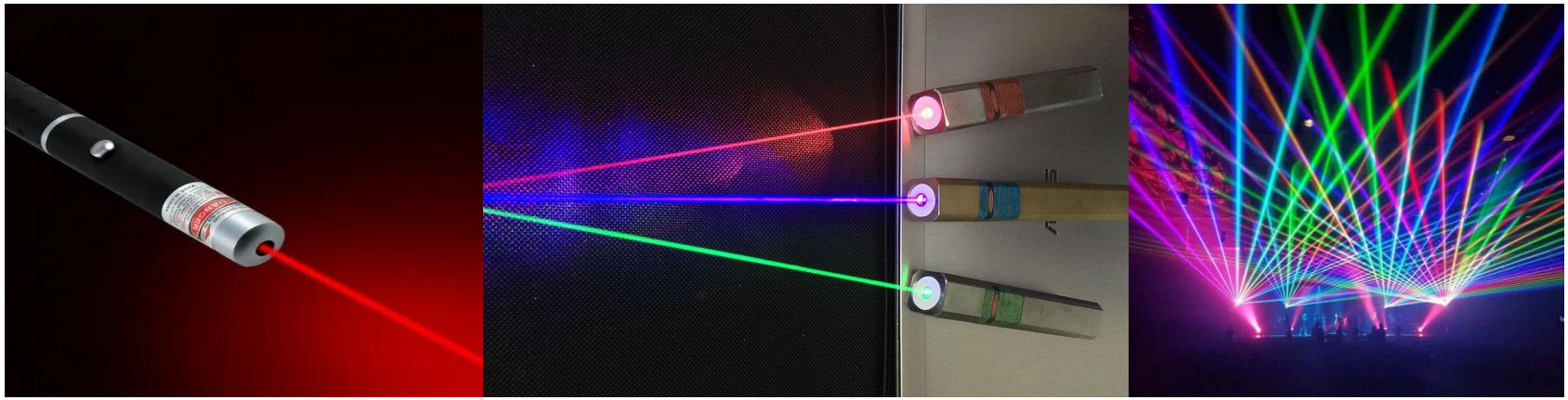
LASER



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LASER

LASER stands for '*Light Amplification by Stimulated Emission of Radiation*'

Laser is a very intense, concentrated, highly parallel and monochromatic beam of light.

Coherence is very important property of Laser.

Incoherent Light:

The light emitted from the Sun or other ordinary light sources such as tungsten filament and fluorescent tube lights is spread over a wide range of frequencies.

For eg. Sunlight is spread over Infra Red, Visible light and Ultra Violet spectrum. So, the amount of energy available at a particular frequency is very less and hence less intense.

Such light is irregular and mixed of different frequencies, directions and durations, and is incoherent.

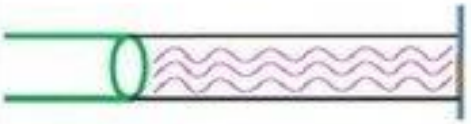
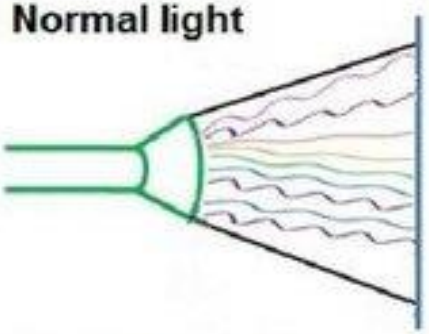
Incoherent light is due to spontaneous and random emission of photons by the atoms in excited state. These photons will not be in phase with each other.

