Astronomy 210

Section 1– MWF 1500-1550

134 Astronomy Building

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MTF 10:30-11:30 a.m.
or by appointment

This Class (Lecture 2):

The Night Sky

Next Class:

Early Cosmology

Homework #1 due next Fri!

http://eeyore.astro.uiuc.edu/~lwl/classes/astro210/spring05/

Music: *Fly A\way* – Lenny Kravitz

Outline

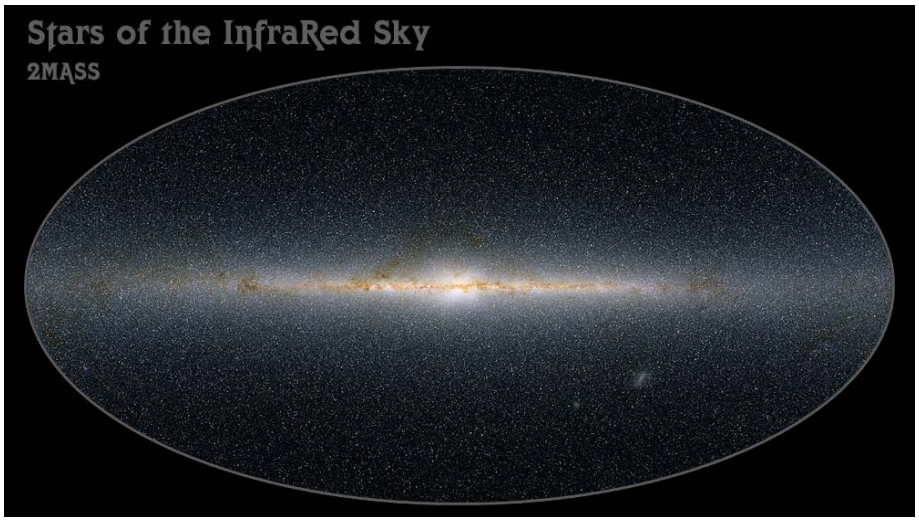
- Constellations
- The Celestial Sphere
- Motions of the Sky
- Seasons

A Sky Full of Stars

On a clear night at a dark site (away from city lights), about how many stars can we see with the naked eye?

1) **A few million**
2) **A few thousand**
3) **A few hundred**
4) **A few hundred thousand**

It's Full of Stars!



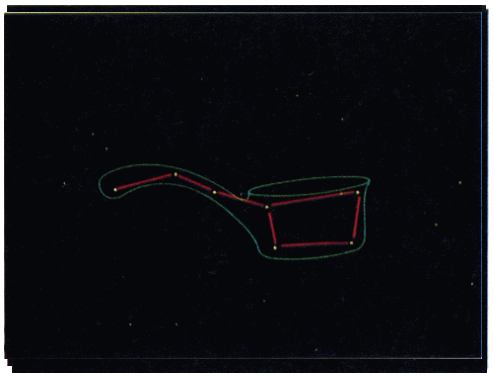
http://coolcosmos.ipac.caltech.edu/image_galleries/legacy/2m_allsky_stars/

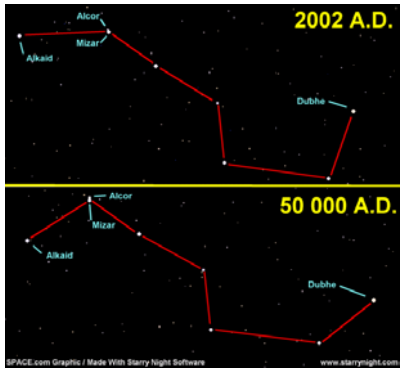
A Sky Full of Stars

- **The average person on a clear night can see about 3000 stars**
  - 6000-8000 total visible (about half are below the horizon)
  - All in our Galaxy and relatively close to us
- **In late July 2003, the total number of stars in the observable Universe was estimated to be:**
  - 70 sextillion (70 thousand million million million million or 7×10^{22})
  - About 10 times the number of grains of sand on all of the Earth's beaches and deserts

