Second lecture

Elements of light propagation theories II

Msc. Eman Ahmed

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Department of Medical physics sciences

Al-Mustaqbal University

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❖Energy of a Photon

Photon energy is the energy carried by a single photon. The amount of energy is directly proportional to the photon's electromagnetic frequency and thus equivalently, is inversely proportional to the wavelength. The higher the photon's frequency, the higher its energy. Equivalently, the longer the photon's wavelength the lower its energy. The photon energy is given by:

$E_p = h\gamma = hc/\lambda$ ……….(4)

Where: Ep represents the energy of a photon of wavelength λ, or frequency ν. In this equation, h is known as Planck's constant. Its value is 6.625×10^{-34} J.s.

❖Photon energy units

a. Joule unite: when the wavelength is expressed in meters or the frequency in Hertz, the photon energy gives in Joules (J.)

Example (4)

Calculate the photon energy of the output of a He-Ne laser (λ=632.8 nm) and a CO_2 laser (λ=10.6 µm).

$$Ep = \frac{6.625 \times 10^{-34} \times 3 \times 10^{8}}{10.6 \times 10^{-6}}$$

$= 1.88 \times 10^{-20}$ J for CO_2 laser photon.

$$E_p = \frac{hc}{\lambda}$$

$$E_p = \frac{6.625 \times 10^{-34} \times 3 \times 10^{8}}{632.8 \times 10^{-9}}$$

$= 3.14 \times 10^{-19}$ J for the He-Ne laser photon.

b. Electron volts (eV) unite: An eV is the energy expended in moving an electron through a one-volt potential difference. The relationship between Joules and eV is as follows:

$$1\ eV = 1.602 \times 10^{-19}\ J$$

This simply results from the fact that an electron has a charge of 1.602×10^{-19} Coulombs (C) and is multiplied by 1 V.