Glossary of Astronomical Terms

Absolute magnitude A measure the light given out by a celestial object. It is the magnitude the object would be if it were 10 parsecs (about 33 light-years) away.

Absolute zero The temperature at which the motion of atoms and molecules stops. It is 0 degrees Kelvin or -273.16 degrees Celsius.

Accretion The process by which dust and gas accumulate into larger bodies such as stars and planets.

Accretion disk A disk of gas, dust and larger objects that surrounds and orbits a massive body like a star or black hole.

Achondrite A stony meteorite that contains no chondrules.

Albedo The fraction of light reflected from a surface. The albedo of the Moon is 7%.

Altitude The angular distance of an object above the horizon.

Anti-matter Matter consisting of quarks and leptons with charges opposite that of ordinary matter.

Aperture The diameter of the opening through which light passes when coming into a telescope or camera.

Aphelion The point in the orbit of a planet or other body where it is farthest from the Sun.

Apogee The point in the orbit of the Moon or artificial satellite where it is farthest from the Earth.

Apparent magnitude see 'Magnitude'.

Asteroid A body smaller than a planet, composed mostly of rock and/or iron, that orbits Sun. Most asteroids in the solar system lie between the orbits of Mars and Jupiter.

Astronomical unit (AU) The mean distance between the Earth and the Sun, approximately 150 000 000 km.

Atmosphere A layer of gas surrounding a celestial body.

AU See 'Astronomical unit'.

Aurora A glow in the atmosphere of a planet caused by charged particles from the Sun being steered by the planet's magnetic field into the atmosphere, generally around the magnetic poles. Sometimes called 'Aurora borealis' in the northern hemisphere and 'Aurora australis' in the southern hemisphere.

Axis The line through an object around which it rotates.

Azimuth Along with altitude, a means of defining the position of an object in the sky. Azimuth is the angle measured clockwise from north to the point on the horizon directly below an object.

Baryon A subatomic particle consisting of three quarks. Protons and neutrons are the main types.

Big bang The theorised event in which the universe began to expand from a very small, very dense, very hot object about 13.8 billion years ago.

Binary star Two stars orbiting each other.

Black dwarf A hypothetical star remnant which emits no light, and which is what white dwarfs will evolve into after many billions of years. The universe isn't yet old enough for any black dwarfs to exist.

Black hole A celestial body whose surface gravity is so strong that light cannot escape from it.

Blue giant A very massive, hot blue star which has left the main sequence on the HR diagram.

Blue moon Originally, the third full moon in a season (3 months) with four full moons. More commonly, the second full moon in a month. This happens occasionally because full moons occur every 29.5 days. A blue moon is not actually blue.

Blueshift A shift in the lines of a light-emitting object's spectrum toward the blue end caused when the object is moving towards an observer. The amount of blueshift indicates the speed of the approach.

Bolide A very bright meteor. Fireball.

Boson A force carrying particle with integer spin that is not constrained by the Pauli exclusion principle which states that no two particles can be in the same quantum state in the same place. Bosons include 8 types of gluons which are exchanged between quarks to convey the strong nuclear force, the photon which is exchanged between charged particles to convey the electromagnetic force, the W^+, W^- and Z bosons which convey the weak force and the Higgs boson which causes particles to have mass. The graviton is another possible boson.

Brane theory See 'String theory'.

Brown dwarf A star-like object which is not sufficiently massive to cause the fusion of hydrogen. Brown dwarfs may, however, shine weakly from the energy released in the gravitational collapse at their formation. Brown dwarfs have masses between 0.013 and 0.08 solar masses. There are possibly more brown dwarfs than stars, though they are very difficult to find.

Captured obit Also known as a synchronous orbit. An orbit in which the orbiting body keeps the same side facing the orbited body, as the Moon does with the Earth. Orbits of bodies which are close together tend to become synchronous due to tidal affects.

Celestial equator A circle around the sky halfway between the north and south celestial poles.

Celestial poles The points in the sky directly above Earth's north and south poles. The points around which stars appear to rotate in the sky as the Earth rotates

Celestial sphere An imaginary sphere around the Earth on which the stars and planets appear to be positioned.

Cepheid variable A variable red giant star whose brightness rises and falls in a regular cycle. The period of fluctuation is related to the absolute magnitude of the star, allowing them to be used as standard candles.

Chandrasekhar limit The largest stable mass of a white dwarf star. In a white dwarf, collapse is prevented by electron degeneracy pressure, but this is only sufficient for stars up to 1.4 solar masses. If the mass of a white dwarf exceeds the Chandrasekhar limit, e.g. by sucking in material from an orbiting red giant, then it will collapse producing a type 1a supernova.

Chondrite A meteorite that contains chondrules.

Chondrule Glassy spheres around a millimetre in diameter found in chondritic meteorites, thought to originate by the splashing of melted rock in planetisimal collisions.

Chromosphere The part of the Sun's atmosphere immediately above the visible surface (photosphere).

Circumpolar star A star that never sets. At the poles, all visible stars are circumpolar; at the equator, none are.

Circumstellar disk A disk of gas, dust and larger objects orbiting a star.

Coma A cloud of gas and dust being released from the nucleus of a comet as it is heated by the Sun.

Comet A mass of ice, dust and rock fragments that partly evaporates, releasing a coma and a tail if it comes close to the Sun. Most comets are thought to orbit the Sun in the Oort cloud, with some being thrown off course by the gravitational effect of passing stars or other bodies.

Confinement The inability of quarks to exist outside of a hadron, like a proton or neutron. The energy required to separate a quark from a hadron is sufficient to produce new quarks which then combine with the quarks which one is trying to separate.

Conjunction An event that occurs when two or more mobile celestial objects (like planets) appear close together in the sky.

Constellation A grouping of stars that make an imaginary picture in the sky. The sky is officially divided into 88 constellations.

