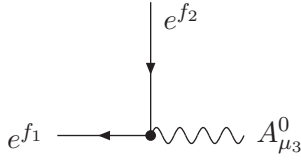
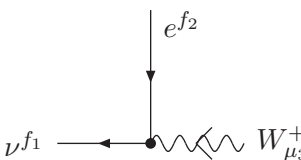
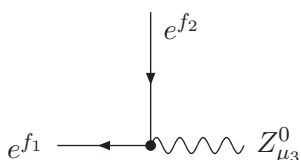
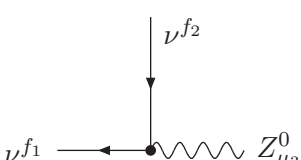


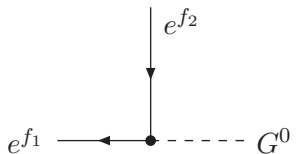
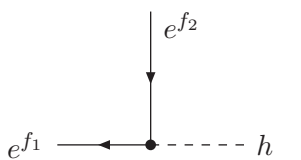
A SMEFT interaction vertices

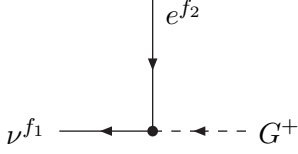
CAUTION: interaction vertices printed below are shown including only terms up to mass dimension-6. Interactions proportional to products of dimension-6 Wilson coefficients, even if calculated and included in other output formats (Mathematica, Feynarts, UFO etc.), are too complicated for printout and 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

	$+ \frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} \delta_{f_1 f_2} \gamma^{\mu_3} - \frac{i\bar{g}'^2 \bar{g}^2 v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} \delta_{f_1 f_2} C^{\varphi WB} \gamma^{\mu_3}$
	$- \frac{i\bar{g}}{\sqrt{2}} U_{f_2 f_1}^* \gamma^{\mu_3} P_L$
	$- \frac{i}{2\sqrt{\bar{g}'^2 + \bar{g}^2}} \delta_{f_1 f_2} ((\bar{g}'^2 - \bar{g}^2) \gamma^{\mu_3} P_L + 2\bar{g}'^2 \gamma^{\mu_3} P_R) \\ + \frac{i\bar{g}'\bar{g}v^2}{2(\bar{g}'^2 + \bar{g}^2)^{3/2}} \delta_{f_1 f_2} C^{\varphi WB} ((\bar{g}'^2 - \bar{g}^2) \gamma^{\mu_3} P_L - 2\bar{g}^2 \gamma^{\mu_3} P_R)$
	$- \frac{1}{2} i \sqrt{\bar{g}'^2 + \bar{g}^2} \delta_{f_1 f_2} \gamma^{\mu_3} P_L - \frac{i\bar{g}'\bar{g}v^2}{2\sqrt{\bar{g}'^2 + \bar{g}^2}} \delta_{f_1 f_2} C^{\varphi WB} \gamma^{\mu_3} P_L$

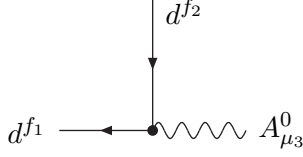
A.2 Lepton–Higgs–gauge vertices

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

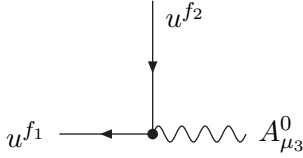


$$-\frac{i\sqrt{2}}{v}P_R U_{g_1 f_1}^* m_{l_{g_1}} \delta_{g_1 f_2}$$

A.3 Quark-gauge vertices

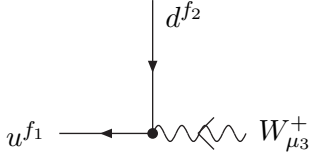


$$+\frac{i\bar{g}'\bar{g}}{3\sqrt{\bar{g}'^2+\bar{g}^2}}\delta_{f_1 f_2}\gamma^{\mu_3}-\frac{i\bar{g}'^2\bar{g}^2v^2}{3(\bar{g}'^2+\bar{g}^2)^{3/2}}\delta_{f_1 f_2}C^{\varphi WB}\gamma^{\mu_3}$$

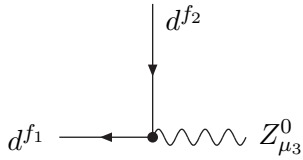


$$-\frac{2i\bar{g}'\bar{g}}{3\sqrt{\bar{g}'^2+\bar{g}^2}}\delta_{f_1 f_2}\gamma^{\mu_3}+\frac{2i\bar{g}'^2\bar{g}^2v^2}{3(\bar{g}'^2+\bar{g}^2)^{3/2}}\delta_{f_1 f_2}C^{\varphi WB}\gamma^{\mu_3}$$

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

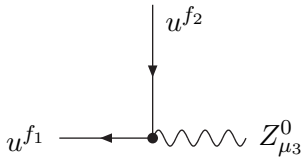


$$-\frac{i\bar{g}}{\sqrt{2}}K_{f_1 f_2}\gamma^{\mu_3}P_L-2vp_3^\nu K_{g_1 f_2}\sigma^{\mu_3\nu}P_L C_{g_1 f_1}^{uW*}$$



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

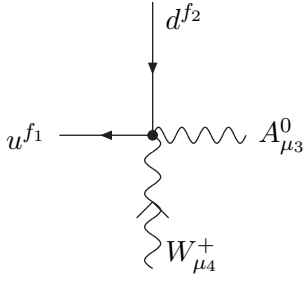
$$+\frac{i\bar{g}'\bar{g}v^2}{6(\bar{g}'^2+\bar{g}^2)^{3/2}}\delta_{f_1 f_2}C^{\varphi WB}((3\bar{g}'^2+\bar{g}^2)\gamma^{\mu_3}P_L-2\bar{g}^2\gamma^{\mu_3}P_R)$$



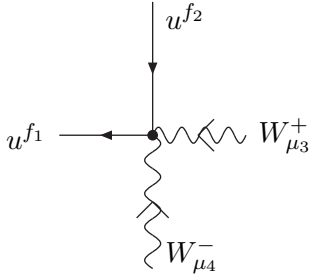
$$+\frac{i}{6\sqrt{\bar{g}'^2+\bar{g}^2}}\delta_{f_1 f_2}((\bar{g}'^2-3\bar{g}^2)\gamma^{\mu_3}P_L+4\bar{g}'^2\gamma^{\mu_3}P_R)$$

$$-\frac{i\bar{g}'\bar{g}v^2}{6(\bar{g}'^2+\bar{g}^2)^{3/2}}\delta_{f_1 f_2}C^{\varphi WB}((3\bar{g}'^2-\bar{g}^2)\gamma^{\mu_3}P_L-4\bar{g}^2\gamma^{\mu_3}P_R)$$

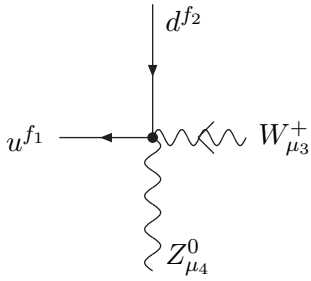
$$-\frac{\sqrt{2}\bar{g}v}{\sqrt{\bar{g}'^2+\bar{g}^2}}p_3^\nu(C_{f_2 f_1}^{uW*}\sigma^{\mu_3\nu}P_L+C_{f_1 f_2}^{uW}\sigma^{\mu_3\nu}P_R)$$



$$-\frac{2\bar{g}'\bar{g}v}{\sqrt{\bar{g}'^2+\bar{g}^2}}K_{g_1f_2}\sigma^{\mu_3\mu_4}P_L C_{g_1f_1}^{uW*}$$

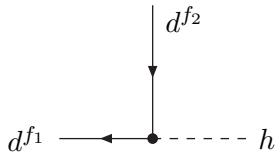


$$-\sqrt{2}\bar{g}v\left(\sigma^{\mu_3\mu_4}P_L C_{f_2f_1}^{uW*}+C_{f_1f_2}^{uW}\sigma^{\mu_3\mu_4}P_R\right)$$

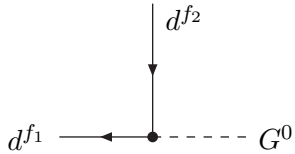


$$+\frac{2\bar{g}^2v}{\sqrt{\bar{g}'^2+\bar{g}^2}}K_{g_1f_2}\sigma^{\mu_3\mu_4}P_L C_{g_1f_1}^{uW*}$$

