Reading: Chapter 2, Section 2.2 and 2.4;
Problem Set #2: Due Tomorrow/Monday in recitation
Problem Set #3: Available now, due next Friday/Monday

Brief review of last time: **The Moon's Orbit & Eclipses**

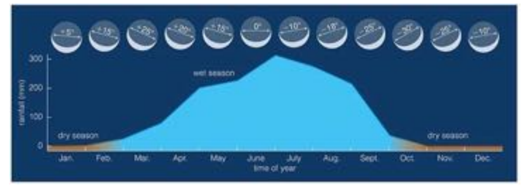
- Moon's Orbit and Eclipses
  - eclipses possible only when New/Full moon is at a node
- Anatomy of a Shadow
- Circumstances of eclipses
- Lunar eclipse: Sun at one node, Moon at the other (at full moon)
- Solar eclipse: Sun at one node, Moon at the same (at new moon)

Today: Early Science - prehistory forward

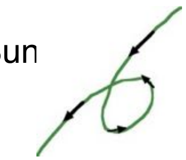
- Motions of the Planets:
  concluding the discovery of our solar system
- Early Science
  - prehistoric discoveries: visual observations - motivations

The Early Days...

- Prehistoric Discoveries
  - Motivation: Calendar = survival
    Cosmology = order = higher being

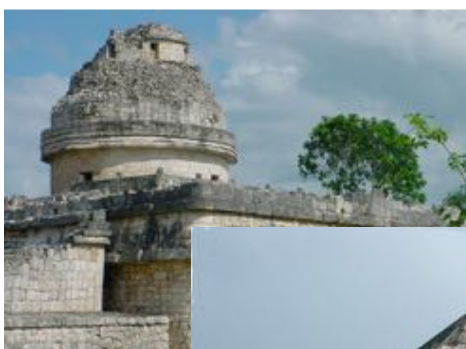


- Ecliptic + Zodiac — paths of planets and Sun
- Solstice — seasons
- Saros cycle — eclipses



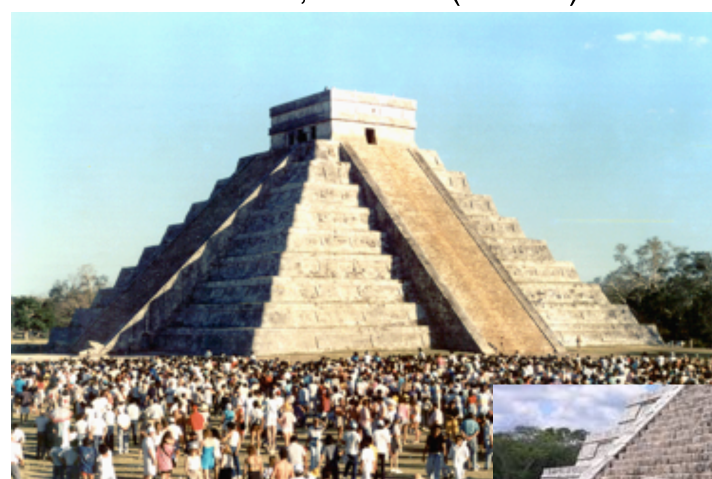
Ancient Calendars and Calculators

- Chichen Itza, Yucatan (Mexico): Annual "Calendar"



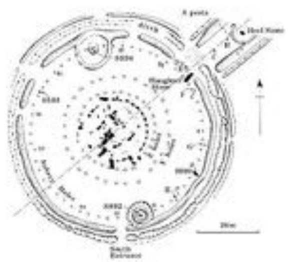
Ancient Calendars and Calculators

- Chichen Itza, Yucatan (Mexico): Annual "Calendar"



