CREATE ZAHB

This test is to show the evolution of a few different mass pre-ZAHB stars into ZAHB stars. A list of masses (`masses_filename = 'zahb_masses.list'`) is read in, and for each mass, `MESA` takes a pre-saved model named `pre_zahb.mod` and relaxes its mass and evolves it until the mass fraction for center helium drops below the `HB_limit`, which, is set in `inlist_create_zahb` to 0.9.

In addition to the `HB_limit`, the inlist contains a few other important controls. These include some mixing controls (`mixing_length_alpha = 1.9 ; use_Henyey_MLT = .true.`), atmosphere option (`which_atm_option = 'photosphere_tables'`), and some opacity controls.

The file (`zahb_masses.list`) contains three masses: $0.49M_\odot$, $0.70M_\odot$, and $1.2M_\odot$. Each one is run consecutively in the order listed, and all the log files from each run are stored in the same `LOGS/` directory. To differentiate the log files from each run, they are named with prefixes, such as `i001_history.data` and `i001_log1.data` for the first run, `i002_history.data` and `i002_log1.data` for the second run, etc.

Since all these models derive from the same `pre_zahb.mod`, they all have very similar cores. The plot below, which shows the evolution of the center temperature and density (figure 1), is nearly identical for each run.

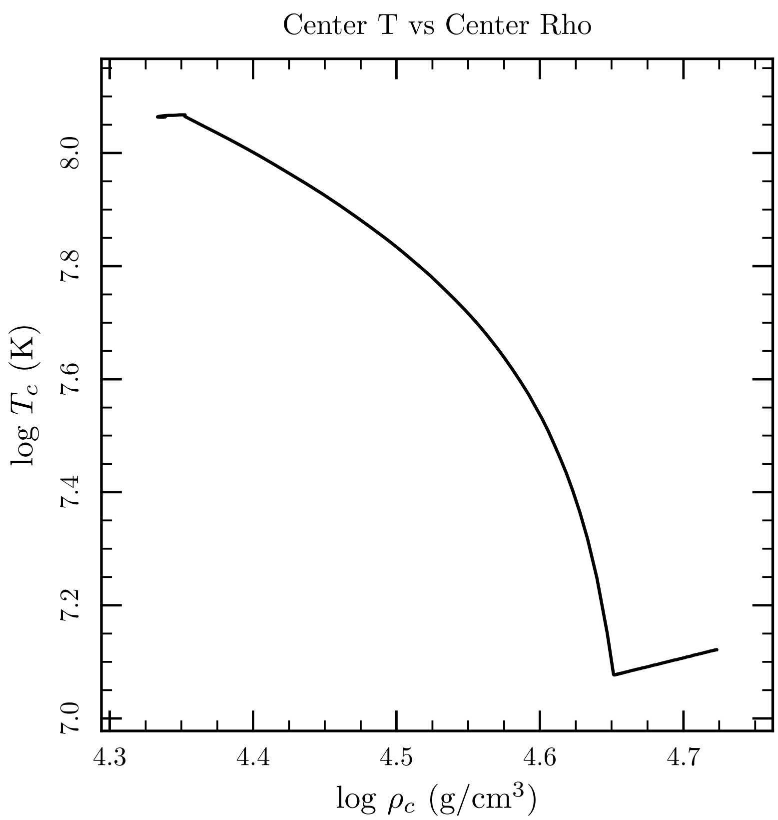

Figure 1: Evolution of center temperature and density, same for all runs

The important difference between these models is the size of the envelope. Below are abundance and burning rate profiles from the end of each run. First is the $0.49M_{\odot}$ model (figures 2 and 3).

