Lecture 8: September 10, 2010

- What is the total mass of the human race?
- What is the total mass of the mosquito species?

Announcements: Homework due today.
Leave on front desk

2.5 The Moon, Our Constant Companion

Our goals for learning:

- Why do we see phases of the Moon?
- What conditions are necessary for an eclipse?
- Why were eclipses difficult for ancient peoples to predict ?

Lunar Motion

The Moon like the sun also moves gradually eastward through the constellations, but the Moon only takes 29.5 days to complete cycle unlike 1 yr for the Sun.

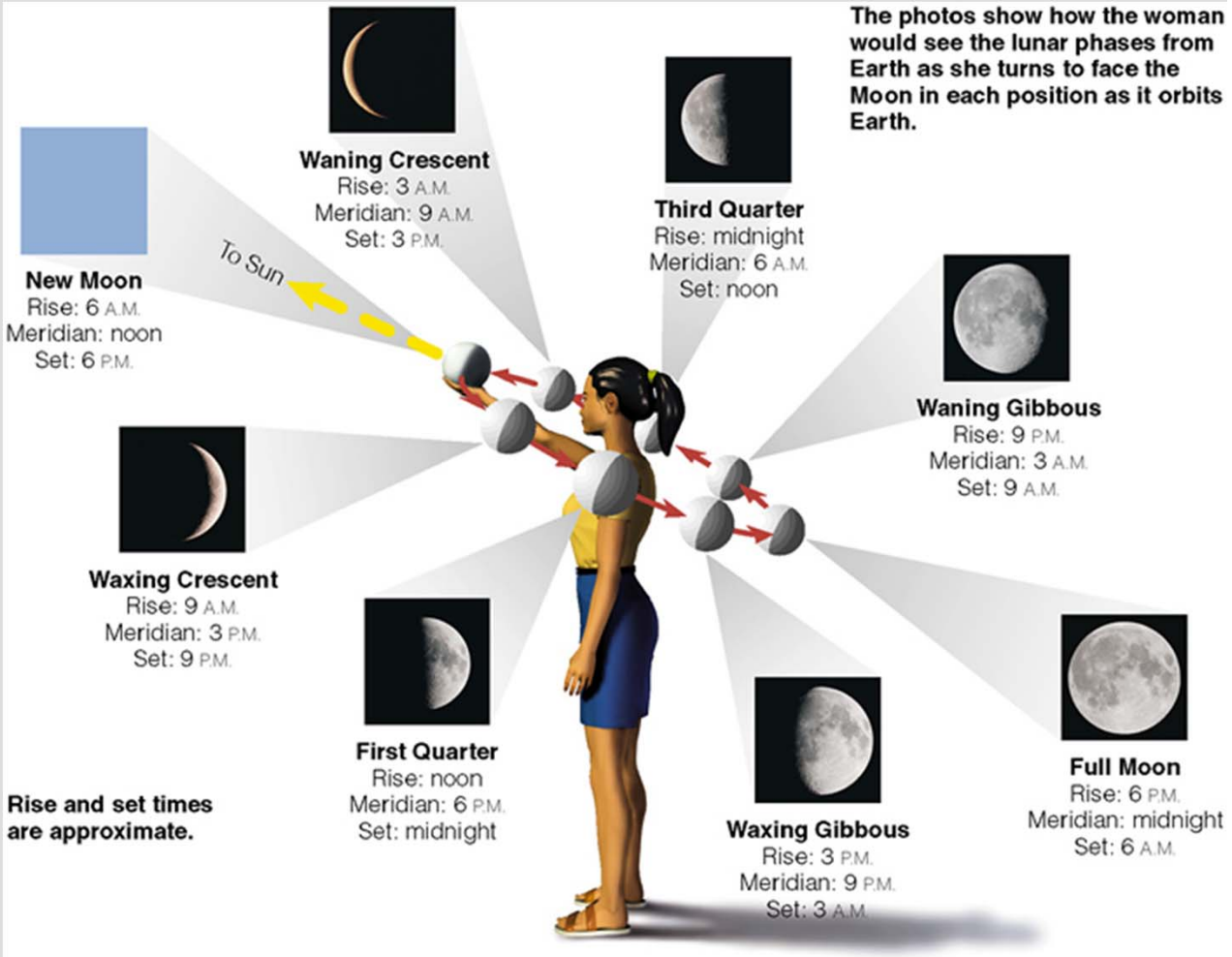
- new
- crescent
- first quarter
- gibbous
- full
- gibbous
- last quarter
- crescent

