

Astronomical Coordinates
&
Telescopes

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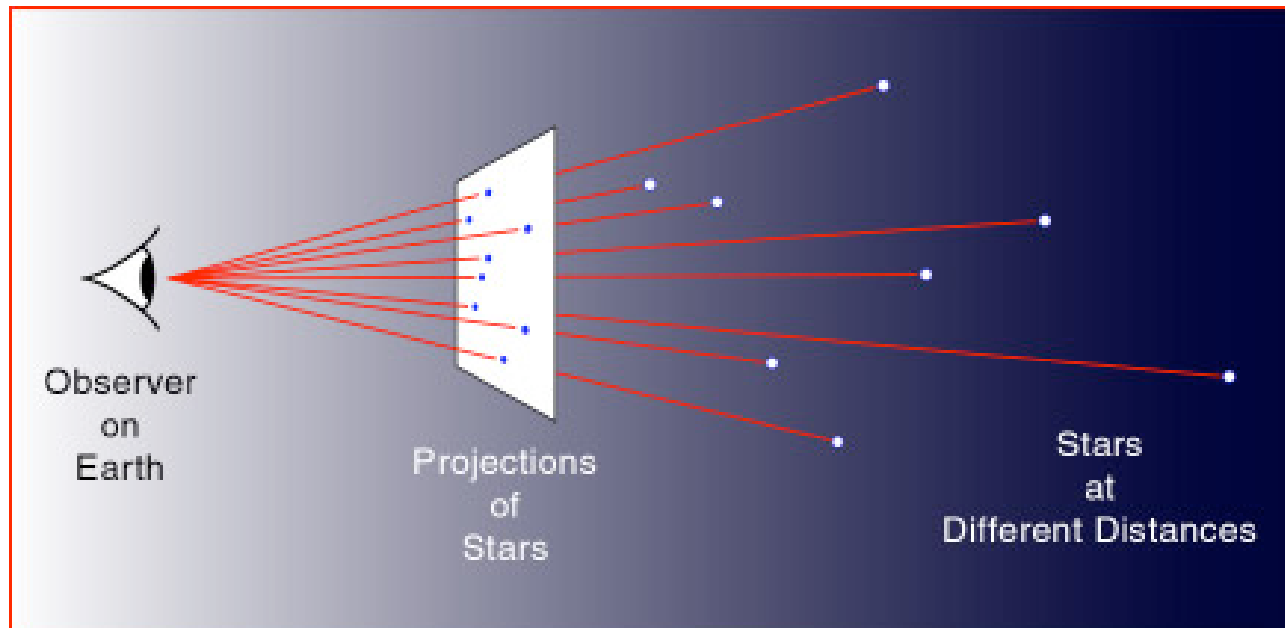
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Observing Basics

- Astronomical coordinates
- The telescope
- The infrared camera

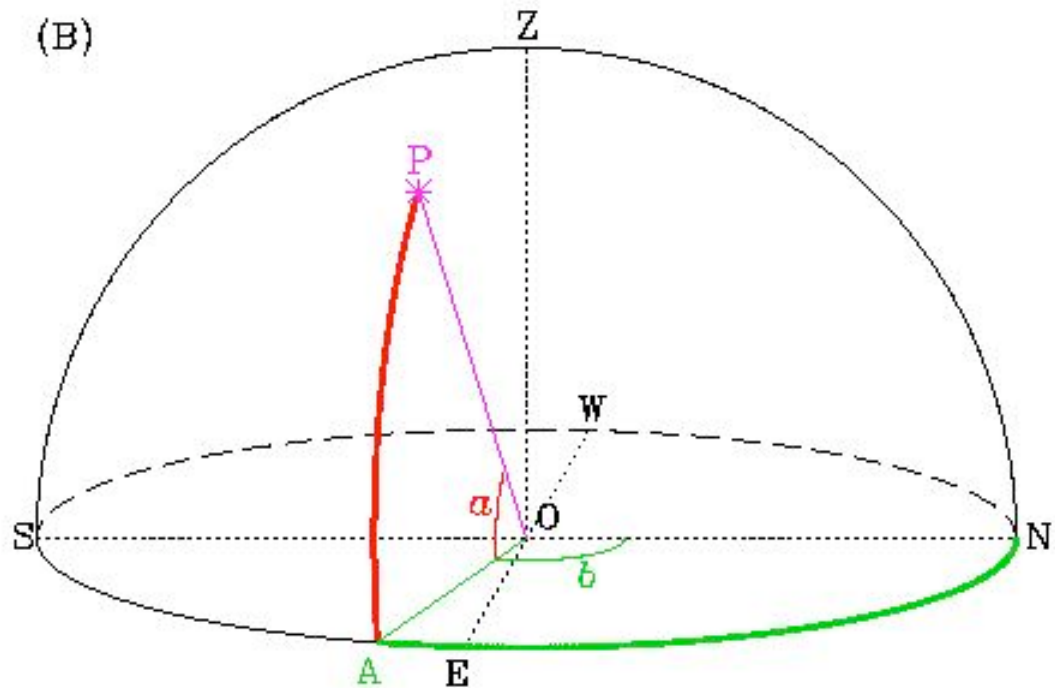
Astronomical Coordinates

- 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!

