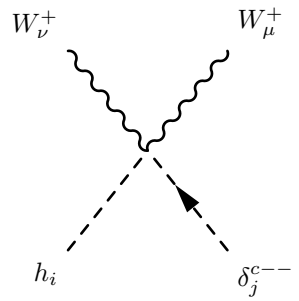
$$\frac{i}{2}\Big(\sqrt{2}g_R\cos\phi_W Z^+_{j3}Z^H_{i3}\Big(2g_B Z^Z_{12}-g_R Z^Z_{32}\Big)$$
$$+\,g_2\Big(-\sqrt{2}\sin\phi_W Z^+_{j4}Z^H_{i4}\Big(2g_B Z^Z_{12}-g_2 Z^Z_{22}\Big)$$
$$+\,g_R\Big(Z^+_{j1}\Big(\cos\phi_W Z^H_{i2}Z^Z_{22}+\sin\phi_W Z^H_{i1}Z^Z_{32}\Big)-Z^+_{j2}\Big(\cos\phi_W Z^H_{i1}Z^Z_{22}+\sin\phi_W Z^H_{i2}Z^Z_{32}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{345}$$



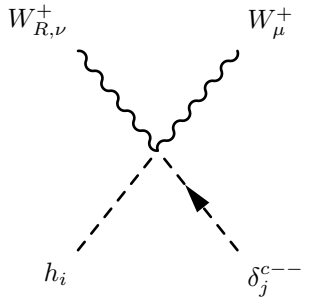
$$\frac{i}{2}\Big(\sqrt{2}g_R\sin\phi_W Z^+_{j3}Z^H_{i3}\Big(2g_B Z^Z_{13}-g_R Z^Z_{33}\Big)$$
$$+\,g_2\Big(\sqrt{2}\cos\phi_W Z^+_{j4}Z^H_{i4}\Big(2g_B Z^Z_{13}-g_2 Z^Z_{23}\Big)$$
$$+\,g_R\Big(Z^+_{j1}\Big(-\cos\phi_W Z^H_{i1}Z^Z_{33}+\sin\phi_W Z^H_{i2}Z^Z_{23}\Big)+Z^+_{j2}\Big(\cos\phi_W Z^H_{i2}Z^Z_{33}-\sin\phi_W Z^H_{i1}Z^Z_{23}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{346}$$



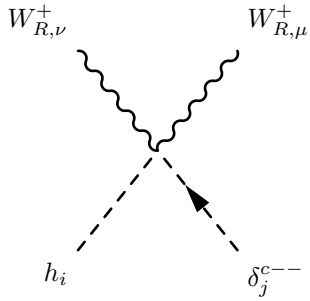
$$\frac{i}{2}\Big(\sqrt{2}g_R\cos\phi_W Z^+_{j3}Z^H_{i3}\Big(2g_B Z^Z_{13}-g_R Z^Z_{33}\Big)$$
$$+\,g_2\Big(-\sqrt{2}\sin\phi_W Z^+_{j4}Z^H_{i4}\Big(2g_B Z^Z_{13}-g_2 Z^Z_{23}\Big)$$
$$+\,g_R\Big(Z^+_{j1}\Big(\cos\phi_W Z^H_{i2}Z^Z_{23}+\sin\phi_W Z^H_{i1}Z^Z_{33}\Big)-Z^+_{j2}\Big(\cos\phi_W Z^H_{i1}Z^Z_{23}+\sin\phi_W Z^H_{i2}Z^Z_{33}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{347}$$



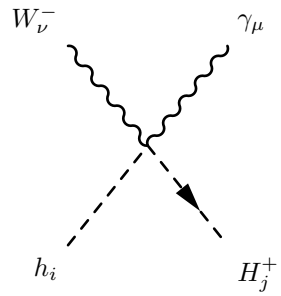
$$-i\sqrt{2}\Big(g_2^2\cos\phi_W^2 Z_{j2}^{++}Z_{i4}^H + g_R^2\sin\phi_W^2 Z_{j1}^{++}Z_{i3}^H\Big)\Big(g_{\mu\nu}\Big) \tag{348}$$



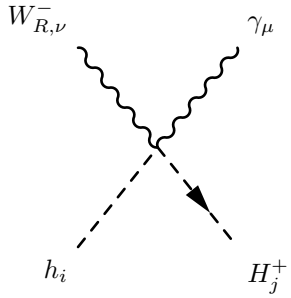
$$-i\sqrt{2}\cos\phi_W\sin\phi_W\Big(-g_2^2 Z_{j2}^{++}Z_{i4}^H + g_R^2 Z_{j1}^{++}Z_{i3}^H\Big)\Big(g_{\mu\nu}\Big) \tag{349}$$



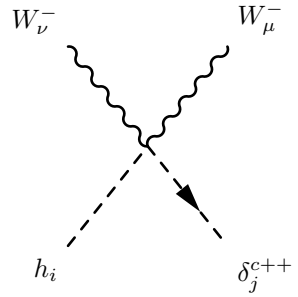
$$-i\sqrt{2}\Big(g_2^2\sin\phi_W^2 Z_{j2}^{++}Z_{i4}^H + g_R^2\cos\phi_W^2 Z_{j1}^{++}Z_{i3}^H\Big)\Big(g_{\mu\nu}\Big) \tag{350}$$



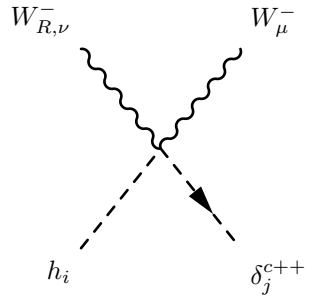
$$\frac{i}{2}\Big(\sqrt{2}g_R\sin\phi_W Z^+_{j3}Z^H_{i3}\Big(2g_BZ^Z_{11}-g_RZ^Z_{31}\Big)$$
$$+\,g_2\Big(\sqrt{2}\cos\phi_W Z^+_{j4}Z^H_{i4}\Big(2g_BZ^Z_{11}-g_2Z^Z_{21}\Big)$$
$$+\,g_R\Big(Z^+_{j1}\Big(-\cos\phi_W Z^H_{i1}Z^Z_{31}+\sin\phi_W Z^H_{i2}Z^Z_{21}\Big)+Z^+_{j2}\Big(\cos\phi_W Z^H_{i2}Z^Z_{31}-\sin\phi_W Z^H_{i1}Z^Z_{21}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{351}$$



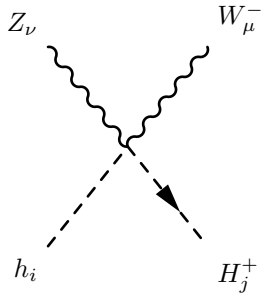
$$\frac{i}{2}\Big(\sqrt{2}g_R\cos\phi_W Z^+_{j3}Z^H_{i3}\Big(2g_BZ^Z_{11}-g_RZ^Z_{31}\Big)$$
$$+\,g_2\Big(-\sqrt{2}\sin\phi_W Z^+_{j4}Z^H_{i4}\Big(2g_BZ^Z_{11}-g_2Z^Z_{21}\Big)$$
$$+\,g_R\Big(Z^+_{j1}\Big(\cos\phi_W Z^H_{i2}Z^Z_{21}+\sin\phi_W Z^H_{i1}Z^Z_{31}\Big)-Z^+_{j2}\Big(\cos\phi_W Z^H_{i1}Z^Z_{21}+\sin\phi_W Z^H_{i2}Z^Z_{31}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{352}$$



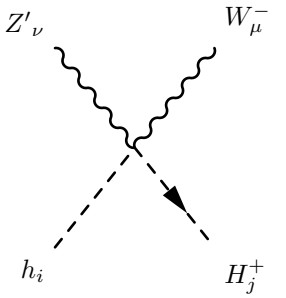
$$- i\sqrt{2}\Big(g_2^2 \cos\phi_W^2 Z_{j2}^{++} Z_{i4}^H + g_R^2 \sin\phi_W^2 Z_{j1}^{++} Z_{i3}^H\Big)\Big(g_{\mu\nu}\Big) \tag{353}$$



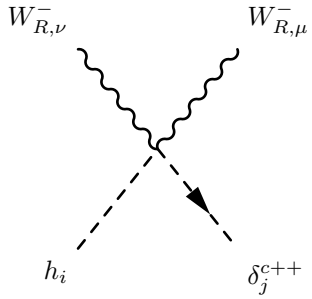
$$- i\sqrt{2}\cos\phi_W \sin\phi_W\Big(- g_2^2 Z_{j2}^{++} Z_{i4}^H + g_R^2 Z_{j1}^{++} Z_{i3}^H\Big)\Big(g_{\mu\nu}\Big) \tag{354}$$



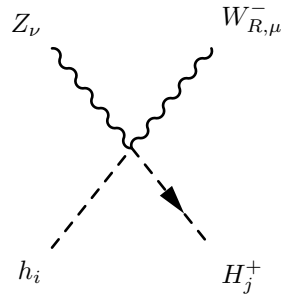
$$\begin{aligned}
&\frac{i}{2}\Big(\sqrt{2} g_R \sin\phi_W Z_{j3}^+ Z_{i3}^H \Big(2 g_B Z_{12}^Z - g_R Z_{32}^Z\Big) \\
&+ g_2\Big(\sqrt{2}\cos\phi_W Z_{j4}^+ Z_{i4}^H \Big(2 g_B Z_{12}^Z - g_2 Z_{22}^Z\Big) \\
&+ g_R\Big(Z_{j1}^+\Big(- \cos\phi_W Z_{i1}^H Z_{32}^Z + \sin\phi_W Z_{i2}^H Z_{22}^Z\Big) + Z_{j2}^+\Big(\cos\phi_W Z_{i2}^H Z_{32}^Z - \sin\phi_W Z_{i1}^H Z_{22}^Z\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big)
\end{aligned} \tag{355}$$



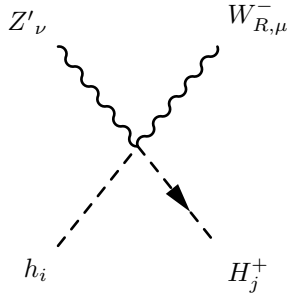
$$\frac{i}{2}\Big(\sqrt{2}g_R\sin\phi_W Z^+_{j3}Z^H_{i3}\Big(2g_B Z^Z_{13}-g_R Z^Z_{33}\Big)$$
$$+g_2\Big(\sqrt{2}\cos\phi_W Z^+_{j4}Z^H_{i4}\Big(2g_B Z^Z_{13}-g_2 Z^Z_{23}\Big)$$
$$+g_R\Big(Z^+_{j1}\Big(-\cos\phi_W Z^H_{i1}Z^Z_{33}+\sin\phi_W Z^H_{i2}Z^Z_{23}\Big)+Z^+_{j2}\Big(\cos\phi_W Z^H_{i2}Z^Z_{33}-\sin\phi_W Z^H_{i1}Z^Z_{23}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{356}$$



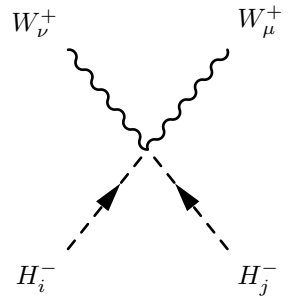
$$-i\sqrt{2}\Big(g_2^2\sin\phi_W^2 Z^{++}_{j2}Z^H_{i4}+g_R^2\cos\phi_W^2 Z^{++}_{j1}Z^H_{i3}\Big)\Big(g_{\mu\nu}\Big) \tag{357}$$



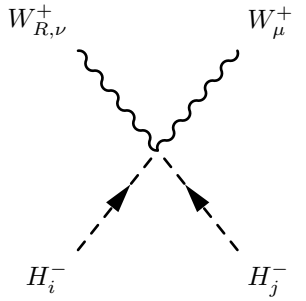
$$\frac{i}{2}\Big(\sqrt{2}g_R\cos\phi_W Z^+_{j3}Z^H_{i3}\Big(2g_B Z^Z_{12}-g_R Z^Z_{32}\Big)$$
$$+g_2\Big(-\sqrt{2}\sin\phi_W Z^+_{j4}Z^H_{i4}\Big(2g_B Z^Z_{12}-g_2 Z^Z_{22}\Big)$$
$$+g_R\Big(Z^+_{j1}\Big(\cos\phi_W Z^H_{i2}Z^Z_{22}+\sin\phi_W Z^H_{i1}Z^Z_{32}\Big)-Z^+_{j2}\Big(\cos\phi_W Z^H_{i1}Z^Z_{22}+\sin\phi_W Z^H_{i2}Z^Z_{32}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{358}$$



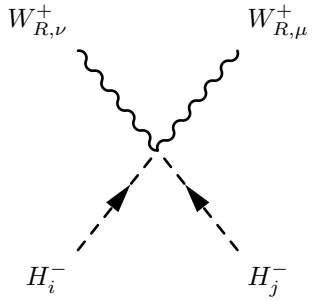
$$\frac{i}{2}\Big(\sqrt{2}g_R\cos\phi_W Z^+_{j3}Z^H_{i3}\Big(2g_B Z^Z_{13}-g_R Z^Z_{33}\Big)$$
$$+\,g_2\Big(-\sqrt{2}\sin\phi_W Z^+_{j4}Z^H_{i4}\Big(2g_B Z^Z_{13}-g_2 Z^Z_{23}\Big)$$
$$+\,g_R\Big(Z^+_{j1}\Big(\cos\phi_W Z^H_{i2}Z^Z_{23}+\sin\phi_W Z^H_{i1}Z^Z_{33}\Big)-Z^+_{j2}\Big(\cos\phi_W Z^H_{i1}Z^Z_{23}+\sin\phi_W Z^H_{i2}Z^Z_{33}\Big)\Big)\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{359}$$



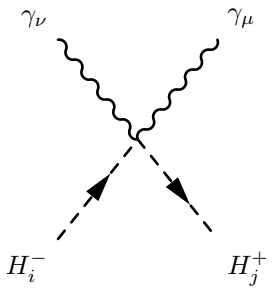
$$-\,ig_2 g_R\sin 2\phi_W\Big(Z^+_{i1}Z^+_{j2}+Z^+_{i2}Z^+_{j1}\Big)\Big(g_{\mu\nu}\Big) \tag{360}$$



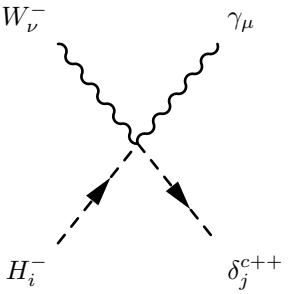
$$-\,ig_2 g_R\cos 2\phi_W\Big(Z^+_{i1}Z^+_{j2}+Z^+_{i2}Z^+_{j1}\Big)\Big(g_{\mu\nu}\Big) \tag{361}$$



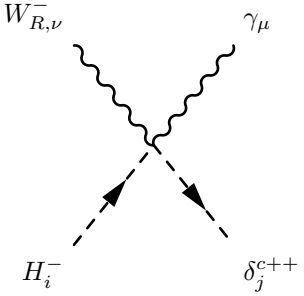
$$ig_2 g_R \sin 2\phi_W \Big(Z^+_{i1} Z^+_{j2} + Z^+_{i2} Z^+_{j1}\Big)\Big(g_{\mu\nu}\Big) \tag{362}$$



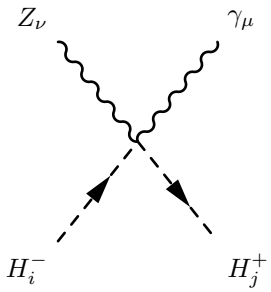
$$\frac{i}{2}\Big(4g_B^2 Z^+_{i3} Z^+_{j3} Z^{Z,2}_{11} + 4g_B^2 Z^+_{i4} Z^+_{j4} Z^{Z,2}_{11} + \Big(Z^+_{i1} Z^+_{j1} + Z^+_{i2} Z^+_{j2}\Big)\Big(g_2 Z^Z_{21} + g_R Z^Z_{31}\Big)^2\Big)\Big(g_{\mu\nu}\Big) \tag{363}$$



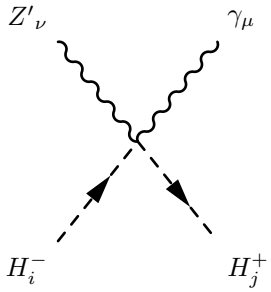
$$-i\Big(g_2 \cos\phi_W Z^+_{i4} Z^{++}_{j2}\Big(2g_B Z^Z_{11} + g_2 Z^Z_{21}\Big) + g_R \sin\phi_W Z^+_{i3} Z^{++}_{j1}\Big(2g_B Z^Z_{11} + g_R Z^Z_{31}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{364}$$



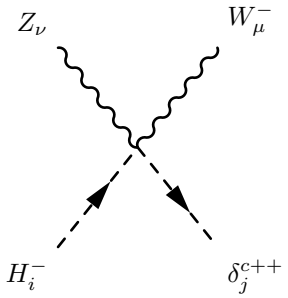
$$-i\Big(-g_2 \sin\phi_W Z^+_{i4} Z^{++}_{j2}\Big(2g_B Z^Z_{11} + g_2 Z^Z_{21}\Big) + g_R \cos\phi_W Z^+_{i3} Z^{++}_{j1}\Big(2g_B Z^Z_{11} + g_R Z^Z_{31}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{365}$$



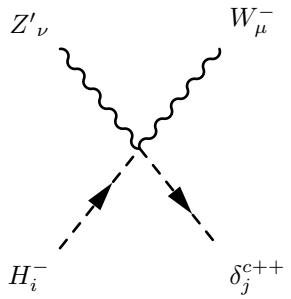
$$\frac{i}{2}\Big(4g_B^2 Z_{i3}^+ Z_{j3}^+ Z_{11}^Z Z_{12}^Z + 4g_B^2 Z_{i4}^+ Z_{j4}^+ Z_{11}^Z Z_{12}^Z + \Big(Z_{i1}^+ Z_{j1}^+ + Z_{i2}^+ Z_{j2}^+\Big)\Big(g_2 Z_{21}^Z + g_R Z_{31}^Z\Big)\Big(g_2 Z_{22}^Z + g_R Z_{32}^Z\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{366}$$



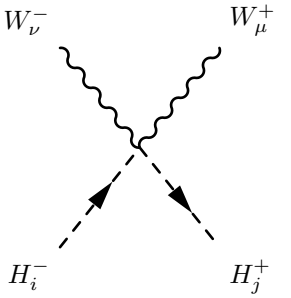
$$\frac{i}{2}\Big(4g_B^2 Z_{i3}^+ Z_{j3}^+ Z_{11}^Z Z_{13}^Z + 4g_B^2 Z_{i4}^+ Z_{j4}^+ Z_{11}^Z Z_{13}^Z + \Big(Z_{i1}^+ Z_{j1}^+ + Z_{i2}^+ Z_{j2}^+\Big)\Big(g_2 Z_{21}^Z + g_R Z_{31}^Z\Big)\Big(g_2 Z_{23}^Z + g_R Z_{33}^Z\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{367}$$



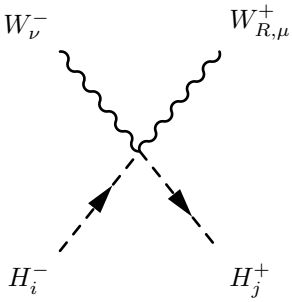
$$-i\Big(g_2 \cos\phi_W Z_{i4}^+ Z_{j2}^{++}\Big(2g_B Z_{12}^Z + g_2 Z_{22}^Z\Big) + g_R \sin\phi_W Z_{i3}^+ Z_{j1}^{++}\Big(2g_B Z_{12}^Z + g_R Z_{32}^Z\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{368}$$



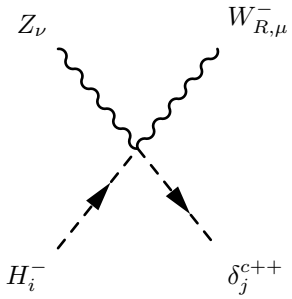
$$-i\Big(g_2\cos\phi_W Z^+_{i4}Z^{++}_{j2}\Big(2g_BZ^Z_{13}+g_2Z^Z_{23}\Big)+g_R\sin\phi_W Z^+_{i3}Z^{++}_{j1}\Big(2g_BZ^Z_{13}+g_RZ^Z_{33}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{369}$$



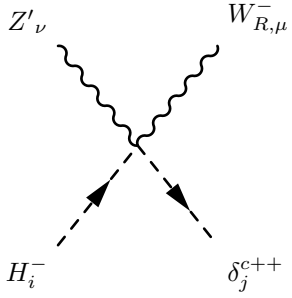
$$\begin{aligned}&\frac{i}{2}\Big(\Big(g_2^2\cos\phi_W^2+g_R^2\sin\phi_W^2\Big)Z^+_{i1}Z^+_{j1}+\Big(g_2^2\cos\phi_W^2+g_R^2\sin\phi_W^2\Big)Z^+_{i2}Z^+_{j2}\\&+4\Big(g_2^2\cos\phi_W^2Z^+_{i4}Z^+_{j4}+g_R^2\sin\phi_W^2Z^+_{i3}Z^+_{j3}\Big)\Big)\Big(g_{\mu\nu}\Big)\end{aligned} \tag{370}$$



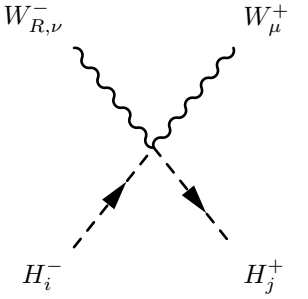
$$-\frac{i}{4}\sin 2\phi_W\Big(4g_2^2Z^+_{i4}Z^+_{j4}-4g_R^2Z^+_{i3}Z^+_{j3}+\Big(-g_R^2+g_2^2\Big)Z^+_{i1}Z^+_{j1}+\Big(-g_R^2+g_2^2\Big)Z^+_{i2}Z^+_{j2}\Big)\Big(g_{\mu\nu}\Big) \tag{371}$$



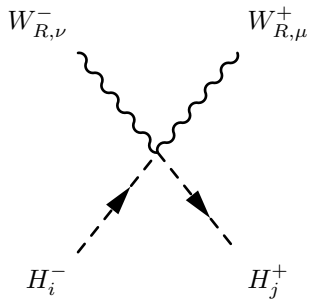
$$-i\Big(-g_2\sin\phi_W Z^+_{i4}Z^{++}_{j2}\Big(2g_BZ^Z_{12}+g_2Z^Z_{22}\Big)+g_R\cos\phi_W Z^+_{i3}Z^{++}_{j1}\Big(2g_BZ^Z_{12}+g_RZ^Z_{32}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{372}$$



