Chapter 1: Discovering the Night Sky

Constellations:

- Recognizable patterns of the brighter stars that have been derived from ancient legends. Different cultures have associated the patterns with their own legends.

- Useful as an aid in locating stars. However, they are not very useful when astronomers need to communicate the exact location of a star, galaxy, nebula, or other object to other astronomers.

- The sky is divided into 88 unequal areas that we call constellations.

- Southern constellations are of more recent origin.

- The older constellation names originate from Greek mythology.

Star Names:

Arabic Names: Brightest stars have Arabic names such as; Sirius, Antares, Arcturus, ...

Bayer Designations: Greek letters followed by the constellation name. The brightest star in a constellation is given the letter alpha (α), the second brightest beta (β), and so on.

Flamsteed Numbers: When the Greek alphabet is exhausted numbers are used to designate relative brightness.

Magnitudes: The brightness of stars are described by a number called a magnitude. A difference of one magnitude represents a difference of about 2.5 in actual brightness.

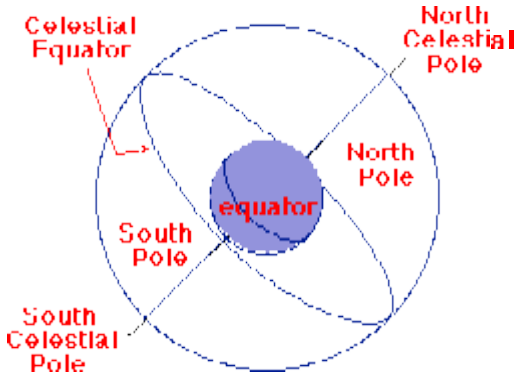
example: If two stars differ by 5 magnitudes the difference in brightness is:

$$2.5^5 = (2.5)(2.5)(2.5)(2.5)(2.5) = 100.$$

CELESTIAL SPHERE: Ancient concept still in use to relate positions and apparent motions in the sky.

Celestial Equator (CE): Divides celestial sphere into two equal halves (north and south). It can be thought of as the projection of the Earth's equator onto the celestial sphere.

Celestial Poles (NCP, SCP): Points on celestial sphere about which the stars appear to rotate. These are the points where the Earth's rotational axis intersect with the celestial sphere. They can be thought of as the intersection of the Earth's rotational axis with the celestial sphere.



Horizon: The plane where the Earth meets the sky.

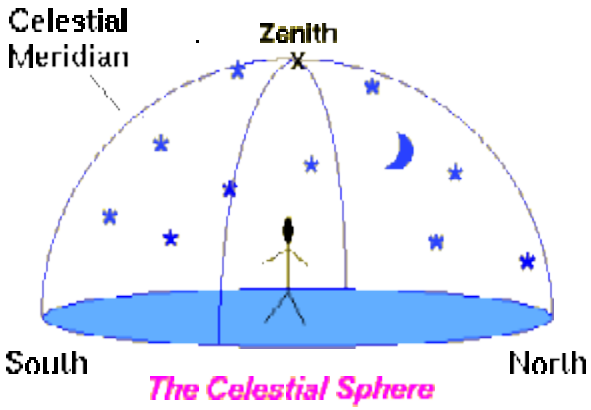
Altitude: The angle of a star above the horizon

Azimuth: The angle of a star along the horizon measured East from the North cardinal point

Cardinal Points: The compass directions (north, south, east and west).

Meridian: The projection of the observers line of longitude onto the celestial sphere. As the Earth rotates different stars will cross the observer's meridian. The meridian is the line that runs from the south point on the horizon to the north point on the horizon.

Zenith: The point directly overhead for an observer.

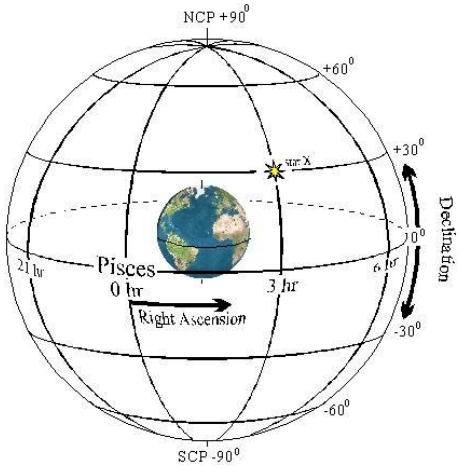


Ecliptic: The apparent path that the Sun traces out in the sky due to the revolution of the Earth about the Sun. The ecliptic is inclined to the celestial equator by an angle of 23.5 degrees due to the tilt of the Earth's rotational axis. The Sun's motion along the ecliptic is from west to east at a rate of about one degree per day.

