

Homework V

Suggested reading:

1. Peskin sections 16.5, 17.1 and 17.2.
2. Pokorski section 8.1.

due date December 6th

1. Consider that the neutral pion is described by a scalar field π whose interactions with photons and the proton (ψ) is governed by

$$\mathcal{L} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + \frac{1}{2}\partial_\mu\pi\partial^\mu\pi - \frac{m_\pi^2}{2}\pi^2 + \bar{\psi}(i\partial_\mu\gamma^\mu - eA_\mu\gamma^\mu - m)\psi + i\lambda\pi\bar{\psi}\gamma^5\psi.$$

Obtain the decay width $\pi \rightarrow \gamma\gamma$.

2. Consider the following alternative proposal for the QED Lagrangian:

$$\mathcal{L} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + \bar{\psi}(i\partial_\mu\gamma^\mu + Q_L e A_\mu\gamma^\mu)P_L\psi + \bar{\psi}(i\partial_\mu\gamma^\mu + Q_R e A_\mu\gamma^\mu)P_R\psi,$$

where $P_{L,R}$ are the chiral projectors. Requiring the cancelation of the anomaly of the current coupling to the gauge boson, show that we must have $Q_L = Q_R$ to have a consistent model.

3. Consider the standard model. Show that the currents coupling to the gauge bosons are not anomalous. Show, on the other hand, that the currents associated to baryon and lepton number are anomalous.