ASTR 1020: Stars & Galaxies

September 20, 2013

- Reading: Chapter 15, section 15.1.
- *MasteringAstronomy* Homework on The Sun is due Sep. 20th.
- Exam 1 will be next Friday!
- Volunteer for "Astronomy in the News".

Astronomy Picture of the Day

Pleiades Star Cluster
3000 stars, 400 light years away, 13 light years across

Today's Class: Measuring brightness of the Stars

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

Clicker Question from Reading

What two pieces of information would you need in order to determine a star's luminosity?

A) apparent brightness and mass
B) apparent brightness and temperature
C) apparent brightness and distance
D) temperature and distance

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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.

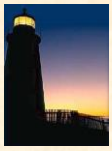
- Observing many different stars lets us figure out the sequence of a single star's life.

- 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.

Stellar Luminosity

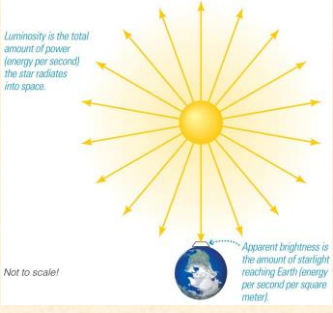
- What we measure: apparent brightness
  = how bright it appears to us here on earth
- What we want to know: luminosity
  = how much energy is emitted per second (Joules/sec or watts)
  a.k.a. absolute luminosity

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



Luminosity:

Amount of power a star radiates (energy per second = watts).

Apparent brightness:

Amount of starlight that reaches Earth (energy per second per square meter).

The brightness of a star depends on both distance and luminosity.

Clicker Question

How does the Sun's luminosity compare to that of other stars in the Milky Way?

A. The Sun's luminosity is greater than most stars in the Milky Way.
B. The Sun's luminosity is greater than about half the stars in the Milky Way.
C. The Sun's luminosity is less than most stars in the Milky Way.

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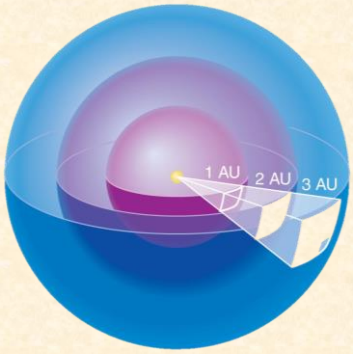
Inverse square law



- The amount of luminosity passing through each sphere is the same.

  Area of sphere: 4π (radius)^2

- Divide luminosity by area to get brightness.

- 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

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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!

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**