Constellations

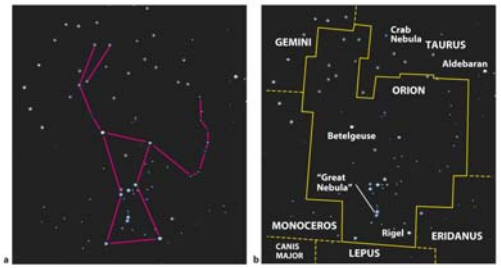
- **Constellations** -- a visual grouping of stars
  - named after gods, heroes, and animals





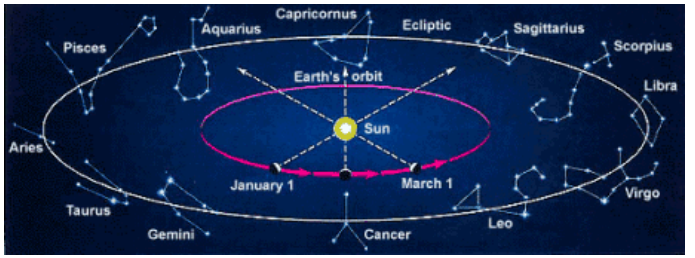
Constellations & Asterisms

- Today we have 88 "official" constellations
  - 50 ancient, 38 modern
  - Every region of the sky "belongs" to an official constellation
- Commonly recognized, but "unofficial" patterns are called **asterisms**
  - Parts of constellations
    - Big Dipper, Great Square, etc.
  - Cross-constellation patterns
    - The Summer Triangle, etc..



The Zodiac

- The most famous of ancient constellations
  - Origins deep in our agricultural past
  - Many constellations symbolize planting or harvesting
  - 12 constellations (sort of), one for each lunar cycle per year.

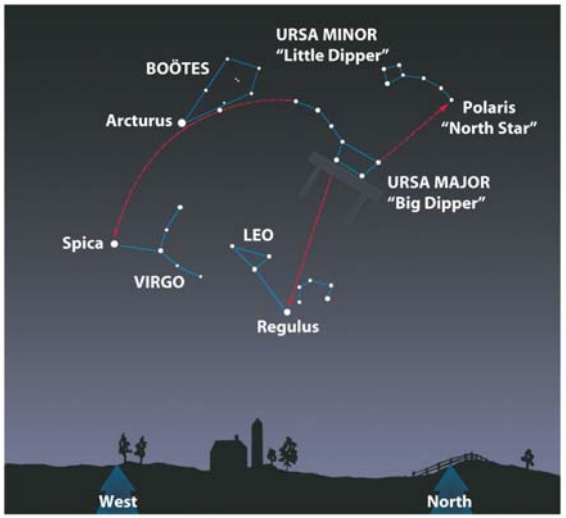


The Real Zodiac

Table 1-1
The 13 Constellations of the Zodiac

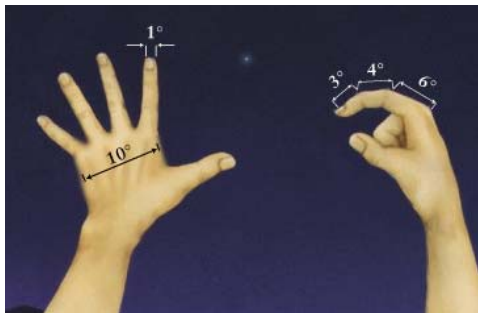
Constellation	Dates of Sun's Passage Through
Pisces	March 13–April 20
Aries	April 20–May 13
Taurus	May 13–June 21
Gemini	June 21–July 20
Cancer	July 20–August 11
Leo	August 11–September 18
Virgo	September 18–November 1
Libra	November 1–November 22
Scorpius	November 22–December 1
Ophiuchus	December 1–December 19
Sagittarius	December 19–January 19
Capricorn	January 19–February 18
Aquarius	February 18–March 13

