

# Planetary Motions & The Correct Solar System Model

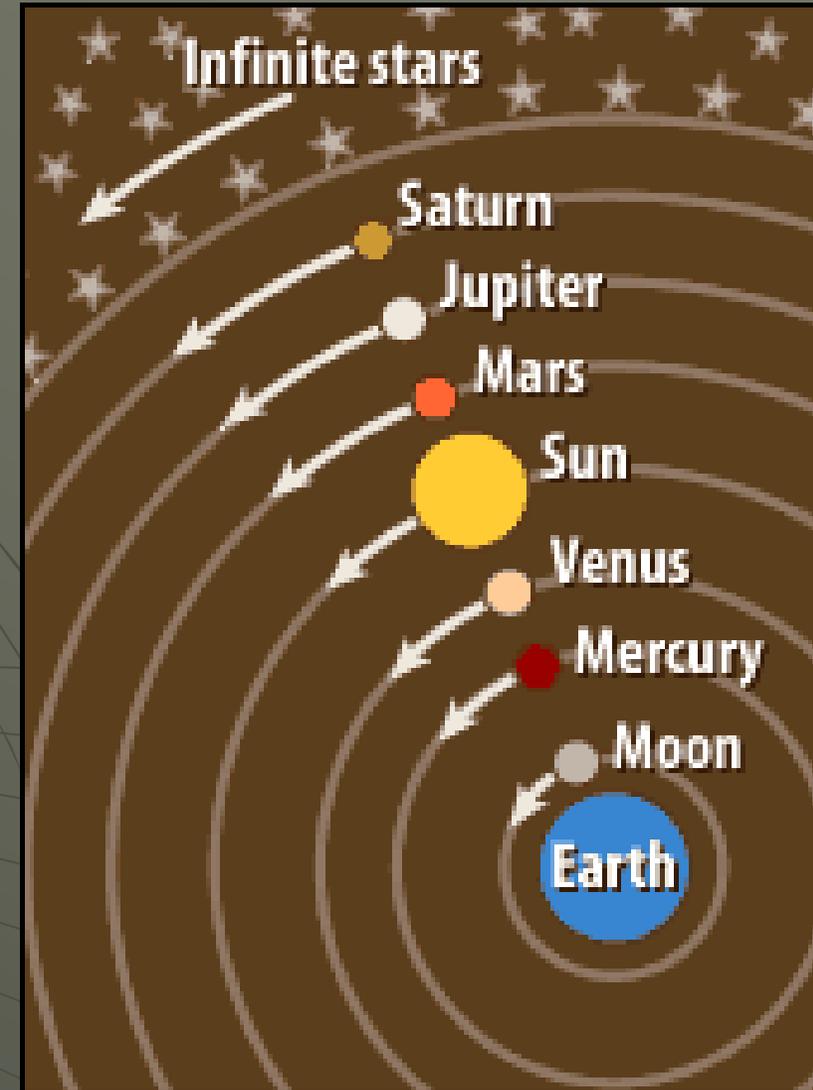
- ◆ Objectives:
  - Why do the planets move so weird???
  - How did people (only 400 years ago) really figure out the Sun is at the center of the solar system?

# Review: Daily Motion of the Stars

- ◆ Stars appear to rise in East, reach their highest position in southern sky (on meridian), set in western sky.  $E \rightarrow W$
- ◆ **Over the course of a day**, this is also the apparent motion of sun, moon, and planets.  $E \rightarrow W$
- ◆ **Over the course of several days**, when comparing them to the **background stars**, sun, moon, and superior planets drift  $W \rightarrow E$  (**ANIMATION**)
  - Sun moves eastward through  $\approx 1$  zodiac constellation per month ( $1^\circ$  per day)
  - The moon moves eastward about  $12^\circ$  per day

# Before Copernicus

- ◆ Model of the Solar System:
  1. **Geocentric:** The entire sky revolves around a stationary Earth.
    - ◆ The Sun, Moon, and planets are closer than the stars, explaining their rate of movement across the sky compared to the very far away background stars
    - ◆ [Animation](#)



