PES UNIVERSITY ONLINE

ENGINEERING PHYSICS

K Raghavendra Rao, Ph.D.

Department of Science and Humanities

PES UNIVERSITY ONLINE

Class #42

Carbon dioxide laser

- Gas laser
- Molecular laser
- CO_2 molecule: Modes
- Construction
- Energy level diagram

ENGINEERING PHYSICS

CO_2 laser

- ***Suggested Reading***

1. Optical Electronics, A. Yariv

2. Course material developed by the Department

- ***Reference Videos***

https://ocw.mit.edu/resources/res-6-005-understanding-lasers-and-fiberoptics-spring-2008/laser-fundamentals-i/

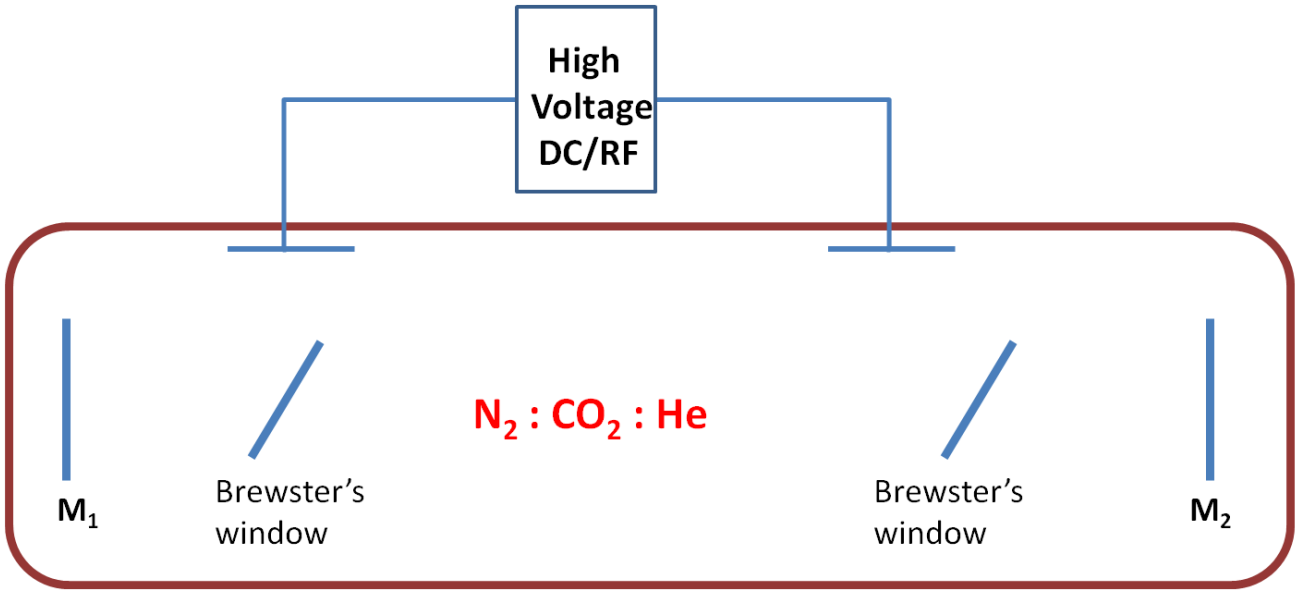
ENGINEERING PHYSICS

CO_2 laser

- Molecular laser
- Transitions in molecular energies
- IR laser
- High power laser (kW)

ENGINEERING PHYSICS

CO_2 laser : Construction



Quartz tube

- Evacuated quartz tube (long and narrow)
- Gas mixture of $N_2 : CO_2 : He$
- A DC or RF supply for electron discharge through the gas mixture
- The mirrors and Brewster windows are made of semiconducting materials such as Ge to avoid IR absorption.

ENGINEERING PHYSICS

CO_2 laser

CO_2 molecule has three modes of vibration:

1. Symmetric stretching
2. Asymmetric stretching and
3. Bending mode.

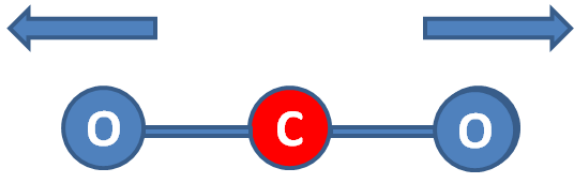
- The quantized energies of the symmetric stretching are denoted as (n00)
- The quantized energies of the asymmetric stretching are denoted as (00n)
- The quantized energies of the bending mode are denoted as (0n0)

where n is a positive integer.