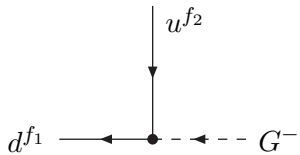
A.4 Quark-Higgs-gauge vertices



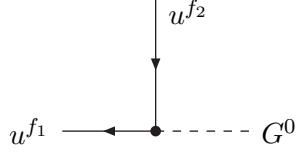
$$-\frac{i}{v}m_{d_{f_1}}\delta_{f_1f_2}-ivC^{\varphi\Box}m_{d_{f_1}}\delta_{f_1f_2}+\frac{iv}{4}C^{\varphi D}m_{d_{f_1}}\delta_{f_1f_2}+\frac{iv^2}{\sqrt{2}}\left(P_L C_{f_2f_1}^{d\varphi*}+P_R C_{f_1f_2}^{d\varphi}\right)$$



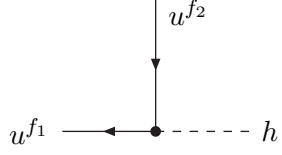
$$+\frac{1}{v}\gamma^5m_{d_{f_1}}\delta_{f_1f_2}-\frac{v}{4}C^{\varphi D}\gamma^5m_{d_{f_1}}\delta_{f_1f_2}$$



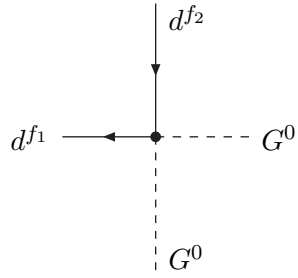
$$-\frac{i\sqrt{2}}{v}\left(P_L K_{f_2g_1}^*m_{d_{f_1}}\delta_{f_1g_1}-P_R K_{g_1f_1}^*m_{u_{g_1}}\delta_{g_1f_2}\right)$$



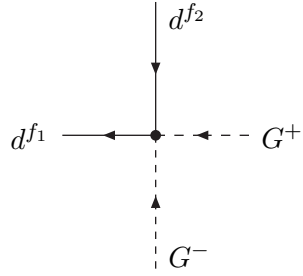
$$-\frac{1}{v}\gamma^5 m_{u_{f_1}} \delta_{f_1 f_2} + \frac{v}{4} C^{\varphi D} \gamma^5 m_{u_{f_1}} \delta_{f_1 f_2}$$



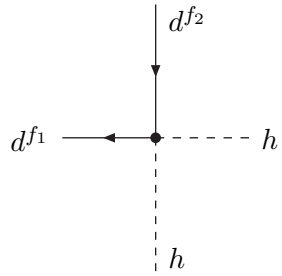
$$-\frac{i}{v} m_{u_{f_1}} \delta_{f_1 f_2} - i v C^{\varphi \square} m_{u_{f_1}} \delta_{f_1 f_2} + \frac{i v}{4} C^{\varphi D} m_{u_{f_1}} \delta_{f_1 f_2}$$



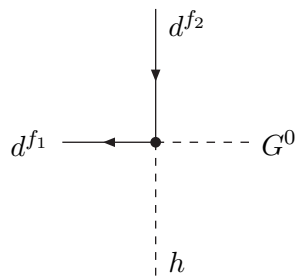
$$+\frac{i v}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{d\varphi*} + P_R C_{f_1 f_2}^{d\varphi} \right)$$



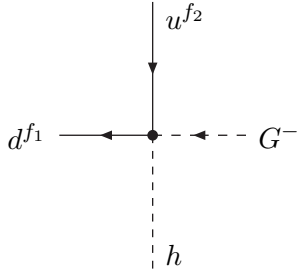
$$+\frac{i v}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{d\varphi*} + P_R C_{f_1 f_2}^{d\varphi} \right)$$



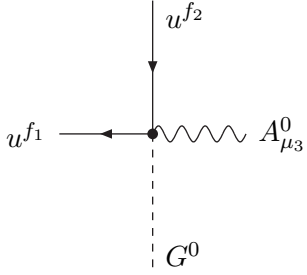
$$+\frac{3 i v}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{d\varphi*} + P_R C_{f_1 f_2}^{d\varphi} \right)$$



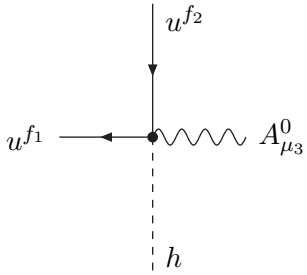
$$+\frac{v}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{d\varphi*} - P_R C_{f_1 f_2}^{d\varphi} \right)$$



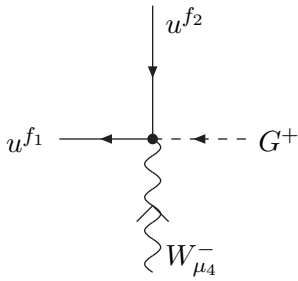
$$+ivP_L K_{f_2 g_1}^* C_{g_1 f_1}^{d\varphi^*}$$



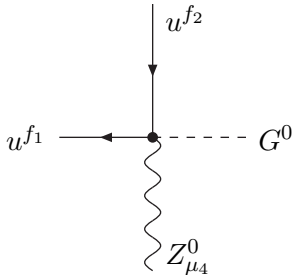
$$-\frac{i\sqrt{2}\bar{g}'}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_3^\nu (C_{f_2 f_1}^{uW^*} \sigma^{\mu_3 \nu} P_L - C_{f_1 f_2}^{uW} \sigma^{\mu_3 \nu} P_R)$$



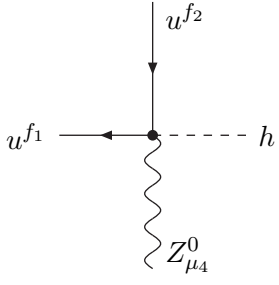
$$-\frac{\sqrt{2}\bar{g}'}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_3^\nu (C_{f_2 f_1}^{uW^*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{uW} \sigma^{\mu_3 \nu} P_R)$$



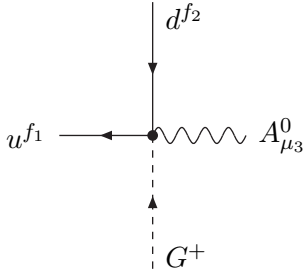
$$+2\sqrt{2}p_4^\nu C_{f_2 f_1}^{uW^*} \sigma^{\mu_4 \nu} P_L$$



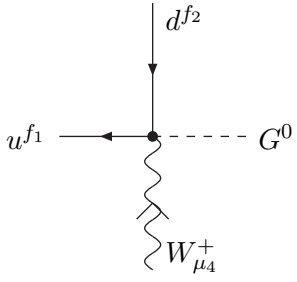
$$-\frac{i\sqrt{2}\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_4^\nu (C_{f_2 f_1}^{uW^*} \sigma^{\mu_4 \nu} P_L - C_{f_1 f_2}^{uW} \sigma^{\mu_4 \nu} P_R)$$



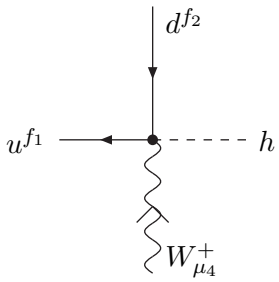
$$-\frac{\sqrt{2}\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_4^\nu (C_{f_2 f_1}^{uW*} \sigma^{\mu_4 \nu} P_L + C_{f_1 f_2}^{uW} \sigma^{\mu_4 \nu} P_R)$$



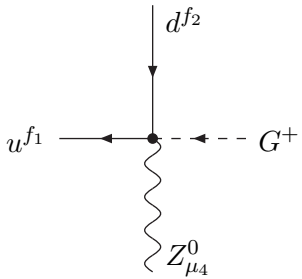
$$-\frac{2\bar{g}'}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_3^\nu K_{g_1 f_2} \sigma^{\mu_3 \nu} P_L C_{g_1 f_1}^{uW*}$$



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

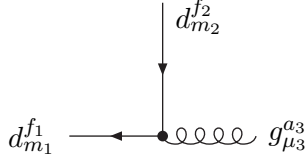


$$-2p_4^\nu K_{g_1 f_2} \sigma^{\mu_4 \nu} P_L C_{g_1 f_1}^{uW*}$$

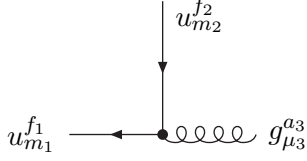


$$-\frac{2\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_4^\nu K_{g_1 f_2} \sigma^{\mu_4 \nu} P_L C_{g_1 f_1}^{uW*}$$

