Class 2
Early models of the “Universe”

- Ancient ideas and preconceptions
- Development of the modern (Sun centered) view of the Solar System
- The scientific method at work...

I : Greek Astronomy

- Greeks seemed to be first culture to study the world in a systematic and logical manner
- But this was 2000+ year ago, so extremely limited technology was available!
- Put yourself in their shoes... what do your own senses tell you about the world and the wider Universe?
- Greeks knew the Earth was a sphere
  - They understood that **Lunar eclipses** occur when the Moon passes through the Earth’s shadow
  - The shadow is always circular... so Earth must be spherical
Greeks knew how big the Earth was!

- Sun reaches different mid-day “heights” in the sky at different places on the Earth’s surface
  - Pioneered by Erathosthenes (276-195 BC)
  - Alexandria to Syene = 5000 strades
  - Sun appears to shift by 7 degrees (1/50th circle)
  - Circumference of Earth =5000st x50=250,000 st.
  - We think 1 strade about 1/6 kilometer... so they got a circumference of about 42,000 km

- Idea of a spherical Earth was “ok” on aesthetic/philosophical grounds
Ancient Greek’s maps of the world
So that’s the Earth... what about the rest of the “Universe”

Most ancient thinking was based on the **Geocentric model** of Aristotle

- Earth is at the center of the Universe
- Earth is still (does not rotate!)
- The planets, Sun, Moon moves in circles around Earth
- The stars are fixed onto a giant sphere that surrounds the whole system
- There is nothing (no space) beyond the stars
This idea fails to explain an important phenomenon, **retrograde motion**

- All astronomical objects move across the sky from East to West.
- But, relative to the stars, planets normally move (slowly) from West to East.
- Some planets known to the Greeks (Mars, Jupiter and Saturn) sometimes reversed course and moved (relative to stars) East to West... this is retrograde motion!
- Hard to explain within Aristotle’s geocentric model.
Retrograde motion

- Ptolemy added a new ingredient to explain retrograde motion
  - Suggested a system of “epicycles”

(a) Planetary motion modeled as a combination of circular motions
Even with Ptolemy’s epicycles, the predicted positions of planets differed from real positions... needed more epicycles
What are the predictions of Ptolemy’s geocentric model and how do they compare with observations?

A revolutionary idea from Aristarchus (310BC-230BC)...  
- Maybe the Sun is at the center, and all of the planets orbit around the Sun!  
- Retrograde motion can then be explained as due to the Earth “overtaking” the other planets on their orbits  
- This was motivated by Aristarchus’s first attempts to measure the ratio of the distances of the Sun and the Moon... he found that the Sun must be much further away and hence must be huge! If its so big, why can’t it be at the center?

II : Early Heliocentric models
Aristarchus
(ca. 310-230 BC)
Aristarchus’s idea didn’t catch on... it appeared to contradict observations
Heliocentric model was finally revived by Copernicus
- Many believe that he “discovered” the idea of the heliocentric model by reading Aristarchus
- Irrespective... this was the beginning of the end for the Earth-centered idea.

Nicholaus Copernicus (1473-1543)