

Glossary

- A scan** a graph of reflected ultrasound signal strength versus time
- accelerating universe** recent measurements indicate that the rate of expansion of the universe is increasing rather than decreasing
- acoustic impedance** the product of the density of a substance and the speed of sound in that substance
- adiabatic** a change in which no heat enters or leaves a system
- age of the universe** the time from the Big Bang to the present time
- angular acceleration** the rate of change of angular velocity
- angular magnification** the ratio of the angle subtended by the image to the angle subtended by the object
- apparent brightness** the received power per unit area
- Archimedes' principle** the upthrust force on a body totally or partially immersed in a fluid is equal to the weight of the fluid that has been displaced by the body
- astronomical unit** the average radius of the Earth's orbit around the Sun
- attenuation** the loss of energy as radiation passes through matter
- attenuation coefficient** the probability per unit length that a particular photon will be absorbed
- B scan** a two-dimensional ultrasound image formed by putting together many A scans
- bending of light** when light bends in the curved space around a massive body
- Bernoulli effect** the lift on a wing when air above the wing flows faster than air under it
- Bernoulli equation** the equation relating the pressure, speed and height in the steady flow of a fluid
- Big Bang model** the prevailing model of the universe in which space, time, mass and energy were all created about 14 billion years ago
- binary star** a system of two stars orbiting a common centre
- black hole** a point in space where the curvature is infinite; an end product in the stellar evolution of very massive stars
- Carnot cycle** a cycle in a pressure–volume diagram consisting of two isothermal and two adiabatic changes
- Cepheid variables** stars with a periodic variation in the apparent brightness caused by expansions and contractions of the star's surface
- Chandrasekhar limit** the maximum mass of a white dwarf star, about 1.4 solar masses
- chromatic aberration** a defect of lenses due to the dependence of the refractive index on wavelength that leads to coloured images
- clock synchronisation** the process by which all clocks in a given frame are arranged to show the same time
- cluster of galaxies** a group of galaxies attracting each other gravitationally
- compound microscope** an instrument that magnifies images using two converging lenses
- conservation of angular momentum** when the net external torque on a system is zero, the total angular momentum of the system is constant
- constellation** a group of stars forming a recognisable pattern
- contrast** use of X-ray absorbing materials to line organs so that they can better be seen in an X-ray image
- converging lens** a lens where a set of incident rays parallel to the principal axis refract through the lens passing through a point on the principal axis on the other side of the lens
- concave mirror** a mirror in which a set of rays parallel to the principal axis reflect such that they pass through a point on the principal axis in front of the mirror
- cosmic background radiation** black body radiation in the microwave region at a temperature of about 2.7 K filling the Universe
- cosmological principle** the principle according to which the Universe, on a very large scale, is uniform and isotropic
- cosmological redshift** the interpretation of the observed red-shift in the light of distant galaxies in terms of space stretching in-between the source and the observer
- critical density** the density for which the rate of expansion of a flat (zero curvature) universe with zero cosmological constant approaches zero as time approaches infinity.
- curvature** the 'bending' of spacetime according to the mass and energy it contains so that spacetime does not obey the rules of Euclidean geometry
- damping** the presence of resistive forces that result in a decrease in the amplitude due to loss of energy in an oscillating system
- dark energy** energy that fills the universe and is thought to be responsible for the observed accelerated rate of expansion of the universe
- dark matter** matter that is too cold to radiate but is inferred to exist because of its gravitational effects
- decibel scale** a logarithmic scale on which intensity is measured
- density** the ratio of mass to volume
- diverging lens** a lens where a set of incident rays parallel to the principal axis refract through the lens such that their extensions pass through a point on the principal axis on the same side of the lens as the incident rays
- convex mirror** a mirror in which a set of rays parallel to the principal axis reflect such that their extensions pass through a point on the principal axis behind the mirror
- entropy** a measure of the disorder of a system
- equation of continuity** in laminar flow, the product of fluid speed and cross-sectional area of the tube is constant
- equivalence principle** states that it is impossible to distinguish effects of gravity from those of acceleration
- event horizon** a surface around a black hole where the escape speed is the speed of light
- first law of thermodynamics** the heat supplied to a system is equal to the change in the internal energy plus the work done
- flowtube** a set of neighbouring streamlines