Lions, Virgins, and Bears



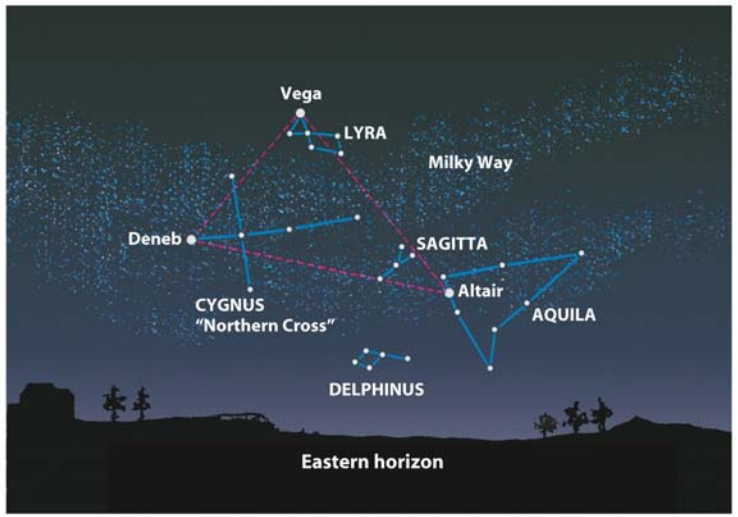
Angular Sizes on the Sky

- Diameter of Sun or Moon roughly half a degree
- Jupiter is about 45 arcseconds
- Earth rotates at 360 degrees/24 hours or 15 degrees per hour
- 1 arcsecond is the angular size of a dime from about 2.5 miles away

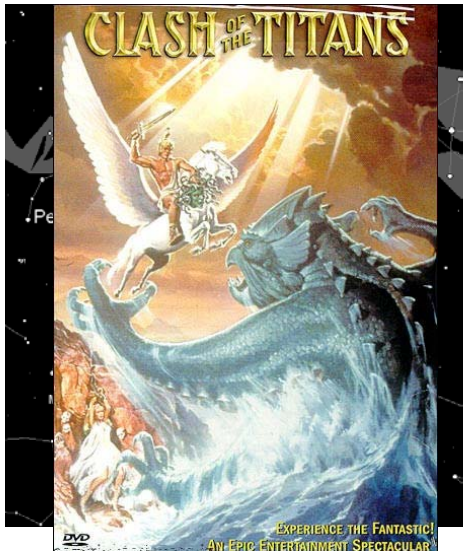


2.5 miles!

The Summer Triangle



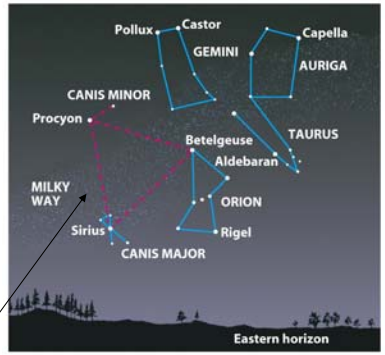
Clash of the Titans (Fall Sky)



- The fall sky tells the tale of Andromeda and Perseus
- An entire Greek myth in the sky!
- Also a major motion picture!

Star Names

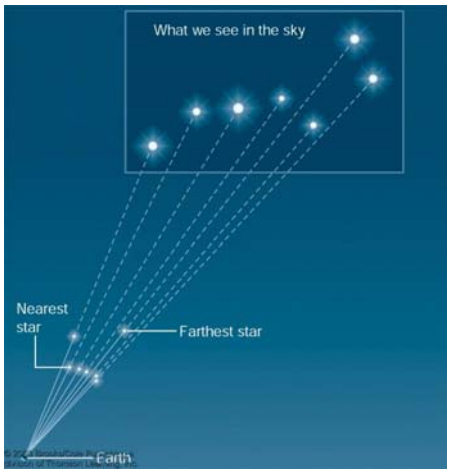
- Many bright stars have **proper names**
- Examples
  - Sirius – from Greek for "scorching"
  - Betelgeuse – from Arabic for "the armpit of the central one"



