MAKE INERT CORE

This test is to show how to create a planet with an inert core in `MESA`. There are twelve inlists that are run consecutively, and if they have run successfully, the terminal output at the end of the run should read ‘‘`finished all inlists for make_inert_core`’’.

inlist_rc1: This first inlist loads a pre-saved 0.003 $M_\odot$ model and removes the desired mass of the core (e.g., if want rocky core = 10 $M_{Earth} = 3 \times 10^{-5}$ $M_\odot$, the change to mass = $3 \times 10^{-3} - 3 \times 10^{-5} = 0.00297$, `relax_mass_scale = .true. ; new_mass = 0.00297`), sets the atmosphere option (`which_atm_option = 'tau_10_tables'`), then runs for 10 steps (`save_model_number = 11`).

inlist_rc2: This fills in the mass of the core (`relax_M_center = .true. ; new_mass = 0.003`), changes the atmosphere option (`which_atm_option = 'tau_100_tables'`), then runs for 10 steps.

inlist_rc3: This sets the radius of the core (`relax_R_center = .true. ; new_R_center = 1.1252e9 ! in cm`), then runs for 20 steps.

inlist_rc4: This further relaxes the mass of the star (`new_mass = 0.001`), then runs for 40 steps.

inlist_rc5: This sets the luminosity of the core (`relax_L_center = .true. ; new_L_center = 3.7e23 ! in ergs/second`), then runs for 100 steps (`steps_to_take_before_terminate = 100`).

inlist_rc6: This changes the `tau_factor` (moves the outer cell of the model to a new optical depth: `set_tau_factor = .true. ; set_to_this_tau_factor = 100`), changes the atmosphere option (`which_atm_option = 'simple_photosphere'`), then runs for 20 steps.

inlist_rc7: This ramps up the irradiation (`relax_irradiation = .true. ; relax_to_this_irrad_flux = 4d8 ! erg s/\-1 cm/\-2 ; irrad_col_depth = 1 ! g cm/\-2`), then runs for 20 steps.

inlist_rc8: This holds the irradiation at its new value (irradiation is kept at this value for the remainder to the run: `set_irradiation = .true. ; set_to_this_irrad_flux = 4d8 ! erg s/\-1 cm/\-2`), resets the `tau_factor` (`set_to_this_tau_factor = 1`), then runs for 10 steps.

inlist_rc9: This changes the atmosphere option (`which_atm_option = 'grey_and_kap'`), sets a mass loss rate (`mass_change = -1d-7`), then runs until it hits the lower mass limit (`star_mass_min_limit = 0.0004`).

inlist_rc10: This turns off mass loss, then runs for 100 steps (`steps_to_take_before_terminate = 100`).

inlist_rc11: This turns on mass loss again (`mass_change = -1d-8`), then runs until it hits the lower mass limit (`star_mass_min_limit = 0.0003`).

inlist_rc12: This turns off mass loss, then runs until its age limit is reached (`max_age = 1d8`).

The end result is a fully convective 0.3 M_J planet with a 10 M_E inert core, with abundances shown in log mass fraction in the profile below (figure 1). `MESA` does not print data about the inert core to the the log files, so the plots below only show data from the convective envelope.

To the right is a temperature-density profile taken at several different ages (figure 2), showing relatively constant surface temperature due to irradiation.

