The Copernican Revolution

For Thomas Kuhn, the transition from the geocentric to the heliocentric universe was a classic example of a scientific revolution. In this lecture, I shall explore the criteria by which the revolutionary nature of the change in world-view between the time of Copernicus and Galileo might be judged. Are we to see Copernicus as the ‘timid canon’ portrayed by Arthur Koestler in his widely read book The Sleepwalkers? Or was he someone whose intentions were far more radical than he dared to present them in the De revolutionibus orbium celestium? And what of Galileo? An insensitive opportunist in search of personal aggrandisement? Or the ‘martyr’ of science, as commonly portrayed in nineteenth-century sources? My core argument will be that the truly revolutionary implications of the heliocentric universe only became apparent with the much later assimilation of the Copernican model to the far more daring vision of an infinite universe that tended to reduce the human race to insignificance.

Basic reading:

The basic reading for this week is in:

John Henry, *The Scientific Revolution and the origins of Modern Science* (Basingstoke, 2002), chapter 3; Henry’s book can be recommended as a reasonably priced and accessible work to accompany the lectures on the sixteenth and seventeenth centuries

Thomas S. Kuhn, *The Structure of Scientific Revolutions* (first published in 1962, but reprinted frequently since; latest paperback edition at £9.50), especially chapters 7 and 10, but you really need to read the whole book in order to understand the thrust of Kuhn’s argument

Other reading:

Marie Boas, *The Scientific Renaissance 1450–1630* (1962), chapters 4 and 11; still a clear, reliable introduction after more than forty years


Peter Dear, *Revolutionizing the Sciences. European Knowledge and its Ambitions, 1500-1700* (Basingstoke, 2001); a rather dispersed treatment, mainly in chapters 2 and 6

Arthur Koestler, *The Sleepwalkers. A History of Man’s Changing Vision of the Universe* (London, 1959); a full but very accessible account of perceptions of the universe from Copernicus to Galileo, to be read with caution

Alexandre Koyré, *From the Closed World to the Infinite Universe* (Baltimore, Maryland, 1957), chapter 2 and as much else as you can manage (in a far from elementary treatment)

Thomas S. Kuhn, *The Copernican Revolution. Planetary Astronomy in the Development of Western Thought* (Cambridge, Mass., 1957); a detailed treatment

Jerome J. Langford, *Galileo, Science, and the Church* (Ann Arbor, Michigan, 1966); a detailed account of the Galileo affair, written from a well-informed Catholic perspective
Suggested essay titles

- How fully does Copernicus conform to Thomas Kuhn’s representation of a scientific ‘revolutionary’?
- Are there any grounds for believing that Galileo brought his troubles on his own head?
- ‘The real revolution in early modern cosmology was not the transition from the geocentric to the heliocentric view of the heavens but the extension of that transition to embrace the concept of the infinite universe’. Do you agree?

Peter Apian’s representation of the geocentric universe, from Apian, *Cosmographia* (Ingolstadt, 1529)
Notes

The medieval world-view A geocentric and anthropocentric universe replete with meaning. In this universe humanity mattered, but the message that nature communicated was above all of our fallen state: our position in the geocentric universe placed us in the most corrupt, degraded position.

The challenge to Ptolemaic astronomy
The increased demands of navigation, astrology, calendar reform, etc., placed pressure on the old world-view. To the Renaissance astronomers (e.g. Regiomontanus, Peurbach) who reread Ptolemy through humanist eyes, expecting to find Ptolemy’s original predictions more accurate than those that contemporaries made from the corrupted texts then available, it came as a surprise to discover that the opposite was the case. By the first half of the 16C, the case for reform was overwhelming, and Copernicus has to be seen as one of a number of astronomers who were responding to the challenge.

Right: The universe portrayed by Thomas Digges in his A Perfit Description of the Celestiall Orbes (1576)

Copernicus’s system
Copernicus described his heliocentric system in his De revolutionibus orbium coelestium (1543). The system had a number of conservative elements: bounded universe, orbit of the earth still defining the centre of the material world, retains epicycles, etc. Also the unsigned preface (in fact by Osiander) intimated that Copernicus had intended his system to be a computing device and not to convey a physical reality. Which is true? Probably both, but NB how significant that ‘dual’ approach would have been at the time: to do computational and physical astronomy at the same time was highly innovative.

Reception
While the book was not ignored, it aroused little excitement, perhaps because of Osiander’s preface. In England Thomas Digges took it up and broke with the idea of a universe bounded by the sphere of the fixed stars (1576). Later, on the Continent, Giordano Bruno speculated on the possibility of an infinite universe, so helping to make the Copernican system more radical than it had originally been. Also at least one important alternative available: Tycho Brahe’s ‘mixed’ system

Galileo Observations with the telescope (Jupiter’s moons, phases of Venus, surface of moon) persuaded G of the truth of the Copernican system quite early. His Sideres nuncius (1610) brought the matter into the open. Many in the Catholic Church were willing to discuss the new ideas: despite some opposition (e.g. the Jesuit Christopher Scheiner) heliocentricity was not ruled out. But Galileo’s refusal to compromise and insistence on the Church’s immediate revision of its teaching ensured his downfall. The final straw was G’s unflattering portrayal of the Pope in his Dialogue on the Two Chief World Systems (1632). House arrest followed G’s encounter with the Holy Office.

Victory of heliocentricity
A complex process, effected not by any one crucial observation but by gradual assimilation. By c1650 all but the most resolute diehards were convinced, and even Kepler’s elliptical orbits (never countenanced by G) had won widespread acceptance.