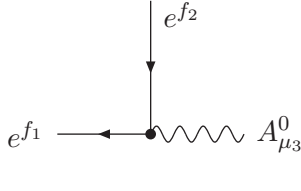


A SMEFT interaction vertices

CAUTION: interaction vertices printed below are shown including only terms up to mass dimension-6. Interactions proportional to products of dimension-6 Wilson coefficients, even if calculated and included in other output formats (Mathematica, Feynarts, UFO etc.), are too complicated for printout and for manual calculations. If necessary, they can be inspected visually displaying relevant variables (for their list see `SmeftFR` manual) in the Mathematica notebook.

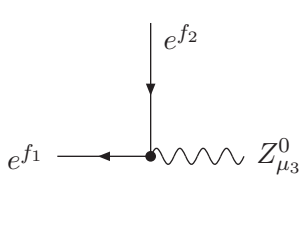
A.1 Lepton–gauge vertices



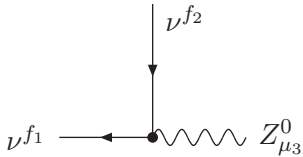
$$+ \frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} \delta_{f_1 f_2} \gamma^{\mu_3} - \frac{i\bar{g}'^2 \bar{g}^2 v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} \delta_{f_1 f_2} C^{\varphi W B} \gamma^{\mu_3} \\ - \frac{\sqrt{2}\bar{g}v}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_3^\nu (C_{f_2 f_1}^{e B*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{e B} \sigma^{\mu_3 \nu} P_R)$$



$$- \frac{i\bar{g}}{\sqrt{2}} U_{f_2 f_1}^* \gamma^{\mu_3} P_L$$



$$- \frac{i}{2\sqrt{\bar{g}'^2 + \bar{g}^2}} \delta_{f_1 f_2} ((\bar{g}'^2 - \bar{g}^2) \gamma^{\mu_3} P_L + 2\bar{g}'^2 \gamma^{\mu_3} P_R) \\ + \frac{i\bar{g}'\bar{g}v^2}{2(\bar{g}'^2 + \bar{g}^2)^{3/2}} \delta_{f_1 f_2} C^{\varphi W B} ((\bar{g}'^2 - \bar{g}^2) \gamma^{\mu_3} P_L - 2\bar{g}^2 \gamma^{\mu_3} P_R) \\ + \frac{\sqrt{2}\bar{g}'v}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_3^\nu (C_{f_2 f_1}^{e B*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{e B} \sigma^{\mu_3 \nu} P_R)$$

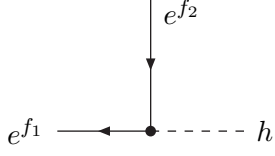


$$- \frac{1}{2} i \sqrt{\bar{g}'^2 + \bar{g}^2} \delta_{f_1 f_2} \gamma^{\mu_3} P_L - \frac{i\bar{g}'\bar{g}v^2}{2\sqrt{\bar{g}'^2 + \bar{g}^2}} \delta_{f_1 f_2} C^{\varphi W B} \gamma^{\mu_3} P_L$$

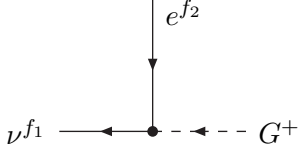
A.2 Lepton–Higgs–gauge vertices



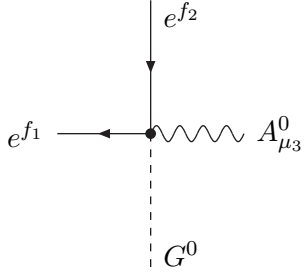
$$+ \frac{1}{v} \gamma^5 m_{l_{f_1}} \delta_{f_1 f_2} - \frac{v}{4} C^{\varphi D} \gamma^5 m_{l_{f_1}} \delta_{f_1 f_2}$$



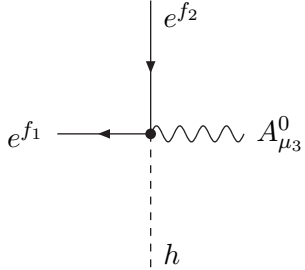
$$-\frac{i}{v}m_{l_{f_1}}\delta_{f_1 f_2} - ivC^{\varphi\Box}m_{l_{f_1}}\delta_{f_1 f_2} + \frac{iv}{4}C^{\varphi D}m_{l_{f_1}}\delta_{f_1 f_2}$$



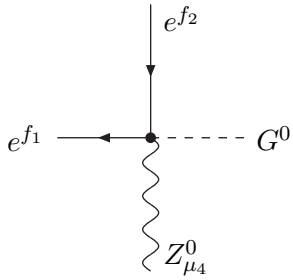
$$-\frac{i\sqrt{2}}{v}P_R U_{g_1 f_1}^* m_{l_{g_1}} \delta_{g_1 f_2}$$



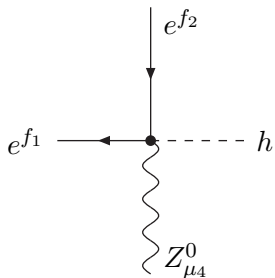
$$+\frac{i\sqrt{2}\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_3^\nu (C_{f_2 f_1}^{eB*}\sigma^{\mu_3\nu}P_L - C_{f_1 f_2}^{eB}\sigma^{\mu_3\nu}P_R)$$



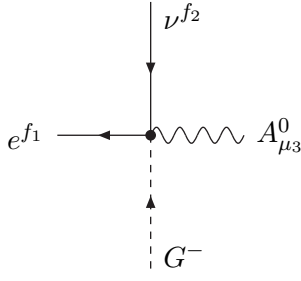
$$-\frac{\sqrt{2}\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_3^\nu (C_{f_2 f_1}^{eB*}\sigma^{\mu_3\nu}P_L + C_{f_1 f_2}^{eB}\sigma^{\mu_3\nu}P_R)$$



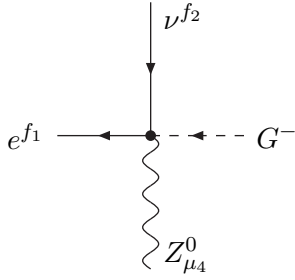
$$-\frac{i\sqrt{2}\bar{g}'}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_4^\nu (C_{f_2 f_1}^{eB*}\sigma^{\mu_4\nu}P_L - C_{f_1 f_2}^{eB}\sigma^{\mu_4\nu}P_R)$$



$$+\frac{\sqrt{2}\bar{g}'}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_4^\nu (C_{f_2 f_1}^{eB*}\sigma^{\mu_4\nu}P_L + C_{f_1 f_2}^{eB}\sigma^{\mu_4\nu}P_R)$$

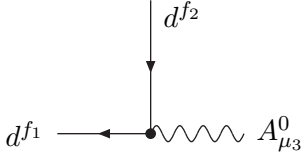


$$-\frac{2\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_3^\nu U_{g_1 f_2} \sigma^{\mu_3 \nu} P_L C_{g_1 f_1}^{eB*}$$

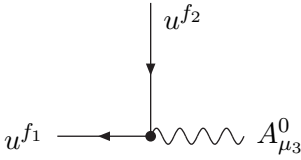


$$+\frac{2\bar{g}'}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_4^\nu U_{g_1 f_2} \sigma^{\mu_4 \nu} P_L C_{g_1 f_1}^{eB*}$$

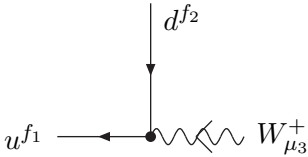
A.3 Quark-gauge vertices



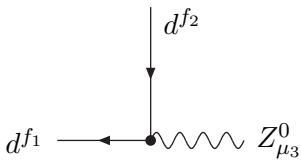
$$+\frac{i\bar{g}'\bar{g}}{3\sqrt{\bar{g}'^2 + \bar{g}^2}} \delta_{f_1 f_2} \gamma^{\mu_3} - \frac{i\bar{g}'^2 \bar{g}^2 v^2}{3(\bar{g}'^2 + \bar{g}^2)^{3/2}} \delta_{f_1 f_2} C^{\varphi WB} \gamma^{\mu_3}$$



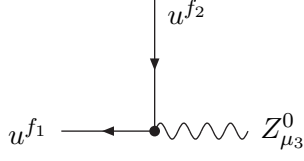
$$-\frac{2i\bar{g}'\bar{g}}{3\sqrt{\bar{g}'^2 + \bar{g}^2}} \delta_{f_1 f_2} \gamma^{\mu_3} + \frac{2i\bar{g}'^2 \bar{g}^2 v^2}{3(\bar{g}'^2 + \bar{g}^2)^{3/2}} \delta_{f_1 f_2} C^{\varphi WB} \gamma^{\mu_3} \\ - \frac{\sqrt{2}\bar{g}'v}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_3^\nu (C_{f_2 f_1}^{uW*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{uW} \sigma^{\mu_3 \nu} P_R)$$



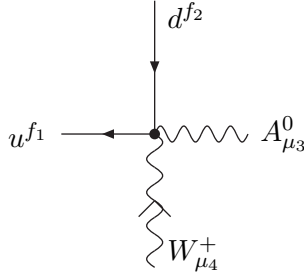
$$-\frac{i\bar{g}}{\sqrt{2}} K_{f_1 f_2} \gamma^{\mu_3} P_L - 2vp_3^\nu K_{g_1 f_2} \sigma^{\mu_3 \nu} P_L C_{g_1 f_1}^{uW*}$$



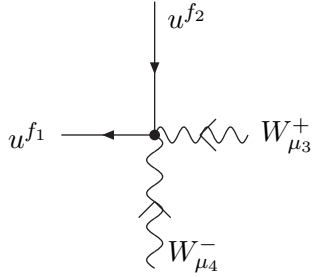
$$+\frac{i}{6\sqrt{\bar{g}'^2 + \bar{g}^2}} \delta_{f_1 f_2} ((\bar{g}'^2 + 3\bar{g}^2) \gamma^{\mu_3} P_L - 2\bar{g}'^2 \gamma^{\mu_3} P_R) \\ + \frac{i\bar{g}'\bar{g}v^2}{6(\bar{g}'^2 + \bar{g}^2)^{3/2}} \delta_{f_1 f_2} C^{\varphi WB} ((3\bar{g}'^2 + \bar{g}^2) \gamma^{\mu_3} P_L - 2\bar{g}^2 \gamma^{\mu_3} P_R)$$



