

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

J. E. Baker  
UC Berkeley, Spring 2000

**Cosmology in Ancient Greece: Plato and Eudoxus**

I. Socrates (approx. 470–399 BC)

- “Called down philosophy from the skies.” (Cicero)
- Emphasis on human, ethical, moral (not just cosmological) issues
- Time of great social turmoil (war, corruption, population decline, ...)
- Preached the need for a new moral philosophy
- Dialogs: unyielding questioning of others’ knowledge
- Condemned by parents of “corrupted youth”, death by poison
- Dialogs survive as written by student Plato

II. Plato (approx. 428–348 BC)

- Goals:
  - Formulate new moral philosophy based on immutable truths
  - Educate new “philosopher-kings” to rule the “ideal society” (in fact a very unattractive aristocracy!)
- Founded Academy (perhaps first university), lasted 900 years!
- Division of the cosmos into two realms:
  - A) Forms: perfect, true reality, world of Ideas
  - B) Physical world: imperfect shadow of ideal reality
    - Cave allegory
    - Line vs. drawing of a line
- Cosmology presented in *Timaeus*
  - Abstract deity (“demiurge”): principles of reason, order
  - Teleology: belief in cosmic design
  - Pythagorean number mysticism replaced by geometrical mysticism
  - Five elements with shape of five Platonic solids:
    - A) Fire — Tetrahedron (4, triangle)
    - B) Earth — Cube (6, square)
    - C) Air — Octahedron (8, triangle)
    - D) Cosmos — Dodecahedron (12, pentagon)
    - E) Water — Icosahedron (20, triangle)
  - Earth at cosmic center
  - Celestial objects are all perfect spheres
  - All orbits are circular
  - Only one world (only possible likeness of the ideal)
- Challenge to students: “Save the phenomena”
  - Observational science (astronomy) demoted to secondary role
  - Nevertheless, it can serve as a bridge to the divine mind
  - How can complicated planetary motions (e.g., retrograde) be described as a combination of simple circular motions?

III. Eudoxus (c. 408–356 BC)

- Devised a “solution” to Plato’s challenge
- Nested spheres: 4 for each planet, 3 for sun, 3 for moon, 1 for fixed stars  $\Rightarrow$  27 total spheres!
- Four spheres for each planet:
  - Outer: daily rotation
  - Next: “annual” motion through Zodiac

- Inner 2: hippede (figure-8) motion to explain retrograde motion
- All spheres are free to rotate about different axes
- Motion is transferred: Apparent motion given by combined motions of all spheres
- Spheres are abstract geometrical construction, not thought of as physically real
- Good qualitative description of planetary motions
- Unanswered mysteries:
  - Why is motion transferred between spheres?
  - How to explain variable brightness of planets?

#### IV. Callippus (about 370–310 BC)

- Extended Eudoxus' model by adding 7 new spheres (total 34)
- Added one each for Mercury, Venus and Mars, and two each for Sun and Moon
- Better description of retrograde motion
  - Hippede replaced by more complicated, elongated figure