NS He

This test is to show a 1.4 $M_\odot$ neutron star undergoing a thermonuclear instability. To check if this test ran successfully, `MESA` checks that the power released from helium burning reaches $10^8 L_\odot$ and then drops below $10^7 L_\odot$. If it has done this, the terminal output at the end of the run should read ``` ``gone through peak He burn and beyond'' ```.

Note: `MESA` is not computing the core of the neutron star, consider the "core" of the model the bottom of the envelope.

This test case creates the envelope of a neutron star, and accretes pure ^{4}He at a rate of $3\times10^{-9} M_\odot$/yr (`mass_change = 3d-9`). The neutron star accretes for just over 2 days before ignition, as shown by the luminosity plot to the left (figure 1). The plot to the right shows the mass of helium throughout the run (figure 2). This shows that helium mass increased through accretion until ignition of the envelope, and that over half the helium present right before burning is used up by the time power released from helium burning drops below $10^7 L_\odot$.

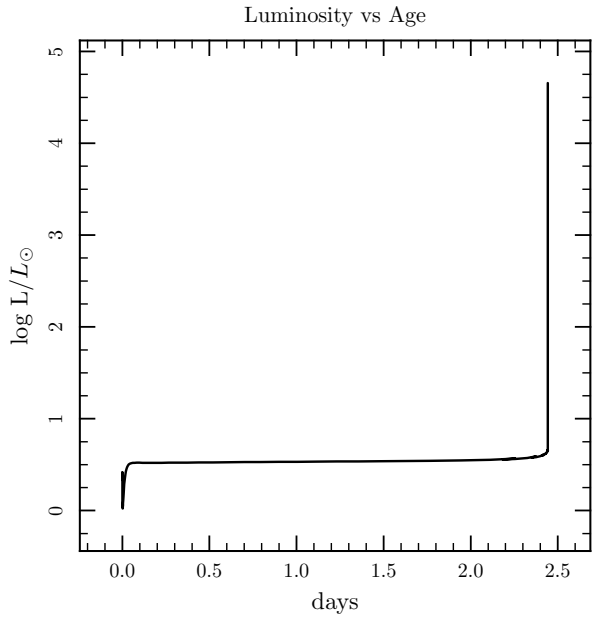

Figure 1: Luminosity plot shows burst period

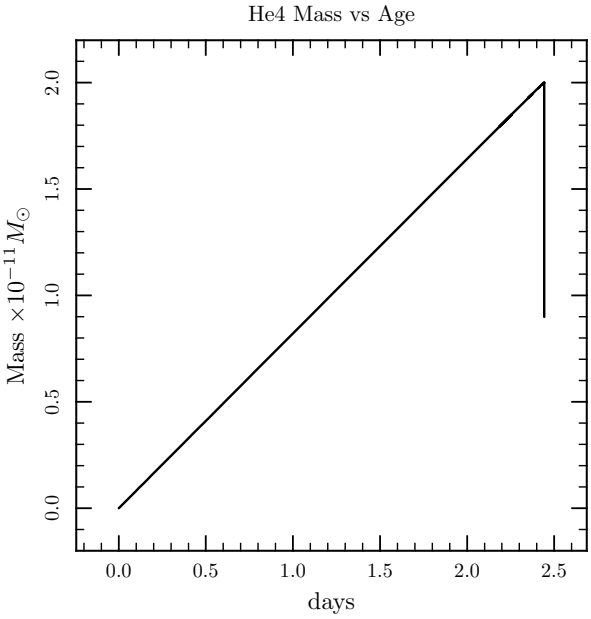

Figure 2: Helium mass plot show increase from accretion and drop from burning

The envelope of this neutron star is initially composed of ^{56}Fe. After helium is added and burned into heavier elements, the abundance profile (figure 3) shows a more diverse envelope. This abundance profile plots the log of the mass fraction against logP.

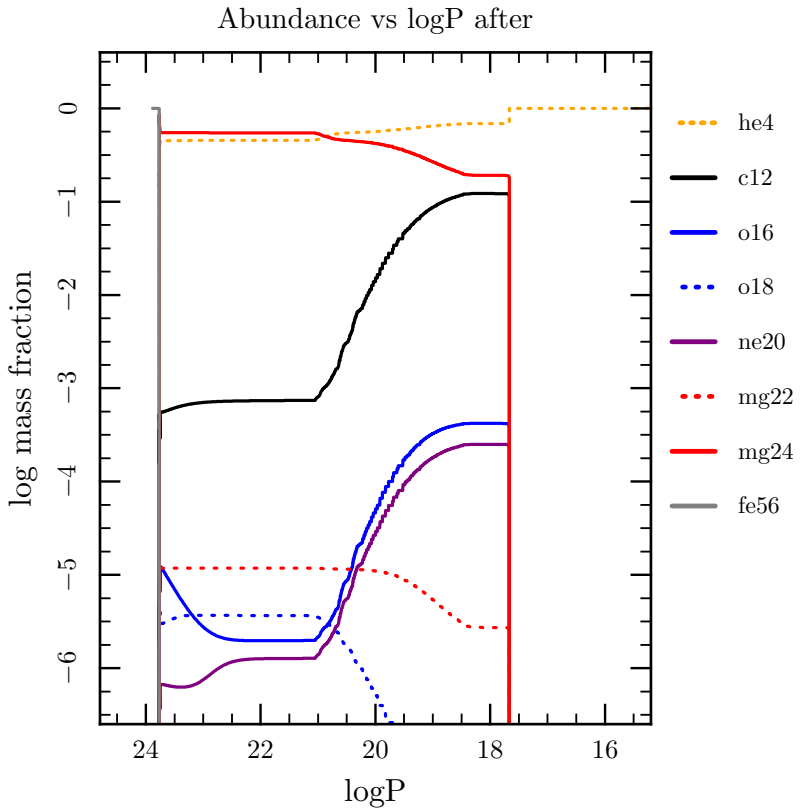

Figure 3: Abundance profile showing that the envelope is mainly carbon

The burning rate profile to the left (figure 4), taken at peak burning, is dominated by neon burning, followed by carbon and oxygen burning. Those top three burning rates are themselves dominated by alpha captures. The profile to the right (figure 5) gives temperature vs density at the beginning, end, and at the peak of nuclear burning. This shows the heat generated from burning at the bottom of the envelope moving out towards the surface.

