Al-Mustaqbal University
Department of Medical Physics
Laser Principles
Third Stage

كلية المستقبل الجامعة
قسم الفيزياء الطبية
اساسيات الليزر
المرحلة الثالثة

اساسيات الليزر

المحاضرة الثانية

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Properties of laser

Laser Definition

Lasers can be defined as a device that activates electrons to emit electromagnetic radiation. This laser definition means radiation can take the form of any kind on the electromagnetic spectrum, from radio waves to gamma rays.

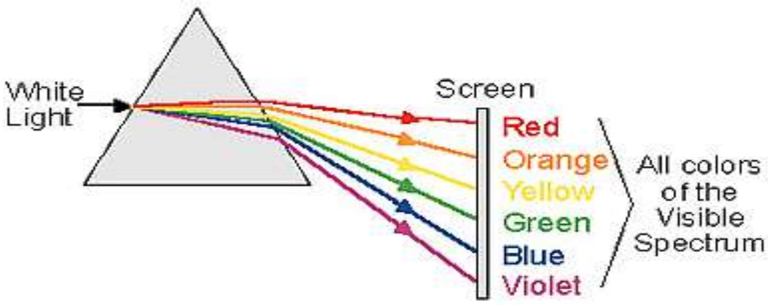
The term "laser" originated as an acronym for "light amplification by stimulated emission of radiation".

A laser emits a beam of electromagnetic radiation that is always monochromatic, collimated and coherent in nature. Lasers consist of three main components: a lasing medium (solid, liquid or gas), a stimulating energy source (pump) and an optical resonator. a wide variety of uses in clinical medicine. Lasers cause tissue damage by various mechanisms and these are mainly determined by power density (irradiance) of the beam and exposure time. It is imperative to be aware of the risks associated with laser use in terms of tissue damage (burns and eye injuries) and fire hazards. Strict controls should be implemented governing the safe use of lasers in hospital practice, and all staff must be familiar with all safety measures to prevent injury and fires.

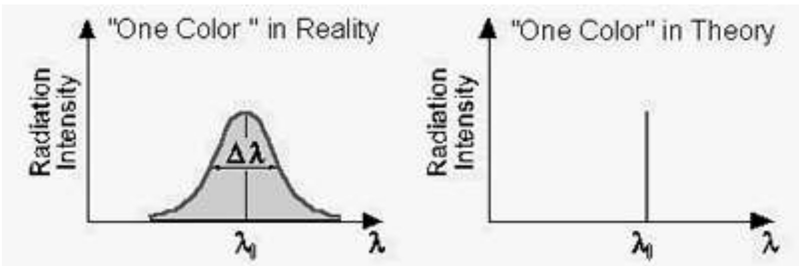
Properties of laser

Monochromatic:

The light emitted from a laser is monochromatic, that is, it is of one wavelength (color). In contrast, ordinary white light is a combination of many different wavelengths (colors).When "white light" is transmitted through a prism, it is divided into the different colors which are in it.(Figure1-a) and LASER radiation does not have all those color, because it has only one same wavelength and phase. And Mono-chromaticity also means that LASER has a high intensity of the light within the very small wavelength. So it can have a high energetic level in microscopic region. (Figure 1-b) Actually, the temperature of the Laser radiation is higher than Sun. (more than 6000K)



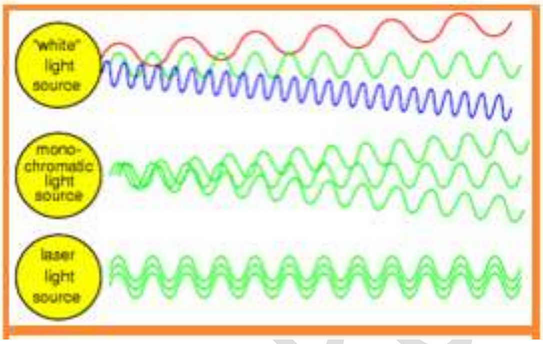
(Figure1-a)



