

SOLAR & SOLAR ECLIPSE GLOSSARY

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A

anisotropic: exhibiting properties with different values when measured in different directions. Phenomena associated with eclipses include shadow bands (also known as flying shadows), which are similar to shadows on the bottom of a swimming pool. They occur only just prior to and after totality, when a narrow solar crescent acts as an anisotropic light source.²

annular solar eclipse - A solar eclipse in which the Moon's antumbral shadow traverses Earth (the Moon is too far from Earth to completely cover the Sun). During the maximum phase of an annular eclipse, the Sun appears as a blindingly bright ring surrounding the Moon.¹

annularity - The maximum phase of an annular eclipse during which the Moon's entire disk is seen silhouetted against the Sun. Annularity is the period between second and third contact during an annular eclipse. It can last from a fraction of a second to a maximum of 12 minutes 29 seconds.¹

anomalistic month - The time required for the Moon to make one revolution around its orbit with respect to the perigee; the length of the mean anomalistic month as calculated for the year 2000 is 27.55455 days (27d 13h 18m 33s); the actual duration can vary by several days due to the gravitational perturbations of the Sun on the Moon's eccentric orbit.¹

antumbra - The antumbra is that part of the Moon's shadow that extends beyond the umbra. It is similar to the penumbra in that the Sun is only partially blocked by the Moon. From within the antumbra, the Sun appears larger than the Moon which is seen in complete silhouette. An annular eclipse is seen when an observer passes through the antumbra.¹

aphelion - The point along a planetary orbit that is farthest from the Sun; Earth's mean distance at aphelion is 152,097,701 km; Earth's true distance at aphelion varies from 152,083,140 km to 152,104,533 km because of gravitational perturbations of the Sun, Moon and planets; See: [*Earth at Perihelion and Aphelion: 2001 to 2100*](#).¹

apogee - The point along the Moon's orbit that is farthest from Earth; the Moon's mean distance at apogee is 405,504 km; the Moon's true distance at apogee varies from 404,042 to 406,725 km because of gravitational perturbations of the Sun and Earth; See: [*Moon at Perigee and Apogee: 2001 to 2100*](#).¹

B

Baily's beads: the row of brilliant points of sunlight shining through valleys on the edge of the moon that are seen for a few seconds just before and after the central phase in an eclipse of the sun.² This phenomenon is also known as the diamond ring effect.³

Besselian elements - The Besselian elements are a series of time dependent variables used to calculate various aspects of a solar eclipse. They describe the movement of the Moon's shadow with respect to the fundamental plane. This plane passes through the center of Earth and is oriented perpendicular to the Moon's shadow axis. Next, the shadow cone is projected onto Earth's surface including the effects of Earth's rotation, the flattening of Earth and the latitude, longitude and elevation of the observer. The local circumstances at the observer's position can then be calculated including the eclipse contact times, eclipse magnitude and the duration of totality (or annularity).¹

Brown Lunation Number - the number given to each [lunation](#) beginning at the first new moon of 1923, the year when Ernest W. Brown's lunar theory was introduced in the major national astronomical almanacs.¹

C

center of figure - The center of figure of a celestial body (e.g., planet, moon) is the apparent center of the object with respect to its surface and takes into account irregularities in its shape. If the distribution of mass is not uniform, then the [center of mass](#) does not coincide with the *center of figure*. In the case of the Moon, the offset between the *center of mass* and *center of figure* is ~0.5 kilometers.¹

center of mass - In orbital mechanics, the equations of motion of celestial bodies (stars, planets, moons, etc.) are formulated as point masses located at the centers of mass. In other words, the motion of a celestial body can be predicted assuming the object's entire mass is concentrated into one single point called the *center of mass*.¹

central eclipse - A solar eclipse in which the central axis of the Moon's shadow cone traverses Earth thereby producing a central line in the eclipse track. The umbra or antumbra falls entirely upon Earth so the ground track has both a northern and southern limit. Central solar eclipses can be either total, annular or hybrid.¹

central eclipse (one limit) - A solar eclipse in which the central axis of the Moon's shadow cone traverses Earth. However, a portion of the umbra or antumbra misses Earth throughout the eclipse and the resulting ground track has just one limit. Central solar eclipses with one limit can be either total, annular or hybrid.¹

central line - The central line is the locus of points of intersection of the axis of the Moon's shadow with the surface of Earth. It is sometimes called the "center line" or "centerline".¹

central phase – see **totality**

chromosphere: the region of the atmosphere of a star (such as the sun between the star's photosphere and its corona)²

