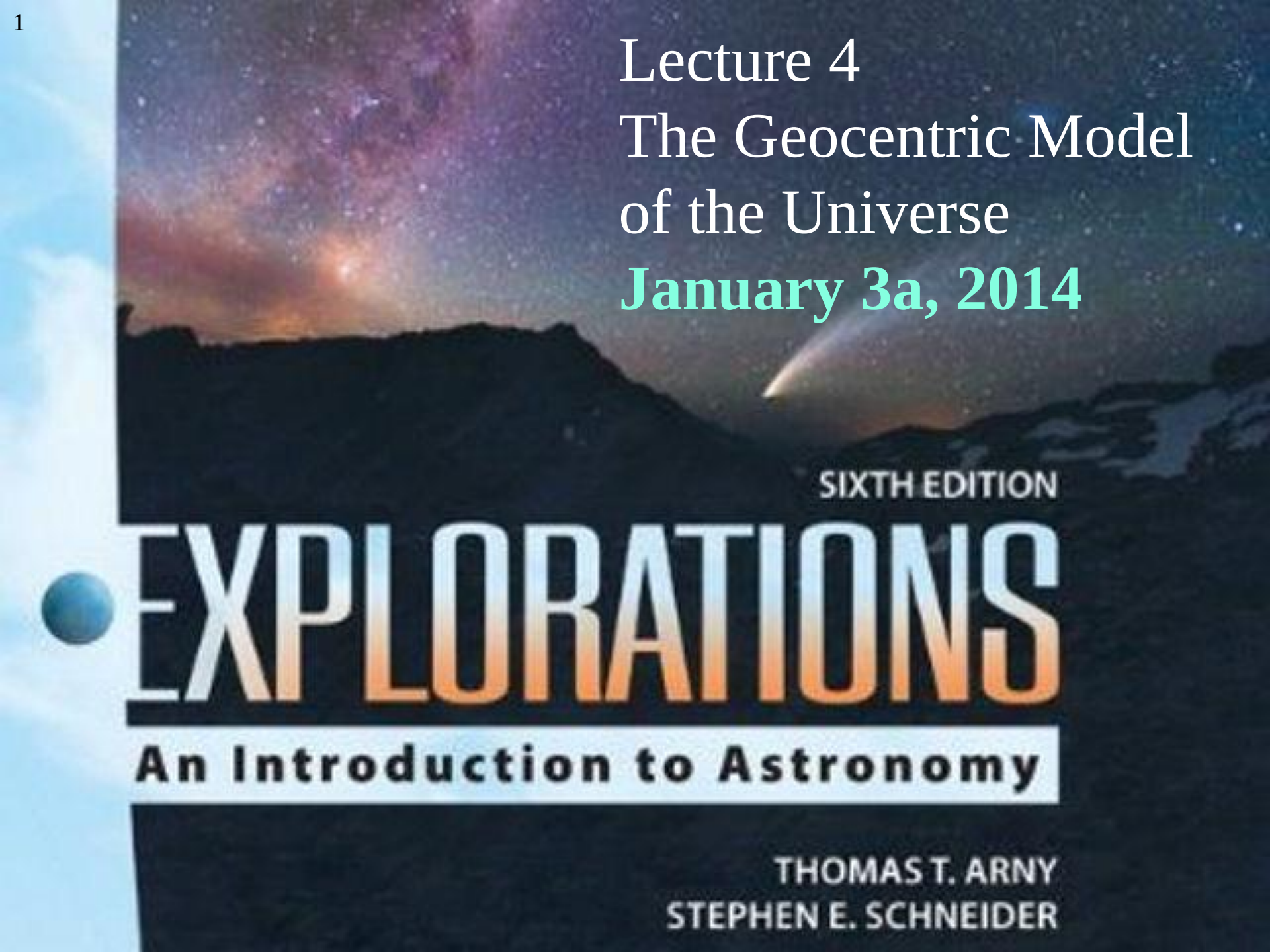


Lecture 4

The Geocentric Model of the Universe

January 3a, 2014



SIXTH EDITION

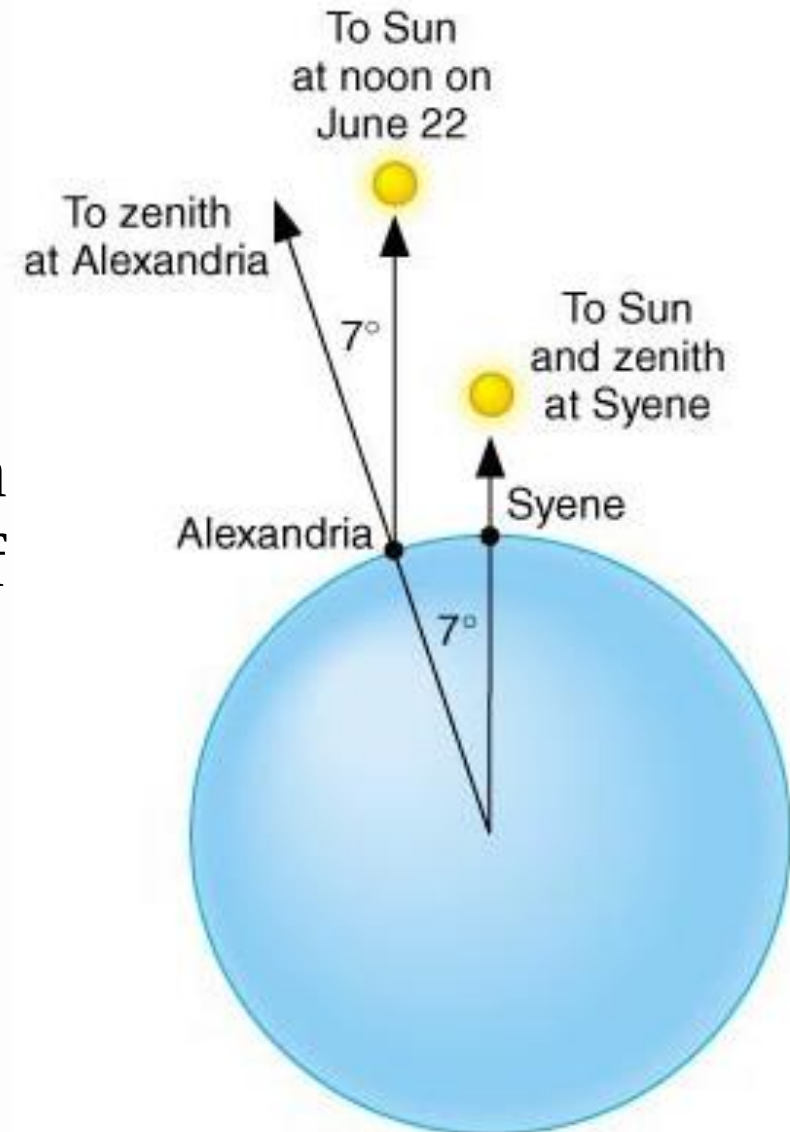