Incoherent Light

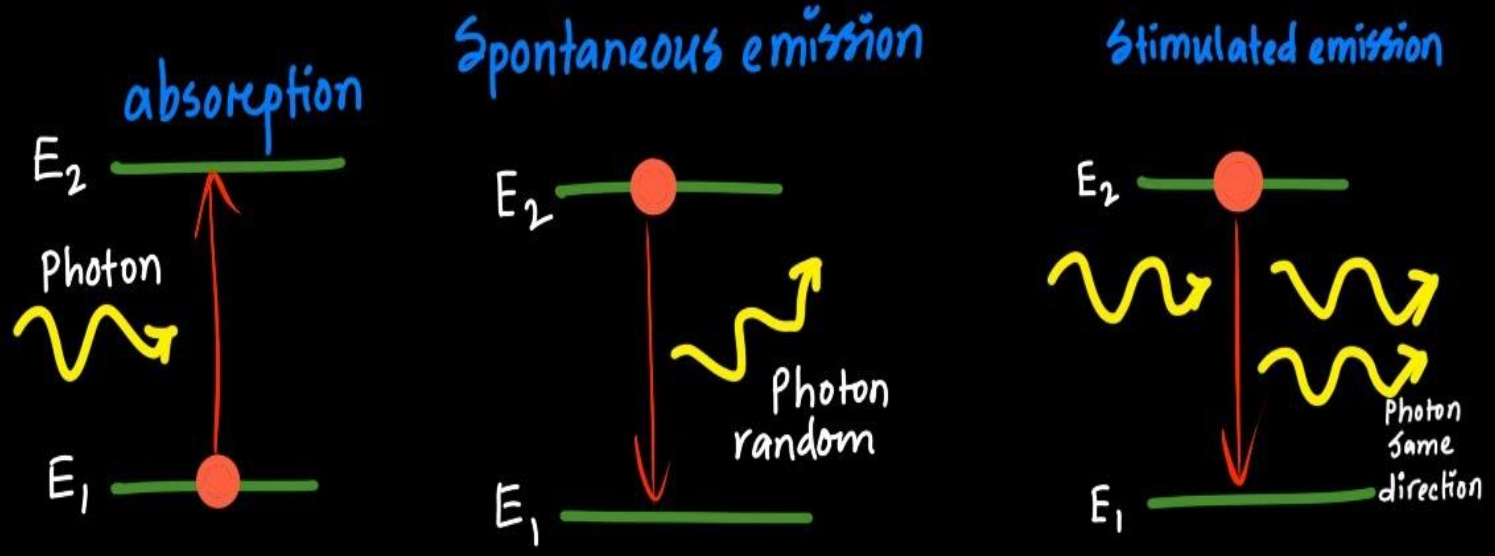
Laser light differs from ordinary light

	Laser Light	Ordinary Light
