Types of radiation

There are three main types of nuclear radiation: alpha radiation, beta radiation, and gamma radiation. Each type of radiation has distinct characteristics and properties:

1-Alpha Radiation (α): Alpha radiation is a heavy, very short-range particle

Some characteristics of alpha radiation are:

Particle Nature: Alpha particles consist of two protons and two neutrons, essentially a helium nucleus $^{4}_{2}He_{2}$.

Charge: Positively charged (+2e).

Mass: Relatively heavy compared to other types of radiation (4.0015 u) or 6.642×10^{-24} g.

Ionizing Power: Alpha particles have low penetrating power but high ionizing power. They can be stopped by a sheet of paper or a few centimeters of air. Alpha-emitting materials can be harmful to humans if the materials are inhaled, swallowed, or absorbed through open wounds.

2-Beta Radiation (β):

Beta radiation is a light, short-range particle and is actually an ejected electron. Some characteristics of beta radiation are:

Particle Nature: Beta particles are high-energy, high-speed electrons can be either electrons (β-) or positrons (β+).

Charge: Beta- particles are negatively charged, while beta+ particles are positively charged.

Mass: the electron mass (symbol: m_e) 5.486×10^{-4} U or 9.109×10^{-31}Kg .

Penetration or Ionizing Power: Beta particles have higher penetrating power compared to alpha particles. They can be stopped by materials like plastic or a few millimeters of aluminum.

3-Gamma and X Radiation

Gamma radiation and x rays are highly penetrating electromagnetic radiation. Some characteristics of these radiations are:

Electromagnetic nature: Gamma rays are electromagnetic waves similar to X-rays but with higher energy.

Charge: Gamma rays are electrically neutral.

Mass: Gamma rays have no mass.

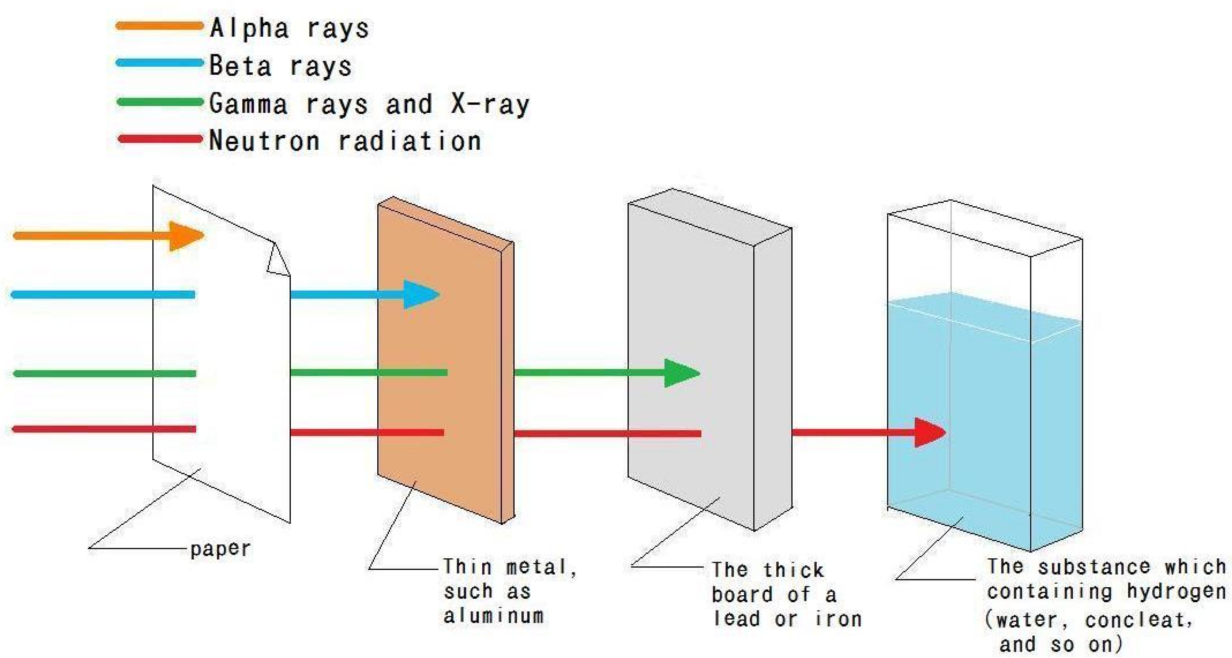
Penetration: Gamma radiation or x rays are able to travel many feet in air and many inches in human tissue. They readily penetrate most materials and are sometimes called "penetrating" radiation and requires dense materials such as lead or several centimeters of concrete to effectively shield against it.

