



Electromagnetic spectrum

... actually, not love but electromagnetic radiation is all around!

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Basic terms

Dualism of matter – wave and particle nature of matter. (Evidences!)

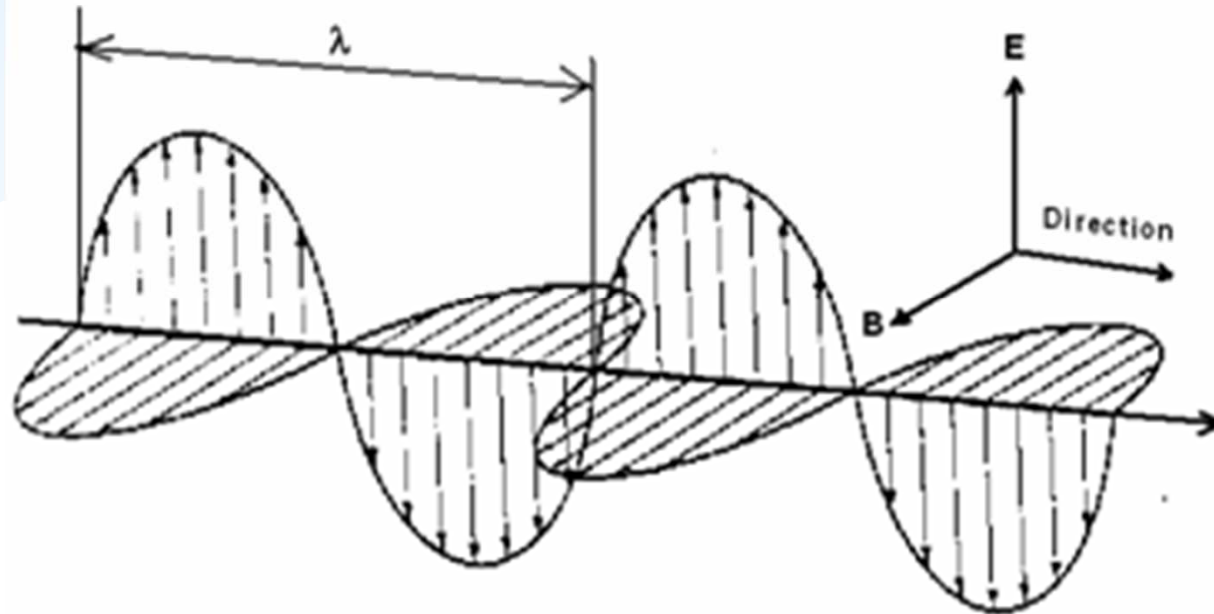
Electromagnetic radiation can be defined as transverse oscillations of an electromagnetic field which propagate in discrete quanta of energy which can be considered particles. These particles have zero rest mass, they are called **photons**.

The basic properties of electromagnetic radiation are given by its energy which is directly proportional to the frequency of its oscillations and inversely proportional to their wavelength (Plank's equation):

$$E = hf = hc/\lambda$$

Basic terms

Electromagnetic radiation consists of **electromagnetic waves**, which are synchronized oscillations of electric and magnetic fields. The oscillations of the two fields are perpendicular to each other and perpendicular to the direction of energy and wave propagation. The wavefront of electromagnetic waves emitted from a point source (such as a light bulb) is a sphere. The position of an electromagnetic wave within the electromagnetic spectrum could be characterized by either its frequency of oscillation or its wavelength (next week lectures).



Electromagnetic radiation.

**B - magnetic flux density, E - intensity of electric field,
 λ = wavelength.**

Speed of Electromagnetic Radiation

= Speed of light:

The speed (velocity) of light (in a vacuum) c is one of the most important physical constants:

$$c = 299\,792\,458 \text{ m}\cdot\text{s}^{-1} \approx 3 \times 10^8 \text{ m}\cdot\text{s}^{-1}$$

It is the highest speed which can be approached by a physical body with non-zero rest mass. The speed of light in vacuum was used for the modern **definition of the meter**:

1 meter is the distance which is travelled by light in vacuum during $\frac{1}{299\,792\,458}$ s.

Dependence on medium!

