

33-467: Astrophysics of Stars and the Galaxy

Due: Friday 18th November.

Guidelines for Project - Part I

- Download the stellar evolution code *EZ Code* from:
<http://www.kitp.ucsb.edu/paxton/EZ-intro.html>. The file is `EZ.tar`. Place this in your directory and unpack it using `>tar xvf EZ.tar`. It will unpack in a list of directories. There are a lot of detailed instructions and descriptions of the code on the web page. You should read the paper on the link astro-ph/0405130.
- For the first part of the project you are supposed to learn how to run the code and how to plot the results in any interface of your choice by reproducing some of the results of runs that are presented on the webpages. You should make sure you can plot line graphs from data files produced by the code (e.g. with something like Maple, Mathematica, Java, IDL...)
- Run the code for three mass stars $M = 1M_{\odot}, 5M_{\odot}, 20M_{\odot}$ for a composition (Z) of your choice.
- Plot the evolutionary tracks on the HR diagram for each of the three stars after the main sequence [10 points]. Identify the various stages of the evolution according to the processes characterizing each stage (see examples from Demo 2). These should include where relevant (e.g. all for the $5M_{\odot}$: Hydrogen core burning (label with H_c), thick hydrogen burning shell burning, (label with H_{TS}) shell hydrogen burning (H_s), helium core burning (He), carbon burning (C), gravitational contraction phases, convective envelope extension/disappearance etc. [6 points] In a table, or on the HR diagram themselves indicate the elapsed time in years between the labeled points on the evolutionary tracks [6 points]. In order to do this you will have to look at various log files and in particular at the `burn.log` file produced.
- Describe in detail, in an accompanying write-up, the various stages of evolution of the stars by comparing them in the three models. For example:
 - (a) Plot and describe the luminosity and radius evolution for the three models [10 points], identify on these plots the points labeled on the respective HR diagrams. What are the most important burning processes in $M = 1M_{\odot}$ versus $5M_{\odot}$ stars [5 points]?
 - (b) Tabulate the values of the core mass to total mass in the three models upon leaving the main sequence [4 points]. What is the maximum core mass at the end of the main sequence in the three models [3 points]?
 - (c) For the $M = 1M_{\odot}$ and $5M_{\odot}$ stars plot the radius, density, temperature, luminosity and hydrogen abundance as a function of enclosed mass during the main sequence hydrogen burning phase. [6 points]
 - (d) What fraction of hydrogen is left in the core when the stars leave the main sequence [6 points]? Do stars leave the main sequence after burning much of their hydrogen [4 points]? You can read up some explanation for the existence of maximum core mass and briefly summarize it on your report [5 extra-credit points].

Total = 60 points

Project Assessment

- The project is worth 30% of the total grade.
- I am not interested in you getting 'the right answer', but you should show a good level of understanding of what is going on.
- Part I of the project is worth 10% of the total grade. You should show the ability to plot the relevant output files from the code and write up a discussion of your results in the form of a brief report which includes the plots and a description of the evolutionary stages of three stars (as described in Part I of the Guidelines). This is due Friday November 18th.
- Part II of the project is worth the remaining 20%. 15% of which is the actual work and write-up (Due Wednesday December 7th in class) and 5% is for a 20 minutes in class presentation you will give the last week of classes (Dec 5th and 7th).