

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? *How do I determine ANGULAR MOMENTUM & PARITY OF d, π^- , γ , π^0 ?*

- (a) $\pi^- d \rightarrow \pi^0 nn$
- (b) $\pi^- d \rightarrow \gamma nn$

β - IDENTICAL or if DIFF S.W.?

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) $\eta \rightarrow \pi^0 \pi^0$
- (b) $\eta \rightarrow \pi^+ \pi^-$
- (c) $\eta \rightarrow \pi^0 \pi^0 \pi^0$
- (d) $\eta \rightarrow \gamma \gamma$
- (e) $\eta \rightarrow \gamma \gamma \gamma$
- (f) $\eta \rightarrow \pi^0 \gamma$
- (g) $\eta \rightarrow \pi^0 \gamma \gamma$

β PARITY \rightarrow EM
 β - Why EM vs STRONG?
 I DON'T UNDERSTAND THE $L=0$ ARGUMENT & HOW PARITY WORKS AT
 $L=0$ for this too? not forming bound states

doesn't viol β
 violates β not I_3

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 $\pi^0 \pi^0$? *because of $C = (-1)^{L+S}$ FOR ρ meson see GRIF. ρ meson*

4. The $K^*(892)$ is the 3S_1 strange meson, where K^{*+} is $u\bar{s}$ and K^{*0} is $d\bar{s}$. *K^+, K^0 1S_1*

see TD USE PARITY & P.

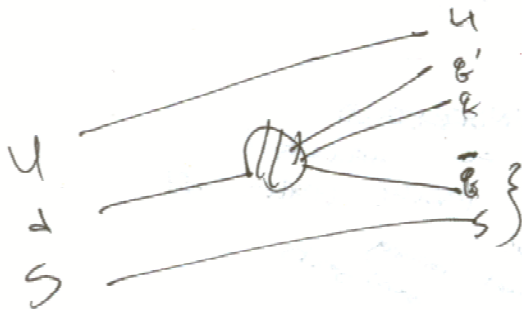
- (a) By what force does the K^* decay? Why?
- (b) Determine the branching ratios for the charged and neutral decays of $K^* \rightarrow K\pi$, ie. $K^{*+} \rightarrow K^0 \pi^+$, $K^{*+} \rightarrow K^+ \pi^0$, $K^{*0} \rightarrow K^0 \pi^0$, and $K^{*0} \rightarrow K^+ \pi^-$. *$\rightarrow K^+ \pi^+$? DIFF $\frac{1}{\sqrt{2}}$ $\frac{1}{\sqrt{2}}$*
- (c) Why doesn't $K^{*0} \rightarrow K^- \pi^+$ occur?
- (d) Make an order of magnitude estimate for the branching ratios $K^* \rightarrow K\gamma$ and $K^* \rightarrow \pi\pi$. Compare these against the PDG values.

5. The Λ is the uds baryon.

\uparrow d_s CAN TAKE \uparrow etc

- (a) By what force does the Λ decay? Why?
- (b) The two dominant Λ decay modes are $\Lambda \rightarrow p\pi^-$ and $\Lambda \rightarrow n\pi^0$. 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.

Why not strange mesons?
 \rightarrow check masses



What's $\Delta I = 1/2$ rule?

$$\left(\frac{1}{\sqrt{2}}\right)^2 \begin{aligned} &K^+ \rightarrow \pi^+\pi^0 \\ &\frac{2}{3} K^0 \rightarrow \pi^+\pi^- \quad (K_S) \\ &\frac{1}{3} K^0 \rightarrow \pi^0\pi^0 \end{aligned}$$

$K \rightarrow \pi\pi$

$$\Lambda \quad 0$$

$$p\pi \quad \frac{1}{2} \quad \frac{3}{2}$$

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

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

$$\langle 3/2 | H | I=0 \rangle = \underline{M_{3/2}}$$

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