Physics 8.322, Spring 2003
Homework #3

Due **Monday, March 3** by 4:00 PM in the 8.322 homework box in 4-339B.

1. Using the box normalization conventions used in class to compute the density of states $\rho(E)$ for an electron in a plane wave state, compute the density of states $\rho(E)$ for a photon of energy $E = \hbar\omega$ and fixed polarization in a solid angle $d\Omega$.

2. Sakurai: Problem 40, Chapter 5 (page 356).

3. In problem 2 you have calculated the spontaneous decay rate of the hydrogen atom for the transition 2p $\rightarrow$ 1s, neglecting electron spin and nuclear spin.

(a) Continue to neglect nuclear spin, but include electron spin. Calculate the rates for $2\ ^2\mathrm{p}_{1/2}, m_j = 1/2$ to decay to the states $1\ ^2\mathrm{s}_{1/2}, m_j = \pm 1/2$. (We use here the spectroscopic notation $n\ ^{2s+1}l_j$.)

(b) Now consider the same process in deuterium, and take into account the nuclear spin ($I_{\text{deuteron}} = 1$). Find the rates for all possible hyperfine components of the transition

$$2\ ^2\mathrm{p}_{1/2}, F, m_F \rightarrow 1\ ^2\mathrm{s}_{1/2}, F', m'_F$$

4. Calculate the free space spontaneous emission decay rate for the single photon

$$2\ ^2\mathrm{s}_{1/2}, F = 1 \rightarrow 2\ ^2\mathrm{s}_{1/2}, F = 0$$

hyperfine transition in hydrogen.

5. Calculate the free space spontaneous emission decay rate for the single photon 3d $\rightarrow$ 1s transition in hydrogen.