1 Stellar properties

Basic Stellar Properties

- Luminosity (energy per second emitted)
- Temperature
- Chemical Composition
- Size (radius)
- Mass

2 Parallax

Parallax - Review

Parallax: apparent shift in the position of a foreground object relative to the background as the observer’s point of view changes

Measuring Parallax

- Observe a star 6 months apart
- “parallax” = half of apparent shift
- parallax measured in arcseconds

A star with a parallax of 1″ is at a distance of 1 parsec (1 pc)
Parallax Formula

Parallax Formula

\[
\text{distance (in parsecs)} = \frac{1}{\text{parallax (in arc seconds)}}
\]

Parallax Example

Proxima Centauri has a stellar parallax of 0.77″ then,

\[
\text{distance to Proxima Centauri} = \frac{1}{0.77″} = 1.3 \text{ pc}
\]

Solar Neighborhood

Parallax limitations

- Parallaxes of 0.03″ or less can be measured (distances < 30 pc) from the ground
- *Hipparchus* satellite can measure parallaxes to 200 pc
3 Luminosity and Brightness

Luminosity (absolute brightness)

Luminosity: Energy per second emitted by a star (measured in Watts or J/s)

- *intrinsic* property → independent on location of observer

Apparent Brightness

Apparent Brightness: measure of energy flux (energy per second per unit area) as seen from Earth.

\[ \text{apparent brightness} \propto \frac{\text{luminosity}}{\text{distance}^2} \]

Stars of the same luminosity will appear fainter if they are farther away

Magnitude System

- Brightness is typically measure in magnitudes
- A 1 magnitude change corresponds to a factor of 2.5 in apparent brightness
- A first-magnitude star is 2.5 times brighter than a second-magnitude star
- A first-magnitude star is \((2.5)^5 \approx 100\) times brighter than a six-magnitude star
Absolute Magnitude

**Absolute Magnitude**: the apparent magnitude of a star if it were at a distance of 10 pc

Absolute magnitude can be regarded as a measure of luminosity

**Relationship between apparent magnitude, absolute magnitude, and distance**

\[ m = M + 5 \log_{10} \left( \frac{D}{10 \text{ pc}} \right) \]

If we measure a star's apparent magnitude and know its absolute magnitude, we can calculate its distance

\[ D = 10 \text{ pc} \times 10^{(m - M)/5} \]

**Luminosity from absolute magnitude**

**Luminosity-Absolute Magnitude Relationship**

\[ L \text{ (solar units)} = 10^{-(M - 4.83)/2.5} \]

**Example**

\(\alpha\)-Centauri A has an apparent magnitude of -0.01. From parallax measurements we find that its distance is 1.35 pc.

Given:

- \( D = 1.35 \text{ pc} \)
- \( m = -0.01 \)

Find: absolute magnitude and luminosity

**Example**

\[ m = M + 5 \log_{10} \left( \frac{D}{10 \text{ pc}} \right) \]

\[-0.01 = M + 5 \log_{10} \left( \frac{1.35}{10} \right)\]

\[-0.01 = M + (-4.35)\]

The absolute magnitude of \(\alpha\)-Centauri A is \(M = 4.34\)
Example

\[ L = 10^{-(M - 4.83)/2.5} L_\odot \]

\[ L = 10^{-(4.34 - 4.83)/2.5} L_\odot \]

\[ L = 1.57 L_\odot \]

The luminosity of \(\alpha\)-Centauri A is 1.57 times the luminosity of the Sun.