LASER
&
IT'S APPLICATIONS

(CO-4 Part-II)

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Ruby Laser

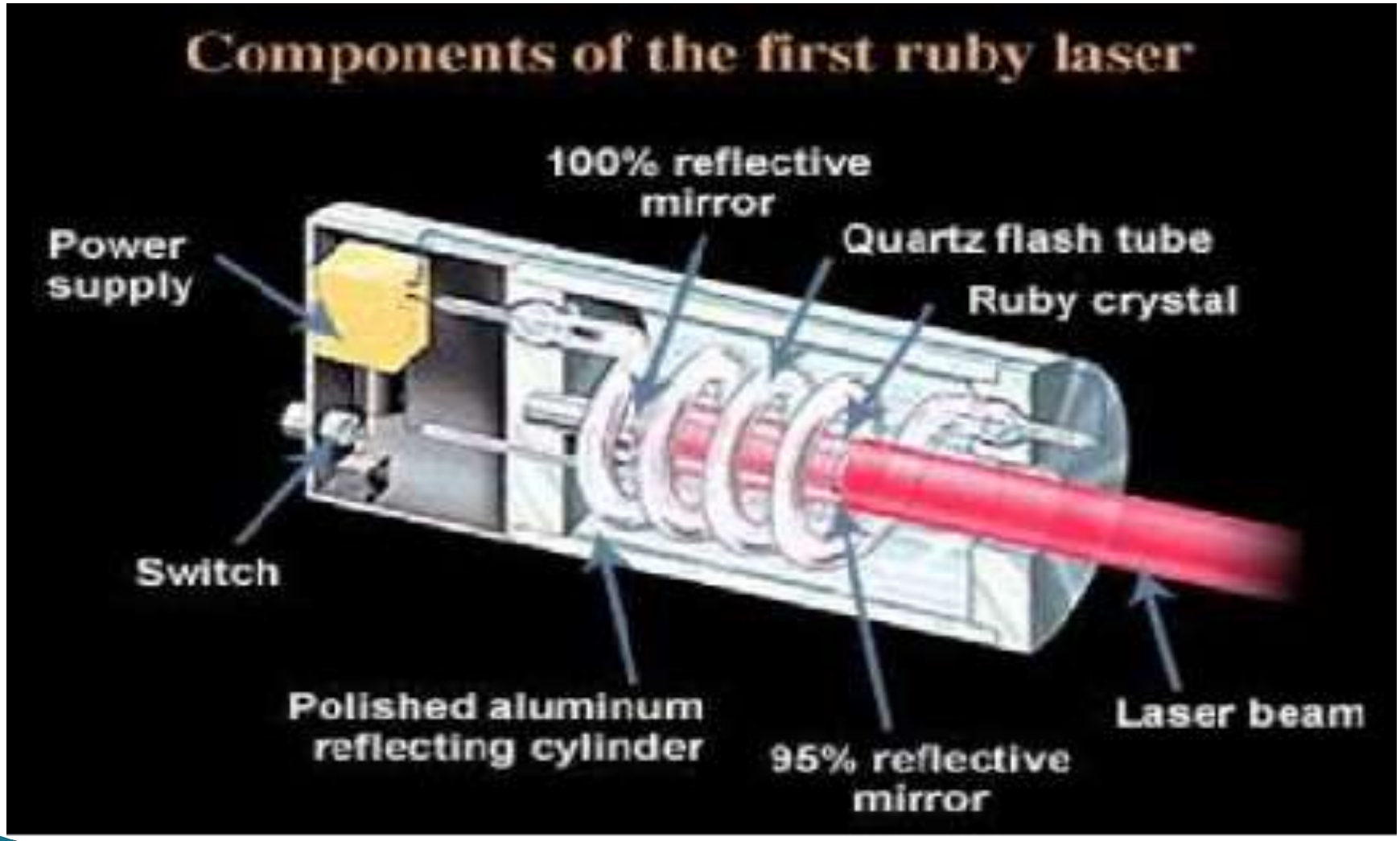

Figure.1*

Construction of Ruby laser

- Ruby laser is a ***three energy level system***.
- In ruby laser a cylindrical ruby rod made up of aluminum oxide (Al_2O_3) which is doped with 0.05% of chromium oxide(Cr_2O_3).
- The rod is wounded by a helical flash lamp filled with xenon gas.
- One end of rod is fully silvered and the other one partially silvered so it act as optical resonator.
- Active medium are Cr^{+3} Ions.
- Population inversion is achieved by optical pumping.
- Cr^{+3} ions are responsible for pink/red colour.

