

PHYC 523: QQuantum Field Theory I

Fall 2016

Homework Assignment #2

(Due October 19, 2016)

1- Show that the Lagrangian density of a massless Dirac field is invariant under the chiral transformation:

$$\psi \rightarrow e^{i\beta\gamma^5} \psi,$$

and find the corresponding Noether current j_5^μ .

Now consider a massless Dirac field coupled to two real scalar fields σ and π of mass m described by the following Lagrangian density:

$$\mathcal{L} = i\bar{\psi}\gamma^\mu\partial_\mu\psi + h\bar{\psi}(\sigma + i\gamma^5\pi)\psi + \frac{1}{2}\partial^\mu\sigma\partial_\mu\sigma + \frac{1}{2}\partial^\mu\pi\partial_\mu\pi - \frac{1}{2}m^2(\sigma^2 + \pi^2) - \frac{\lambda}{4}(\sigma^2 + \pi^2)^2,$$

where h and λ are dimensionless coupling. Show that \mathcal{L} has chiral symmetry provided that σ and π are rotated into one another under an infinitesimal chiral transformation:

$$\delta\sigma = 2\beta\pi \quad , \quad \delta\pi = -2\beta\sigma.$$

2- Problem (3.2) from Peskin and Schroeder.

3- Problem (3.6) from Peskin and Schroeder.

4- Problem (3.8) from Peskin and Sschroeder.