PHYS 202-
INTRODUCTORY ASTRONOMY AND COSMOLOGY, SECTION 102

Matthew Cooper, with Andrew J. Gerrard

Spring 2024 Syllabus Review

VERIFICATION OF STUDENT PRESENCE

- The U.S. Department of Education has rules that govern the eligibility of students to receive financial aid.

- NJIT must verify that a student is present and attending classes in which s/he is registered before disbursing any financial aid to the student.

ASTRONOMY

Chapter 2 OBSERVING THE SKY: THE BIRTH OF ASTRONOMY

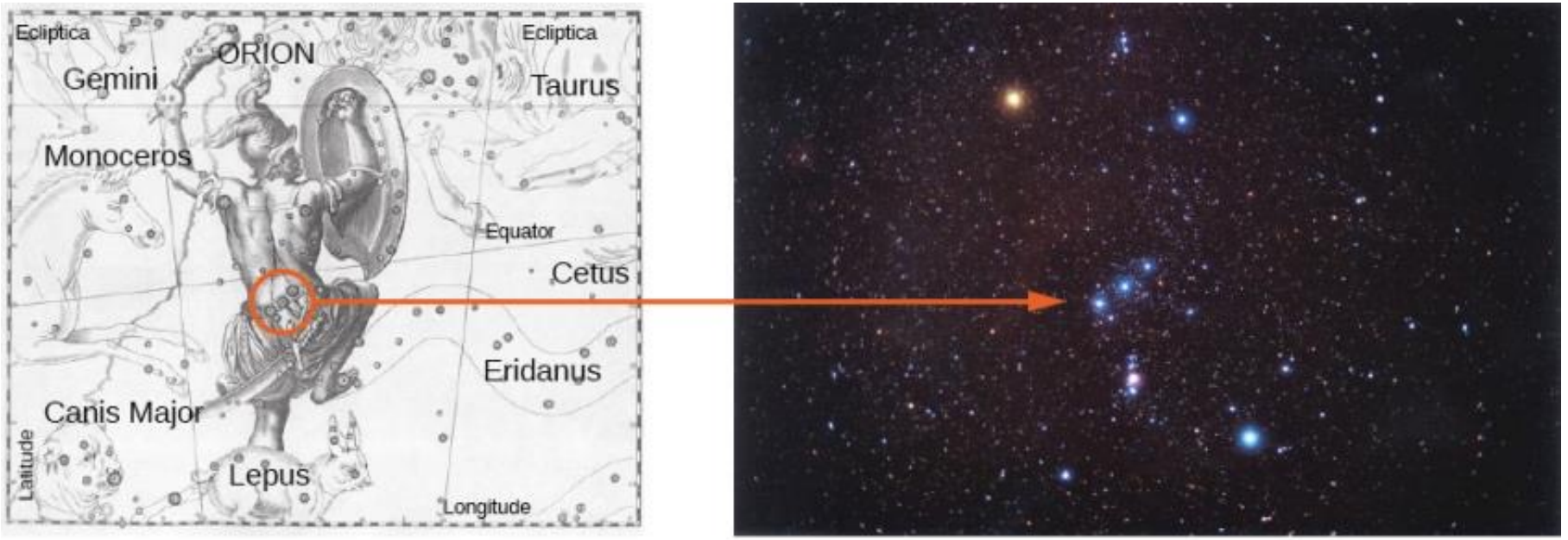
openstax™

AFTER SUNSET: THE STARS

NASA “Picture of the Day” 2007 April 14

https://apod.nasa.gov/apod/ap070414.html

FIGURE 2.8

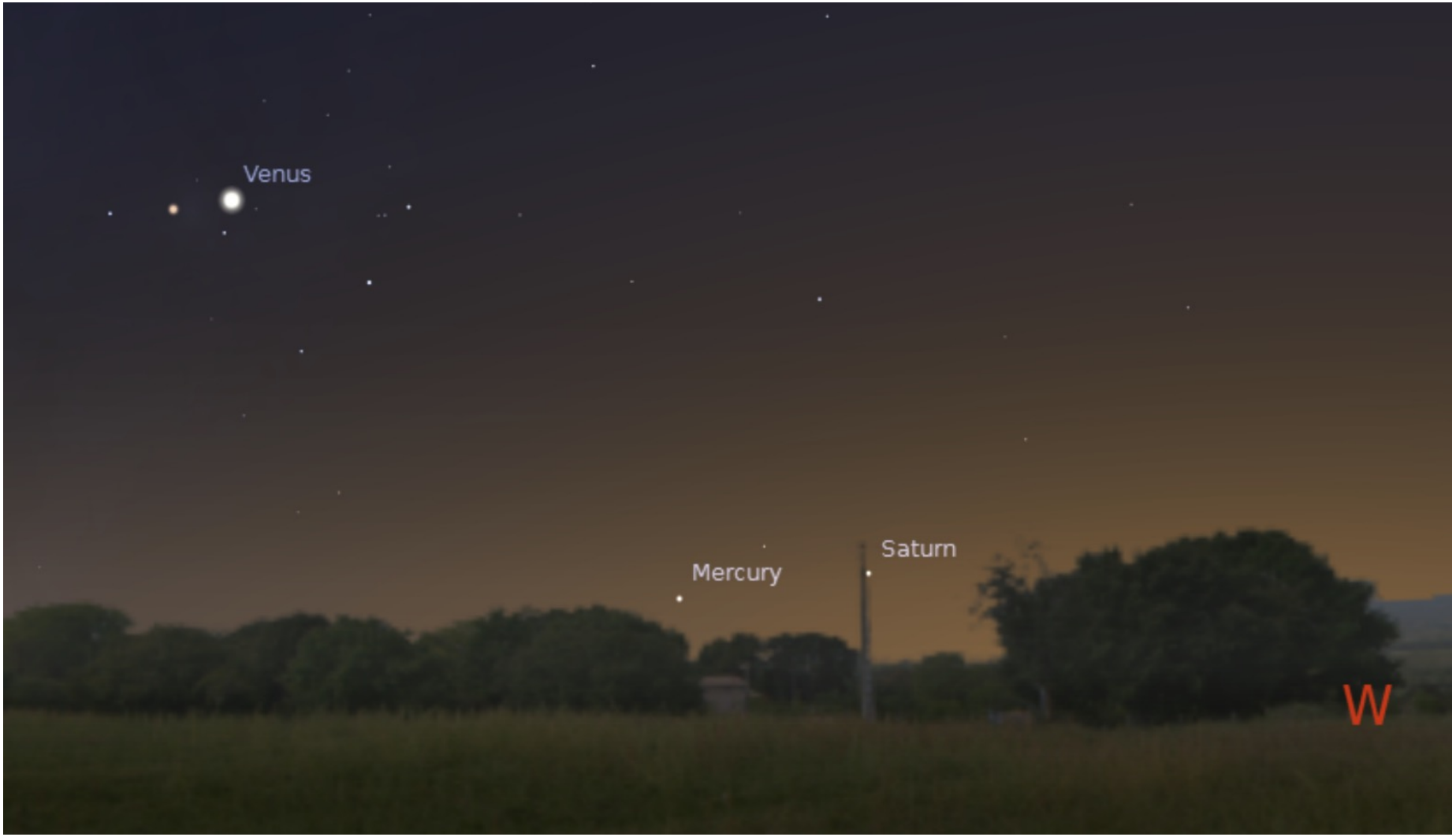


Orion.

(a) The winter constellation of Orion, the hunter, is surrounded by neighboring constellations, as illustrated in the seventeenth-century atlas by Hevelius.