Coordinate time The time between two events as measured by an observer in an inertial frame, i.e. one who doesn't undergo any acceleration. Compare 'proper time', which is the time between two events as measured by a clock travelling in space-time between those two events.

Corona The outer part of the Sun's atmosphere, above the chromosphere. It is only visible from Earth during a total solar eclipse.

Coronal mass ejection An outburst of charged particles from the Sun that moves outwards through the solar system. If it is directed towards the earth, it can cause intense auroras and problems with communications and power grids.

Cosmic microwave background radiation The electromagnetic radiation coming very close to uniformly from all directions in space. It is the radiation that was emitted at the time when atoms could first form, 380 000 years after the big bang. The formation of atoms stopped the separate atomic

nuclei and electrons from absorbing all the radiation that was being produced, allowing it to then continue to travel through the universe until this day. The radiation was emitted when the universe was about 3000 K and was thus mostly at visible wavelengths, but the expansion of space has stretched the photons to microwaves with wavelengths corresponding to about 2.7 K.

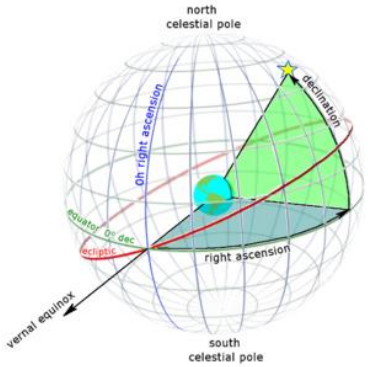
Cosmic rays Protons and other particles that impact the Earth's atmosphere with very high energies, mostly from supernovas and the like.

Cosmology The study of the universe as a whole.

Crater A bowl-shaped depression formed by the impact of an object from space or by volcanic activity.

Dark matter Matter of unknown nature that seems to cluster in and around galaxies. It doesn't interact with light, but its gravitational effects cause the outer parts of galaxies to orbit faster than they would without the presence of dark matter. It is estimated that there is about 4 times as much dark matter (by mass) as ordinary matter in the universe.

Declination Along with right ascension, declination is a measure of the location of a celestial object on the celestial sphere. It is the angle of the object upwards from the celestial equator.



Density The mass of a unit volume of a material. Density can vary from 1 atom per cubic metre in inter-galactic space to 1 billion tonnes per cubic centimetre in neutron stars, and even more in black holes.

Doppler effect The change in frequency of sound or light caused by the relative motion of the emitter and the observer. In the case of light, it produces red shift if they are moving apart, blue shift if they are moving towards one another.

Double star Two stars which appear close together in the sky. They may be a binary system in orbit around each other or one may be much further away than the other, just on similar lines of sight.

Dwarf Planet A celestial body that orbiting a star, that is massive enough to be rounded by its own gravity, but which has not cleared its orbit of planetesimals. Pluto is a well known example.

Eccentricity A number that defines the shape of an orbit, 0 for a perfectly circular orbit, 0 to 1 for elliptical orbits, 1 for parabolic orbits and >1 for hyperbolic orbits. Bodies in circular or elliptical orbits will keep coming back to the same position; those in parabolic and hyperbolic orbits never will.

Eclipse An event in which one celestial body totally or partially stops light from a star reaching another celestial body. In an eclipse of the Sun (solar eclipse), the Moon prevents sunlight reaching some points on Earth; in an eclipse of the Moon (lunar eclipse), the Earth prevents sunlight reaching certain points on the Moon.

Eclipsing binary A binary system (commonly a binary star or a star and planet), where one object passes in front of the other, cutting off some or all of its light.

Ecliptic The path the Sun makes around the celestial sphere as the Earth orbits the Sun.

Ejecta Material from a solid celestial body ejected by the impact of a smaller body and scattered over the surface of the larger body.

Electromagnetic radiation Photons of various frequencies (radio waves being the lowest, then microwaves, infra-red, light, ultra-violet, X-rays, then gamma rays, the highest). It consists of variation of electric and magnetic fields in space and travels at the speed of light, about 300 000 km/s.

Electromagnetic spectrum The range of frequencies of electromagnetic radiation from radio waves to gamma rays.

Electron The negatively charged fundamental particles present in all atoms. They orbit the positively charged nucleus, but can be separated from the atom, turning the atom into an ion, and travel independently. They are the charge carriers in electric currents.

Electron degeneracy pressure The resistance of matter to compression produced by the resistance of electrons to being in the same quantum state as expressed in the Pauli exclusion principle. Electron degeneracy pressure is the force that keeps white dwarfs from gravitational collapse and will do the job as long as the mass of the white dwarf is less than 1.4 solar masses.

Ellipse A 2D shape that looks like a squashed circle or oval. They vary from near circles (with width almost equal to length and eccentricity close to 0) to near parabolas (with length almost infinitely larger than with and eccentricity close to 1).

Ellipsoid A 3D shape that looks like a squashed sphere. The 3D equivalent of an ellipse.

Elliptical galaxy A galaxy in the shape of an ellipsoid (the 3D equivalent of an ellipse). Typically, they are generally fairly large and smooth in appearance. They contain mostly older stars with little interstellar gas and dust. They are thought to be produced by the merger of galaxies of comparable size.

Elongation The angular distance of Mercury or Venus from the Sun as seen from Earth.

Equinox The two times when the Sun crosses the celestial equator in its annual path around the celestial sphere. They occur around March 21 and September 22. At the equinoxes, the Sun rises or sets at the poles and all places on Earth have 12 hours day and 12 hours night.

Escape velocity The speed required for an object to completely escape the gravitational pull of a planet or other body if launched from the surface with no further propulsion.

Event horizon The surface of a black hole below which nothing can escape its gravity.

Extra-terrestrial Not originating on Earth.

Eyepiece The smaller lens at the viewing end of a telescope.

Fermion A matter particle with non-integer spin that obeys the Pauli exclusion principle which says that no two fermions can occupy the same quantum state in the same place. Fermions include 6 types of quarks, 6 types of leptons as well as anti-particles and mirror image particles of these.

