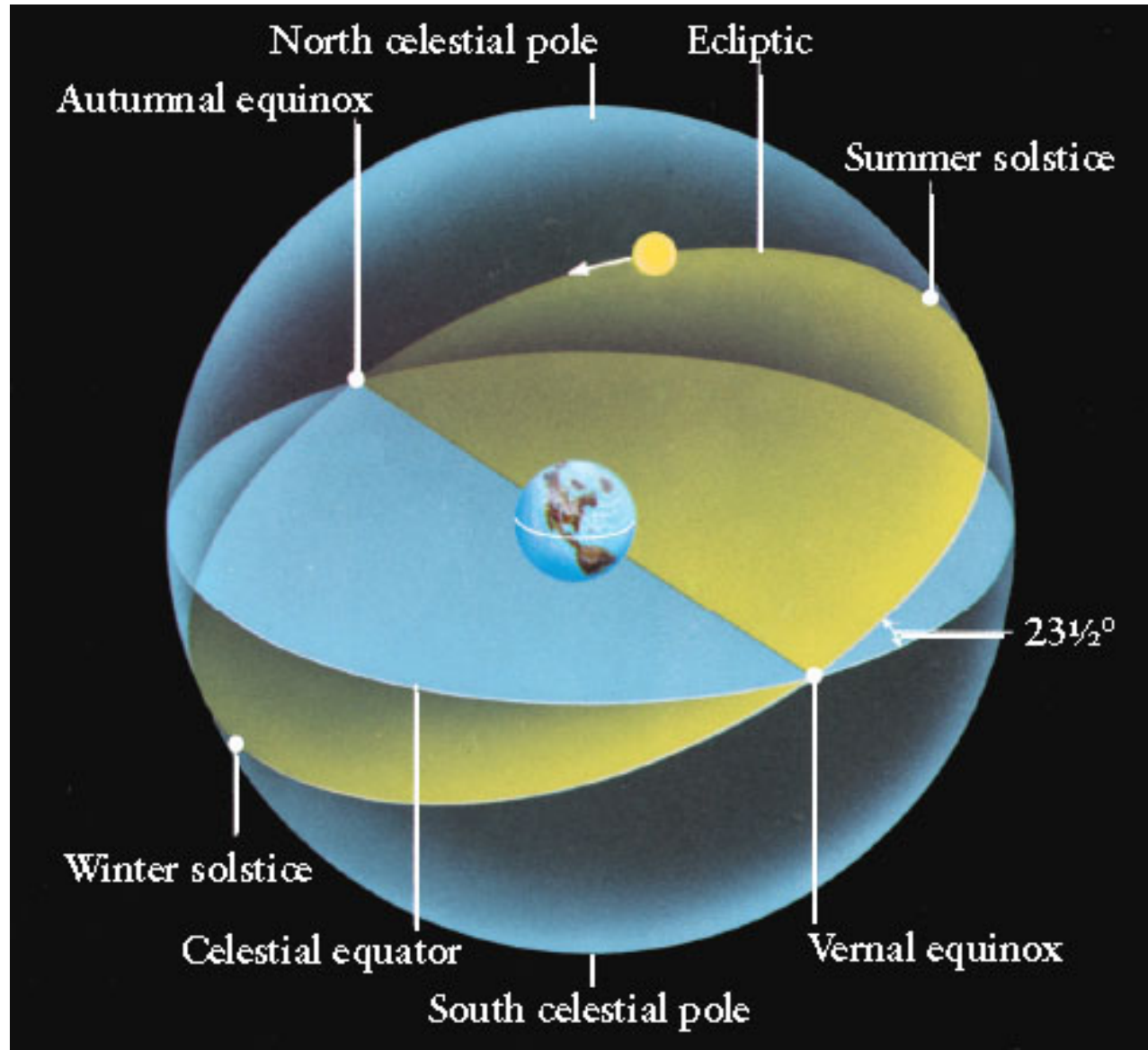
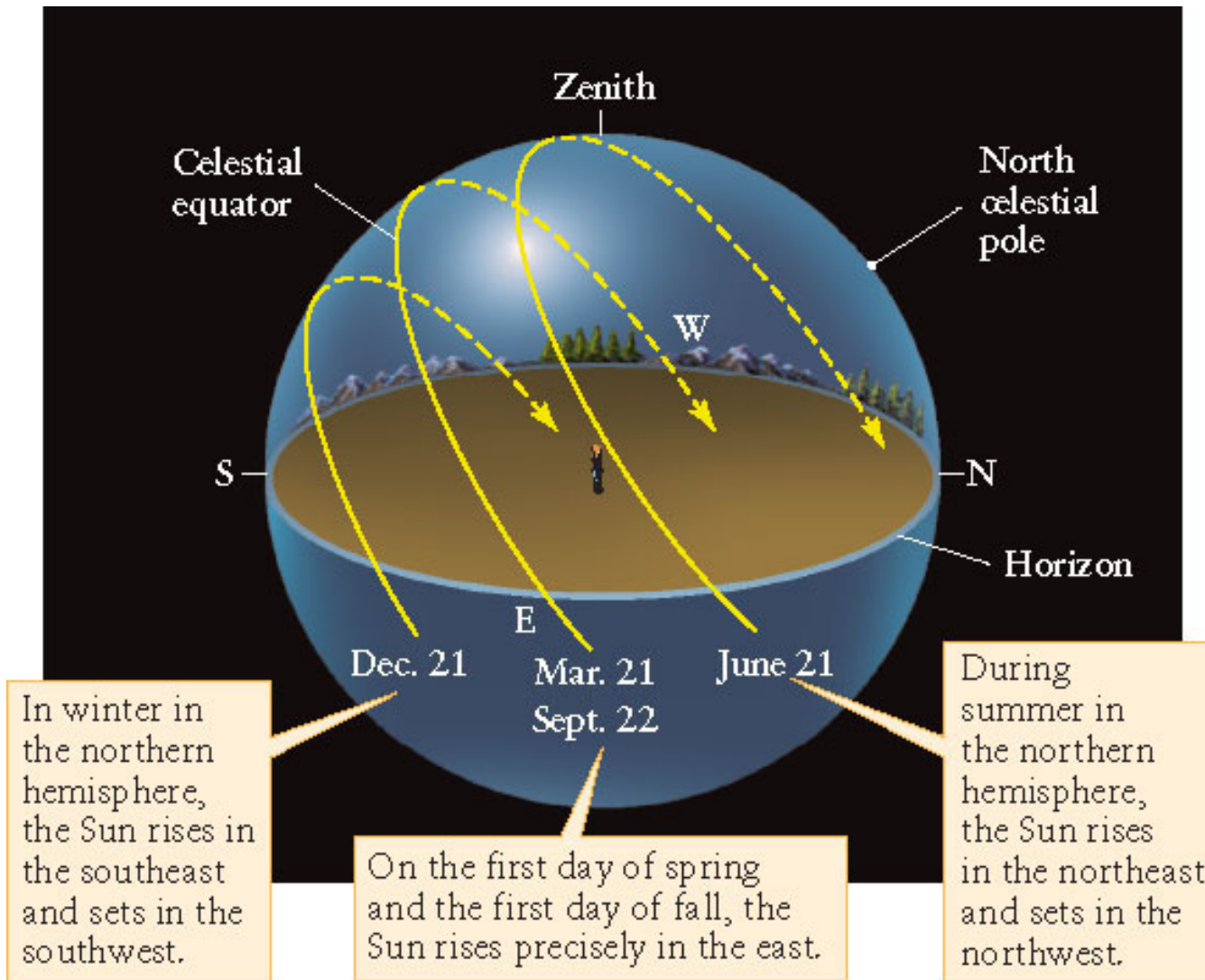


