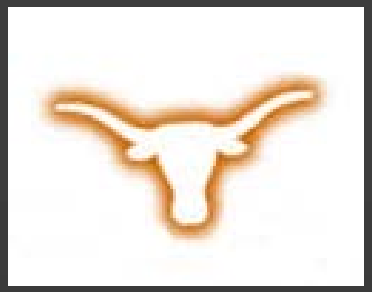
Astronomy 350L

(Spring 2005)



The History and Philosophy of Astronomy

(Lecture 4: Middle Ages I)

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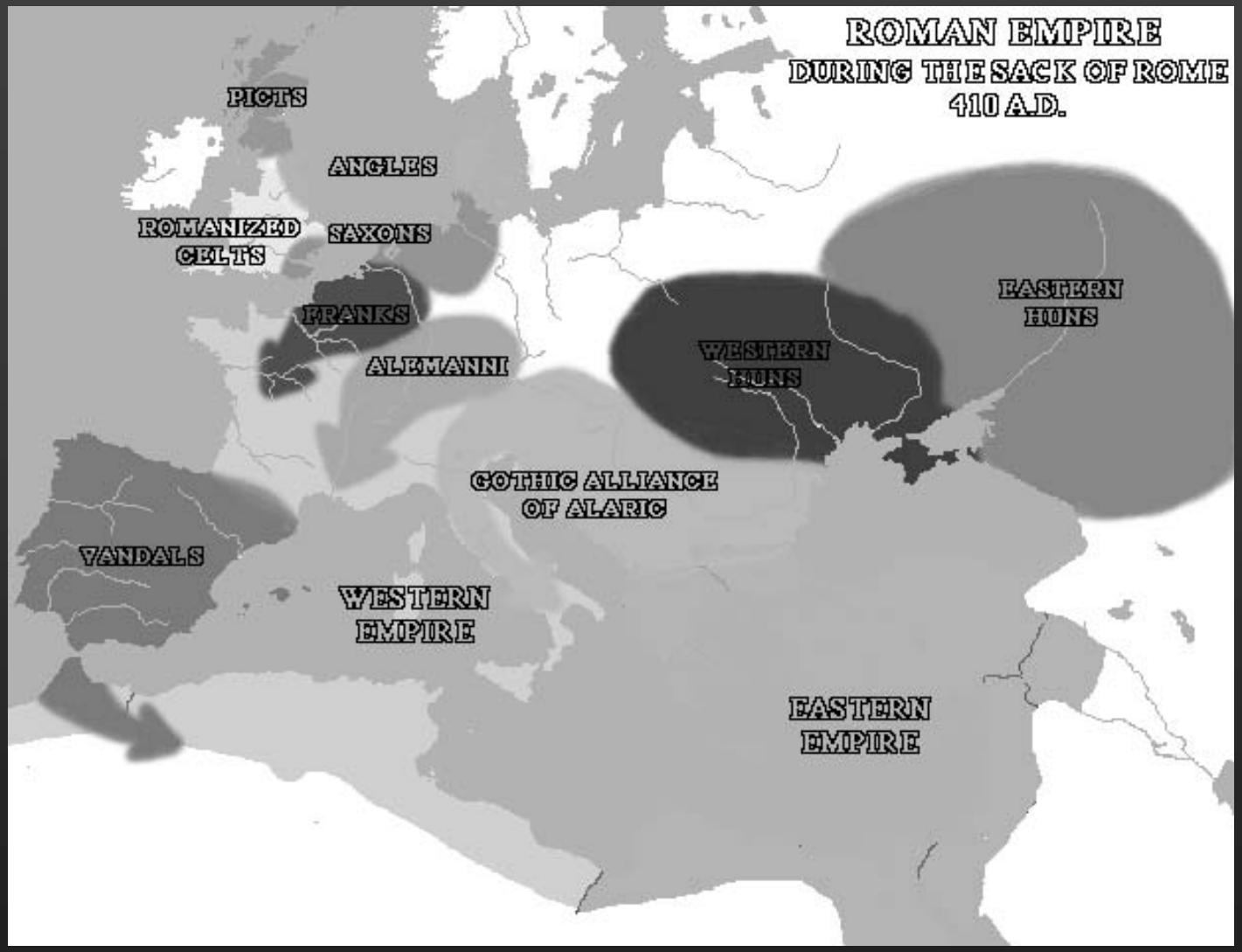
Medieval Astronomy and Cosmology

- Middle Ages I (Jan. 27)
  - Decline of Western (Mediteranean) Civilization
    - Early Middle Ages (“Dark Ages”): 500 – 1000 AD
  - Ascendancy of Islamic Astronomy (800 – 1400 AD)
    - Preservation and transformation of ancient knowledge
- Middle Ages II (Feb. 1)
  - Recovery of European Civilization
    - High and Late Middle Ages (c. 1000 – 1450 AD)
  - Setting the Stage for the Copernican Revolution
    - Recasting of the Ancient Tradition

The Fall of Rome



- “Barbarians” (Germanic tribes/Huns) at the gate

The Fall of Rome

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The Fall of Rome

Q: Why did it happen?

