ASTR 1020: Stars & Galaxies  
February 6, 2008

- MasteringAstronomy Homework on The Sun is due Feb. 11th.
- Reading: Chapter 15, Section 15.1.

Fiske Planetarium Show: Colorado Skies: Celestial Mechanics, Thursday, Feb. 7th at 8:00 pm.

Today’s Class: Measuring brightness of the Stars

- Measuring apparent brightness of stars.
- Measuring stellar luminosities.
- Magnitudes.

A passive science

- Stars are so small compared to their distance to us that we almost never have the resolution to see their sizes and details directly—"point sources"
- We deduce everything by measuring the amount of light (brightness) at different wavelengths (color, spectra)

- Stars take millions, billions of years to go through their life stages— we rarely see a single star change
- Observing many different stars lets us figure out the sequence of a single star’s life

Stellar Luminosity

- What we measure: apparent brightness = how bright it appears to us here on earth
- What we want to know: luminosity = how much energy is emitted (Joules/sec or watts) a.k.a. absolute luminosity

- Next few lectures: focus on how we figure out the properties of stars.
- Coming soon: how we deduce the ages and life histories of stars.
A Big Problem in Astronomy

- A star of a given apparent brightness could be EITHER a very luminous star far away OR a low-luminosity star close

NEED TO KNOW THE DISTANCE TO THE STAR

Clicker Question

These two stars have about the same luminosity -- which one appears brighter?

A. Alpha Centauri
B. The Sun

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Inverse square law

Luminosity passing through each sphere is the same

The relationship between apparent brightness and luminosity depends on distance:

\[
\text{Brightness} = \frac{\text{Luminosity}}{4\pi (\text{distance})^2}
\]

We can determine a star’s luminosity if we can measure its distance and apparent brightness:

\[
\text{Luminosity} = 4\pi (\text{distance})^2 \times \text{Brightness}
\]
Clicker Question

How would the apparent brightness of Alpha Centauri change if it were three times farther away?

A. It would be only 1/3 as bright  
B. It would be only 1/6 as bright  
C. It would be only 1/9 as bright  
D. It would be three times brighter

Magnitudes: all you need to know

• Dates back from the original Hipparchus (190 BC).
• Convenient only because it can handle huge ranges in brightness (factors of $10^{12}$) via logarithms.
• A kind of ranking of a star’s brightness.

Apparent magnitude ZERO is the brightest star in the sky. 
Mag 7 is faintest naked eye can see. 
Mag 30 = faintest ever really detected.

NOTE THE BACKWARDS SCALE! 
Bigger number is fainter!

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How do we measure the distances to astronomical objects?

• We’ll keep asking this question again over the semester
• Several techniques, each valid for different objects at different distances
• Technique #1 for next class: PARALLAX