

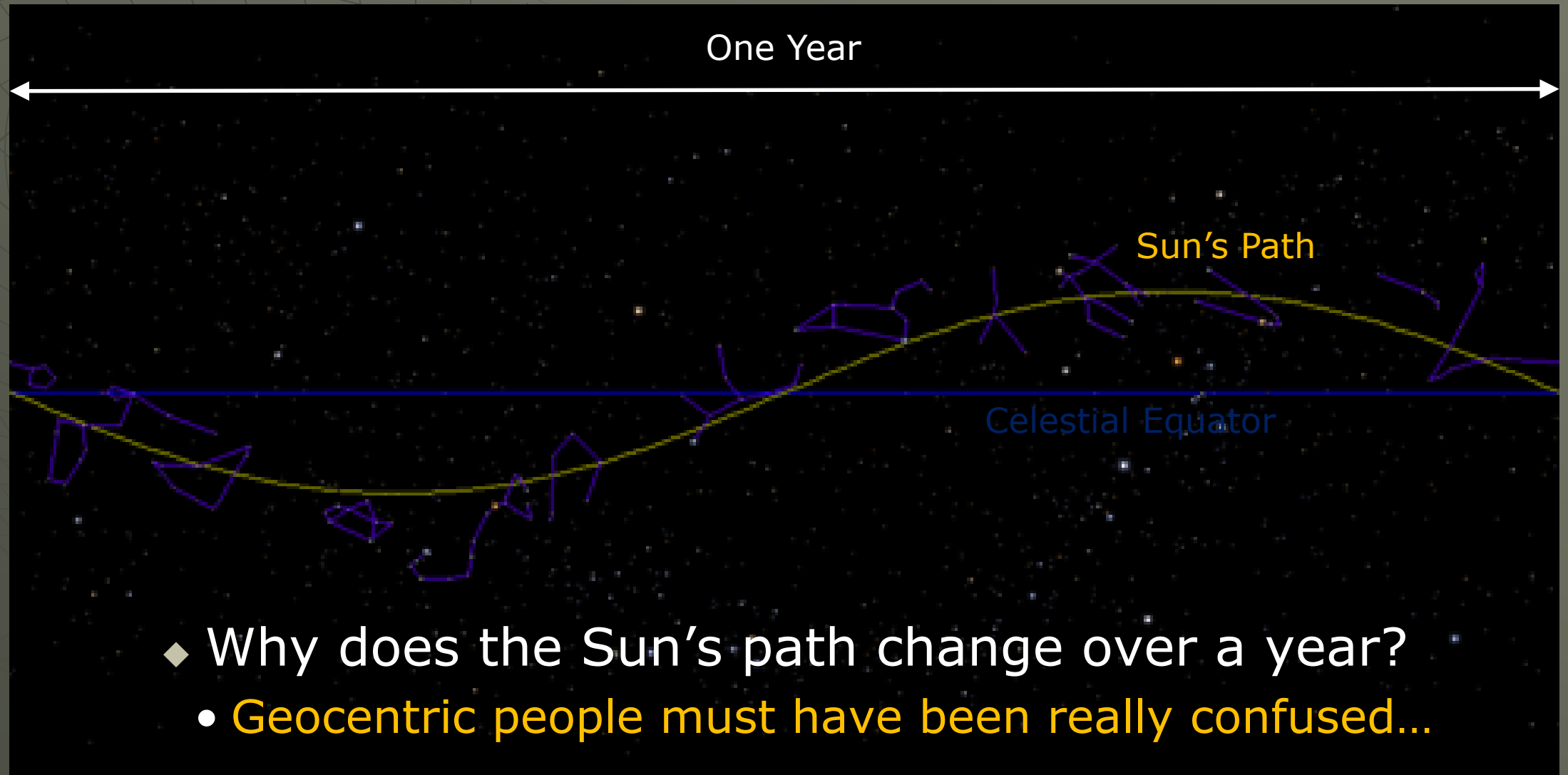
Path of the Sun



- ◆ Objectives

- How and Why does the Sun change its altitude and position over a year
- What are the Effects of these changes

Sun's Doesn't Cover the Same Constellations!

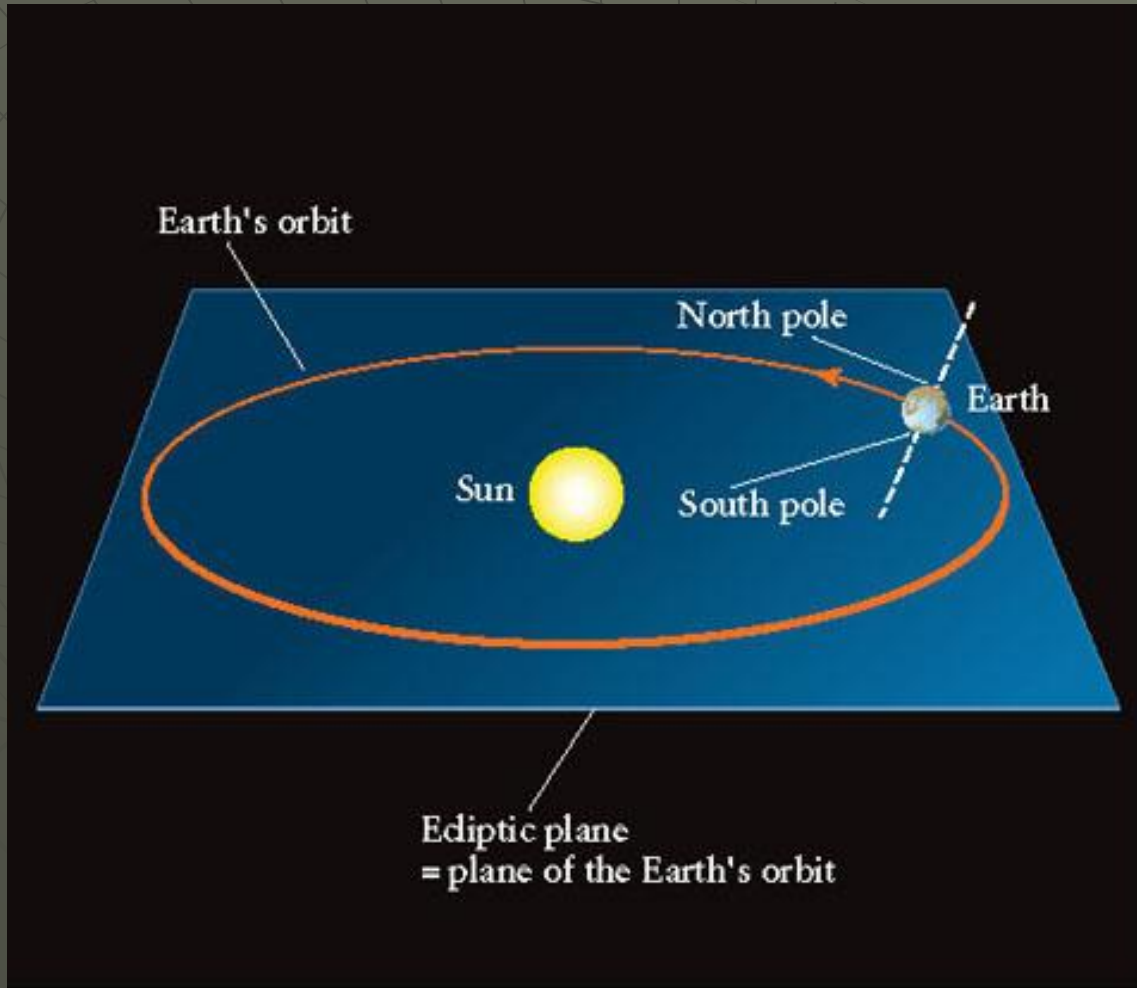


- ◆ Why does the Sun's path change over a year?
 - Geocentric people must have been really confused...

