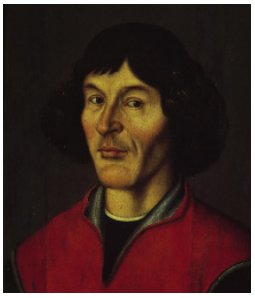
The Copernican Revolution
The Beginning of Science—13 Sept



Nicholas Copernicus
(1473-1543)

Tycho Brahe
(1546–1601)

Johannes Kepler
(1571–1630)

Columbus 1492

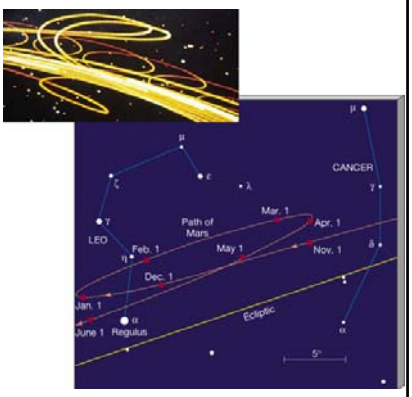
Jamestown 1607

Cosmology of Greek Astronomers

- 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.
- The earth and things on the earth are base objects. They do not move.
- The sun and moon are heavenly objects. Therefore they move in a circle at constant speed.

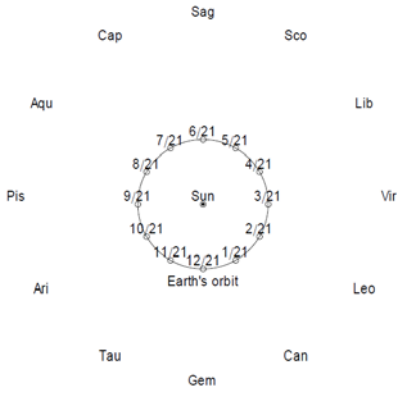
Motion of Planets

- Greek astronomers
  - Explained the motion of the sun, moon, & stars successfully.
  - 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.

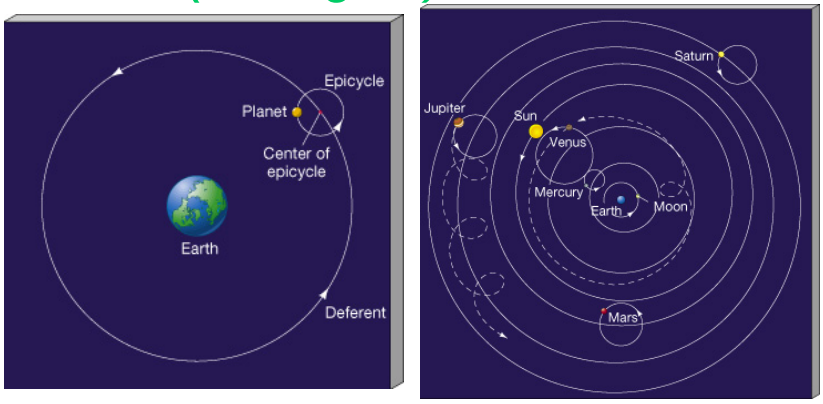


Motion of the sun with respect to the stars

- Q: Which constellation is west of Virgo? Hint: Draw the horizon. Stars set in the west.
  A. Leo
  B. Libra
- Between Sept and Oct, the sun moves from Virgo to Libra, which is ___ to ___.



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



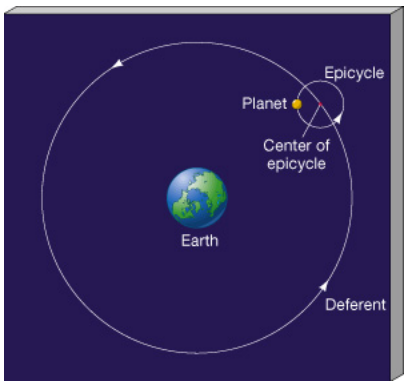
- Earth is at the center. Earth is immobile.
- Planets move on an epicycle. Epicycle moves on a deferent. Double motion allows retrograde motion.
- The deferents of Venus & Mercury are on the line between the sun and Earth.

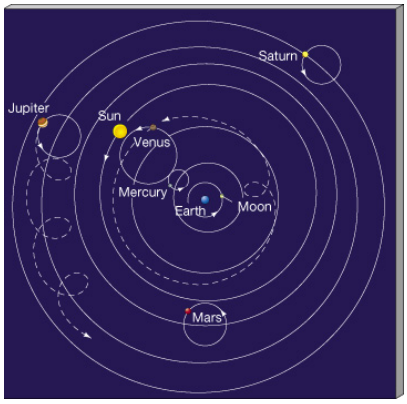
Ptolemy's model

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

Why Venus is never seen at midnight

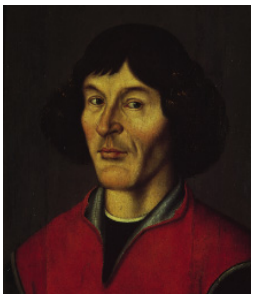




- The deferents of Venus & Mercury are on the line between the sun and Earth.

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 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.

- Venus is never seen far from the sun. Never seen at midnight. How did C explain this?