Astronomy 122

Section 1– TR 1300-1350

1320 Digital Computer Laboratory

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Office Hours:
T 10:30-11:30 a.m. or
by appointment

This Class (Lecture 4):

The Earth-Moon System

Next Class:

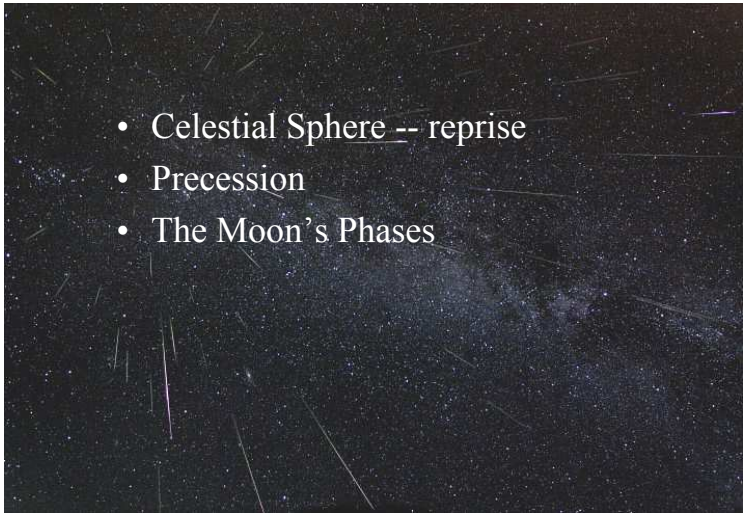
Gravity and the Planets

Homework #1 due Fri!

http://eeyore.astro.uiuc.edu/~lwl/classes/astro122/spring06/

Music: *Walking on the Moon* – The Police

Outline



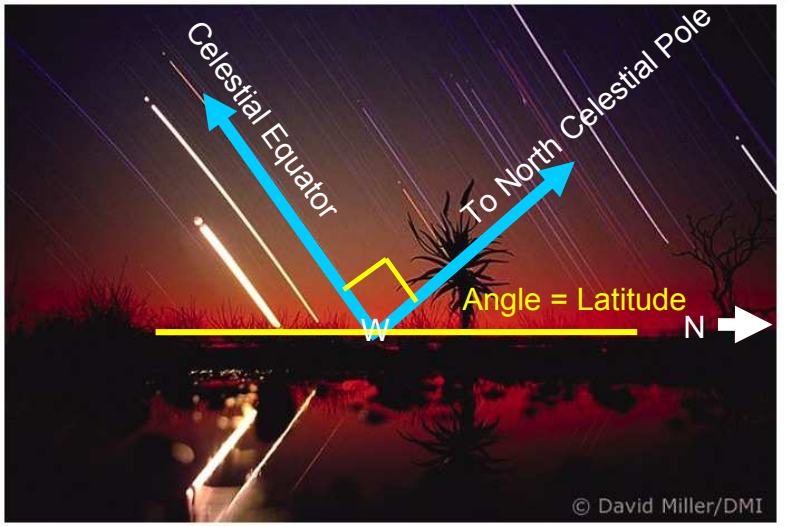
- Celestial Sphere -- reprise
- Precession
- The Moon's Phases

Celestial Sphere

- ..\..\..\..\animation\celsphere1.avi

http://brahms.phy.vanderbilt.edu/~rknop/astromovies/celsphere1.html

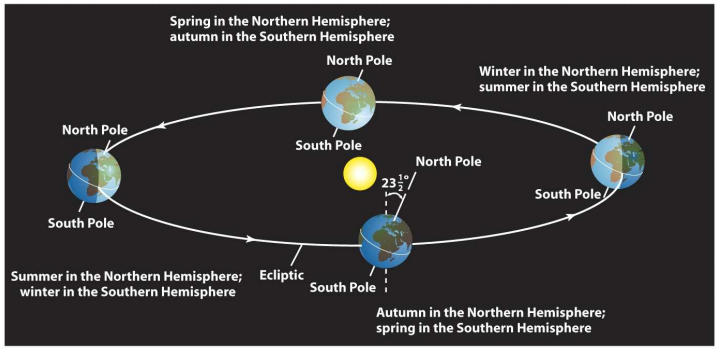
Motions in the Sky



What Causes the Seasons?

So what does cause the seasons?

