Astronomy 122

This Class (Lecture 5):

Gravity and the Planets

Homework #2 due Fri!

Next Class:

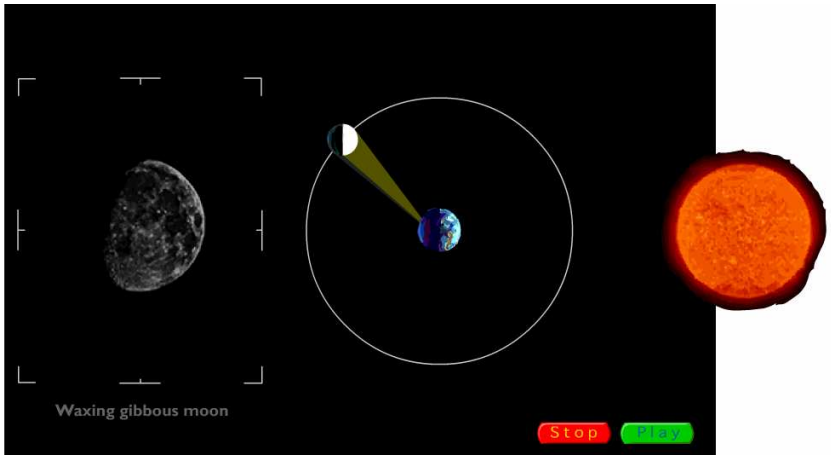
The Nature of Light

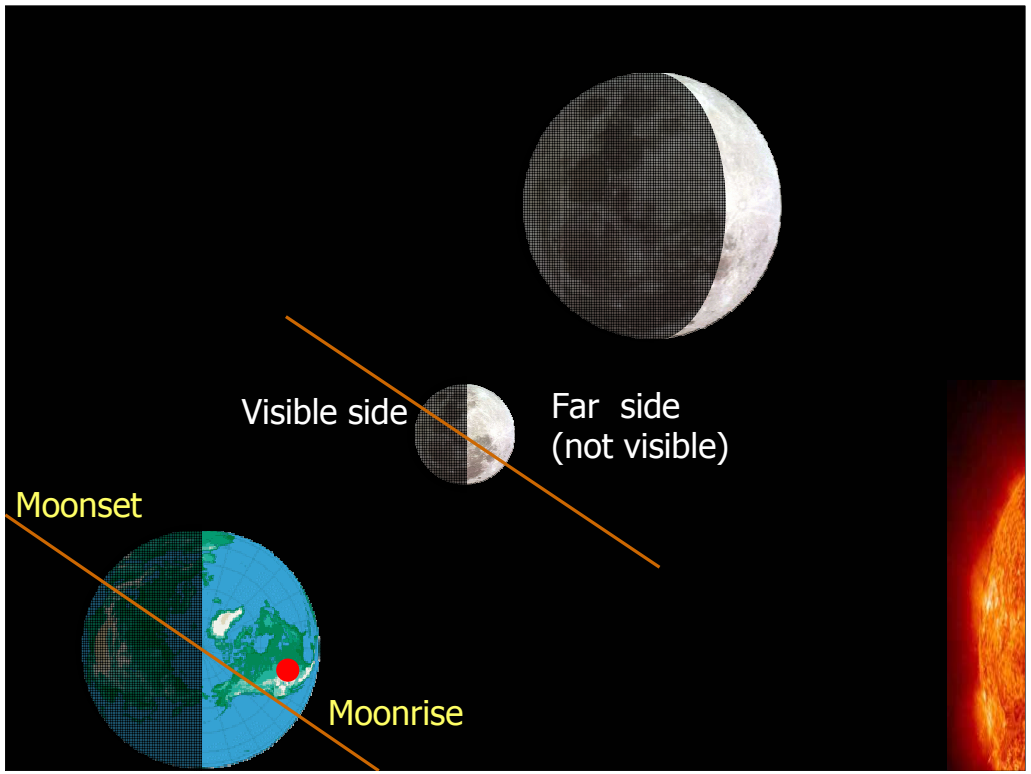
Music: *Spaceboy* – The Smashing Pumpkins