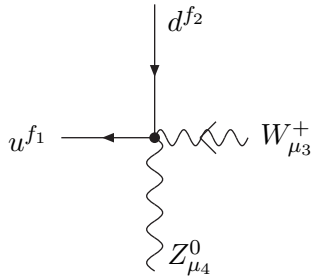
$$\begin{aligned}
& + \frac{i}{6\sqrt{\bar{g}'^2 + \bar{g}^2}} \delta_{f_1 f_2} \left((\bar{g}'^2 - 3\bar{g}^2) \gamma^{\mu_3} P_L + 4\bar{g}'^2 \gamma^{\mu_3} P_R \right) \\
& - \frac{i\bar{g}'\bar{g}v^2}{6(\bar{g}'^2 + \bar{g}^2)^{3/2}} \delta_{f_1 f_2} C^{\varphi WB} \left((3\bar{g}'^2 - \bar{g}^2) \gamma^{\mu_3} P_L - 4\bar{g}^2 \gamma^{\mu_3} P_R \right) \\
& - \frac{\sqrt{2}\bar{g}v}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_3^\nu \left(C_{f_2 f_1}^{uW*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{uW} \sigma^{\mu_3 \nu} P_R \right)
\end{aligned}$$



$$- \frac{2\bar{g}'\bar{g}v}{\sqrt{\bar{g}'^2 + \bar{g}^2}} K_{g_1 f_2} \sigma^{\mu_3 \mu_4} P_L C_{g_1 f_1}^{uW*}$$

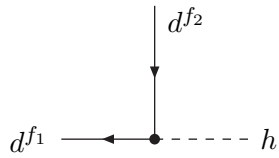


$$- \sqrt{2}\bar{g}v \left(\sigma^{\mu_3 \mu_4} P_L C_{f_2 f_1}^{uW*} + C_{f_1 f_2}^{uW} \sigma^{\mu_3 \mu_4} P_R \right)$$

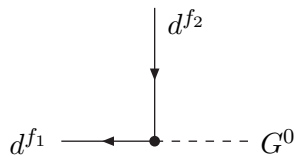


$$+ \frac{2\bar{g}^2 v}{\sqrt{\bar{g}'^2 + \bar{g}^2}} K_{g_1 f_2} \sigma^{\mu_3 \mu_4} P_L C_{g_1 f_1}^{uW*}$$

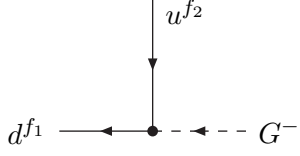
A.4 Quark–Higgs–gauge vertices



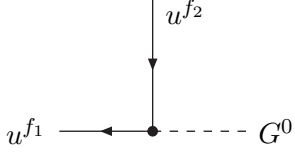
$$- \frac{i}{v} m_{d_{f_1}} \delta_{f_1 f_2} - i v C^{\varphi \square} m_{d_{f_1}} \delta_{f_1 f_2} + \frac{i v}{4} C^{\varphi D} m_{d_{f_1}} \delta_{f_1 f_2} + \frac{i v^2}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{d\varphi*} + P_R C_{f_1 f_2}^{d\varphi} \right)$$



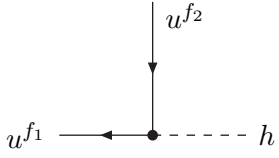
$$+ \frac{1}{v} \gamma^5 m_{d_{f_1}} \delta_{f_1 f_2} - \frac{v}{4} C^{\varphi D} \gamma^5 m_{d_{f_1}} \delta_{f_1 f_2}$$



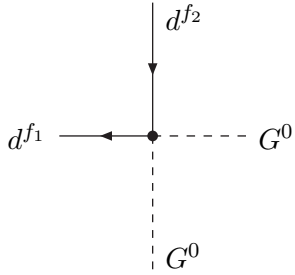
$$-\frac{i\sqrt{2}}{v} \left(P_L K_{f_2 g_1}^* m_{d_{f_1}} \delta_{f_1 g_1} - P_R K_{g_1 f_1}^* m_{u_{g_1}} \delta_{g_1 f_2} \right)$$



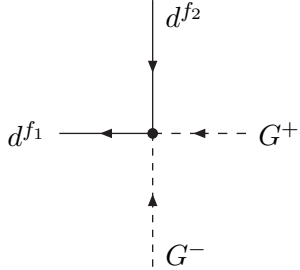
$$-\frac{1}{v} \gamma^5 m_{u_{f_1}} \delta_{f_1 f_2} + \frac{v}{4} C^{\varphi D} \gamma^5 m_{u_{f_1}} \delta_{f_1 f_2}$$



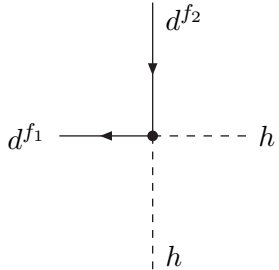
$$-\frac{i}{v} m_{u_{f_1}} \delta_{f_1 f_2} - i v C^{\varphi \square} m_{u_{f_1}} \delta_{f_1 f_2} + \frac{i v}{4} C^{\varphi D} m_{u_{f_1}} \delta_{f_1 f_2}$$



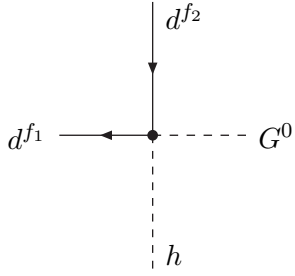
$$+\frac{i v}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{d\varphi*} + P_R C_{f_1 f_2}^{d\varphi} \right)$$



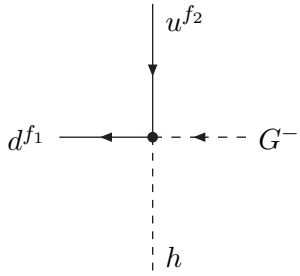
$$+\frac{i v}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{d\varphi*} + P_R C_{f_1 f_2}^{d\varphi} \right)$$



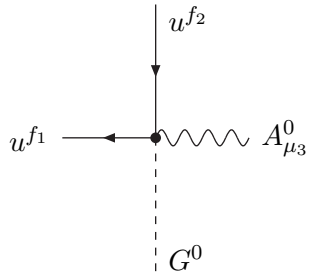
$$+\frac{3 i v}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{d\varphi*} + P_R C_{f_1 f_2}^{d\varphi} \right)$$



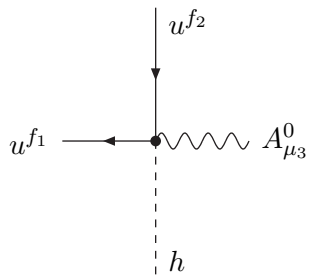
$$+\frac{v}{\sqrt{2}}\left(P_L C_{f_2 f_1}^{d\varphi*}-P_R C_{f_1 f_2}^{d\varphi}\right)$$



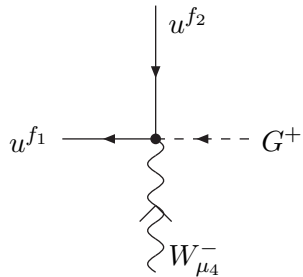
$$+ivP_L K_{f_2 g_1}^* C_{g_1 f_1}^{d\varphi*}$$



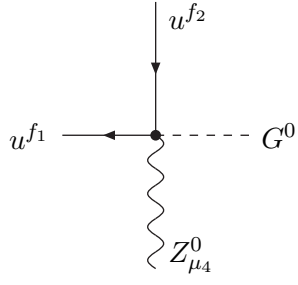
$$-\frac{i\sqrt{2}\bar{g}'}{\sqrt{\bar{g}'^2+\bar{g}^2}}p_3^\nu\left(C_{f_2 f_1}^{uW*}\sigma^{\mu_3\nu}P_L-C_{f_1 f_2}^{uW}\sigma^{\mu_3\nu}P_R\right)$$



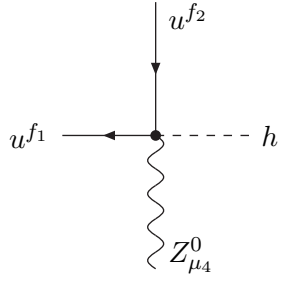
$$-\frac{\sqrt{2}\bar{g}'}{\sqrt{\bar{g}'^2+\bar{g}^2}}p_3^\nu\left(C_{f_2 f_1}^{uW*}\sigma^{\mu_3\nu}P_L+C_{f_1 f_2}^{uW}\sigma^{\mu_3\nu}P_R\right)$$



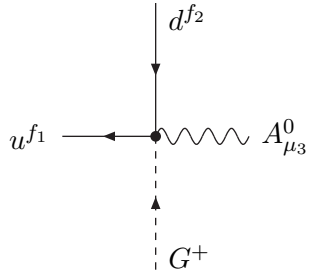
$$+2\sqrt{2}p_4^\nu C_{f_2 f_1}^{uW*}\sigma^{\mu_4\nu}P_L$$



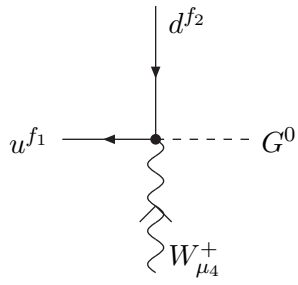
$$-\frac{i\sqrt{2}\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_4^\nu (C_{f_2 f_1}^{uW*} \sigma^{\mu_4 \nu} P_L - C_{f_1 f_2}^{uW} \sigma^{\mu_4 \nu} P_R)$$



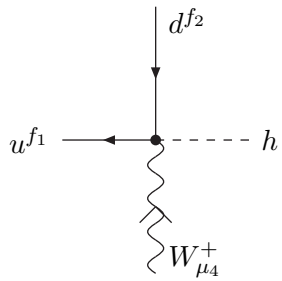
$$-\frac{\sqrt{2}\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_4^\nu (C_{f_2 f_1}^{uW*} \sigma^{\mu_4 \nu} P_L + C_{f_1 f_2}^{uW} \sigma^{\mu_4 \nu} P_R)$$



