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

Exercise 7 (20/01/12)

NOTE: Check out the exciting new features added to WTTS (**/vol/software/software/astro/wtts/wtts**) over Christmas (e.g. the gnuplot options can now be changed as you like just by right clicking into the Gnuplot options!) if you are coming to class first time this year!

13. **Use** a high mass model (maybe the $20\,M_\odot$ model from last class) to answer the following:

1. Using the **Internals tab**, select an appropriate model to find out how much mass needs to be stripped off the envelope to get a WNL star (recall lecture notes or turn the page for now!).
2. How would your answer change in order to get a WNE/WC star from your selected model?
3. What would be your answers to 1 & 2 using the Latest model?

14. Evolve a $40\,M_\odot$ star stripping mass off its envelope (can do this by going to "**Mass Loss and Gain**" in the **Options tab** and set **INIT_DAT.CMI=-7.5E-06** or maybe higher...might CRASH!).

1. Plot and save the HRD. Can you trace the evolutionary phases?
2. Comment on the effect of mass loss on the position in the HRD (might compare it with a normal star).

Wolf-Rayet(WR) Stars

The spectra of WR stars reveal increased CNO abundances, indicating that they are the exposed H- or He-burning cores of massive stars. On the basis of the surface abundances they are classified into several subtypes:

1. **WNL** stars have hydrogen present on their surfaces (with $X(H) < 0.4$) and increased He and N abundances, consistent with equilibrium values from the CNO-cycle
2. **WNE** stars are similar to WNL stars in terms of their He and N abundances, but they lack hydrogen ($X(H) = 0$)
3. **WC** stars have no hydrogen, little or no N, and increased He, C and O abundances (consistent with partial He-burning)
4. **WO** stars are similar to WC stars with strongly increased O abundances (as expected for nearly complete He burning)

This apparently represents an evolutionary sequence of exposure of deeper and deeper layers, as a massive star is peeled off to a larger and larger extent by mass loss.