

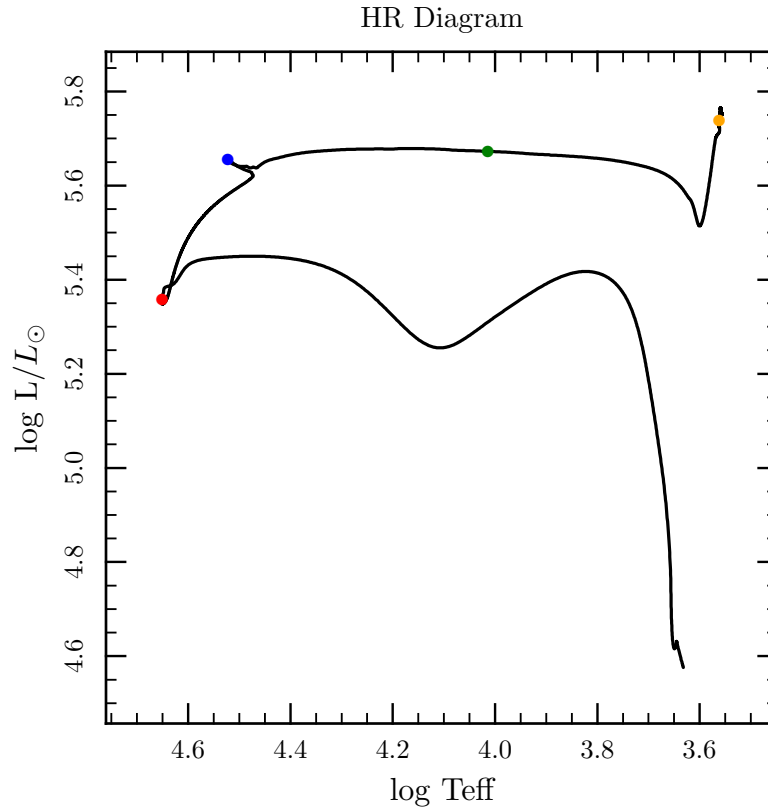
## MAKE MASSIVE FOR O BURN

This test is to show a  $40 M_{\odot}$  pre-main sequence star evolved to the Asymptotic Giant Branch. Therefore, this test should be cut off when the mass fraction for center neon drops below  $10^{-4}$  (`xa_central_lower_limit_species(1) = 'ne20' ; xa_central_lower_limit(1) = 1d-4`).

The inlist sets the following nuclear reaction rate controls:

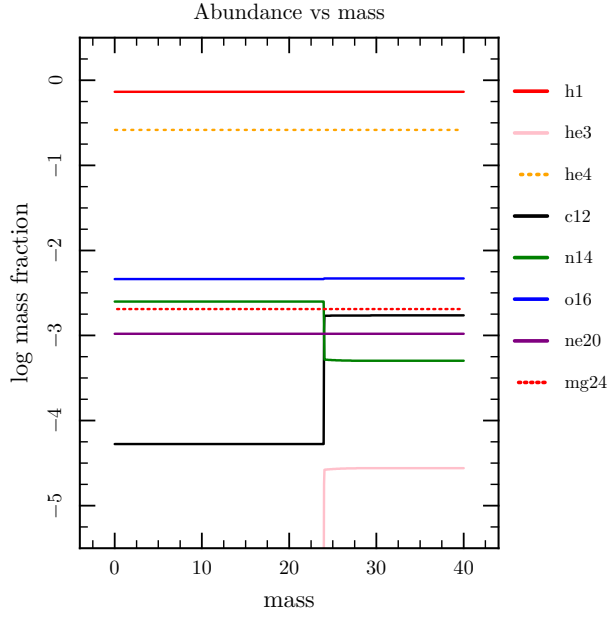
- `set_rate_c12ag = 'Buchmann'`
- `num_special_rate_factors = 1`
- `reaction_for_special_factor(:) = 'r_c12_ag_o16'`
- `special_rate_factor(1) = 1.1`
- `rate_factor_for_fe56ec_to_cr56 = 1d-4`

The HR-diagram below shows the evolution through the whole run (figure 1), with some important transitions marked by the colored dots. The red dot marks the start of the main sequence. The blue dot marks the end of hydrogen burning in the core. The green dot marks the start of helium burning in the core. The orange dot marks the end of helium burning in the core. After the orange dot, helium and hydrogen burning continue in hot shells around the core.

