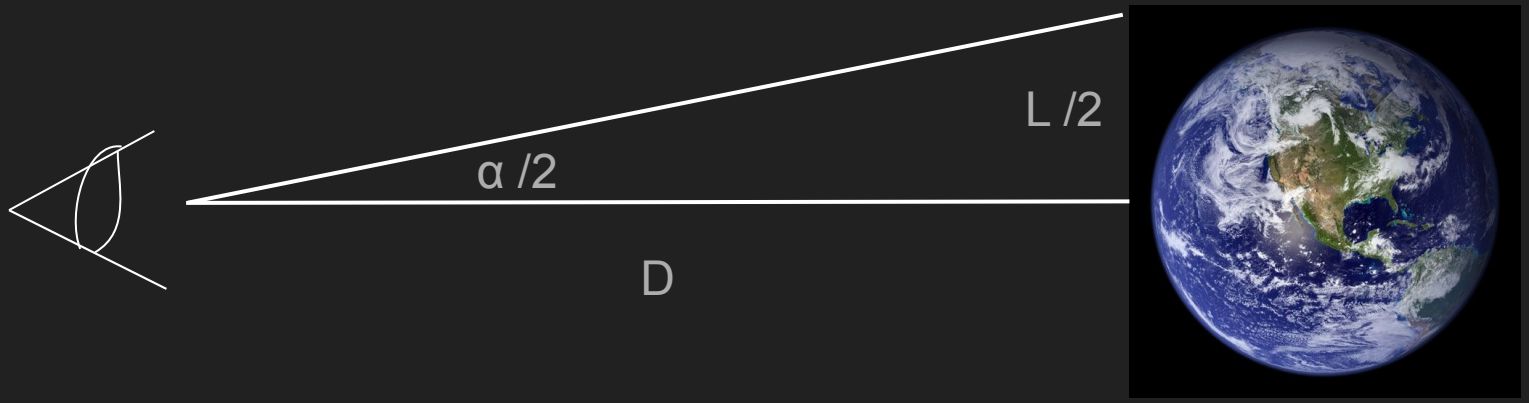

The Sky Above

Angular size

- Linear size- Size of an object in units distance (units meters, inches, feet, centimeters, etc.)
- Angular size- Apparent size of an objects, function of linear size and distance (units radians, degrees, arcseconds)

Angular size

Angular size



Angular size

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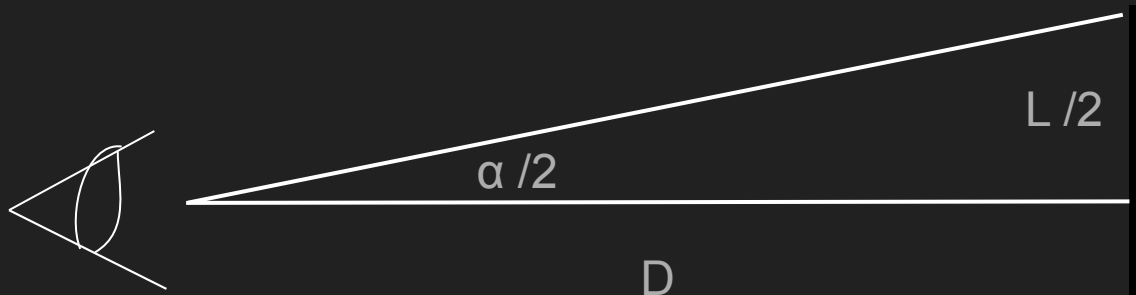

$$\sin\left(\frac{\alpha}{2}\right) = \frac{L/2}{D}$$

if $D >> L/2$, then ...

$$\sin\left(\frac{\alpha}{2}\right) \approx \frac{\alpha}{2}$$

$$\frac{\alpha}{2} = \frac{L}{2D}$$

$$\alpha \text{ (radians)} = \frac{L}{D}$$

Angular size- units

- Linear size has units distance.
- Linear size does not depend on distance we observe.
- Angular size does depend on distance!
- Angular size is an angle (angle an object is spread across the sky).
- Angular size formula gives angle in radians.
- More convenient to use degrees, arcminutes, and arcseconds.

