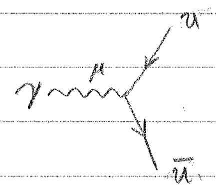
Feynman rules for $A_\mu J^\mu$ interactions

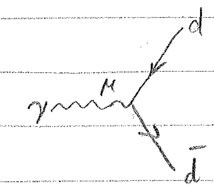
Neutral currents

Electromagnetic (QED)

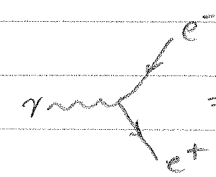
QED



$= -ieQ_u\gamma^\mu$

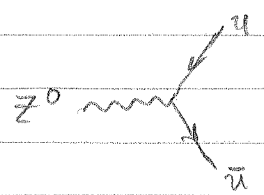


$= -ieQ_d\gamma^\mu$

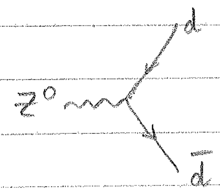


$= -ieQ_e\gamma^\mu$

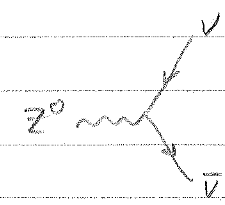
Weak (Z^0)



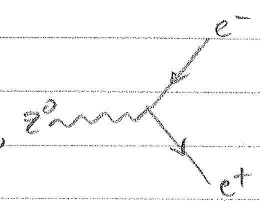
,



,



,



$$= -\frac{i}{2} g_Z \left(g_V^f \gamma^\mu - g_A^f \gamma^\mu \gamma_5\right) = -i g_Z \gamma^\mu \left(g_L^f \hat{P}_L + g_R^f \hat{P}_R\right)$$

where: $g_V^f = T_f^3 - 2Q_f \sin^2\theta_W$ $\qquad$ $g_L^f = T_f^3 - Q_f \sin^2\theta_W$

$g_A^f = T_f^3$ $\qquad$ $g_R^f = - Q_f \sin^2\theta_W$

Table of neutral current couplings

Note: $g_L^2 + g_R^2 = \frac{1}{2}(g_V^2 + g_A^2)$

	Q_f	g_A	g_V
$u,\ c,\ t$	$+2/3$	$1/2$	$+\frac{1}{2} - \frac{4}{3}\sin^2\theta_W \simeq 0.1917$
$d,\ s,\ b$	$-1/3$	$-1/2$	$-\frac{1}{2} + \frac{2}{3}\sin^2\theta_W \simeq -0.3459$
$\nu_e,\ \nu_\mu,\ \nu_\tau$	0	$1/2$	$\frac{1}{2} + 0 \simeq 0.5$
$e^-\ \mu^-\ \tau^-$	-1	$-1/2$	$-\frac{1}{2} + 2\sin^2\theta_W \simeq -0.0376$

Comments on electroweak neutral current interactions

For low energy phenomenology, convenient to divide electromagnetic and weak neutral currents into vector and axial currents.

	Electromagnetic coupling strength $= e$	Weak neutral coupling strength $= g_Z = g/\cos\theta_W$
Vector	Q_{EM}	$Q_{weak} = 2T^3 - 4Q_{EM}\sin^2\theta_W$
Axial vector	0	T^3

Rather a surprise that the axial parts are so simple given that the standard model is formulated in terms of left & right chiral couplings. (Note especially how parity is restored in the IR!)

— this simplicity originates from the hypercharge assignments, which in turn are fixed by ABJ anomaly cancellation conditions.