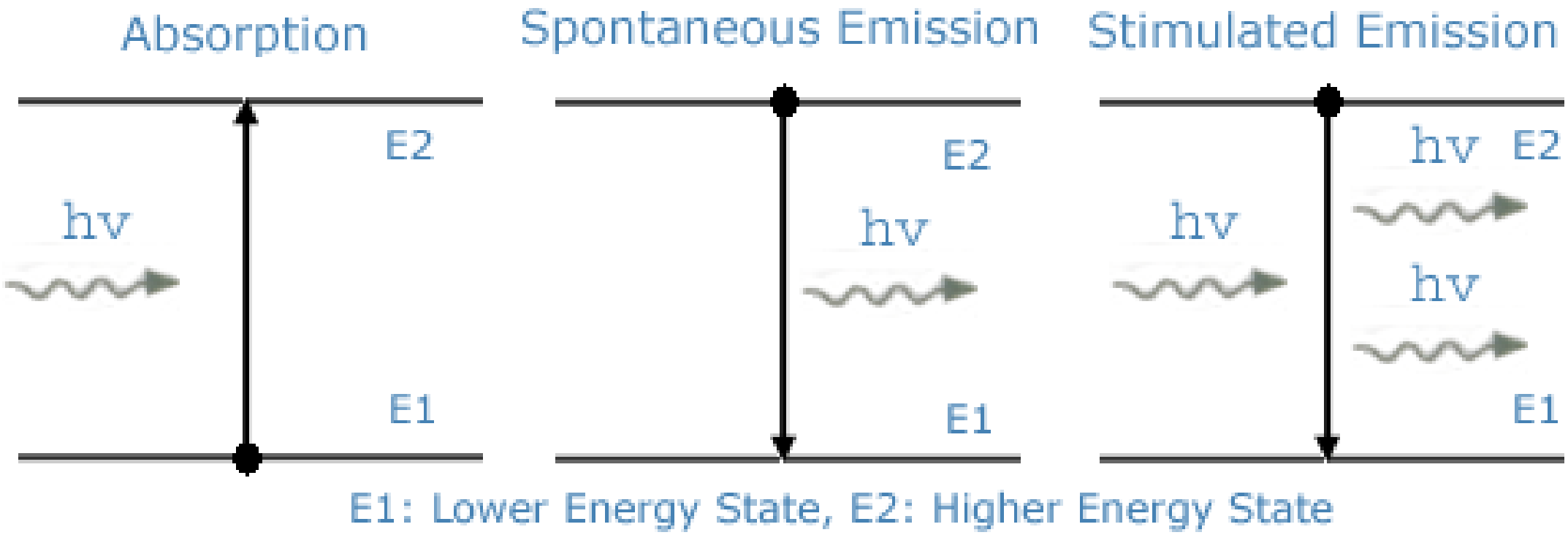
Stimulated Emission

- In 1917 Albert Einstein proposed another way of interaction of light with matter which is called as stimulated emission. This process involves decay of atom from excited state to ground state using a photon of light.



Rate Of Stimulated Emission

- Rate of stimulated emission = dN_2/dt

  where N_2 = population of the excited state

$$-dN_2/dt \propto N_2\rho(h\nu_{12})$$

$$-dN_2/dt = B_{21}\, N_2\rho(h\nu_{12})$$

where B_{21} is called as rate constant of stimulated emission ,21 indicates that transition is from level 2 to 1.

Principle of Detail Balance

- According to principle of detail balance for a system rate of upward transition is equal to the rate of downward transition at equilibrium.