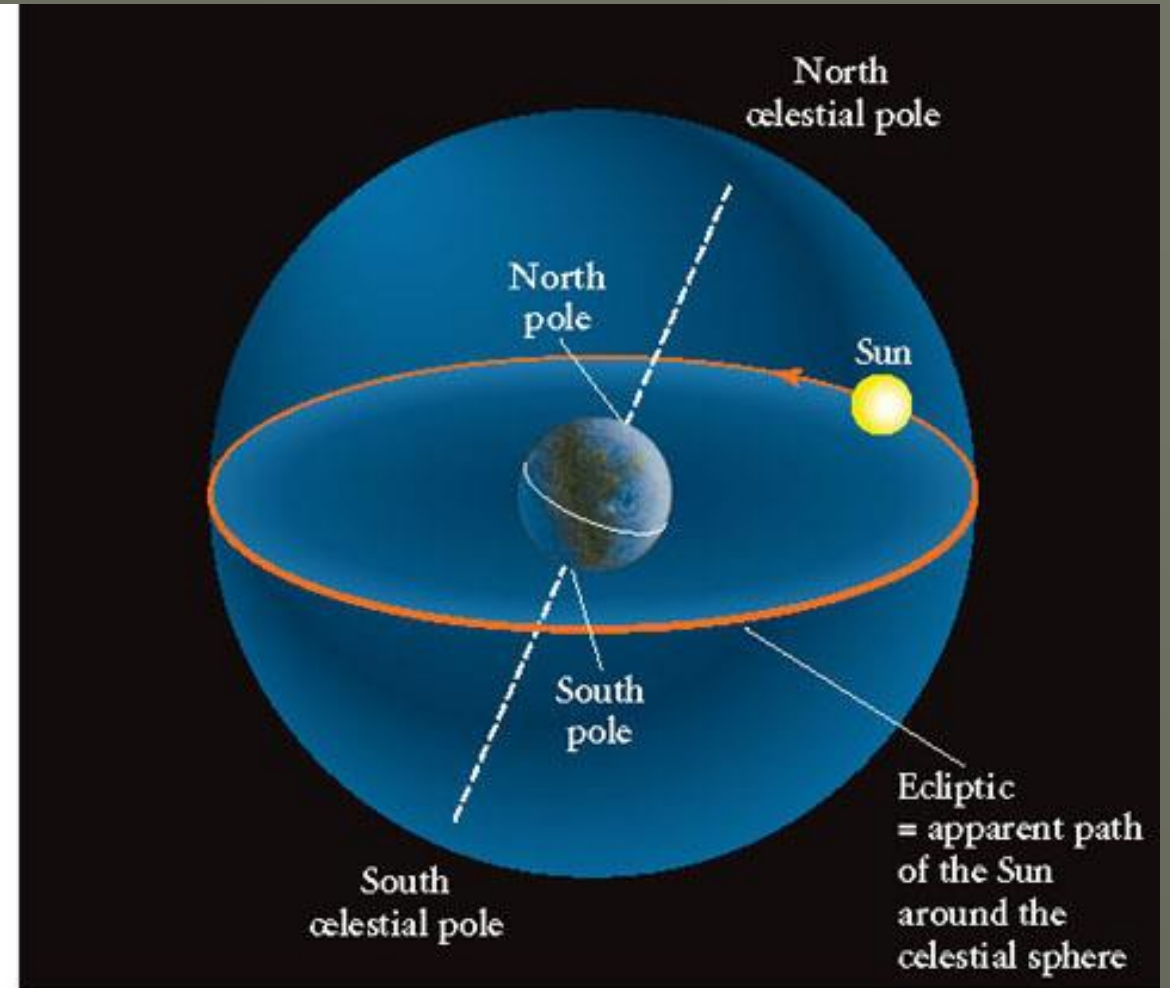
Get out of the way, Sun!

- ◆ As earth orbits the sun, the sun appears to be in front of certain constellations
 - **Zodiac** constellations
- ◆ We see constellations that are “away” from the sun

The Earth Orbits the Sun



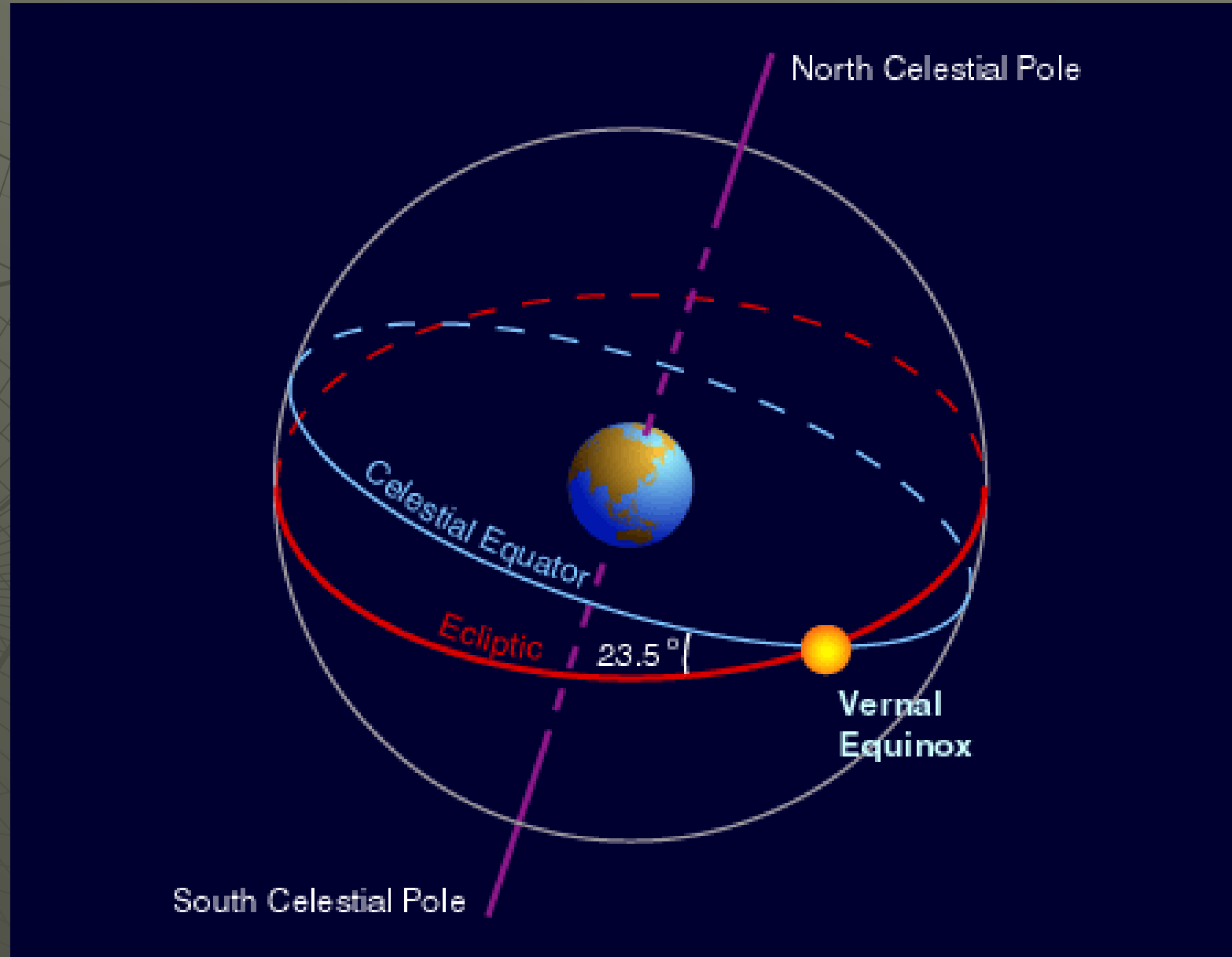
(a) In reality the Earth orbits the Sun once a year