A.5 Quark-gluon vertices

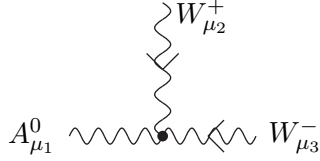


$$-i\bar{g}_s\delta_{f_1f_2}\mathcal{T}_{m_1m_2}^{a_3}\gamma^{\mu_3}$$

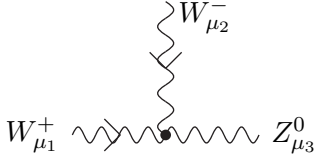


$$-i\bar{g}_s\delta_{f_1f_2}\mathcal{T}_{m_1m_2}^{a_3}\gamma^{\mu_3}$$

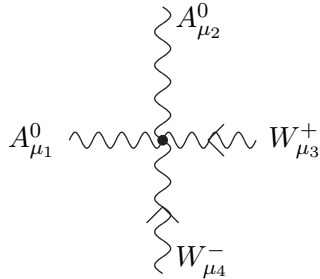
A.6 Gauge self interaction vertices



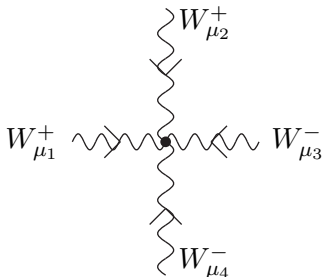
$$+\frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2+\bar{g}^2}}(\eta_{\mu_1\mu_2}p_1^{\mu_3}-\eta_{\mu_1\mu_2}p_2^{\mu_3}-\eta_{\mu_1\mu_3}p_1^{\mu_2}+\eta_{\mu_1\mu_3}p_3^{\mu_2}+\eta_{\mu_2\mu_3}p_2^{\mu_1}-\eta_{\mu_2\mu_3}p_3^{\mu_1})+\frac{i\bar{g}^2v^2}{(\bar{g}'^2+\bar{g}^2)^{3/2}}C^{\varphi WB}(\bar{g}'^2\eta_{\mu_1\mu_2}p_2^{\mu_3}-\bar{g}'^2\eta_{\mu_1\mu_3}p_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



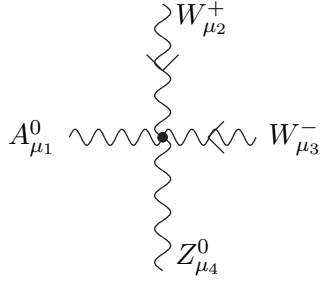
$$+\frac{i\bar{g}^2}{\sqrt{\bar{g}'^2+\bar{g}^2}}(\eta_{\mu_1\mu_2}p_1^{\mu_3}-\eta_{\mu_1\mu_2}p_2^{\mu_3}-\eta_{\mu_1\mu_3}p_1^{\mu_2}+\eta_{\mu_1\mu_3}p_3^{\mu_2}+\eta_{\mu_2\mu_3}p_2^{\mu_1}-\eta_{\mu_2\mu_3}p_3^{\mu_1})+\frac{i\bar{g}'\bar{g}v^2}{(\bar{g}'^2+\bar{g}^2)^{3/2}}C^{\varphi WB}(\bar{g}'^2\eta_{\mu_1\mu_2}p_1^{\mu_3}-\bar{g}'^2\eta_{\mu_1\mu_2}p_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



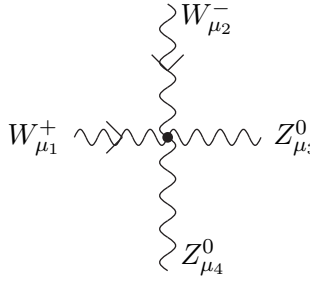
$$+\frac{i\bar{g}'^2\bar{g}^2}{\bar{g}'^2+\bar{g}^2}(\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}+\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}-2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})-\frac{2i\bar{g}'^3\bar{g}^3v^2}{(\bar{g}'^2+\bar{g}^2)^2}(\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}+\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}-2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})C^{\varphi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



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

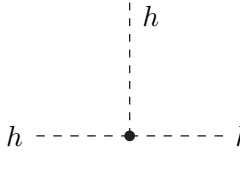


$$\begin{aligned}
& -\frac{i\bar{g}'\bar{g}^3}{\bar{g}'^2 + \bar{g}^2} (2\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} - \eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}) - \frac{i\bar{g}'^2\bar{g}^2v^2}{(\bar{g}'^2 + \bar{g}^2)^2} (\bar{g}' \\
& - \bar{g})(\bar{g}' + \bar{g}) (2\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}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

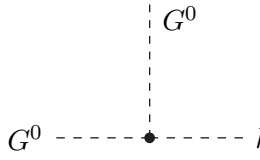


$$\begin{aligned}
& + \frac{i\bar{g}^4}{\bar{g}'^2 + \bar{g}^2} (\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} + \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} - 2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}) \\
& + \frac{2i\bar{g}'^3\bar{g}^3v^2}{(\bar{g}'^2 + \bar{g}^2)^2} (\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} + \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} - 2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}) C^{\varphi WB}
\end{aligned}$$

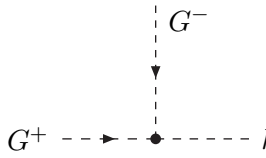
A.7 Higgs–gauge vertices



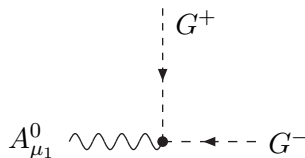
$$\begin{aligned}
& -3i\lambda v + 15iv^3C^{\varphi} \\
& -ivC^{\varphi\Box} (3p_1 \cdot p_1 + 2p_1 \cdot p_2 + 2p_1 \cdot p_3 + 3p_2 \cdot p_2 + 2p_2 \cdot p_3 + 3p_3 \cdot p_3 + 9\lambda v^2) \\
& + \frac{iv}{4}C^{\varphi D} (9\lambda v^2 - 4(p_1 \cdot p_2 + p_1 \cdot p_3 + p_2 \cdot p_3))
\end{aligned}$$



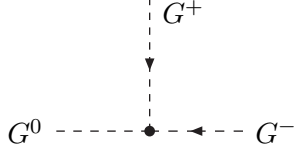
$$\begin{aligned}
& -i\lambda v + 3iv^3C^{\varphi} - ivC^{\varphi\Box} (p_1 \cdot p_1 + 2p_1 \cdot p_2 + p_2 \cdot p_2 + p_3 \cdot p_3 + \lambda v^2) \\
& + \frac{iv}{4}C^{\varphi D} (3\lambda v^2 - 4p_1 \cdot p_2)
\end{aligned}$$



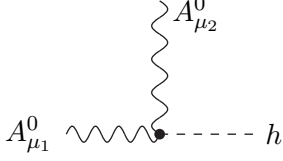
$$\begin{aligned}
& -i\lambda v + 3iv^3C^{\varphi} - ivC^{\varphi\Box} (p_1 \cdot p_1 + 2p_1 \cdot p_2 + p_2 \cdot p_2 + p_3 \cdot p_3 + \lambda v^2) \\
& + \frac{iv}{4}C^{\varphi D} (\lambda v^2 - 2(p_1 \cdot p_3 + p_2 \cdot p_3))
\end{aligned}$$



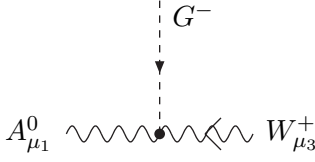
$$-\frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} (p_2^{\mu_1} - p_3^{\mu_1}) + \frac{i\bar{g}'^2\bar{g}^2v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB} (p_2^{\mu_1} - p_3^{\mu_1})$$



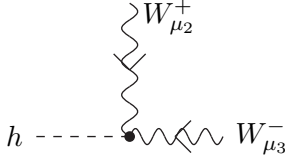
$$-\frac{v}{2}(p_1 \cdot p_2 - p_1 \cdot p_3)C^{\varphi D}$$



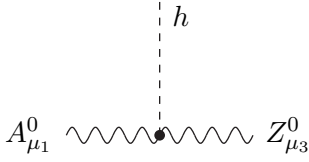
$$+\frac{4i\bar{g}'^2v}{\bar{g}'^2+\bar{g}^2}C^{\varphi W}(p_1^{\mu_2}p_2^{\mu_1}-p_1 \cdot p_2\eta_{\mu_1\mu_2})-\frac{4i\bar{g}'\bar{g}v}{\bar{g}'^2+\bar{g}^2}C^{\varphi WB}(p_1^{\mu_2}p_2^{\mu_1}-p_1 \cdot p_2\eta_{\mu_1\mu_2})$$



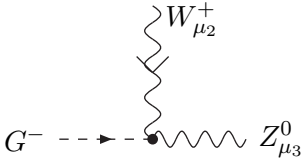
$$+\frac{i\bar{g}'\bar{g}^2v}{2\sqrt{\bar{g}'^2+\bar{g}^2}}\eta_{\mu_1\mu_3}-\frac{i\bar{g}v}{2(\bar{g}'^2+\bar{g}^2)^{3/2}}C^{\varphi WB}(\eta_{\mu_1\mu_3}(\bar{g}'^2(4p_1 \cdot p_3+\bar{g}^2v^2)+4\bar{g}^2p_1 \cdot p_3)-4(\bar{g}'^2+\bar{g}^2)p_1^{\mu_3}p_3^{\mu_1})$$



