Topics for Today

- How do we measure brightness of stars: and why apparent vs absolute magnitudes?
- We shall use binary stars to determine stellar masses
- Detail read 16.5 H-R Diagram + 16.6 Star Clusters -- overview read Chap 17 Star Stuff
- Mid-Term Exam 1 (graded) returned today – plus answer sheets
- Homework Set 4 due in class this Friday
- Solar Observing Day 2 – tomorrow (bright)
- Review (Crib) Sheet # 1 competition today

FIRST MID-TERM EXAM

- Grade boundaries, based on 145 points:
  - If 123/145 (85%) or over, A's [24%]
  - 112/145 (77%) or over, B's [28%]
  - 84/145 (58%) or over, C's [36%]
  - 70/145 (48%) or over, D's [ 7%]
- Also +, plain, and –– within these ranges
- Median grade 78%; highest 98% (1), 97% (1)
- Go through answer sheet – and talk to us if do not understand our choices. Keep exam + answers for future review (comp final)

Oh to describe a star!

B. Which is a red supergiant?

- A. Spectral type G2, luminosity class V
- B. Spectral type M2, luminosity class I
- C. Spectral type O9, luminosity class I
- D. Spectral type M1, luminosity class V
Magnitudes: Apparent vs Absolute

- Giving measures to stellar luminosities
- Built on choices made by Greeks!

Stellar Magnitudes

Weird system: brighter is smaller magnitude, even negative!

Of cultural importance even if a bit confusing (secret society!)

Measuring Brightness magnitudes

m
apparent mag: what looks like in sky

M
absolute mag: what would look like if at 10pc distance (LUMINOSITY)

Color Index: B - V
magnitudes assigned using photometric FILTERS
(quicker than taking spectra to classify stars)

Hertzsprung-Russell (H-R) Diagram
Luminosity (magnitude) vs Spectral class (temperature)
Stellar puzzle

- Two stars, Antony and Cleopatra, are both of spectral class M3, and of the same apparent brightness (magnitude) in the sky. Cleopatra shows narrow absorption lines in her spectrum, Anthony broad ones. Which star must be far more distant?

- A. Antony
- B. Cleopatra

Estimating the size of a star -- its RADIUS

Stefan-Boltzmann

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MEASUREMENTS OF STARS:

Temperature (from internal laws)
Brightness (photometry)
=> Luminosity

Recall: Stefan-Boltzmann Law:

L = 4\pi R^2 \sigma T^4

=> Luminosity & Temp => Radius

But how to get the mass?
(Trickier! See Binaries)
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“Proper motions”
wiggly motions (parallax) and binaries …

Stellar motions in sky...

With respect to “fixed stars”

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Proper motion causes:
1. Actual motion of star, relative to gas
2. Effect of Sun moving our galaxy

Wiggly look in print of proper motion = parallax

1. Due to extra motion
2. Due to Sun's motion
3. Sidereal shift ~ 1/year
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BINARY STARS

4 varieties:

Visual
Astrometric
Spectroscopic
Eclipsing

Evidence of orbital motion (...how we detect them):

1. Visual Binary
   - Track more motion of both stars

2. Astrometric Binary
   - Wiggly motion of one star
   - Telescopic parallax

3. Spectroscopic Binary
   - Abnormal lines of one or both stars
   - Doppler shift

4. Eclipsing Binary
   - Our star blocks or distorts light from other
   - Double images, light curve

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Visual binary: Sirius A and Sirius B

Rare: need to be very near, widely spaced
Eclipsing binaries

one star gets in front or behind other

Eclipsing: Variations in brightness with time

Very useful (can even infer stellar radii), but RARE
… viewing angle has to be right on edge!