Astronomical Coordinates
&
Telescopes

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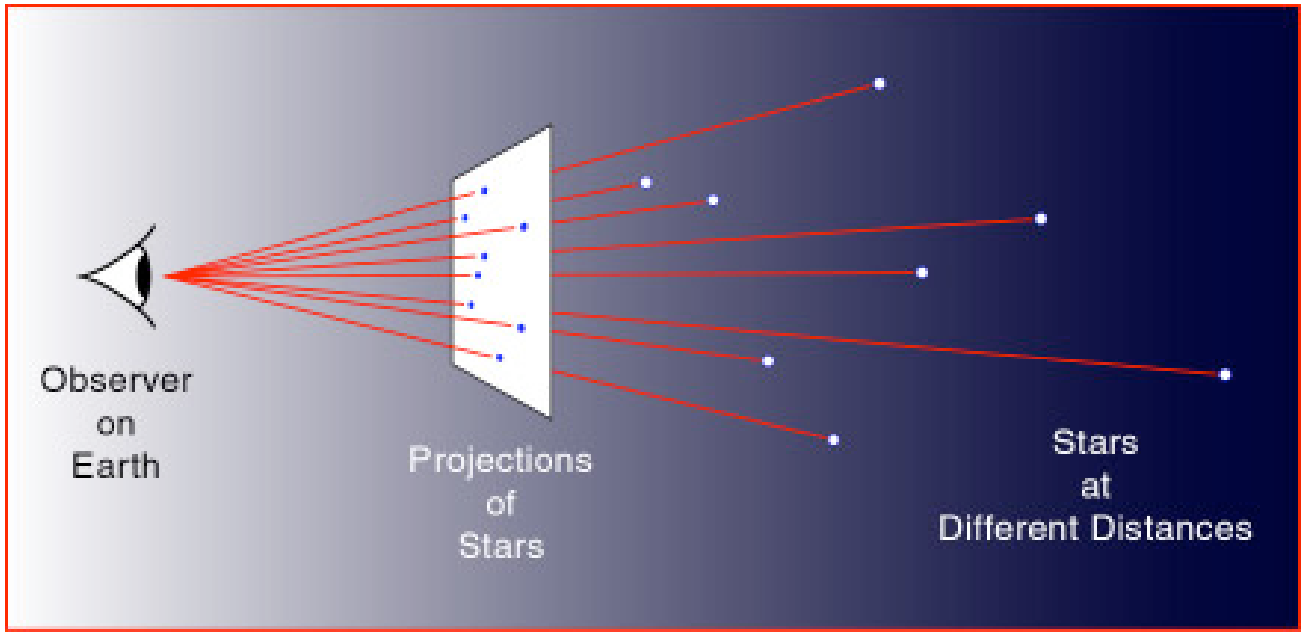
Observing Basics

- Astronomical coordinates
- The telescope
- The infrared camera

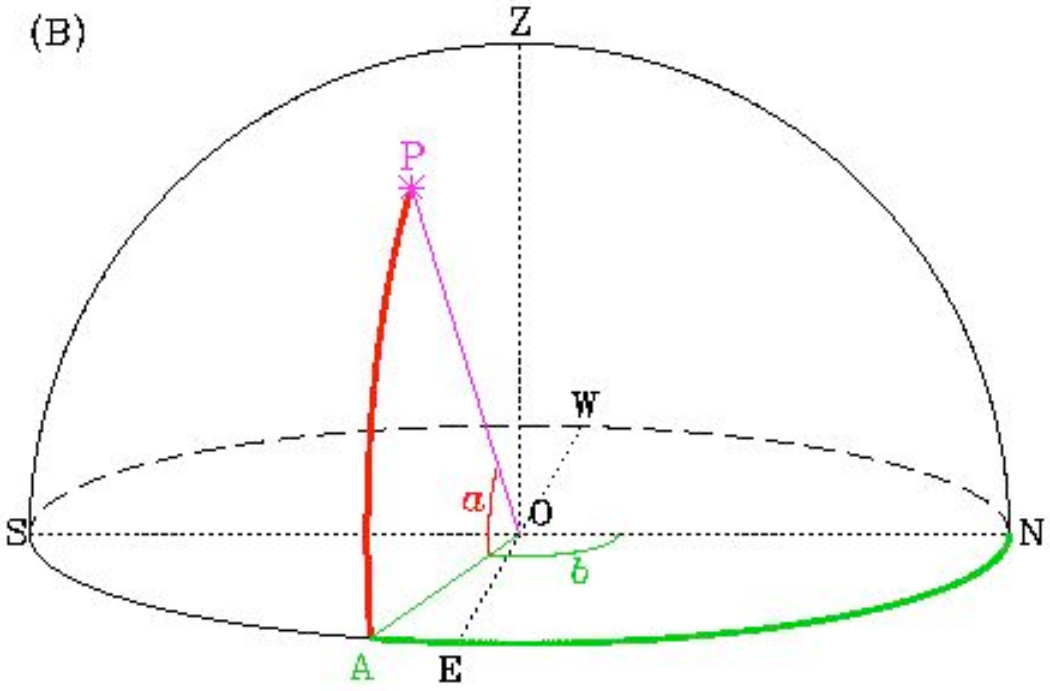
Astronomical Coordinates

- Celestial sphere
  - Stars and other astronomical objects occupy three dimensional space
  - Since they are at great distances from the earth, it is convenient to describe their location as the projection of their position onto a sphere which is centered at the observer