(b) It appears to us that the Sun travels around the celestial sphere once a year

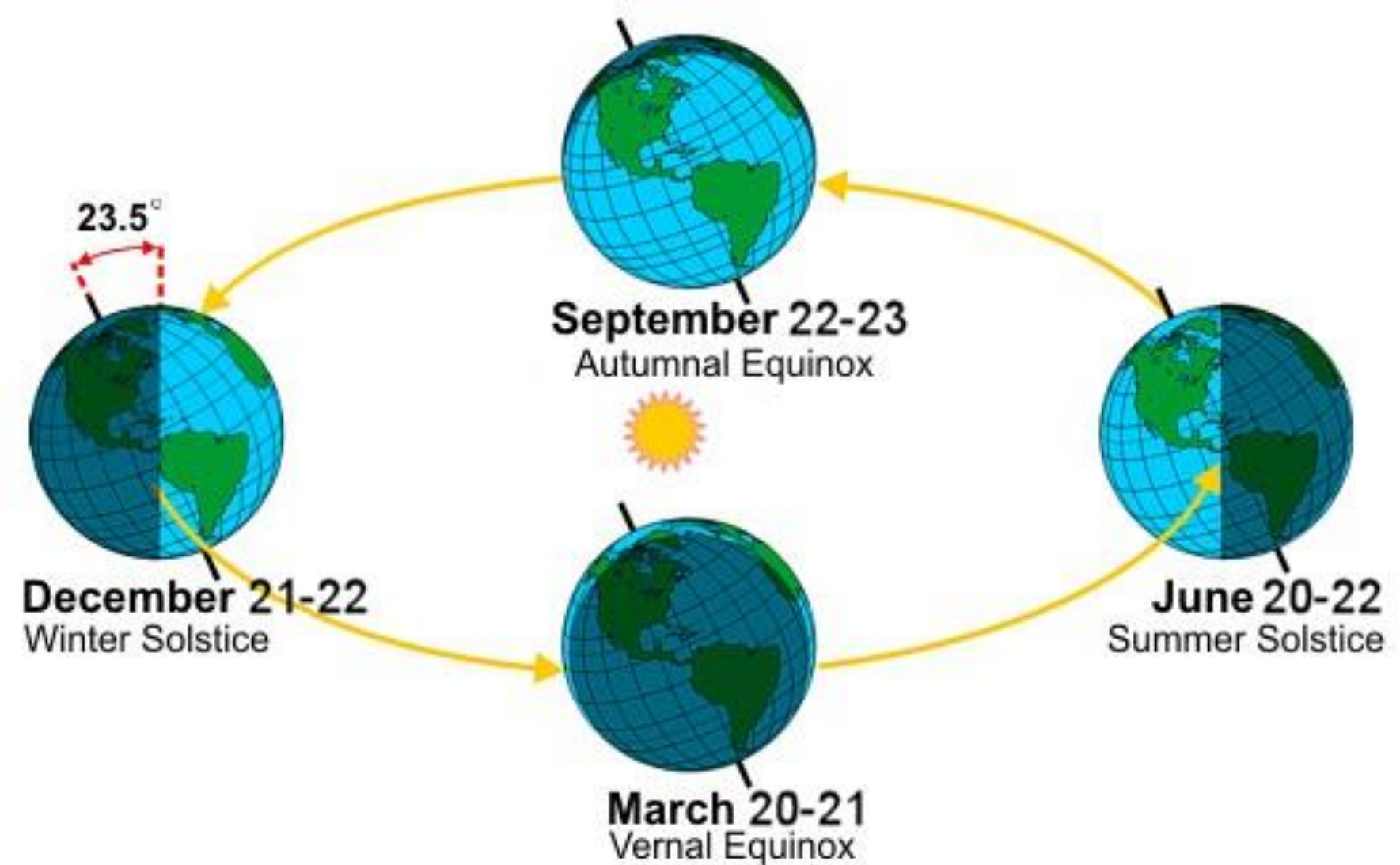
Ecliptic

- **Ecliptic:** the plane of solar system
 - Includes: Sun, planets, and zodiac constellations
- Earth's orbit is tilted at 23.5 degrees