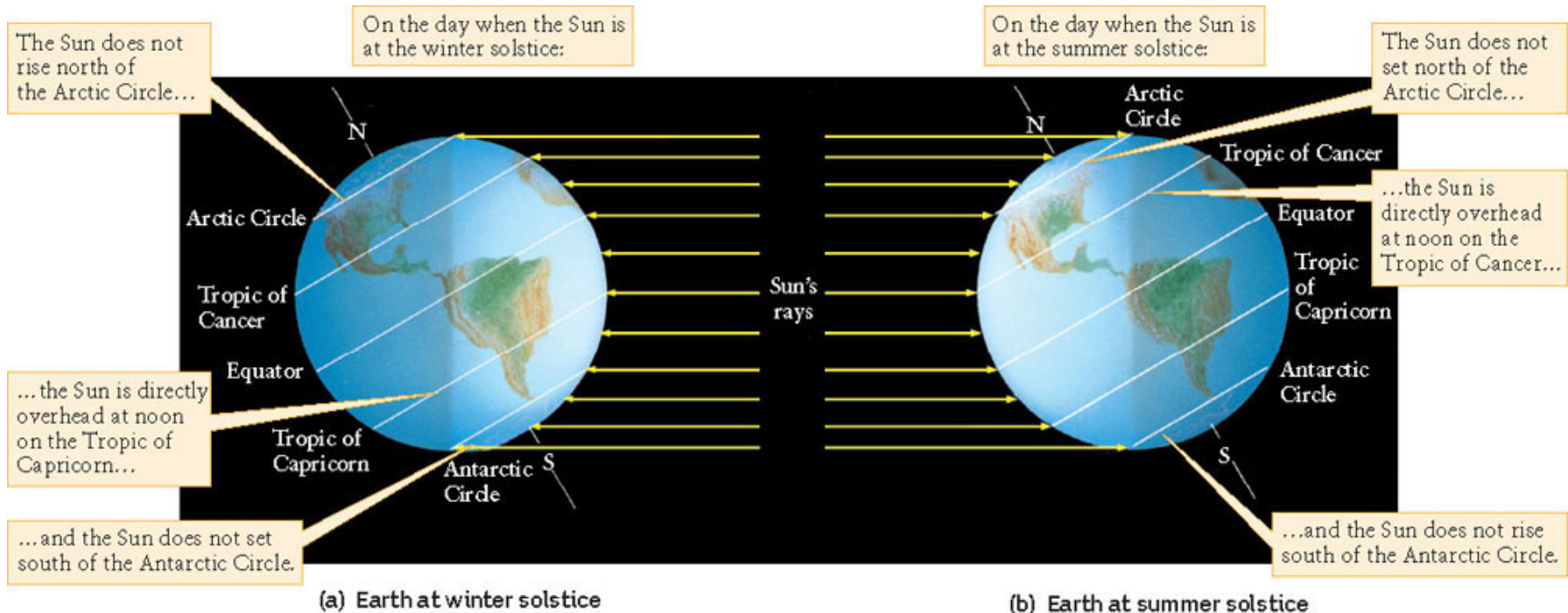
# The Ecliptic, Equinoxes, and Solstices



