

## Physics 556/714 Problem Set #5

due *beginning of class* Thursday Oct 16

1. Griffiths problem 4.21: "Show that  $e^{i\pi\sigma_z/2} = i\sigma_z$  "
2. Griffiths problem 4.35: "Is the neutrino an eigenstate of P?"
3. Griffiths problem 4.36: "Using the information in Table 4.6"
4. Griffiths problem 4.37: "The dominant decays of the  $\eta$  meson are"
5. Consider a particle/antiparticle pair of spin zero bosons.
  - a) What is the charge conjugation of such a pair?
  - b) Verify that C and P are each conserved in the strong decay  $\rho^0 \rightarrow \pi^+ \pi^-$
  - c) What can you say about the charge conjugation of a particle/antiparticle pair of vector (spin 1) bosons? Support your claim with reference to Clebsch-Gordon coefficients.
6. Consider the sequential decay  $D^0 \rightarrow \bar{K}^{*0} \pi^0$  with  $\bar{K}^{*0} \rightarrow K^+ \pi^-$ .
  - a) What are the spins of all the particles involved?
  - b) In the rest frame of the  $D^0$ , what is the orbital angular momentum  $|l,m\rangle$  of the  $\bar{K}^{*0} \pi^0$  system, measured with z axis along the  $\bar{K}^{*0}$  momentum direction?
  - c) In the rest frame of the  $\bar{K}^{*0}$  what is the orbital angular momentum  $|l,m\rangle$  of the  $K^+ \pi^-$  system, measured with z' axis along the  $K^+$  momentum direction?
  - d) What is the distribution of angle  $\theta$  between the  $K^+$  direction measured in the  $\bar{K}^{*0}$  rest frame and the  $\bar{K}^{*0}$  direction measured in the  $D^0$  rest frame?

### 714 students please also do the following:

7. What possible values of spin, parity and charge conjugation ( $J^{PC}$ ) are possible for
  - a) a meson made up of a quark-antiquark pair?
  - b) a boson made up of two gluons?  
(In this case it may help you to know that the two-gluon color singlet state is symmetric under color exchange.)
  - c) Are there any  $J^{PC}$  states that result from the combination of two gluons but are not possible from the combination of quark-antiquark? If so, these states would be said to have "exotic quantum numbers", and their discovery would be strong evidence for the existence of "glueballs".