In addition to alpha, beta, and gamma radiation, there are other types of radiation that play significant roles in various contexts. One such type is neutron radiation. Neutrons are subatomic particles that are found in the nucleus of an atom along with protons. Here are some key characteristics of neutrons:

Mass: Neutrons have a mass of approximately 1 atomic mass unit (amu), which is roughly equivalent to the mass of a proton.

Charge: Neutrons are electrically neutral, meaning they have no electric charge. Unlike protons, which have a positive charge, neutrons carry no charge.

Penetration Power: The ability of neutrons to penetrate matter depends on their energy. Neutrons with higher energies can penetrate more deeply into materials. The interaction of neutrons with matter is primarily through the strong nuclear force, and their penetration ability is influenced by factors like the type and density of the material.

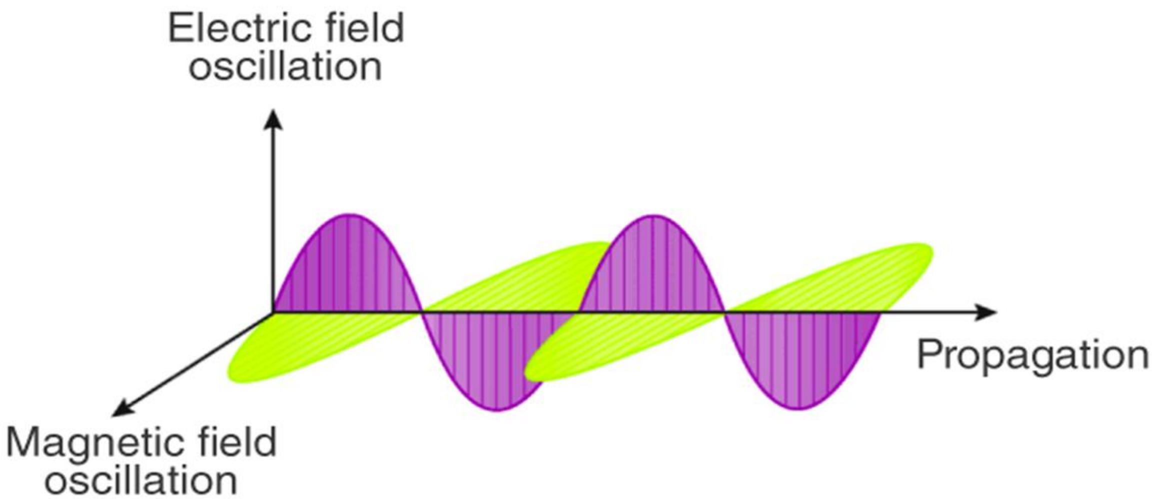


Classification of Radiation

Radiation can be classified into several categories based on different criteria, such as the nature of the particles or waves involved, their energy, and their origin. Here are some common classifications of radiation:

1- Electromagnetic Radiation: Electromagnetic radiation is a form of energy derived from oscillating magnetic and electrostatic fields and is capable of transmission through empty space where its velocity is equal to speed of light.