Celestial Coordinate System: Like the terrestrial coordinate system of longitude and latitude the celestial sphere is divided into a coordinate system that is analogous to the terrestrial system.

Declination: The angle north or south of the celestial equator. It is directly analogous to latitude and is measured from 0 to + 90 degrees in the Northern Hemisphere and from 0 to –90 degrees in the Southern Hemisphere.

Right Ascension: The angle measured east from the vernal equinox. Rather than using degrees of arc we use units of time. The celestial equator is divided into 24 hours (1 hr. is equal to 15 degrees). Each hour of RA is divided into 60 minutes and each minute is divided into 60 seconds.



Concept Test

The "equatorial system" of coordinates

a) uses the celestial equator as a fundamental reference circle.
b) uses the vernal equinox as a fundamental reference point.
c) is "attached" to the celestial sphere.
d) uses two angles to define a direction in the sky.
e) All of the other answers are correct.

Motion of the Sun: due to rotation and revolution of the Earth.

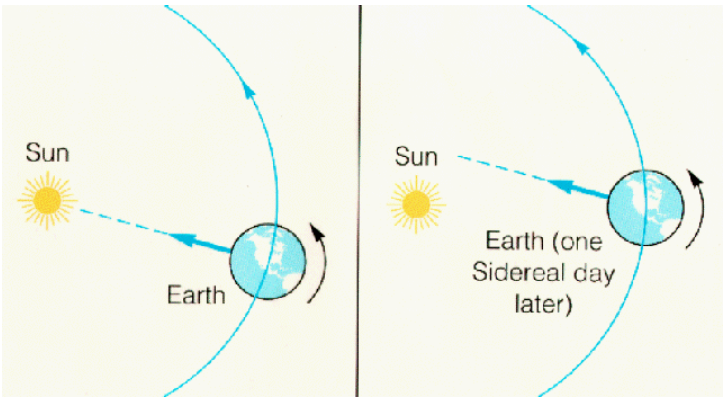
Diurnal: Daily rising and setting motion. Solar day is defined as two consecutive transits of the Sun across the meridian. (Rotation)

Annual: 1^{o} per day eastward motion of Sun relative to background stars. The Sun rises and sets 2 hours earlier each month. (Revolution)

Solar vs. Sidereal Day:

Solar Day: Two consecutive transits of the Sun across the meridian.

Sidereal Day: Time for a star to make two consecutive transits across the meridian. The sidereal day is about 4 minutes shorter. This difference is due to the Earth's revolution about the Sun.



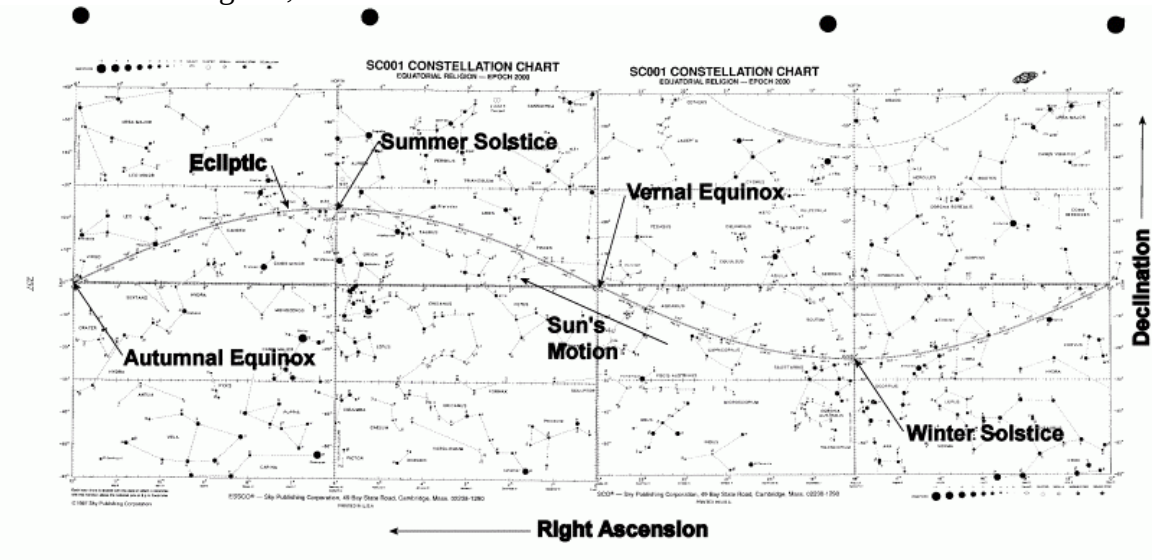
Seasons: Due to the 23.5^{o} tilt of the Earth's axis.