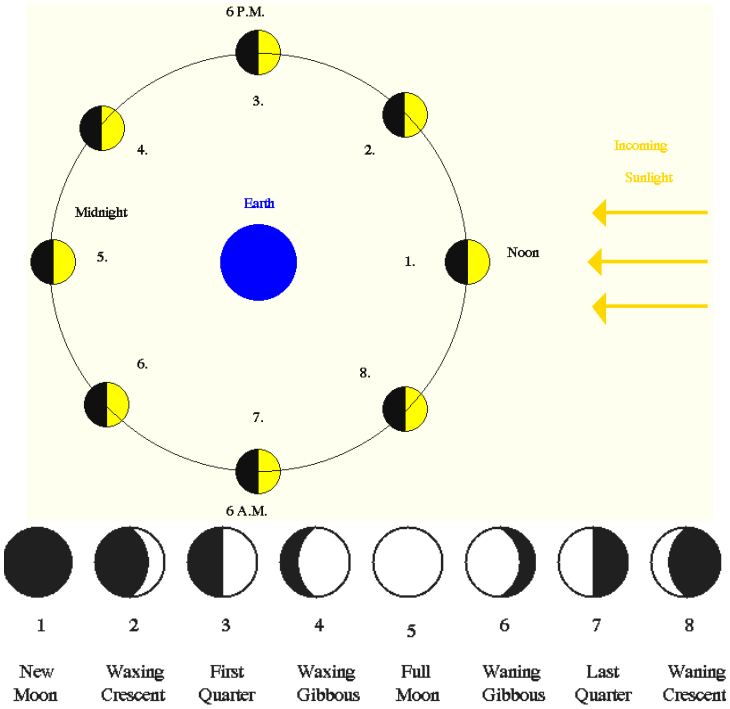
Outline

The Cycle of Phases

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

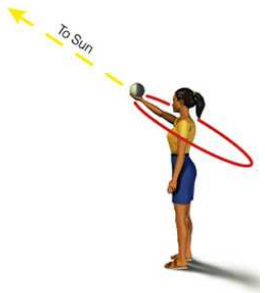






At Home Phases Demo

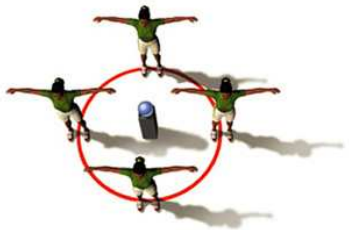
- Hold a softball (or equivalent) toward the sun (or a lightbulb)
- Spin around, and watch the ball experience phases like the Moon!



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.

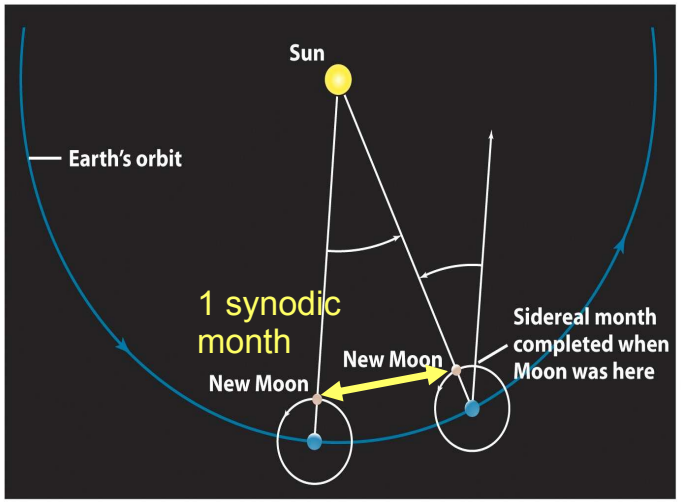
There is a side we don't see, but during the New Moon phase, it is well lit.

