KSP Week 3 Presentation

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Finding Our Way in the Sky

- Radio astronomers use the celestial coordinate system to locate objects in the sky.
- The system is similar to the latitude and longitude system used on Earth.
- Key coordinates:
  - **Right Ascension** (RA - α) - analogous to longitude, measured in hours, minutes, and seconds.
  - **Declination** (Dec - δ)- analogous to latitude, measured in degrees, arcminutes, and arcseconds.
- Radio telescopes can be precisely aimed using these coordinates.
- Seconds of Arc $= 15\cos(\delta) \times$ Seconds of RA

Celestial Coordinate System

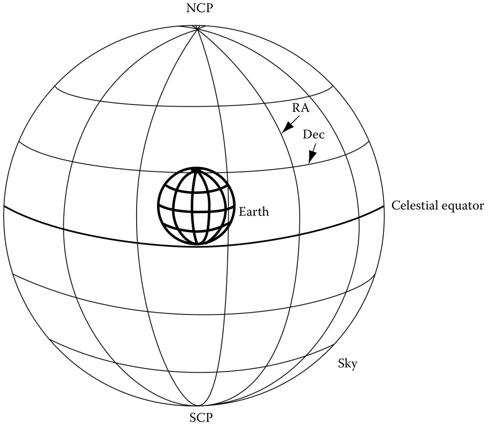

Figure: Celestial coordinate system

Observer-Centered Definitions

- **Horizon:** The circle where the sky meets the Earth.
- **Zenith:** The point directly above the observer.
- **Altitude or Elevation:** Angular height of an object above your horizon at any given moment
- **Azimuth:** The angular position of an object along the horizon relative to due north.
- **Meridian:** The line that goes from the north to the south pole.
- **Transit:** The moment when an object crosses the meridian.
- **Hour Angle:** The angular distance between the meridian and the object.

Azimuth and Altitude make a pair of angles that completely define an object's position in the sky *relative to the observer,* whereas RA and Dec are *absolute* coordinates.

Sky Coordinates Example

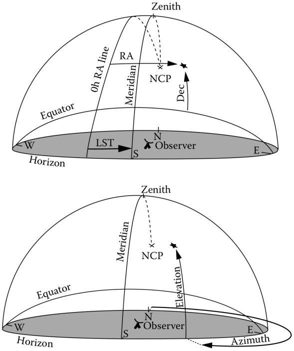

Figure: Depiction of sky coordinates as viewed by the observer (top) and observer-centered coordinates (bottom)

Apparent Sizes

- The apparent size of an object in the sky depends on the distance to the object.
- The solid angle subtended by an object is the angle that the object appears to occupy in the sky.
- Solid angle is measured in steradians.
- The solid angle Ω subtended by an object is given by

  $$\Omega = \frac{A}{r^2}$$

  where A is the area of the object and r is the distance to the object.
- The solid angle of a sphere with radius r is 4π steradians.

Basic Structure of a Traditional Radio Telescope

- The primary components of a radio telescope:
  - Antenna - collects radio waves.
  - Receiver - amplifies the weak signals collected by the antenna.
  - Amplifier - further boosts the signal strength.
  - Detector - converts the radio signals into a form that can be recorded and analyzed.
  - Data Recorder - stores the signal data for further processing.
- The dish shape of the antenna helps focus the radio waves onto the receiver.
- Modern radio telescopes often use arrays of antennas to increase resolution and sensitivity.

Basic Structure of a Traditional Radio Telescope

- A traditional radio telescope has five main parts: parabolic reflector, mount, feeds, receivers, and computer.
- **Parabolic Reflector**:
  - Collects and focuses radio waves.
  - Sensitivity depends on the dish's diameter.
  - Example: The Arecibo telescope (305 meters in diameter).
- **Mount**:
  - Holds and moves the dish.
  - Altitude-Azimuth mounts are commonly used.
- **Feeds and Receivers**:
  - Feeds convert EM waves to signals.
  - Receivers process and amplify signals.
- **Computer**:
  - Stores and analyzes the digital signal.

Basic Structure of a Traditional Radio Telescope

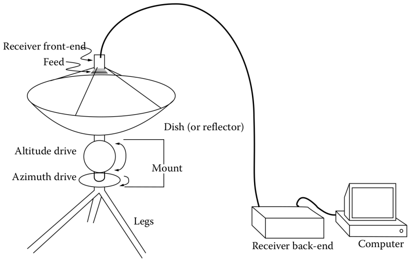

Figure: Basic structure of a traditional radio telescope

Measures of the Amount of Radiation

- **Total Energy Emitted** - The total energy emitted by an object.
- **Luminosity** (L) - The total energy emitted by an object per unit time in all directions.
- **Flux** (F) - The energy received per unit time per unit area.
- **Flux Density** (F_ν) - The flux per unit frequency interval.
- **Intensity** (I_ν) - The flux density per unit solid angle.