(Figure 1-b)

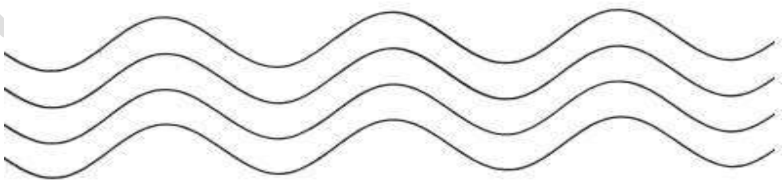
Directional:

Lasers emit light that is highly directional. Laser light is emitted as a relatively narrow beam in a specific direction , The directivity depends on the angle of divergence . Ordinary light, such as coming from the sun, a light bulb, or a candle, is emitted in many directions away from the source.



Coherent:

LASER radiation is composed of waves at the same wavelength, which start at the same time and keep their relative phase as they advance. So, when two or more LASER radiations can make regular interference each other, LASER radiation has a coherency.



Coherent Light Waves

There are two types of coherence:

1- spatial coherence: refers to whether there are irregularities in the optical phase in a cross-sectional of the laser.

2- temporal coherence: refers to the time duration over which the phase of the beam is well defined.

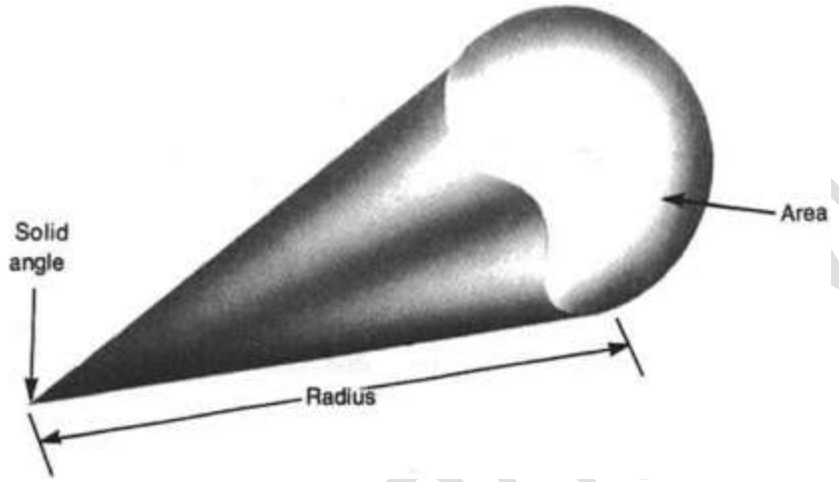
The temporal coherence time (τ_c) is given by the reciprocal of the spectral line width Δv, the coherence length (ζ_c) is given by

$$\zeta_c = c\ \tau_c = c\ 1/\Delta v$$

Ordinary light is not coherent because it comes from independent atoms which emit on time scales of about10^{-8} seconds. There is a degree of coherence in sources like the mercury green line and some other useful spectral sources, but their coherence does not approach that of a laser.

Brightness:

When you say that one light source is brighter than another, you mean that the brighter source creates a greater intensity on the surface of your retina when you look at the source. The intensity on this surface depends on the intensity of the source and the extent to which the light spreads out after it leaves the source. The faster light spreads out, the less reaches your eye. This spreading out of the light is called the divergence of the source, and it can be measured in terms of the solid angle formed by the light leaving the source. the magnitude of a solid angle is measured in steradians.



The brightness of an optical source is defined as the source's intensity divided by the solid angle of its divergence

$$B = P/A\ \Omega$$

in which

P is the power of the source

A is its cross-sectional area

Ω is solid angle steradians

Note that, because steradians are dimensionless, the dimensions of brightness are watts per square meter. the same dimensions as for intensity. But brightness is different from intensity because the intensity of a source doesn't depend on its divergence.

The combination of these properties gives the laser radiation many advantages, like achieving very high power densities, not available from other sources.