

ASTRONOMY 9: HISTORY OF COSMOLOGY  
**Handout #13**

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**Copernicus: A Reluctant Revolutionary**

I. Nicolas Copernicus (1473–1543, Poland)

- Moves Sun back to (well, near) center
- Revolutionary implications:
  - Earth is just another planet going round the sun
  - Demolishes Aristotelian spheres and walled-in medieval Christian universe
  - Universe becomes vast (lack of parallax)
  - Erases division of earthly vs. celestial realms
  - Aristotelian physics unsatisfactory: where is the center?
  - Breaks the close link between man, god, and universe
  - Loss of stability, rest, order
  - The Greeks did not discover all scientific knowledge
- Idea that our place in universe is not special: still called the **Copernican Principle**
- But these revolutionary ideas were not trumpeted (or even consciously recognized) by Copernicus! Merely *implied* by his work
- Heliocentric idea at first *welcomed* by relatively open-minded Church! Big trouble only decades after death of Copernicus, around 1600
- Copernicus was conservative, backward-looking, unwitting instigator of his revolution
- Last Aristotelian of the great scientists, at home in the medieval cosmos
- By standards of his day, Copernicus was a relic of an earlier world view!
  - Aristotelian physics long called into question by Bacon, Oresme, Cusa, ...
  - Aristarchus' heliocentric ideas never really forgotten, and were discussed openly prior to Copernicus
  - Winds of humanist Renaissance blowing from Italy, little effect on Copernicus despite his studies at Bologna
  - Still answering Plato's challenge to "save the phenomena", not trying to revolutionize cosmology
- Blind faith in ancient authority
  - Data mostly from Ptolemy
  - Only 27 recorded observations of his own, didn't bother to get modern instruments
  - Spent a lot of energy accounting for variation (not really there) in precession of equinoxes
- Other important revolutions going on
  - Luther's *95 Theses* and Reformation
  - Invention of printing press—rise of vernacular
  - Journey of Columbus—Europe is not the center of the world?
- Caged in almost Pythagorean secrecy, little courage of conviction, plagued by doubts and fears of ridicule (but little threat of religious persecution)
- The Copernican system
  - Introduces even *more* epicycles than Ptolemy! (About 48 vs. 40)
  - No real observational improvement over Ptolemy
  - Only circular motions
  - Sun is displaced from center of orbits—as bad as the despised equants!
- Born of wealthy merchant parents, influenced by overbearing uncle Lucas and scandalous brother Andreas
- Studies some astronomy at Univ of Cracow (1490s)
- Studies Canon law at Bologna (1496)

- Studies medicine at Padua (1501)
- Cushy job as Canon of Frauenburg cathedral, few responsibilities
- Unsocial life largely spent locked away in lonely tower at Frauenburg
- Few human relationships: lived with housekeeper Anna Schillings until ordered by Church to get rid of her (Counter Reformation), one close friend (Giese), one disciple (Rheticus)
- Motivation for heliocentric idea: Ptolemy's equants not in accord with Aristotelian physics!
- *Commentariolus* (Little Commentary): preliminary announcement of heliocentric idea, manuscript only, 1510–1514
- Seven axioms:
  - A) Heavenly bodies do not all move round same center
  - B) Earth is center of moon's orbit and terrestrial gravity, but not universe
  - C) Sun is the center of the universe
  - D) Earth's distance from Sun much smaller than to stars
  - E) Earth's rotation causes daily rising and setting
  - F) Annual motion of Sun against fixed stars due to Earth's orbit
  - G) Retrograde motion also due to heliocentric orbits
- *First Account*: written by Rheticus, no mention of Copernicus by name, 1539
- *On the Revolutions of the Heavenly Spheres*, 1543, one of the worst-selling books in history!
- Not placed on Index of forbidden books for 73 years
- Copernicus delays publication for decades, finally gives in to pressure from Rheticus and Giese
- In dedication to Pope, Copernicus mentions Giese and others who influenced him, but not Rheticus!
- Rheticus demoted from Dean at Wittenburg to mere cushy Prof at Leipzig due to his homosexuality
- Leaves publication of *Revolutions* to pal Osiander
- Osiander views heliocentric idea as mere calculating hypothesis, does not believe in its *truth*
- Anonymously adds preface which goes too far in appeasing theologians: Copernicus merely "saving the phenomena"
- Died of cerebral hemorrhage 1543, may have just seen published copy of *Revolutions* with Osiander's preface
- Hit on idea of **ellipse** for planetary motions, but for the wrong reasons and by faulty logic! Crossed out in manuscript
- Given Copernicus' trepidation and lack of originality and courage, why wasn't heliocentric model hit on earlier?
  - Physics wasn't there yet—deficiencies in Aristotle recognized, but no replacement yet
  - Copernicus was really interpreting Ptolemy, *not nature*; waste of time to humanist scientists
- Why does Copernicus get all the attention?
  - He *systematized* the heliocentric idea into a cosmological model (though one rooted in the past)
  - Writings attract notoriety (mostly heresy) at the right time

## II. Thomas Digges (1546–1595, England)

- Translated part of Copernicus' *Revolutions*
- Leader of English Copernicans
- Precise observations of Tycho's (1572) SN
- Lack of parallax implied very large distance
- Added a new idea to Copernican model: **infinite space**, with stars at varying distances