(Edward Gibbon, 1737-94)

• Gibbon's *Decline and Fall of the Roman Empire:*
- decadent society
- economical pressure
- constant threat of invasion
- corrupt government

The European Dark Ages

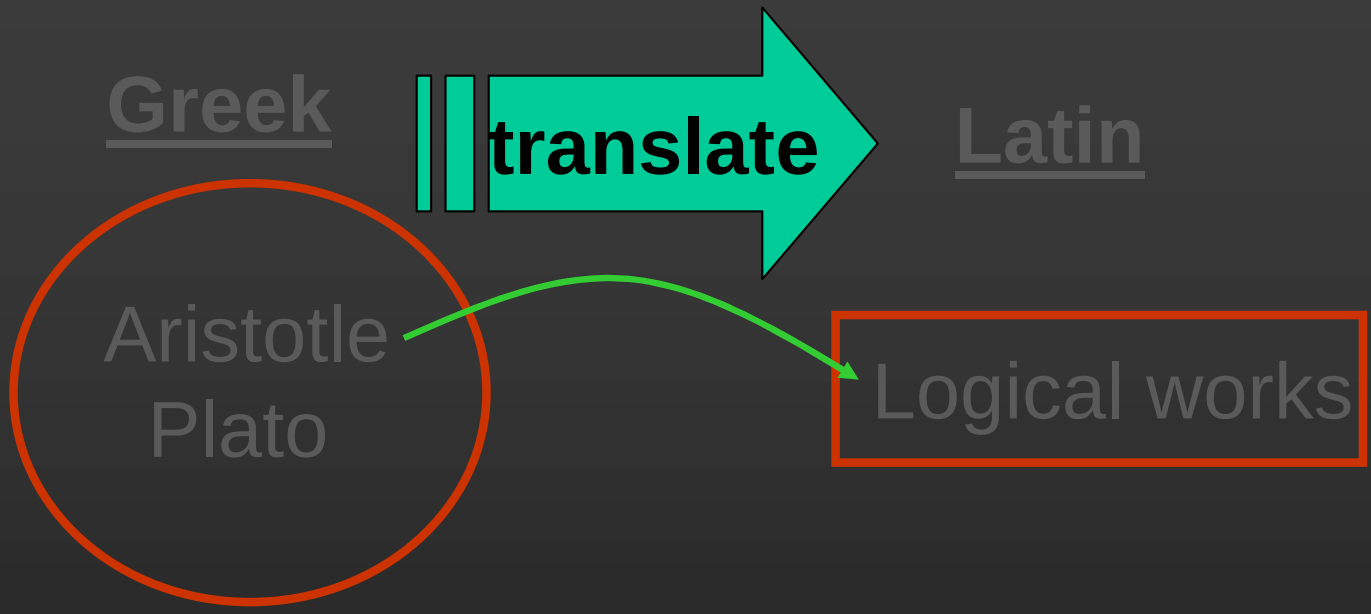
- Early Christianity initially hostile toward pagan learning, especially astronomy/astrology
- Loss of libraries and ancient texts
- Greek language was largely forgotten only simplified Latin
- Life was brutish and short, primitive economic level
- a tremendous decline in cultural sophistication

A Rescue Attempt: Boethius (480-524 AD)

- "The Last Roman"
- Court official under Theoderic, King of the Ostrogoths (ruler of post-Roman Italy)
- executed for treason
- *The Consolation of Philosophy*