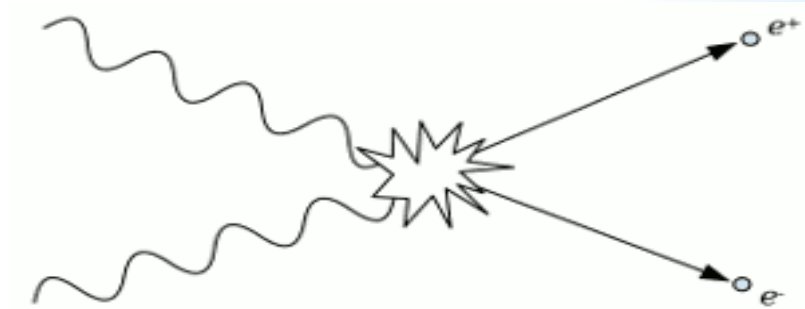
$$n = \frac{c}{v}$$

n ... index of refraction

v ... speed of light in a certain medium

Electromagnetic Spectrum – Interactions

Photons – pair production



Nukleus – NMR – MRI

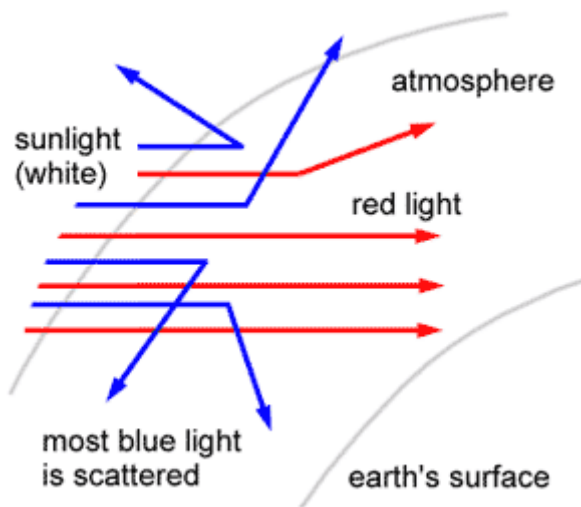


With the electron shell

Electromagnetic Spectrum – Interactions

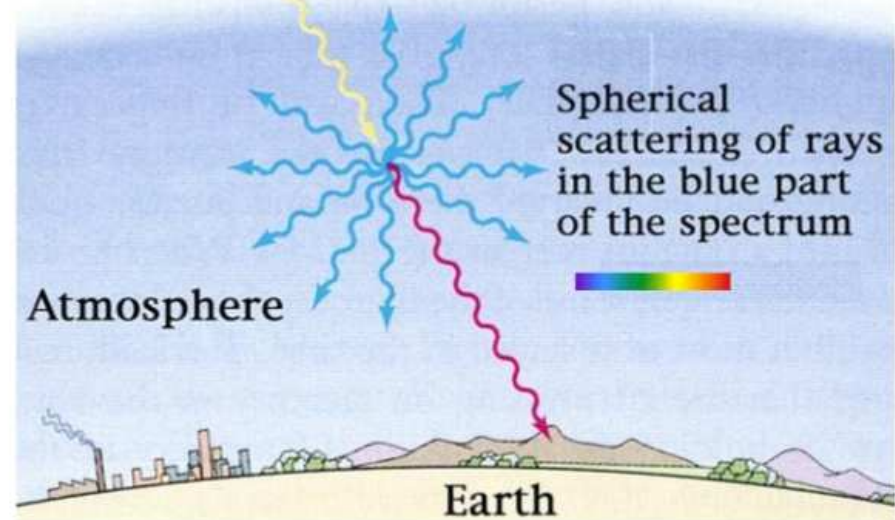
Electron cloud (shell):