Observer's Coordinates

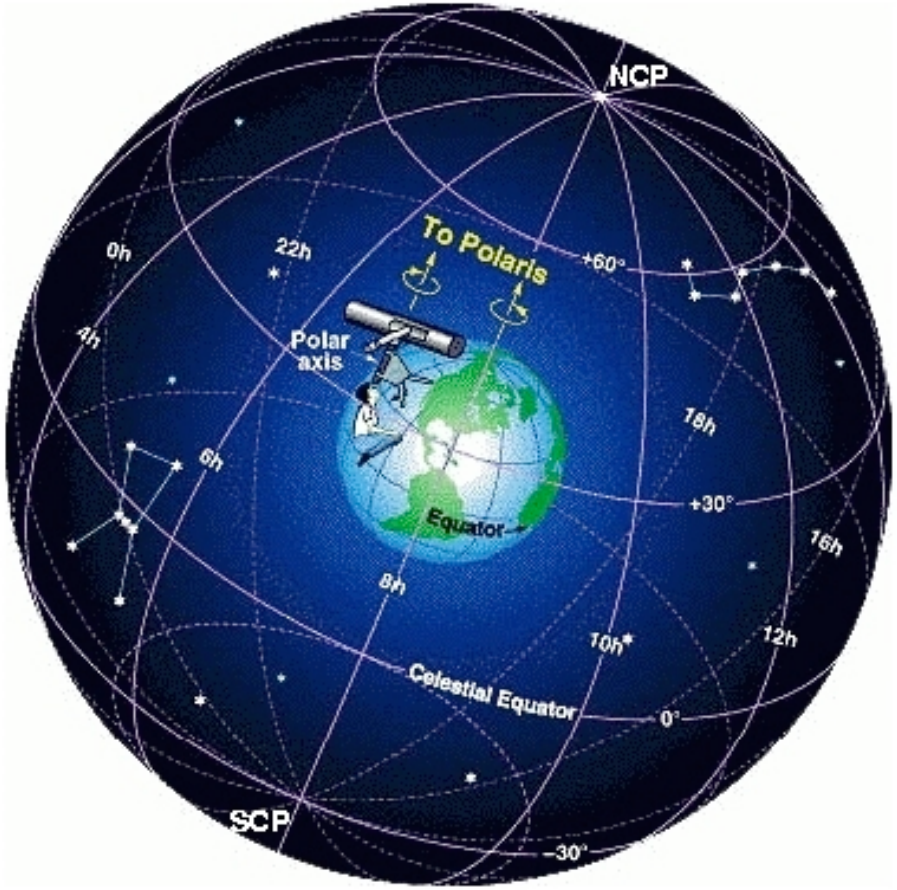
- Coordinates of P relative to observer O
- ***Altitude*** (a) is the angle AOP
  - Altitude is the angle above the horizon
- ***Azimuth*** (b) is the angle NOA
  - Degrees E from N
- Observer's coordinates (horizon coordinates) for stars change!



Sunrise, Sunset & Star Trails

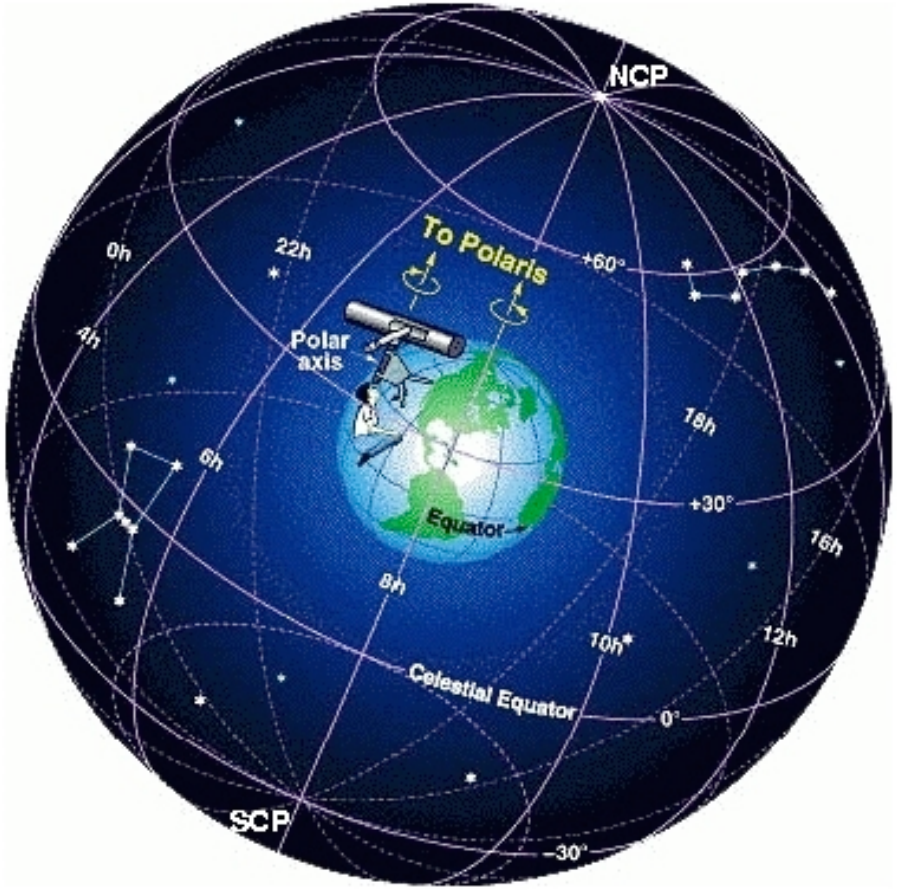
Celestial Sphere

- Coordinates on the celestial sphere are analogous to latitude & longitude
  - ***Declination***
  - ***Right ascension***