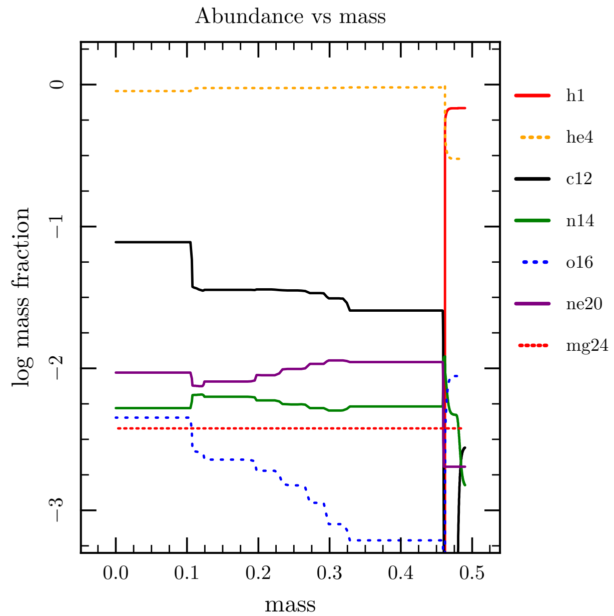

Figure 2: $0.49M_{\odot}$ Abundance profile from end of run

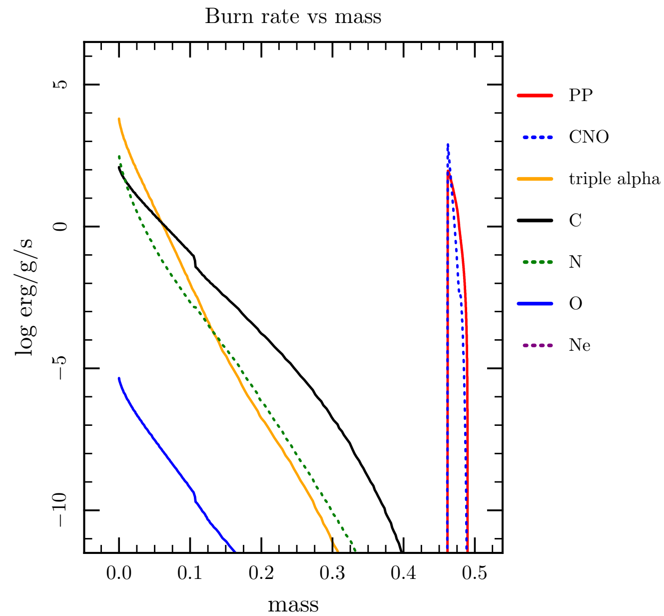

Figure 3: $0.49M_{\odot}$ burning rate profile from end of run

Next is the $0.70M_{\odot}$ model (figures 4and 5).

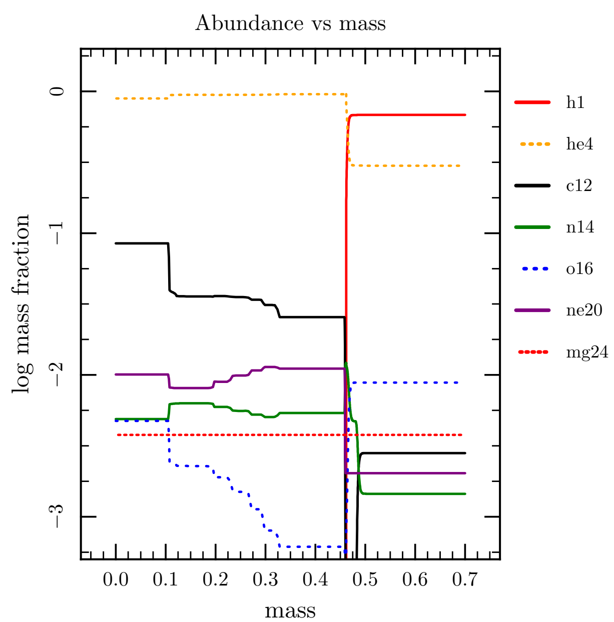

Figure 4: $0.70M_{\odot}$ Abundance profile from end of run

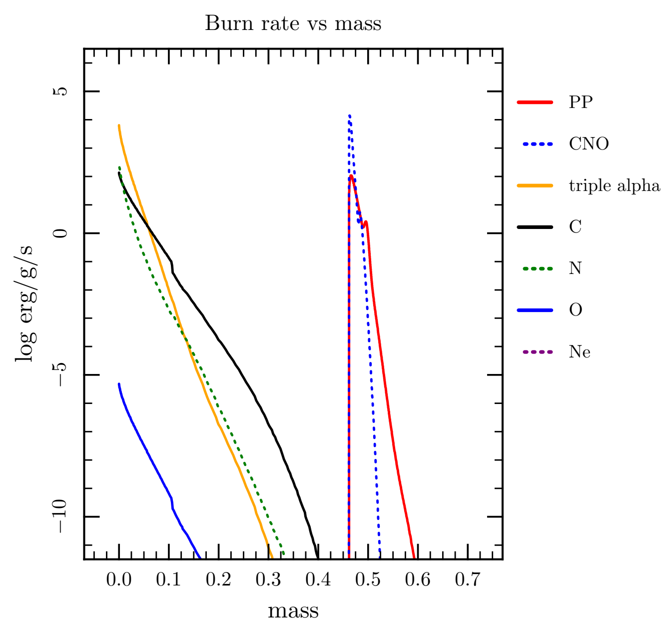

Figure 5: $0.70M_{\odot}$ burning rate profile from end of run

Finally, the $1.2M_{\odot}$ model (figures 6and 7).