The winter triangle

Constellations Are Patterns

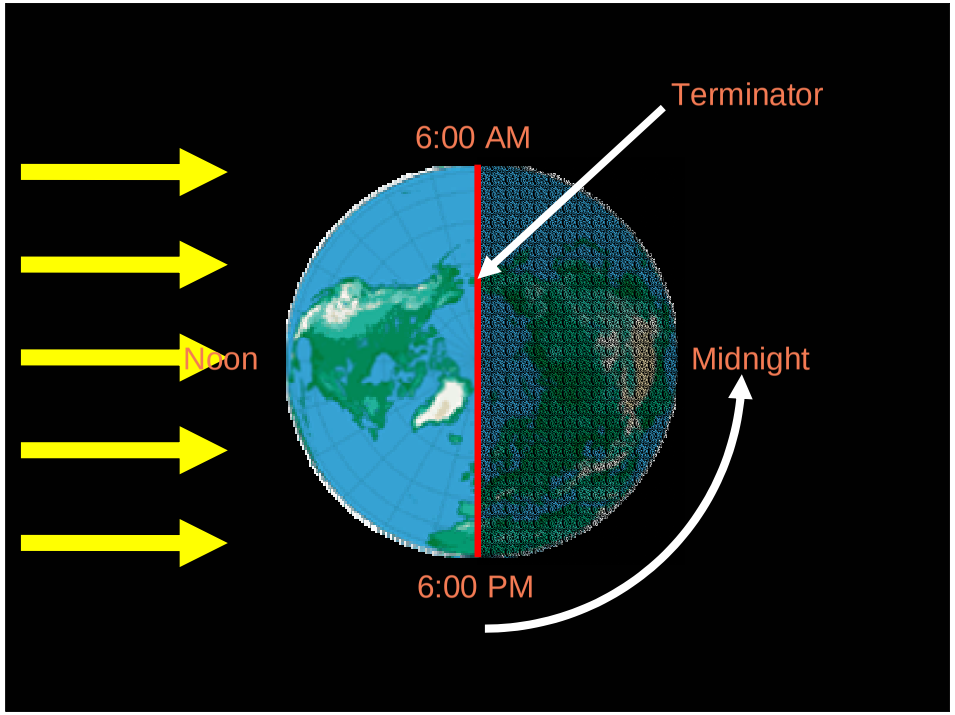
- Remember, the constellations are *patterns*
  - Usually not physically associated
  - Stars in a constellation can be *very* far away from each other
- The sky would look very different from another solar system



The Data

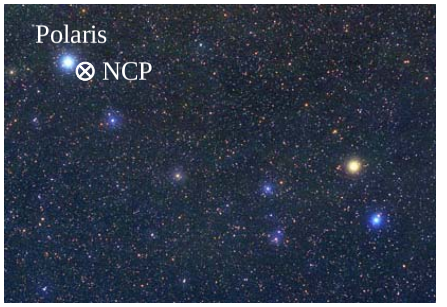
- Look at the Stars.
- What are the Data?
  - Diurnal motions
  - Seasonal motions
- How can we use those to make a model of what we can see with naked eye astronomy?

http://www.ex-astris-scientia.org/gallery/stmagazine/data-queen-kiss.jpg
http://atropos.as.arizona.edu/aiz/teaching/a250/lecture1.html



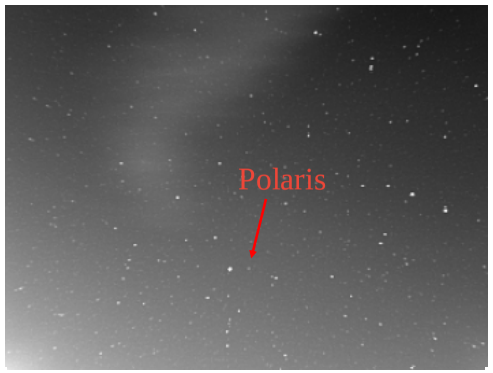
Polaris, the Pole Star

- Polaris is a star that appears very close to the North Celestial Pole (NCP)
- If you find Polaris, you know North.
- Very useful for ocean navigation
- Is it the brightest star in the Sky?