Rayleigh scatter



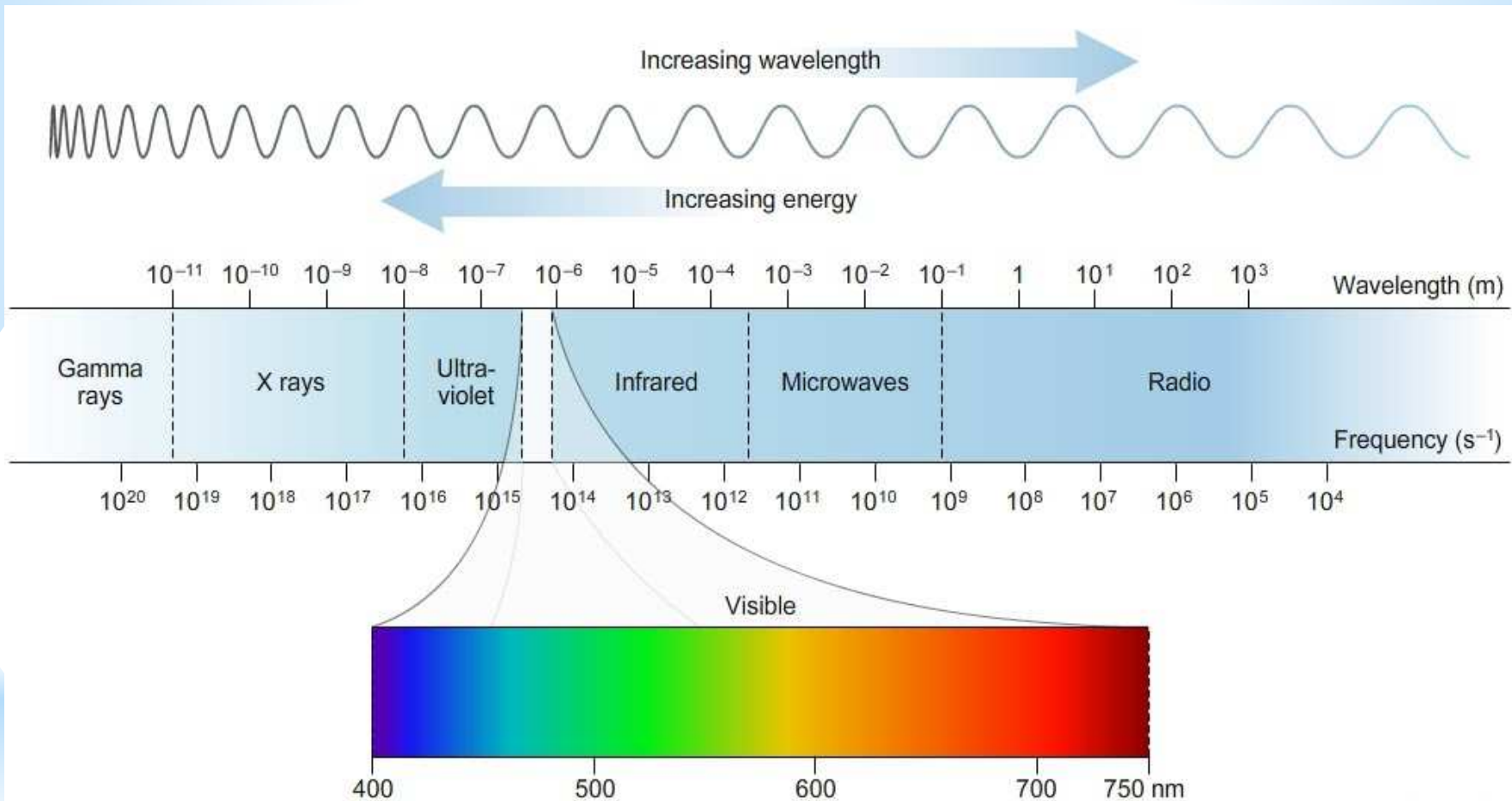
Rayleigh Scattering: why the sky is blue

Rays from the sun



Excitation, Photoelectric effect and Compton effect (scatter) – later

Electromagnetic Spectrum



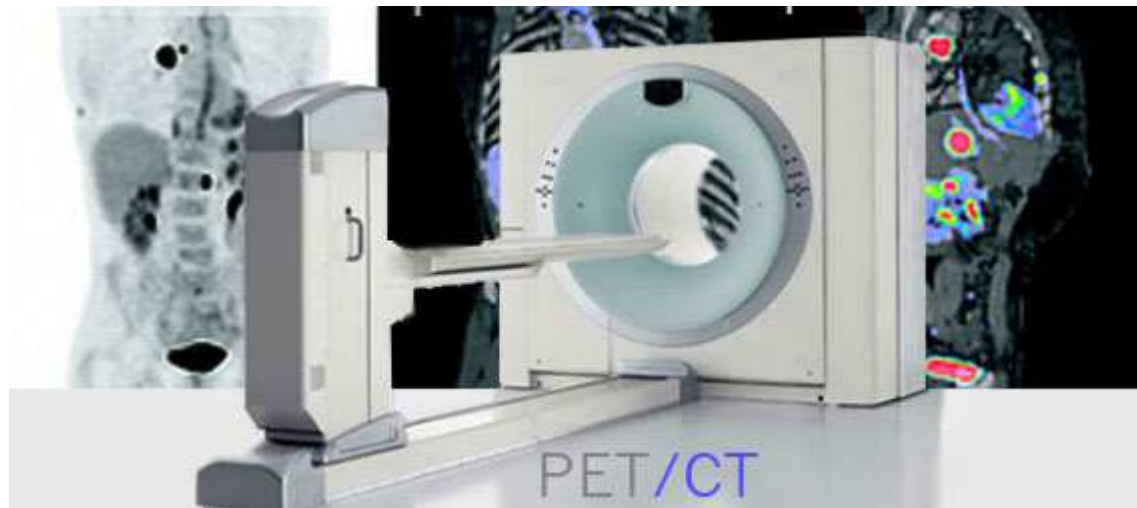
Electromagnetic Spectrum – Gamma rays and X-rays

Ionizing radiation!