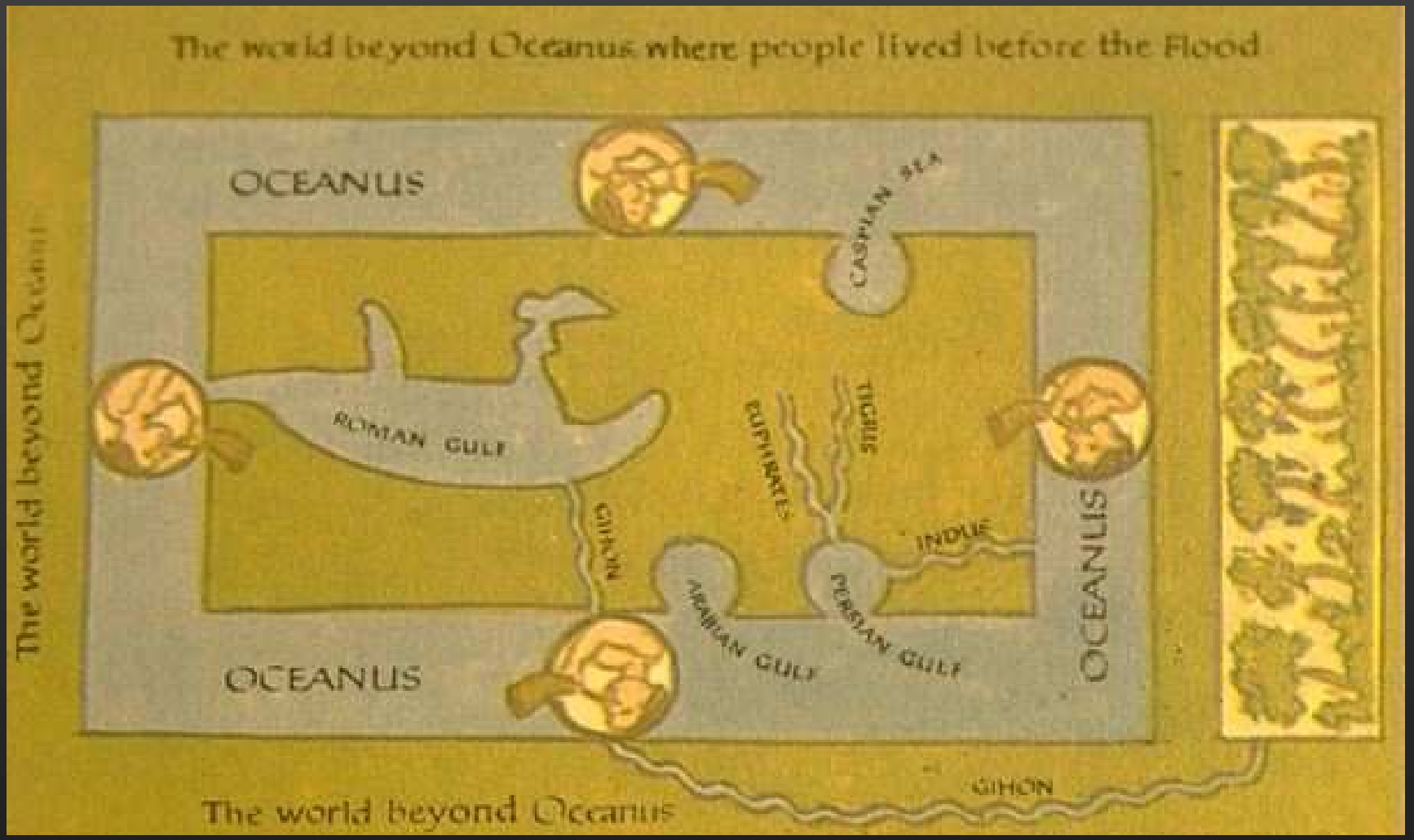
A Rescue Attempt: Boethius (480-524 AD)

- His (hyper-ambitious) program:



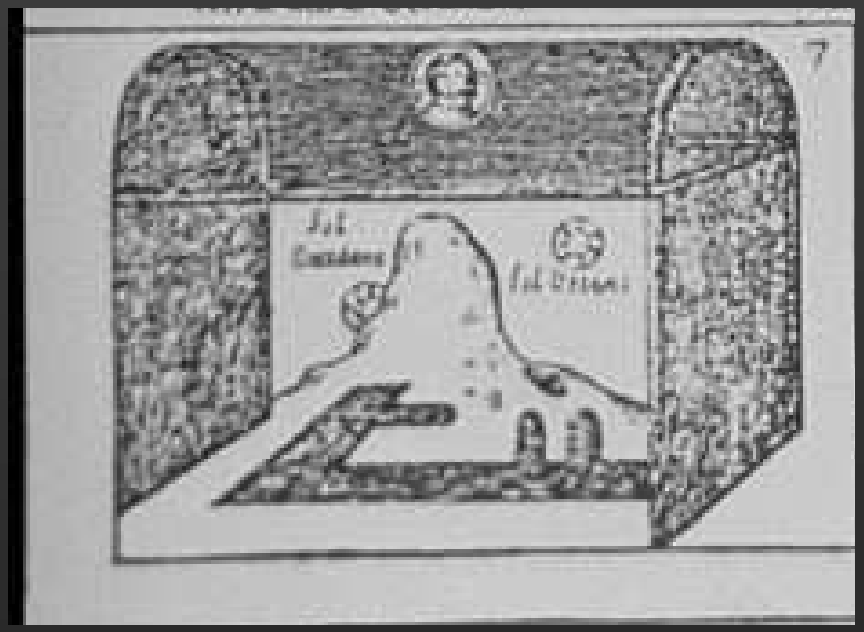
- ran out of time: most texts lost for Latin West!
- only rescued Plato text: Timaeus (trans. Calcidius)
- (Greek) works of astronomy forgotten for centuries!

