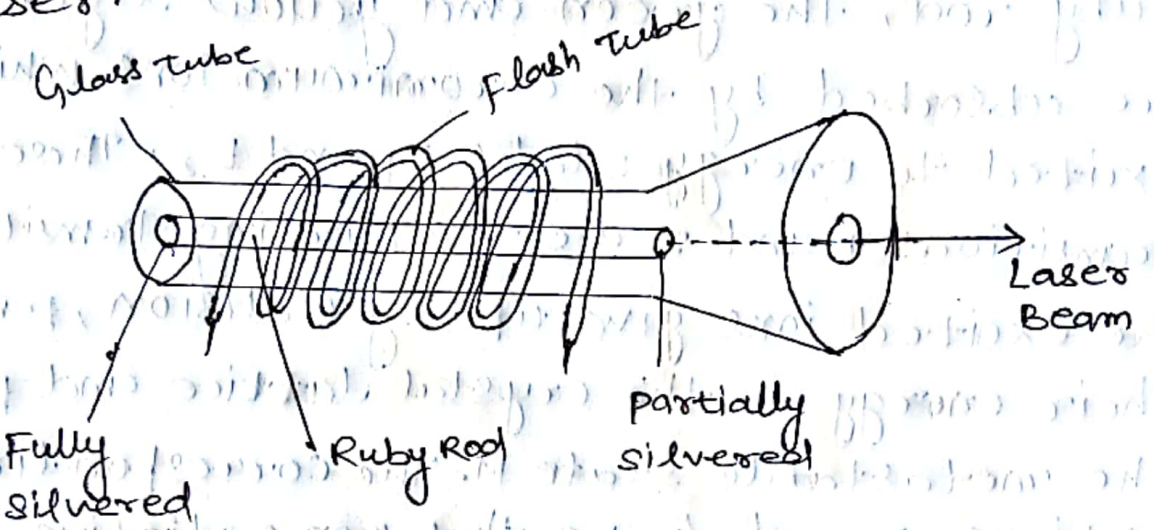
Prof: Vidya Sagar
Department of Physics
Raja Singh College, Siwan

B.Sc (Part-II) Hons
Paper-III

Working of Ruby Laser

The Ruby Laser:— This is the first laser developed in 1960, and is a solid state laser.

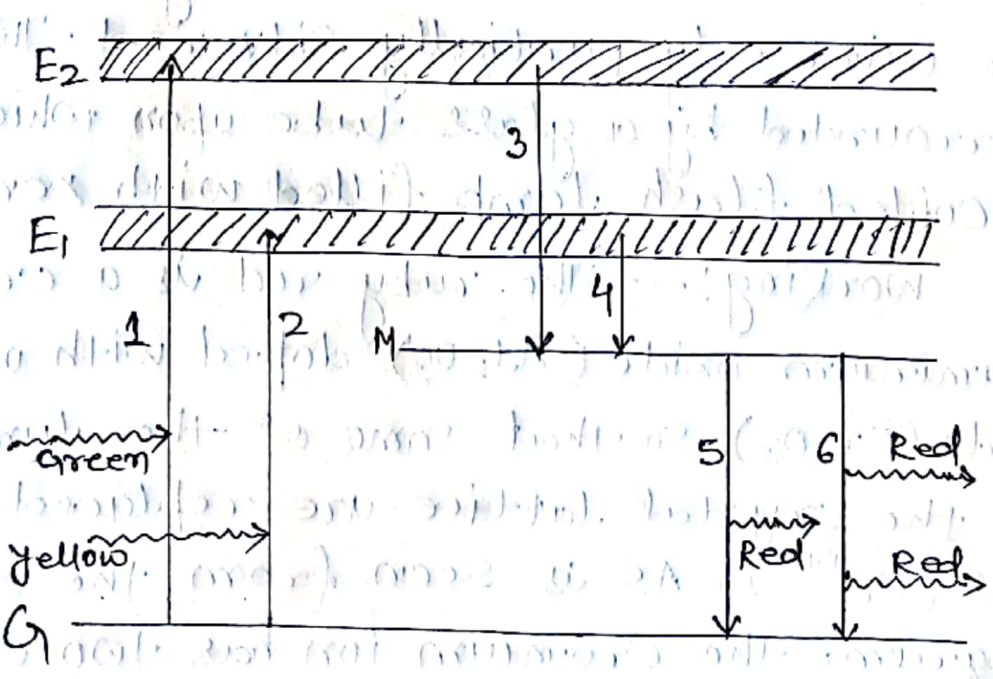


It ~~Consist~~ Consists of a pink ruby cylindrical rod whose ends are optically flat and parallel. one end is fully silvered and the other only partially silvered. The rod is surrounded by a glass tube upon which is wound a coiled flash lamp filled with xenon gas.

working:— The ruby rod is a crystal of aluminium oxide (Al_2O_3) doped with 0.05% chromium oxide (Cr_2O_3), so that some of the aluminium atoms in the crystal lattice are replaced by Chromium ions (Cr^{+++}). As is seen from the energy level diagram; the Cromium ion has two energy bands

E_1 and E_2 above its ground level G_1, and a metastable level M slightly below the energy band E_1. The level M has a life-time of about 3×10^{-3} second which is about 10^5 times greater than the life-time of other excited levels E_1 and E_2.

When a flash of light falls upon the ruby rod, the green and yellow light photons are absorbed by the chromium ions which are excited to energy states E_1 and E_2. These absorption transitions 1 and 2 are the pumping transitions. The excited ions give up, by collision, part of their energy to the crystal lattice and pass to the metastable state M. The corresponding transitions 3 and 4 are thus non radiative. Since the state M has a very long life, the number of ions in this state goes on increasing and exceeds the number in the ground state G_1.



Thus population inversion is established between metastable state M and ground state G.

When an ions passes spontaneously from the metastable state to the ground state it ~~means~~ emits a red photons of wavelength 6943 Å. This photons travels through the ruby rod and if it is moving parallel to the axis of the crystal, is reflected back and forth by the silvered ends until it stimulates an excited ion and causes it to emit a fresh photon in phase with the stimulating photon (stimulated transitions). The process is repeated again and again because the photons repeatedly move along the crystal being reflected from its ends. The photons thus multiply. When the photon beam becomes sufficiently intense, part of it imerges through the partially silvered end of the crystal.

Application:— The laser beam has certain characteristics which are not present in beams derived from other light source It is (i) highly coherent, (ii) almost perfectly monochromatic, (iii) extremely intense and (iv) almost perfectly parallel. Due to these characteristics the laser beam can be used with advantages in holography, radio communication in outer space, ranging and detection of targets, generation of high heat in a small space, piercing hole in hard materials, welding, and in delicate surgery.