

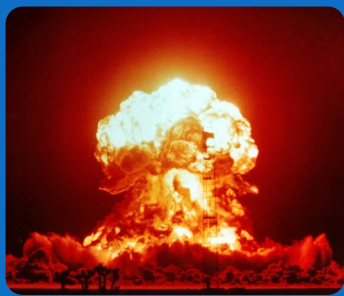
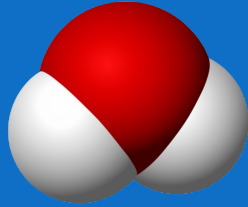
THE ELECTROMAGNETIC RADIATION SPECTRUM

Timothy Langer



Gamma rays – 10^{-12} m and less

On the EM spectrum, Gamma Rays have the highest amount of energy; they are emitted by the radioactive elements, for example during nuclear fission in nuclear explosions. Their wavelength is so small that it is shorter



in distance than that of a single water molecule. It is though that this limit comes about due to thought to the vicinity of the Planck length. The confusingly named alpha, beta and delta radiation are actually not electromagnetic.

Electromagnetic Radiation (EMR)

Electromagnetic radiation consists of *electromagnetic waves*, which are synchronised oscillations of electrical charge and magnetic field. This radiation travels through vacuum at the speed of light. Albert Einstein theorised that the speed of light is the fastest anything can travel, and has not yet been proven wrong.

X-rays ~ 10^{-10} m – 10^{18} Hz

X-rays were discovered in the 19th century by Wilhelm Röntgen. They are often used for medicinal purposes, since they travel through soft tissue but not solids such as bone. Just like Gamma rays and ultraviolet light, X-rays are a type of ionising radiation and therefore harmful to living tissue, with excessive doses causing cancer or radiation sickness. Therefore before performing something such as a CT scan, the benefits must be weighed up against the risks.



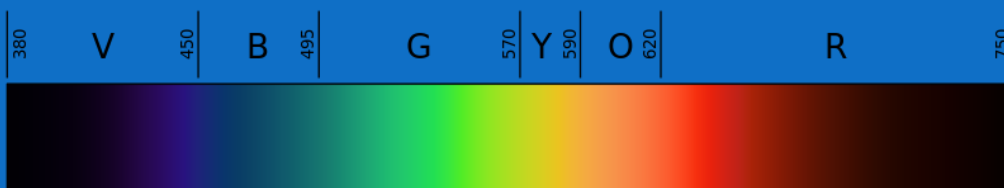
While generally considered invisible to the naked eye, X-rays can be visible in certain circumstances, with several scientists who first experimented with the rays recording a faint "blue-grey" glow.

Ultraviolet light – 10 to 400 nm

Most ultraviolet light is absorbed by the earth's atmosphere except UVA and UVB. This is the invisible electromagnetic radiation that gives one a suntan, is used as a form of protecting against fake bank notes and credit cards and used as a disinfectant due to the way ultraviolet (especially UVC) denatures DNA. Ultraviolet rays are invisible to the human eye, however, some young people & mammals and many insects & birds can see all or part of the UV spectrum.



Visible light – 400 to 700 nanometres – 430 to 750 terahertz



Visible light is the portion of the EM spectrum that is visible to the human eye. EMR becomes invisible to humans (infrared) when the photons no longer have enough energy to cause a change in the human retina and so it is not seen. At the other end,

ultraviolet light is invisible because the rods and cones in the human eye are damaged and cannot detect such wavelengths. On Earth, the main source of light is the Sun; a lot of this energy is absorbed by photosynthesising plants. White light is not a single wavelength but rather a combination of all of the visible wavelengths. The energy of light (and other EM waves) is called a photon. Not surprisingly, photons (i.e. light) travels at the speed of light (299,792,458 m/s). Light, like other EM waves, can be reflected and refracted. The sky appears blue to humans because the atmosphere scatters light and the shorter wavelength blue gets scattered the most.

Infrared – 10^{-5} m

Infrared radiation is sensed by humans as heat and is below the range of human vision. Anything that is not at absolute zero emits IR. This wavelength is useful as communication between a remote and the TV. Night vision goggles infrared imaging to convert infrared into visible wavelengths. In general there are many applications of infrared. Strong infrared radiation in industry can cause damage to the eyes or even blindness.



Microwaves & radio waves – 1mm to 100km

Uses: TV, radio, Wi-Fi, microwave ovens, GPS, RADAR (**RA**dio **D**etection **A**nd **R**anging)

Different radio frequencies have different purposes. Some studies have shown microwaves to be carcinogenic, however there are experiments to use these waves to *fight* cancer instead. Radio waves are considered safe.