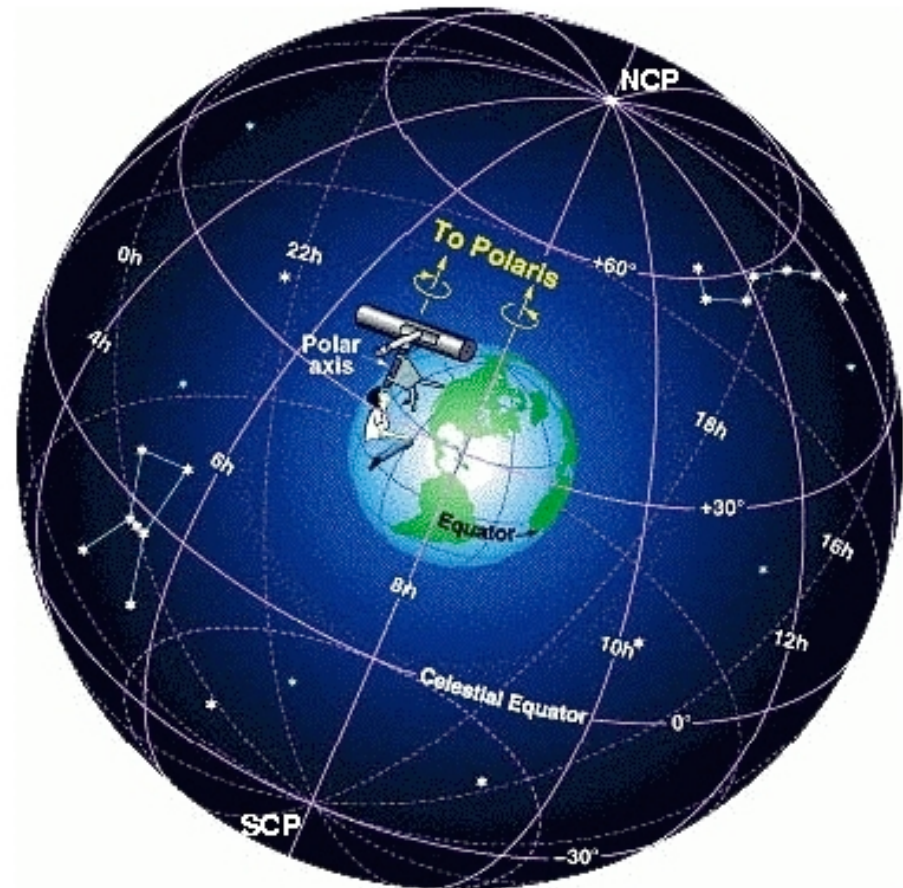


Sunrise, Sunset & Star Trails



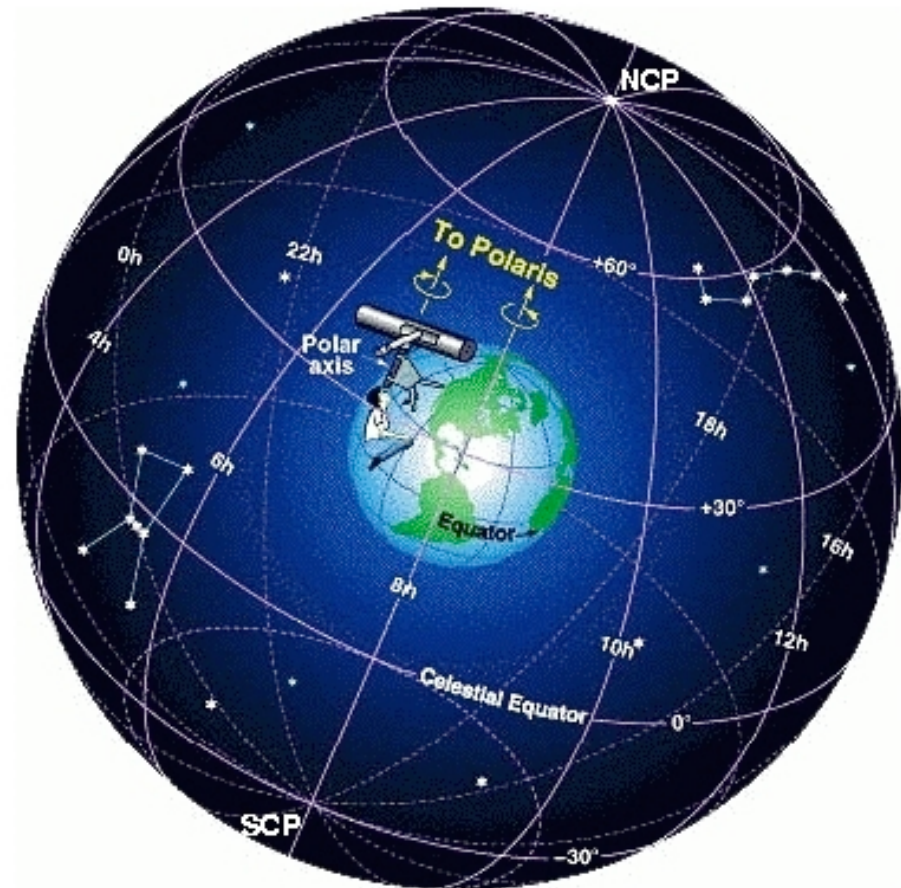
Celestial Sphere

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



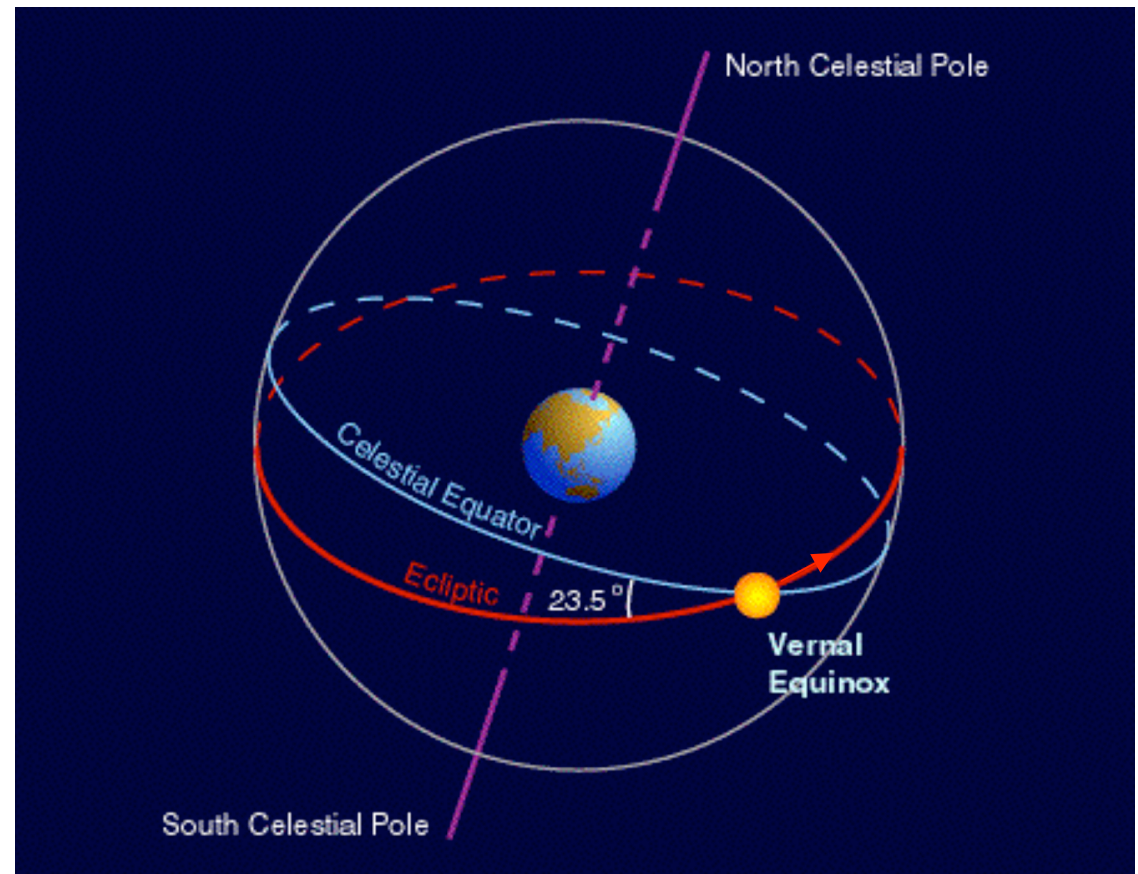
Celestial Poles & Equator

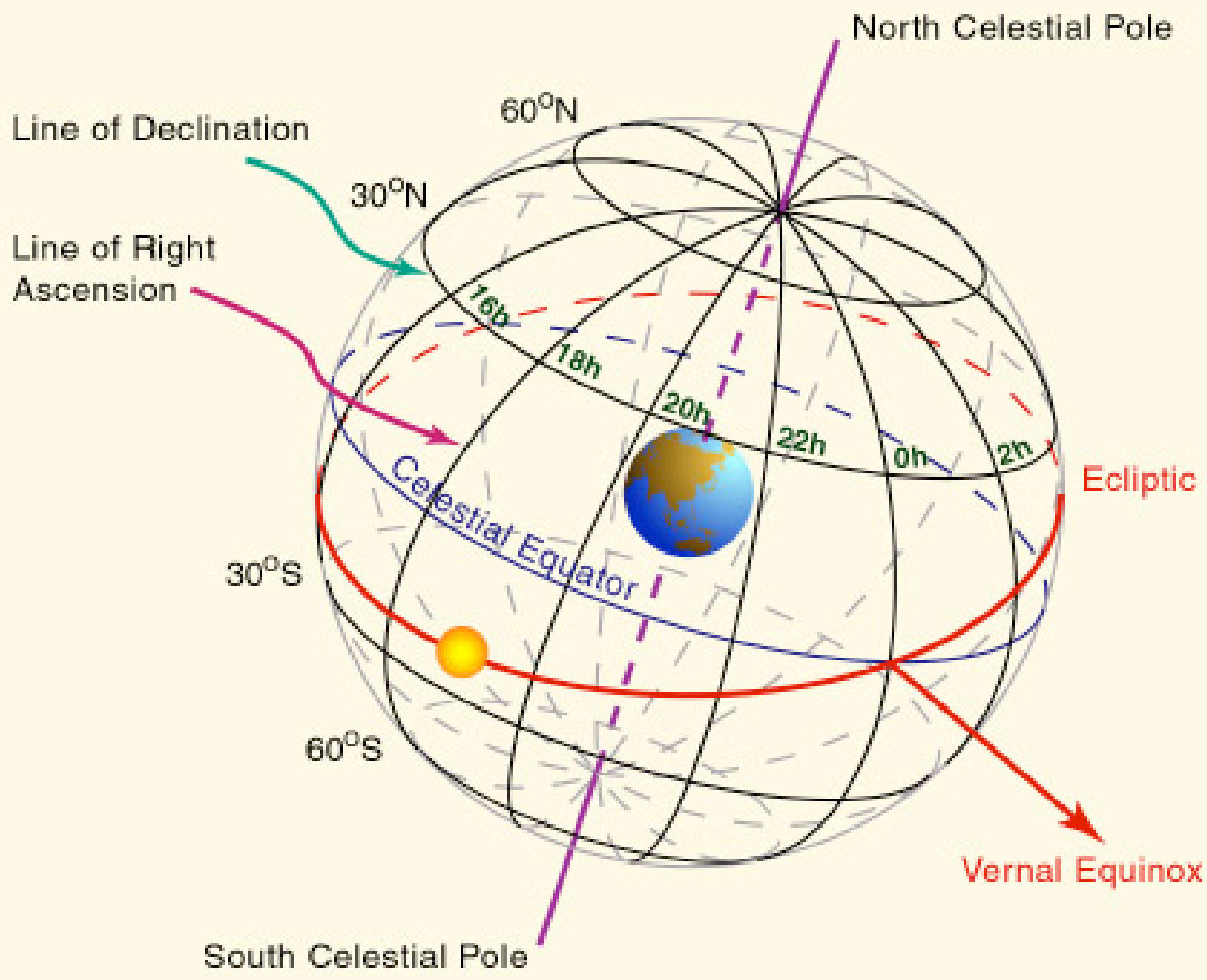
