8.325 Homework 6

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Due: Thur. May 3.

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

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

which we discussed in two different ways in lecture.

Problem 3) Baryon and Lepton Number

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

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

a) Compute the matrix element and the decay rate Γ_{π^0} for $\pi^0 \to \gamma\gamma$ through the anomaly. (You may use results from lecture.) Using the experimental values for m_π and f_π compare your result with the experimental value for the decay rate in the PDG (http://pdg.lbl.gov/).

b) Consider η^0, the 8'th Goldstone boson of the spontaneous symmetry breaking $SU(3)_L \times SU(3)_R \to SU(3)_V$ in QCD. Assume that the decay $\eta^0 \to \gamma\gamma$ also preceedes through the axial anomaly and compute $\Gamma_{\eta^0}/\Gamma_{\pi^0}$.