Coordinated Universal Time (UTC) - The primary time standard by which the world regulates clocks and time; UTC is one of several closely related successors to [Greenwich Mean Time \(GMT\)](#); for most common purposes, UTC is synonymous with GMT, although GMT is no longer precisely defined by the scientific community; while [Universal Time \(UT1\)](#) is based on the [rotation](#) of Earth in relation to distant celestial objects (stars and quasars), UTC is based on [International Atomic Time](#) and is adjusted to remain within 1 second of [Universal Time \(UT1\)](#) through the occasional addition of a [leap second](#).¹

corona: the tenuous outermost part of the atmosphere of a star (such as the sun)²

D

declination - The latitude of a point on the celestial sphere using the equatorial coordinate system; declination divides the sky into 180 degrees (90 degrees north (+) and south (-) of the celestial equator)¹

ΔT (Delta T) - ΔT (Delta T) is the time difference obtained by subtracting [Universal Time \(UT1\)](#) from [Terrestrial Dynamical Time \(TD\)](#). It is a measure of how much Earth's [rotation](#) period has changed. See [Delta T](#) for more information.¹

diamond ring effect – see **Baily's beads**

draconic month - The average interval between two successive passes of the moon through the ascending node of its orbit and is equal to 27.212220 days (27 d 5 h 5 min 35.8 s); the moon's orbit slowly rotates westward on its axis and precesses over 360 ° in a period of 18.6 years.¹

E

earthshine: sunlight reflected by the earth that illuminates the dark part of the moon²

eclipse magnitude - Eclipse magnitude is the fraction of the Sun's diameter occulted by the Moon. It is strictly a ratio of diameters and should not be confused with eclipse obscuration, which is a measure of the Sun's surface area occulted by the Moon. Eclipse magnitude may be expressed as either a percentage or a decimal fraction (e.g., 50% or 0.50). By convention, its value is given at the instant of greatest eclipse.¹

eclipse obscuration - Eclipse obscuration is the fraction of the Sun's area occulted by the Moon. It should not be confused with eclipse magnitude, which is the fraction of the Sun's diameter occulted by the Moon. Eclipse obscuration may be expressed as either a percentage or a decimal fraction (e.g., 50% or 0.50).¹

eclipse season - An eclipse season is a period during which the Sun appears close enough to one of the Moon's [nodes](#) to permit an eclipse to occur. Each season lasts approximately 34 days and repeats at about 173-day intervals. Thus there are always two full eclipse seasons each year. The 173-day interval is the time it takes the Sun to travel from one lunar [node](#) to the next. Because the Moon's [synodic period](#) is shorter than an eclipse season, there is at least one solar and one lunar eclipse during every eclipse season. (see [Wikipedia](#))¹

ecliptic - The apparent path of the Sun on the celestial sphere as seen from Earth; the plane of Earth's orbit around the Sun as seen projected onto the sky from Earth; the Moon and planets all appear within several degrees of the ecliptic.¹

ephemeris - A table of values that gives the positions of astronomical objects in the sky over a range of times; the positions of celestial objects (Sun, Moon, planets, etc.) are given in [right ascension](#) (celestial longitude) and [declination](#) (celestial latitude); the plural is *ephemerides*.¹

equinox - The moment in time at which the vernal point, celestial equator, and other elements are used in the definition of a celestial coordinate system; Equinox J2000 is the current standard equinox taken at 2000 January 1 at 12:00:00 [Terrestrial Time \(TT\)](#).¹

eye safety - The only time that the Sun can be viewed safely with the naked eye is during a total eclipse, when the Moon completely covers the disk of the Sun. It is never safe to look at a partial or annular eclipse, or the partial phases of a total solar eclipse, without the proper equipment and techniques. Even when 99% of the Sun's surface (the photosphere) is obscured during the partial phases of a solar eclipse, the remaining crescent Sun is still intense enough to cause permanent retinal damage, especially when viewed through binoculars or other optical aids.¹