(b) A photograph shows the Orion region in the sky. Note the three blue stars that make up the belt of the hunter. The bright red star above the belt denotes his armpit and is called Betelgeuse (pronounced “Beetel-juice”). The bright blue star below the belt is his foot and is called Rigel. (credit a: modification of work by Johannes Hevelius; b: modification of work by Matthew Spinelli)

SOMETIMES AT SUNSET: PLANETS WITH DIFFERENT ORBITS

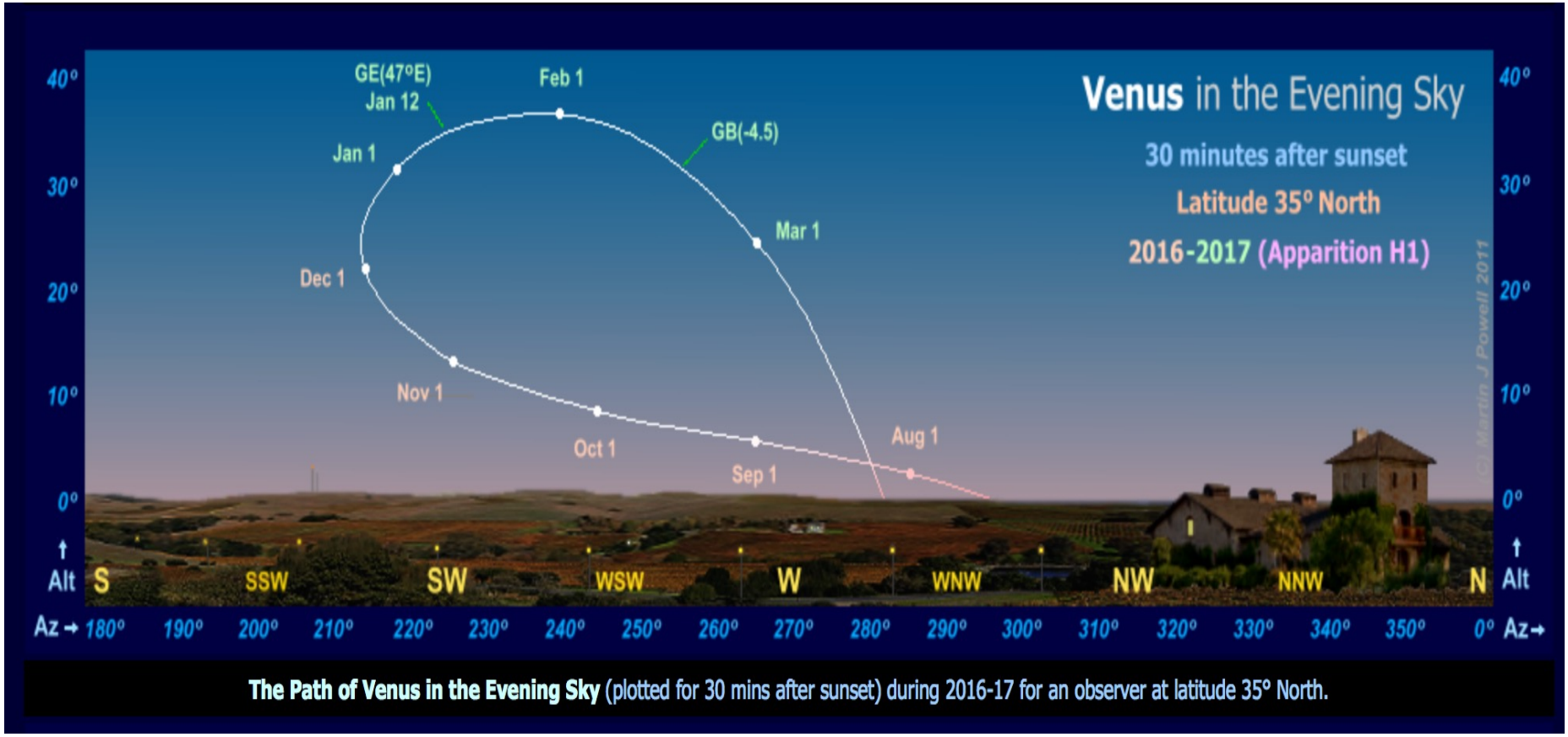


http://astro-interest.com/wp-content/uploads/2014/07/Venus-and-Mercury-as-Evening-Stars.png

SUN, VENUS, MOON, JUPITER EVERY SIX MINUTES: THE *ECLIPTIC*

http://amandabauer.blogspot.com/2007/10/saturn-venus-and-regulus-together-again.html

THE PATH OF VENUS IN THE EVENING SKY



The Path of Venus in the Evening Sky (plotted for 30 mins after sunset) during 2016-17 for an observer at latitude 35° North.

Retrograde Motion

WHY?

"THE WORLD'S FIRST COMPUTER": THE *ANTIKYTHERA MECHANISM*

On a stormy night approximately 80–60 BC … a heavily overloaded Roman Galley sank just off the coast of Antikythera, scattering its cargo on the ocean floor.

Nearly two millennia later, just after the turn of the 20th century… a group of sponge divers… in Antikythera… stumble[d] upon the ancient treasure lost at sea.

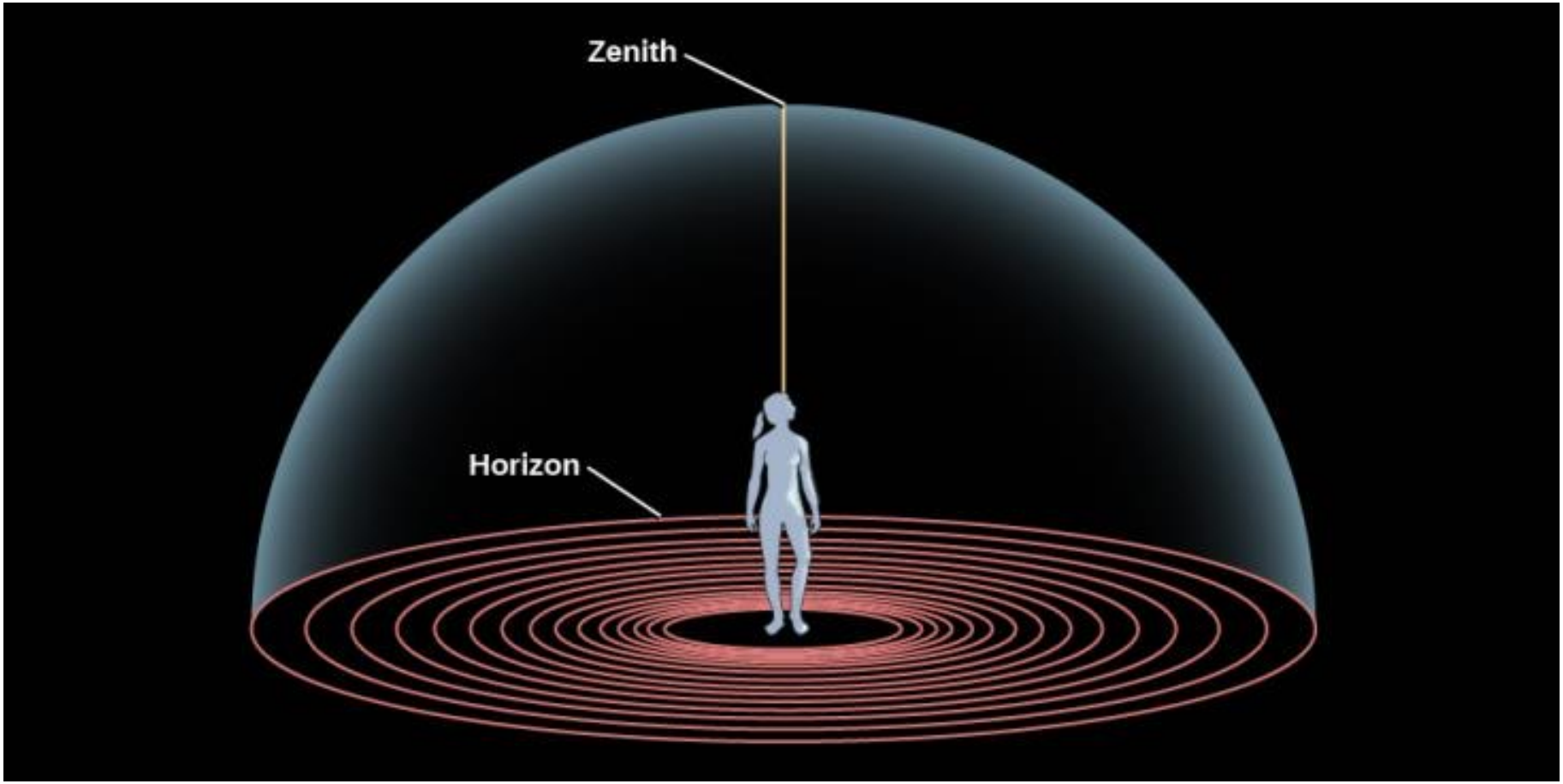
https://utsglobalstudio.wordpress.com/2015/05/07/the-worlds-first-computer-the-antikythera-mechanism/

