ARGON-ION LASER

➢ Introduction:

- Argon-Ion Laser is a 4-level Ion Laser and was fabricated by William Bridges in 1964.
- It was one of the first lasers to ionize atoms and produce light at multiple wavelengths.

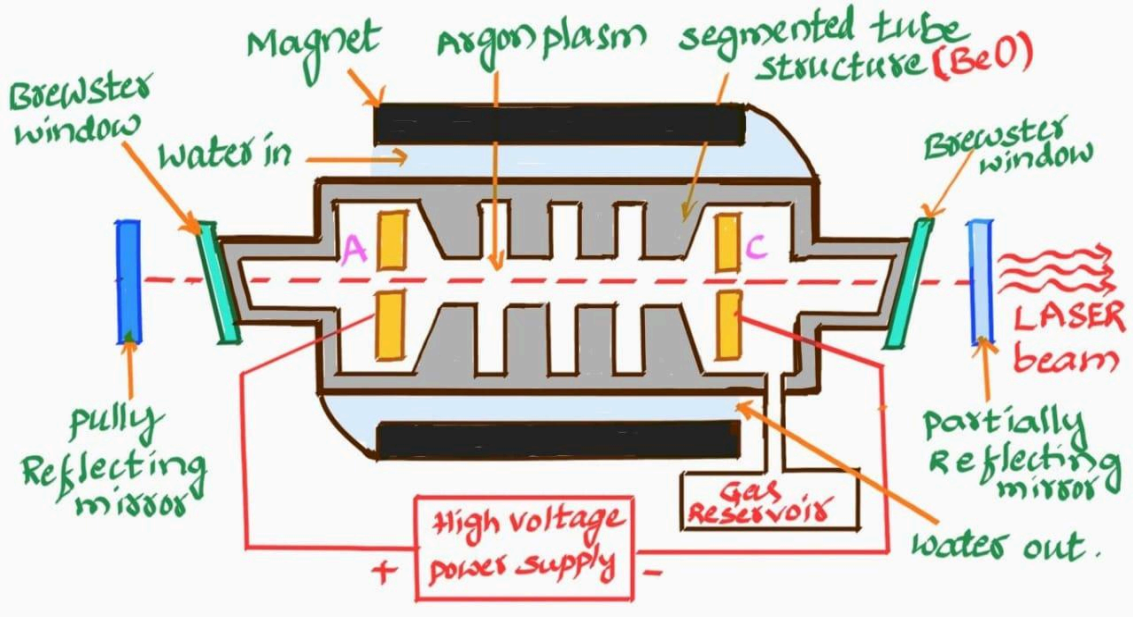
➢ Principle:

- An argon ion laser works by ionizing Ar atoms and using a continuous discharge to excite the ions and produce light of multiple wavelengths.

➢ Main Components:

- **Active medium:** Argon gas
- **Pumping source:** High voltage power supply
- **Resonating cavity:** Arrangement of reflecting mirrors
- **Pumping mechanism:** Electrical discharge

➢ Construction:

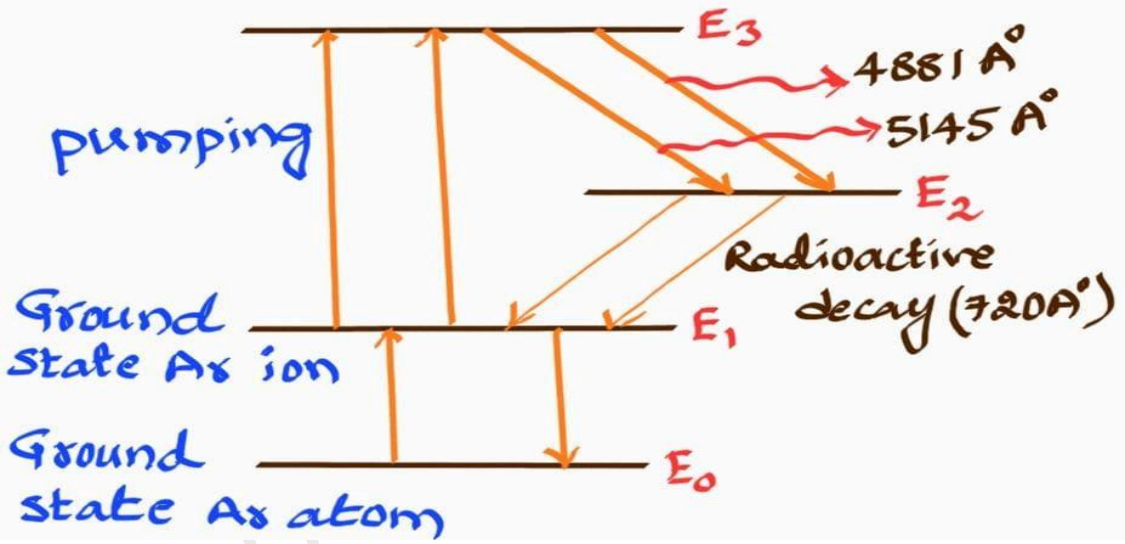


- The Argon Laser uses a segmented tube of Beryllia(BeO) or graphite, containing ionized Argon as the active medium.
- High-voltage electrodes(cathode & anode) at each end of the segmented tube create an electrical discharge, ionizing the Argon atoms.
- A surrounding solenoid magnet confines the Argon, increasing density and temperature, which excites and ionizes the Argon atoms for higher laser gain.

- A cooling system circulates water to prevent thermal damage and ensure stable operation. The gas Reservoir helps to maintain proper gas pressure in the tube.
- Two Brewster windows are positioned at the tube ends with Brewster's angle with respect to the optical axis of the laser.
- The optical resonator is completed by two external mirrors, one fully reflecting and other partially reflecting for laser output.

➢ Working:

- When the power supply is activated, it creates a powerful electrical discharge (arc) between the electrodes, ionizing the Argon gas within the tube and raising the Ar - ions to higher energy levels.
- The energy level diagram of Ar-ion Laser is shown below.



- Ar - atoms are pumped to E_3 by two step electron collisions during electric discharge. First, the ground state(E_0) neutral Argon atoms are Ionized to ground state(E_1), second, the ground state(E_1) Ar-ions are excited to E_3.
- The life time of upper laser level 10^{-8} s while that of the lower laser level is of the order of 10^{-9} s. So, the condition for population inversion is satisfied and emit multiple laser wavelengths ranging from 720A° (IR) to 5145 A° (visible Green) with most of the power developed at 4881 A° and 5145 A°
- Excited Ar ions in energy level E_3 fall back to E_2(metastable state) through either spontaneous emission or stimulated emission and emitted a laser beam of wavelengths 4881 A° and 5145 A° respectively.
- Ar - ions in E_2(metastable state) readily decay to Ar-ion ground state(E_1), releasing photons of wavelenth 720 A°

➢ Advantages:

- Large widths of spectrum which emit multiple wavelengths.
- High output & High gain system.
- Very small divergence.
- Low operational cost.

➢ Disadvantages

- Requires a cooling system to manage heat.
- Not suitable portability.
- Large amount of power supply.
- Low efficiency.

➢ Applications

- Used to treat Glaucoma and diabetic eye diseases.
- Used in Raman spectroscopy.
- Used in holography & Forensic Science.
- Used in dermatology to treat skin conditions.
- Used in ophthalmology for retinal photocoagulation and eye surgeries.
- Used in material processing including cutting and engraving.
- Used manufacturing of high quality components.
- Used in semiconductor fabrications and Lithography.
- Used as a source for optical pumping.

➢ Characteristics of Laser:

- It produces continuous wave output, providing stable and consistent light.
- It achieves high output power levels often exceeding 1 watt.
- It produces highly collimated and has excellent beam quality, making it ideal for precision work.