Lecture: September 20, 2010

- What is the mass of the Earth?

Announcements:

Second homework is due today.

Next Observatory opportunity is tomorrow,
Tuesday, September 21

First exam will be next Monday in class
Will cover material up through Copernicus – not Kepler.

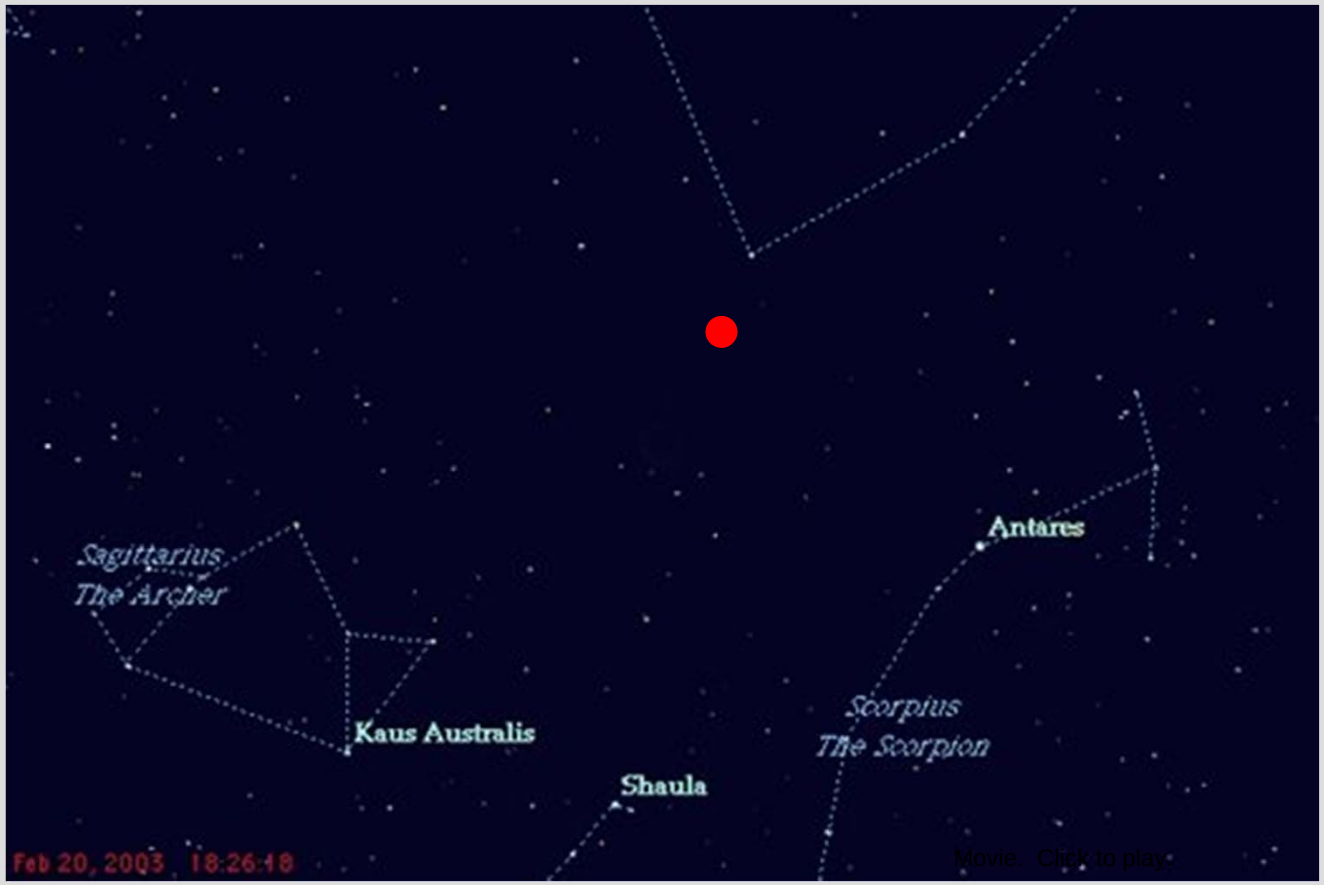
Claudius Ptolemy (AD 100-170)

Almagest

- star catalogue
- instruments
- motions & **model** of planets, Sun, Moon

His model fit the data, made accurate predictions, but was horribly contrived!

