

# Cosmic Times Master Glossary

**Note:** If a word has changed meaning through the course of the Cosmic Times newspapers, alternate definitions are noted after the modern definition.

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## A

### **Absolute**

being independent of the system of measurement or external references.

### **acoustic**

of or relating to sound

### **afterglow**

Light emitted after removing the source of energy.

### **aggregate**

An aggregate is an assemblage of various particles. In this case, aggregates of many stars form nebulae or galaxies.

### **agog**

eager, full of intense interest

### **Andromeda Galaxy**

A large spiral galaxy visible to the naked eye, and the closest spiral galaxy to the Milky Way. It lies 2.2 million light-years from Earth in the constellation Andromeda in the Northern Hemisphere between Lacerta and Perseus and south of Cassiopeia. Also known as Messier 31, M31, or NGC 224.

### **anisotropy**

The property of having measurements that differ when measured in a different direction.

### **Archimedes**

An ancient Greek physicist and mathematician. His discovery of how to determine the volume of an irregular solid by water displacement is his most famous principle – Archimedes' Principle.

### **astronomical**

Deals with Astronomy

### **astrophysicist**

A person who studies the part of astronomy that deals principally with the physics of the universe, including luminosity, density, temperature, and the chemical composition of stars, galaxies, and the interstellar medium.

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## B

### **bandwidths**

The range of signal frequencies that can be carried on a communications channel.

### **baryon**

Any of the subatomic particles that interact via the strong nuclear force. Most commonly, these are protons and neutrons. Their presence in the universe is determined through their gravitational and electromagnetic interactions.

### **binary stars**

Binary stars are two stars that orbit around a common center of mass. An X-ray binary is a special case where one of the stars is a collapsed object such as a white dwarf, neutron star, or black hole, and the separation between the stars is small enough so that matter is transferred from the normal star to the compact star, producing X-rays in the process.

### **black hole**

an area in space with such a strong gravitational pull that no matter or energy can escape from it. Black holes are so named because even light cannot escape from them.

### **blackbody radiation**

Blackbody radiation is produced by an object which is a perfect absorber of heat. Perfect absorbers must also be perfect radiators. For a blackbody at a temperature  $T$ , the intensity of radiation emitted  $I$  at a particular energy  $E$  is given by Planck's law:

$$I(E, T) = 2 E^3 [h^2 c^2 (e^{E/kT} - 1)]^{-1}$$

where  $h$  is Planck's constant,  $k$  is Boltzmann's constant, and  $c$  is the speed of light.

### **blackbody temperature**

The temperature of an object if it is re-radiating all the thermal energy that has been added to it; if an object is not a blackbody radiator, it will not re-radiate all the excess heat and the leftover will go toward increasing its temperature.

### **Boltzmann constant**

A constant that describes the relationship between temperature and kinetic energy for molecules in an ideal gas. It is equal to  $1.380622 \times 10^{-23}$  J/K (see scientific notation).

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## C

### **celestial**

Relating to the sky or the heavens

**Cepheid**

Type of variable star that exhibits a regular pattern of changing brightness as a function of time. The period of the pulsation pattern is directly related to the star's intrinsic brightness. Thus, Cepheid variables are a powerful tool for determining distances in modern astronomy.

**COBE**

The Cosmic Background Explorer satellite used to measure the diffuse infrared and microwave radiation from the early universe to the limits set by our astrophysical environment.

**coma**

The nebulous envelope around the nucleus of a comet

**constellation**

A constellation is a specific and recognizable grouping of stars. Constellations are given names to distinguish them.

**Copernicus**

A Polish astronomer, born in the 15th century, who challenged the existing views by suggesting that the sun was the center of the solar system and the universe instead of Earth.

**cosmic microwave background (CMB)**

The background of radiation mostly in the frequency range  $3 \times 10^8$  to  $3 \times 10^{11}$  Hz discovered in space in 1965. It is believed to be the cosmologically redshifted radiation released by the Big Bang itself.

**cosmic ray**

Atomic nuclei (mostly protons) and electrons that are observed to strike the Earth's atmosphere with exceedingly high energies.

**cosmology**

The astrophysical study of the history, structure, and dynamics of the universe.

**cosmological constant**

A constant term (labeled Lambda) that Einstein added to his general theory of relativity in the mistaken belief that the Universe was neither expanding nor contracting. The cosmological constant was found to be unnecessary once observations indicated the Universe was expanding. Had Einstein believed what his equations were telling him, he could have claimed the expansion of the Universe as perhaps the greatest and most convincing prediction of general relativity; he called this the "greatest blunder of my life".

**cosmos**

The universe as a whole

**contortion**

A twisting or deforming action.

**cubit**

An ancient measure of length equal to the distance between the elbow and the fingertips or approximately 18 inches.

