Biophysics I

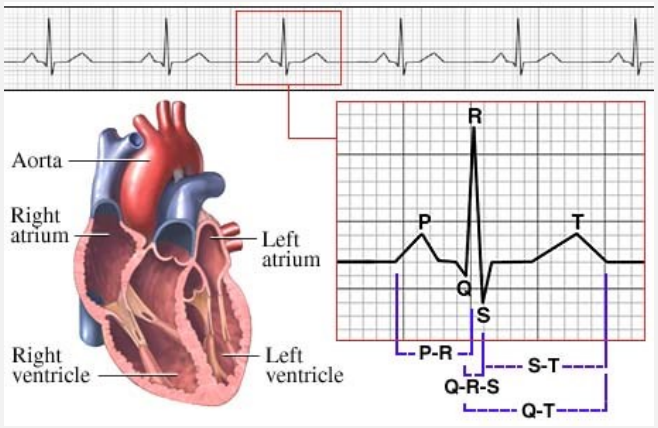
1. Introduction, Radiations

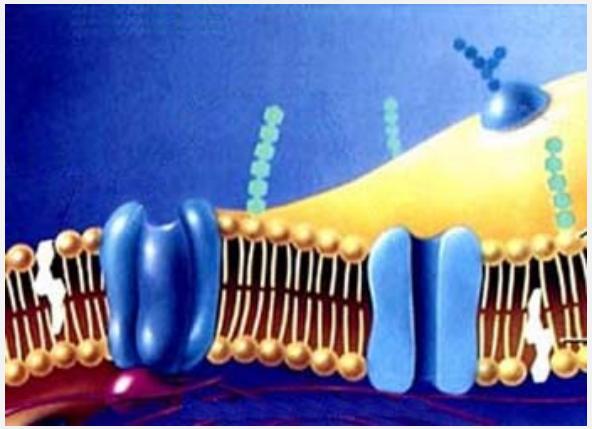
G. Schay

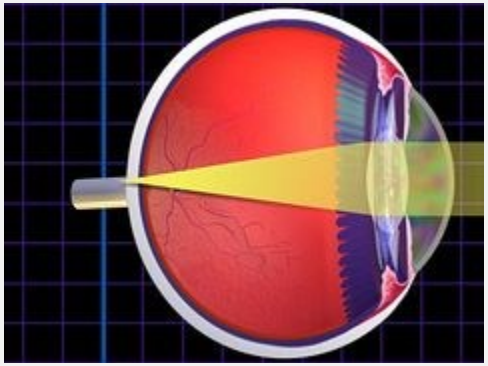
What is the subject of biophysics?

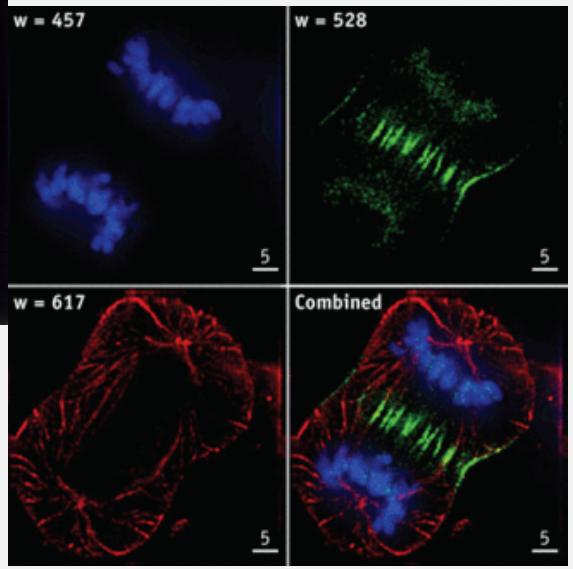
Physical backgrounds of biological processes

Physical methods in biology and medicine









Scientific method

Observations, experiments = data collection

Data analysis = finding causative relations among data

Relations = **mathematical models** describing the dependence of observations on independent variables (parameters)

Model building is always simplification.

The most simple but usable model is "the law" of the given topic.

