Order of Business

1. Syllabus
2. Homework 1: available on class website, due Mon 1/28
3. General questions?
4. Lecture

Today’s topic: Coordinates
Text: Chapter 1 & Chapter 4 (chapter 4 esp. helpful for HW)
Supplementary Reading:
   *Spherical Trig*, handout on class website
Textbooks

Required 4100 & 6100

Observational Astronomy (2nd ed)
by D. Scott Birney

Amazon new $73, used and eText available
Bookstore new $87, rent $65

Required 6100, Recommended 4100

Handbook of CCD Astronomy (2nd ed)
by Steve Howell

Amazon new $49, used and eText available
Bookstore new $55, used $41, rent $24

check eBay and other discount sites (get correct edition!) but ACQUIRE ASAP!
**Asterisms**: patterns formed from bright stars (like Orion’s body)

Mostly from Greek mythology, passed down over the last 2500 years
Some asterisms share names with constellations
Constellations -
88 defined sections of the night sky

Bright stars are usually named according to their brightness
-- brightest star is *alpha*
-- second brightest is *beta*
-- etc.

For Constellation Orion:
-- Alpha Orionis (aka Betelgeuse)
-- Beta Orionis (aka Rigel)

*only 24 Greek letters, but more than 24 stars in this constellation!!*

Constellations not particularly helpful for celestial navigation
Celestial Sphere - projection of celestial objects onto an imaginary sphere that encircles the Earth.

Celestial objects are often described in terms of their location on the celestial sphere (equatorial coordinates).

Apparent positions of objects are given by their angles with respect to agreed reference points.
Celestial sphere reference points similar to those on the Earth.

Celestial Equator - extension of Earth’s equator into the celestial sphere

North Celestial Pole - extension of Earth’s north pole

South Celestial Pole - extension of Earth’s south pole
Equatorial Coordinates

**Celestial Sphere**

- **Declination (δ)** - similar to latitude; measures degrees north (+) or south (-) of the Celestial Equator.

**Earth**

- **Right Ascension (α)** - similar to longitude; measures hours or degrees east or west of vernal equinox.

- 24 hours = 360° or 15°/hr
- 1 hr = 60 min = 3600 sec
Celestial Sphere Reference Points

- Line of constant declination
- Celestial sphere
- North celestial pole (+90° declination)
- Sun’s annual path around celestial sphere
- Line of constant right ascension
- Angle of right ascension
- Earth’s equator
- Angle of declination
- Vernal equinox (0 h/24 h right ascension)
- Celestial equator
- South celestial pole (~90° declination)
For reference:
angular diameter of full moon = $1/2^\circ$

$1/2^\circ = 30 \text{ arcmin (′)} = 1800 \text{ arcsec (″)}$

Equatorial coordinates usually given as:

RA or $\alpha = 12h\ 30m\ 05.5s$
Dec or $\delta = +30^\circ\ 15^\prime\ 10.0^\prime$
Altitude -
angle relative to the horizon
(+ above, - below)

Azimuth -
angle relative to North
(N = 0°, S = 180°)
**Zenith** -
Point directly above observer’s head; highest point in the sky

**Meridian** -
great circle that runs through zenith and both celestial poles;
marks the point where a celestial object stops rising and begins setting
meridian marks highest point in sky for each object as Earth rotates

→ best time to observe that object!

celestial objects “transit” as they cross the meridian
Where do the cardinal directions go in this video?
Where is the visible celestial pole? What is its altitude?
Where do the cardinal directions go in this video?
Where is the visible celestial pole? What is its altitude?

http://www.astro.gsu.edu/HLCO/gallery/index.html

video is at the bottom of the page
Geometry on the sky requires spherical trigonometry

For more details, refer to Spherical Trig handout on class website

A, B, C $\rightarrow$ angles

$\alpha, \beta, \gamma$ $\rightarrow$ arcs

all 6 are measured in degrees

$A + B + C > 180^\circ$

(can be between $180^\circ$ and $540^\circ$)

Spherical law of sines

$$\frac{\sin A}{\sin a} = \frac{\sin B}{\sin b} = \frac{\sin C}{\sin c}$$

Spherical law of cosines

$$\cos c = \cos a \cos b + \sin a \sin b \cos C$$
Hour Angle - angle between a celestial object and the meridian, measured in hours;

- when object is rising (east of meridian)
+ when object is setting (west of meridian)

Useful rule of thumb: Objects are typically observable between -4h and +4h
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Airmass -
column of air through which a celestial object is observed; objects at the zenith will have airmass = 1.0 by definition

\[ \text{airmass of object} \sim \frac{1}{\cos z} = \sec z \]

higher altitude = lower airmass

**Useful rule of thumb:**
Objects are best observed at airmass < 2.0