Wavelength $< 1\text{nm}$
Differences!?

Sources: natural
artificial

Diagnostics



Therapy

Electromagnetic Spectrum – UV

Wavelength 1nm – 400nm

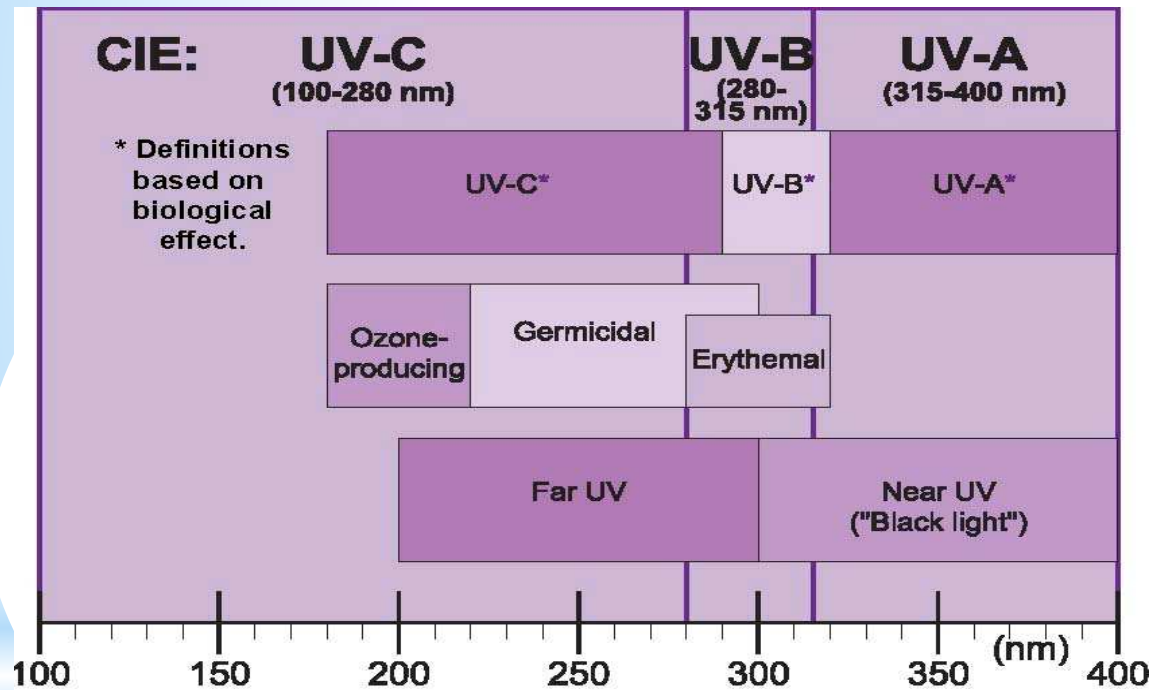


Fig. 1.2 Common ultraviolet band designations.

