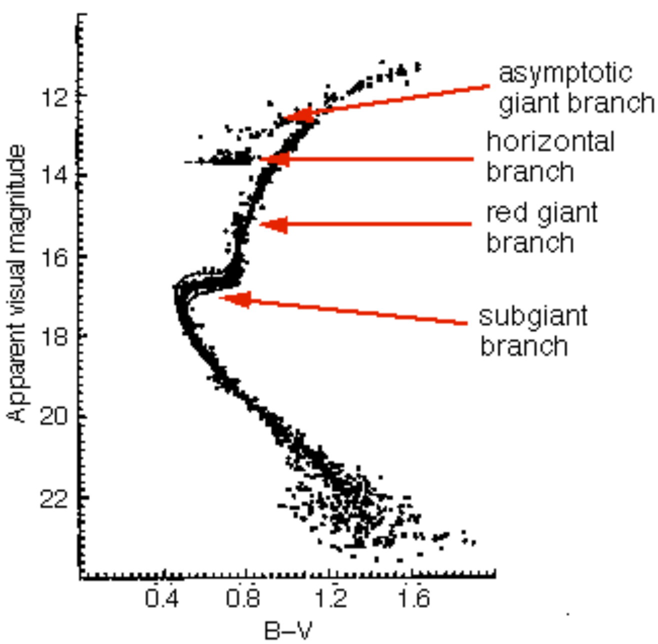
PHY983 - Nuclear Astrophysics - Spring 2009
Homework Set 5
Due: Feb 20, 2009 beginning of lecture
Key words: hydrostatic equilibrium, main sequence, absolute and apparent magnitudes, globular cluster ages

Problem 1 [5pts]:

Derive the absolute visual magnitude of the sun given that the observed visual magnitude is -26.73. Also compare the absolute visual magnitude to the absolute bolometric magnitude of the sun (see lecture notes) and explain the difference qualitatively.

Problem 2a[10 pts]:

Globular clusters are great laboratories for stellar evolution as they are a group of stars that was born at the same time and that are all at about the same distance from earth. In addition, distances to globular clusters can be determined relatively accurate (as many stars can be used to obtain many measurements). Plotting the observed visual magnitude versus the magnitude difference between blue and visual wavelengths (B-V)(A measure for the color or effective temperature) directly maps out a Hertzsprung-Russell (HR) diagram because all stars are at the same distance to the earth and therefore the observed magnitudes do not need to be corrected for distance variations. The picture below shows the HR diagram of the globular cluster 47 Tucanae. As you can see, many of the stars have moved already off the main sequence. Determine the age of 47 Tuc from the observed main sequence turnoff point using the following method:



Determine the luminosity of the stars at the main sequence turnoff relative to the sun. These stars must be just at the end of their main sequence lifetime. You can then use the

Luminosity-Mass and Mass-Main Sequence Lifetime relations from class to determine the age of these stars. Note that the observed visual magnitude has to be converted into an absolute bolometric magnitude. You can use the tables below to determine the bolometric correction (correction to obtain the total observed magnitude from the observed magnitude in the V spectral band). The distance to 47 Tuc is often given in form of a "distance modulus" M - m =-13.27.

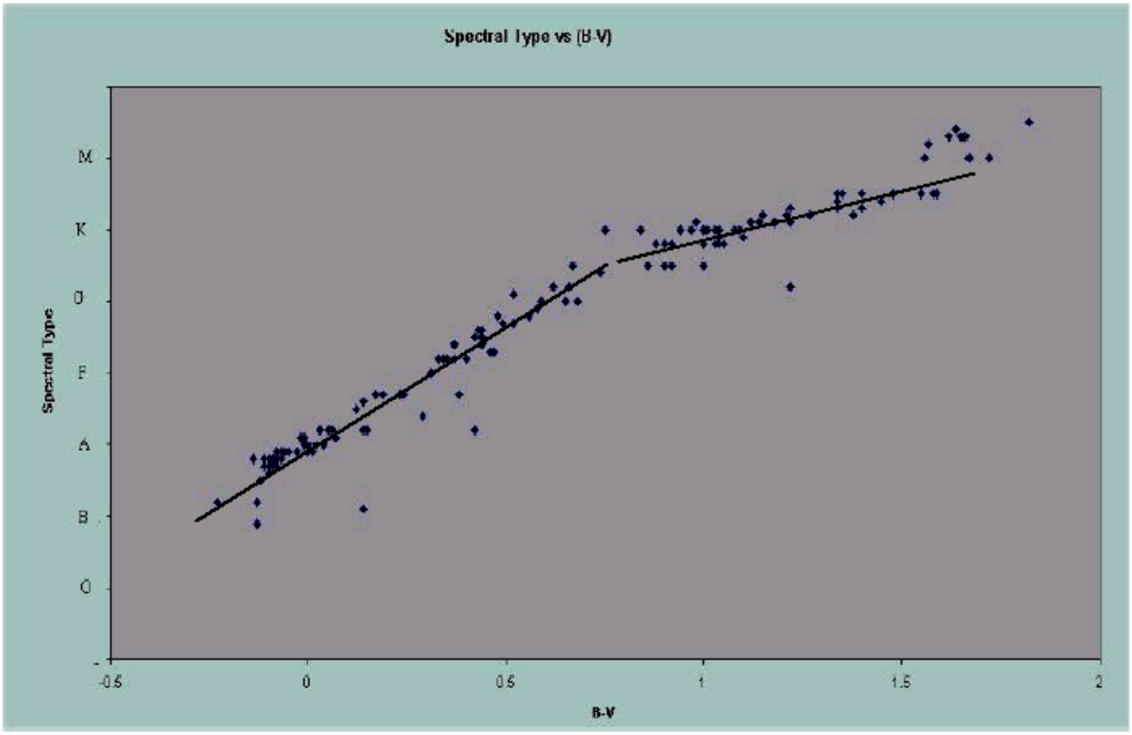
Class	Main Sequence	Giants	Supergiants
O3	-4.3	-4.2	-4.0
B0	-3.00	-2.9	-2.7
A0	-0.15	-0.24	-0.3
F0	-0.01	0.01	0.14
G0	-0.10	-0.13	-0.1
K0	-0.24	-0.42	-0.38
M0	-1.21	-1.28	-1.3
M8	-4.0		

Table 1: Table of bolometric corrections for some stars. After Kaler 1997, p. 263.

Bolometric correction: $M=M_{bol} = M_v$ + correction in table

To get the spectral type from the B-V measurement you can use this figure:

Spectral Type versus B-V for 150 stars from the Bright Star Catalog



<u>Problem 2b</u> [5pts]:

Using the distance modulus given in Problem 2a, what is the distance to 47 Tuc in parsecs and in light years ?

<u>Problem 2c</u> [2pts]:

Compare your age of 47 Tuc with the professional analysis in the literature. Give the reference of the paper(s) you are using. Also, compare the age with the age of the universe.

<u>Problem 3</u> [5pts]:

Read Imbriani et al A&A 420, 625–629 (2004). Explain, why a change in the 14N(p,g) reaction rate (increase or decrease – as measured, why is that rate important?) (the S-factor is proportional to the reaction rate) leads to a change (increase or decrease – explain) in the derived globular cluster ages. Make a sketch of the HR diagram and draw isochrones for different 14N(p,g) rates to make the point clearly.