Fermi paradox A paradox attributed to Enrico Fermi, which points out that, considering the number of planets that there are likely to be in the universe which would be suitable for the evolution of intelligent life capable of travelling between star systems, it is surprising that there is no evidence of any extra-terrestrials ever having visited Earth. Various resolutions have been proposed, though none has been widely accepted.

Filament A strand of cool gas above the photosphere following a magnetic field line.

Fireball A very bright meteor. Bolide.

Flare A temporary bright patch of the surface of a star.

Flare star A red dwarf star with frequentlchanges in brightness caused by flares on its surface.

Galactic halo The roughly spherical region above and below the disk of a spiral or lenticular galaxy which contains a low density of mainly old stars and globular clusters.

Galactic bulge A bulge of mainly old stars at the centre of a spial galaxy.

Galaxy A grouping of millions to trillions of stars and inter-stellar gas and dust orbiting around their common centre of mass. Most galaxies are irregular, spiral, lenticular or elliptical.

Galilean moons Jupiter's four largest moons, easily seen through a small telescope. They are Io, Europa, Ganymede and Calisto.

Gamma ray The highest frequency, highest energy and shortest wavelength form of electromagnetic radiation with frequencies above 3×10^{19} Hz and wavelengths less than 10^{-11} m.

Gas giant A large planet composed predominantly of hydrogen and helium.

General relativity See ‘Relativity – general’.

Geosynchronous orbit An orbit in which a satellite orbits around the equator of a planet with orbital angular velocity equal to the rotational angular velocity of the planet. A satellite in geosynchronous orbit remains above one position of the planet's surface.

Globular Cluster A small dense spherical cluster of thousands to millions of old stars with little or no interstellar gas and dust. Most orbit a galaxy forming part of the galactic halo.

Granule A convection cell on the surface of the Sun's photosphere about 1500 km across and lasting about 8 to 15 minutes.

Gravitational Lens A concentration of mass such as a galaxy or galaxy cluster that bends light rays from a background object. They can enlarge images and produce multiple images of distant objects.

Gravity A mutual physical attraction between all bodies with mass. In general relativity, it is seen as the result of curvature of space-time as a result of the presence of matter and energy.

Greenhouse Effect An increase in temperature under an atmosphere caused when incoming short-wavelength radiation passes through the atmosphere, but outgoing long-wavelength radiation is absorbed by it. Carbon dioxide, methane and water are some of the main gases responsible for this effect as they transmit visible light but absorb infra-red radiation.

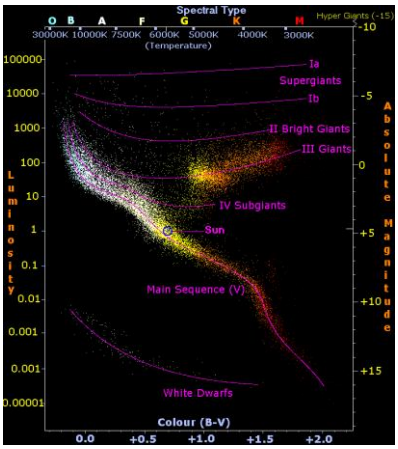
Hadron A subatomic particle consisting or quarks and gluons. Baryons (like protons and neutrons) are hadrons with three quarks; mesons are hadrons with a quark and an antiquark.

Heliopause The points around the Sun, beyond the orbit of Pluto, where the solar wind runs into the interstellar medium and is stopped by it.

Heliosphere The space inside the heliopause.

Hertzsprung-Russel diagram (HR diagram) A plot of stars' luminosities against their spectral class (indicating surface temperature). Different types of stars plot in different regions of the diagram.

Hertzsprung-Russel diagram



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Hills Cloud See 'Oort Cloud'.

HR diagram See 'Hertzsprung-Russel diagram'.

Hydrogen The simplest element consisting of one proton and one electron. It makes up about 75% of the ordinary matter in the universe.

Hubble's Law The law that says that the distance to a galaxy is proportional to the speed with which it is moving away. This is a result of the fairly uniform expansion of the universe.

Hydrostatic equilibrium The balance between gravity which tends to cause a body to collapse and internal pressure which tends to cause it to expand. In a normal star, the internal pressure is produced by the motion of the particles and the gamma radiation.

Ice The solid state of water and other light molecules like methane and ammonia.

Ice giant A planet like Uranus and Neptune that contains a large amount of methane, ammonia and water as well as hydrogen and helium.

Inclination The angle between the orbital plane of a solar system body and the orbital plane of the Earth.

Inferior conjunction A conjunction that occurs when a planet passes near or in front of the Sun and is on the same side of the Sun as the Earth. This can only happen with Mercury and Venus.

Infrared Electromagnetic radiation with wavelength a bit longer than that of visible light (from 0.7 microns to 1 mm)

International Astronomical Union (IAU) An international organization that defines astronomical terms. For instance, in 2006, it defined 'planet' in a way that excluded Pluto.

Interplanetary magnetic field The magnetic field produced by the solar wind.

Interstellar medium The gas and dust between the stars of a galaxy.

Ionosphere A layer of a planet's upper atmosphere containing a large number of ions. On Earth, the ionosphere extends from about 40 km to 400 km above the surface.

Iron meteorite A meteorite that is composed mainly of metallic iron and lesser nickel.

Irregular galaxy A galaxy with no symmetrical shape. Newly formed galaxies and galaxies that have been disturbed by the passing of another galaxy are often irregular.

Irregular satellite A satellite which does not orbit the planet roughly in the equatorial plane and in the same direction as the rotation of the planet. Irregular planets are believed to have been captured by the planet's gravity rather than forming with the planet.

Jansky A unit of flux density from radio wave sources equal to 10^{-26} W/m^2/Hz.

Jet A narrow stream of particles ejected at high speed from the magnetic poles of a rotating star or black hole.