Working of Ruby Laser

- When the flash of light falls on ruby rod the chromium ions excited to higher energy states (E_3) from ground energy state (E_1). The transition from E_1 to E_3 is the optical pumping transition(Absorption).
- After staying up to 10^{-8} second ions get transmitted to the metastable state (E_2). The transition from E_3 to E_2 is the radiation less transition.
- Metastable state (E_2) is long lived state (life time 10^{-3}sec). Hence the number of Cr^{+3} ions goes on increasing in E_2. Thus population inversion achieved between E_2 and E_1. Transition from (E_2 to E_1) is the laser transition of a wavelength of 6943Å and laser emission is pulsed one.

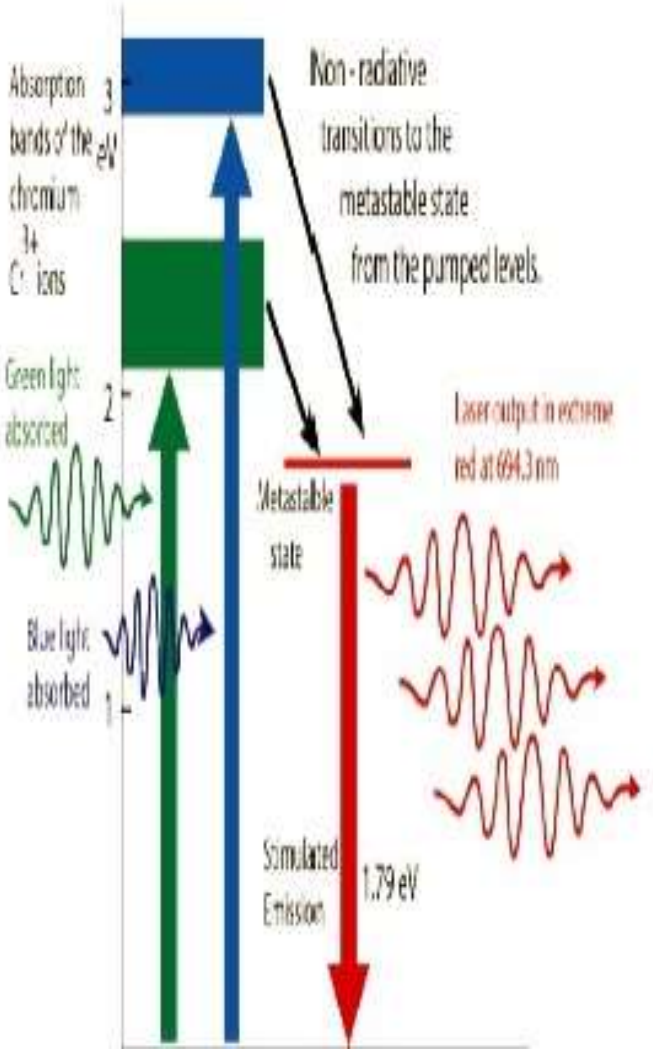

Figure.2*

Drawbacks of Ruby Laser

Drawbacks of Ruby Laser are as follows.

- The Laser output is not continuous but in the form of pulses of microsecond.
- Low efficiency because only green components of pumping light is utilized.
- Required high pumping power because laser transition terminates at the ground state.
- Defects present due to crystalline imperfection.