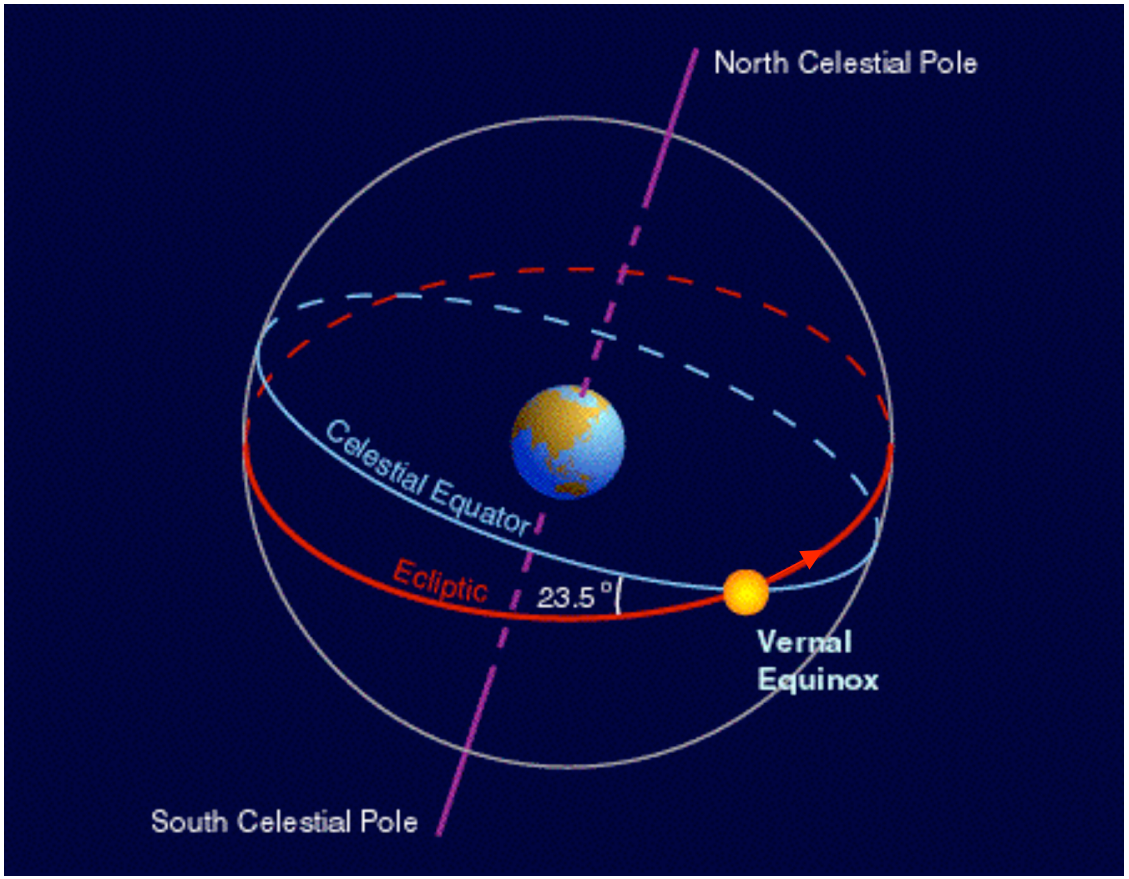
Celestial Poles & Equator

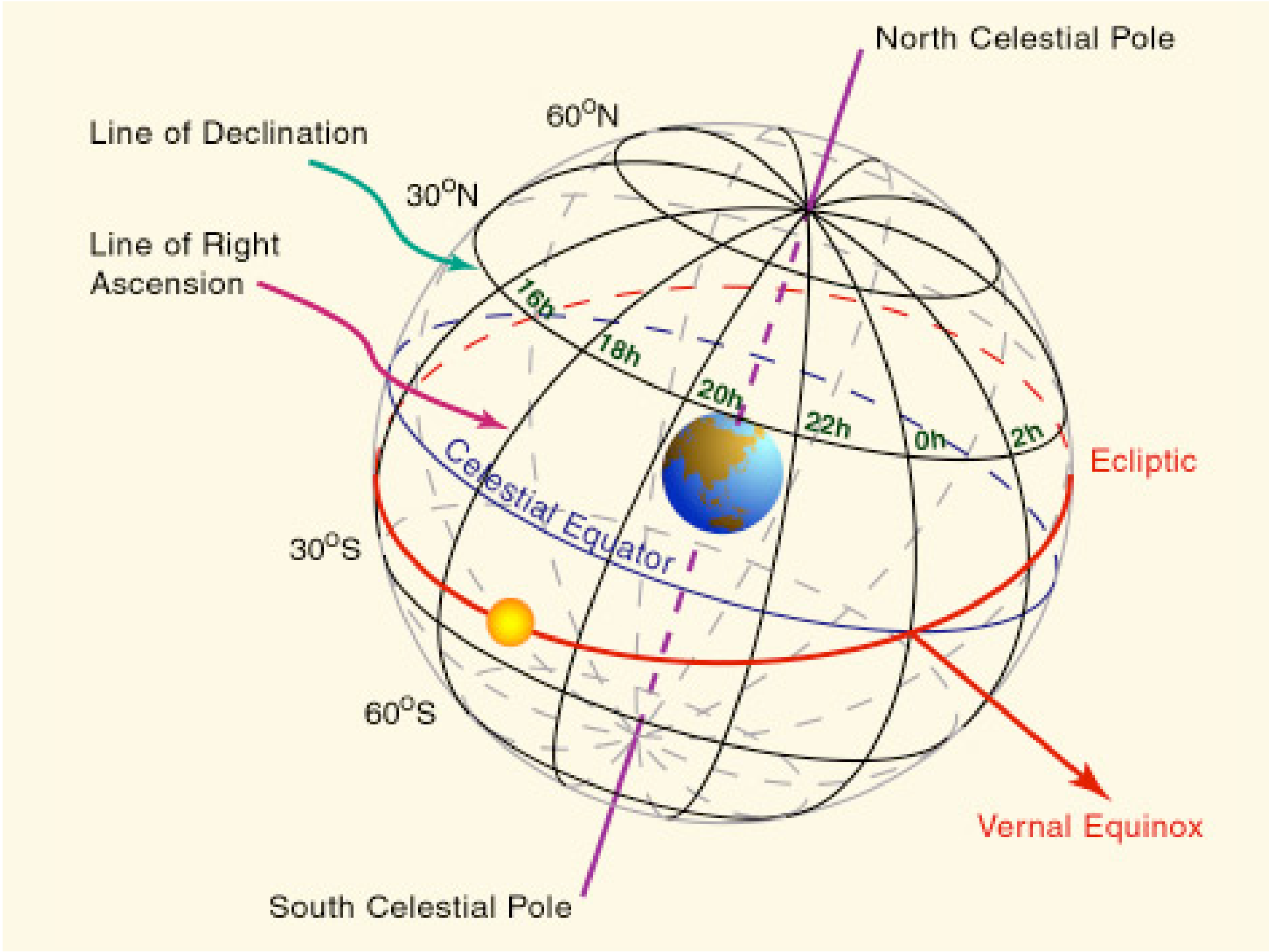
- N & S ***celestial poles*** are defined by the projection of the earth's spin axis onto the celestial sphere
- ***Celestial equator*** is the projection of the earth's equator onto the celestial sphere
  - Objects on the celestial equator have a declination of zero degrees
  - The N & S poles are declination +/- 90 degrees



