SOLAR CALIBRATION

This test is to show how MESA can search a parameter space to find a model that matches solar observations. It loads a pre-main sequence model and evolves it until it reaches an age of 4.57 Gyr (`max_age = 4.57d9`).

The inlist sets the following nuclear reaction and opacity controls in the `&star_job` section:

- `change_net = .true.`
- `new_net_name = 'pp_and_cno_extras.net'`
- `set_rate_c12ag = 'Kunz'`
- `set_rate_n14pg = 'Imbriani'`
- `kappa_file_prefix = 'OP'`
- `kappa_lowT_prefix = 'lowT_fa05_gs98'`

The `&controls` section contains many other controls, including a maximum timestep (`max_years_for_timestep = 1d7`), and some diffusion controls (see documentation for `1.5M_with_diffusion` for discussion of diffusion controls).

When the maximum age is reached, MESA checks some values against their target values (listed in `inlist_calibration_controls`) and does a χ^2 test. For this test case, this is where the computation stops. If we had chosen a `search_type` in `inlist_calibration_controls` other than `'use_first_values'` a new set of starting parameters would be chosen in the ranges specified (by the user in `inlist_calibration_controls`) according to the selected algorithm, and evolution would be started all over again with the same controls as before. This cycle will continue searching the given parameter space and generating a χ^2 value for each set of starting parameters until the algorithm has narrowed the parameter space sufficiently and the χ^2 values have stopped getting smaller. After that it will print out a results file with χ^2 values and starting and ending parameter values for each run. This process allows users to search for a model that matches solar observations.

The HR-diagram below (figure 1) shows the model from the pre-main sequence to the middle of the main sequence.

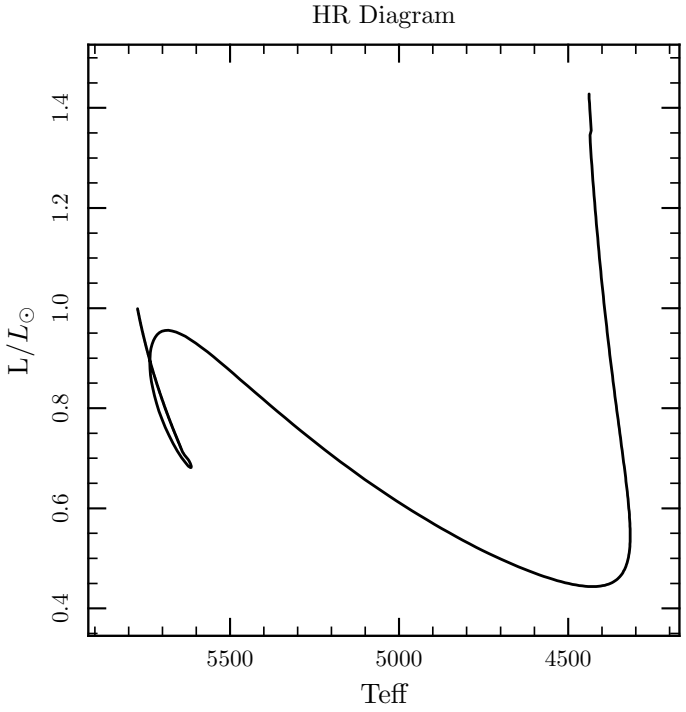

Figure 1

The profiles below show the abundances (figure 2) and burning rates (figure 2) from the end of the run.

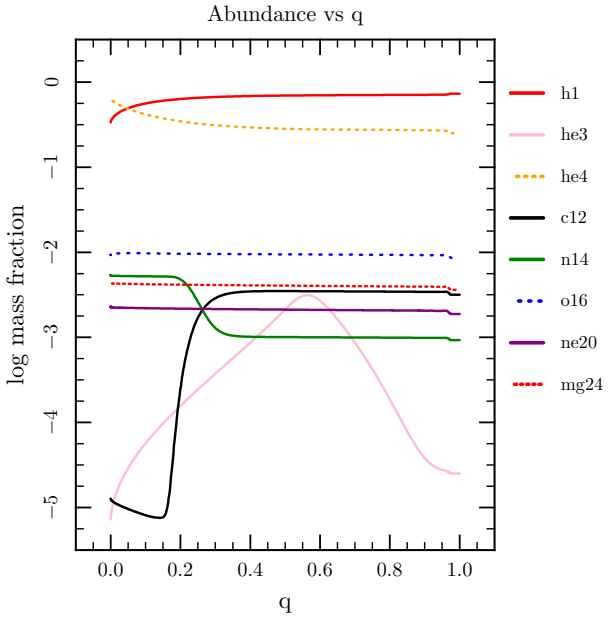

Figure 2

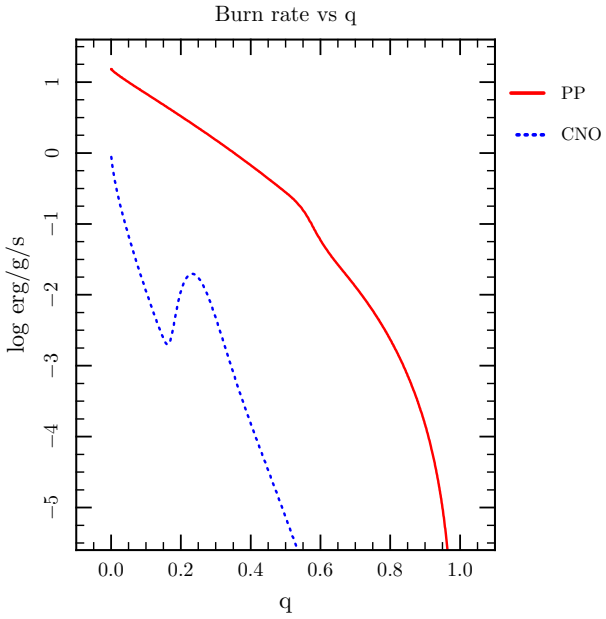

Figure 3

To the left is a plot of the evolution of the radius of the star (figure 3). The plot to the right shows the evolution of the center temperature and density (figure 4).