- It's the tilt of the Earth's spin axis
  - Affects the length of day **and** intensity of sunlight

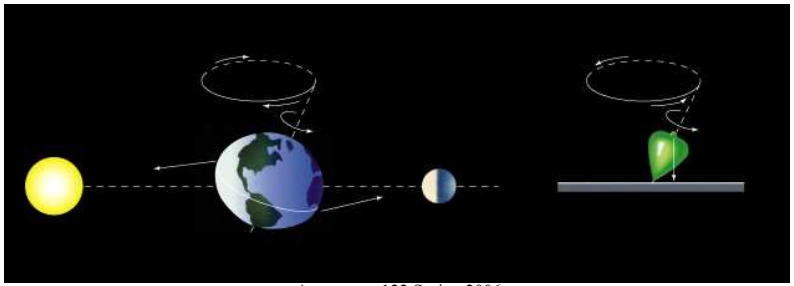


"Thinking Cap" Question

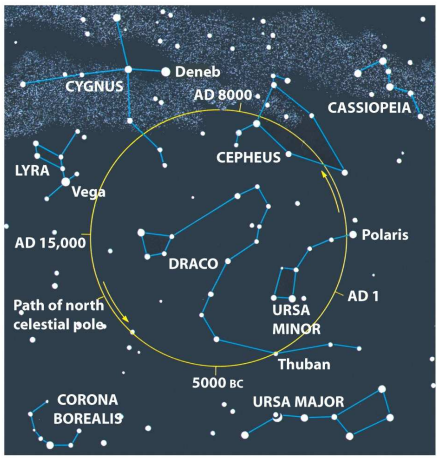
June 21st is the summer solstice and December 21st is the winter solstice. However, they are not the hottest and coldest days of the year (those occur in July and January, on average). Why is this?

Precession

- As the Earth spins it also wobbles slowly, like a top
  - This wobble takes 26,000 years
  - Geek-speak: Called **precession**



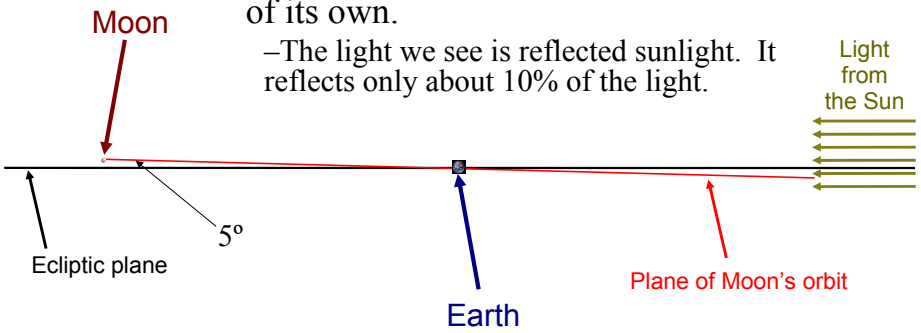
What Does This Mean?



- Polaris won't always be the North Star!
- In the time of the Egyptian pharaohs, it was Thuban
- In about 13,000 AD it will be Vega (sort of)