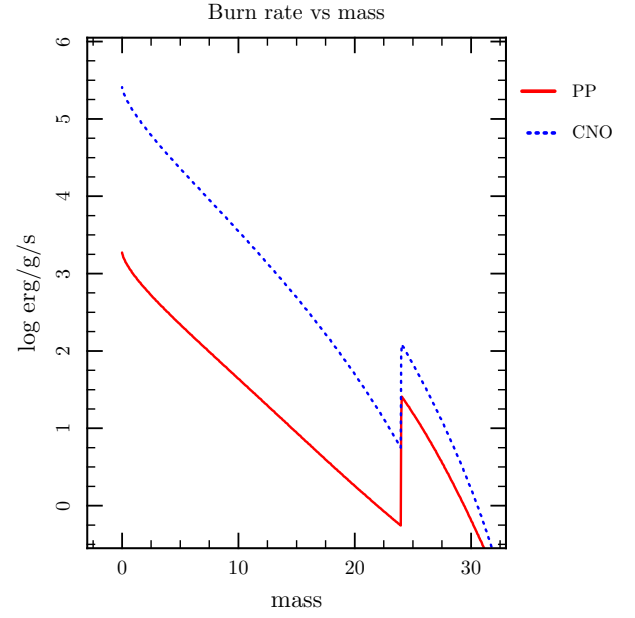


**Figure 1:** Red: start of pre ms, Blue: end of H burning in core, Green: start of He burning in core, Orange: end of He burning in core

Below are an abundance profile (figure 2) and a burning rate profile (figure 3) from the start of the main sequence (red dot on HR-diagram, figure 1)

