Astronomy 123 – Stars and Stellar Structure
Fall 2002

Week 1 – Basic functioning of stars, radiation, and stellar properties

Snacks: David

This class will be partly a review of the very basics of stars, from a theoretical point of view, and partly about light and how the properties of stars are measured.

Read Ch. 3 in Ostlie and Carroll; Visit the reserve shelf and browse the books there. You will need one of them to solve the HR diagram problem below.

Review your notes from Astro 16; use the encyclopedias of astronomy, other astro textbooks, and our textbook. Be prepared to lead the indicated **discussion** on the following topics:

1. (Rabi, Kate) *Hydrostatic equilibrium*: How is a star held up against the force of gravity? A nice presentation would include a quick derivation and an explanation of the force balance, the pressure gradient in a hydrostatic atmosphere, also perhaps, a description of the scale height.
2. (Stephanie, Matt) *Nuclear energy generation*: How does a star produce energy at its center? A nice presentation might include information about the mass-defect and main sequence lifetimes or perhaps about the strong temperature dependence of reaction rates and how that tends to make stars very stable.
3. (Mark, Genevieve) *Energy transport*: What happens to the photons that are produced in the center of a star? A nice presentation could address how a gamma ray produced in a nuclear reaction works its way out of the star, a million years later emerging as an optical photon. You will discuss opacity and at least describe convection.
4. (Roban, Danielle & Dave) *Stellar atmospheres*: Why do they have their observed frequency distributions (and what do they look like)? A nice presentation will discuss LTE and probably Kirchoff's laws, and will certainly explain why there are lines in a star's spectrum and

what we can learn from them. And I don't see how you could not show at least one actual stellar spectrum.

Problems:

1. Make a precise and neat HR diagram by plotting specific and well determined values of the effective temperature and luminosity for a series of main-sequence stars as well as some giants, supergiants, and white dwarfs. I don't mean specific stars, though it would be cool if you could put a couple of specific, famous stars on there at the end. Rather, I mean idealized, standard stars of a specific spectral type and luminosity class. The reserve book *Astrophysical Quantities* should have these values.

   Make sure to indicate the extremes of temperature and luminosity.

   Take care in how you plot the data and label the axes.

   Draw and label several contours of constant radius.

   Indicate the *masses* and *B-V colors* of several representative stellar types, including those at the extremes of the main sequence.

2. Ostlie and Carroll problems 3.2, 3.6, 3.8, 3.9, 3.17 (for this last one, assuming that the change in radius while this star pulsates is negligible, what is the difference in temperature at the extremes of lambda Sco's variability?)

3. What is the size of a circular 5800 K blackbody emitter that, when held at arm's length (50 cm), generates a flux of 1,3600,000 ergs s^{-1} cm^{-2} at your eye? Compare the angle subtended by such a source to the sun's solid angle. Express both angles in steradians.

You will write up answers to all the Problems, and hand them in by the end of the day on Friday. I may only grade a subset of them, but I will provide you with solutions.