Angular size- degrees

- Degrees and radians

$$180\ ^\circ = \pi \text{ radians}$$

Angular size- arcminutes

- Arcminutes and degrees

$$60' = 1\ ^\circ$$

Angular size- arcseconds

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- Arcseconds and arcminutes

$$60'' = 1'$$

Angular size- common angular sizes

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Milky Way- 30° x 360°

Angular size- common angular sizes

Andromeda galaxy- 3° x 1°

Angular size- common angular sizes

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Moon- ~0.5°, 30’

Angular size- common angular sizes

Jupiter- 50’ (closest), 30’ (furthest)

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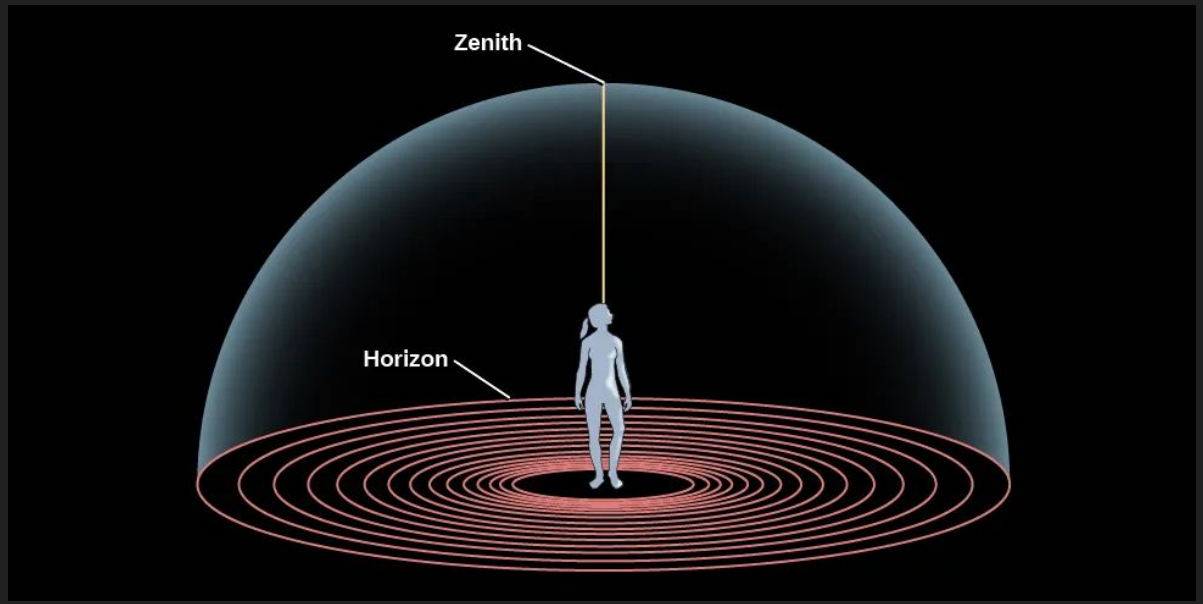
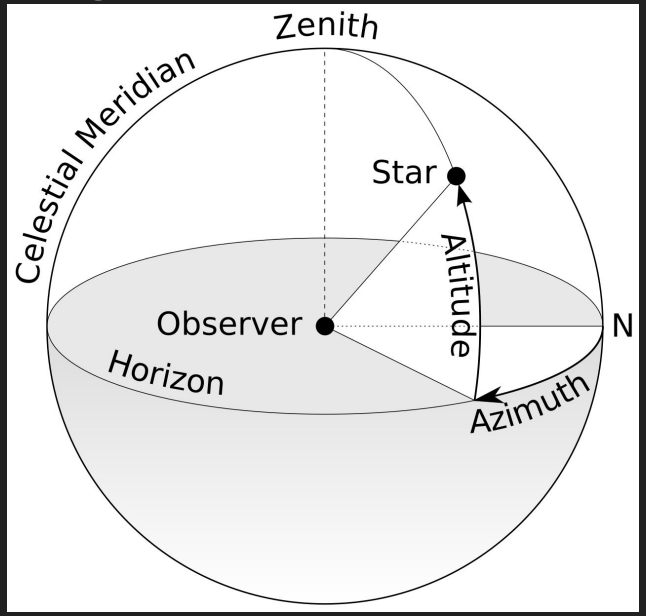
results