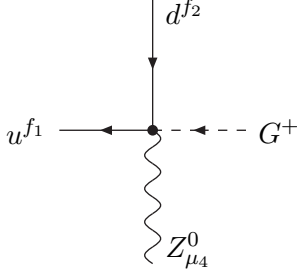
$$-\frac{2\bar{g}'}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_3^\nu K_{g_1 f_2} \sigma^{\mu_3 \nu} P_L C_{g_1 f_1}^{uW*}$$



$$-2ip_4^\nu K_{g_1 f_2} \sigma^{\mu_4 \nu} P_L C_{g_1 f_1}^{uW*}$$

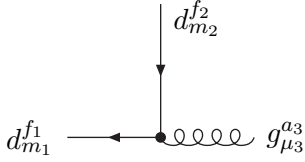


$$-2p_4^\nu K_{g_1 f_2} \sigma^{\mu_4 \nu} P_L C_{g_1 f_1}^{uW*}$$

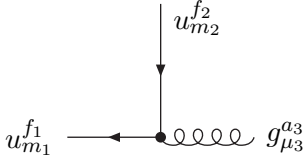


$$-\frac{2\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_4^\nu K_{g_1 f_2} \sigma^{\mu_4 \nu} P_L C_{g_1 f_1}^{uW*}$$

A.5 Quark-gluon vertices

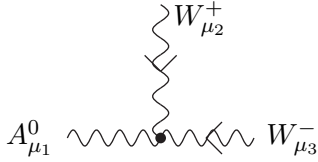


$$-i\bar{g}_s \delta_{f_1 f_2} \mathcal{T}_{m_1 m_2}^{a_3} \gamma^{\mu_3}$$

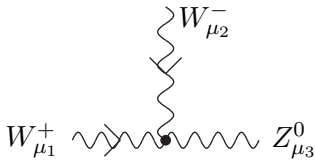


$$-i\bar{g}_s \delta_{f_1 f_2} \mathcal{T}_{m_1 m_2}^{a_3} \gamma^{\mu_3}$$

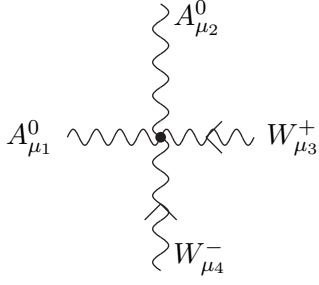
A.6 Gauge self interaction vertices



$$\begin{aligned} & + \frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} (\eta_{\mu_1 \mu_2} p_1^{\mu_3} - \eta_{\mu_1 \mu_2} p_2^{\mu_3} - \eta_{\mu_1 \mu_3} p_1^{\mu_2} + \eta_{\mu_1 \mu_3} p_3^{\mu_2} + \eta_{\mu_2 \mu_3} p_2^{\mu_1} \\ & - \eta_{\mu_2 \mu_3} p_3^{\mu_1}) + \frac{i\bar{g}^2 v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB} (\bar{g}'^2 \eta_{\mu_1 \mu_2} p_2^{\mu_3} - \bar{g}'^2 \eta_{\mu_1 \mu_3} p_3^{\mu_2} \\ & - \bar{g}'^2 \eta_{\mu_2 \mu_3} p_2^{\mu_1} + \bar{g}'^2 \eta_{\mu_2 \mu_3} p_3^{\mu_1} + \bar{g}^2 \eta_{\mu_1 \mu_2} p_1^{\mu_3} - \bar{g}^2 \eta_{\mu_1 \mu_3} p_1^{\mu_2}) \end{aligned}$$

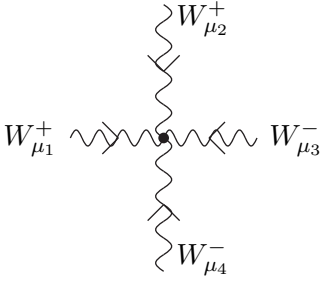


$$\begin{aligned} & + \frac{i\bar{g}^2}{\sqrt{\bar{g}'^2 + \bar{g}^2}} (\eta_{\mu_1 \mu_2} p_1^{\mu_3} - \eta_{\mu_1 \mu_2} p_2^{\mu_3} - \eta_{\mu_1 \mu_3} p_1^{\mu_2} + \eta_{\mu_1 \mu_3} p_3^{\mu_2} + \eta_{\mu_2 \mu_3} p_2^{\mu_1} \\ & - \eta_{\mu_2 \mu_3} p_3^{\mu_1}) + \frac{i\bar{g}'\bar{g}v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB} (\bar{g}'^2 \eta_{\mu_1 \mu_2} p_1^{\mu_3} - \bar{g}'^2 \eta_{\mu_1 \mu_2} p_2^{\mu_3} \\ & - \bar{g}'^2 \eta_{\mu_1 \mu_3} p_1^{\mu_2} + \bar{g}'^2 \eta_{\mu_2 \mu_3} p_2^{\mu_1} - \bar{g}^2 \eta_{\mu_1 \mu_3} p_3^{\mu_2} + \bar{g}^2 \eta_{\mu_2 \mu_3} p_3^{\mu_1}) \end{aligned}$$

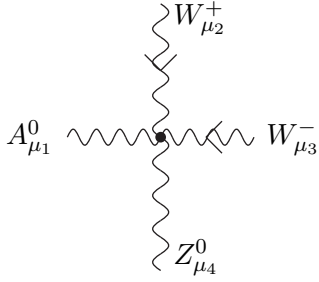


$$+\frac{i\bar{g}'^2\bar{g}^2}{\bar{g}'^2+\bar{g}^2}(\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}+\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}-2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})$$

$$-\frac{2i\bar{g}'^3\bar{g}^3v^2}{(\bar{g}'^2+\bar{g}^2)^2}(\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}+\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}-2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})C^{\varphi WB}$$

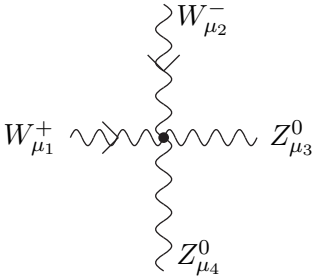


$$-i\bar{g}^2(\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}+\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}-2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})$$



$$-\frac{i\bar{g}'\bar{g}^3}{\bar{g}'^2+\bar{g}^2}(2\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}-\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}-\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})-\frac{i\bar{g}'^2\bar{g}^2v^2}{(\bar{g}'^2+\bar{g}^2)^2}(\bar{g}'$$

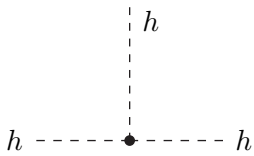
$$-\bar{g})(\bar{g}'+\bar{g})(2\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}-\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}-\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})C^{\varphi WB}$$



$$+\frac{i\bar{g}^4}{\bar{g}'^2+\bar{g}^2}(\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}+\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}-2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})$$

$$+\frac{2i\bar{g}'^3\bar{g}^3v^2}{(\bar{g}'^2+\bar{g}^2)^2}(\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}+\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}-2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})C^{\varphi WB}$$

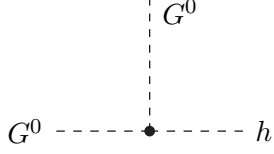
A.7 Higgs-gauge vertices



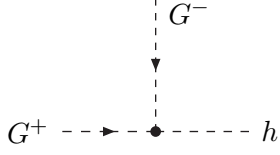
$$-3i\lambda v+15iv^3C^{\varphi}$$

$$-ivC^{\varphi\Box}(3p_1\cdot p_1+2p_1\cdot p_2+2p_1\cdot p_3+3p_2\cdot p_2+2p_2\cdot p_3+3p_3\cdot p_3+9\lambda v^2)$$

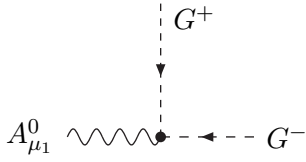
$$+\frac{iv}{4}C^{\varphi D}(9\lambda v^2-4(p_1\cdot p_2+p_1\cdot p_3+p_2\cdot p_3))$$



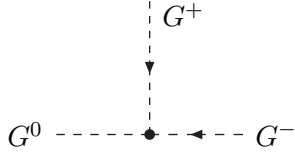
$$-i\lambda v + 3iv^3 C^\varphi - iv C^{\varphi\Box} (p_1 \cdot p_1 + 2p_1 \cdot p_2 + p_2 \cdot p_2 + p_3 \cdot p_3 + \lambda v^2) + \frac{iv}{4} C^{\varphi D} (3\lambda v^2 - 4p_1 \cdot p_2)$$



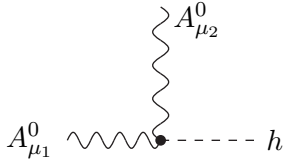
$$-i\lambda v + 3iv^3 C^\varphi - iv C^{\varphi\Box} (p_1 \cdot p_1 + 2p_1 \cdot p_2 + p_2 \cdot p_2 + p_3 \cdot p_3 + \lambda v^2) + \frac{iv}{4} C^{\varphi D} (\lambda v^2 - 2(p_1 \cdot p_3 + p_2 \cdot p_3))$$



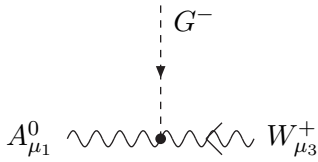
$$-\frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} (p_2^{\mu_1} - p_3^{\mu_1}) + \frac{i\bar{g}'^2 \bar{g}^2 v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB} (p_2^{\mu_1} - p_3^{\mu_1})$$



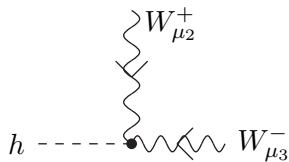
$$-\frac{v}{2} (p_1 \cdot p_2 - p_1 \cdot p_3) C^{\varphi D}$$



