Ph 441/541 Problem Set 2

Due: Friday, February 10, 2012

1. Stars near the Sun:

In this problem you will use the on-line services of the Centre de Données Astronomiques de Strassbourg (CDS; Astronomical Data Center in English) to identify stars near the Sun and determine their properties. The VizieR service (http://vizier.u-strasbg.fr/viz-bin/VizieR) is an astronomical catalog database, enabling searches for and in catalogs. The Simbad service (http://simbad.u-strasbg.fr/simbad/) is a searchable database of astronomical objects, giving what is known about each. The Aladin service (http://aladin.u-strasbg.fr/aladin.gml), which we will not use in this problem, is an interactive software sky atlas that allows a user to display digitized astronomical images and overlay entries from catalogs.

a. Find the new reduction (van Leeuwen 2007) of the Hipparcos catalog using VizieR by entering hip2 in the find box and hitting return (or pushing the Find button). Select "The Astrometric Catalogue" and push the "Query selected Tables" button. This will take you to a page where you can select entries from the catalog based on entered constraints. Retrieve from the catalog all stars with distances from the Sun less than or equal to 10 pc. Note that the unit for parallaxes in the catalog is *milli*arcseconds. The default choice of columns to retrieve is OK. How many such stars are there? Make sure that your limit on the number of returned rows is large enough to return all of the stars matching your search criterion.

b. Save your selected stars to disk as "ascii text/plain" (or some other format, if you prefer). The H_p magnitude is approximately a V-band magnitude. Use the data in the table to calculate the absolute H_p magnitude, M_{Hp}, for every star. Use Excel or some other software package of your choice. Show a plot of M_{Hp} versus $B-V$; use different symbols for star with distance uncertainties greater than and less than 5%. Make sure that the most luminous stars appear at the top of this plot and red stars to the right. Approximately where would the Sun lie in this plot?

c. What is the most luminous star in your sample (smallest M_{Hp})? Give the HIP #, right ascension, declination, M_{Hp}, and $B-V$. Repeat for the least luminous star. What is the angular separation between these two stars in degrees?

d. Use Simbad to search for the most and least luminous stars in your sample. Search by identifier using the HIP #. What are the names of these stars (both are famous, at least in astronomical circles)? What are their spectral types?

e. One of the well-measured stars far below the main sequence in the plot from part b) has $M_{Hp} = 13.27$ and $B-V = 0.196$. Using the table from Gray handed out in class, what is the approximate T_{eff} of this star? (Use the properties of main sequence stars, though this star is clearly not on the main sequence.) Find the HIP # of the star and look it up in Simbad. What is its name and spectral type?

f. (Ph 541 students only) Assuming that $M_{hp} = M_V$, use the table from Gray to estimate an approximate radius in $R_\odot$ for the star in the previous part.

2. Spectroscopic "Parallax":
The spectrum of a star indicates that it has a type of A0 V (strong hydrogen lines). The observed color is $B - V = 0.20$ and the apparent magnitude is $V = 9.6$.

a. How much has the color of this star been changed by interstellar extinction? By how many magnitudes has it been dimmed? Use the table from Gray handed out in class.

b. What is the distance to the star?

c. (Ph 551 students only) The properties tabulated for each spectral type in the table from Gray are averages. Use the H–R diagram of nearby stars compiled from Hipparcos data (in the lecture slides) to estimate the uncertainty in the distance calculated in b). Assume that interstellar extinction is negligible for the stars in the diagram.

3. Colors of Blackbodies (Ph 541 students only):
Assuming that each emits a pure blackbody spectrum, determine the $U - B$ and $B - V$ colors of stars with temperatures of 44,500 K (O star), 9,000 K (A star), 6,000 K (G star), and 3,000 K (M star). Assume that the filter response is narrow enough that you can approximate the integral over the spectrum and filter response curve by the value of the Planck function at the central wavelength of the filter times the filter bandwidth. Ignore interstellar dust and the Earths atmosphere. Use the flux calibrations for the Johnson photometric system: $f_\lambda(0) = 4.22 \times 10^{-9}$, 6.40×10^{-9}, and 3.75×10^{-9} erg cm^{-2} s^{-1} Å^{-1} for the U, B, and V bands, respectively. How accurately do the colors need to be measured in order to distinguish between these different stellar classes? Express your answer in terms of the fractional error in flux.