Radiations

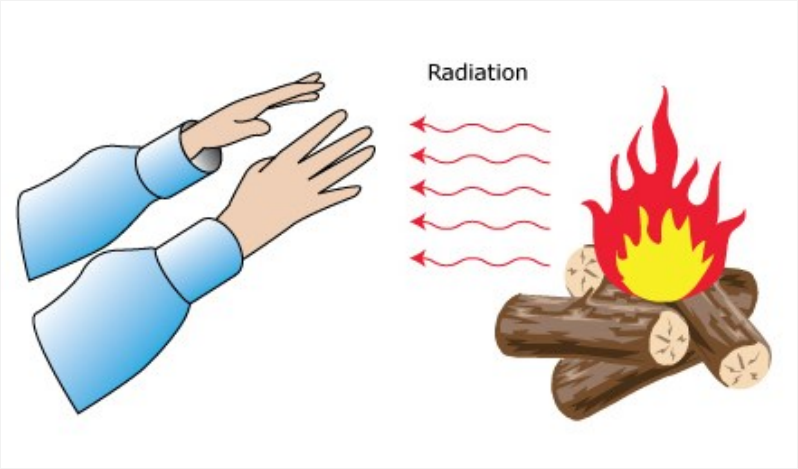
radiation = release (emission) and transfer (propagation) of energy (in the form of waves or particles)

Examples:

sound, light

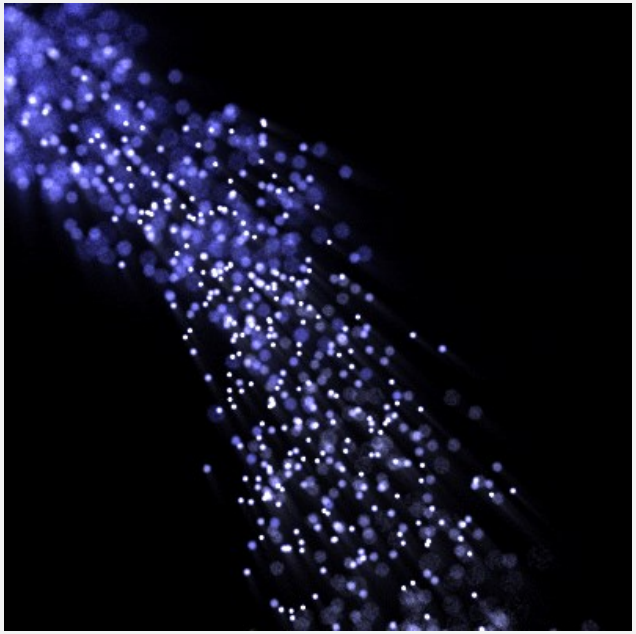
radiowaves, X-ray

nuclear radiations

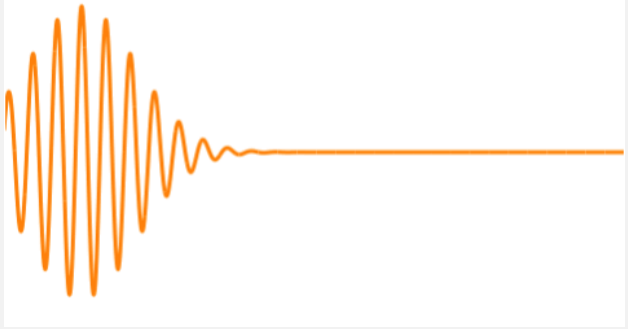


Energy is often distributed in "packages"

particles



light

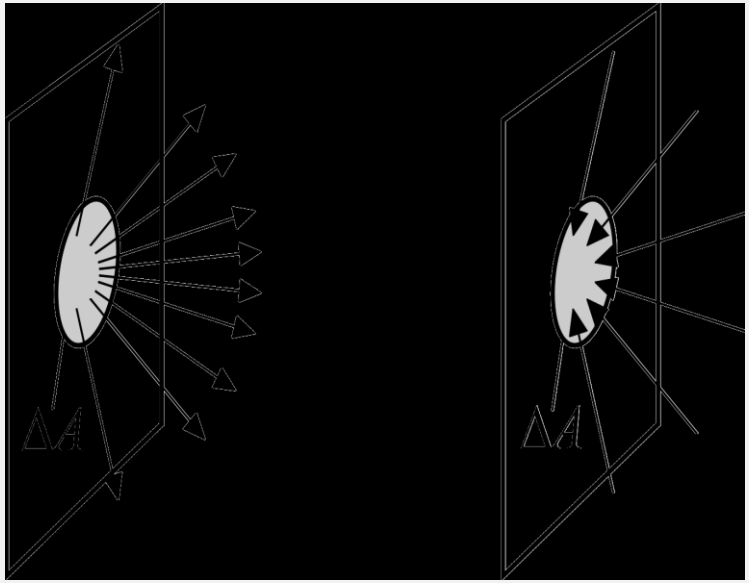


energy can be distributed in discrete units also in waves.