waxing

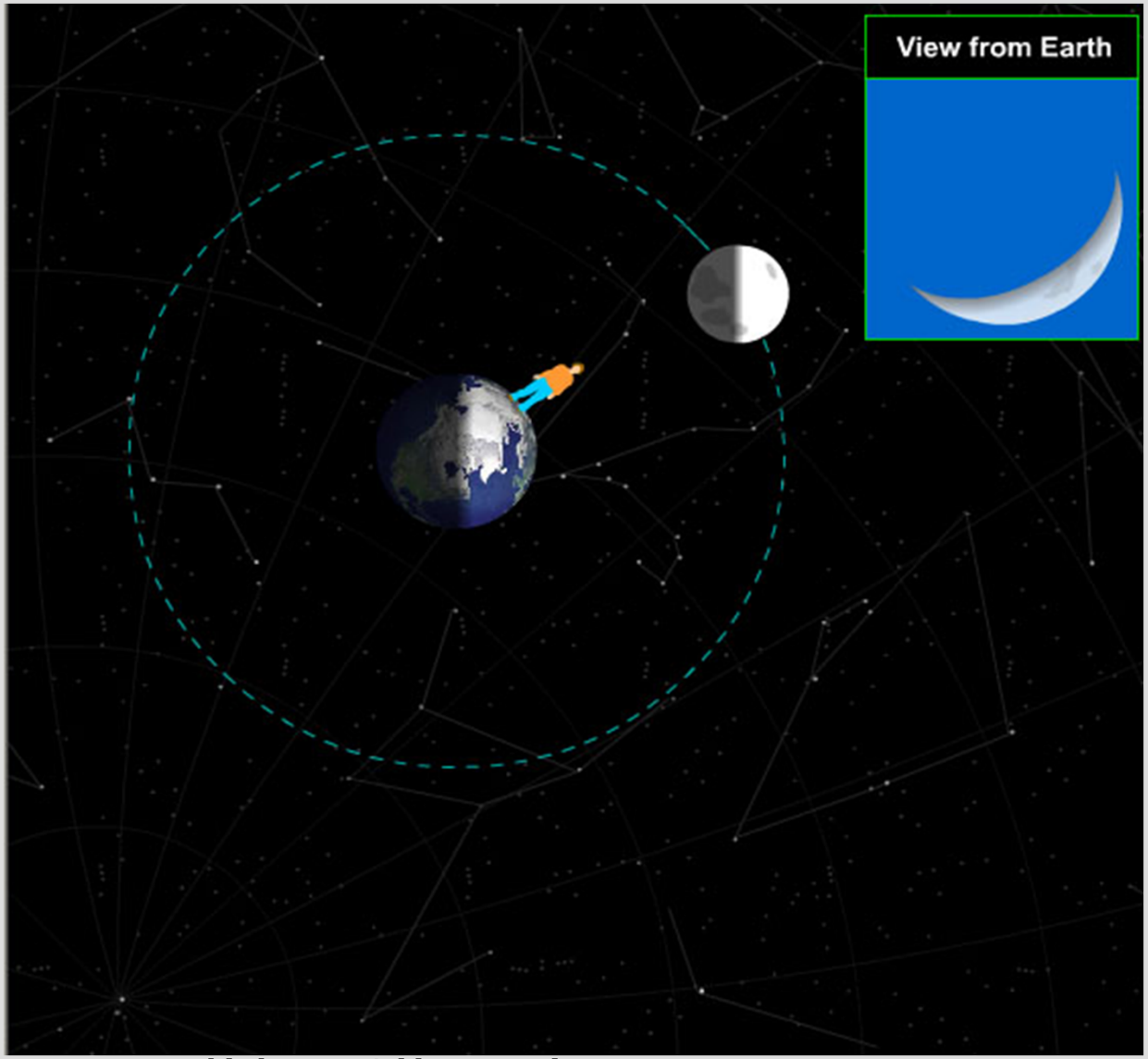
waning

Why do we see phases?

- Half the Moon illuminated by Sun and half dark
- We see some combination of the bright and dark faces
- IF How to simulate phases



