KFUPM
Department of Physics
Phys412

Homework # 3

Due on Saturday, March 17, 2007

Problem 1

The upper laser level of the two ultraviolet He-Cd laser decay radiatively via the laser transitions that occur at 325.0 nm with a transition probability of A = 7.8×10^5 s^{-1} and at 353.6 nm with A = 1.6×10^5 s^{-1}. Find the total lifetime of the upper energy level due to these two transitions.

Problem 2

Calculate the transition probability for the transition in hydrogen from the excited sublevel $2p\,^2P^0_{3/2}$ to the ground level $1s\,^2S_{1/2}$.
The wave function for $2p\,^2P^0_{3/2}$ level is

$$u2 = \frac{1}{8\pi^{1/2}a_0^{5/2}} re^{-r/2a_0}\sin\theta e^{i\phi},$$

and the wave function for $1s\,^2S_{1/2}$ level is

$$u1 = \frac{1}{\pi^{1/2}a_0^{3/2}} e^{-r/a_0}.$$

Here a_0 is the Bohr radius = 0.0529 nm and r, θ, and ϕ are the polar coordinates. The transition wavelength of these two levels is 121.7 nm.

Problem 3

Use the hard-sphere model to derive equation 2.5.12 of your textbook.

Problem 4

Show that the convolution of two Gaussian lines of widths $\Delta\nu_1$ and $\Delta\nu_2$ gives a Gaussian line of width $\Delta\nu = \sqrt{\Delta\nu_1^2 + \Delta\nu_2^2}$.

Problem 5

Derive equation 2.8.4 from equations 2.8.1, 2.8.2, and 2.8.3 of your textbook.