# The Sun's Daily Path Across the Sky



# Tropics and Circles



**Arctic Circle:**  $90^\circ - 23\frac{1}{2}^\circ = 66\frac{1}{2}^\circ$  North Latitude

**Antarctic Circle:**  $90^\circ - 23\frac{1}{2}^\circ = 66\frac{1}{2}^\circ$  South Latitude

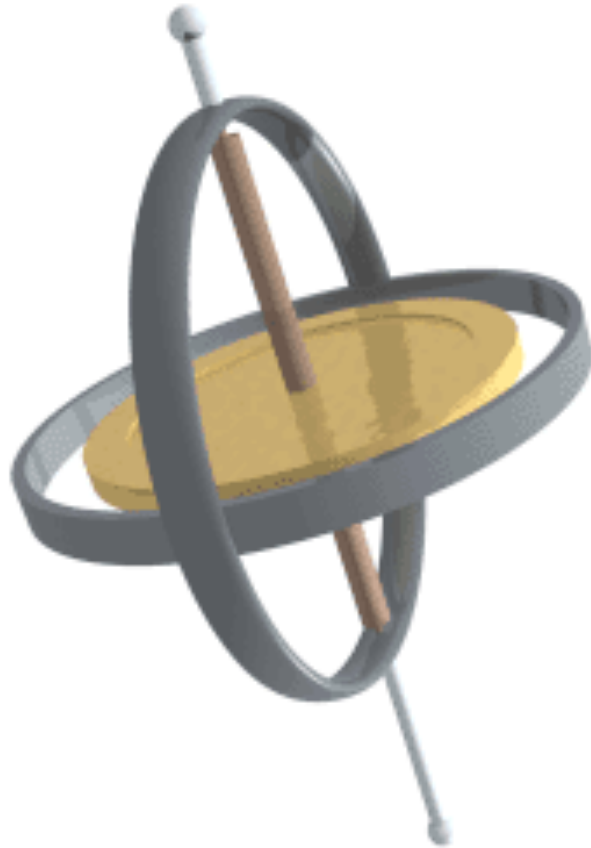
**Tropic of Cancer:**  $23\frac{1}{2}^\circ$  North latitude