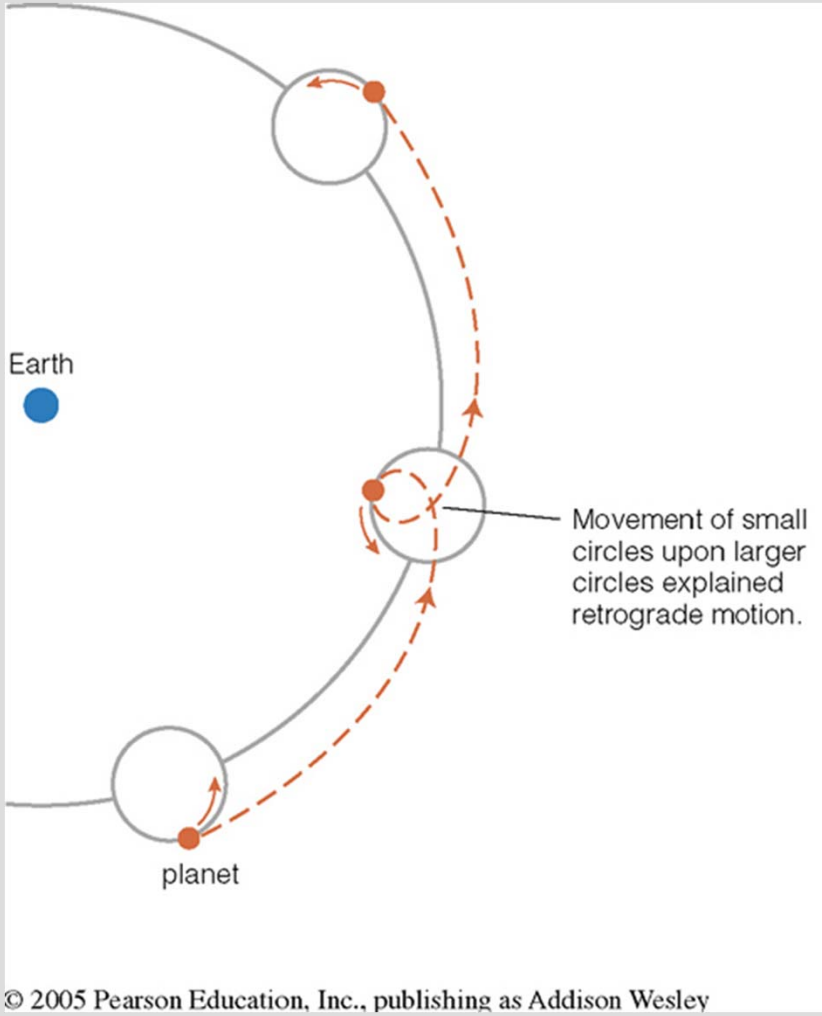
How does one explain *retrograde* motion?



Over a period of 10 weeks, Mars appears to stop, back up, then go forward again.

Ptolemy's Geocentric Model

- Earth is at center
- Sun orbits Earth
- Planets orbit on small circles whose centers orbit the Earth on larger circles
  - [the small circles are called **epicycles**]



Ptolemy's Geocentric Model

- This explained retrograde motion
- Inferior planet epicycles were fixed to the Earth-Sun line
- This explained why Mercury & Venus never strayed far from the Sun!
- Orbital order: Moon, Mercury, Venus, Sun, Mars, Jupiter, Saturn

3.4 The Copernican Revolution

Our goals for learning:

- Briefly describe the roles of Copernicus, Tycho, Kepler, and Galileo.
- What are Kepler's three laws of planetary motion?

Nicolaus Copernicus (1473-1543)

He thought Ptolemy's model was contrived

Yet he believed in circular motion

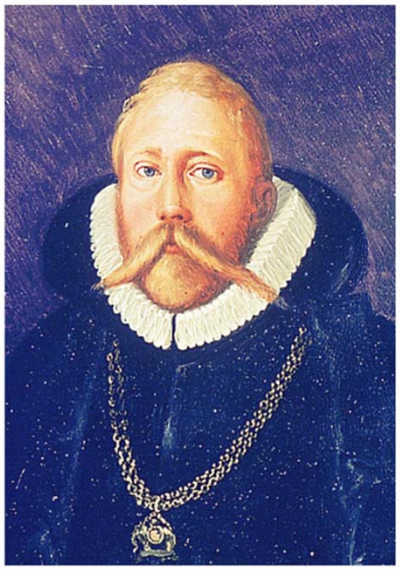
De Revolutionibus Orbium Coelestium

Copernicus' Heliocentric Model

- Sun is at center
- Earth orbits like any other planet
- Inferior planet orbits are smaller
- Retrograde motion occurs when we "lap" Mars & the other superior planets