- fluctuations in CMB** minute variations in the temperature of the cosmic background radiation (CMB)
- focal length** the distance from the centre of a lens or a mirror to the focal point
- focal point** for a lens, it is the point on the principal axis to which a set of refracted rays (or their extensions) converge when rays parallel to the principal axis are incident on the lens; for a mirror, it is the equivalent point for the set of reflected rays (or their extensions)
- galaxy** a very large number of stars bound together in one very large body
- Galilean transformation** the equations relating measurements in two reference frames moving past each other at constant velocity according to classical mechanics
- geodesic** a path of least length in curved space
- graded-index fibre** an optic fibre in which the refractive index of the core decreases gradually away from the core centre
- gradient field** additional magnetic field to which a patient is exposed in MRI in order to determine the point of absorption of the RF radiation
- gravitational red-shift** the decrease in the frequency of light as it rises in a gravitational field
- half-value thickness** the distance moved through a material at which the intensity is reduced by a factor of two
- Hertzsprung–Russell diagram** a plot of luminosity versus temperature for stars
- Hubble's law** distant galaxies move away from each other with speeds proportional to their separations
- hydrostatic equilibrium** the state of zero net force and zero net torque of a system immersed in a fluid
- ideal fluid** a theoretical fluid that is incompressible, has no viscosity and flows with laminar flow
- invariant** a quantity that has the same value in two different frames
- isobaric** a change in which the pressure is kept constant
- isothermal** a change in which the temperature is kept constant
- isovolumetric** a change in which the volume is kept constant
- Jean's criterion** a dust cloud will collapse and form a protostar when the gravitational potential energy of the particles making up the cloud is greater than their kinetic energy
- laminar flow** smooth flow with velocities of adjacent fluid layers parallel; the velocity at each point in the fluid is constant in time
- length contraction** the phenomenon in which a moving length is shorter when compared to a similar length at rest
- light year** the distance travelled by light in one year
- linear magnification** the ratio of image length to object length
- Lorentz transformation** the equations relating measurements in two reference frames moving past each other at constant velocity according to relativity
- luminosity** the total power radiated by a star
- magnetic resonance imaging (MRI)** imaging method using the phenomenon of nuclear magnetic resonance
- main sequence** a region of the Hertzsprung–Russell diagram from top left to bottom right containing stars undergoing fusion of hydrogen to helium
- mass absorption coefficient** the ratio of the linear attenuation coefficient to the density of the material
- mass–luminosity relation** the luminosity of main sequence stars is proportional to a power of their mass
- material dispersion** the dependence of the refractive index on wavelength in an optic fibre, which leads to different travel times for different wavelengths
- Minkowski diagram** another name for a spacetime diagram
- moment of inertia** a property of rigid, extended bodies that has to do with the distribution of mass around an axis
- muon decay** experiments in support of time dilation and length contraction
- natural frequency** the frequency of oscillation of an isolated system
- near point** the smallest distance at which the eye can focus without strain
- neutron capture** absorption of neutrons by nuclei
- neutron star** an end product in stellar evolution in which neutron degeneracy pressure is in equilibrium with gravitational pressure
- normal adjustment** for a telescope in normal adjustment, the final image is formed at infinity; for a microscope, the final image is formed at the near point
- nucleosynthesis** the processes by which the elements were produced
- Oppenheimer–Volkoff limit** the maximum mass of a neutron star, about three solar masses
- optic fibre** a thin tube in which light can propagate through successive total internal reflections
- parallax** a method to measure distances that uses the fact that an object looks shifted relative to a distant background when viewed from two different positions
- parsec** the distance at which the angle subtended by a length equal to one astronomical unit is one arc second
- Pascal's principle** a change in pressure applied to a point in an enclosed incompressible fluid is transmitted to all other parts of the fluid and its container
- planetary nebula** the ejection of mass from a red giant star
- postulates of relativity** in all inertial reference frames the speed of light in vacuum is the same; in all inertial reference the laws of physics are the same
- Pound–Rebka experiment** the experiment in which gravitational red-shift was first observed
- principal axis** an imaginary line passing through the centre of a lens or a mirror and normal to it
- proton spin relaxation** time taken for an excited proton to return to the ground state
- Q factor** a dimensionless number related to the amount of damping in a system that is equal to $2\pi \times \frac{\text{energy stored}}{\text{energy lost per cycle}}$; the higher the Q factor, the longer the system oscillates before stopping
- R process** rapid absorption of neutrons by nuclei building elements heavier than bismuth-209
- radiation pressure** the outward pressure in a star created as a result of the energy produced in the star's core
- radio interferometry** the formation of an image using more than one radio telescope by combining the individual images