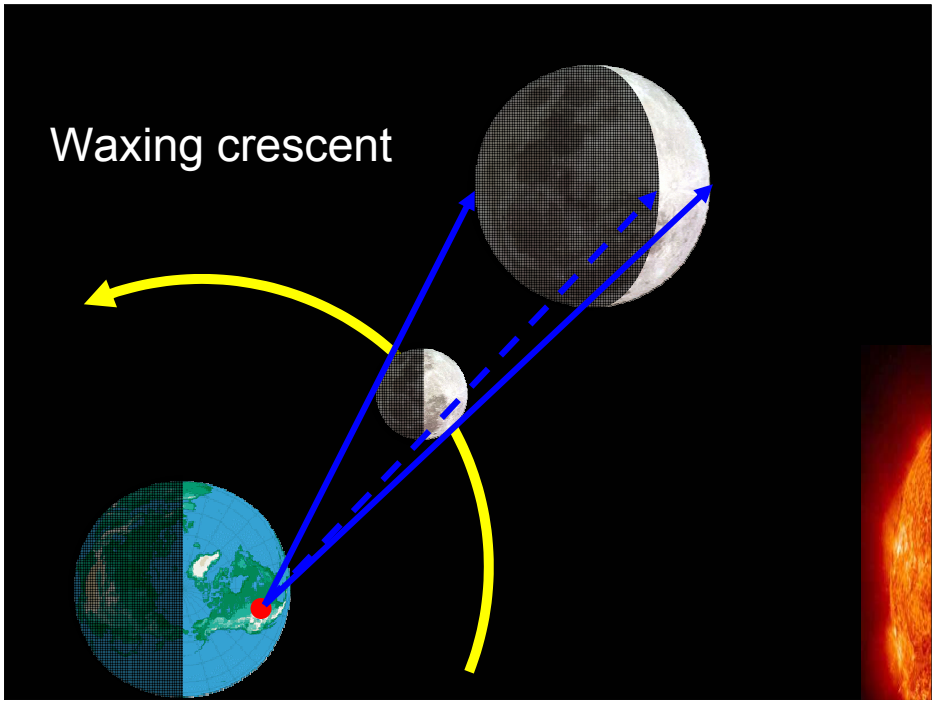
The Lunar Orbit

- The Moon is Earth's nearest neighbour in space
  - About 30 Earth diameters away
- Orbits the Earth once in a little under a month
  - Like the Earth orbits the Sun, the Moon orbits the Earth counter-clockwise
    - The Moon does not give off any light of its own.
      - –The light we see is reflected sunlight. It reflects only about 10% of the light.



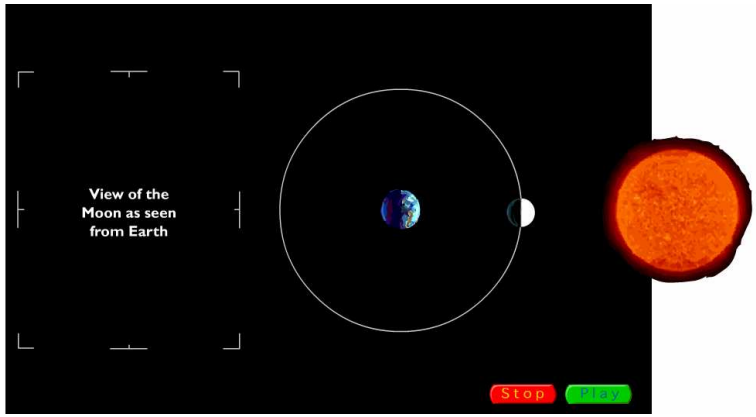
Phases of the Moon

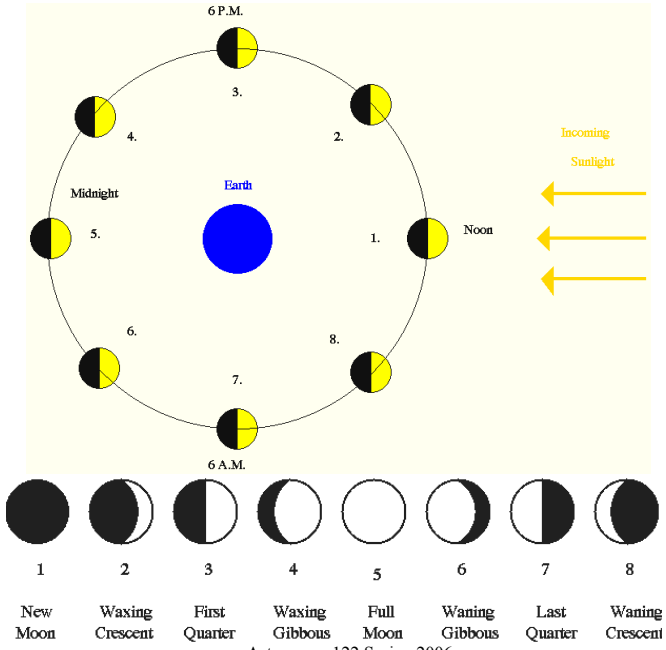
- Over the orbit, the Moon's appearance changes radically
- The apparent **Phases** of the Moon depend on how much of the sun-lit side of the Moon we can see.
- This is caused by the relative positions of the Earth, Moon, and Sun.
- **Not** caused by the shadow of the Earth



The Cycle of Phases

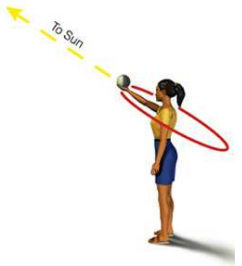
As the Moon orbits the Earth, we see it go through a cycle of phases





At Home Phases Demo

- Hold a softball (or equivalent) toward the sun (or a lightbulb)
- Spin around, and watch the ball experience phases like the Moon!

