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 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:
  \[
  HA = LST - RA
  \]
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
Telescope Design

NOTES:
1. E.F.L. 240 INCHES
2. BASE RADII
   A. 150.000 CCV
   B. 65.278 CVX

MNTG. FLANGE
CASS. FOCUS

Primary
Secondary

30.625
19.250
52.560
75.000
10.5
10.75
Secondary Mirror

- Mirror
- Focus motor
- Spiders
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

- Control computer
- Flip mirror
- Cold head
- 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