- N & S *celestial poles* are defined by the projection of the earth's spin axis onto the celestial sphere
- *Celestial equator* is the projection of the earth's equator onto the celestial sphere
 - Objects on the celestial equator have a declination of zero degrees
 - The N & S poles are declination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



Defining Celestial Zero Points

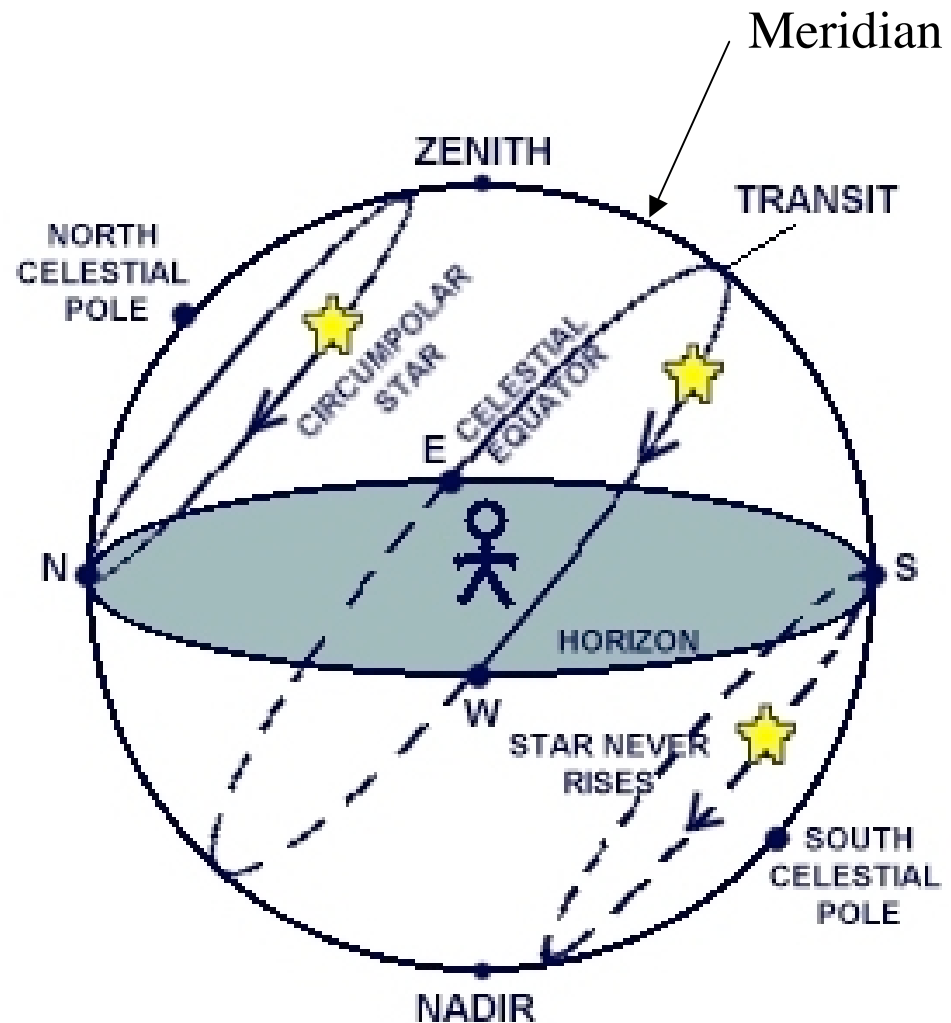
- The spin axis of the earth provides a natural definition of one direction
- The location of the sun, when it crosses the celestial equator in the spring defines the other
 - Defines $RA = 0$





