Medieval Astronomy and Cosmology

• Middle Ages I (Jan. 27)
  - Decline of Western (Mediterranean) 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

• “Barbarians” (Germanic tribes/Huns) at the gate
Q: Why did it happen?

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

(Edward Gibbon, 1737-94)
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 Theodoric, 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:
  - Translate Greek works into Latin
  - 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

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

Almagest
Precision Astronomy: Great Observatories

Ulugh Beg (d. 1449)

- Grandson of Tamerlane

Samarkand

- Great mural sextant
Ulugh Beg’s Star Catalogue

- first major new catalogue of stars since time of Hipparchus (2\textsuperscript{nd} 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!

• 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