AA 201 : Introduction to Astronomy – Example problems

1. Estimate the average convective scale height of the sun. [Consider the average density and average pressure as 1.4 g/cc and $\text{Pressure}_{\text{core}}/2$ respectively]

2. From the H-R diagramin figure 1 calculate the average density of sun, Sirius A and Sirius B.

3. Make a very rough estimate of the wavelengths at which a star of mass $9M\odot$ and a star of mass $0.25M\odot$ will give out maximum radiation given Sun's temperature is 6000 K.

4. Consider a H-burning star of mass $M = 3M\odot$, with a luminosity L of $80L\odot$. The nuclear energy is generated only in the central 10% of the mass, and the energy generation rate per unit mass, ǫnuc, depends on the mass coordinate as $\varepsilon_{nuc} = \varepsilon_c\,(1 - m/0.1M)$. Calculate and draw the luminosity profile, l, as a function of the mass, m. Express ε_c in terms of the known quantities for the star.

5. Assume that the density of a star varies linearly as

$$\rho(r)=\rho_{central}\,(1 - r/R)$$

where $\rho_{central}$ is the central density and R is the radius of the star. This is a more realistic scenario as compared to the constant density models. Find the mass m(r), the pressure p(r), and T(r) as function of r. Assume the star to be a star of mass M. Plot the results as a function of r.

6. Look at the HR-diagram in figure 2. Assume that you observe a main sequence star with spectral class G0. The apparent magnitude of the star is m = 1. Roughly what luminosity and absolute magnitude would you expect the star to have? (use the diagram) Using this result, can you give a rough approximation of the distance?

7. From the H-R diagram find out the luminotsities ($L\odot$) and temperatures of a red supergiant, a red giant, a main sequence star and a white dwarf. Find out the corresponding radius for each class of star.

8. From the H-R diagram find out the luminotsities ($L\odot$) and temperatures of an O, a F and a M type star. Determine the masses of all three stars from the luminosity; express them in solar mass. Note how much it differs from the quoted mass. Can you give reason for this difference? Calculate the main-sequence lifetime of all the different types of stars based on their mass. Determine the radii of all three stars; express them in solar radii. If all three stars were at a distance of 10 parsecs, what would their apparent magnitudes be? If all three stars were at a distance of our Sun, how much brighter/ fainter than the Sun would they be?

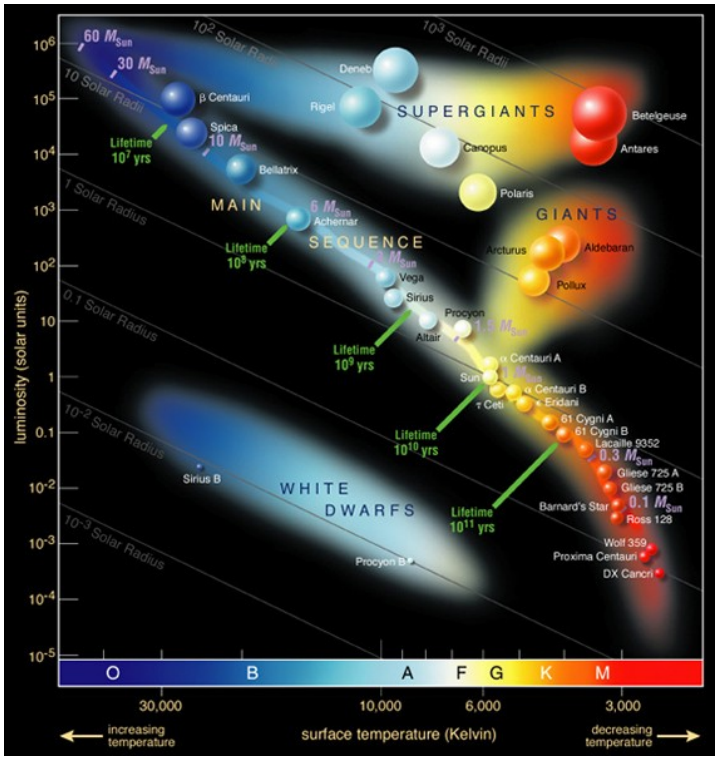

Figure 1: H-R diagram of stars in the Milkyway

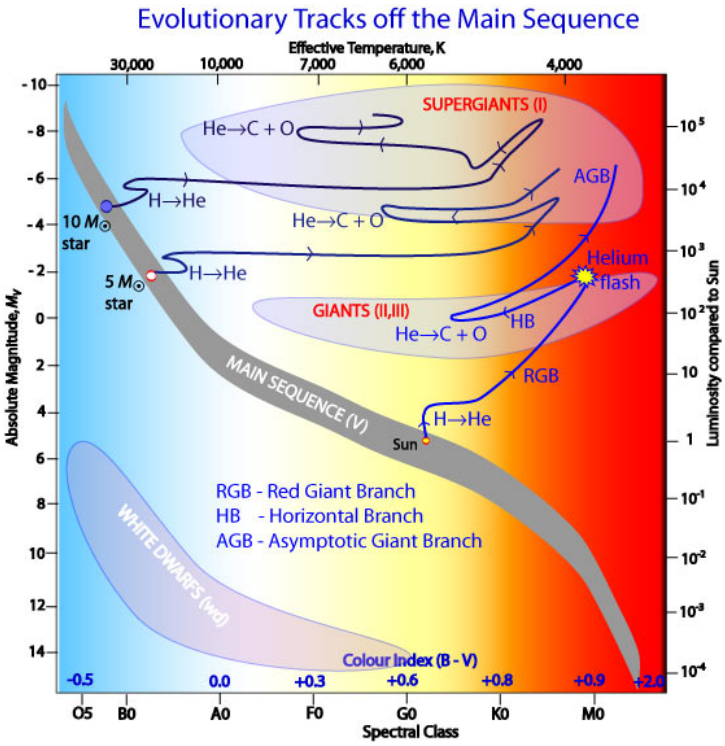

Figure 2: H-R diagram showing evolutionary tracks