Applied Physics (16SACAPH2)
Unit – III – LASER
(He-Ne Laser)

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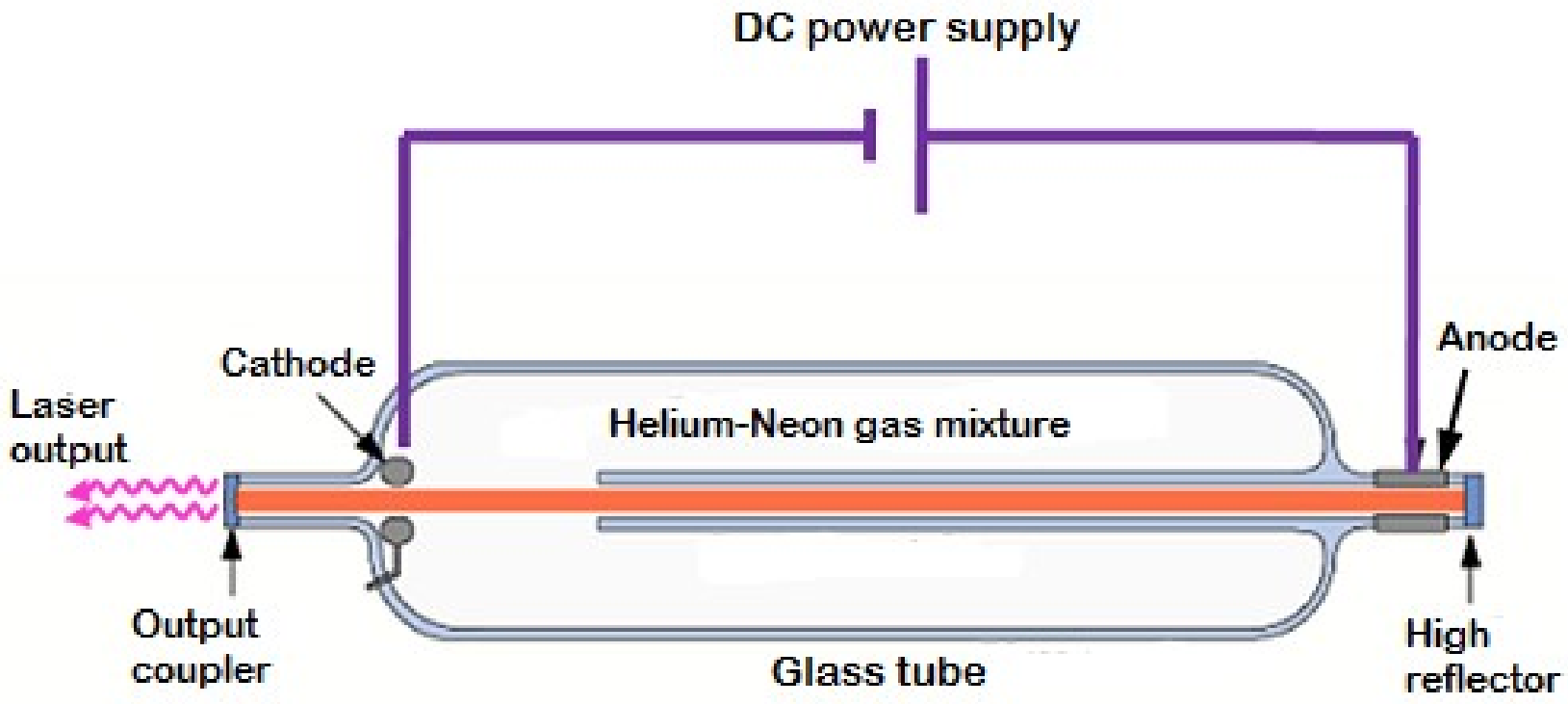
Helium - Neon Laser

- **Introduction**
  - This was the first gas laser to be operated successfully.
  - It was invented by Ali Javan and his co-workers at Bell Telephone Laboratories in the USA in 1961.
  - Its usual operation wavelength is 6328Å in the red portion of the visible spectrum.
  - He-Ne laser is a four-level laser.