Defining Celestial Zero Points

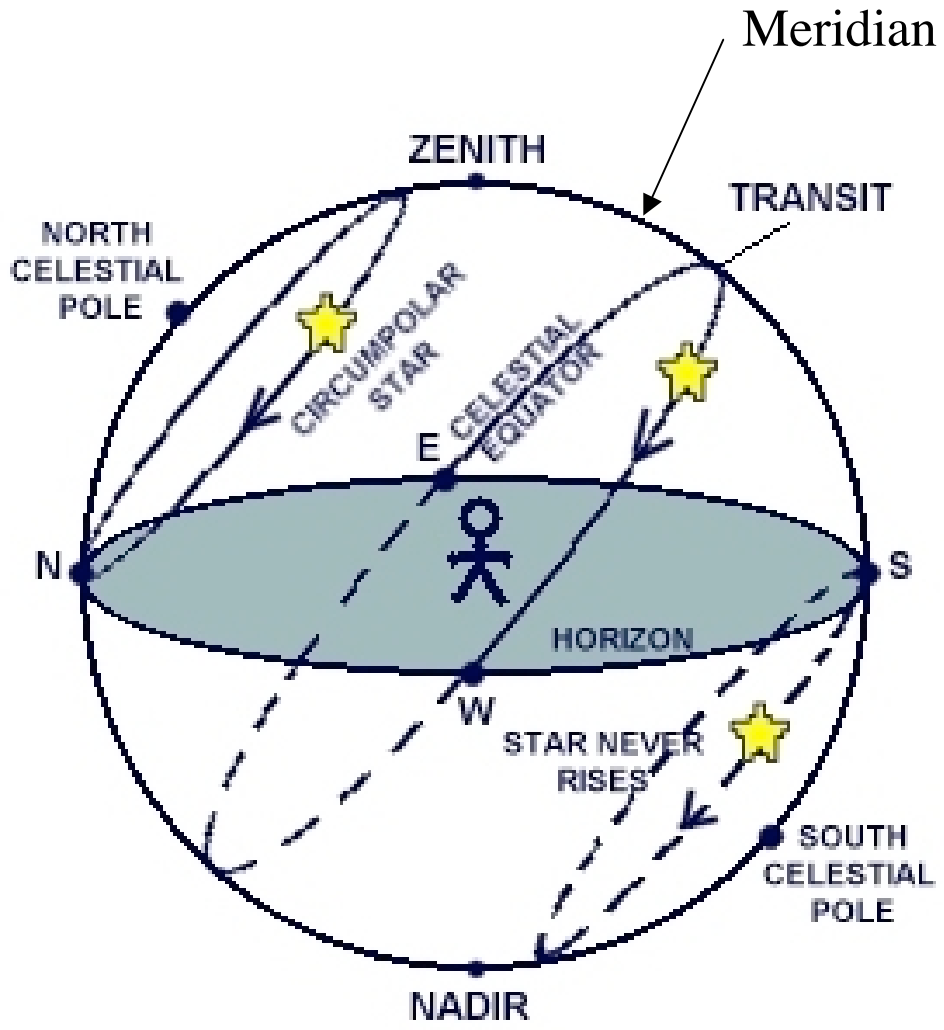
- The spin axis of the earth provides a natural definition of one direction
- The location of the sun, when its crosses the celestial equator in the spring defines the other
  - Defines RA = 0




North Celestial Pole
60°N
Line of Declination
30°N
Line of Right Ascension
16h
18h
20h
22h
0h
2h
Ecliptic
Celestial Equator
30°S
60°S
Vernal Equinox
South Celestial Pole

Rising & Setting

- The observer's ***meridian*** is the great circle drawn through the N pole, which passes directly overhead
- An star ***transits*** when it crosses the meridian
- The elevation of a star is greatest when it transits



Sidereal Time

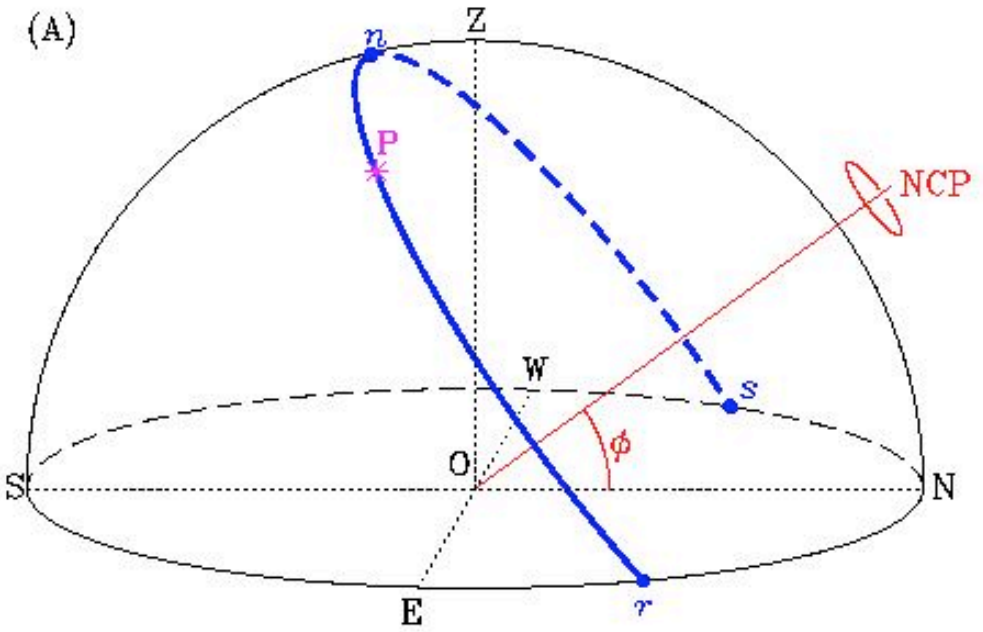
- The ***sidereal time*** is measured by the rotation of the Earth, with respect to the stars (rather than relative to the Sun)
  - Local sidereal time is the right ascension of a star on the observer's meridian
  - One sidereal day corresponds to the time taken for the earth to rotate once with respect to the stars and lasts approximately 23 h 56 min