**Tropic of Capricorn :**  $23\frac{1}{2}^\circ$  South Latitude

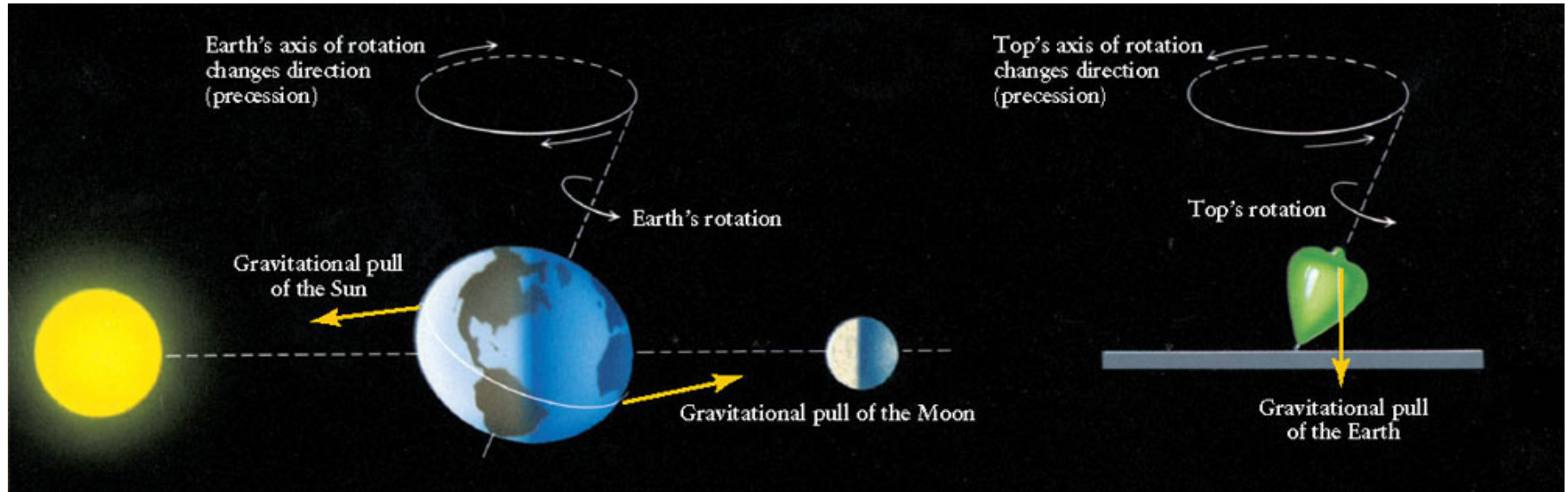
# The Midnight Sun



# Precession



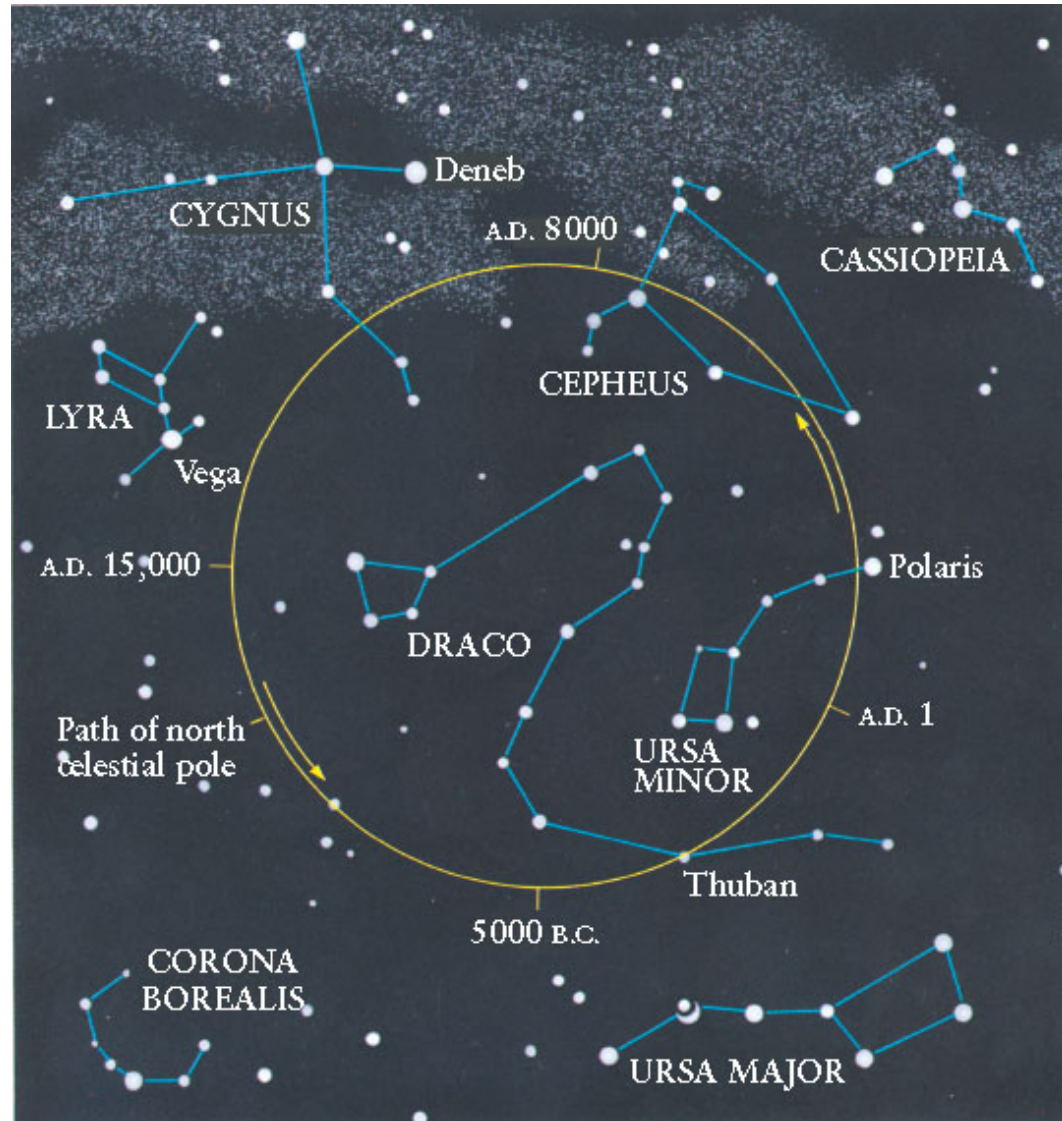
# Earth's Precession



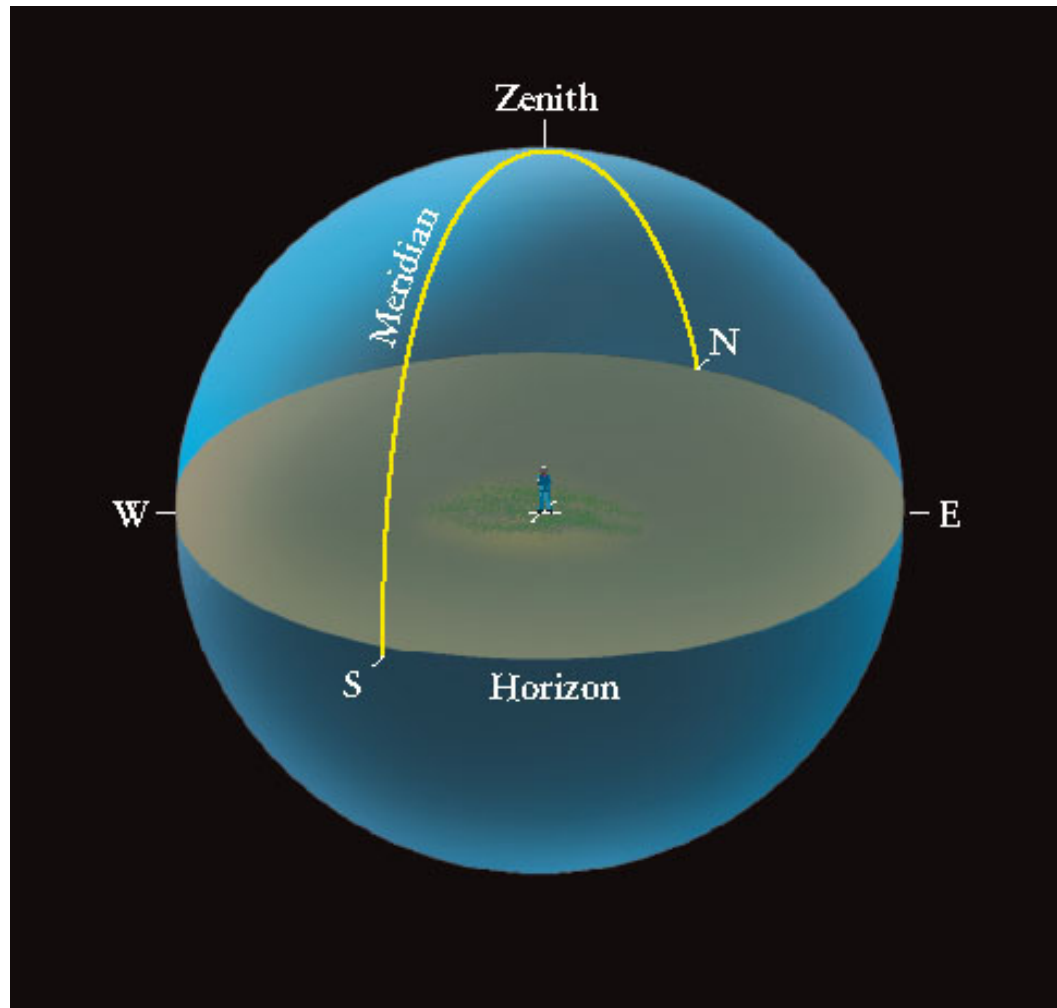
In addition to its rotation and revolution, the Earth's axis also precesses (wobbles) like a top. The angle between the ecliptic and the equator remains at  $23.5^\circ$ , but the direction changes. The period of this precession of the equinoxes is about 26,000 years.