THE ANTIKYTHERA MECHANISM

https://utsglobalstudio.wordpress.com/2015/05/07/the-worlds-first-computer-the-antikythera-mechanism/

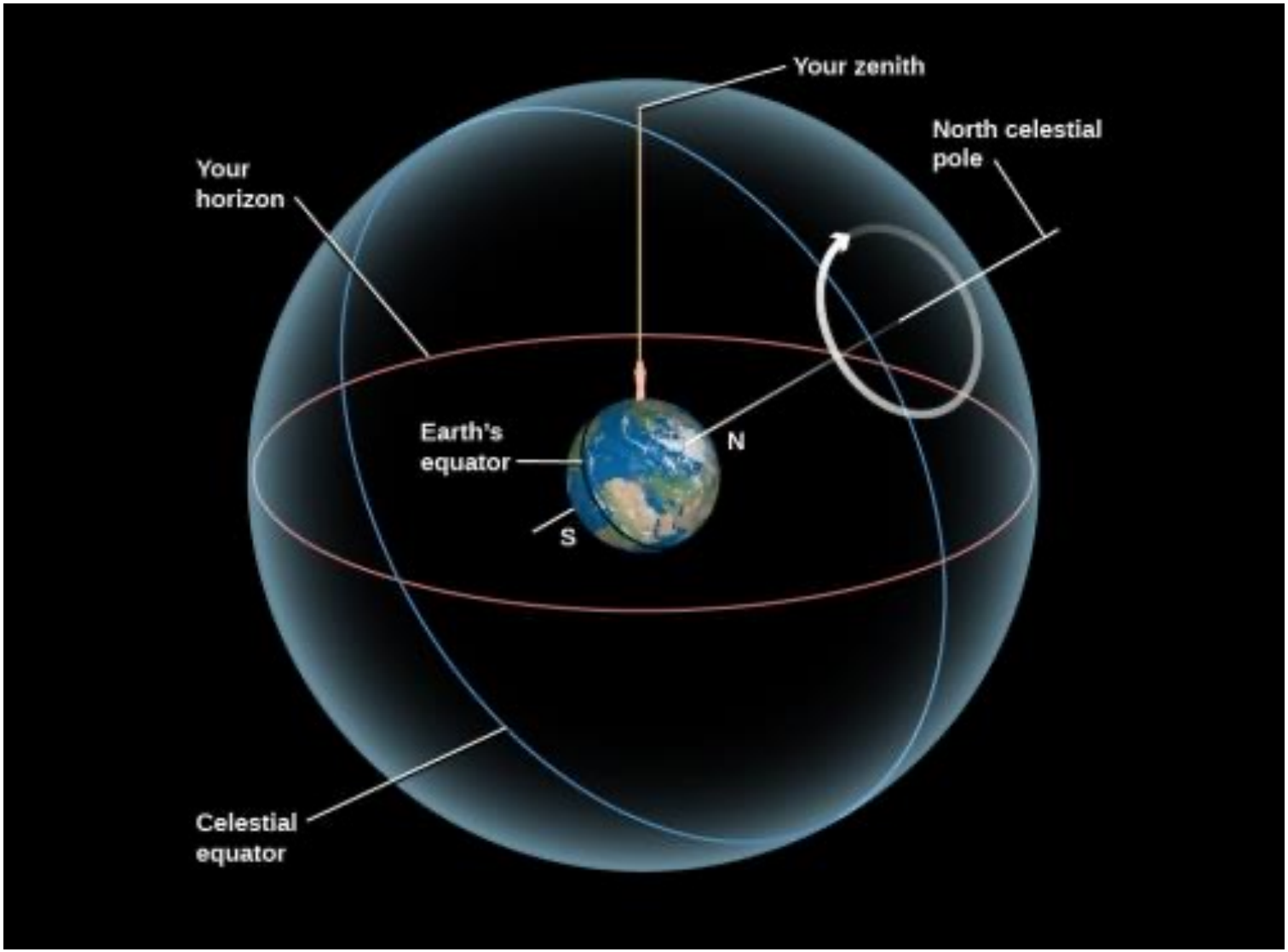
NOWADAYS YOU CAN MODEL THE APPEARANCE OF THE *SKY WITH OPEN SOURCE SOFTWARE*:

THIS IS AN EXAMPLE USING STELLARIUM



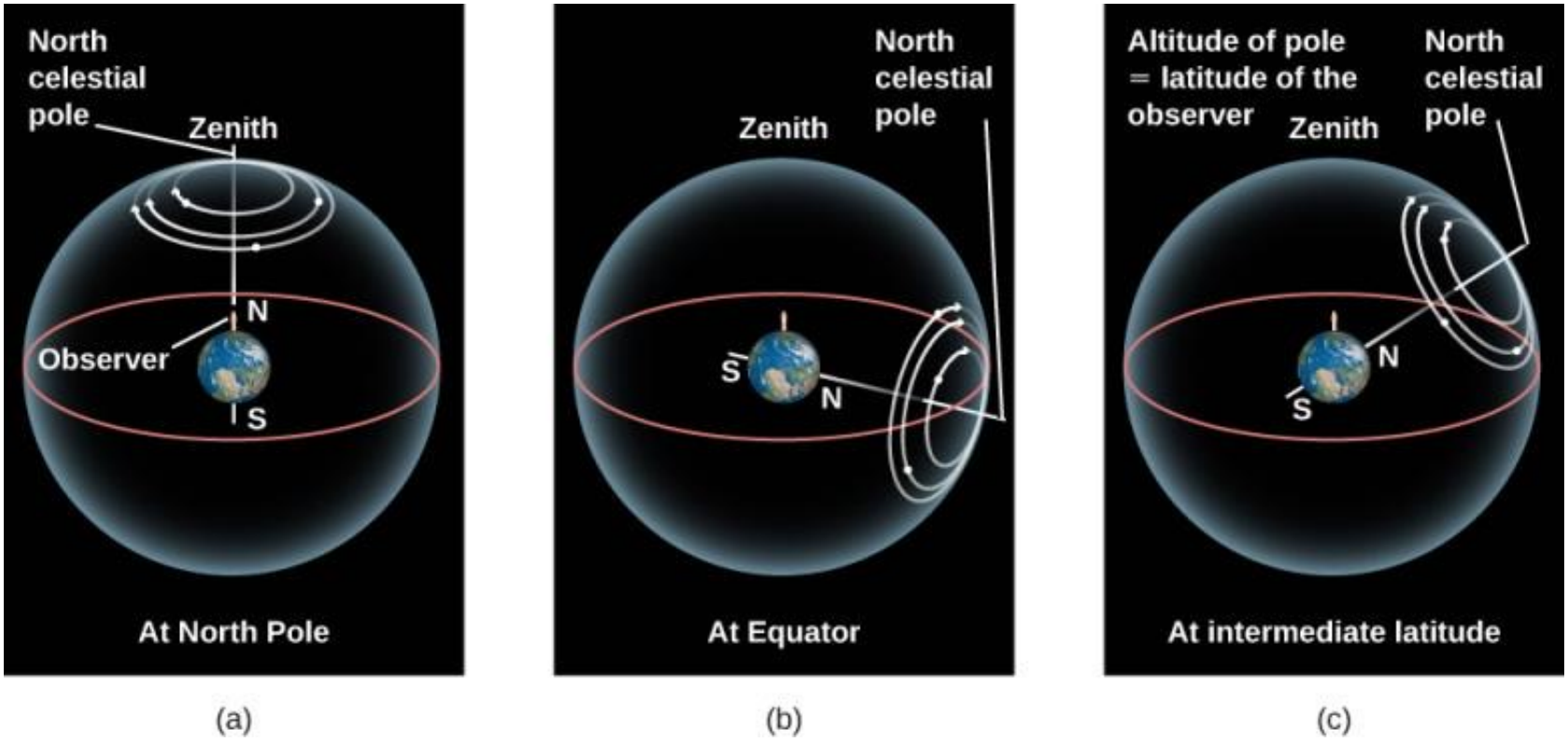
The Sky around Us. The horizon is where the sky meets the ground; an observer's ***Zenith*** is the point directly overhead.

