Zusammenfassung 19|11

10.3. Higgs-Mechanismus im Lagrange-Formalismus

$$\mathcal{L}_{Higgs} = \underbrace{\frac{1}{2}(\partial_\mu \phi)(\partial^\mu \phi)^*}_{T} + \underbrace{\mu^2 \phi\phi^* - \lambda^2(\phi\phi^*)^2}_{V}$$

Zustand niedrigster Energie (= Vakuum):

$$|\phi_0| = \frac{v}{\sqrt{2}} \quad \text{mit } v = \frac{\mu}{\lambda}$$

v.e.v. = vacuum expectation value

Entwicklung von $\phi(x)$ um ϕ_0:

$$\phi(x) = \frac{1}{\sqrt{2}}(v + \eta(x) + i\xi(x))$$

$$\Rightarrow \mathcal{L} = \underbrace{\left[\frac{1}{2}\partial_\mu\eta\partial^\mu\eta - \mu^2\eta^2\right]}_{\text{massives Higgs-Boson}} + \underbrace{\frac{1}{2}(\partial_\mu\xi)(\partial^\mu\xi)}_{\text{masseloses Goldstone-Boson}} + \dots$$

10.3.1. Wechselwirkung mit e.-m. Feld

$$\mathcal{L} = \mathcal{L}_{Higgs} + \mathcal{L}_{Photon} \quad \text{mit } D_\mu = \partial_\mu + iqA_\mu$$

$$\Rightarrow \mathcal{L} = (D_\mu\phi)(D^\mu\phi)^* + \mu^2\phi\phi^* - \lambda^2(\phi\phi^*)^2 - \frac{1}{4}F_{\mu\nu}F^{\mu\nu}$$

Entwicklung um ϕ_0: $\phi = \frac{1}{\sqrt{2}}(v + \eta(x) + i\xi(x))$

$$\Rightarrow \mathcal{L} \approx \left[\frac{1}{2}(\partial_\mu\eta)(\partial^\mu\eta) - \mu^2\eta^2\right] + \underbrace{\frac{1}{2}(\partial_\mu\xi)(\partial^\mu\xi)}_{?}$$

(A)

$$- \frac{1}{4}F_{\mu\nu}F^{\mu\nu} + \frac{1}{2}q^2v^2A_\mu A^\mu + \underbrace{qvA_\mu(\partial^\mu\xi)}_{?}$$

Eichtransformation mit $\chi(x) = -\frac{1}{qv}\xi(x)$

$$\Rightarrow \mathcal{L} = \underbrace{\left[\frac{1}{2}(\partial_\mu\eta)(\partial^\mu\eta) - \mu^2\eta^2\right]}_{\text{mass. Higgs}} - \underbrace{\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + \frac{1}{2}q^2v^2A'_\mu A'^\mu + \dots}_{\text{mass. Photon}}$$

(B)

mit $M_A = qv$

2 Beschreibungen:

(A) mass. η, masseloses ξ, masseloses A^μ

(B) mass. η, massives A^μ (ξ "aufgegessen")