



 POLITECNICO DI MILANO



Philosophical Issues of Computer Science ***Science, paradigms, and scientific revolutions***

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March, 9th 2020



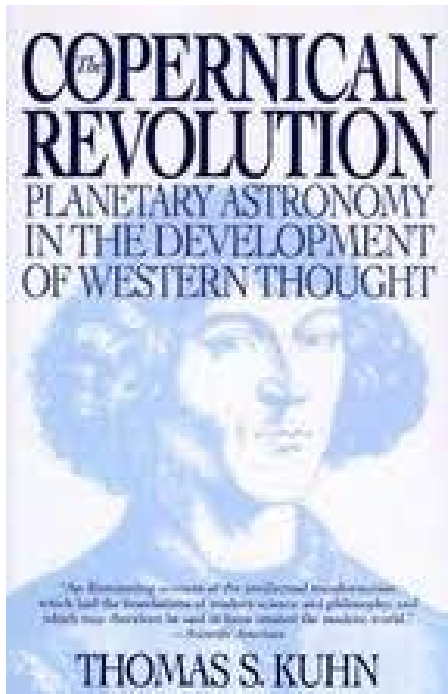
- Goals of science (and a bit of the history of scientific revolution)
- *Questions? Let's try today with the microphone*
- Technology and technical artefacts
- Technology and engineering
- *Questions?*



Three answers

3

- How does science work?
- Three answers, or pieces of an answer
- Rivals, alternative starting points, or paths into the problem
 - **Empiricism**
 - **Mathematics and science**
 - **Social structure and science**

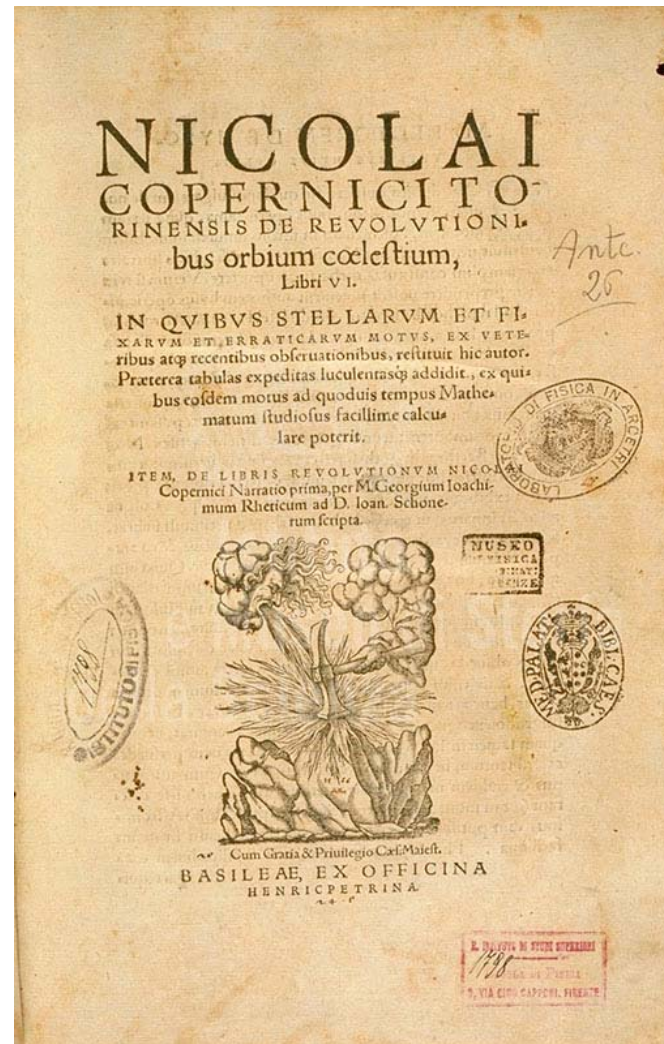


Starting from astronomy and ending in physics

Copernican Revolution as paradigmatic of scientific revolutions



De Revolutionibus Orbium Coelestium (1543)



