Chapter 3

Eclipses and Ancient Astronomy

The moon completes one orbit around the Earth (as defined by the stars) in approximately 27.3 days. This is **one sidereal month**. Each day the Moon moves about **13 degrees** east with respect to the background stars.

The position of the Moon relative to the Earth and Sun defines the phases. It takes approximately 29.5 days to complete a full cycle of phases --- **one synodic (or lunar) month.**

The synodic period is longer than the sidereal month because of the earths orbital motion about the sun.

Moon phases.

new moon, waxing crescent, first quarter, waxing gibbous , full moon, waning gibbous, last quarter, waning crescent, **new moon**.

NB

Waxing -- Apparent illuminated area increasing with time.

Waning - Apparent illuminated are decreasing.

Each moon phase defines a particular Sun-Earth-Moon geometry.

Crescent --- Angular distance (*between a line joining the Sun and the Earth, and a line joining the Earth and the Moon*) is less than 90^{o}. Less than half of the illuminated hemisphere is seen from Earth.

First quarter ---- Angular distance is 90^{o}. Half of the illuminated moon is seen.

Gibbous --- Angular distance is greater than 90^{o}. More than half of the illuminated hemisphere is seen from Earth.

NB: Observe a thin waning crescent. As thin, Moon must be close to Sun. Because it is a waning crescent, the moon must lie slightly east of the Sun. On successive days the moon will move east with respect to the sun. A first quarter moon will rise at approximately noon. A full moon will rise around sunset.

Eclipses

Eclipses occur when one body passes in front of another.

Solar Eclipse

Occurs when the Moon passes between the Earth and the Sun. The Sun is occulted, and the Moon's shadow falls on the Earth. This happens when the Moon's phase is NEW.

A **TOTAL** eclipse occurs when the Moon hides the Sun's disc completely, allowing the Corona to be seen (Moon is at Perigee).

An **ANNULAR** eclipse occurs when the alignment is perfect but the Moons angular diameter is too small to fully block the Sun (i.e. the Moon is at Apogee).

The eclipse path is quite narrow --- always less than 270km. Totality lasts less than 7.5 minutes.

Lunar Eclipse

Occurs when the Earth passes between the Moon and the Sun. The Earths shadow falls on the Moon. This happens when the moons phase is FULL.

During a lunar eclipse the Moon can appear reddish. This is caused by the refraction of sunlight by the Earths atmosphere. Totality can last for up to 1hr 42 minutes.

The orbital plane of the moon is tilted by approximately 5 deg with respect to the ecliptic. This causes the solar and lunar eclipse cycles.

The intersection of the plane of the Earth's orbit and the plane of the Moons orbit is known as **the line of nodes.**

Because of the Sun's gravitational pull, the line of nodes shifts gradually westward --- it takes 18.61 years for 1 full revolution.

Eclipses only occur when the Sun and Moon are near the line of nodes. Only then is the Earth, Sun and Moon in straight line.

Saros Cycle.

To get an identical alignment of the moon and sun takes 1 Saros cycle --- 6585.3 days. Eclipses separated by 1 saros cycle for a series have similar properties such as the length of totality.

An observer on Earth has to wait 3 Saros cycles to get the eclipses to repeat.

Eclipse Year.

Time it takes from one alignment of the Sun on the nodes to the next alignment.

1 Eclipse year= 365.25/(1+1/18.61) days

= 346.6 days

In 1 Saros cycle, the number of eclipse years (19) and the number of lunar months (223) are both integer.