**culminating**

Coming to completion

**Cygnus A**

A radio source in the constellation Cygnus in the Northern Hemisphere

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**D**

**dark energy**

Dark energy is a hypothesized form of energy in space that exerts a negative pressure. This changes the gravitational effect to account for the differences between the theoretical and observational results of gravitational effects on visible matter.

**dark matter**

Name given to the mass whose existence is deduced from the analysis of galaxy rotation curves but which until now, has escaped all detections. There are many theories on what dark matter could be. Not one, at the moment, is convincing enough and the question is still a mystery.

**deviation**

The difference between a value in a frequency distribution and the average

**dissipate**

To spread thin and eventually vanish.

**Doppler effect**

The apparent change in wavelength of sound or light caused by the motion of the source, observer or both. Waves emitted by a moving object as received by an observer will be blueshifted (compressed) if approaching, redshifted (elongated) if receding. It occurs both in sound and light. How much the frequency changes depends on how fast the object is moving toward or away from the receiver.

**dwarfed**

Appearing smaller or inferior

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**E**

**electro-weak force**

The unification of the electromagnetic force and the weak nuclear force

**electromagnetic spectrum**

The full range of frequencies, from radio waves to gamma rays, that characterizes light.

**emission**

The production of light, or more generally, electromagnetic radiation by an atom or other object.

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**F**

**fledgling**

New or inexperienced

**fluctuations**

Variations in the primordial universe

**fluorescing**

The emission of electromagnetic radiation, (especially visible light) stimulated e by the absorption of incident radiation and lasting only as long as the incident radiation is continued.

**fusion**

Joining together – used in atomic science to indicate the joining of particles in a nucleus.

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**G**

**galactic disk**

The galactic disc is the plane in which the spirals, bars and discs of disc galaxies exist. This area tends to have more gas and dust, and younger stars than galactic bulges, or galactic haloes.

**galaxy**

A component of our universe made up of gas and a large number (usually more than a million) of stars held together by gravity. When capitalized, Galaxy refers to our own Milky Way Galaxy.

**General Relativity**

The geometric theory of gravitation developed by Albert Einstein, incorporating and extending the theory of special relativity to accelerated frames of reference and introducing the principle that gravitational and inertial forces are equivalent. The theory has consequences for the bending of light by massive objects, the nature of black holes, and the fabric of space and time.

General Relativity is an extension of the Special Theory of Relativity to include gravitation and acceleration.

**globular clusters**

A spherically symmetric collection of stars which shared a common origin. The cluster may contain up to millions of stars spanning up to 50 parsecs.

**Grand Unified Theory**

The Grand Unified Theory attempts to combine the four forces that are known (gravity, electromagnetism, strong nuclear, and weak nuclear) into one theory.

**gravitational waves**

Ripples in space-time caused by the motion of objects in the universe. The most notable sources are orbiting neutron stars, merging black holes, and collapsing stars. Gravitational waves are also thought to emanate from the Big Bang.

**gravity**

a fundamental physical force that is responsible for interactions which occur because of mass between particles, between large bodies of matter (as stars and planets), and between particles (as photons) and large bodies of matter.

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**H****Holmdel Horn**

Radio antenna located in Holmdel, NJ used by Penzias and Wilson when they came across the cosmic microwave background radiation. The Horn Antenna is a National Historic Landmark

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**I****infrared**

Electromagnetic radiation at wavelengths longer than the red end of visible light and shorter than microwaves (roughly between 1 and 100 microns). Almost none of the infrared portion of the electromagnetic spectrum can reach the surface of the Earth, although some portions can be observed by high-altitude aircraft (such as the Kuiper Observatory) or telescopes on high mountaintops (such as the peak of Mauna Kea in Hawaii).

**Integrated Sachs-Wolfe Effect**

The Sachs-Wolfe effect, named after Rainer Kurt Sachs and Arthur Michael Wolfe, is a property of the cosmic microwave background radiation (CMB), in which photons are gravitationally redshifted, and the spectrum appears uneven.

**intrinsic brightness**

Intrinsic brightness is also called absolute magnitude tells how bright a star would be without the effects of distance or absorption due to interstellar dust or gas.

**intrinsic luminosity**

The intrinsic luminosity of a star is its actual brightness and magnitude, not simply its apparent brightness that we can witness from earth. A star's intrinsic luminosity can be determined from its apparent brightness and its distance from earth.

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**J**

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**K**

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**L****light year**

A unit of length used in astronomy that equals the distance light travels in a year. At the rate of 300,000 kilometers per second (671 million miles per hour), 1 light-year is equivalent to  $9.46053 \times 10^{12}$  km, 5,880,000,000,000 miles or 63,240 AU.

**luminosity**

The rate at which a star or other object emits energy, usually in the form of electromagnetic radiation. The luminosity of a star depends on BOTH its temperature (hotter stars give out more energy) -- and its radius (surface area increases as radius increases).