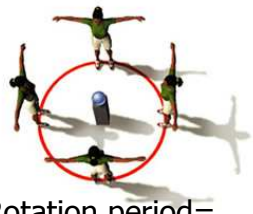


http://www.astro.uiuc.edu/projects/data/MoonPhases/index.html

The Face of the Moon

- Did you notice that we only see one face of the Moon?
- Does this mean the moon doesn't rotate?
- *No*, the Moon rotates so that the same face is always pointed at the Earth
- A lunar day equals a lunar orbit!

No rotation



Rotation period= Orbit period

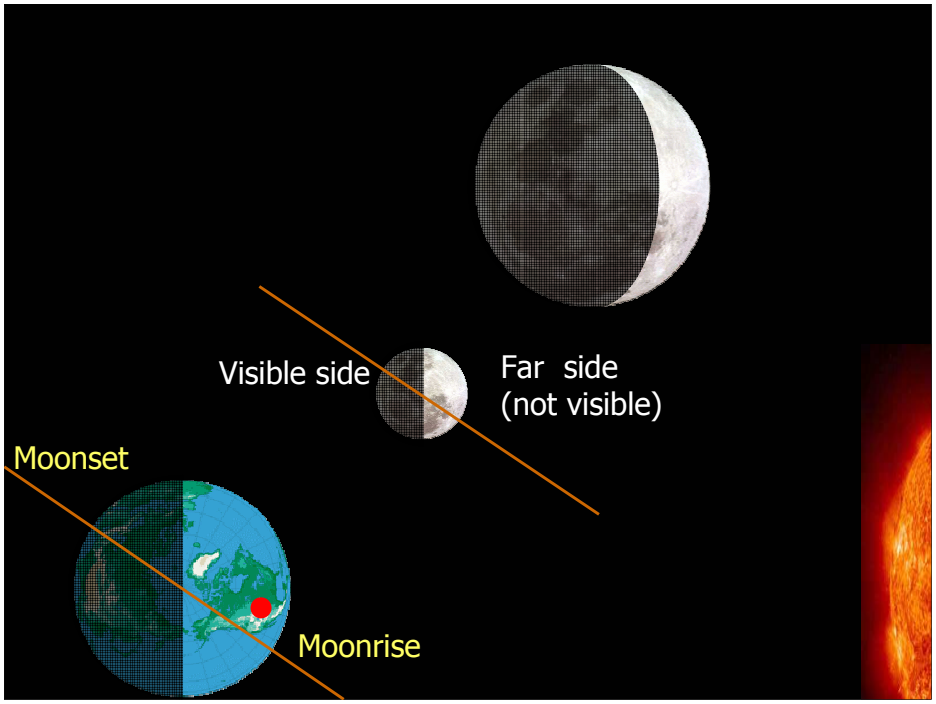
Dark Side of the Moon?

Is there really a dark side of the Moon?

NO! It is better called the Far Side of the Moon.

There is a side we don't see, but during the New Moon phase, it is well lit.

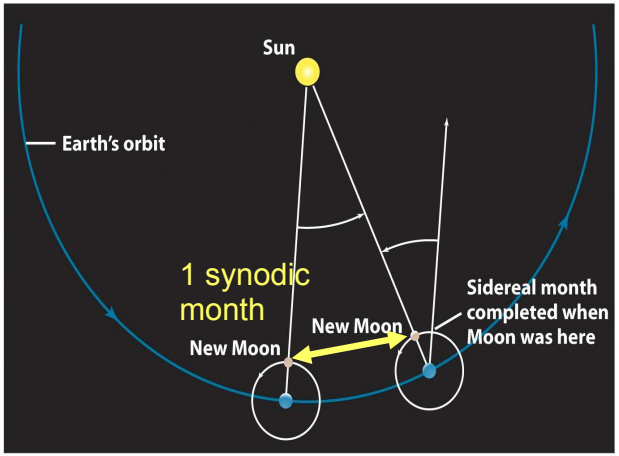
Basically the lunar day is nearly a month long.



