

Ministry of Higher Education and Scientific Research

Al – Zahraa University for Women

College of Medical and Health Technologies



Theoretical

Introduction to Laser Physics

Lecture 1

2026-2027

Dr. Afrah Yas

Introduction to Laser:

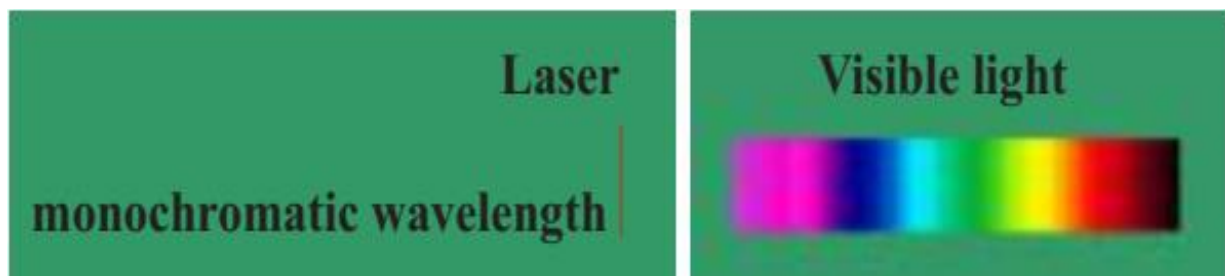
Laser has become an important element in many technological products like (Communications: Optical fiber data transmission) , (Industry: Cutting, welding, and precision measurement) , (Medicine: Surgery, diagnostics, cosmetic treatments), (Science: Spectroscopy, atomic and molecular studies), (Daily life: Barcode scanners, CD/DVD players, laser printers) also use laser.

Laser Definition:

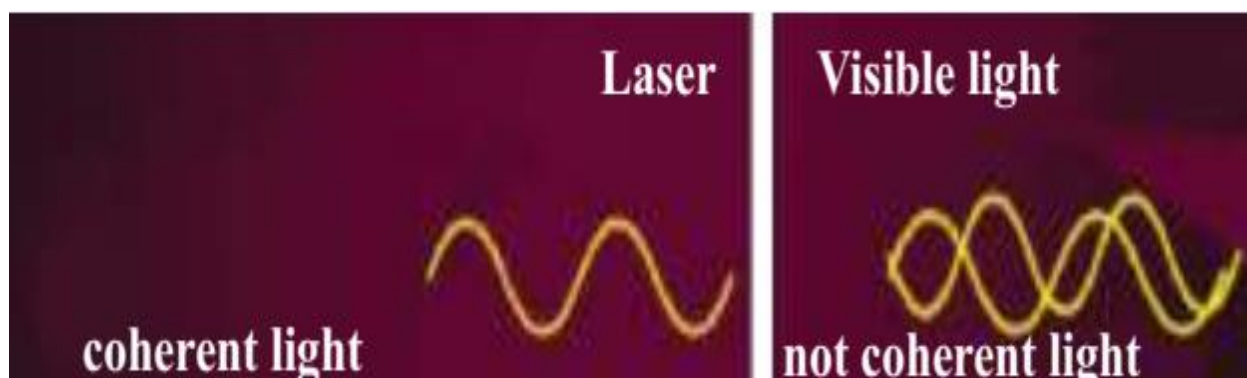
Light Amplification by the Stimulated Emission of Radiation.

Properties of laser light:

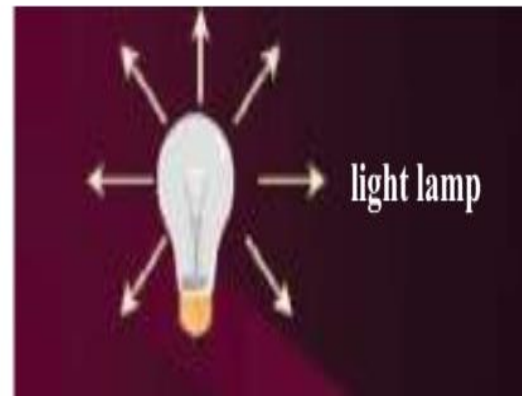
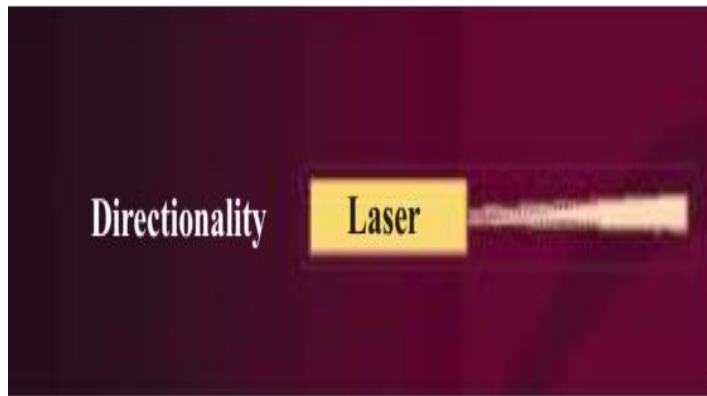
1. Monochromatic wavelength (monochromaticity): It has one wavelength. Laser beam has the purest spectrum of all light sources. Light emitting from other sources has a wide range of wavelengths.