Earth's Orbit

Sun crosses
Celestial equator



Sun is
Highest in
N Hemisphere

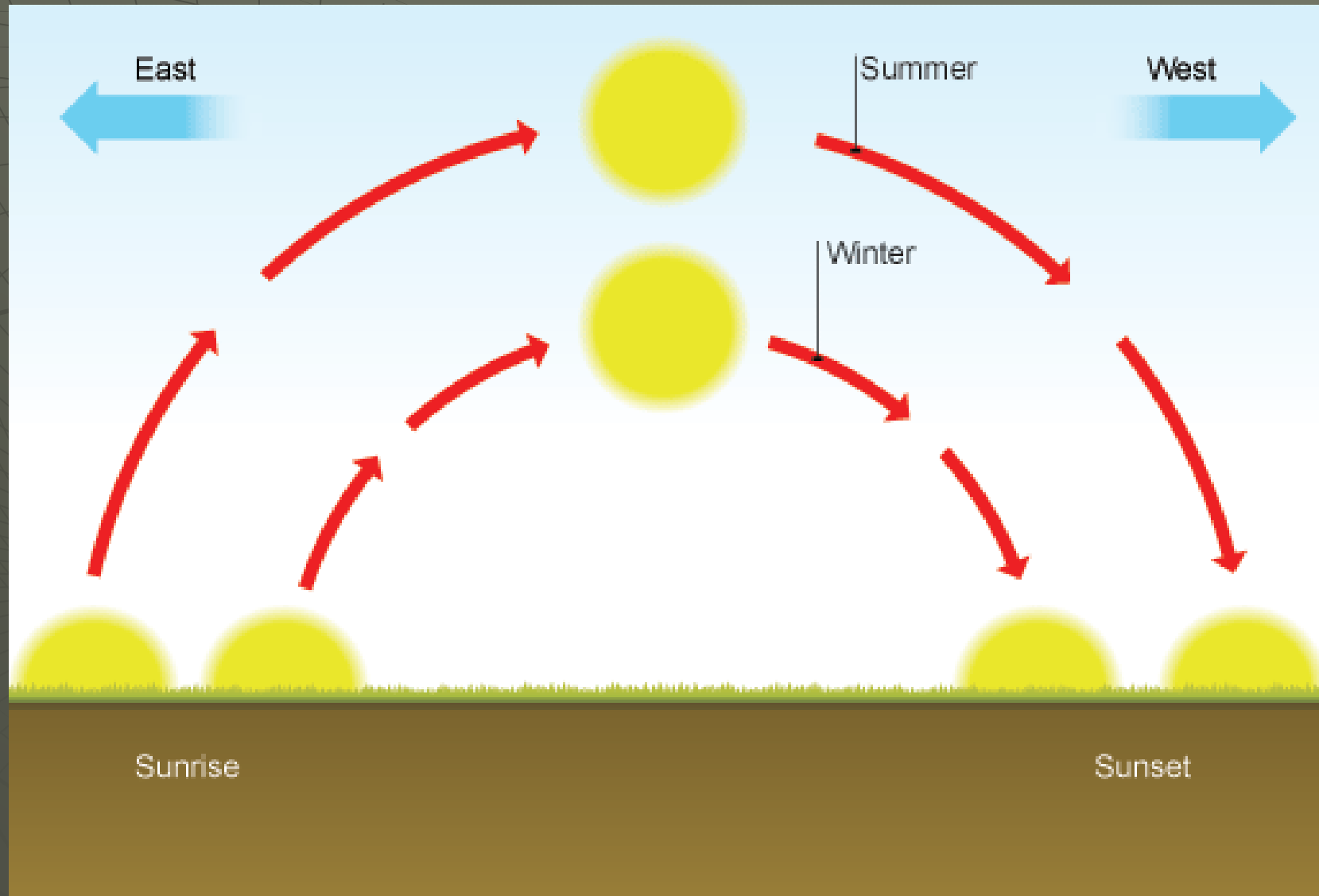
Sun crosses
Celestial equator

Sun is
Lowest in
N Hemisphere

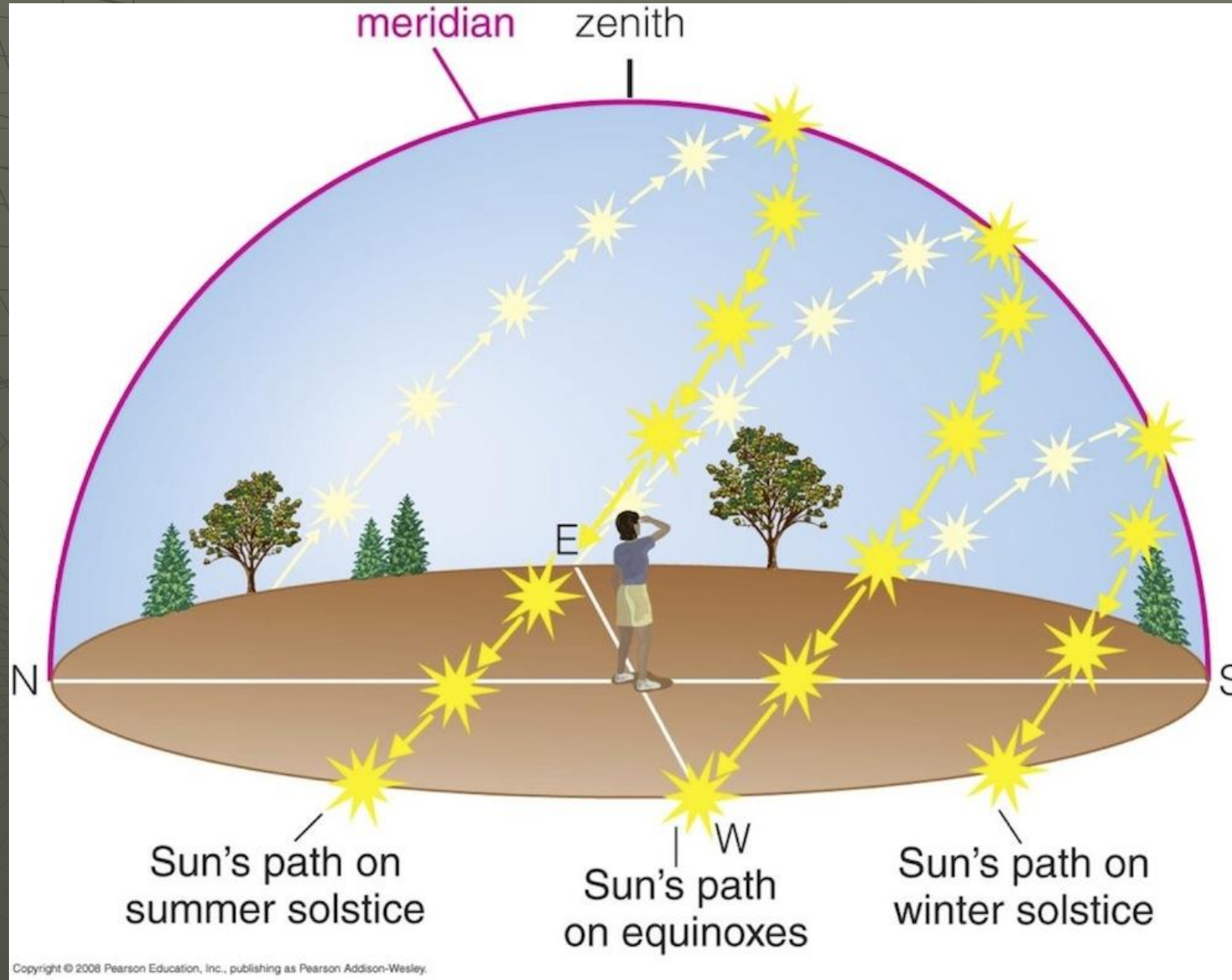
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- ◆ Ecliptic
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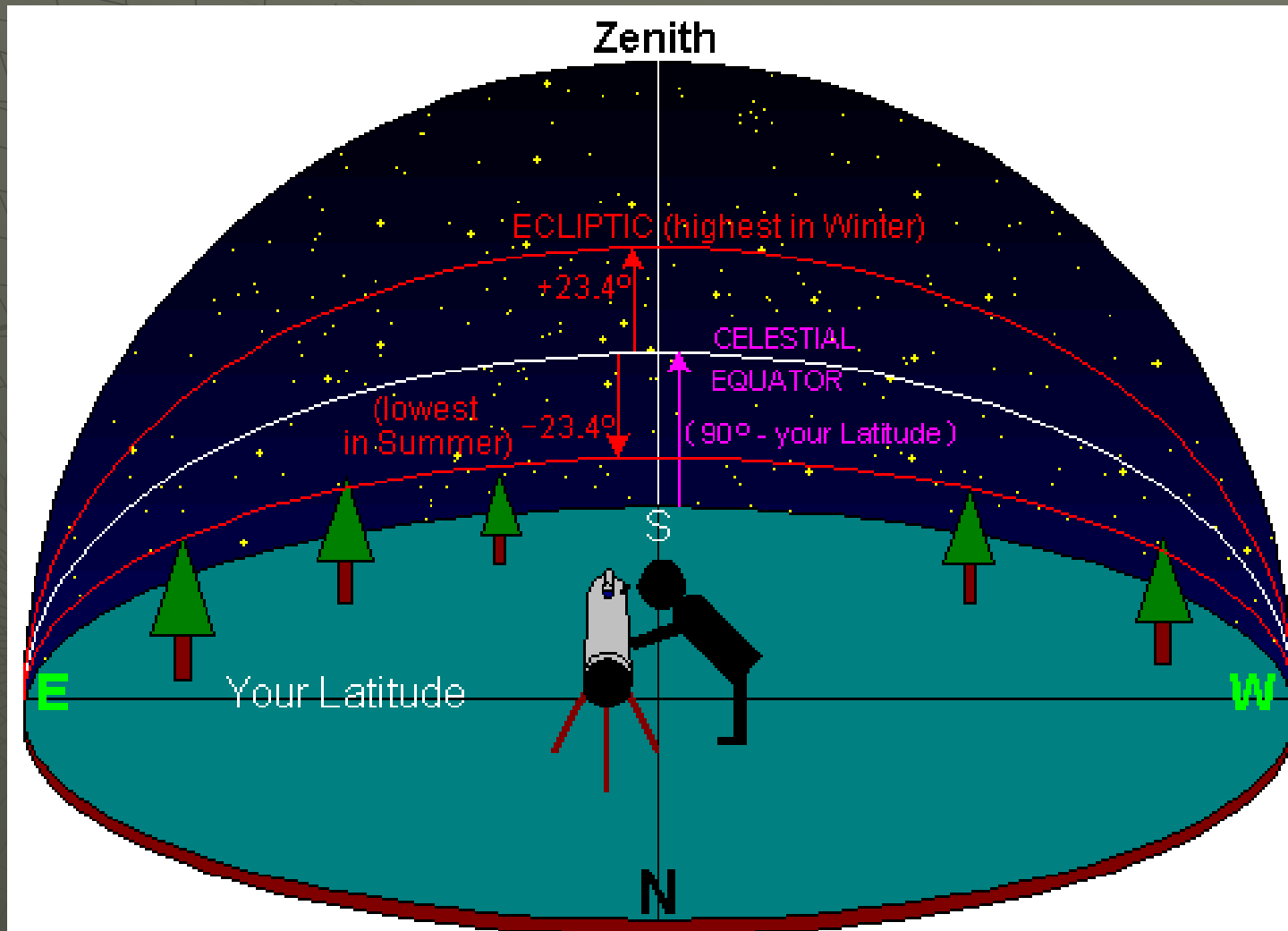
Sun's Path at Different Times of the Year



