iii) Large number of neodymium ions is collected in energy level E_2. Hence population inversion condition is achieved between the energy level E_2 and E_1.

iv) Few of neodymium ions in E_2 spontaneously emit a photon of energy $E_2 - E_1 = h\nu$ there by it returned to energy level E1. This emitted photon will trigger the neodymium ions in E2 hence a chain of stimulated photons are emitted.

v) The generated photon travels back and forth between the plane mirrors and stimulates more number of neodymium ions in E2 and grows in strength.

vi) After enough strength has been attained high intensity of laser beam of wavelength 1.064 μm is emitted through the partially reflecting mirror.

Gas laser

Helium- neon Gas laser

Gas lasers are the most widely used laser, they range from low power He-Ne laser to high power CO_2 laser.

Active medium

In the He-Ne laser the active medium is the mixture of 10 parts of helium and one part of neon (Typically 1mm of Hg and .1 mm of Hg).Neon provides the laser levels for the laser transition. The helium atoms are not directly involved in the laser transition , they provide efficient excitation mechanism to neon atoms.

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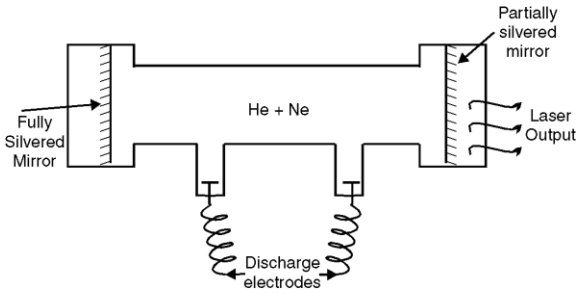
Gas discharge tube

It is made up of fused quartz tube with diameter of 11 cm and length 80 cm. The end faces of the discharge tube are tilted at the Brewster angle to get polarized output. A fully reflecting concave mirror placed at one end and partially reflecting concave mirror at other end. H e-Ne laser is excited by applying 2 to 4 KV in the range of radio frequency.



Excitation process

The excitation process is due to atom-atom inelastic collision. During electric discharge ,the electrons with kinetic energy by impact with He atoms. He atoms are excited them to higher energy state by inelastic collision. This collision is called as first kind.

$$e^* + He \rightarrow e + He^*$$

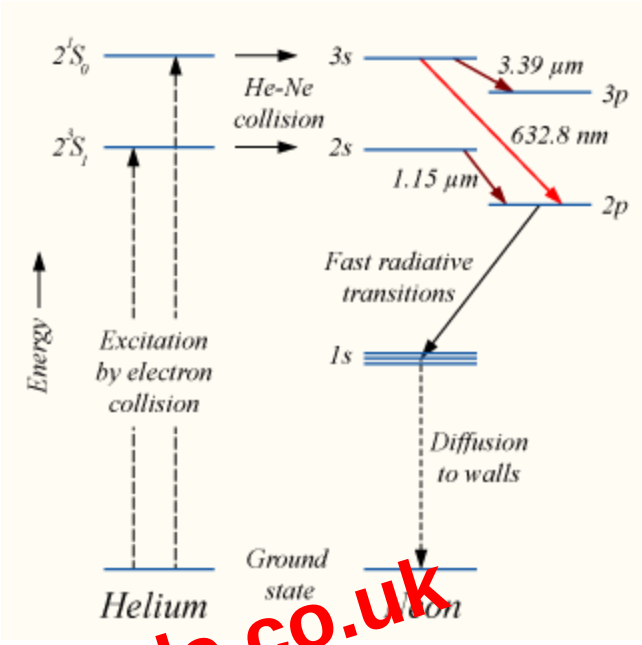
The higher energy levels of He atoms are equal to 3s and 2s energy levels of Ne. In the discharge tube as helium and neon ratio is 10:1, all the Ne atoms will collide with He atoms and raised to higher energy levels. This inelastic collision is called as second kind.

$$He^* + Ne \rightarrow He + Ne_*$$

where (*) represents an excited state

Working

Collision of the excited helium atoms with the ground-state neon atoms results in transfer of energy to the neon atoms, exciting them into the 2s and 3s states. The number of neon atoms entering the excited states builds up as further collisions between helium and neon atoms occur, causing a population inversion between the neon 3s and 2s, and 3p and 2p states. Spontaneous emission between the 3s and 2p states results in emission of 632.8 nm wavelength light, the typical operating wavelength of a He-Ne laser. After this, fast radiative decay occurs from the 2p to the 1s energy levels, which then decay to the ground state via collisions of the neon atoms with the container walls. Because of this last required step, the bore size of the laser cannot be made very large and the HeNe laser is limited in size and power.\



With the correct selection of cavity mirrors, other wavelengths of laser emission of the HeNe laser are possible. The 3s→3p and 2s→2p transitions give infrared operation at 3.39 μm and 1.15 μm wavelengths.

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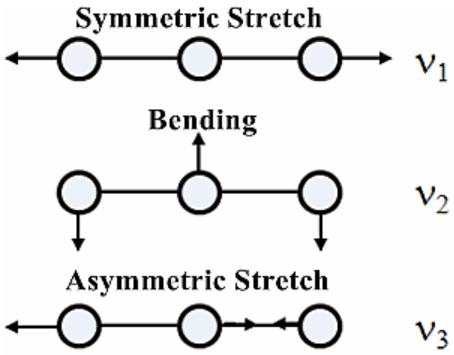
Molecular lasers- the carbon dioxide laser

The first molecular carbon dioxide laser invented in the year 1963 by C.K.N .Patel which is one of the most powerful laser.

Principle

In carbon dioxide laser the laser action takes place between the vibrational energy levels of carbon dioxide molecule. There are three modes of vibration as given below

1. Symmetric stretching and the quantum numbers are (100)
2. Asymmetric stretching and the quantum numbers are (001)
3. Bending vibration and the quantum numbers are (010)



The active medium

The active medium is CO_2 gas and N_2 is used for efficient excitation of CO_2 molecules. He gas is added to enhance the efficiency and to transfer heat from the center of the tube to the walls. The ratio of CO_2 : N_2 : He are 1:4:5.