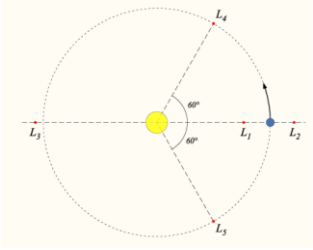
Kelvin A measure of temperature. The degrees are the same size as the degrees on the Celsius scale. But they are counted from absolute zero rather than the freezing point of water. So the number of Kelvins (K) is the temperature in degrees Celsius plus 273.16.

Kepler's laws Three laws developed by Johannes Kepler concerning the orbits of the planets in the solar system:

1. A planet orbits the Sun in an ellipse with the Sun at one focus.
2. A line from the Sun to a planet sweeps out equal areas in equal times.
3. The square of a planet's orbital period is proportional to the cube of its semi major axis.

Kuiper Belt A large ring of bodies ranging up to the size of dwarf planets like Pluto orbiting the Sun between about 30 and 50 AU from the Sun, beyond the orbit of Neptune. The bodies are made of ices and lesser rock and are believed to be left-overs of the original material that formed the planets.

Lagrange point Where a medium-sized body (like a planet) orbits a larger body (like the Sun), there are five Lagrange points, L1 to L5, where a small body can remain in a stable position relative to the medium and large bodies.



Large Hadron Collider The world's largest and most powerful particle accelerator, built by CERN (the European Organisation for Nuclear Research) under the Swiss-French border near Geneva. The main tunnel is circular with a circumference of 27 km. It is used to accelerate protons and other particles to speeds up to 99.999 999% of the speed of light and collide them with other particles coming at the same speed in the opposite direction in order to provide the energy necessary to produce new particles, like the Higgs boson.

Lenticular galaxy A galaxy shaped like a lens but without a spiral structure.

Lepton A light fundamental particle. There are six types: electrons, muons, taus, electron neutrinos, muon neutrinos and tau neutrinos and six corresponding anti-particles. Only electrons, electron neutrinos and their anti-particles are stable, though the anti-particles annihilate if they interact with a normal particle of the same type.

Libration A slight apparent wobbling of the Moon as it orbits the Earth which allows 59% of its surface to be seen from Earth.

Light year The distance light travels in a year, approximately 10 trillion kilometres, 10 000 000 000 000 km.

Limb The edge of a celestial body as seen from Earth.

Local Group A cluster of about 30 galaxies of which the Milky Way and the Andromeda Galaxy are members.

Loop quantum gravity A theory of quantum gravity which aims to incorporate quantum theory and general relativity into a single theory. Untested and not widely accepted.

Luminosity The amount of light emitted by a star.

Lunar eclipse An eclipse in which the Moon passes through the shadow of the Earth. In a total lunar eclipse the whole moon is completely shaded; in a partial lunar eclipse, just part of the Moon is completely shaded; in a penumbral lunar eclipse, just part of the Moon is partly shaded with the Earth obscuring only part of the Sun.

Lunar month The average time between successive new moons or full moons, equal to 29 days 12 hours 44 minutes. Also called a synodic month or a lunation.

M-theory See 'string theory'.

Magellanic Clouds Two small, irregular galaxies orbiting the Milky Way galaxy at close range, visible in the southern sky.

Magnetar A neutron star with a particularly intense magnetic field, about a trillion times as strong as the Earth's.

Magnetic Field A region of space in which moving electric charges experience a magnetic force.

Magnetic Pole A point on a body where the magnetic field lines are perpendicular to the surface. There are generally two, a north pole and a south pole.

Magnetosphere The area around a planet experiencing a strong magnetic field from the planet. Magnetospheres tend to deflect the solar wind, providing protection for any atmosphere and life on the planet.

Magnitude The brightness of a star or other object in the sky as seen from Earth. The scale used is arbitrary, ranging from –1.4 for the Sirius, the brightest star in the sky after the Sun to about 6 for the feintest stars visible to the naked eye. Each unit step in magnitude corresponds to a 2.5-times decrease in brightness. More precisely, 5 steps correspond to a 100-times decrease. The Sun is magnitude –26.7, the full moon –12.6. Also called 'apparent magnitude' or 'visual magnitude' to distinguish it from 'absolute magnitude'.

Main sequence star A star which is fusing hydrogen to helium as its power source and which therefore sits on the 'main sequence' curve on a Hertzsprung-Russell diagram.

Mare A large, roughly circular, smooth plain with few craters on the Moon. The word means 'sea' as this is what they were initially thought to be. They are now known to be areas of solidified lava flows, possibly resulting from major impacts. Plural: maria.

Mass A measure of the amount of matter in a body, defined either by its inertia or by its gravitational attraction to other bodies. Most subatomic particles have mass because of their interaction with the Higgs field.

Matter Anything that contains mass and takes up space.

Meson A subatomic particle consisting of a quark and an anti-quark.

Metal When used by astronomers, 'metal' means any element heavier than helium. When the universe first formed, it was just hydrogen and helium with no metals. Now it contains about 1.5% metals.

Metallicity The percentage of metals (elements heavier than helium) in an astronomical object or the universe as a whole.

Meteor The momentary streak of light produced when a small particle of rock or dust enters the Earth's atmosphere and is heated by friction. Meteors are commonly called 'shooting stars'.

Meteor Shower An event where numerous meteors enter the Earth's atmosphere from the same direction in space over a period of a few days. They occur when the Earth passes through the debris trail left behind by a comet.

Meteorite **A piece of rock or metal (or both) that enters the atmosphere and reaches the ground.**

Meteoroid An object, smaller than an asteroid or comet, in orbit around the Sun, that can become a meteorite if it hits the Earth.

Molecular Cloud A cloud of cold gas in interstellar space composed mainly of hydrogen molecules. Large molecular clouds can condense to produce thousands of new stars.

Monopole A theorised object consisting of just a single magnetic pole.

Nadir The point on the celestial sphere vertically downwards from an observer. Opposite of 'zenith'.