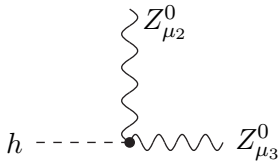
$$+\frac{1}{2}i\bar{g}^2v\eta_{\mu_2\mu_3}+\frac{1}{2}i\bar{g}^2v^3\eta_{\mu_2\mu_3}C^{\varphi\Box}-\frac{1}{8}i\bar{g}^2v^3\eta_{\mu_2\mu_3}C^{\varphi D}+4ivC^{\varphi W}(p_2^{\mu_3}p_3^{\mu_2}-p_2 \cdot p_3\eta_{\mu_2\mu_3})$$



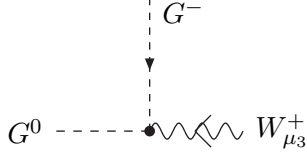
$$+\frac{4i\bar{g}'\bar{g}v}{\bar{g}'^2+\bar{g}^2}C^{\varphi W}(p_1^{\mu_3}p_3^{\mu_1}-p_1 \cdot p_3\eta_{\mu_1\mu_3})+\frac{2iv}{\bar{g}'^2+\bar{g}^2}(\bar{g}'-\bar{g})(\bar{g}'+\bar{g})C^{\varphi WB}(p_1^{\mu_3}p_3^{\mu_1}-p_1 \cdot p_3\eta_{\mu_1\mu_3})$$



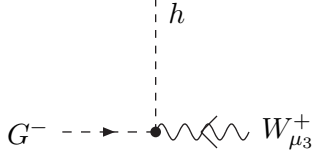
$$-\frac{i\bar{g}'^2\bar{g}v}{2\sqrt{\bar{g}'^2+\bar{g}^2}}\eta_{\mu_2\mu_3}-\frac{1}{4}i\bar{g}v^3\sqrt{\bar{g}'^2+\bar{g}^2}\eta_{\mu_2\mu_3}C^{\varphi D}-\frac{i\bar{g}'v}{2(\bar{g}'^2+\bar{g}^2)^{3/2}}C^{\varphi WB}(\eta_{\mu_2\mu_3}(-4\bar{g}'^2p_2 \cdot p_3-4\bar{g}^2p_2 \cdot p_3+\bar{g}^4v^2)+4(\bar{g}'^2+\bar{g}^2)p_2^{\mu_3}p_3^{\mu_2})$$



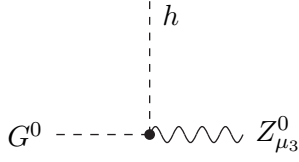
$$+\frac{iv}{2}(\bar{g}'^2+\bar{g}^2)\eta_{\mu_2\mu_3}+\frac{iv^3}{2}(\bar{g}'^2+\bar{g}^2)\eta_{\mu_2\mu_3}C^{\varphi\Box}+\frac{3iv^3}{8}(\bar{g}'^2+\bar{g}^2)\eta_{\mu_2\mu_3}C^{\varphi D}+\frac{4i\bar{g}^2v}{\bar{g}'^2+\bar{g}^2}C^{\varphi W}(p_2^{\mu_3}p_3^{\mu_2}-p_2 \cdot p_3\eta_{\mu_2\mu_3})+\frac{i\bar{g}'\bar{g}v}{\bar{g}'^2+\bar{g}^2}C^{\varphi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



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

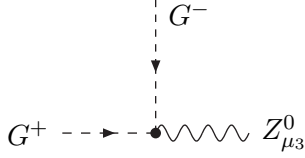


$$+\frac{i\bar{g}}{2}(p_1^{\mu_3}-p_2^{\mu_3})+\frac{1}{2}i\bar{g}v^2C^{\varphi\Box}(p_1^{\mu_3}-p_2^{\mu_3})-\frac{1}{8}i\bar{g}v^2C^{\varphi D}(p_1^{\mu_3}-p_2^{\mu_3})$$



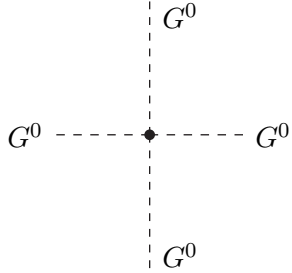
$$-\frac{1}{2}\sqrt{\bar{g}'^2+\bar{g}^2}(p_1^{\mu_3}-p_2^{\mu_3})-\frac{1}{2}v^2\sqrt{\bar{g}'^2+\bar{g}^2}C^{\varphi\Box}(p_1^{\mu_3}-p_2^{\mu_3})$$

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



$$+\frac{i}{2\sqrt{\bar{g}'^2+\bar{g}^2}}(\bar{g}'-\bar{g})(\bar{g}'+\bar{g})(p_1^{\mu_3}-p_2^{\mu_3})+\frac{1}{4}iv^2\sqrt{\bar{g}'^2+\bar{g}^2}C^{\varphi D}(p_1^{\mu_3}-p_2^{\mu_3})$$

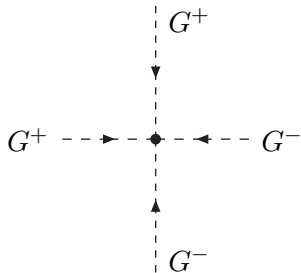
$$-\frac{i\bar{g}'\bar{g}v^2}{2(\bar{g}'^2+\bar{g}^2)^{3/2}}(\bar{g}'-\bar{g})(\bar{g}'+\bar{g})C^{\varphi WB}(p_1^{\mu_3}-p_2^{\mu_3})$$



$$-3i\lambda+9iv^2C^{\varphi}-i(3p_1\cdot p_1+2p_1\cdot p_2+2p_1\cdot p_3+2p_1\cdot p_4$$

$$+3p_2\cdot p_2+2p_2\cdot p_3+2p_2\cdot p_4+3p_3\cdot p_3+2p_3\cdot p_4+3p_4\cdot p_4)C^{\varphi\Box}$$

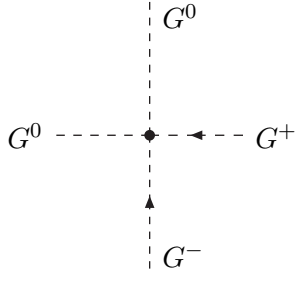
$$+iC^{\varphi D}(-p_1\cdot p_2-p_1\cdot p_3-p_1\cdot p_4-p_2\cdot p_3-p_2\cdot p_4-p_3\cdot p_4+3\lambda v^2)$$



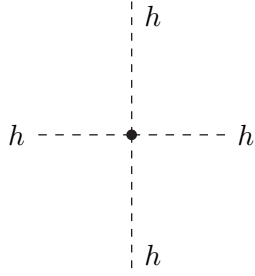
$$-2i\lambda+6iv^2C^{\varphi}$$

$$-2i(p_1\cdot p_1+p_1\cdot p_3+p_1\cdot p_4+p_2\cdot p_2+p_2\cdot p_3+p_2\cdot p_4+p_3\cdot p_3+p_4\cdot p_4)C^{\varphi\Box}$$

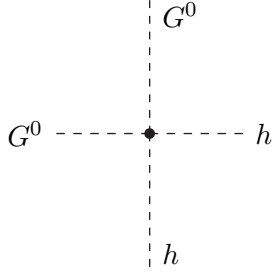
$$-i(p_1\cdot p_3+p_1\cdot p_4+p_2\cdot p_3+p_2\cdot p_4)C^{\varphi D}$$



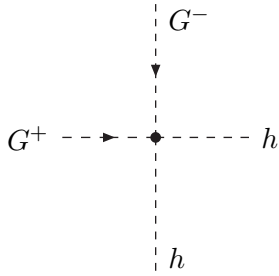
$$-i\lambda + 3iv^2 C^\varphi - i(p_1 \cdot p_1 + 2p_1 \cdot p_2 + p_2 \cdot p_2 + p_3 \cdot p_3 + 2p_3 \cdot p_4 + p_4 \cdot p_4) C^{\varphi\Box} \\ + \frac{i}{2} C^{\varphi D} (-p_1 \cdot p_3 - p_1 \cdot p_4 - p_2 \cdot p_3 - p_2 \cdot p_4 + \lambda v^2)$$



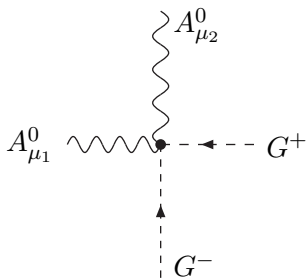
$$-3i\lambda + 45iv^2 C^\varphi - iC^{\varphi\Box} (3p_1 \cdot p_1 + 2p_1 \cdot p_2 + 2p_1 \cdot p_3 + 2p_1 \cdot p_4 \\ + 3p_2 \cdot p_2 + 2p_2 \cdot p_3 + 2p_2 \cdot p_4 + 3p_3 \cdot p_3 + 2p_3 \cdot p_4 + 3p_4 \cdot p_4 + 12\lambda v^2) \\ + iC^{\varphi D} (-p_1 \cdot p_2 - p_1 \cdot p_3 - p_1 \cdot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



