



The Scientific Revolution: Its Classical and Christian History with Dr. Ted Davis

Lecture 13: Tycho's Compromise

Outline:

Tycho's Compromise: An Alternative to Aristotle and Copernicus

- Tycho Brahe (1546-1601) was born into controversy, the result of a feud between his father & his uncle—the circumstances are not entirely clear.
 - The result: he grew up as the only child of his aunt & uncle (who was basically his step-father).
 - As a university student at Rostock, Tycho fought a duel with swords in which he lost part of his nose; this may have grown out of an argument related to Tycho's astrological prediction that the sultan of Turkey would die following a lunar eclipse in Oct 1586.
 - He is said later to have worn a nosepiece of silver & gold. When his body was exhumed in 1901, however, copper stains were found around his nose.
- Through royal patronage, in 1576 Tycho was made feudal lord of a whole island, which he called Hven, the island of Venus. (Today this is part of Sweden.) His noble status gave him substantial income, which he spent on his scientific work.
 - There he built a magnificent castle, Uraniborg, that functioned as an astronomical observatory and an alchemical laboratory.
 - Basically, like many scientists today, he ran a laboratory staffed by a team of researchers.
 - However, the high winds greatly interfered with observations from the castle, so he built a second observatory, Stjerneborg (castle of the stars), mostly underground to shield his instruments.
 - Simply put, Tycho was without any doubt the greatest observer of the heavens before the invention of the telescope. His observations were qualitatively superior to anything previously done— more accurate (closer to the truth) and more precise (smaller margins of error), perhaps even 10 times better.
 - Superbly made instruments were a crucial factor, and he was simply extraordinarily good at this. For example, this enormous (19-foot high) quadrant that Tycho designed for a friend but never used himself: it took 20 men one month to make it.



- Tycho's observations were also quantitatively superior—he published more observations of the heavens than all previous astronomers combined!
- The unprecedented precision of his observations was crucial to Kepler's discovery of the elliptical orbits of the planets.
 - Two of his most important observations, in terms of their consequences, took place in the 1570s—before he had built Uraniborg. First, a new star (nova stella) in 1572 that was visible for 2 years before vanishing from sight.
 - Then, a bright comet in 1577.
 - Taken together, these observations led Tycho to abandon important parts of the Aristotelian cosmology:
 - The unchanging heavens & solid celestial spheres.
- Tycho determined that the comet, like the new star, was beyond the sphere of the moon. Furthermore, it moved through the region of the planets, getting closer & farther from the earth—was it going through the spheres?
 - Tycho also admired the mathematics of Copernicus—though he never accepted the actual motion of the earth. In August 1563, while still a student, he had observed a conjunction of Jupiter & Saturn.
 - The standard astronomical tables, based on Ptolemy, missed the actual date for the conjunction by a whole month. New tables based on Copernicus missed it by only a few days. This led him to respect Copernicus' mathematics, though he later thought that his inability to find the diurnal parallax of Mars meant it couldn't be correct.
 - Furthermore, in his opinion the earth's motion was impossible—that was not an option for him. This convinced Tycho that a new theory of the heavens was needed, and he would provide it!
 - Why couldn't he accept the earth's motion? Motion on a moving earth should be very different than what we actually experience.
 - Cannonballs fired to the east shouldn't fly the same distance as when fired to the west.
 - If the earth moves, annual parallax should be visible—but Tycho couldn't find it! If the stars are really that far away, they must be enormous—hundreds of times larger than the Sun—incredible to Tycho.
 - To sum it up in Tycho's own words, the Copernican theory “expertly and completely circumvents all that is superfluous or discordant in the system of Ptolemy.... Yet it ascribes to the Earth—that hulking, lazy body, unfit for motion—a motion as quick as that of the aetherial torches [the stars].” —translation by Owen Gingerich, *The Eye of Heaven* (1993), p. 181.
 - As a Lutheran, Tycho also agreed with Luther that moving the Earth contradicted the Bible. In a letter to mathematician Christoph Rothmann, who cited Augustine to argue that the Bible was accommodated to the ordinary person's understanding and wasn't



intended to teach astronomy, Tycho defended a strongly literalistic view of biblical texts about the Sun and the Earth. He reproached Rothmann, saying, “far be it from us to decide that [the Scriptures] speak in so vulgar a way that they do not also seem to set out truths.”—translation by Ann Blair, “Tycho Brahe’s Critique of Copernicus and the Copernican System,” *Journal of the History of Ideas* 51 (1990): 355-377.

- A few years after Tycho’s death, Galileo saw several new things in the heavens with a telescope. He used his discoveries to argue that Copernicus was right, but many astronomers were not convinced. Why not?
 - Everything Galileo saw could be fully understood within the Tychonic system, without having to put the earth in motion—a great advantage at the time!
 - Because Tycho’s system did not move the earth, it found substantial support at that time—especially from Jesuit astronomers, such as Giovanni Battista Riccioli (1598-1671). In his *Almagestum novum* (1651), Riccioli agreed that Ptolemy’s system had to be discarded, but the weight of the evidence favored Riccioli’s own version of Tycho’s model over Copernicus!
- Tycho’s work raised two key questions:
 - One: If there are no ether spheres to carry the planets around the earth, then what could be the cause of planetary motion? Kepler & Newton would offer answers, in which the Sun is the cause of planetary motion.
 - Two: If the earth is really moving—something Tycho denied—then why can’t we tell from ordinary observations? Galileo & Newton would offer answers, in terms of inertia.