Homework Problems X

1. Construct the visible line spectrum of hydrogen by selecting the energy transitions of the Balmer series, which are emission transitions terminating at the n = 2 excited state. Calculate the initial and final energy levels, wavelengths, and color of each line you expect to observe.

2. For a system of atoms (in equilibrium), having two energy levels $E_1$ and $E_2$, show that at a high temperature of the material, the number densities of the two energy states tend to become equal.

3. For a ruby laser ($\lambda = 694$ nm) emitting a laser pulse with duration of 0.3 nanoseconds, what is (a) the spectral bandwidth $\Delta \nu$, and b) the coherence length $\Delta x_c$? If the diameter of the laser beam leaving the laser cavity is 5 mm, what is (c) the beam diameter at a distance of 500 km?

4. Describe the advantages of a four-energy level laser system over a three-level system.

5. What is the transition rate for the neon atoms in a He-Ne laser for the 632.8 nm emission if the laser output power is 1 mW? If the internal beam waist diameter is 0.6 mm, what is the divergence of the beam? If the Doppler-broadened transition bandwidth of the laser emission is 1.4 GHz at 632 nm, what is the maximum cavity length for single-axial mode operation? Make a sketch of the transition linewidth and the corresponding cavity modes.