KFUPM
Department of Physics
Phys412

Homework # 4

Due on Sunday, March 26, 2007

Problem 1

Consider a transition between the ground state and an upper level that has a radiative spontaneous lifetime of 10 ns. The resonant frequency of this transition is 500 nm. Ignoring nonradiative decay mechanisms, calculate the saturation intensity for this transition. Plot the fraction of the population in the upper level, N_2/N_t as a function of time for I/I_s = 0.1, 1, and 10. Assume that at time t=0, a resonant light is switched on the system and at this time all atoms are in the ground state and.

Problem 2

In this problem you will show that a homogenous line is broaden by the intensity of the laser light that probe it. This is called power broadening. Start with equations (2.4.32) and (2.8.9) to show that the absorption coefficient for homogenous line is given by

$$\alpha(\nu-\nu_0)=\alpha_0(0)\frac{1}{1+\frac{I}{I_{S0}}+(\frac{2(\nu-\nu_0)}{\Delta\nu_0})^2},$$

where I_{s0} is the saturation intensity at $\nu = \nu_0$, $\alpha_0(0)$ is the absorption coefficient for $I<<I_{s0}$ and at $\nu = \nu_0$, and $\Delta\nu_0$ is the FWHM of the Lorentzian homogenous line. Show also that the absorption coefficient has a Lorentzian line shape with FWHM of $\Delta\nu_0\sqrt{1+\frac{I}{I_{S0}}}$.

Problem 3

The Doppler broadening is the predominant broadening mechanism for He-Ne laser at λ = 632.8 nm. Find the Doppler linewidth for Ne line at λ = 632.8 nm at T = 300 K. Calculate the peak cross section for this transition if its natural linewidth is 0.540 MHz.

Problem 4

Problem 3.3 from your textbook

Problem 5

Problem 3.4 from your textbook