



Unit : IV

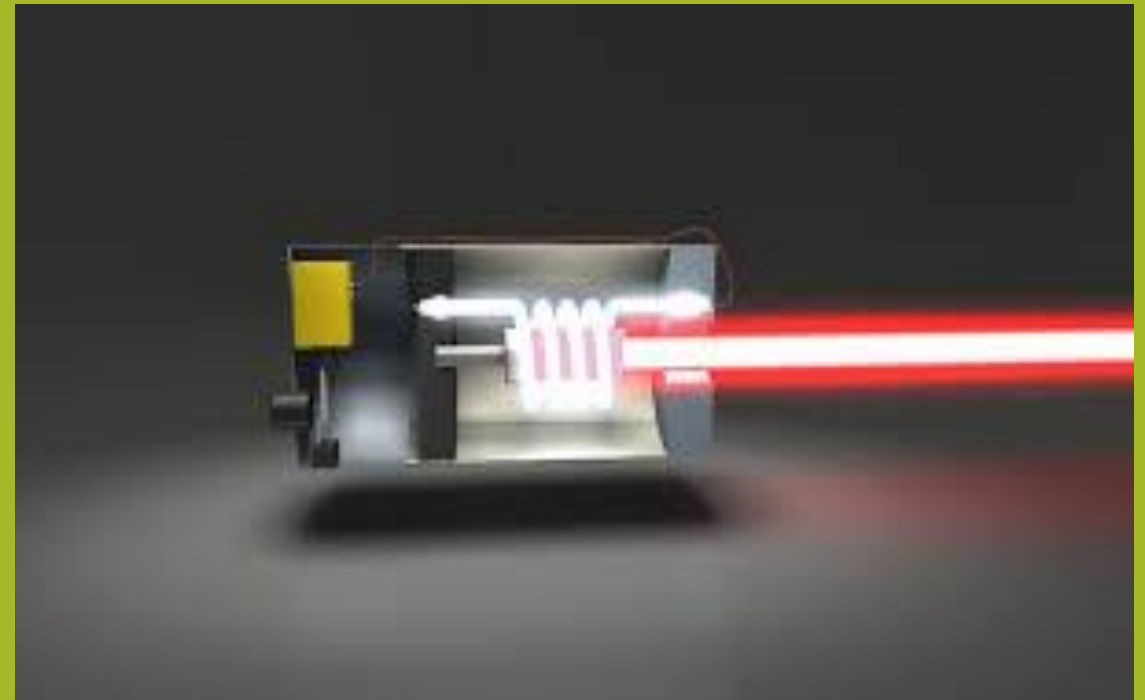
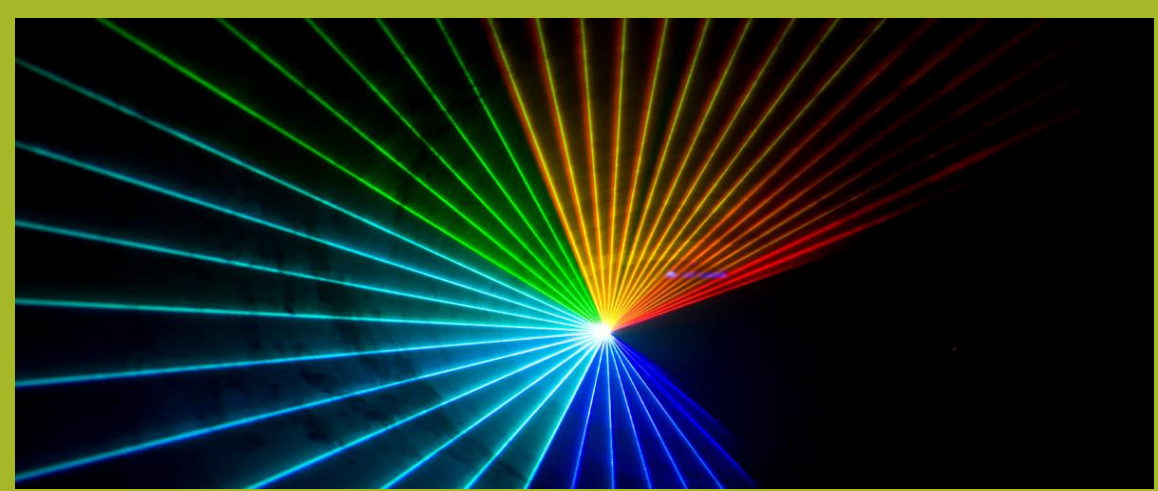
# *lasers*

BY

BHANUDAS NARWADE

ASST.PROF.