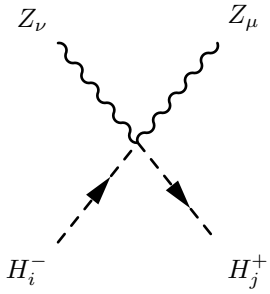
$$-i\Big(-g_2\sin\phi_W Z^+_{i4}Z^{++}_{j2}\Big(2g_BZ^Z_{13}+g_2Z^Z_{23}\Big)+g_R\cos\phi_W Z^+_{i3}Z^{++}_{j1}\Big(2g_BZ^Z_{13}+g_RZ^Z_{33}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{373}$$



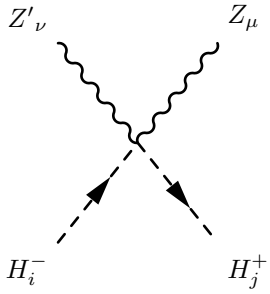
$$-\frac{i}{4}\sin 2\phi_W\Big(4g_2^2Z^+_{i4}Z^+_{j4}-4g_R^2Z^+_{i3}Z^+_{j3}+\Big(-g_R^2+g_2^2\Big)Z^+_{i1}Z^+_{j1}+\Big(-g_R^2+g_2^2\Big)Z^+_{i2}Z^+_{j2}\Big)\Big(g_{\mu\nu}\Big) \tag{374}$$



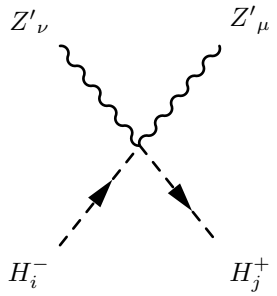
$$\frac{i}{2}\Big(\Big(g_2^2\sin\phi_W^2+g_R^2\cos\phi_W^2\Big)Z^+_{i1}Z^+_{j1}+\Big(g_2^2\sin\phi_W^2+g_R^2\cos\phi_W^2\Big)Z^+_{i2}Z^+_{j2} \\ +4\Big(g_2^2\sin\phi_W^2Z^+_{i4}Z^+_{j4}+g_R^2\cos\phi_W^2Z^+_{i3}Z^+_{j3}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{375}$$



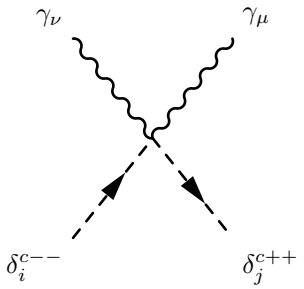
$$\frac{i}{2}\Big(4g_B^2Z^+_{i3}Z^+_{j3}Z^{Z,2}_{12}+4g_B^2Z^+_{i4}Z^+_{j4}Z^{Z,2}_{12}+\Big(Z^+_{i1}Z^+_{j1}+Z^+_{i2}Z^+_{j2}\Big)\Big(g_2Z^Z_{22}+g_RZ^Z_{32}\Big)^2\Big)\Big(g_{\mu\nu}\Big) \tag{376}$$



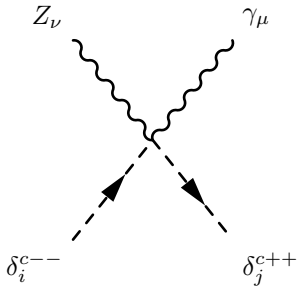
$$\frac{i}{2}\Big(4g_B^2Z^+_{i3}Z^+_{j3}Z^Z_{12}Z^Z_{13}+4g_B^2Z^+_{i4}Z^+_{j4}Z^Z_{12}Z^Z_{13} \\ +\Big(Z^+_{i1}Z^+_{j1}+Z^+_{i2}Z^+_{j2}\Big)\Big(g_2Z^Z_{22}+g_RZ^Z_{32}\Big)\Big(g_2Z^Z_{23}+g_RZ^Z_{33}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{377}$$



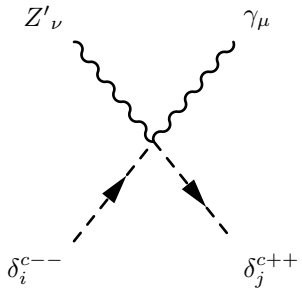
$$\frac{i}{2}\Big(4g_B^2 Z_{i3}^+ Z_{j3}^+ Z_{13}^{Z,2} + 4g_B^2 Z_{i4}^+ Z_{j4}^+ Z_{13}^{Z,2} + \Big(Z_{i1}^+ Z_{j1}^+ + Z_{i2}^+ Z_{j2}^+\Big)\Big(g_2 Z_{23}^Z + g_R Z_{33}^Z\Big)^2\Big)\Big(g_{\mu\nu}\Big) \tag{378}$$



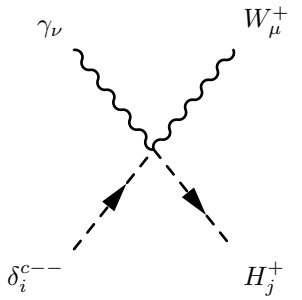
$$2i\Big(Z_{i1}^{++} Z_{j1}^{++}\Big(g_B Z_{11}^Z + g_R Z_{31}^Z\Big)^2 + Z_{i2}^{++} Z_{j2}^{++}\Big(g_2 Z_{21}^Z + g_B Z_{11}^Z\Big)^2\Big)\Big(g_{\mu\nu}\Big) \tag{379}$$



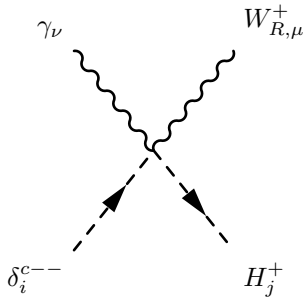
$$2i\Big(Z_{i1}^{++} Z_{j1}^{++}\Big(g_B Z_{11}^Z + g_R Z_{31}^Z\Big)\Big(g_B Z_{12}^Z + g_R Z_{32}^Z\Big) + Z_{i2}^{++} Z_{j2}^{++}\Big(g_2 Z_{21}^Z + g_B Z_{11}^Z\Big)\Big(g_2 Z_{22}^Z + g_B Z_{12}^Z\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{380}$$



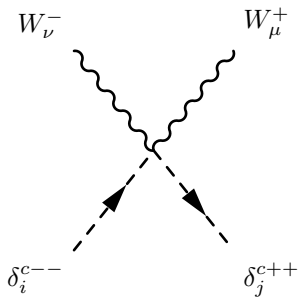
$$2i\Big(Z_{i1}^{++}Z_{j1}^{++}\Big(g_BZ_{11}^Z+g_RZ_{31}^Z\Big)\Big(g_BZ_{13}^Z+g_RZ_{33}^Z\Big)+Z_{i2}^{++}Z_{j2}^{++}\Big(g_2Z_{21}^Z+g_BZ_{11}^Z\Big)\Big(g_2Z_{23}^Z+g_BZ_{13}^Z\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{381}$$



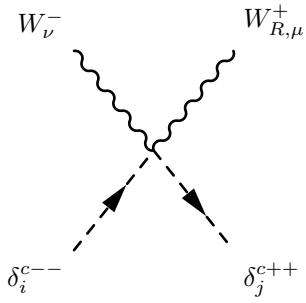
$$-i\Big(g_2\cos\phi_WZ_{j4}^+Z_{i2}^{++}\Big(2g_BZ_{11}^Z+g_2Z_{21}^Z\Big)+g_R\sin\phi_WZ_{j3}^+Z_{i1}^{++}\Big(2g_BZ_{11}^Z+g_RZ_{31}^Z\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{382}$$



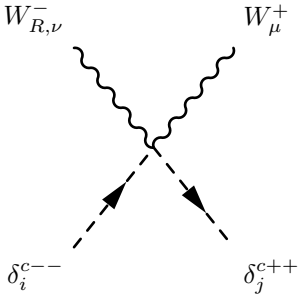
$$-i\Big(-g_2\sin\phi_WZ_{j4}^+Z_{i2}^{++}\Big(2g_BZ_{11}^Z+g_2Z_{21}^Z\Big)+g_R\cos\phi_WZ_{j3}^+Z_{i1}^{++}\Big(2g_BZ_{11}^Z+g_RZ_{31}^Z\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{383}$$



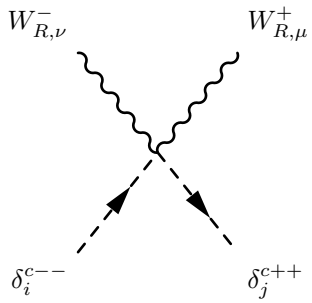
$$i\Big(g_2^2\cos\phi_W^2 Z_{i2}^{++}Z_{j2}^{++} + g_R^2\sin\phi_W^2 Z_{i1}^{++}Z_{j1}^{++}\Big)\Big(g_{\mu\nu}\Big) \tag{384}$$



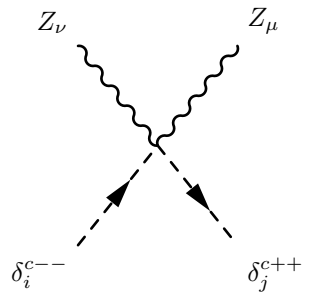
$$i\cos\phi_W\sin\phi_W\Big(-g_2^2 Z_{i2}^{++}Z_{j2}^{++} + g_R^2 Z_{i1}^{++}Z_{j1}^{++}\Big)\Big(g_{\mu\nu}\Big) \tag{385}$$



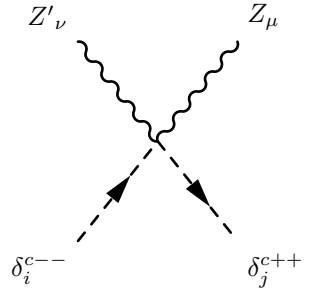
$$i\cos\phi_W\sin\phi_W\Big(-g_2^2 Z_{i2}^{++}Z_{j2}^{++} + g_R^2 Z_{i1}^{++}Z_{j1}^{++}\Big)\Big(g_{\mu\nu}\Big) \tag{386}$$



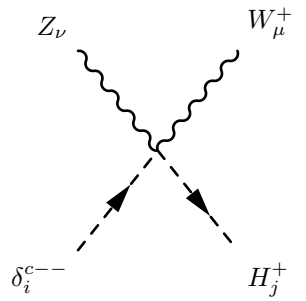
$$i\Big(g_2^2 \sin\phi_W^2 Z_{i2}^{++} Z_{j2}^{++} + g_R^2 \cos\phi_W^2 Z_{i1}^{++} Z_{j1}^{++}\Big)\Big(g_{\mu\nu}\Big) \tag{387}$$



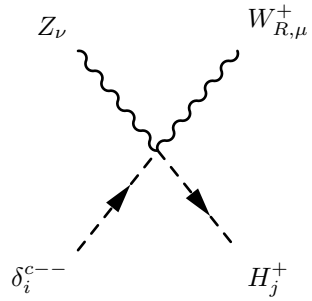
$$2i\Big(Z_{i1}^{++} Z_{j1}^{++}\Big(g_B Z_{12}^Z + g_R Z_{32}^Z\Big)^2 + Z_{i2}^{++} Z_{j2}^{++}\Big(g_2 Z_{22}^Z + g_B Z_{12}^Z\Big)^2\Big)\Big(g_{\mu\nu}\Big) \tag{388}$$



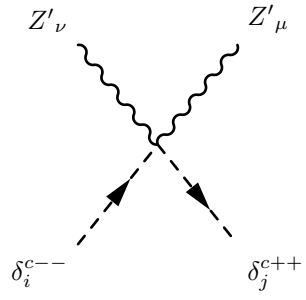
$$2i\Big(Z_{i1}^{++} Z_{j1}^{++}\Big(g_B Z_{12}^Z + g_R Z_{32}^Z\Big)\Big(g_B Z_{13}^Z + g_R Z_{33}^Z\Big) + Z_{i2}^{++} Z_{j2}^{++}\Big(g_2 Z_{22}^Z + g_B Z_{12}^Z\Big)\Big(g_2 Z_{23}^Z + g_B Z_{13}^Z\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{389}$$



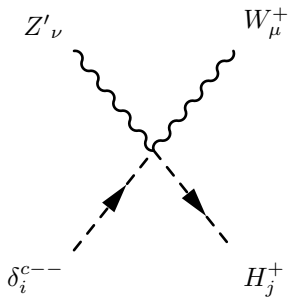
$$-i\Big(g_2\cos\phi_W Z_{j4}^+ Z_{i2}^{++}\Big(2g_B Z_{12}^Z + g_2 Z_{22}^Z\Big) + g_R\sin\phi_W Z_{j3}^+ Z_{i1}^{++}\Big(2g_B Z_{12}^Z + g_R Z_{32}^Z\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{390}$$



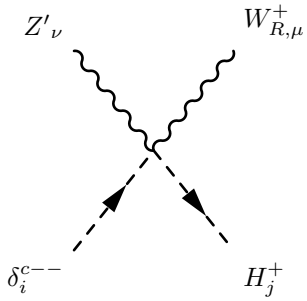
$$-i\Big(-g_2\sin\phi_W Z_{j4}^+ Z_{i2}^{++}\Big(2g_B Z_{12}^Z + g_2 Z_{22}^Z\Big) + g_R\cos\phi_W Z_{j3}^+ Z_{i1}^{++}\Big(2g_B Z_{12}^Z + g_R Z_{32}^Z\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{391}$$



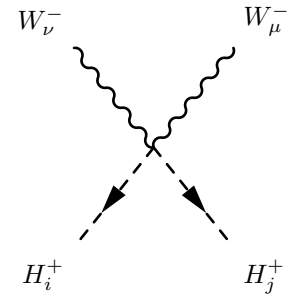
$$2i\Big(Z_{i1}^{++}Z_{j1}^{++}\Big(g_B Z_{13}^Z + g_R Z_{33}^Z\Big)^2 + Z_{i2}^{++}Z_{j2}^{++}\Big(g_2 Z_{23}^Z + g_B Z_{13}^Z\Big)^2\Big)\Big(g_{\mu\nu}\Big) \tag{392}$$



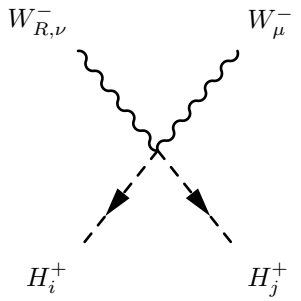
$$-i\Big(g_2\cos\phi_W Z^+_{j4}Z^{++}_{i2}\Big(2g_BZ^Z_{13}+g_2Z^Z_{23}\Big)+g_R\sin\phi_W Z^+_{j3}Z^{++}_{i1}\Big(2g_BZ^Z_{13}+g_RZ^Z_{33}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{393}$$



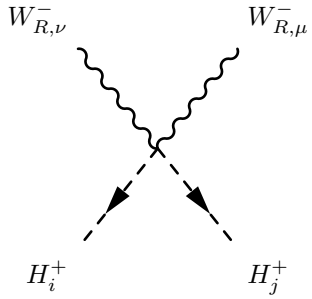
$$-i\Big(-g_2\sin\phi_W Z^+_{j4}Z^{++}_{i2}\Big(2g_BZ^Z_{13}+g_2Z^Z_{23}\Big)+g_R\cos\phi_W Z^+_{j3}Z^{++}_{i1}\Big(2g_BZ^Z_{13}+g_RZ^Z_{33}\Big)\Big)\Big(g_{\mu\nu}\Big) \tag{394}$$



$$-ig_2g_R\sin 2\phi_W\Big(Z^+_{i1}Z^+_{j2}+Z^+_{i2}Z^+_{j1}\Big)\Big(g_{\mu\nu}\Big) \tag{395}$$

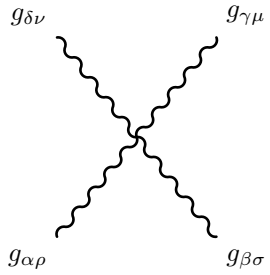


$$- ig_2 g_R \cos 2\phi_W \Big(Z^+_{i1} Z^+_{j2} + Z^+_{i2} Z^+_{j1} \Big) \Big(g_{\mu\nu} \Big) \tag{396}$$



$$ig_2 g_R \sin 2\phi_W \Big(Z^+_{i1} Z^+_{j2} + Z^+_{i2} Z^+_{j1} \Big) \Big(g_{\mu\nu} \Big) \tag{397}$$

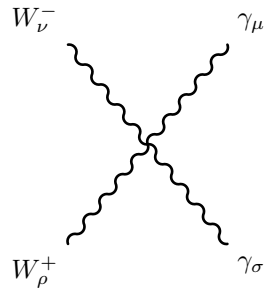
8.9 Four Vector Boson-Interaction



$$- ig_3^2 \Big(\sum_{a=1}^{8} f_{\alpha,\delta,a} f_{\beta,\gamma,a} + \sum_{a=1}^{8} f_{\alpha,\gamma,a} f_{\beta,\delta,a} \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{398}$$

$$+ ig_3^2 \Big(- \sum_{a=1}^{8} f_{\alpha,\beta,a} f_{\gamma,\delta,a} + \sum_{a=1}^{8} f_{\alpha,\delta,a} f_{\beta,\gamma,a} \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{399}$$

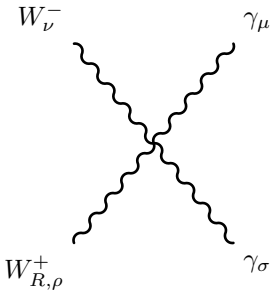
$$+\ ig_3^2\Big(\sum_{a=1}^{8} f_{\alpha,\gamma,a}f_{\beta,\delta,a} + \sum_{a=1}^{8} f_{\alpha,\beta,a}f_{\gamma,\delta,a}\Big)\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{400}$$



$$\frac{i}{2}\Big(\cos 2\phi_W\Big(g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2}\Big) + g_2^2 Z_{21}^{Z,2} + g_R^2 Z_{31}^{Z,2}\Big)\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{401}$$

$$+\ \frac{i}{2}\Big(\cos 2\phi_W\Big(g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2}\Big) + g_2^2 Z_{21}^{Z,2} + g_R^2 Z_{31}^{Z,2}\Big)\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{402}$$

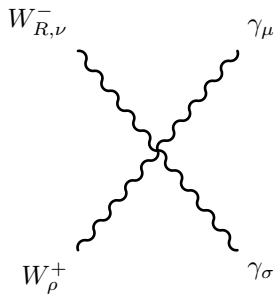
$$+\ -i\Big(\cos 2\phi_W\Big(g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2}\Big) + g_2^2 Z_{21}^{Z,2} + g_R^2 Z_{31}^{Z,2}\Big)\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{403}$$



$$-\ i\cos\phi_W \sin\phi_W\Big(g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2}\Big)\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{404}$$

$$+\ -i\cos\phi_W \sin\phi_W\Big(g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2}\Big)\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{405}$$

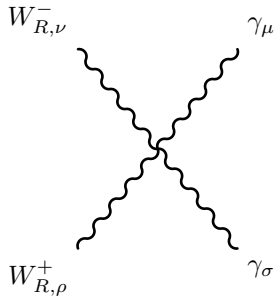
$$+\ i\sin 2\phi_W\Big(g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2}\Big)\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{406}$$



$$- i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2} \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{407}$$

$$+ -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2} \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{408}$$

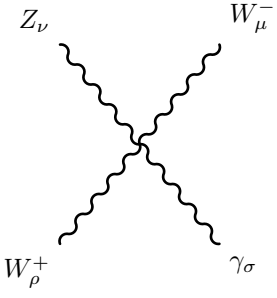
$$+ i \sin 2\phi_W \Big(g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2} \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{409}$$



$$- \frac{i}{2} \Big(\cos 2\phi_W \Big(g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2} \Big) - g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2} \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{410}$$

$$+ -\frac{i}{2} \Big(\cos 2\phi_W \Big(g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2} \Big) - g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2} \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{411}$$

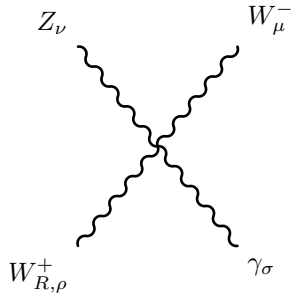
$$+ i \Big(\cos 2\phi_W \Big(g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2} \Big) - g_2^2 Z_{21}^{Z,2} - g_R^2 Z_{31}^{Z,2} \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{412}$$



$$\frac{i}{2}\Big(\cos 2\phi_W\Big(g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z\Big) + g_2^2 Z_{21}^Z Z_{22}^Z + g_R^2 Z_{31}^Z Z_{32}^Z\Big)\Big(g_{\rho\sigma} g_{\mu\nu}\Big) \tag{413}$$

$$+\ -i\Big(\cos 2\phi_W\Big(g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z\Big) + g_2^2 Z_{21}^Z Z_{22}^Z + g_R^2 Z_{31}^Z Z_{32}^Z\Big)\Big(g_{\rho\mu} g_{\sigma\nu}\Big) \tag{414}$$

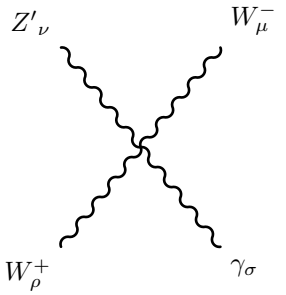
$$+\ \frac{i}{2}\Big(\cos 2\phi_W\Big(g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z\Big) + g_2^2 Z_{21}^Z Z_{22}^Z + g_R^2 Z_{31}^Z Z_{32}^Z\Big)\Big(g_{\rho\nu} g_{\sigma\mu}\Big) \tag{415}$$



$$-\ i\cos\phi_W \sin\phi_W\Big(g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z\Big)\Big(g_{\rho\sigma} g_{\mu\nu}\Big) \tag{416}$$

$$+\ i\sin 2\phi_W\Big(g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z\Big)\Big(g_{\rho\mu} g_{\sigma\nu}\Big) \tag{417}$$

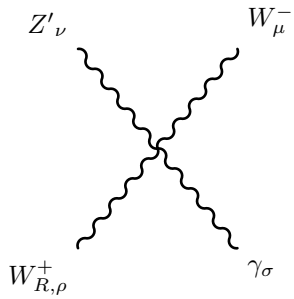
$$+\ -i\cos\phi_W \sin\phi_W\Big(g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z\Big)\Big(g_{\rho\nu} g_{\sigma\mu}\Big) \tag{418}$$



$$\frac{i}{2}\Big(\cos 2\phi_W\Big(g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z\Big) + g_2^2 Z_{21}^Z Z_{23}^Z + g_R^2 Z_{31}^Z Z_{33}^Z\Big)\Big(g_{\rho\sigma} g_{\mu\nu}\Big) \tag{419}$$

$$+\ -i\Big(\cos 2\phi_W\Big(g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z\Big) + g_2^2 Z_{21}^Z Z_{23}^Z + g_R^2 Z_{31}^Z Z_{33}^Z\Big)\Big(g_{\rho\mu} g_{\sigma\nu}\Big) \tag{420}$$