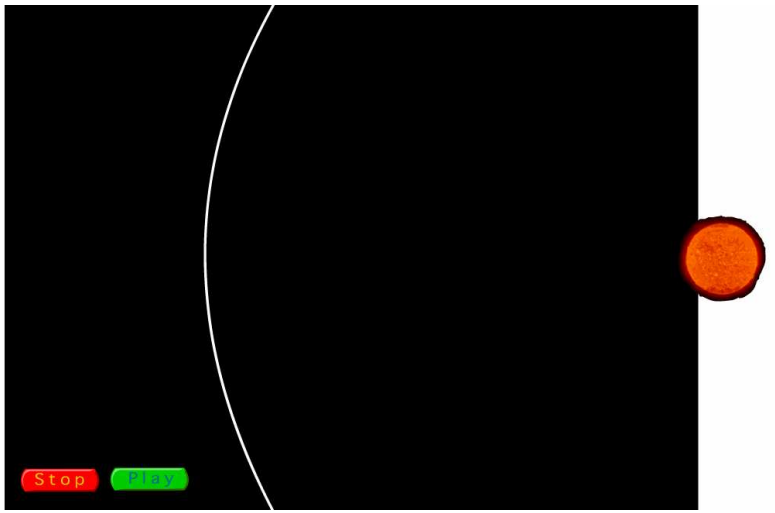
A "Moonth"

- The month is based on the time it takes the Moon to cycle through its phases
  - 29.5 days – called *synodic period*
- Moon makes one full orbit of the Earth in 27.3 days
  - Called its *sidereal period*
- Because of the Earth's orbit about the Sun, the Moon travels more than a full orbit each synodic period
  - 360 degrees/27.3 days = 13.2 degrees/day
  - Earth rotates about 15 degrees/hour
  - So Moon rises 13.2/15 hours = 53 minutes later each day

Synodic vs. Sidereal Period



Synodic vs. Sidereal Period

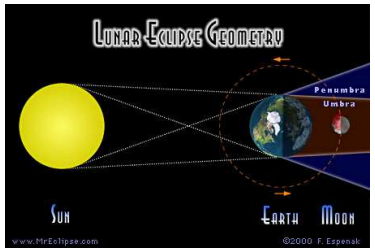


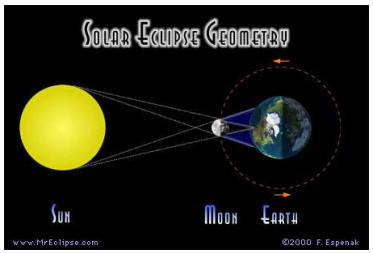
Basic of Eclipses

- Lunar Eclipse
  - When the Moon passes into the Earth's shadow
  - Sun – Earth – Moon

    full moon
- Solar Eclipse
  - When the Earth crosses the Moon's shadow
  - Sun – Moon – Earth

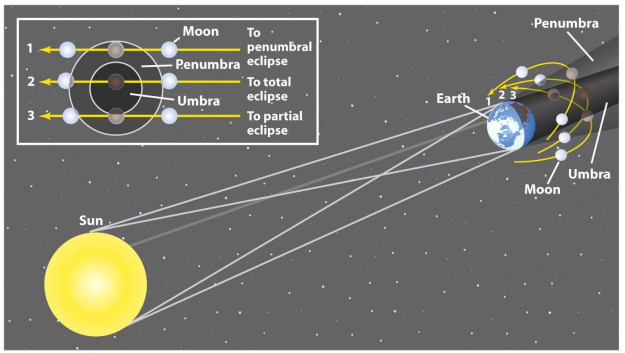
    new moon
- Why don't eclipses happen *every* full and new moon?





Lunar Eclipses

- Three types
  - **Total** - The Moon goes completely through the Earth's umbra
  - **Partial** – The Moon only goes partly through the umbra
  - **Penumbral** – The Moon only passes into the penumbra



Umbra? Penumbra?

Latin for "complete shadow" and "partial shadow"

Total Lunar Eclipse– Time Lapse

- Occurs when the Moon passes through Earth's umbra completely.

- Occur roughly twice a year, and last for about an hour or two.
- Can be seen by anyone experiencing night during the lunar eclipse.

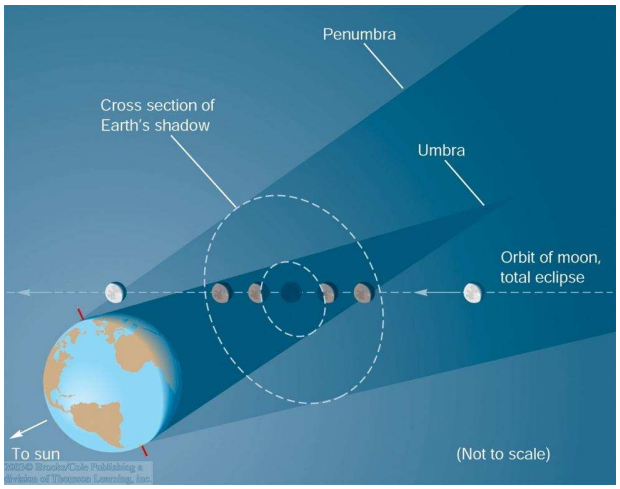
http://www.mreclipse.com/LEphoto/TLE20001/T00sequence1w.JPG

