D-II (Physics Sub.)

Laser: Introduction, Principle and Applications

By

Dr. AMIT KUMAR SINGH
Department of Physics
Marwari College, Darbhanga

Contents

- **Introduction**
- **Properties of laser beam**
- **Interaction of Radiation with matter**
- **Population inversion: A necessary condition for light amplification**
- **Applications of Lasers**
- **References**

LASERS

History of the LASER

• Invented in 1958 by Charles Townes (Nobel prize in Physics 1964) and Arthur Schawlow of Bell Laboratories

• Was based on Einstein's idea of the "particle wave duality" of light, more than 30 years earlier

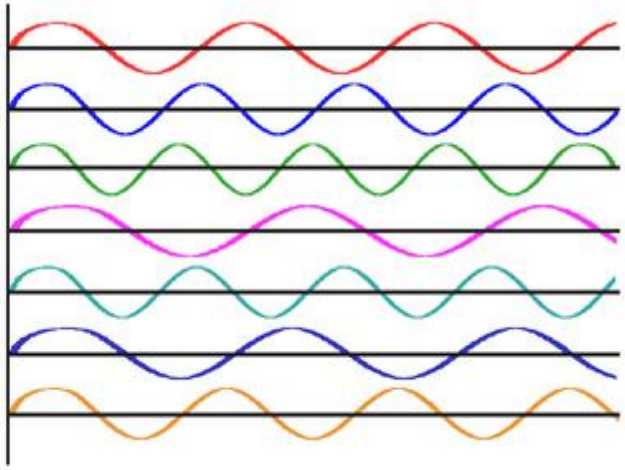
• Originally called MASER (m = "microwave")

What is Laser?

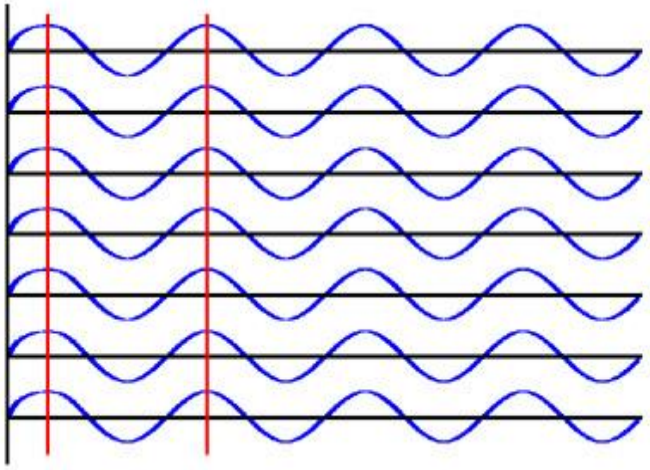
Light **A**mplification by **S**timulated **E**mission of **R**adiation

- A device produces a **coherent beam** of optical radiation by stimulating electronic, ionic, or molecular transitions to higher energy levels
- When they return to lower energy levels by stimulated emission, they emit energy.

Coherence



Incoherent light waves



Coherent light waves

Properties of Laser

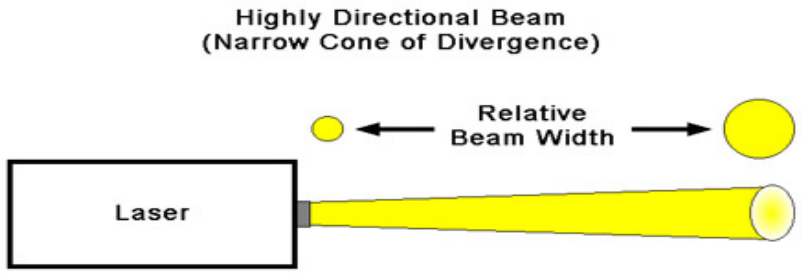
- The light emitted from a laser is **monochromatic**, that is, it is of one color/wavelength. In contrast, ordinary white light is a combination of many colors (or wavelengths) of light.

- Lasers emit light that is highly **directional**, that is, laser light is emitted as a relatively narrow beam in a specific direction. Ordinary light, such as from a light bulb, is emitted in many directions away from the source.

- The light from a laser is said to be **coherent**, which means that the wavelengths of the laser light are in phase in space and time. Ordinary light can be a mixture of many wavelengths.

- Laser beam is extremely **intense**.

Directionality



Conventional light source

Divergence angle (θ_d)

Basic concepts for a laser

- Absorption
- Spontaneous Emission
- Stimulated Emission
- Population inversion

To be continued….