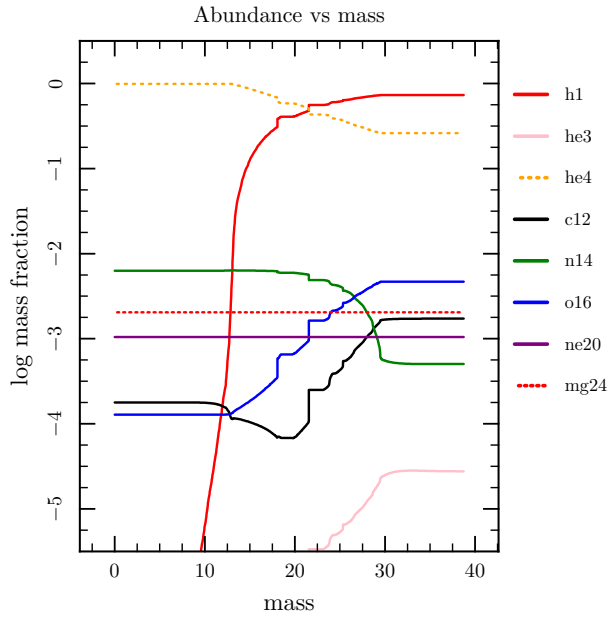


**Figure 2:** Abundance profile at red dot

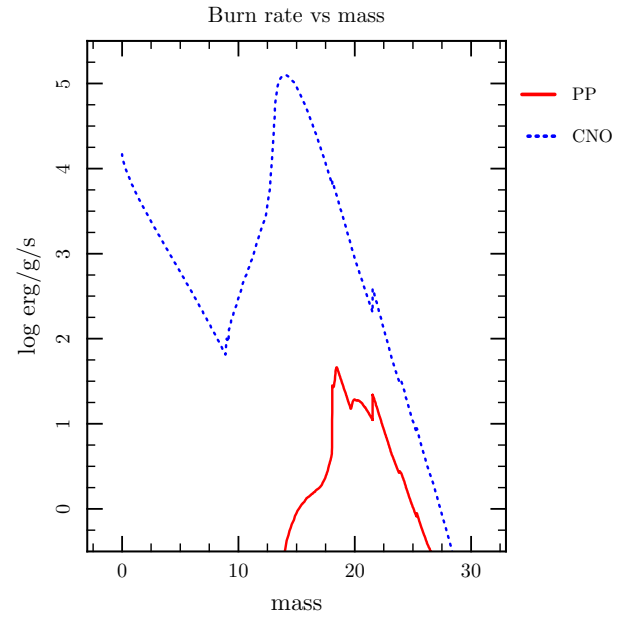


**Figure 3:** Burning rate profile at red dot

Below are an abundance profile (figure 4) and a burning rate profile (figure 5) from the end of hydrogen burning in the core (blue dot on HR-diagram, figure 1)

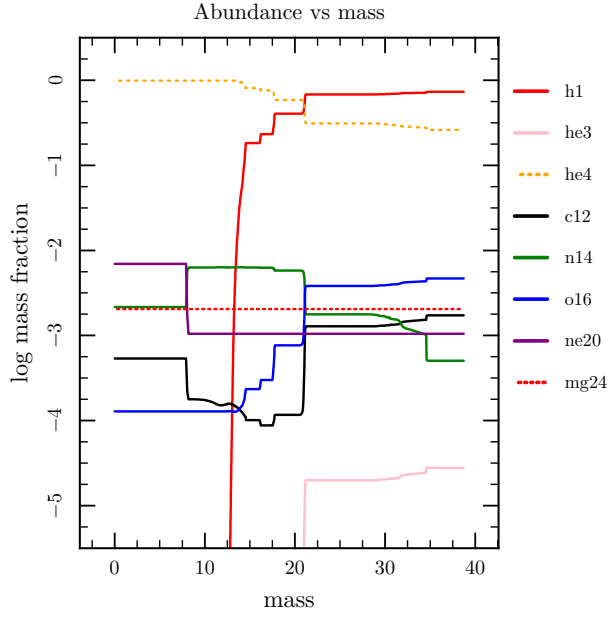


**Figure 4:** Abundance profile at blue dot

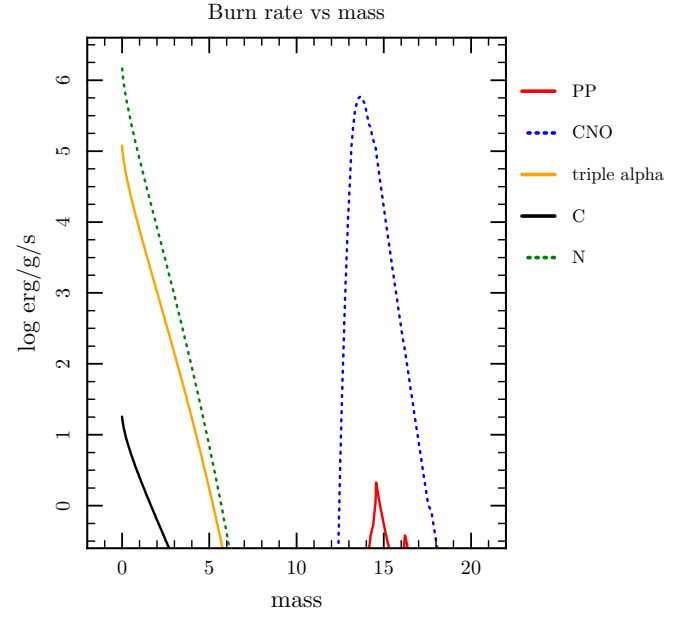


**Figure 5:** Burning rate profile at blue dot

Below are an abundance profile (figure 6) and a burning rate profile (figure 7) from the start of helium burning in the core (green dot on HR-diagram, figure 1)

