Zusammenfassung 12.

11.3. Lokale $SU(2)_L \times U(1)_Y$ Transformationen
11.4.

Schw. Isospin: $$\begin{pmatrix}\nu_e\\ e\end{pmatrix}'_L = \exp\left(i\frac{g}{2}\vec{\tau}\cdot\vec{\beta}(x)\right)\begin{pmatrix}\nu_e\\ e\end{pmatrix}_L$$

Schw. Hyperladung: $$\begin{pmatrix}\nu_e\\ e\end{pmatrix}'_L = \exp\left(i\frac{g'}{2}Y_L\chi(x)\right)\begin{pmatrix}\nu_e\\ e\end{pmatrix}_L$$

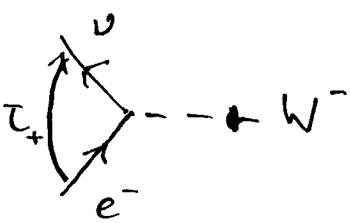
und $$e_R = \exp\left(i\frac{g'}{2}Y_R\chi(x)\right) e_R$$

Physikalische Felder:

$$\boxed{\begin{aligned} W^{\pm\mu} &= \frac{1}{\sqrt{2}}\left(W_1^{\mu} \pm i W_2^{\mu}\right)\\ A^{\mu} &= \cos\Theta_W B^{\mu} + \sin\Theta_W W_3^{\mu}\\ Z^{\mu} &= -\sin\Theta_W B^{\mu} + \cos\Theta_W W_3^{\mu}\end{aligned}}$$

Kopplungen:

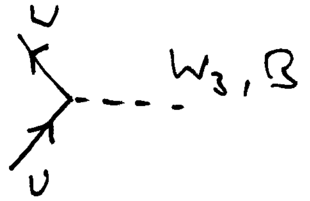
1) charged current



$$\mathcal{M} \sim i\frac{g}{\sqrt{2}}\bar{\nu}_L\gamma_\mu\tau_+ e_L W^{(-)\mu}$$

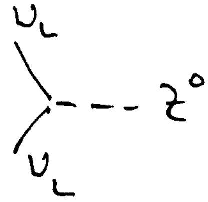
$$= i\frac{g}{\sqrt{2}}\nu\gamma_\mu\frac{(1-\gamma_5)}{2}e W^{(-)\mu}$$

2) neutral current $\nu_e \to \nu_e$



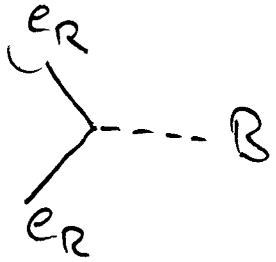
$$\mathcal{M} \sim -i\frac{g}{2}\bar{\nu}\gamma_\mu\tau_3\nu_L W_3^\mu + i\frac{g'}{2}\bar{\nu}_L\gamma_\mu\nu_L B^\mu$$

$\Rightarrow$ nur



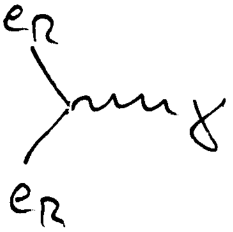
trägt bei: $-i\frac{g}{2\cos\theta_W}\bar{u}(\nu)\gamma_\mu\frac{1-\gamma^5}{2}u(\nu)$

3) neutral current $e_R \to e_R$



$$\mathcal{M} \sim ig'\bar{u}_R\gamma_\mu u_R B^\mu$$

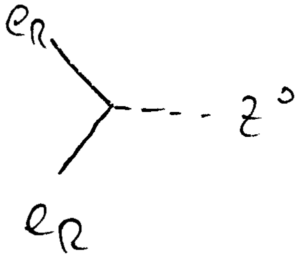
$\Rightarrow$



$\sim ie\bar{u}_R\gamma_\mu u_R A^\mu$

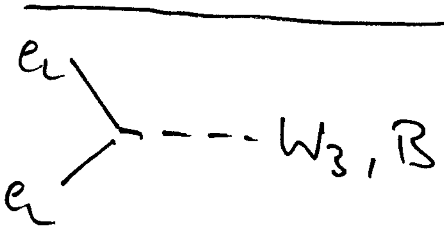
$$\boxed{\begin{aligned} e &= g'\cos\theta_W \\ &= g\sin\theta_W \end{aligned}}$$

und



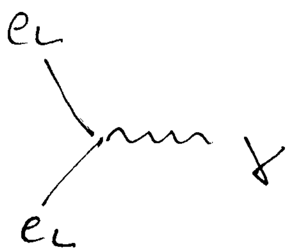
$\sim ig'\sin\theta_W\bar{u}_R\gamma_\mu u_R Z^\mu$

4) neutral current $e_L \to e_L$

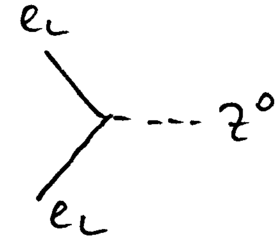


$$\mathcal{M} \sim -i\frac{g}{2}\bar{u}_L\gamma_\mu\tau_3 u_L W_3^\mu - ig'\bar{u}_L\gamma_\mu u_L B^\mu$$

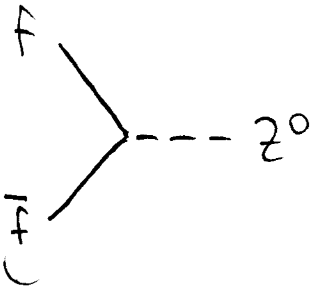
$\Rightarrow$



$\sim ie\bar{u}_L\gamma_\mu u_L A^\mu$

and  $\sim \frac{g(2\sin^2\theta_W-1)}{\cos\theta_W}\,\bar{u}_L\gamma_\mu u_L Z^\mu$

5) Z^0-Kopplung an beliebiges Fermion:



$$\boxed{-i\,\frac{g}{2\cos\theta_W}\,\bar{u}_f\,\gamma_\mu\,(v_f - a_f\gamma_5)\,u_f}$$

v_f = Vektorkopplung $= I_3 - 2Q_f\sin^2\theta_W$

a_f = Axialvektorkopplung I_3

11.5. Eichboson-Massen

Higgsfeld $\phi = \begin{pmatrix}\phi^+\\ \phi^0\end{pmatrix}$ $\boxed{T=\frac{1}{2},\ Y=1}$

Lagrangian:

$$\mathcal{L}_{Higgs} = (\partial^\mu\phi)^+(\partial_\mu\phi) + \mu^2\phi^+\phi - \lambda^2(\phi^+\phi)^2$$

und $\mathcal{L}_{gauge} = -\frac{1}{4}F^{i}_{\mu\nu}F^{\mu\nu i} - \frac{1}{4}f_{\mu\nu}f^{\mu\nu}$