WD O Ne IGNITE

This test is to show an oxygen-neon white dwarf undergoing ignition of its core elements as it nears the Chandrasekhar mass limit. Therefore, the test should be cut off when the center temperature reaches 10^9 K (`log_center_temp_limit = 9.0`).

There are four separate inlists for this test case, each with a separate purpose, which are run sequentially. The first inlist, inlist_wd_1, loads a saved white dwarf model, `1.316_from_8.5_z2m2.mod`, and removes the small remaining helium envelope through a negative accretion rate (`mass_change = -1d-7`) until surface helium drops below a mass fraction of 10^{-8} (`xa_surface_lower_limit(1) = 1d-8`). Then it saves a model to be loaded by the second inlist, inlist_wd_2, which turns off accretion and allows the star to cool until the center temperature drops below 5×10^7 K (`log_center_temp_lower_limit = 7.7`). Then it saves a model to be loaded by the third inlist, inlist_wd_3, which turns on accretion of pure carbon at a rapid rate of 10^{-6} $M_{\odot}$/yr (`mass_change = 1d-6`) until the mass reaches 1.34 $M_{\odot}$ (`star_mass_max_limit = 1.34`). Then it saves a model to be loaded by the final inlist, inlist_wd_4, which lowers the spatial resolution (`mesh_delta_coeff` from 0.5 to 1.5) and continues accretion at the same rate until the center temperature reaches 10^9 (`log_center_temp_limit = 9.0`). All of the following plots use data generated by the last inlist.

The profile to the left (figure 1) shows the abundance of elements in the star at the start of inlist_wd_4 plotted against logxq where logxq = log(1-q) and q is the fraction of star mass interior to outer boundary of each zone, moving outward from the core. The HR-diagram to the right (figure 2) shows the smooth increase in effective temperature and luminosity from gravitational potential energy release from accreting carbon, followed by a disruption in those smooth trends caused by ignition of the core. (Note: The Ne20 shown here actually represents Ne22, this is because `MESA` is using a simplified nuclear reaction network.)

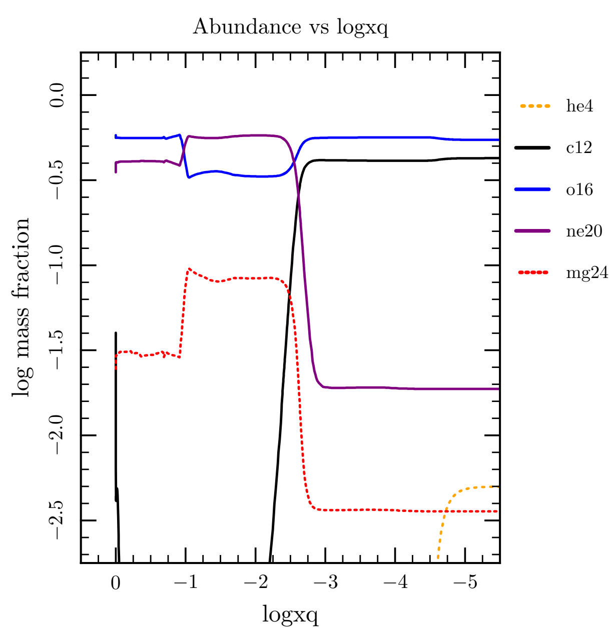

Figure 1: Abundance profile shows oxygen and neon core with a thin carbon outer shell

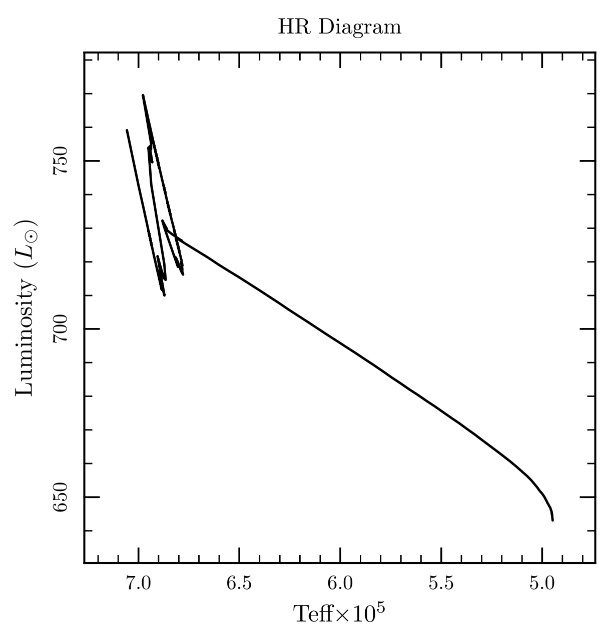

Figure 2: H.R. Diagram shows smooth increases in effective temperature and luminosity, disrupted when core burning starts

To see this disruption more clearly, effective temperature (figure 3) and luminosity (figure 4) are plotted against log(years before end of run).