HORIZON



Circles on the *Celestial Sphere*. Here we show the (imaginary) celestial sphere around Earth, on which objects are fixed, and which rotates around Earth on an axis. In reality, it is Earth that turns around this axis, creating the illusion that the sky revolves around us. Note that Earth in this picture has been tilted so that your location is at the top and the North Pole is where the N is. The apparent motion of celestial objects in the sky around the pole is shown by the circular arrow.

FIGURE 2.5



Star Circles at Different Latitudes. The turning of the sky looks different depending on your latitude on Earth.

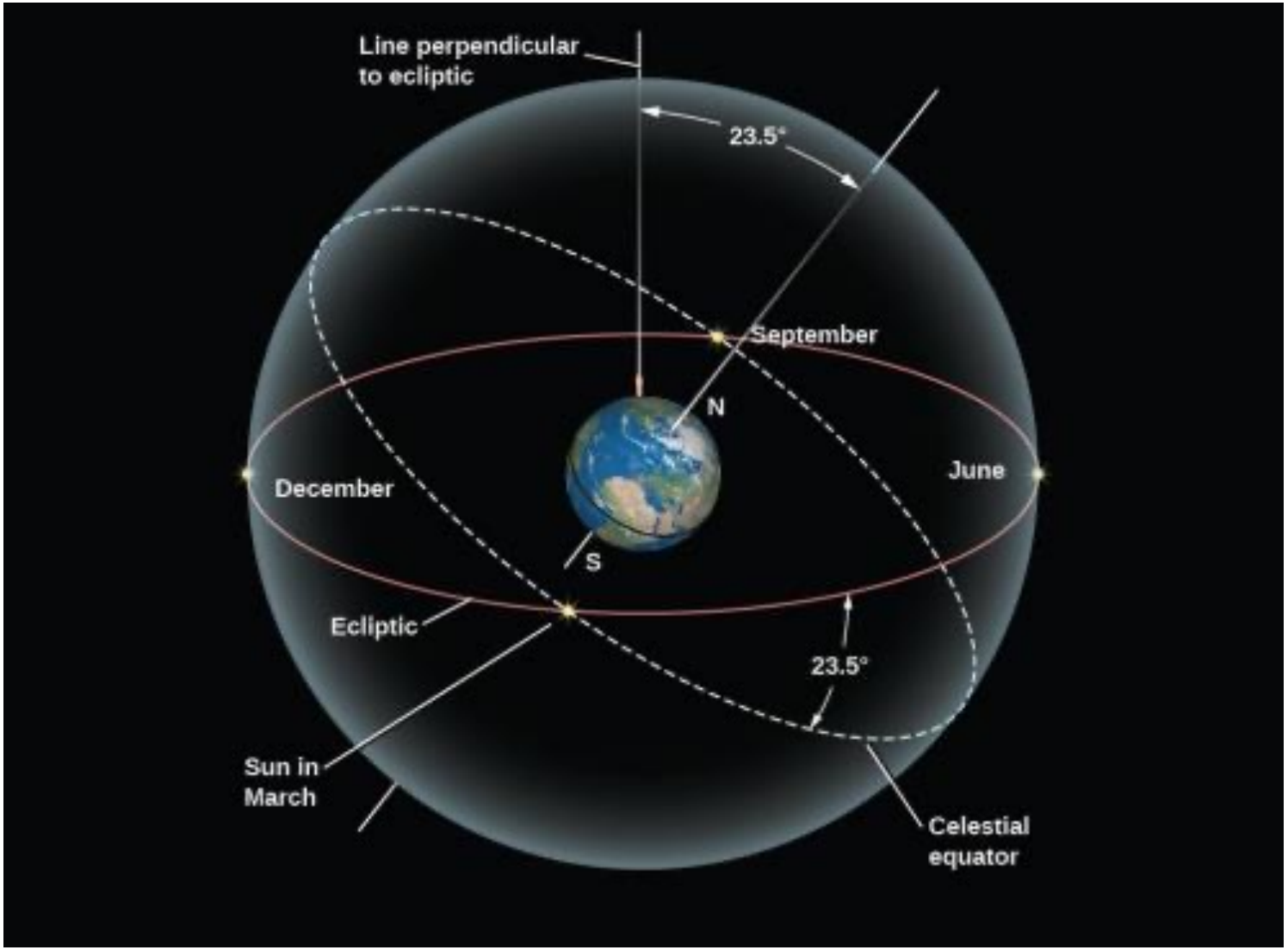
(a) At the North Pole, the stars circle the zenith and do not rise and set.

(b) At the equator, the celestial poles are on the horizon, and the stars rise straight up and set straight down.

(c) At intermediate latitudes, the north celestial pole is at some position between overhead and the horizon. Its angle above the horizon turns out to be equal to the observer's latitude. Stars rise and set at an angle to the horizon.

FIGURE 2.4

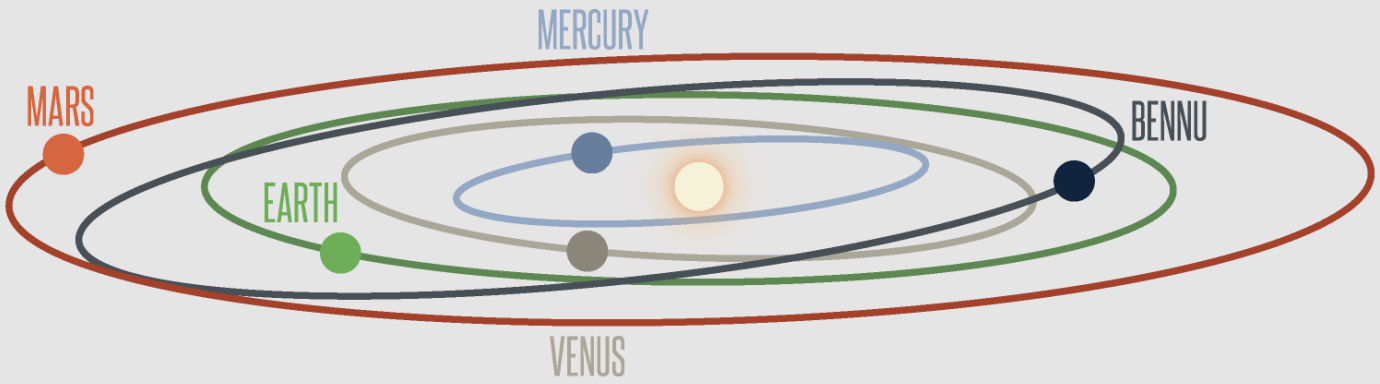
Circling the South Celestial Pole. This long-exposure photo shows trails left by stars as a result of the apparent rotation of the celestial sphere around the south celestial pole. (In reality, it is Earth that rotates.) (Credit: ESO/Iztok Bončina)



The Celestial Tilt. The celestial equator is tilted by 23.5° to the ecliptic. As a result, North Americans and Europeans see the Sun north of the celestial equator and high in our sky in June, and south of the celestial equator and low in the sky in December.