Solstice & Equinox

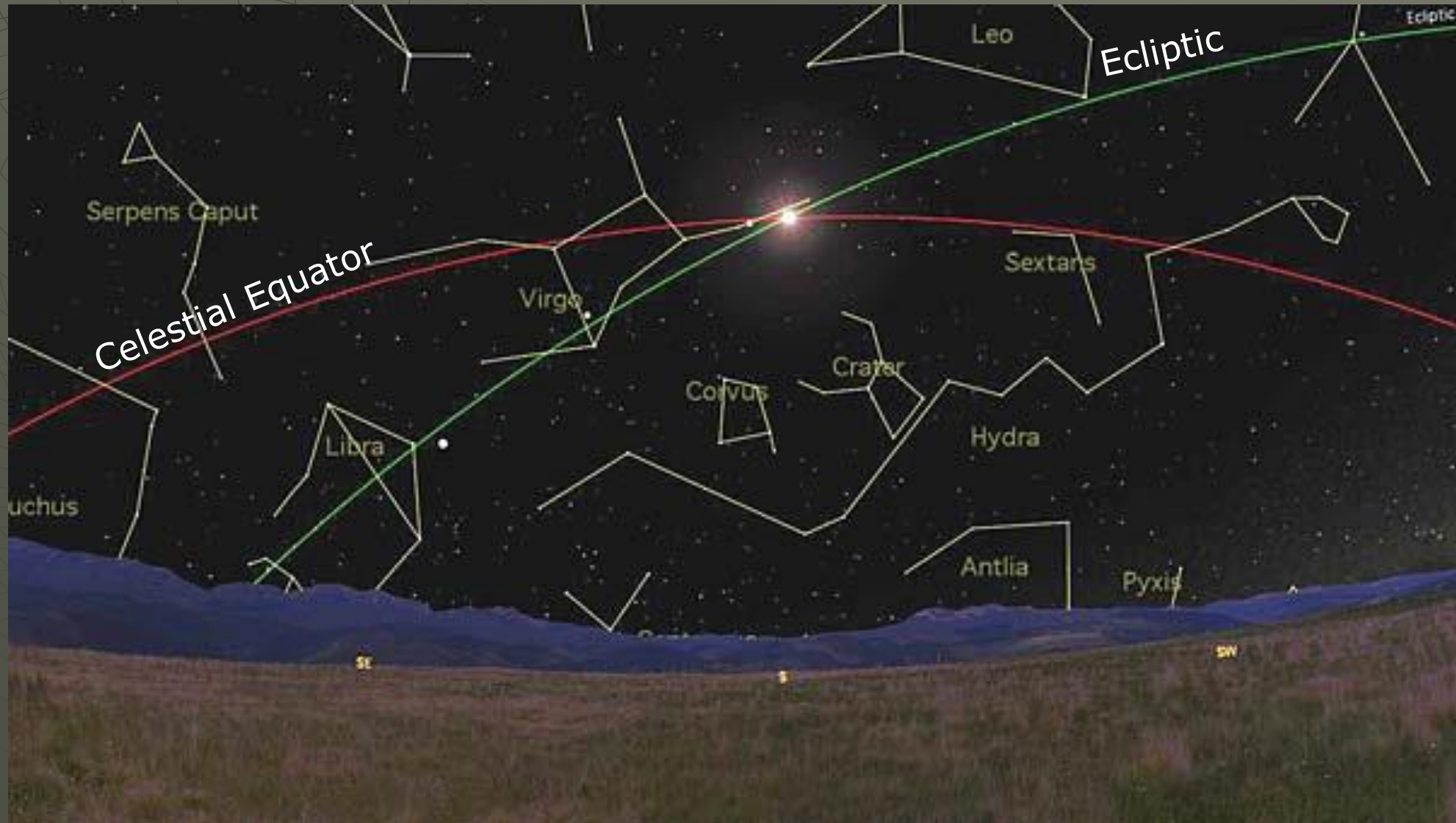


Solstices

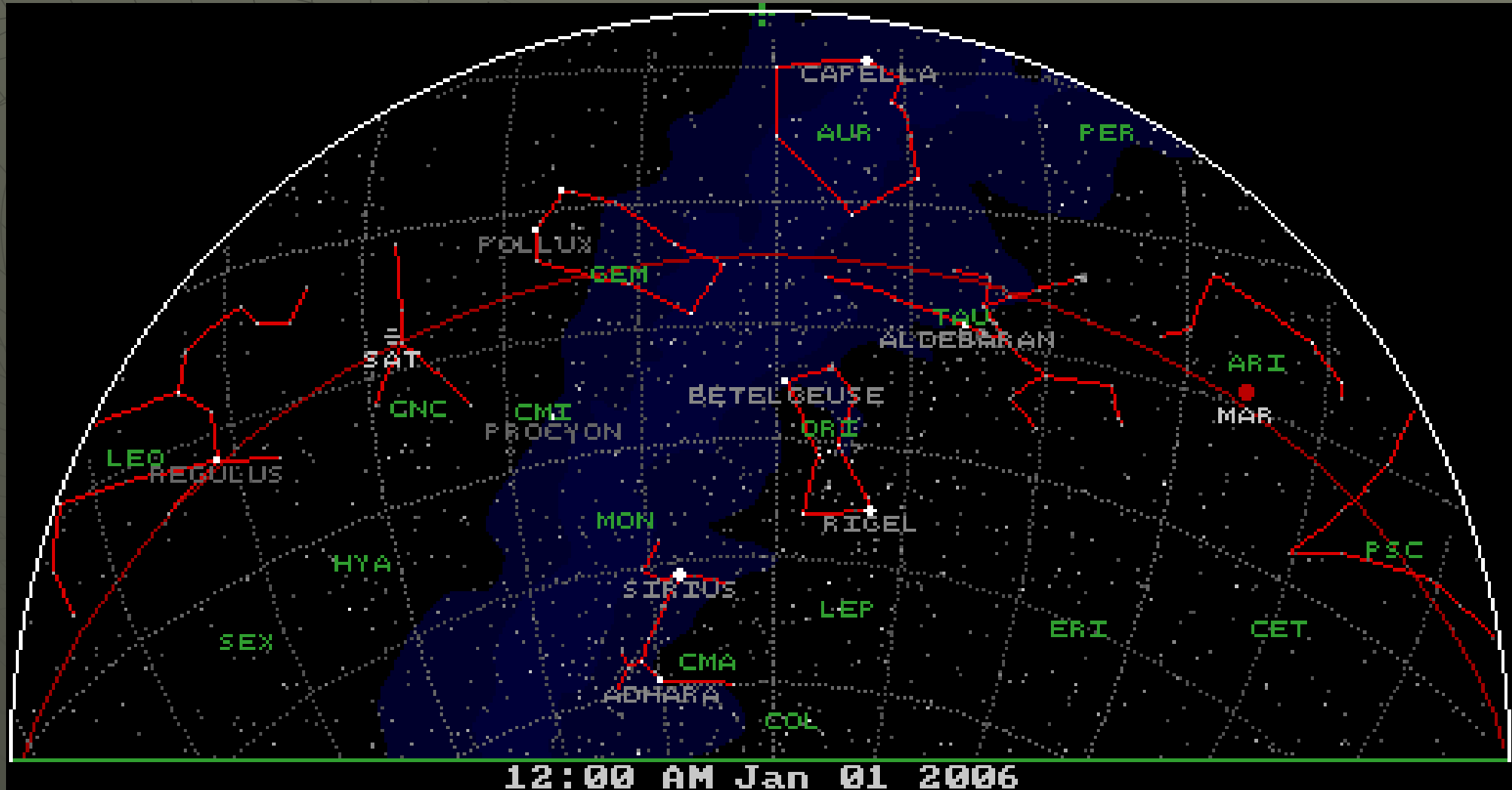


The Ecliptic ranges up to 23.4° from the Celestial Equator

Equinox



Ecliptic Animation

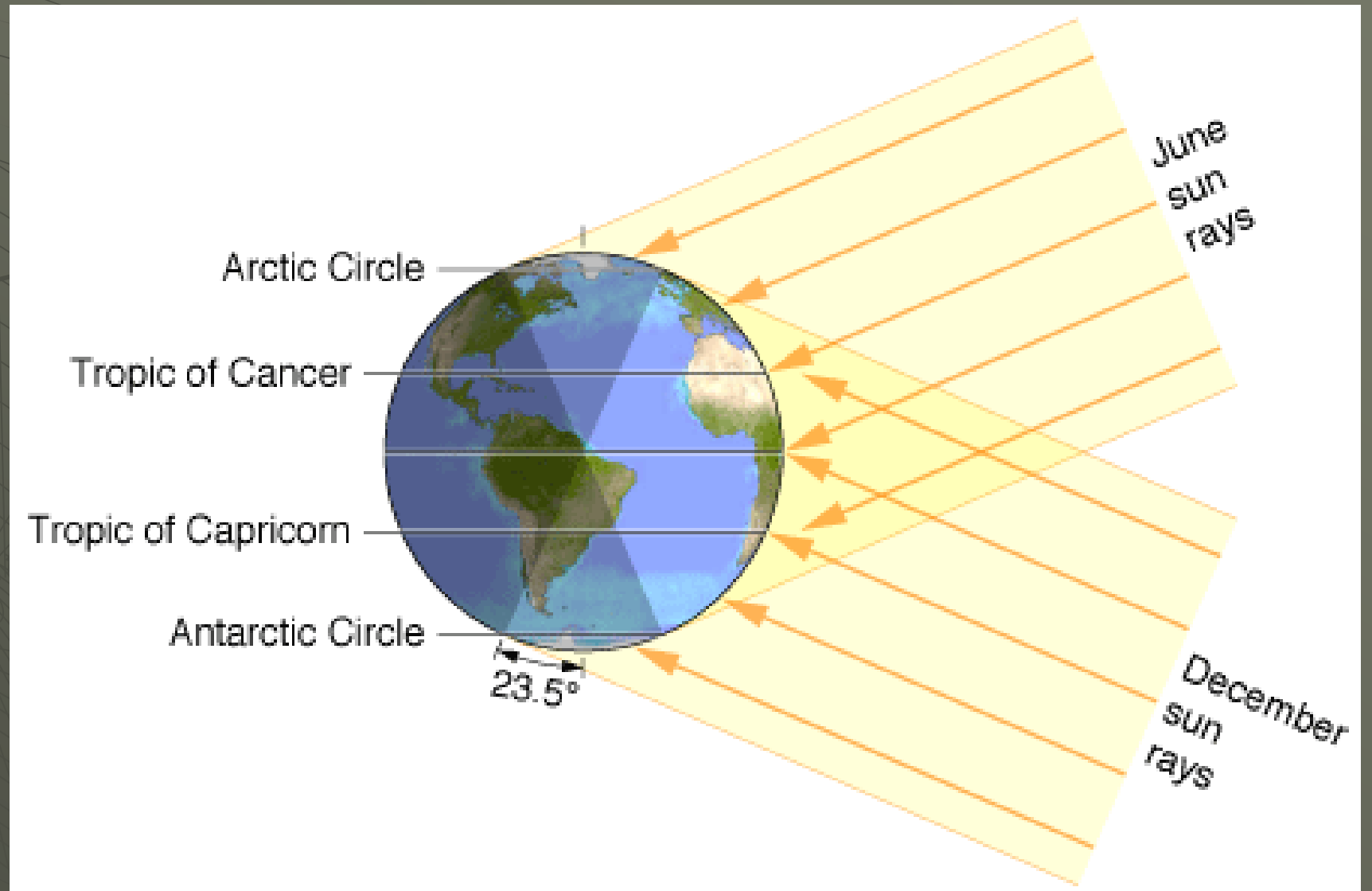


Changing Declination of the Sun

- ◆ Throughout year, sun slowly changes its north/south position.
 1. Summer Solstice (June 21st) : Sun 23.5° above (*north of*) celestial equator
 2. Autumnal Equinox (Sept. 21st): Sun *on* celestial equator
 3. Winter Solstice (Dec. 21st): Sun 23.5° below (*south of*) celestial equator
 4. Vernal Equinox (March 21st): Sun *on* celestial equator