Basically the lunar day is nearly a month long.

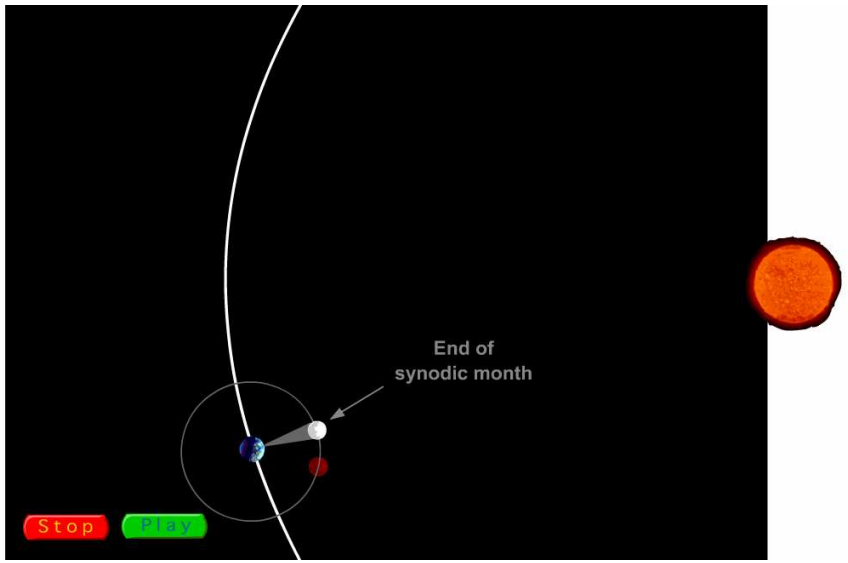
A "Moonth"

- 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

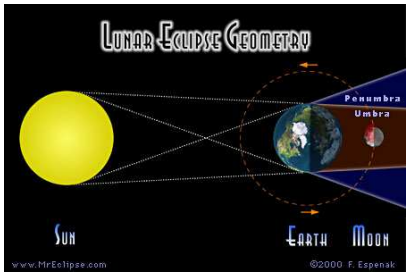


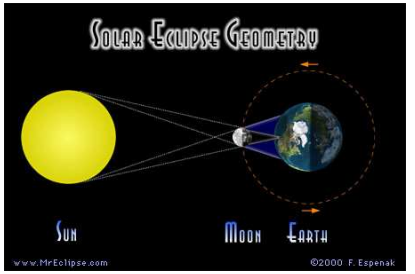
Basic of Eclipses

- 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

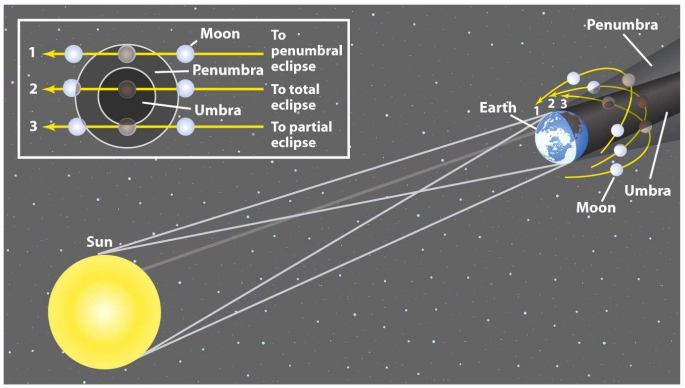
    new moon
- Why don't eclipses happen *every* full and new moon?





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.