Vernal Equinox: Point where the Sun crosses the celestial equator on March 21.

Summer Solstice: Maximum angle above celestial equator, 23.5 degrees, on June 21.

Autumnal Equinox: Point where the Sun crosses the celestial equator on Sept. 22.

Winter Solstice: Sun reaches lowest angle below the celestial equator, -23.5 degrees, on Dec. 21.



Concept Test

In the northern hemisphere, during which month is the Earth closest to the Sun?

a. Spring
b. Summer
c. Fall
d. Winter

How would one go about determining when the Earth is closest to the Sun?

Precession: Earth wobbles like a spinning top due to the gravitational pull of the Moon and Sun. Period of the wobble is 26,000 years.

Eclipses and Motion of the Moon

Motion of the Moon: Motion relative to background stars is 13 degrees eastward per day along a path inclined 5 degrees to the celestial equator.

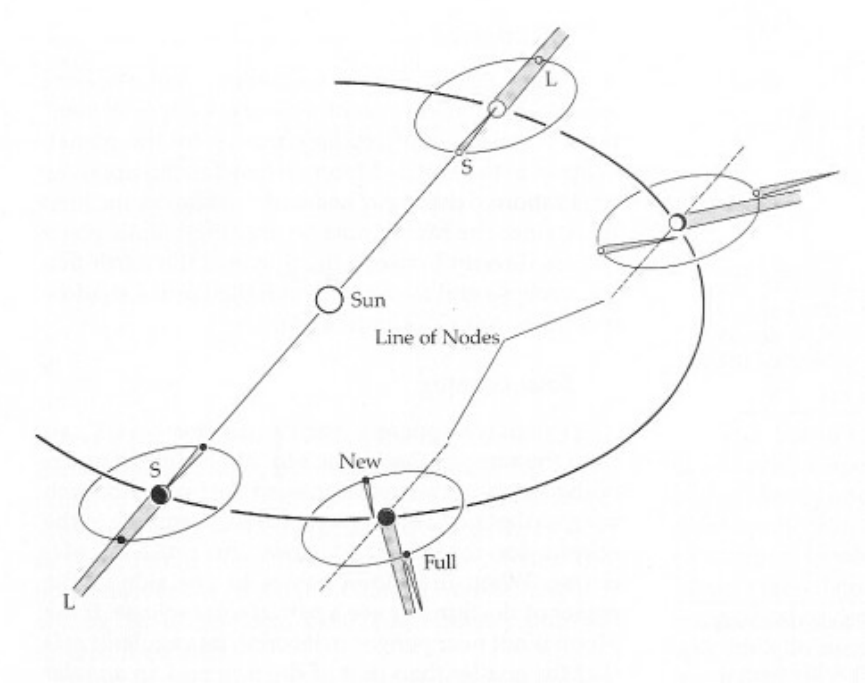
Sidereal Period: Time for the Moon to make two consecutive passages of a star (27.3 days).

Synodic Period: The time between two consecutive new moons (29.5 days).

Phases: see handout.

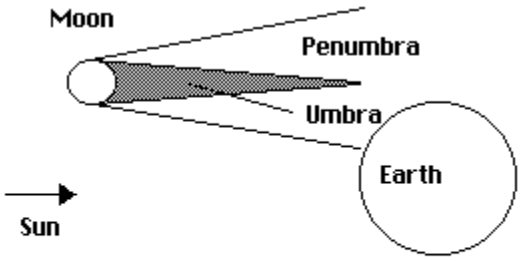
Angular Size: 1/2 degree, which is the same as the Sun thus leading to eclipses of the Sun.

Eclipses: For eclipses to occur the Moon must be at one of the nodes of its orbit and the phase of the Moon must be Full or New.

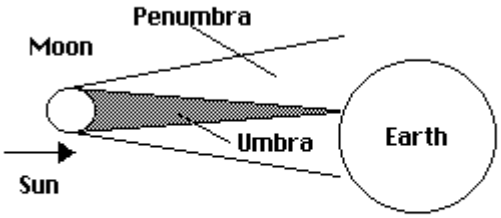


Solar eclipses occur when the phase of the Moon is New. Due to the small size of the Moon's shadow solar eclipses are seen by relatively few people.