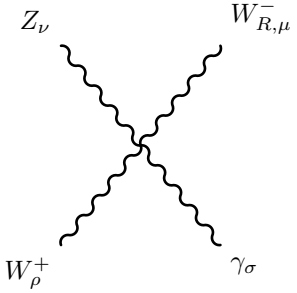
$$+\ \frac{i}{2}\Big(\cos 2\phi_W\Big(g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z\Big) + g_2^2 Z_{21}^Z Z_{23}^Z + g_R^2 Z_{31}^Z Z_{33}^Z\Big)\Big(g_{\rho\nu} g_{\sigma\mu}\Big) \tag{421}$$



$$- i \cos\phi_W \sin\phi_W \left(g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z \right) \left(g_{\rho\sigma} g_{\mu\nu} \right) \tag{422}$$

$$+ i \sin 2\phi_W \left(g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z \right) \left(g_{\rho\mu} g_{\sigma\nu} \right) \tag{423}$$

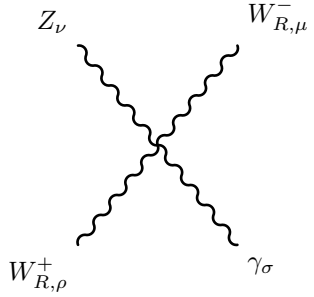
$$+ -i \cos\phi_W \sin\phi_W \left(g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z \right) \left(g_{\rho\nu} g_{\sigma\mu} \right) \tag{424}$$



$$- i \cos\phi_W \sin\phi_W \left(g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z \right) \left(g_{\rho\sigma} g_{\mu\nu} \right) \tag{425}$$

$$+ i \sin 2\phi_W \left(g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z \right) \left(g_{\rho\mu} g_{\sigma\nu} \right) \tag{426}$$

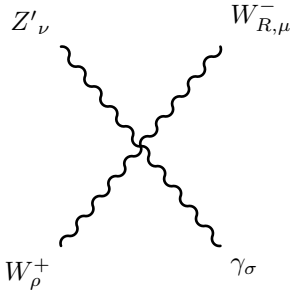
$$+ -i \cos\phi_W \sin\phi_W \left(g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z \right) \left(g_{\rho\nu} g_{\sigma\mu} \right) \tag{427}$$



$$- \frac{i}{2}\Big(\cos 2\phi_W \Big(g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z \Big) - g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{428}$$

$$+ \; i\Big(\cos 2\phi_W \Big(g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z \Big) - g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{429}$$

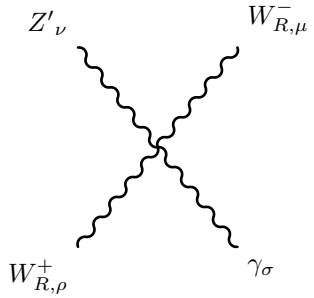
$$+ \; -\frac{i}{2}\Big(\cos 2\phi_W \Big(g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z \Big) - g_2^2 Z_{21}^Z Z_{22}^Z - g_R^2 Z_{31}^Z Z_{32}^Z \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{430}$$



$$- \; i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{431}$$

$$+ \; i \sin 2\phi_W \Big(g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{432}$$

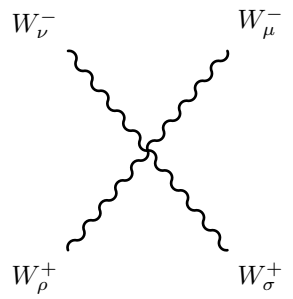
$$+ \; -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{433}$$



$$- \frac{i}{2}\Big(\cos 2\phi_W \Big(g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z \Big) - g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{434}$$

$$+ \; i\Big(\cos 2\phi_W \Big(g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z \Big) - g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{435}$$

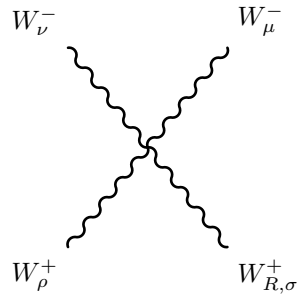
$$+ \; -\frac{i}{2}\Big(\cos 2\phi_W \Big(g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z \Big) - g_2^2 Z_{21}^Z Z_{23}^Z - g_R^2 Z_{31}^Z Z_{33}^Z \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{436}$$



$$\frac{i}{4}\Big(4\Big(-g_R^2+g_2^2\Big)\cos 2\phi_W+\Big(g_2^2+g_R^2\Big)\Big(3+\cos 4\phi_W\Big)\Big)\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{437}$$

$$+\ -\frac{i}{8}\Big(4\Big(-g_R^2+g_2^2\Big)\cos 2\phi_W+\Big(g_2^2+g_R^2\Big)\Big(3+\cos 4\phi_W\Big)\Big)\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{438}$$

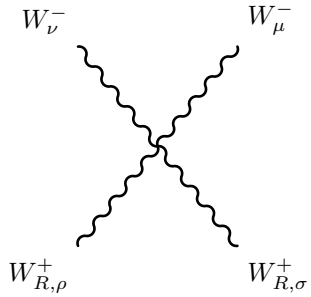
$$+\ -\frac{i}{8}\Big(4\Big(-g_R^2+g_2^2\Big)\cos 2\phi_W+\Big(g_2^2+g_R^2\Big)\Big(3+\cos 4\phi_W\Big)\Big)\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{439}$$



$$-\frac{i}{2}\Big(\Big(g_2^2+g_R^2\Big)\cos 2\phi_W-g_R^2+g_2^2\Big)\sin 2\phi_W\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{440}$$

$$+\ \frac{i}{4}\Big(\Big(g_2^2+g_R^2\Big)\cos 2\phi_W-g_R^2+g_2^2\Big)\sin 2\phi_W\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{441}$$

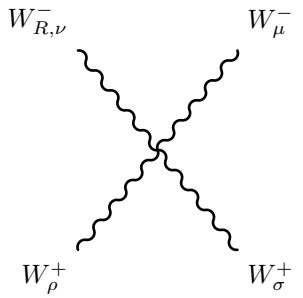
$$+\ \frac{i}{4}\Big(\Big(g_2^2+g_R^2\Big)\cos 2\phi_W-g_R^2+g_2^2\Big)\sin 2\phi_W\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{442}$$



$$\frac{i}{2}\Big(g_2^2+g_R^2\Big)\sin 2\phi_W^2\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{443}$$

$$+\ -\frac{i}{4}\Big(g_2^2+g_R^2\Big)\sin 2\phi_W^2\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{444}$$

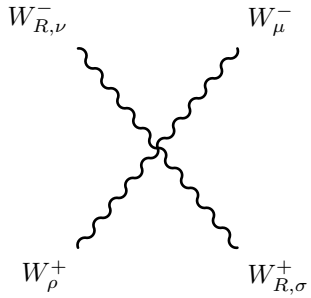
$$+\ -\frac{i}{4}\Big(g_2^2+g_R^2\Big)\sin 2\phi_W^2\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{445}$$



$$-\frac{i}{2}\Big(\Big(g_2^2+g_R^2\Big)\cos 2\phi_W-g_R^2+g_2^2\Big)\sin 2\phi_W\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{446}$$

$$+\ \frac{i}{4}\Big(\Big(g_2^2+g_R^2\Big)\cos 2\phi_W-g_R^2+g_2^2\Big)\sin 2\phi_W\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{447}$$

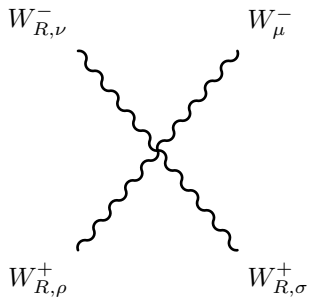
$$+\ \frac{i}{4}\Big(\Big(g_2^2+g_R^2\Big)\cos 2\phi_W-g_R^2+g_2^2\Big)\sin 2\phi_W\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{448}$$



$$\frac{i}{2}\Big(g_2^2+g_R^2\Big)\sin 2\phi_W^2\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{449}$$

$$+\ -\frac{i}{4}\Big(g_2^2+g_R^2\Big)\sin 2\phi_W^2\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{450}$$

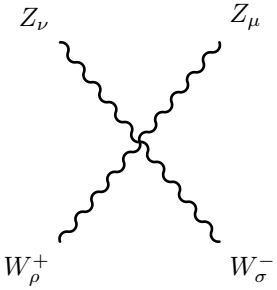
$$+\ -\frac{i}{4}\Big(g_2^2+g_R^2\Big)\sin 2\phi_W^2\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{451}$$



$$\frac{i}{2}\Big(-g_2^2+\Big(g_2^2+g_R^2\Big)\cos 2\phi_W+g_R^2\Big)\sin 2\phi_W\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{452}$$

$$+\,-\frac{i}{4}\Big(-g_2^2+\Big(g_2^2+g_R^2\Big)\cos 2\phi_W+g_R^2\Big)\sin 2\phi_W\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{453}$$

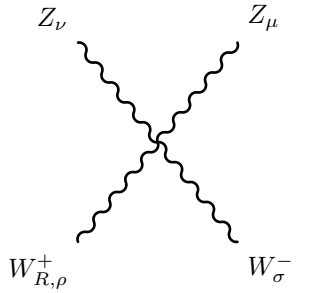
$$+\,-\frac{i}{4}\Big(-g_2^2+\Big(g_2^2+g_R^2\Big)\cos 2\phi_W+g_R^2\Big)\sin 2\phi_W\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{454}$$



$$-\,i\Big(\cos 2\phi_W\Big(g_2^2Z_{22}^{Z,2}-g_R^2Z_{32}^{Z,2}\Big)+g_2^2Z_{22}^{Z,2}+g_R^2Z_{32}^{Z,2}\Big)\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{455}$$

$$+\,\frac{i}{2}\Big(\cos 2\phi_W\Big(g_2^2Z_{22}^{Z,2}-g_R^2Z_{32}^{Z,2}\Big)+g_2^2Z_{22}^{Z,2}+g_R^2Z_{32}^{Z,2}\Big)\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{456}$$

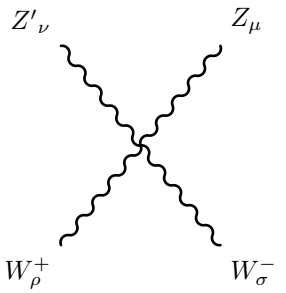
$$+\,\frac{i}{2}\Big(\cos 2\phi_W\Big(g_2^2Z_{22}^{Z,2}-g_R^2Z_{32}^{Z,2}\Big)+g_2^2Z_{22}^{Z,2}+g_R^2Z_{32}^{Z,2}\Big)\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{457}$$



$$i \sin 2\phi_W \Big(g_2^2 Z_{22}^{Z,2} - g_R^2 Z_{32}^{Z,2} \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{458}$$

$$+ \; -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{22}^{Z,2} - g_R^2 Z_{32}^{Z,2} \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{459}$$

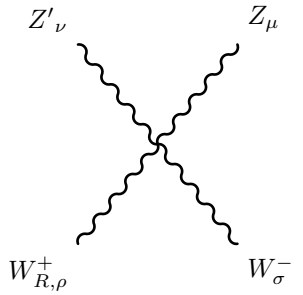
$$+ \; -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{22}^{Z,2} - g_R^2 Z_{32}^{Z,2} \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{460}$$



$$- i \Big(\cos 2\phi_W \Big(g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) + g_2^2 Z_{22}^Z Z_{23}^Z + g_R^2 Z_{32}^Z Z_{33}^Z \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{461}$$

$$+ \; \frac{i}{2} \Big(\cos 2\phi_W \Big(g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) + g_2^2 Z_{22}^Z Z_{23}^Z + g_R^2 Z_{32}^Z Z_{33}^Z \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{462}$$

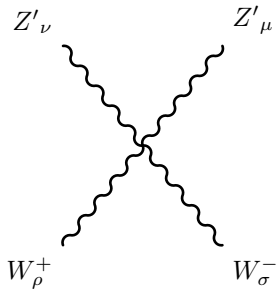
$$+ \; \frac{i}{2} \Big(\cos 2\phi_W \Big(g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) + g_2^2 Z_{22}^Z Z_{23}^Z + g_R^2 Z_{32}^Z Z_{33}^Z \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{463}$$



$$i \sin 2\phi_W \Big(g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{464}$$

$$+ \; -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{465}$$

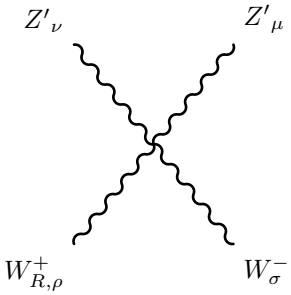
$$+ \; -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{466}$$



$$- i\Big(\cos 2\phi_W \Big(g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2} \Big) + g_2^2 Z_{23}^{Z,2} + g_R^2 Z_{33}^{Z,2} \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{467}$$

$$+ \frac{i}{2}\Big(\cos 2\phi_W \Big(g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2} \Big) + g_2^2 Z_{23}^{Z,2} + g_R^2 Z_{33}^{Z,2} \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{468}$$

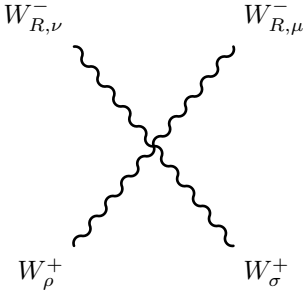
$$+ \frac{i}{2}\Big(\cos 2\phi_W \Big(g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2} \Big) + g_2^2 Z_{23}^{Z,2} + g_R^2 Z_{33}^{Z,2} \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{469}$$



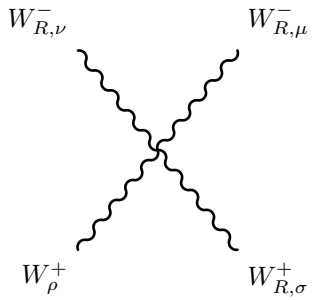
$$i \sin 2\phi_W \Big(g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2} \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{470}$$

$$+ -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2} \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{471}$$

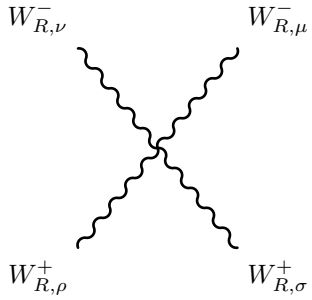
$$+ -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2} \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{472}$$



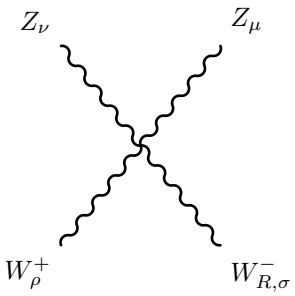
$$\frac{i}{2}\Big(g_2^2+g_R^2\Big)\sin 2\phi_W^2\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{473}$$
$$+\ -\frac{i}{4}\Big(g_2^2+g_R^2\Big)\sin 2\phi_W^2\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{474}$$
$$+\ -\frac{i}{4}\Big(g_2^2+g_R^2\Big)\sin 2\phi_W^2\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{475}$$



$$\frac{i}{2}\Big(-g_2^2+\Big(g_2^2+g_R^2\Big)\cos 2\phi_W+g_R^2\Big)\sin 2\phi_W\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{476}$$
$$+\ -\frac{i}{4}\Big(-g_2^2+\Big(g_2^2+g_R^2\Big)\cos 2\phi_W+g_R^2\Big)\sin 2\phi_W\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{477}$$
$$+\ -\frac{i}{4}\Big(-g_2^2+\Big(g_2^2+g_R^2\Big)\cos 2\phi_W+g_R^2\Big)\sin 2\phi_W\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{478}$$



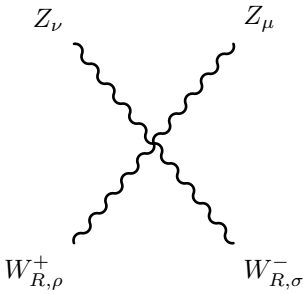
$$\frac{i}{4}\Big(-4\Big(-g_R^2+g_2^2\Big)\cos 2\phi_W+\Big(g_2^2+g_R^2\Big)\Big(3+\cos 4\phi_W\Big)\Big)\Big(g_{\rho\sigma}g_{\mu\nu}\Big) \tag{479}$$
$$+\ -\frac{i}{8}\Big(-4\Big(-g_R^2+g_2^2\Big)\cos 2\phi_W+\Big(g_2^2+g_R^2\Big)\Big(3+\cos 4\phi_W\Big)\Big)\Big(g_{\rho\mu}g_{\sigma\nu}\Big) \tag{480}$$
$$+\ -\frac{i}{8}\Big(-4\Big(-g_R^2+g_2^2\Big)\cos 2\phi_W+\Big(g_2^2+g_R^2\Big)\Big(3+\cos 4\phi_W\Big)\Big)\Big(g_{\rho\nu}g_{\sigma\mu}\Big) \tag{481}$$



$$i \sin 2\phi_W \Big(g_2^2 Z_{22}^{Z,2} - g_R^2 Z_{32}^{Z,2} \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{482}$$

$$+ \; -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{22}^{Z,2} - g_R^2 Z_{32}^{Z,2} \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{483}$$

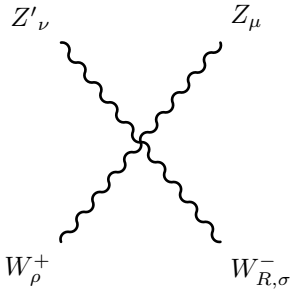
$$+ \; -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{22}^{Z,2} - g_R^2 Z_{32}^{Z,2} \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{484}$$



$$i \Big(\cos 2\phi_W \Big(g_2^2 Z_{22}^{Z,2} - g_R^2 Z_{32}^{Z,2} \Big) - g_2^2 Z_{22}^{Z,2} - g_R^2 Z_{32}^{Z,2} \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{485}$$

$$+ \; -\frac{i}{2} \Big(\cos 2\phi_W \Big(g_2^2 Z_{22}^{Z,2} - g_R^2 Z_{32}^{Z,2} \Big) - g_2^2 Z_{22}^{Z,2} - g_R^2 Z_{32}^{Z,2} \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{486}$$

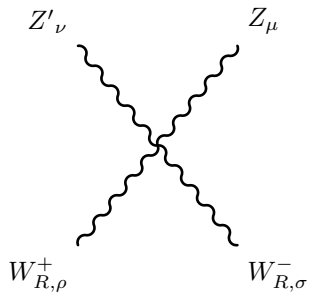
$$+ \; -\frac{i}{2} \Big(\cos 2\phi_W \Big(g_2^2 Z_{22}^{Z,2} - g_R^2 Z_{32}^{Z,2} \Big) - g_2^2 Z_{22}^{Z,2} - g_R^2 Z_{32}^{Z,2} \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{487}$$



$$i \sin 2\phi_W \Big(g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{488}$$

$$+ \; -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{489}$$

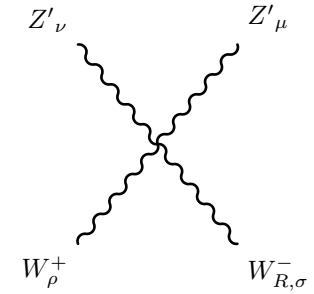
$$+ \; -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{490}$$



$$i \Big(\cos 2\phi_W \Big(g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) - g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{491}$$

$$+ \; -\frac{i}{2} \Big(\cos 2\phi_W \Big(g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) - g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{492}$$

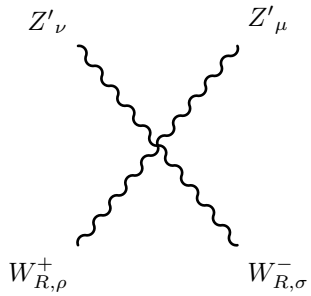
$$+ \; -\frac{i}{2} \Big(\cos 2\phi_W \Big(g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) - g_2^2 Z_{22}^Z Z_{23}^Z - g_R^2 Z_{32}^Z Z_{33}^Z \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{493}$$



$$i \sin 2\phi_W \Big(g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2} \Big) \Big(g_{\rho\sigma} g_{\mu\nu} \Big) \tag{494}$$

$$+ \; -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2} \Big) \Big(g_{\rho\mu} g_{\sigma\nu} \Big) \tag{495}$$

$$+ \; -i \cos\phi_W \sin\phi_W \Big(g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2} \Big) \Big(g_{\rho\nu} g_{\sigma\mu} \Big) \tag{496}$$

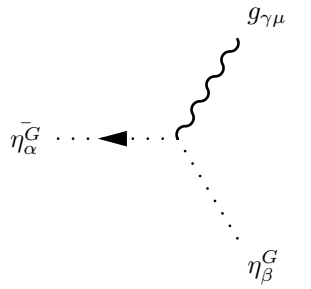


$$i\Big(\cos 2\phi_W\Big(g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2}\Big) - g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2}\Big)\Big(g_{\rho\sigma} g_{\mu\nu}\Big) \tag{497}$$

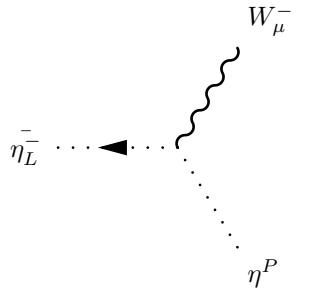
$$+ -\frac{i}{2}\Big(\cos 2\phi_W\Big(g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2}\Big) - g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2}\Big)\Big(g_{\rho\mu} g_{\sigma\nu}\Big) \tag{498}$$

$$+ -\frac{i}{2}\Big(\cos 2\phi_W\Big(g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2}\Big) - g_2^2 Z_{23}^{Z,2} - g_R^2 Z_{33}^{Z,2}\Big)\Big(g_{\rho\nu} g_{\sigma\mu}\Big) \tag{499}$$

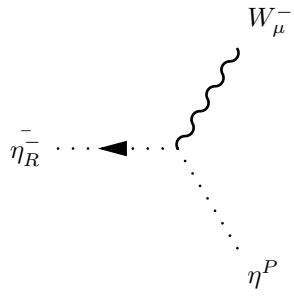
8.10 Two Ghosts-One Vector Boson-Interaction