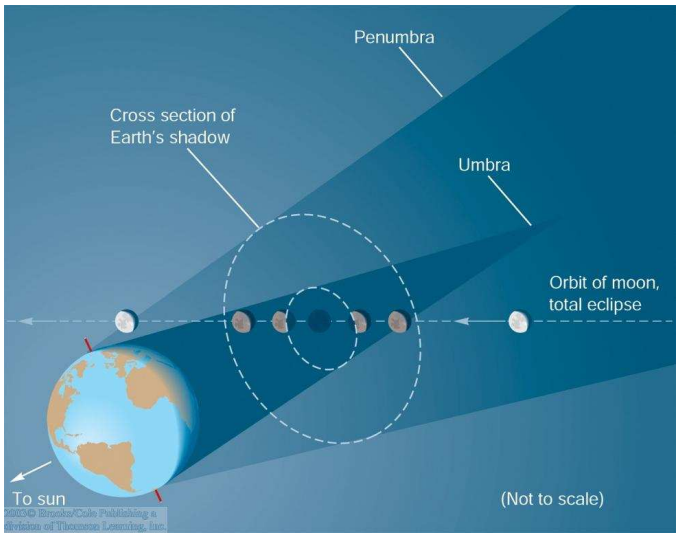
http://www.mreclipse.com/LEphoto/TLE20001/T00sequence1w.JPG

Red Moon

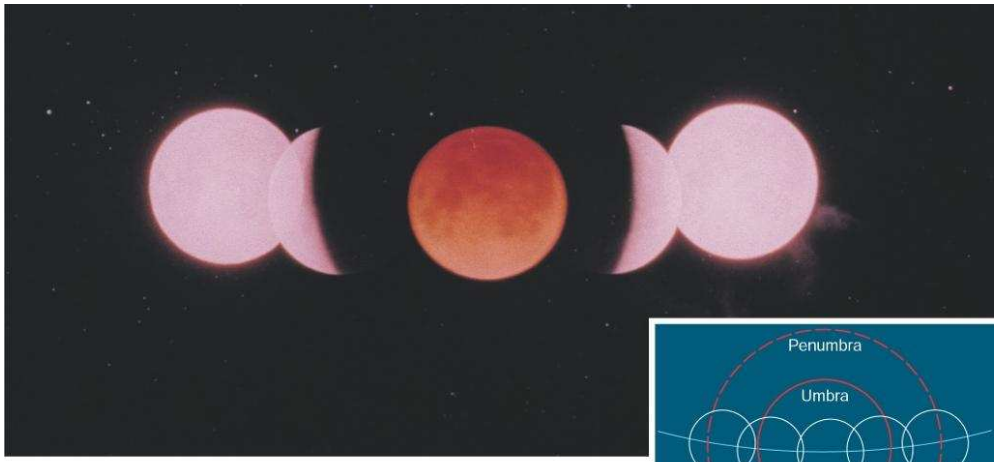
- During a total lunar eclipse, the Moon turns a blood-red/burnt orange color.

- 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



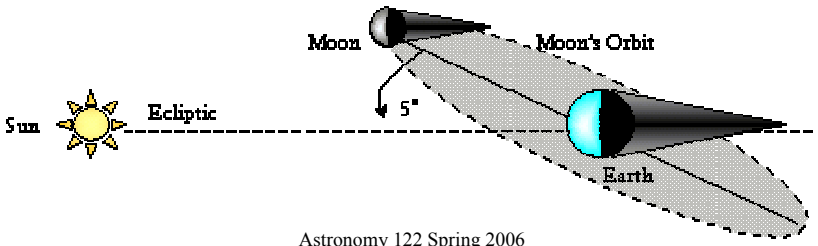
Eclipsed



Color depends on Earth's Atmosphere

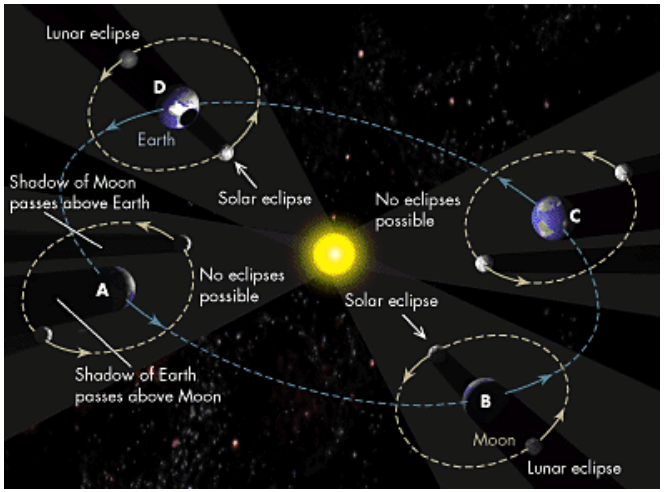
The Moon's Orbit is Tilted!

