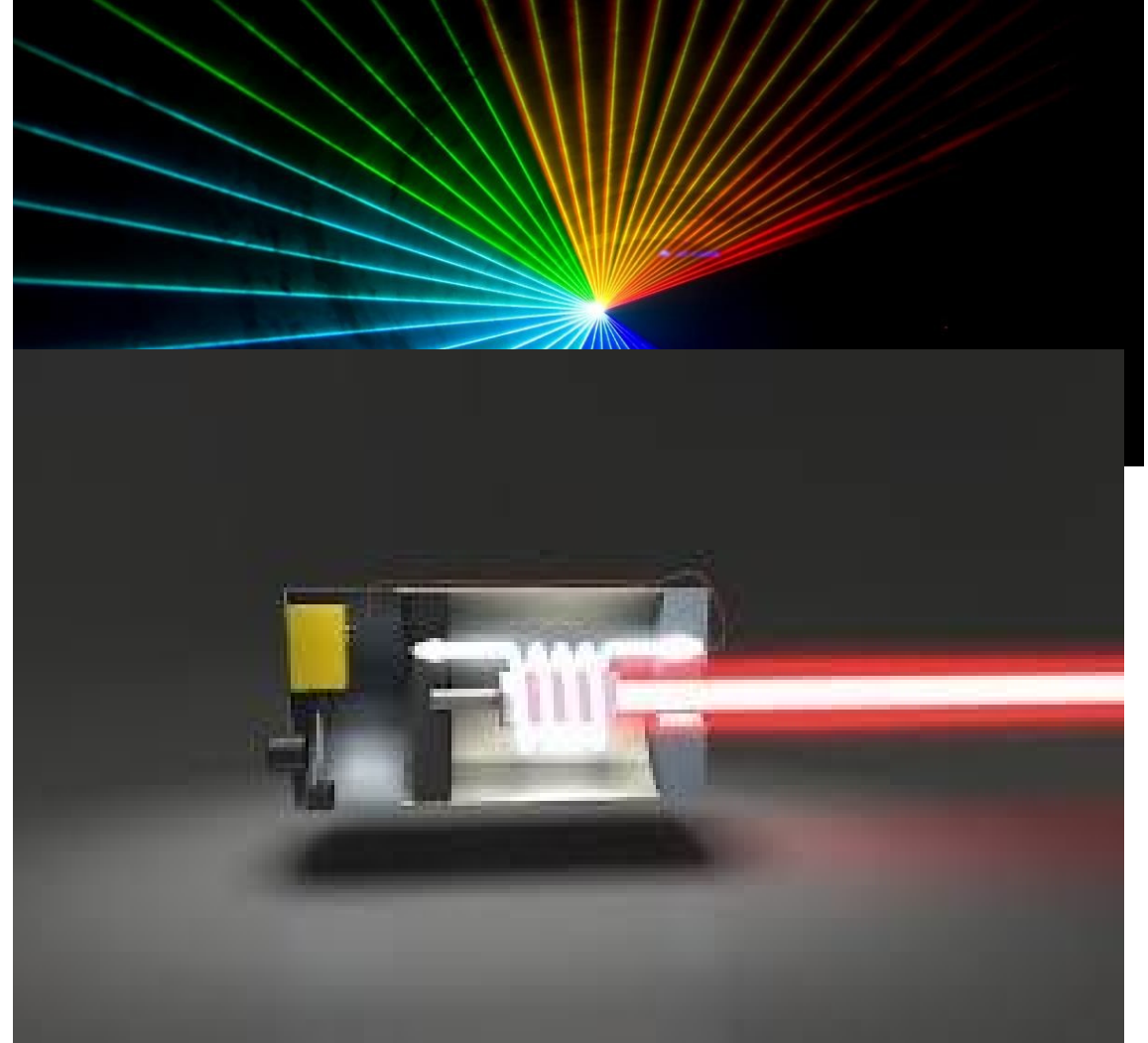


Lasers



LASERS:

Laser is **Photonic** device

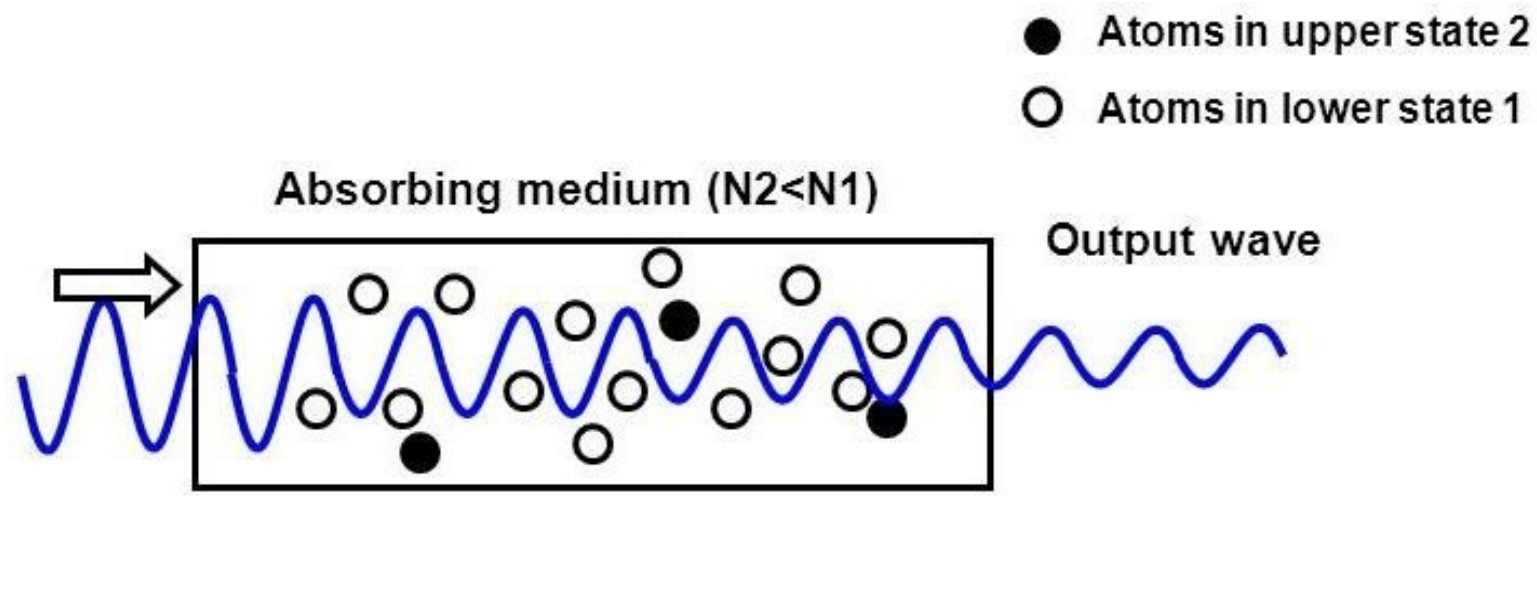
LASER : **L**ight **A**mplification through **S**timulated **E**mission
of **R**adiation Laser : A source of light

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



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

Process of the transfer of energy from atom to light is light amplification Light amplification can converted into source of light

Laser is monochromatic coherent light source

Radiation incident on material is viewed as

stream of photon Each photon carries energy $E =$

$h\nu$

When photon travels through medium,three difference processes occurs

1. Absorption
2. Spontaneous emission
3. Stimulated emission

Interaction of matter :

1. Absorption:

When photon of energy E incident on

$$= h\nu = (E_2 - E_1)$$

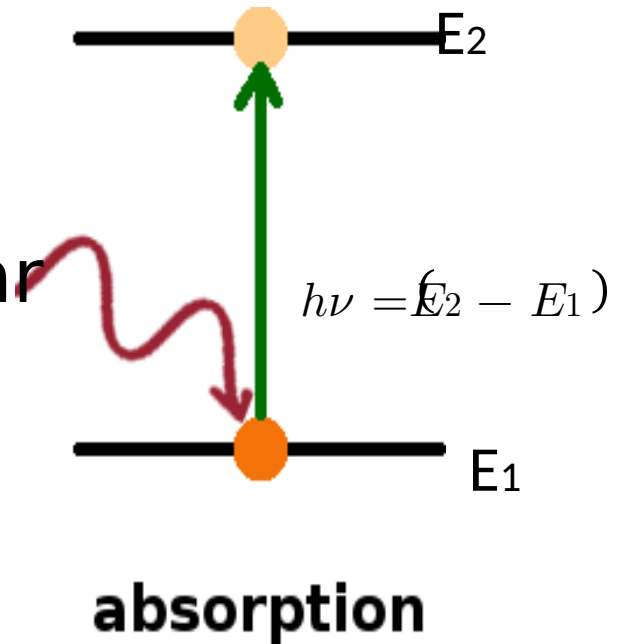
atom, it impart its energy to atom and disappear

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

2. Spontaneous Emission:

Excited atom reverts to lower energy level by releasing

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

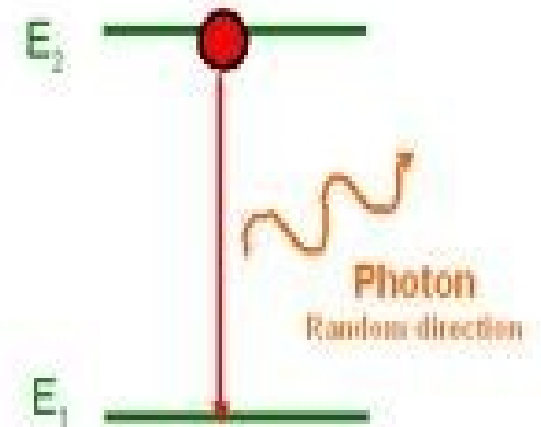
Instant of transition, direction of propagation, plane of polarization all random