[Animation of Earth's Precession.](#)

# The Effect of Earth's Precession on the Apparent Position of Stars

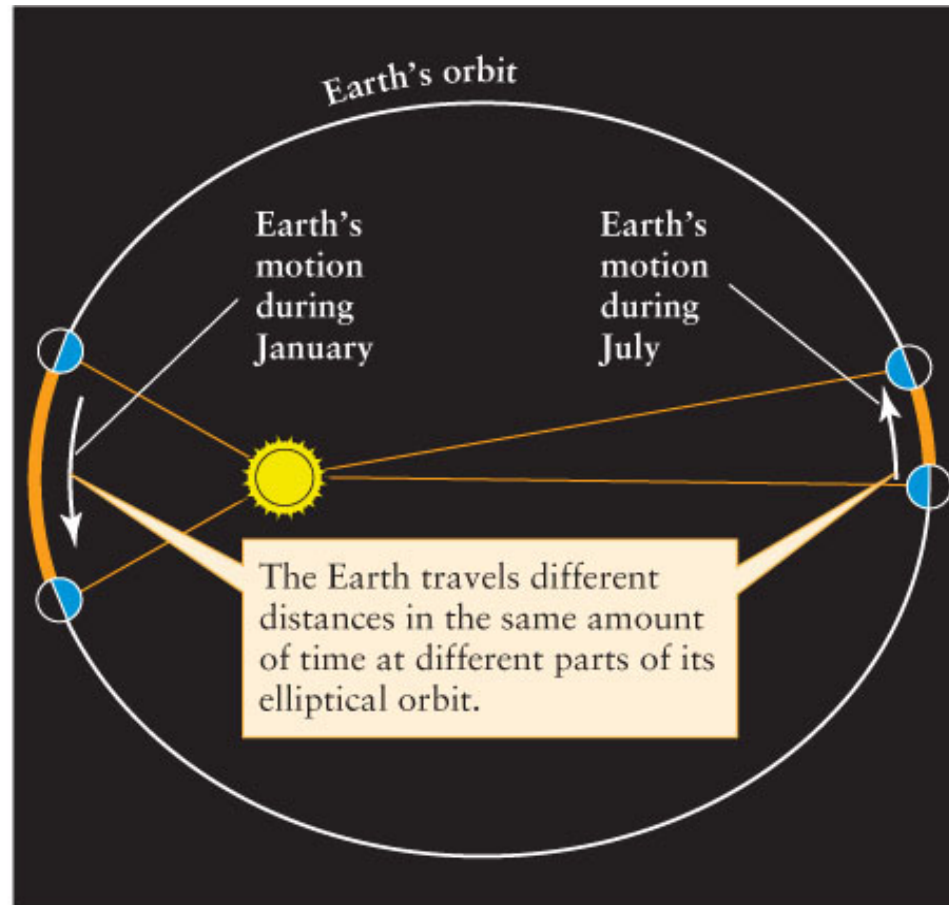


# Meridian and Apparent Solar Day



An apparent solar day is the time between two successive crossings of the Meridian by the sun.

# The Sun as a Timekeeper



(a) A month's motion of the Earth along its orbit

The length of an **apparent solar day** is not the same throughout the year. Astronomers thus came up with the **mean solar day** which is exactly 24 hours.

# The Sun as a Timekeeper

The earth is divided into 24 time zones.

The time of a zone is set to the mean solar time of the meridian that roughly runs through the center of the zone.