Quantities

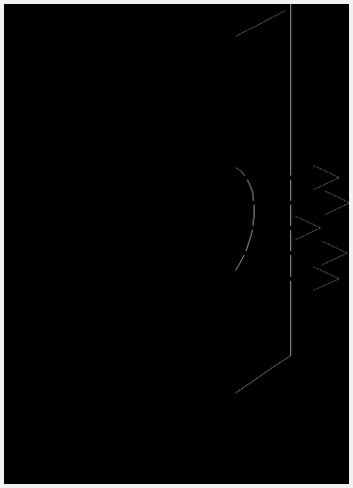
Radiant emittance:

$M = \Delta P/\Delta A = \Delta E/\Delta t \Delta A$



Irradiance

$E_{be} = \Delta P/\Delta A$ (W/m^2)

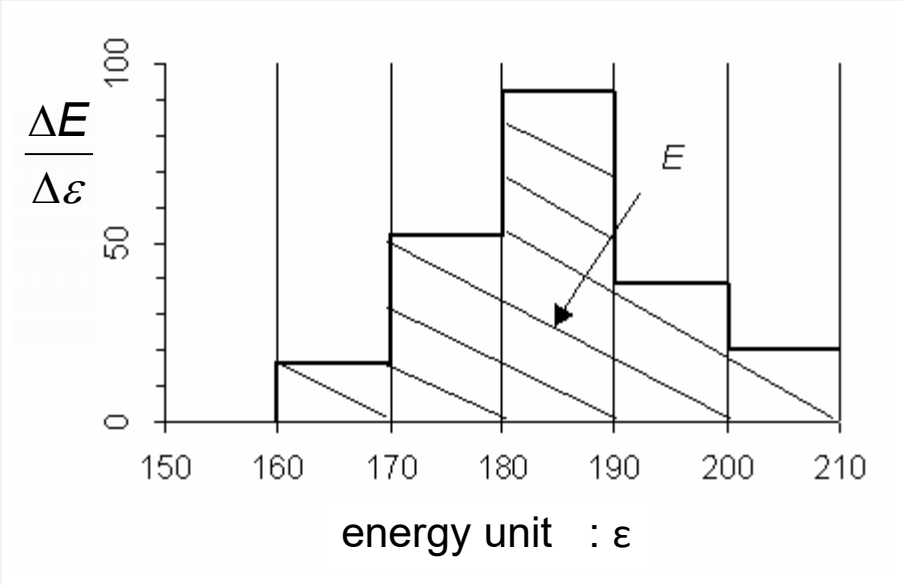


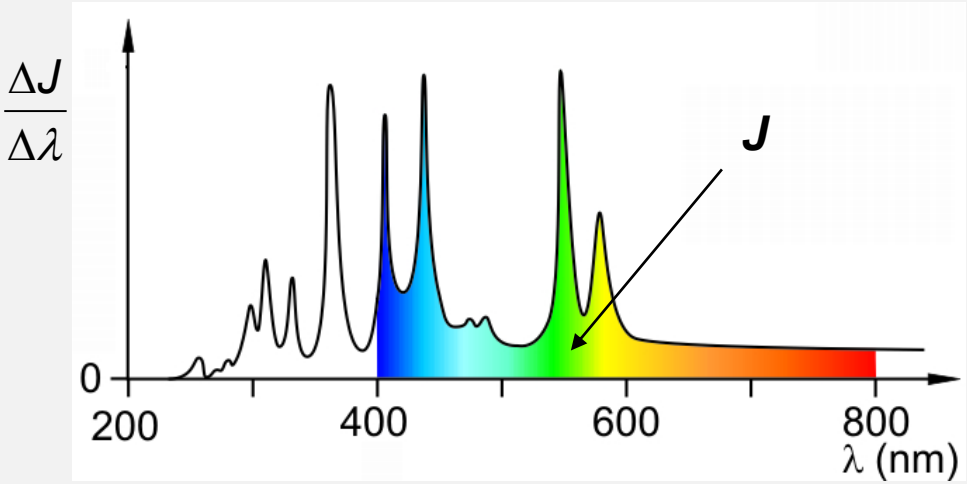
Intensity

$J_E = \Delta E/\Delta t \Delta A$

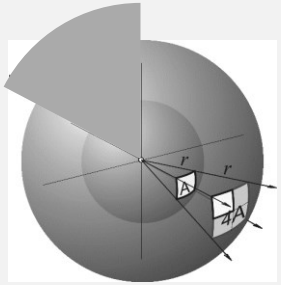
The incoming radiation is perpendicular to the surface.