Not

monochromatic

Spread in all directions

Spontaneous emission



Interaction of matter

Incoherents

Interaction of matter

3. Stimulated Emission:

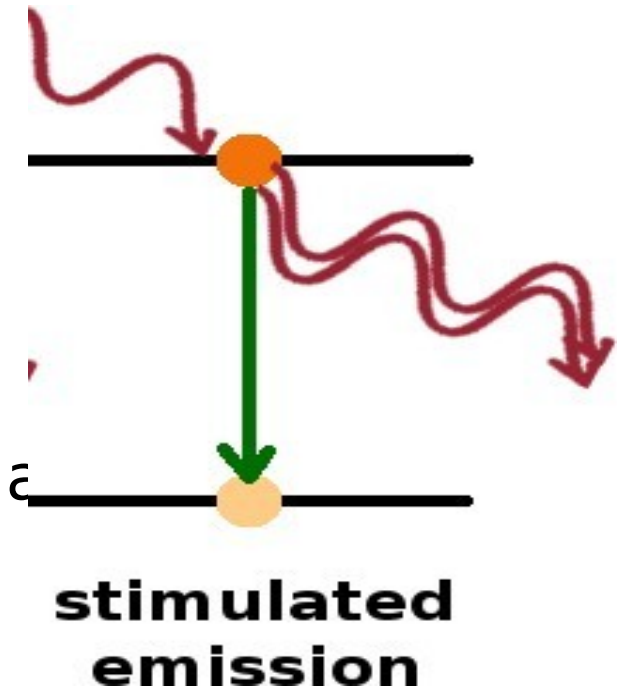
According to Einstein if photon can stimulate an atom from lower energy level to higher by absorption transition then photon should also be able to stimulate atom from same upper level to lower.

This alternative mechanism depends on photon density called stimulated emission

Excited state atom may interact with photon and make a 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

3. Stimulated Emission:

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

emission

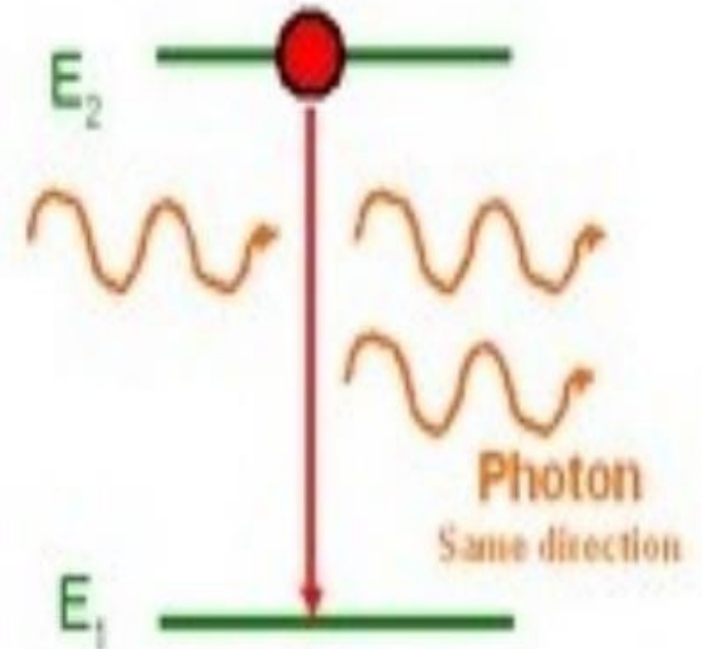
$$A^* + h\nu = A + 2h\nu$$

Characteristics:

Controllable from outside

Induced photon and stimulated photon in the same direction
Induced photon identical with stimulated by frequency, phase, plane of polarization