EXPLORATIONS

An Introduction to Astronomy

THOMAS T. ARNY
STEPHEN E. SCHNEIDER

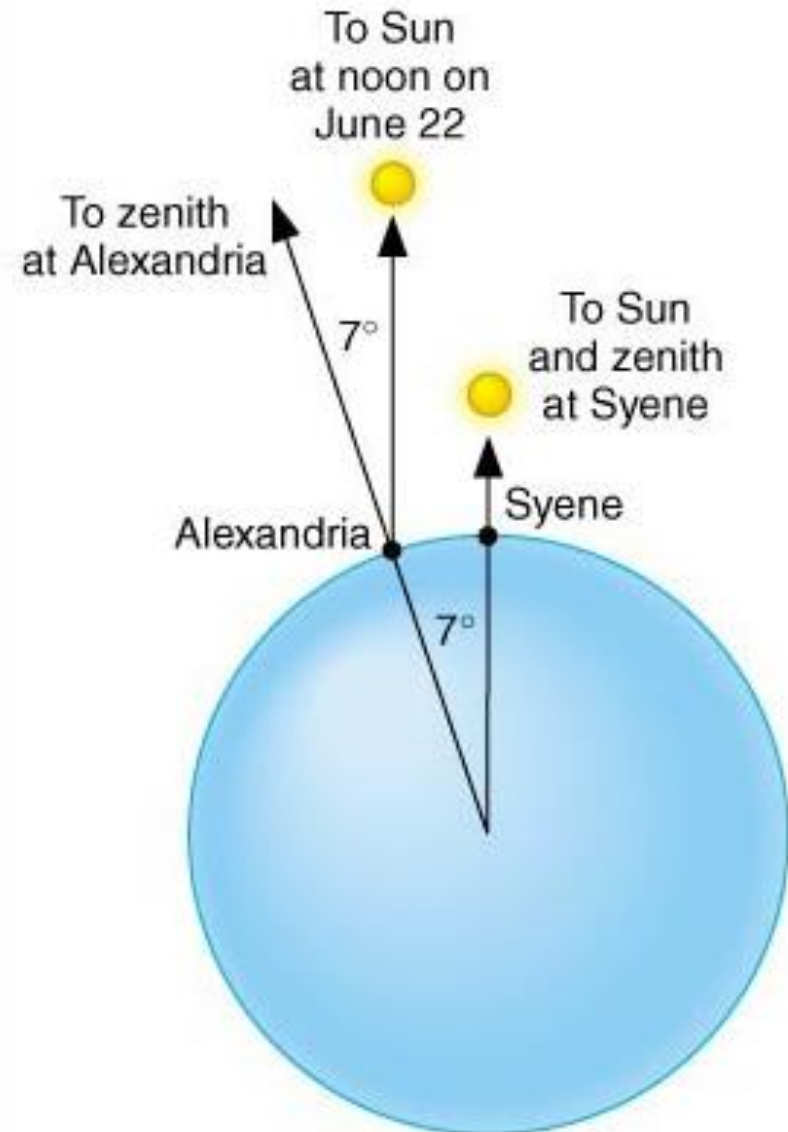
² Size of the Earth – Eratosthenes (200 BC)