Phases of the Moon

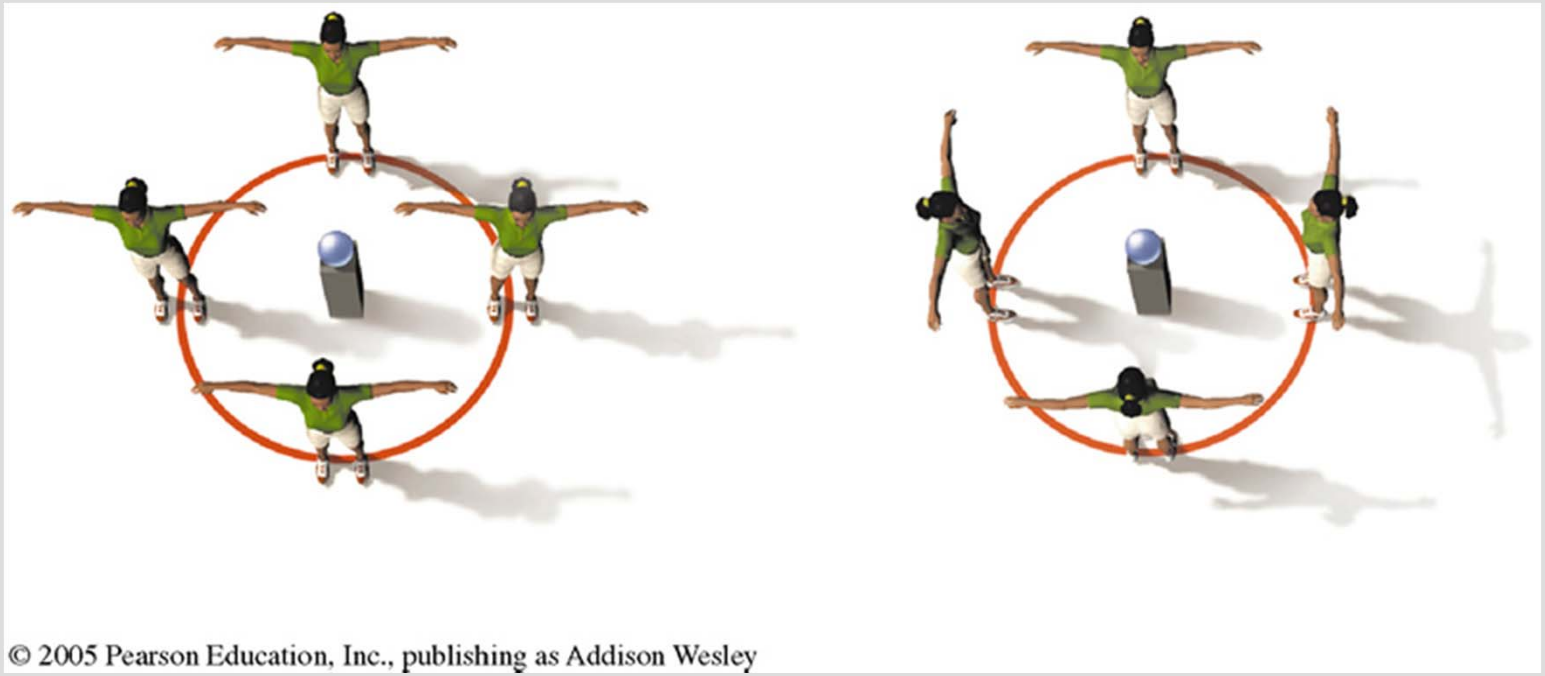


Telling Time by the Moon

- Do at board

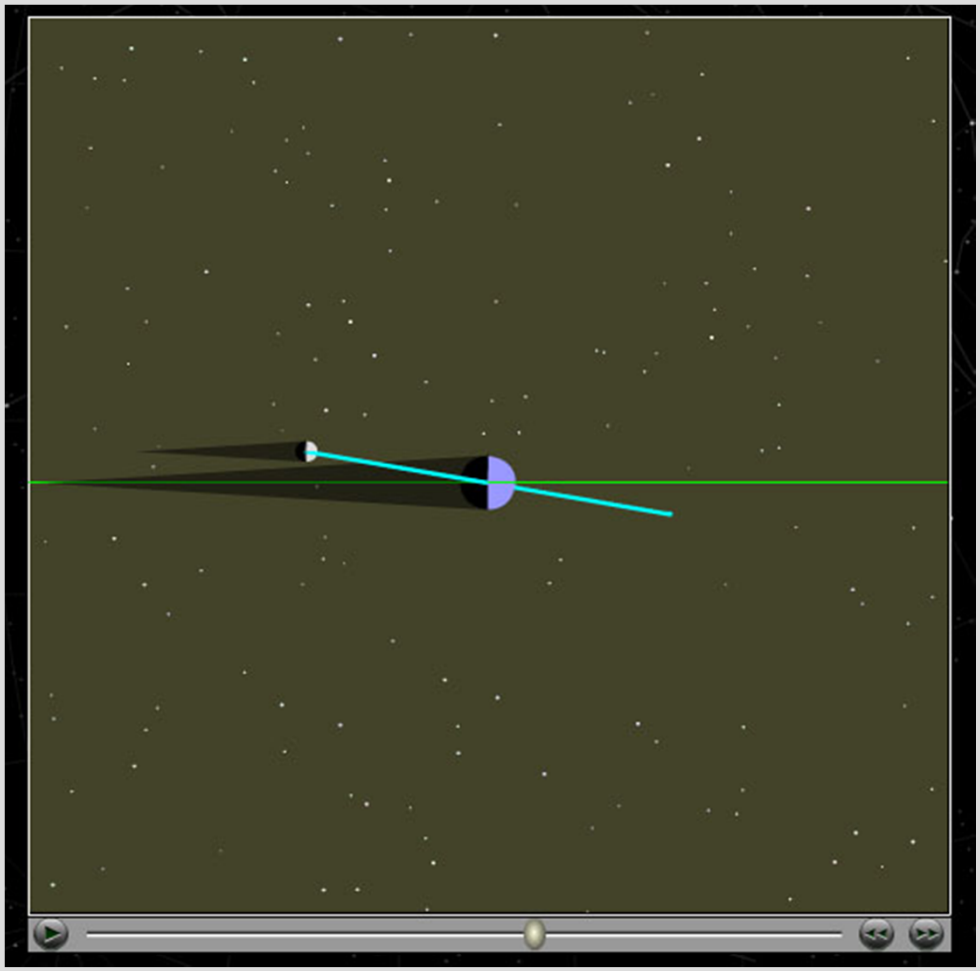
Why do we see the same face?

Rotation period = orbital period



Eclipses

- The Earth & Moon cast shadows.
- When either passes through the other's shadow, we have an **eclipse**.
- Why don't we have an eclipse every full & new Moon?
- IF Cause of Eclipses 2
- IF Tilt of Moon's orbit