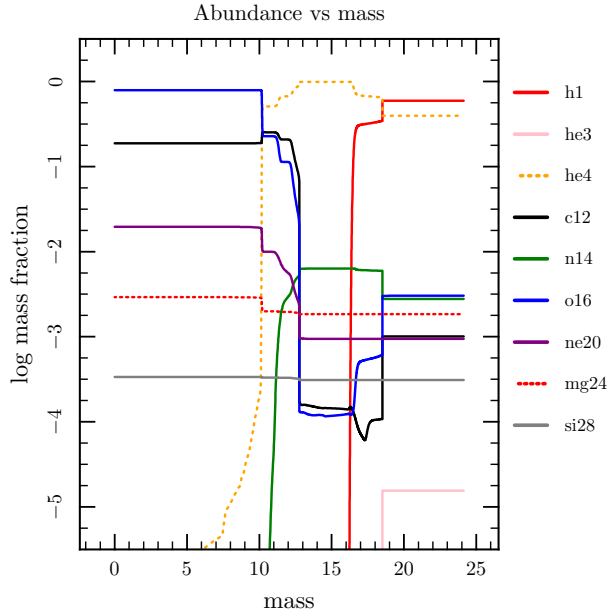


**Figure 6:** Abundance profile at green dot

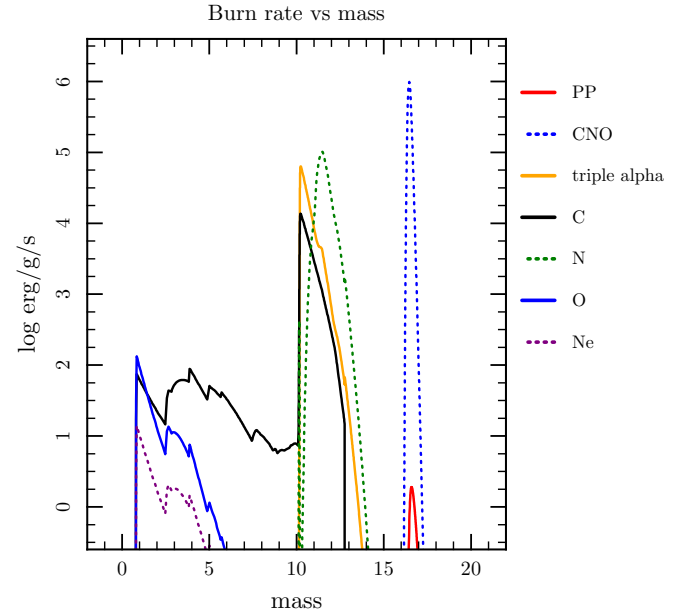


**Figure 7:** Burning rate profile at green dot

Below are an abundance profile (figure 8) and a burning rate profile (figure 9) from the end of helium burning in the core (orange dot on HR-diagram, figure 1).