F

first contact - The instant when the partial phase of an eclipse begins.¹

focal point: a center of activity, interest, or attention²

fourth contact - The instant when the partial phase of an eclipse ends.¹

G

gamma - Gamma is the distance of the Moon's shadow axis from Earth's center in units of equatorial Earth radii. It is defined at the instant of greatest eclipse when its absolute value is at a minimum.¹

geocentric - As seen from the center of Earth; the geocentric coordinate of a planet is the position of the planet as seen from Earth's center.¹

greatest duration - Greatest duration (for total eclipses) is defined as the instant when the duration of totality reaches a maximum along the path of a total eclipse. The calculation of greatest duration requires an accurate lunar limb profile to account for the effects of mountains and valleys around the circumference of the Moon on the duration of totality. The length of totality calculated at *greatest duration* may differ by 1-2 seconds compared with [*greatest eclipse*](#), and the geographic location may differ by a hundred kilometers or more.¹

greatest eclipse - Greatest eclipse is defined as the instant when the axis of the Moon's shadow cone passes closest to Earth's center. The computation of the duration of totality at this point is typically done using a smooth edge for the Moon that ignores the effects of mountains and valleys along the lunar limb. For total eclipses, the instant of greatest eclipse offers a good approximation (1-2 seconds) to the maximum duration of totality along the entire eclipse path. Far more rigorous calculations using the Moon's limb profile are required to predict the instant of [*greatest duration*](#) (of totality) and a more accurate value for the maximum length of totality. For annular eclipses, the instant of *greatest duration* may occur either near the time of greatest eclipse or near the sunrise and sunset points of the eclipse path.¹

Greenwich Mean Time (GMT) - A time system originally referring to mean solar time at the Royal Observatory (Greenwich, London), which later became adopted as a global time standard; it is essentially the same as [*Coordinated Universal Time \(UTC\)*](#) which is a standard astronomical time system (astronomers no longer use the term "Greenwich Mean Time"); for more information, see: [*Greenwich Mean Time \(Wikipedia\)*](#).¹

Gregorian Calendar - The civil calendar based on 12 months of 365 days, and a leap year of 366 days every 4 years; the Gregorian is a modification of the [Julian Calendar](#) - normally, all years divisible by 4 are leap years, but years divisible by 100 are *NOT* leap years, while years divisible by 400 *ARE* leap years; the Gregorian Calendar first came into use in 1582 with the [Gregorian Calendar Reform \(Wikipedia\)](#), and currently the internationally accepted civil calendar; for more information, see: [Gregorian Calendar \(Wikipedia\)](#).¹

H

horizontal parallax - The apparent shift in the Moon's position when viewer by two observers who see the Moon directly in the zenith and on the horizon, respectively; it can also be defined as the angle subtended at the distance of the Moon by the radius of the Earth; also referred to as *lunar parallax* or *lunar horizontal parallax* for more information, see: [lunar parallax \(Wikipedia\)](#).¹

hybrid solar eclipse - A solar eclipse in which the Moon's umbral and antumbral shadows traverse Earth (the eclipse appears annular and total along different sections of its path). Hybrid eclipses are also known as annular-total eclipses. In most cases, hybrid eclipses begin as annular, transform into total, and then revert back to annular before the end of their track. In rare instances, a hybrid eclipse may begin annular and end total, or vice versa.¹

J

Julian Calendar - The civil calendar based on 12 months of 365 days, and a leap year of 366 days every 4 years; the Julian Calendar was used from 46 BCE until the [Gregorian Calendar](#) reform in 1582; for more information, see: [Julian Calendar \(Wikipedia\)](#).¹

Julian Date - The number of days and fractions elapsed since noon Universal Time on January 1, 4713 BCE; the Julian date is a convenient way of calculating dates in astronomical predictions; the [Calendar Date Converter](#) can be used to convert between [Gregorian Calendar](#) date, [Julian Calendar](#) date and Julian Date.¹

Julian year - A unit of time defined as exactly 365.25 days.¹

L

leap second - A one-second adjustment that is occasionally applied to [Coordinated Universal Time \(UTC\)](#) in order to keep its time of day close to [Universal Time \(UT1\)](#) or mean solar time; for more information, see: [leap second \(Wikipedia\)](#).¹

libration - While Moon generally keeps one hemisphere facing Earth as it orbits, the Moon also undergoes a small rocking motion, permitting an observer on Earth to see up to 58% of the Moon's surface. This motion is called libration and it has three components:

- Libration in longitude results from the eccentricity of the Moon's orbit around Earth; the Moon's rotation sometimes leads and sometimes lags its orbital position.
- Libration in latitude results from a slight inclination between the Moon's axis of rotation and the normal to the plane of its orbit around Earth.
- Diurnal libration is a small daily oscillation due to Earth's rotation, which carries an observer from one side to the other of the straight line joining the centers of Earth and the Moon. This allows the observer to view at the Moon from slightly different directions and see around the edges of the Moon.