“LOCAL” Perspective
vs.
“OUTSIDER LOOKING IN” PERSPECTIVE

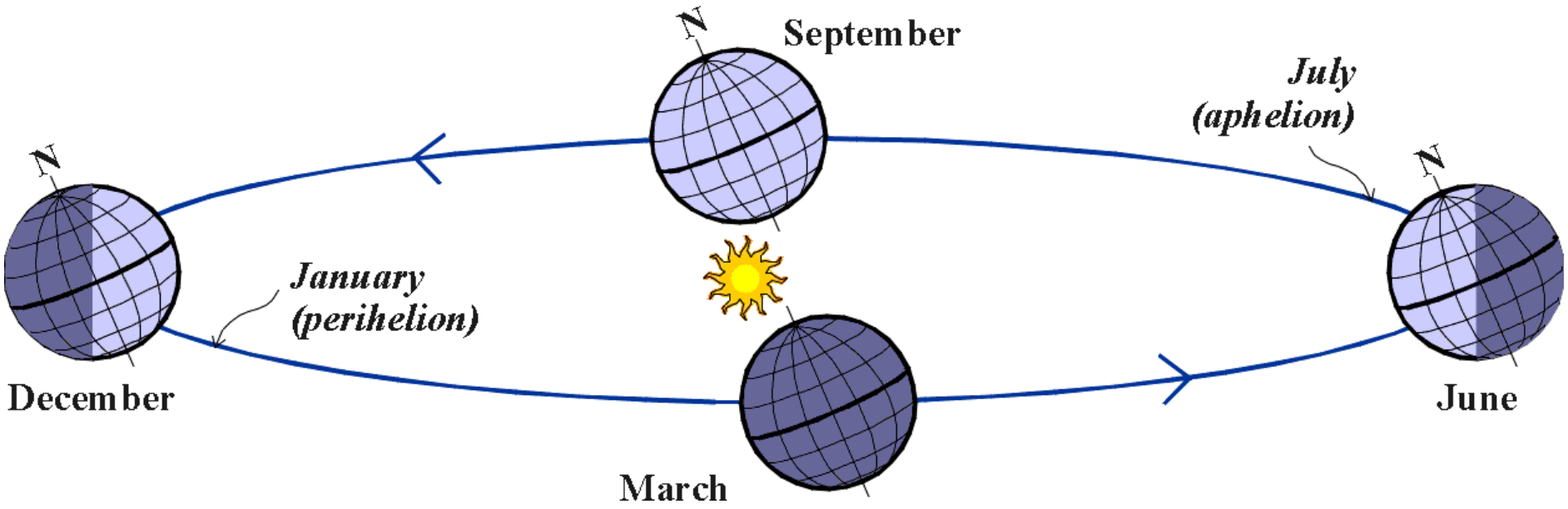
WORD OF THE WEEK | ECLIPTIC PLANE



The plane on which the Earth moves around the Sun; used as the reference plane for the Solar System. Most planets in our solar system orbit the Sun on or near this plane.

Earth orbits the Sun at 0°. Bennu orbits the Sun 6° off of the ecliptic plane.