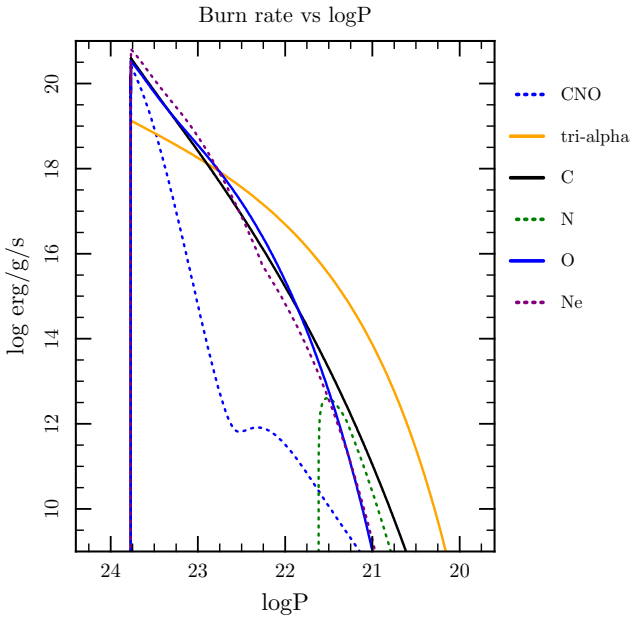

Figure 4: Burning rate profile at peak burning

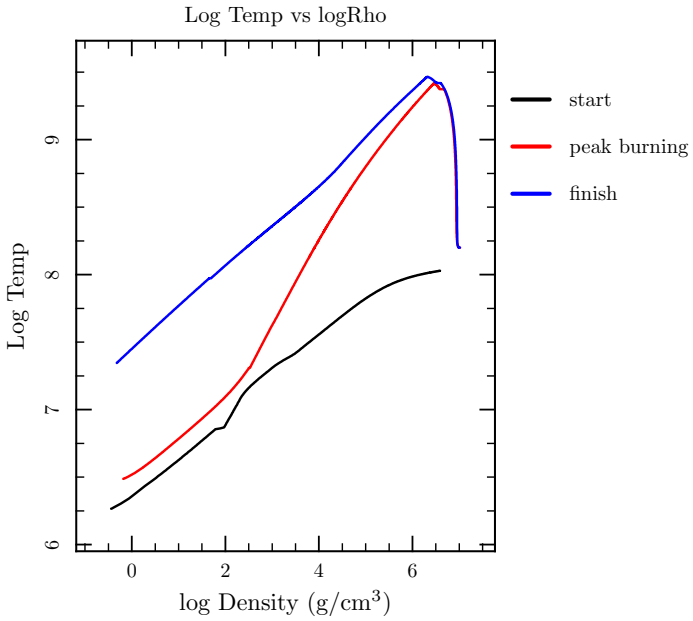

Figure 5: Temp vs Density profile at beginning, end, and peak burning

This final plot (figure 6) 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.

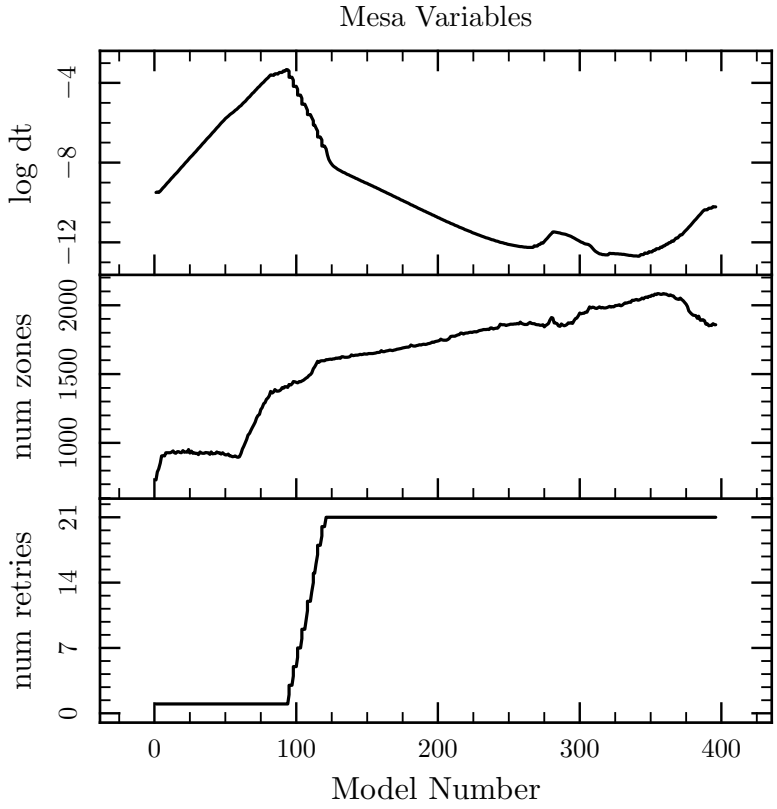

Figure 6: MESA variables plotted against model number show how hard MESA is working