Tycho Brahe (1546-1601)

- Greatest observer of his day
- Charted accurate positions of planets
- Observed a nova in 1572
- Heliocentric but Earth didn't move – no parallax

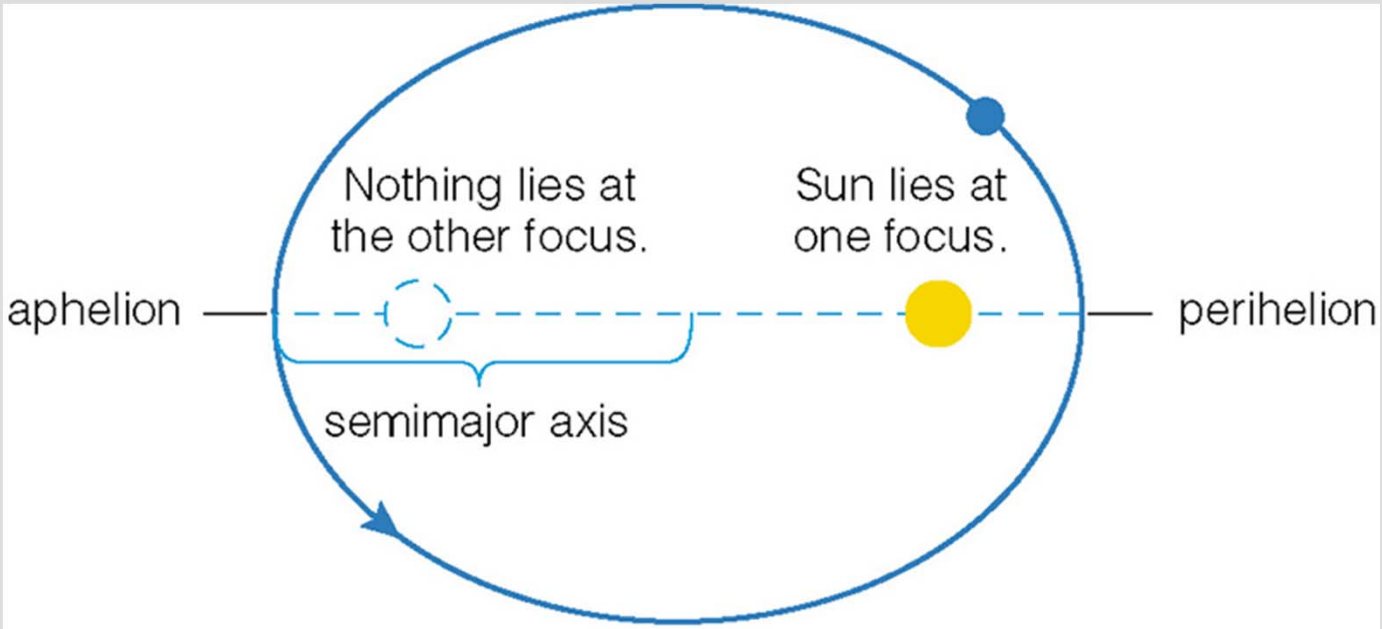


Johannes Kepler (1571-1630)