Hour Angle and Right Ascension

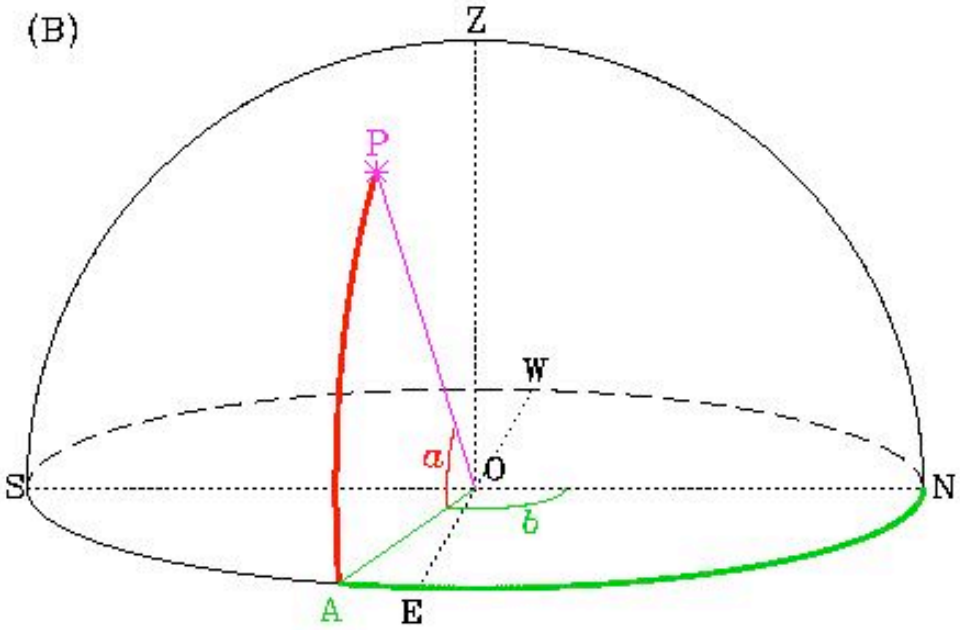
- ***Hour angle*** (HA) is the angle between an observer's meridian and the hour circle on which some celestial body lies
- Expressed in hours, minutes & seconds, HA gives the time elapsed since a celestial body's last transit (HA > 0), or the time unit the next transit (HA < 0)
- Hence:

