

Astronomy 350L (Spring 2005)



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-intutive 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)

AD CLARISSIMVM VIRVM D. IOANNEM SCHONE-RVM, DE LIBRIS REVOLVTIO nű eruditifimi viri,& Mathema tici excellentifimi,Reuerendi D. Doctoris Nicolai Cos pernici Torunnai, Cas nonici Varmiens fis,per quendam Iuuenem,Mas thematica fiudio fum NARRATIO PRIMA.

ALCINOVS.

Bat N's LAW Signer lines of graph the pi Aderte galerspile

 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

NICOLAI COPERNICI

net, in quo terram cum orbe lunari tanquam epicyclo contineri dizimus. Quinto loco Venus nono menfe reducitur, Sextum denicp locum Mercurius tenet, octuaginta dierum fpacio circu currens, la medio uero omnium refidet Sol. Quis enim in hoc



pulcherimo templo lampadem hanc in alio uel meliori loco po neret, quàm unde cocum fimul polsit illuminare: Siquidem non inepte quidam lucernam mundi, ali menten, ali rectorem uocant. Trimegiftus uifibilem Deum, Sophodis Electra intuente omnia. Ita profecto tanquam in folio re gali Sol relidens circum agentem gubernat Afrorum familiam. Tellus quocy minime fraudatur lunari minifterio, fed ut Ariffoteles de animalibus ait, maximă Luna cu terra cognatione habet, Concipit interes à Soleterra, et impregnatur annuo partu. Inuenimus igitur fub hac • 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

Ptolemy

Copernicus





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

Copernicus vs Ptolemy: Retrogression

Ptolemy

Copernicus





- 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

<u>Ptolemy</u>

Copernicus





Copernican system: Maximum elongation natural consequence
Ptolemy: Need to make ad-hoc assumption

Principle of Perfect Uniformity

• eliminate un-Platonic equant with double epicycle! <u>equant</u> double-epicycle



Same device as used by Arabs: Did he know?

Big Problem: Missing Stellar Parallax



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



Martin Luther: 1517



• Birthplace of Protestant Reformation!

Philipp Melanchthon: Luther's Secretary of Education





 Appointed two new professors of astronomy at Wittenberg University!

Appointment 1: Joachim Rheticus (1514-76)

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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

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• 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



Thomas Kuhn (1922-96)

- 1. "Normal" science
- 2. Anomalies, conflicts
- 3. New framework (paradigm)
- 4. "Normal" science

• 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