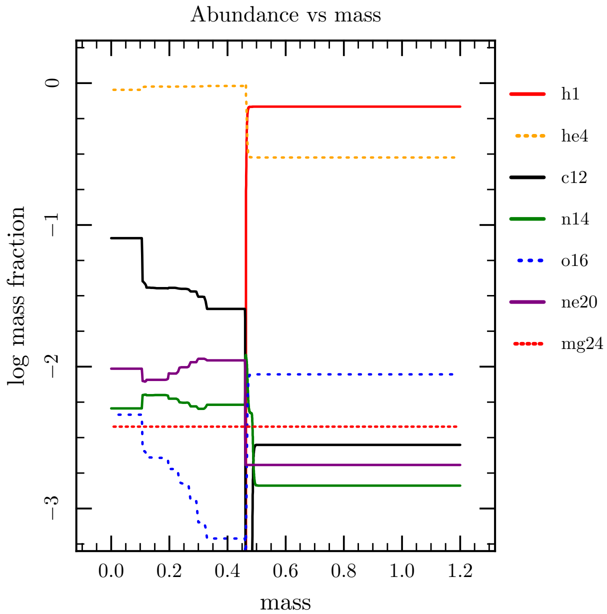

Figure 6: $1.2M_{\odot}$ Abundance profile from end of run

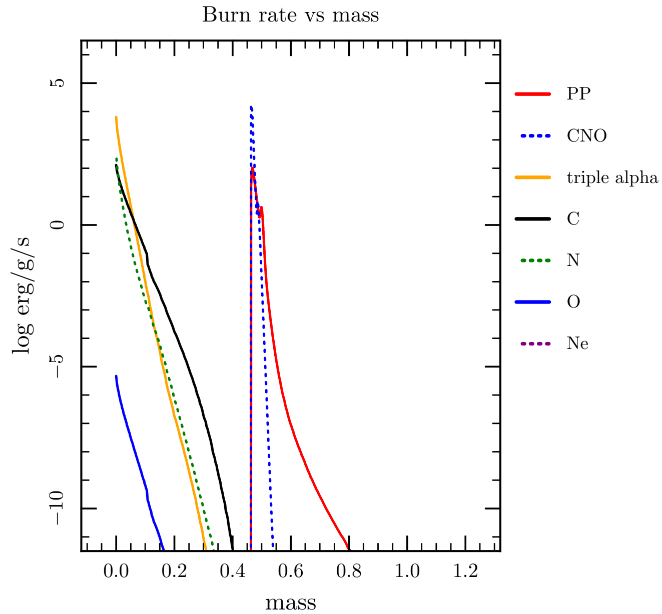

Figure 7: $1.2M_{\odot}$ burning rate profile from end of run

Since all the models have very similar cores, and the ending condition (`HB_limit`) depends on the core, the models have similar evolution times, about 5 Myr. Therefore, we can construct an isochrone on the HR-diagram. The isochrone below (figure 8) was constructed from running the test case with `zahb_masses.list_big`, instead of `zahb_masses.list`, which has 18 masses, but with the same range ($0.49M_{\odot}$ to $1.2M_{\odot}$), and plotting the ending luminosity and effective temperature from each model.

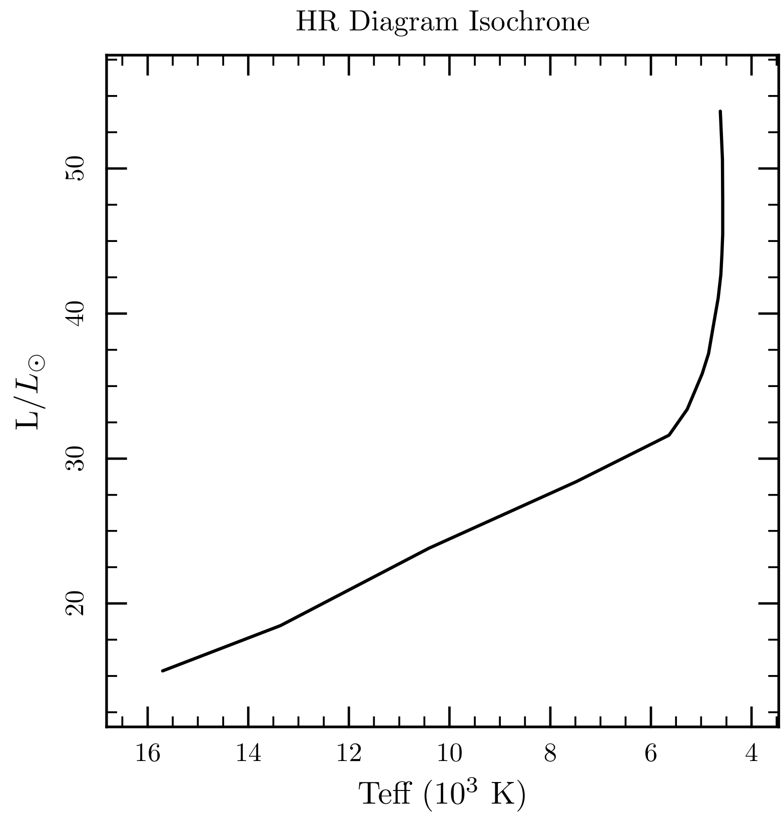

Figure 8: Isochrone of ZAHB stars from $0.49M_{\odot}$ to $1.2M_{\odot}$