The apparent orientation of the Moon's disk as seen from Earth is described by three angles:

- l - libration in longitude.
- b - libration in latitude.
- c - position angle of Moon's north axis with respect to celestial north.¹

limb Darkening- is an optical effect seen in stars (including the Sun), where the central part of the disk appears brighter than the edge, or limb.²

lunation - the time elapsed from one New Moon to the next). In the year 2000, the average length of a lunation was 29.530588 days (or 29 days, 12 hours, 44 minutes, and 3 seconds). However, the length of any one synodic month can vary from 29.26 to 29.80 days due to the perturbing effects of the Sun's gravity on the Moon's eccentric orbit.¹

N

node - The Moon's orbit is tipped about 5.1° to Earth's orbit around the Sun. The two points where the Moon's orbit crosses Earth's orbit are called the nodes. The *ascending node* is where the Moon crosses to the north of Earth's orbit. The *descending node* is where it crosses to the south.¹

non-central eclipse (one limit) - A solar eclipse in which the central axis of the Moon's shadow cone misses Earth. However, one edge of the umbra or antumbra grazes Earth thereby producing a ground track with one limit and no central line. Non-central solar eclipses can be either total, annular or hybrid. (Partial eclipses can also be considered non-central eclipses in which only the penumbral shadow traverses Earth's surface)¹

O

occultation – the interruption of the light from a celestial body or of the signals from a spacecraft by the intervention of a celestial body; especially an eclipse of a star or planet by the moon.³

orbital node - is either of the two points where an orbit intersects a plane of reference to which it is inclined.²

orbital plane - the orbital plane of a revolving body is the geometric plane in which its orbit lies³

P

path of totality – the narrow track of shadow that appears on the surface of the earth during an eclipse³

partial eclipse - A solar eclipse in which the Moon's penumbral shadow traverses Earth (umbral and antumbral shadows completely miss Earth). During a partial eclipse, the Moon appears to block part (but not all) of the Sun's disk. From the prospective of an individual observer, a partial eclipse is one in which the observer is within the penumbral shadow but outside the path of the umbral or antumbral shadows. ¹

penumbra - The penumbra is the weak or pale part of the Moon's shadow. From within the penumbra, the Sun is only partially blocked by the Moon as in the case of a partial eclipse. This contrasts with the umbra, where the Sun is completely blocked resulting in a total eclipse.¹

perihelion - The point along a planetary orbit that is closest to the Sun; Earth's mean distance at perihelion is 147,098,074 km; Earth's true distance at perihelion varies from 147,091,358 km to 147,112,452 km because of gravitational perturbations of the Sun, Moon and planets; See: [*Earth at Perihelion and Aphelion: 2001 to 2100*](#).¹

perigee - The point along the Moon's orbit that is closest to Earth; the Moon's mean distance at perigee is 363,396 km; the Moon's true distance at perigee varies from 356,355 to 370,399 km because of gravitational perturbations of the Sun and Earth; See: [*Moon at Perigee and Apogee: 2001 to 2100*](#).¹

photosphere – the luminous surface layer of the sun or a star²

R

retrograde motion - orbital or rotational motion of an object in the direction opposite the rotation of its primary, that is, the central object³

right ascension - The longitude of a point on the celestial sphere using the equatorial coordinate system; right ascension divides the sky into 24 sections called hours (1 hour = 15 degrees).¹

S

saros - The periodicity and recurrence of solar (and lunar) eclipses is governed by the Saros cycle, a period of approximately 6,585.3d (18yr 11d 8h). When two eclipses are separated by a period of one Saros, they share a very similar geometry. The eclipses occur at the same node with the Moon at nearly the same distance from Earth and at the same time of year. Thus, the Saros is a useful tool for organizing eclipses into families or series. Each series typically lasts 12 or 13 centuries and contains 70 or more eclipses.¹ For more information, see [Eclipses and the Saros](#). The [Saros Catalog of Solar Eclipses: Saros 0 - 180](#) provides complete details for all current Saros cycles.¹

second contact - The instant when the total or annular phase of an eclipse begins.¹

shadow bands – one of a series of darkish narrow parallel bands seen to rush swiftly across the landscape just before or after totality in a solar eclipse probably due to optical effects of the earth's atmosphere²

sidereal month - the mean time of the moon's revolution in its orbit with reference to a star's position: 27 days, 7 hours, 43 minutes, 11.5 seconds of mean time²

sidereal time - A time scale that is based on Earth's rotation measured relative to the fixed stars; the sidereal time at a geographic location is equal to the [right ascension](#) crossing the local meridian at any given instant.¹

