



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

Lecture 15: Kepler's New Astronomy: Celestial Physics and the Harmonies of the World

Outline:

Kepler's New Astronomy: Celestial Physics and the Harmonies of the World

- In 1600, Kepler moved to Prague, capitol of the Holy Roman Empire under Rudolf II, King of Hungary and Bohemia. Rudolph brought many artists, alchemists, and astronomers to his court.
 - What drew Kepler there was a job working as a calculator for Tycho Brahe, who had gone there himself because his children were not allowed to inherit in Denmark, since their mother was not of noble birth; the laws in Prague were different. Tycho wants Kepler to help him prove his own (Tychonian) cosmology, and to some extent Kepler acquiesces.
 - But, Kepler has his own ideas about getting access to Tycho's precious observations—to help him refine and prove his own version of the Copernican cosmology. Thus, the two men with opposing agendas finally meet, in February 1600.
 - “Tycho de Brahe and Johannes Keplerus, co-founders of the new universe, met face to face, silver nose to scabby cheek. Tycho was fifty-three, Kepler twenty-nine. Tycho was an aristocrat, Kepler a plebeian; Tycho a Croesus [wealthy man], Kepler a church mouse [meek man]; Tycho a Great Dane, Kepler a mangy mongrel.”
 - “They were opposites in every respect but one: the irritable, choleric disposition which they shared. The result was constant friction, flaring into heated quarrels, followed by halfhearted reconciliations.” (Arthur Koestler, *The Watershed*, p. 109)
 - In 1601, “Tycho has the good grace to die,” leaving Kepler to his own devices (quoting a lecture by Victor Thoren). He is buried in Týn Church.
 - Over the next few years, Kepler begs and steals observational data from Tycho's dull-witted son-in-law, who hasn't a clue what to do with it. The key data are those for the planet Mars— because (except for Mercury) it has the most eccentric (elliptical) orbit of the planets then known.



- After years of fruitless efforts to figure out the details of Mars' orbit, from observations made from a moving earth, Kepler finally realizes that Mars moves in an orbit that is not circular, nor compounded from circles. It's an ellipse!
- Kepler figured this out by comparing very carefully the tiny difference between an orbit that is perfectly circular vs one that is only slightly elliptical. Tycho's data is actually good enough to reveal the difference; without it, Kepler would never have discovered this. He is rapturous:
 - "I awoke as if from a sleep; a new light broke on me." "The roads that lead man to knowledge are as wondrous as that knowledge itself."
- Kepler goes on to state revolutionary conclusions. Today we customarily call them "Kepler's laws" of planetary motion, though he doesn't call them "laws."
 - Law one: Planets orbit the sun in elliptical paths. The sun is located not in the center, but at one of the two foci of the ellipse. Kepler was the first to use the Latin word "focus" (fireplace) a geometrical context.
 - Law two: Planets move around the sun with speeds that change. They go faster when they are closer to the sun, and slower when further away. A line from the planet to the sun traces out equal areas in equal times.
- The conclusion that planets move in ellipses, not figures derived from circles in combination, breaks with 2000 years of science.
- If there are no crystal spheres to carry the planets, as Tycho had shown, then what causes it?
 - Kepler offers a new mechanism to explain planetary motion. I wonder whether Kepler's daily encounter with the great clock might have led him to start thinking of the universe as a great clockwork mechanism.
 - "My aim is to show that the heavenly machine is not some kind of divine, live being, but a kind of clockwork ... insofar as nearly all the manifold motions are caused by a most simple, magnetic, and material force, just as the motions of the clock are caused by a simple weight." (Letter to Herwart von Hohenburg, Feb 1605)
 - Kepler offers a new mechanism to explain planetary motion. The Sun is the cause, using magnetism and its own rotation around an axis to sweep the planets around. The Sun is an unusual magnet, with a north pole all over its surface. The Earth is also a magnet, with a north and south pole.
 - Here, Kepler was partly inspired by William Gilbert, who had argued in *De magnete* (1600) that the earth is a huge magnet. (This is how Gilbert had accounted for the compass, among other things.)