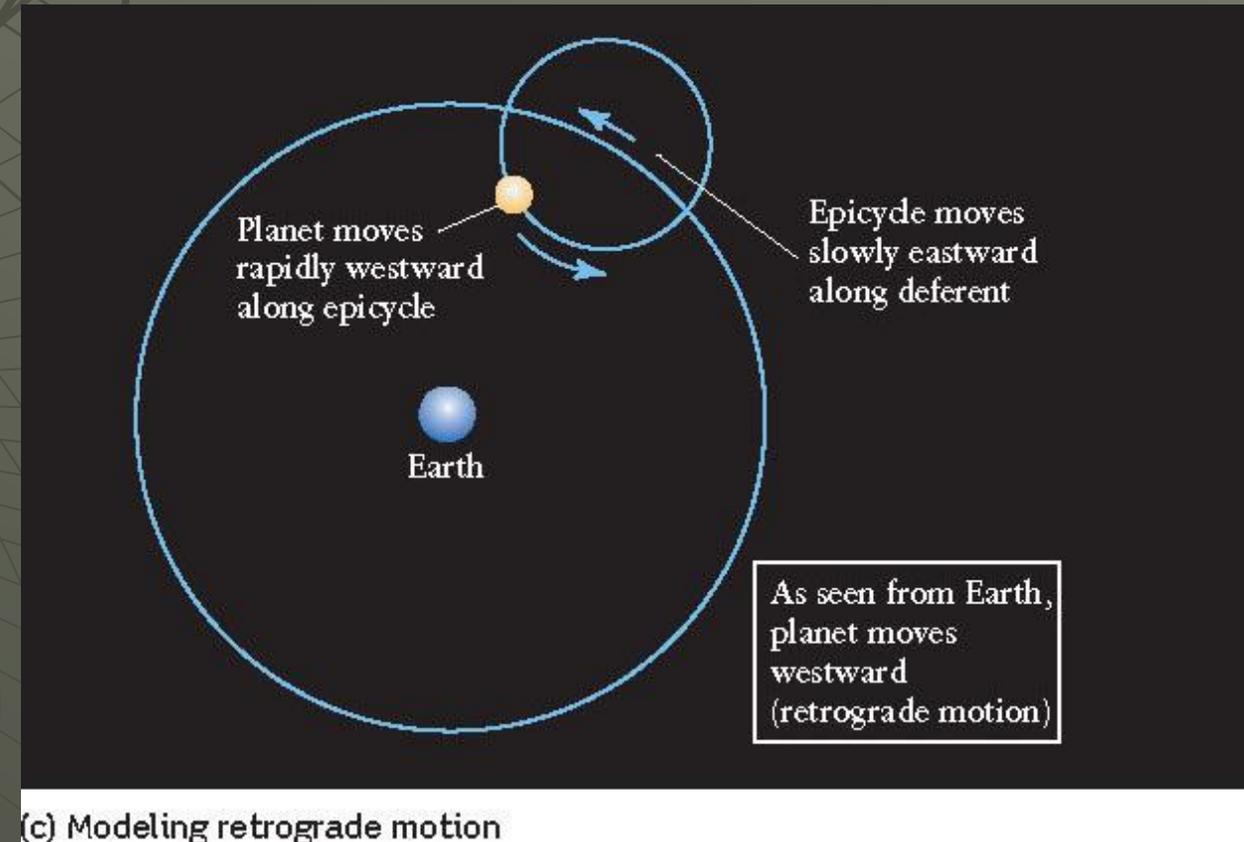
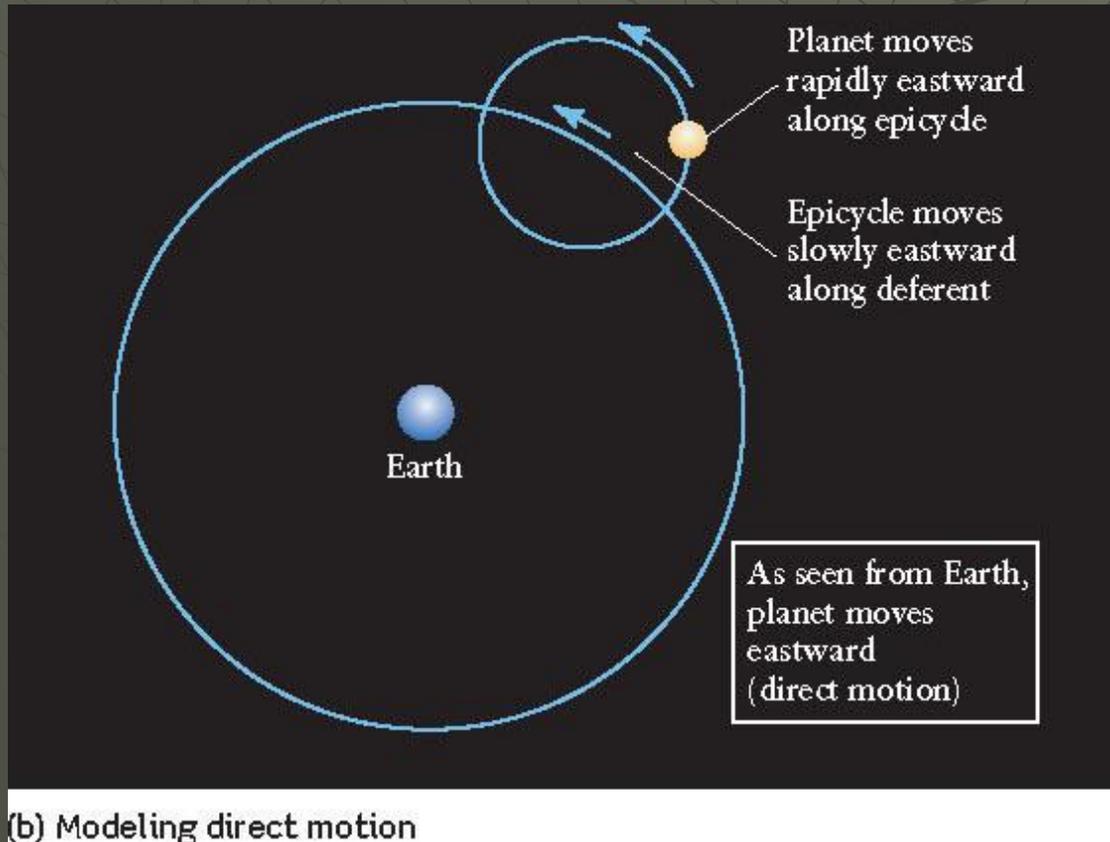
# Retrograde Motion

- ◆ [Animation](#)
- ◆ What the.....
  - **Retrograde Motion:** Apparent westward motion of a planet against the stars
    - ◆ **Westward**
  - **Aka:** a planet moving in the opposite direction it should be.

# We are not at the center of the Universe!

I don't think so...

