Homework #1
Due Feb 2

Read Griffiths chapters 4

1. When π^- are stopped in liquid deuterium, they are captured in an S-wave orbit. From this orbit can the following reactions occur?

   (a) $\pi^- d \to \pi^0 nn$

   (b) $\pi^- d \to \gamma nn$

   Recall that deuterium is a 1^+ state, and consider conservation of angular momentum and parity.

2. The η is a pseudoscalar ($J^{PC} = 0^{-+}$) meson with $I = 0$. Are the following decays allowed, and if so by what interaction? (Hint: as long as at least one decay occurs by the Strong or EM interaction, Weak decays will be very heavily suppressed and can be ignored)

   (a) $\eta \to \pi^0\pi^0$

   (b) $\eta \to \pi^+\pi^-$

   (c) $\eta \to \pi^0\pi^0\pi^0$

   (d) $\eta \to \gamma\gamma$

   (e) $\eta \to \gamma\gamma\gamma$

   (f) $\eta \to \pi^0\gamma$

   (g) $\eta \to \pi^0\gamma\gamma$

   Consider conservation of angular momentum, parity and charge conjugation.

3. The $\rho(770)$ is an $I = 1$ meson of u and d quarks, in a $^3S_1$ state. Why doesn't the ρ^0 decay to $\pi^0\pi^0$?

4. The $K^*(892)$ is the $^3S_1$ strange meson, where K^{*+} is $u\bar{s}$ and K^{*0} is $d\bar{s}$.

   (a) By what force does the K^* decay? Why?

   (b) Determine the branching ratios for the charged and neutral decays of $K^* \to K\pi$, ie. $K^{*+} \to K^0\pi^+$, $K^{*+} \to K^+\pi^0$, $K^{*0} \to K^0\pi^0$, and $K^{*0} \to K^+\pi^-$.

   (c) Why doesn't $K^{*0} \to K^-\pi^+$ occur?

   (d) Make an order of magnitude estimate for the branching ratios $K^* \to K\gamma$ and $K^* \to \pi\pi$. Compare these against the PDG values.

5. The Λ is the uds baryon.

(a) By what force does the Λ decay? Why?

(b) The two dominant Λ decay modes are $\Lambda \to p\pi^-$ and $\Lambda \to n\pi^0$. Assuming the $\Delta I = 1/2$ rule holds what are the branching ratios for these two modes?

(c) Compare your answers against the PDG values.

(d) Draw the Feynman diagrams for these two decay modes.

$(\frac{1}{2\tau})^2$ $K^+ \to \pi^+\pi^0$

Γ $\quad$ $\frac{2}{3}$ $K^0 \to \pi^+\pi^-$ (K_S)

$\frac{1}{3}$ $K^0 \to \pi^0\pi^0$

what's ΔI = 1/2 even?

Why not strange mesons?

→ check masses

$K \to \pi\pi$

Λ $\quad$ 0

$p\pi$ $\quad$ 1/2 $\quad$ 3/2

$\langle p\pi | H | \Lambda \rangle$

$\langle I=\frac{1}{2} | H | I=0 \rangle = M_{1/2}$

$\langle 3/2 | H | I=3/2 \rangle = M_{3/2}$

$M_{3/2} = \frac{1}{25} M_{1/2}$