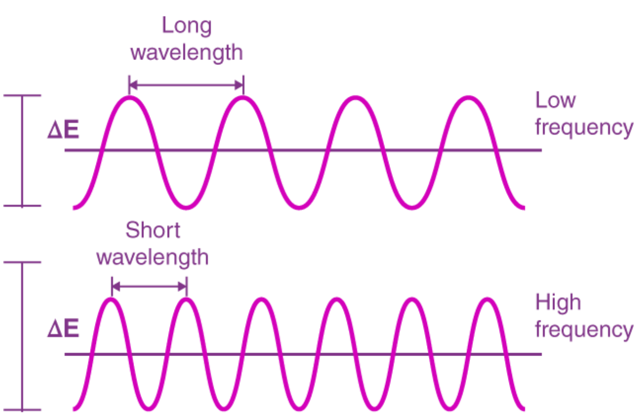
ELECTROMAGNETIC WAVES

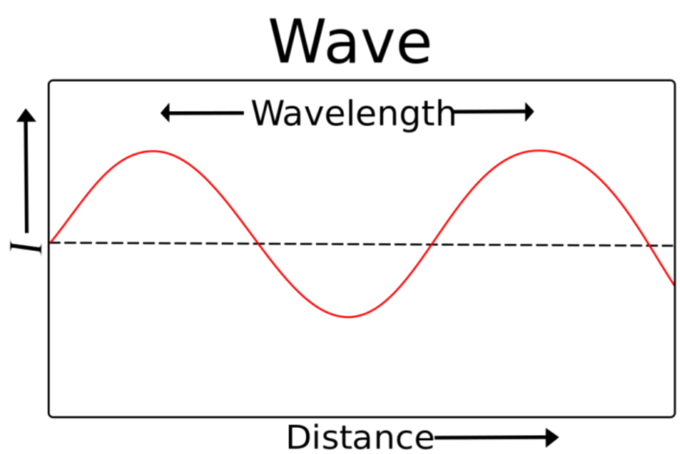


Electromagnetic radiation (EMR): exhibits several properties that are fundamental to its nature and behavior. Here are some key properties of electromagnetic radiation:

Wavelength and Frequency:

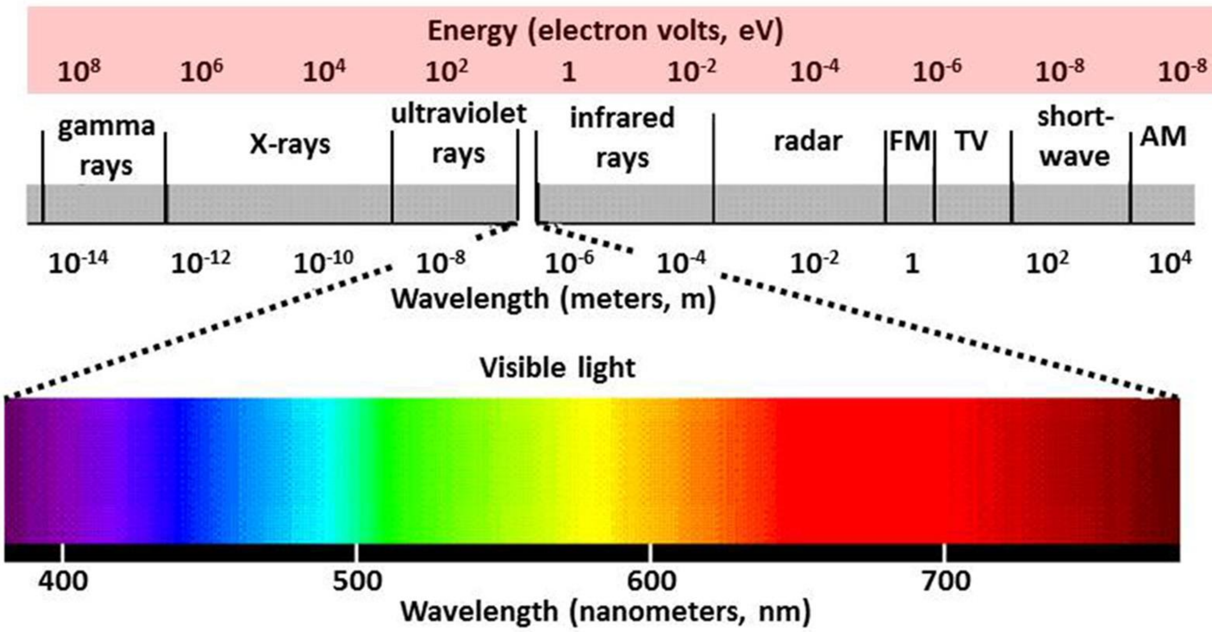
EMR can be characterized by its wavelength (λ) and frequency (ν). The relationship between these two properties is given by the speed of light (c): $c = \lambda\nu$.