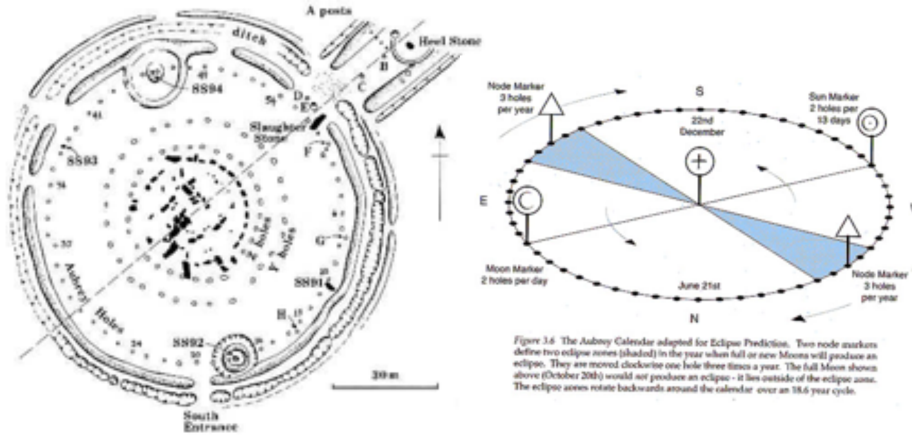
Ancient Calendars and Calculators

- Ecliptic / Equinox / Eclipse marker: Stonehenge



Ancient Calendars and Calculators

- Ecliptic / Equinox / Eclipse marker: Stonehenge



Towards a more complete Universe

- **Early Science: The (500 BCE - 150 CE)**
  - spherical Earth (Pythagoras)
  - **relative distances of Sun, Moon, Earth (Aristarchus, 300BCE)**
  - size of the Earth (Eratosthenes)

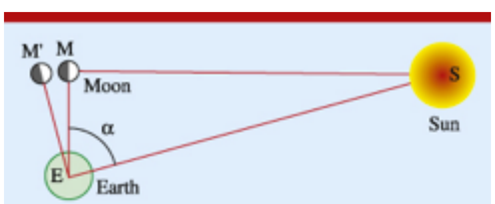
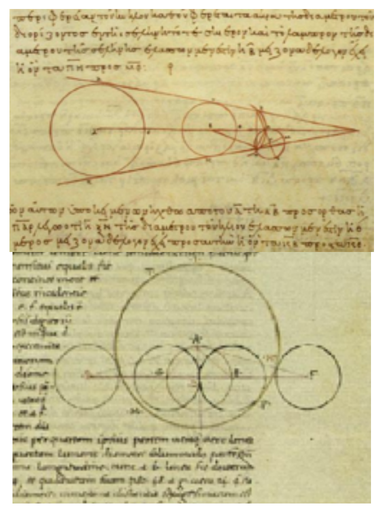


Figure 3. Relative position of the Moon in the quarter phase (this figures is not to scale).

- at precise moment of 1st/3rd quarter:
  - measure angle **α**
- this will be less than 90 degrees
- 90 - **α** is angular size of Moon's orbit as viewed from the Sun
- (Moon distance) / (Sun distance) = cos (**α**)
- Aristarchus measured 87 degrees; actual answer is 89.86 degrees.

Towards a more complete Universe

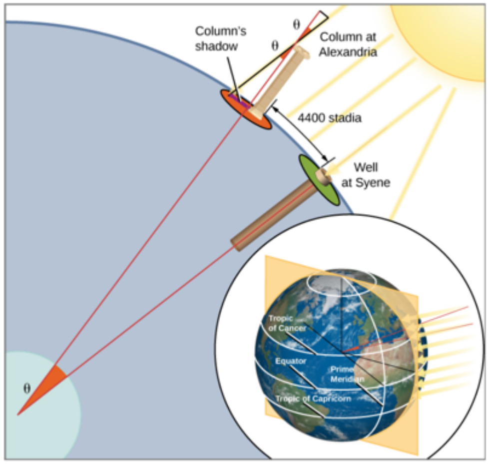
- **Early Science: The (500 BCE - 150 CE)**
  - spherical Earth (Pythagoras)
  - **relative dimensions of Sun, Moon, Earth (Aristarchus, 300BCE)**
  - size of the Earth (Eratosthenes)