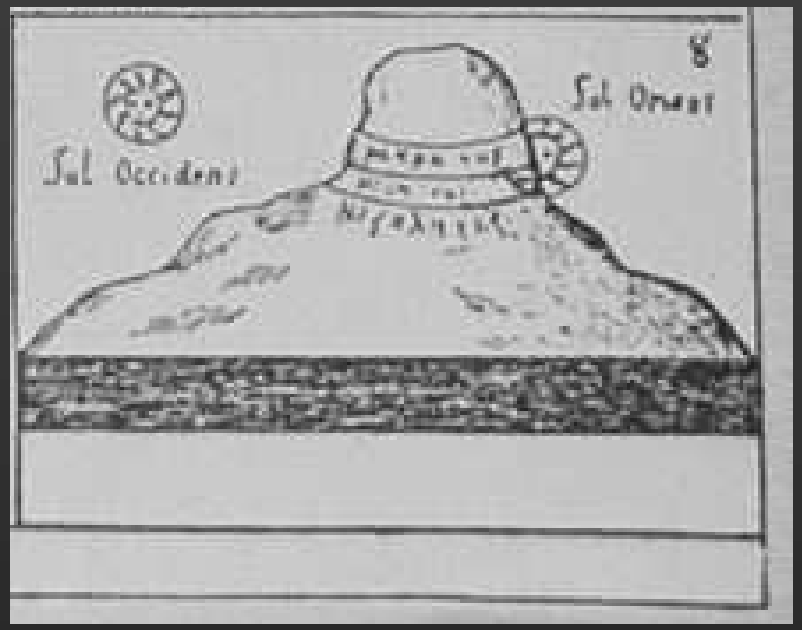
Kosmas Indikopleustes (6th cent. AD)



- Repudiating the idea that Earth is a Sphere!

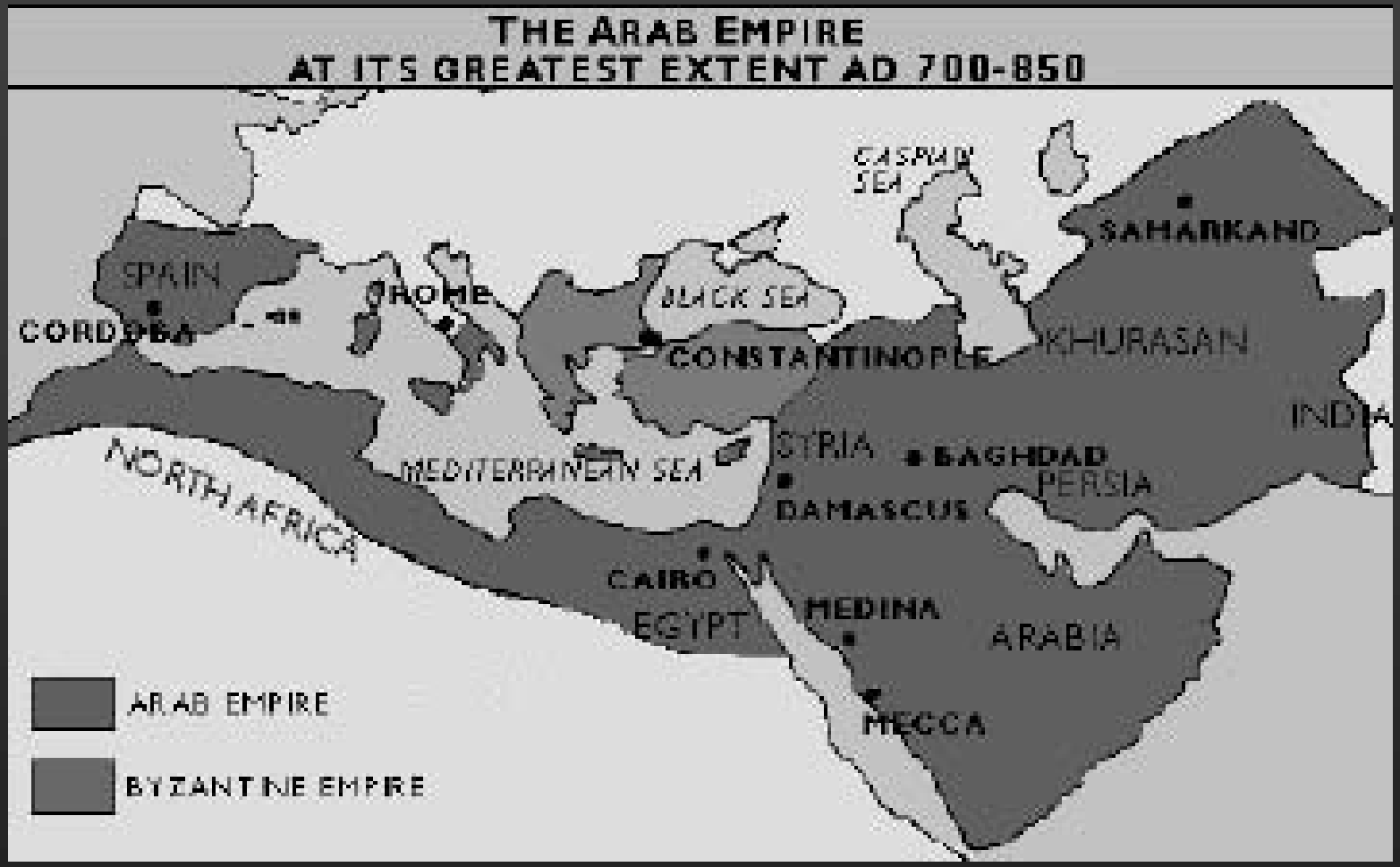
Kosmas Indikopleustes (6th cent. AD)