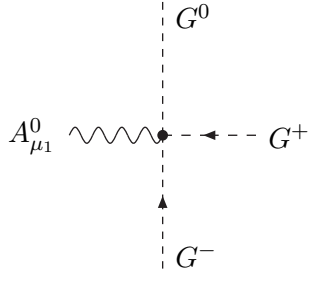
$$-i\lambda + 9iv^2 C^\varphi \\ - iC^{\varphi\Box} (p_1 \cdot p_1 + 2p_1 \cdot p_2 + p_2 \cdot p_2 + p_3 \cdot p_3 + 2p_3 \cdot p_4 + p_4 \cdot p_4 + 2\lambda v^2) \\ + iC^{\varphi D} (-p_1 \cdot p_2 - p_3 \cdot p_4 + \lambda v^2)$$



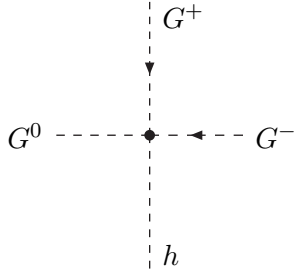
$$-i\lambda + 9iv^2 C^\varphi \\ - iC^{\varphi\Box} (p_1 \cdot p_1 + 2p_1 \cdot p_2 + p_2 \cdot p_2 + p_3 \cdot p_3 + 2p_3 \cdot p_4 + p_4 \cdot p_4 + 2\lambda v^2) \\ + \frac{i}{2} C^{\varphi D} (-p_1 \cdot p_3 - p_1 \cdot p_4 - p_2 \cdot p_3 - p_2 \cdot p_4 + \lambda v^2)$$



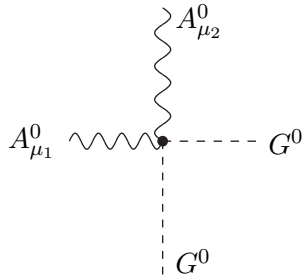
$$+ \frac{2i\bar{g}'^2 \bar{g}^2}{\bar{g}'^2 + \bar{g}^2} \eta_{\mu_1 \mu_2} + \frac{4i\bar{g}'^2}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1 \mu_2}) \\ - \frac{4i\bar{g}' \bar{g}}{(\bar{g}'^2 + \bar{g}^2)^2} C^{\varphi WB} (\eta_{\mu_1 \mu_2} (\bar{g}'^2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



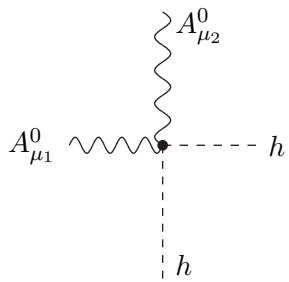
$$+ \frac{\bar{g}' \bar{g} v}{\sqrt{\bar{g}'^2 + \bar{g}^2}} C^{\varphi D} p_2^{\mu_1}$$



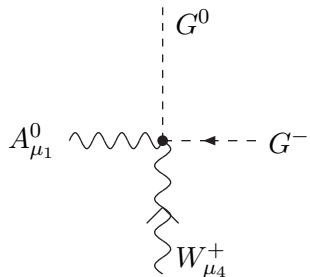
$$- \frac{1}{2} (p_1 \cdot p_2 - p_1 \cdot p_3 - p_2 \cdot p_4 + p_3 \cdot p_4) C^{\varphi D}$$



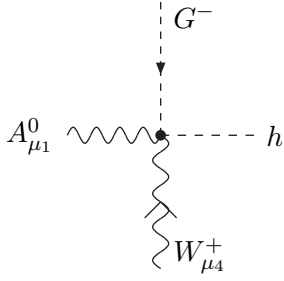
$$+ \frac{4i\bar{g}'^2}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1 \mu_2}) - \frac{4i\bar{g}' \bar{g}}{\bar{g}'^2 + \bar{g}^2} C^{\varphi WB} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1 \mu_2})$$



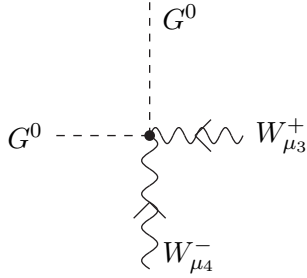
$$+ \frac{4i\bar{g}'^2}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1 \mu_2}) - \frac{4i\bar{g}' \bar{g}}{\bar{g}'^2 + \bar{g}^2} C^{\varphi WB} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1 \mu_2})$$



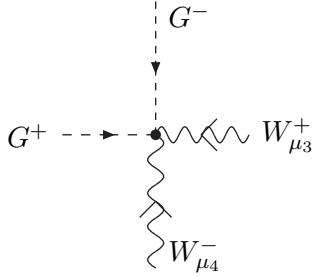
$$\begin{aligned} & - \frac{\bar{g}' \bar{g}^2}{2\sqrt{\bar{g}'^2 + \bar{g}^2}} \eta_{\mu_1 \mu_4} + \frac{\bar{g}' \bar{g}^2 v^2}{8\sqrt{\bar{g}'^2 + \bar{g}^2}} \eta_{\mu_1 \mu_4} C^{\varphi D} \\ & + \frac{\bar{g}}{2(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi WB} (\eta_{\mu_1 \mu_4} (\bar{g}'^2 (4p_1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



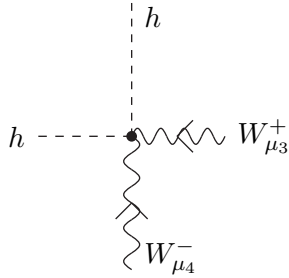
$$\begin{aligned}
& + \frac{i\bar{g}'\bar{g}^2}{2\sqrt{\bar{g}'^2 + \bar{g}^2}}\eta_{\mu_1\mu_4} + \frac{i\bar{g}'\bar{g}^2v^2}{2\sqrt{\bar{g}'^2 + \bar{g}^2}}\eta_{\mu_1\mu_4}C^{\varphi\Box} - \frac{i\bar{g}'\bar{g}^2v^2}{8\sqrt{\bar{g}'^2 + \bar{g}^2}}\eta_{\mu_1\mu_4}C^{\varphi D} \\
& - \frac{i\bar{g}}{2(\bar{g}'^2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



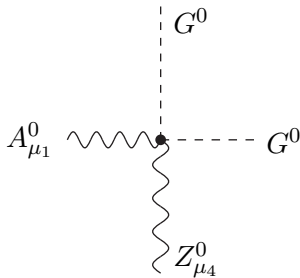
$$+ \frac{i\bar{g}^2}{2}\eta_{\mu_3\mu_4} - \frac{1}{4}i\bar{g}^2v^2\eta_{\mu_3\mu_4}C^{\varphi D} + 4iC^{\varphi W}(p_3^{\mu_4}p_4^{\mu_3} - p_3 \cdot p_4\eta_{\mu_3\mu_4})$$



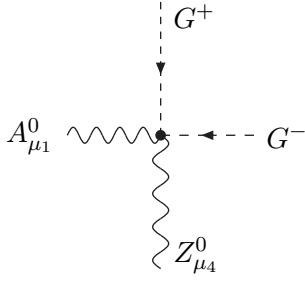
$$+ \frac{i\bar{g}^2}{2}\eta_{\mu_3\mu_4} + \frac{1}{2}i\bar{g}^2v^2\eta_{\mu_3\mu_4}C^{\varphi D} + 4iC^{\varphi W}(p_3^{\mu_4}p_4^{\mu_3} - p_3 \cdot p_4\eta_{\mu_3\mu_4})$$



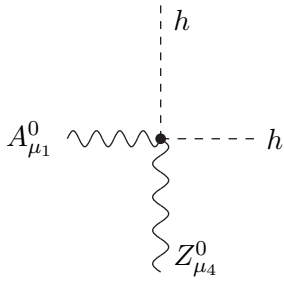
$$+ \frac{i\bar{g}^2}{2}\eta_{\mu_3\mu_4} + i\bar{g}^2v^2\eta_{\mu_3\mu_4}C^{\varphi\Box} - \frac{1}{4}i\bar{g}^2v^2\eta_{\mu_3\mu_4}C^{\varphi D} + 4iC^{\varphi W}(p_3^{\mu_4}p_4^{\mu_3} - p_3 \cdot p_4\eta_{\mu_3\mu_4})$$