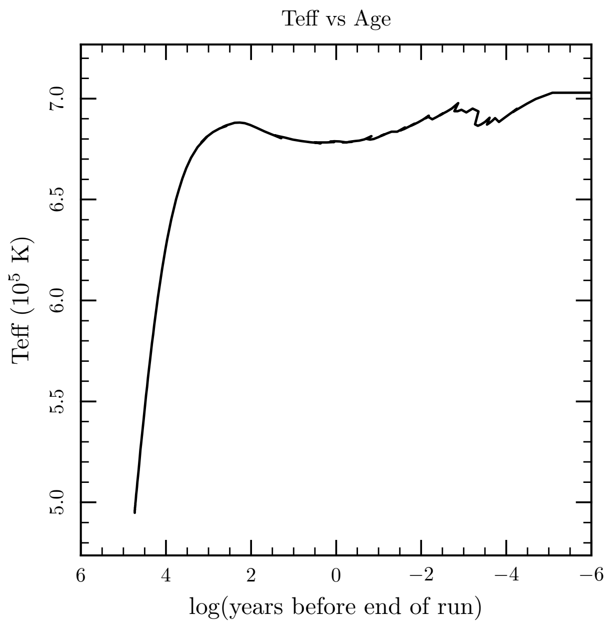

Figure 3: Close-up of disruption of effective temperature from core ignition

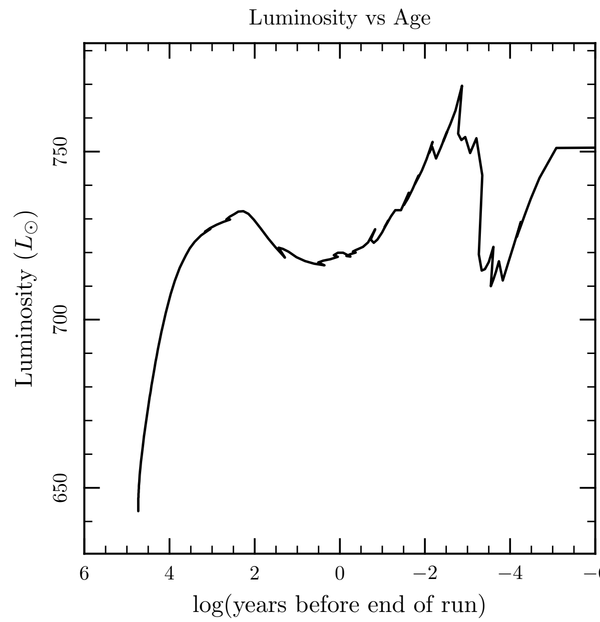

Figure 4: Close-up of disruption of luminosity from core ignition

This next profile (figure 5) shows the burning rates right at the end of the run. The elements that are releasing the most energy from nuclear burning are oxygen, neon, and sodium. The elements such as sodium, nitrogen, and silicon have neglible abundances in the star, but relatively high burning rates because they are being consumed as soon as they are produced. The profile to the right figure 6) shows temperature vs. density at three different ages, revealing a steep rise in temperature at the core during ignition.