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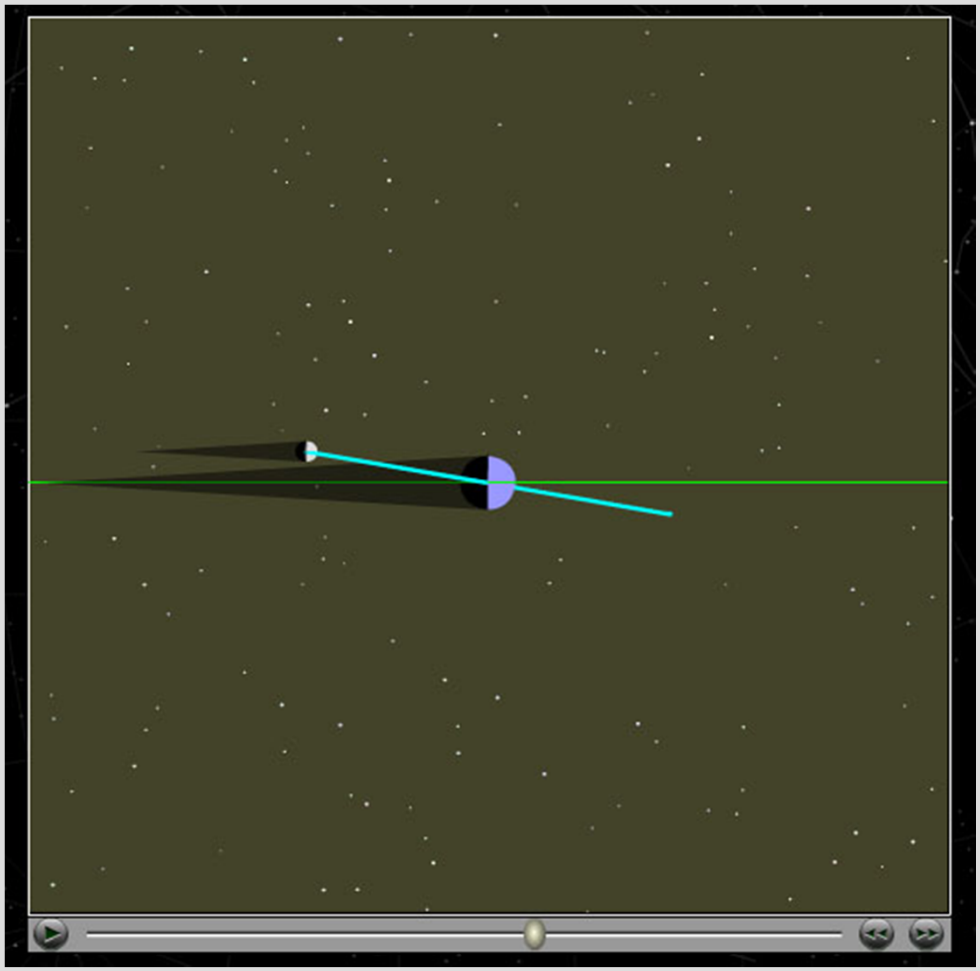
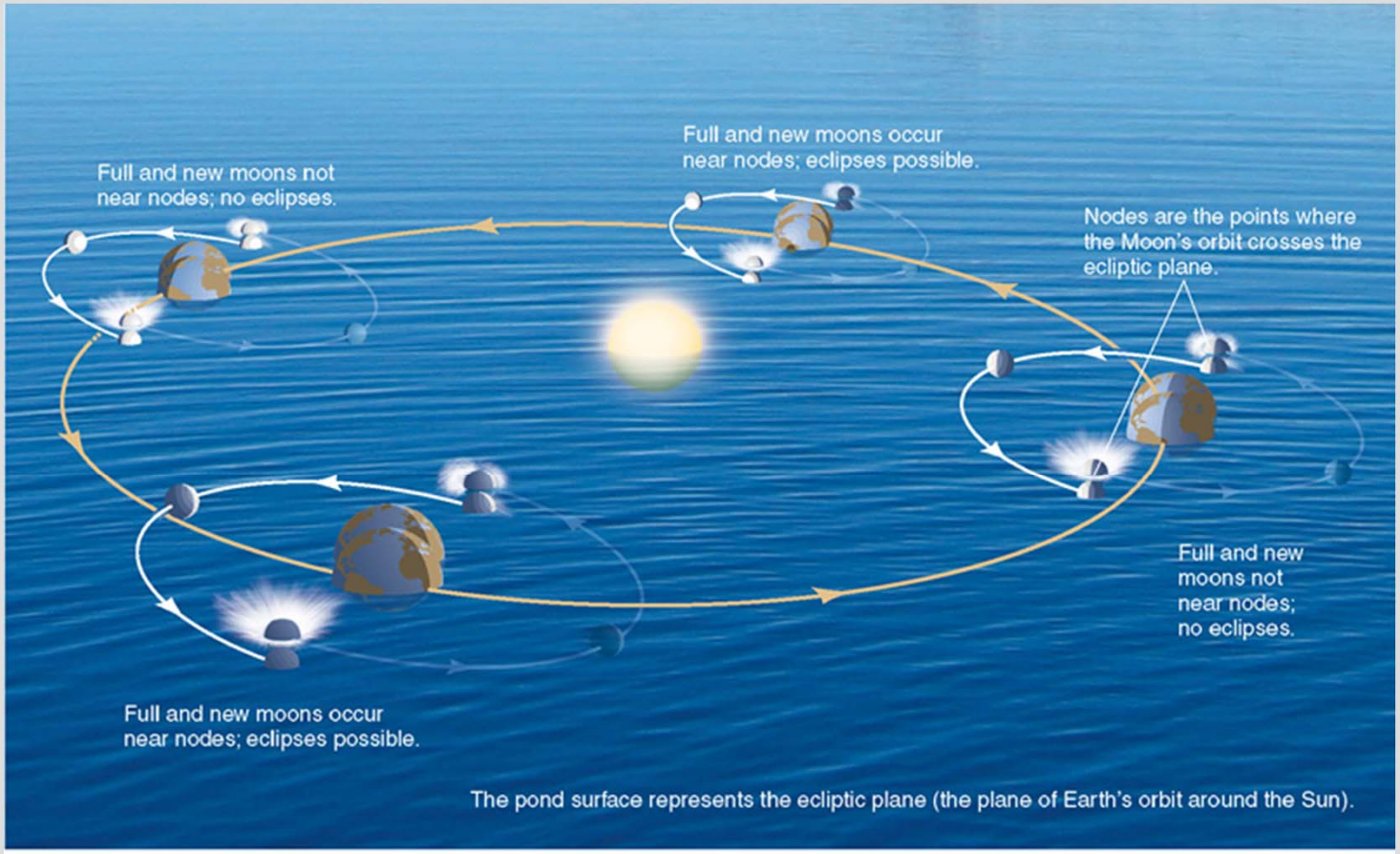