Spectrum: the distribution of enrgy-units

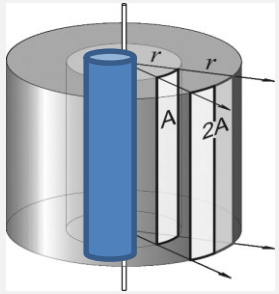




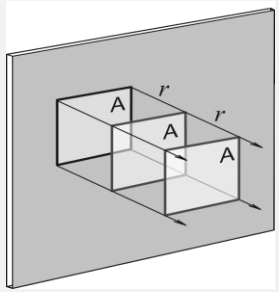
typical radiation source geometry



Point-like source
$A \sim r^2 \rightarrow J \sim 1/r^2$



Line-source:
$A \sim r \rightarrow J \sim 1/r$



Flat panel source:
$A \sim \text{constant} \rightarrow J \sim \text{constant}$

General description of waves

periodic disturbances in space and time, transferring energy

Waves differ in

- type of energy
- intensity
- mechanism of propagation

Characteristic values

Period in space – *wavelength*

λ [m] or [nm]

displacement – *amplitude*

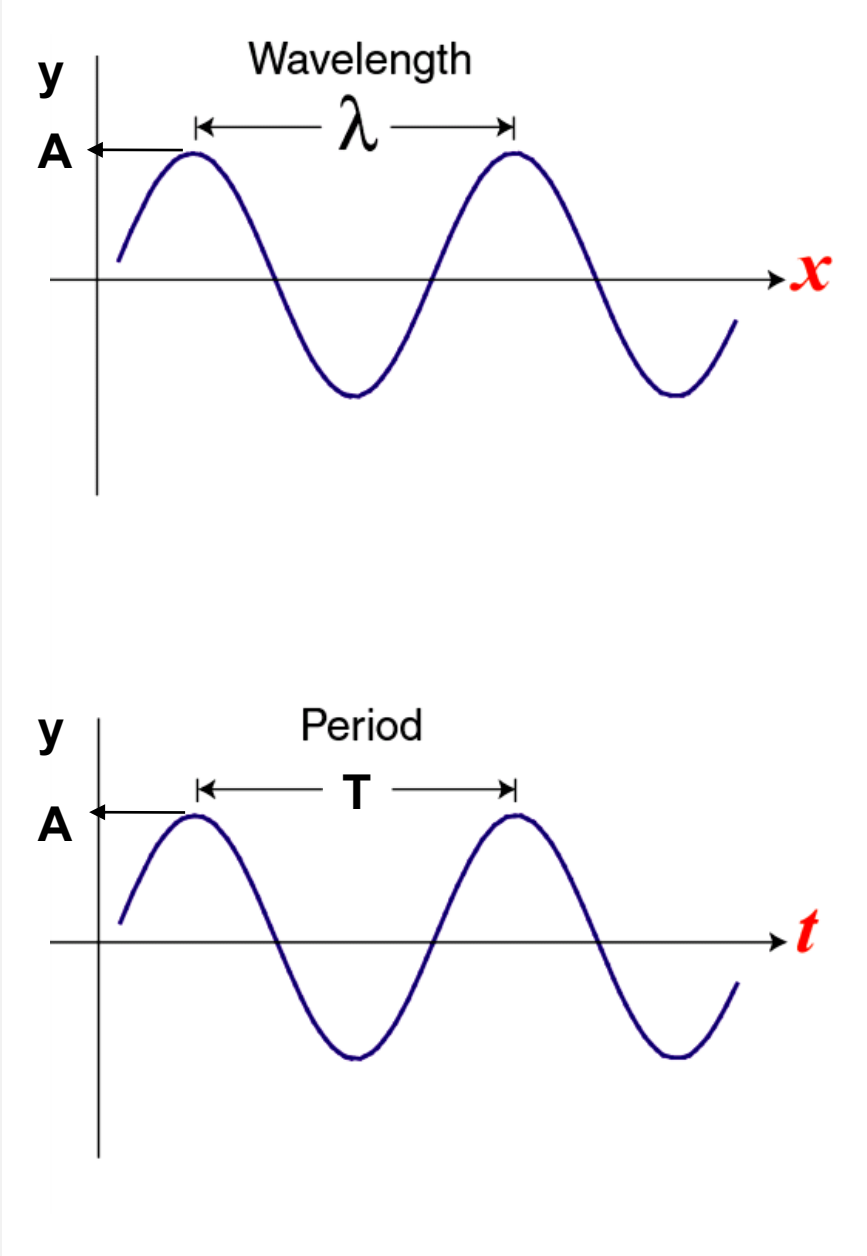
$$E \sim A^2$$

Period in time – *period, T*

– *frequency, f*

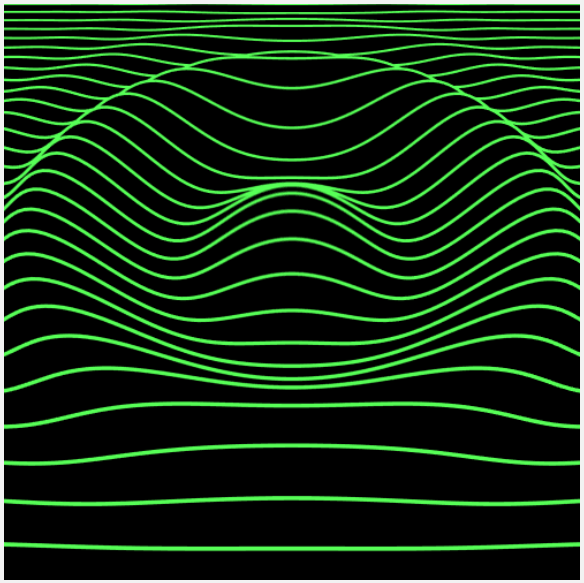
$$f = \frac{1}{T}\left[\frac{1}{s}\right]$$

velocity of waves: c = λ/T = λf

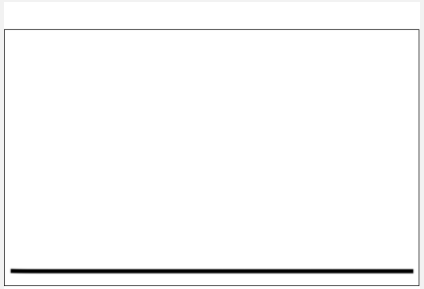


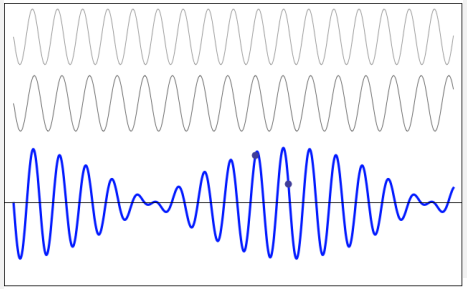
Indications for a wave nature:

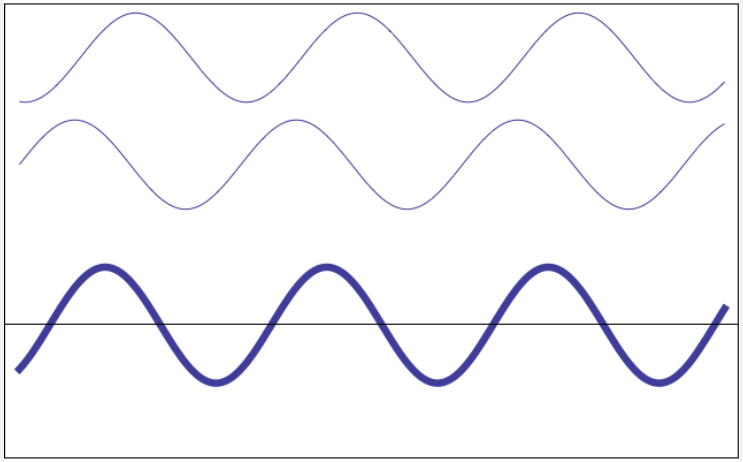
- diffraction
- superposition / interference
- polarization