Revolution (turn around) of the celestial bodies



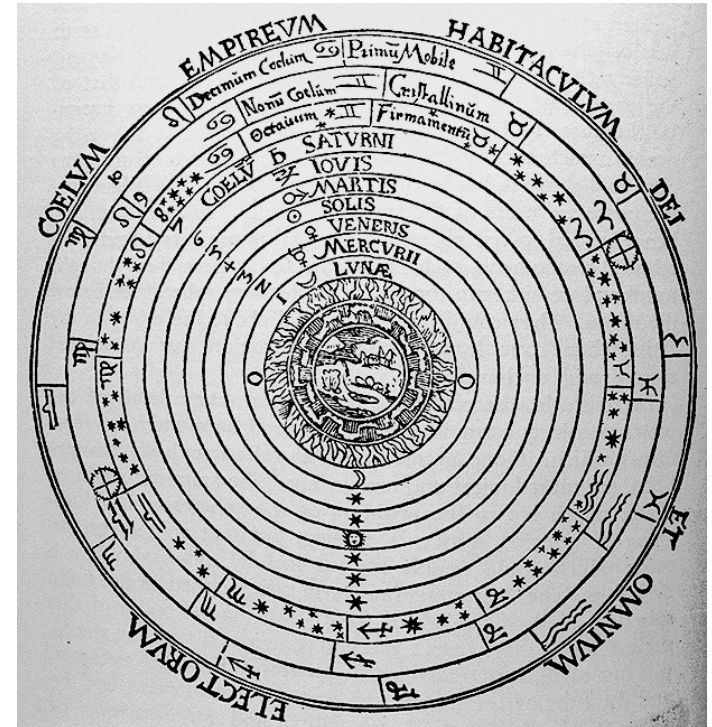
- Period from Copernicus to Newton, including such luminaries as Kepler, Galileo, Bacon, Descartes, Huygens, Boyle, Leibniz



- Important changes in **theory, method, practices, instrumentation, social organization, and social status** ranging over a variety of projects



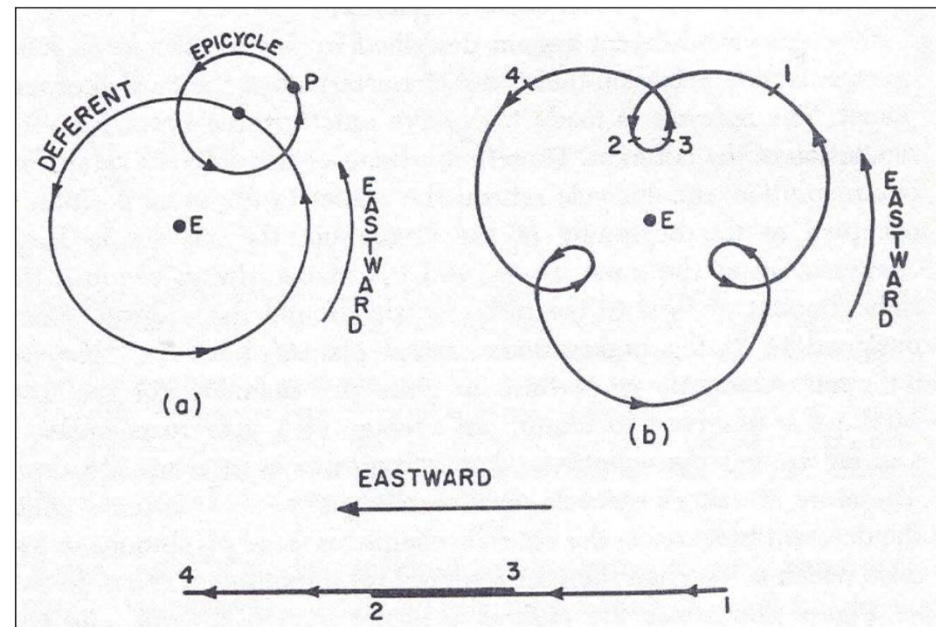
- Central Earth and planets (including Sun) moving around it
- Two **distinct regions** of the cosmos
 - The Heavens (*supralunar*) perfect, no change, circular motions
 - Terrestrial (*sublunar*) change, non-circular motions





The problem of planets motion

- **Retrograde motion** of planets, opposite direction to daily motion (E-W) of celestial sphere
- Deferent/epicycle solution (III-II cent. BC)
- Designed to precisely explain planetary motions (**to save phenomena**), but also to be in accordance with the accepted philosophy