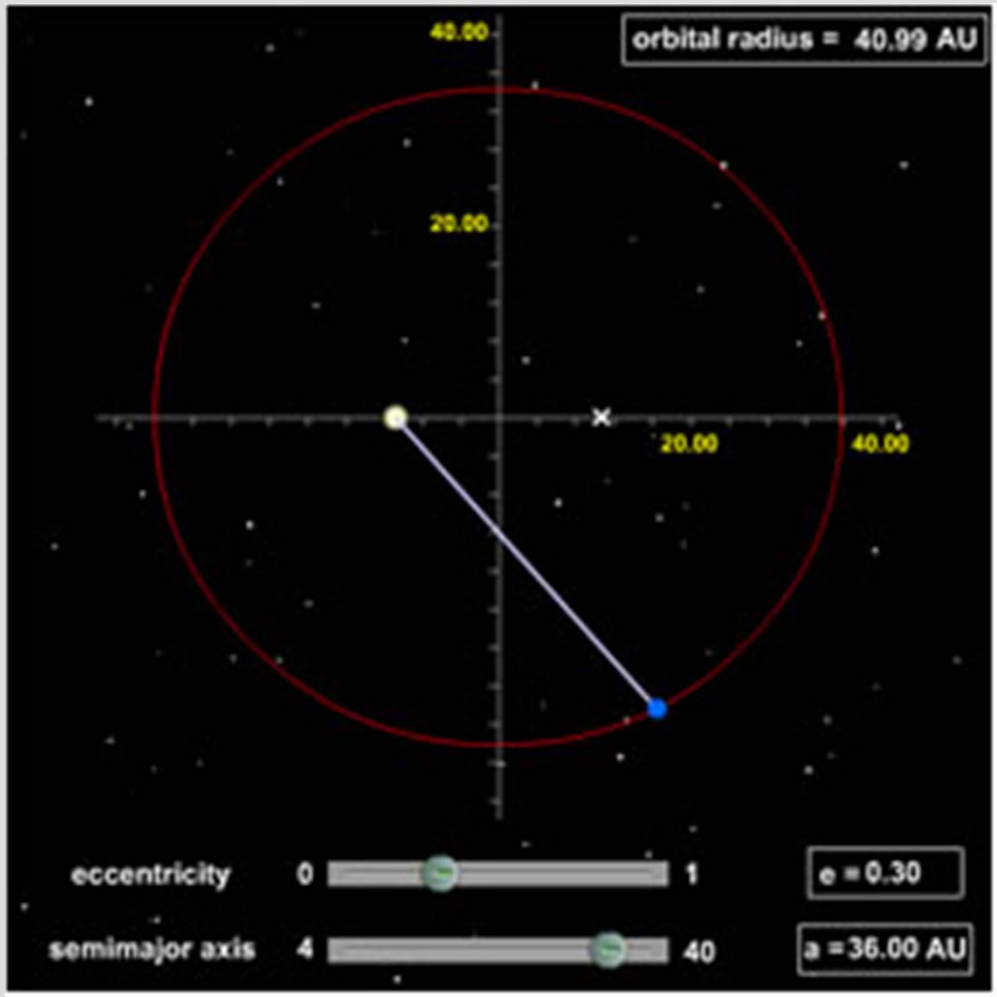
- Greatest theorist of his day
- a mystic
- there were no heavenly spheres
- *forces* made the planets move

Kepler's Laws

1 Each planet's orbit around the Sun is an ellipse, with the Sun at one focus.

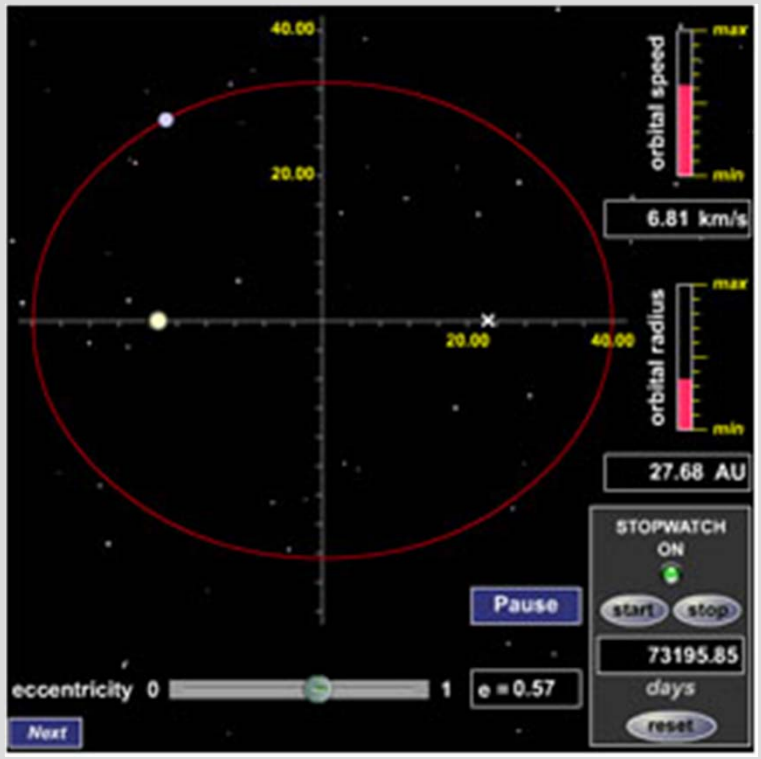


Eccentricity of an Ellipse



Kepler's Laws

2 A planet moves along its orbit with a speed that changes in such a way that a line from the planet to the Sun sweeps out equal areas in equal intervals of time.



Kepler's Laws

3 The ratio of the cube of a planet's average distance from the Sun to the square of its orbital period is the same for each planet.

$$a^3 / P^2 = 1$$

$$a^3 = P^2$$