- ◆ Ptolemy invented epicycles...
- ◆ Overly complicated, only explains retrograde motion (not well), and nothing else... **No patterns to the movement**

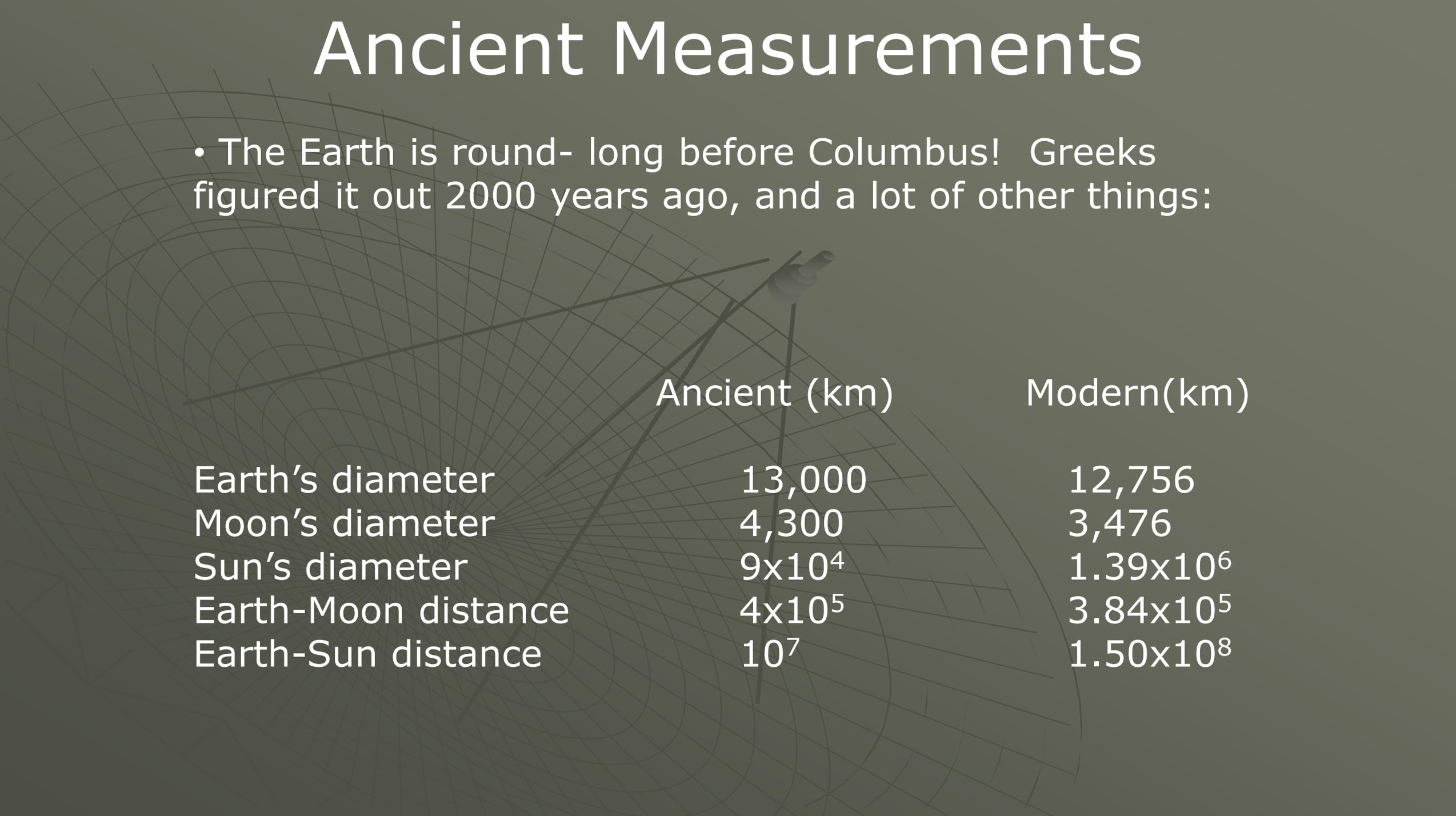


# Mercury and Venus

- ◆ [Skyviewcafe.com](http://Skyviewcafe.com); Start 10-28-2008; Transit mercury; Horizon to zenith
- ◆ Never appear further from sun (Mercury:  $28^\circ$  , Venus:  $48^\circ$  )
- ◆ If Mercury orbited Earth, then we should be able to see it away from the Sun.
- ◆ Geocentric: Mercury orbits in exactly the same period as the Sun...with epicycles!