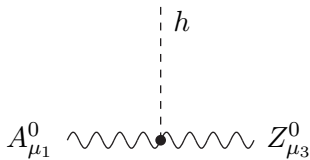
$$+\frac{4i\bar{g}'^2 v}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1 \mu_2}) - \frac{4i\bar{g}'\bar{g}v}{\bar{g}'^2 + \bar{g}^2} C^{\varphi WB} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1 \mu_2})$$



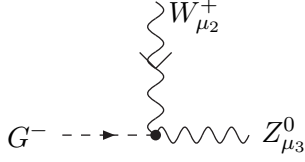
$$+\frac{i\bar{g}'\bar{g}^2 v}{2\sqrt{\bar{g}'^2 + \bar{g}^2}} \eta_{\mu_1 \mu_3} - \frac{i\bar{g}v}{2(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB} (\eta_{\mu_1 \mu_3} (\bar{g}'^2 (4p_1 \cdot p_3 + \bar{g}^2 v^2) + 4\bar{g}^2 p_1 \cdot p_3) - 4(\bar{g}'^2 + \bar{g}^2) p_1^{\mu_3} p_3^{\mu_1})$$



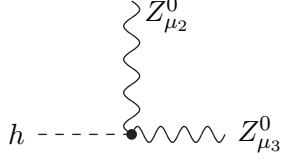
$$+\frac{1}{2} i\bar{g}^2 v \eta_{\mu_2 \mu_3} + \frac{1}{2} i\bar{g}^2 v^3 \eta_{\mu_2 \mu_3} C^{\varphi\Box} - \frac{1}{8} i\bar{g}^2 v^3 \eta_{\mu_2 \mu_3} C^{\varphi D} + 4iv C^{\varphi W} (p_2^{\mu_3} p_3^{\mu_2} - p_2 \cdot p_3 \eta_{\mu_2 \mu_3})$$



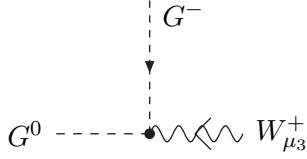
$$+\frac{4i\bar{g}'\bar{g}v}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_1^{\mu_3} p_3^{\mu_1} - p_1 \cdot p_3 \eta_{\mu_1 \mu_3}) + \frac{2iv}{\bar{g}'^2 + \bar{g}^2} (\bar{g}' - \bar{g})(\bar{g}' + \bar{g}) C^{\varphi WB} (p_1^{\mu_3} p_3^{\mu_1} - p_1 \cdot p_3 \eta_{\mu_1 \mu_3})$$



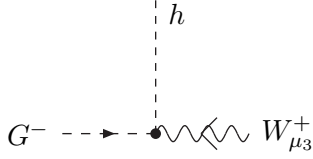
$$\begin{aligned}
& -\frac{i\bar{g}'^2\bar{g}v}{2\sqrt{\bar{g}'^2+\bar{g}^2}}\eta_{\mu_2\mu_3}-\frac{1}{4}i\bar{g}v^3\sqrt{\bar{g}'^2+\bar{g}^2}\eta_{\mu_2\mu_3}C^{\varphi D} \\
& -\frac{i\bar{g}'v}{2(\bar{g}'^2+\bar{g}^2)^{3/2}}C^{\varphi WB}(\eta_{\mu_2\mu_3}(-4\bar{g}'^2p_2\cdot p_3-4\bar{g}^2p_2\cdot p_3+\bar{g}^4v^2) \\
& +4(\bar{g}'^2+\bar{g}^2)p_2^{\mu_3}p_3^{\mu_2})
\end{aligned}$$



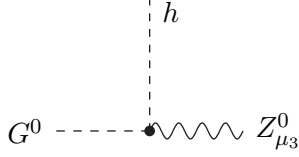
$$\begin{aligned}
& +\frac{iv}{2}(\bar{g}'^2+\bar{g}^2)\eta_{\mu_2\mu_3}+\frac{iv^3}{2}(\bar{g}'^2+\bar{g}^2)\eta_{\mu_2\mu_3}C^{\varphi\Box} \\
& +\frac{3iv^3}{8}(\bar{g}'^2+\bar{g}^2)\eta_{\mu_2\mu_3}C^{\varphi D}+\frac{4i\bar{g}^2v}{\bar{g}'^2+\bar{g}^2}C^{\varphi W}(p_2^{\mu_3}p_3^{\mu_2}-p_2\cdot p_3\eta_{\mu_2\mu_3}) \\
& +\frac{i\bar{g}'\bar{g}v}{\bar{g}'^2+\bar{g}^2}C^{\varphi WB}(\eta_{\mu_2\mu_3}(-4p_2\cdot p_3+\bar{g}'^2v^2+\bar{g}^2v^2)+4p_2^{\mu_3}p_3^{\mu_2})
\end{aligned}$$



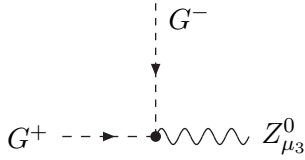
$$+\frac{\bar{g}}{2}(p_1^{\mu_3}-p_2^{\mu_3})+\frac{\bar{g}v^2}{8}C^{\varphi D}(3p_1^{\mu_3}+p_2^{\mu_3})$$



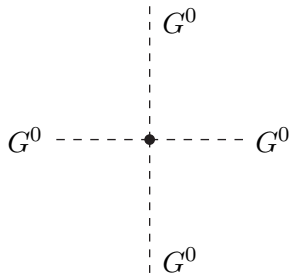
$$+\frac{i\bar{g}}{2}(p_1^{\mu_3}-p_2^{\mu_3})+\frac{1}{2}i\bar{g}v^2C^{\varphi\Box}(p_1^{\mu_3}-p_2^{\mu_3})-\frac{1}{8}i\bar{g}v^2C^{\varphi D}(p_1^{\mu_3}-p_2^{\mu_3})$$



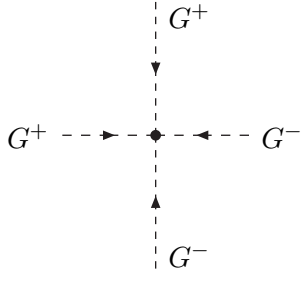
$$\begin{aligned}
& -\frac{1}{2}\sqrt{\bar{g}'^2+\bar{g}^2}(p_1^{\mu_3}-p_2^{\mu_3})-\frac{1}{2}v^2\sqrt{\bar{g}'^2+\bar{g}^2}C^{\varphi\Box}(p_1^{\mu_3}-p_2^{\mu_3}) \\
& -\frac{1}{2}v^2\sqrt{\bar{g}'^2+\bar{g}^2}C^{\varphi D}p_1^{\mu_3}-\frac{\bar{g}'\bar{g}v^2}{2\sqrt{\bar{g}'^2+\bar{g}^2}}C^{\varphi WB}(p_1^{\mu_3}-p_2^{\mu_3})
\end{aligned}$$



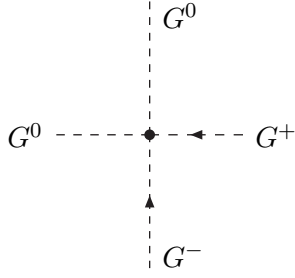
$$\begin{aligned}
& +\frac{i}{2\sqrt{\bar{g}'^2+\bar{g}^2}}(\bar{g}'-\bar{g})(\bar{g}'+\bar{g})(p_1^{\mu_3}-p_2^{\mu_3})+\frac{1}{4}iv^2\sqrt{\bar{g}'^2+\bar{g}^2}C^{\varphi D}(p_1^{\mu_3}-p_2^{\mu_3}) \\
& -\frac{i\bar{g}'\bar{g}v^2}{2(\bar{g}'^2+\bar{g}^2)^{3/2}}(\bar{g}'-\bar{g})(\bar{g}'+\bar{g})C^{\varphi WB}(p_1^{\mu_3}-p_2^{\mu_3})
\end{aligned}$$



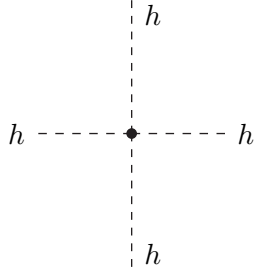
$$\begin{aligned}
& -3i\lambda+9iv^2C^{\varphi}-i(3p_1\cdot p_1+2p_1\cdot p_2+2p_1\cdot p_3+2p_1\cdot p_4 \\
& +3p_2\cdot p_2+2p_2\cdot p_3+2p_2\cdot p_4+3p_3\cdot p_3+2p_3\cdot p_4+3p_4\cdot p_4)C^{\varphi\Box} \\
& +iC^{\varphi D}(-p_1\cdot p_2-p_1\cdot p_3-p_1\cdot p_4-p_2\cdot p_3-p_2\cdot p_4-p_3\cdot p_4+3\lambda v^2)
\end{aligned}$$



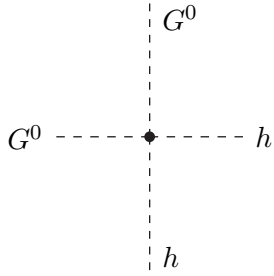
$$\begin{aligned}
& -2i\lambda + 6iv^2 C^\varphi \\
& - 2i(p_1 \cdot p_1 + p_1 \cdot p_3 + p_1 \cdot p_4 + p_2 \cdot p_2 + p_2 \cdot p_3 + p_2 \cdot p_4 + p_3 \cdot p_3 + p_4 \cdot p_4) C^{\varphi\Box} \\
& - i(p_1 \cdot p_3 + p_1 \cdot p_4 + p_2 \cdot p_3 + p_2 \cdot p_4) C^{\varphi D}
\end{aligned}$$



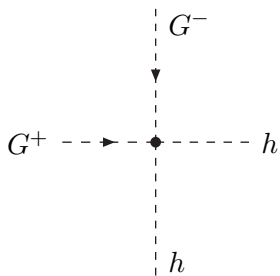
$$\begin{aligned}
& -i\lambda + 3iv^2 C^\varphi - i(p_1 \cdot p_1 + 2p_1 \cdot p_2 + p_2 \cdot p_2 + p_3 \cdot p_3 + 2p_3 \cdot p_4 + p_4 \cdot p_4) C^{\varphi\Box} \\
& + \frac{i}{2} C^{\varphi D} (-p_1 \cdot p_3 - p_1 \cdot p_4 - p_2 \cdot p_3 - p_2 \cdot p_4 + \lambda v^2)
\end{aligned}$$



