

NATS 1740 6.0 – Astronomy

Chapter 3 - The Science of Astronomy

Michael De Robertis

1. **Roots of Modern Science**
2. **Geocentrism**
3. **Heliocentrism**

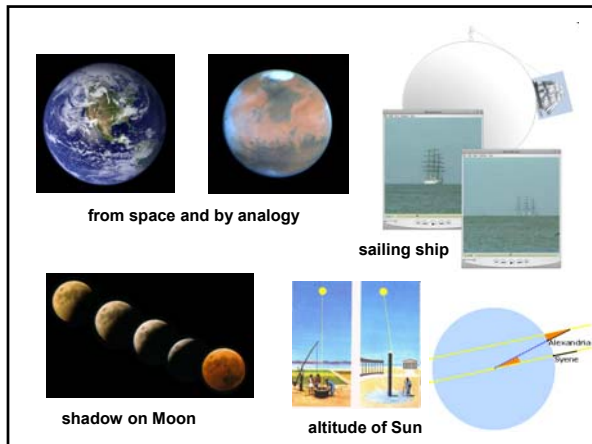
1. Roots of Modern Science:

- all ancient cultures practiced the *scientific method* at some rudimentary level
- related observed patterns through stories (*narratives*)
- applications extended to *time-keeping & navigation*



- traced to *Ancient Greece*
- developed logically consistent *models* that represented physical systems and had explanatory power (often using mathematics)
- concerned with *how* the world works
- E.g., How do we know Earth is round?





Observations were essential to the Greeks:

- Erasthones (240 B.C.) estimated Earth's radius to within 5% of the accepted value.
- Aristarchus (260 B.C.) calculated ratio of Moon/Sun distance and postulated a heliocentric universe.

When the Moon is exactly at quarter phase, the ratio of the Earth-Sun to Earth-Moon distance can be measured knowing the Earth-Moon-Sun angle.

The Greeks were well aware that:

- all celestial objects move E → W during a night
- stars move (gradually) E → W from night-to-night
- Moon moves W → E from night-to-night
- Planets ("wanderers") normally move W → E night-to-night, but sometimes move E → W (**retrograde**)

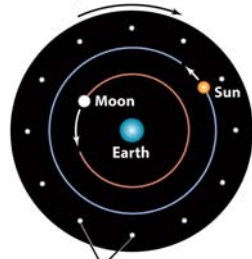
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2. Geocentrism:

The Greeks also imposed some constraints on their models that were based on philosophy (*teleology*) rather than observations.

For example, Aristotle's view that Earth must be at the centre of the universe (*geocentrism*) and Plato's view that all other bodies must revolve about Earth in perfect circles (*deferents*).

Celestial sphere rotates to the west



Stars fixed on celestial sphere

Greek Geocentric Model

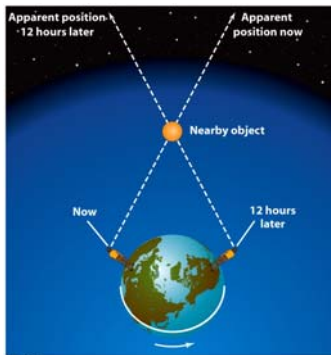


Figure 4-1
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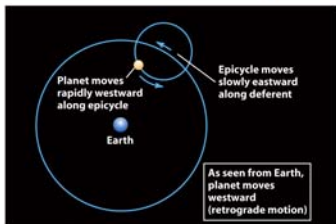
Most Greeks rejected heliocentrism because stars did not exhibit measurable *parallax* (an apparent shift of position with respect to the background during the night).

Either the stars were very far away, or they revolved about Earth daily.



Figure 4-2
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Retrograde motion (loops) was a challenge for geocentric models, requiring a great deal of complexity (e.g., *epicycles* or "circles within circles"....).



Modeling retrograde motion

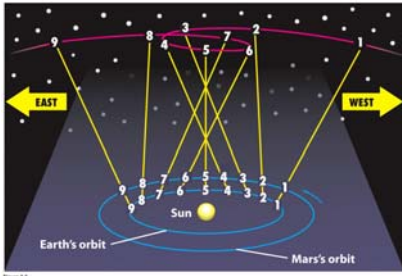


Figure 4.8
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The heliocentric model was able to explain retrograde motion straightforwardly, however, since planets closer to the Sun travel faster than those further away (thus satisfying **Occam's razor** better than geocentric models).



Astronomers of historical importance. From antiquity (left, Ptolemy; right, Hipparchos), and from the 16th & 17th C; (from left to right, Copernicus, Kepler, Brahe, Galilei and Newton).



3. Heliocentrism:

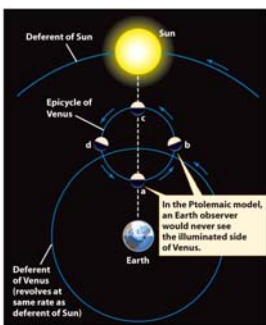


Figure 4.10
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In the 16th C, beginning with Copernicus, the heliocentric model gained favour with scientists. There were many reasons besides the explanation of retrograde motion including:

- Planetary phases (as seen through telescopes) expected in a geocentric model were sometimes quite different from those observed...