• Mono-chromatic		
• Directional		
• Coherent		

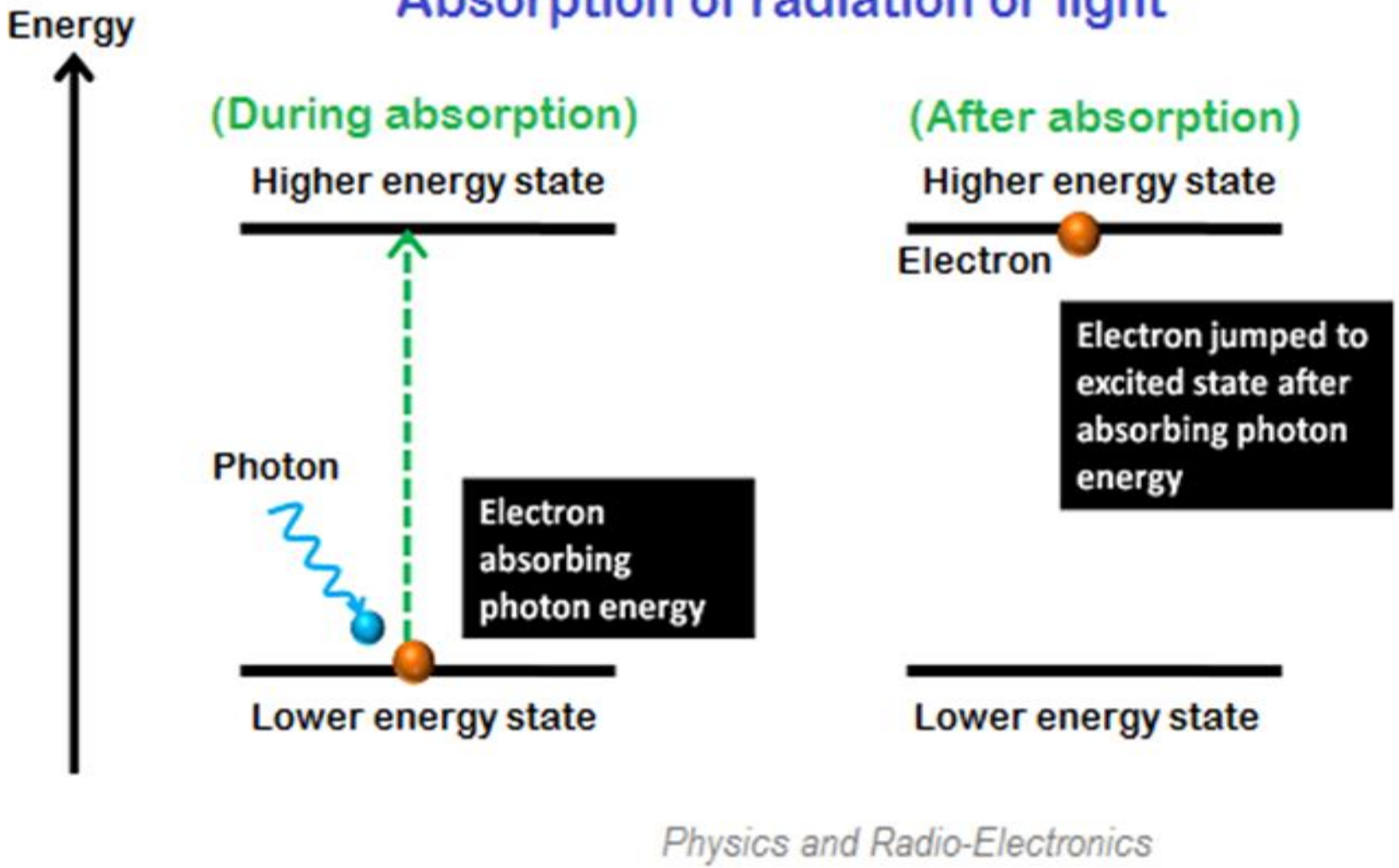
Light Amplification by Stimulated Emission of Radiation

