LASERS (Einstein's A.B coefficients)

* There are 3 fundamental process that we will discuss.

"Stimulated" & "Induced" Madiation

N₂ (INITIAL)

$$N_2$$
 E_1 Spontaneous

 N_1 E_1 V_{21} d N_2 N_1 E_1 Spontaneous

 $V_{21} = A_{21} \cdot N_2$

*
$$N_2$$
 (INITIAL)

Ez N_2
 N_1
 N_1
 N_2
 N_1
 N_2
 N_3
 N_4
 N_1
 N_2
 N_1
 N_2
 N_3
 N_4
 N_4
 N_5
 N_6
 N_6

$$N_1$$
 N_2
 N_1
 N_2
 N_3
 N_4
 N_1
 N_2
 N_3
 N_4
 N_4
 N_4
 N_4
 N_4
 N_5
 N_5

 V_{ab} and V_{ab} \longrightarrow no of atoms coming form level a to level by peop unit time.

 $u(v) \rightarrow it$ is the energy density of incoming hv.

* By thesimodynamical polinciple (polinciple of detailed balance)

we have to compute u(v) follow above formula.

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

$$\alpha(v) = \frac{A_{21}}{B_{12} \left(\frac{N_1}{N_1} - \frac{B_{21}}{B_{12}} \right)}$$

$$\frac{N_1}{N_2} = \frac{e^{-E_1/R_1}}{e^{-E_2/R_T}} = \exp\left(\frac{h\nu}{\kappa\tau}\right)$$

$$u(y) = \frac{A_{21}}{B_{12} \left(e^{hy/KT} - \frac{B_{21}}{B_{12}}\right)}$$

3 0 0 00

original of it is application

* form Black body gladiation:

$$u(v) = \frac{8\pi h v^3}{6^3 \left(e^{h}/k_1 - r^2\right)}$$

A coefficient is related to respond tight to coeff is related to absorption

19001 1001 1001

and stimulated emission of light

$$\frac{A_{21}}{B_{12}} = \frac{8\pi h v^3}{c^3} , \frac{B_{21}}{6\pi} = 11$$

* Note:

the following.

$$\frac{T_{21}}{U_{21}} = \frac{B_{21} N_2 u(v)}{A_{21} N_2} = \frac{1}{(e^{hv/kT} - 1)}$$

$$\frac{hv}{kT} = \ln a$$

At In a two level system population invertion, is not possible.

At In a two level system

The this can't happen

No this can't happen

No this can't happen

Ez

System is it is apposite

No this can't is apposite

No this can't happen

No this can't happen

No this can't happen

No this can't happen

Ez

System is it is apposite

aign convention
$$1 \longrightarrow a (+)$$
$$a \longrightarrow 1 (-)$$

the population of lowest level is the population of lowest level is i.e., N1 > N2 initially.

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* The state of change in the population in upper level

$$\frac{dN_2}{dt} = \left(+W_pN_1\right) + \left(-W_pN_2\right) + \left(-N_2\right)$$

The total population is $N = N_1 + N_2 \Rightarrow \frac{dN_1}{dt} = -\frac{dN_2}{dt}$

what steady state: $\frac{dN_2}{dt} = 0$ because rake of in coming then boungoing is same

If we need population investsion other .

$$N_2 > N_1 + N_2 + N_3 + N_4 + N_4 + N_5 + N_6 + N_6$$

$$N_2 = \frac{Wp}{Wp + \frac{1}{Z}} (N_1)$$

$$\Rightarrow N_2 = \frac{\mu_p}{\mu_p + \frac{1}{2}} (N - N_2)$$

$$\Rightarrow N_2 = \frac{Mp}{3Mp + \frac{1}{2}} N \Rightarrow \frac{Mp}{3Mp + \frac{1}{2}} N > \frac{N}{2}$$

* Destinations & Conceptual -> 80% }

FAT.

Numerical -> 20%

THREE devel System: (LASER)

F₃ (shoot lived state)

E₂ ('metastable' state)

E₁ (ground state)

- In these level pumping scheme the atoms originally in the ground scale age pumped into the excited state by some external. Sociale of energy (electric discharge, Xe flash lamp)
- Into a cowest excited state which is known as "Metastable state".

* Atoms stay in metastable state for about 10 6 to 10.78 s Theorefore it is possible for a range no of atoms to accumulate in the smetastable state ...

* In the metastable state population can exceed the population of lowest level and it leads to "population investsion".

JOUR - devel SySTEM:

* Aloms asjé pumped forom asjound State (E) to level four (E4) Follow this level, the atoms decay to the "metastable" state" and the population population in this level grows rapidity.

* If the "lifetime" of level 4 to level 3 (i.e. 7 13) is shoult companed to level

Lases Lases * Silfnant (* Ghatak. * Laud

3 to level 2 (1.c, Z32). (181) smarsya man and theory

* A population investion forom 3 -> a can be achieved and maintained with modestate excitation (like elecastic dischasige, Xe flash lamp, etc)

(DIDES FORMAN)

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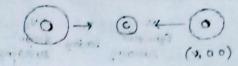
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PUMPINGI MECHANISM: FELL * Chemical 91x7 * Optical pumping. * In Injection Euggient * Eleanical discharige

VIBRATIONAL Modes Or CO2

* Symmetric Stretching mode:



* Bending mode :



* Assymmetric styletching mode:



- simultaneously depositing, appripaching carlbon atom.
- * The movecule seizes to be exactly unearly as the atoms move at the movecular axis.
- mode in one dist asston atoms move in the opp. dist

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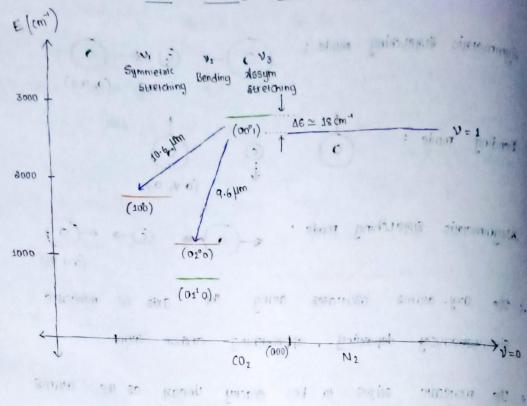
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- * The perevant vibrational energy levels for electribinic ground at area of coop & N2: 15 given in picture:
- * No is diatom morecure, so it has only vibrational mode whose towest two energy tevers (>=0, >=1) are indicated in fig.
- * But CO2 is a tollatomic molecule. It has three mon degesale modes of vibolation (i) sym. staletching (ii) Bending (iii) Asym other
- of 3 modes. Separational after at cossesponding energy revers as the energy $\pm n_1 h v_1 + n_2 h v_2 + n_3 h v_3$ where v_1, v_2, v_3 are frequently of 3 modes.
- ex: (0:10) level corresponds (superiscript is for angular momentum (1)) to an osc, in which there is one vibrational quant in mode a similarly (0200) mode can be described.

the lasing action takes place blu (apo 1) and (10°0) tever foot 2 = 10.6 µm, atthough it is possible to obtain OBC. b/w (00°1) and (02°0) at $\lambda \simeq 9.6 \, \mu m$. Canifornia is a paritorial of the s is small first - Missing their the elementary or new steps of the the annual of the solution of the same of , and several of these · compared to an analytical to an amount of a grid for the market arms fair activities of est country for the second control of country of country of ed some man and to the absent that we promote the first of women that , has been not on the I work to process at many in process that our course come rate one per coming our on comme 1111 drains and among and among the contract of the contract of