Experimentelle Elementarteilchenphysik

Ulrich Husemann
Humboldt-Universität zu Berlin
Sommersemester 2009

SU(3)

- Strukturkonstanten: alle $f^{abc} = 0$ außer:

$$f^{123} = 1, \quad f^{147} = f^{246} = f^{257} = f^{345} = f^{516} = f^{637} = \frac{1}{2}, \quad f^{458} = f^{678} = \frac{\sqrt{3}}{2}$$

- Gell-Mann-Matrizen: $T^a = 1/2\ \lambda^a$

$$\lambda^1 = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \quad \lambda^2 = \begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \quad \lambda^3 = \begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 0 \end{pmatrix},$$

$$\lambda^4 = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \end{pmatrix}, \quad \lambda^5 = \begin{pmatrix} 0 & 0 & -i \\ 0 & 0 & 0 \\ i & 0 & 0 \end{pmatrix}, \quad \lambda^6 = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix},$$

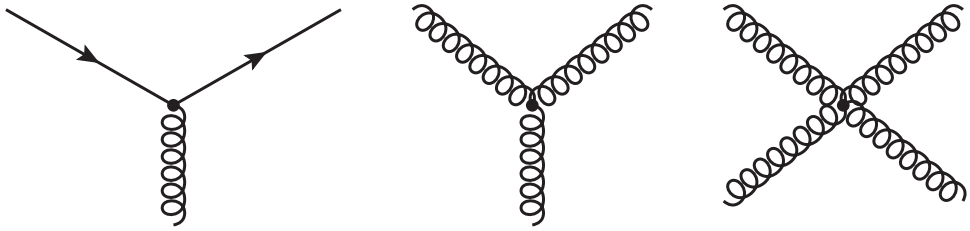
$$\lambda^7 = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & -i \\ 0 & i & 0 \end{pmatrix}, \quad \lambda^8 = \frac{1}{\sqrt{3}} \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 2 \end{pmatrix}$$

QCD-Wechselwirkungen

- Lagrangedichte:

$$\mathcal{L}_{\mathrm{QCD}} = \bar{\psi}(i\partial\!\!\!/ - m)\psi - q\bar{\psi}\gamma^{\mu}T^{a}\psi A^{a}_{\mu} - \frac{1}{4}F^{a}_{\mu\nu}F^{a,\mu\nu}$$

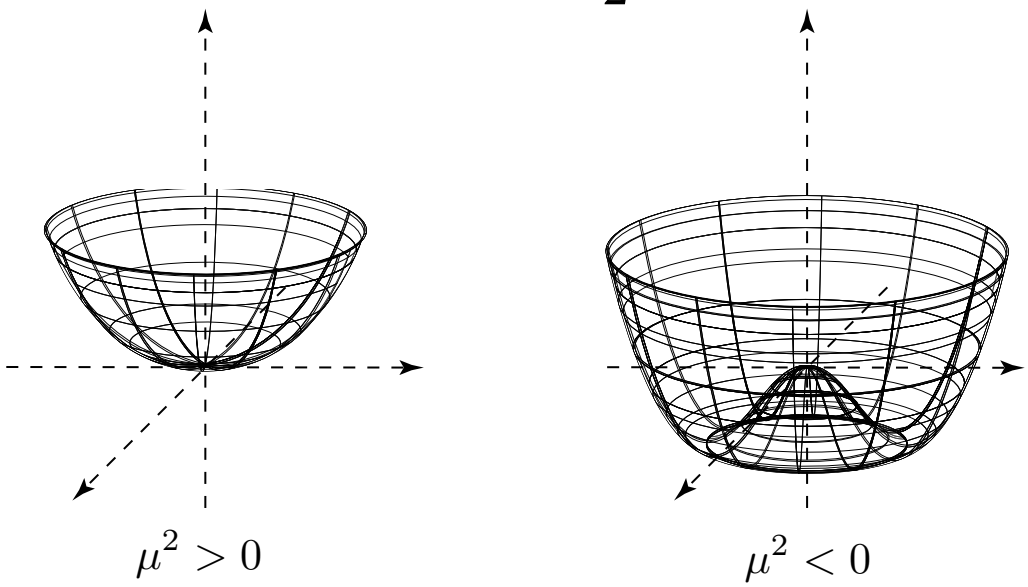
→ Wechselwirkungen:



$\sim \bar{\psi}\gamma^{\mu}T^{a}\psi A^{a}_{\mu}$ $\sim A^3$ $\sim A^4$

ϕ^4-Potenzial

$$V = \mu^2\phi\phi^* + \frac{\lambda}{2}(\phi\phi^*)^2$$



$\mu^2 > 0$ $\mu^2 < 0$

Geladene Ströme

$$\begin{aligned}\mathcal{L}_{\mathrm{CC}} &= -\frac{g}{\sqrt{2}}\left[J_\mu^{+\mathrm{CC}}\, W^{\mu,-} + J_\mu^{-\mathrm{CC}} W^{\mu,+}\right] \\ &= -\frac{g}{\sqrt{2}}\left[\left(\bar{\nu}_e \gamma_\mu \frac{1}{2}(1-\gamma_5)\, e\right) W^{\mu,-} + \left(\bar{e}\gamma_\mu \frac{1}{2}(1-\gamma_5)\,\nu_e\right) W^{\mu,+}.\right]\end{aligned}$$