LASERS (Einstein's A, B coefficients)

* There are 3 fundamental process that we will discuss.

"Stimulated" & "Induced" radiation.

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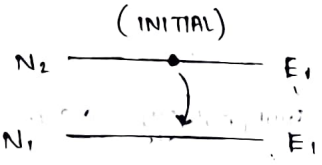
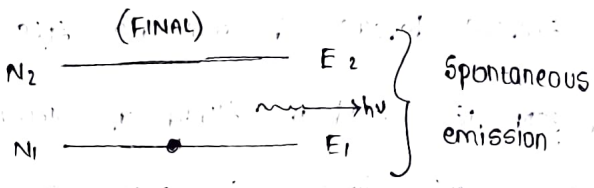


U_{21} & N_2

$$U_{21} = A_{21} N_2$$



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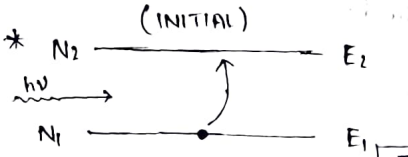
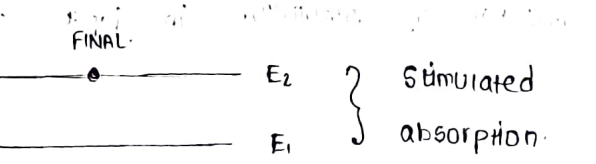


Γ_{12} & $N_1 u(\nu)$

$$\Gamma_{12} = B_{12} N_1 u(\nu)$$



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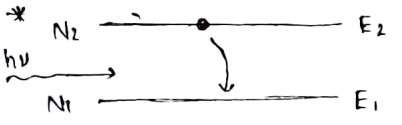
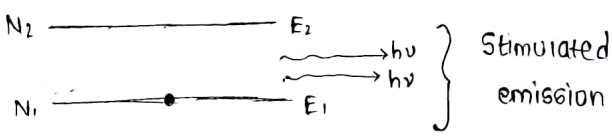




Γ_{21} & $N_2 u(\nu)$

$$\Gamma_{21} = B_{21} N_2 u(\nu)$$

U_{ab} or Γ_{ab} ⟶ no. of atoms coming from level a to level b per unit time.

$u(\nu)$ ⟶ it is the energy density of incoming $h\nu$.

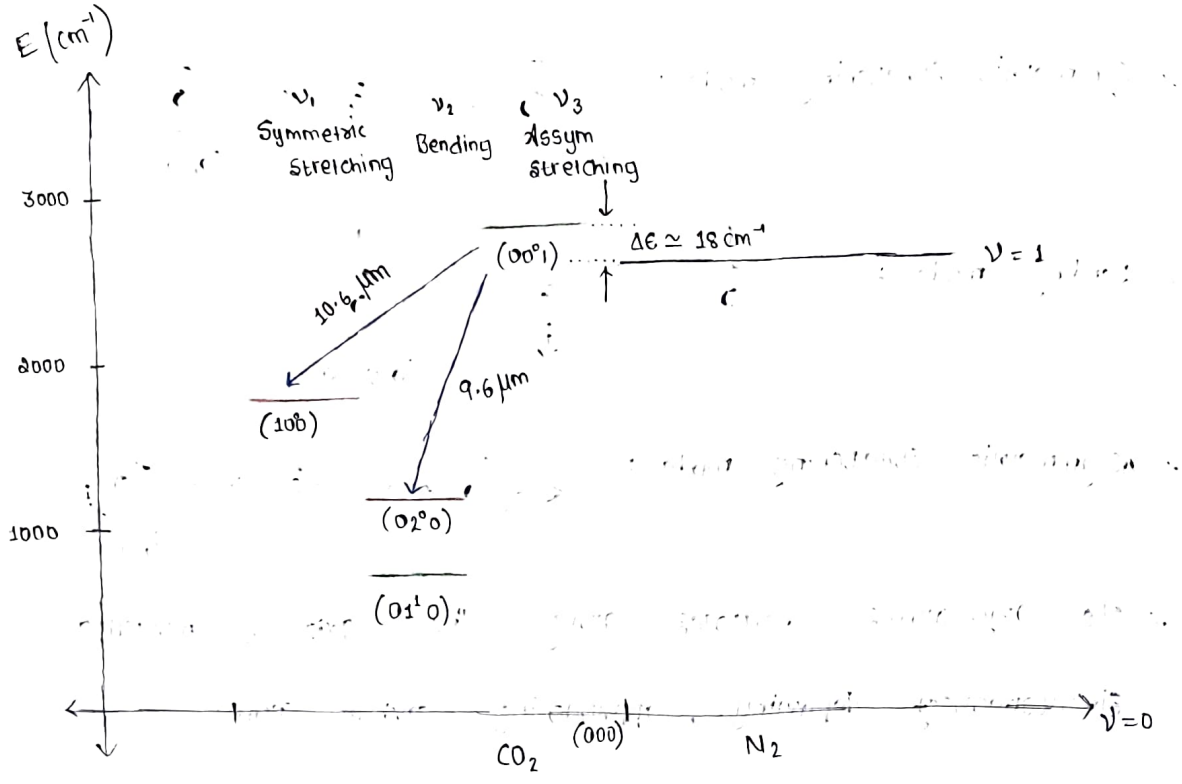
* By thermodynamical principle (principle of detailed balance)

$$\Gamma_{12} = \Gamma_{21} + U_{21}$$

we have to compute $u(\nu)$ from above formula.

$$u(\nu) = \frac{A_{21} N_2}{B_{12} N_1 - B_{21} N_2}$$

CO_2 energy level diagram



* The relevant vibrational energy levels for electronic ground states of CO_2 & N_2 is given in picture

* N_2 is diatom molecule, so it has only vibrational mode whose lowest two energy levels $(v=0, v=1)$ are indicated in fig.

* But CO_2 is a triatomic molecule. It has three non degerate modes of vibration (i) Sym. stretching (ii) Bending (iii) Asym stretch.

* The osc. behaviour ~~one~~ at corresponding energy levels are described by three quantum nos., so the energy

$E = n_1h\nu_1 + n_2h\nu_2 + n_3h\nu_3$ where ν_1, ν_2, ν_3 are freq. of 3 modes.

ex: (01^10) level corresponds (superscript is for angular momentum (l)) to an osc. in which there is one vibrational quantum in mode 2. Similarly (02^00) mode can be described.