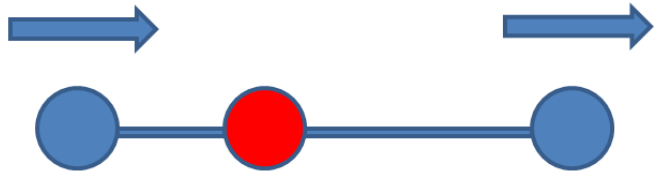
ENGINEERING PHYSICS

CO_2 Molecule: Modes

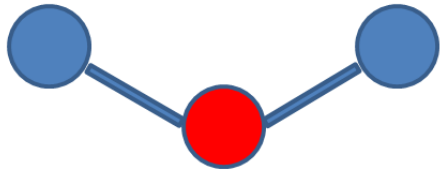
Symmetric stretching
Bond lengths always equal



Asymmetric stretching
Bond lengths Unequal



Bending mode



ENGINEERING PHYSICS

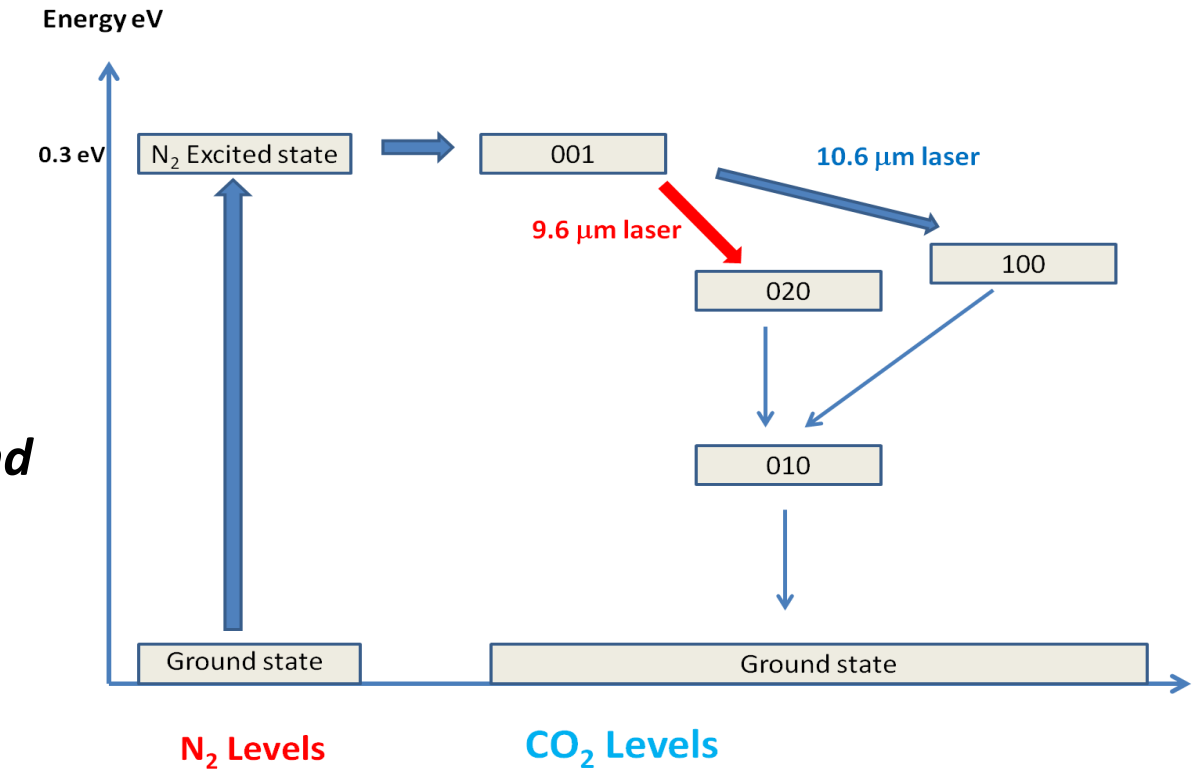
CO_2 laser Energy level diagram

Collision of the first kind

$$e^* + N_2 \rightarrow e + N_2^*$$

Collision of the second kind

$$N_2^* + CO_2 \rightarrow N_2 + CO_2^*$$



- Fast moving electrons from the discharge collide with N_2 molecules and excite them to their first excited state at 0.3 eV.
- These excited N_2 molecules then collide with CO_2 molecules and selectively excite them to the asymmetric 001 state.

CO_2 laser

Check Your Understanding (Yes/No)

1. ***The energy difference between states of molecular vibrations correspond to UV wavelength***

2. ***Nitrogen gas is a buffer gas in this system***

3. ***He gas is used to depopulate the (010) state***

4. ***Carbon dioxide laser produces a powerful IR beam***

THANK YOU

Raghavendra Rao K, Ph.D.

Associate Professor, Department of Science and Humanities

raghavendrarao@pes.edu