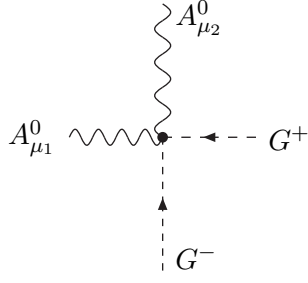
$$\begin{aligned}
& -3i\lambda + 45iv^2 C^\varphi - iC^{\varphi\Box} (3p_1 \cdot p_1 + 2p_1 \cdot p_2 + 2p_1 \cdot p_3 + 2p_1 \cdot p_4 \\
& + 3p_2 \cdot p_2 + 2p_2 \cdot p_3 + 2p_2 \cdot p_4 + 3p_3 \cdot p_3 + 2p_3 \cdot p_4 + 3p_4 \cdot p_4 + 12\lambda v^2) \\
& + iC^{\varphi D} (-p_1 \cdot p_2 - p_1 \cdot p_3 - p_1 \cdot p_4 - p_2 \cdot p_3 - p_2 \cdot p_4 - p_3 \cdot p_4 + 3\lambda v^2)
\end{aligned}$$



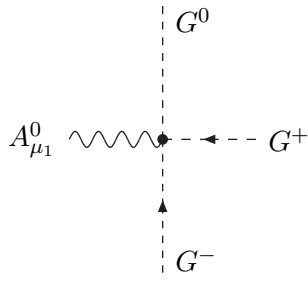
$$\begin{aligned}
& -i\lambda + 9iv^2 C^\varphi \\
& - iC^{\varphi\Box} (p_1 \cdot p_1 + 2p_1 \cdot p_2 + p_2 \cdot p_2 + p_3 \cdot p_3 + 2p_3 \cdot p_4 + p_4 \cdot p_4 + 2\lambda v^2) \\
& + iC^{\varphi D} (-p_1 \cdot p_2 - p_3 \cdot p_4 + \lambda v^2)
\end{aligned}$$



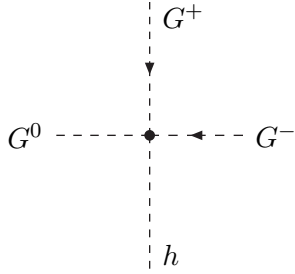
$$\begin{aligned}
& -i\lambda + 9iv^2 C^\varphi \\
& - iC^{\varphi\Box} (p_1 \cdot p_1 + 2p_1 \cdot p_2 + p_2 \cdot p_2 + p_3 \cdot p_3 + 2p_3 \cdot p_4 + p_4 \cdot p_4 + 2\lambda v^2) \\
& + \frac{i}{2} C^{\varphi D} (-p_1 \cdot p_3 - p_1 \cdot p_4 - p_2 \cdot p_3 - p_2 \cdot p_4 + \lambda v^2)
\end{aligned}$$



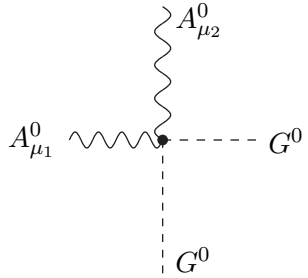
$$\begin{aligned}
& + \frac{2i\bar{g}'^2\bar{g}^2}{\bar{g}'^2 + \bar{g}^2} \eta_{\mu_1\mu_2} + \frac{4i\bar{g}'^2}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1\mu_2}) \\
& - \frac{4i\bar{g}'\bar{g}}{(\bar{g}'^2 + \bar{g}^2)^2} C^{\varphi WB} (\eta_{\mu_1\mu_2} (\bar{g}'^2 (p_1 \cdot p_2 + \bar{g}^2 v^2) + \bar{g}^2 p_1 \cdot p_2) \\
& - (\bar{g}'^2 + \bar{g}^2) p_1^{\mu_2} p_2^{\mu_1})
\end{aligned}$$



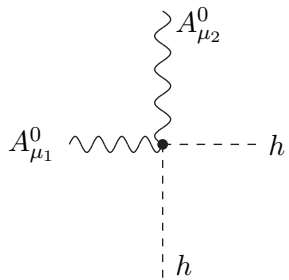
$$+ \frac{\bar{g}'\bar{g}v}{\sqrt{\bar{g}'^2 + \bar{g}^2}} C^{\varphi D} p_2^{\mu_1}$$



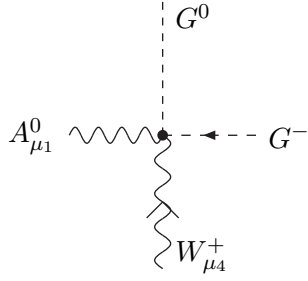
$$-\frac{1}{2}(p_1 \cdot p_2 - p_1 \cdot p_3 - p_2 \cdot p_4 + p_3 \cdot p_4) C^{\varphi D}$$



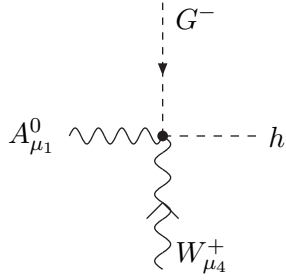
$$+ \frac{4i\bar{g}'^2}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1\mu_2}) - \frac{4i\bar{g}'\bar{g}}{\bar{g}'^2 + \bar{g}^2} C^{\varphi WB} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1\mu_2})$$



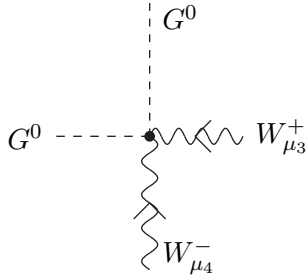
$$+ \frac{4i\bar{g}'^2}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1\mu_2}) - \frac{4i\bar{g}'\bar{g}}{\bar{g}'^2 + \bar{g}^2} C^{\varphi WB} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1\mu_2})$$



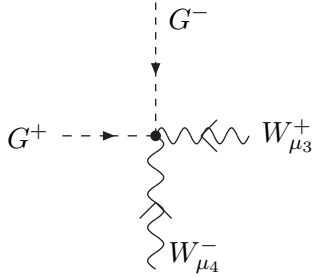
$$\begin{aligned}
& -\frac{\bar{g}'\bar{g}^2}{2\sqrt{\bar{g}'^2+\bar{g}^2}}\eta_{\mu_1\mu_4} + \frac{\bar{g}'\bar{g}^2v^2}{8\sqrt{\bar{g}'^2+\bar{g}^2}}\eta_{\mu_1\mu_4}C^{\varphi D} \\
& + \frac{\bar{g}}{2(\bar{g}'^2+\bar{g}^2)^{3/2}}C^{\varphi WB}(\eta_{\mu_1\mu_4}(\bar{g}'^2(4p_1\cdot p_4+\bar{g}^2v^2)+4\bar{g}^2p_1\cdot p_4) \\
& - 4(\bar{g}'^2+\bar{g}^2)p_1^{\mu_4}p_4^{\mu_1})
\end{aligned}$$



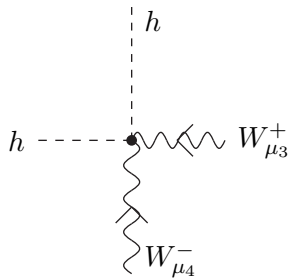
$$\begin{aligned}
& +\frac{i\bar{g}'\bar{g}^2}{2\sqrt{\bar{g}'^2+\bar{g}^2}}\eta_{\mu_1\mu_4} + \frac{i\bar{g}'\bar{g}^2v^2}{2\sqrt{\bar{g}'^2+\bar{g}^2}}\eta_{\mu_1\mu_4}C^{\varphi\Box} - \frac{i\bar{g}'\bar{g}^2v^2}{8\sqrt{\bar{g}'^2+\bar{g}^2}}\eta_{\mu_1\mu_4}C^{\varphi D} \\
& - \frac{i\bar{g}}{2(\bar{g}'^2+\bar{g}^2)^{3/2}}C^{\varphi WB}(\eta_{\mu_1\mu_4}(\bar{g}'^2(4p_1\cdot p_4+\bar{g}^2v^2)+4\bar{g}^2p_1\cdot p_4) \\
& - 4(\bar{g}'^2+\bar{g}^2)p_1^{\mu_4}p_4^{\mu_1})
\end{aligned}$$



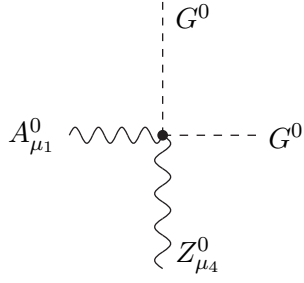
$$+\frac{i\bar{g}^2}{2}\eta_{\mu_3\mu_4} - \frac{1}{4}i\bar{g}^2v^2\eta_{\mu_3\mu_4}C^{\varphi D} + 4iC^{\varphi W}(p_3^{\mu_4}p_4^{\mu_3} - p_3\cdot p_4\eta_{\mu_3\mu_4})$$



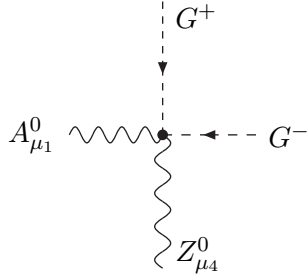
$$+\frac{i\bar{g}^2}{2}\eta_{\mu_3\mu_4} + \frac{1}{2}i\bar{g}^2v^2\eta_{\mu_3\mu_4}C^{\varphi D} + 4iC^{\varphi W}(p_3^{\mu_4}p_4^{\mu_3} - p_3\cdot p_4\eta_{\mu_3\mu_4})$$