- 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

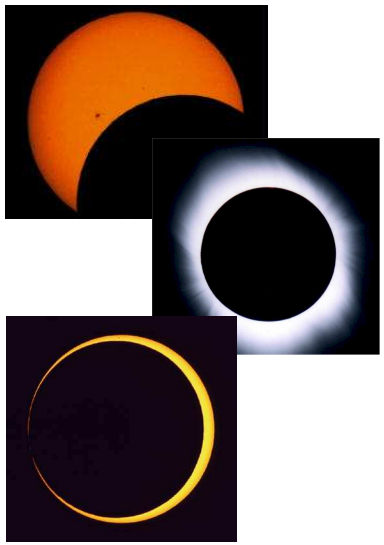
Nodes are the two points in each orbit at which the Moon crosses the Earth's orbital plane. For lunar or solar eclipses to occur the nodes must be aligned with the Earth and the Sun. Hence, eclipses can occur only twice per year and these epochs are called eclipse seasons.



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

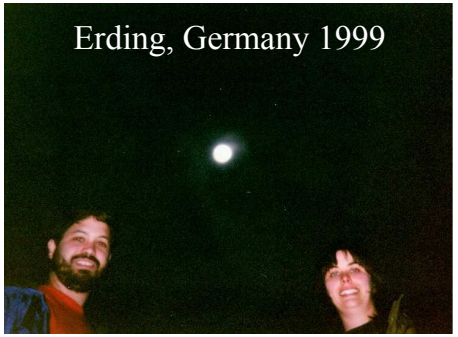
Solar Eclipses

- 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

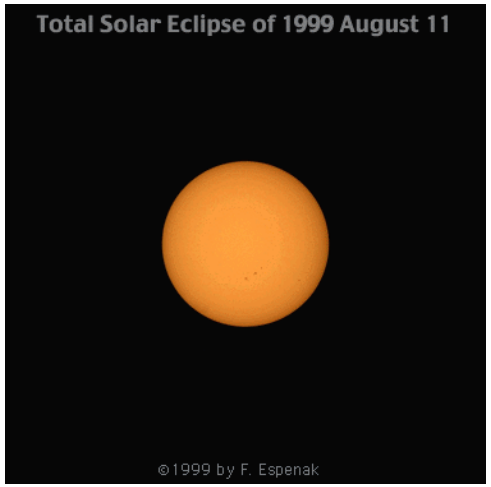


Solar Eclipses

- Moon casts a shadow on the Earth.
- Only possible because the Moon and Sun are approximately the same size as seen from Earth, around ½ a degree.
- Occur roughly twice a year, and last only a matter of minutes.
- The Moon's shadow can't completely cover the Earth. so Viewable only in a very small band of area across the Earth (about 270 km in width).



Total Solar Eclipses



- If you are within the Moon's umbra, you will see a total solar eclipse
- As the Moon covers the Sun, light shines through lunar valleys, creating a "diamond ring" effect
- At totality, we can see the *corona*, a halo of very hot gas around the Sun

Digitally Added Picture

http://antwrp.gsfc.nasa.gov/apod/image/9909/corona99_espanek.jpg

An Eclipse Movie

http://www.saxton.org/eclipse/eclipse.mov

Are they nuts?