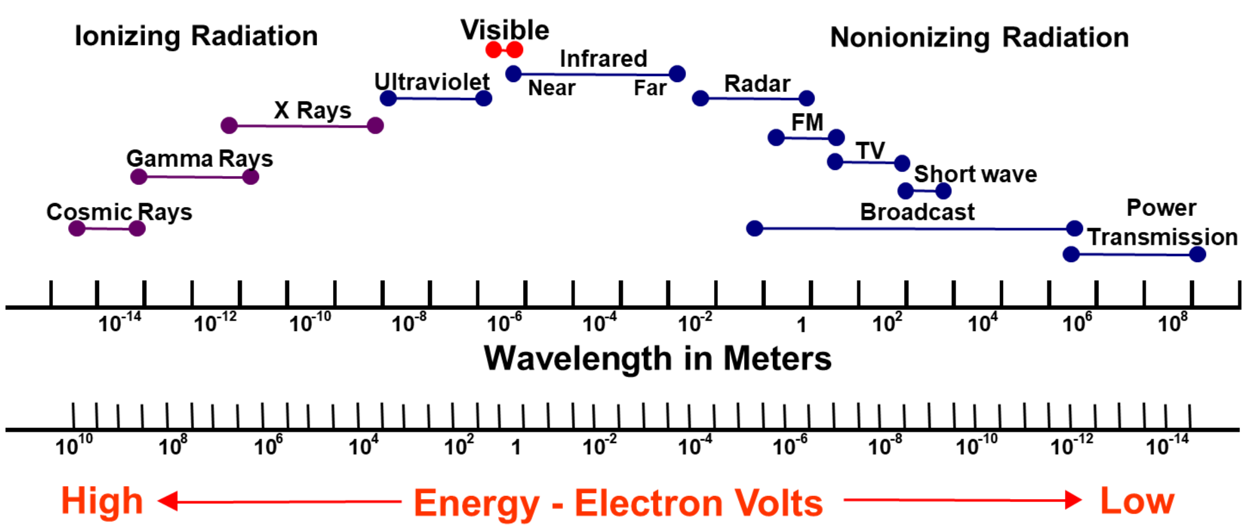




Types of Electromagnetic Radiation

The electromagnetic spectrum is divided into several regions, each with distinct characteristics and applications. Here are the main types of electromagnetic radiation, listed in order of increasing wavelength:





Each type of electromagnetic radiation has unique properties and interactions with matter. The classification is based on the energy and frequency of the waves. As you move from radio waves to gamma rays, the energy of the photons increases, and the corresponding wavelengths decrease. The different regions of the electromagnetic spectrum have diverse applications across various scientific, medical, industrial, and communication fields.

1- Gamma Rays:

Wavelength Range: Shortest wavelengths (below 0.01 nanometers).

Applications: Medical treatment (radiotherapy), industrial applications, nuclear reactions

2- X-Rays:

Wavelength Range: From about 10 nanometers to 0.01 nanometers.

Applications: Medical imaging (X-ray radiography), airport security screening, industrial testing.

3-Ultraviolet (UV) Radiation:

Wavelength Range: From about 400 nanometers to 10 nanometers.

Applications: Germicidal lamps, fluorescence, some medical treatments.

4- Visible Light:

Wavelength Range: From 700 nanometers to about 400 nanometers.

Applications: Vision, photography, optical communication.

5- Infrared Radiation (IR):

Wavelength Range: From about one millimeter to 700 nanometers.

Applications: Infrared heaters, night vision technology, infrared spectroscopy.

6- Microwaves:

Wavelength Range: From about one millimeter to one meter.

Applications: Microwave ovens, satellite communication, radar, wireless communication.

7- Radio Waves:

Wavelength Range: Longest wavelengths (from hundreds of meters to thousands of kilometers).

Applications: Broadcasting, telecommunications, radar.

Example: what is the wavelength of electromagnetic radiation if the frequency is $1.5 \times 10^{12} HZ$? $C = 3 \times 10^8 m/s$

$$C = \lambda f \rightarrow \quad \lambda = \frac{C}{f} = \frac{3\times10^8}{1.5\times10^{12}} = 2 \times 10^{-4} m = 200\mu m$$

Example: what is the frequency of electromagnetic radiation in the wavelength is $1 \times 10^{-11} m$

$$f = \frac{C}{\lambda} = \frac{3 \times 10^8 m/s}{1 \times 10^{-11} m} = 3 \times 10^{19} s^{-1}$$