Introduction to Astronomy

“The oldest science”

Scientific Method - a method to study nature, not a compilation of “facts” - no absolute truth!

(1) Collect, correlate, and interpret data from observable world

(2) Build models, make testable predictions for future observations

(3) If a model survives numerous successful tests => “theory” or “law”

Astrophysics - application of laboratory physics to astronomical phenomena, with the additional potential to discover new physics.

Astrology

- If Sun (day/night) and Moon (tides) affect our lives, why not the planets and stars as well?
- Signs of the Zodiac based on presence of Sun in each of 12 Zodiac constellations at different times of the year
- System based on that of Babylonians. But the system is out of date! Sun was in Aries at vernal equinox, back in 300 B.C., but is now in Pisces, and nearly in Aquarius. Shift of annual solar position in Zodiac constellations due to Earth's precession.

History of Astronomy

Origins - keeping track of calendar; astrology

Ancient contributors - Babylonians, China, India, …

Greeks, ~600 BC to 400 AD, develop geometry and mathematical models

Some highlights of Greek astronomy:

Plato (428 - 348 BC) - uniform circular motion

Aristotle (384 - 322 BC) - model of universe, a geocentric model in which all objects are spherical

Aristarchos (310 - ~230 BC) - relative distance of Sun and Moon and heliocentric solar system

Eratosthenes (276 - ~195 BC) - size of spherical Earth

History of Astronomy (continued)

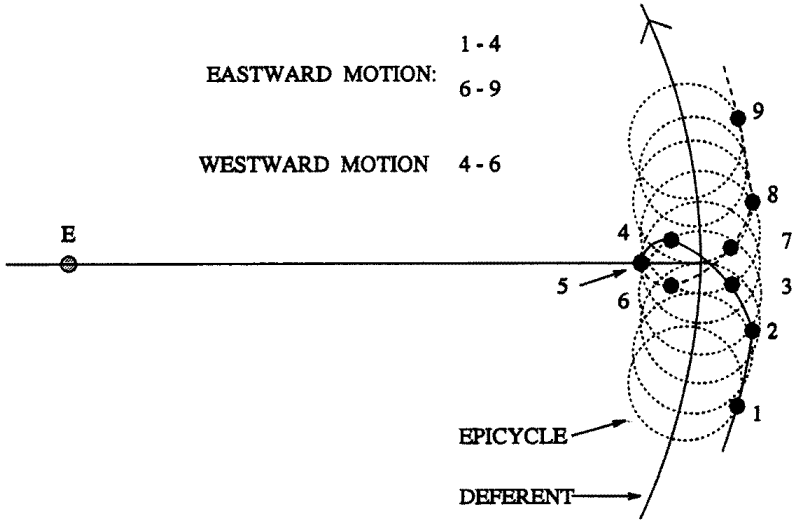
Hipparchos (2nd century BC) - star catalogues, detected precession of equinoxes

Ptolemy (~125 AD) - ‘The Almagest’ (13 volumes on Greek astronomy) => Ptolemaic universe

Basic assumption: planetary motions can be explained by a combination of uniform circular motions

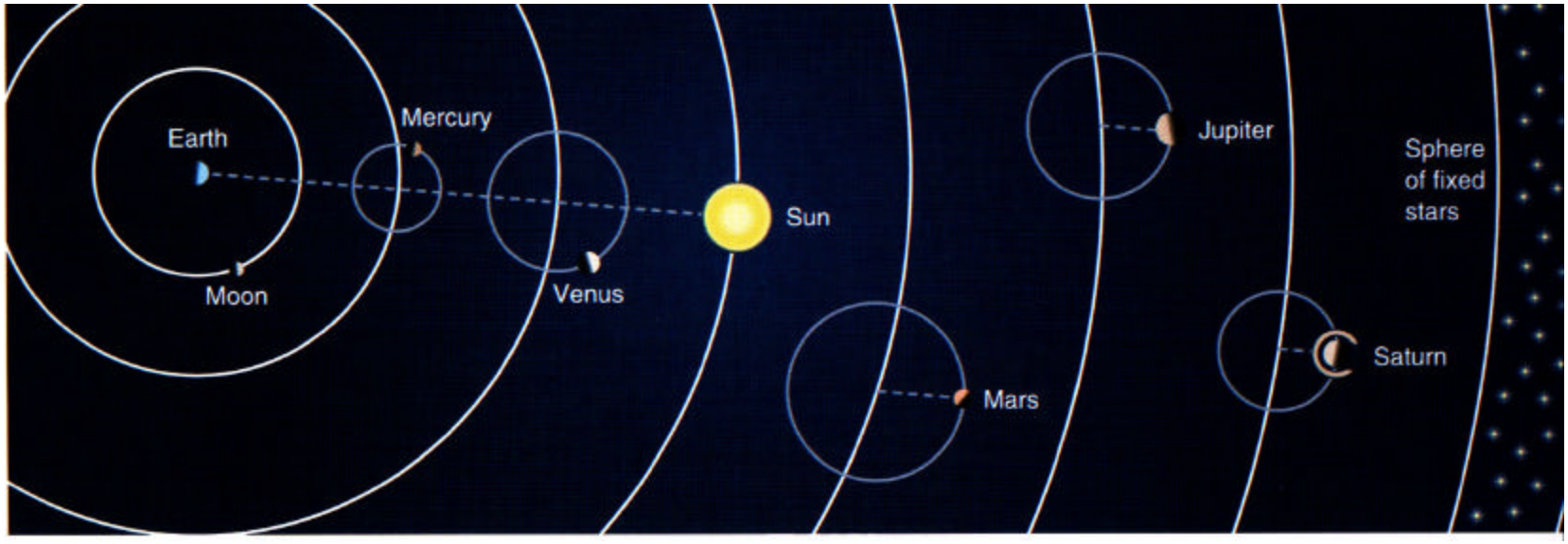
Ptolemy's System

Explanation of retrograde motions in terms of epicycles.



Planets move in epicycles which revolve around larger circles known as deferents.

Ptolemy's System



Require centers of epicycles of Mercury and Venus to lie along Earth-Sun line, but other planets are free of this restriction. Earth actually slightly off center in complete model!

Model expanded continuously to account for more accurate position measurements. In use for > 1400 yrs, leading to 240 circles by middle ages.

Rise of Modern Astronomy and Astrophysics

Copernicus (1473-1543) - heliocentric model, “On the Revolution of Heavenly Spheres” => revolutionary! Published after death.

Tyco Brahe (1546-1601) - large body of highly accurate data

Kepler (1571-1630) - used Brahe’s data to calculate planetary orbits => Kepler’s Laws of Motion

Galileo (1564-1642) - used telescope to confirm many aspects of heliocentric model

Newton (1642-1727) - Theory of Gravitation & Laws of Motion explained motion of planets, occurrence of tides,…

Led to modern astrophysics.