**luminosity-decline relation**

A correction factor for supernovae that are dimmer than the standard Type Ia supernova which allows astronomers to measure distance more accurately.

**luminous**

Emitting light

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**M****MACHOS**

MAssive Compact Halo Objects – one possible type of Dark Matter.

## **Magellanic Clouds**

The two Magellanic Clouds are irregular dwarf galaxies, which are the Milky Way's closest neighbors. Historically they have been thought to be orbiting our Galaxy, but recent research suggests that they are members of our Local Group of galaxies, but are just passing by. They are visible from the southern hemisphere.

## **magnitude**

The degree of brightness of a celestial body designated on a numerical scale, on which the brightest star has magnitude -1.4 and the faintest star visible without a telescope has magnitude 6. So, the lower the number, the brighter the star; the higher the magnitude, the dimmer the star. A decrease of one magnitude represents an increase in apparent brightness by a factor of 2.512; also called apparent magnitude.

## **Megahertz**

One million hertz where each hertz is one vibration per second. This is the frequency of the radio wave.

## **microwave**

Electromagnetic radiation that has a longer wavelength (between 1 mm and 30 cm) than visible light. Microwaves can be used to study the Universe, communicate with satellites in Earth orbit, and cook popcorn.

## **minuscule**

Very small

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# **N**

## **Near-infrared telescopes.**

Near-infrared telescopes collect light in the region of the electromagnetic spectrum just below visible light. Whereas, most infrared radiation is warm, near-infrared waves are not hot at all – in fact, you cannot even feel them. These shorter wavelengths are the ones used by your TV's remote control.

## **nebula**

A diffuse mass of interstellar dust and gas. A reflection nebula shines by light reflected from nearby stars. An emission nebula shines by emitting light as electrons recombine with protons to form hydrogen. The electrons were made free by the ultraviolet light of a nearby star shining on a cloud of hydrogen gas. A planetary nebula results from the explosion of a solar-like type star.

Historically, the term nebula referred to any fuzzy patch in the sky that could not be resolved by telescopes. Up until 1920, this included galaxies. The term “nebula” to mean “galaxy” was in use in publications until at least the mid-1940s.

## **neutrinos**



A fundamental particle produced in massive numbers by the nuclear reactions in stars; they are very hard to detect because the vast majority of them pass completely through the Earth without interacting.

**neutron**

An uncharged particle in the nucleus of an atom

**Newton**

Physicist known for Three Laws of Motion, Law of Universal Gravitation and invention of calculus.

**NGC 3521**

A spiral galaxy in the constellation Leo

**NGC 972**

A spiral galaxy in the constellation Ares

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**O**

**optical telescopes**

A telescope that collect light in the region of the electromagnetic spectrum that is visible light.

**oscillating**

Swinging to and from a position

**oscillating universe**

A theory stating that the gravitational attraction of the mass within the universe will eventually slow down and stop the expansion of the universe eventually resulting in a 'Big Crunch' where all the matter in the universe will be contracted into a small volume of high density

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**P**

**parsecs**

The distance to an object which has a parallax of one arc second. It is equal to 3.26 light years, or  $3.1 \times 10^{18}$  cm. A kiloparsec (kpc) is equal to 1000 parsecs. A megaparsec (Mpc) is equal to a million ( $10^6$ ) parsecs.

**photographic plates**

Early photography used a light-sensitive emulsion of silver salts applied to a glass plate. In this context, a photographic plate can be considered another term for a photograph.

**polarization**

A special property of light; light has three properties, brightness, color and polarization. Polarization is a condition in which the planes of vibration of the various rays in a light beam are at least partially aligned.

**Pravda**

A newspaper in former the Soviet Union

**primordial**

Primordial matter refers to the matter in the universe that was first formed, and has been in existence since the existence of the universe itself.

**pulsar**

A rotating neutron star which generates regular pulses of radiation. Pulsars were discovered by observations at radio wavelengths but have since been observed at optical, X-ray, and gamma-ray energies.

**pulsation**

A regular variation of light intensity of a star.

**Pythagoras**

Ancient Greek mathematician and philosopher best know for the Pythagorean Theorem for right triangles.

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**Q**

**quantum fluctuations**

A temporary change in energy at a given point due to variations predicted by the Heisenberg Uncertainty Principle. These variations could have caused inflation.

**quarks**

Subatomic particles that make up baryons and mesons. Three quarks are needed to make a proton or a neutron.

**quasar**

An enormously bright object at the edge of our universe which emits massive amounts of energy. In an optical telescope, they appear point-like, similar to stars, from which they derive their name (quasar = quasi-stellar). Current theories hold that quasars are one type of AGN

**quintessence**

A hypothetic form of dark energy, a scalar field that accelerated the expansion of the universe.

