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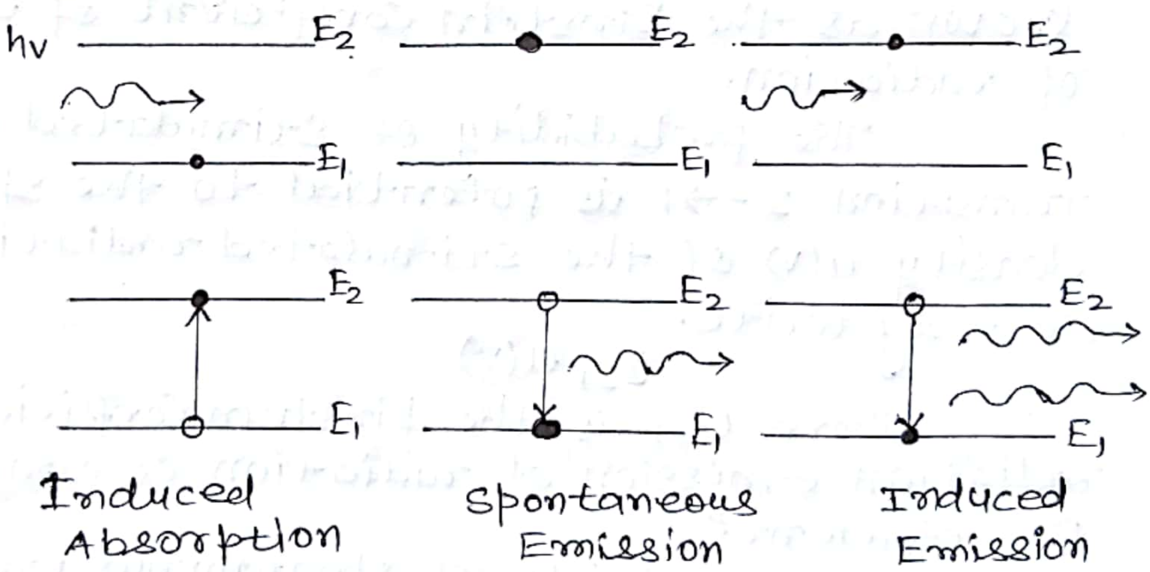
B.Sc (part-II) Hons
paper - III

Einstein A and B Co-efficient.

Consider a Sample of free atoms some of which are in ground State with energy E_1 and some in the excited state with energy E_2. If photons of energy $h\nu = E_2 - E_1$ are incident on this Sample, the photons can interact with atom in two ~~ground state~~ differen ways:-

(i) In the figure the incident photon is absorbed by an atom in the ground State E_1, thereby leaving the atom in the excited state E_2. This process is called stimulated or induced absorption.



(ii) once in the excited State, two things can be happen to the atom. Firstly the atom may decay by spontaneous emission, as show in figure. Here the atom emits a photon of energy $h\nu = E_2 - E_1$ in an arbitarary direction.

The other alternative for the atom in the excited state E_2 is to decay as Stimulated or induced emission, as show in figure. In this case, the incident photon of energy $h\nu = E_2 - E_1$ induces the atom to decay by emitting a photon that travels in the direction of the incident photon. For each incident photon, we will have two photons going in the same direction. Thus we have achieved two things:- an amplified as well as an unidirectional coherent beam.

The probability of occurrence per unit time of the induced or stimulated absorption transition $1 \rightarrow 2$ depends upon the properties of the states 1 and 2 and is proportional to the rate at which photons of frequency ν fall on the atom and so to the spectral energy density $u(\nu)$ of the incident radiation. Thus

$$P_{1\rightarrow 2} = B_{12}\, u(\nu) \qquad \text{--- (1)}$$

where B_{12} is the proportionality constant and is known as the Einstein coefficient of absorption of radiation.

The probability of stimulated emission transition $2 \rightarrow 1$ is potential to the spectral energy density $u(\nu)$ of the stimulated radiation so that we may write.

$$B_{21}\, u(\nu)$$

where B_{21} is the Einstein coefficient of stimulated ~~radiation~~ emission of radiation or simply "Einstein's B coefficient."

The probability of spontaneous emission $2 \rightarrow 1$ determined only by the properties of states 2 and 1. Einstein wrote the probability per unit time as A_{21}. This is known as Einstein coefficient of spontanous emission of radiation or simply "Einstein's A coefficient"

The total probability for an atom in state 2 to drop to be lower state, therefore

$$P_{2\rightarrow t} = A_{21} + B_{21}\, u(\nu) \qquad \text{--- (2)}$$