OSIRIS-REx
ASTEROID SAMPLE RETURN MISSION


N
September
July
(aphelion)
N
N
January
(perihelion)
December
June
March

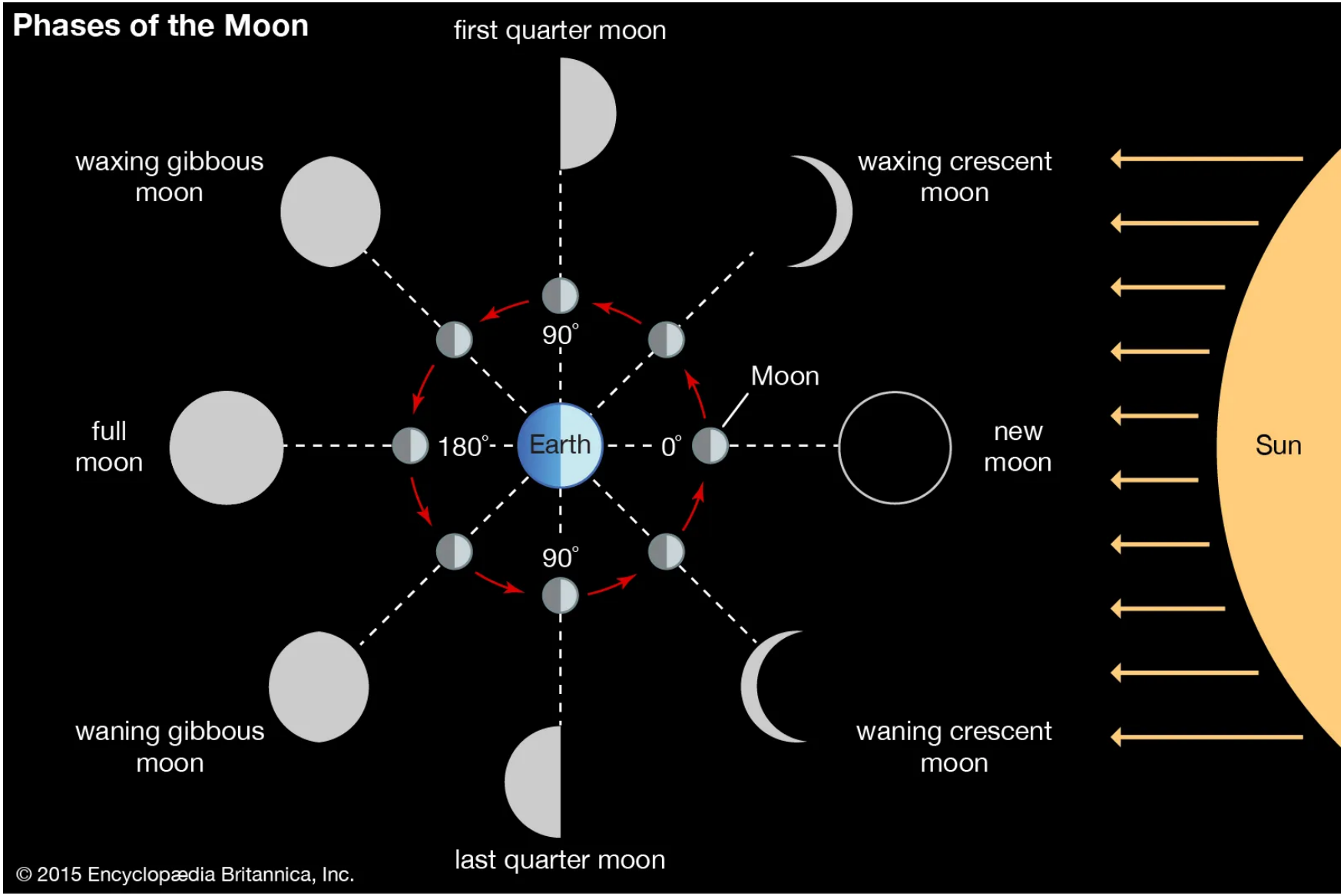
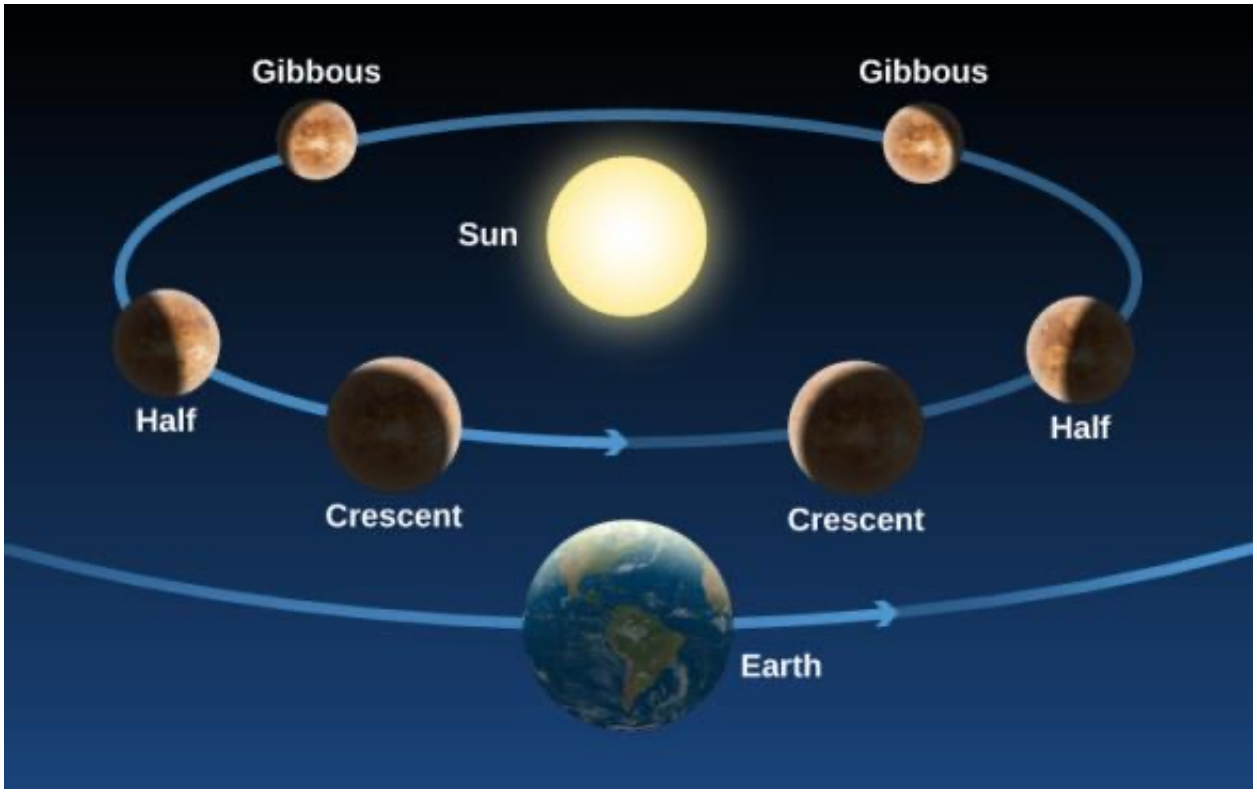
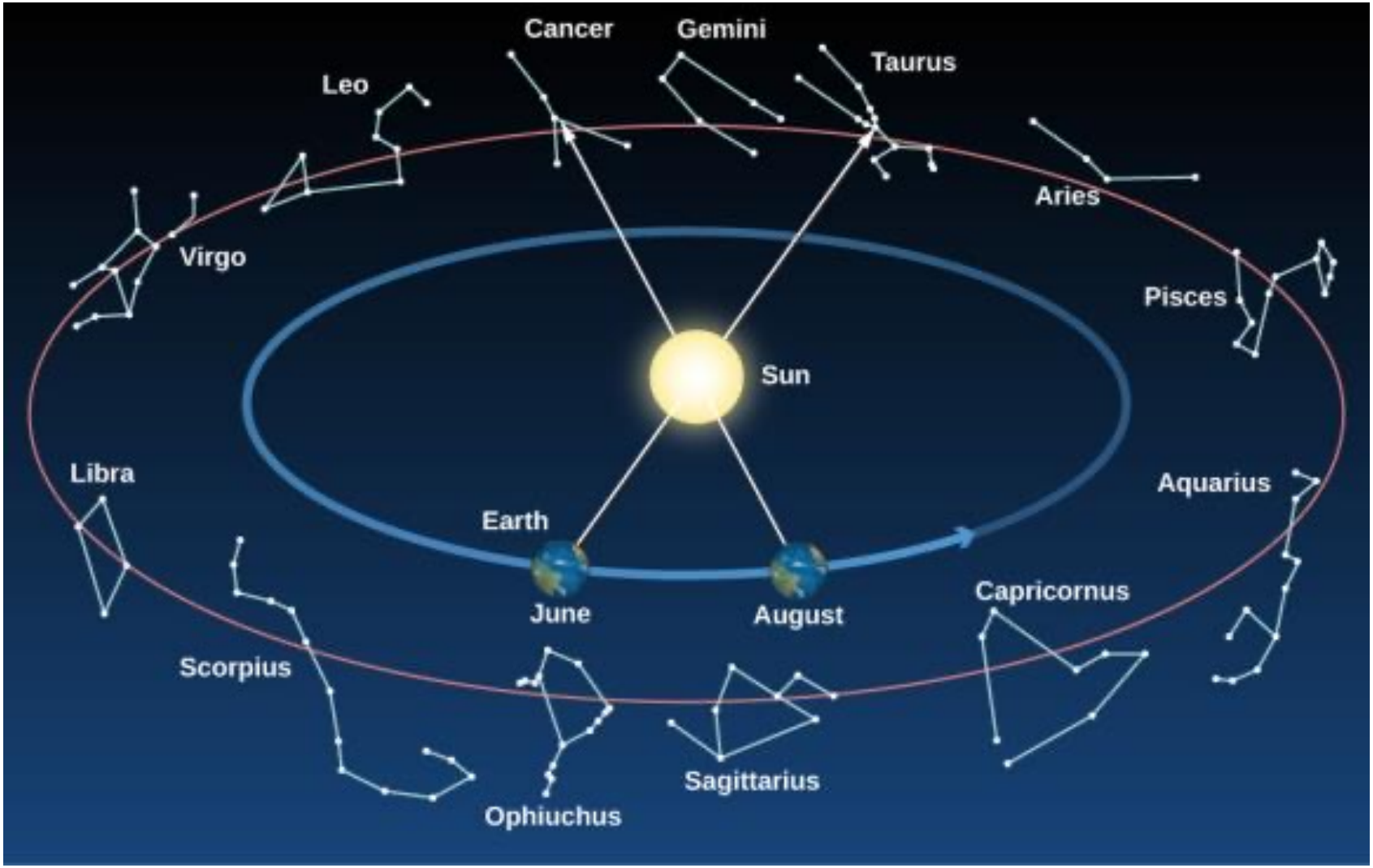

Phases of the Moon
first quarter moon
waxing gibbous moon
waxing crescent moon
90°
Moon
full moon
180°
Earth
0°
new moon
Sun
90°
waning gibbous moon
waning crescent moon
last quarter moon
© 2015 Encyclopædia Britannica, Inc.