Astronomical coordinate systems



Astronomical coordinate systems- alt-az

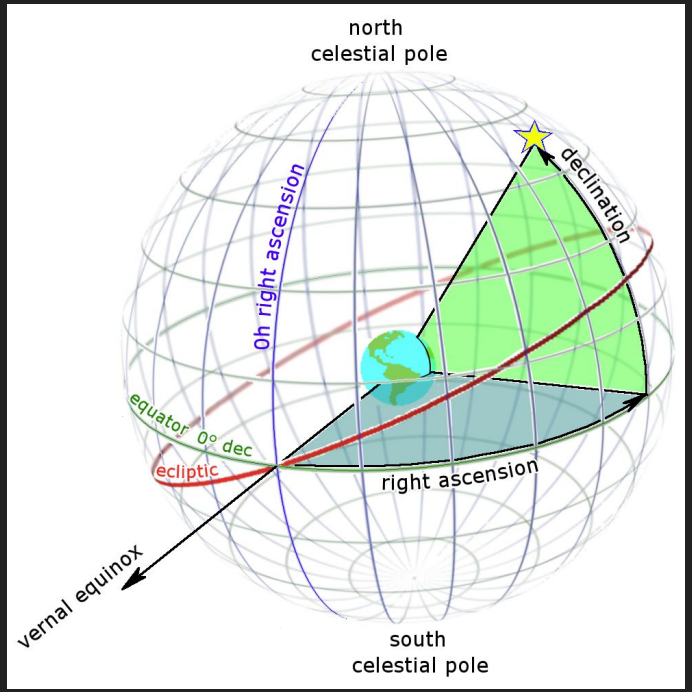
- a.m.- *ante meridiem*, before the sun crosses the meridian.
- p.m.- *post meridiem*, after the sun crosses the meridian.
- Not true for daylight savings



Astronomical coordinate systems- alt-az

- All visible stars appear certain distance above the horizon.
- Alt-az- altitude and azimuth.
- Altitude- angular distance above the horizon (0–90 °).
- Azimuth- angular distance clockwise from north-axis (0–360 °).
- Coordinates are very simple to observe.
- Since these depend on location of observation, coordinates are not universal.

Astronomical coordinate systems- Equatorial



Astronomical coordinate systems- Equatorial

- Latitude and longitude projected into the sky.
- Celestial equator- Earth's equator on the sky.
- Celestial poles, Earth's poles on the sky.
- Zenith depends on locations, celestial equator and poles do not.
- Right Ascension- Angle left and right from 0 ° (like the prime meridian on Earth). Sometimes reported in hours.
- Right Ascension most commonly reported in hours:minutes:seconds (1 hour = 15 °, 60' = 1 hour, 60'' = 1')
- Declination- Angle above or below the celestial equator (-90 to 90 °).
- Declination most commonly reported in degrees:minutes:seconds (60' = 1°, 60'' = 1').
- Equatorial coordinates do not depend on location!

Astronomical coordinate systems- Galactic

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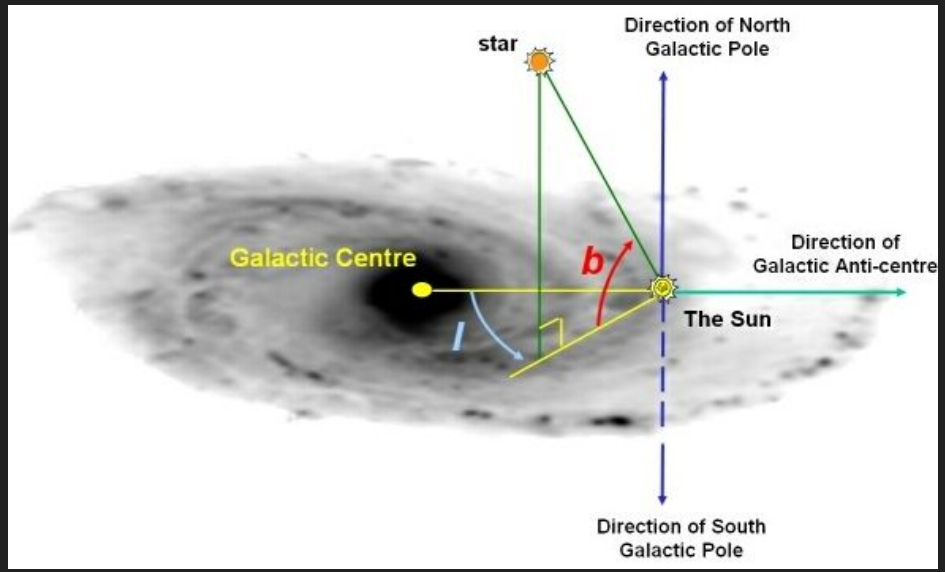

Astronomical coordinate systems- Galactic

- Galactic longitude and latitude (l, b)
- Galactic longitude- angle counterclockwise from galactic center (0 to 360 °).
- Galactic latitude- angle above or below the galactic plane (-90 to 90 °).
- Centered on Milky Way galaxy.
- No easy relation to equatorial coordinates.