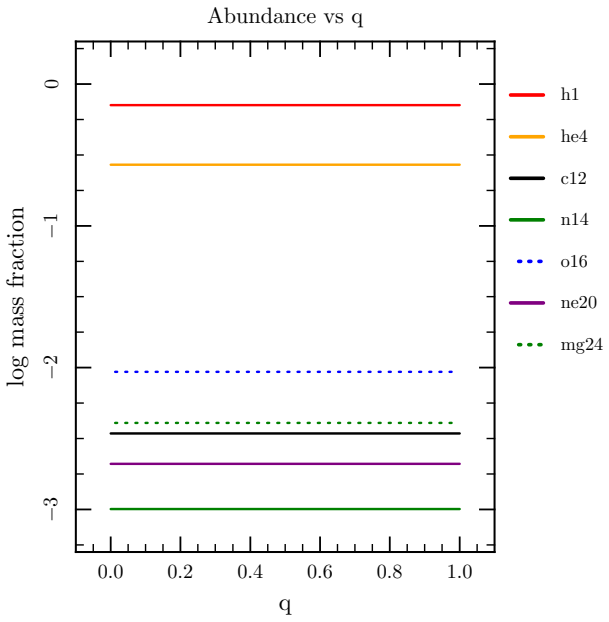

Figure 1: Abundance profile showing full convection

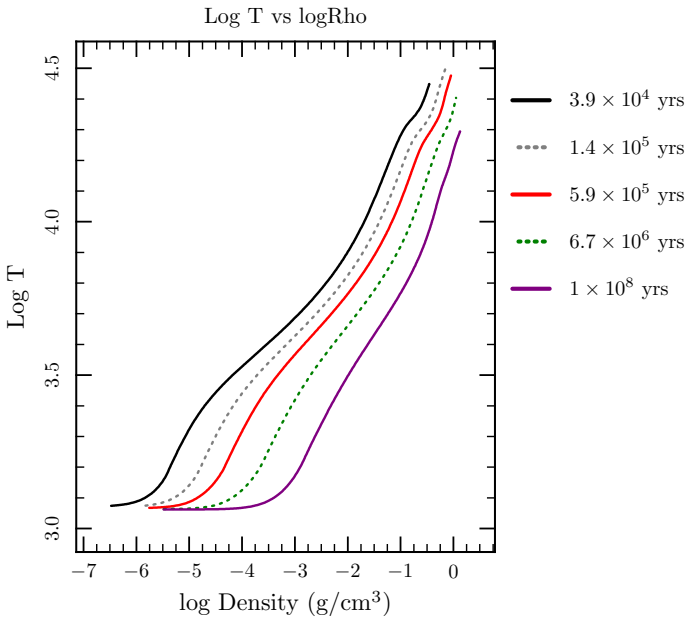

Figure 2: Temperature-density profile at several ages

This final plot (figure 3) 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.

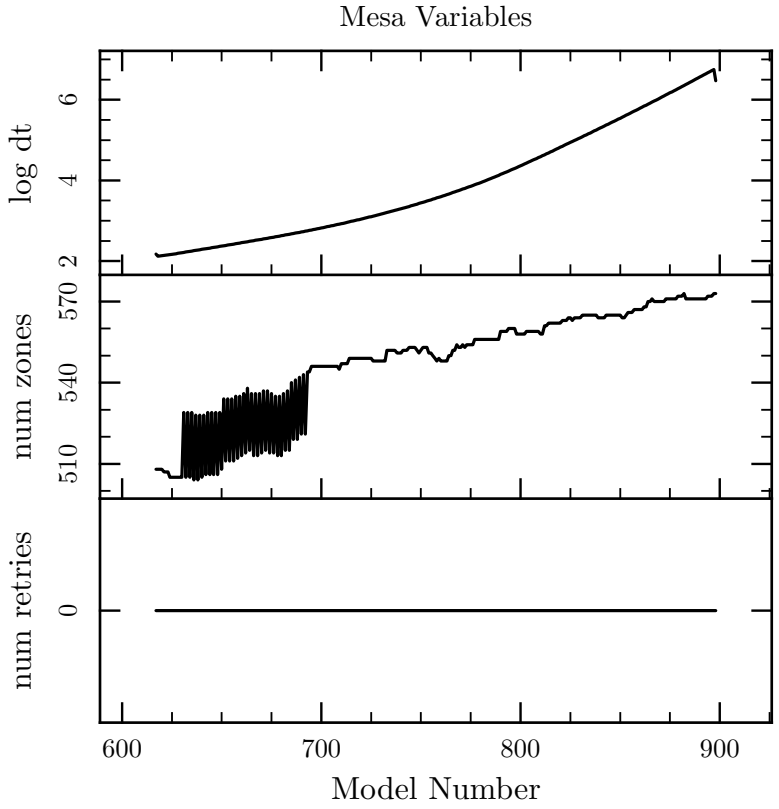

Figure 3: MESA variables plotted against model number show how hard MESA is working