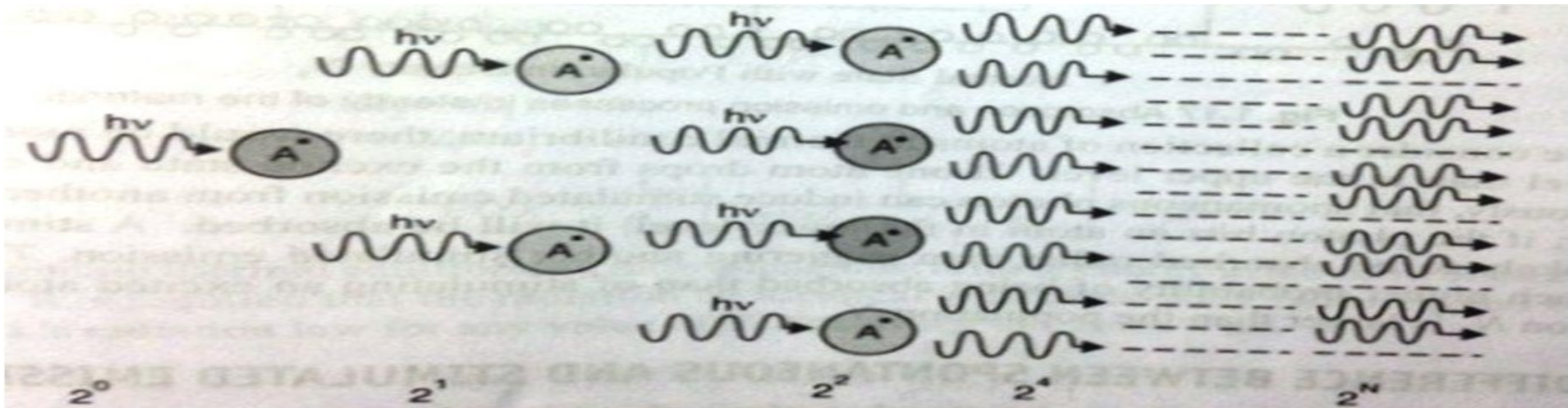
Stimulated emission



Interaction of matter

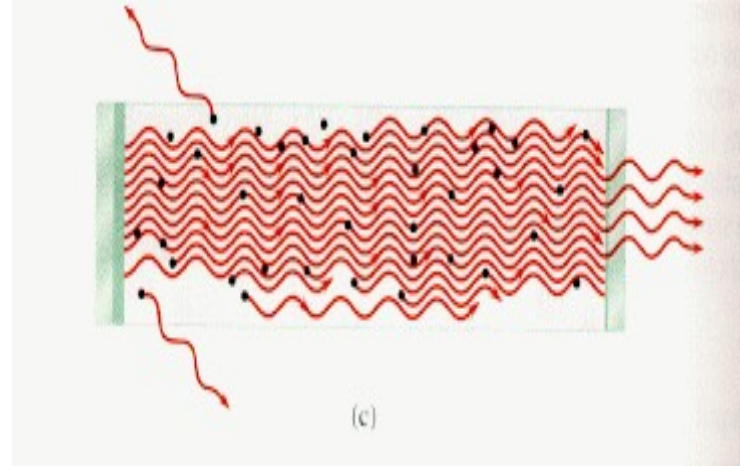
3. Stimulated Emission:
Multiplication of photons

Multiplication of Stimulated Photons



Interaction of matter

3. Stimulated
Emission: Light
amplification
Coherent
monochromatic



Components of

Active Medium:

Atoms causes laser action called active centers Medium hosting active centres called active medium Pump: supplies energy

Achieve population inversion

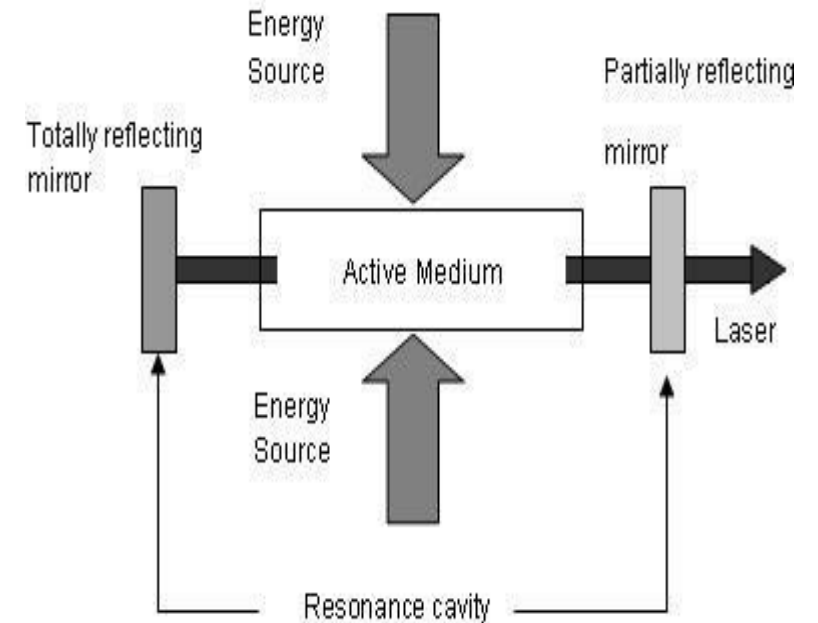
$N_2 \gg N_1$ Three types:

Electrical discharge

Optical pumping

Direct

conversion



HE-NE

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 Å

Properties of

Directionality

Negligence divergence:

plane waves High intensity

High degree of coherence

High monochromaticity