

## Lecture 9 (p.2) Observing the Stars and Planets: Clockwork of the Universe

29 JNUry, 2005

(Continue reading Chapter 4 as background for lecture notes)

**General:** Here we discuss the Earth-Moon system – the appearance of the Moon from the earth - and the nature of eclipses (lunar and solar) involving the Earth-Moon-Sun system.

### VI. The Phases of the Moon

A. Moon's orbit -- The Moon is in orbit about the Earth.

**Sidereal period** = 27.3days (period of revolution with respect to fixed stars)

**Synodic period** = 29.5days (period of revolution with respect to direction of Sun)

Period of revolution of the Moon is referred to as a **Lunar month**

The light we see from the Moon is only the reflected light from that portion of the sunlit face of the Moon that is in the hemisphere facing the Earth.

B. Phases -- Appearance of Moon from Earth

**New** (all dark: Sun and Moon rise and set at ~ the same time)

**Waxing Crescent**

**First Quarter**

**Waxing Gibbous**

**Full** (fully lit hemisphere: Moon rises just as Sun sets)

**Waning Gibbous**

**Third Quarter**

**Waning Crescent**

Once every Synodic month, the Moon passes through a progression of “phases” that refer to the fraction of the hemisphere toward Earth that is lit up. Eight phases representing the appearance of the Moon from Earth at ~3.6 day (i.e.  $29.5 / 8 = 3.6$ ) intervals are normally recognized.

### VII. Eclipses (in the Sun-Earth-Moon system)

A. General concepts: Eclipses occur due to the alignment of the Sun-Earth-Moon in the ecliptic plane such that sunlight is blocked from reaching either the Earth or Moon. If the Moon's orbital plane were to lie exactly in the ecliptic plane, then eclipses should occur during every New and every Full Moon phase, or as many as ~24 times each year. However, eclipses are not this frequent due to the fact that **the Moon's orbital plane is tilted by ~5° from the ecliptic plane.**

Relative sizes: in a billion-to-1 scale model the Moon is a pea, the Earth a grape, and the Sun is a 1.5meter sphere. The Earth-Moon distance is ~1 foot and the Sun-Earth distance is ~150 meters. Given these dimensions, it turns out that the angular diameter of the Sun and the Moon as seen from the Earth are both identical (i.e. 1/2 degree)

When: **Eclipse seasons** only occur near the solstices (**May--July**) or (**Nov--Jan**) when the Moons “line of nodes” points toward the Sun

Types: 2 basic types of eclipses (**Total eclipse and Partial eclipse**)

Shadow: **Umbra** = dark (smallest) central portion; **Penumbra** = lighter (larger) surrounding region

B. **Lunar Eclipses** (Moon passes through Earth's shadow)

-- only occur during Full Moon

-- relatively long total blockage - Moon is in the Earth's Umbra for ~1 hour

-- partial eclipse lasts for many hours

-- can usually be seen from anywhere on dark side of the Earth

C. **Solar Eclipses** (Earth passes through Moon's shadow)

-- only occur during New Moon

-- total blockage occurs over very small region and lasts only ~5 min. Path of Umbra may be several thousand miles long.

-- Annular Eclipse: Umbra does not quite touch the Earth's surface

-- Partial Eclipse: crescent Sun still visible, and can be seen from larger portion of Earth's surface for 1--2 hours