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

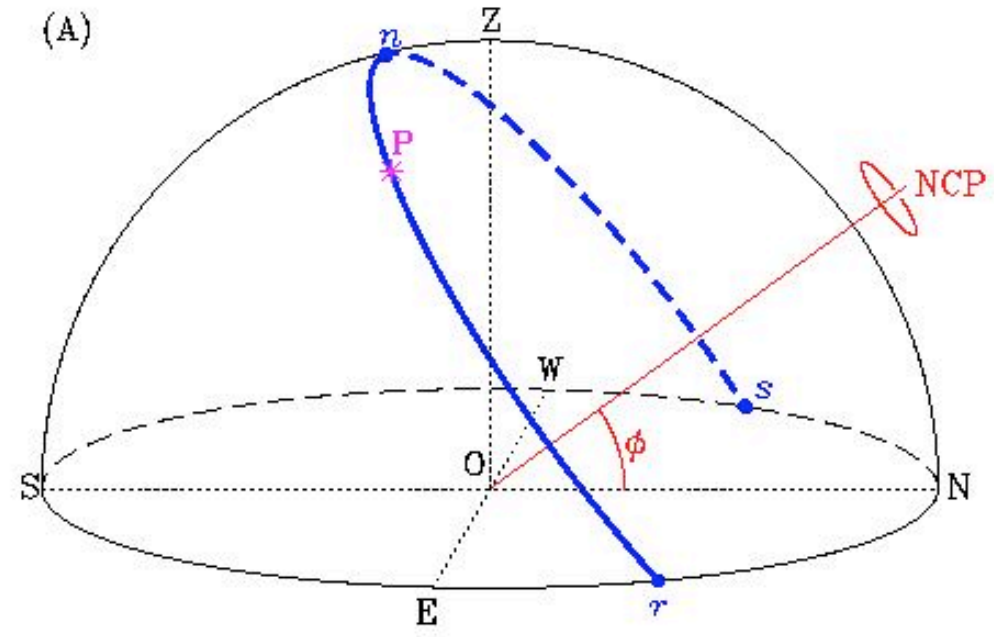
- The *sidereal time* is measured by the rotation of the Earth, with respect to the stars (rather than relative to the Sun)
 - Local sidereal time is the right ascension of a star on the observer's meridian
 - One sidereal day corresponds to the time taken for the earth to rotate once with respect to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

Hour Angle and Right Ascension

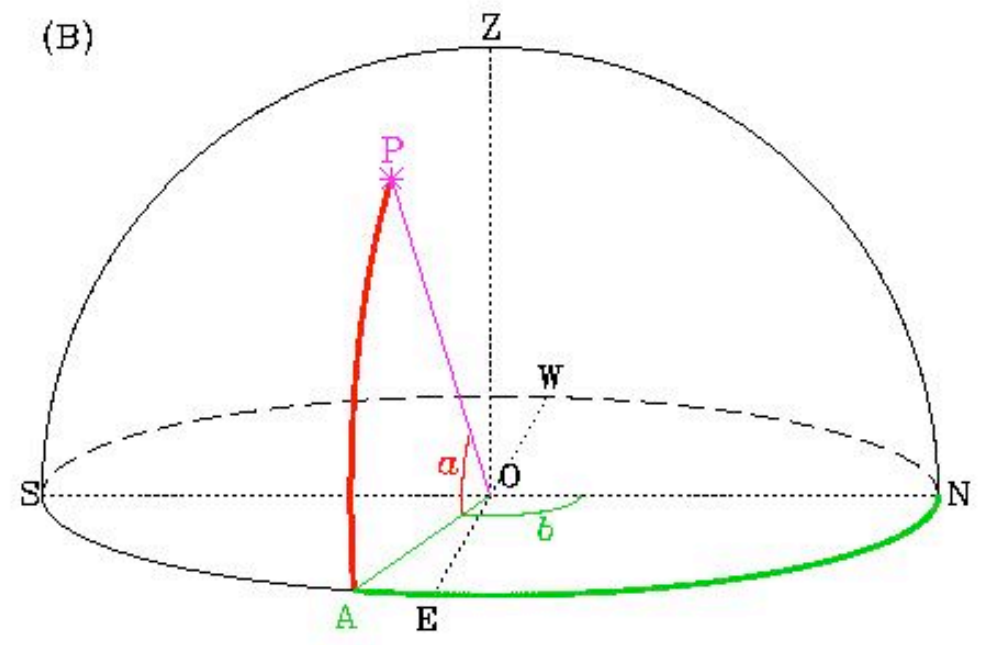
- *Hour angle* (HA) is the angle between an observer's meridian and the hour circle on which some celestial body lies
- Expressed in hours, minutes & seconds, HA gives the time elapsed since a celestial body's last transit (HA > 0), or the time unit the next transit (HA < 0)
- Hence:

$$\text{HA} = \text{LST} - \text{RA}$$

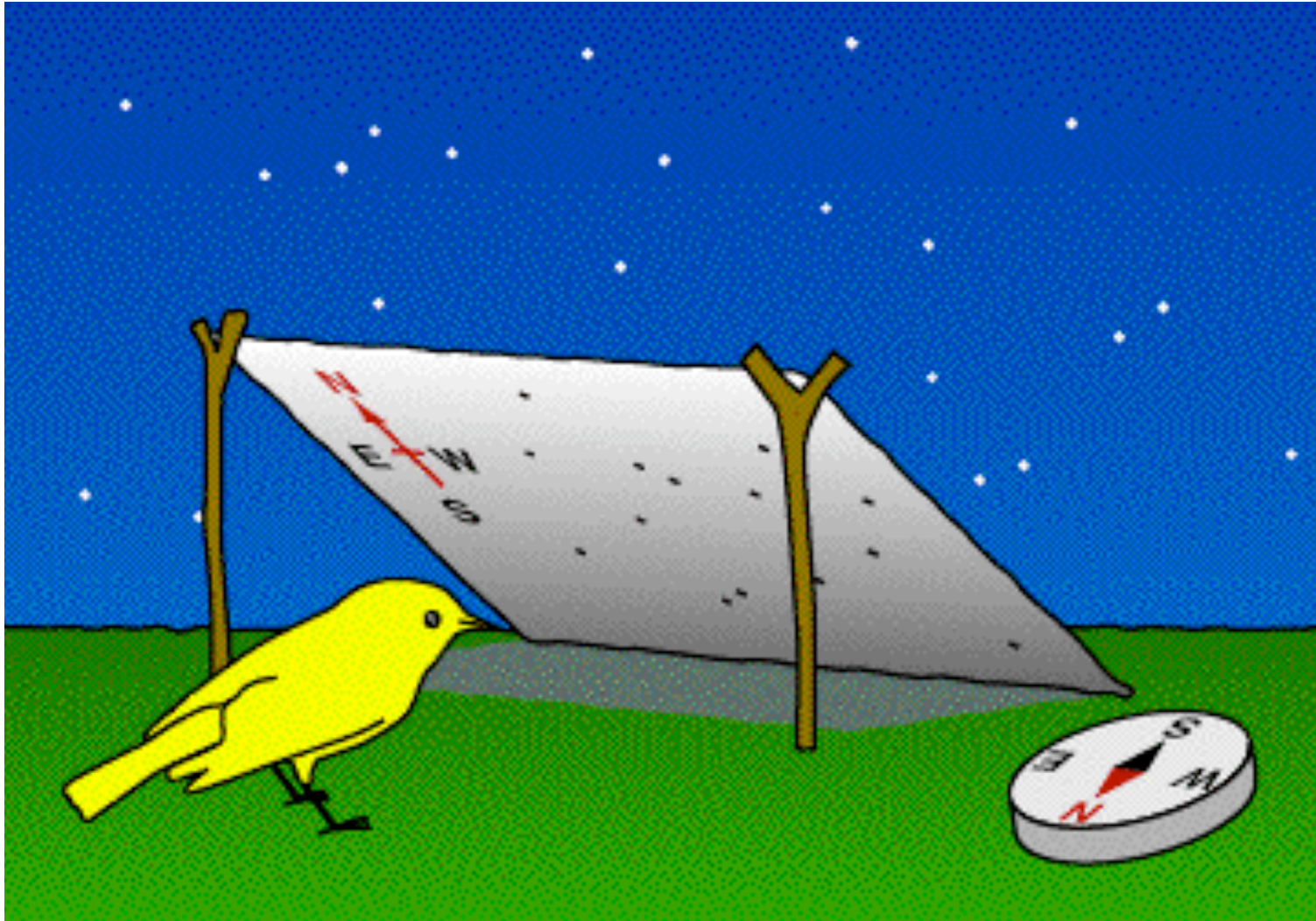
Celestial
coordinates