The northern celestial pole

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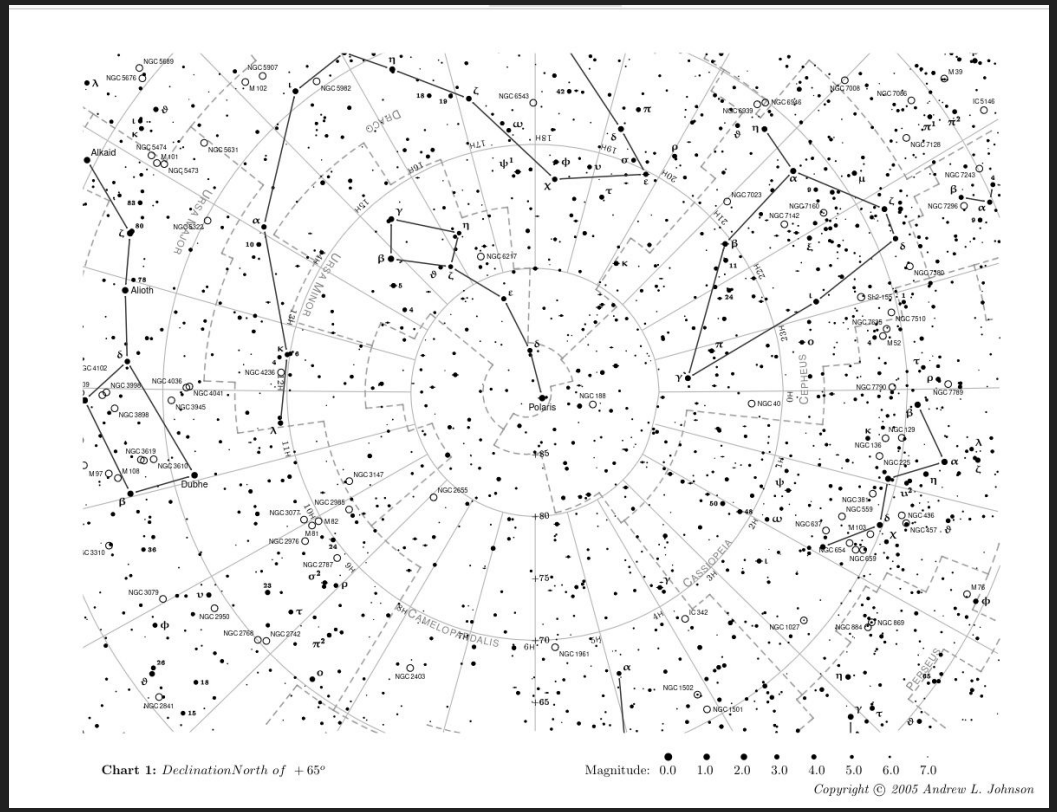

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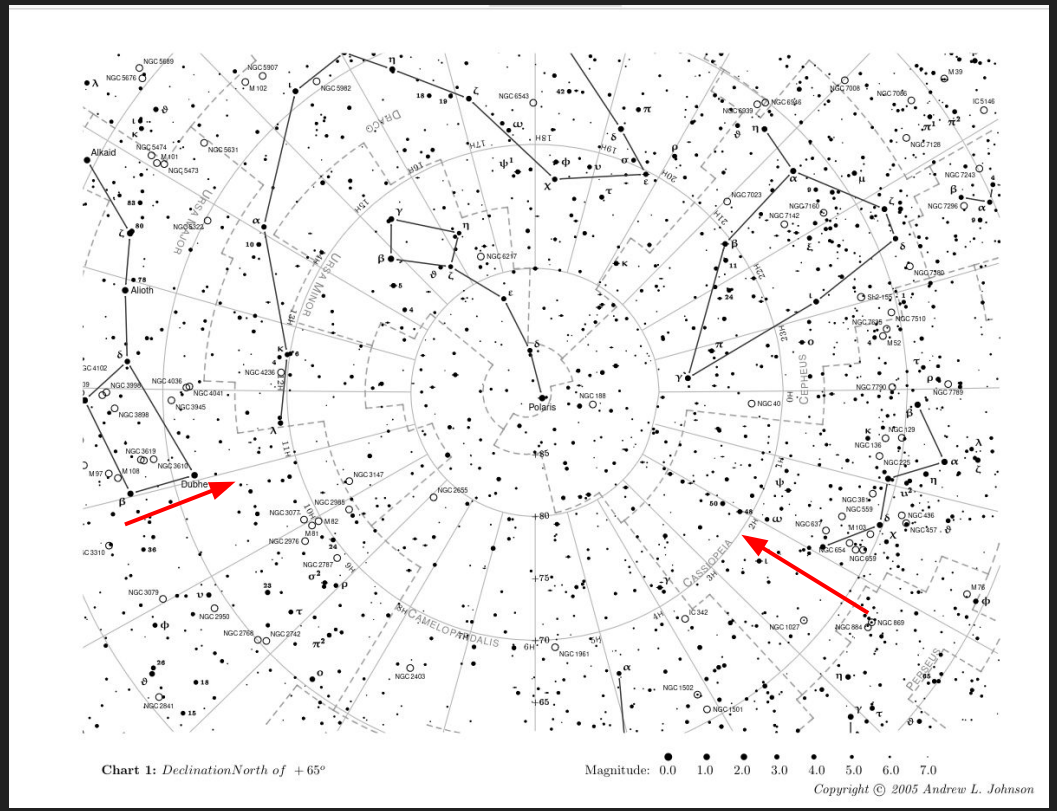

