The Scientific Revolution: Its Classical and Christian History

with Dr. Ted Davis

Lecture 6.1: Saving the *Phenomena*: Ancient Greek Astronomy & the Influence of Plato

Outline:

Saving the *Phenomena*: Ancient Greek Astronomy & the Influence of Plato

- The most challenging problem tackled by Greek astronomy: how can the motions of the planets (i.e. the *phenomena*) be explained (i.e. saved).
- Greek astronomers made two main assumptions:
    - **Geocentrism** – obvious from ordinary astronomical and physical observations and from common sense. (Yet there were notable exceptions: Pythagoreans, Aristarchus.)
        - Why **geocentric**? It really looks like the stars rotate around the earth! The idea of the earth spinning on its axis at many hundreds of km/hr seems unbelievable.
        - 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.
        - This is called **annual parallax**. Annual parallax exists, but it was not observed until 1838. The absence of observable parallax was a very strong argument against the motion of the Earth around the Sun.
        - A rare exception to the assumption of geocentrism was the Pythagoreans.
        - A leading Pythagorean, Philolaus of Croton (ca. 470-ca. 385 BC), held a cosmology in which the earth, the sun, the planets and the stars all go around a "central fire" that is never directly seen from the earth. This was not a heliocentric model, nor was it geocentric – and it never really took hold.
        - The Pythagoreans believe that the music of the spheres was audible, but we don't notice it.
        - Another exception to the assumption of geocentrism: Aristarchus of Samos (c. 310-230). "The Copernicus of antiquity" taught a heliocentric cosmology that contemporaries could not accept.
        - The book Aristarchus wrote about this idea is lost; we know about it only second-hand, from a passage in a later book by Archimedes, The Sand Reckoner. According to Archimedes ,

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Aristarchus realized that his hypothesis meant that the size of the universe must be enormously greater than we think, in order to explain why parallax cannot be seen – the stars are so far way that the parallax angle is just too small for us to detect.

- Because parallax was invisible, Aristarchus' heliocentric model was just too hard to accept. It also challenged prevailing Greek religious ideas about the perfection of the heavens – how could the lowly earth be part of the divine heavens? And, it contradicted Aristotle's ideas about motion on the earth.

- **Perfection of the heavens** – inferred from the constancy of celestial phenomena and from Greek theology. This mean that circles and spheres were to be used in explaining the heavens.
  - Thus with few exceptions, the Greeks assumed the Earth is at rest in the center, while the Moon, Sun, planets and stars rotate around us in "perfect" spheres and circles. According to tradition, Plato articulated (Plato's dictum) this picture of the world as follows:
    - **What circular motions, uniform and perfectly regular are to be admitted as hypotheses that it might be possible to save the appearance presented by the planets?** This quotation was attributed to Plato around 900 years later by Simplicius of Cilicia, in his commentary on Aristotle's *De caelo* ("On the Heavens").
    - **What circular motions uniform and perfectly regular**, are to be admitted as hypotheses so that it might be possible to save the appearances presented by the planets?
    - The wording of the question gave the rules for doing astronomy in the Greek tradition – the rules for making acceptable mathematical models of heavenly motion. Only circles (and spheres) can be used – and they must move (rotate) uniformly with constant speeds of rotation.
    - What circular motions uniform and perfectly regular, **are to be admitted as hypotheses** so that it might be possible to save the appearances presented by the planets?
    - "Hypotheses" in this context did not mean what it does today; it did not mean educated guesses that might turn out to be true. Rather, "hypotheses" were useful fictions – purely "hypothetical,' mathematical models. This attitude is called "instrumentalism," rather than "realism." If this seems a strange attitude for a scientist to hold, consider quantum mechanics.

        - What circular motions uniform and perfectly regular, are to be admitted as hypotheses **so that it might be possible to save the appearances presented by the planets.**
        - To "save the appearances," or to "save the phenomena" meant to give a theoretical explanation for what we see in the sky.
- The subsequent history of Greek astronomy is a series of attempts to account for planetary motion, using circles that rotate with constant speeds. This tradition was not broken until the early 1600s – when Kepler introduced ellipses.
    - This is how scientific tradition usually works: certain core ideas are retained and passed on to the next generation of scientists, who modify them and tweak them in response to new information or to improve explanations of what is already known.
    - These core ideas constitute what Thomas Kuhn called a "paradigm," a broad conceptual scheme that unifies diverse facts and experimental/observational practices into a clear picture that explains certain aspects of nature.

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