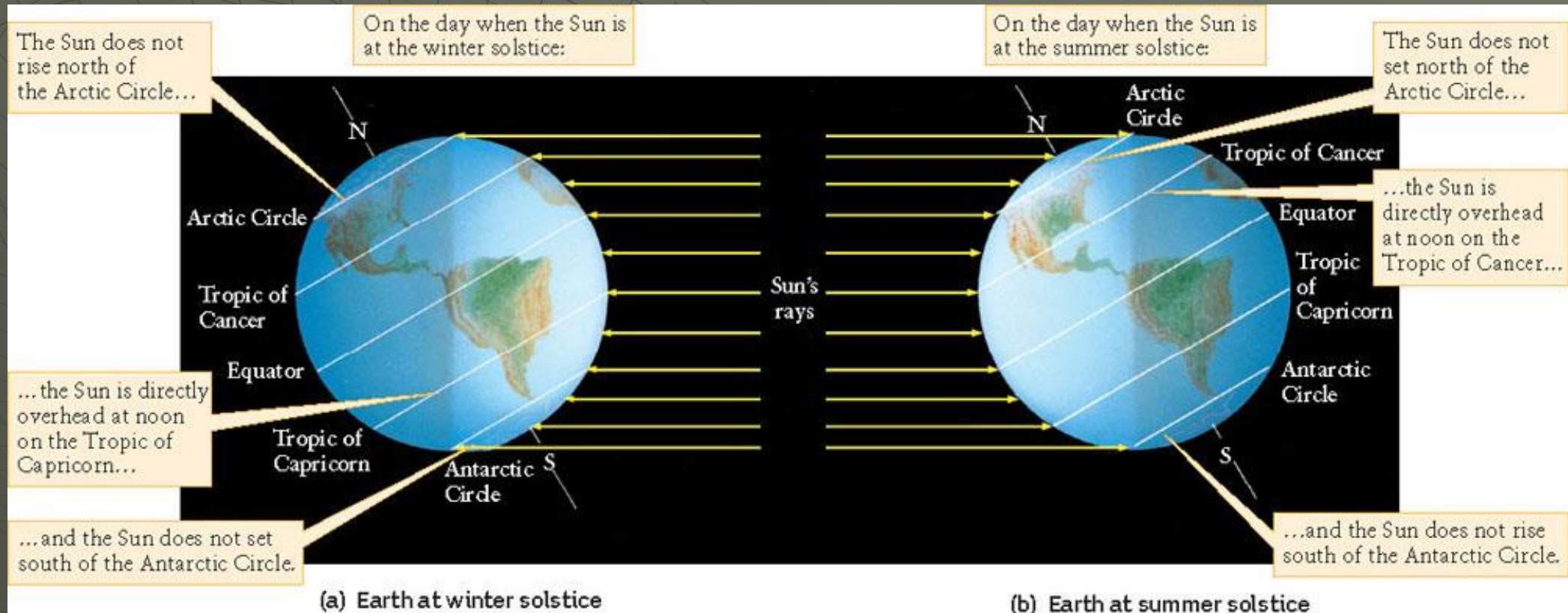
The Sun from Different Latitudes

- Tropic of Cancer:
 - Sun is directly overhead during the summer solstice
- Tropic of Capricorn:
 - Sun is directly overhead during the winter solstice



Circumpolar Sun!

At some locations and times, even the sun is circumpolar or does not rise!



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- ◆ Seasonal Stars
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TPS

Q: The Sun never _____ above the _____ circle on the Winter Solstice?

A) rises, antarctic

B) sets, antarctic

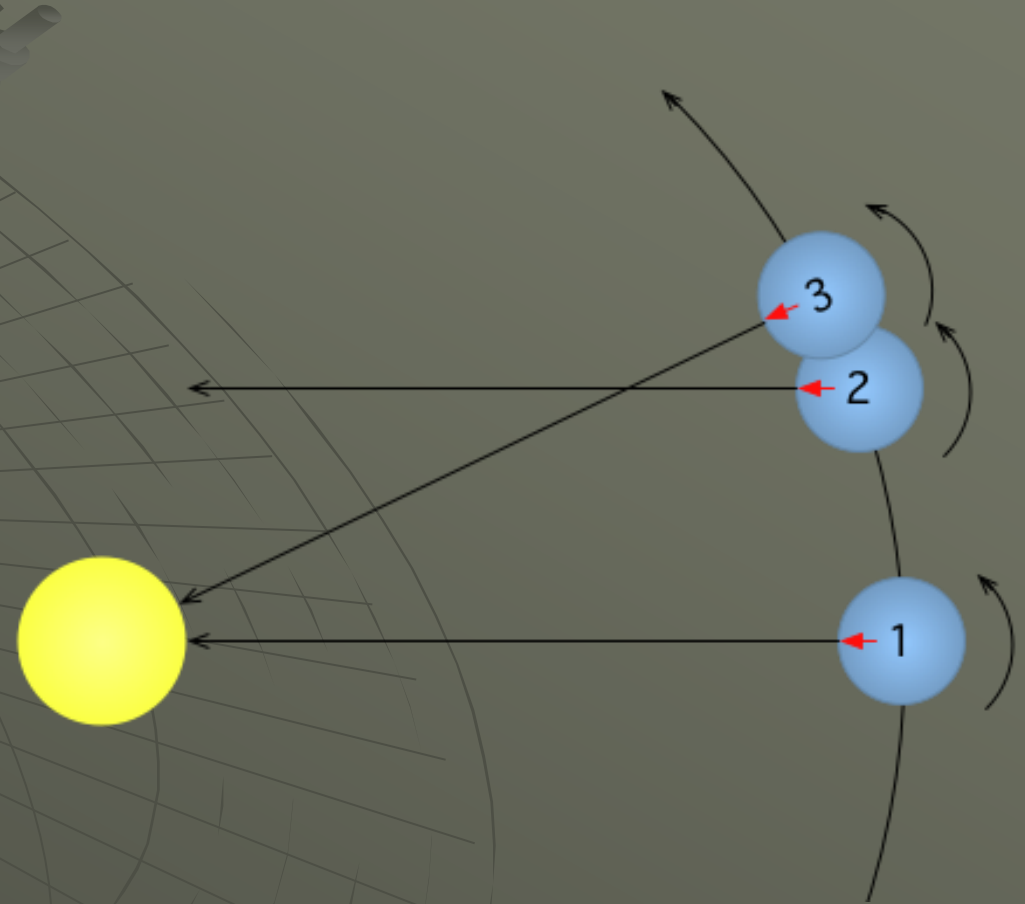
C) rises, arctic

D) B and C

Sidereal Day

- Days are defined from when the Sun crosses the Local Meridian: **24 hours**
- **But the stars take 23 hours and 56 minutes!!!**

