

# Homework Set No. 3, Physics 880.08

Deadline – Monday, February 21, 2011

**1. a.** (15 pts) Calculate the differential cross section  $d\sigma/dt$  for electron-positron annihilation into two photons, i.e., for

$$e^- + e^+ \rightarrow \gamma + \gamma.$$

You may assume that electron and positron are massless. Express your answer in terms of Mandelstam variables  $s$ ,  $t$  and  $u$ , and electromagnetic coupling constant  $\alpha_{EM}$ .

(Hint: you may want to use the replacement

$$\sum_{\lambda=\pm} \epsilon_{\mu}^{(\lambda)}(k) \epsilon_{\nu}^{(\lambda)}(k) \rightarrow -g_{\mu\nu}$$

when summing over photon polarizations.)

**b.** (10 pts) Calculate the differential cross section  $d\sigma/dt$  for the inverse process (again assuming that  $e^+$  and  $e^-$  are massless):

$$\gamma + \gamma \rightarrow e^- + e^+.$$

Express your answer in terms of Mandelstam variables  $s$ ,  $t$  and  $u$ , and  $\alpha_{EM}$ . Compare the answer with the result of part **a**. Comment.

**2.** (25 pts) Problem 5.2 in Peskin and Schroeder. Clarification to their problem formulation: you are asked to find the differential cross section in the center-of-mass frame. Also write an expression for  $d\sigma/dt$ .