Question

If we took a time-lapse photo of the starry night sky toward Polaris, what would it look like?

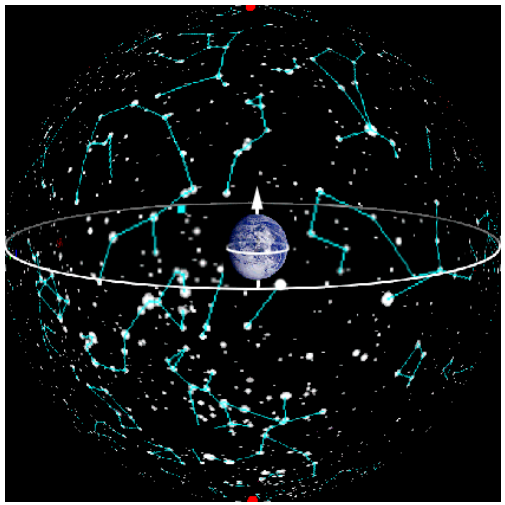


Daily Paths

- Earth's rotation creates daily (dirunal) motion of the stars, Sun, Moon, & planets
- Earth spins eastward, so stars appear to move westward – **daily paths**

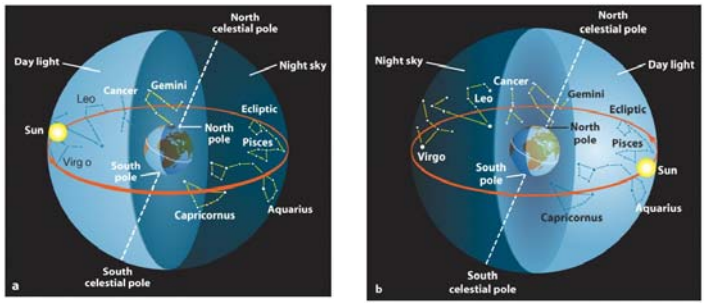
The Celestial Sphere

Imagine the Sun, Moon, & stars on a transparent globe around the Earth



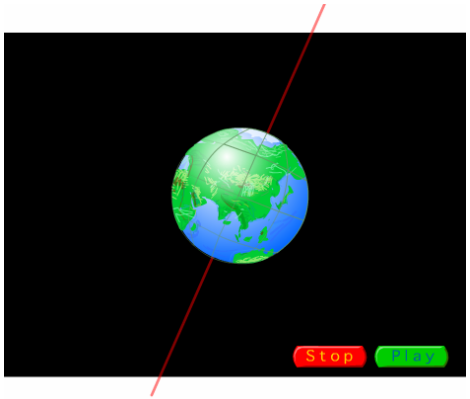
Seasonal Motion

- As the Earth orbits the Sun, the stars visible at night change– The constellations are different in every season.
- A star crosses the meridian one hour earlier every two weeks.



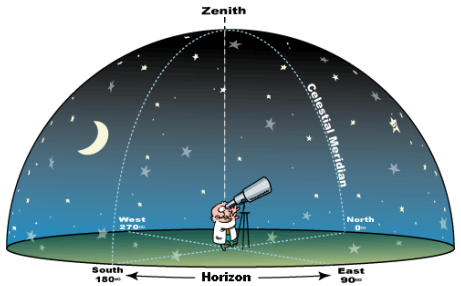
Celestial Poles and Equator

- **Celestial poles** – extensions of the Earth's axis onto the celestial sphere
- **Celestial equator** – project the Earth's equator onto the celestial sphere