Observer's
coordinates

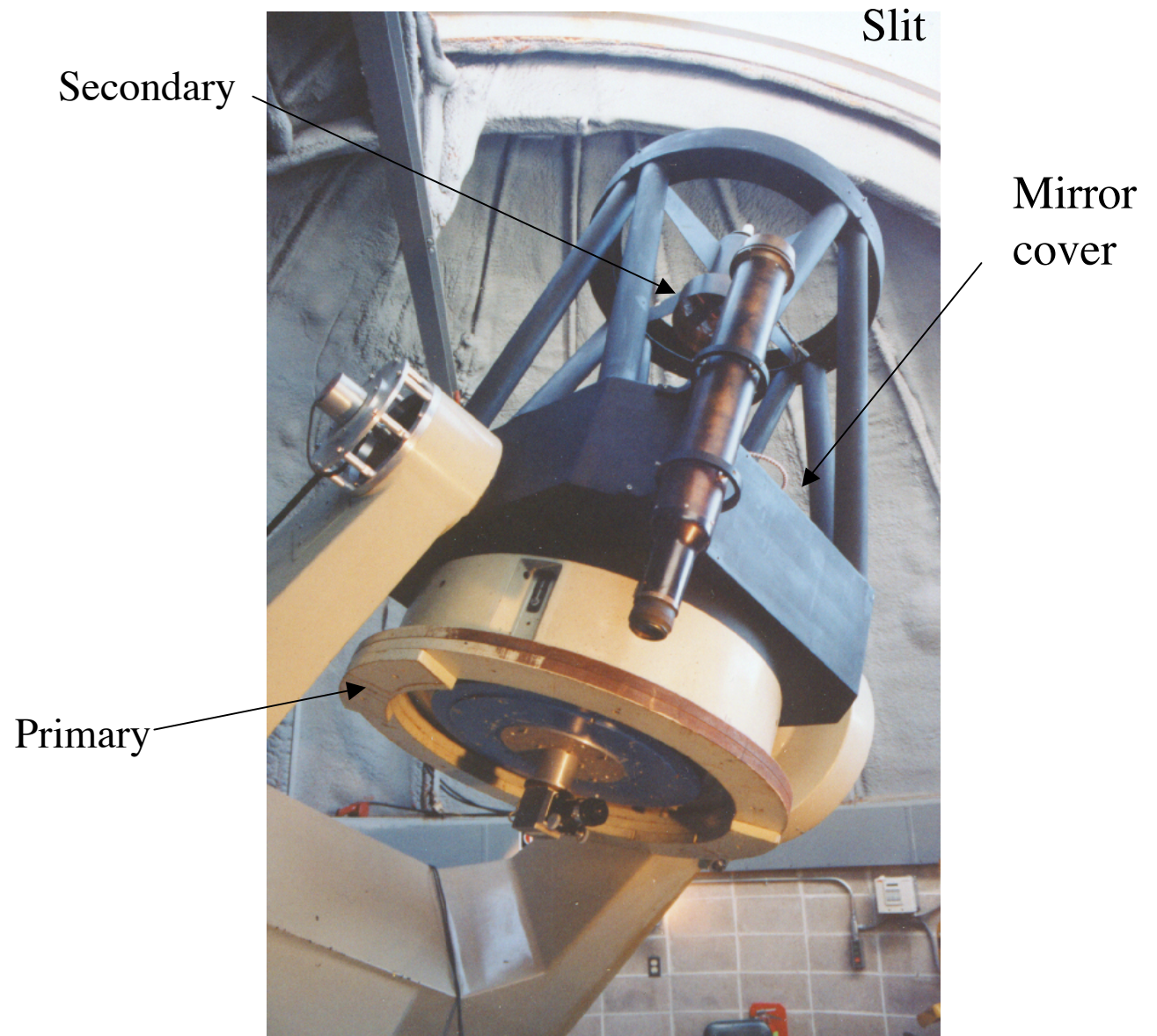


Why is E on the Left?



