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
Why does the Sun’s path change over a year?

- Geocentric people must have been really confused...
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**: 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 Lowest in N Hemisphere

Sun is Highest in N Hemisphere

September 22-23
Autumnal Equinox

December 21-22
Winter Solstice

March 20-21
Vernal Equinox

June 20-22
Summer Solstice
Ecliptic
• pg 13
Sun’s Path at Different Times of the Year
Solstice & Equinox

- Sun's path on summer solstice
- Sun's path on equinoxes
- Sun's path on winter solstice

Meridian and zenith points marked on the diagram.
Solstices

The Ecliptic ranges up to 23.4° from the Celestial Equator.
Changing Declination of the Sun

Throughout year, sun slowly changes its north/south position.

1. Summer Solstice (June 21\textsuperscript{st}): Sun 23.5° above (\textit{north of}) celestial equator
2. Autumnal Equinox (Sept. 21\textsuperscript{st}): Sun \textit{on} celestial equator
3. Winter Solstice (Dec. 21\textsuperscript{st}): Sun 23.5° below (\textit{south of}) celestial equator
4. Vernal Equinox (March 21\textsuperscript{st}): Sun \textit{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!
Seasonal Stars

- Pg 7
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 \( \rightarrow \) 23:56
- Solar Day: 1 rotation with respect to the sun \( \rightarrow \) 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.
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 ≈ 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 ≈ 365.24 days

We use the tropical year

Gregorian calendar: includes leap years to account for that ~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.
One cycle takes 26,000 years
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