$$HA = LST - RA$$

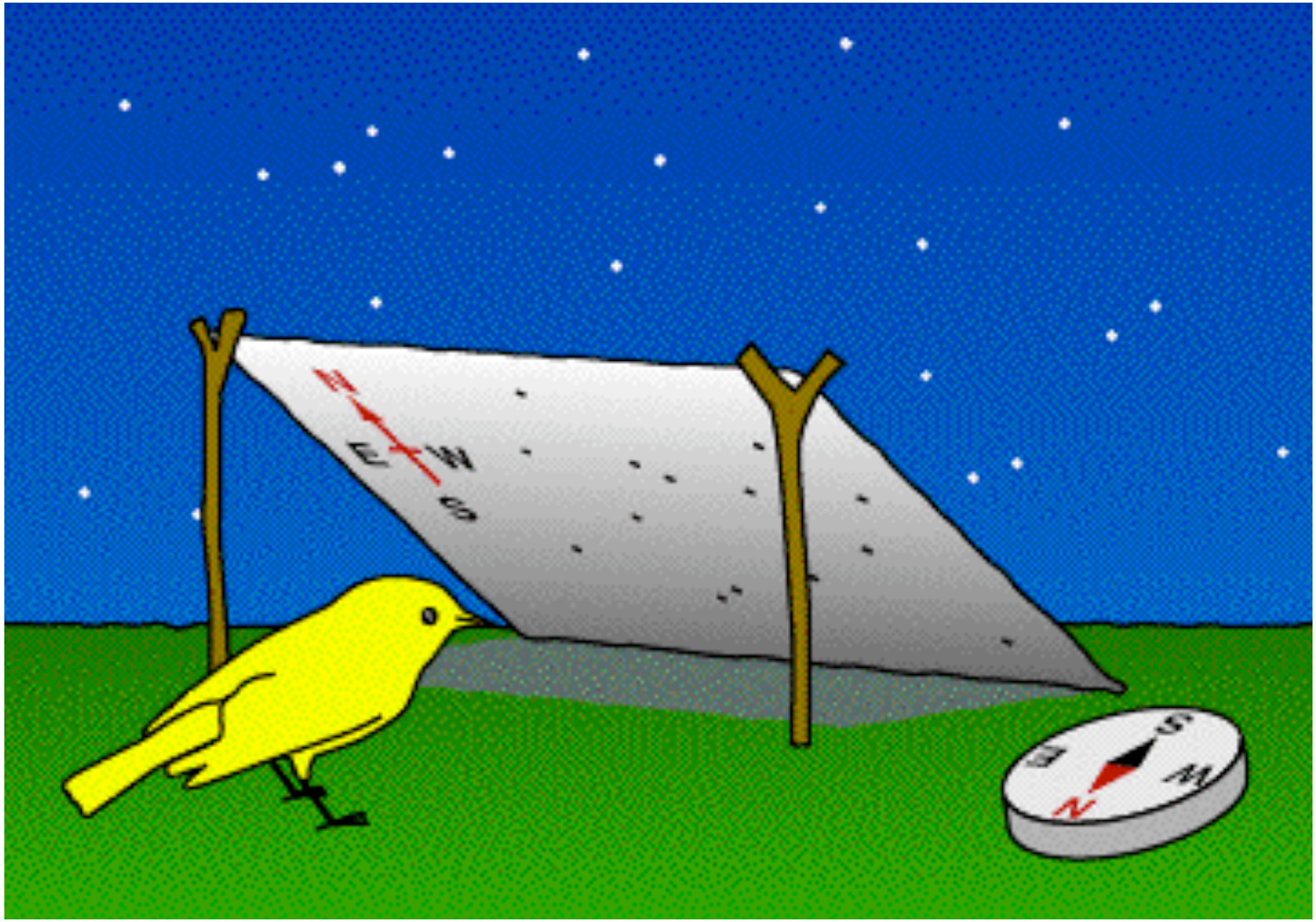
Celestial coordinates



Observer's coordinates

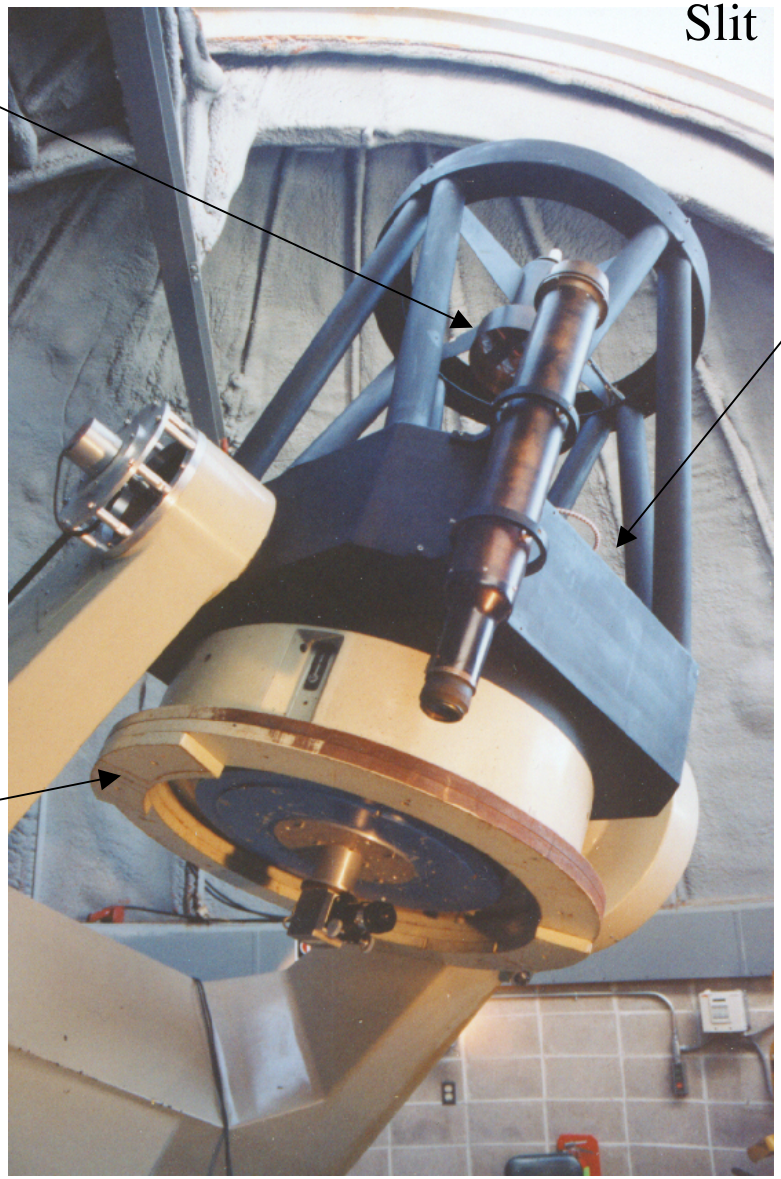


Why is E on the Left?