Nebula A cloud of gas and dust in interstellar space within a galaxy.

Neutrino A very light fundamental particle produced in nuclear reactions and travelling through the universe at very close to the speed of light. They interact very rarely with other particles, most passing right through the Earth without being affected by it. About 100 trillion neutrinos from the Sun pass through each human each second.

Neutron A particle consisting of an up quark and two down quarks (plus gluons and virtual particles). It has about the same mass as a proton, but no charge. Along with protons, neutrons make up the nuclei of all atoms heavier than hydrogen. They decay to protons and electrons if separated from an atomic nucleus.

Neutron degeneracy pressure The resistance of matter to compression produced by the resistance of neutrons to being in the same quantum state as expressed in the Pauli exclusion principle. Neutron degeneracy pressure is the force that keeps neutron stars from gravitational collapse.

Neutron Star A compressed core of an exploded star made up mostly of compacted neutrons. Neutron stars have strong magnetic fields and tend to emit jets of energy along their magnetic axis. This can result in a pulsar.

Newton's law of universal gravitation The law which states that any two bodies apply a mutual attractive force on each other equal to the product of their masses multiplied by the universal gravitational constant, G (6.7×10^{-11}), and divided by the square of the distance between their centres of mass.

Newton's Laws of Motion Three laws, developed by Isaac Newton, describing the motion of bodies:

1. A body continues at rest or in a state of constant velocity unless it is acted upon by an external force.
2. The force required to cause a body to accelerate is equal to the mass of the body multiplied by the acceleration: $F = ma$.
3. When a body applies a force to second body, the second body applies a force to the first which is equal in magnitude and opposite in direction.

Nova The sudden brightening of a white dwarf when it accretes enough hydrogen from an orbiting red giant to create an atmosphere thick and hot enough for run-away fusion to occur, This causes the atmosphere to explode into space emitting light for a few weeks to months.

Nuclear fusion The process whereby small nuclei are combined to make larger ones. Nuclear fusion is the reaction that fuels stars. In the Sun, hydrogen nuclei are fused to form helium with the release of energy.

Nucleon A proton or neutron inside the nucleus of an atom.

Obliquity The angle between a body's equatorial plane and its orbital plane.

Oblateness The equatorial bulging of rotating body due to the centrifugal effect.

Occultation An event that occurs when one celestial body conceals or obscures another, for example when the moon passes in front of a planet.

Oort Cloud A zone containing billions of predominantly ice planetesimals that is believed to exist in the outer reaches of the solar system. The Inner Oort Cloud (also called the Hills Cloud) is a torus shape in the same plane as the planets, ranging from 2000 to 20 000 AU from the Sun; the Outer Oort Cloud is spherical, completely surrounding the Sun and ranging from 20 000 to possibly 200 000 AU (3 light years) from the Sun. It is frequently disturbed by passing stars, sending icy bodies into the inner solar system as comets.

Open cluster A collection of young stars that formed together from a nebula and are still more closely spaced than surrounding stars. They may or may not still be associated with the nebula or bound by gravity.

Opposition A solar system planet further out than Earth is at opposition when it is in the opposite direction from the Sun in the sky as seen from Earth and therefore at its closest to the Earth.

Orbit The path of a body as it moves through space under the gravitational influence of another object. Orbits can be circular, elliptical, parabolic or hyperbolic.

Parallax The apparent change in position of a nearby object (e.g. a close star) against the background of more distant objects as the observer moves (e.g. as the Earth moves around the Sun).

Parsec The distance at which an object will have a parallax of one second of arc and the Earth orbits the Sun. A parsec is about 3.26 light-years. A kiloparsec is 1000 parsecs etc.

Penumbra The area on, say, the Moon, where the Sun is partly obscured by an eclipsing body like the Earth.

Perigee The point in the orbit of the Moon or other satellite at which it is closest to the Earth.

Perihelion The point in the orbit of a planet or other body where it is closest to the Sun.

Perturbation Deviation of a planet or satellite from its calculated orbital motion.

Phase The apparent change (from crescent to half to gibbous to full) in shape of the lit part of the Moon, Mercury or Venus as seen from Earth as its position changes relative to the Earth and the Sun.

Photon A particle of electromagnetic radiation. Photons move in straight lines at the speed of light through empty space.

Photosphere The visible surface of the Sun.

Planet A celestial body orbiting a star that is not itself a star, but is massive enough to be rounded by its own gravity and has cleared its orbital region of planetesimals.

Planetary nebula A shell of gas and dust produced as a red giant star throws off its outer layers into the surrounding space, leaving a white dwarf. The nebula is illuminated by the white dwarf.

Planetisimal A small lump of dust, ice, rock and/or metal orbiting a star. Planetisimals generally form from smaller particles in the accretion disk in the early stages of a star's life and tend to combine to form larger bodies like planets and satellites, though some remain as planetesimals. Asteroids, comets and TNOs are examples in the solar system

Plasma A state of matter, common at high temperature like inside stars, consisting of atomic nuclei and electrons not bound into atoms.

Precession The gradual shift in the direction of the rotational axis of a body that is in orbit around another body. Generally, the rotation axis traces out a circle around the perpendicular to the orbital plane. The Earth's axis precesses roughly every 26 000 years causing the Sun to move through different zodiac signs at a given time of the year.

Prograde orbit An orbit in the same direction as the rotation of the body being orbited or in the same direction as most other objects orbiting that body.

Proper motion The apparent angular motion across the sky of an object as seen from Earth. Usually applied to stars as they move around the galaxy.

Proper time The time between two events as measured by a clock travelling in space-time between those two events. Compare 'coordinate time' which is the time between two events as measured by an observer in an inertial frame, i.e. one who doesn't undergo any acceleration.

Proton A subatomic particle consisting of two up quarks and one down quark (plus gluons and virtual particles). Protons have a charge of +1 and, along with neutrons, form the nuclei of atoms.