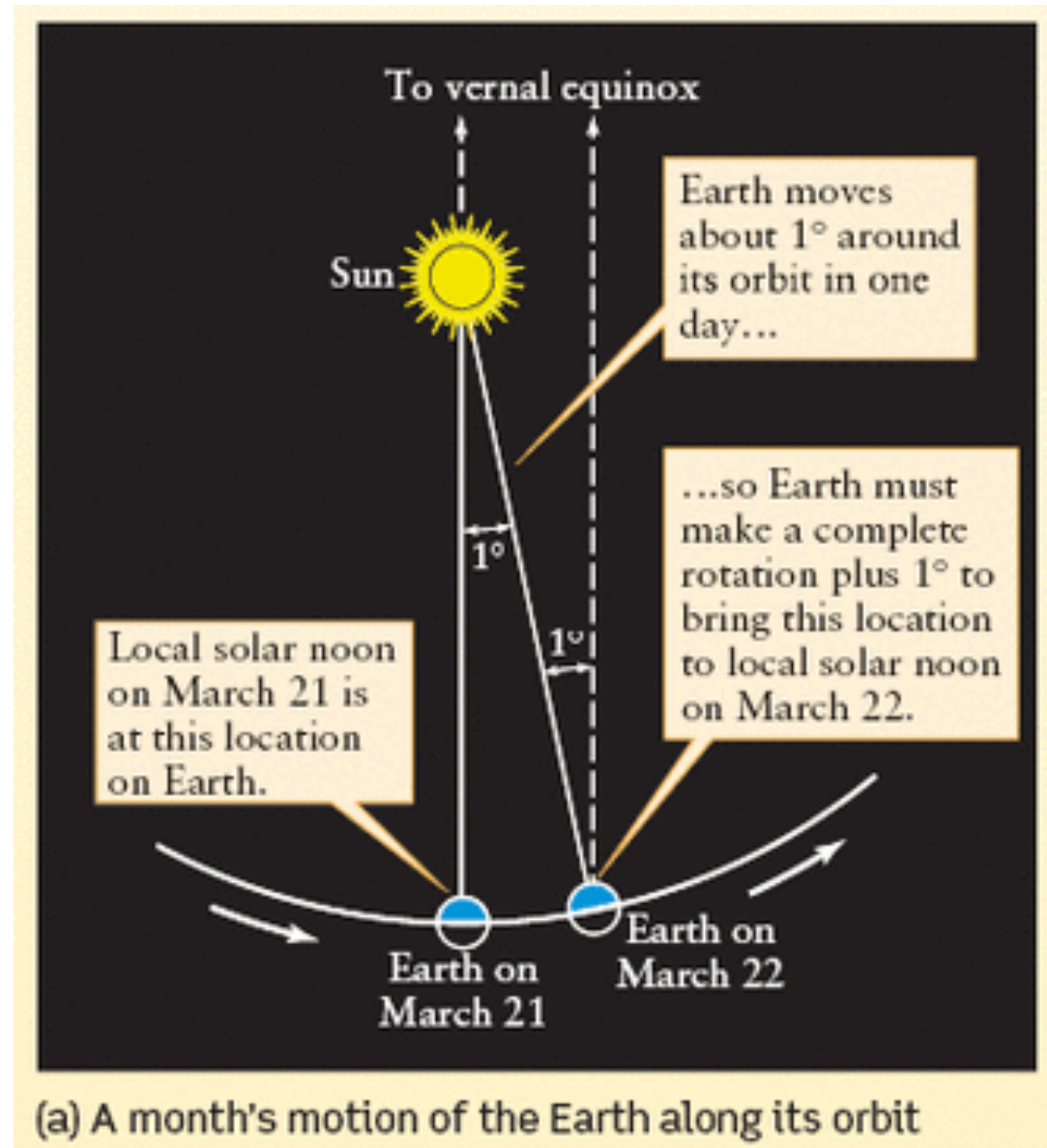
# The stars as a time keeper: Siderial Time

Noon in **solar time** is the moment when the **sun** crosses the upper Meridian.

0:00h **Siderial time** is defined as the moment the Vernal Equinox crosses the upper Meridian.

