Week 2 (due Jan. 20)

1. Consider a beam of neutral kaons passing through a slab of material which acts on the $K^0$ and $\bar{K}^0$ components of the beam as follows:

$$|K^0\rangle \mapsto a|K^0\rangle, \quad |\bar{K}^0\rangle \mapsto b|\bar{K}^0\rangle.$$  

Here $a$ and $b$ are complex numbers. Suppose the slab is placed some distance $L = \tau$ from the kaon source, and that at the source the kaons are all $K^0$. Assume also that $K_S$ and $K_L$ are given by the difference and sum of $K^0$ and $\bar{K}^0$, respectively. Find the fraction of $K_S$ in the beam right after passing through the slab, as a function of $\tau$. Express the answer in terms of $a, b, \Gamma_S, \Gamma_L$, and the mass difference between $K_S$ and $K_L$.

2. Compute the ratio of decay rates of the charged pion $\pi^-$ into $e^-\bar{\nu}_e$ and $\mu^-\bar{\nu}_\mu$. (Assuming the neutrino is massless). Compare with experimental data.