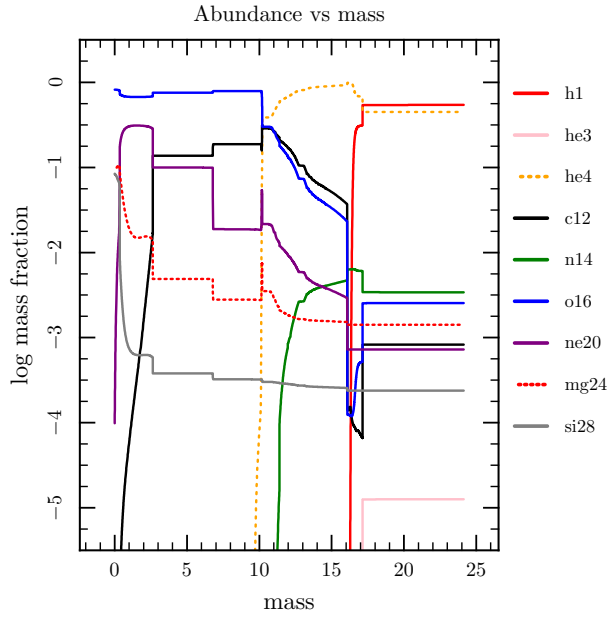


**Figure 8:** Abundance profile at orange dot

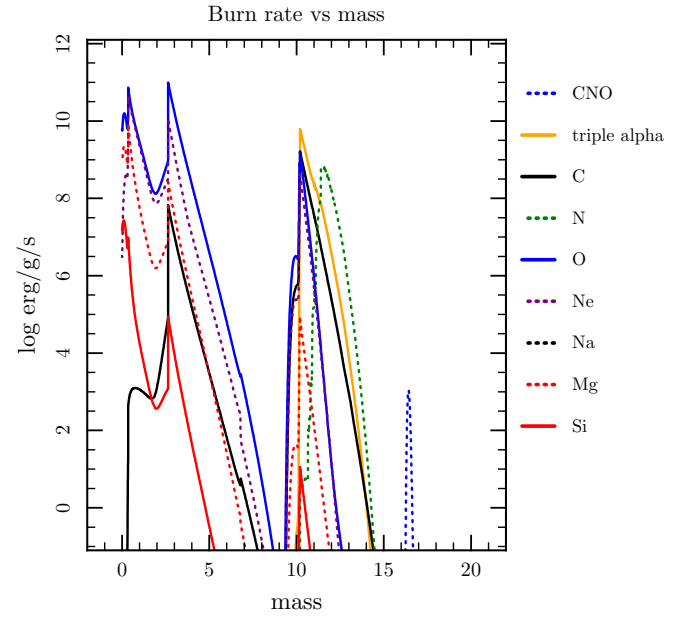


**Figure 9:** Burning rate profile at orange dot

Below are an abundance profile (figure 8) and a burning rate profile (figure 9) from the end of the run.

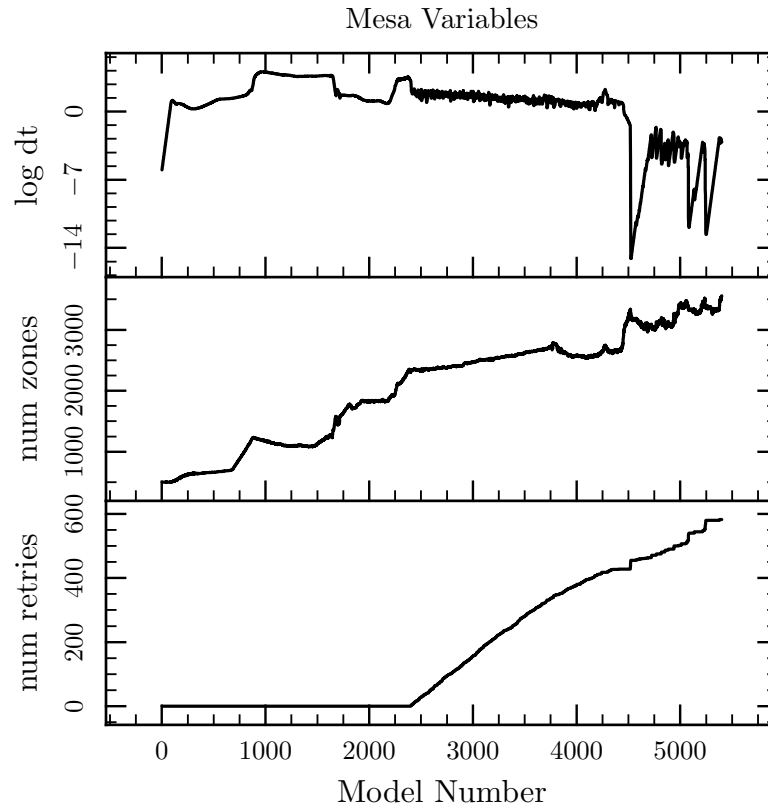


**Figure 10:** Abundance profile from end of run



**Figure 11:** Burning rate profile from end of run

This final plot (figure 12) 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 12:** MESA variables plotted against model number show how hard MESA is working