2.3 Heliocentric Models

PRE-LECTURE READING 2.3

- *Astronomy Today,* 8th Edition (Chaisson & McMillan)
- *Astronomy Today,* 7th Edition (Chaisson & McMillan)
- *Astronomy Today,* 6th Edition (Chaisson & McMillan)

VIDEO LECTURE

- Heliocentric Models[1] (19:00)

SUPPLEMENTARY NOTES

Basic Heliocentric Model

- See Basic Heliocentric Model[2].

Sun

- Center of the solar system

Earth

- Revolves (orbits) around the sun once every tropical year
- Rotates (spins) on axis once every sidereal day

Moon

- Revolves (orbits) around Earth once every sidereal month

Planets

- Only the five naked-eye planets—Mercury, Venus, Mars, Jupiter, and Saturn—were known at this time. Earth is also considered to be a planet in the heliocentric model.

[1] http://youtu.be/fJVEHI3uOtw
[2] http://en.wikipedia.org/wiki/Heliocentric_model

The planets have three properties that both geocentric and heliocentric models of the universe must explain:

- Unlike the sun and the moon, the planets do not move across the sky at a uniform rate. They "wander," which is what the word "planet" means. Most of the time, they move prograde, but periodically they slow down and stop, change course and move retrograde for a while, slow down and stop again, and then resume their prograde motion.
- The planets are brightest when in retrograde.
- Mercury and Venus are always within certain angles of the sun. This is not the case for the other planets, which can be opposite of the sun in the sky.

Aristarchus (310-230 BC)

- See Aristarchus[3].
- Proposed the basic heliocentric model, in which:
  - Retrograde motion is a natural consequence of observing planets not from a fixed, central location but from another, moving planet: As Earth passes another planet, the planet will appear to move retrograde, instead of prograde, across our sky.
  - Planets are brightest when they are closest to Earth, which occurs when Earth passes them, which is when they appear to be in retrograde.
  - Mercury and Venus are always within certain angles of the sun, and never opposite of the sun in the sky, simply because their orbits are interior to Earth's orbit.
- However:
  - Aristarchus could not explain why we do not feel Earth's rotation. (There is a force associated with this—the Coriolis force[4]—but it is small compared to the force of gravity and was not definitively measured until the late 18^{th} century.)
  - Aristarchus's model described the motions of the planets qualitatively, but was not very accurate quantitatively.
- Consequently, Aristarchus's model lost out to Aristotle's and later Ptolemy's models.

Nicolaus Copernicus (1473-1543)

- See Nicolaus Copernicus[5].
- Wrote *De Revolutionibus Orbium Coelestium*[6] (*On the Revolutions of the Celestial Spheres*), also known as *De Revolutionibus*, reviving the heliocentric model (1543)

[3] http://en.wikipedia.org/wiki/Aristarchus_of_Samos
[4] http://en.wikipedia.org/wiki/Coriolis_effect
[5] http://en.wikipedia.org/wiki/Copernicus
[6] http://en.wikipedia.org/wiki/De_Revolutionibus

- Shifted the center of each planet's orbit by a different amount in a different direction
- Added small epicycles to each planet's orbit
- Copernicus's model described the motions of the planets more accurately than Ptolemy's model (but still not perfectly).
- However, the addition of orbit offsets and epicycles negated the simplicity of the basic heliocentric model. See Occam's Razor[7].

EXERCISES

- Experiment with UNL's Epicycles Demo[8].
- Experiment with UNL's Retrograde Motion[9].
- Experiment with UNL's Planetary Configurations Simulator[10].

ASSIGNMENT 2

- Do Question 3.

[7] http://en.wikipedia.org/wiki/Occam's_razor
[8] http://astro.unl.edu/classaction/animations/renaissance/pathtracer.html
[9] http://astro.unl.edu/classaction/animations/renaissance/retrograde.html
[10] http://astro.unl.edu/classaction/animations/renaissance/configurationssimulator.html