

I. Electromagnetic radiation

- A. Rotating or spinning charged particles (electrons, protons, atoms, molecules, etc.) generate a magnetic field
- B. Whenever these particles are disturbed (i.e. accelerated) they emit packets of energy (photons) proportional to the magnitude of the disturbance
- C. Photons can have a range of energies
 - 1. $c = \lambda \nu$
 - 2. $E = h\nu$ or $E = hc/\lambda$
 - 3. This range of energies is the spectrum of electromagnetic radiation
- D. A consequence of quantum mechanics: particles can only absorb/emit photons of specific energies that correspond to energy transitions the particle is permitted to make
- E. Different environments result in different energies for the same transition
 - 1. Evidence: atomic spectra
- F. Types of transitions: changes in spin states, changes in the energy levels of electrons in atoms, changes in molecular orbitals, etc.

type	wavelength	frequency (Hz)	transition
gamma ray	$< 0.05 \text{ \AA}$	$> 6 \times 10^{19}$	nuclear
x-ray	0.05 - 100 \AA	$3.0 \times 10^{16} - 6 \times 10^{19}$	K & L shell electrons
far (vacuum) UV	10 - 180 nm	$1.7 \times 10^{15} - 3.0 \times 10^{16}$	middle shell electrons
near UV	180 - 350 nm	$8.6 \times 10^{14} - 1.7 \times 10^{15}$	valence electrons
visible	350 - 770 nm	$3.9 \times 10^{14} - 8.6 \times 10^{14}$	valence electrons
near IR	770 - 2500 nm	$1.2 \times 10^{14} - 3.9 \times 10^{14}$	molecular vibrations
middle IR	2.5 - 50 μm	$6.0 \times 10^{12} - 1.2 \times 10^{14}$	molecular vibrations
far IR	50 - 1000 μm	$3.0 \times 10^{11} - 6.0 \times 10^{12}$	molecular rotations
microwaves	1 - 300 mm	$1.0 \times 10^9 - 3.0 \times 10^{11}$	molecular rotations
radio waves	$> 300 \text{ mm}$	$< 1.0 \times 10^9$	electron and nuclear spin

G. Spectroscopy and spectrometry: definitions

- 1. Spectroscopy: the science that deals with the interactions of electromagnetic radiation with matter

2. Spectrometry: the quantitative measurement of the intensity of electromagnetic radiation at one or more wavelengths with a photoelectric detector
3. Spectrum: a plot of analytical signal versus wavelength, frequency, or wavenumber with all other variables held constant
4. Peaks are characterized by shape, height (intensity), width, and position

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