# Ancient Measurements

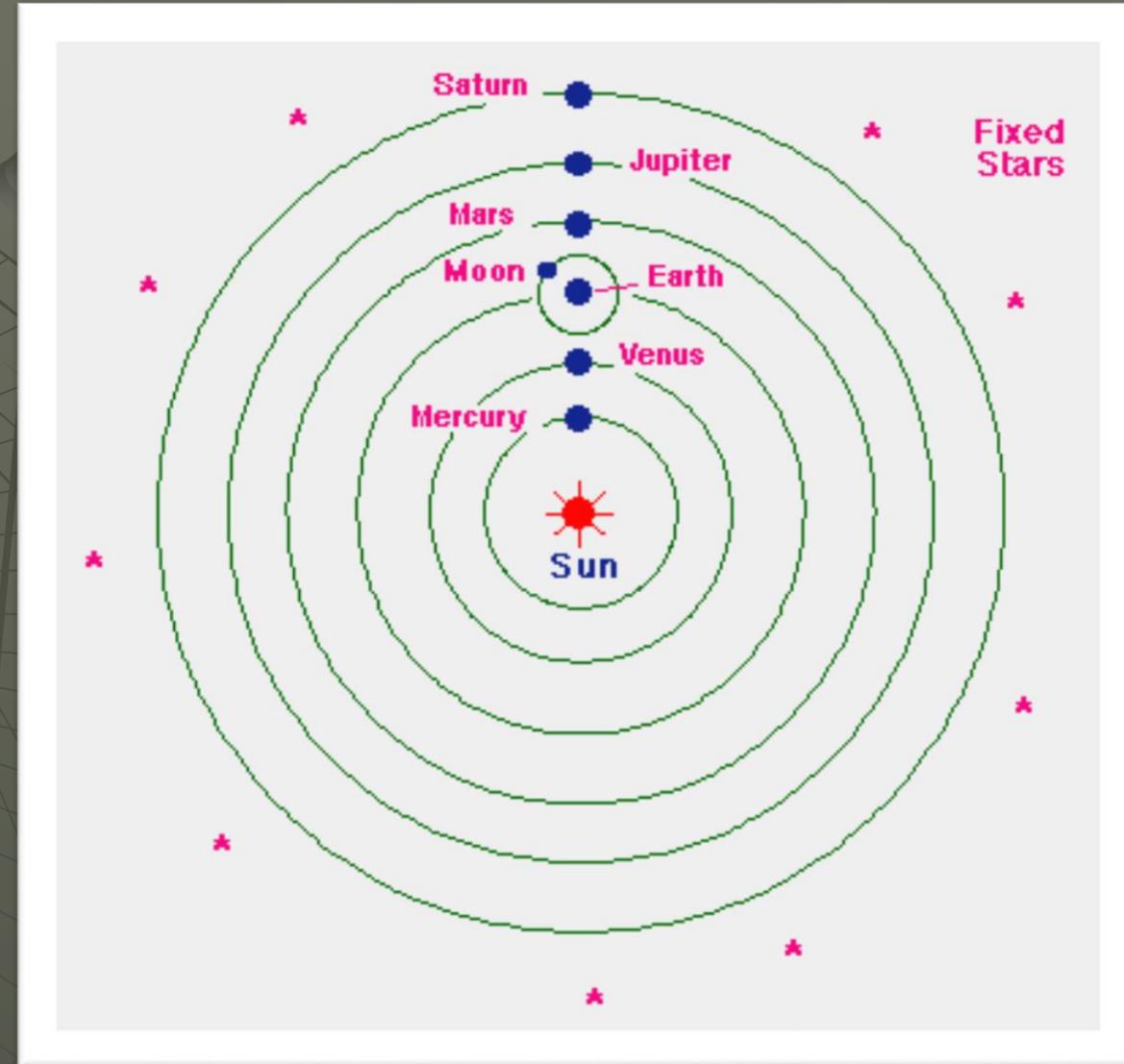
- The Earth is round- long before Columbus! Greeks figured it out 2000 years ago, and a lot of other things:



	Ancient (km)	Modern(km)
Earth's diameter	13,000	12,756
Moon's diameter	4,300	3,476