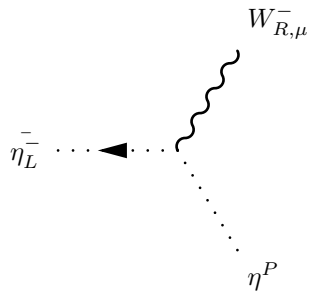
$$g_3 f_{\alpha,\beta,\gamma}\Big(p_\mu^{\eta_\beta^G}\Big) \tag{500}$$



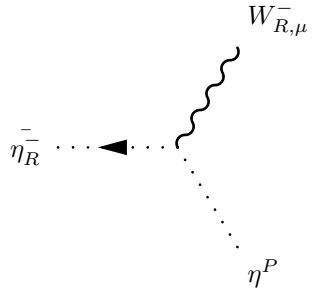
$$i\Big(g_2 \cos\phi_W^2 Z_{21}^Z + g_R \sin\phi_W^2 Z_{31}^Z\Big)\Big(p_\mu^{\eta^P}\Big) \tag{501}$$



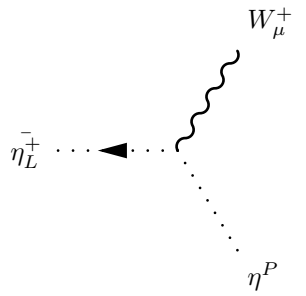
$$-i\cos\phi_W \sin\phi_W\Big(g_2 Z_{21}^Z - g_R Z_{31}^Z\Big)\Big(p_\mu^{\eta^P}\Big) \tag{502}$$



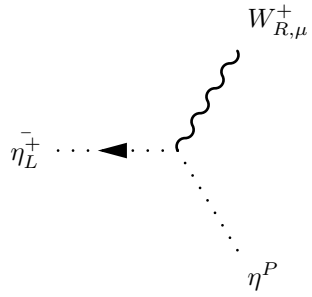
$$-i\cos\phi_W \sin\phi_W\Big(g_2 Z_{21}^Z - g_R Z_{31}^Z\Big)\Big(p_\mu^{\eta^P}\Big) \tag{503}$$



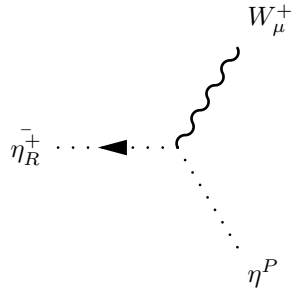
$$i\Big(g_2 \sin\phi_W^2 Z_{21}^Z + g_R \cos\phi_W^2 Z_{31}^Z\Big)\Big(p_\mu^{\eta^P}\Big) \tag{504}$$



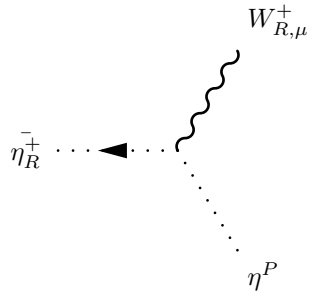
$$-i\Big(g_2 Z_{21}^{Z,*}\cos\phi_W^2 + g_R Z_{31}^{Z,*}\sin\phi_W^2\Big)\Big(p_\mu^{\eta^P}\Big) \tag{505}$$



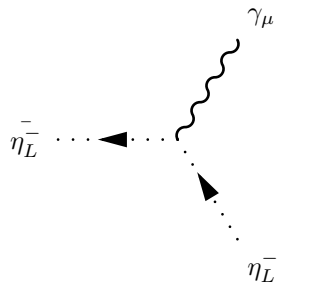
$$i\Big(g_2 Z_{21}^{Z,*} - g_R Z_{31}^{Z,*}\Big)\cos\phi_W\sin\phi_W\Big(p_\mu^{\eta^P}\Big) \tag{506}$$



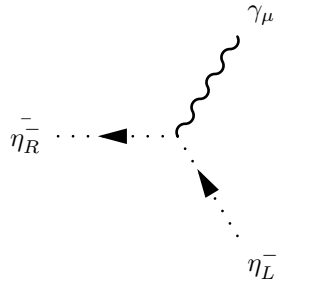
$$i\Big(g_2 Z_{21}^{Z,*} - g_R Z_{31}^{Z,*}\Big)\cos\phi_W\sin\phi_W\Big(p_\mu^{\eta^P}\Big) \tag{507}$$



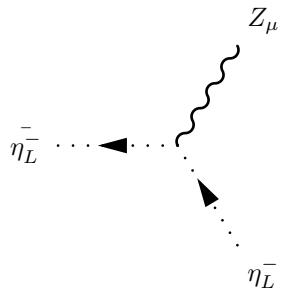
$$-i\Big(g_2 Z_{21}^{Z,*}\sin\phi_W^2 + g_R Z_{31}^{Z,*}\cos\phi_W^2\Big)\Big(p_\mu^{\eta^P}\Big) \tag{508}$$



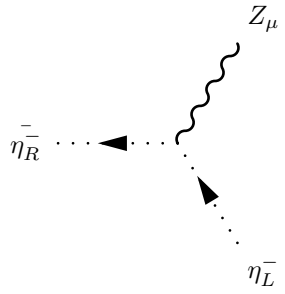
$$-i\Big(g_2\cos\phi_W^2 Z_{21}^Z + g_R\sin\phi_W^2 Z_{31}^Z\Big)\Big(p_\mu^{\eta^-_L}\Big) \tag{509}$$



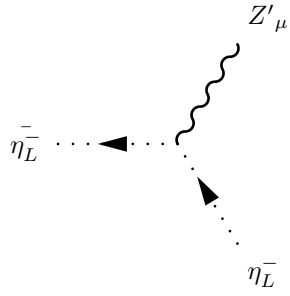
$$i\cos\phi_W\sin\phi_W\Big(g_2 Z_{21}^Z - g_R Z_{31}^Z\Big)\Big(p_\mu^{\eta^-_L}\Big) \tag{510}$$



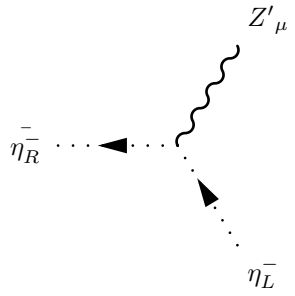
$$-i\Big(g_2\cos\phi_W^2 Z_{22}^Z + g_R\sin\phi_W^2 Z_{32}^Z\Big)\Big(p_\mu^{\bar{\eta_L^-}}\Big) \tag{511}$$



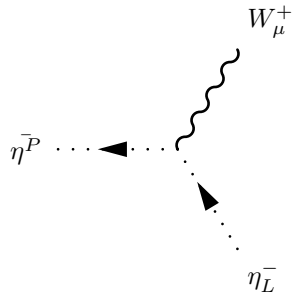
$$i\cos\phi_W\sin\phi_W\Big(g_2 Z_{22}^Z - g_R Z_{32}^Z\Big)\Big(p_\mu^{\bar{\eta_L^-}}\Big) \tag{512}$$



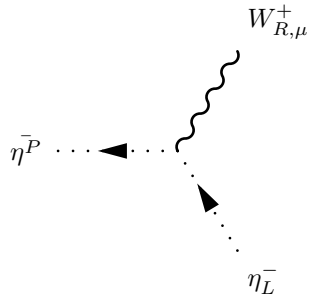
$$-i\Big(g_2\cos\phi_W^2 Z_{23}^Z + g_R\sin\phi_W^2 Z_{33}^Z\Big)\Big(p_\mu^{\bar{\eta_L^-}}\Big) \tag{513}$$



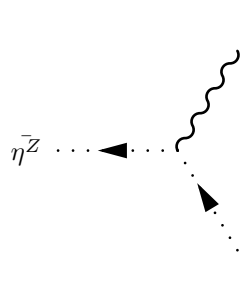
$$i \cos\phi_W \sin\phi_W \Big(g_2 Z_{23}^Z - g_R Z_{33}^Z \Big) \Big(p_\mu^{\eta_L^-} \Big) \tag{514}$$



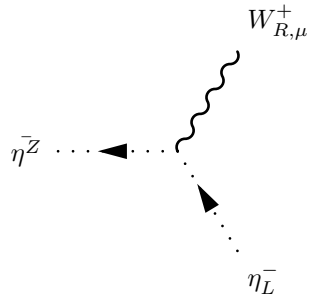
$$i \Big(g_2 Z_{21}^{Z,*} \cos\phi_W^2 + g_R Z_{31}^{Z,*} \sin\phi_W^2 \Big) \Big(p_\mu^{\eta_L^-} \Big) \tag{515}$$



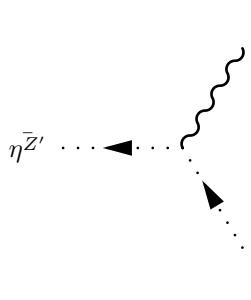
$$- i \Big(g_2 Z_{21}^{Z,*} - g_R Z_{31}^{Z,*} \Big) \cos\phi_W \sin\phi_W \Big(p_\mu^{\eta_L^-} \Big) \tag{516}$$



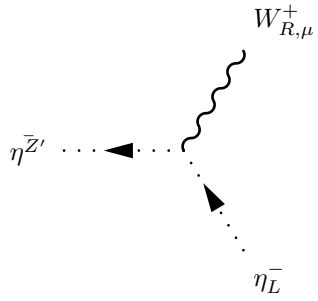
$$i\Big(g_2 Z_{22}^{Z,*}\cos\phi_W^2 + g_R Z_{32}^{Z,*}\sin\phi_W^2\Big)\Big(p_\mu^{\eta_L^-}\Big) \tag{517}$$



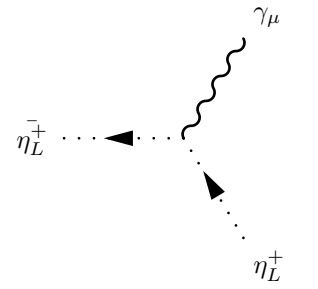
$$-i\Big(g_2 Z_{22}^{Z,*} - g_R Z_{32}^{Z,*}\Big)\cos\phi_W\sin\phi_W\Big(p_\mu^{\eta_L^-}\Big) \tag{518}$$



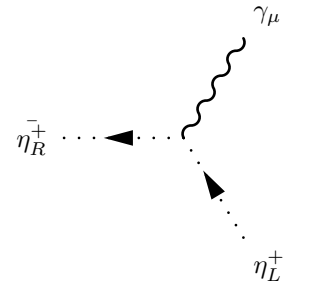
$$i\Big(g_2 Z_{23}^{Z,*}\cos\phi_W^2 + g_R Z_{33}^{Z,*}\sin\phi_W^2\Big)\Big(p_\mu^{\eta_L^-}\Big) \tag{519}$$



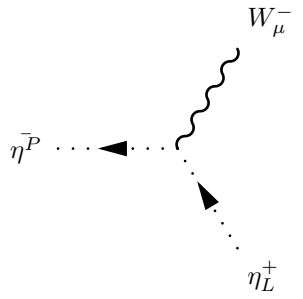
$$-i\Big(g_2 Z_{23}^{Z,*} - g_R Z_{33}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta_L^-}\Big) \tag{520}$$



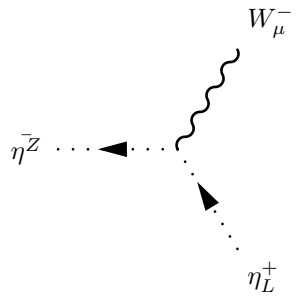
$$i\Big(g_2 Z_{21}^{Z,*}\cos\phi_W^2 + g_R Z_{31}^{Z,*}\sin\phi_W^2\Big)\Big(p_\mu^{\eta_L^+}\Big) \tag{521}$$



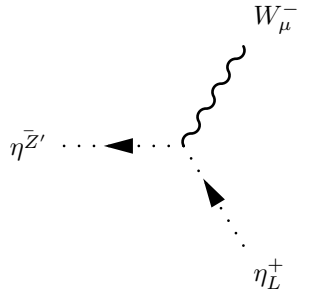
$$-i\Big(g_2 Z_{21}^{Z,*} - g_R Z_{31}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta_L^+}\Big) \tag{522}$$



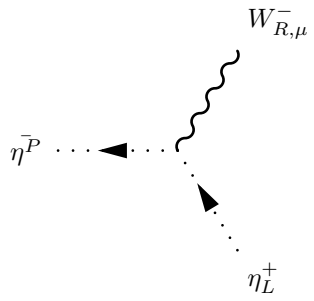
$$-i\Big(g_2 Z_{21}^{Z,*}\cos\phi_W^2 + g_R Z_{31}^{Z,*}\sin\phi_W^2\Big)\Big(p_\mu^{\eta_L^+}\Big) \tag{523}$$



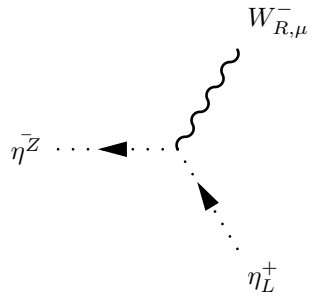
$$-i\Big(g_2 Z_{22}^{Z,*}\cos\phi_W^2 + g_R Z_{32}^{Z,*}\sin\phi_W^2\Big)\Big(p_\mu^{\eta_L^+}\Big) \tag{524}$$



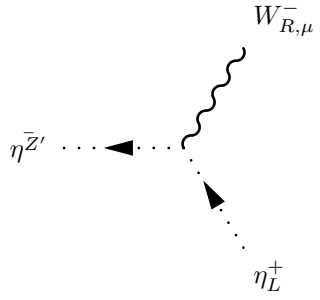
$$-i\Big(g_2 Z_{23}^{Z,*}\cos\phi_W^2 + g_R Z_{33}^{Z,*}\sin\phi_W^2\Big)\Big(p_\mu^{\eta_L^+}\Big) \tag{525}$$



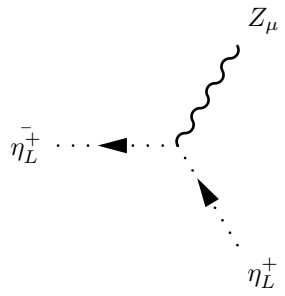
$$i\Big(g_2 Z_{21}^{Z,*} - g_R Z_{31}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta_L^+}\Big) \tag{526}$$



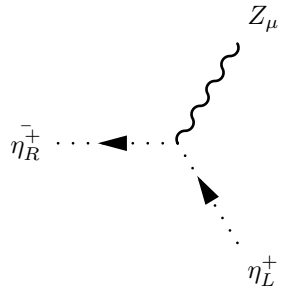
$$i\Big(g_2 Z_{22}^{Z,*} - g_R Z_{32}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta_L^+}\Big) \tag{527}$$



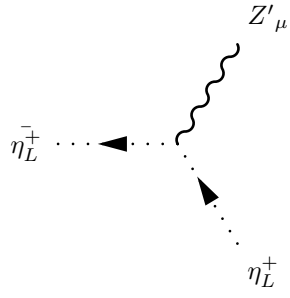
$$i\Big(g_2 Z_{23}^{Z,*} - g_R Z_{33}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta_L^+}\Big) \tag{528}$$



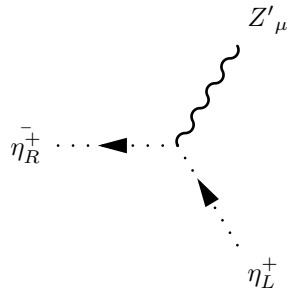
$$i\Big(g_2 Z_{22}^{Z,*}\cos\phi_W^2 + g_R Z_{32}^{Z,*}\sin\phi_W^2\Big)\Big(p_\mu^{\eta_L^+}\Big) \tag{529}$$



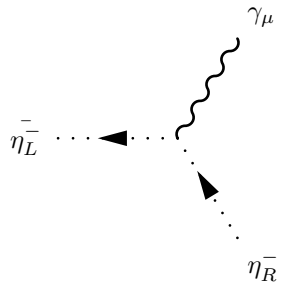
$$-i\Big(g_2 Z_{22}^{Z,*} - g_R Z_{32}^{Z,*}\Big)\cos\phi_W\sin\phi_W\Big(p_\mu^{\eta_L^+}\Big) \tag{530}$$



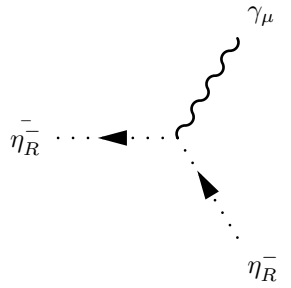
$$i\Big(g_2 Z_{23}^{Z,*}\cos\phi_W^2 + g_R Z_{33}^{Z,*}\sin\phi_W^2\Big)\Big(p_\mu^{\eta_L^+}\Big) \tag{531}$$



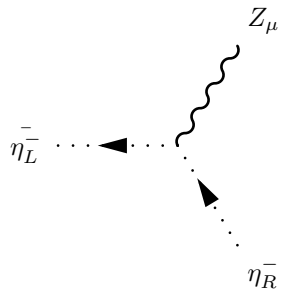
$$-i\Big(g_2 Z_{23}^{Z,*} - g_R Z_{33}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta_L^+}\Big) \tag{532}$$



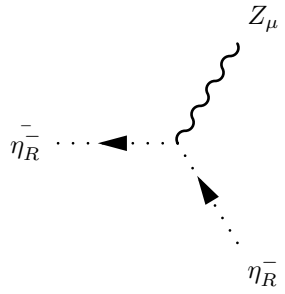
$$i\cos\phi_W \sin\phi_W \Big(g_2 Z_{21}^{Z} - g_R Z_{31}^{Z}\Big)\Big(p_\mu^{\eta_R^-}\Big) \tag{533}$$



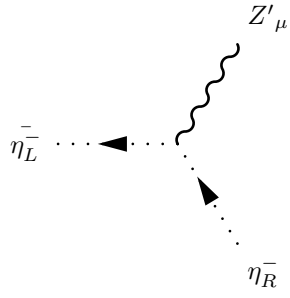
$$-i\Big(g_2 \sin\phi_W^2 Z_{21}^{Z} + g_R \cos\phi_W^2 Z_{31}^{Z}\Big)\Big(p_\mu^{\eta_R^-}\Big) \tag{534}$$



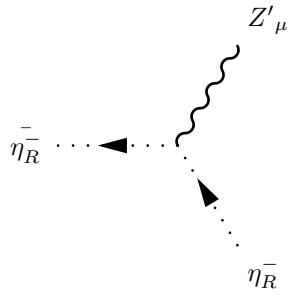
$$i\cos\phi_W \sin\phi_W \Big(g_2 Z_{22}^Z - g_R Z_{32}^Z\Big)\Big(p_\mu^{\eta_R^-}\Big) \tag{535}$$



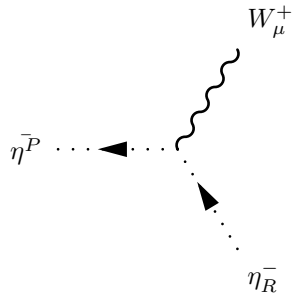
$$-i\Big(g_2 \sin\phi_W^2 Z_{22}^Z + g_R \cos\phi_W^2 Z_{32}^Z\Big)\Big(p_\mu^{\eta_R^-}\Big) \tag{536}$$



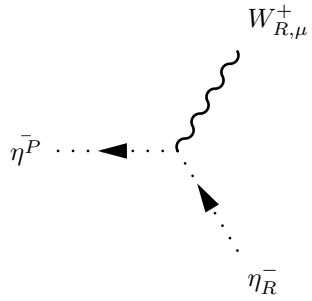
$$i\cos\phi_W \sin\phi_W \Big(g_2 Z_{23}^Z - g_R Z_{33}^Z\Big)\Big(p_\mu^{\eta_R^-}\Big) \tag{537}$$



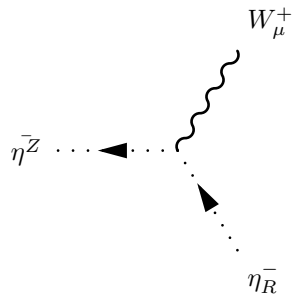
$$-i\Big(g_2 \sin\phi_W^2 Z_{23}^Z + g_R \cos\phi_W^2 Z_{33}^Z\Big)\Big(p_\mu^{\bar{\eta_R}}\Big) \tag{538}$$



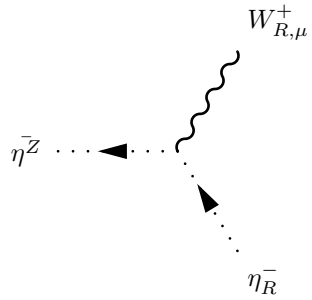
$$-i\Big(g_2 Z_{21}^{Z,*} - g_R Z_{31}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\bar{\eta_R}}\Big) \tag{539}$$



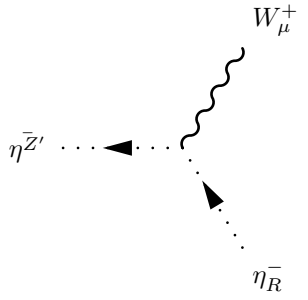
$$i\Big(g_2 Z_{21}^{Z,*} \sin\phi_W^2 + g_R Z_{31}^{Z,*} \cos\phi_W^2\Big)\Big(p_\mu^{\bar{\eta_R}}\Big) \tag{540}$$



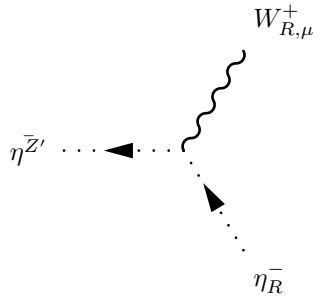
$$-i\Big(g_2 Z_{22}^{Z,*} - g_R Z_{32}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\bar{\eta_R}}\Big) \tag{541}$$



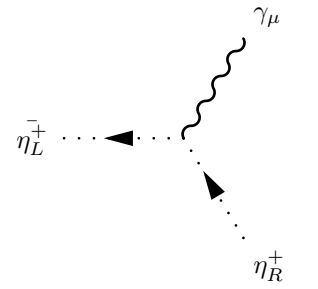
$$i\Big(g_2 Z_{22}^{Z,*}\sin\phi_W^2 + g_R Z_{32}^{Z,*}\cos\phi_W^2\Big)\Big(p_\mu^{\bar{\eta_R}}\Big) \tag{542}$$



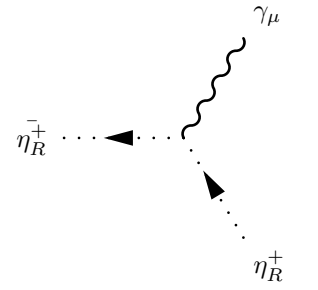
$$-i\Big(g_2 Z_{23}^{Z,*} - g_R Z_{33}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\bar{\eta_R}}\Big) \tag{543}$$



