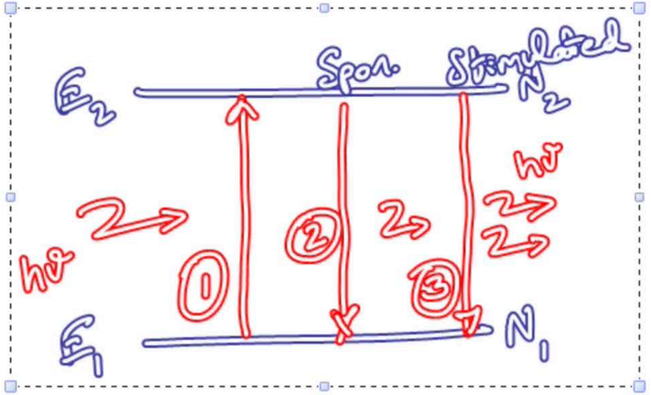
Note Title 8/27/2018

Learning Objective: Identify the fundamental principles of photon interaction w/ atoms

Analyze light generation and amplification



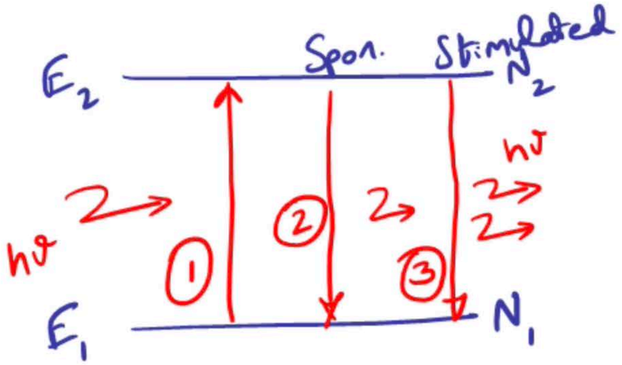
Under steady state conditions,

$$R_{abs} = R_{spon} + R_{stim}$$

$$B' N_1 \rho_{abs} = A N_2 + B N_2 \rho_{em}$$

If $\rho_{em} = \rho_{abs}$, $\quad \rho_{em} = \dfrac{A N_2}{B' N_1 - B N_2} = \dfrac{A/B}{\frac{B'}{B} \cdot \frac{N_1}{N_2} - 1}$

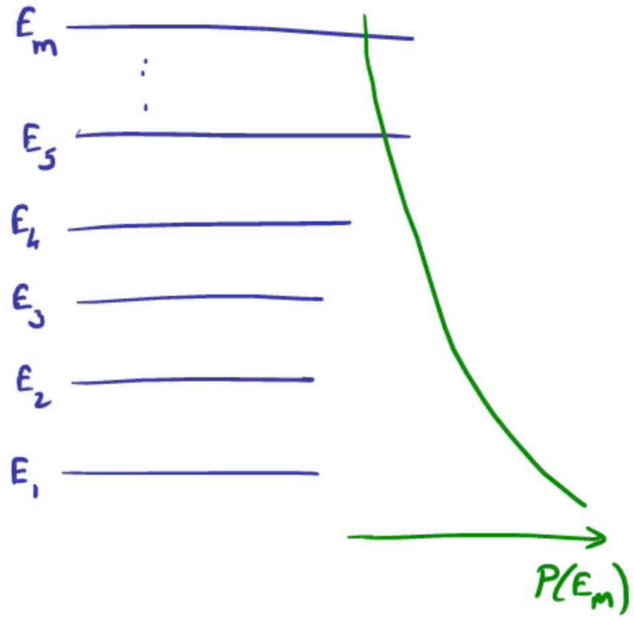
$\Rightarrow$ Similar to Planck's ρ_{em} for blackbody radiation



Under thermal equilibrium conditions.

$$P(E_m) \propto \exp\left(-\frac{E_m}{K_B T}\right)$$

$K_B \rightarrow$ Boltzmann const.



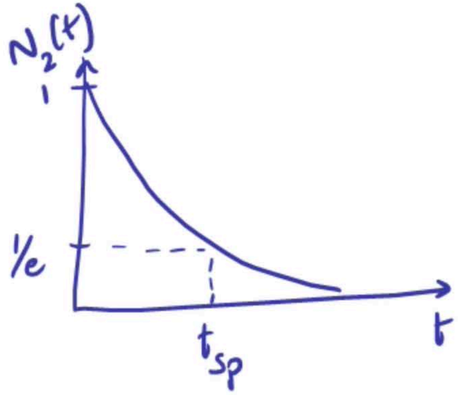
If there are N number of atoms

$$\frac{N_m}{N} = P(E_m) \Rightarrow \frac{N_2}{N_1} = \exp\left(-\frac{E_2 - E_1}{K_B T}\right)$$

