

# Fall Quarter 2007

## UCSD Physics 214 & UCSB Physics 225

### Homework 3

All the questions revolve around isospin and or the “generalized Pauli principle”. I’m guessing that 1,5, and 6 are easier than some of the others. You might want to start with the easier ones.

1. What are the branching fractions of  $K^{*0}$  to  $K^0\pi^0$ ,  $K^+\pi^-$ , and  $K^-\pi^+$  ?
2. The parity of the charged pion can be deduced from the capture of  $\pi^-$  in deuterium:  $\pi^- d \rightarrow nn$ . The capture takes place from an  $S=0$  state. Show that this reaction implies that the pion has odd parity. (Hint: Deuterons have spin 1 and even parity.)
3. Consider a  $\pi^0\pi^0$  system in a state of angular momentum  $l$ . This could occur in the decay  $X \rightarrow \pi^0\pi^0$  if the spin of the decaying particle is  $S_x = l$ , since the pion is spinless.
  - a. What values of Isospin  $I$  are allowed for the  $\pi^0\pi^0$  system?
  - b. The  $\pi^0\pi^0$  system can be described by a wave function that is a product of the spin and isospin wave functions. What is the symmetry of the space part of the wavefunction under interchange of the two pions? What can we say about the allowed values of  $l$  ?
  - c. Is the decay  $\rho^0 \rightarrow \pi^0\pi^0$  allowed? If so, by what interaction?
4. In which isospin states can (a)  $\pi^+\pi^-\pi^0$  (b)  $\pi^0\pi^0\pi^0$  exist?
5. Some of the most interesting isospin relationships are triangles in the complex plane. Show such a relationship for the amplitudes of the three scattering processes:
  - a. Neutron  $\pi^0 \rightarrow$  proton  $\pi^-$
  - b. Proton  $\pi^- \rightarrow$  proton  $\pi^-$
  - c. Proton  $\pi^+ \rightarrow$  proton  $\pi^+$
6. Consider proton deuteron scattering. The deuteron has  $I=0$  while the proton is of course  $I=1/2$ . There are two final states with pions:
 
$$\pi^0 + \text{He}^3 \text{ and } \pi^+ + \text{H}^3$$

$\text{He}^3$  and  $\text{H}^3$  form an Isodoublet, the former being  $+1/2$  the latter  $-1/2$ . Predict the ratio of cross sections for the two reactions.