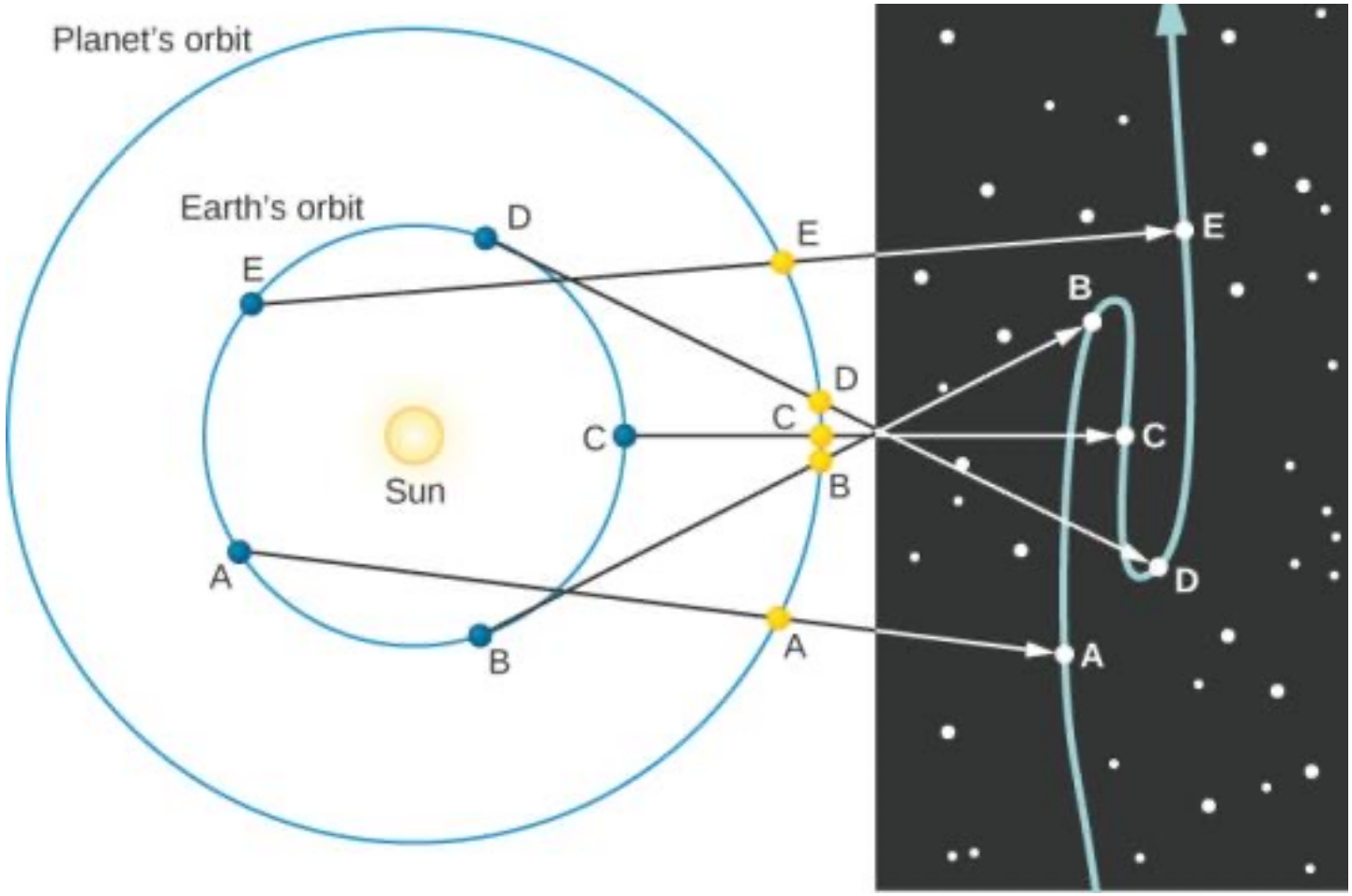
FIGURE 2.18



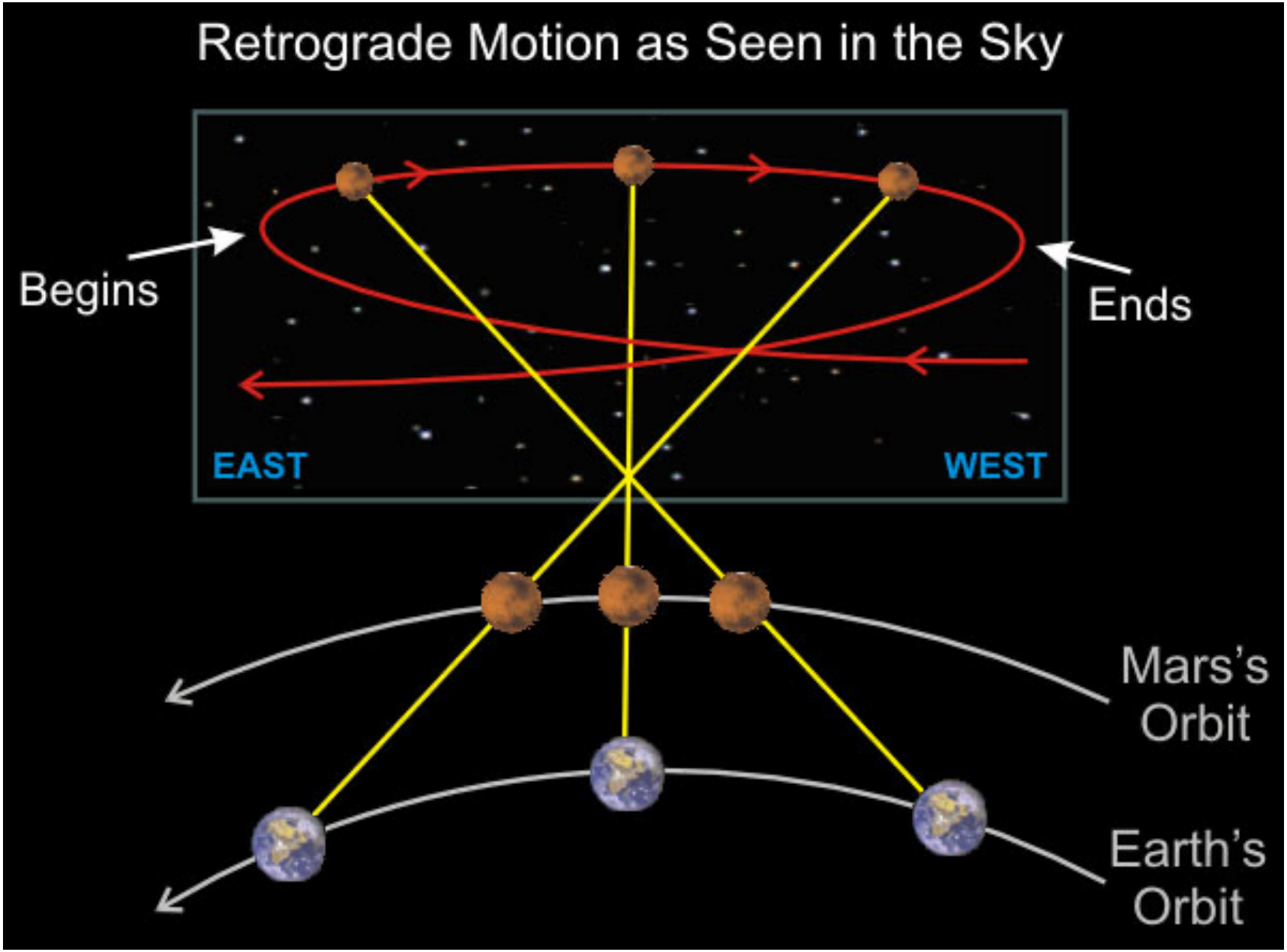
Phases of Venus. As Venus moves around the Sun, we see changing illumination of its surface, just as we see the face of the Moon illuminated differently in the course of a month.



Constellations on the Ecliptic. As Earth revolves around the Sun, we sit on "platform Earth" and see the Sun moving around the sky. The circle in the sky that the Sun appears to make around us in the course of a year is called the *ecliptic*. This circle (like all circles in the sky) goes through a set of constellations. The ancients thought these constellations, which the Sun (and the Moon and planets) visited, must be special and incorporated them into their system of astrology. Note that at any given time of the year, some of the constellations crossed by the ecliptic are visible in the night sky; others are in the day sky and are thus hidden by the brilliance of the Sun.



Retrograde Motion **of a Planet beyond Earth's Orbit.** The letters on the diagram show where Earth and Mars are at different times. By following the lines from each Earth position through each corresponding Mars position, you can see how the retrograde path of Mars looks against the background stars.


Retrograde Motion as Seen in the Sky
Begins
Ends
EAST
WEST
Mars's Orbit
Earth's Orbit

But this
“OUTSIDER LOOKING IN”
PERSPECTIVE
did not come easily

openstax™

FIGURE 2.16

Nicolaus Copernicus (1473–1543). Copernicus was a cleric and scientist who played a leading role in the emergence of modern science. Although he could not prove that Earth revolves about the Sun, he presented such compelling arguments for this idea that he turned the tide of cosmological thought and laid the foundations upon which Galileo and Kepler so effectively built in the following century.

