

**CL37\_Q1. Why a two level system is not suitable for producing laser action at thermal equilibrium?**

**Ans:**

The basic requirement for light amplification is that the stimulated emission should be predominant over the spontaneous emission.

We know that stimulated emission is possible only when the upper energy state has a higher population than the lower energy state. Suppose if we have two levels in laser system the condition it requires is  $N_2 > N_1$  to establish population inversion

. But from the MB distribution function  $\frac{N_1}{N_2} = \exp^{\frac{h\nu}{kT}} \gg 1$

For a two level system in equilibrium this implies that T has to be negative if  $N_2$  has to be greater than  $N_1$ . Hence it is not possible to obtain population inversion between  $E_2$  and  $E_1$  in a two level system

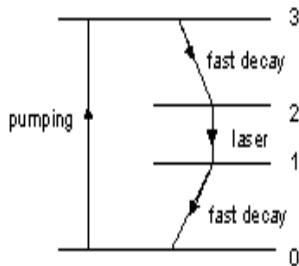
**CL37\_Q2. Bring out the difference between three level and four level lasers.**

**Ans:**

In three level systems population inversion is between the ground and the intermediate state and the ground state is quickly depleted resulting in a discontinuous phenomenon of stimulated emission. Whereas four level lasers ground level is not involved in lasing action. Here the absorption levels and the emission levels are completely decoupled. In this way the system can behave in a continuous mode and can produce a continuous LASER.

**CL37\_Q3. Draw the energy level diagram and explain how 4-level laser systems work.**

**Ans:**



A four level system can effectively decouple the absorption levels and the emission levels. In a four level system the absorption is between the lower (ground) state  $E_1$  and the higher excited state  $E_4$ . Electrons in the excited state decays non-radiatively to the intermediate meta stable state  $E_3$ . The electrons are stimulated to transit to a lower energy state  $E_2$  (above  $E_1$ ). Finally the electrons from the level  $E_2$  fall back to the ground state maintaining the population of the lower  $E_1$  so that the process of excitation can continue. The absorption is between  $E_1$  and  $E_4$  whereas the stimulated emission is between  $E_3$  and  $E_2$ . Thus the energy states in the two processes are completely decoupled. In this way the system can behave in a continuous mode and can produce a continuous LASER

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