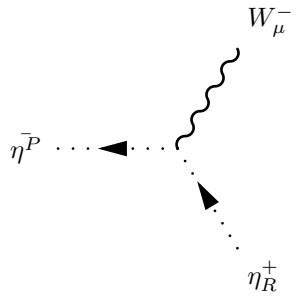
$$i\Big(g_2 Z_{23}^{Z,*} \sin\phi_W^2 + g_R Z_{33}^{Z,*} \cos\phi_W^2\Big)\Big(p_\mu^{\eta_R^-}\Big) \tag{544}$$



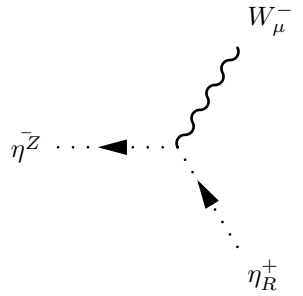
$$-i\Big(g_2 Z_{21}^{Z,*} - g_R Z_{31}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta_R^+}\Big) \tag{545}$$



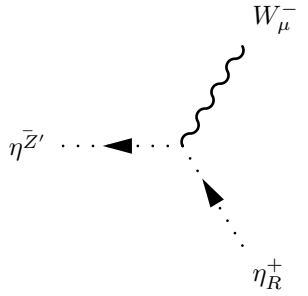
$$i\Big(g_2 Z_{21}^{Z,*} \sin\phi_W^2 + g_R Z_{31}^{Z,*} \cos\phi_W^2\Big)\Big(p_\mu^{\eta_R^+}\Big) \tag{546}$$



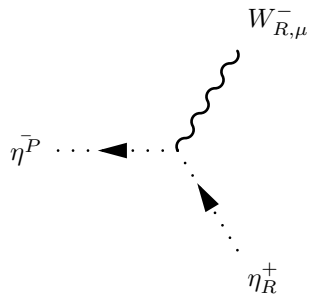
$$i\Big(g_2 Z_{21}^{Z,*} - g_R Z_{31}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta_R^+}\Big) \tag{547}$$



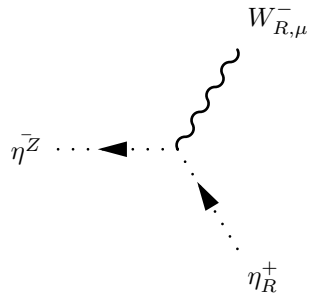
$$i\Big(g_2 Z_{22}^{Z,*} - g_R Z_{32}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta_R^+}\Big) \tag{548}$$



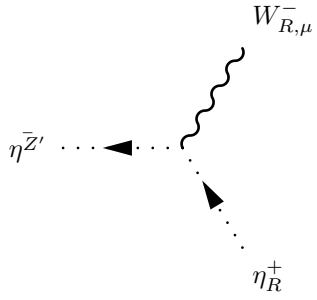
$$i\Big(g_2 Z_{23}^{Z,*} - g_R Z_{33}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta_R^+}\Big) \tag{549}$$



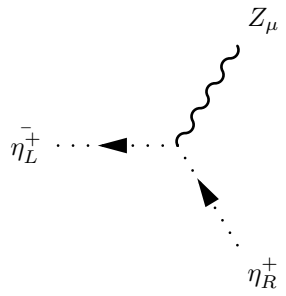
$$-i\Big(g_2 Z_{21}^{Z,*}\sin\phi_W^2 + g_R Z_{31}^{Z,*}\cos\phi_W^2\Big)\Big(p_\mu^{\eta_R^+}\Big) \tag{550}$$



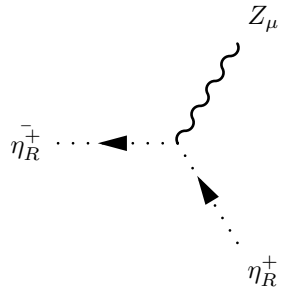
$$-i\Big(g_2 Z_{22}^{Z,*}\sin\phi_W^2 + g_R Z_{32}^{Z,*}\cos\phi_W^2\Big)\Big(p_\mu^{\eta_R^+}\Big) \tag{551}$$



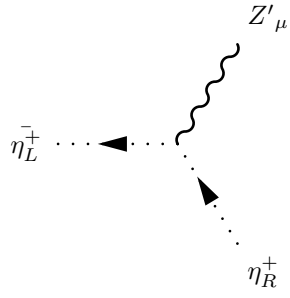
$$-i\Big(g_2 Z_{23}^{Z,*}\sin\phi_W^2 + g_R Z_{33}^{Z,*}\cos\phi_W^2\Big)\Big(p_\mu^{\eta_R^+}\Big) \tag{552}$$



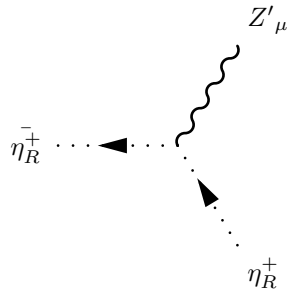
$$-i\Big(g_2 Z_{22}^{Z,*} - g_R Z_{32}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta_R^+}\Big) \tag{553}$$



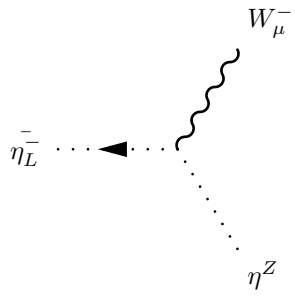
$$i\Big(g_2 Z_{22}^{Z,*}\sin\phi_W^2 + g_R Z_{32}^{Z,*}\cos\phi_W^2\Big)\Big(p_\mu^{\eta_R^+}\Big) \tag{554}$$



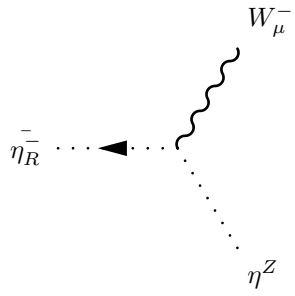
$$-i\Big(g_2 Z_{23}^{Z,*} - g_R Z_{33}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta_R^+}\Big) \tag{555}$$



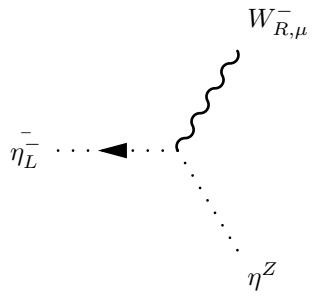
$$i\Big(g_2 Z_{23}^{Z,*} \sin\phi_W^2 + g_R Z_{33}^{Z,*} \cos\phi_W^2\Big)\Big(p_\mu^{\eta_R^+}\Big) \tag{556}$$



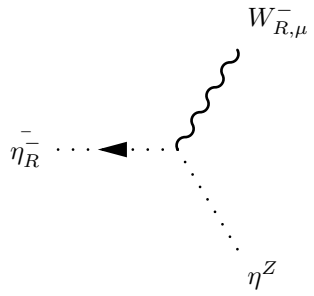
$$i\Big(g_2 \cos\phi_W^2 Z_{22}^Z + g_R \sin\phi_W^2 Z_{32}^Z\Big)\Big(p_\mu^{\eta^Z}\Big) \tag{557}$$



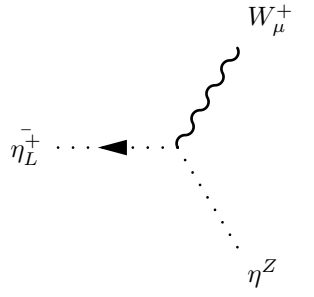
$$-\,i\cos\phi_W \sin\phi_W\Big(g_2 Z_{22}^Z - g_R Z_{32}^Z\Big)\Big(p_\mu^{\eta^Z}\Big) \tag{558}$$



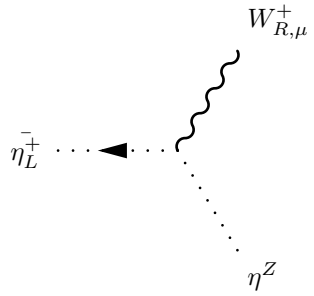
$$-i\cos\phi_W \sin\phi_W \Big(g_2 Z^Z_{22} - g_R Z^Z_{32}\Big)\Big(p_\mu^{\eta^Z}\Big) \tag{559}$$



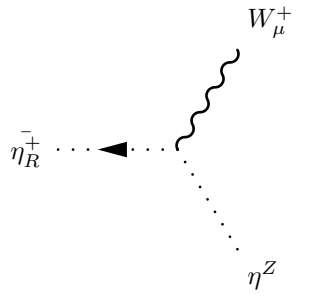
$$i\Big(g_2 \sin\phi^2_W Z^Z_{22} + g_R \cos\phi^2_W Z^Z_{32}\Big)\Big(p_\mu^{\eta^Z}\Big) \tag{560}$$



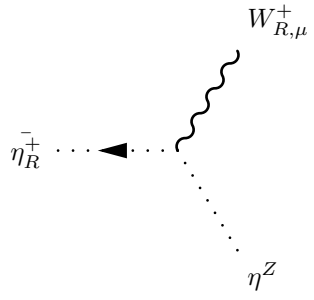
$$-i\Big(g_2 Z^{Z,*}_{22} \cos\phi^2_W + g_R Z^{Z,*}_{32} \sin\phi^2_W\Big)\Big(p_\mu^{\eta^Z}\Big) \tag{561}$$



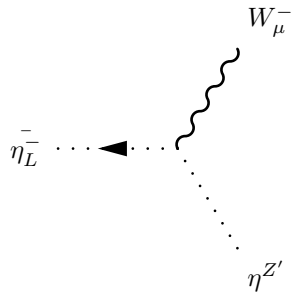
$$i\Big(g_2 Z_{22}^{Z,*} - g_R Z_{32}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta^Z}\Big) \tag{562}$$



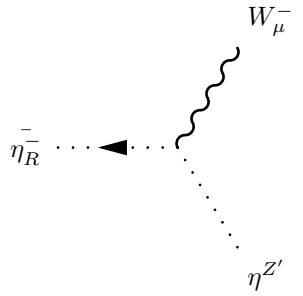
$$i\Big(g_2 Z_{22}^{Z,*} - g_R Z_{32}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta^Z}\Big) \tag{563}$$



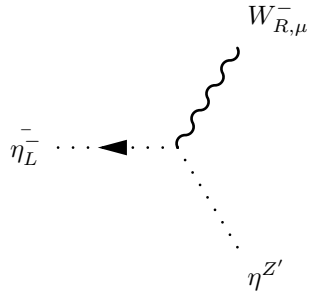
$$-i\Big(g_2 Z_{22}^{Z,*}\sin\phi_W^2 + g_R Z_{32}^{Z,*}\cos\phi_W^2\Big)\Big(p_\mu^{\eta^Z}\Big) \tag{564}$$



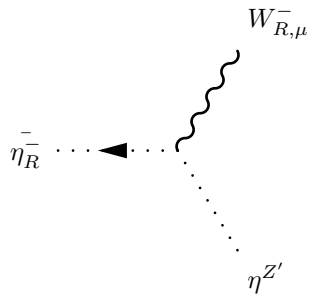
$$i\Big(g_2 \cos\phi_W^2 Z_{23}^Z + g_R \sin\phi_W^2 Z_{33}^Z\Big)\Big(p_\mu^{\eta^{Z'}}\Big) \tag{565}$$



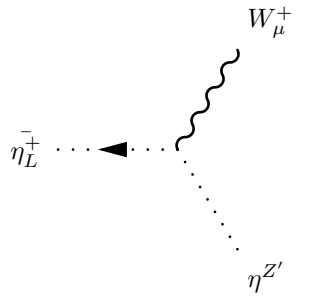
$$-\,i\cos\phi_W \sin\phi_W\Big(g_2 Z_{23}^Z - g_R Z_{33}^Z\Big)\Big(p_\mu^{\eta^{Z'}}\Big) \tag{566}$$



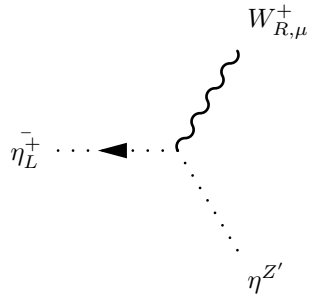
$$-\,i\cos\phi_W \sin\phi_W\Big(g_2 Z_{23}^Z - g_R Z_{33}^Z\Big)\Big(p_\mu^{\eta^{Z'}}\Big) \tag{567}$$



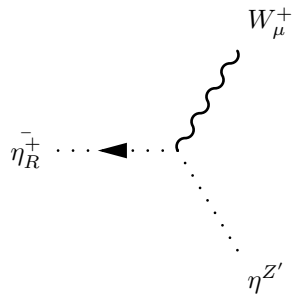
$$i\Big(g_2 \sin\phi_W^2 Z_{23}^Z + g_R \cos\phi_W^2 Z_{33}^Z\Big)\Big(p_\mu^{\eta^{Z'}}\Big) \tag{568}$$



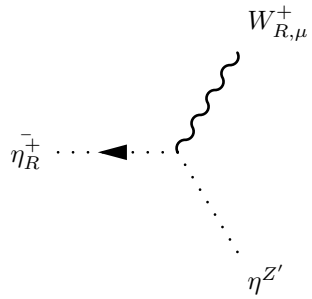
$$-i\Big(g_2 Z_{23}^{Z,*} \cos\phi_W^2 + g_R Z_{33}^{Z,*} \sin\phi_W^2\Big)\Big(p_\mu^{\eta^{Z'}}\Big) \tag{569}$$



$$i\Big(g_2 Z_{23}^{Z,*} - g_R Z_{33}^{Z,*}\Big)\cos\phi_W \sin\phi_W\Big(p_\mu^{\eta^{Z'}}\Big) \tag{570}$$

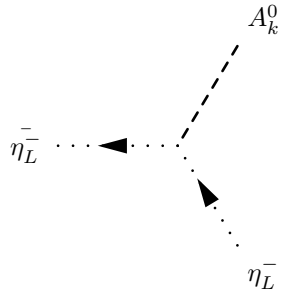


$$i\Big(g_2 Z_{23}^{Z,*} - g_R Z_{33}^{Z,*}\Big)\cos\phi_W \sin\phi_W \Big(p_\mu^{\eta^{Z'}}\Big) \tag{571}$$

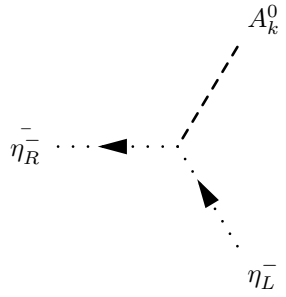


$$-i\Big(g_2 Z_{23}^{Z,*}\sin\phi_W^2 + g_R Z_{33}^{Z,*}\cos\phi_W^2\Big)\Big(p_\mu^{\eta^{Z'}}\Big) \tag{572}$$

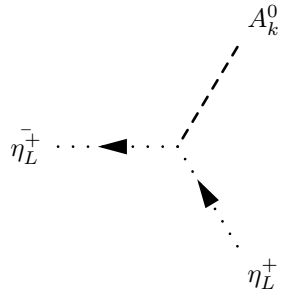
8.11 Two Ghosts-One Scalar-Interaction



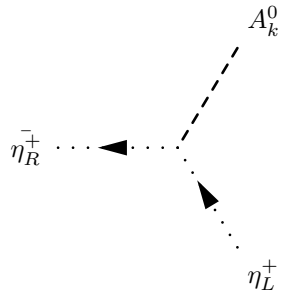
$$\frac{1}{4}\xi_{W^-}\Big(v_d\Big(g_2^2\cos\phi_W^2 - g_R^2\sin\phi_W^2\Big)Z_{k1}^{Ah} + \Big(-g_2^2 v_u\cos\phi_W^2 + g_R^2 v_u\sin\phi_W^2\Big)Z_{k2}^{Ah}$$
$$- g_R^2 v_R\sin\phi_W^2 Z_{k3}^{Ah} - g_2^2 v_L\cos\phi_W^2 Z_{k4}^{Ah}\Big) \tag{573}$$



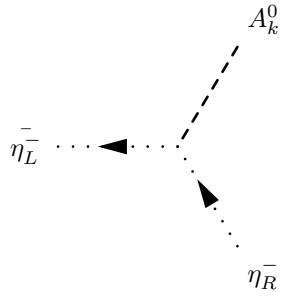
$$\frac{1}{8}\xi_{W_R^-}\Big(-\Big(2g_2g_Rv_u+\Big(g_2^2+g_R^2\Big)v_d\sin 2\phi_W\Big)Z_{k1}^{Ah}+\Big(2g_2g_Rv_d+\Big(g_2^2+g_R^2\Big)v_u\sin 2\phi_W\Big)Z_{k2}^{Ah} \\ +\sin 2\phi_W\Big(g_2^2v_LZ_{k4}^{Ah}-g_R^2v_RZ_{k3}^{Ah}\Big)\Big) \tag{574}$$



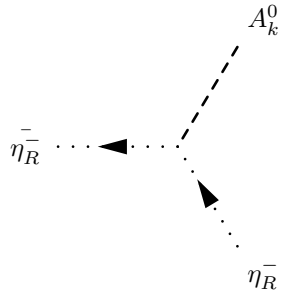
$$\frac{1}{4}\xi_{W^-}\Big(\Big(-g_2^2v_d\cos\phi_W^2+g_R^2v_d\sin\phi_W^2\Big)Z_{k1}^{Ah}+v_u\Big(g_2^2\cos\phi_W^2-g_R^2\sin\phi_W^2\Big)Z_{k2}^{Ah} \\ +g_R^2v_R\sin\phi_W^2Z_{k3}^{Ah}+g_2^2v_L\cos\phi_W^2Z_{k4}^{Ah}\Big) \tag{575}$$



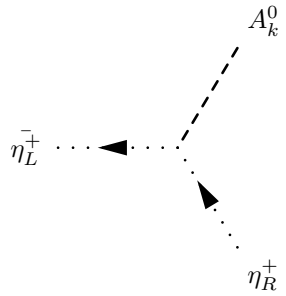
$$-\frac{1}{8}\xi_{W_R^-}\Big(-\Big(2g_2g_Rv_u+\Big(g_2^2+g_R^2\Big)v_d\sin 2\phi_W\Big)Z_{k1}^{Ah}+\Big(2g_2g_Rv_d+\Big(g_2^2+g_R^2\Big)v_u\sin 2\phi_W\Big)Z_{k2}^{Ah} \\ +\sin 2\phi_W\Big(g_2^2v_LZ_{k4}^{Ah}-g_R^2v_RZ_{k3}^{Ah}\Big)\Big) \tag{576}$$



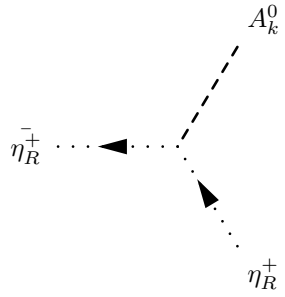
$$\frac{1}{8}\xi_{W^-}\Big(-\Big(-2g_2g_Rv_u+\Big(g_2^2+g_R^2\Big)v_d\sin 2\phi_W\Big)Z_{k1}^{Ah}+\Big(-2g_2g_Rv_d+\Big(g_2^2+g_R^2\Big)v_u\sin 2\phi_W\Big)Z_{k2}^{Ah}$$
$$+\sin 2\phi_W\Big(g_2^2v_LZ_{k4}^{Ah}-g_R^2v_RZ_{k3}^{Ah}\Big)\Big) \tag{577}$$



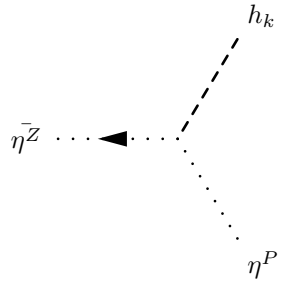
$$-\frac{1}{4}\xi_{W_R^-}\Big(v_d\Big(-g_2^2\sin\phi_W^2+g_R^2\cos\phi_W^2\Big)Z_{k1}^{Ah}+\Big(g_2^2v_u\sin\phi_W^2-g_R^2v_u\cos\phi_W^2\Big)Z_{k2}^{Ah}$$
$$+g_R^2v_R\cos\phi_W^2Z_{k3}^{Ah}+g_2^2v_L\sin\phi_W^2Z_{k4}^{Ah}\Big) \tag{578}$$



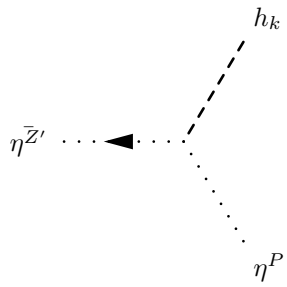
$$-\frac{1}{8}\xi_{W^-}\Big(-\Big(-2g_2g_Rv_u+\Big(g_2^2+g_R^2\Big)v_d\sin 2\phi_W\Big)Z_{k1}^{Ah}+\Big(-2g_2g_Rv_d+\Big(g_2^2+g_R^2\Big)v_u\sin 2\phi_W\Big)Z_{k2}^{Ah}$$
$$+\sin 2\phi_W\Big(g_2^2v_LZ_{k4}^{Ah}-g_R^2v_RZ_{k3}^{Ah}\Big)\Big) \tag{579}$$



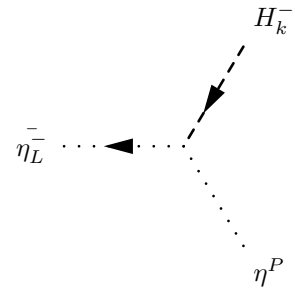
$$\frac{1}{4}\xi_{W_R^-}\Big(v_d\Big(-g_2^2\sin\phi_W^2+g_R^2\cos\phi_W^2\Big)Z_{k1}^{Ah}+\Big(g_2^2v_u\sin\phi_W^2-g_R^2v_u\cos\phi_W^2\Big)Z_{k2}^{Ah}$$
$$+g_R^2v_R\cos\phi_W^2Z_{k3}^{Ah}+g_2^2v_L\sin\phi_W^2Z_{k4}^{Ah}\Big) \tag{580}$$