The southern celestial pole

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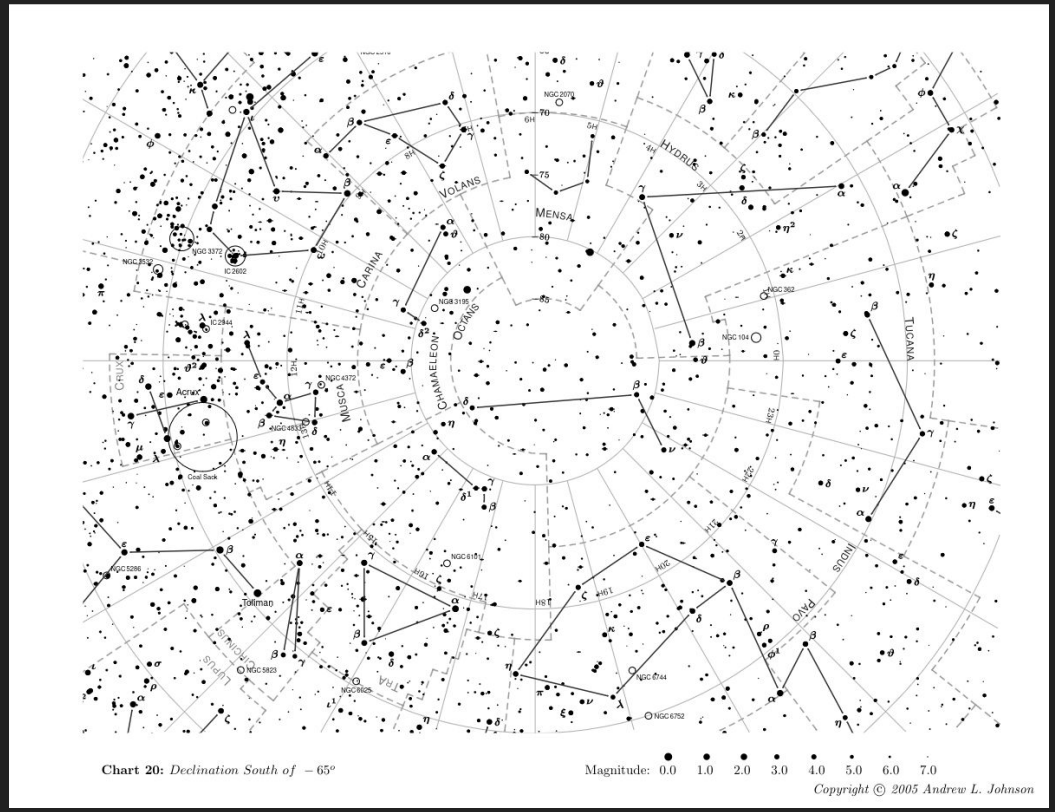
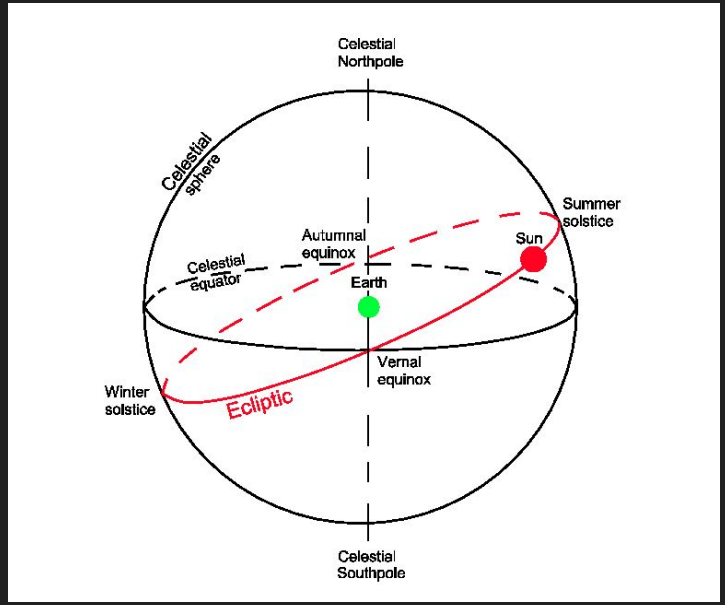