$$= \exp\left(-\frac{\Delta E}{K_B T}\right)$$

$$\rho_{em} = \frac{A/B}{\frac{B'}{B}\exp\left(\frac{h\nu}{k_B T}\right) - 1}$$

provided $\frac{A}{B} = 8\pi h \frac{\nu^3}{c^3}$ & $B' = B$

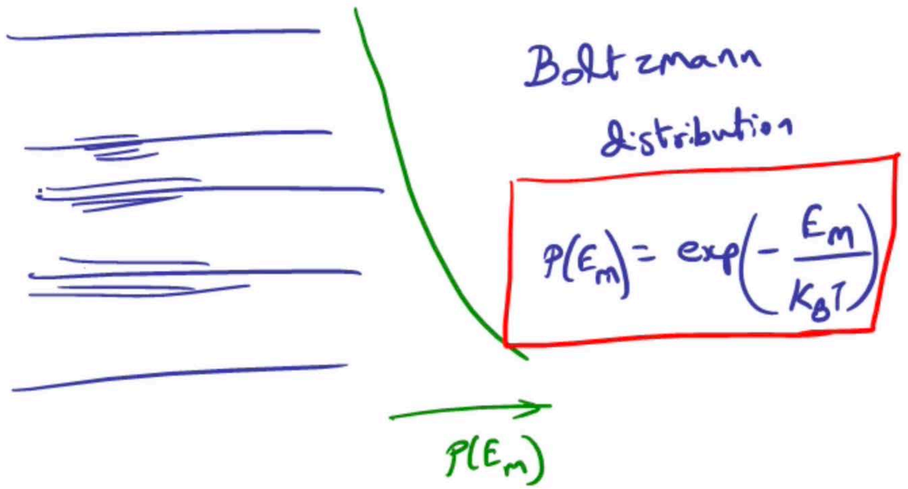


$$A = P_{sp} = \frac{1}{t_{sp}}$$

$$B = \frac{\lambda^3}{8\pi h t_{sp}}$$

Collection of atoms

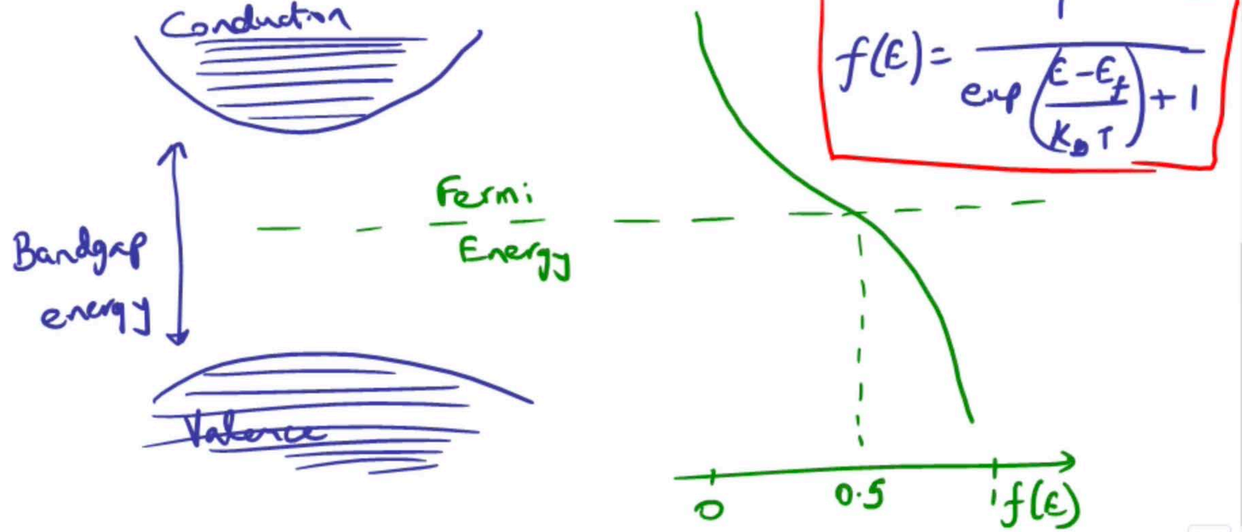
Dilute gas of atoms



Periodic arrangement of atoms w/ overlapping wavefunctions (Semiconductors)

Fermi-Dirac

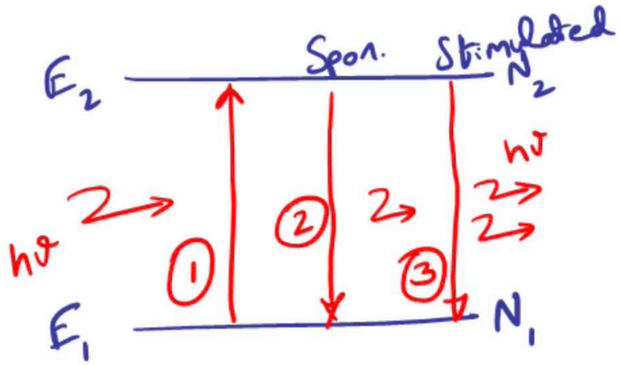
$$f(E) = \frac{1}{\exp\left(\frac{E - E_f}{K_B T}\right) + 1}$$



Note Title 8/27/2018

Learning Objective: Identify the fundamental principles of photon interaction w/ atoms

Analyze light generation and amplification



Under steady state conditions,

$$R_{abs} = R_{spon} + R_{stim}$$

$$B' N_1 P_{abs} = A N_2 + B N_2 P_{em}$$

If $P_{em} = P_{abs}$, $P_{em} = \frac{A N_2}{B' N_1 - B N_2} = \frac{A/B}{\frac{B'}{B}\cdot\frac{N_1}{N_2} - 1}$

$\Rightarrow$ Similar to Planck's P_{em} for blackbody radiation

$$\rho_{em} = \frac{A/B}{\frac{B'}{B} \exp\left(\frac{h\nu}{k_B T}\right) - 1}$$

Observation 1: $k_B T > \Delta E$

$R_{spon} >> R_{stim}$ (Thermal light sources)