- In Syene, Egypt, the Sun would shine straight down wells at noon on the summer solstice (June 21)
 - The Sun is at zenith at noon on the solstice along the Tropic of Cancer (23.5° north latitude)
- In Alexandria, the Sun was $7^\circ 12'$ south of zenith at that time.



Size of the Earth

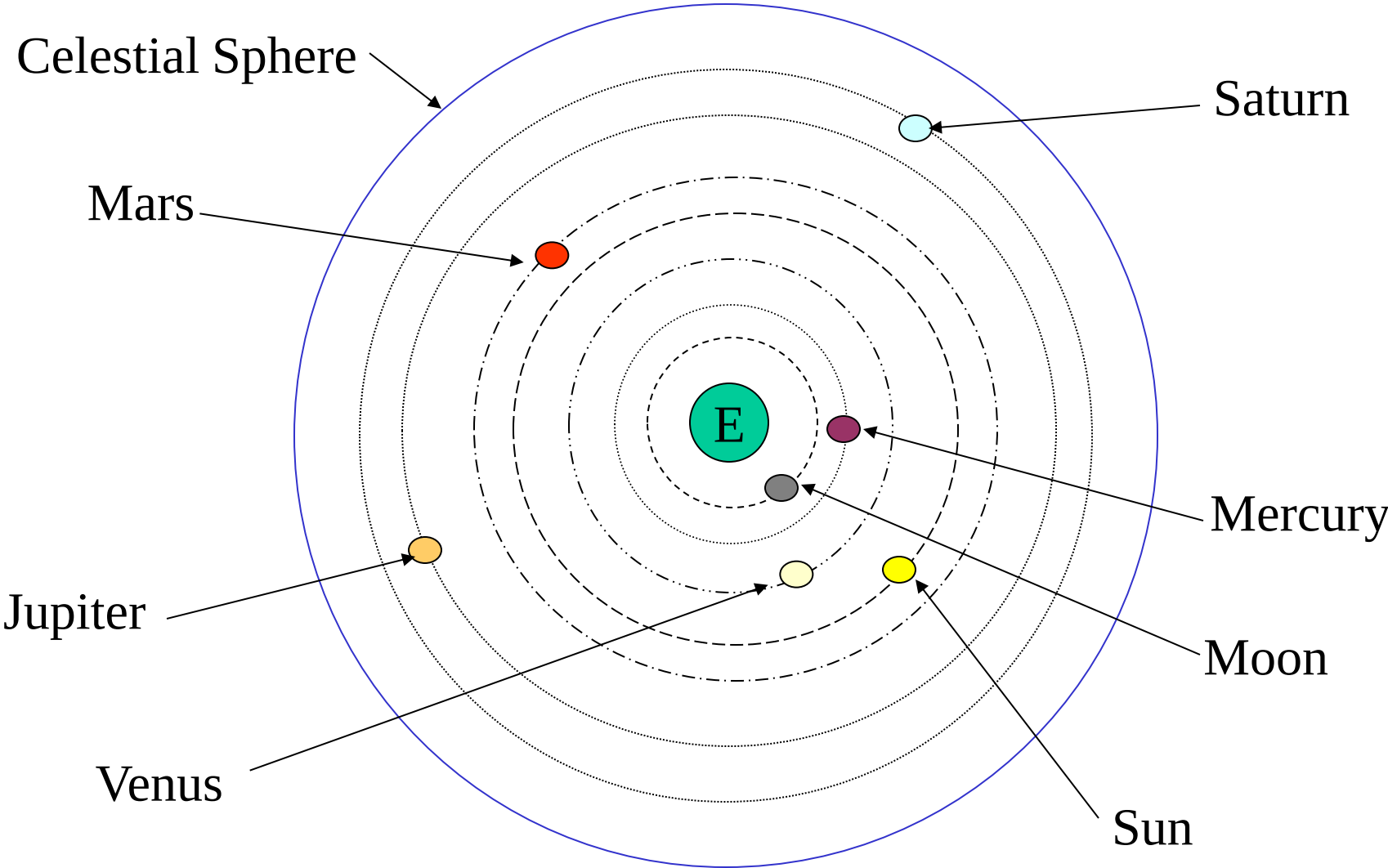
- $(7^\circ 12')/360^\circ = 1/50$ Therefore, the distance from Syene to Alexandria = $1/50$ circumference of Earth
- Circumference of Earth $\sim 40,000$ km
- Actual = 40,074 km
- In reality, [Eratosthenes](#) made a number of errors that tended to cancel out, producing a remarkably accurate estimate