DEGLOOR COLLEGE, DEGLOOR





# LASERS:

Laser is **Photonic** device

LASER : **L**ight **A**mplification through **S**timulated **E**mission of **R**adiation

Laser : A source of light

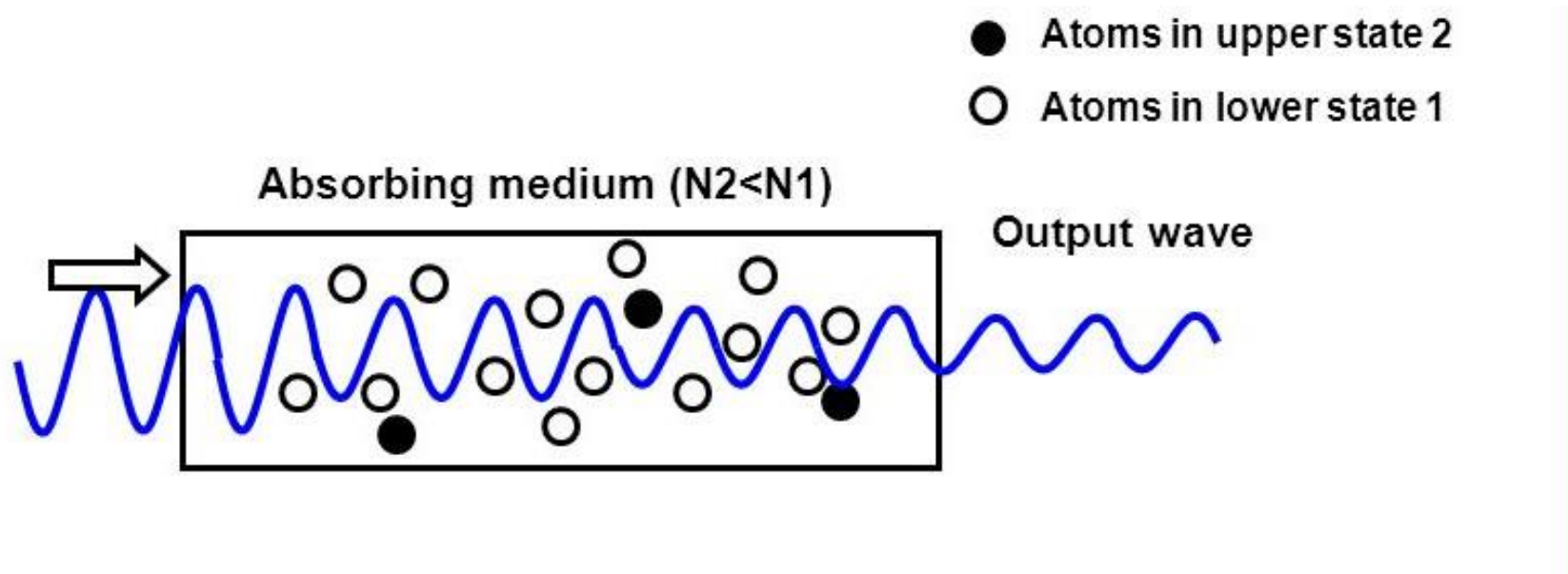
Laser : produces highly directional coherent monochromatic light beam

Based upon Albert Einstein's theoretical C. H. Townes in 1954 developed first practical

Laser is the effect of interaction of matter with light



# Attenuation of light in an optical medium



When light travels through medium, gradual reduction in intensity due to  
1) Absorption and 2) Scattering of light in medium  
Reduction in intensity with distance called attenuation of light