- Moon's orbit tilted 5° to ecliptic plane
  - Crosses ecliptic plane only at the two **nodes**
  - Eclipse possible only when full/new occur near nodes



Eclipses

Moon's orbit tilted 5° wrt ecliptic. Eclipses occur when Moon's orbit intersects the ecliptic (node):

at new moon — solar eclipse

you must be in Moon's shadow to see it

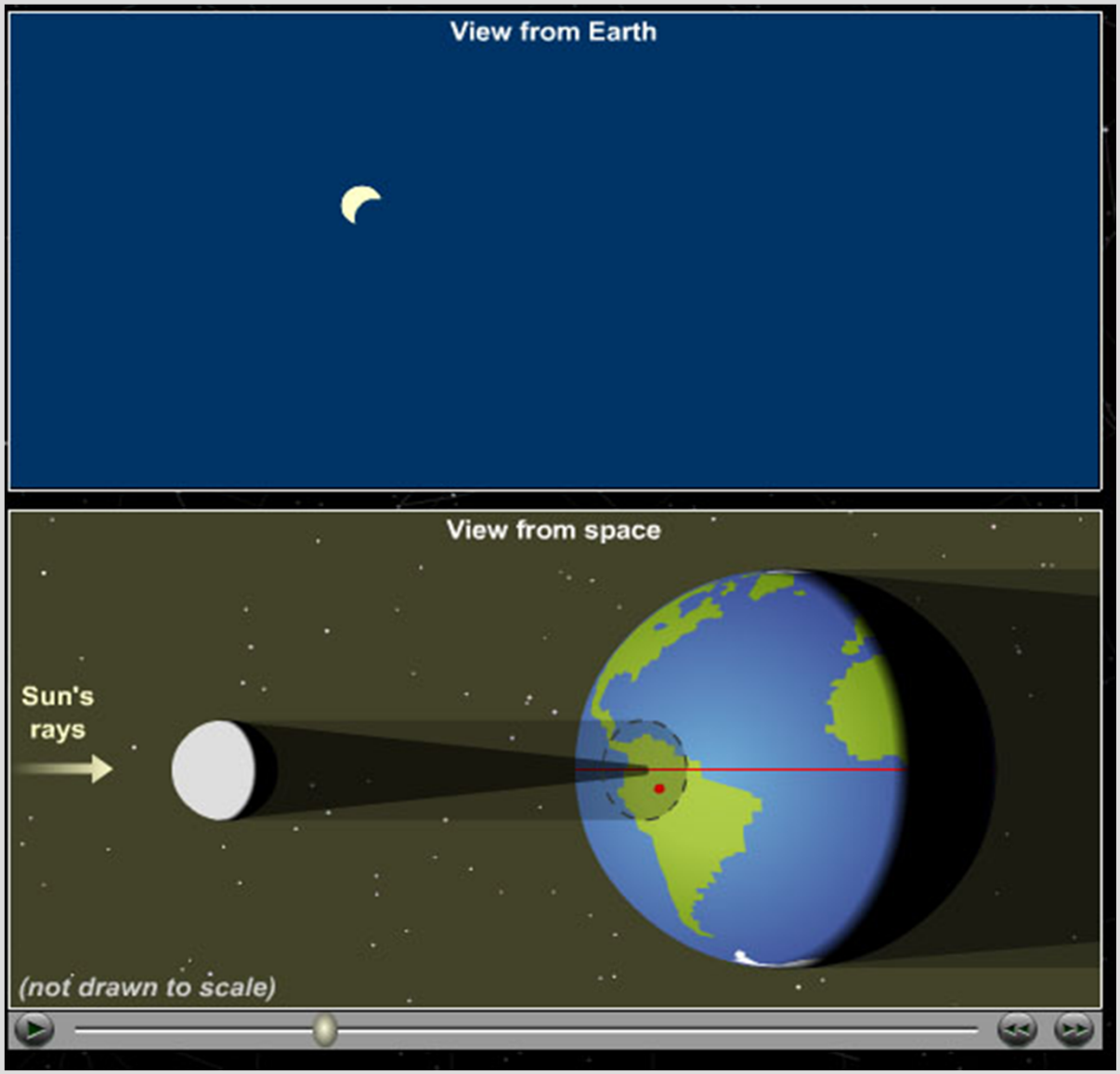
within umbra: total solar eclipse

within penumbra: partial solar eclipse