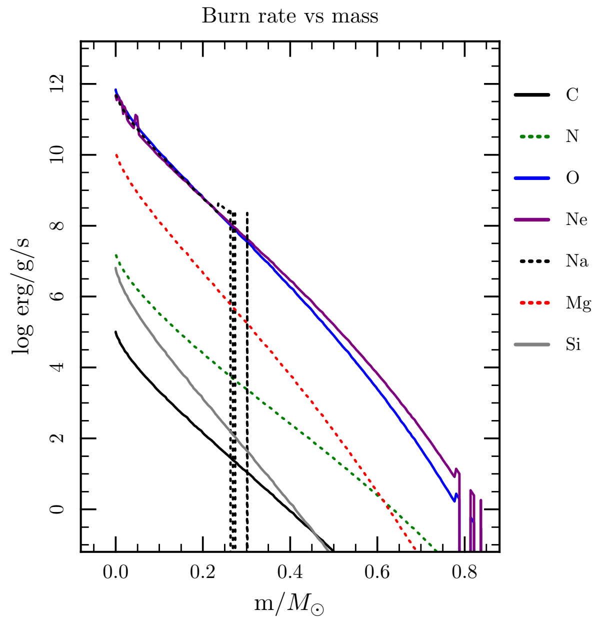

Figure 5: Burning rate profile from end of run

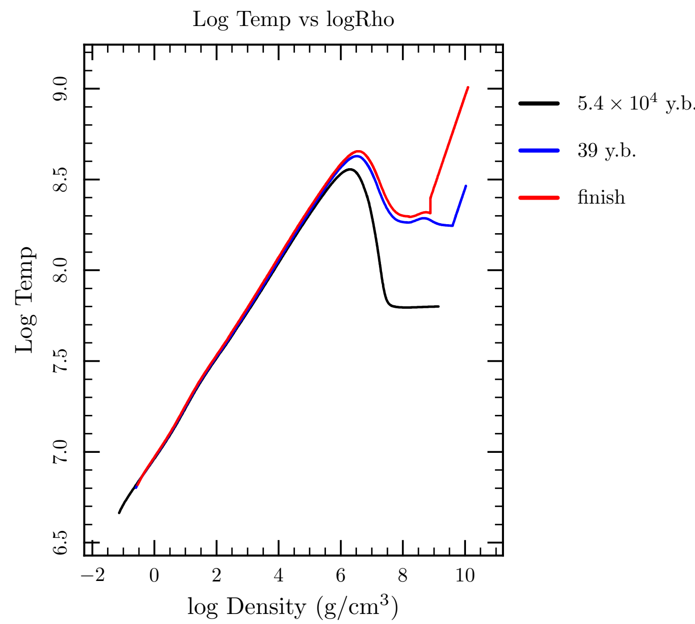

Figure 6: Temperature vs Density profile shows steep temperature increase in core, y.b. = years before finish)

This final plot (figure 7) shows a few internal `MESA` variables, such as the size of the time-step, the number of zones, and the number of retries against the model number in order to give some understanding of how hard `MESA` is working throughout the run and where some areas of problems/interest might be.

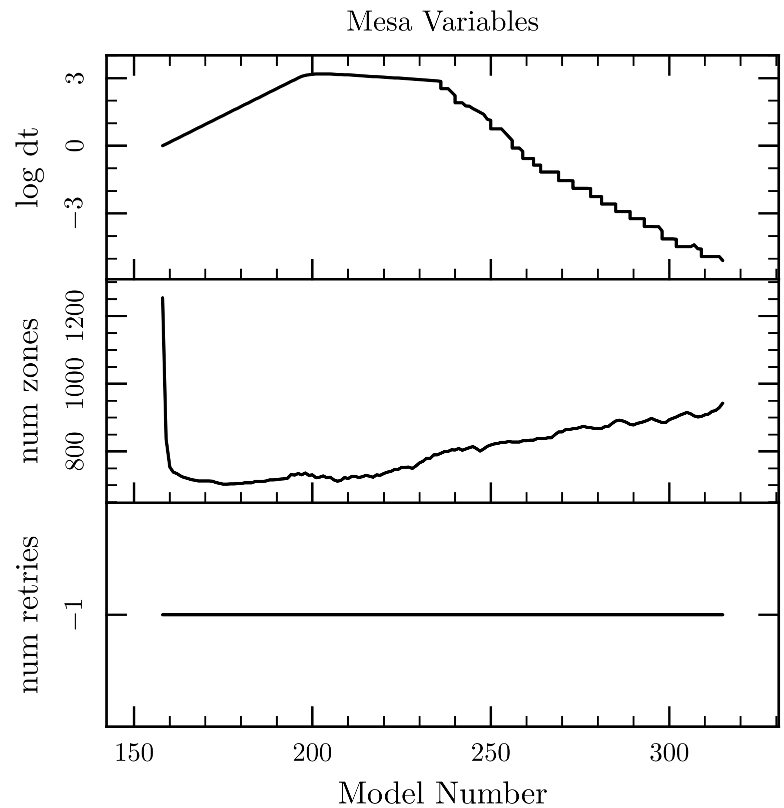

Figure 7: `MESA` variables plotted against model number show how hard `MESA` is working