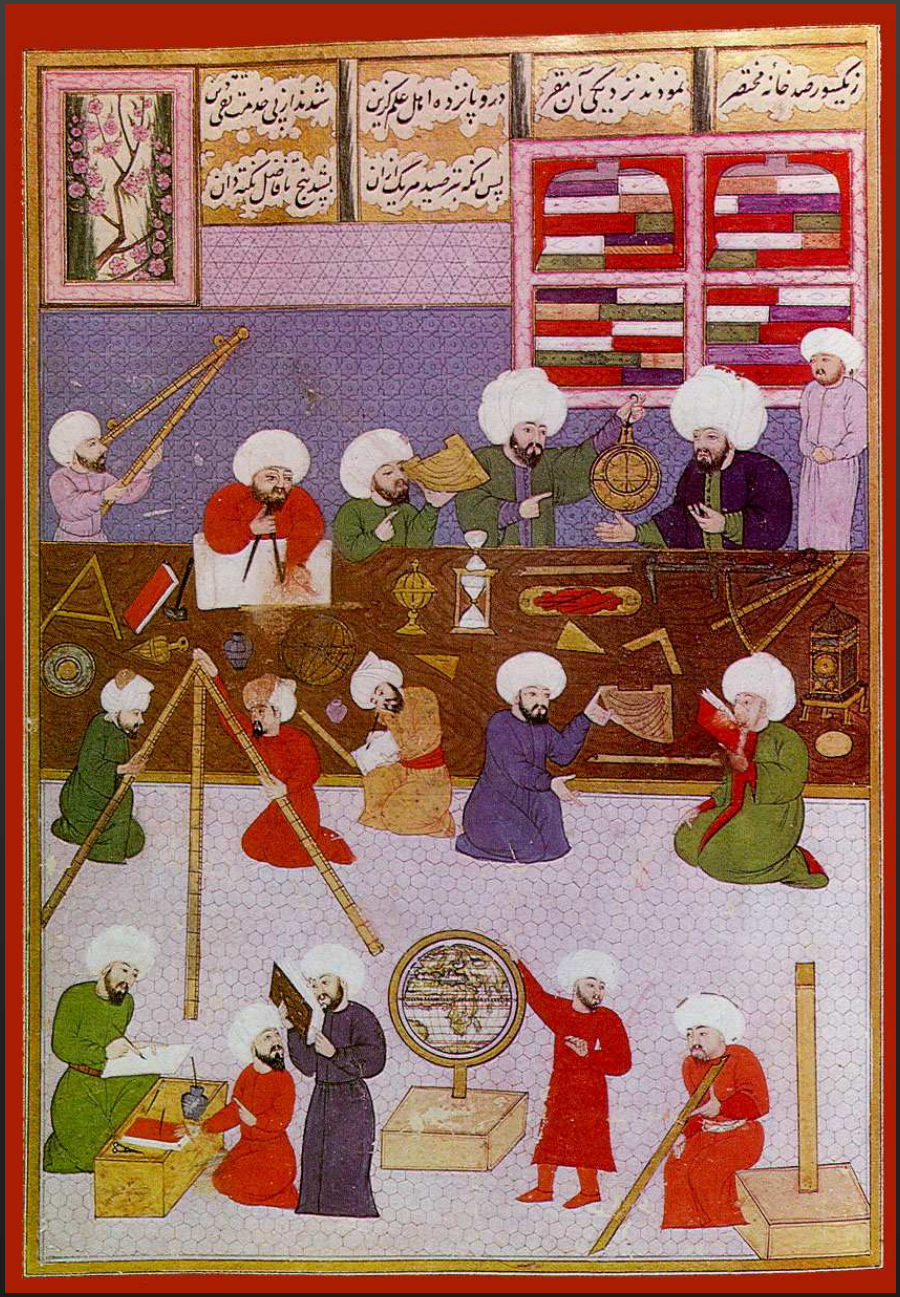
- Universe is tabernacle!
  - Very low standard of secular learning!
  - Re-accept spherical Earth only 500 years later!

The Ascendancy of Medieval Islam



- Emergence of vibrant and tolerant civilization!

Islam: The Need for Astronomy



- religious requirements:
  - predict beginning of month
  - altitude of Sun (hours of prayer)