# Interaction of matter with light:

Process of the transfer of energy from atom to light is light amplification

Light amplification can be converted into source of light

Laser is monochromatic coherent light source

Radiation incident on material is viewed as stream of photons

Each photon carries energy  $E = h\nu$

When a photon travels through a medium, three different processes occur

1. Absorption
2. Spontaneous emission
3. Stimulated emission



# Interaction of matter with light

## 1. Absorption:

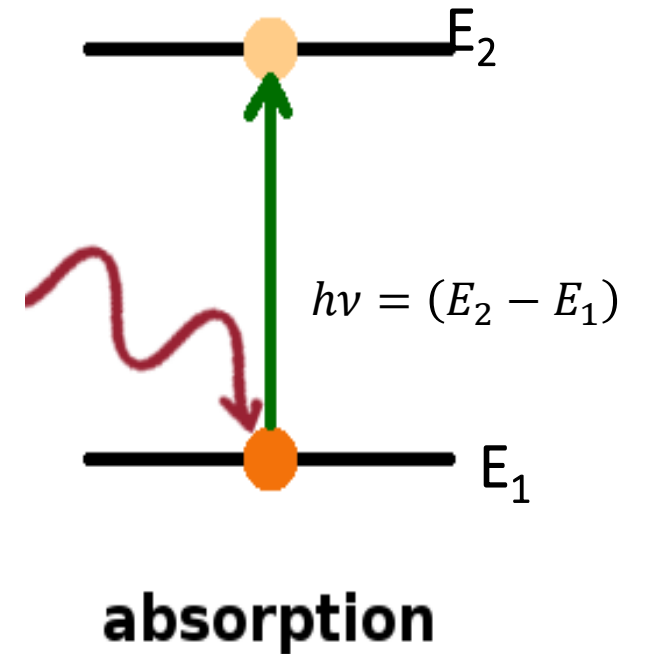
When photon of energy  $E = h\nu = (E_2 - E_1)$  incident on atom, it impart its energy to atom and disappear

Atom absorb incident photon, absorb adequate energy and jump to excited state

Transition called absorption transition referred as induced absorption

$A + h\nu = A^*$       A is atom in lower state

$A^*$  atom in excited state





# Interaction of matter with light:

## 2. Spontaneous Emission:

Excited atom reverts to lower energy level by releasing a photon of energy  $h\nu = (E_2 - E_1)$

Emission of photon occurs on its own and without any external impetus called spontaneous Emission

$$A^* = A + h\nu$$

### Characteristics:

Probabilistic in nature

Not controlled from outside

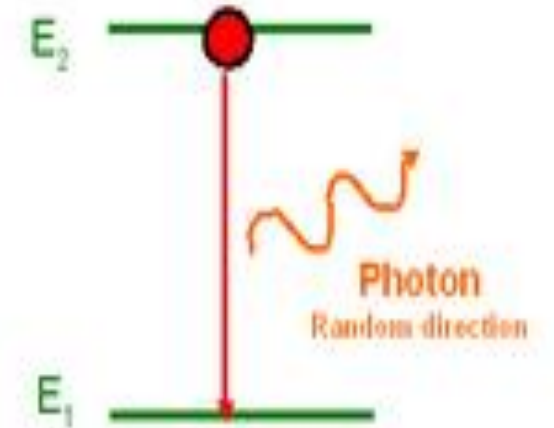
Instant of transition, direction of propagation, plane of polarization all random

Not monochromatic

Spread in all directions

Incoherents

### Spontaneous emission





# Interaction of matter with light:

## 3. Stimulated Emission:

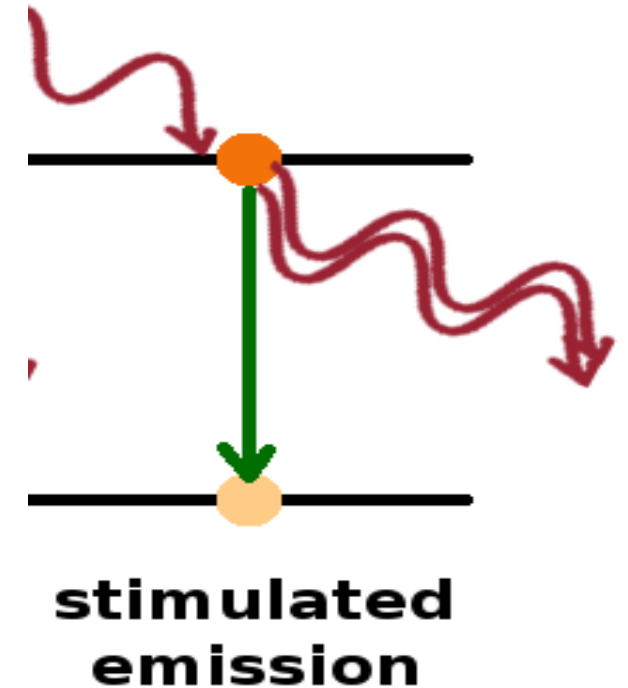
According to Einstein if photon can stimulate an atom from lower energy level to higher by absorption transition then photon should also be able to stimulate atom from same upper level to lower.

