

Astrophysics and Medical Physics Definitions

A **planet** orbits a star and has sufficient mass that its own gravity gives it a round shape. It has no fusion and it has cleared its orbit of most other objects.

A **planetary satellite** is a body in orbit around a planet (includes moons and artificial satellites).

The **main sequence** is the main period in a star's life when the inward pressure due to gravity is balanced by the outward pressure of hydrogen fusion.

A **red giant** is an expanding star towards the end of its life where no fusion occurs in the core but fusion occurs in the shell around the core causing the surface of the star to expand and cool.

A **white dwarf** is small, dense, hot remnant of a low mass star in which fusion no longer occurs.

A **neutron star** is the remnant core of a massive star with a core of mass greater than the Chandrasekhar limit consisting almost entirely of neutrons and formed as the result of a supernova.

A **black hole** is the remnant of an extremely massive star formed as a result of matter collapsing to a singularity. Its density is sufficiently great that even photons cannot escape from it.

The **Hertzsprung-Russell diagram** is a graph of increasing luminosity plotted against decreasing temperature. The main sequence runs from top left (large, hot, bright stars) to bottom right (smaller, cooler, dimmer stars) with giants and supergiants top right and white dwarfs bottom left.

A **black body** is an idealised object that would absorb all electromagnetic radiation that is incident on it and would emit a characteristic distribution of wavelengths at a specific temperature.

Wien's displacement law: $\lambda_{\max} \propto 1/T$ or $\lambda_{\max}T = \text{Wien's constant}$

Luminosity is the total radiant power output of a star. Unit: watts (W)

Stefan's Law $L = 4\pi r^2 \sigma T^4$

An **emission line spectrum** consists of bright lines against a dark background and is produced by the specific frequencies of electromagnetic radiation emitted by excited atoms as their electrons fall from higher energy levels to lower ones.

An **absorption line spectrum** consists of dark lines against a continuous spectrum and is produced by the specific frequencies of electromagnetic radiation absorbed by atoms as their electrons are excited from lower energy levels to higher ones.

An **astronomical unit (AU)** is the average distance of the Earth from the Sun and is approximately 1.5×10^{11} m.

A **light-year (ly)** is the distance travelled by light in a vacuum in one year.

A **parsec (pc)** is the distance that gives a parallax angle of 1 arc second with a baseline of length 1 AU.

Parallax angle is the apparent shift of a star against the background of more distant stars as the Earth makes a quarter of an orbit around the Sun. Parallax angle (in arc seconds) = $1/\text{distance (in pc)}$ $p = 1/d$

The **cosmological principle** states that on a large scale the universe is uniform. ie It is **homogeneous** and **isotropic**.

The **Doppler Effect** is the change in frequency and wavelength received from an object moving relative to an observer compared to the wavelength without relative motion.

Hubble's Law: The speed of recession of a galaxy is proportional to its distance. $v = H_0 d$

Age of the universe = $1/\text{Hubble constant}$ ($=1/H_0$) [H_0 must be in s^{-1}]

The big bang theory: the universe started with all matter and energy coming from a single point that expanded rapidly outwards.

Cosmic microwave background radiation (CMBR) is the electromagnetic radiation corresponding to black body radiation at a temperature of 2.7 K and is the remnant of the gamma photons formed early in the formation of the universe when the universe became transparent with subsequent expansion and cooling causing red shift into the microwave part of the spectrum. It is uniform in all directions with only small variations.

Dark matter is matter that neither emits or absorbs light and cannot currently be observed except by its gravitational effect.

Dark energy is a form of energy that has been hypothesised to explain the expansion of the universe.

An **X-ray tube** produces X-ray photons by firing electrons from a hot cathode onto an anode using a very high p.d. in an evacuated tube.

Simple Scattering: An X-ray photon is scattered elastically by an electron in an atom.

The **photoelectric effect** An X-ray photon is absorbed so that one electron gains enough energy to escape from the atom.

Compton scattering: An electron is removed by an X-ray photon which itself loses energy and is scattered.

Pair production: The energy of a high energy X-ray photon is converted into an electron-positron pair.

Intensity is the power per unit cross-sectional area. Units Wm^{-2}

Contrast media are materials with high atomic number that can be ingested or injected into the patient to reveal the outline of soft tissue in an X-ray image.

The **piezoelectric effect** is production of an induced e.m.f in certain crystals when they are compressed. Alternately, when a p.d. is applied across them in one direction, they shrink slightly. When the p.d. is reversed they expand slightly.

Acoustic impedance = density x speed of sound in the material $Z = \rho c$