The ecliptic

- Plane above and below the celestial equator.
- Path the Sun takes throughout the year.
- Eclipses occur when the Sun and Moon intersect on the ecliptic.



The ecliptic

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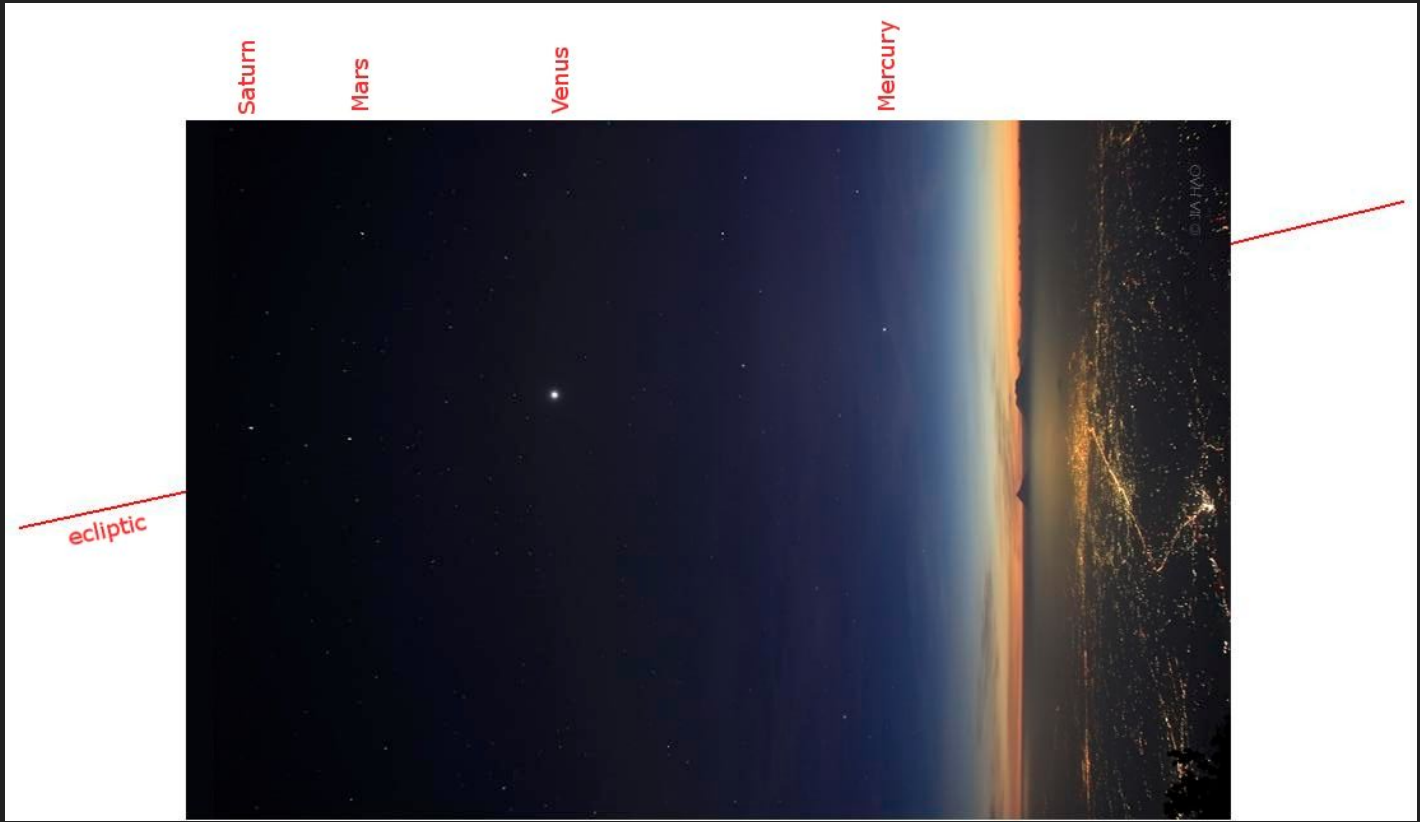