Total rate of absorption = Total rate of emission

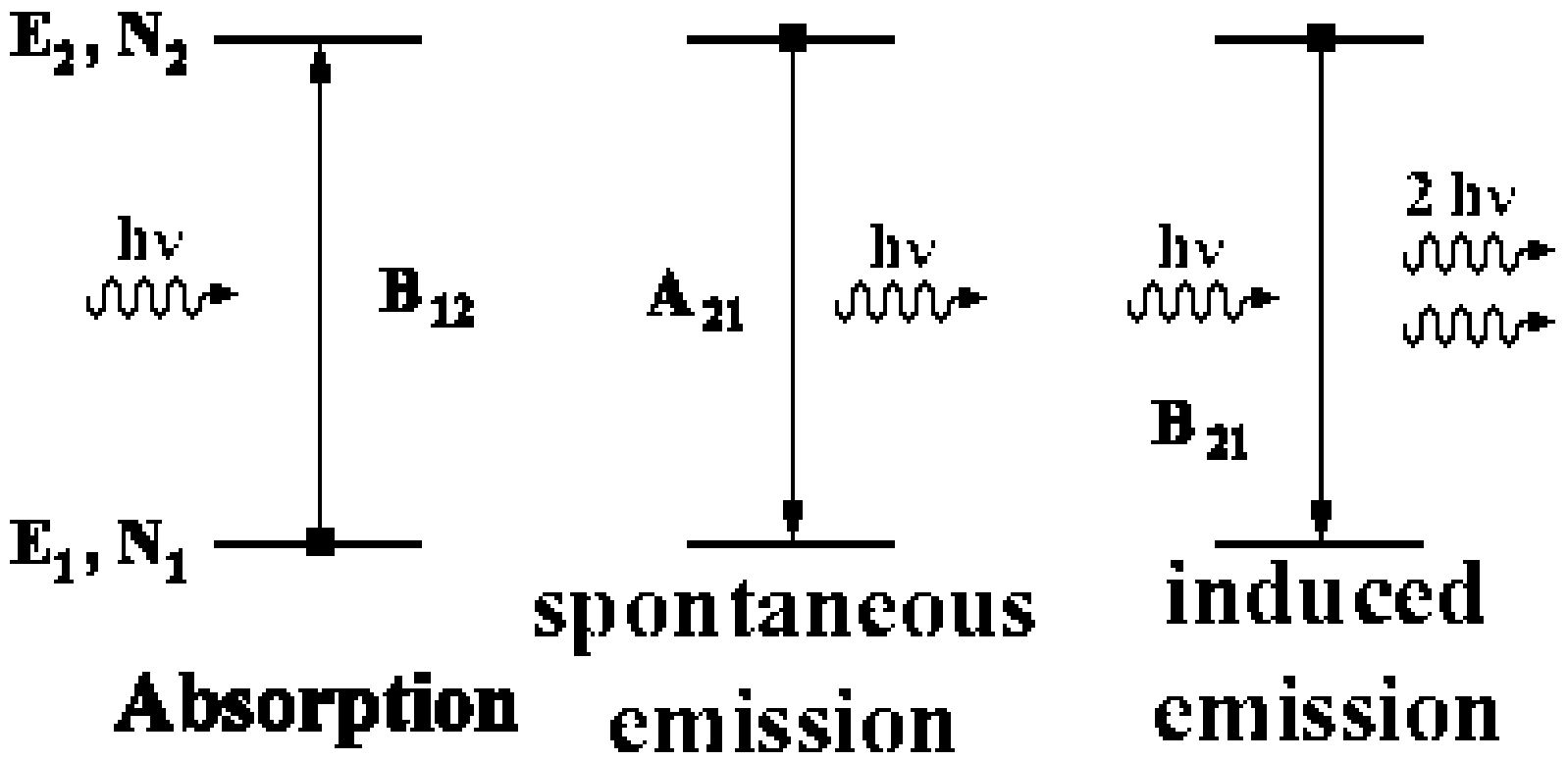
- Rate of absorption = $B_{12}N_1\rho(h\nu 12)$ --1
- Rate of spontaneous emission = $A_{21}N_2$
- Rate of stimulated emission = $B_{21}N_2\rho(h\nu_{12})$
- Total rate of emission = $A_{21}N_2 + B_{21}N_2\rho(h\nu_{12})$ --2

From 1 & 2 -

$$\mathbf{B_{12}N_1\rho(h\nu_{12}) = A_{21}N_2 + B_{21}N_2\rho(h\nu_{12})}$$

B_{12}, B_{21}, A_{21} are collectively called as Einstein coefficients.

Calculation of Einstein Coefficients



- On solving the equation for $\rho(h\nu_{12})$ we get:-

$$\rho(h\nu_{12}) = \frac{A_{21}N_2}{B_{12}N_1}\left(\frac{1}{1-\left(\frac{B_{21}N_2}{B_{12}N_1}\right)}\right) \qquad \text{-- 3}$$

Ratio of population of two state at equilibrium is given by Boltzmann distribution law:-

$$N_2/N_1 = e^{-(h\nu_{12}/kT)} \qquad \text{-- 4}$$

Here k is Boltzmann constant and T is temperature.

Using 4 & 3 :-

$$\rho(h\nu_{12}) = \frac{A_{21}}{B_{12}}\left(\frac{e^{-h\nu_{12}/kT}}{1-\left(\frac{B_{21}}{B_{12}}e^{-h\nu_{12}/kT}\right)}\right)$$