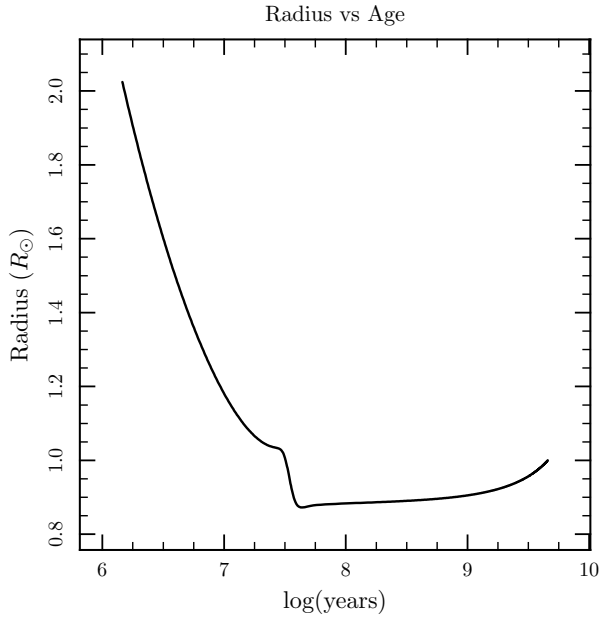

Figure 4

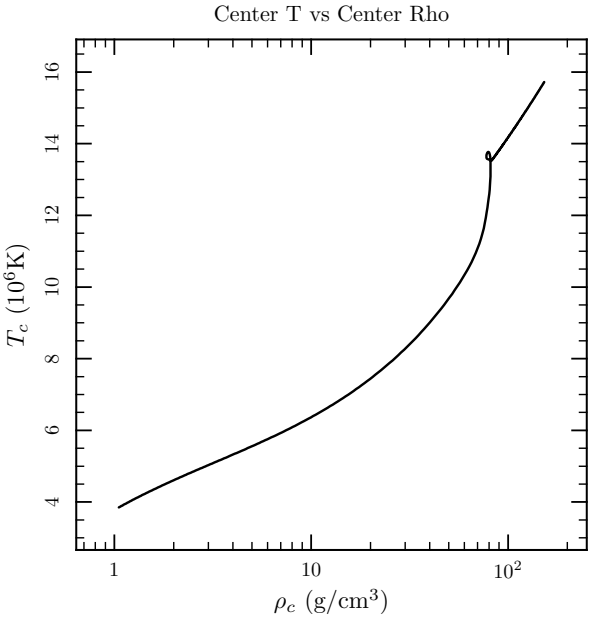

Figure 5

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.

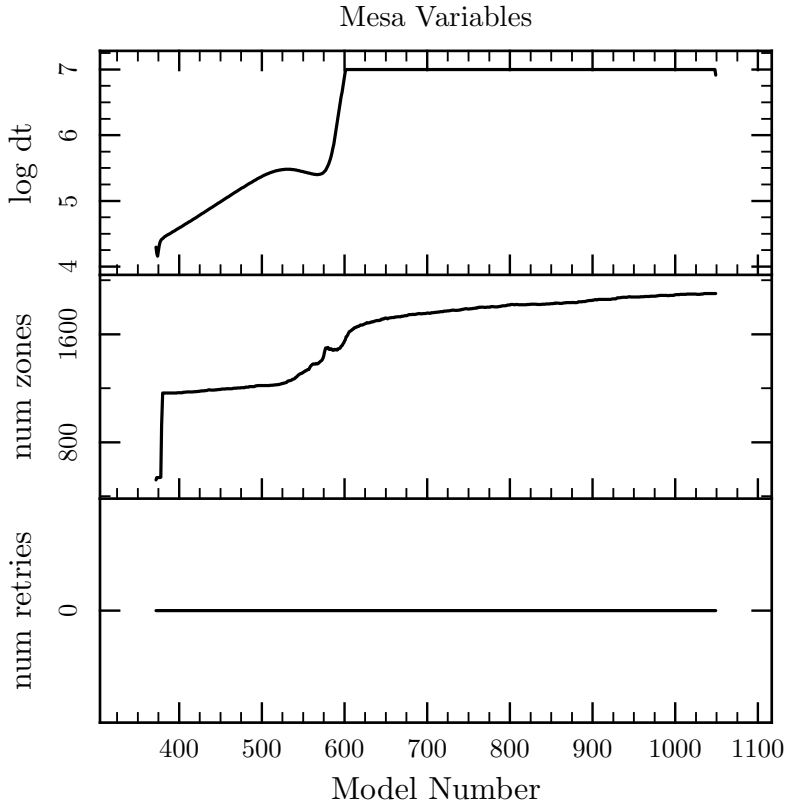

Figure 6: MESA variables plotted against model number show how hard MESA is working