ASSIGNMENT-2

PHYSICS-II

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Batch-F2

Q.1 Define the terms -

(i) Stimulated Absorption -

When a photon of light having Energy $E_2 - E_1 = h\nu$ is incident on an atom in the ground state, the atom in ground state E_1 may absorb the photon and jump to higher state E_2. This process is called stimulated Absorption. This is so called because the incident photons has stimulated the atom to absorb the energy.

(ii) Spontaneous Emission -

Normally the excited state is an unstable state where the lifetime of an atom is very short around 10^{-8} sec. Hence the atom is in excited state, E_2 returns to the ground state spontaneously by releasing one photon of energy $h\nu$. This process is called spontaneous Emission.

(iii) Stimulated Emission -

In this process an incident photon is absorbed by an excited atom, as a result of which atom becomes unstable in state E_2 and make a transition to the ground state. by releasing two photons. This is called stimulated Emission.

(iv) Pumping -

The process of supplying energy to laser medium in order to achieve popular inversion is called Pumping. Optical pumping is a process in which light is used to raise electrons from a lower energy level in an atom or molecule to a higher one.

(v) Meta-stable state →

Meta stable state is an excited state of an atom or other system with a longer lifetime than other excited states. However, it has shorter lifetime than other excited.

(vi) Population Inversion →

It is the redistribution of atomic Energy levels that takes place in a system so that laser action can occur.

(vii) Active Medium →

The active laser medium is the source of optical gain within a laser. The gain results from the stimulated Emission of electronic or molecular transitions to a laser energy from a higher energy state previously populated by a pump source.

Q.2 Find the Relation between Eienstein A & B coefficients.

Ans- In thermal equations at temp T with radiation frequency n and Energy Density u(ν). Let N_1 & N_2 be the number of atoms in Energy states 1 and 2 respectively at any instant. The number of atoms in state 1 absorb a photon and give rise to absorption per unit time.

From Equation –

$$P_{12} = P_{21}$$

$$N_1 B_{12} u(\nu) = N_2 [A_{21} + B_{21} u(\nu)]$$

$$\left[\frac{N_1}{N_2} \cdot \frac{B_{12}}{B_{21}} - 1\right] u(\nu) = \frac{A_{21}}{B_{21}}$$

$$u(\nu) = \frac{\frac{A_{21}}{B_{21}}}{\left[\frac{N_1 B_{12}}{N_2 B_2} - 1\right]}$$

Acc. to Boltzmann Distribution Law, no. of atoms N_1 & N_2 in Energy states E_1 and E_2 in thermal equilibrium at temp T is-

$$\frac{N_1}{N_2} = e^{E_2 - E_1/kT}$$

Substituting $\frac{N_1}{N_2}$ in equation (1) -

$$u(\nu) = \frac{A_{21}/B_{21}}{\frac{B_{12}}{B_{21}} e^{E_2 - E_1/kT} - 1} \quad \text{— (2)}$$