Protoplanetary disk A rotating disk of gas, dust and planetisimals surrounding a newly formed star, materials from which later form planets and other bodies.

Protostar A dense accumulation of gas and dust within a nebula which eventually becomes a star.

Pulsar A neutron star which emits energy along two jets, one from each of its magnetic poles, and in which the magnetic poles do not coincide with the rotational axis. The jets thus sweep repeatedly around the sky. If they sweep through the direction of an observer, the observer sees regular pulses of radiation, making the star a pulsar.

Quantum field theory The theory that space is pervaded by fields for different types of particles (24 is a commonly proposed number), that particles are disturbances of those fields containing energy and that disturbances in some of the fields can impact the behaviour of other fields at the same location.

Quantum theory The description of the nature and behaviour of subatomic particles. It tends to be counter-intuitive because their nature and behaviour are quite different from those of the objects we see in everyday life. For instance, until it is observed, a particle is in many places at the same time and in many states at the same time. Although the theory is well accepted, the interpretation of some facets of it is still not agreed upon. For example, the wave function of a particle collapses, changing it from a superposition of many states to a single state, when the particle is observed. But there is no agreement on what constitutes an observation.

Quark One of the fundamental particles which, along with gluons, make up protons and neutrons. There are 6 types: up and down quarks make up the protons and neutrons of regular matter; charm, and top quarks are unstable more massive versions of the up quark; strange and bottom quarks are unstable more massive versions of the down quark. Up, charm and top quarks have a charge of $+^2/_3$; down, strange and bottom quarks have a charge of $-^1/_3$. Because of the phenomenon of confinement, quarks cannot be separated form protons and neutrons except at extremely high temperature like in the big bang.

Quasar A point-like source of light in the centre of a distant galaxy, much brighter than most galaxies. They are thought to be produced by super-massive black holes which are actively consuming large quantities of gas and stars.

Radial velocity The component of the velocity of an object either towards or away from an observer.

Radiant The point in the sky from which the meteors in a meteor shower seem to radiate.

Radiation Energy and/or matter emitted from an object in all or many directions.

Radiation belt A region within the magnetosphere of a planet or other object which contains are high density of fast-moving charged particles. The Earth's radiation belts are called the Van Allen Belts.

Radio astronomy The study of celestial objects by observing the radio waves they emit. Large radio telescopes are used for this purpose.

Radio galaxy A galaxy that gives off large amounts of energy in the radio wave part of the electromagnetic spectrum.

Red dwarf A star between 0.08 and 0.5 solar masses. Red dwarfs are small and red and shine weakly, commonly with frequent flares. Red dwarfs make up some 85% of all stars and include the Sun's nearest neighbour, Proxima Centauri, though no red dwarfs can be seen from Earth with the naked eye because of their dimness. Because they burn their hydrogen so slowly, they will keep burning for hundreds of billions to trillions of years.

Red giant A very large red star which is produced when the hydrogen fuel in the core runs out, allowing partial gravitational collapse with consequent heating, the inception of hydrogen fusion closer to the surface and a large increase in size. Stars like the Sun expand to a diameter of 1 to 5 AU and spend about a billion years as a red giant before throwing off their outer layers to form a white dwarf and a planetary nebula.

Redshift A shift in the lines of an object's spectrum toward the red end. Redshift indicates that an object is moving away from the observer. The larger the redshift, the faster the object is moving away. Red shift is quantified with the variable *z*, the fractional change in wavelength. $z = \frac{\lambda_{\text{obs}} - \lambda_{\text{emit}}}{\lambda_{\text{emit}}}$, where λ_{obs} is the observed wavelength and λ_{emit} is the wavelength emitted from the source. The value of *z* for the most distant observed objects is 11.1, corresponding to a time 400 million years after the big bang.

Regular satellite A satellite that orbits close to a planet in a nearly circular, equatorial orbit. Regular satellites are believed to have formed along with the planet, unlike irregular satellites which are believed to have been captured by the planet's gravity.

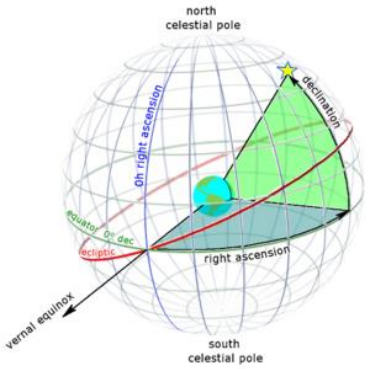
Relativity – General A theory proposed by Einstein and now very well established and accepted, explaining gravity as the curvature of space-time caused by the presence of mass, energy and momentum.

Relativity – Special A theory proposed by Einstein and now very well established and accepted, detailing the logical consequences of the observed fact that the speed of light is the same relative to any observer, irrespective of their motion. It describes the changes in the length and mass of an object as it moves faster as well as changes in the speed at which time passes. The most famous equation, $E = mc^2$, shows how energy possesses mass and how mass and energy are interchangeable.

Resonance A state in which two orbiting bodies have their orbital periods in a simple ratio as a result of gravitational interaction between the two bodies. As an example, the ratio of the periods of Neptune and Pluto is 2:3.

Retrograde motion The motion of a planet when it reverses it usual progression around the ecliptic for a while because the Earth is overtaking it.

Retrograde orbit The orbit of a satellite which travels in the opposite direction to that of the planet's rotation.



Right ascension Along with declination, right ascension is a measure of the location of a celestial object on the celestial sphere. It is the angle to the left along the celestial equator from the position of the Sun at the northern hemisphere spring equinox.

Ring galaxy A rare type of galaxy in the shape of a ring. The ring usually contains luminous blue stars. Ring galaxies are believed to have been formed when another galaxy passes through it at high speed.

Roche limit The smallest distance from a celestial body at which purely gravitational forces can hold together a secondary body of the same mean density in orbit around it. At a lesser distance the tidal forces of the primary would break up the secondary.

