PHYS633 Introduction to Stellar Astrophysics Spring 2008

Homework 4: The theoretical Zero-Age Main Sequence (ZAMS)

Due in class on Monday, March 17th, 2008

1. Use EZ Web to calculate ZAMS stellar models with metallicity Z = 0.02 and masses M = 0.1, 0.25, 0.5, 1.0, 2.5, 5.0, 10.0, 25.0, 50.0 and 100 $M_\odot$. To obtain ZAMS models, you will need to set 'Maximum Model Number' to 0.

First check that $L = 4\pi\sigma R^2 T_{eff}^{\ 4}$, where L, R, and T_{eff} are from columns 4, 5, and 6 of the summary file respectively. The EZ star program uses the values $L_\odot$ = 3.844 10^{26} W, $R_\odot$ = 6.9598 10^8 m. The Stefan – Boltzmann constant, σ, is 5.6705 10^{-8} W m^{-2} K^{-4}.

From the resulting summary files, create plots of:

- log L vs. log M
- log R vs. log M
- log T_{eff} vs. log M

(with log M as the abscissa).

The plots should be printed on paper, and can be created using Excel or any other program of your choice. Ensure that the axes are well labeled.

2. Find the best-fit straight line to the data in each of the plots. Based on the fit, estimate the parameters ξ and η in the mass-radius and mass-luminosity relations given by equation (22.1) of Kippenhahn & Weigert. What do these values tell you about the variation in radius and luminosity along the ZAMS?

3. Assume that all stellar models convert the same fraction of their total mass into energy during their lifetimes. Knowing that the Sun (with M = 1 $M_\odot$) is expected to have a lifetime of 10 billion years, estimate the lifetimes of the other models. (Assume L remains constant for each star).

Which stars live the longest, and which the shortest – and why?