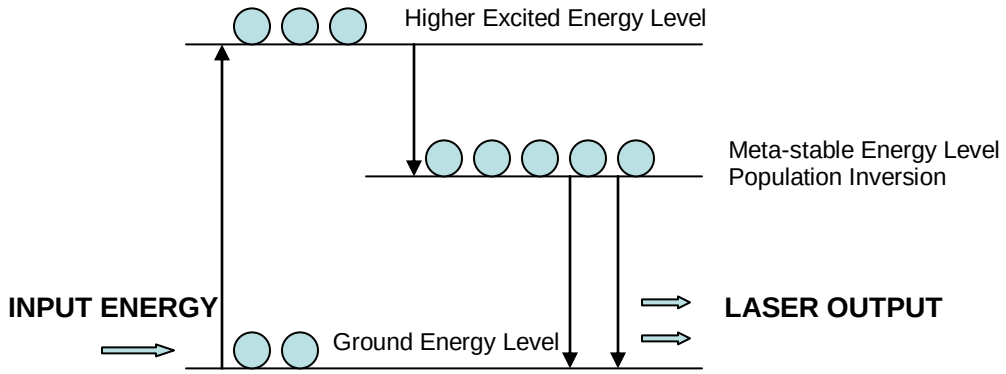
# ESSENTIAL COMPONENTS OF LASER

**The essential components of a laser are –**

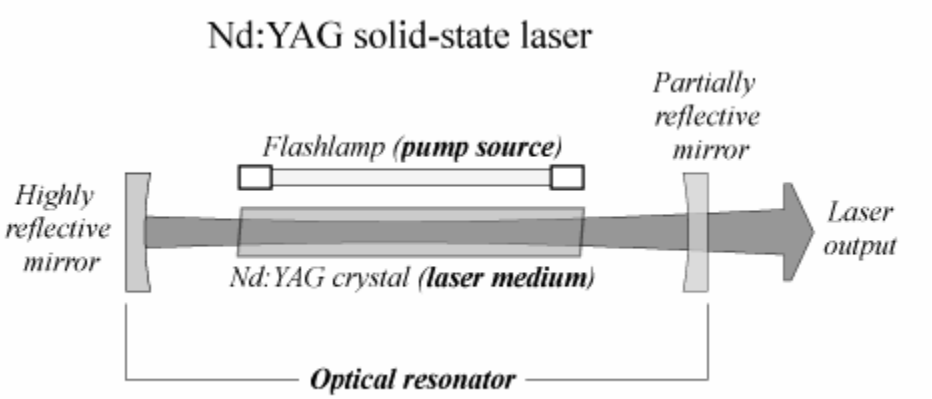
**Pumping –** In order to realize and maintain the state of population inversion, it is necessary that the atoms must be continuously promoted from the lower level to the excited level. Energy is to be supplied somehow to the laser medium to raise atoms from the lower level to the excited level and for maintaining population at the excited level at a value greater than that of the lower energy. The process by which atoms are raised from the lower level to the upper level is called pumping. Population inversion cannot be achieved by heating the material. The most commonly used pumping methods are: optical pumping, electric discharge, direct conversion, chemical reaction, inelastic atom-atom collision etc.




**Meta-stable states –** An atom can be excited to a higher energy level by supplying energy to it. Normally, excited states have short life times and release their excess energy in a matter of nano-seconds ($10^{-9}$ second) by spontaneous emission. Thus, population inversion cannot be established. To achieve this, an excited state with a longer life time is needed. Such states where atoms remain for an appreciable time ($10^{-6}$ to $10^{-3}$ second) are known as meta-stable states. In meta-stable state, population of atoms can exceed the population of atoms of a lower level and lead to the state of population inversion. If the meta-stable states do not exist, there could be no population inversion, no stimulated emission and hence no laser action.

**Active medium –** Atoms in general are characterized by a large number of energy levels. However, all types of atoms are not suitable for laser operation. Even in a medium consisting of different species of atoms, only a fraction of atoms of a particular species are suitable for stimulated emission and laser action. Those atoms which cause light amplification are called active centers. The rest of the medium acts as host and supports active centers. The medium hosting the active centers is called an active medium. An active medium is thus a medium which, when excited, reaches the state of population inversion, and

eventually causes light amplification. An active medium must have at least one meta-stable state. The active medium may be a solid, a liquid or a gas, on the basis of which different lasers are classified.




**Optical resonator –** Optical resonator is required to provide high photon field. It consists of two mirrors facing each other. The active medium is enclosed by this cavity. One of the mirrors is fully reflective while the other is partially reflective, say 99.9%. The optical cavity so formed is made use of to make stimulated emission possible in more number of atoms in the active medium, which increases the intensity of the laser beam.

Initially, the active centers are in ground state. After pumping process, state of population inversion is achieved. Spontaneous photons are emitted in all directions in initial stage. To generate coherent light, photons traveling in a specific direction are selected while others are rejected. These particular photons are made to pass through the medium a number of times with the help of two mirrors, due to which more and more strength is achieved. Laser beam

oscillations begin when the amount of amplified light becomes equal to the total amount of light lost through the sides of the resonator. As the oscillations build up to enough intensity, it emerges through the partially reflective (partially transmitting) mirror as highly collimated, coherent and intense beam of light called as laser light.

**Energy source –** Energy source raises the system to an excited state, causing population inversion via pumping that breaks the thermal equilibrium.

Source : http://msk1986.files.wordpress.com/2011/04/sem-ii-coherence-laser.pdf