Today

- Why temperature and spectral lines are closely linked in classifying stars O B A... M
- Proceed to lay the stars out on the "Hertzsprung – Russell" (or H-R) diagram
- Weird scale for stellar magnitudes
- Absolute vs apparent magnitude
- Observatory Night # 3 tomorrow (Wed)
- Re-read Chap 16, "Properties of Stars"
- Start overview read Chap 17, "Star Stuff"
- Will return graded Exam 1 next Tues

Reading Clicker Q

E.

- The luminosity of a star is
  - A. apparent brightness of the star in the sky
  - B. surface temperature of the star
  - C. lifetime of the star
  - D. total amount of light that the star will radiate over its entire lifetime
  - E. total amount of light that the star radiates every second

Puzzle Clicker: Stellar Parallax

- The biggest ground-based telescopes with adaptive optics can measure a star's position to accuracies of about 0.05 arcsec. How far away could they map the positions of stars via parallax?
  - A. 2 pc = 6.5 light years
  - B. 20 pc = 65 light years
  - C. 200 pc = 650 light years

Parallax

B. maximum distance is set by the accuracy with which you can measure positions in the sky (space does better than ground)

Distance (pc) = 1 / 0.05 arcsec = 20 pc = 65 ly

Best parallax measurer: Hipparcos satellite 1989-1993

- Space measurements not affected by atmosphere
- Measurement made many times until accurate to 0.001 arcsec (1000 pc or 3300 ly)
- 100,000 stars mapped
- (2.5 million to slightly lesser accuracy)
Devising the strange temperature code

- Original classification of spectra (1890) was:
  A = strongest hydrogen feature
  B = less strong hydrogen …C, D, etc.

- Annie Jump Cannon realized that a different sequence made more sense (~1910)

→ O B A F G K M !!

Spectral Classification: O B A F G K M

Which ABSORPTION lines are strongest

Hottest stars: O B
- ionized helium only

Hot stars: A F
- helium, hydrogen

Cooler stars: G
- hydrogen, heavier atoms

Coolest stars: M
- molecules, (complex absorption bands)

SURFACE TEMPERATURE explains it

- Cecelia P-G used the new SAHA EQUATION to estimate how many electrons remain attached to atoms as temperature changes (or level of ionization)

(Harvard PhD thesis 1925)

Cecelia Payne-Gaposchkin

O B A F G K M → decreasing temperature

Why temperature and spectral lines are linked?

SAHA gives the answer:

can estimate "population of different energy levels" in H, He ...

and ionization

SAHA predicts spectral line strengths with temperature
Further refinements:

DECIMAL SUBDIVISION

LUMINOSITY CLASSES

Sun is: G2 V

COLOR CLASS

Hertzsprung-Russell (H-R) Diagram

Luminosity (magnitude) vs Spectral class (temperature)

H - R Namesakes

Ejnar Hertzsprung

Henry Norris Russell

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?)

M = m if at distance 10pc

(Slightly) screwy world of MAGNITUDES

Measuring BRIGHTNESS magnitudes

$m$
apparent mag: what looks like in sky

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