- In Kepler's scheme, the magnetic push-pull of the Sun combines with the circular motion of the planet as it's swept around the Sun, like an oarsman steering a boat in the current.
- Kepler published these startling new claims in his greatest book, **Astronomia nova** (1609), which he dedicated to Rudolph II. It featured his work on the planet Mars, but described the whole solar system and provided a new celestial physics—a scientific theory for how the planets work, if there are no ether spheres to move them.
 - Kepler's emphasis on physical causes in astronomy, instead of just trying to find mathematical models that save the phenomena, was revolutionary. His former teacher, Michael Mästlin, did not agree with this approach:
 - "I think that one should leave physical causes out and should explain astronomical matters with the aid of astronomical [i.e., geometrical], not physical causes and hypotheses." –Mästlin to Kepler, 1616
 - In the preface, he added his views about interpreting the Bible, relative to a moving earth. He had originally intended to offer those views in his first book, *Mysterium cosmographicum* (1596), but the printer had balked after consulting theologians at Tübingen.
 - "Now the Holy Scriptures, too, when treating common things (concerning which it is not their purpose to instruct humanity), speak with humans in the human manner, in order to be understood by them. They make use of what is generally acknowledged, in order to weave in other things more lofty and divine."
 - "No wonder, then, if scripture also speaks in accordance with human perception when the truth of things is at odds with the senses, whether or not humans are aware of this. Who is unaware that the allusion in Psalm 19 is poetical? Here, under the image of the sun, are sung the spreading of the Gospel and even the sojourn of Christ the Lord in this world on our behalf, and in the singing the sun is said to emerge from the tabernacle of the horizon like a bridegroom from his marriage bed, exuberant as a strong man for the race."
 - Concerning the passage in Joshua 10, which Luther had used against Copernicus, Kepler added: "But thoughtless persons pay attention only to the verbal contradiction, 'the sun stood still' versus 'the earth stood still', not considering that this contradiction can only arise in an optical and astronomical context, and does not carry over into common usage."



- In other words: Scripture is written in common language, for the understanding of the ordinary person; it is not a science book. This is known as the principle of accommodation.
- **Principle of accommodation:** The Bible is inspired by God the Holy Spirit, who speaks to human authors. Wishing to convey spiritual truths to everyone, the Holy Spirit employed popular language, in order to be understood by all. Thus, the Bible is “accommodated” to the understanding of the ordinary person. It was not meant to be scientific & it would be a mistake to interpret it in a scientific way.
 - Like Copernicus, Kepler was exasperated by those who ignorantly criticized astronomical ideas that they did not understand: “Whoever is so weak that he cannot believe Copernicus without offending his piety, and who damns whatever philosophical opinions he pleases, I advise him to mind his own business and to stay at home and fertilize his own garden, and when he turns his eyes toward the visible heavens (the only way he sees them), let him pour forth praise and gratitude to God the Creator. Let him assure himself that he is serving God no less than the astronomer to whom God has granted the privilege of seeing more clearly with the eyes of the mind.”
- Kepler believed that his greatest discovery was that of the harmonies of the world, explained in his book, **Harmonices mundi** (1619). Dedicated to King James I of England, he was responding to ideas of the Englishman, Robert Fludd.
 - Kepler’s *Harmonies* gives yet another answer to the question, why do the planets move around the Sun in elliptical orbits with changing speeds? Because they make music as they go, with their notes determined by their speeds. The music is mathematical and mental, not audible; but, God is a mathematician, so God “hears” it.
 - The earth, wracked by constant warfare, sings: “mi-sery, fa-mine, misery, fa-mine.” Through mathematics, however, we could learn to read God’s message of harmony and live in harmony with one another.
 - “Accordingly the movements of the heavens are nothing except a certain everlasting polyphony (intelligible, not audible) with dissonant tunings, like certain syncopations or cadences (wherewith men imitate these natural dissonances), which tends towards fixed and prescribed clauses—the single clauses having six terms (like voices) — and which marks out and distinguishes the immensity of time with those notes. Hence it is no longer a surprise that man, the ape of his Creator, should finally have discovered the art of singing polyphonically, which



was unknown to the ancients, namely in order that he might play the everlastingness of all created time in some short part of an hour by means of an artistic concord of many voices and that he might to some extent taste the satisfaction of God the Workman with His own works, in that very sweet sense of delight elicited from this music which imitates God."

- "Eighteen months ago, the first light of dawn hit me; three months ago, the light of morning; and then, only a few days ago, the complete light of the sun has revealed this remarkable spectacle. Now, nothing holds me back. Indeed, I live in a secret frenzy. I sneer at mortals and defy them by the following public proclamation: I have pillaged the golden bowls of Egypt, to decorate a holy tabernacle for my God, far from the lands of the Egyptians. If you will forgive me, then I am happy. If you are angry with me, I will survive it. Well then, I will throw the dice; I will write a book, if not for the present time, then for posterity. To me, they are one and the same. If the book must wait a thousand years to find its readers, so what? God has waited six thousand years to find a true witness.