KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
Particle Physics (Phys. 441)

Assignment # 3
Due to Saturday November 27, 2004

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1. Problem 4.38 in Griffiths (page 141). (20 pts)

2. Explain why the short lived Kaon, K_s^0, decays to π^+, π^- ($K_s^0 \longrightarrow \pi^+ \, \pi^-$) with roughly twice the probability the decay to two π^0 mode ($K_s^0 \longrightarrow \pi^0 \, \pi^0$). (20 pts)

3. **Numerical Analysis**:

   We have shown in class that if one start with pure K^0 beam of unit intensity, then the intensities of K^0 and $\bar{K}^0$ after time are

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\begin{aligned}
I(K^0) &= \frac{1}{4}\left[e^{-\frac{t}{\tau_S}} + e^{-\frac{t}{\tau_L}} + 2e^{-\left(\frac{t}{2\tau_S}+\frac{t}{2\tau_L}\right)}\cos[\Delta m\, t]\right] \\
I(\bar{K}^0) &= \frac{1}{4}\left[e^{-\frac{t}{\tau_S}} + e^{-\frac{t}{\tau_L}} - 2e^{-\left(\frac{t}{2\tau_S}+\frac{t}{2\tau_L}\right)}\cos[\Delta m\, t]\right],
\end{aligned}
$$

   where $\tau_S = 0.893 \times 10^{-10}$ s, $\tau_L = 0.517 \times 10^{-7}$ s and $\Delta m.\tau_S = 0.474$.

   (a) Express the above intensities in terms of the dimensionless parameter $\frac{t}{\tau_S}$. Then plot the intensities as a function of $\frac{t}{\tau_S}$. (10 pts.)

   (b) Study the above intensities in the following two cases:(i) $\Delta m \ll \Delta\Gamma$, (ii) $\Delta m \gg \Delta\Gamma$, where $\Delta\Gamma = \Gamma_S - \Gamma_L$. (20 pts.)

   (c) Experimentally, $B^0 - \bar{B}^0$ mixing has been observed while no $D^0 - \bar{D}^0$ mixing has been observed. What can you tell about the quantities Δm and $\Delta\Gamma$ in these two cases. (10 pts.)