ENEE 496 Spring 2004

Problem Set 1. Due February 17, 2004

(1) A particle has a lineshape function for frequencies $|\nu - \nu_0| \leq \pi\Delta/2$

$$g(\nu_0, \nu) = C\cos\Big(\frac{\nu_0 - \nu}{\Delta}\Big).$$

(a) What is the value of C needed to normalize this function?
(b) What is the fullwidth at half maxiumum (FWHM) of this function? This is the frequency spacing between the two frequencies where $g(\nu_0, \nu) = \frac{1}{2}g(\nu_0, \nu_0)$.

(2) For the line shape function in (1) if A_{21} is 10^8 s^{-1}, what is the stimulated emission rate produced by a monchromatic input signal at a wavelength λ_0=1μm of 1W/m^2 at a frequency 1 FWHM from the line center?

(3) A group of particles with N_2=10^{18} m^{-3} and N_1=10^{17} m^{-3}, which extends from z=0 to ∞ is irradiated beginning at $t = 0$ with a monochromatic plane wave at line center of intensity 1W/m^2. The lineshape and A_{21} are the same as in questions (1) and (2).
(a) Plot the population difference $N_2 - N_1$ as a function of time at z=0.
(b) At what time does $N_2 - N_1$=0?

(4) Plot the shape of the black body radiation distribution $\rho(\nu)$ for temperatures of 1000K, 2000K, up to 10,000K. From these graphs determine the value of the constant F in the relation $\nu_{max}T = F$.

(5) Davis Problem 1.1

(6) Davis Problem 1.3

(7) Davis Problem 1.4

(8) Davis Problem 1.7

(9) Davis Problem 1.9