He-Ne Laser

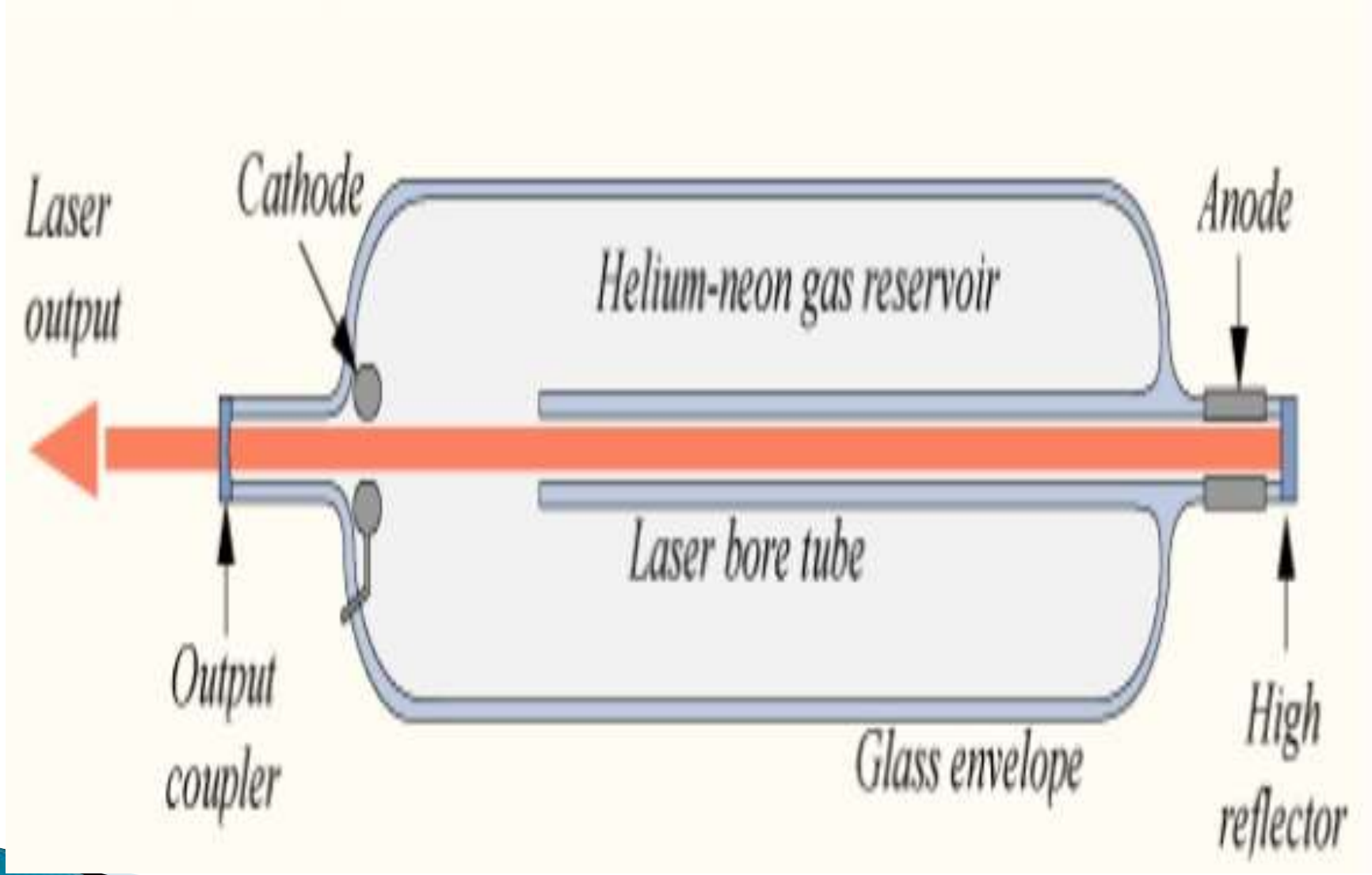

Figure.3*

Construction of He-Ne laser

- He Ne laser is a ***four energy level system***.
- A He-Ne laser consists of large and narrow discharge tube filled with helium and neon gases in the ratio 10:1 at a low pressure.
- The tube is enclosed between fully and partially reflective mirrors which serve as optical cavity.
- Population inversion is achieved by ***electric discharge***.
- Electric discharge is produced in gas by using electrodes.
- ***Ne*** atoms are the ***active centers***.