The Geocentric Universe

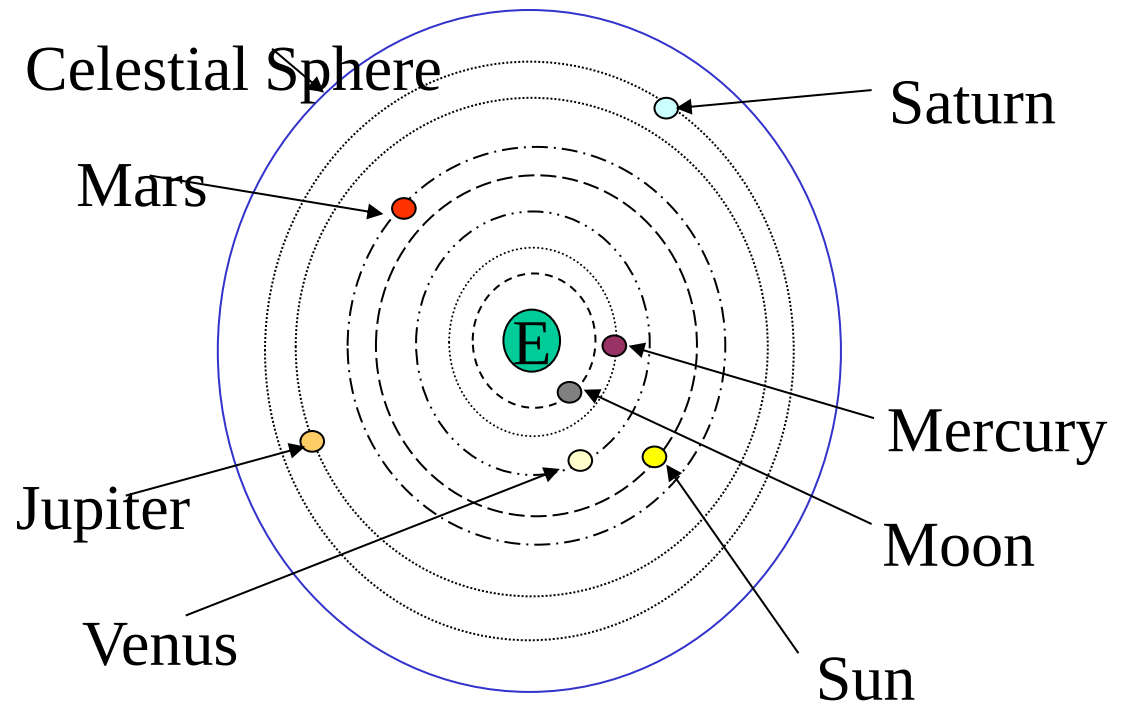
- Ancient people (Aristotle) “knew” from observations that
 - The stars appear fixed on the sky relative to each other.
 - Planets, moon and sun change position with respect to the stars.
 - Mercury and Venus only seen near sun.
- These observations led them to theorize that the Earth is at the center and all objects move around it.

