



Islamic University / Najaf
College of Medical Technology
Department of Radiology Techniques



Radiation Protection 1

Stage 2

Lecture 2

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The Lecture Contents:

- **Electromagnetic (EM) Radiation**

- **Wave-Particle Duality**

- **Wave Characteristics**

- **Particle Characteristics**

- **Electromagnetic Spectrum**

- a) Ionizing**

- b) Non-Ionizing**

Radiation is electromagnetic energy that travels in the form of waves or particles through space or material. The properties of electromagnetic energy are mass less It has a certain speed and travels in straight lines.

-**Electromagnetic radiation**, such as radio waves, microwaves, infrared, visible light, ultraviolet, x-rays, and gamma radiation (γ), The figure (1) shows the electromagnetic spectrum that includes all forms of this energy.

-**Particle radiation**, such as alpha (α), beta (β), proton and neutron.

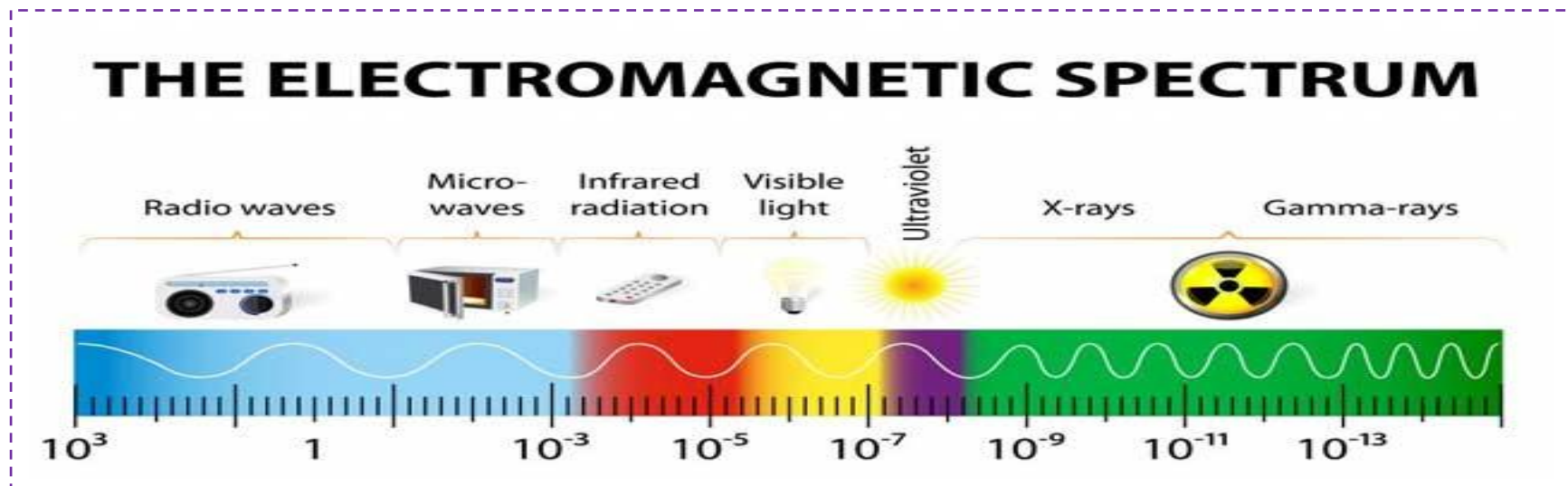


Figure (1): Electromagnetic Spectrum

Wave-particle duality

Wave-particle duality holds that light and matter exhibit properties of both waves and of particles.

Wave particle duality, as light and electrons possess of both wavelike and particle-like characteristics.

That light, which had been considered a form of electromagnetic waves, must also be thought of as.

Particle-like, localized in packets of discrete energy.

Electromagnetic waves consist of two fields, one electric and the other magnetic; the two fields are at right angles to each other and perpendicular to the propagation direction line.

