

ENEE 496 Spring 2005

Problem Set 1. Due February 15, 2005

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

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

- (a) What is the value of C needed to normalize this function?
(b) What is the fullwidth at half maximum (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 monochromatic input signal at a wavelength $\lambda_0=1\mu\text{m}$ of $1\text{W}/\text{m}^2$ at a frequency 0.3 FWHM from the line center?
- (3) A group of particles with $N_2=10^{18} \text{ m}^{-3}$ and $N_1=10^{17} \text{ m}^{-3}$, which extends from $z=0$ to ∞ is irradiated beginning at $t = 0$ with a monochromatic plane wave at line center of intensity $1\text{W}/\text{m}^2$. The lineshape and A_{21} are the same as in questions (1) and (2). Take $\Delta\nu = A_{21}/2\pi$
- (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