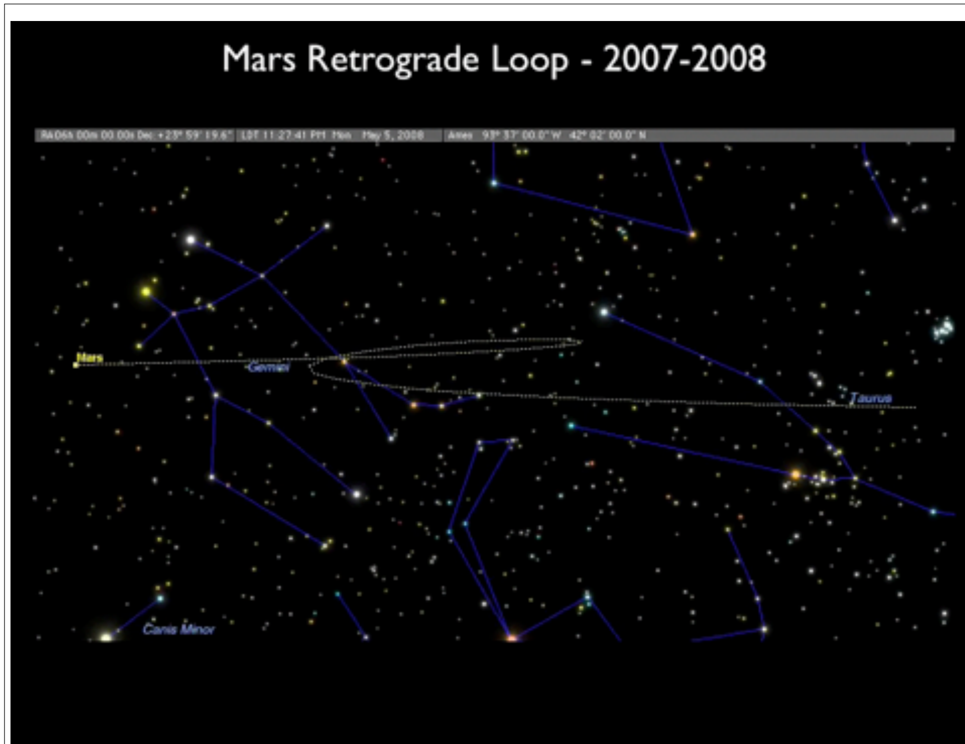
- with results from 1st/3rd quarter:
  - calculate size of Earth's shadow at moon's distance
  - measure how many moons fit
  - find relative size of Moon, Earth, Sun

Towards a more complete Universe

- **Early Science: The (500 BCE - 150 CE)**
  - spherical Earth (Pythagoras)
  - relative dimensions of Sun, Moon, Earth (Aristarchus, 300BCE)
  - **size of the Earth (Eratosthenes, 250 BCE)**

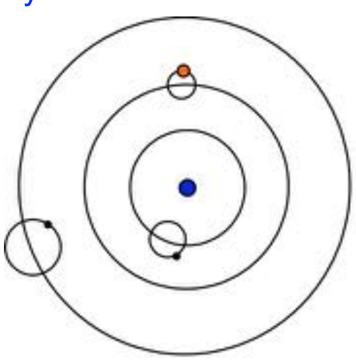


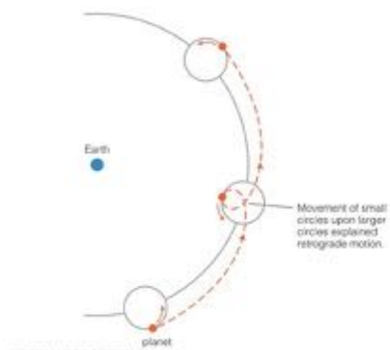
- noon Sun shines straight down well in Syene (near Aswan)
- Angle at Alexandria = 7 degrees
- Syene <-> Alexandria distance is 7/360 of the circumference of the Earth
- 360 x 800km / 7 = 41,000km
- true circumference is 39,800 km



Philosophy + <u>some</u> observation culminated in

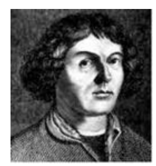
- Ptolemy's computational scheme for celestial motion
  - Earth -centered
  - Uniform, circular Motion
  - Epicycles





towards the modern view

- 1200s: Ptolemy's method off by several *degrees*
  - response: add more epicycles . . .

