

## 8.325 Homework 6

Iain Stewart, April 18, 2008

Due: Thur. May 1.

**Problem 1) Peskin & Schroeder, Problem 19.1, page 686-687**

**Problem 2) Axial-Anomaly in Dimensional Regularization**

Compute the axial anomaly for QED in four-dimensions from the triangle diagram using dimensional regularization (show all your steps ie. not just those displayed in Peskin). Demonstrate that your result is equivalent to a matrix element of the operator equation

$$\partial_\mu J^{\mu 5} = -\frac{e^2}{16\pi^2} F^{\alpha\beta} \tilde{F}_{\alpha\beta} \quad (1)$$

which we discussed in two different ways in lecture.

**Problem 3) Baryon and Lepton Number**

Let  $B^\mu$  be the current for baryon number, and  $L^\mu$  be the current for lepton number. Show that  $B^\mu$  has an anomaly, but that  $B^\mu - L^\mu$  does not.

**Problem 4) The decays  $\pi^0 \rightarrow \gamma\gamma$  and  $\eta \rightarrow \gamma\gamma$**

- a) Compute the matrix element and the decay rate  $\Gamma_{\pi^0}$  for  $\pi^0 \rightarrow \gamma\gamma$  through the anomaly. (You may use results from lecture.) Using the experimental values for  $m_\pi$  and  $f_\pi$  compare your result with the experimental value for the decay rate in the PDG (<http://pdg.lbl.gov/>).
- b) Consider  $\eta^0$ , the 8'th Goldstone boson of the spontaneous symmetry breaking  $SU(3)_L \times SU(3)_R \rightarrow SU(3)_V$  in QCD. Assume that the decay  $\eta^0 \rightarrow \gamma\gamma$  also proceeds through the axial anomaly and compute  $\Gamma_{\eta^0}/\Gamma_{\pi^0}$ .