Sun's diameter	$9 \times 10^4$	$1.39 \times 10^6$
Earth-Moon distance	$4 \times 10^5$	$3.84 \times 10^5$
Earth-Sun distance	$10^7$	$1.50 \times 10^8$

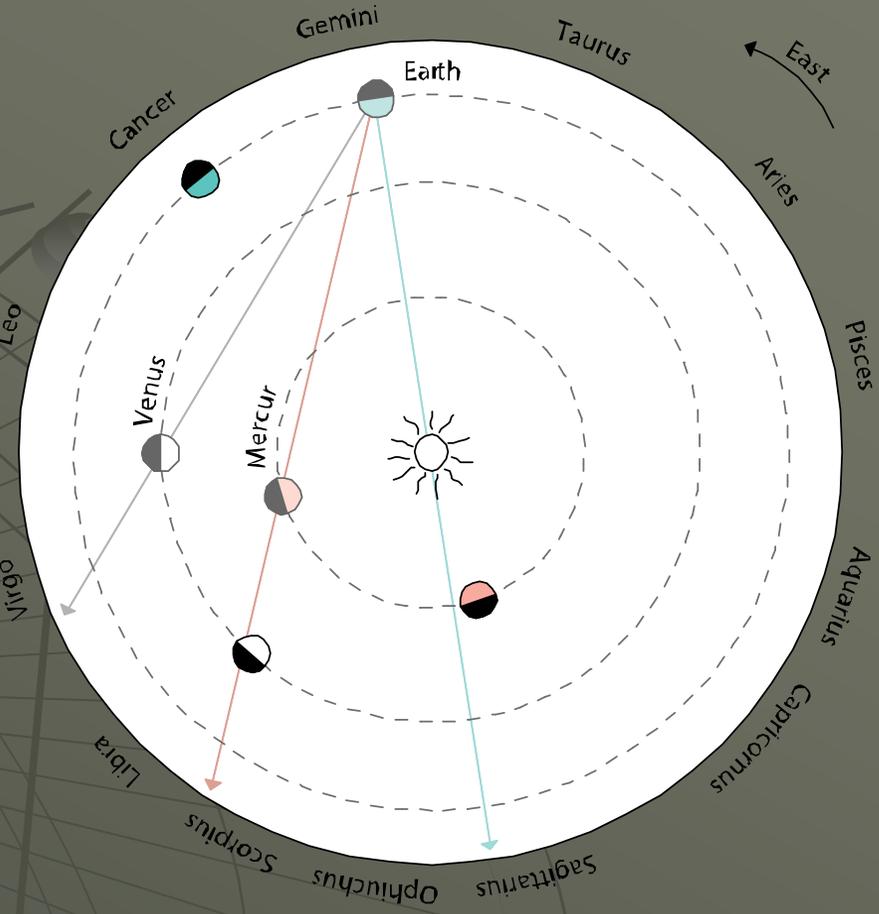
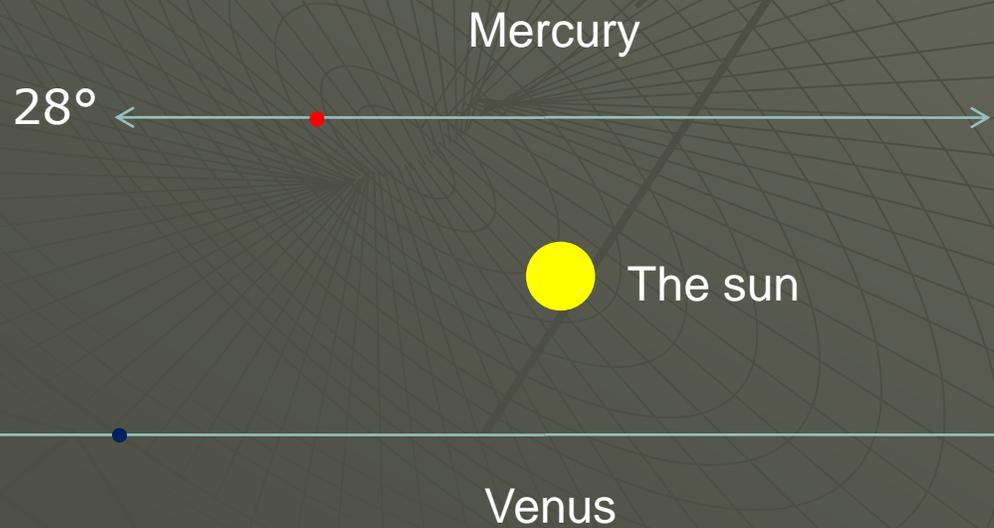
# Copernicus!