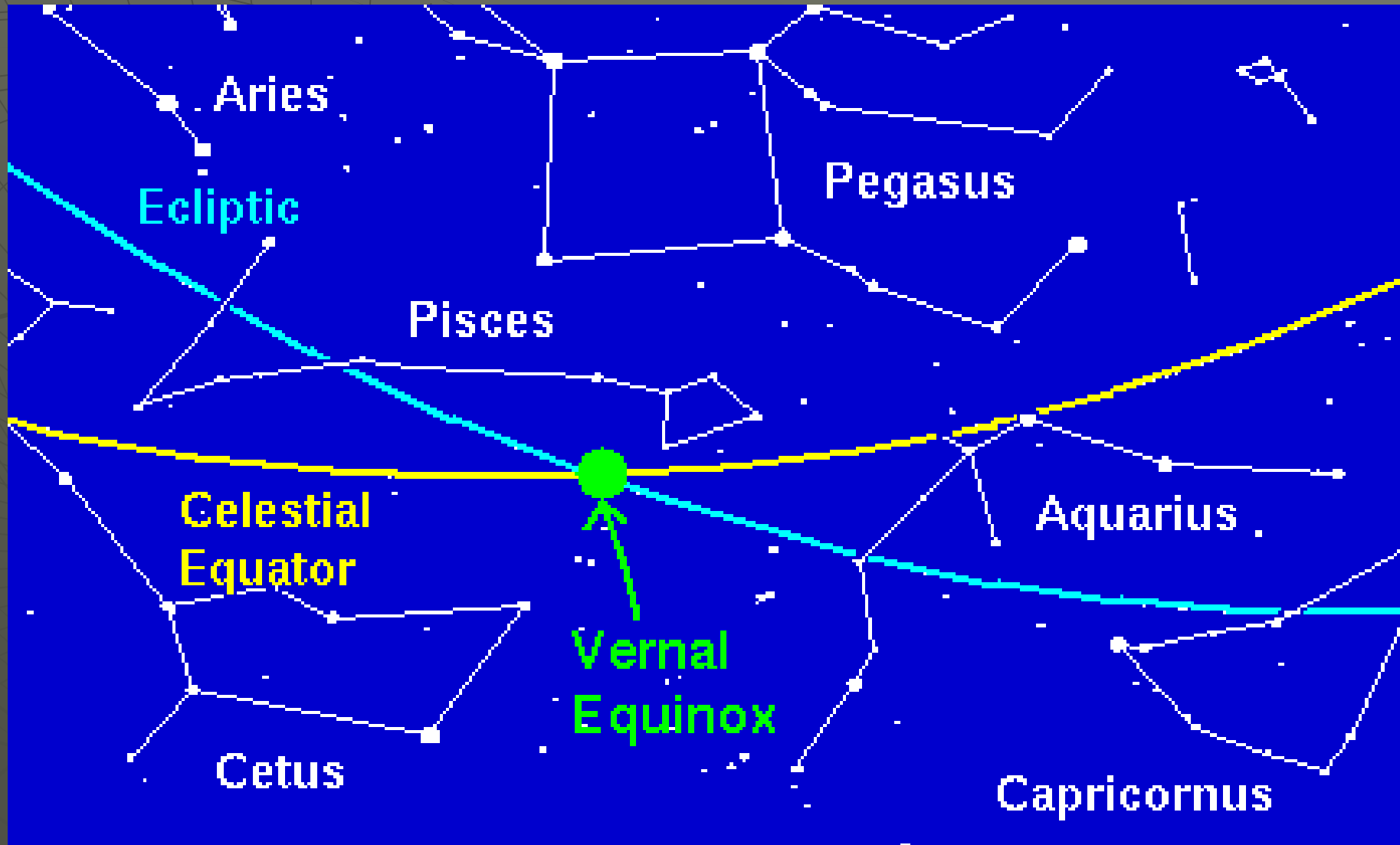
- ◆ Sidereal Day: 1 rotation with respect to the stars → 23:56
 - ◆ Solar Day: 1 rotation with respect to the sun → 24:00
- ★
- ◆ Point 1: The sun and a distant star are both on the observer's meridian.
 - ◆ Point 2: The same star reaches the meridian (sidereal day)
 - ◆ Point 3: The sun has again returned to meridian (solar day)
 - ◆ It takes an extra four minutes to go from Point 2 to 3.



Sidereal Year

- As you may have guessed, a sidereal year is how long it takes Earth to complete one orbit exactly, with respect to the stars.
- 1 sidereal year = 365d 6h 9m 10s \approx 365.25 days
- A tropical year is the time it takes for the Sun to go from vernal equinox and back (ecliptic crosses the equator)
- 1 tropical year = 365d 5h 48m 46s \approx 365.24 days
 - We use the tropical year
- Gregorian calendar: includes leap years to account for that \sim 0.25 days

Why does the Sun Shift to Different Constellations???



Precession

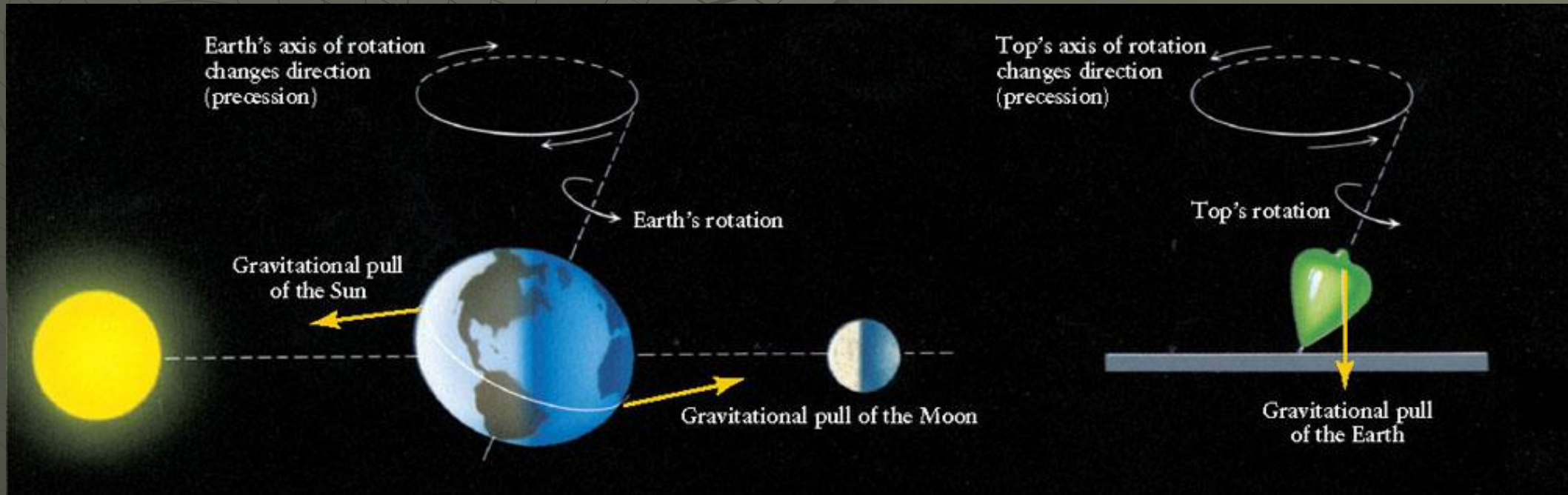
- 1 sidereal year = 365d 6h 9m 10s
 - 1 tropical year = 365d 5h 48m 46s
-

20 mins 24 sec

- ◆ The intersection of the Ecliptic-Equator is moving with respect to the stars!

Precession

Because the Earth is rotating and being pulled by gravity (Sun and Moon), the direction of its axis precesses, like a spinning top



Precession

One cycle takes 26,000 years



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- ◆ Siderial Day
 - Pg 11

- ◆ How will the Sun's position in the sky at noon change if you travel 20° south?
 - A. The Sun's altitude will decrease by 20°
 - B. The Sun's altitude will increase by 20°

- ◆ During the summer solstice in Laramie, WY at noon, the Sun will be:
 - A. At zenith
 - B. In the southern sky
 - C. In the Northern sky
 - D. Not visible

◆ At what latitude will the Sun cross the zenith on an equinox?

A. 41

B. 0

C. 23.5

D. 90