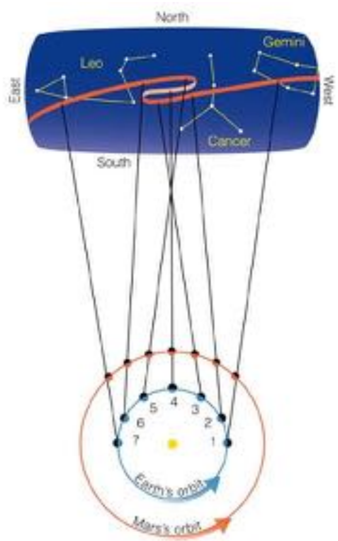


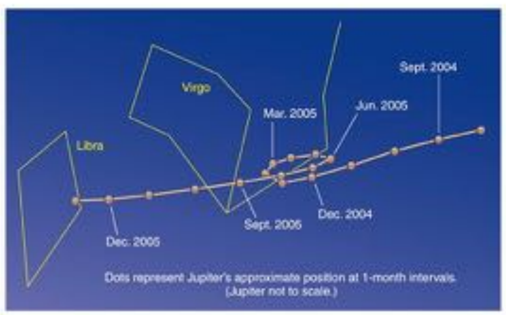
1543: Copernicus
- moved sun to center -----> Revolutionary!

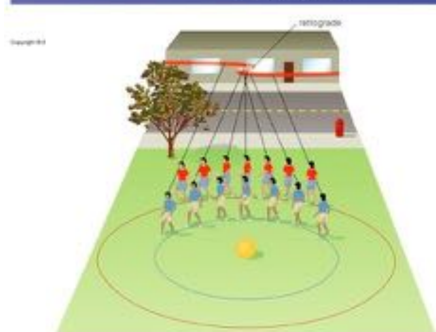
1580: Tycho Brahe
- precise positions of planets
- stars are fixed, therefore very distant
- sky is not immutable

- 1609: Galileo
  - astronomer: telescopic studies show Copernicus was right
  - physicist: experiments with Gravity

Looping Planets



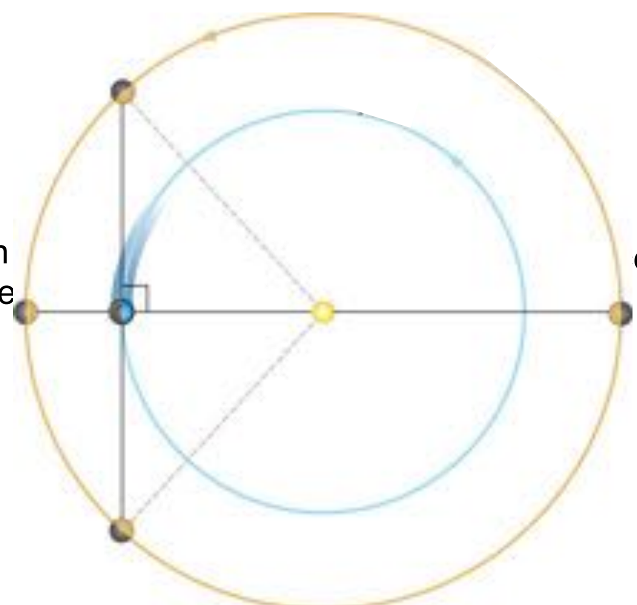




planetary alignments

(outer planet)

opposition (retrograde loop midpoint)



onjunction w/ Sun