Working of He Ne Laser

- When the power is switched on, electrons from the discharge collide with the He and Ne atoms and pump to excited state 20.61eV ($2's_1$).
- Helium atoms after transferring their energies (0.05eV additional energy) to neon atoms & ne atoms are excited from 20.61eV (2s) to 20.66 eV (3s).
- 20.66 eV (3s) is a metastable state of ne atoms.

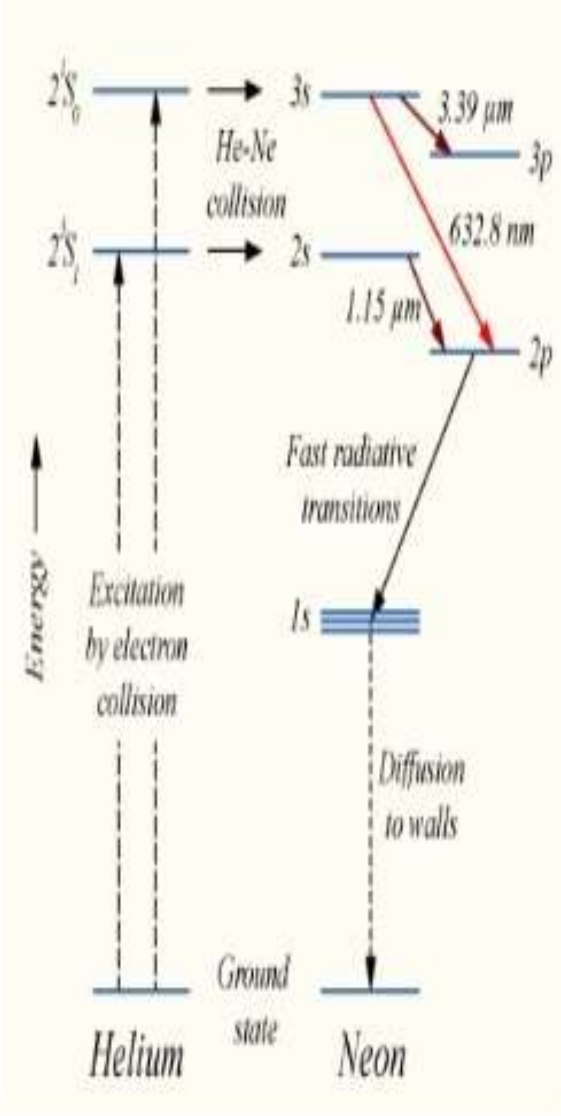

Figure.4*

- When Ne atom passes, from Metastable state to an excited state of 18.70 eV (2p) it emits a spontaneous photon of wavelength 6328Å.
- This photon travels through the gas mixture and move back & forth by mirror ends along the axis of the tube and stimulate the ne atom.
- The population in this level 20.66 eV (3s) is more than those in lower levels 18.70 eV (2p) and 3p.
- The emission of radiation having wavelength 6328Å is red in colour and it gives continuous emission of radiation. Transition from 20.66eV to 18.70eV is laser transition.

Advantages of He Ne laser

- Power needed for excitation is less because laser transition does not terminate at the ground state.
- Operate in ***CW mode*** (continuous wave) instead of pulse form output.
- ***High efficiency*** as compare to Ruby laser.
- Active medium in the form of gas. So, impurities in active medium is minimum.

Applications of lasers

In Communication

- In optical fiber communication laser bandwidth is very high as compared to the radio and microwave communications.
- As it has large bandwidth, more amount of data can be sent & more channels are simultaneously transmitted.

In industry

- Lasers range finder is used to measure distance to making maps by surveyors.
- Lasers can be used to blast holes in diamonds and hard steel.

In Medical science

- CO_2 laser is specially used in spinal and brain tumour excision and kidney stone extrusion.
- Argon and CO_2 lasers are used in treatment of liver and lungs .
- Lasers are used in the treatment of Glaucoma.
- It is very useful in removing extraneous blood vessels that can form on the retina. the thin, light- sensitive membrane at the back of the eyeball.

References:
Figure.1-4* Laser & Its Applications by G. Hemanth & G. Guru Prasad
https://www.slideshare.net/81217436 24/lasers-ppt