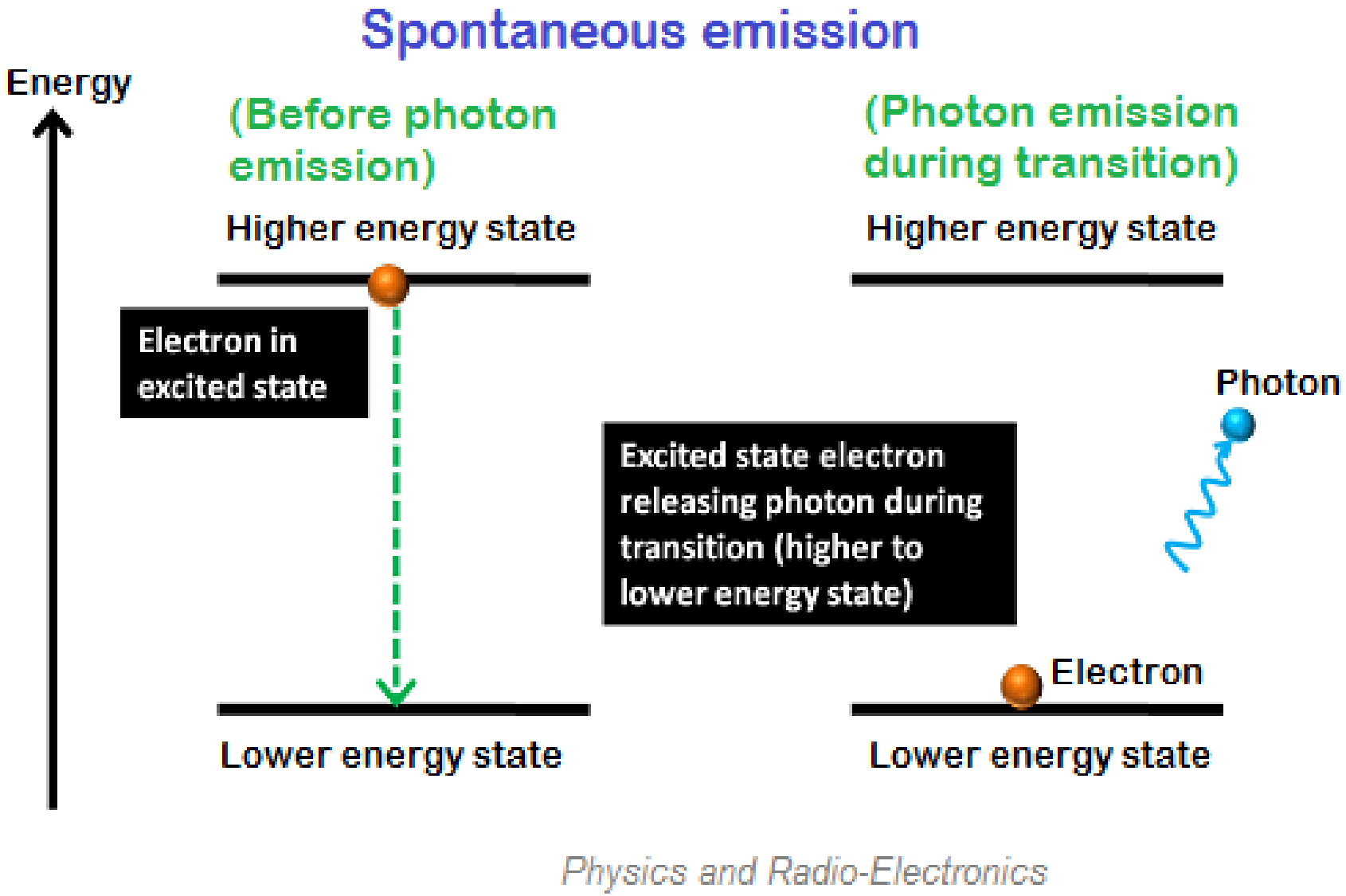
Laser light	Normal light
	
1- Monochromatic if visible	1- Polychromatic
2- Coherent	2- Noncoherent
3- Directional (Colimated i.e. with minimal divergence or parallel)	3- Nondirectional (nocolimated i.e. Scattered)
4- High intensity	4- Low intensity