2. Coherency: The waves of a laser beam have the same phase, direction and energy. Thus, two waves can constructive interference.



3. Directionality: Laser waves remain parallel for a long distance with a little divergence from each other. This means that laser beams relatively maintain intensity while normal light waves propagate randomly in all directions.



4. Brightness: Energy of laser beam waves concentrate in a small space because they do not diverge, therefore, laser beam has a very high brightness



Nature of Light:

Maxwell's equations predict the existence of electromagnetic waves and their behavior. Examples of light include radio and infrared waves, visible light, ultraviolet radiation, and X-rays. Interestingly, not all light phenomena can be explained by Maxwell's theory. Experiments performed early in the twentieth

century showed that light has corpuscular, or particle-like, properties.

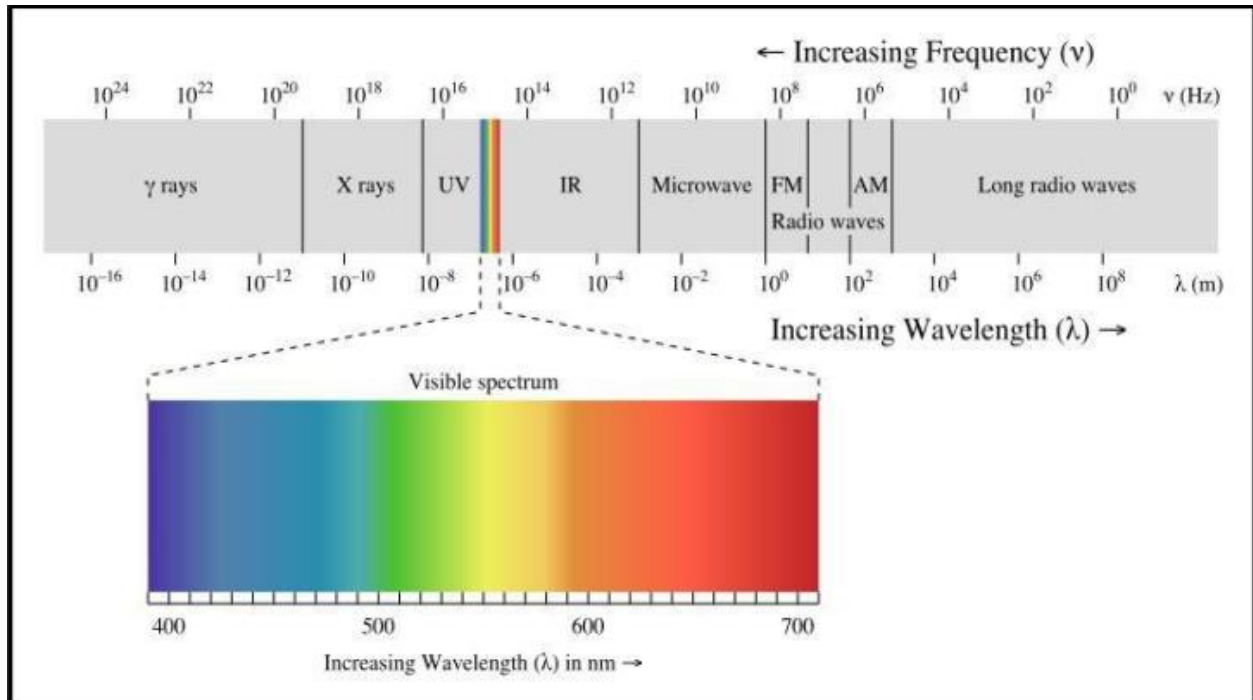
- Wavelength (λ): The distance between successive peaks of the wave.
- Frequency (ν): The number of wave cycles passing a point per second.
- Energy ($E = h\nu$): Each photon carries energy proportional to its frequency.
- Phase: The relative position of the wave oscillations at a given time.
- Polarization: The orientation of the electric field vector of the wave.
- Intensity: The power transmitted per unit area.