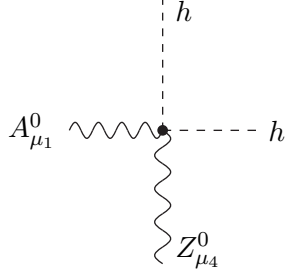
$$+\frac{i\bar{g}^2}{2}\eta_{\mu_3\mu_4} + i\bar{g}^2v^2\eta_{\mu_3\mu_4}C^{\varphi\Box} - \frac{1}{4}i\bar{g}^2v^2\eta_{\mu_3\mu_4}C^{\varphi D} + 4iC^{\varphi W}(p_3^{\mu_4}p_4^{\mu_3} - p_3\cdot p_4\eta_{\mu_3\mu_4})$$



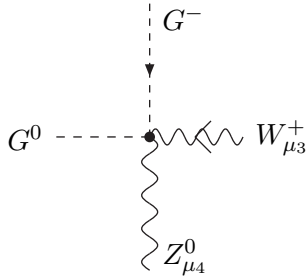
$$\begin{aligned}
& + \frac{4i\bar{g}'\bar{g}}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_1^{\mu_4} p_4^{\mu_1} - p_1 \cdot p_4 \eta_{\mu_1 \mu_4}) \\
& + \frac{2i}{\bar{g}'^2 + \bar{g}^2} (\bar{g}' - \bar{g})(\bar{g}' + \bar{g}) C^{\varphi WB} (p_1^{\mu_4} p_4^{\mu_1} - p_1 \cdot p_4 \eta_{\mu_1 \mu_4})
\end{aligned}$$



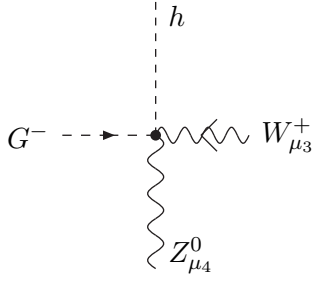
$$\begin{aligned}
& - \frac{i\bar{g}'\bar{g}}{\bar{g}'^2 + \bar{g}^2} (\bar{g}' - \bar{g})(\bar{g}' + \bar{g}) \eta_{\mu_1 \mu_4} - \frac{1}{2} i\bar{g}'\bar{g} v^2 \eta_{\mu_1 \mu_4} C^{\varphi D} \\
& + \frac{4i\bar{g}'\bar{g}}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_1^{\mu_4} p_4^{\mu_1} - p_1 \cdot p_4 \eta_{\mu_1 \mu_4}) + \frac{2i}{(\bar{g}'^2 + \bar{g}^2)^2} (\bar{g}' - \bar{g})(\bar{g}' \\
& + \bar{g}) C^{\varphi WB} (\eta_{\mu_1 \mu_4} (\bar{g}'^2 (p_1 \cdot p_4 + \bar{g}^2 v^2) + \bar{g}^2 p_1 \cdot p_4) - (\bar{g}'^2 + \bar{g}^2) p_1^{\mu_4} p_4^{\mu_1})
\end{aligned}$$



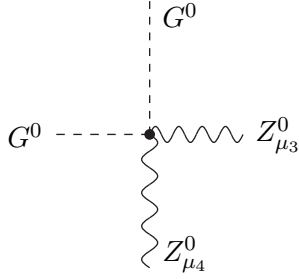
$$\begin{aligned}
& + \frac{4i\bar{g}'\bar{g}}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_1^{\mu_4} p_4^{\mu_1} - p_1 \cdot p_4 \eta_{\mu_1 \mu_4}) \\
& + \frac{2i}{\bar{g}'^2 + \bar{g}^2} (\bar{g}' - \bar{g})(\bar{g}' + \bar{g}) C^{\varphi WB} (p_1^{\mu_4} p_4^{\mu_1} - p_1 \cdot p_4 \eta_{\mu_1 \mu_4})
\end{aligned}$$



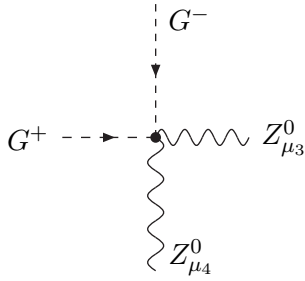
$$\begin{aligned}
& + \frac{\bar{g}'^2 \bar{g}}{2\sqrt{\bar{g}'^2 + \bar{g}^2}} \eta_{\mu_3 \mu_4} + \frac{\bar{g} v^2}{8\sqrt{\bar{g}'^2 + \bar{g}^2}} (\bar{g}'^2 + 2\bar{g}^2) \eta_{\mu_3 \mu_4} C^{\varphi D} \\
& + \frac{\bar{g}'}{2(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB} (\eta_{\mu_3 \mu_4} (-4\bar{g}'^2 p_3 \cdot p_4 - 4\bar{g}^2 p_3 \cdot p_4 + \bar{g}^4 v^2) \\
& + 4(\bar{g}'^2 + \bar{g}^2) p_3^{\mu_4} p_4^{\mu_3})
\end{aligned}$$



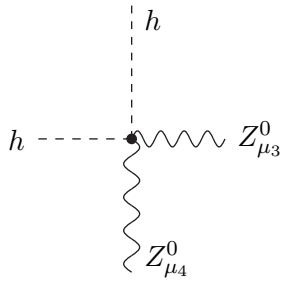
$$\begin{aligned}
& -\frac{i\bar{g}'^2\bar{g}}{2\sqrt{\bar{g}'^2+\bar{g}^2}}\eta_{\mu_3\mu_4}-\frac{i\bar{g}'^2\bar{g}v^2}{2\sqrt{\bar{g}'^2+\bar{g}^2}}\eta_{\mu_3\mu_4}C^{\varphi\Box}\\
& -\frac{i\bar{g}v^2}{8\sqrt{\bar{g}'^2+\bar{g}^2}}(5\bar{g}'^2+6\bar{g}^2)\eta_{\mu_3\mu_4}C^{\varphi D}\\
& -\frac{i\bar{g}'}{2(\bar{g}'^2+\bar{g}^2)^{3/2}}C^{\varphi WB}(\eta_{\mu_3\mu_4}(-4\bar{g}'^2p_3\cdot p_4-4\bar{g}^2p_3\cdot p_4+\bar{g}^4v^2)\\
& +4(\bar{g}'^2+\bar{g}^2)p_3^{\mu_4}p_4^{\mu_3})
\end{aligned}$$



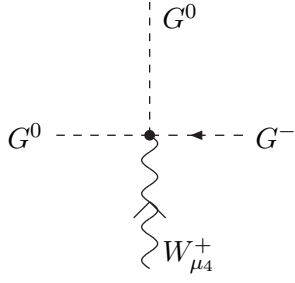
$$\begin{aligned}
& +\frac{i}{2}(\bar{g}'^2+\bar{g}^2)\eta_{\mu_3\mu_4}+\frac{iv^2}{4}(\bar{g}'^2+\bar{g}^2)\eta_{\mu_3\mu_4}C^{\varphi D}\\
& +\frac{4i\bar{g}^2}{\bar{g}'^2+\bar{g}^2}C^{\varphi W}(p_3^{\mu_4}p_4^{\mu_3}-p_3\cdot p_4\eta_{\mu_3\mu_4})\\
& +\frac{i\bar{g}'\bar{g}}{\bar{g}'^2+\bar{g}^2}C^{\varphi WB}(\eta_{\mu_3\mu_4}(-4p_3\cdot p_4+\bar{g}'^2v^2+\bar{g}^2v^2)+4p_3^{\mu_4}p_4^{\mu_3})
\end{aligned}$$



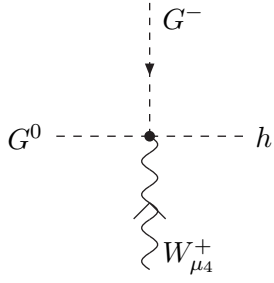
$$\begin{aligned}
& +\frac{i}{2(\bar{g}'^2+\bar{g}^2)}(\bar{g}'-\bar{g})^2(\bar{g}'+\bar{g})^2\eta_{\mu_3\mu_4}+\frac{iv^2}{2}(\bar{g}'-\bar{g})(\bar{g}'+\bar{g})\eta_{\mu_3\mu_4}C^{\varphi D}\\
& +\frac{4i\bar{g}^2}{\bar{g}'^2+\bar{g}^2}C^{\varphi W}(p_3^{\mu_4}p_4^{\mu_3}-p_3\cdot p_4\eta_{\mu_3\mu_4})\\
& -\frac{i\bar{g}'\bar{g}}{(\bar{g}'^2+\bar{g}^2)^2}C^{\varphi WB}(\eta_{\mu_3\mu_4}(-2\bar{g}'^2(2p_3\cdot p_4+\bar{g}^2v^2)\\
& -4\bar{g}^2p_3\cdot p_4+\bar{g}'^4v^2+\bar{g}^4v^2)+4(\bar{g}'^2+\bar{g}^2)p_3^{\mu_4}p_4^{\mu_3})
\end{aligned}$$



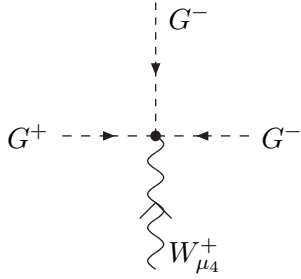
$$\begin{aligned}
& +\frac{i}{2}(\bar{g}'^2+\bar{g}^2)\eta_{\mu_3\mu_4}+iv^2(\bar{g}'^2+\bar{g}^2)\eta_{\mu_3\mu_4}C^{\varphi\Box}\\
& +\frac{5iv^2}{4}(\bar{g}'^2+\bar{g}^2)\eta_{\mu_3\mu_4}C^{\varphi D}+\frac{4i\bar{g}^2}{\bar{g}'^2+\bar{g}^2}C^{\varphi W}(p_3^{\mu_4}p_4^{\mu_3}-p_3\cdot p_4\eta_{\mu_3\mu_4})\\
& +\frac{i\bar{g}'\bar{g}}{\bar{g}'^2+\bar{g}^2}C^{\varphi WB}(\eta_{\mu_3\mu_4}(-4p_3\cdot p_4+\bar{g}'^2v^2+\bar{g}^2v^2)+4p_3^{\mu_4}p_4^{\mu_3})
\end{aligned}$$