This alternative mechanism depends on photon density called stimulated emission

Excited state atom may interact with photon and make a downward transition

Photon is said to stimulate or induce the excited atom to emit photon of energy  $h\nu = (E_2 - E_1)$

Passing photon does not disappears and in addition to second photon which is emitted by excited atom







# Interaction of matter with light:

## 3. Stimulated Emission:

Phenomenon of forced photon emitted by excited atom due to action of external agency called stimulated or induced emission

$$A^* + h\nu = A + 2h\nu$$

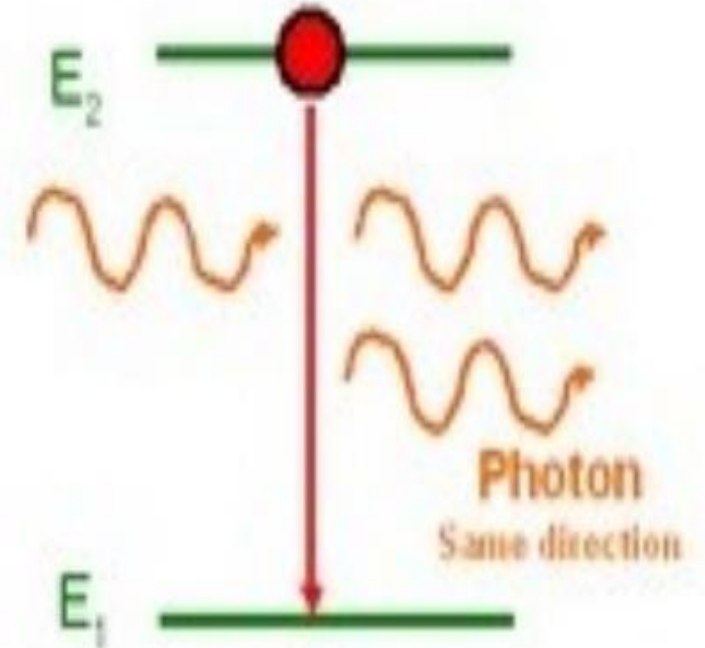
### Characteristics:

Controllable from outside

Induced photon and stimulated photon in the same direction

Induced photon identical with stimulated by frequency, phase, plane of polarization