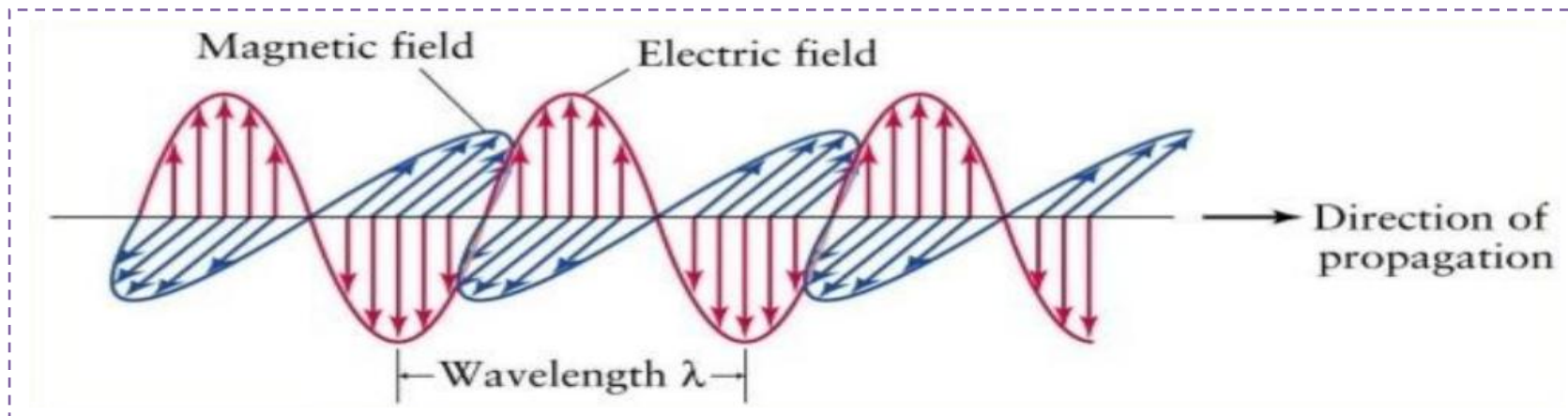


Figure (2)

Wave Characteristics

Electromagnetic waves are characterized by a number of parameters which are:

- 1) **Amplitude** is the height of the top or the depth of the bottom.
- 2) **Wavelength** is the distance between two peaks or troughs.

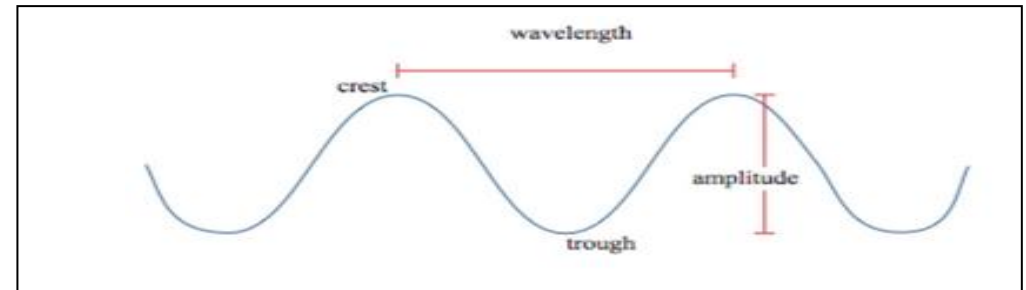


Figure (3)

- 3) **Frequency** is the ratio of a wave repeating itself in a unit of time, it is measured in hertz (Hz).
- 4) **Velocity of Wave propagation** is the distance a wave travels during a specified period of time through space or matter.
- 5) **Wave Period** is the wave period expresses the time it takes for a particle to make a complete Vibration rotation, and it is measured in units of time, such as: seconds, hours, days, and years, for example, the Earth needs to revolve a complete revolution around the sun 365 days.

Electromagnetic waves differ among themselves in the amount of energy; energy depends on the

wavelength and frequency, the decrease the wavelength, the increase the frequency and the increase the energy and vice versa. The relationship between wavelength and frequency is:

$$\lambda = \frac{v}{f}$$

λ : Wave length the unit (m)

v : The velocity of a wave in a vacuum or through a substance The unit (m/s)

f : Frequency the unit (Hz)

Radiation energy is proportional to frequency according to the relationship:

$$E = hf$$

E : Radiation energy in unit (ev or J)

h : Planck constant (6.63×10^{-34}) J.S

Particle Characteristics

Particles have a number of properties:

- 1) Charge** particles vary with different charges, such as a proton with a positive charge and a negatively charged electron, and a particle may be neutral, such as a neutron.

2) Mass each particle has a specific mass that differs from the other particle.

Ionizing Radiation

The process in which an electron is given enough energy to break away from an atom is called ionization. This process results in the formation of two charged particles or ions: the molecule with a net positive charge, and the free electron with a negative charge. Ionizing radiation is the energy produced from natural or artificial sources. It has more energy than non-ionizing radiation, enough to cause chemical changes by breaking chemical bonds. This effect can cause damage to living tissue.

Non-Ionizing Radiation

Its energy is sufficient It is radiation that has insufficient energy to separate an electron from an atom. for the electron to transfer between energy levels, or its energy is insufficient to transfer the electron because the energy of its binding to the nucleus is greater than the energy applied