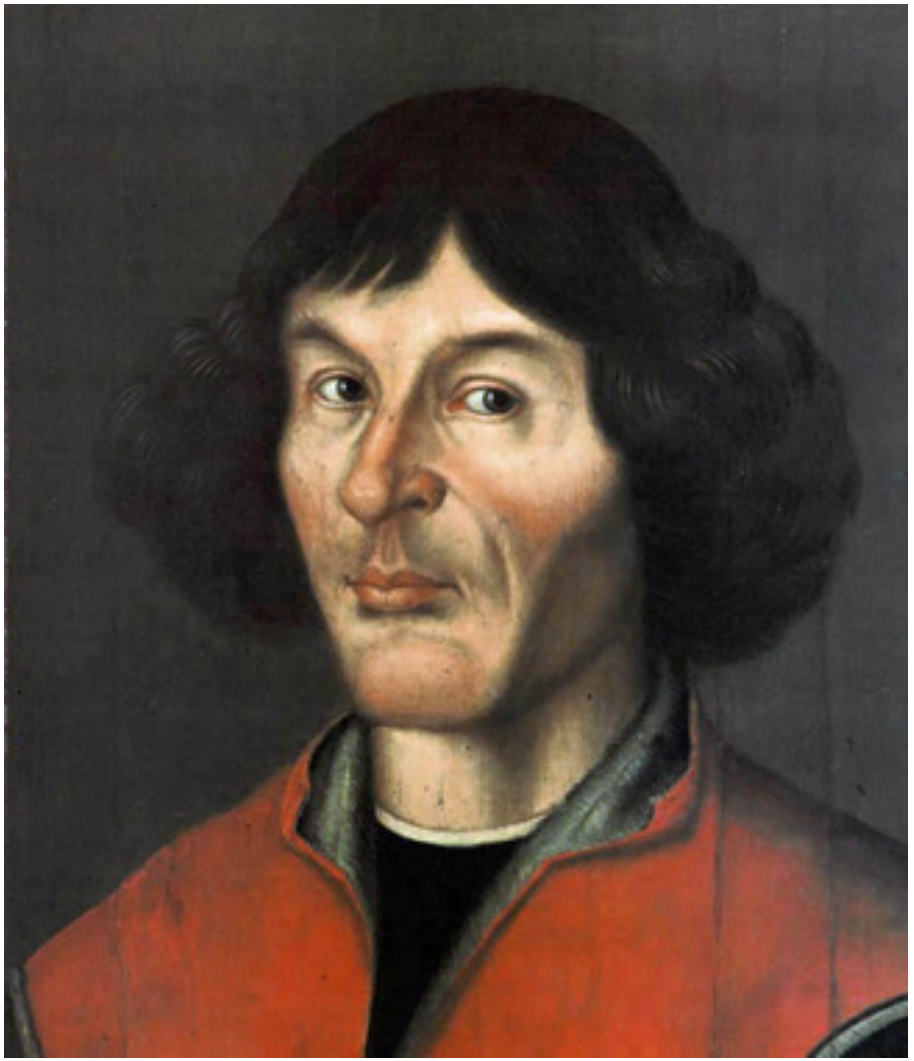
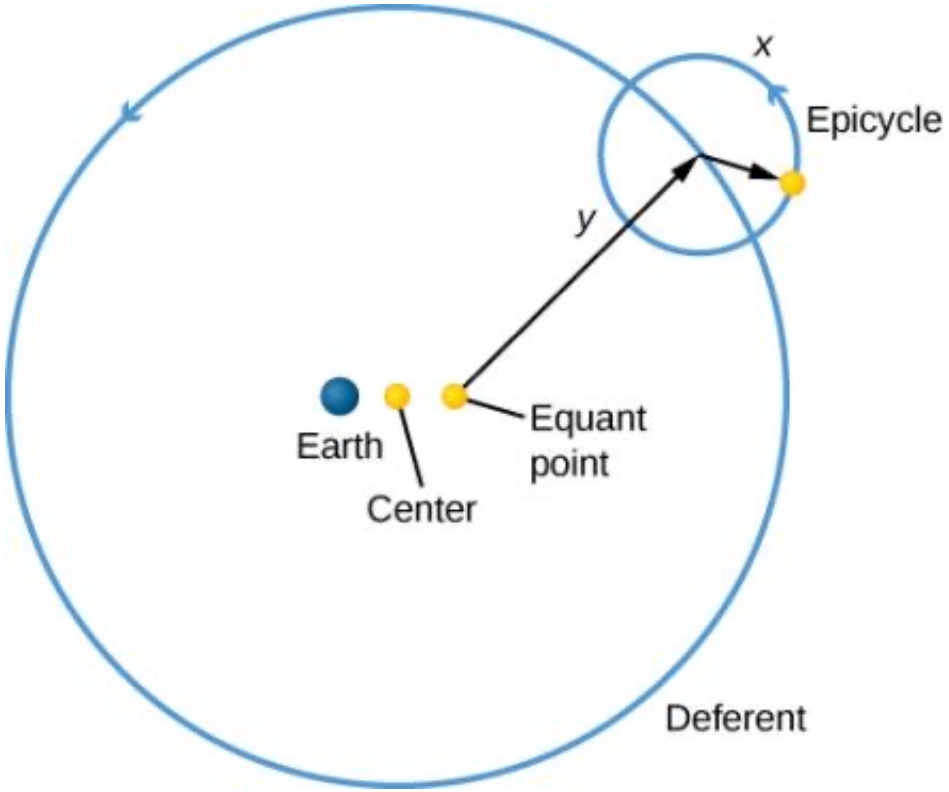
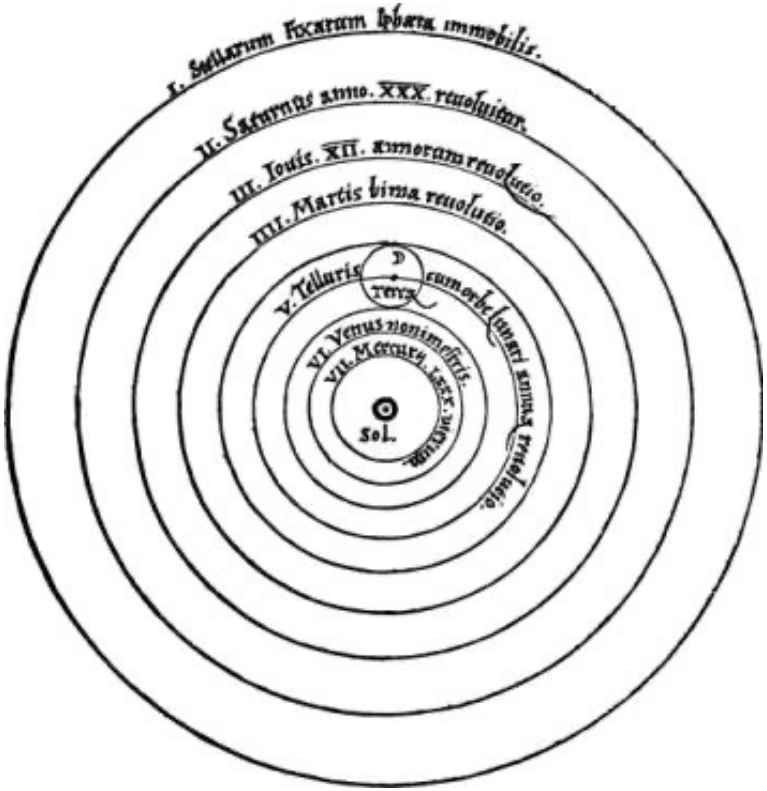


FIGURE 2.14



Ptolemy's Complicated Cosmological System. Each planet orbits around a small circle called an *epicycle*. Each epicycle orbits on a larger circle called the *deferent*. This system is not centered exactly on Earth but on an offset point called the *equant*. The Greeks needed all this complexity to explain the actual motions in the sky because they believed that Earth was stationary and that all sky motions had to be circular.

FIGURE 2.17



Copernicus' System. Copernicus developed a heliocentric plan of the solar system. This system was published in the first edition of *De Revolutionibus Orbium Coelestium*. Notice the word *Sol* for "Sun" in the middle. (credit: Nicolai Copernici)

FIGURE 2.19

Galileo Galilei (1564–1642). Galileo advocated that we perform experiments or make observations to ask nature its ways. When Galileo turned the telescope to the sky, he found things were not the way philosophers had supposed.

FIGURE 2.20

Telescope Used by Galileo. The telescope has a wooden tube covered with paper and a lens 26 millimeters across.