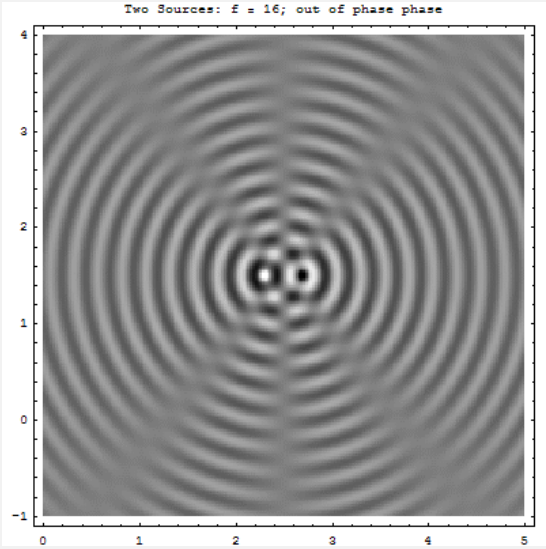
Superposition of waves: the individual disturbances ("motions") are summed up at any given point in space.

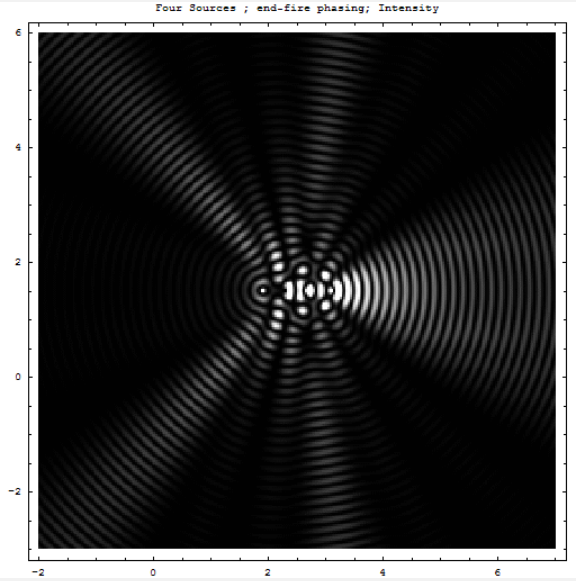






https://www.acs.psu.edu/drussell/demos/superposition/superposition.html

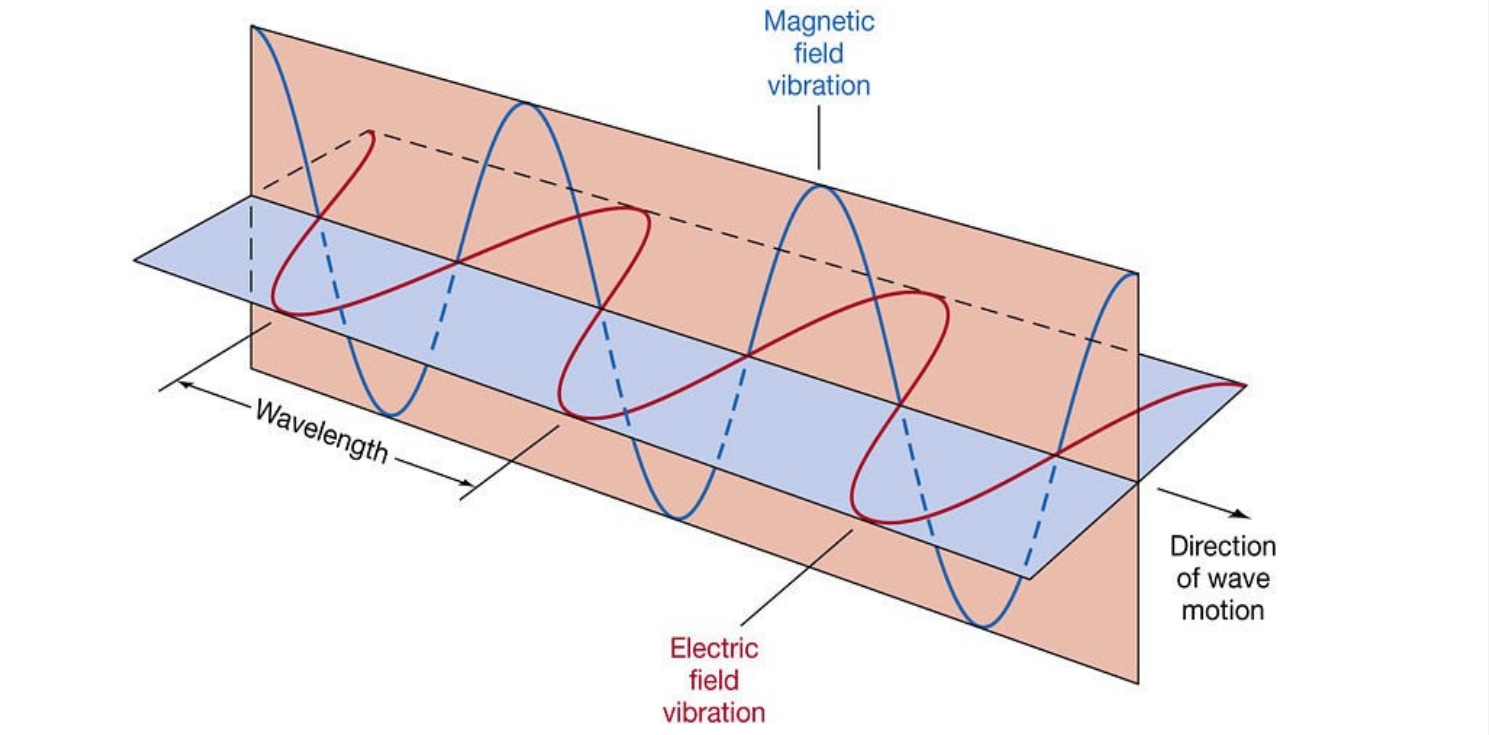




Dual nature of light

Wave – electric and magnetic fields vary sinusoidally