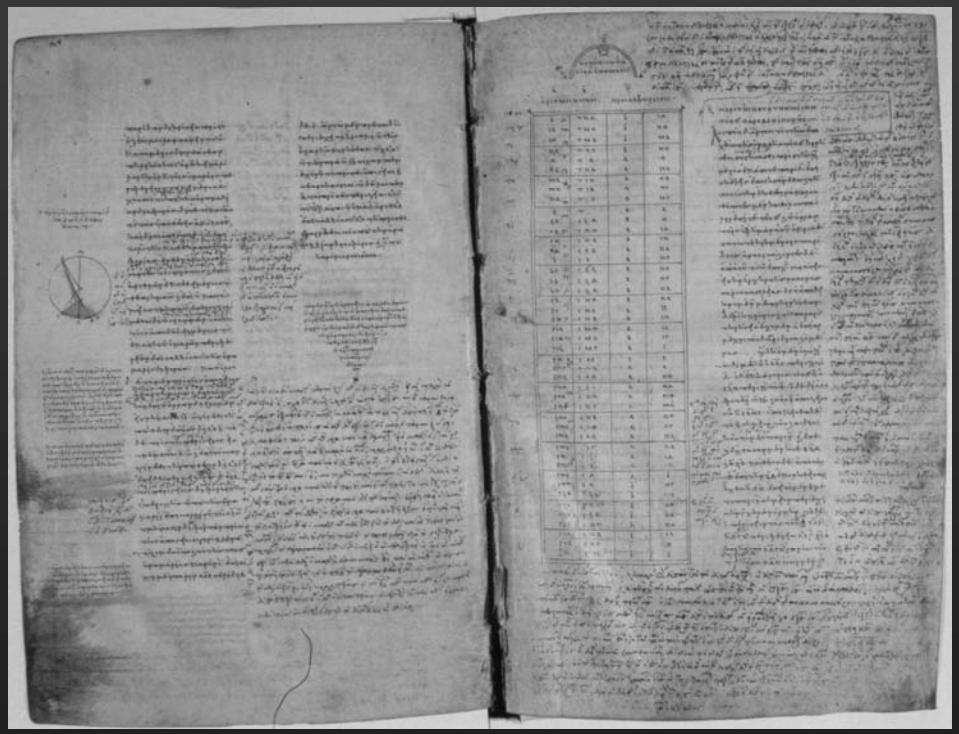
- establish office of *muwaqqit* (mosque timekeeper)

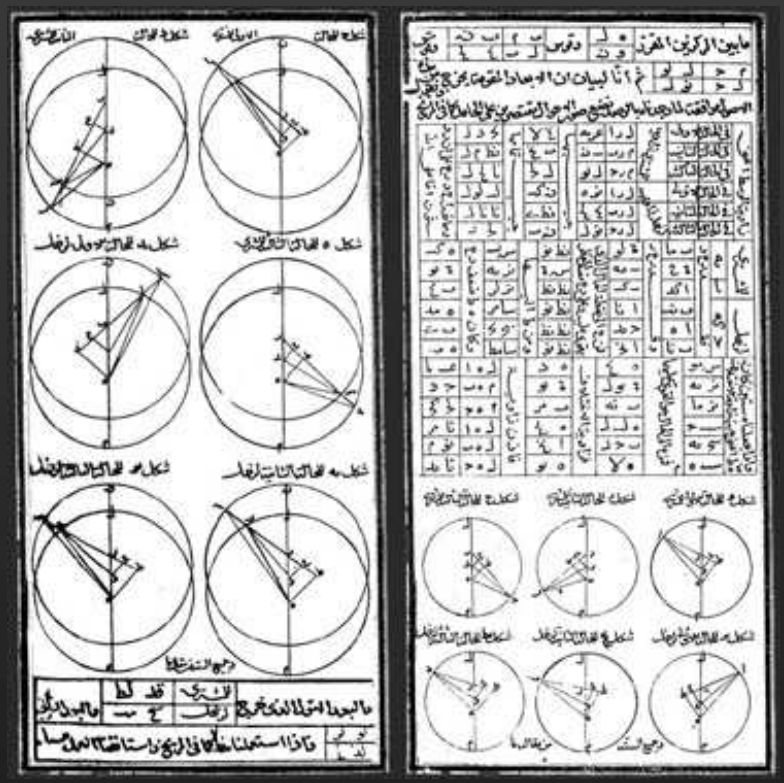
→ Astronomers respected position in society!

The House of Wisdom in Baghdad (9th cent. AD)

- Vigorous effort to translate Greek texts into Arabic
  - Caliph al-Mamun (Abbasid dynasty, 750 – 1258)

- **Translating Ptolemy:**





Greek: Syntaxis → Arabic: Almagest

Ptolemaic System within Islamic Astronomy

Almagest

- No fundamental modification
  to Aristotelian-Ptolemaic cosmology!
- Improvements in precision
  - building of major observatories!
  - improved mathematical methods!
- Discussion of doubts about Ptolemy!

