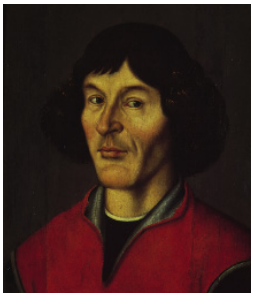
The Copernican Revolution
The Beginning of Science



Nicholas Copernicus
(1473-1543)

Tycho Brahe
(1546–1601)

Johannes Kepler
(1571–1630)

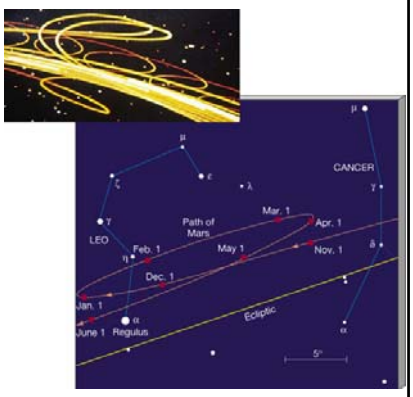
Columbus 1492

Jamestown 1607

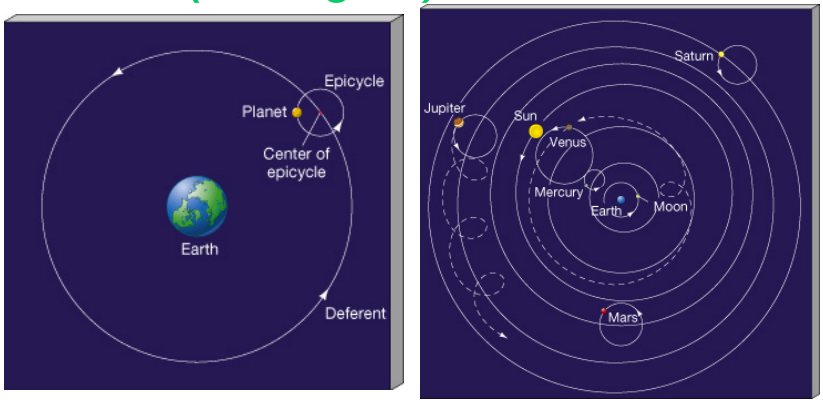
- Homework 1 is due today
  - You may turn in homework without penalty until the graded papers are returned.
  - Your lowest homework score will be dropped.
- Homework 2 is due Mon, 21 Sept.
  - Download it from angel or pick up a copy.
  - Missouri Club is Fri, 18 Sept.

Motion of Planets

- Greek astronomers
  - Explained the motion of the sun, moon, & stars successfully, as we did with plastic celestial sphere.
  - The motion of the planets was the outstanding question of astronomy.
    - Their explanation was complicated and wrong.
- What is the motion of the sun with respect to the stars? West to east about 1 degree per day.
- Motion of planets with respect to the stars.
  - Planets usually move west to east with respect to the stars. (Prograde)
  - Sometimes, they move backwards. (Retrograde)
  - When the earth is nearly between the sun and Mars, Mars moves backwards. When Venus is nearly between the sun and earth, Venus moves backwards.



Ptolemy's Model in *Syntaxis (Almagest)*, 140AD



- Earth is at the center. Earth is immobile.
- Planets move on an epicycle. Epicycle moves on a deferent.
- The deferents of Venus & Mercury are on the line between the sun and Earth.

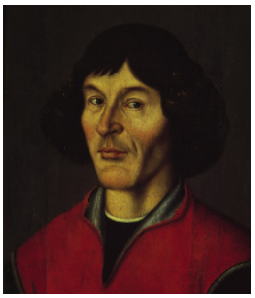
Ptolemy's model

1. How did Ptolemy explain the passing of a day?
   A. The earth spins around its axis once.
   B. The earth moves around the sun once.
   C. The sun spins around its axis once.
   D. The sun moves around the earth once.
2. How did Ptolemy explain retrograde motion of Mars?
   A. When Earth overtakes Mars, it appears to go backwards.
   B. Mars move in the backwards direction when the motion on the epicycle is opposite the motion of the epicycle on the deferent.
   C. Ptolemy could not explain retrograde motion.