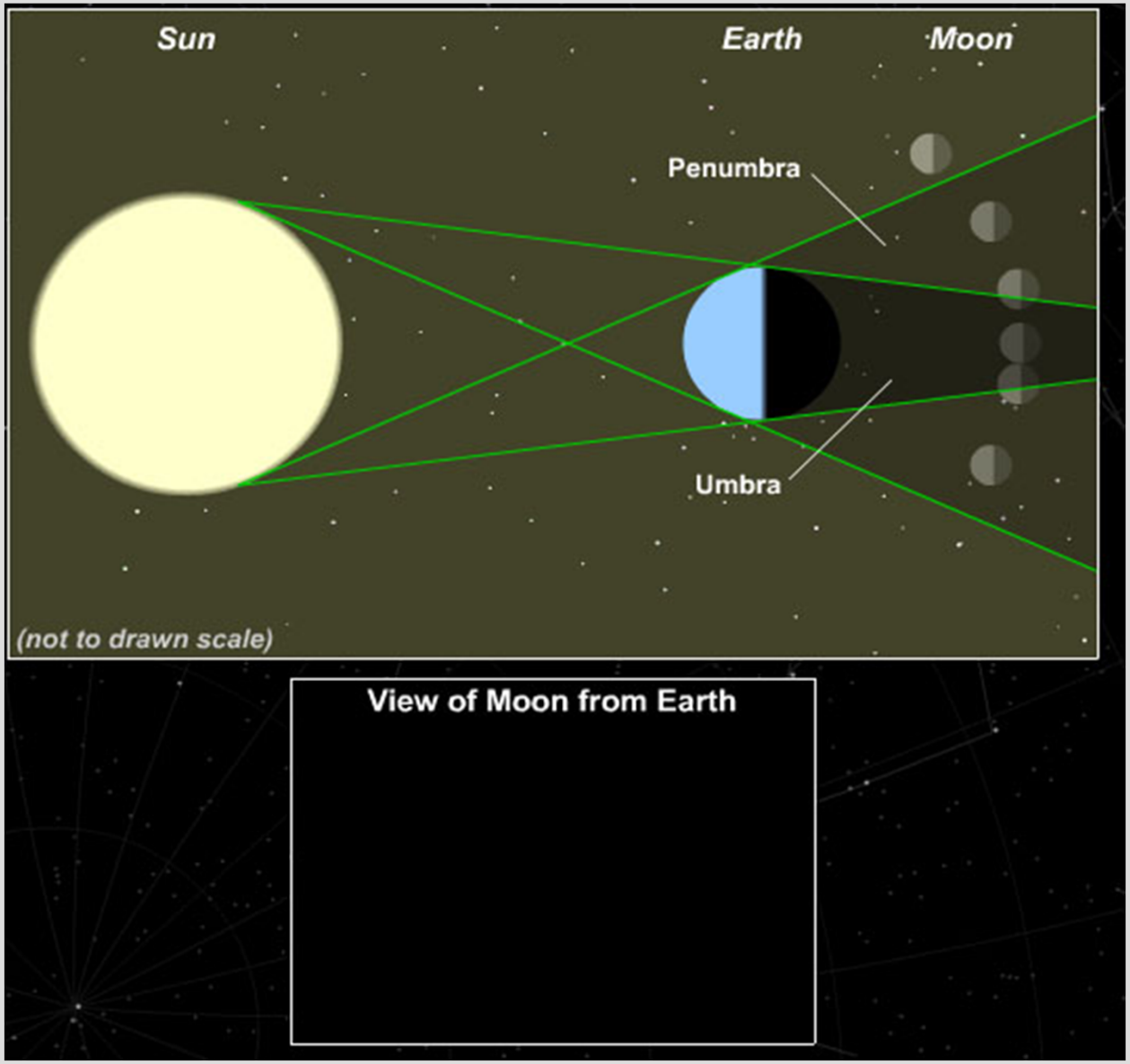
at full moon — lunar eclipse

everyone on the nighttime side of Earth can see it

Solar Eclipse
IF Evolution of Total/Partial Solar Eclipse

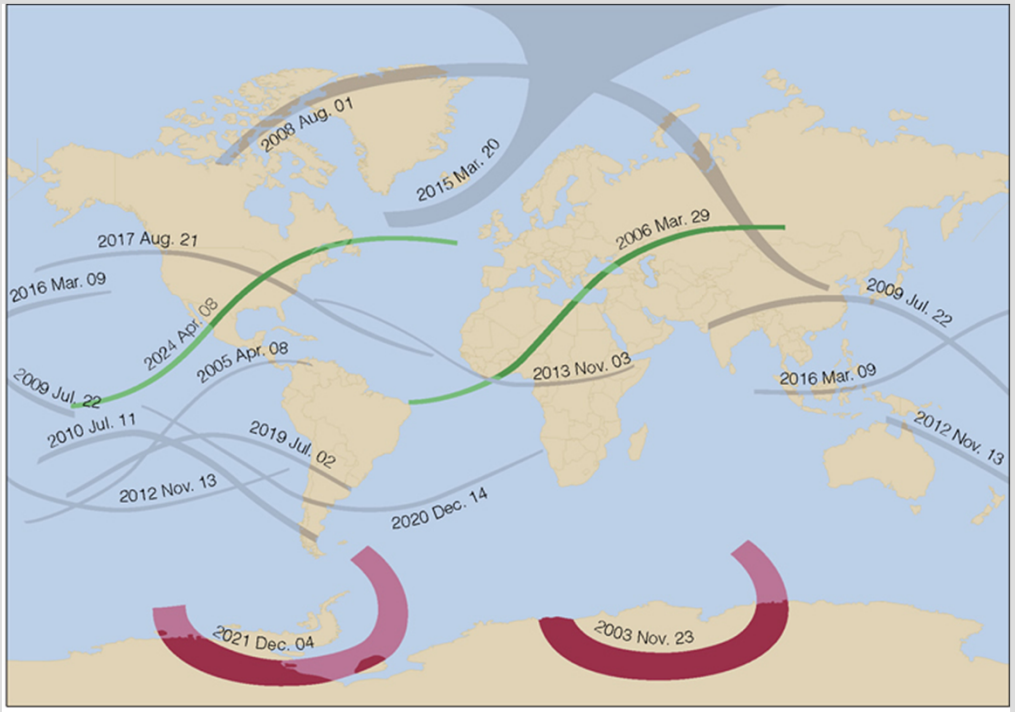


Lunar Eclipse
IF Lunar eclipses



Eclipse Predictions

- Eclipses recur in the approx. 18 yr, 11 1/3 day saros cycle
- But even then, eclipse location and type (e.g., partial, total) may vary