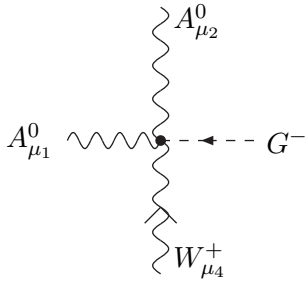
$$+\frac{i\bar{g}v}{2}C^{\varphi D}(p_1^{\mu_4}+p_2^{\mu_4})$$



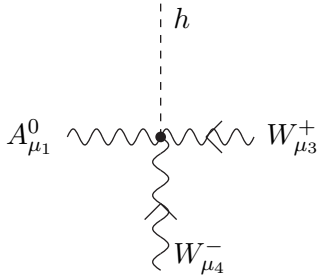
$$+\frac{\bar{g}v}{2}C^{\varphi D}(2p_1^{\mu_4}-p_3^{\mu_4})$$



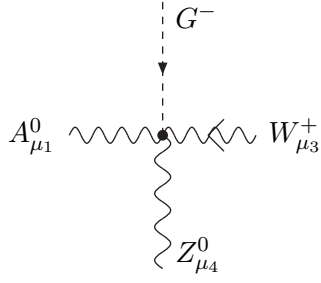
$$-\frac{1}{2}i\bar{g}vC^{\varphi D}(2p_1^{\mu_4}-p_2^{\mu_4}-p_3^{\mu_4})$$



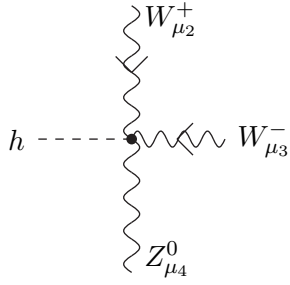
$$-\frac{2i\bar{g}'\bar{g}^2v}{\bar{g}'^2+\bar{g}^2}C^{\varphi WB}(\eta_{\mu_1\mu_2}p_1^{\mu_4}+\eta_{\mu_1\mu_2}p_2^{\mu_4}-\eta_{\mu_1\mu_4}p_1^{\mu_2}-\eta_{\mu_2\mu_4}p_2^{\mu_1})$$



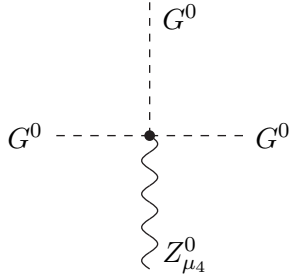
$$-\frac{4i\bar{g}'\bar{g}v}{\sqrt{\bar{g}'^2+\bar{g}^2}}C^{\varphi W}(\eta_{\mu_1\mu_3}p_1^{\mu_4}-\eta_{\mu_1\mu_3}p_3^{\mu_4}-\eta_{\mu_1\mu_4}p_1^{\mu_3}+\eta_{\mu_1\mu_4}p_4^{\mu_3} \\ +\eta_{\mu_3\mu_4}p_3^{\mu_1}-\eta_{\mu_3\mu_4}p_4^{\mu_1})+\frac{2i\bar{g}^2v}{\sqrt{\bar{g}'^2+\bar{g}^2}}C^{\varphi WB}(\eta_{\mu_1\mu_3}p_1^{\mu_4}-\eta_{\mu_1\mu_4}p_1^{\mu_3})$$



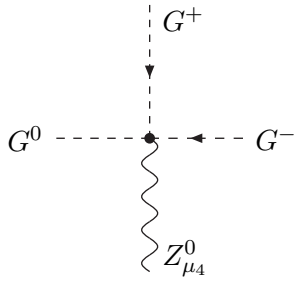
$$+ \frac{2i\bar{g}v}{\bar{g}'^2 + \bar{g}^2} C^{\varphi WB} (\bar{g}'^2 (\eta_{\mu_1\mu_4} p_4^{\mu_3} - \eta_{\mu_3\mu_4} p_4^{\mu_1}) + \bar{g}^2 \eta_{\mu_1\mu_3} p_1^{\mu_4} - \bar{g}^2 \eta_{\mu_1\mu_4} p_1^{\mu_3})$$



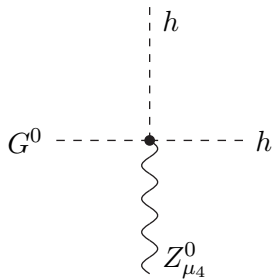
$$- \frac{4i\bar{g}^2 v}{\sqrt{\bar{g}'^2 + \bar{g}^2}} C^{\varphi W} (\eta_{\mu_2\mu_3} p_2^{\mu_4} - \eta_{\mu_2\mu_3} p_3^{\mu_4} - \eta_{\mu_2\mu_4} p_2^{\mu_3} + \eta_{\mu_2\mu_4} p_4^{\mu_3} + \eta_{\mu_3\mu_4} p_3^{\mu_2} - \eta_{\mu_3\mu_4} p_4^{\mu_2}) - \frac{2i\bar{g}'\bar{g}v}{\sqrt{\bar{g}'^2 + \bar{g}^2}} C^{\varphi WB} (\eta_{\mu_2\mu_4} p_4^{\mu_3} - \eta_{\mu_3\mu_4} p_4^{\mu_2})$$



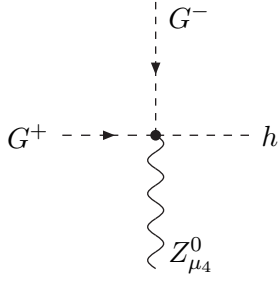
$$- \frac{1}{2} v \sqrt{\bar{g}'^2 + \bar{g}^2} C^{\varphi D} (p_1^{\mu_4} + p_2^{\mu_4} + p_3^{\mu_4})$$



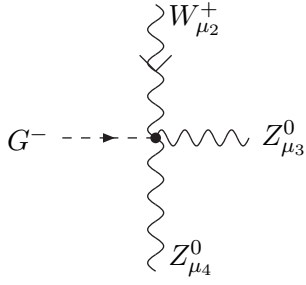
$$- \frac{v}{2\sqrt{\bar{g}'^2 + \bar{g}^2}} (\bar{g}' - \bar{g})(\bar{g}' + \bar{g}) C^{\varphi D} p_1^{\mu_4}$$



$$- \frac{1}{2} v \sqrt{\bar{g}'^2 + \bar{g}^2} C^{\varphi D} (3p_1^{\mu_4} - p_2^{\mu_4} - p_3^{\mu_4})$$

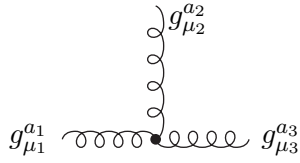


$$+\frac{1}{2}iv\sqrt{\bar{g}'^2+\bar{g}^2}C^{\varphi D}(p_1^{\mu_4}-p_2^{\mu_4})$$

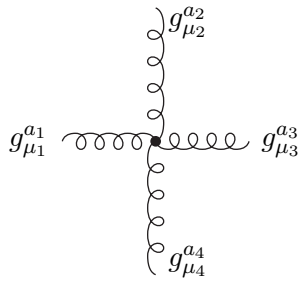


$$-\frac{2i\bar{g}'\bar{g}^2v}{\bar{g}'^2+\bar{g}^2}C^{\varphi WB}(\eta_{\mu_2\mu_3}p_3^{\mu_4}+\eta_{\mu_2\mu_4}p_4^{\mu_3}-\eta_{\mu_3\mu_4}(p_3^{\mu_2}+p_4^{\mu_2}))$$

A.8 Gluon self interaction vertices



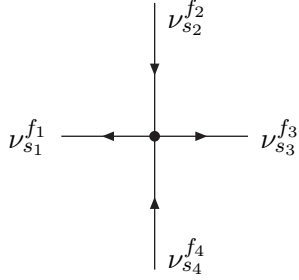
$$-\bar{g}_sf_{a_1a_2a_3}(\eta_{\mu_1\mu_2}p_1^{\mu_3}-\eta_{\mu_1\mu_2}p_2^{\mu_3}-\eta_{\mu_1\mu_3}p_1^{\mu_2}+\eta_{\mu_1\mu_3}p_3^{\mu_2}+\eta_{\mu_2\mu_3}p_2^{\mu_1}-\eta_{\mu_2\mu_3}p_3^{\mu_1})$$



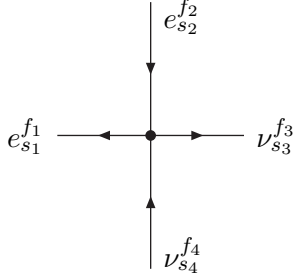
$$\begin{aligned} &+i\bar{g}_s^2((\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}-\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4})f_{a_1a_2b_1}f_{a_3a_4b_1} \\ &+(\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}-\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})f_{a_1a_3b_1}f_{a_2a_4b_1} \\ &+(\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}-\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})f_{a_1a_4b_1}f_{a_2a_3b_1}) \end{aligned}$$

A.9 Higgs–gluon vertices

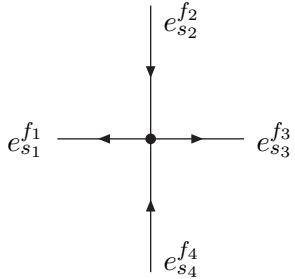
A.10 Four lepton vertices



$$\begin{aligned}
& +iC_{g_1g_2g_3g_4}^{ll*} (U_{g_1f_3}U_{g_3f_1}^* (U_{g_2f_2}U_{g_4f_4}(\gamma^\mu P_L)_{s_1s_4}(\gamma^\mu P_L)_{s_3s_2} \\
& + U_{g_2f_4}U_{g_4f_2}(\gamma^\mu P_L)_{s_1s_2}(\gamma^\mu P_L)_{s_3s_4}) \\
& + U_{g_1f_1}^*U_{g_3f_3}^* (U_{g_2f_4}U_{g_4f_2}(\gamma^\mu P_L)_{s_1s_4}(\gamma^\mu P_L)_{s_3s_2} \\
& + U_{g_2f_2}U_{g_4f_4}(\gamma^\mu P_L)_{s_1s_2}(\gamma^\mu P_L)_{s_3s_4}))
\end{aligned}$$



$$+2iU_{g_2f_4}U_{g_1f_3}^*(\gamma^\mu P_L)_{s_1s_2}(\gamma^\mu P_L)_{s_3s_4}C_{f_1f_2g_1g_2}^{ll}$$