Your View of the Sky

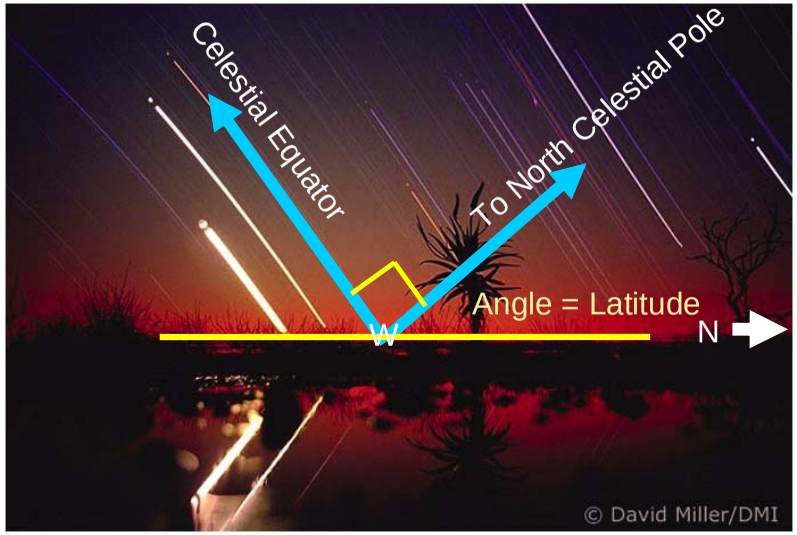
- **Zenith** – point directly overhead
- **Horizon** – marks the intersection of Earth and sky
- **Meridian** – from North to South through the zenith



Celestial Coordinates

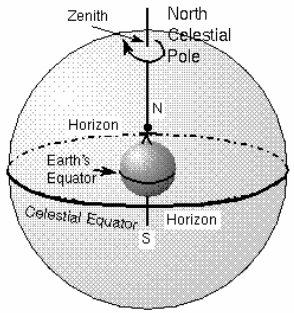
- Measuring North-South
  - **Earth:** Latitude, measures from the equator
  - **Sky:** Declination, measures from the celestial equator
- Measuring East-West
  - **Earth:** Longitude, measured from Greenwich, England
  - **Sky:** Right Ascension, measured from the Vernal Equinox (position of the Sun on first day of Spring)

Motions in the Sky



Changes with Latitude

- The positions of the celestial poles and celestial equator on the sky depend on your latitude
- Note: The celestial equator always crosses the horizon at due east and due west



Latitude = 90° N (at North Pole)
altitude of NCP = 90°

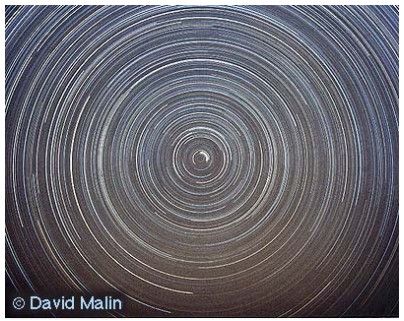
Question

You observe a star rising directly to the east. When this star reaches its highest position above the horizon, where will it be?

a) High in the northern sky
b) High in the eastern sky
c) High in the southern sky
d) High in the western sky
e) Directly overhead

Circumpolar Stars

- The sky appears to spin around Polaris.
- Earth's rotation is counter clockwise, if you were to look down on the North Pole
- Most stars' daily paths rise in the east and set in the west
- But, some are so close to Polaris, they can't reach the horizon!
- Called *circumpolar stars*



At the North Pole

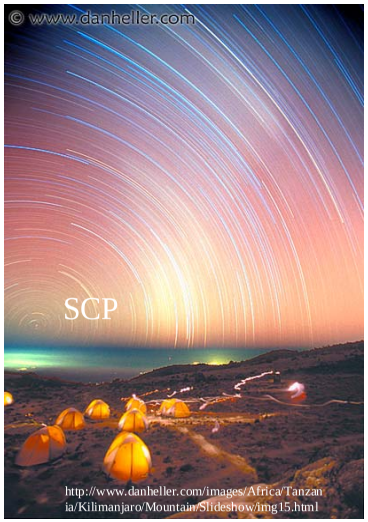
- Polaris is directly overhead
- The sky appears to spin around it
- Stars don't rise or set, they just go around
- All stars are circumpolar at the pole!