Annular Eclipse Movie

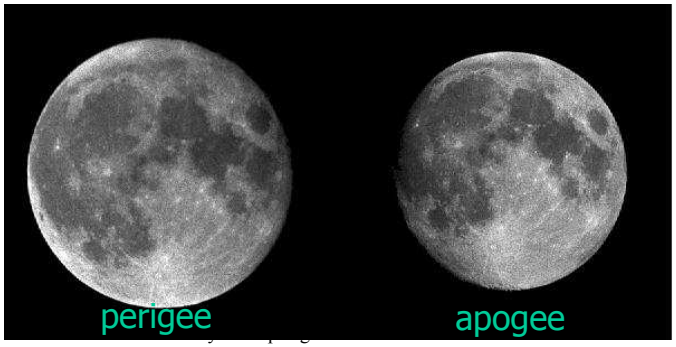
http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=38085

Annular Eclipse

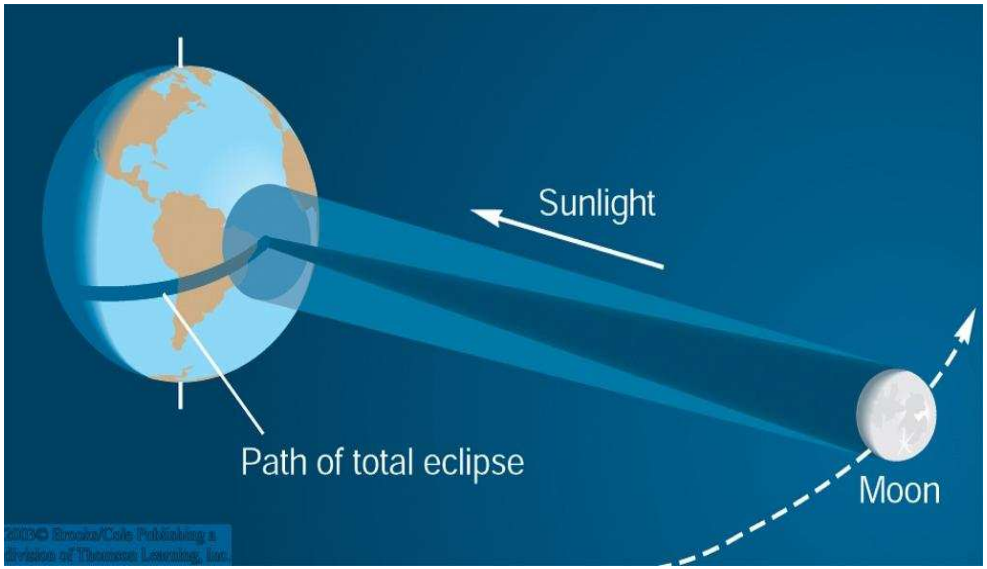
- When the Moon is farthest from the Earth, it is too small in the sky to completely cover the Sun
- This results in an ring of sunlight around the Moon
- Called an *annular eclipse*

More on the Lunar Orbit

- The Moon's orbit around the Earth not a perfect circle
  - Distance from the Earth to the Moon varies by 10%
- This makes a noticeable difference in the Moon's size in the sky