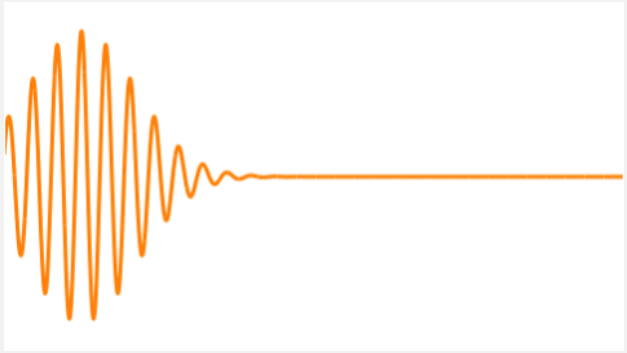
Electromagnetic radiation



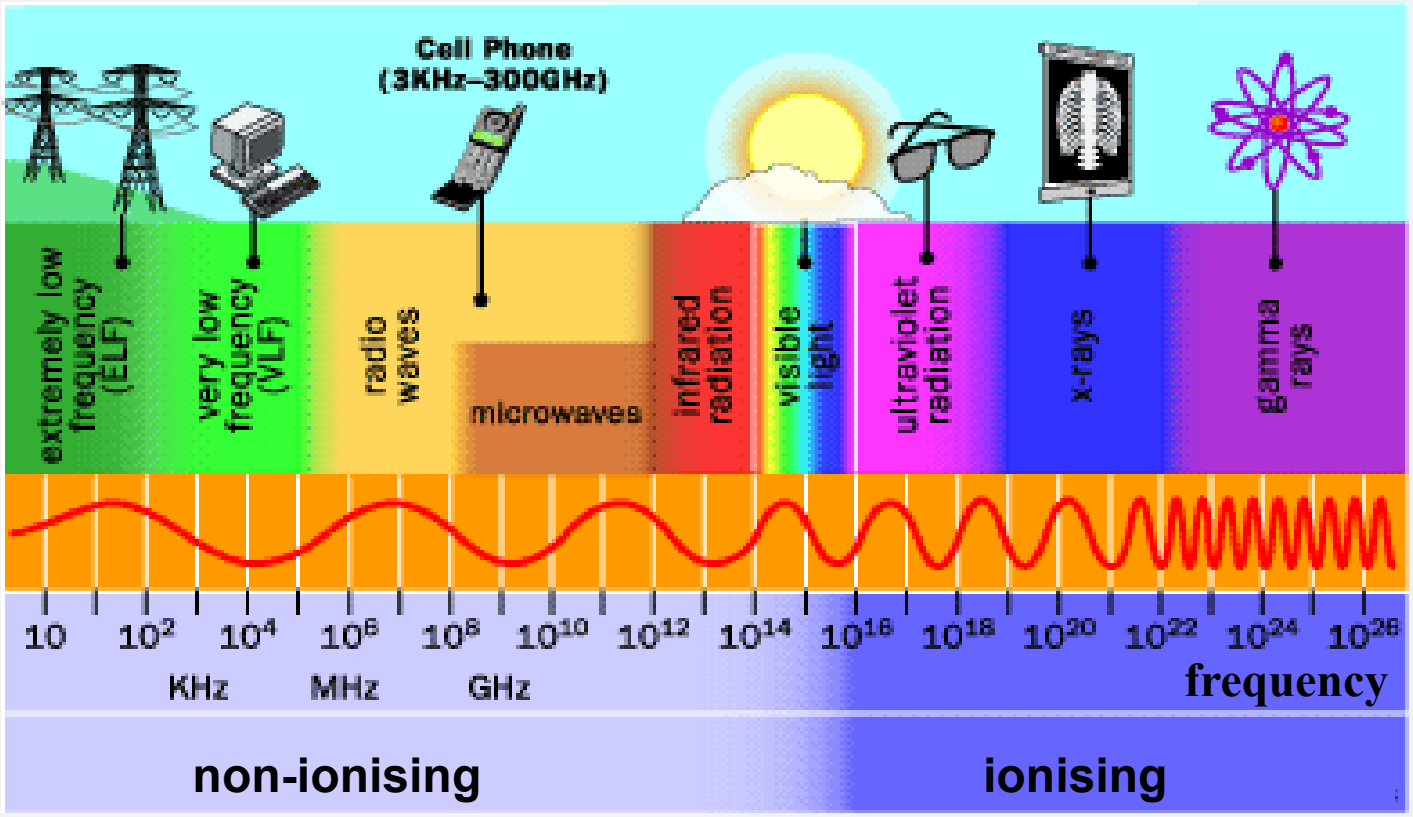
Dual nature of light

Energy of photon: $\varepsilon = hf = h\frac{c}{\lambda}$

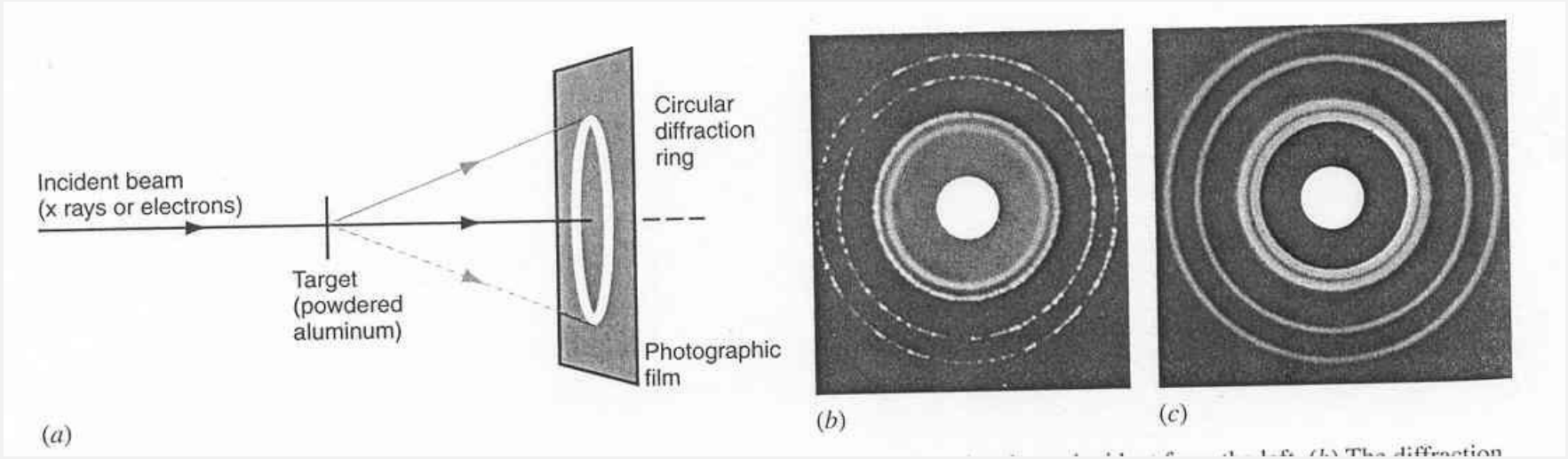
Planck constant: $h = 6.62 \cdot 10^{-34}\, Joule \cdot s$



Classification of electromagnetic radiation



Wave nature of particles



electrons can produce diffraction patterns
so they are waves as well.

Clinton Joseph Davisson **George Paget Thomson**

Nobel-prize 1937

"for their experimental discovery of the diffraction of electrons by crystals"

Related chapters in

Damjanovich, Fidy, Szöllősi: Medical Biophysics

II. 2. 1.

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2.1.2
2.1.3
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