At the Equator

- Polaris is right on the horizon
- Stars rise straight up from the eastern horizon and set straight down on the western horizon
- No stars are circumpolar at the equator!

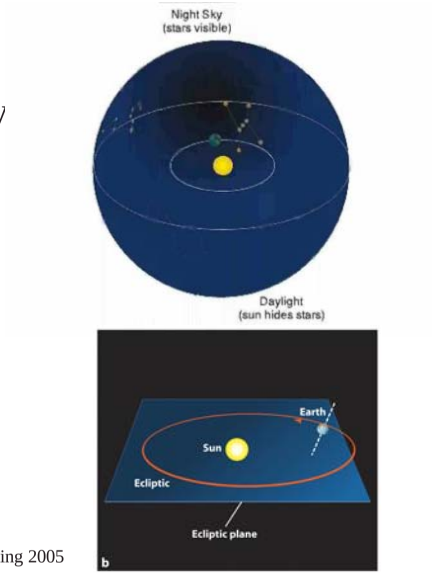
South of the Equator

- South of the equator, you can't see Polaris
- You do see the South Celestial Pole



Free Trip Around the Sun

- The Earth orbits the Sun every 365 days
- The plane of the Earth's orbit is called the **ecliptic**

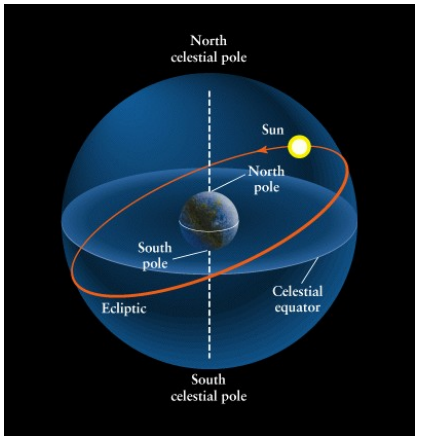


"Living on Earth may be expensive, but it includes an annual free trip around the sun."

-Asleigh Brilliant

The Ecliptic on the Celestial Sphere

- The ecliptic can also be drawn on the celestial sphere
- Note, the ecliptic and the celestial equator are not the same circles
- The Earth's axis is tilted to the ecliptic plane by 23.5°



The Sun Moves in the Sky

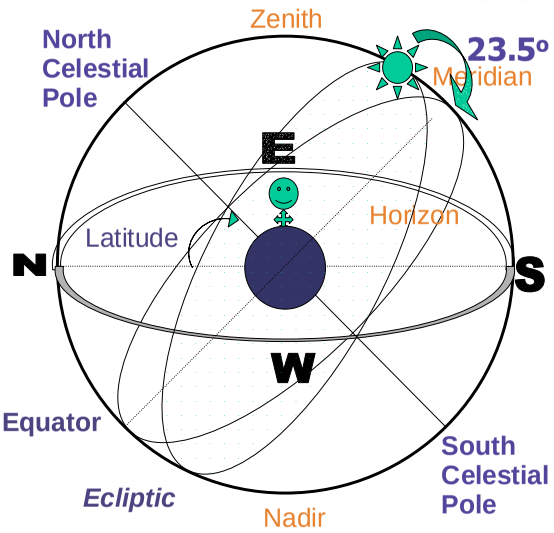
http://planck.phys.uwosh.edu/mike/exercises/anim/ecliptic_movie.mov

The Gregorian Calendar

- Actually, the revolution period is 365.2422... days long
- A regular calendar year is 365 days long
- Accounting for difference
  - Leap years: 1 extra day every 4 years = 365.25 days
  - No leap years every 100 years = 365.24 days
  - Add leap year every 400 years = 365.2425 days

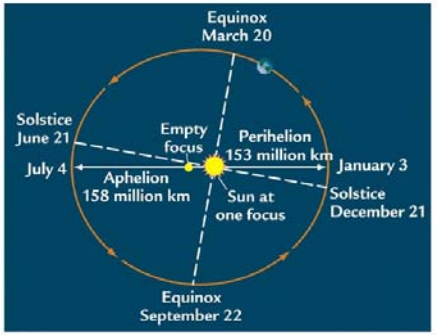
Building A Celestial Sphere

- NCP is up from horizon at an angle equal to your latitude
- Equator is 90º from NCP
- Ecliptic is 23.5º tilted from equator



What Causes the Seasons?