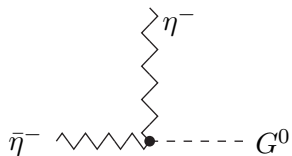
$$+2i\left(C_{f_1f_4f_3f_2}^{ll}(\gamma^\mu P_L)_{s_1s_4}(\gamma^\mu P_L)_{s_3s_2} + C_{f_1f_2f_3f_4}^{ll}(\gamma^\mu P_L)_{s_1s_2}(\gamma^\mu P_L)_{s_3s_4}\right)$$

A.11 Two quark–two lepton vertices

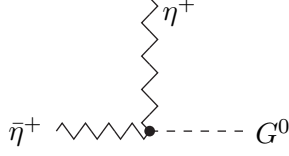
A.12 Four quark vertices

A.13 Baryon and lepton number violating four fermion vertices

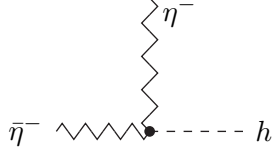
A.14 Ghost vertices



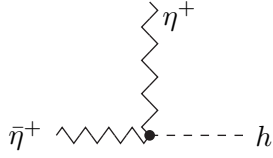
$$+\frac{1}{4}\bar{g}^2v\xi_W - \frac{1}{16}\bar{g}^2v^3\xi_W C^{\varphi D}$$



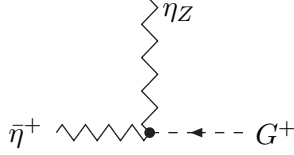
$$-\frac{1}{4}\bar{g}^2 v \xi_W + \frac{1}{16}\bar{g}^2 v^3 \xi_W C^{\varphi D}$$



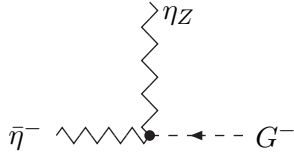
$$+\frac{1}{4}i\bar{g}^2 v \xi_W + \frac{1}{4}i\bar{g}^2 v^3 \xi_W C^{\varphi \square} - \frac{1}{16}i\bar{g}^2 v^3 \xi_W C^{\varphi D}$$



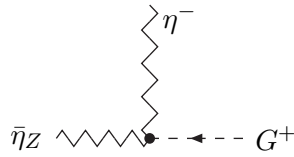
$$+\frac{1}{4}i\bar{g}^2 v \xi_W + \frac{1}{4}i\bar{g}^2 v^3 \xi_W C^{\varphi \square} - \frac{1}{16}i\bar{g}^2 v^3 \xi_W C^{\varphi D}$$



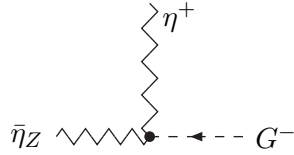
$$+\frac{i\bar{g}v\xi_W}{4\sqrt{\bar{g}'^2 + \bar{g}^2}}(\bar{g} - \bar{g}')(\bar{g}' + \bar{g}) + \frac{i\bar{g}'\bar{g}^2 v^3 \xi_W}{4(\bar{g}'^2 + \bar{g}^2)^{3/2}}(\bar{g}' - \bar{g})(\bar{g}' + \bar{g})C^{\varphi WB}$$



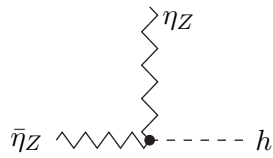
$$+\frac{i\bar{g}v\xi_W}{4\sqrt{\bar{g}'^2 + \bar{g}^2}}(\bar{g} - \bar{g}')(\bar{g}' + \bar{g}) + \frac{i\bar{g}'\bar{g}^2 v^3 \xi_W}{4(\bar{g}'^2 + \bar{g}^2)^{3/2}}(\bar{g}' - \bar{g})(\bar{g}' + \bar{g})C^{\varphi WB}$$



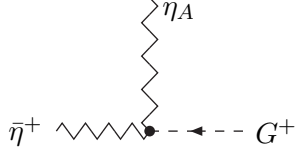
$$-\frac{1}{4}i\bar{g}v\sqrt{\bar{g}'^2 + \bar{g}^2}\xi_Z - \frac{1}{8}i\bar{g}v^3\sqrt{\bar{g}'^2 + \bar{g}^2}\xi_Z C^{\varphi D} - \frac{i\bar{g}'\bar{g}^2 v^3 \xi_Z}{4\sqrt{\bar{g}'^2 + \bar{g}^2}}C^{\varphi WB}$$



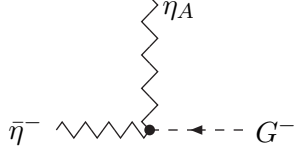
$$-\frac{1}{4}i\bar{g}v\sqrt{\bar{g}'^2 + \bar{g}^2}\xi_Z - \frac{1}{8}i\bar{g}v^3\sqrt{\bar{g}'^2 + \bar{g}^2}\xi_Z C^{\varphi D} - \frac{i\bar{g}'\bar{g}^2 v^3 \xi_Z}{4\sqrt{\bar{g}'^2 + \bar{g}^2}}C^{\varphi WB}$$



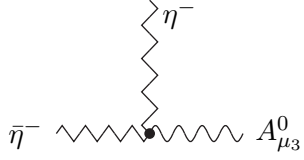
$$+\frac{1}{4}iv\xi_Z (\bar{g}'^2 + \bar{g}^2) + \frac{1}{4}iv^3\xi_Z (\bar{g}'^2 + \bar{g}^2) C^{\varphi \square} \\ + \frac{1}{16}iv^3\xi_Z (\bar{g}'^2 + \bar{g}^2) C^{\varphi D} + \frac{1}{2}i\bar{g}'\bar{g}v^3\xi_Z C^{\varphi WB}$$



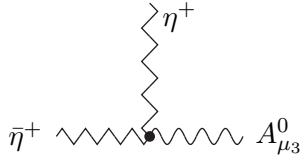
$$+ \frac{i\bar{g}'\bar{g}^2 v \xi_W}{2\sqrt{\bar{g}'^2 + \bar{g}^2}} - \frac{i\bar{g}'^2 \bar{g}^3 v^3 \xi_W}{2(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB}$$



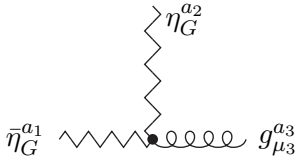
$$+ \frac{i\bar{g}'\bar{g}^2 v \xi_W}{2\sqrt{\bar{g}'^2 + \bar{g}^2}} - \frac{i\bar{g}'^2 \bar{g}^3 v^3 \xi_W}{2(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB}$$



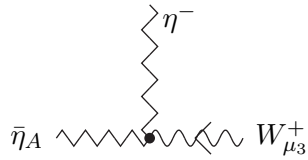
$$+ \frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_1^{\mu_3} - \frac{i\bar{g}'^2 \bar{g}^2 v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB} p_1^{\mu_3}$$



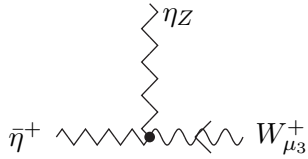
$$- \frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_1^{\mu_3} + \frac{i\bar{g}'^2 \bar{g}^2 v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB} p_1^{\mu_3}$$



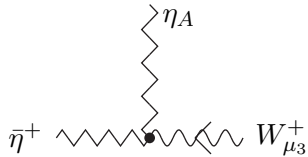
$$- \bar{g}_s f_{a_3 a_1 a_2} p_1^{\mu_3}$$



$$- \frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_1^{\mu_3} - \frac{i\bar{g}^4 v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB} p_1^{\mu_3}$$



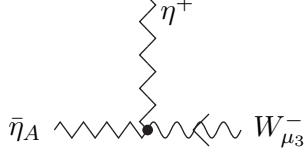
$$+ \frac{i\bar{g}^2}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_1^{\mu_3} + \frac{i\bar{g}'^3 \bar{g} v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB} p_1^{\mu_3}$$



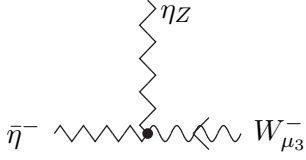
$$+ \frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_1^{\mu_3} - \frac{i\bar{g}'^2 \bar{g}^2 v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB} p_1^{\mu_3}$$



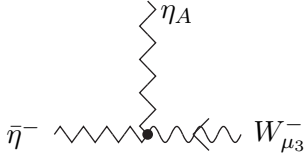
$$-\frac{i\bar{g}^2}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_1^{\mu_3} + \frac{i\bar{g}'\bar{g}^3v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}}C^{\varphi WB}p_1^{\mu_3}$$



$$+\frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_1^{\mu_3} + \frac{i\bar{g}^4v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}}C^{\varphi WB}p_1^{\mu_3}$$



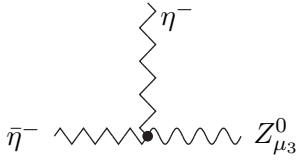
$$-\frac{i\bar{g}^2}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_1^{\mu_3} - \frac{i\bar{g}'^3\bar{g}v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}}C^{\varphi WB}p_1^{\mu_3}$$



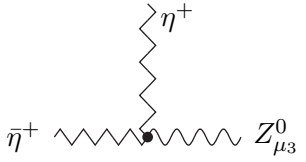
$$-\frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_1^{\mu_3} + \frac{i\bar{g}'^2\bar{g}^2v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}}C^{\varphi WB}p_1^{\mu_3}$$



$$+\frac{i\bar{g}^2}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_1^{\mu_3} - \frac{i\bar{g}'\bar{g}^3v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}}C^{\varphi WB}p_1^{\mu_3}$$



$$+\frac{i\bar{g}^2}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_1^{\mu_3} + \frac{i\bar{g}'^3\bar{g}v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}}C^{\varphi WB}p_1^{\mu_3}$$



$$-\frac{i\bar{g}^2}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_1^{\mu_3} - \frac{i\bar{g}'^3\bar{g}v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}}C^{\varphi WB}p_1^{\mu_3}$$