Stimulated Emission Explained

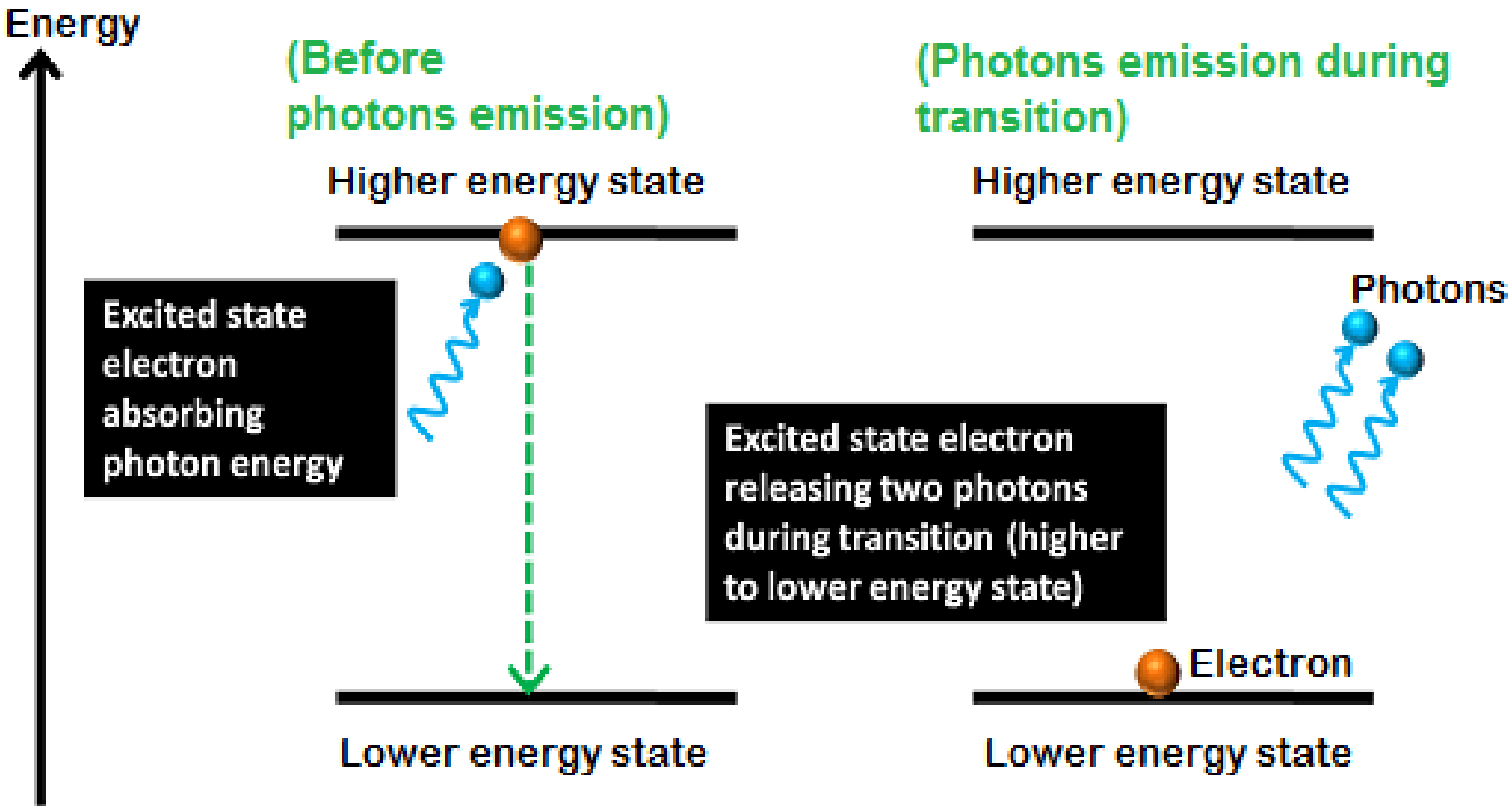


Absorption of radiation or light




Spontaneous emission
Energy
(Before photon emission)
(Photon emission during transition)
Higher energy state
Higher energy state
Electron in excited state
Photon
Excited state electron releasing photon during transition (higher to lower energy state)
Electron
Lower energy state
Lower energy state

Stimulated emission

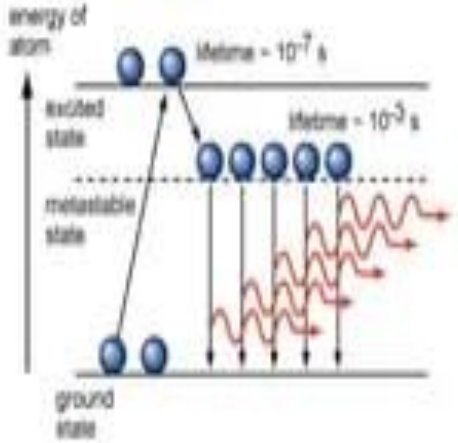


Difference between spontaneous and stimulated emission

Spontaneous	stimulated
1. Emission of light photon takes place immediately without any inducement.	1. Emission of a light photon is by inducement of a photon having energy equal to the emitted photon energy.
2. Polychromatic radiation	2. Monochromatic radiation
3. Incoherent radiation	3. Coherent radiation
4. Less directionality	4. High directionality
5. Less intense	5. High intense