Rogue planet A planet-like body that does not orbit a star. Some may have been ejected from stellar systems by gravitational interaction with other planets; some may have condensed directly from star-forming nebulae rather than in the accretion disks of stars.

Rotation The spin of a body about its axis. In some contexts, a single turn about the axis.

Saros cycle A period of 223 synodic months (6,585.3 days or 18 years 11 days 8 hours) that can be used to predict solar and lunar eclipses. Also known as a saros series.

Satellite A natural or artificial body in orbit around a planet.

Scattered disk A collection of small mostly icy bodies which orbit the Sun at distances from 30 to 100 AU with orbits which can be quite eccentric and at quite high angles to the plane of the planets. They are thought to be the result of scattering of objects through interaction with the outer planets.

Seyfert galaxy A spiral galaxy with a very bright and variably bright centre. The light is believed to come from the central super-massive black hole, rising in intensity when large objects like stars are devoured.

Shepherd moon A satellite that shapes a planetary ring through gravitational forces.

Sidereal Of, relating to, or concerned with the stars. Sidereal rotation is that measured with respect to the background stars rather than with respect to an object being orbited.

Sidereal month The average period of revolution of the Moon around the Earth relative to the background stars. Its length is 27 days, 7 hours, 43 minutes.

Sidereal period The period of revolution of a planet around the Sun or a satellite around its primary measured with respect to the background stars.

Singularity A theoretical point in space with infinite mass density and infinite curvature. It is theorised that singularities occur at the centres of black holes and that the big bang arose from one. However, the known laws of physics break down in such situations and many doubt the actual possibility of singularities.

Small solar system body A solar system body that is smaller than a dwarf planet. Examples are asteroids and comets.

Solar cycle The roughly 11-year semi-periodic variation in sunspot activity on the Sun.

Solar eclipse A phenomenon that occurs when the Moon passes between the Earth and the Sun, blocking light from the Sun locally. A total solar eclipse occurs when the Moon is close enough to completely block the Sun's light. An annular solar eclipse occurs when the Moon is farther away and is not able to completely block the light. This results in a ring of light around the Moon. A partial solar eclipse occurs when the Moon covers only part of the Sun.

Solar flare A temporary brightening of a patch of the Sun's photosphere, often giving rise to a solar prominence and/or a coronal mass ejection.

Solar prominence An eruption of hot plasma from the Sun’s surface.

Solar system The Sun and the matter orbiting it including planets, dwarf planets, satellites and small solar system bodies like asteroids and comets as well as gas and dust. The solar system extends out to the limit of the Oort cloud, more than a light year from the Sun, though the term is sometimes used for just the part in the vicinity of the planets.

Solar wind The continuous flow of charged particles that travel from the Sun out to the heliopause where they are stopped by the inter-stellar medium.

Solstice The times of the year when the Sun is at its furthest north or south of the celestial equator. These occur on or about June 21 and December 22.

Special relativity See ‘Relativity – special’.

Spectrometer An instrument connected to a telescope that measures the intensity of each wavelength of light from a star or other light source, producing a spectrum.

Spectroscopy The technique of observing the spectrum of electromagnetic radiation from an object to determine its temperature, composition and speed.

Spectrum The range of wavelengths that make up electromagnetic radiation. A spectrum of visible light is produced when light passes through a prism or when sunlight passes through rain drops forming a rainbow.

Spicules Hair-like jets of plasma moving upwards in the Sun's chromosphere.

Spiral galaxy A disk-shaped galaxy with spiral arms and a central bulge. The arms contain clouds of gas and dust and many new stars; the central bulge contains mainly older stars and little inter-stellar material. There is generally a super-massive black hole in the centre of the bulge. Our galaxy, the Milky Way, is a spiral galaxy.

Standard candle A star or supernova whose absolute magnitude can be determined from its characteristics like its period of variability in brightness. Knowledge of their absolute magnitude allows their distance to be calculated.

Standard model A generally accepted model of particle physics which specifies the existence of certain fundamental particles, namely 6 types of quarks, 6 types of leptons, 13 bosons (including 8 types of gluons, the photon, the W^+, W^- and Z bosons and the Higgs boson. There are also anti-particles for many of these as well as mirror image particles of most particles and anti-particles.

Star A roughly spherical mass of hot plasma that generated energy through nuclear fusion in its core and radiates it into space, largely as electromagnetic radiation.

Star cluster A group of stars smaller than a galaxy, with significantly more stars per unit volume than in the surrounding space.

Steady state theory The theory that the universe is expanding but remains in an overall unchanging state because new matter is being continually being created in the gaps left by expansion. This theory was largely abandoned in the 1960s in favour of the big bang theory when the cosmic microwave background radiation was discovered.

Stellar wind The ejection of charged particles from the surface of a star. The stellar wind of the Sun is called the solar wind.

Stony meteorite A meteorite composed or rock (mostly magnesium silicates), thought to be material left over from the accretion of the planets.

Stony iron meteorite A meteorite containing both rock (silicates) and metallic iron.

String theory An untested theory that all subatomic particles are expressions of extremely small strings vibrating in different modes in around 10 dimensions. Superstring theory, M-theory and brane theory are variations on string theory.

Strong nuclear force (also called the strong force) The force which holds quarks together in hadrons like protons and neutrons. It is conveyed inside nucleons by the exchange of gluons. A residue of the strong force extends outside of the hadrons and holds the protons and neutrons together in the nucleus of an atom. This is achieved by the exchange of mesons between nucleons.

Sunspot A patch on the Sun's surface that is cooler than surrounding areas (about 3000 K compared to the usual 6000 K). When viewed, they appear black compared to the surrounding areas, although if seen in isolation they would glow brightly. Sunspots are associated with disturbances in the Sun's magnetic field.

Supergiant A very large red giant.

Supermoon A full moon that occurs when the moon is at or close to perigee (closest approach in its orbit to Earth). A full moon at perigee is 14% wider and 30% brighter than a full moon at apogee.