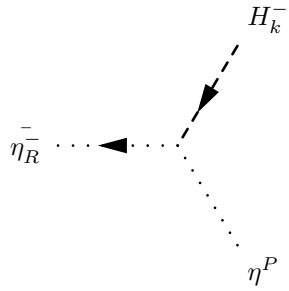
$$-\frac{i}{8}\xi_Z\Big(-4g_2g_Bv_LZ_{22}^{Z,*}Z_{k4}^HZ_{11}^Z+4g_B^2v_RZ_{k3}^HZ_{11}^ZZ_{12}^Z+4g_B^2v_LZ_{k4}^HZ_{11}^ZZ_{12}^Z$$
$$+g_2^2v_dZ_{22}^{Z,*}Z_{k1}^HZ_{21}^Z+g_2^2v_uZ_{22}^{Z,*}Z_{k2}^HZ_{21}^Z+4g_2^2v_LZ_{22}^{Z,*}Z_{k4}^HZ_{21}^Z$$
$$-4g_2g_Bv_LZ_{k4}^HZ_{12}^ZZ_{21}^Z-4g_2g_Bv_LZ_{k4}^HZ_{11}^ZZ_{22}^Z+g_2^2v_dZ_{k1}^HZ_{21}^ZZ_{22}^Z$$
$$+g_2^2v_uZ_{k2}^HZ_{21}^ZZ_{22}^Z+4g_2^2v_LZ_{k4}^HZ_{21}^ZZ_{22}^Z-g_2g_Rv_dZ_{22}^{Z,*}Z_{k1}^HZ_{31}^Z$$
$$-g_2g_Rv_uZ_{22}^{Z,*}Z_{k2}^HZ_{31}^Z-4g_Bg_Rv_RZ_{k3}^HZ_{12}^ZZ_{31}^Z-g_2g_Rv_dZ_{k1}^HZ_{22}^ZZ_{31}^Z$$
$$-g_2g_Rv_uZ_{k2}^HZ_{22}^ZZ_{31}^Z+4g_BZ_{12}^{Z,*}\Big(v_LZ_{k4}^H\Big(-g_2Z_{21}^Z+g_BZ_{11}^Z\Big)+v_RZ_{k3}^H\Big(g_BZ_{11}^Z-g_RZ_{31}^Z\Big)\Big)$$
$$+g_RZ_{32}^{Z,*}\Big(-\Big(v_dZ_{k1}^H+v_uZ_{k2}^H\Big)\Big(g_2Z_{21}^Z-g_RZ_{31}^Z\Big)+Z_{k3}^H\Big(-4g_Bv_RZ_{11}^Z+4g_Rv_RZ_{31}^Z\Big)\Big)$$
$$-4g_Bg_Rv_RZ_{k3}^HZ_{11}^ZZ_{32}^Z-g_2g_Rv_dZ_{k1}^HZ_{21}^ZZ_{32}^Z-g_2g_Rv_uZ_{k2}^HZ_{21}^ZZ_{32}^Z$$
$$+g_R^2v_dZ_{k1}^HZ_{31}^ZZ_{32}^Z+g_R^2v_uZ_{k2}^HZ_{31}^ZZ_{32}^Z+4g_R^2v_RZ_{k3}^HZ_{31}^ZZ_{32}^Z\Big) \tag{581}$$



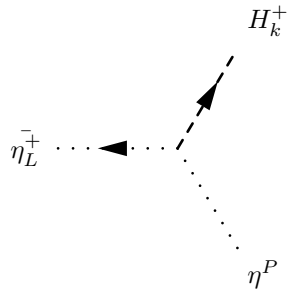
$$
\begin{aligned}
&-\frac{i}{8}\xi_{Z'}\Big(-4g_2g_Bv_LZ_{23}^{Z,*}Z_{k4}^HZ_{11}^Z+4g_B^2v_RZ_{k3}^HZ_{11}^ZZ_{13}^Z+4g_B^2v_LZ_{k4}^HZ_{11}^ZZ_{13}^Z\\
&+g_2^2v_dZ_{23}^{Z,*}Z_{k1}^HZ_{21}^Z+g_2^2v_uZ_{23}^{Z,*}Z_{k2}^HZ_{21}^Z+4g_2^2v_LZ_{23}^{Z,*}Z_{k4}^HZ_{21}^Z\\
&-4g_2g_Bv_LZ_{k4}^HZ_{13}^ZZ_{21}^Z-4g_2g_Bv_LZ_{k4}^HZ_{11}^ZZ_{23}^Z+g_2^2v_dZ_{k1}^HZ_{21}^ZZ_{23}^Z\\
&+g_2^2v_uZ_{k2}^HZ_{21}^ZZ_{23}^Z+4g_2^2v_LZ_{k4}^HZ_{21}^ZZ_{23}^Z-g_2g_Rv_dZ_{23}^{Z,*}Z_{k1}^HZ_{31}^Z\\
&-g_2g_Rv_uZ_{23}^{Z,*}Z_{k2}^HZ_{31}^Z-4g_Bg_Rv_RZ_{k3}^HZ_{13}^ZZ_{31}^Z-g_2g_Rv_dZ_{k1}^HZ_{23}^ZZ_{31}^Z\\
&-g_2g_Rv_uZ_{k2}^HZ_{23}^ZZ_{31}^Z+4g_BZ_{13}^{Z,*}\Big(v_LZ_{k4}^H\Big(-g_2Z_{21}^Z+g_BZ_{11}^Z\Big)+v_RZ_{k3}^H\Big(g_BZ_{11}^Z-g_RZ_{31}^Z\Big)\Big)\\
&+g_RZ_{33}^{Z,*}\Big(-\Big(v_dZ_{k1}^H+v_uZ_{k2}^H\Big)\Big(g_2Z_{21}^Z-g_RZ_{31}^Z\Big)+Z_{k3}^H\Big(-4g_Bv_RZ_{11}^Z+4g_Rv_RZ_{31}^Z\Big)\Big)\\
&-4g_Bg_Rv_RZ_{k3}^HZ_{11}^ZZ_{33}^Z-g_2g_Rv_dZ_{k1}^HZ_{21}^ZZ_{33}^Z-g_2g_Rv_uZ_{k2}^HZ_{21}^ZZ_{33}^Z\\
&+g_R^2v_dZ_{k1}^HZ_{31}^ZZ_{33}^Z+g_R^2v_uZ_{k2}^HZ_{31}^ZZ_{33}^Z+4g_R^2v_RZ_{k3}^HZ_{31}^ZZ_{33}^Z\Big)
\end{aligned}
\tag{582}
$$



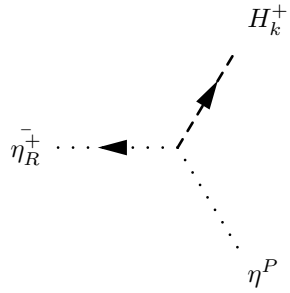
$$
\begin{aligned}
&-\frac{i}{4}\xi_{W^-}\Big(g_2Z_{21}^{Z,*}\Big(g_2v_u\cos\phi_W-g_Rv_d\sin\phi_W\Big)Z_{k2}^+\\
&+g_RZ_{31}^{Z,*}\Big(g_2v_u\cos\phi_W-g_Rv_d\sin\phi_W\Big)Z_{k2}^++\sqrt{2}g_Bg_Rv_RZ_{11}^{Z,*}\sin\phi_WZ_{k3}^+\\
&+\sqrt{2}g_2g_Bv_LZ_{11}^{Z,*}\cos\phi_WZ_{k4}^+-g_2^2v_d\cos\phi_WZ_{k1}^+Z_{21}^Z+g_2g_Rv_u\sin\phi_WZ_{k1}^+Z_{21}^Z\\
&-g_2g_Rv_d\cos\phi_WZ_{k1}^+Z_{31}^Z+g_R^2v_u\sin\phi_WZ_{k1}^+Z_{31}^Z\Big)
\end{aligned}
\tag{583}
$$



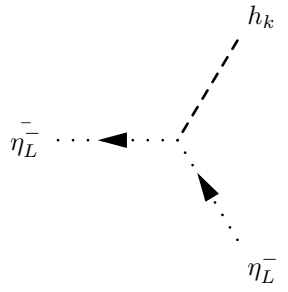
$$
\begin{aligned}
&-\frac{i}{4}\xi_{W_R^-}\Big(-g_2 Z_{21}^{Z,*}\Big(g_2 v_u \sin\phi_W + g_R v_d \cos\phi_W\Big) Z_{k2}^+ \\
&- g_R Z_{31}^{Z,*}\Big(g_2 v_u \sin\phi_W + g_R v_d \cos\phi_W\Big) Z_{k2}^+ + \sqrt{2} g_B g_R v_R Z_{11}^{Z,*} \cos\phi_W Z_{k3}^+ \\
&- \sqrt{2} g_2 g_B v_L Z_{11}^{Z,*} \sin\phi_W Z_{k4}^+ + g_2 g_R v_u \cos\phi_W Z_{k1}^+ Z_{21}^Z + g_2^2 v_d \sin\phi_W Z_{k1}^+ Z_{21}^Z \\
&+ g_R^2 v_u \cos\phi_W Z_{k1}^+ Z_{31}^Z + g_2 g_R v_d \sin\phi_W Z_{k1}^+ Z_{31}^Z\Big)
\end{aligned} \tag{584}
$$



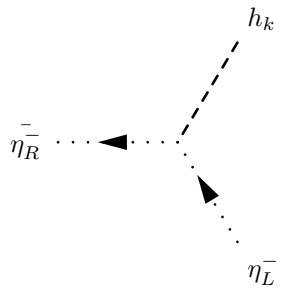
$$
\begin{aligned}
&\frac{i}{4}\xi_{W^-}\Big(g_2 Z_{21}^{Z,*}\Big(g_2 v_d \cos\phi_W - g_R v_u \sin\phi_W\Big) Z_{k1}^+ \\
&+ g_R Z_{31}^{Z,*}\Big(g_2 v_d \cos\phi_W - g_R v_u \sin\phi_W\Big) Z_{k1}^+ - \sqrt{2} g_B g_R v_R \sin\phi_W Z_{k3}^+ Z_{11}^Z \\
&- \sqrt{2} g_2 g_B v_L \cos\phi_W Z_{k4}^+ Z_{11}^Z - g_2^2 v_u \cos\phi_W Z_{k2}^+ Z_{21}^Z \\
&+ g_2 g_R v_d \sin\phi_W Z_{k2}^+ Z_{21}^Z - g_2 g_R v_u \cos\phi_W Z_{k2}^+ Z_{31}^Z + g_R^2 v_d \sin\phi_W Z_{k2}^+ Z_{31}^Z\Big)
\end{aligned} \tag{585}
$$



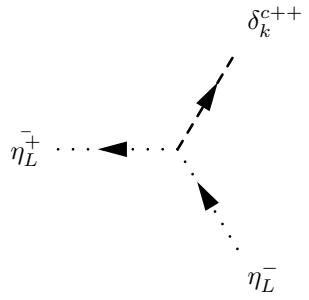
$$\frac{i}{4}\xi_{W_R^-}\Big(- g_2 Z_{21}^{Z,*}\Big(g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W\Big) Z_{k1}^+ \\ - g_R Z_{31}^{Z,*}\Big(g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W\Big) Z_{k1}^+ - \sqrt{2} g_B g_R v_R \cos\phi_W Z_{k3}^+ Z_{11}^Z \\ + \sqrt{2} g_2 g_B v_L \sin\phi_W Z_{k4}^+ Z_{11}^Z + g_2 g_R v_d \cos\phi_W Z_{k2}^+ Z_{21}^Z + g_2^2 v_u \sin\phi_W Z_{k2}^+ Z_{21}^Z \\ + g_R^2 v_d \cos\phi_W Z_{k2}^+ Z_{31}^Z + g_2 g_R v_u \sin\phi_W Z_{k2}^+ Z_{31}^Z\Big) \tag{586}$$



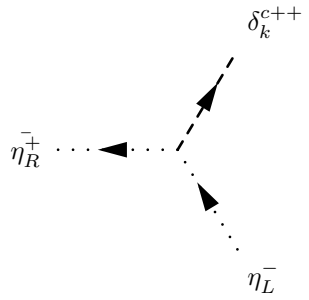
$$- \frac{i}{4}\xi_{W^-}\Big(\Big(- 2 g_2 g_R v_u \cos\phi_W \sin\phi_W + g_2^2 v_d \cos\phi_W^2 + g_R^2 v_d \sin\phi_W^2\Big) Z_{k1}^H \\ + \Big(- 2 g_2 g_R v_d \cos\phi_W \sin\phi_W + g_2^2 v_u \cos\phi_W^2 + g_R^2 v_u \sin\phi_W^2\Big) Z_{k2}^H \\ + g_R^2 v_R \sin\phi_W^2 Z_{k3}^H + g_2^2 v_L \cos\phi_W^2 Z_{k4}^H\Big) \tag{587}$$



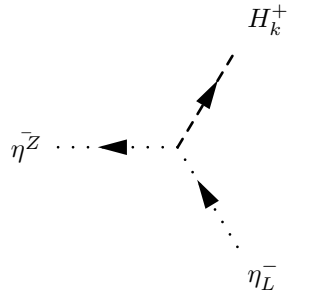
$$\frac{i}{8}\xi_{W_R^-}\Big(\Big(2g_2g_Rv_u\cos 2\phi_W+\Big(-g_R^2+g_2^2\Big)v_d\sin 2\phi_W\Big)Z_{k1}^H$$
$$+\Big(2g_2g_Rv_d\cos 2\phi_W+\Big(-g_R^2+g_2^2\Big)v_u\sin 2\phi_W\Big)Z_{k2}^H$$
$$+\sin 2\phi_W\Big(g_2^2v_LZ_{k4}^H-g_R^2v_RZ_{k3}^H\Big)\Big) \tag{588}$$



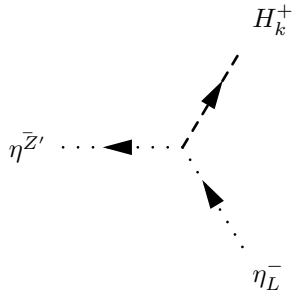
$$\frac{i}{2}\frac{1}{\sqrt{2}}\xi_{W^-}\Big(g_2^2v_L\cos\phi_W^2Z_{k2}^{++}+g_R^2v_R\sin\phi_W^2Z_{k1}^{++}\Big) \tag{589}$$



$$\frac{i}{4}\frac{1}{\sqrt{2}}\xi_{W_R^-}\sin 2\phi_W\Big(-g_2^2v_LZ_{k2}^{++}+g_R^2v_RZ_{k1}^{++}\Big) \tag{590}$$

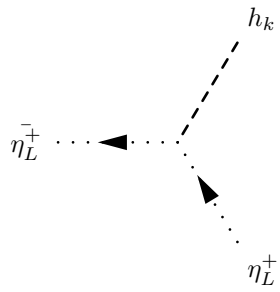


$$
\begin{aligned}
&- \frac{i}{8}\xi_Z\Big(2\sqrt{2}g_B g_R v_R Z_{12}^{Z,*}\sin\phi_W Z_{k3}^+ \\
&+ g_R Z_{32}^{Z,*}\Big(-\Big(g_2 v_d\cos\phi_W + g_R v_u\sin\phi_W\Big)Z_{k1}^+ + \Big(g_2 v_u\cos\phi_W + g_R v_d\sin\phi_W\Big)Z_{k2}^+ \\
&- 2\sqrt{2}g_R v_R\sin\phi_W Z_{k3}^+\Big) \\
&+ 2\sqrt{2}g_2 g_B v_L Z_{12}^{Z,*}\cos\phi_W Z_{k4}^+ \\
&+ g_2 Z_{22}^{Z,*}\Big(\Big(g_2 v_d\cos\phi_W + g_R v_u\sin\phi_W\Big)Z_{k1}^+ - \Big(g_2 v_u\cos\phi_W + g_R v_d\sin\phi_W\Big)Z_{k2}^+ \\
&- 2\sqrt{2}g_2 v_L\cos\phi_W Z_{k4}^+\Big) \\
&+ 2\sqrt{2}g_B g_R v_R\sin\phi_W Z_{k3}^+ Z_{12}^Z + 2\sqrt{2}g_2 g_B v_L\cos\phi_W Z_{k4}^+ Z_{12}^Z \\
&+ g_2^2 v_d\cos\phi_W Z_{k1}^+ Z_{22}^Z + g_2 g_R v_u\sin\phi_W Z_{k1}^+ Z_{22}^Z - g_2^2 v_u\cos\phi_W Z_{k2}^+ Z_{22}^Z \\
&- g_2 g_R v_d\sin\phi_W Z_{k2}^+ Z_{22}^Z - 2\sqrt{2}g_2^2 v_L\cos\phi_W Z_{k4}^+ Z_{22}^Z \\
&- g_2 g_R v_d\cos\phi_W Z_{k1}^+ Z_{32}^Z - g_R^2 v_u\sin\phi_W Z_{k1}^+ Z_{32}^Z + g_2 g_R v_u\cos\phi_W Z_{k2}^+ Z_{32}^Z \\
&+ g_R^2 v_d\sin\phi_W Z_{k2}^+ Z_{32}^Z - 2\sqrt{2}g_R^2 v_R\sin\phi_W Z_{k3}^+ Z_{32}^Z\Big)
\end{aligned}
\tag{591}
$$

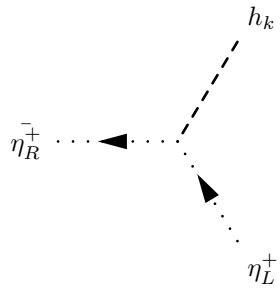


$$
\begin{aligned}
&- \frac{i}{8}\xi_{Z'}\Big(2\sqrt{2}g_B g_R v_R Z_{13}^{Z,*}\sin\phi_W Z_{k3}^+ \\
&+ g_R Z_{33}^{Z,*}\Big(-\Big(g_2 v_d\cos\phi_W + g_R v_u\sin\phi_W\Big)Z_{k1}^+ + \Big(g_2 v_u\cos\phi_W + g_R v_d\sin\phi_W\Big)Z_{k2}^+ \\
&- 2\sqrt{2}g_R v_R\sin\phi_W Z_{k3}^+\Big) \\
&+ 2\sqrt{2}g_2 g_B v_L Z_{13}^{Z,*}\cos\phi_W Z_{k4}^+ \\
&+ g_2 Z_{23}^{Z,*}\Big(\Big(g_2 v_d\cos\phi_W + g_R v_u\sin\phi_W\Big)Z_{k1}^+ - \Big(g_2 v_u\cos\phi_W + g_R v_d\sin\phi_W\Big)Z_{k2}^+ \\
&- 2\sqrt{2}g_2 v_L\cos\phi_W Z_{k4}^+\Big) \\
&+ 2\sqrt{2}g_B g_R v_R\sin\phi_W Z_{k3}^+ Z_{13}^Z + 2\sqrt{2}g_2 g_B v_L\cos\phi_W Z_{k4}^+ Z_{13}^Z \\
&+ g_2^2 v_d\cos\phi_W Z_{k1}^+ Z_{23}^Z + g_2 g_R v_u\sin\phi_W Z_{k1}^+ Z_{23}^Z - g_2^2 v_u\cos\phi_W Z_{k2}^+ Z_{23}^Z \\
&- g_2 g_R v_d\sin\phi_W Z_{k2}^+ Z_{23}^Z - 2\sqrt{2}g_2^2 v_L\cos\phi_W Z_{k4}^+ Z_{23}^Z
\end{aligned}
$$

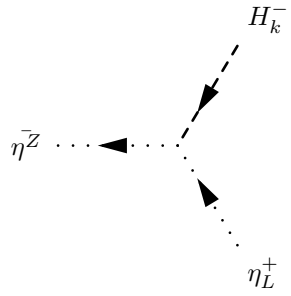
$$- g_2 g_R v_d \cos\phi_W Z^+_{k1} Z^Z_{33} - g_R^2 v_u \sin\phi_W Z^+_{k1} Z^Z_{33} + g_2 g_R v_u \cos\phi_W Z^+_{k2} Z^Z_{33}$$
$$+ g_R^2 v_d \sin\phi_W Z^+_{k2} Z^Z_{33} - 2\sqrt{2} g_R^2 v_R \sin\phi_W Z^+_{k3} Z^Z_{33}\Big) \tag{592}$$



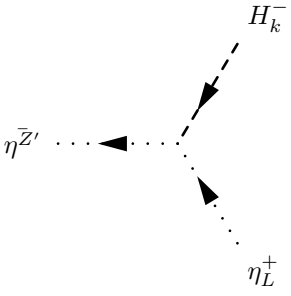
$$- \frac{i}{4}\xi_{W^-}\Big(\Big(- 2 g_2 g_R v_u \cos\phi_W \sin\phi_W + g_2^2 v_d \cos\phi_W^2 + g_R^2 v_d \sin\phi_W^2\Big) Z^H_{k1}$$
$$+ \Big(- 2 g_2 g_R v_d \cos\phi_W \sin\phi_W + g_2^2 v_u \cos\phi_W^2 + g_R^2 v_u \sin\phi_W^2\Big) Z^H_{k2}$$
$$+ g_R^2 v_R \sin\phi_W^2 Z^H_{k3} + g_2^2 v_L \cos\phi_W^2 Z^H_{k4}\Big) \tag{593}$$



$$\frac{i}{8}\xi_{W^-_R}\Big(\Big(2 g_2 g_R v_u \cos 2\phi_W + \Big(- g_R^2 + g_2^2\Big) v_d \sin 2\phi_W\Big) Z^H_{k1}$$
$$+ \Big(2 g_2 g_R v_d \cos 2\phi_W + \Big(- g_R^2 + g_2^2\Big) v_u \sin 2\phi_W\Big) Z^H_{k2}$$
$$+ \sin 2\phi_W \Big(g_2^2 v_L Z^H_{k4} - g_R^2 v_R Z^H_{k3}\Big)\Big) \tag{594}$$