Acc. to Planck's Radiation formula →

$$u(\nu) = \frac{8\pi h \nu^3}{c^3 e^{E_2 + E_1/kT} - 1} \quad \text{— (3)}$$

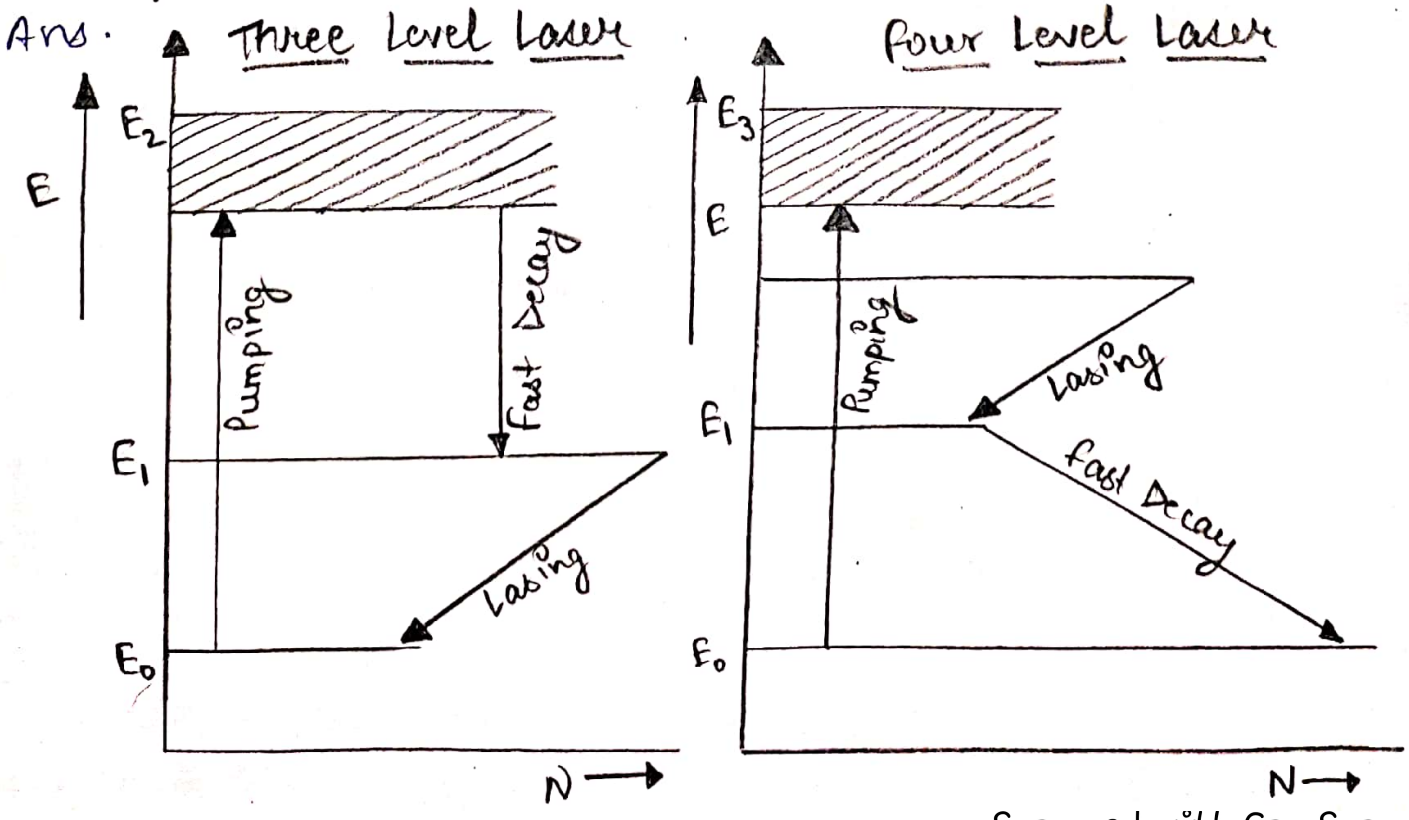
comparing Equation (2) and (3), we get →

$$\frac{B_{12}}{B_{21}} = 1 \Rightarrow \boxed{B_{12} = B_{21}}$$

And $\boxed{\frac{A_{21}}{B_{21}} \Rightarrow \frac{8\pi h \nu^3}{c^3}}$

Q.3 Draw schematic diagram of three level and four level laser.

Ans.



Q.4- Describe the construction and working of a Ruby laser with necessary diagram.

Ans - Construction and Working →

The Ruby laser consist of a Ruby Rod which is made of chromium doped ruby material. At the opposite end of this rod. There are two silver mirror whose one is fully polished and other one is partially polished. A spring is attached to the rod with fully polished end for adjustment of wavelength of Laser light. Around the ruby rod a flash light is kept for the pump input. The whole assembly is kept in the glass tube. Around the neck of the glass tube the R.F. source and switching control is designed in order to switch on and off the flash light for desired intervals.

Energy Level Diagram -