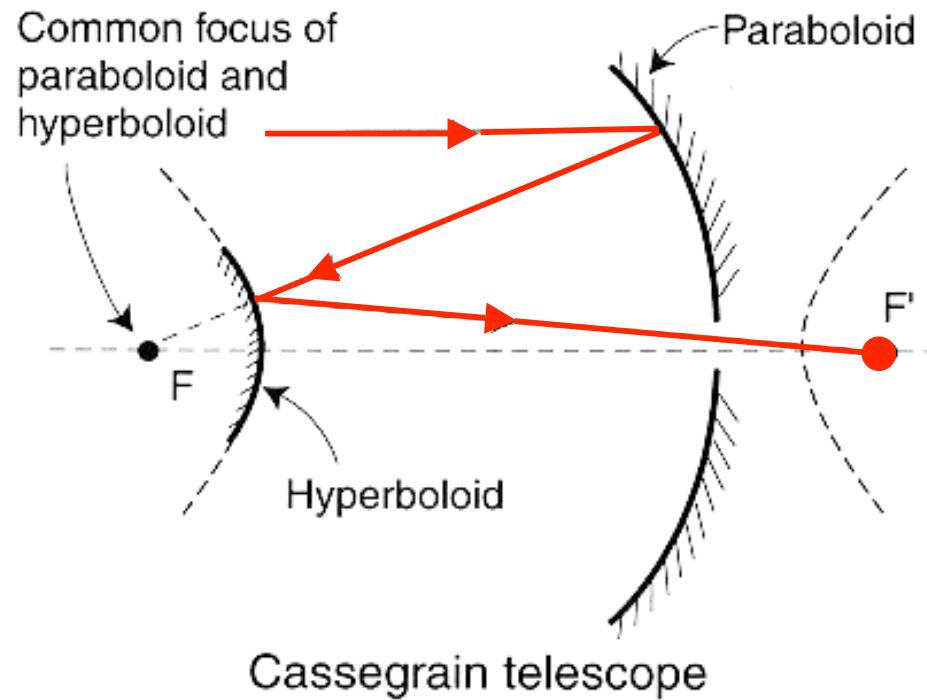
The 30-inch Telescope

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

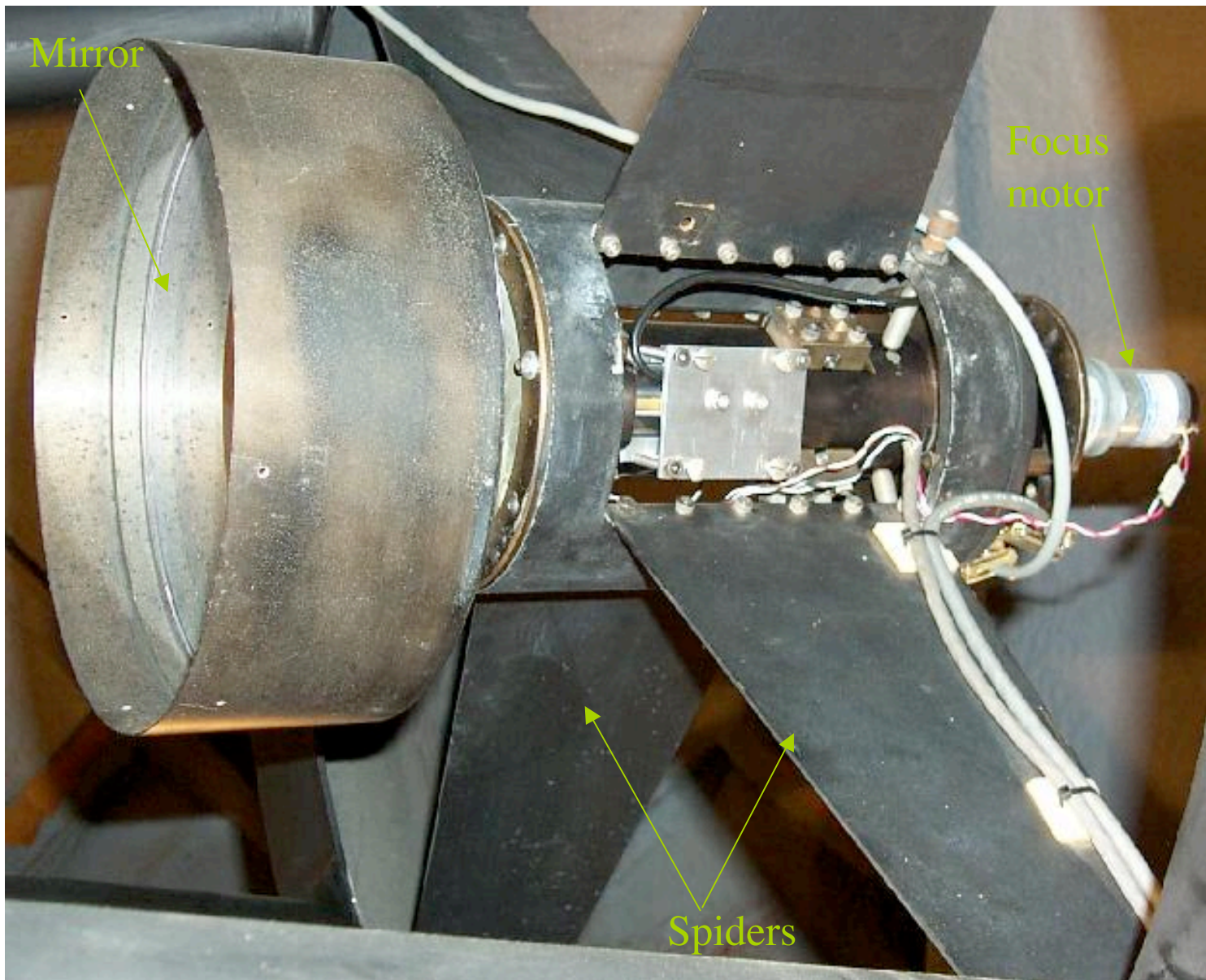


Two Mirror Telescope

- Concave primary
- Convex secondary



Secondary Mirror



Telescope Secondary



The Dome



Dome & Slit



The 30-inch Telescope

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

Declination axis

Hour angle axis

