Ex5a

Exercise 7

7.1 Lasers

In the lecture you learned about the different types of lasers. In this exercise you will do your own research on the following types of lasers:

a) Diode lasers,

b) Nd:YAG lasers,

c) TiSa lasers,

d) Alexandrite lasers

e) Dye lasers,

f) Excimer lasers.

Give typical powers and pulse energies, pulse lengths, pulse repetition rates. Give the tuning ranges (if applicable).

7.2 The Two Level System

Assume a system of N idealized atoms with two non-degenerate states. A light source emits photons of energy $E = \hbar\omega_{12}$ which is exactly the energy difference between the ground state $|1\rangle$ and the excited state $|2\rangle$.

a) What are the possible transitions between the states? Make a sketch.

b) Describe $\dot{N}_1 = \frac{\partial N_1}{\partial t}$ and $\dot{N}_2 = \frac{\partial N_2}{\partial t}$ using Einstein coefficients. Here, N_1 and N_2 are the numbers of atoms in the corresponding state.

c) In the case of equilibrium ($\dot{N}_1 = \dot{N}_2 = 0$), what is $\Delta N = N_2 - N_1$? Plot $\frac{\Delta N}{N}$ as a function of the coefficient A (pumping power). Could you build a laser with this system?

7.3 The Three Level System

Assume a system of N idealized atoms with three non-degenerate states. A light source emits photons of energy $E = \hbar\omega_{13}$ which is exactly the energy difference between the ground state $|1\rangle$ and the upper excited state $|3\rangle$. The lower excited state $|2\rangle$ lies between $|1\rangle$ and $|3\rangle$.

a) What are the possible transitions between the states? Make a sketch.

b) Describe $\dot{N}_1 = \frac{\partial N_1}{\partial t}$, $\dot{N}_2 = \frac{\partial N_2}{\partial t}$ and $\dot{N}_3 = \frac{\partial N_3}{\partial t}$ using Einstein coefficients. Here, N_1, N_2 and N_3 are the numbers of atoms in the corresponding state.

c) Assume B_{32} to be larger than B_{21} and much larger than B_{31}.
In the case of equilibrium ($\dot{N}_1 = \dot{N}_2 = \dot{N}_3 = 0$), what is $\Delta N = N_2 - N_1$? Plot $\frac{\Delta N}{N}$ as a function of the coefficient A (pumping power). Could you build a laser with this system?