Stars, Galaxies & Universe
Announcements

- No labs this week!
- Add/drop issues to be taken care of in main office: 203 VAN
- All clickers in the bookstore will work in class (there is an updated clicker and an old clicker for sale).
- Textbook is useful resource, but class notes should guide your learning (we won't cover everything in textbook!)
- First reading quiz: Monday (8/30)
- First homework in ICON should be completed between 8/26 (Thurs) and 8/30 (Mon)

Clicker Frequency Setting

1. Hit “Channel” button
2. Hit 44
   Light should be flashing
   Red/Green while setting
3. Press “Channel Button”
4. Light should settle on green if the setting worked

Lecture 2 Outline

• Review of celestial sphere
• Sky from different positions on Earth
• Daily Motion (Motion #1)
• Annual Motion (Motion #2)
• Seasons
Coordinates in the Night sky: Horizon System

The altitude of Big Dipper star and Polaris

Celestial Sphere: Extension of the Earth’s Coordinates
The Night Sky at the North Pole
Polaris (N. Celestial Pole) fixed overhead
Other stars move westward on horizon
Can not see the “southern celestial sky”

Night Sky at the Equator

The Night Sky near the Equator
Most of us are in between these extremes
we see fixed Polaris (N. Celestial Pole star)

The **altitude** of Polaris
is the same as the observer’s **latitude**
What is responsible for the motion of the stars each night?

Motion #1: Diurnal Motion
Motion of Earth on its axis = ~24 hours (23h 56m 4.1s)

- stars, sun, planets appear to move WESTWARD (rise E, set W)
- constellations normally “fixed” in the sky
- Earth’s motion causes constellations to “rise”, “set”

Earth’s rotation=not exactly 24h period - 4 minutes extra
- amount of time between a star reaching the same position (meridian) on two sequential nights: 4 minutes; star will “rise” 4 minutes earlier each nt.
**Motion #2: Annual motion**
- Earth travels around the Sun in 1 “year” – 365 “Earth days”
- orbit is not quite a perfect circle (ellipse)
- depends on the size of the orbit around the Sun (distance)
  - Mars – 1.9 “Earth years”
  - Mercury – 88 “Earth days” – 0.25 “Earth year”
  - Pluto – 250 “Earth years”

As Earth orbits our Sun, different constellations are visible at different times of the year.

- The circumpolar constellations (i.e. the ones around Polaris) are always the same because they are visible no matter where Earth is in its orbit.
- Constellations are essentially “fixed” relative to our motions

More complex: Earth is tilted 23.5 degree tilt on its axis
- “axis” runs through the N and S poles
- tilted with respect to the Earth’s orbital plane
  - N. Summer: N. hemisphere tilted toward Sun
  - N. Winter: S. hemisphere tilted toward Sun
The DIRECTNESS of the rays is what causes the seasons to occur:
- summer (N. Hemisphere) – more VERTICAL RAYS
- winter (N. Hemisphere) – fewer VERTICAL RAYS

Fact 1: Earth-Sun distance only changes by 3% over the year.
Fact 2: Earth is actually closest to the Sun during January!!

Ecliptic: apparent path of the Sun in the sky makes a 23.5 degree angle with celestial equator.

“On Earth”, we observe changes over the course of the year due to the tilt of the Earth on its axis.
Dec 21 – Sun most Southerly in Sky

June 21 – Sun most Northerly in Sky

Sept 21 – ecliptic crosses celestial equator

March 21 – ecliptic crosses celestial equator

Sept 21 – Autumnal equinox

March 21 – Vernal equinox

North celestial pole

South celestial pole

23.5°

23.5°
Two ways to look at Earth-Sun relationship

N. Hemisphere winter: ecliptic (sun) south of celestial equator

N. Hemisphere summer: ecliptic (sun) north of celestial equator