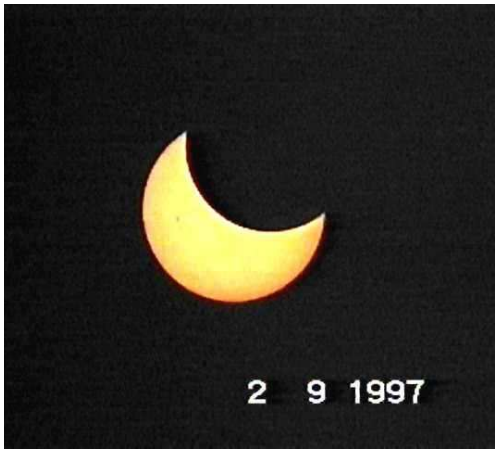


Total vs. Partial Solar Eclipses



Partial Eclipse

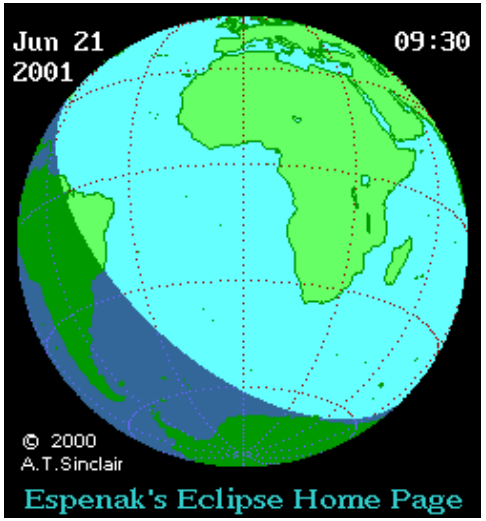
- Like the Earth's shadow, the Moon's shadow has an *umbra* and a *penumbra*
- If you are in the penumbra, you only see a partial eclipse
- Even if people a few miles away see a total eclipse!



http://antwrp.gsfc.nasa.gov/apod/image/9709/soleclipse1_staiger_big.jpg

Path of the Eclipse

Shadow of the Moon races across globe.

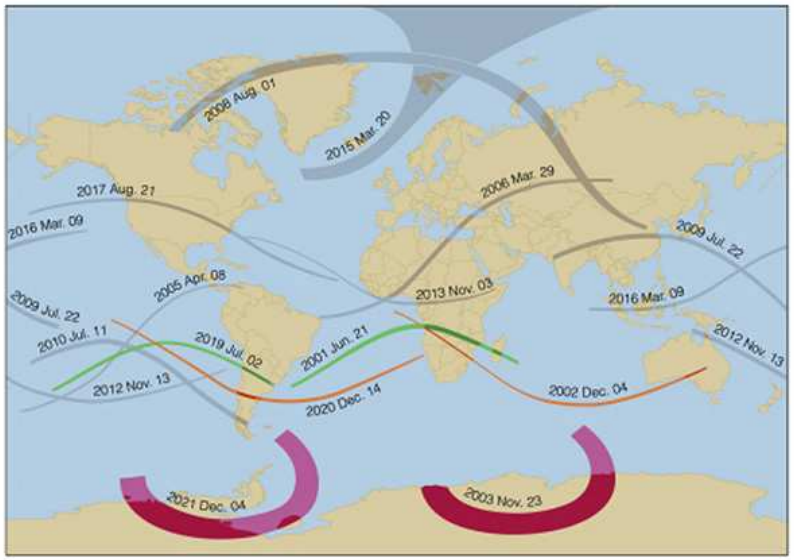


http://sunearth.gsfc.nasa.gov/eclipse/TSE2001/T01animate.html

Solar Eclipse Seen from Space

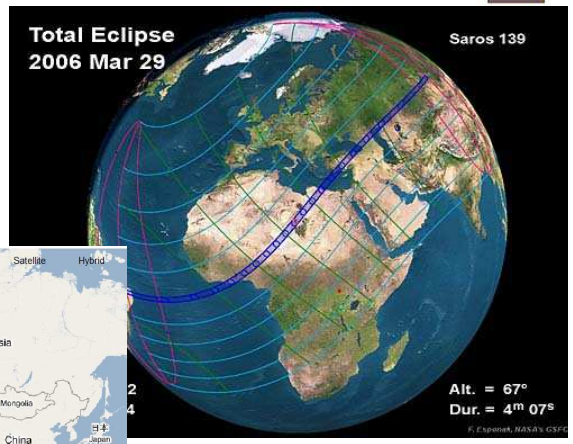
http://antwrp.gsfc.nasa.gov/apod/ap990830.html

Which Solar Eclipse Would You Like to Witness?



2006 Eclipse

Field trip anyone?



http://sunearth.gsfc.nasa.gov/eclipse/SEmono/TSE2006/TSE2006.html

2006