radio telescope a telescope that forms images by processing received radio waves

ray diagram a diagram showing the paths of refracted rays through a lens or the rays reflected off a mirror

real image an image formed by the intersection of actual rays

red giant very large, cool, reddish star with large luminosity

reference frame a coordinate system with clocks at every point in space

reflecting telescope a telescope that forms images using mirrors and reflection

refracting telescope a telescope that forms images using lenses and refraction

relativistic momentum the product of mass, velocity and the Lorentz gamma factor

resonance the state when the frequency of an externally applied periodic force equals the natural frequency of the system

rest energy the energy required to create a particle out of the vacuum

rest frame the frame of reference in which an object is at rest

Reynold's number dimensionless number characterising laminar (low values) or turbulent flow (high values)

rotation curves graphs of rotation speeds of galaxies versus radial distance

rotational equilibrium the condition that the net torque on a system is zero

S process slow absorption of neutrons by nuclei building elements up to bismuth-209

scale factor a term taken to roughly indicate the 'radius' of the universe

second law of thermodynamics the entropy of the universe always increases

sharpness the ability to see edges of different organs or different types of tissue

simultaneity events that are simultaneous in one frame and happen at different points in space will not be simultaneous in other frames

spacetime diagram a diagram of time and space coordinates used to show the position and time of events

spectral class a classification of stars based on their surface temperature and colour

speed of light the limiting speed that cannot be reached or exceeded by any material body

spherical aberration a defect of lenses and mirrors due to rays far from the principal axis having different focal lengths that leads to distortions in the image

star main sequence stars are spherical gaseous masses consisting mostly of hydrogen that are in equilibrium between gravitational pressure and radiation pressure; off the main sequence, stars have various compositions and means of equilibrium

stellar cluster a group of stars sufficiently close to each other to be attracting each other gravitationally

stellar evolution the processes by which a main sequence star leaves the main sequence and ends up in a final stage

stellar spectra sets of wavelengths that can be emitted by stars

step-index fibre an optic fibre in which the refractive index changes abruptly between core and cladding

Stokes' law the law giving the drag force on a spherical body moving through a fluid; the drag force is proportional to the speed and radius of the body

streamlines imaginary curves, tangents to which give the velocity vectors in fluid flow

supercluster a large number of clusters of galaxies

thermal efficiency the ratio of useful mechanical work done to the input energy

time dilation the phenomenon in which a moving clock runs slow when compared to a similar clock at rest

torque the product of force and the perpendicular distance between the line of action of the force and the rotation axis

total energy the sum of the rest and the kinetic energy of a particle

translational equilibrium the condition that the net force on a system is zero

turbulence the phenomenon of turbulent flow

turbulent flow fluid flow with velocities and densities varying wildly from point to point

twin paradox the 'paradox' where an astronaut leaving a twin behind on Earth returns after a long trip – according to the Earth-bound twin, the astronaut must be younger, but according to the astronaut, the Earth and the twin moved away and returned so the Earth-bound twin must be younger

type Ia supernova the increase in luminosity when material from one star in a binary star system falls into the other star (which is usually a white dwarf), initiating fusion

type II supernova the increase in luminosity when a massive red super giant star explodes

ultrasound sound of frequency higher than 20 kHz

velocity addition the formula relating speeds in two reference frames

virtual image an image formed by the intersection of extensions of rays

viscosity roughly, a measure of how resistive the fluid is to flowing motion

waveguide dispersion rays entering the fibre at different angles follow different paths and hence have different travel times

white dwarf an end product in stellar evolution in which electron degeneracy pressure is in equilibrium with gravitational pressure

worldline the path of a particle as shown on a spacetime diagram

X-rays electromagnetic radiation with a typical wavelength of 10^{-10} m