Stars and Stellar Evolution (WS11-12)
Computer Practicum with WTTS

Exercise 2 (25/11/11)

NOTE: Please save your plots (using the PNG plotting option, "Save As") in your email (use a free terminal), answer the exercises using them and send your answers to sutirtha@astro.uni-bonn.de (maybe over the weekend!). Mention your folder name (e.g.SSE_WTTS#) in the subject (discuss and work with your group mate(s)).

4. Using the $1\,\mathrm{M}_\odot$ ($Z = 0.02$) model from last class, answer the following:

1. Using the Structure tab, plot the radius of your star as a function of time.
   a) When does the star pass through the current solar radius?
   b) Based on (a), how would you rate this as an appropriate model of the Sun?
   c) Can you think of any effect that could improve this? OPTIONAL:try adjusting the convection parameter CALP in the mixing tab (under options).
2. Select Central Abundances of C, N, and O and plot them (might want to use logY axis) as a function of time. Try to answer the following (you might want to refer to the familiar nuclear chain in Figure 1):
   a) What are the initial abundances of C, N and O? What is their sum i.e. $C+N+O$?
   b) Why does the carbon abundance drop quickly at early times (you might want to chose log x axis to see this) ?
   c) What does the carbon turn into and which burning cycle is involved? What is the main product of this burning cycle?
   d) What happens to the oxygen abundance after $6\mathrm{Gyr}$? Why does it not happen earlier? Hint: recall reaction cross-sections and the Gamow peak
   e) What does the oxygen turn into and which burning cycle is involved? What is the main product of this burning cycle?
   f) What is the sum $C + N + O =$ at $t = 0, 5, 10\mathrm{Gyr}$? Why is this sum (almost) a constant? Why is it not (quite) constant?

5.Evolve a high mass model $\mathrm{M} = 15\,\mathrm{M}_\odot$(create a subdirectory named 15Msun within your SSE_WTTS directory) and answer the following:

1. Trace time evolution of the central temperature and central abundances of the different products of nuclear burning (chose appropriate scales for your plots).
2. Plot log central density vs log central temperature .

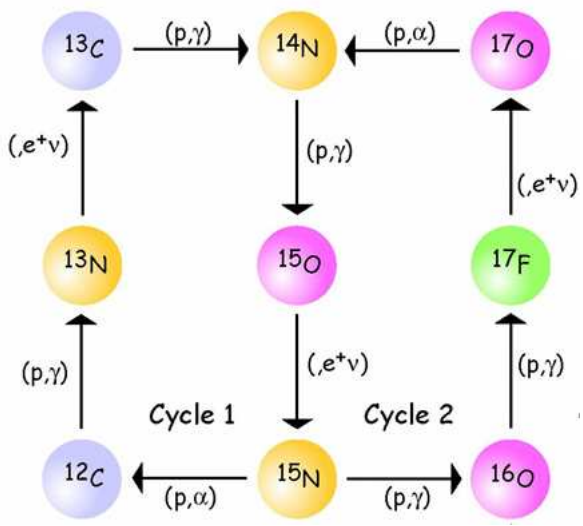

Figure 1: The CNO cycle

a) Can you identify the onset of various burning stages in the course of evolution of such a star (using your previous results)?

b) What are the central temperatures corresponding to these nuclear burning episodes?

3. Compare this with the $1\,\mathrm{M}_{\odot}$ model. What are the timescales for nuclear burning in each case?