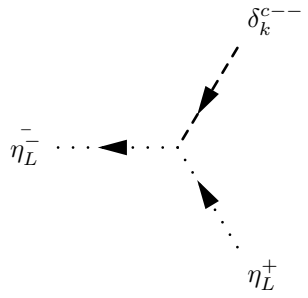


$$
\begin{aligned}
&-\frac{i}{8}\xi_Z\Big(2\sqrt{2}g_Bg_Rv_RZ_{12}^{Z,*}\sin\phi_WZ_{k3}^+\\
&+g_RZ_{32}^{Z,*}\Big(-\Big(g_2v_d\cos\phi_W+g_Rv_u\sin\phi_W\Big)Z_{k1}^+ + \Big(g_2v_u\cos\phi_W+g_Rv_d\sin\phi_W\Big)Z_{k2}^+\\
&-2\sqrt{2}g_Rv_R\sin\phi_WZ_{k3}^+\Big)\\
&+2\sqrt{2}g_2g_Bv_LZ_{12}^{Z,*}\cos\phi_WZ_{k4}^+\\
&+g_2Z_{22}^{Z,*}\Big(\Big(g_2v_d\cos\phi_W+g_Rv_u\sin\phi_W\Big)Z_{k1}^+ - \Big(g_2v_u\cos\phi_W+g_Rv_d\sin\phi_W\Big)Z_{k2}^+\\
&-2\sqrt{2}g_2v_L\cos\phi_WZ_{k4}^+\Big)\\
&+2\sqrt{2}g_Bg_Rv_R\sin\phi_WZ_{k3}^+Z_{12}^Z+2\sqrt{2}g_2g_Bv_L\cos\phi_WZ_{k4}^+Z_{12}^Z\\
&+g_2^2v_d\cos\phi_WZ_{k1}^+Z_{22}^Z+g_2g_Rv_u\sin\phi_WZ_{k1}^+Z_{22}^Z-g_2^2v_u\cos\phi_WZ_{k2}^+Z_{22}^Z\\
&-g_2g_Rv_d\sin\phi_WZ_{k2}^+Z_{22}^Z-2\sqrt{2}g_2^2v_L\cos\phi_WZ_{k4}^+Z_{22}^Z\\
&-g_2g_Rv_d\cos\phi_WZ_{k1}^+Z_{32}^Z-g_R^2v_u\sin\phi_WZ_{k1}^+Z_{32}^Z+g_2g_Rv_u\cos\phi_WZ_{k2}^+Z_{32}^Z\\
&+g_R^2v_d\sin\phi_WZ_{k2}^+Z_{32}^Z-2\sqrt{2}g_R^2v_R\sin\phi_WZ_{k3}^+Z_{32}^Z\Big)
\end{aligned}
\tag{595}
$$

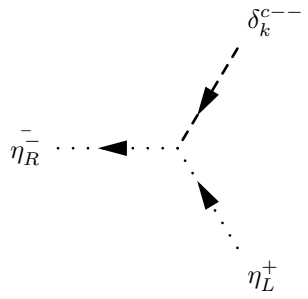


$$
\begin{aligned}
&-\frac{i}{8}\xi_{Z'}\Big(2\sqrt{2}g_Bg_Rv_RZ_{13}^{Z,*}\sin\phi_WZ_{k3}^+\\
&+g_RZ_{33}^{Z,*}\Big(-\Big(g_2v_d\cos\phi_W+g_Rv_u\sin\phi_W\Big)Z_{k1}^+ + \Big(g_2v_u\cos\phi_W+g_Rv_d\sin\phi_W\Big)Z_{k2}^+
\end{aligned}
$$

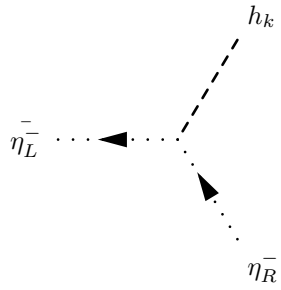
$$
\begin{aligned}
&- 2\sqrt{2} g_R v_R \sin\phi_W Z^+_{k3}\Big) \\
&+ 2\sqrt{2} g_2 g_B v_L Z^{Z,*}_{13} \cos\phi_W Z^+_{k4} \\
&+ g_2 Z^{Z,*}_{23}\Big(\Big(g_2 v_d \cos\phi_W + g_R v_u \sin\phi_W\Big) Z^+_{k1} - \Big(g_2 v_u \cos\phi_W + g_R v_d \sin\phi_W\Big) Z^+_{k2} \\
&- 2\sqrt{2} g_2 v_L \cos\phi_W Z^+_{k4}\Big) \\
&+ 2\sqrt{2} g_B g_R v_R \sin\phi_W Z^+_{k3} Z^Z_{13} + 2\sqrt{2} g_2 g_B v_L \cos\phi_W Z^+_{k4} Z^Z_{13} \\
&+ g_2^2 v_d \cos\phi_W Z^+_{k1} Z^Z_{23} + g_2 g_R v_u \sin\phi_W Z^+_{k1} Z^Z_{23} - g_2^2 v_u \cos\phi_W Z^+_{k2} Z^Z_{23} \\
&- g_2 g_R v_d \sin\phi_W Z^+_{k2} Z^Z_{23} - 2\sqrt{2} g_2^2 v_L \cos\phi_W Z^+_{k4} Z^Z_{23} \\
&- g_2 g_R v_d \cos\phi_W Z^+_{k1} Z^Z_{33} - g_R^2 v_u \sin\phi_W Z^+_{k1} Z^Z_{33} + g_2 g_R v_u \cos\phi_W Z^+_{k2} Z^Z_{33} \\
&+ g_R^2 v_d \sin\phi_W Z^+_{k2} Z^Z_{33} - 2\sqrt{2} g_R^2 v_R \sin\phi_W Z^+_{k3} Z^Z_{33}\Big)
\end{aligned} \tag{596}
$$



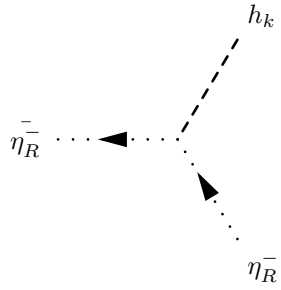
$$
\frac{i}{2}\frac{1}{\sqrt{2}}\xi_{W^-}\Big(g_2^2 v_L \cos\phi_W^2 Z^{++}_{k2} + g_R^2 v_R \sin\phi_W^2 Z^{++}_{k1}\Big) \tag{597}
$$



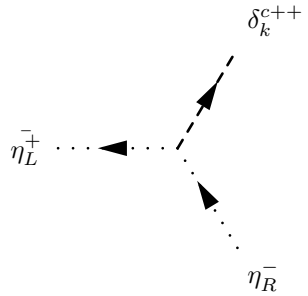
$$
\frac{i}{4}\frac{1}{\sqrt{2}}\xi_{W_R^-}\sin 2\phi_W\Big(- g_2^2 v_L Z^{++}_{k2} + g_R^2 v_R Z^{++}_{k1}\Big) \tag{598}
$$



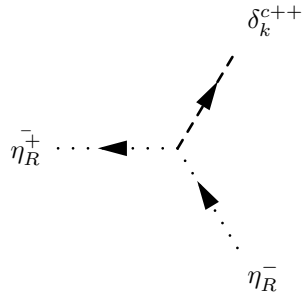
$$\frac{i}{8}\xi_{W^-}\Big(\Big(2g_2g_Rv_u\cos 2\phi_W+\Big(-g_R^2+g_2^2\Big)v_d\sin 2\phi_W\Big)Z_{k1}^H \\ +\Big(2g_2g_Rv_d\cos 2\phi_W+\Big(-g_R^2+g_2^2\Big)v_u\sin 2\phi_W\Big)Z_{k2}^H \\ +\sin 2\phi_W\Big(g_2^2v_LZ_{k4}^H-g_R^2v_RZ_{k3}^H\Big)\Big) \tag{599}$$



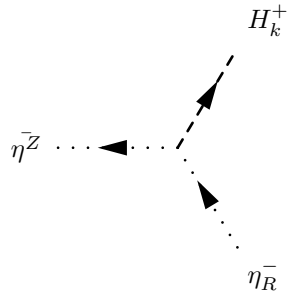
$$-\frac{i}{4}\xi_{W_R^-}\Big(\Big(g_2\sin\phi_W\Big(2g_Rv_u\cos\phi_W+g_2v_d\sin\phi_W\Big)+g_R^2v_d\cos\phi_W^2\Big)Z_{k1}^H \\ +\Big(g_2\sin\phi_W\Big(2g_Rv_d\cos\phi_W+g_2v_u\sin\phi_W\Big)+g_R^2v_u\cos\phi_W^2\Big)Z_{k2}^H \\ +g_R^2v_R\cos\phi_W^2Z_{k3}^H+g_2^2v_L\sin\phi_W^2Z_{k4}^H\Big) \tag{600}$$



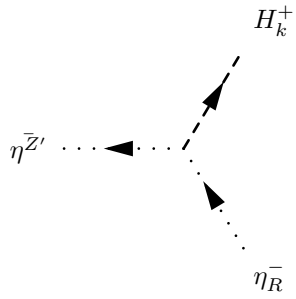
$$\frac{i}{4}\frac{1}{\sqrt{2}}\xi_{W^-}\sin 2\phi_W\Big(-g_2^2 v_L Z_{k2}^{++}+g_R^2 v_R Z_{k1}^{++}\Big) \tag{601}$$



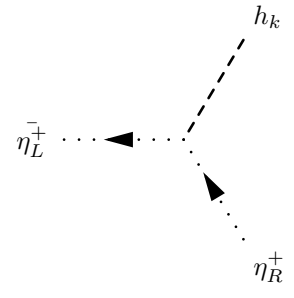
$$\frac{i}{2}\frac{1}{\sqrt{2}}\xi_{W_R^-}\Big(g_2^2 v_L\sin\phi_W^2 Z_{k2}^{++}+g_R^2 v_R\cos\phi_W^2 Z_{k1}^{++}\Big) \tag{602}$$



$$\begin{aligned}
&-\frac{i}{8}\xi_Z\Big(2\sqrt{2}g_B g_R v_R Z_{12}^{Z,*}\cos\phi_W Z_{k3}^+\\
&-g_R Z_{32}^{Z,*}\Big(\Big(-g_2 v_d\sin\phi_W+g_R v_u\cos\phi_W\Big)Z_{k1}^++\Big(g_2 v_u\sin\phi_W-g_R v_d\cos\phi_W\Big)Z_{k2}^+\\
&+2\sqrt{2}g_R v_R\cos\phi_W Z_{k3}^+\Big)\\
&-2\sqrt{2}g_2 g_B v_L Z_{12}^{Z,*}\sin\phi_W Z_{k4}^+\\
&+g_2 Z_{22}^{Z,*}\Big(\Big(-g_2 v_d\sin\phi_W+g_R v_u\cos\phi_W\Big)Z_{k1}^++\Big(g_2 v_u\sin\phi_W-g_R v_d\cos\phi_W\Big)Z_{k2}^+\\
&+2\sqrt{2}g_2 v_L\sin\phi_W Z_{k4}^+\Big)\\
&+2\sqrt{2}g_B g_R v_R\cos\phi_W Z_{k3}^+ Z_{12}^Z-2\sqrt{2}g_2 g_B v_L\sin\phi_W Z_{k4}^+ Z_{12}^Z\\
&+g_2 g_R v_u\cos\phi_W Z_{k1}^+ Z_{22}^Z-g_2^2 v_d\sin\phi_W Z_{k1}^+ Z_{22}^Z-g_2 g_R v_d\cos\phi_W Z_{k2}^+ Z_{22}^Z\\
&+g_2^2 v_u\sin\phi_W Z_{k2}^+ Z_{22}^Z+2\sqrt{2}g_2^2 v_L\sin\phi_W Z_{k4}^+ Z_{22}^Z-g_R^2 v_u\cos\phi_W Z_{k1}^+ Z_{32}^Z\\
&+g_2 g_R v_d\sin\phi_W Z_{k1}^+ Z_{32}^Z+g_R^2 v_d\cos\phi_W Z_{k2}^+ Z_{32}^Z-g_2 g_R v_u\sin\phi_W Z_{k2}^+ Z_{32}^Z\\
&-2\sqrt{2}g_R^2 v_R\cos\phi_W Z_{k3}^+ Z_{32}^Z\Big)
\end{aligned} \tag{603}$$

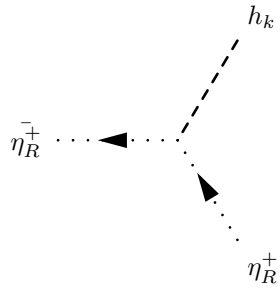


$$
\begin{aligned}
&-\frac{i}{8}\xi_{Z'}\Big(2\sqrt{2}g_B g_R v_R Z_{13}^{Z,*}\cos\phi_W Z_{k3}^+ \\
&- g_R Z_{33}^{Z,*}\Big(\Big(-g_2 v_d\sin\phi_W + g_R v_u\cos\phi_W\Big)Z_{k1}^+ + \Big(g_2 v_u\sin\phi_W - g_R v_d\cos\phi_W\Big)Z_{k2}^+ \\
&+ 2\sqrt{2}g_R v_R\cos\phi_W Z_{k3}^+\Big) \\
&- 2\sqrt{2}g_2 g_B v_L Z_{13}^{Z,*}\sin\phi_W Z_{k4}^+ \\
&+ g_2 Z_{23}^{Z,*}\Big(\Big(-g_2 v_d\sin\phi_W + g_R v_u\cos\phi_W\Big)Z_{k1}^+ + \Big(g_2 v_u\sin\phi_W - g_R v_d\cos\phi_W\Big)Z_{k2}^+ \\
&+ 2\sqrt{2}g_2 v_L\sin\phi_W Z_{k4}^+\Big) \\
&+ 2\sqrt{2}g_B g_R v_R\cos\phi_W Z_{k3}^+ Z_{13}^Z - 2\sqrt{2}g_2 g_B v_L\sin\phi_W Z_{k4}^+ Z_{13}^Z \\
&+ g_2 g_R v_u\cos\phi_W Z_{k1}^+ Z_{23}^Z - g_2^2 v_d\sin\phi_W Z_{k1}^+ Z_{23}^Z - g_2 g_R v_d\cos\phi_W Z_{k2}^+ Z_{23}^Z \\
&+ g_2^2 v_u\sin\phi_W Z_{k2}^+ Z_{23}^Z + 2\sqrt{2}g_2^2 v_L\sin\phi_W Z_{k4}^+ Z_{23}^Z - g_R^2 v_u\cos\phi_W Z_{k1}^+ Z_{33}^Z \\
&+ g_2 g_R v_d\sin\phi_W Z_{k1}^+ Z_{33}^Z + g_R^2 v_d\cos\phi_W Z_{k2}^+ Z_{33}^Z - g_2 g_R v_u\sin\phi_W Z_{k2}^+ Z_{33}^Z \\
&- 2\sqrt{2}g_R^2 v_R\cos\phi_W Z_{k3}^+ Z_{33}^Z\Big)
\end{aligned}
\tag{604}
$$

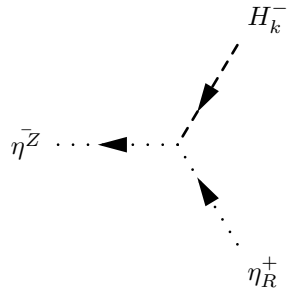


$$
\begin{aligned}
&\frac{i}{8}\xi_{W^-}\Big(\Big(2g_2 g_R v_u\cos 2\phi_W + \Big(-g_R^2 + g_2^2\Big)v_d\sin 2\phi_W\Big)Z_{k1}^H \\
&+ \Big(2g_2 g_R v_d\cos 2\phi_W + \Big(-g_R^2 + g_2^2\Big)v_u\sin 2\phi_W\Big)Z_{k2}^H
\end{aligned}
$$

$$+ \sin 2\phi_W \Big(g_2^2 v_L Z_{k4}^H - g_R^2 v_R Z_{k3}^H \Big) \Big) \tag{605}$$

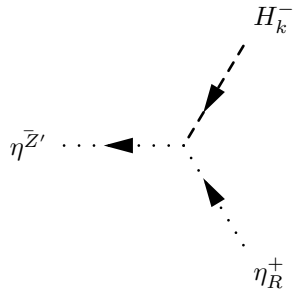


$$\begin{aligned}
&- \frac{i}{4} \xi_{W_R^-} \Big(\Big(g_2 \sin\phi_W \Big(2 g_R v_u \cos\phi_W + g_2 v_d \sin\phi_W \Big) + g_R^2 v_d \cos\phi_W^2 \Big) Z_{k1}^H \\
&+ \Big(g_2 \sin\phi_W \Big(2 g_R v_d \cos\phi_W + g_2 v_u \sin\phi_W \Big) + g_R^2 v_u \cos\phi_W^2 \Big) Z_{k2}^H \\
&+ g_R^2 v_R \cos\phi_W^2 Z_{k3}^H + g_2^2 v_L \sin\phi_W^2 Z_{k4}^H \Big)
\end{aligned} \tag{606}$$

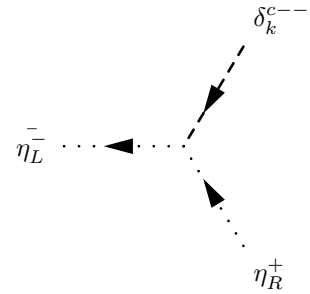


$$\begin{aligned}
&- \frac{i}{8} \xi_Z \Big(2\sqrt{2} g_B g_R v_R Z_{12}^{Z,*} \cos\phi_W Z_{k3}^+ \\
&- g_R Z_{32}^{Z,*} \Big(\Big(- g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W \Big) Z_{k1}^+ + \Big(g_2 v_u \sin\phi_W - g_R v_d \cos\phi_W \Big) Z_{k2}^+ \\
&+ 2\sqrt{2} g_R v_R \cos\phi_W Z_{k3}^+ \Big) \\
&- 2\sqrt{2} g_2 g_B v_L Z_{12}^{Z,*} \sin\phi_W Z_{k4}^+ \\
&+ g_2 Z_{22}^{Z,*} \Big(\Big(- g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W \Big) Z_{k1}^+ + \Big(g_2 v_u \sin\phi_W - g_R v_d \cos\phi_W \Big) Z_{k2}^+ \\
&+ 2\sqrt{2} g_2 v_L \sin\phi_W Z_{k4}^+ \Big) \\
&+ 2\sqrt{2} g_B g_R v_R \cos\phi_W Z_{k3}^+ Z_{12}^Z - 2\sqrt{2} g_2 g_B v_L \sin\phi_W Z_{k4}^+ Z_{12}^Z \\
&+ g_2 g_R v_u \cos\phi_W Z_{k1}^+ Z_{22}^Z - g_2^2 v_d \sin\phi_W Z_{k1}^+ Z_{22}^Z - g_2 g_R v_d \cos\phi_W Z_{k2}^+ Z_{22}^Z
\end{aligned}$$

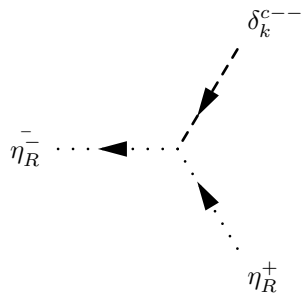
$$
\begin{aligned}
&+ g_2^2 v_u \sin\phi_W Z_{k2}^+ Z_{22}^Z + 2\sqrt{2} g_2^2 v_L \sin\phi_W Z_{k4}^+ Z_{22}^Z - g_R^2 v_u \cos\phi_W Z_{k1}^+ Z_{32}^Z \\
&+ g_2 g_R v_d \sin\phi_W Z_{k1}^+ Z_{32}^Z + g_R^2 v_d \cos\phi_W Z_{k2}^+ Z_{32}^Z - g_2 g_R v_u \sin\phi_W Z_{k2}^+ Z_{32}^Z \\
&- 2\sqrt{2} g_R^2 v_R \cos\phi_W Z_{k3}^+ Z_{32}^Z \Big)
\end{aligned} \tag{607}
$$



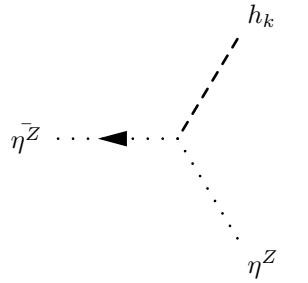
$$
\begin{aligned}
&- \frac{i}{8} \xi_{Z'} \Big(2\sqrt{2} g_B g_R v_R Z_{13}^{Z,*} \cos\phi_W Z_{k3}^+ \\
&- g_R Z_{33}^{Z,*} \Big(\Big(- g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W \Big) Z_{k1}^+ + \Big(g_2 v_u \sin\phi_W - g_R v_d \cos\phi_W \Big) Z_{k2}^+ \\
&+ 2\sqrt{2} g_R v_R \cos\phi_W Z_{k3}^+ \Big) \\
&- 2\sqrt{2} g_2 g_B v_L Z_{13}^{Z,*} \sin\phi_W Z_{k4}^+ \\
&+ g_2 Z_{23}^{Z,*} \Big(\Big(- g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W \Big) Z_{k1}^+ + \Big(g_2 v_u \sin\phi_W - g_R v_d \cos\phi_W \Big) Z_{k2}^+ \\
&+ 2\sqrt{2} g_2 v_L \sin\phi_W Z_{k4}^+ \Big) \\
&+ 2\sqrt{2} g_B g_R v_R \cos\phi_W Z_{k3}^+ Z_{13}^Z - 2\sqrt{2} g_2 g_B v_L \sin\phi_W Z_{k4}^+ Z_{13}^Z \\
&+ g_2 g_R v_u \cos\phi_W Z_{k1}^+ Z_{23}^Z - g_2^2 v_d \sin\phi_W Z_{k1}^+ Z_{23}^Z - g_2 g_R v_d \cos\phi_W Z_{k2}^+ Z_{23}^Z \\
&+ g_2^2 v_u \sin\phi_W Z_{k2}^+ Z_{23}^Z + 2\sqrt{2} g_2^2 v_L \sin\phi_W Z_{k4}^+ Z_{23}^Z - g_R^2 v_u \cos\phi_W Z_{k1}^+ Z_{33}^Z \\
&+ g_2 g_R v_d \sin\phi_W Z_{k1}^+ Z_{33}^Z + g_R^2 v_d \cos\phi_W Z_{k2}^+ Z_{33}^Z - g_2 g_R v_u \sin\phi_W Z_{k2}^+ Z_{33}^Z \\
&- 2\sqrt{2} g_R^2 v_R \cos\phi_W Z_{k3}^+ Z_{33}^Z \Big)
\end{aligned} \tag{608}
$$



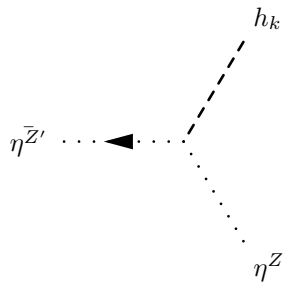
$$\frac{i}{4}\frac{1}{\sqrt{2}}\xi_{W^-}\sin 2\phi_W\Big(-g_2^2 v_L Z_{k2}^{++}+g_R^2 v_R Z_{k1}^{++}\Big) \tag{609}$$



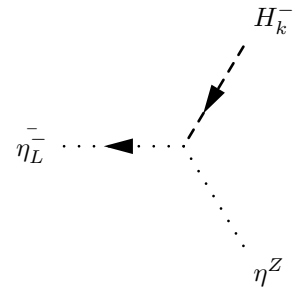
$$\frac{i}{2}\frac{1}{\sqrt{2}}\xi_{W_R^-}\Big(g_2^2 v_L\sin\phi_W^2 Z_{k2}^{++}+g_R^2 v_R\cos\phi_W^2 Z_{k1}^{++}\Big) \tag{610}$$



