The Scientific Revolution
with Dr. Ted Davis

Lesson 4.1: The New World Picture: The New World Picture of Copernicus

Outline:

The New World: The New World Picture of Copernicus

- The system of Copernicus and the system of Brahe
- Jan Glogowczyk, *Introduction compendiosum in tractatum sphere materialis magistri Joanis de Sacrobusto* (1513)
    - This image has the four elements of Aristotle (Earth, Water, Air, Fire).
    - This image also contains the spheres above the elements above the elements on the terrestrial world (ether).
    - This figure has both Christian elements (Jesus and the saved as well as classical Greek elements.
- The old world picture was geocentric; hierarchical, with two different worlds – celestial and terrestrial; and finite (bounded), with the stars all on a single sphere at the edge.
- The world was finite for the Greeks and for nearly everyone who had thought of it.
    - Finite – very large in human terms, about 20,000 times the radius of the earth (80 million miles) to the stellar sphere; so, the whole ball of the universe was about 160 million miles in diameter – we are just insignificant specks (Ptolemy).
    - This idea is very old.
- The new world picture of Copernicus was heliocentric; not hierarchical – no division between the heavens & the earth; but still finite (bounded), at least for Copernicus himself and many others. However, some Copernicans began to speculate about an infinite universe – the absence of parallax contributes to this. Nicolaus Copernicus, *De revolutionibus* (1543)
    - If the earth really moves around the sun, then the stars should appear to be in slightly different locations at different times of the year – annual parallax, but it was not observed until 1838. The absence of observable parallax was a very strong argument against the Copernican theory.
    - Copernicus himself needed to expand the size of the universe by at least 1,000 times in radius (the distance to the stars), to explain why parallax could not be seen. Yet he still thought the universe had an edge. Some went further, advancing an actually ***infinite*** universe, containing uncountable stars that were just like the Sun; to be visible at such vast distances, those stars had to be huge and very bright.

- If the universe is really that large, with countless other suns, some also wondered whether other planetary systems exist, containing living things – perhaps even intelligent life! This idea is called **the plurality of worlds**, after a book by the French mathematician Bernard le Bovier de Fontenelle, *Entretiens sur le pluralite des mondes* (1686).
- For example, the English minister John Wilkins, *The Discovery of a World in the Moone* (1638 and 1640). Wilkins claims that it is "probable there may be inhabitants in this other World, but of what kind there are is uncertain."

- The acceptance of the new world picture was not fast – it took more than 150 years. Before it could be fully accepted, new observational evidence and a new physics of motion was needed. Several key steps were involved in this change; for a fuller account, take the longer course.
  - **One key step** was taken by Tycho Brahe (1546-1601), the greatest pre-telescopic observer of the heavens. His observations led him to challenge the old idea that the heavens are "perfect" and immutable (without change).
  - This called into question Aristotle's notion that the heavens are changeless.
  - Tycho's observations of a new star ("nova") in 1572 showed that change takes place in the heavenly region, since the new star is beyond the Moon.
  - Tycho's observations of a comet in 1577 also showed that change takes place in the heavenly region – contrary to Aristotle. (Aristotle wrote about comets, meteors, and other atmospheric phenomena in his book, *On the meteors*, from which we get the word "meteorology.)
  - He had regarded comet as phenomena in the earth's upper atmosphere below the Moon, partly because they indicated change.
  - Tycho did not accept heliocentrism – he found no evidence of Earth's motion. Instead, he had his own version of a geocentric theory, to replace Ptolemy's – the earth at rest in the center, the sun going round the earth, and all other planets going round the sun.
  - **Another key step** was taken by Johannes Kepler (1571-1630). He rejected the view, universally accepted since antiquity, that planets must move in circles.
  - From very careful detailed study of observed positions of Mars for many years, Kepler concluded that the planets all move about the sun in ellipses, not circles – and with changing speeds depending on the distance from the Sun.
  - Kepler went on to write the first textbook of Copernican astronomy, *Epitomes astronomiae Copernicanae* (1618-21). His conclusions about planetary motion were essential for Newton's theory of universal gravitation.