2.6 The Ancient Mystery of the Planets

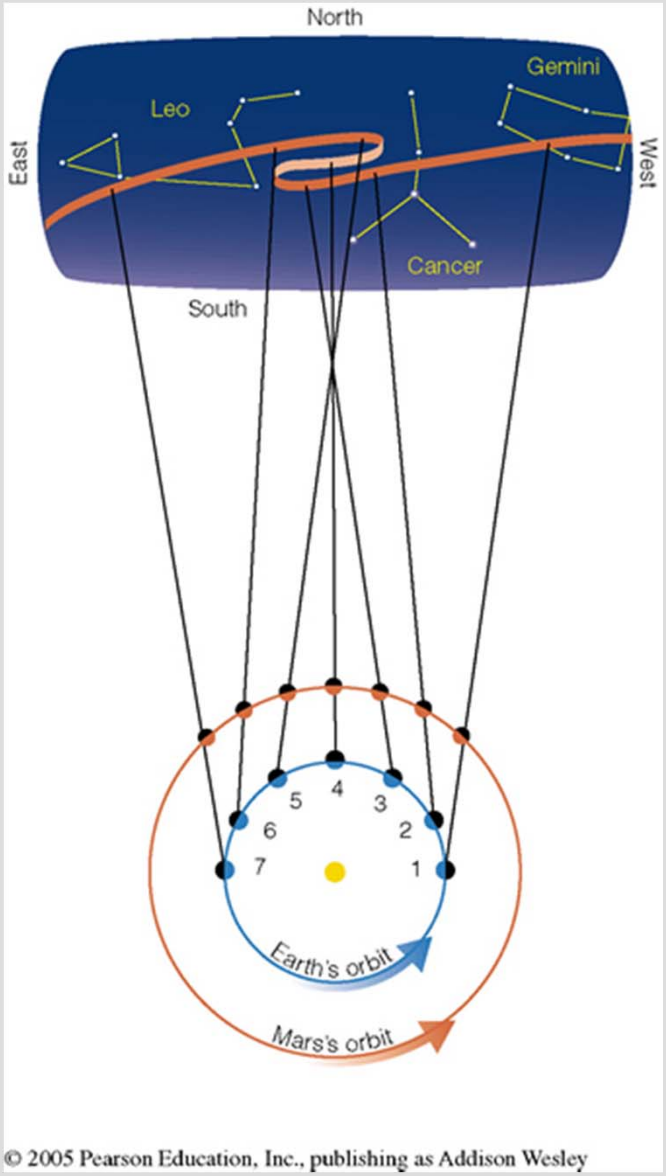
Our goals for learning:

- Why do planets sometimes seem to move backwards relative to the stars?
- Why did the ancient Greeks reject the idea that the Earth goes around the Sun, even though it offers a more natural explanation for planetary motion?

Planets Known in Ancient Times

- Mercury
  - difficult to see; always close to Sun in sky
- Venus
  - very bright when visible — morning or evening “star”
- Mars
  - noticeably red
- Jupiter
  - very bright
- Saturn
  - moderately bright