Superior conjunction A conjunction that occurs when a planet passes near or behind the Sun and is on the opposite side of the Sun from the Earth.

Supernova An explosion of a star producing a huge amount of light for a few days to months. There are different types with different causes. Core-collapse supernovas occur at the ends of the lives of large stars (more than 9 times the mass of the Sun). These stars fuse hydrogen to helium, then helium to carbon, oxygen, neon, magnesium, silicon and finally iron maintaining the star's inner temperature and pressure and stopping it from collapsing. However, fusing iron does not produce any further energy, so, once the core is largely iron, it collapses to a very small mass of neutrons or a black hole. The outer layers fall onto the core at about ¼ the speed of light. The gravitation and strong-force energy released in the collapse causes the outer layers of the star to be ejected into space at about $^{1}/_{10}$ the speed of light, exposing the core at about one billion Kelvin. These supernovas produce elements heavier than helium (metals) and spread them through space. Type 1a supernovas occur when a white dwarf sucks material off an orbiting red giant. When it reaches the Chandrasekhar limit (1.4 times the mass of the Sun), it undergoes sudden fusion of carbon and oxygen to heavier elements producing an explosion which may scatter the whole star into space.

Supernova remnant An expanding shell of gas and dust ejected at high speeds by a supernova explosion. Many supernova remnants are illuminated by radiation from the remaining neutron star.

Superstring theory See 'string theory'.

Synchronous rotation See 'captured orbit'.

Synodic month The time from one new moon or full moon to the next, 29.53 days.

Synodic period The interval between successive oppositions or inferior conjunctions of a planet as seen from Earth.

Tektite A glass bead up to a few centimetres in size formed when a meteorite or asteroid strikes the ground throwing drops of liquified rock into the atmosphere.

Telescope An instrument that uses lenses, mirrors and/or large solid or wire dishes to enable distant small objects to be magnified and thus seen and photographed more clearly. Telescopes can

be on the ground or in space and can record in a wide range of the electromagnetic spectrum from radio waves to X-rays.

Terminator The boundary between the light side and the dark side of a planet or other body.

Terrestrial Originating on Earth.

Terrestrial planet A planet, like the Earth, composed mainly of rock and iron.

Theory of everything (TOE) A hoped-for theory that might one day incorporate quantum theory (which accounts for the strong, weak and electromagnetic interactions) and general relativity (which accounts for gravity) in a single theory. String theory and loop quantum gravity are two attempts at such a theory.

Tidal force The difference in gravitational attraction experienced by the near and far sides of bodies which are close together in space, e.g. the Earth and the Moon. The result is a stretching of the bodies towards each other.

Tidal heating If the tidal force experienced by a body changes its direction relative to the body (e.g. because of rotation) or its intensity (e.g. from being in an eccentric orbit), the body will be internally distorted, resulting in frictional heating. Such heating produces the volcanic activity on Jupiter's moon Io.

TNO See 'Trans-Neptunian object'.

Transit The passage of a celestial body across the disk of a larger one, e.g. the passage of Venus across the face of the Sun as viewed form Earth.

Trans-Neptunian object (TNO) Any of the many smaller objects that orbit the Sun beyond the orbit of Neptune.

Trojan A small object orbiting the Sun at one of the Lagrange points of a planet. For example, several asteroids orbit the Sun stably at Jupiter's Lagrange points.

Ultraviolet Electromagnetic radiation with wavelengths between 400 and 10 nm, shorter than visible light, but longer than X-rays. Earth's atmosphere (especially the ozone in the stratosphere) blocks most of the ultraviolet light from the Sun.

Umbra The part of an eclipsed body where the light is completely blocked. For example, in a lunar eclipse, it is the part of the Moon where the Sun is totally blocked by the Earth. Compare 'penumbra'.

Universal time coordinated (UTC) Also known as Greenwich Mean Time, this is local mean time on the Greenwich meridian. UTC is used by astronomers as a standard measure of time.

Van Allen belts The Earth's radiation belts.

Variable star A star that fluctuates in brightness. In intrinsic variables the light output of the star varies; in extrinsic variables, the amount of light reaching the Earth varies because of some cause outside of the star, e.g. obscuration by an eclipsing binary star or planet.

View finder A small, low-magnification, wide-field telescope attached to a larger telescope. The view finder is used to help point the larger telescope towards the desired object.

Visible light Electromagnetic radiation that is visible to the human eye. Its wavelength ranges from 400 nm for violet light to 700 nm for red light.

Virgo Cluster A cluster of over 2000 galaxies located mainly within the constellation of Virgo. This cluster is located about 60 million light-years from Earth.

Virgo supercluster A cluster of galaxy clusters including the Virgo Cluster and the Local Group (which includes the Milky Way). It is about 110 million light years across and is part of the even larger Laniakea Supercluster.

Wavelength The distance between consecutive crests of a wave.

White dwarf A very small, white star formed when a Sun-like star uses up its fuel supply, throws off its outer layers and collapses. A white dwarf is about the size of the Earth, but around a million times more massive. Its density is about 1 tonne/cm^3.

X-ray Electromagnetic radiation with wavelengths between 10 nm and 10 pm, shorter than ultraviolet light but longer than gamma rays.

X-ray astronomy The study of celestial objects by observing the X-rays they emit.

X-ray star A celestial object that gives off X-rays as a major portion of its radiation.

Yellow dwarf A star with a mass similar to that of the Sun during its life on the main sequence.

Zenith The point on the celestial sphere vertically above an observer.

Zodiac The part of the celestial sphere around the ecliptic in which the Sun, moon, and all of the planets can always be found.

Zodiac constellation One of the 13 constellations (traditionally 12) through which the ecliptic passes.

Zodiacal light A faint diffuse light that can sometimes be seen above the horizon around the ecliptic after sunset or before sunrise. It results from sunlight being reflected off dust and other particles in the plane of the Solar System.

Except where otherwise acknowledged, diagrams are from Wikipedia.