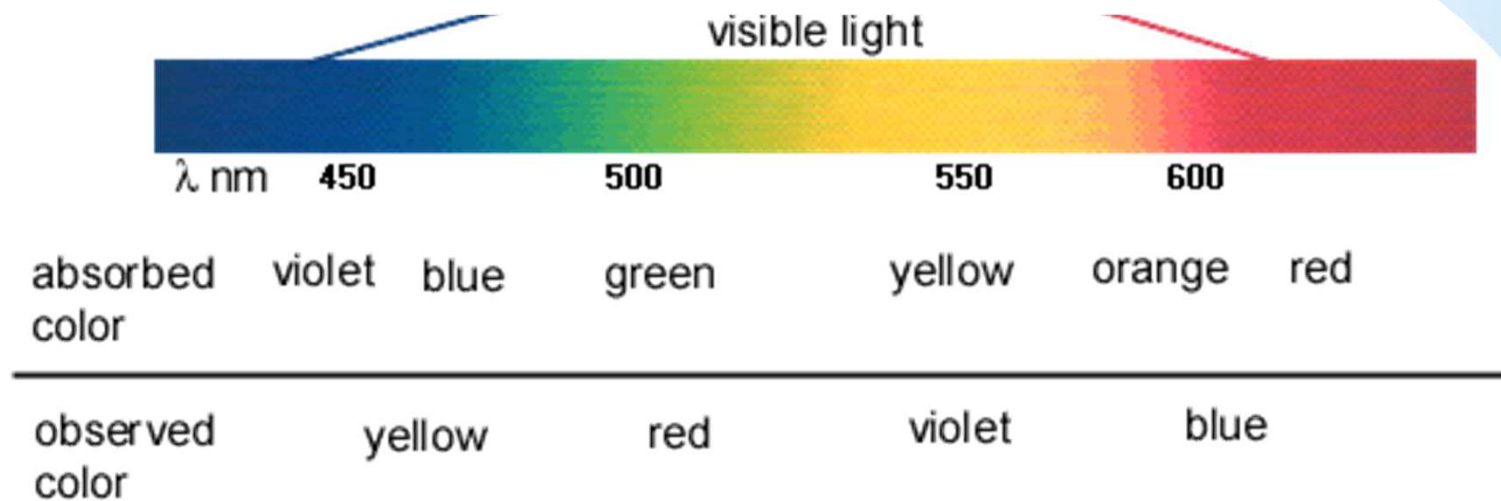


Human: Vitamin D X Melanoma!

Electromagnetic Spectrum – Visible Light

Wavelength 400nm – 800nm

Vision!

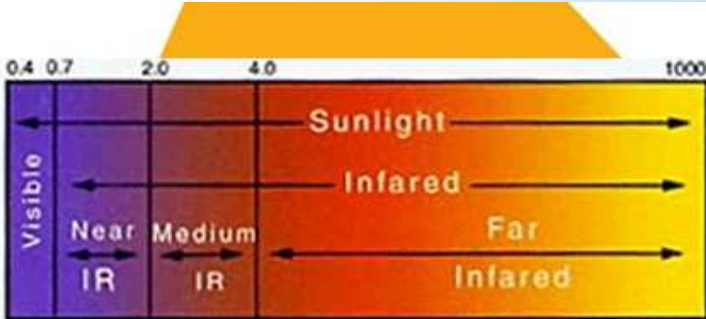


Circadian rhythm – biological clock!

Electromagnetic Spectrum – IR

Wavelength 800nm – 1mm

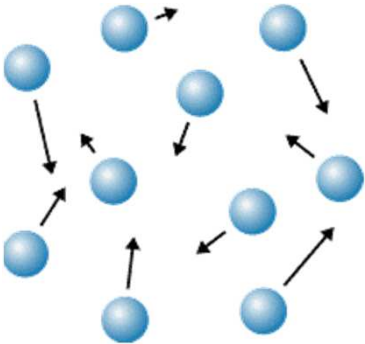
IR Band	Wavelength Range
IR-A	700nm - 1400nm
IR-B	1400nm - 3000nm
IR-C	3000nm - 1 mm



Heat



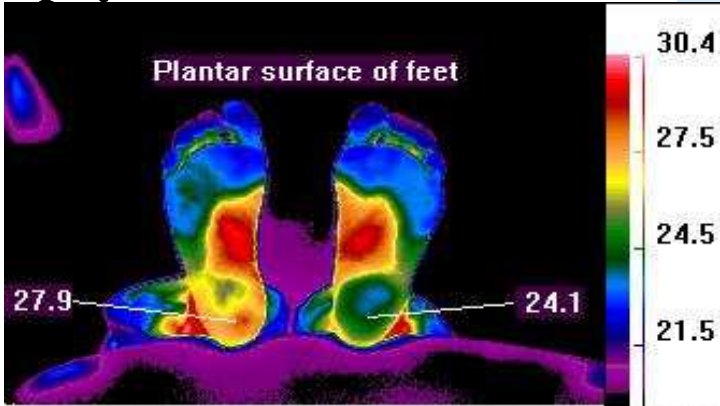
Movement



from thermometry to



thermography



Electromagnetic Spectrum – Microwaves

Wavelength 1mm – 1m

Communication –



Cell phones!!!

Cooking - oven



Medicine – physiotherapy... and indirectly



Cyberknife

Electromagnetic Spectrum – Radio Waves

Wavelength 1m – 1km

Communication – radio and TV



Medicine – MRI!



Electromagnetic Spectrum – AC !

Alternating currents!

electricity network frequency: 50 – 60 Hz