## Stimulated emission



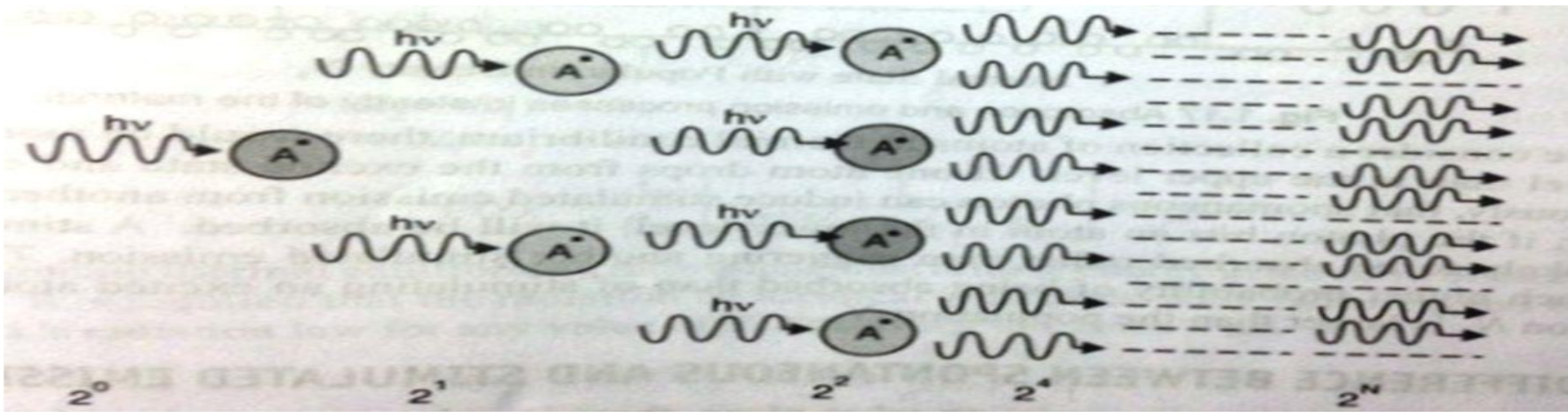




# Interaction of matter with light:

## 3. Stimulated Emission: Multiplication of photons

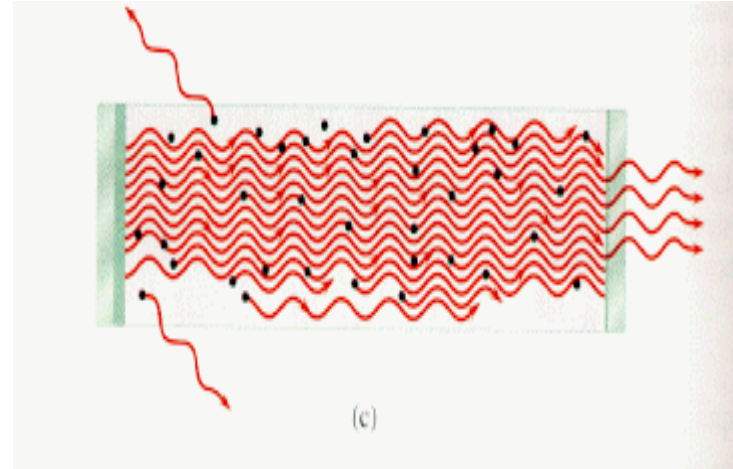
### Multiplication of Stimulated Photons





# Interaction of matter with light:

3. Stimulated Emission:  
Light amplification  
Coherent  
monochromatic





# Components of laser:

Active Medium:

Atoms causes laser action called active centers

Medium hosting active centres called active medium

Pump: supplies energy

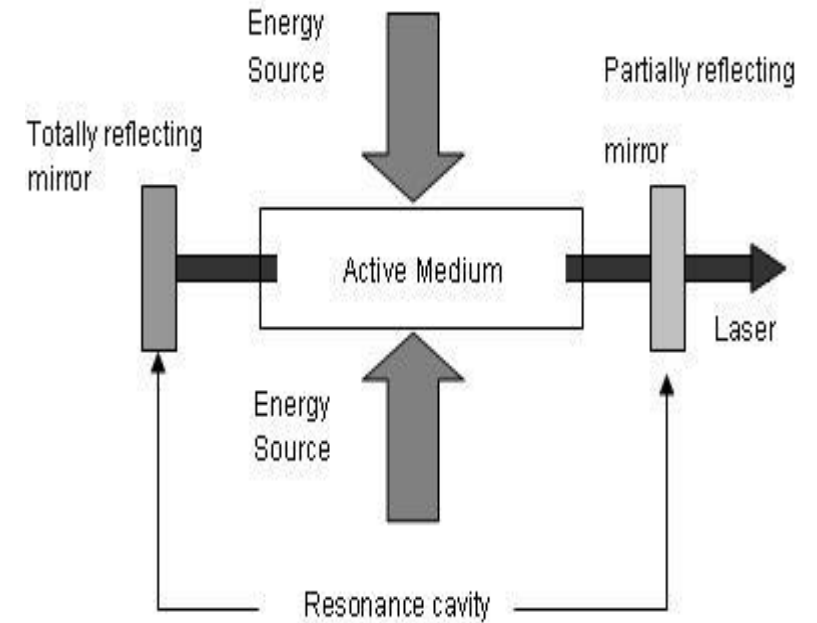
Active population inversion  $N_2 \gg N_1$

Three types:

Electrical discharge

Optical pumping

Direct conversion





# HE-NE LASERS:

Gas laser

Used in college laboratories

Operate with rarefied gases as a active medium

Excited by electric discharge

Discharge tube filled with mixture of Helium- Neon as 10:1

Neon atoms are active centers

He-Ne employs four level pumping scheme

Generate laser beam of red colour of wavelength 6328 A0



# Properties of laser:

Directionality

Negligence divergence: plane waves

High intensity

High degree of coherence

High monochromaticity