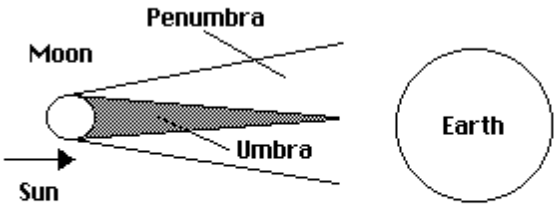
Partial Solar Eclipse: The umbra of the Moon's shadow misses the Earth. We see only a portion of the Sun covered by the Moon.



Total Solar Eclipse: The umbra of the Moon's shadow reaches the Earth's surface resulting in the Moon completely covering the Sun.

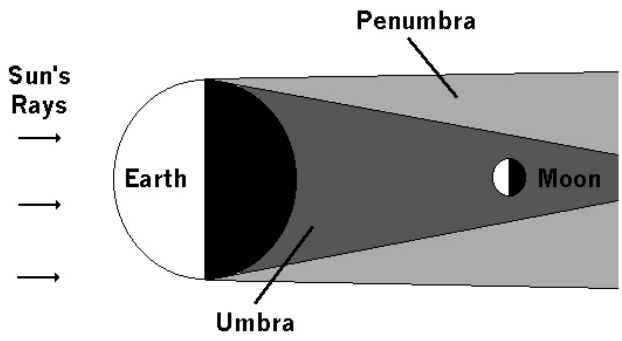


Annular Solar Eclipse: The umbra of the Moon's shadow does not reach the Earth's surface resulting in a ring of the Sun being visible around the Moon.

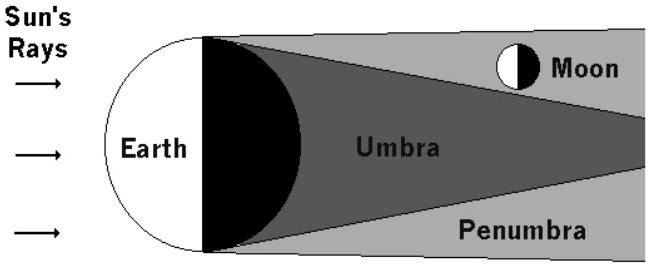


Lunar eclipses occur when the phase of the Moon is Full.

Total Lunar Eclipse:



Partial Lunar Eclipse:



Motions of the Planets: Eastward along the ecliptic with retrograde loops due to the relative motion of the Earth to the planets.

Configurations:

Superior Planets (planets farther from the Sun than the Earth):

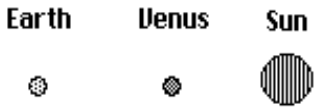
Opposition: Occurs when a superior planet and the earth lie along a line on the same side of the Sun.

Conjunction: Occurs when a superior planet and the Earth lie along a line on opposite sides of the Sun.

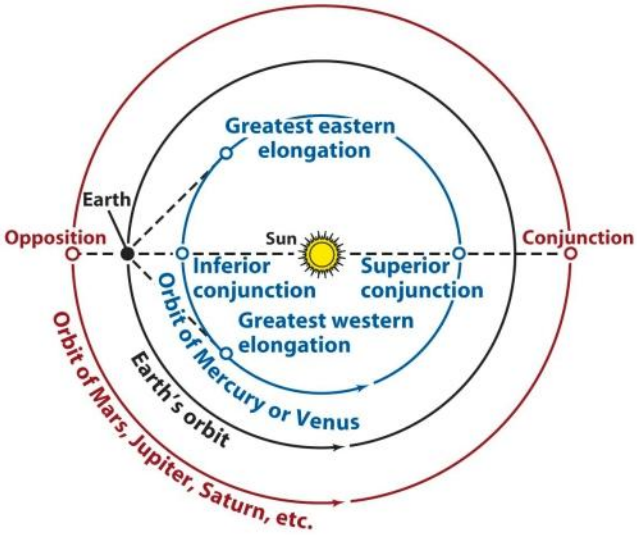
Inferior Planets (closer to the Sun):

Superior Conjunction: Occurs when an inferior planet and the Earth lie along a line on opposite sides of the Sun.

Inferior Conjunction: Occurs when an inferior planet and the Earth lie along a line on the same side of the Sun.



Greatest Eastern and Western Elongation: Occur when the angle between the Sun, planet and Earth is 90 degrees. The is the best time to observe inferior planets.



Concept Test

At the instant that Mars is at opposition for an observer looking at Mars (on the observer's local meridian) what time is it?

a) 6 AM.
b) Noon.
c) 6 PM.
d) Midnight.