MONASH University

School of Physics and Astronomy
ASP4000 – 2017
Due: before Class 18

ASP4000 Stars

Homework Set 5

Perform all calculations and provide results using cgs units or solar units where appropriate. Final results for long time scales may be converted to "yr".

1. **Studying Stellar Evolution with MESA**
   For each of the studies below,

   - plot central evolution in the $T_c - \rho_c$ plane and indicate central H ignition, central H depletion, central He ignition, and central He depletion;

     [10 each marks]

   - make a Hertzsprung Russell Diagram of the evolution starting at the Zero-Age Main Sequence (ZAMS). Indicate the same points as above;

     [10 each marks]

   - discuss the features of and differences in the tracks.

     [5 each marks]

   (a) **Compute a grid of stellar models from $6\,M_\odot$ to $24\,M_\odot$ in $2\,M_\odot$ steps, from hydrogen burning to end of central helium burning (follow evolution until $T_c = 5\times10^8\,K$ to be sure) for one of the metallicities below.**

   [25 total marks]

   (b) **Compute a grid of stellar models for an initial mass of one of the masses above, but varying initial metallicity, using $Z = 0$, 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}, 0.002, 0.005, 0.01, 0.02, and 0.04.**

   [25 total marks]

NOTES:

- There should be a total of 4 plots.
- H ignition may be defined as the point when 1 % of the initial hydrogen is burnt. You may also use that as ZAMS.
- Similar for He ignition - 1 % of the helium left after hydrogen depletion has been burnt.
- for depletion I take the point when the mass fraction has dropped to 1×10^{-4}.
- Some useful settings for MESA may be

```
! stop when the center mass fraction of he4 drops below this limit
  xa_central_lower_limit_species(1) = 'he4'
  xa_central_lower_limit(1) = 1d-10

! stopt before C ignintion
  log_center_temp_limit = 8.7

! frequent history output
  history_interval = 1
```