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## R

### **radial velocity**

The speed at which an object is moving away or toward an observer. By observing spectral lines, astronomers can determine how fast objects are moving away from or toward us; however, these spectral lines cannot be used to measure how fast the objects are moving across the sky.

### **radiation**

Energy emitted in the form of waves (light) or particles (photons)

### **red shift**

A consequence of the Doppler Effect where all the spectral lines are moved to longer (redder) wavelengths when the source is moving away from the receiver.

### **remnant**

Left over; a surviving trace or vestige

### **ROSAT**

The ROentgen SATellite that was an X-ray satellite launched in 1990

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## S

### **schema**

a framework, outline or model

### **Scorpius**

A constellation named the Scorpion located in the Southern Hemisphere near Libra and Sagittarius .It contains the bright red star Antares

### **Special Relativity**

theory of space time based on two postulates (1) the speed of light is the same for any observer regardless of the speed of either the observer or the source (2) the mathematical forms of the equations of physics are invariant in any inertial reference frame.

### **spectrum (pl. spectra)**

A plot of the intensity of light at different frequencies. Or the distribution of wavelengths and frequencies.

### **spherical galaxy**

A galaxy that has a shape similar to a sphere.

### **spiral nebulae**

Historic term for a spiral galaxy, which changed in the 20th century. A spiral galaxy belongs to one of the three main classes of galaxy. Spiral galaxies consist of a flat, rotating disk of stars, gas and dust, and a central concentration of stars known as the bulge.

**Standard candles**

An object in the universe of known luminosity that can be used to calculate distances.

**Steady State Universe Model**

Model designed by Fred Hoyle and others wherein new material is created as the universe expands.

**strong nuclear force**

One of the four fundamental forces. The strong nuclear force or interaction is the strongest of the fundamental forces. It holds the nucleus together. It is the interaction of quarks and gluons in the nucleus.

**supernova (plural: supernovae)**

(a) The death explosion of a massive star, resulting in a sharp increase in brightness followed by a gradual fading. At peak light output, these type of supernova explosions (called Type II supernovae) can outshine a galaxy. The outer layers of the exploding star are blasted out in a radioactive cloud. This expanding cloud, visible long after the initial explosion fades from view, forms a supernova remnant (SNR).

(b) The explosion of a white dwarf that has accumulated enough material from a companion star to achieve a mass equal to the Chandrasekhar limit. These types of supernovae (called Type Ia) have approximately the same intrinsic brightness, and can be used to determine distances.

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**T****telecommunications**

Telecommunication is the system by which auditory and visual information is transmitted by television, radio, or phone.

**theory**

a testable explanation of observations made in an experiment.

**Theory of General Relativity**

The geometric theory of gravitation developed by Albert Einstein, incorporating and extending the theory of special relativity to accelerated frames of reference and introducing the principle that gravitational and inertial forces are equivalent. The theory has consequences for the bending of light by massive objects, the nature of black holes, and the fabric of space and time

**Type 1a supernovae**

See b above, in supernova definition. Supernovae of predictable intrinsic brightness that can be used as a “standard candle”.

**Type 2 supernovae**

Supernova that do not have the telltale lines of hydrogen in the spectrum.

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## U

### **undulations**

A wavelike motion in a medium without permanent movement of the particles.

### **Universe**

Everything that exists, including the Earth, planets, stars, galaxies, and all that they contain; the entire cosmos.

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## V

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## W

### **wavelength**

The distance between adjacent peaks in a series of periodic waves. Also see electromagnetic spectrum.

### **white dwarf**

A star that has exhausted most or all of its nuclear fuel and has collapsed to a very small size. Typically, a white dwarf has a radius equal to about 0.01 times that of the Sun, but it has a mass roughly equal to the Sun's. This gives a white dwarf a density about 1 million times that of water!

### **Wien's displacement law**

For a blackbody, the product of the wavelength corresponding to the maximum radiance and the thermodynamic temperature is a constant. As a result, as the temperature rises, the maximum of the radiant energy shifts toward the shorter wavelength (higher frequency and energy) end of the spectrum.

### **Wilkinson Microwave Anisotropy Probe (WMAP)**

A NASA satellite designed to detect fluctuations in the cosmic microwave background. From its initial results published in Feb 2003, astronomers pinpointed the age of the universe, its geometry, and when the first stars appeared.

### **WIMPs**

Weakly Interacting Massive Particles that might be a candidate for dark matter in the universe. They interact through the weak nuclear force and gravity.

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## **X**

### **X-ray**

Electromagnetic radiation of very short wavelength and very high-energy; X-rays have shorter wavelengths than ultraviolet light but longer wavelengths than gamma rays.

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## **Y**

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## **Z**

### **zenith**

the zenith at a given point is the local vertical direction pointing away from direction of the force of gravity at that location