The Celestial Sphere, Positions, and Angles

Objectives:
- Develop a coordinate system
- How do you measure distances on a sphere
The Celestial Sphere

- Earth at center of very large sphere
- Because sphere is so large, observer, is also at center (figure not to scale).
- Stars in fixed positions on sphere
Extend the Earth’s Equator

- **Celestial Equator**: Extension of the Earth’s equator.
Earth’s Coordinate System

- **Latitude** (-90 to 90°): A series of full circle arcs which are parallel to the equator.
  - “up-and-down” or “North-to-South”
- **Longitude**: A series of half circle lines which run from the N. pole to the S. pole.
  - “left-to-right” or “West-to-East”
- **Meridian**: Any half circle arc that connects the poles
- **Prime Meridian**: The local Meridian line which runs through Greenwich, England.
Extend the Earth’s Coordinate System

- **Celestial Coordinate System:**
- **Declination (0-90°):** The north/south positions of points on the celestial sphere. “Latitude”
- **Right Ascension (0-24 hrs):** The east/west positions of points on the celestial sphere. “Longitude”
- These two give the location of any object on the sky
Local Horizon Coordinate System

- **Horizon**: Where the Ground meets the sky

- **Azimuth** (0 - 360°)
  - Horizontal direction (N,S,E,W)
    - N = 0°, E = 90°,
    - S = 180°, W = 270°

- **Altitude**
  - “Height” above horizon
  - Horizon = 0°, Zenith = 90°
  - “Local Declination”
Your Observing Location

- **Zenith**
  - point directly overhead
- **Meridian**
  - connects N and S through zenith
- **Noon**
  - sun is on meridian
Which of the following locations on the celestial sphere is closest to the South Celestial Pole?

A. RA = 14 hr, Dec = +88°
B. RA = 14 hr, Dec = -88°
C. RA = 23 hr, Dec = +02°
D. RA = 6 hr, Dec = +24°
• Which of the following coordinates in your local horizon system (Laramie, WY) is closest to the North Celestial Pole?

A. Az. = 45 deg, Alt. = 85°
B. Az. = 220 deg, Alt. = 15°
C. Az. = 0 deg, Alt. = 45°
D. Az. = 100 deg, Alt. = 85°
Tip: For Northern Hemisphere Observers Only

- Altitude of North Star = Approximate Latitude
- If you measure the altitude of Polaris in the sky to be 20°, this means you are observing from approximately 20° N Latitude (or + 20° Latitude). You could be, for example, in Mexico City...
- Laramie: Latitude = + 41°
Two stars are separated by an angle of $24^\circ$ as seen by the observer.

We say the “angular separation is 24 degrees.”
Examples
What would happen if we walked north (really far)?

Find a reference star:

- The *pointer stars* from the Big Dipper point to Polaris (the North Star)
Measure the Circumference of Earth

Air Distance: Lar Shively Arpt, Laramie, WY to Natrona Cty Intl Arpt, Casper, WY

Distance 108 miles
Measuring the Circumference of Earth

- 108 miles (on earth) = 1.5 degrees (on celestial sphere)
- \[ \Rightarrow \frac{108}{1.5} = 72 \text{ (miles/degree)} \]
- Circumference (miles) = 72 (miles/degree) \* 360 (degrees)
- = 25,000 miles [let’s check]
Lecture Tutorial (LT)

- Position
• From a latitude of 90° N, the altitude of the North Celestial Pole is _____ above the horizon?

A. 45°
B. 90°
C. 20°
D. 0°
You measure the altitude of Polaris to be approximately 35°. Looking along the meridian, how many degrees from the zenith will you find the celestial equator?

A. 35°
B. 45°
C. 55°
D. 65°
Where would the observer look to see the star indicated by the arrow?

A. High in the Northeast  
B. High in the Southeast  
C. High in the Northwest  
D. High in the Southwest