Electromagnetic Spectrum:

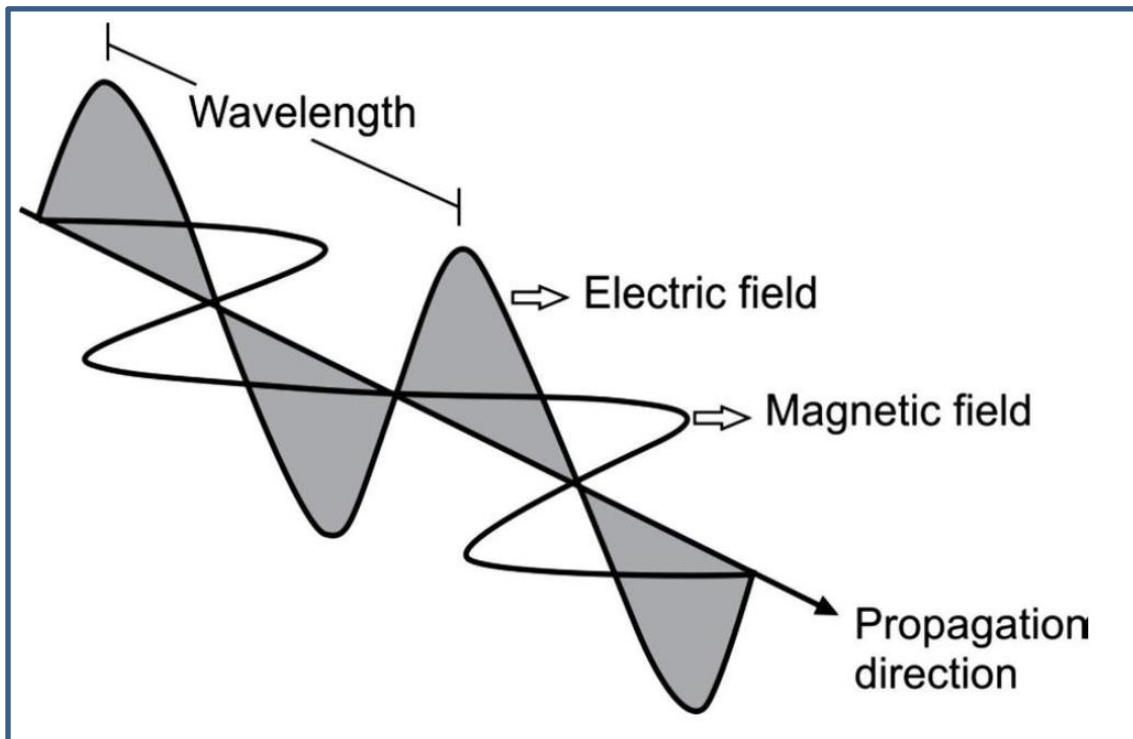
electromagnetic spectrum has a wide range of frequencies, which differ according to source, ways of generating , detection technology and penetration of various media.

- Electromagnetic (EM) radiation is classified by wavelength into radio, microwave, infrared, the visible region we perceive as light, ultraviolet, X ray and gamma (γ) ray.
- The behavior of EM radiation depends on its wavelength. Higher frequencies have shorter wavelengths, and lower frequencies have longer wavelengths.

- Light is a form of electromagnetic waves- travels through space, each color is associated with a different wavelength.
- White light is a mixture of the colors of the rainbow; a prism splits white light into the various colors.



Electromagnetic (EM) radiation is a form of energy that travels through space as oscillating electric and magnetic fields and is characterized by its wavelength, frequency, and amplitude. It is produced by accelerating charged particles, moves at the speed of light in a vacuum, and can be described as both waves and packets of energy called photons. The EM spectrum encompasses a wide range of radiation types, from long wavelength radio waves to short-wavelength gamma rays, with categories including visible light, infrared, ultraviolet, X-rays, and microwaves.



- An electric charge is surrounded by an electric field and if the charge moves, a magnetic field is produced.
- When the charge undergoes an acceleration or deceleration, the magnetic and the electric fields of the charge will vary.
- The combined variation of the electric and magnetic fields results in loss of energy.
- The charge radiates this energy in a form known as electromagnetic radiation.
- The electromagnetic radiation moves in the form of sinusoidal waves.
- The nature of the electromagnetic radiation (X-rays, ultraviolet, etc.) depends on the way in which the electric charges are disturbed.
- Electromagnetic radiations are transverse waves that transfer energy away from the electric charge.
- Electromagnetic radiations may be absorbed or scattered in a medium, resulting in loss of energy.