

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 $\frac{N_1}{N_2} = \exp\left(\frac{h\nu}{kT}\right) \gg 1$

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

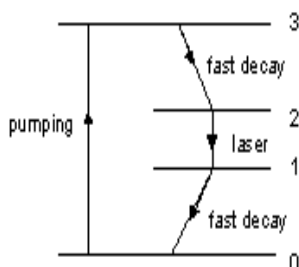
CL37_Q2. Bring out the difference between three level and four level lasers.

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