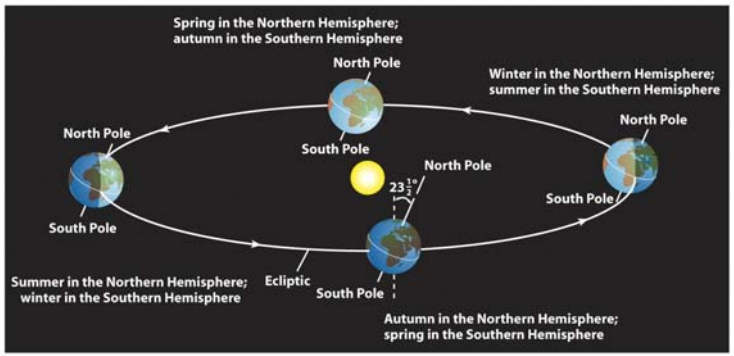
The Earth is closer to the Sun in the summer?



- **No!**
- While the Earth's orbit is not perfectly circular, it is actually closest to the Sun in *January*
- Also, summer in Northern Hemisphere is winter in Southern and vice versa

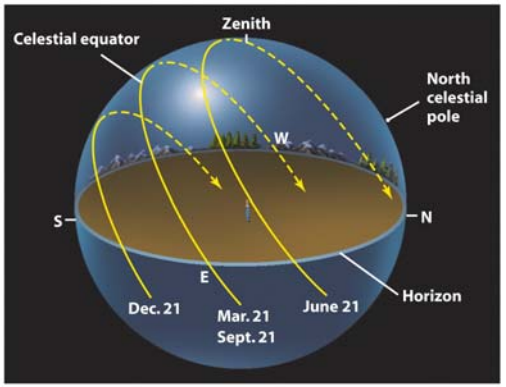
What Causes the Seasons?

So what does cause the seasons?

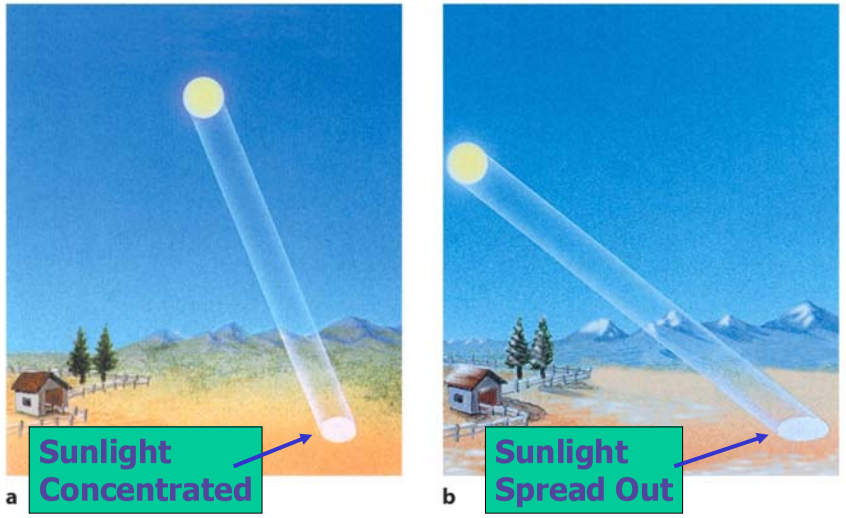


Sun's Daily Paths

- In the summer, the Sun is north of the celestial equator
  - Long days
  - High in the sky
- In the winter, it is south of the celestial equator
  - Short days
  - Low in the sky



Summer vs. Winter



Seasons Around the World