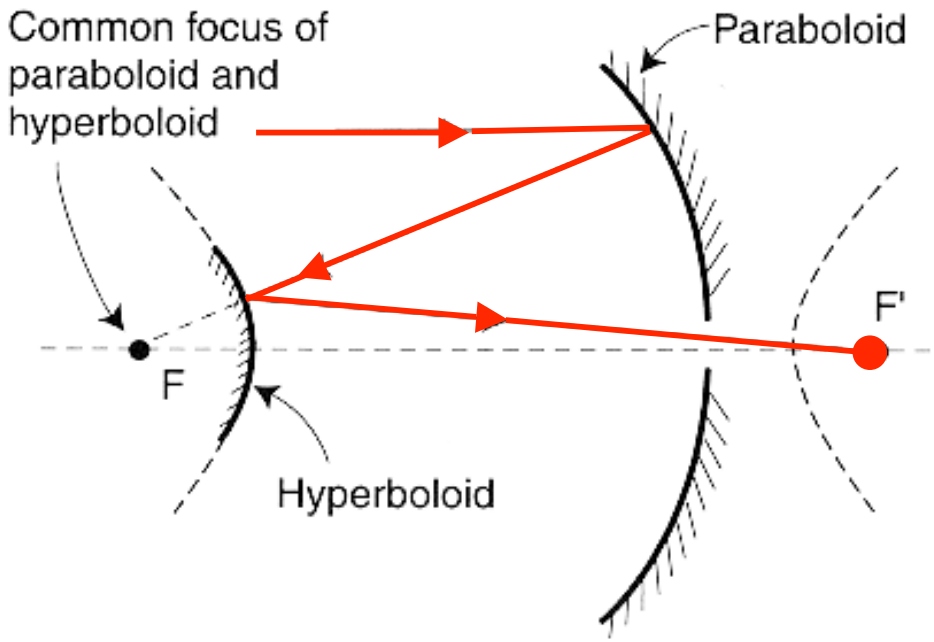
The 30-inch Telescope

- Cassegrain telescope
  - Two mirror telescope
  - Primary & secondary mirrors



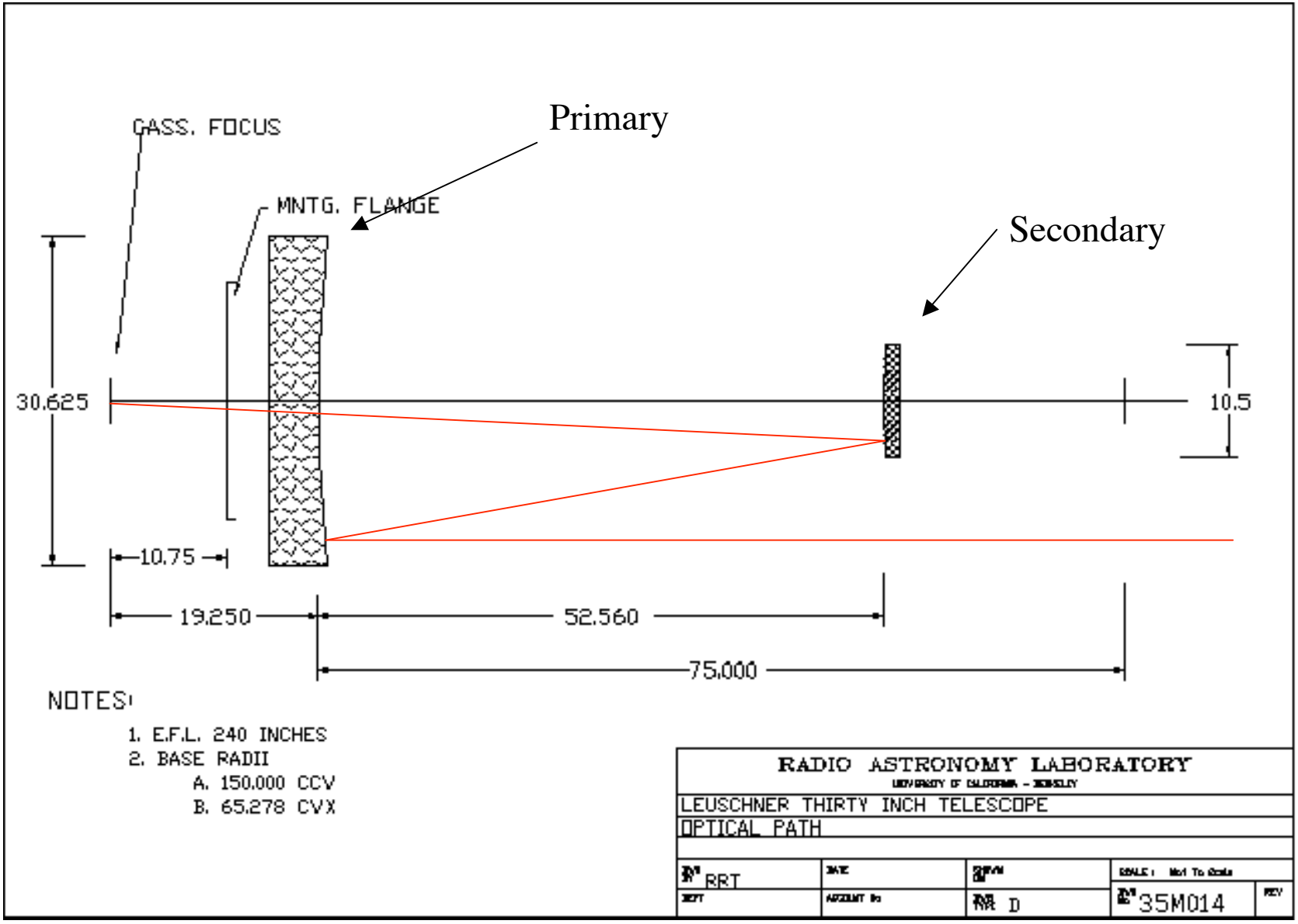
Two Mirror Telescope

- Concave primary
- Convex secondary

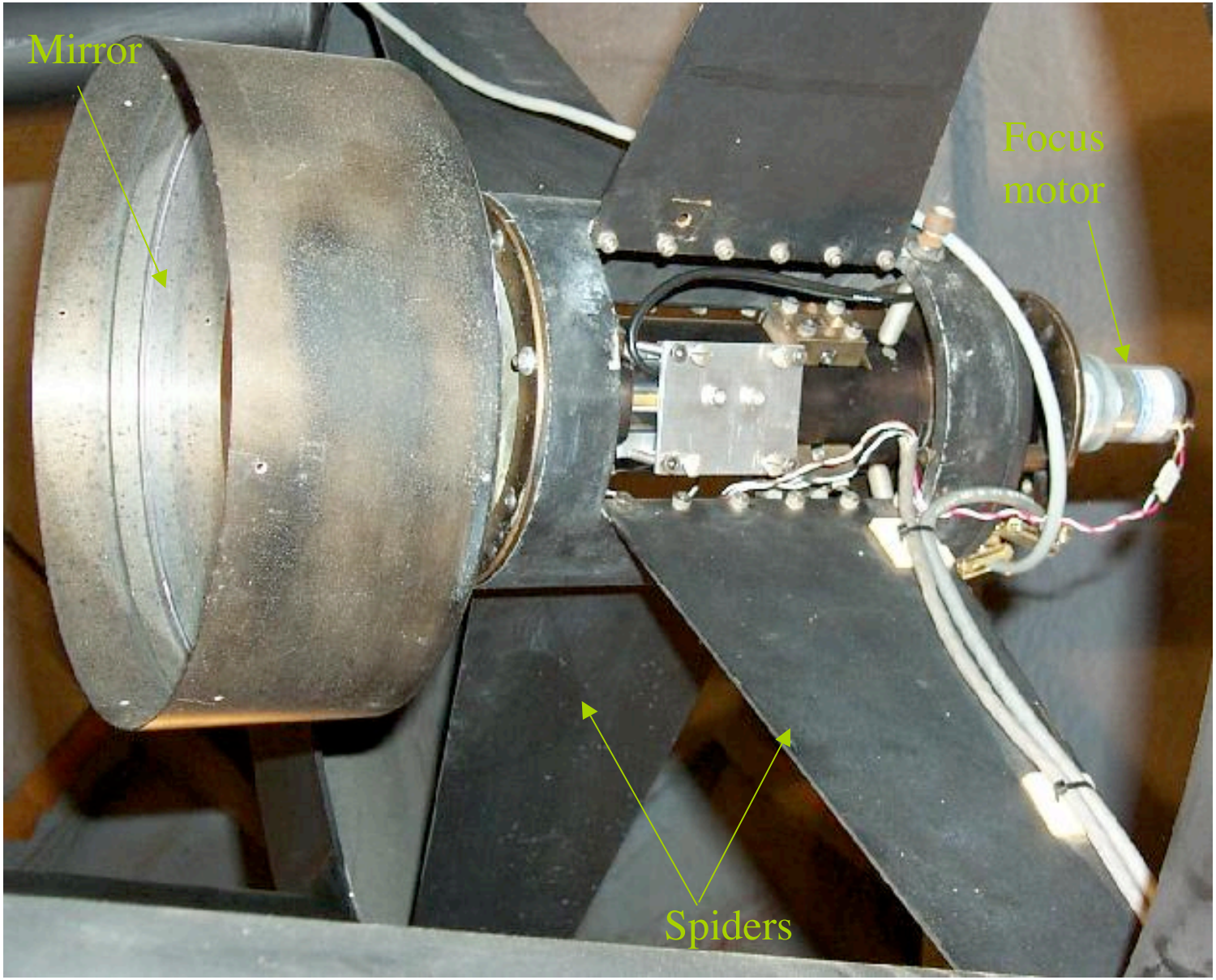


Cassegrain telescope

Telescope Design



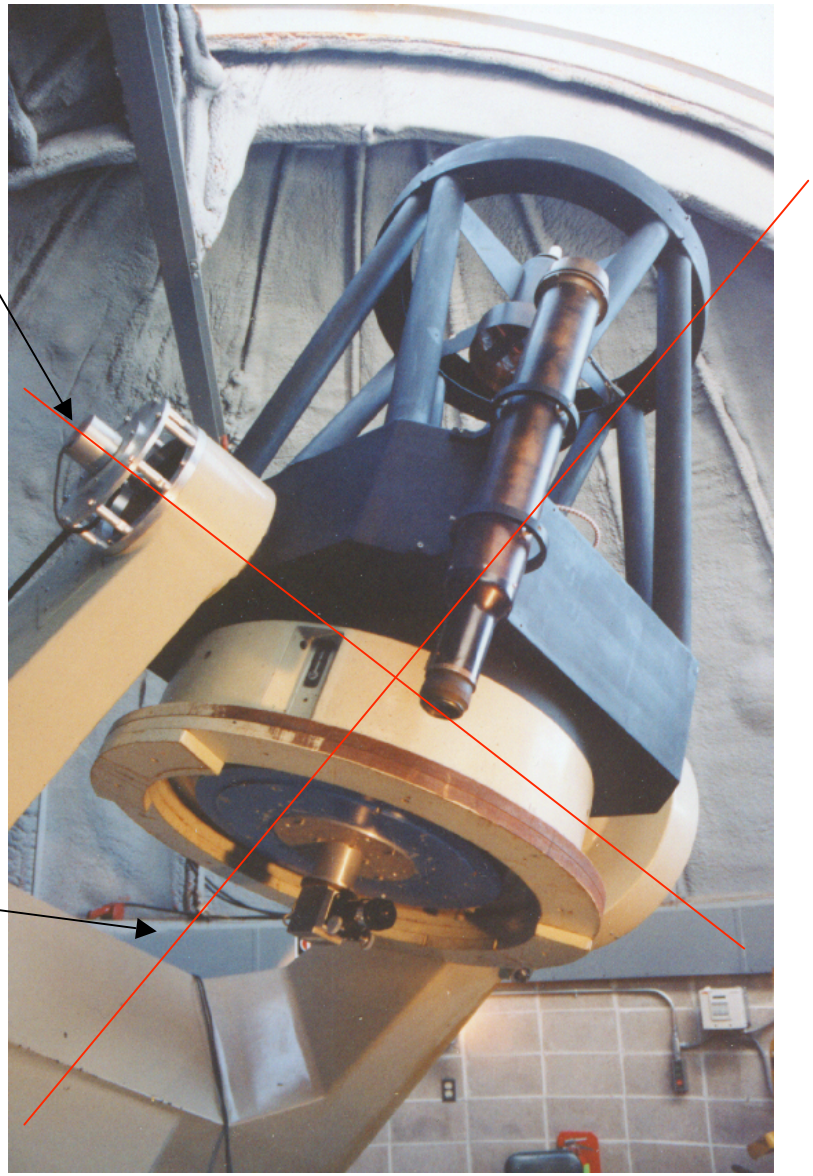
Secondary Mirror



Telescope Secondary

The 30-inch Telescope

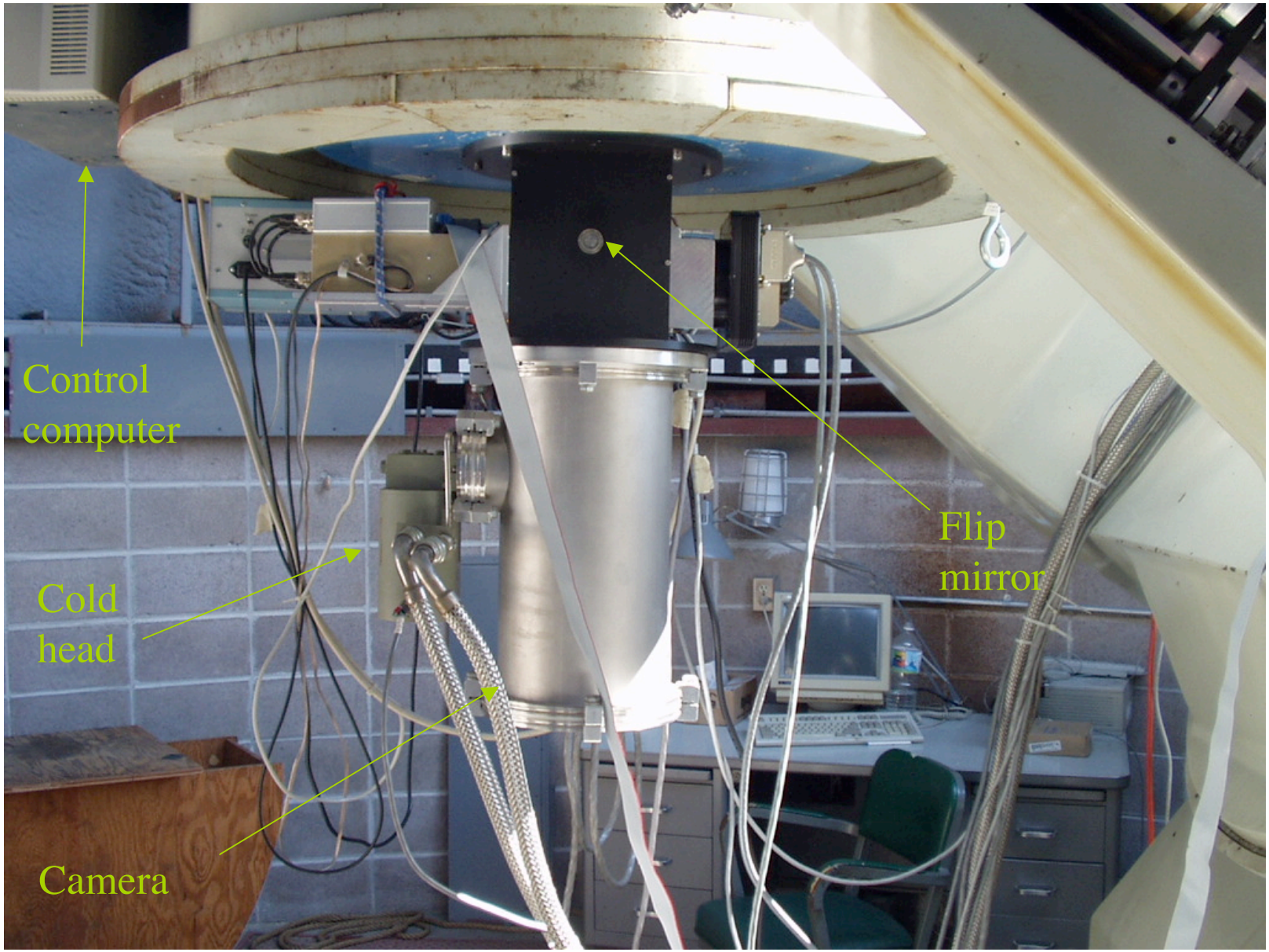
- Equatorial mount
  - Hour angle axis rotates 360 degrees in 23 hours 56 minutes



The Dome

Dome & Slit

The Infrared Camera



Observing

- Turn power on
- Open the dome slit (check the weather)
- Open the primary mirror cover
- Set the flip mirror
- Set focus to nominal position
- Check the pointing offsets
- Select a target and point
  - Check telescope tracking and dome orientation
- Acquire an image
- Close mirror cover & close slit
- Power down