Precision Astronomy: Great Observatories

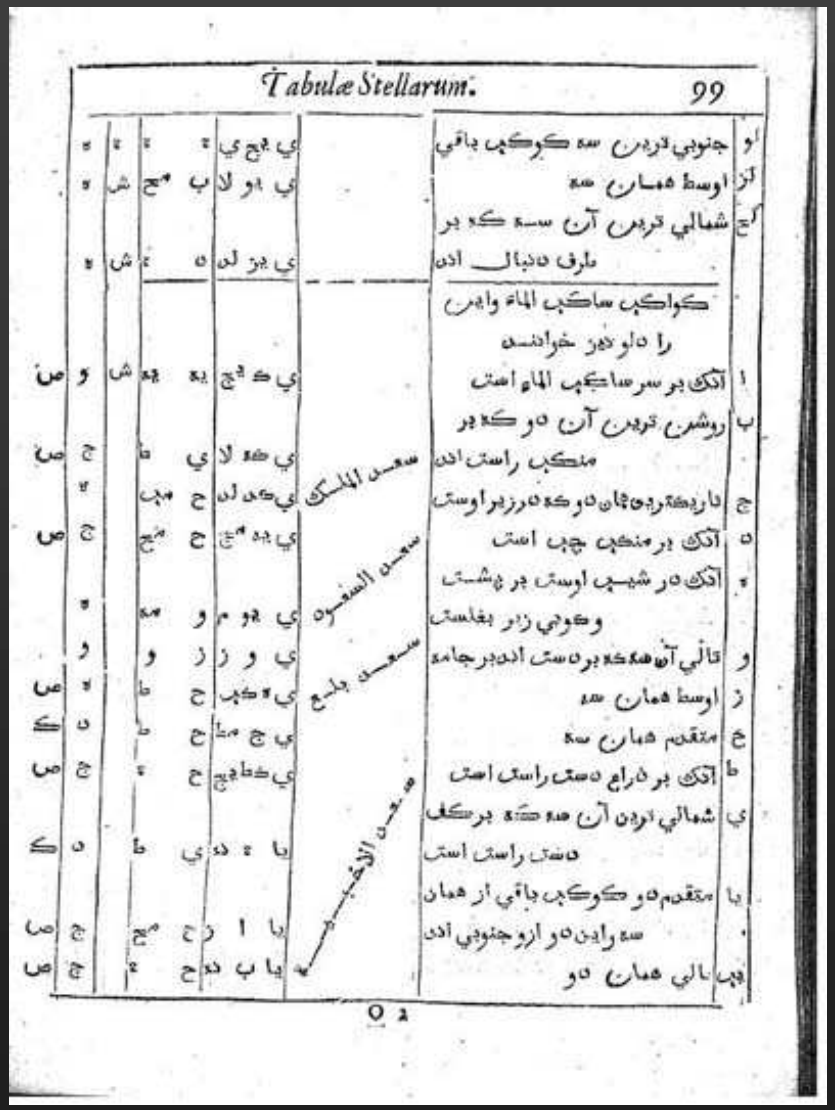
Ulugh Beg (d. 1449)

- Grandson of Tamerlane

Samarkand

- Great mural sextant

Ulugh Beg's Star Catalogue

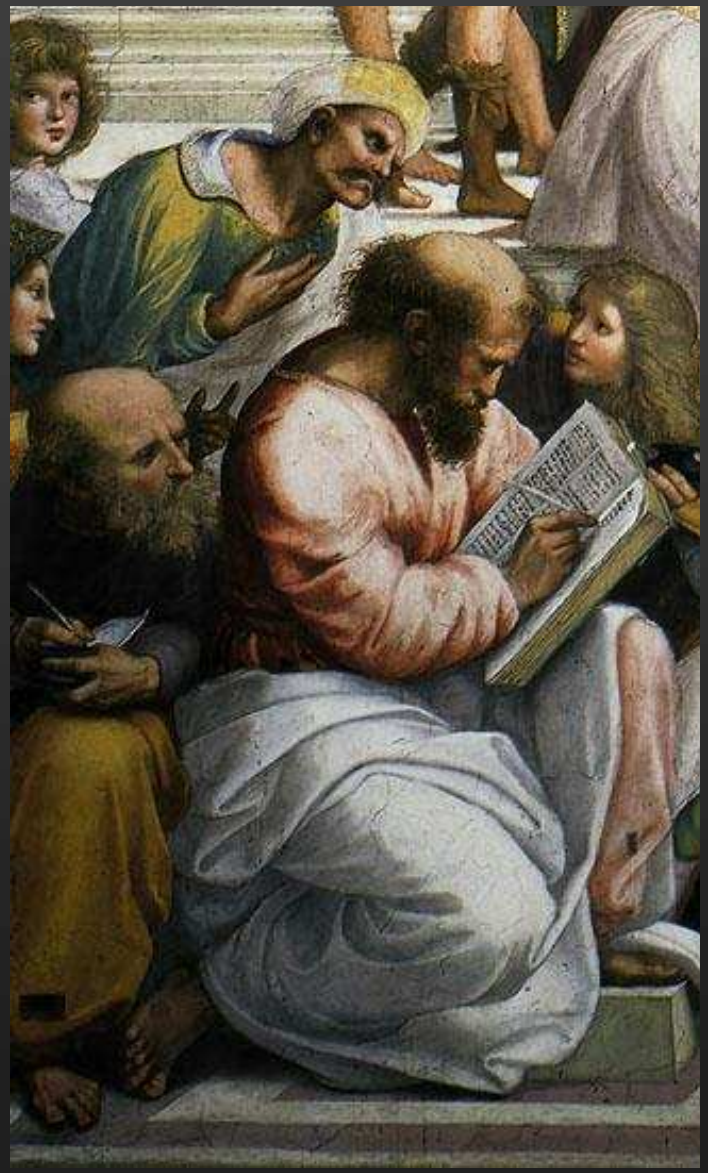

Tabulæ Stellarum. 99

- first major new catalogue of stars since time of Hipparchus (2nd cent. BC)
- high-precision (> 1000 stars)
- unknown in Europe