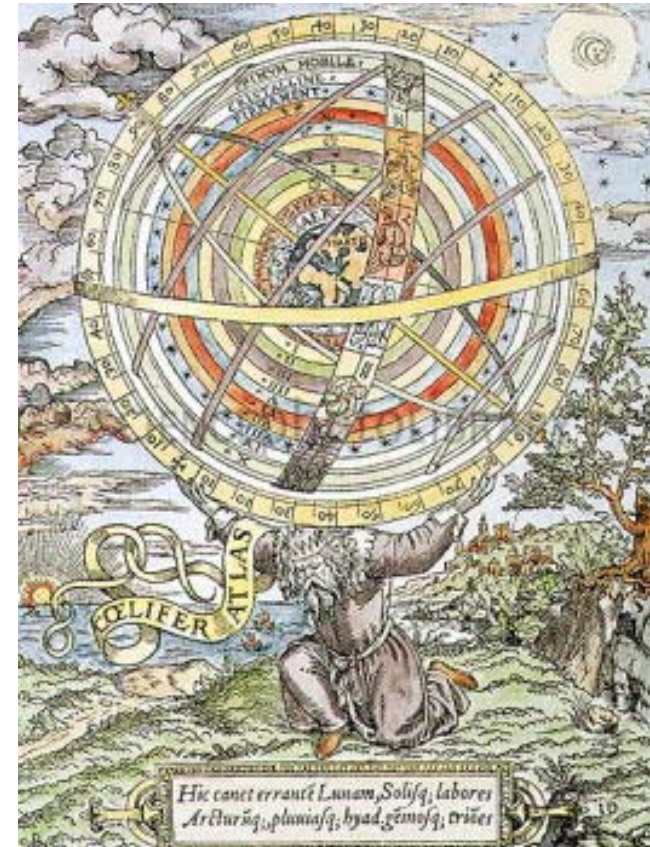




The Ptolemaic system (II cent. AD)

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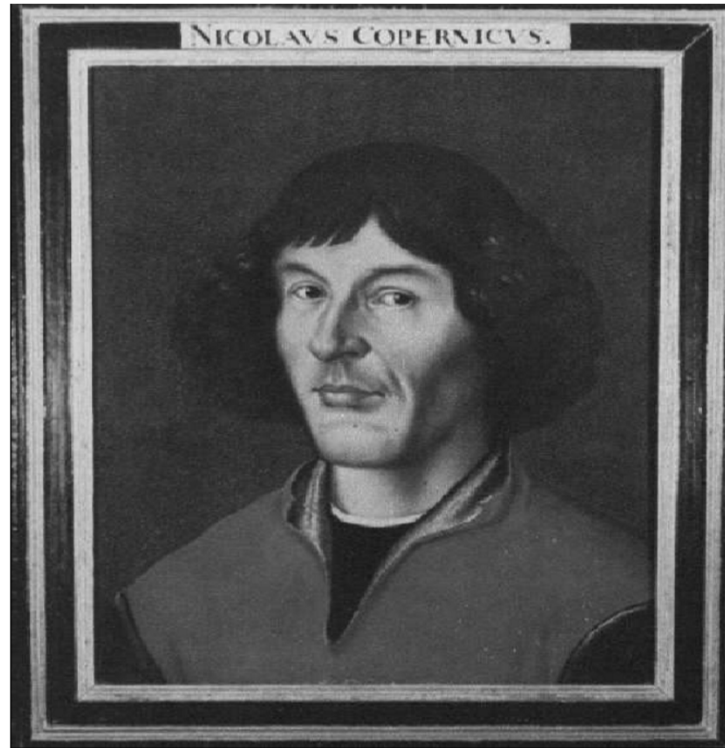
- **Aristotelian** but dominated by **mathematical precision**
- Circles within circles (deferent/epicycle)
- Designed to precisely explain planetary motions
- Proliferating **complexity** (*Copernicus' monster*)