Red Moon

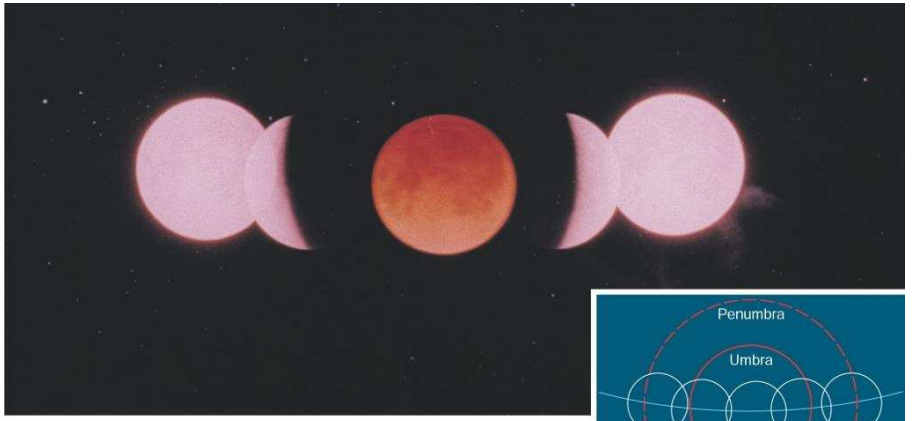
- During a total lunar eclipse, the Moon turns a blood-red/burnt orange color.

- Red color caused by sunlight diffused through the Earth's atmosphere
- Atmosphere scatters blue light away, so Moon is dimly illuminated in red
- The next total eclipse visible in Champaign-Urbana will be in 2007.

Total Lunar Eclipse



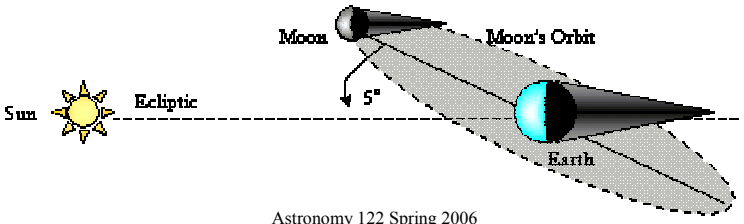
Eclipsed



Color depends on Earth's Atmosphere

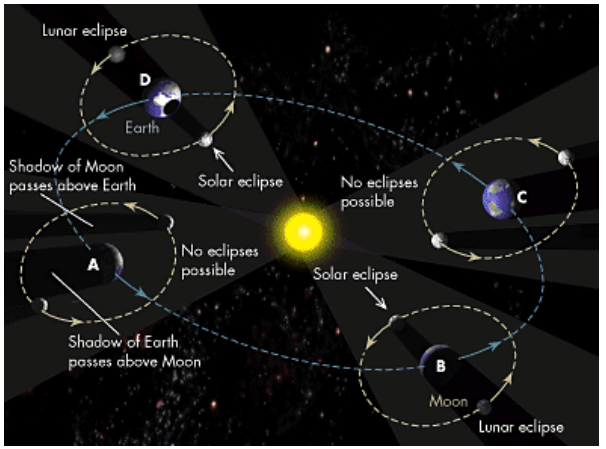
The Moon's Orbit is Tilted!

- The Moon's orbit is tilted to the ecliptic by 5°
- Just like the Earth's rotation axis is tilted to the ecliptic
- The Moon must be near the ecliptic for an eclipse to occur



Eclipse Seasons

Nodes are the two points in each orbit at which the Moon crosses the Earth's orbital plane. For lunar or solar eclipses to occur the nodes must be aligned with the Earth and the Sun. Hence, eclipses can occur only twice per year and these epochs are called eclipse seasons.



http://www.ociw.edu/~mhamuy/moon.html

Solar Eclipses

- Earth passes into the Moon's shadow
- Only occur at the new moon
- Three types
  - **Partial** – when the moon only partially blocks the sun
  - **Total** – when the moon completely blocks the sun
  - **Annular** – when the moon is too small to completely block the sun