The Astrolabe: Universal Astro-calculator

- invented by Greeks, but perfected by Arabs
- measure altitude (height) of stars (or Sun)
- predict position of stars/Sun at given time

Critiquing Ptolemy



- Averroes (1126-98 AD)
- lived in Moorish Andalusia
- “The Commentator” of Aristotle
- philosophical purist: found contrived model of Ptolemy (deviation from uniform spherical motion) inelegant

Critiquing Ptolemy

- Nasir al-Din **al-Tusi** (1201-74 AD)
- lived in Persia
- adviser to Mongol conqueror Hulagu Khan
- one of greatest astronomers during Islamic Period

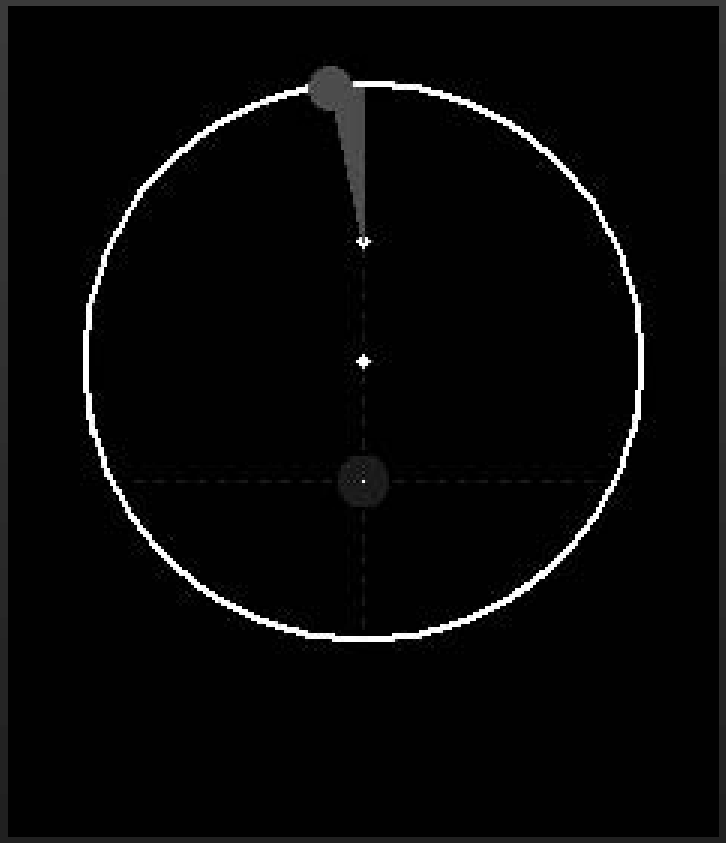
Al-Tusi's Observatory at Maragha

- 12 years of intense effort: Planetary Tables ("zij")

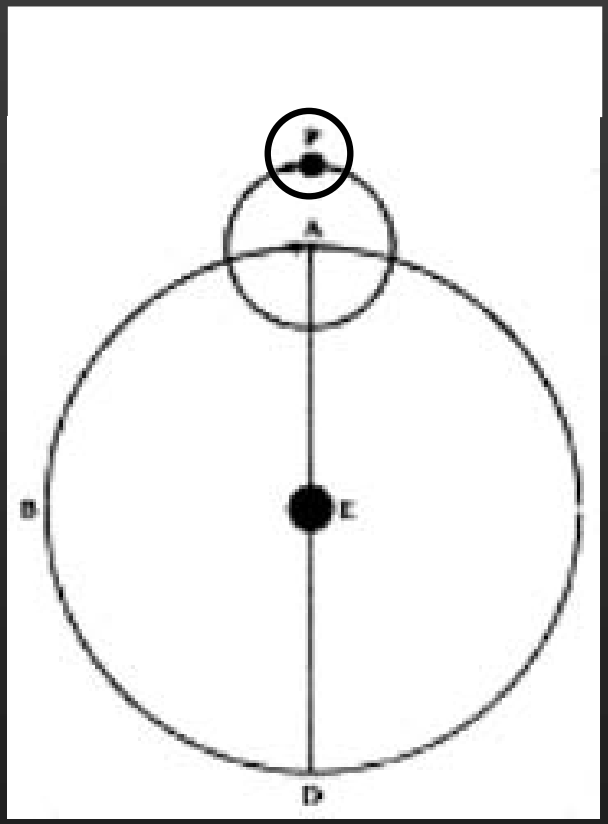
Al-Tusi's Attack on Ptolemy

- eliminate un-Platonic equant with double epicycle!

equant



double-epicycle



- Copernicus did the same: Did he know of al-Tusi?

Legacy of Islamic Astronomy

- Preserved ancient Greek astronomy / philosophy
- Improved mathematical methods
- Diligent observers (astronomical tables)
- Attitude towards Ptolemaic Framework:

  - no fundamental change!
  - improved precision (Great Observatories)
  - raising of doubts
  - elimination of Ptolemaic equant