One Siderial day =  
 **$23^{\text{h}} 56^{\text{m}} 4.091^{\text{s}}$**

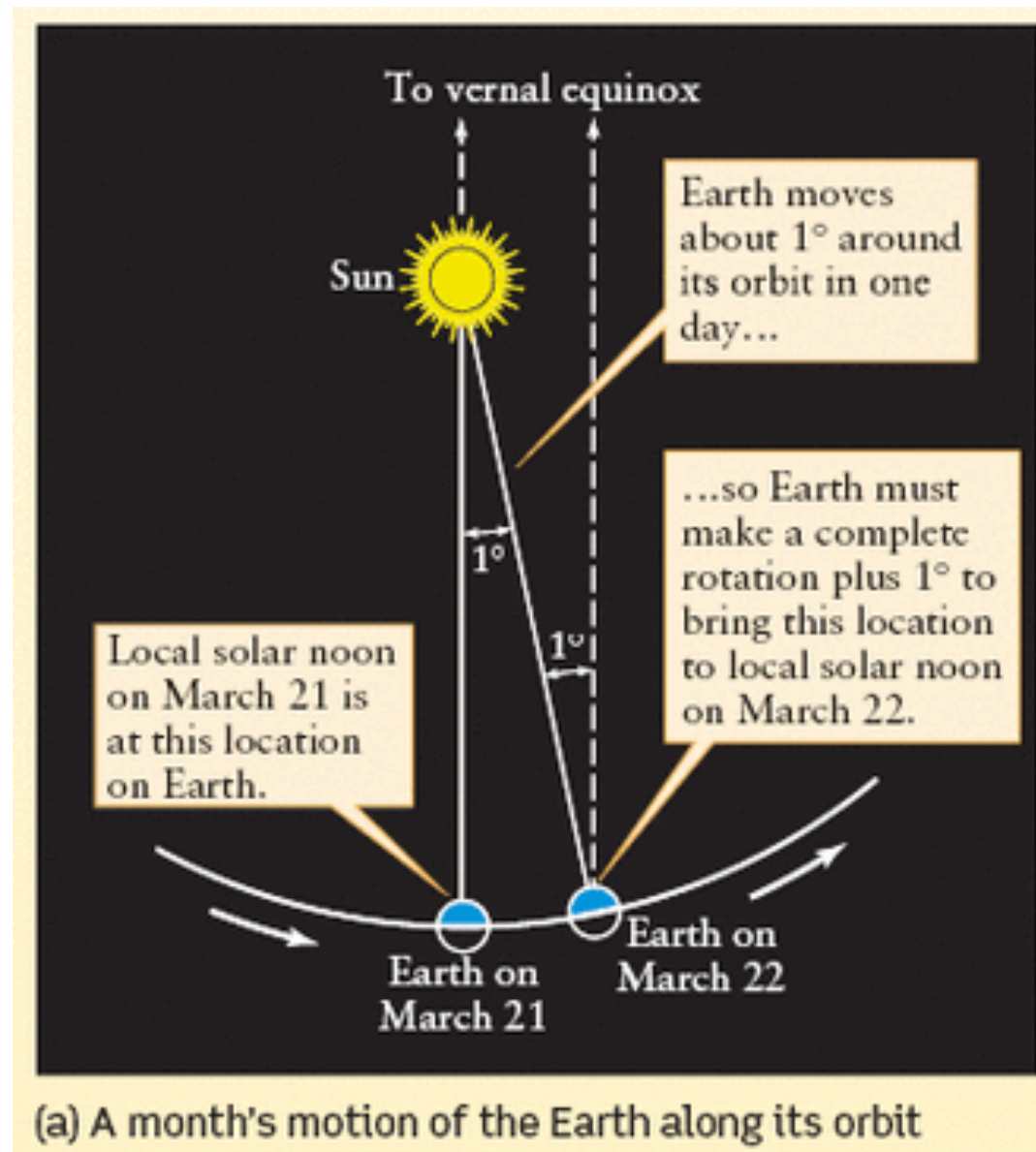
**Siderial Day Animation**



# The stars as a time keeper: Siderial Time

When does the bright star Spica, which has R.A. =  $13^{\text{h}} 25^{\text{m}} 11.6^{\text{s}}$ , Decl. =  $-11^{\circ} 9' 41''$  (epoch 2000) cross your local meridian?

0:00h **Siderial time** is defined as the moment the Vernal Equinox crosses the upper Meridian.



# The stars as a time keeper: Siderial Time



Julius Caesar: established the system of “leap years”



Pope Gregory XIII: Removed days October 4-15, 1582

1 **tropical year** = 365.2422 mean solar days  
( time needed for the Sun to return to the vernal equinox).

1 **siderial year** = 365.2564 mean solar days  
( time needed for the Sun to return to the same position with respect to the stars).

# Modern Day Calendar



Julius Caesar: established the system of “leap years”



Gregory XIII: Removed days October 4-15, 1582

By adding an extra day to the calendar every four years, Julius Caesar hoped to ensure that seasonal astronomical events, would occur on the same date year after year.

Our current calendar is based on the **Gregorian system** that uses the tropical year and a modification of the leap year system.