solar filter - block most of the sunlight to avoid any damage to the eyes. Proper filters are usually made from a durable glass or polymer film that transmits only 0.00001% of the light. For safety, solar filters must be securely fitted over the objective of a refracting telescope or aperture of a reflecting telescope so that the body does not heat up significantly.³

solar flare- a sudden temporary outburst of energy from a small area of the sun's surface²

solar prominences - great clouds of luminous hydrogen, calcium, sodium, and other gases floating above the sun's chromosphere, occasionally erupting violently outward, and being especially numerous in regions above sunspots²

solar scope (solar telescope) - a telescope designed for observations of the sun²

solar viewer (solar viewing glasses or solar eclipse glasses) - are special eyewear designed for direct viewing of the Sun. Standard sunglasses are unable to filter out eye damaging radiation. Solar viewers are required for safe viewing of solar events such as eclipses. The recommended optical density of this eyewear is 5.²

subsolar point - the point on the surface of the earth or a planet at which the sun is at the zenith³

synodic month - The orbital period of the Moon with respect to the Sun; the period of the Moon's phases has a mean duration of 29.530589 days (29 d 12 h 44 min 2.9 s); due to gravitational perturbations in the Moon's orbit, the synodic month varies by +/- 6 hours from one month to the next; see: [Phases of the Moon Photo Gallery](#).¹

syzygy - the nearly straight-line configuration of three celestial bodies (such as the sun, moon, and earth during a solar or lunar eclipse) in a gravitational system²

T

Terrestrial Dynamical Time (TD) - The modern astronomical time standard defined by the International Astronomical Union, used for time-measurements of astronomical observations made from the surface of Earth; Terrestrial Dynamical Time is a uniform time scale free of the irregularities of mean solar time; also known as *Terrestrial Time (TT)*, the "*Astronomical Almanac*" uses TT for its tables of positions (ephemerides) of the Sun, Moon and planets as seen from Earth; for more information, see: [Terrestrial Time \(Wikipedia\)](#).¹

Terrestrial Time (TT) - The modern astronomical time standard defined by the International Astronomical Union, used for time-measurements of astronomical observations made from the surface of Earth; Terrestrial Time is a uniform time scale free of the irregularities of mean solar time; also known as *Terrestrial Dynamical Time (TD)*, the "*Astronomical Almanac*" uses TT for its tables of positions (ephemerides) of the Sun, Moon and planets as seen from Earth; for more information, see: [Terrestrial Time \(Wikipedia\)](#).¹

third contact - The instant when the total or annular phase of an eclipse ends.¹

total solar eclipse - A solar eclipse in which the Moon's umbral shadow traverses Earth (Moon is close enough to Earth to completely cover the Sun). During the maximum phase of a total eclipse, the Sun's disk is completely blocked Moon. The Sun's faint corona is then safely revealed to the naked eye.¹

totality - The maximum phase of a total eclipse during which the Moon's disk completely covers the Sun. Totality is the period between second and third contact during a total eclipse. It can last from a fraction of a second to a maximum of 7 minutes 32 seconds.¹ This is also known as the central phase.³

transit - passage of a celestial body over the meridian of a place or through the field of a telescope, passage of a celestial body over the meridian of a place or through the field of a telescope²

U

umbra - The umbra is the darkest part of the Moon's shadow. From within the umbra, the Sun is completely blocked by the Moon as in the case of a total eclipse. This contrasts with the penumbra, where the Sun is only partially blocked resulting in a partial eclipse.¹

umbraphiles – a person who chases eclipses, meaning shadow lover³

Universal Time (UT1) - A time scale based on the rotation of Earth in relation to distant celestial objects (stars and quasars); UT1 is a non-uniform time scale because Earth's rotational period is slowly increasing due to tidal interaction with the Moon; the modern continuation of Greenwich Mean Time (GMT), i.e., the mean solar time on the Prime Meridian at Greenwich; for the casual user, UT1 (sometimes referred to simply as UT) is essentially the same as GMT and is often used interchangeably; there are several versions of UT including Coordinated Universal Time (UTC); for more information, see: Universal Time (Wikipedia).¹

¹ *Glossary of Eclipse and Astronomy Terms* by Fred Espenak, <https://www.EclipseWise.com>

² Merriam-Webster. (n.d.) Citation. In *Merriam-Webster.com dictionary*. Retrieved 27 July 2021, from <https://www.merriam-webster.com/>

³ Wikipedia. Retrieved 28 July 2021, from <http://www.wikipedia.com/>