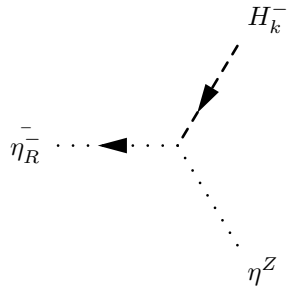
$$\begin{aligned}
&-\frac{i}{8}\xi_Z\Big(g_2^2 v_d|Z_{22}^Z|^2 Z_{k1}^H+g_2^2 v_u|Z_{22}^Z|^2 Z_{k2}^H+4g_2^2 v_L|Z_{22}^Z|^2 Z_{k4}^H\\
&-4g_2 g_B v_L Z_{22}^{Z,*} Z_{k4}^H Z_{12}^Z+4g_B^2 v_R Z_{k3}^H Z_{12}^{Z,2}+4g_B^2 v_L Z_{k4}^H Z_{12}^{Z,2}\\
&-8g_2 g_B v_L Z_{k4}^H Z_{12}^Z Z_{22}^Z+g_2^2 v_d Z_{k1}^H Z_{22}^{Z,2}+g_2^2 v_u Z_{k2}^H Z_{22}^{Z,2}+4g_2^2 v_L Z_{k4}^H Z_{22}^{Z,2}\\
&-g_2 g_R v_d Z_{22}^{Z,*} Z_{k1}^H Z_{32}^Z-g_2 g_R v_u Z_{22}^{Z,*} Z_{k2}^H Z_{32}^Z-8g_B g_R v_R Z_{k3}^H Z_{12}^Z Z_{32}^Z\\
&-2g_2 g_R v_d Z_{k1}^H Z_{22}^Z Z_{32}^Z-2g_2 g_R v_u Z_{k2}^H Z_{22}^Z Z_{32}^Z+g_R^2 v_d Z_{k1}^H Z_{32}^{Z,2}+g_R^2 v_u Z_{k2}^H Z_{32}^{Z,2}\\
&+4g_R^2 v_R Z_{k3}^H Z_{32}^{Z,2}+4g_B Z_{12}^{Z,*}\Big(v_L Z_{k4}^H\Big(-g_2 Z_{22}^Z+g_B Z_{12}^Z\Big)+v_R Z_{k3}^H\Big(g_B Z_{12}^Z-g_R Z_{32}^Z\Big)\Big)\\
&+g_R Z_{32}^{Z,*}\Big(-\Big(v_d Z_{k1}^H+v_u Z_{k2}^H\Big)\Big(g_2 Z_{22}^Z-g_R Z_{32}^Z\Big)+Z_{k3}^H\Big(-4g_B v_R Z_{12}^Z+4g_R v_R Z_{32}^Z\Big)\Big)\Big)
\end{aligned} \tag{611}$$



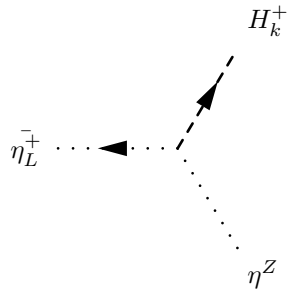
$$
\begin{aligned}
&-\frac{i}{8}\xi_{Z'}\Big(-4g_2g_Bv_LZ_{23}^{Z,*}Z_{k4}^HZ_{12}^Z+4g_B^2v_RZ_{k3}^HZ_{12}^ZZ_{13}^Z+4g_B^2v_LZ_{k4}^HZ_{12}^ZZ_{13}^Z\\
&+g_2^2v_dZ_{23}^{Z,*}Z_{k1}^HZ_{22}^Z+g_2^2v_uZ_{23}^{Z,*}Z_{k2}^HZ_{22}^Z+4g_2^2v_LZ_{23}^{Z,*}Z_{k4}^HZ_{22}^Z\\
&-4g_2g_Bv_LZ_{k4}^HZ_{13}^ZZ_{22}^Z-4g_2g_Bv_LZ_{k4}^HZ_{12}^ZZ_{23}^Z+g_2^2v_dZ_{k1}^HZ_{22}^ZZ_{23}^Z\\
&+g_2^2v_uZ_{k2}^HZ_{22}^ZZ_{23}^Z+4g_2^2v_LZ_{k4}^HZ_{22}^ZZ_{23}^Z-g_2g_Rv_dZ_{23}^{Z,*}Z_{k1}^HZ_{32}^Z\\
&-g_2g_Rv_uZ_{23}^{Z,*}Z_{k2}^HZ_{32}^Z-4g_Bg_Rv_RZ_{k3}^HZ_{13}^ZZ_{32}^Z-g_2g_Rv_dZ_{k1}^HZ_{23}^ZZ_{32}^Z\\
&-g_2g_Rv_uZ_{k2}^HZ_{23}^ZZ_{32}^Z+4g_BZ_{13}^{Z,*}\Big(v_LZ_{k4}^H\Big(-g_2Z_{22}^Z+g_BZ_{12}^Z\Big)+v_RZ_{k3}^H\Big(g_BZ_{12}^Z-g_RZ_{32}^Z\Big)\Big)\\
&+g_RZ_{33}^{Z,*}\Big(-\Big(v_dZ_{k1}^H+v_uZ_{k2}^H\Big)\Big(g_2Z_{22}^Z-g_RZ_{32}^Z\Big)+Z_{k3}^H\Big(-4g_Bv_RZ_{12}^Z+4g_Rv_RZ_{32}^Z\Big)\Big)\\
&-4g_Bg_Rv_RZ_{k3}^HZ_{12}^ZZ_{33}^Z-g_2g_Rv_dZ_{k1}^HZ_{22}^ZZ_{33}^Z-g_2g_Rv_uZ_{k2}^HZ_{22}^ZZ_{33}^Z\\
&+g_R^2v_dZ_{k1}^HZ_{32}^ZZ_{33}^Z+g_R^2v_uZ_{k2}^HZ_{32}^ZZ_{33}^Z+4g_R^2v_RZ_{k3}^HZ_{32}^ZZ_{33}^Z\Big)
\end{aligned}
\tag{612}
$$



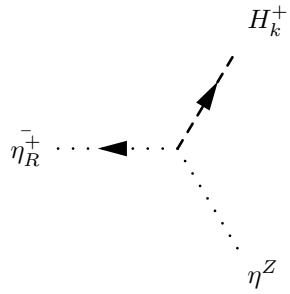
$$
\begin{aligned}
&-\frac{i}{4}\xi_{W^-}\Big(g_2Z_{22}^{Z,*}\Big(g_2v_u\cos\phi_W-g_Rv_d\sin\phi_W\Big)Z_{k2}^+\\
&+g_RZ_{32}^{Z,*}\Big(g_2v_u\cos\phi_W-g_Rv_d\sin\phi_W\Big)Z_{k2}^++\sqrt{2}g_Bg_Rv_RZ_{12}^{Z,*}\sin\phi_WZ_{k3}^+\\
&+\sqrt{2}g_2g_Bv_LZ_{12}^{Z,*}\cos\phi_WZ_{k4}^+-g_2^2v_d\cos\phi_WZ_{k1}^+Z_{22}^Z+g_2g_Rv_u\sin\phi_WZ_{k1}^+Z_{22}^Z\\
&-g_2g_Rv_d\cos\phi_WZ_{k1}^+Z_{32}^Z+g_R^2v_u\sin\phi_WZ_{k1}^+Z_{32}^Z\Big)
\end{aligned}
\tag{613}
$$



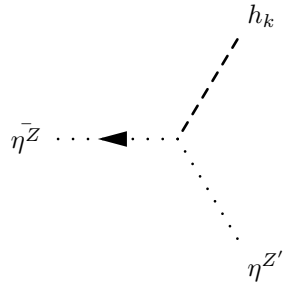
$$
\begin{aligned}
&-\frac{i}{4}\xi_{W_R^-}\Big(-g_2 Z_{22}^{Z,*}\Big(g_2 v_u \sin\phi_W + g_R v_d \cos\phi_W\Big) Z_{k2}^+ \\
&- g_R Z_{32}^{Z,*}\Big(g_2 v_u \sin\phi_W + g_R v_d \cos\phi_W\Big) Z_{k2}^+ + \sqrt{2} g_B g_R v_R Z_{12}^{Z,*} \cos\phi_W Z_{k3}^+ \\
&- \sqrt{2} g_2 g_B v_L Z_{12}^{Z,*} \sin\phi_W Z_{k4}^+ + g_2 g_R v_u \cos\phi_W Z_{k1}^+ Z_{22}^Z + g_2^2 v_d \sin\phi_W Z_{k1}^+ Z_{22}^Z \\
&+ g_R^2 v_u \cos\phi_W Z_{k1}^+ Z_{32}^Z + g_2 g_R v_d \sin\phi_W Z_{k1}^+ Z_{32}^Z\Big)
\end{aligned} \tag{614}
$$



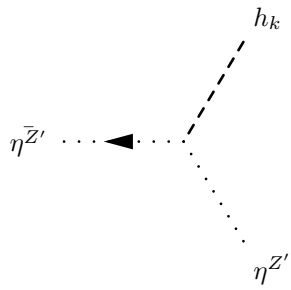
$$
\begin{aligned}
&\frac{i}{4}\xi_{W^-}\Big(g_2 Z_{22}^{Z,*}\Big(g_2 v_d \cos\phi_W - g_R v_u \sin\phi_W\Big) Z_{k1}^+ \\
&+ g_R Z_{32}^{Z,*}\Big(g_2 v_d \cos\phi_W - g_R v_u \sin\phi_W\Big) Z_{k1}^+ - \sqrt{2} g_B g_R v_R \sin\phi_W Z_{k3}^+ Z_{12}^Z \\
&- \sqrt{2} g_2 g_B v_L \cos\phi_W Z_{k4}^+ Z_{12}^Z - g_2^2 v_u \cos\phi_W Z_{k2}^+ Z_{22}^Z \\
&+ g_2 g_R v_d \sin\phi_W Z_{k2}^+ Z_{22}^Z - g_2 g_R v_u \cos\phi_W Z_{k2}^+ Z_{32}^Z + g_R^2 v_d \sin\phi_W Z_{k2}^+ Z_{32}^Z\Big)
\end{aligned} \tag{615}
$$



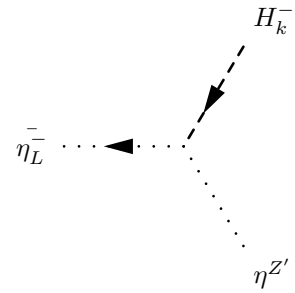
$$\begin{aligned}
&\frac{i}{4}\xi_{W_R^-}\Big(- g_2 Z_{22}^{Z,*}\Big(g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W\Big) Z_{k1}^+ \\
&- g_R Z_{32}^{Z,*}\Big(g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W\Big) Z_{k1}^+ - \sqrt{2} g_B g_R v_R \cos\phi_W Z_{k3}^+ Z_{12}^Z \\
&+ \sqrt{2} g_2 g_B v_L \sin\phi_W Z_{k4}^+ Z_{12}^Z + g_2 g_R v_d \cos\phi_W Z_{k2}^+ Z_{22}^Z + g_2^2 v_u \sin\phi_W Z_{k2}^+ Z_{22}^Z \\
&+ g_R^2 v_d \cos\phi_W Z_{k2}^+ Z_{32}^Z + g_2 g_R v_u \sin\phi_W Z_{k2}^+ Z_{32}^Z\Big)
\end{aligned} \tag{616}$$



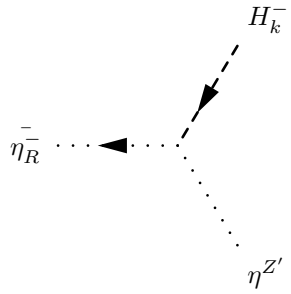
$$\begin{aligned}
&- \frac{i}{8}\xi_Z\Big(- 4 g_2 g_B v_L Z_{22}^{Z,*} Z_{k4}^H Z_{13}^Z + 4 g_B^2 v_R Z_{k3}^H Z_{12}^Z Z_{13}^Z + 4 g_B^2 v_L Z_{k4}^H Z_{12}^Z Z_{13}^Z \\
&- 4 g_2 g_B v_L Z_{k4}^H Z_{13}^Z Z_{22}^Z + g_2^2 v_d Z_{22}^{Z,*} Z_{k1}^H Z_{23}^Z + g_2^2 v_u Z_{22}^{Z,*} Z_{k2}^H Z_{23}^Z \\
&+ 4 g_2^2 v_L Z_{22}^{Z,*} Z_{k4}^H Z_{23}^Z - 4 g_2 g_B v_L Z_{k4}^H Z_{12}^Z Z_{23}^Z + g_2^2 v_d Z_{k1}^H Z_{22}^Z Z_{23}^Z \\
&+ g_2^2 v_u Z_{k2}^H Z_{22}^Z Z_{23}^Z + 4 g_2^2 v_L Z_{k4}^H Z_{22}^Z Z_{23}^Z - 4 g_B g_R v_R Z_{k3}^H Z_{13}^Z Z_{32}^Z \\
&- g_2 g_R v_d Z_{k1}^H Z_{23}^Z Z_{32}^Z - g_2 g_R v_u Z_{k2}^H Z_{23}^Z Z_{32}^Z - g_2 g_R v_d Z_{22}^{Z,*} Z_{k1}^H Z_{33}^Z \\
&- g_2 g_R v_u Z_{22}^{Z,*} Z_{k2}^H Z_{33}^Z - 4 g_B g_R v_R Z_{k3}^H Z_{12}^Z Z_{33}^Z - g_2 g_R v_d Z_{k1}^H Z_{22}^Z Z_{33}^Z \\
&- g_2 g_R v_u Z_{k2}^H Z_{22}^Z Z_{33}^Z + g_R^2 v_d Z_{k1}^H Z_{32}^Z Z_{33}^Z + g_R^2 v_u Z_{k2}^H Z_{32}^Z Z_{33}^Z \\
&+ 4 g_R^2 v_R Z_{k3}^H Z_{32}^Z Z_{33}^Z + 4 g_B Z_{12}^{Z,*}\Big(v_L Z_{k4}^H\Big(- g_2 Z_{23}^Z + g_B Z_{13}^Z\Big) + v_R Z_{k3}^H\Big(g_B Z_{13}^Z - g_R Z_{33}^Z\Big)\Big) \\
&+ g_R Z_{32}^{Z,*}\Big(- \Big(v_d Z_{k1}^H + v_u Z_{k2}^H\Big)\Big(g_2 Z_{23}^Z - g_R Z_{33}^Z\Big) + Z_{k3}^H\Big(- 4 g_B v_R Z_{13}^Z + 4 g_R v_R Z_{33}^Z\Big)\Big)\Big)
\end{aligned} \tag{617}$$



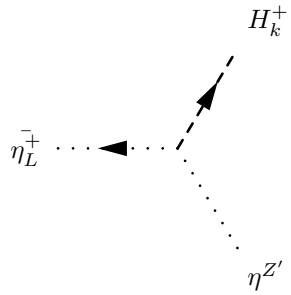
$$
\begin{aligned}
&-\frac{i}{8}\xi_{Z'}\Big(g_2^2 v_d |Z_{23}^Z|^2 Z_{k1}^H + g_2^2 v_u |Z_{23}^Z|^2 Z_{k2}^H + 4g_2^2 v_L |Z_{23}^Z|^2 Z_{k4}^H \\
&- 4g_2 g_B v_L Z_{23}^{Z,*} Z_{k4}^H Z_{13}^Z + 4g_B^2 v_R Z_{k3}^H Z_{13}^{Z,2} + 4g_B^2 v_L Z_{k4}^H Z_{13}^{Z,2} \\
&- 8g_2 g_B v_L Z_{k4}^H Z_{13}^Z Z_{23}^Z + g_2^2 v_d Z_{k1}^H Z_{23}^{Z,2} + g_2^2 v_u Z_{k2}^H Z_{23}^{Z,2} + 4g_2^2 v_L Z_{k4}^H Z_{23}^{Z,2} \\
&- g_2 g_R v_d Z_{23}^{Z,*} Z_{k1}^H Z_{33}^Z - g_2 g_R v_u Z_{23}^{Z,*} Z_{k2}^H Z_{33}^Z - 8g_B g_R v_R Z_{k3}^H Z_{13}^Z Z_{33}^Z \\
&- 2g_2 g_R v_d Z_{k1}^H Z_{23}^Z Z_{33}^Z - 2g_2 g_R v_u Z_{k2}^H Z_{23}^Z Z_{33}^Z + g_R^2 v_d Z_{k1}^H Z_{33}^{Z,2} + g_R^2 v_u Z_{k2}^H Z_{33}^{Z,2} \\
&+ 4g_R^2 v_R Z_{k3}^H Z_{33}^{Z,2} + 4g_B Z_{13}^{Z,*}\Big(v_L Z_{k4}^H\Big(-g_2 Z_{23}^Z + g_B Z_{13}^Z\Big) + v_R Z_{k3}^H\Big(g_B Z_{13}^Z - g_R Z_{33}^Z\Big)\Big) \\
&+ g_R Z_{33}^{Z,*}\Big(-\Big(v_d Z_{k1}^H + v_u Z_{k2}^H\Big)\Big(g_2 Z_{23}^Z - g_R Z_{33}^Z\Big) + Z_{k3}^H\Big(-4g_B v_R Z_{13}^Z + 4g_R v_R Z_{33}^Z\Big)\Big)\Big)
\end{aligned}
\tag{618}
$$



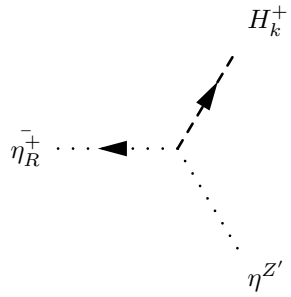
$$
\begin{aligned}
&-\frac{i}{4}\xi_{W^-}\Big(g_2 Z_{23}^{Z,*}\Big(g_2 v_u \cos\phi_W - g_R v_d \sin\phi_W\Big) Z_{k2}^+ \\
&+ g_R Z_{33}^{Z,*}\Big(g_2 v_u \cos\phi_W - g_R v_d \sin\phi_W\Big) Z_{k2}^+ + \sqrt{2} g_B g_R v_R Z_{13}^{Z,*} \sin\phi_W Z_{k3}^+ \\
&+ \sqrt{2} g_2 g_B v_L Z_{13}^{Z,*} \cos\phi_W Z_{k4}^+ - g_2^2 v_d \cos\phi_W Z_{k1}^+ Z_{23}^Z + g_2 g_R v_u \sin\phi_W Z_{k1}^+ Z_{23}^Z \\
&- g_2 g_R v_d \cos\phi_W Z_{k1}^+ Z_{33}^Z + g_R^2 v_u \sin\phi_W Z_{k1}^+ Z_{33}^Z\Big)
\end{aligned}
\tag{619}
$$



$$
\begin{aligned}
&-\frac{i}{4}\xi_{W_R^-}\Big(-g_2 Z_{23}^{Z,*}\Big(g_2 v_u \sin\phi_W + g_R v_d \cos\phi_W\Big) Z_{k2}^+ \\
&- g_R Z_{33}^{Z,*}\Big(g_2 v_u \sin\phi_W + g_R v_d \cos\phi_W\Big) Z_{k2}^+ + \sqrt{2} g_B g_R v_R Z_{13}^{Z,*} \cos\phi_W Z_{k3}^+ \\
&- \sqrt{2} g_2 g_B v_L Z_{13}^{Z,*} \sin\phi_W Z_{k4}^+ + g_2 g_R v_u \cos\phi_W Z_{k1}^+ Z_{23}^Z + g_2^2 v_d \sin\phi_W Z_{k1}^+ Z_{23}^Z \\
&+ g_R^2 v_u \cos\phi_W Z_{k1}^+ Z_{33}^Z + g_2 g_R v_d \sin\phi_W Z_{k1}^+ Z_{33}^Z\Big)
\end{aligned} \tag{620}
$$



$$
\begin{aligned}
&\frac{i}{4}\xi_{W^-}\Big(g_2 Z_{23}^{Z,*}\Big(g_2 v_d \cos\phi_W - g_R v_u \sin\phi_W\Big) Z_{k1}^+ \\
&+ g_R Z_{33}^{Z,*}\Big(g_2 v_d \cos\phi_W - g_R v_u \sin\phi_W\Big) Z_{k1}^+ - \sqrt{2} g_B g_R v_R \sin\phi_W Z_{k3}^+ Z_{13}^Z \\
&- \sqrt{2} g_2 g_B v_L \cos\phi_W Z_{k4}^+ Z_{13}^Z - g_2^2 v_u \cos\phi_W Z_{k2}^+ Z_{23}^Z \\
&+ g_2 g_R v_d \sin\phi_W Z_{k2}^+ Z_{23}^Z - g_2 g_R v_u \cos\phi_W Z_{k2}^+ Z_{33}^Z + g_R^2 v_d \sin\phi_W Z_{k2}^+ Z_{33}^Z\Big)
\end{aligned} \tag{621}
$$



$$\frac{i}{4}\xi_{W_R^-}\Big(- g_2 Z_{23}^{Z,*}\Big(g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W\Big) Z_{k1}^+ \\ - g_R Z_{33}^{Z,*}\Big(g_2 v_d \sin\phi_W + g_R v_u \cos\phi_W\Big) Z_{k1}^+ - \sqrt{2} g_B g_R v_R \cos\phi_W Z_{k3}^+ Z_{13}^Z \\ + \sqrt{2} g_2 g_B v_L \sin\phi_W Z_{k4}^+ Z_{13}^Z + g_2 g_R v_d \cos\phi_W Z_{k2}^+ Z_{23}^Z + g_2^2 v_u \sin\phi_W Z_{k2}^+ Z_{23}^Z \\ + g_R^2 v_d \cos\phi_W Z_{k2}^+ Z_{33}^Z + g_2 g_R v_u \sin\phi_W Z_{k2}^+ Z_{33}^Z\Big) \tag{622}$$

---

9 Clebsch-Gordan Coefficients

- : Gauge group:SU[2], Dynkin labels: (1),(2),(1)

$$K_{1,a,b}^{SU[2],2\times3\times2} = \begin{pmatrix} 0 & 0 \\ 0 & \frac{1}{\sqrt{2}} \\ -1 & 0 \end{pmatrix}_{ab} \tag{623}$$

$$K_{2,a,b}^{SU[2],2\times3\times2} = \begin{pmatrix} 0 & -1 \\ \frac{1}{\sqrt{2}} & 0 \\ 0 & 0 \end{pmatrix}_{ab} \tag{624}$$

$$\tag{625}$$