Helium - Neon Laser

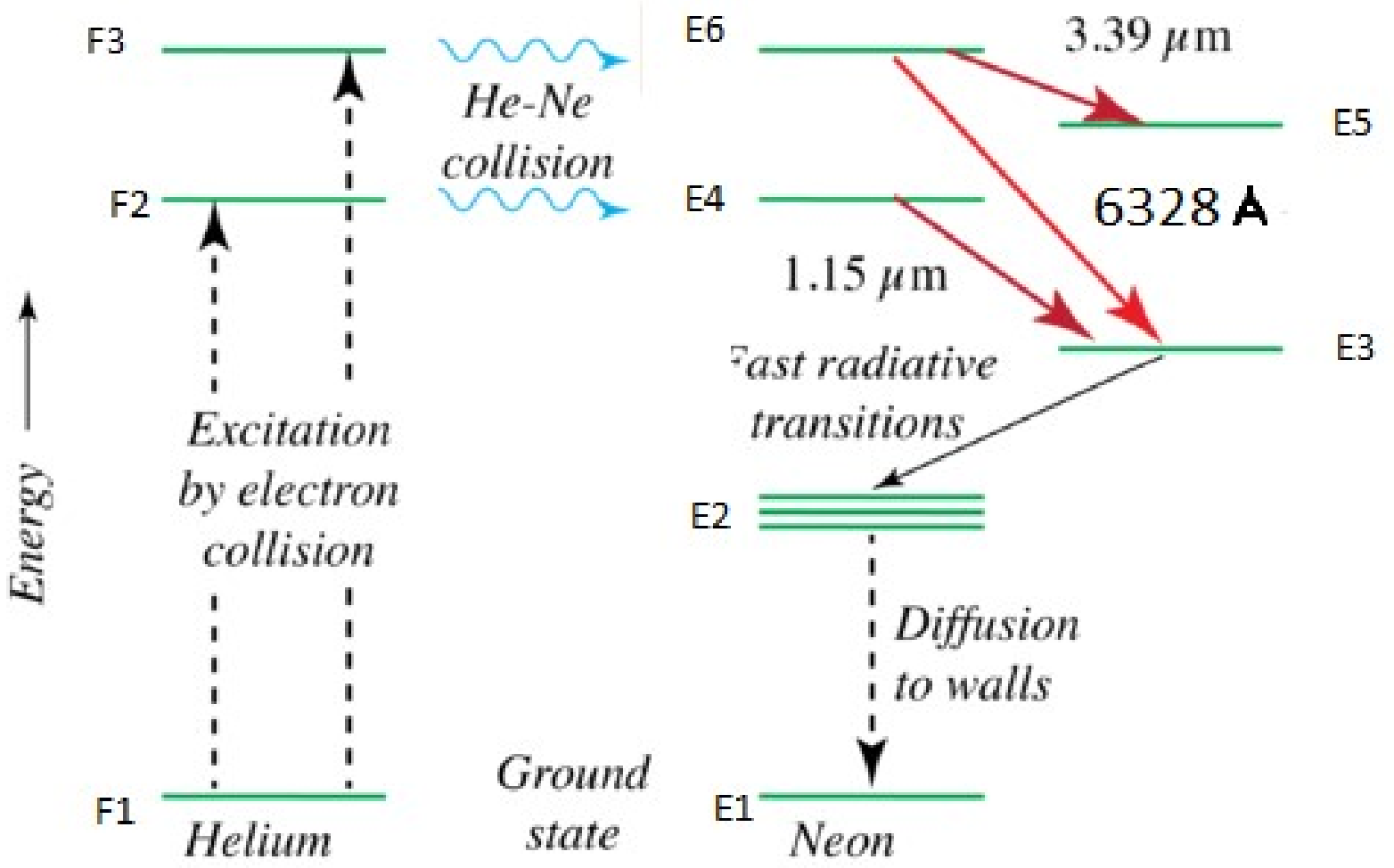
- **Construction**



Construction of a Helium - Neon laser

- This consists of a mixture of helium and neon gases in a ratio of about 10:1.
- The setup consists of a long and narrow discharge tube of length 80 cm and diameter of 1 cm.
- The pressure inside the tube is about 1mm of Hg.
- The energy or pump source of the laser is provided by an electrical discharge of around 1000 volts through an anode and cathode at each end of the glass tube
- The optical cavity of the laser typically consists of a plane, high-reflecting mirror at one end of the laser tube, and a partially transparent mirror of approximately 1% transmission at the other end.

Energy level diagram



Working of a Helium - Neon laser

- Electric discharge is passed through the gas. As electrons have a smaller mass than ions, they acquire a higher velocity.
- The He atoms are more readily excitable than Neon as they are in higher concentration.
- The role of He atoms is to assist in pumping Ne atoms to higher energy levels via inter atomic collisions
- Electrons collides with the He atoms, excite them to the metastable states F2(19.81eV) and F3(20.61eV) stay for a sufficiently long time.
- The excited He atoms losses energy through collision with unexcited Ne atoms, Ne atoms are excited to the metastable states E4(18.7eV) & E6(20.66eV) which have nearly the same energy as the levels of F2 & F3 of He.

Working of a Helium - Neon laser

- The probability of energy transfer from He atoms to Neon atoms is more as there are 10 He atoms to 1Neon atoms in the medium.
- Population inversion is achieved between E6 & E5, E6 &E3, E4 &E3.
- E6 → E3 transition generates a laser beam of red colour of wavelength 6328Å.
- E4 → E3 transition produces laser beam of wavelength 1.15μm (not in visible region).
- E6 → E5 transition results in a laser beam of 3.39μm (not in visible region).
- E3 → E2 transition generates incoherent light due to spontaneous emission (~6000Å)

Working of a Helium - Neon laser

- From the level E2 , the Ne atoms are brought back to the ground state through collisions with the walls.

- Also since E2 level is a metastable state , it can decrease the population inversion by exciting atoms from E2 to E3 . Hence the tube is made narrow so that Ne atoms in level E2 de-excite by collision with the walls of the tube.

- By a proper design of resonator , laser action in Ne is obtained in the visible region (6328Å)

Application

- The Narrow red beam of He-Ne laser is used in supermarkets to read bar codes.
- The He- Ne Laser is used in Holography in producing the 3D images of objects.
- He-Ne lasers have many industrial and scientific uses, and are often used in laboratory demonstrations of optics.

Advantages & Disadvantages of Helium - Neon Laser

- Following are the benefits or **advantages of** Helium - Neon **Laser**:
  - He-Ne laser tube has very small length approximately from 10 to 100cm.
  - Cost of He-Ne laser is less from most of other lasers.
  - Construction of He-Ne laser is also not very complex.
  - He-Ne laser provide inherent safety due to lower power output

- Following are the drawbacks or **disadvantages of** Helium - Neon **Laser**:
  - He-Ne laser is low gain system / device.
  - High voltage requirement.
  - Escaping of gas from laser plasma tube