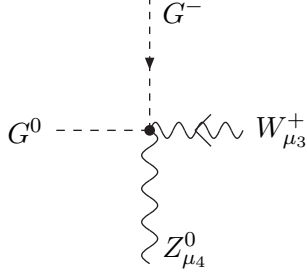
$$\begin{aligned}
& + \frac{4i\bar{g}'\bar{g}}{\bar{g}'^2 + \bar{g}^2}C^{\varphi W}(p_1^{\mu_4}p_4^{\mu_1} - p_1 \cdot p_4\eta_{\mu_1\mu_4}) \\
& + \frac{2i}{\bar{g}'^2 + \bar{g}^2}(\bar{g}' - \bar{g})(\bar{g}' + \bar{g})C^{\varphi WB}(p_1^{\mu_4}p_4^{\mu_1} - p_1 \cdot p_4\eta_{\mu_1\mu_4})
\end{aligned}$$



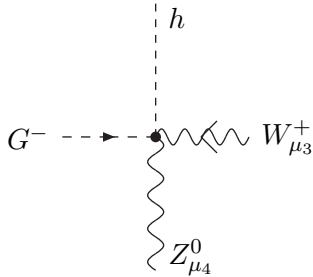
$$\begin{aligned}
& -\frac{i\bar{g}'\bar{g}}{\bar{g}'^2+\bar{g}^2}(\bar{g}'-\bar{g})(\bar{g}'+\bar{g})\eta_{\mu_1\mu_4}-\frac{1}{2}i\bar{g}'\bar{g}v^2\eta_{\mu_1\mu_4}C^{\varphi D} \\
& +\frac{4i\bar{g}'\bar{g}}{\bar{g}'^2+\bar{g}^2}C^{\varphi W}(p_1^{\mu_4}p_4^{\mu_1}-p_1\cdot p_4\eta_{\mu_1\mu_4})+\frac{2i}{(\bar{g}'^2+\bar{g}^2)^2}(\bar{g}'-\bar{g})(\bar{g}'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



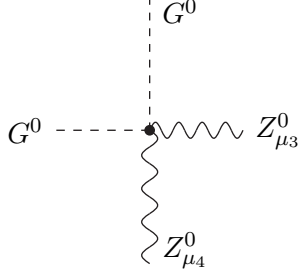
$$\begin{aligned}
& +\frac{4i\bar{g}'\bar{g}}{\bar{g}'^2+\bar{g}^2}C^{\varphi W}(p_1^{\mu_4}p_4^{\mu_1}-p_1\cdot p_4\eta_{\mu_1\mu_4}) \\
& +\frac{2i}{\bar{g}'^2+\bar{g}^2}(\bar{g}'-\bar{g})(\bar{g}'+\bar{g})C^{\varphi WB}(p_1^{\mu_4}p_4^{\mu_1}-p_1\cdot p_4\eta_{\mu_1\mu_4})
\end{aligned}$$



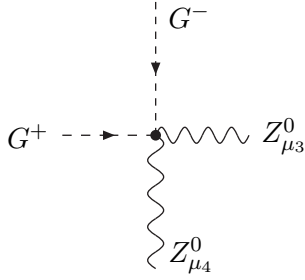
$$\begin{aligned}
& +\frac{\bar{g}'^2\bar{g}}{2\sqrt{\bar{g}'^2+\bar{g}^2}}\eta_{\mu_3\mu_4}+\frac{\bar{g}v^2}{8\sqrt{\bar{g}'^2+\bar{g}^2}}(\bar{g}'^2+2\bar{g}^2)\eta_{\mu_3\mu_4}C^{\varphi D} \\
& +\frac{\bar{g}'}{2(\bar{g}'^2+\bar{g}^2)^{3/2}}C^{\varphi WB}(\eta_{\mu_3\mu_4}(-4\bar{g}'^2p_3\cdot p_4-4\bar{g}^2p_3\cdot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



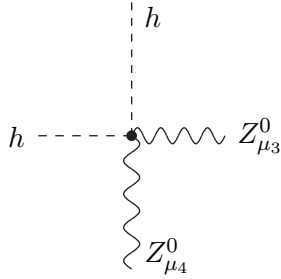
$$\begin{aligned}
& -\frac{i\bar{g}'^2\bar{g}}{2\sqrt{\bar{g}'^2+\bar{g}^2}}\eta_{\mu_3\mu_4}-\frac{i\bar{g}'^2\bar{g}v^2}{2\sqrt{\bar{g}'^2+\bar{g}^2}}\eta_{\mu_3\mu_4}C^{\varphi\Box} \\
& -\frac{i\bar{g}v^2}{8\sqrt{\bar{g}'^2+\bar{g}^2}}(5\bar{g}'^2+6\bar{g}^2)\eta_{\mu_3\mu_4}C^{\varphi D} \\
& -\frac{i\bar{g}'}{2(\bar{g}'^2+\bar{g}^2)^{3/2}}C^{\varphi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



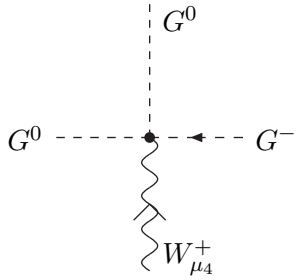
$$\begin{aligned}
& + \frac{i}{2} (\bar{g}'^2 + \bar{g}^2) \eta_{\mu_3\mu_4} + \frac{iv^2}{4} (\bar{g}'^2 + \bar{g}^2) \eta_{\mu_3\mu_4} C^{\varphi D} \\
& + \frac{4i\bar{g}^2}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_3^{\mu_4} p_4^{\mu_3} - p_3 \cdot p_4 \eta_{\mu_3\mu_4}) \\
& + \frac{i\bar{g}'\bar{g}}{\bar{g}'^2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



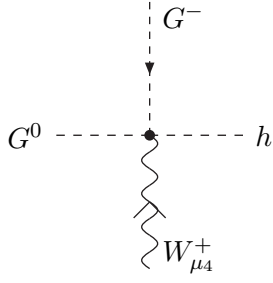
$$\begin{aligned}
& + \frac{i}{2(\bar{g}'^2 + \bar{g}^2)} (\bar{g}' - \bar{g})^2 (\bar{g}' + \bar{g})^2 \eta_{\mu_3\mu_4} + \frac{iv^2}{2} (\bar{g}' - \bar{g})(\bar{g}' + \bar{g}) \eta_{\mu_3\mu_4} C^{\varphi D} \\
& + \frac{4i\bar{g}^2}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_3^{\mu_4} p_4^{\mu_3}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



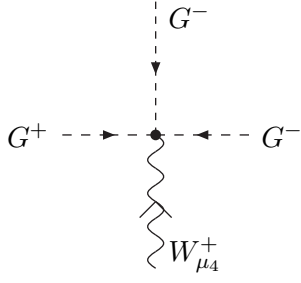
$$\begin{aligned}
& + \frac{i}{2} (\bar{g}'^2 + \bar{g}^2) \eta_{\mu_3\mu_4} + iv^2 (\bar{g}'^2 + \bar{g}^2) \eta_{\mu_3\mu_4} C^{\varphi \square} \\
& + \frac{5iv^2}{4} (\bar{g}'^2 + \bar{g}^2) \eta_{\mu_3\mu_4} C^{\varphi D} + \frac{4i\bar{g}^2}{\bar{g}'^2 + \bar{g}^2} C^{\varphi W} (p_3^{\mu_4} p_4^{\mu_3}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



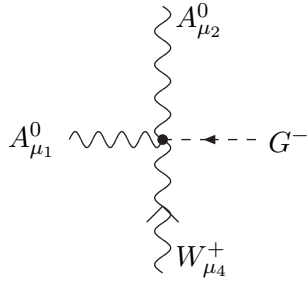
$$+ \frac{i\bar{g}v}{2} C^{\varphi D} (p_1^{\mu_4} + p_2^{\mu_4})$$



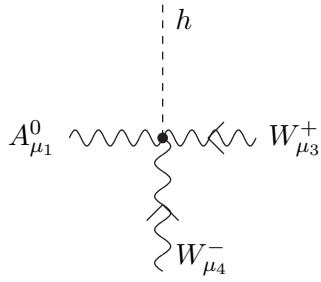
$$+\frac{\bar{g}v}{2}C^{\varphi D}(2p_1^{\mu_4}-p_3^{\mu_4})$$



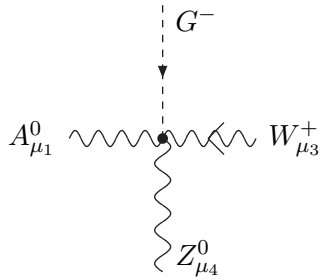
$$-\frac{1}{2}i\bar{g}vC^{\varphi D}(2p_1^{\mu_4}-p_2^{\mu_4}-p_3^{\mu_4})$$