Copernicus' *De Revolutionibus Orbium Coelestium*¹⁰

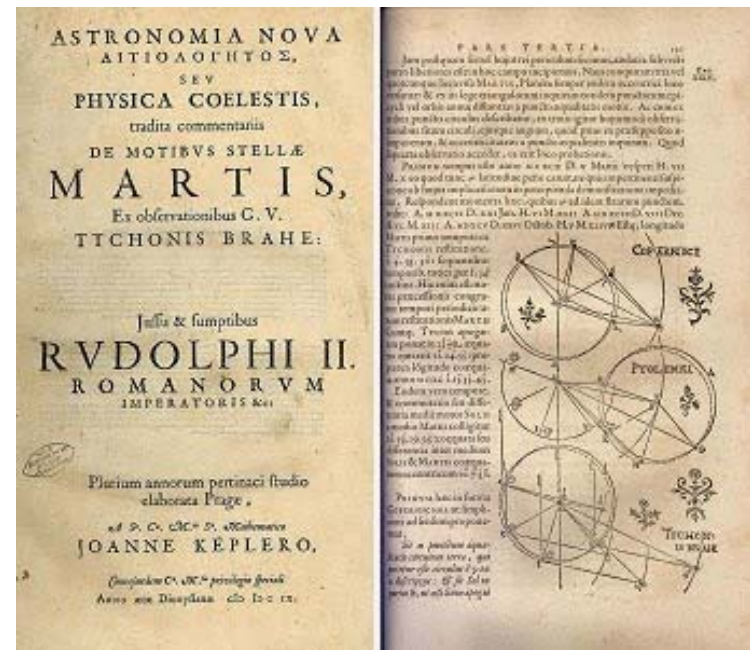
- First detailed theory with the earth moving around the sun (**heliostaticism**)



- Not a revolutionary book, but a 'revolution-making one'



- Copernicanism combined with obsession in finding **mathematical harmony** in the structure of the heavens (**neoplatonism**)
- **Elliptical** orbits (three laws of motion planets)
- Massive **simplification** and better **predictive** accuracy

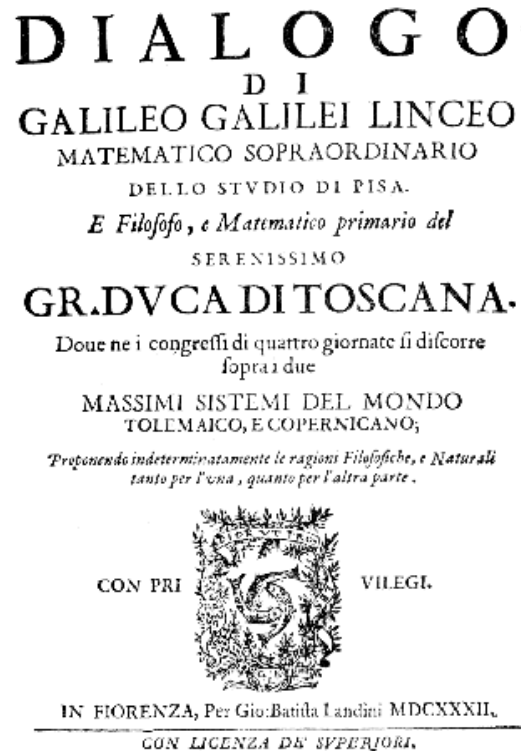




- Use of the **telescope** to observe the heavens
- Observation of a multitude of phenomena **contradicting Aristotle's view** of the world (no *supralunar* and *sublunar* distinction)
- Need to have a **new science** to solve definitively some astronomic problems (e.g. planets motion)



Galilei's *Dialogo sopra i due massimi sistemi* (1632)¹³



- New science making sense of the idea of a **moving Earth** and explaining familiar facts about **dropped** and **thrown objects**
- *Sensate esperienze and certe dimostrazioni*



- **Unified mathematical treatment of motion** both on earth and on heavens



- Combination of **Copernicanism** and a **form of mechanicism** (world made up of tiny “corpuscles” of matter interacting only by local physical contact)



- **Description**
 - Collection of data
 - Is complete description enough for a scientific account?
- **Prediction**
 - Effort to know about the future
 - Is a list of past, present, and future facts enough?
- **Control**
 - Not just predicting, but intervening on the future
 - Preventing and taking care of diseases
- **Organization**
 - Interest in regularities and organizations of facts
- **Explanation**
 - Not just description, but reasons (how and why)
 - Connection between explanation and prediction



- At the end of Scientific Revolution no separation between theory and practice
- **Virtuous relationship** between the invention of new (microscope) or better (telescope) instruments and the progression of sciences (optics)
- Technical knowledge is **precise** (as theoretical knowledge) and guided by precise theoretical principles and laws
- Increasing importance of **applicative** and **engineering** sciences within society
 - **Engineering scientists**



- Godfrey-Smith, Peter (2003), *Theory and Reality. An Introduction to the Philosophy of Science*, Chicago University Press
- Kuhn, Thomas (1957), *The Copernican Revolution: Planetary Astronomy in the Development of Western Thought*, Harvard University Press
- Kuhn, T. (1962). *The Structure of Scientific Revolutions*, Chicago: University of Chicago Press
- Westfall, Richard (1971), *The Construction of Modern Science: Mechanisms and Mechanics*, John Wiley & Sons Inc.