The History and Philosophy of Astronomy

(Lecture 7: Copernicus II)

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De Revolutionibus: The Long Road to Publication

- appeared in print 1543
  - year of Copernicus death

- Q: Why did it take so long?

- Commentariolus (basic ideas):
  - already ~1510

- First (hand-written) draft:
  - already ~1530
De Revolutionibus: Reasons for Procrastination

- Copernicus was a busy man (canon, war, …)
- He was afraid of ridicule because of seemingly counter-intuitive notion of Earth’s motion
  - attempt to perfectionize his new system
- Anticipation of counter-reaction from Church
  - Earth’s motion contradicted by Scripture
- Doubts whether he got it right:
  - it never quite fits
Enter Joachim Rheticus (1514-76)

- professor of mathematics in Wittenberg
- visits Copernicus in Frauenburg
- prods Copernicus toward publication

- *Narratio Prima* (1540, first report):
  - summary of full *De Rev.*
Harmony of Copernican System

- No clear-cut proof possible for heliocentric model
  - actually: problem with missing fix-star parallax

- But Copernicus claims that his system is more elegant ("harmonious") than Ptolemy’s, e.g.:
  - retrogression of planetary motion
  - ordering of planets
  - maximum elongation of Venus and Mercury
  - correlation of opposition and brightness (Mars, Jupiter, Saturn)
Dis-Harmony of Copernican System

- As messy as Ptolemy, not more accurate:
  - a failure really (according to original claim)
Copernicus vs Ptolemy: Retrogression

- Conceptually simpler explanation for retrograde motion (7 spheres vs 12)
- Retrograde motion of planets natural outcome of Earth’s motion!
Copernicus vs Ptolemy: Elongation of Venus

- Observational fact: Venus and Mercury never stray much (in angular distance) from Sun
- Q: How to explain?
Copernicus vs Ptolemy: Elongation of Venus

- Copernican system: Maximum elongation natural consequence
- Ptolemy: Need to make ad-hoc assumption
Principle of Perfect Uniformity

• eliminate un-Platonic equant with double epicycle!

• Same device as used by Arabs: Did he know?
Big Problem: Missing Stellar Parallax

- Not observed (too small) until 1838 (Bessel)!
Big Problem: Missing Stellar Parallax

- Copernicus (correct) idea: Stars are at immense distance (same idea as suggested by Aristarchus)
- Copernican universe (although still finite) much larger than Ptolemaic one
Early Reception of De Revolutionibus
Important Early Role of Wittenberg

• Birthplace of Protestant Reformation!

Martin Luther: 1517
Philipp Melanchthon: Luther’s Secretary of Education

- Appointed two new professors of astronomy at Wittenberg University!
Appointment 1: Joachim Rheticus (1514-76)

• professor of mathematics in Wittenberg

• visits Copernicus in Frauenburg

• prods Copernicus toward publication

• *Narratio Prima* (1540, first report): - summary of full *De Rev.*
Appointment 2: Erasmus Reinhold (1511-53)

- professor of mathematics in Wittenberg
- uses *De Rev.* to calculate new tables of celestial motions
- *Prutenic Tables* (1551) widely used
- Indirect fame for Copernicus
Copernicus fame as “Second Ptolemy”

Strasbourg Cathedral: Astronomical Clock (1574)
Copernicus: Victory by Infiltration

• Practical value of Reinhold’s *Prutenic Tables*
Early Reception: Need for better calendar

(Pope Gregory XIII) • Uses *De Revolutionibus*!
Copernicus: Victory by Infiltration

• Astronomers got used to *De Rev.* as practical tool for predicting celestial motions

• Use despite, not because of, idea of Earth’s motion

• Thus: *De Rev.* never went away (starting point for Kepler and Galileo)

• Copernicus in-built defence: Make book unreadable for nonastronomers (“mathematics is for mathematicians”)

• Osiander’s introduction: Heliocentric hypothesis just convenient device of mathematical astronomy, not real!
Copernican Revolution: A New Generation

- Next generation of astronomers (Kepler, Galileo, ..., Newton)

- Address problems of *New Astronomy* (E.g., consequences of Earth’s motion...)

- Copernicus addressed problems of *Old Astronomy* (E.g., a planetary model without equants...)
De Revolutionibus: Reaction from Church

• Initially: Very friendly!

• In preface of *De Rev.*: Dedication to Pope

(Pope Paul III)
De Revolutionibus: Reaction from Church

- Requested to be briefed about new Copernican theory in 1533

- Q: How could things have turned so sour a short time later???

(Pope Clement VII)
The Christian Universe: Dante’s *Divine Comedy*

- Astronomy = Theology
- Central Earth becomes essential ingredient of Christian Theology
The Copernican Revolution as Paradigm Shift

1. “Normal” science
2. Anomalies, conflicts
3. New framework (paradigm)
4. “Normal” science
5. ...

Thomas Kuhn (1922-96)

- The Structure of Scientific Revolutions (1962)
Freud’s Three Demotions of Humanity

- **Copernicus:**
  - mankind not special in space

- **Darwin:**
  - mankind not specially designed

- **Freud:**
  - human mind (“ego”) not fully in charge, influence from subconscious (“id”)

Sigmund Freud (1856-1939)

- in *Introductory Lectures into Psychoanalysis* (1917)
Copernicus and the Invention of Nihilism
Copernicus and the Invention of Nihilism

• Nietzsche blames Copernicus and modern science for spiritual erosion and cosmic forlornness.

• “Since Copernicus, humanity is rolling from the center into nothingness…”

Friedrich Nietzsche (1844-1900)
Copernicus (part 2)

- *De Revolutionibus*: Not a revolutionary book, but a revolution-making one!

- Slow, but inexorable ascendancy of Copernican system
  - initially based on practical utility
  - Earth’s motion largely ignored
  - provides starting point for New Astronomy (Kepler…)
  - some advantages in (Neoplatonic) elegance

- Great struggle with Church slowly emerging

- After Copernicus: Humankind enters modernity