The zodiac

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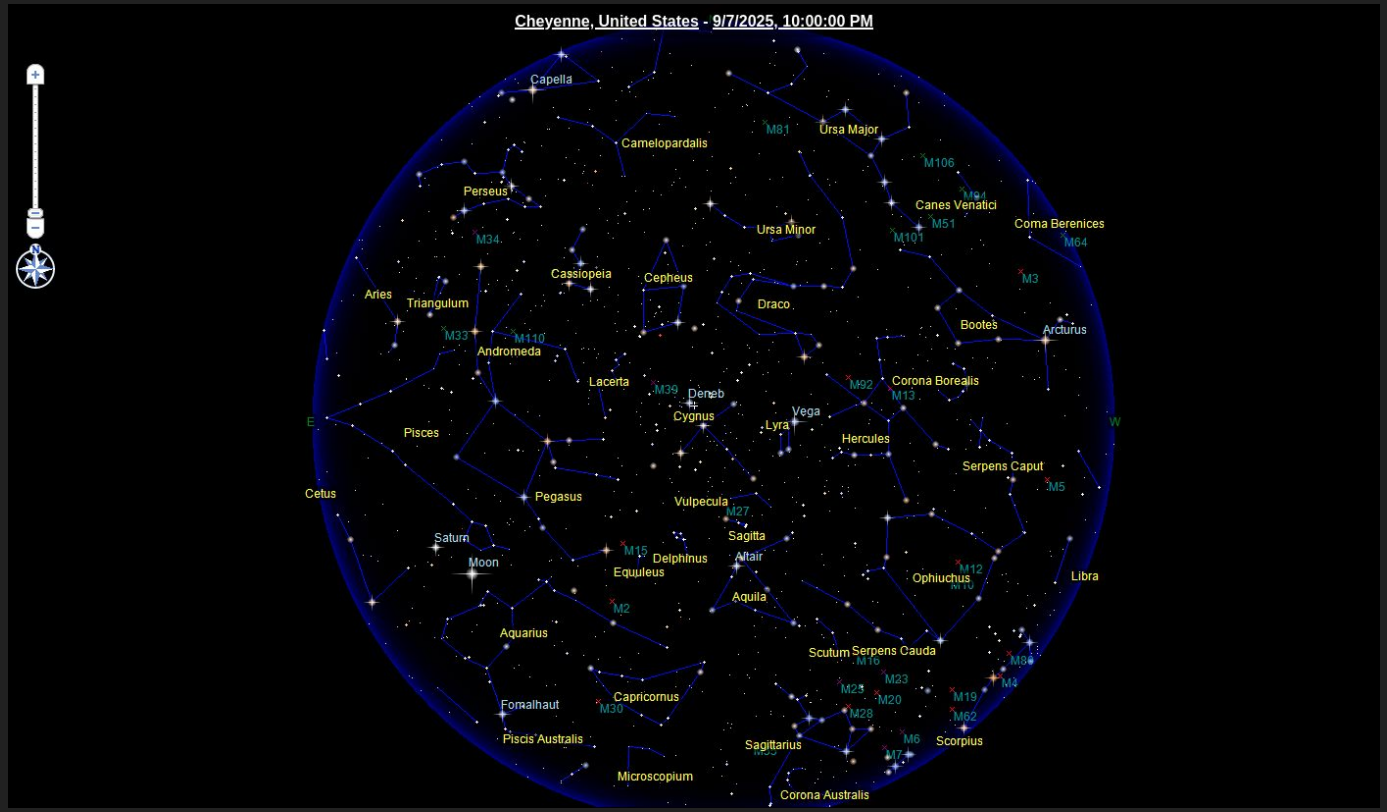
- Constellations along the ecliptic.

