Astronomy 830, Autumn 2003, Problem Set 2

Due Friday, October 10 in class

Problem 1:

On the class website, `http://www.astronomy.ohio-state.edu/~pogge/Ast830/`, follow the link for "Problem Set 2", and retrieve the file named `mlr.dat`. This file contains a table of Masses, Luminosities, and Radii (and their uncertainties) for 122 stars with measured masses from Popper 1980, ARAA, 18, 115. Using these data…

a) Plot M-L and M-R relations, including the uncertainties plotted as error bars.

b) While a single power law of the form $L \approx M^{\alpha}$ would fit most of the data in the M-L relation reasonably well, the low-mass stars clearly deviate in the sense of having higher luminosities than "predicted" by a single power-law fit. Using a linear least squares fitting program (e.g., `lfit`) divide the data into two mass regimes (you decide where to make the cut) and independently fit a power-law to each. This procedure is an example of a "broken power-law fit". Tabulate your results, giving your best-fit values for the normalization and power-law slopes and their uncertainties. Plot your fits over the data. To make this problem more tractable, you may use an unweighted fit (i.e., neglect the errors on L and M), but still plot the error bars.

c) Theoretical Zero-Age Main Sequence M-L formulae are listed in B&M as equation 5.5 (page 280, from Bressan et al. 1993). Make a second graph plotting just your best-fit M-L relation (without the data) and the predictions of Bressan et al., making allowances, as you think best, for differences in the normalization (but not changing the predicted power-law slopes). Comment on your results.

Problem 2:

a) Show that a star's effective temperature can be measured independently of its distance by rewriting the expression for T_{eff} in terms of the *apparent* bolometric magnitude of the star, m_{bol}, and its apparent angular diameter, ϕ, in mas. Choose appropriate units. **Hint:** since you are dealing with magnitudes, recasting the problem in terms of $\log T_{eff}$ as a function of m_{bol} and $\log\phi$ will make the algebra (and the error propagation in part b) a *lot* simpler.

b) Hajian et al. (1998 ApJ, 496, 484) have measured angular diameters for two K- Giants:

Star	MK Type	V mag	Angular Diameter
α Ari	K2III	2.00±0.01	6.80±0.07 mas
α Cas	K0III	2.22±0.01	5.62±0.06 mas

Using the bolometric corrections in Table 3.7 of B&M, estimate T_{eff} for these stars, with uncertainties. Remember to correct the BC's in Table 3.7 for the fact that Schmidt-Kaler's values quoted by B&M use $BC_{V_\odot} = -0.19$, instead of $BC_{V_\odot} = -0.07$ for the new IAU standard calibration.

Problem 3:

Go to the class website, and follow the link marked "Problem Set #2". There you will find a personalized gzip-compressed tar file containing 5 stellar spectra in ASCII format: 3 are the spectra of stars assigned just to you and two are "mystery spectra" (named mstar1.spc and mstar2.spc) that have been assigned to everyone.

Download the files assigned to you. The data are organized in 3 columns in the format:

Col 1	Col 2	Col 3
Pixel	Wavelength (Å)	Flux (normalized to 5500Å)

Plot the spectra as flux versus wavelength for the exercise, using the plotting program of your choice (sm or whatever). The spectra here are presented as "observed", which means that they are on a common (correct) physical flux system, but no corrections have been made for absorption by the Earth's atmosphere or for any interstellar extinction along the lines of sight to these stars. The radial velocities are negligible at the resolution given, so you do **not** expect any Doppler shifts to confuse line identifications.

Assign an MK spectral classification to each star (bonus points for luminosity class, but this is optional – don't spend too much time trying to assign a luminosity class, and no points for just guessing – you have to say why you assigned that class!).

When making your classifications, identify any of the strong lines or spectral features that led you to the classification. All stars fall within the range of MK types given on the plot of spectra handed out in class (see me if you need a fresh copy). An excellent resource is the MKK stellar atlas in the reading room, which uses photographic spectra but identifies key lines for the MK system. A set of scanned digital versions of the MKK atlas are also available on the web (link from the class website). Note that these CCD spectra cover a wider range of wavelengths, especially to the red, than MKK's photographic plates. In every case, justify your spectral classifications (e.g., CaII is weak but Hγ is strong, Strong HI but no HeI, etc.).

The "rules of engagement" for this assignment are to work individually on these spectra. You may come to me for hints or suggestions, but do not ask for help or hints from anyone else.