- How did Ptolemy explain the fact that Venus is never seen far from the sun and never seen at midnight

Copernicus

- Aristotle: The natural motion of "base" objects is to come to rest. The natural motion of "heavenly" objects is to move in a circle at constant speed.
- Copernicus: *De Revolutionibus Orbium Coelestium*, 1543
  - The Earth is not at the center. The Earth is not immobile.
  - The sun is at the center. The planets orbit the sun.

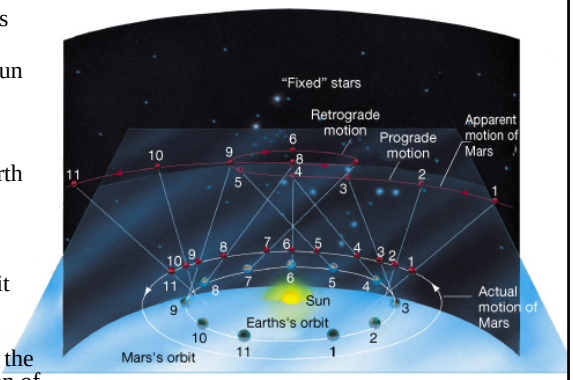


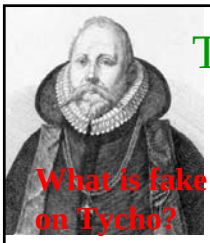
Nicholas Copernicus
(1473-1543)

How did Copernicus explain

1. How did Copernicus explain the night and day?
   A. The earth spins around its axis once.
   B. The earth moves around the sun once.
   C. The sun spins around its axis once.
   D. The sun moves around the earth once.
2. How did Copernicus explain retrograde motion of Mars?
   A. When Earth overtakes Mars, it appears to go backwards.
   B. Mars move in the backwards direction when the motion on the epicycle is opposite the motion of the epicycle on the deferent.
   C. Copernicus could not explain retrograde motion.

• Venus is never seen far from the sun. Never seen at midnight.



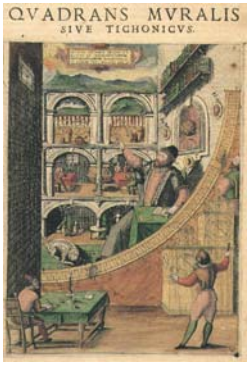


What is fake on Tycho?

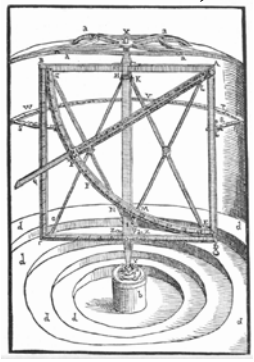
Tycho Brahe's Observations

•On Uraniborg, Tycho measured positions of the planets for 20 years
•Highly accurate & reliable
•Accuracy limited by human eye, not by instruments. Superseded only with telescopes.
•Tyco measured & compensated for instrument flexure, the biggest error.

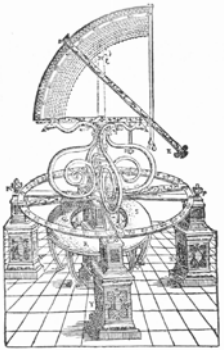
Uraniborg.



Great quadrant (1582)

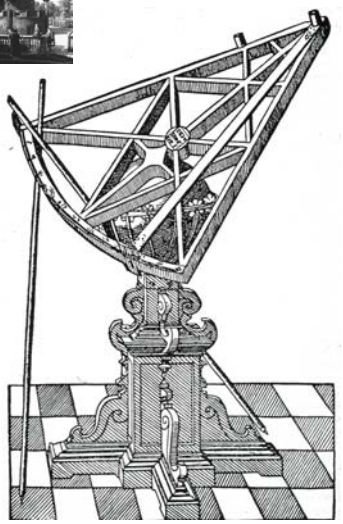


Revolving steel quadrant, 2 m radius (1588)



Brass azimuthal quadrant, 65 cm radius (ca 1576)

Sextants at Uraniborg



Great quadrant (1582)