Basic Geocentric View



Basic Geocentric View

- Order of planets somewhat arbitrary.
- Mercury and Venus always orbit at a velocity that keeps them near the Sun.

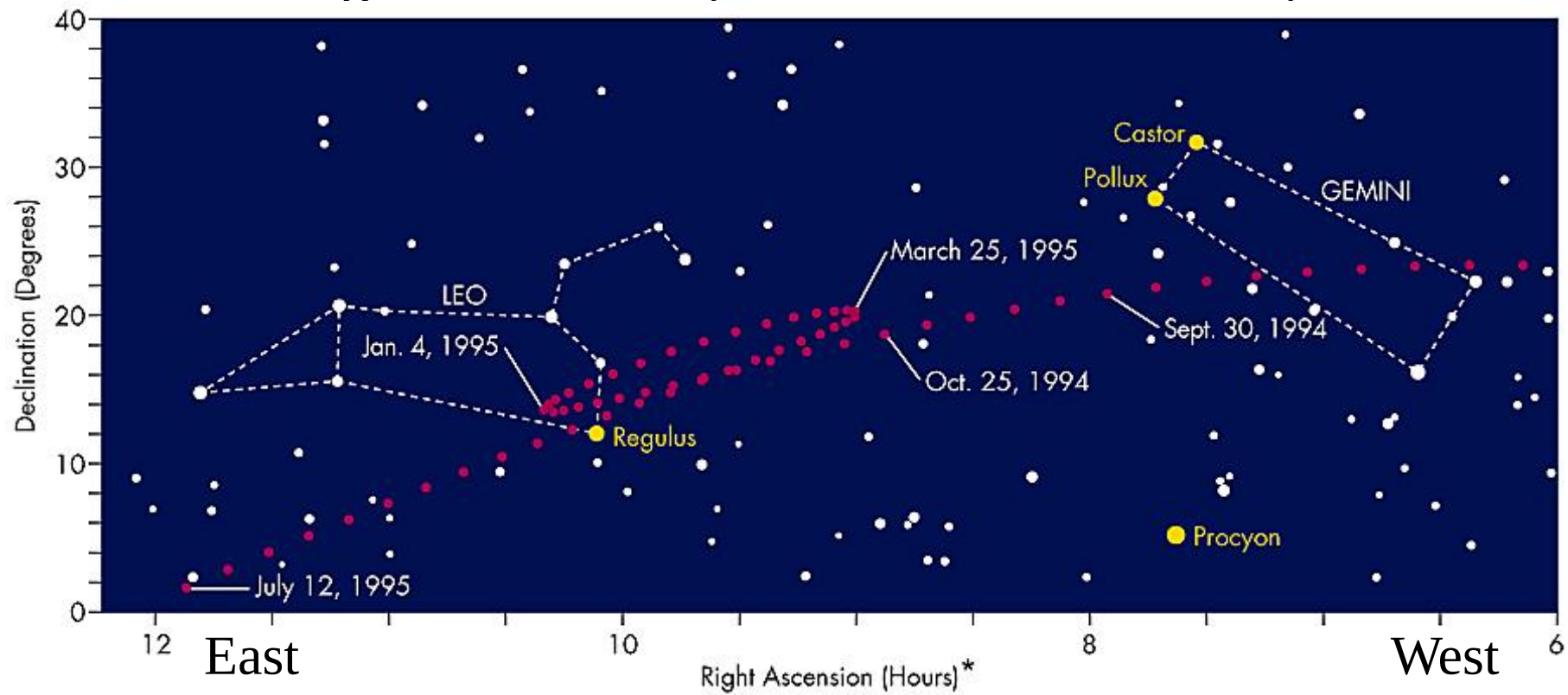


Retrograde Motion

- Planets usually move from west-to-east in the sky with respect to the stars, just like the Sun.
- Sometimes planets go east-to-west in sky, an event called **retrograde motion**.
- Retrograde motion was very hard to explain, representing the main challenge to ancient models of the solar system.