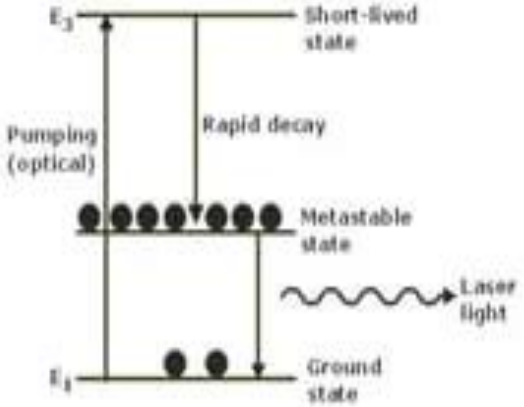
Metastable states

Normally an electron in an excited state will make the transition to a lower state in a time of 10^{-7}s. In contrast an electron may stay in a metastable state for 10^{-3}s.



Metastable states

To achieve population inversion we must have metastable states. These are excited states where electrons stay for unusually long times.



Population inversion

- For light amplification by stimulated emission of radiation the population of excited state must be greater than the population of lower energy state. This condition is called population inversion.

- Laser pumping: refers to **introducing energy into a laser system to produce a population inversion, where there are more atoms or molecules in an excited state than in the ground state**. This increases the probability of stimulated emission of light and enables lasing to occur.

DIFFERENT PUMPING MECHANISMS :

i. ***Optical pumping :*** Exposure to electromagnetic radiation of frequency $\upsilon = (E_2-E_1)/h$ obtained from discharge flash tube results in pumping Suitable for solid state lasers.

ii. ***Electrical discharge :*** By inelastic atom-atom collisions, population inversion is established.

Suitable for Gas lasers

iii. ***Chemical pumping :*** By suitable chemical reaction in the active medium, population of excited state is made higher compared to that of ground state Suitable for liquid lasers.

iv. ***Optical resonator :*** A pair of mirrors placed on either side of the active medium is known as optical resonator. One mirror is completely silvered and the other is partially silvered. The laser beam comes out through the partially silvered mirror.

Applications of laser

- Medicine: bloodless surgery, laser healing
- Industry: Cutting, welding, material heat treatment
- Defense: marking targets, missile defense
- Research: spectroscopy, laser scanning
- Commercial: laser printer, CDs, barcode scanners
- Aesthetics: laser light shows

Laser Applications

Laser Applications

Daily Applications

- Compact disk
- Laser printer
- Optical disc drives
- Optical computer
- Bar code scanner
- Holograms against forgery
- Fiber optic communications
- Free space communications
- Laser shows
- Holograms
- Kinetic sculptures

Medical Applications

- Surgery:
  - o Eyes
  - o General
  - o Dentistry
  - o Dermatology
- Diagnostic Fluorescence
- Soft Laser

Scientific Applications

- Basic Scientific Research
- Spectroscopy
- Nuclear Fusion
- Cooling Atoms
- Short Pulses, Study of Fast Processes

Industrial Applications

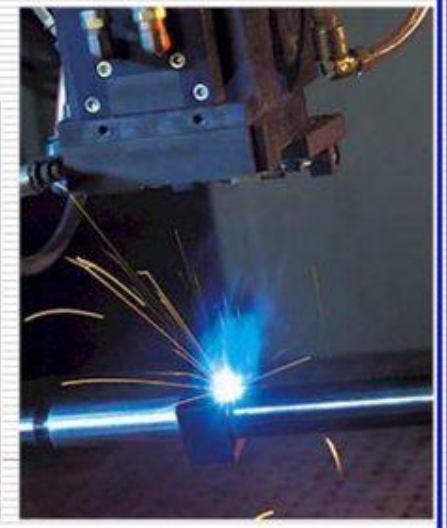
- Measurements
- Straight Lines
- Material Processing
- Spectral Analysis

Military Applications

- Laser range-finder
- Target designation
- Laser weapons
- Laser blinding

Special Applications

- Energy Transport
- Laser Gyroscope
- Fiber Lasers




Thank You