Zenith

- Position on the sky straight up.
- Declination of the zenith is always your observation latitude on Earth

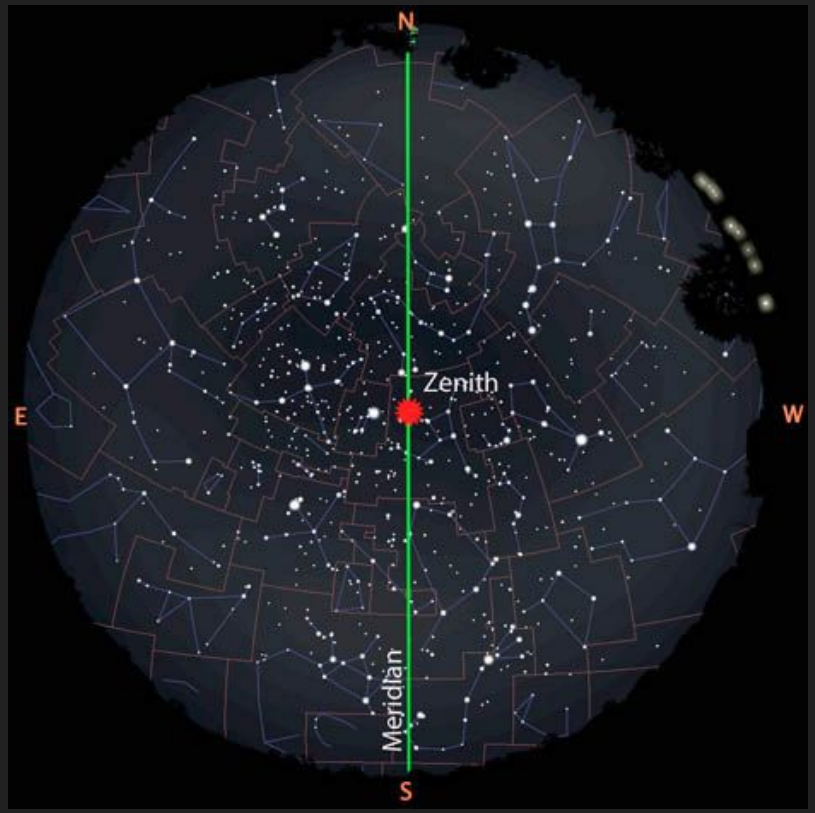
Zenith


Cheyenne, United States - 9/7/2025, 10:00:00 PM
Capella
Camelopardalis
M81
Ursa Major
M106
Perseus
M34
Canes Venatici
M94
M51
M101
Ursa Minor
Coma Berenices
M64
Cassiopeia
Cepheus
M3
Aries
Triangulum
Draco
Bootes
Arcturus
M33
M110
Andromeda
Lacerta
M39
Deneb
M92
Corona Borealis
M13
Cygnus
Vega
Lyra
E
W
Pisces
Hercules
Serpens Caput
M5
Cetus
Pegasus
Vulpecula
M27
Sagitta
Saturn
M15
Delphinus
Altair
Moon
Equuleus
Ophiuchus
M12
Libra
Aquila
M2
Aquarius
Scutum
Serpens Cauda
M16
M8
M4
M23
M25
M20
M19
Capricornus
M30
Fomalhaut
M28
M62
Piscis Australis
M6
Scorpius
Sagittarius
M7
Microscopium
Corona Australis

Sidereal Time

- Measure of time of Earth’s rotation rate with respect to fixed background stars.
- Local Mean Sidereal Time (LMST)- Right Ascension of stars crossing the meridian

Sidereal Time



The Sun throughout the year

- Right Ascension and Declination of the sun are changing throughout the year.
- The Sun has 0 ° Declination on the equinoxes
- The Sun has +23.5 ° declination on the summer solstice (higher in the North).
- The Sun has -23.5 ° declination on the winter solstice (lower in the North).
- The Sun’s right ascension is 0 ° on the vernal equinoix

The Sun throughout the year

Date	Right Ascension of the Sun
21 March	0 h
21 May	4 h
21 July	8 h
21 September	12 h
21 November	16 h
21 January	20 h

- Sun’s right ascension increases two hours every month.

Question

1. Find the speed of the Sun (only in right ascension, ignore declination).
   a. 3.95’ per day b. 0.0657’ per dayc. 30.4’ per day d. 237’ per day

Announcements

- First homework grades. First assignment was for participation, the rest graded on accuracy.
- Second homework assigned today, due Friday
- First lab today, meet in planetarium.

Next time

- The Laws of Planetary Motion