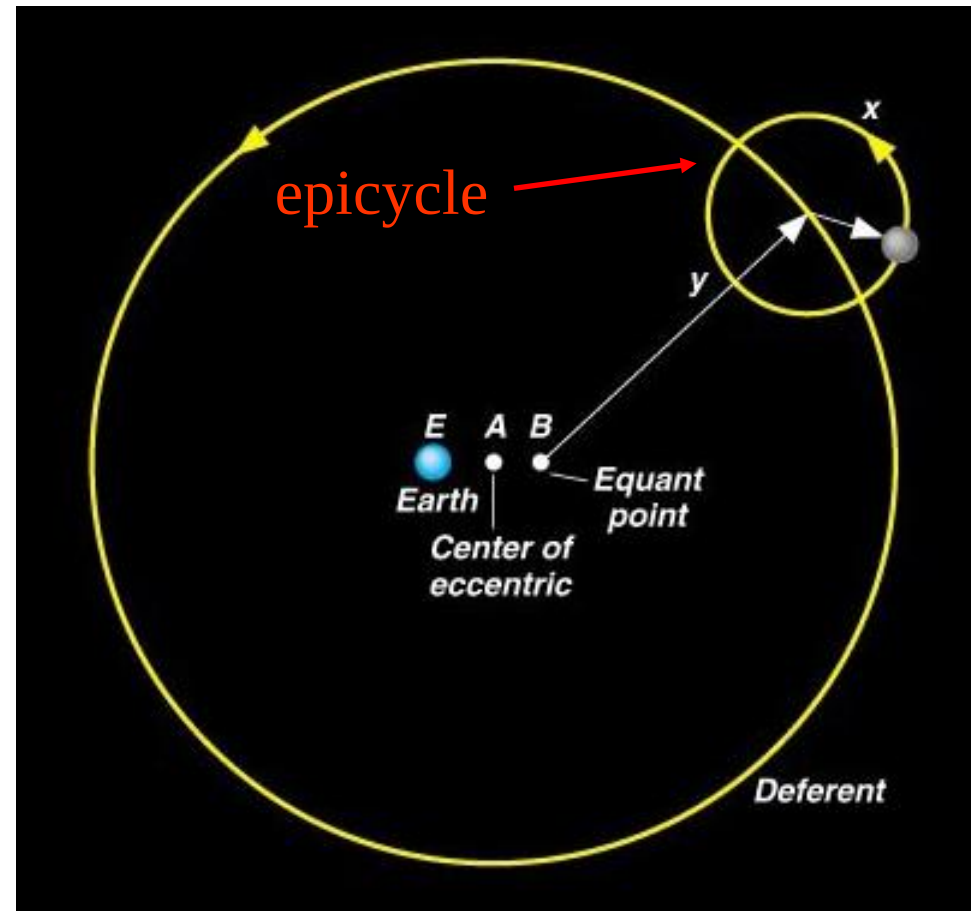
Retrograde Motion

- Direct Motion: Planets usually move from west-to-east in the sky with respect to the stars over long periods of time.
- Retrograde Motion: Planets sometimes change direction and go east-to-west with respect to the stars
- Mars retrograde motion (below and [NASA site](#))



Ptolemy (140 AD)

