WEAK NC interaction

$$\mathcal{L}_I^{NC} = -\frac{g}{2cos\theta_W}\left(j_\alpha^{NC} + J_\alpha^{NC}\right) Z^\alpha$$

$$j_\alpha^{NC} = \frac{1}{2}\left[\sum_\ell \overline{\nu}_\ell \gamma_\alpha \left(1-\gamma_5\right)\nu + \sum_\ell \overline{\ell}\gamma_\alpha\left(g_V^l - g_A^l\gamma_5\right)\ell\right]$$

$$J_\alpha^{NC} = \frac{1}{2}\sum_q \overline{q}\gamma_\alpha\left(g_V^q - g_A^q\gamma_5\right)q$$

with

$$\begin{aligned} g_V^l &= -1 + 4sin^2\theta_W\,,\; g_A^l = -1 \\ g_V^q &= +1 - 4e_q sin^2\theta_W\,,\; g_A^l = +1 \;\; u,c,t \\ g_V^q &= -1 - 4e_q sin^2\theta_W\,,\; g_A^l = -1 \;\; d,s,b \end{aligned}$$

Elementary transition amplitude

$$\mathcal{M} = (\sqrt{2})G_F\, j_\alpha^{NC}\, J_{NC}^\alpha$$

$\frac{g^2}{8M_W^2} = \frac{G_F}{\sqrt{2}}$

$cos^2\theta_W = \frac{M_W^2}{M_Z^2}$

Nucleon current

$$\langle p'|V_\alpha^{NC}|p\rangle = \overline{u}(p')\left[\gamma_\alpha F_1^{NC} + \frac{i}{2m_N}\sigma_{\alpha\beta}q^\beta F_2^{NC}\right]u(p)$$

$$\langle p'|A_\alpha^{CC}|p\rangle = \overline{u}(p')\left[\gamma_\alpha\gamma_5 G_A^{NC}\right]u(p)$$