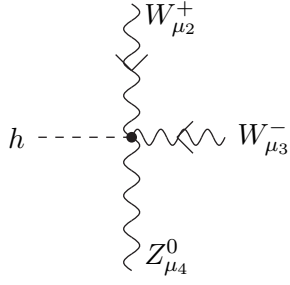
$$-\frac{2i\bar{g}'\bar{g}^2v}{\bar{g}'^2+\bar{g}^2}C^{\varphi WB}(\eta_{\mu_1\mu_2}p_1^{\mu_4}+\eta_{\mu_1\mu_2}p_2^{\mu_4}-\eta_{\mu_1\mu_4}p_1^{\mu_2}-\eta_{\mu_2\mu_4}p_2^{\mu_1})$$



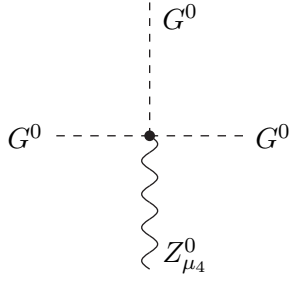
$$-\frac{4i\bar{g}'\bar{g}v}{\sqrt{\bar{g}'^2+\bar{g}^2}}C^{\varphi W}(\eta_{\mu_1\mu_3}p_1^{\mu_4}-\eta_{\mu_1\mu_3}p_3^{\mu_4}-\eta_{\mu_1\mu_4}p_1^{\mu_3}+\eta_{\mu_1\mu_4}p_4^{\mu_3} \\ +\eta_{\mu_3\mu_4}p_3^{\mu_1}-\eta_{\mu_3\mu_4}p_4^{\mu_1})+\frac{2i\bar{g}^2v}{\sqrt{\bar{g}'^2+\bar{g}^2}}C^{\varphi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



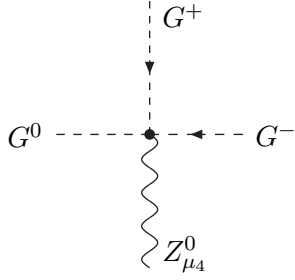
$$+\frac{2i\bar{g}v}{\bar{g}'^2+\bar{g}^2}C^{\varphi WB}(\bar{g}'^2(\eta_{\mu_1\mu_4}p_4^{\mu_3}-\eta_{\mu_3\mu_4}p_4^{\mu_1})+\bar{g}^2\eta_{\mu_1\mu_3}p_1^{\mu_4}-\bar{g}^2\eta_{\mu_1\mu_4}p_1^{\mu_3})$$



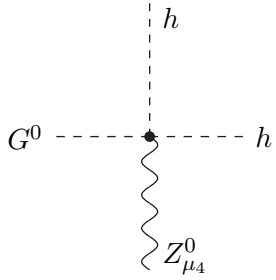
$$-\frac{4i\bar{g}^2v}{\sqrt{\bar{g}'^2+\bar{g}^2}}C^{\varphi W}(\eta_{\mu_2\mu_3}p_2^{\mu_4}-\eta_{\mu_2\mu_3}p_3^{\mu_4}-\eta_{\mu_2\mu_4}p_2^{\mu_3}+\eta_{\mu_2\mu_4}p_4^{\mu_3} \\ +\eta_{\mu_3\mu_4}p_3^{\mu_2}-\eta_{\mu_3\mu_4}p_4^{\mu_2})-\frac{2i\bar{g}'\bar{g}v}{\sqrt{\bar{g}'^2+\bar{g}^2}}C^{\varphi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



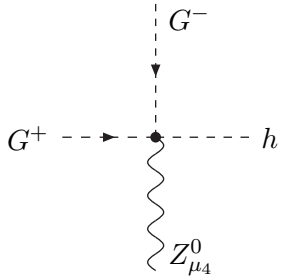
$$-\frac{1}{2}v\sqrt{\bar{g}'^2+\bar{g}^2}C^{\varphi D}(p_1^{\mu_4}+p_2^{\mu_4}+p_3^{\mu_4})$$



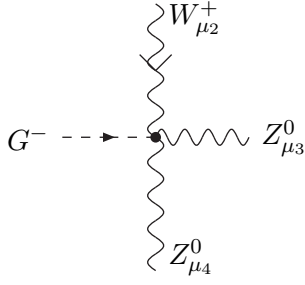
$$-\frac{v}{2\sqrt{\bar{g}'^2+\bar{g}^2}}(\bar{g}'-\bar{g})(\bar{g}'+\bar{g})C^{\varphi D}p_1^{\mu_4}$$



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

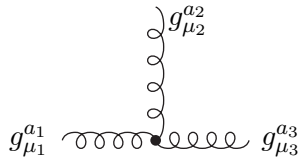


$$+\frac{1}{2}iv\sqrt{\bar{g}'^2+\bar{g}^2}C^{\varphi D}(p_1^{\mu_4}-p_2^{\mu_4})$$

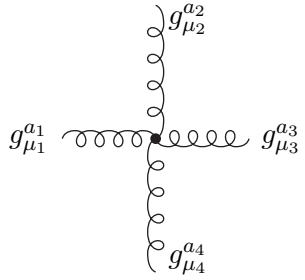


$$-\frac{2i\bar{g}'\bar{g}^2v}{\bar{g}'^2+\bar{g}^2}C^{\varphi WB}(\eta_{\mu_2\mu_3}p_3^{\mu_4}+\eta_{\mu_2\mu_4}p_4^{\mu_3}-\eta_{\mu_3\mu_4}(p_3^{\mu_2}+p_4^{\mu_2}))$$

A.8 Gluon self interaction vertices



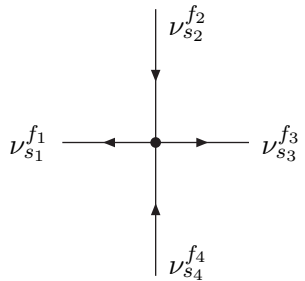
$$-\bar{g}_s f_{a_1 a_2 a_3}(\eta_{\mu_1 \mu_2} p_1^{\mu_3} - \eta_{\mu_1 \mu_2} p_2^{\mu_3} - \eta_{\mu_1 \mu_3} p_1^{\mu_2} + \eta_{\mu_1 \mu_3} p_3^{\mu_2} + \eta_{\mu_2 \mu_3} p_2^{\mu_1} - \eta_{\mu_2 \mu_3} p_3^{\mu_1})$$



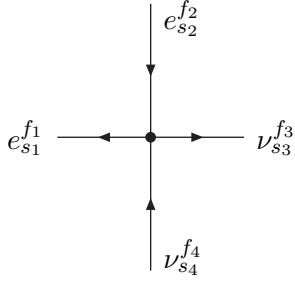
$$\begin{aligned} &+i\bar{g}_s^2((\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}-\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4})f_{a_1a_2b_1}f_{a_3a_4b_1} \\ &+(\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}-\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})f_{a_1a_3b_1}f_{a_2a_4b_1} \\ &+(\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}-\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})f_{a_1a_4b_1}f_{a_2a_3b_1})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

A.9 Higgs–gluon vertices

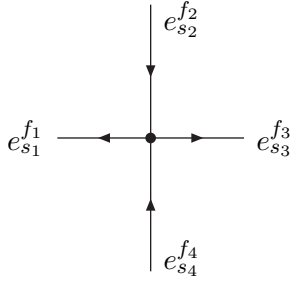
A.10 Four lepton vertices



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



$$+2iU_{g_2 f_4} U_{g_1 f_3}^* (\gamma^\mu P_L)_{s_1 s_2} (\gamma^\mu P_L)_{s_3 s_4} C_{f_1 f_2 g_1 g_2}^{ll}$$



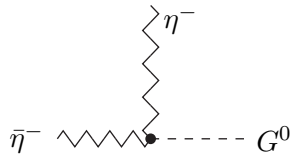
$$+2i \left(C_{f_1 f_4 f_3 f_2}^{ll} (\gamma^\mu P_L)_{s_1 s_4} (\gamma^\mu P_L)_{s_3 s_2} + C_{f_1 f_2 f_3 f_4}^{ll} (\gamma^\mu P_L)_{s_1 s_2} (\gamma^\mu P_L)_{s_3 s_4} \right)$$

A.11 Two quark–two lepton vertices

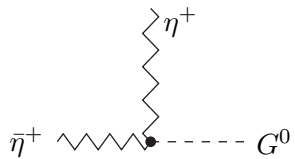
A.12 Four quark vertices

A.13 Baryon and lepton number violating four fermion vertices

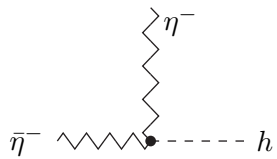
A.14 Ghost vertices



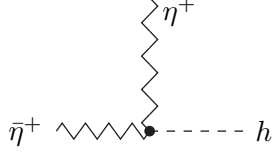
$$+\frac{1}{4}\bar{g}^2 v \xi_W - \frac{1}{16}\bar{g}^2 v^3 \xi_W C^{\varphi D}$$