- ◆ Put the biggest object at the center...the Sun
- ◆ Solar system model:
  - 1. Heliocentric:** The planets revolve around the sun, and moons revolve around their respective planets.
- ◆ **Explains all motions!**
- ◆ And is much simpler

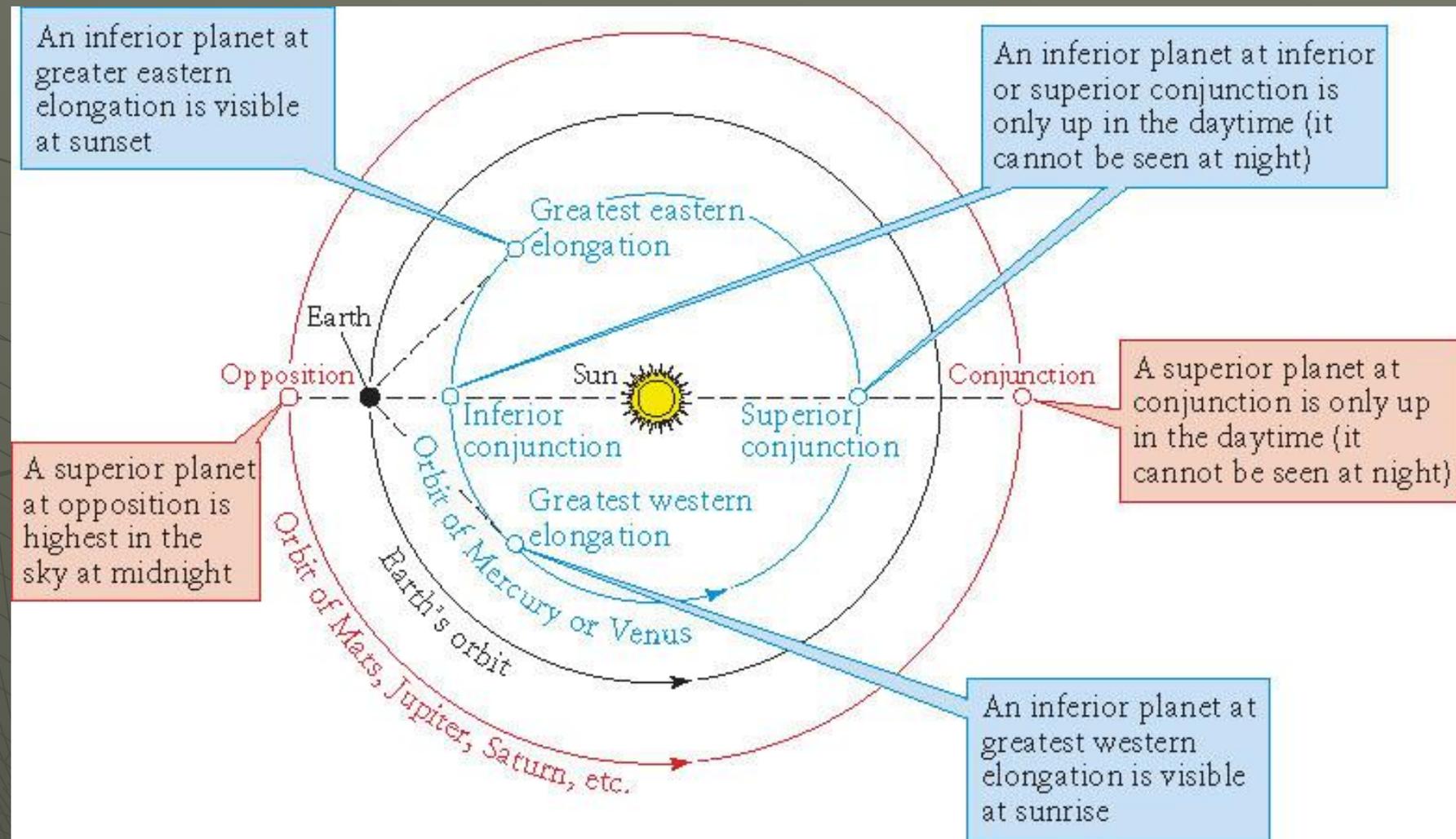


# Inferior Planets

- ◆ Mercury & Venus
- ◆ Explains why they never are more than



# Orbits



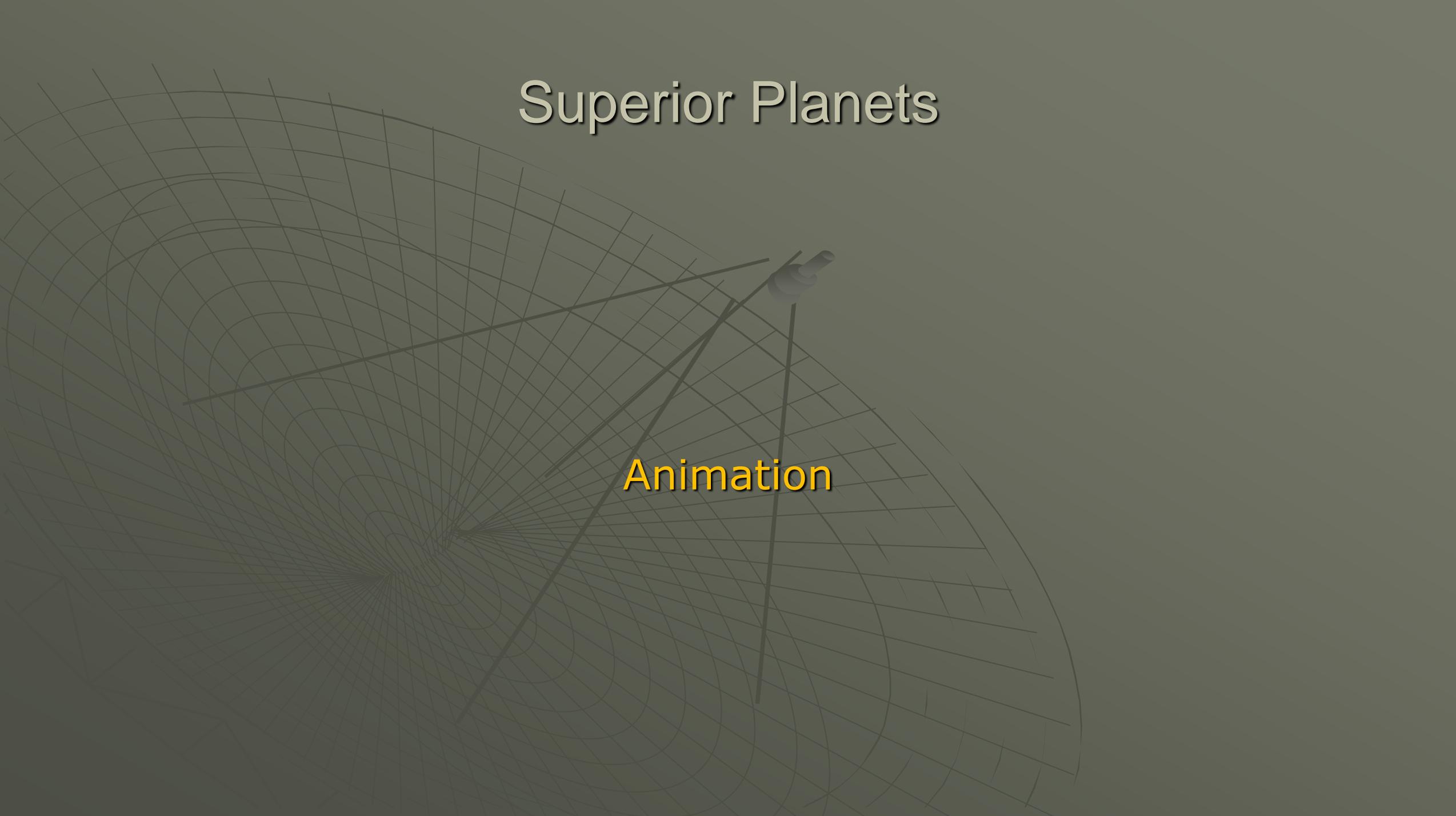
- ◆ **Conjunction:** planet on the Sun's side
- ◆ **Opposition:** opposite the Sun's side

# Superior Planets

- ◆ Mars, Jupiter, Saturn, Neptune
- ◆ Exhibit
  - **Prograde motion:** Motion of a planet in a direction similar to that of other bodies with its system.
    - ◆ **Eastward**
  - **Retrograde motion:** Apparent westward motion of a planet against the stars
    - ◆ **Westward**
  - **Aka:** a planet moving in the opposite direction it should be.