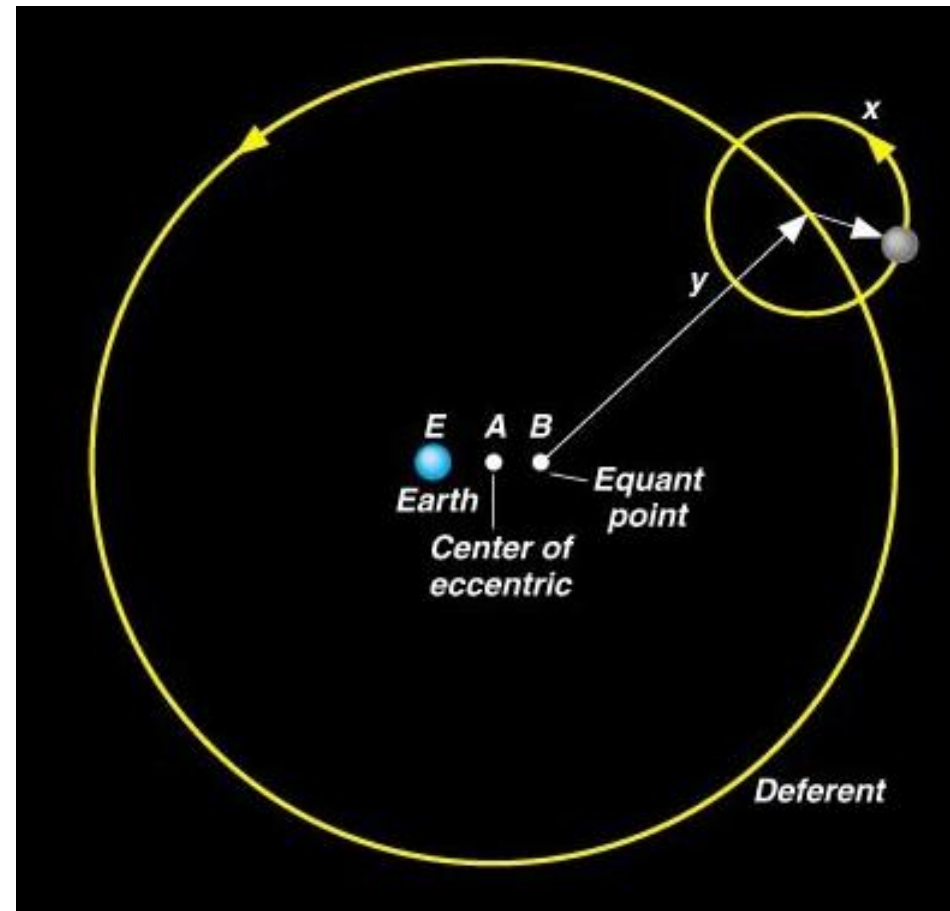
- Planets move on “epicycles”
- Epicycles moved on deferent that was centered not on the Earth, but on an equant point.
- All motions were on circles (“perfect shape”)



Ptolemy (140 AD)

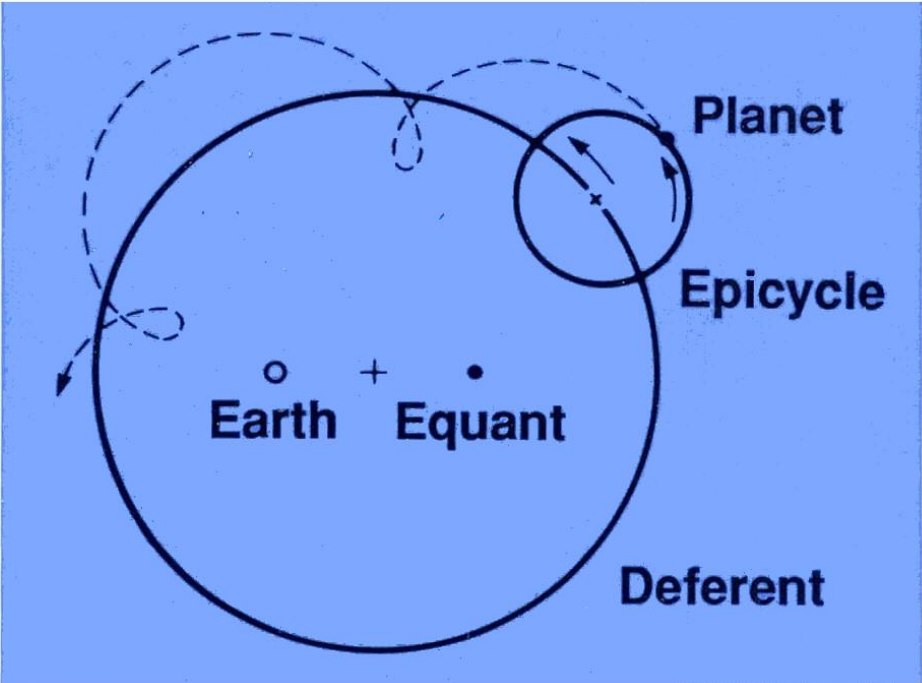
- Size and rates of motion on epicycles was calculated using tabulated data
 - Hipparchus
 - Ptolemy
- Predicted positions of planets with respect to stars with **great accuracy**.
- This theory was accepted for ~15 centuries!

[Java animation of Ptolemy's model](#)



Epicycle and deferent

Seeds/Horizons, 3rd ed., Fig. 4-6; Foundations of Astronomy, 1990 ed., Fig. 4-12



© 1991 Wadsworth, Inc.

The Ptolemaic system

Seeds/Horizons, 3rd ed., Fig. 4-7; Foundations of Astronomy, 1990 ed., Fig. 4-13