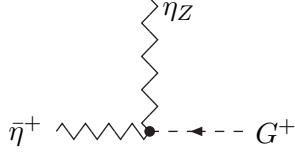
$$-\frac{1}{4}\bar{g}^2 v \xi_W + \frac{1}{16}\bar{g}^2 v^3 \xi_W C^{\varphi D}$$



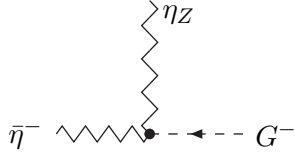
$$+\frac{1}{4}i\bar{g}^2 v \xi_W + \frac{1}{4}\bar{g}^2 v^3 \xi_W C^{\varphi \square} - \frac{1}{16}i\bar{g}^2 v^3 \xi_W C^{\varphi D}$$



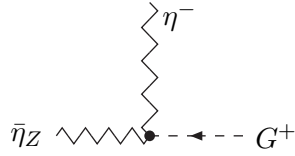
$$+\frac{1}{4}i\bar{g}^2v\xi_W+\frac{1}{4}i\bar{g}^2v^3\xi_W C^{\varphi\Box}-\frac{1}{16}i\bar{g}^2v^3\xi_W C^{\varphi D}$$



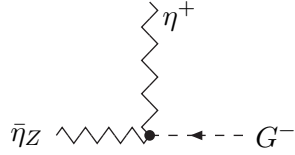
$$+\frac{i\bar{g}v\xi_W}{4\sqrt{\bar{g}'^2+\bar{g}^2}}(\bar{g}-\bar{g}')(\bar{g}'+\bar{g})+\frac{i\bar{g}'\bar{g}^2v^3\xi_W}{4(\bar{g}'^2+\bar{g}^2)^{3/2}}(\bar{g}'-\bar{g})(\bar{g}'+\bar{g})C^{\varphi WB}$$



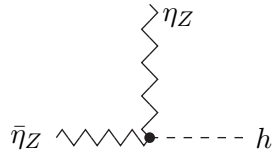
$$+\frac{i\bar{g}v\xi_W}{4\sqrt{\bar{g}'^2+\bar{g}^2}}(\bar{g}-\bar{g}')(\bar{g}'+\bar{g})+\frac{i\bar{g}'\bar{g}^2v^3\xi_W}{4(\bar{g}'^2+\bar{g}^2)^{3/2}}(\bar{g}'-\bar{g})(\bar{g}'+\bar{g})C^{\varphi WB}$$



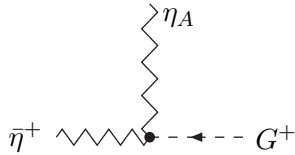
$$-\frac{1}{4}i\bar{g}v\sqrt{\bar{g}'^2+\bar{g}^2}\xi_Z-\frac{1}{8}i\bar{g}v^3\sqrt{\bar{g}'^2+\bar{g}^2}\xi_Z C^{\varphi D}-\frac{i\bar{g}'\bar{g}^2v^3\xi_Z}{4\sqrt{\bar{g}'^2+\bar{g}^2}}C^{\varphi WB}$$



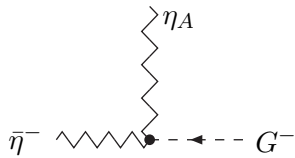
$$-\frac{1}{4}i\bar{g}v\sqrt{\bar{g}'^2+\bar{g}^2}\xi_Z-\frac{1}{8}i\bar{g}v^3\sqrt{\bar{g}'^2+\bar{g}^2}\xi_Z C^{\varphi D}-\frac{i\bar{g}'\bar{g}^2v^3\xi_Z}{4\sqrt{\bar{g}'^2+\bar{g}^2}}C^{\varphi WB}$$



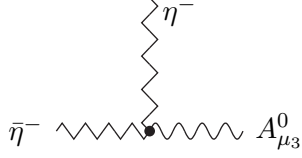
$$+\frac{1}{4}iv\xi_Z(\bar{g}'^2+\bar{g}^2)+\frac{1}{4}iv^3\xi_Z(\bar{g}'^2+\bar{g}^2)C^{\varphi\Box}+\frac{1}{16}iv^3\xi_Z(\bar{g}'^2+\bar{g}^2)C^{\varphi D}+\frac{1}{2}i\bar{g}'\bar{g}v^3\xi_Z C^{\varphi WB}$$



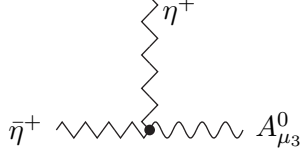
$$+\frac{i\bar{g}'\bar{g}^2v\xi_W}{2\sqrt{\bar{g}'^2+\bar{g}^2}}-\frac{i\bar{g}'^2\bar{g}^3v^3\xi_W}{2(\bar{g}'^2+\bar{g}^2)^{3/2}}C^{\varphi WB}$$



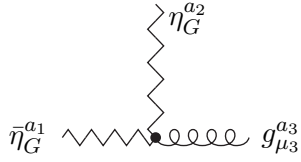
$$+\frac{i\bar{g}'\bar{g}^2v\xi_W}{2\sqrt{\bar{g}'^2+\bar{g}^2}}-\frac{i\bar{g}'^2\bar{g}^3v^3\xi_W}{2(\bar{g}'^2+\bar{g}^2)^{3/2}}C^{\varphi WB}$$



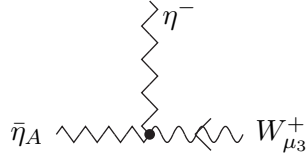
$$+ \frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_1^{\mu_3} - \frac{i\bar{g}'^2 \bar{g}^2 v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi W B} p_1^{\mu_3}$$



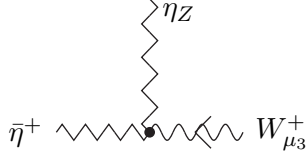
$$- \frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_1^{\mu_3} + \frac{i\bar{g}'^2 \bar{g}^2 v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi W B} p_1^{\mu_3}$$



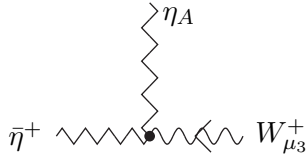
$$- \bar{g}_s f_{a_3 a_1 a_2} p_1^{\mu_3}$$



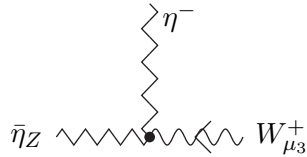
$$- \frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_1^{\mu_3} - \frac{i\bar{g}^4 v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi W B} p_1^{\mu_3}$$



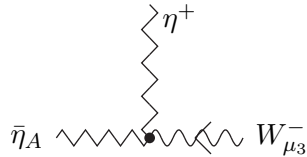
$$+ \frac{i\bar{g}^2}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_1^{\mu_3} + \frac{i\bar{g}'^3 \bar{g} v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi W B} p_1^{\mu_3}$$



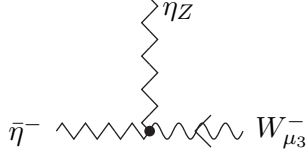
$$+ \frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_1^{\mu_3} - \frac{i\bar{g}'^2 \bar{g}^2 v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi W B} p_1^{\mu_3}$$



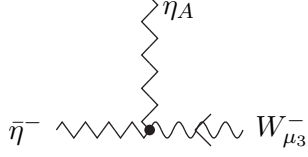
$$- \frac{i\bar{g}^2}{\sqrt{\bar{g}'^2 + \bar{g}^2}} p_1^{\mu_3} + \frac{i\bar{g}'\bar{g}^3 v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}} C^{\varphi W B} p_1^{\mu_3}$$



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



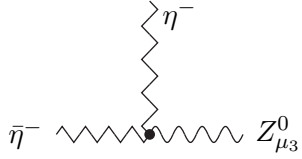
$$-\frac{i\bar{g}^2}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_1^{\mu_3} - \frac{i\bar{g}'^3\bar{g}v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}}C^{\varphi WB}p_1^{\mu_3}$$



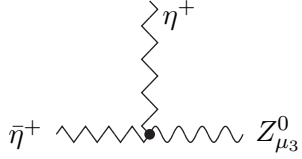
$$-\frac{i\bar{g}'\bar{g}}{\sqrt{\bar{g}'^2 + \bar{g}^2}}p_1^{\mu_3} + \frac{i\bar{g}'^2\bar{g}^2v^2}{(\bar{g}'^2 + \bar{g}^2)^{3/2}}C^{\varphi WB}p_1^{\mu_3}$$



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



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



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