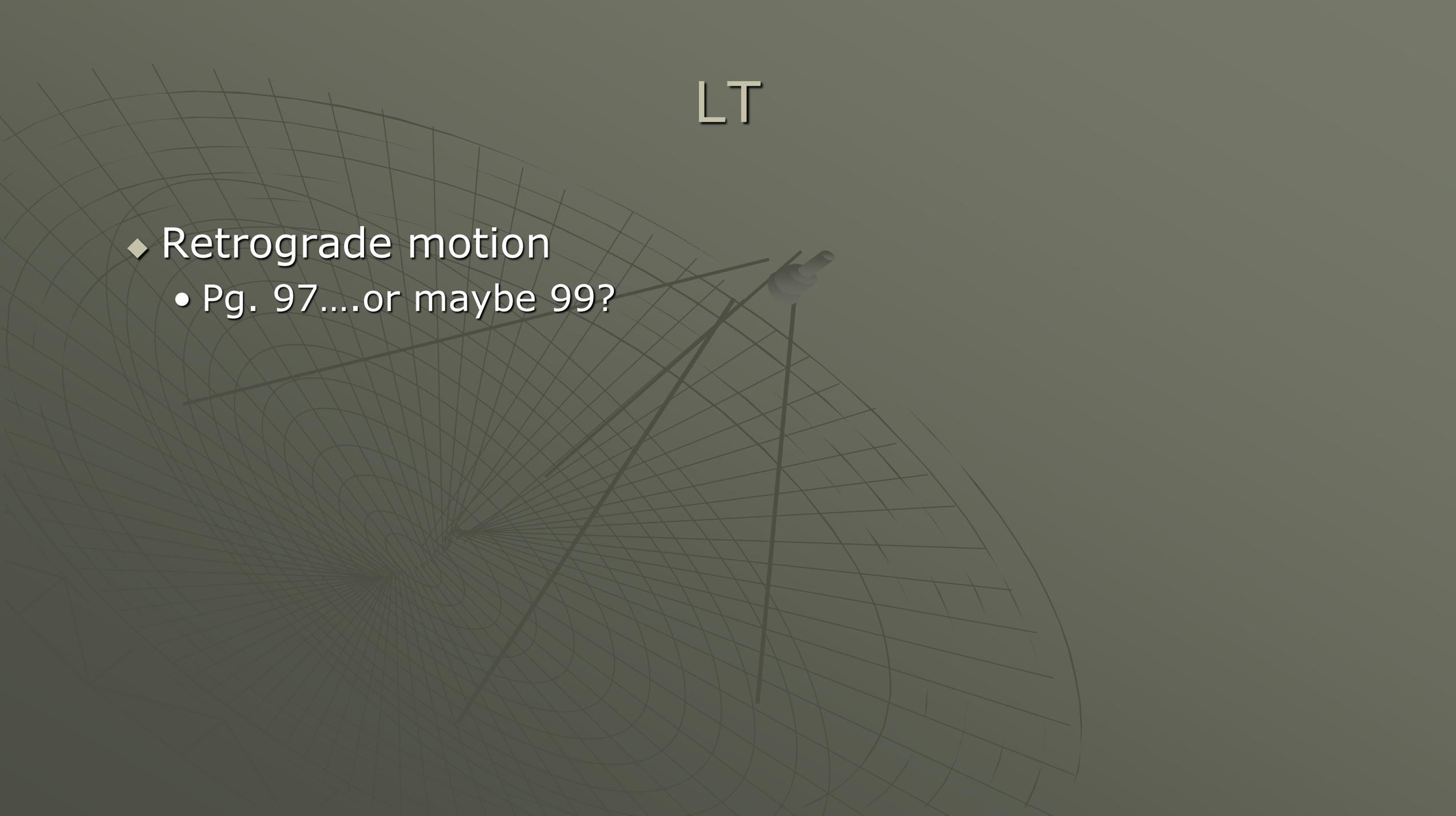
# Superior Planets

Animation



LT

- ◆ Retrograde motion
  - Pg. 97....or maybe 99?



# Burned at the stake

- ◆ Copernicus reluctant to publish his results and died before completing his work
- ◆ He did circulate his findings to a select few for peer review
- ◆ Giordano Bruno: Suggested that space was boundless and that the sun was and its planets were but one of any number of similar systems. There might even be other inhabited worlds with rational beings equal or possibly superior to ourselves. For such blasphemy, Bruno was tried before the Catholic church, condemned and burned at the stake in 1600

# Galileo

- ◆ Used a telescope for the first time and found:
  - Jupiter had moons which orbited it
  - Venus had phases like the moon