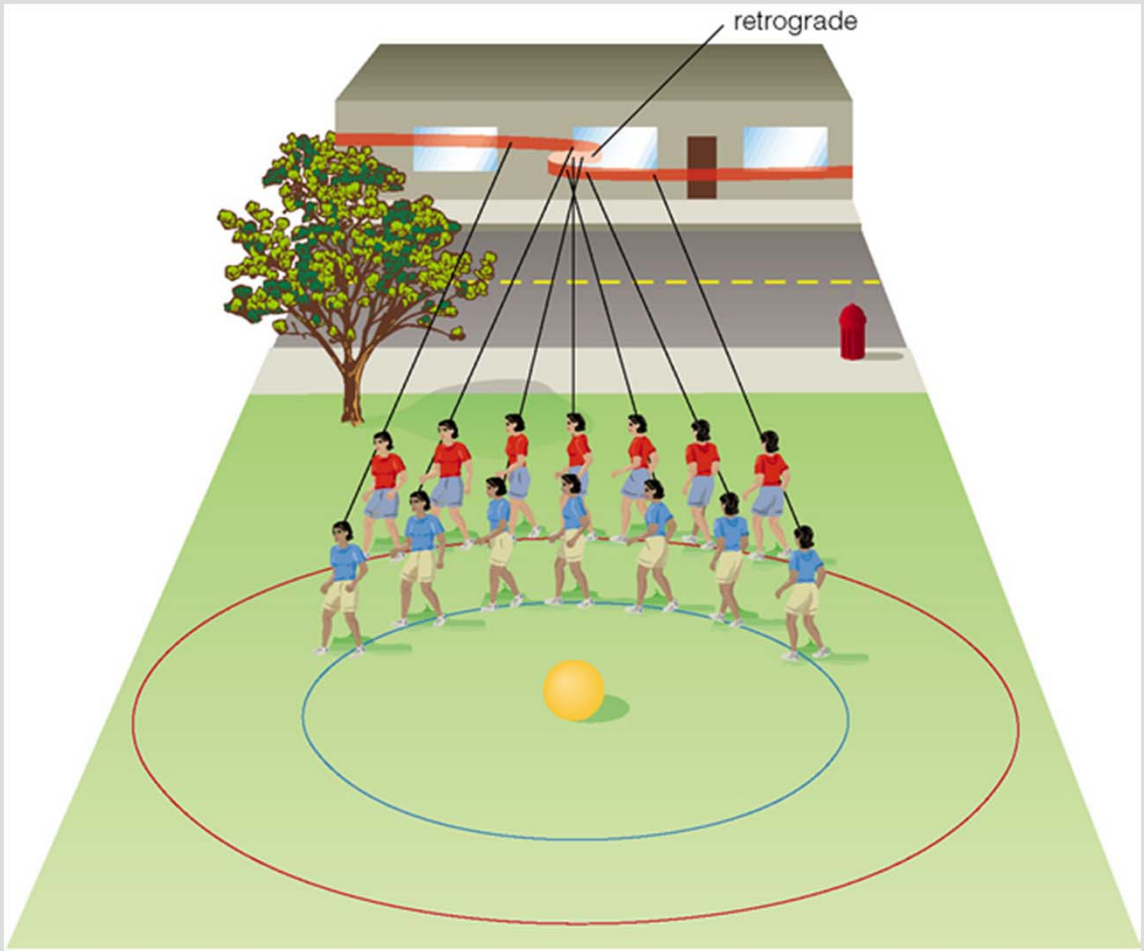
Retrograde Motion



- Like the Sun, planets usually appear to move eastward relative to the stars.
- But as we pass them by in our orbit, they move west relative to the stars for a few weeks or months.

✓ Noticeable over many nights; on a single night, a planet rises in east and sets in west…

Apparent retrograde motion — try it yourself!



Explaining Apparent Retrograde Motion

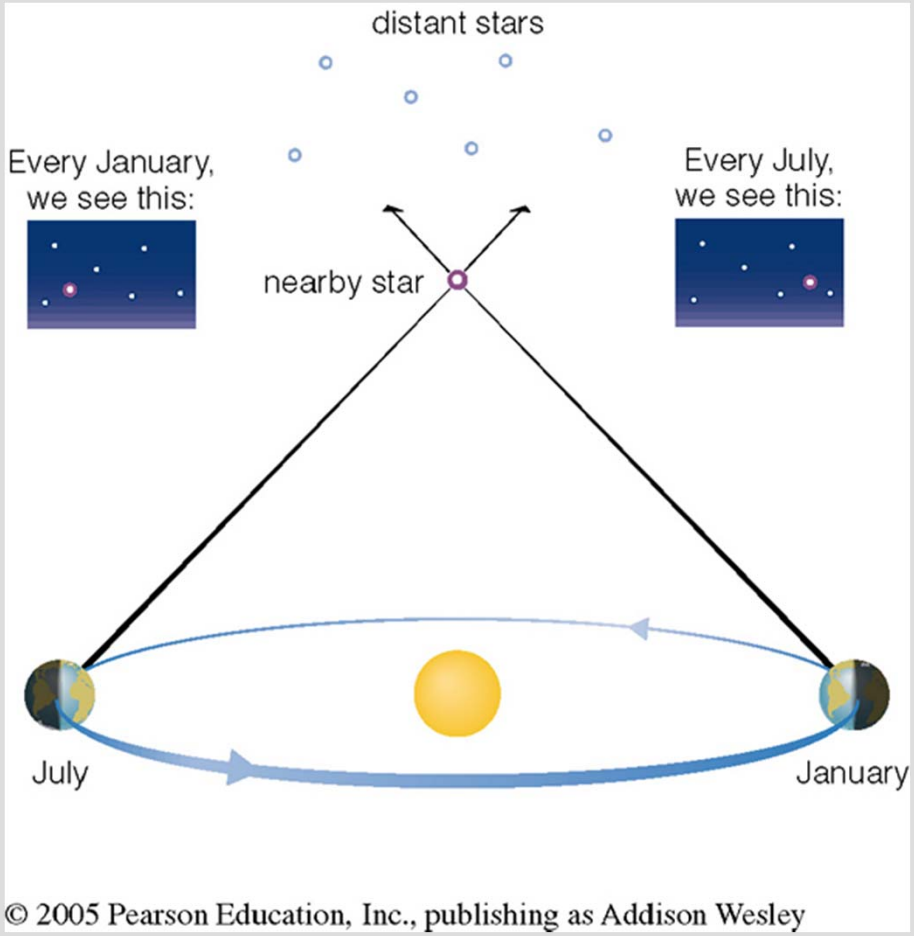
- Easy *for us* to explain: occurs when we "lap" another planet (or when Mercury or Venus lap us)
- But very difficult to explain if you think that Earth is the center of the universe!
- *In fact, ancients considered but rejected the correct explanation…*

Why did the ancient Greeks reject the notion that the Earth orbits the sun?

- It ran contrary to their senses.
- If the Earth rotated, then there should be a “great wind” as we moved through the air.
- Greeks knew that we should see stellar parallax if we orbited the Sun – but they could not detect it.

Parallax Angle

Apparent shift of a star's position due to the Earth's orbiting of the Sun



The nearest stars are <u>much</u> farther away than the Greeks thought.

So the parallax angles of the star are so small, that you need a telescope to observe them.

Possible reasons why stellar parallax was undetectable:

1. Stars are so far away that stellar parallax is too small for naked eye to notice
2. Earth does not orbit Sun; it is the center of the universe

Unfortunately, with notable exceptions like Aristarchus, the Greeks did not think the stars could be *that* far away, and therefore rejected the correct explanation (1)…

Thus setting the stage for the long, historical showdown between Earth-centered and Sun-centered systems.