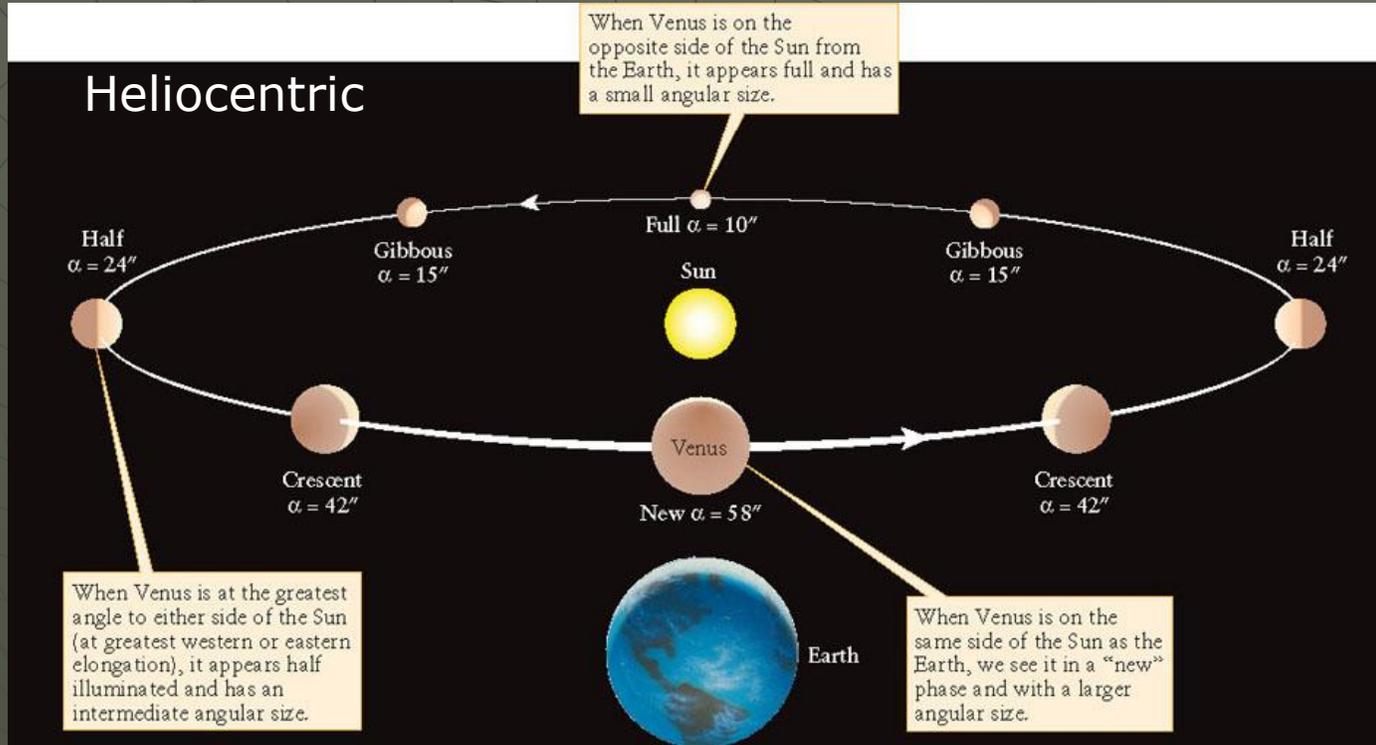
# Jupiter

- ◆ Behaved like a miniature Copernican solar system
- ◆ Not everything revolves around the Earth
- ◆ Galilean moons:
  - Io
  - Europa
  - Ganymede
  - Calisto
- ◆ I Only Eat Green Cats

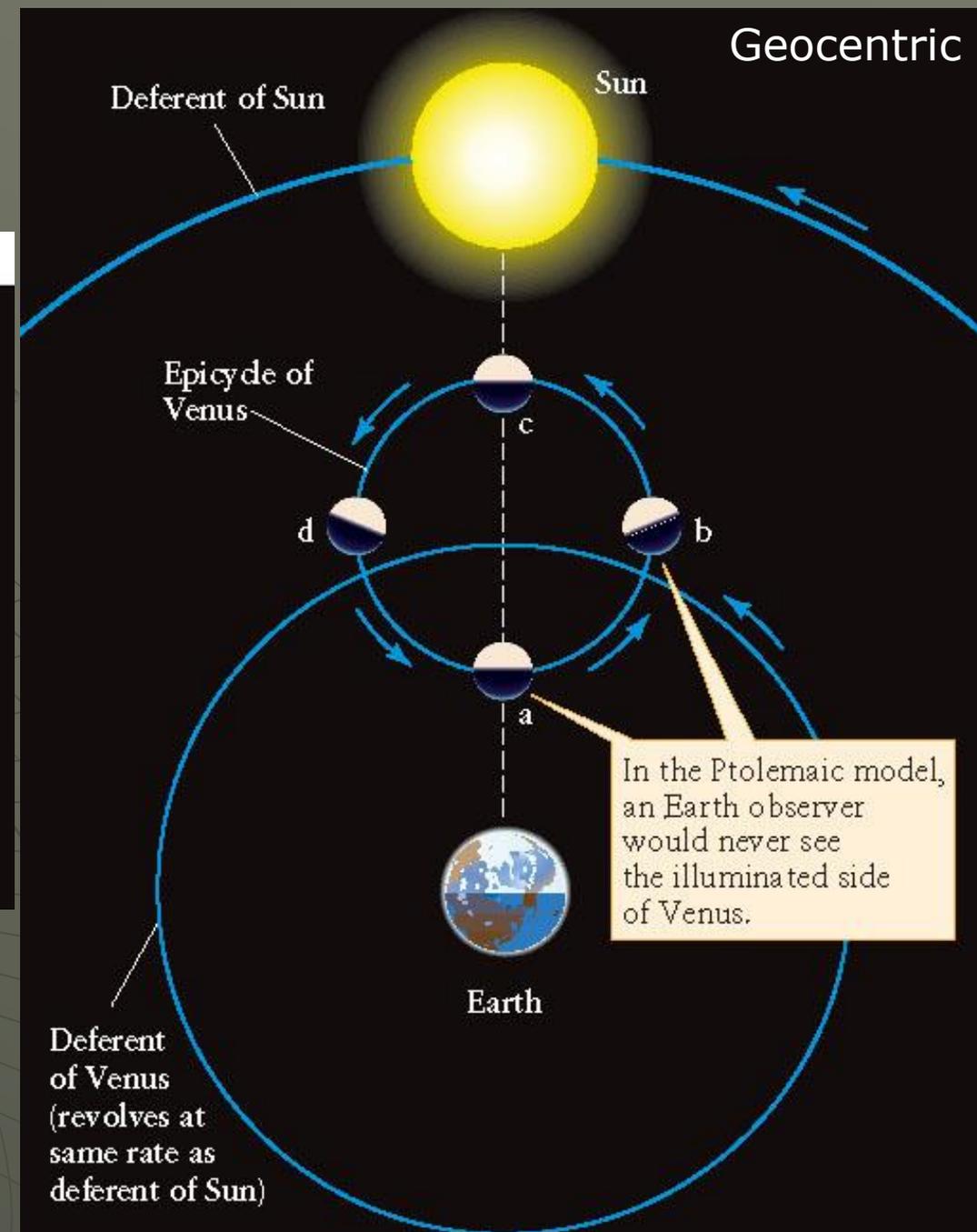
Observations Jupiter  
1610

2d. Febr. marc H. 12	○ **
30. marc	** ○ *
2. Febr.	○ ** *
3. marc	○ * *
3. Ho. 5.	* ○ *
7. marc	* ○ **
6. marc	** ○ *
8. marc H. 13.	* * * ○
10. marc.	* * * ○ *
11.	* * ○ *
12. H. 4 uesp.	* ○ *
13. marc	* ** ○ *
14. Casie.	* * * ○ *

# Phases of Venus



- In a geocentric model with epicycles, you would never see the illuminated side of Venus



# Burned at the stake

- ◆ Galileo: under threat of torture and execution, Galileo was forced to recant his evidence. He was allowed to live under house arrest for the rest of his life after publicly denouncing a heliocentric solar system.

# Activity

- ◆ Get into groups
- ◆ List evidence for and against Geocentric and Heliocentric models
- ◆ Based off of this evidence, make a conclusion about which model is correct...
- ◆ Class discussion
- ◆ This will be graded