

Minilab 4: Deuterium Main Sequence

You may have noticed in the previous minilab that metallicity was set with solar abundance ratios. This isn't quite the right thing to do on the pre main sequence, since some isotopes can be depleted by burning before the main sequence, where we are observing metal abundances in the Sun today. In fact, some isotopes can even burn in objects that never reach main sequence hydrogen burning! Here, we'll look at deuterium. In `inlist_brown_dwarf`, find and uncomment these lines:

```
! set_uniform_initial_composition = .true.
! initial_h1 = 0.71
! initial_h2 = 2d-5 ! if no h2 in current net, then this will be added to h1
! initial_he3 = 2d-5
! initial_he4 = 0.27
! initial_zfracs = 3 ! GS98_zfracs = 3
```

Change `initial_y` back to the default value by commenting out the line you added in the previous minilab:

```
! initial_y = 0.38
```

Now we're properly accounting for the presence of deuterium in protostellar objects. Let's see what it does to the evolution. Choose a mass between $M = 0.03 M_{\odot}$ and $M = 0.3 M_{\odot}$:

```
initial_mass = <mass between 0.03,0.3>
```

Set the maximum age to 1 Gyr:

```
max_age = 1d9
```

To see the effect of deuterium, try setting up a `pgstar` window like the following:

```
History_Track2_win_flag = .true.
History_Track2_yname = 'log_L'
History_Track2_xname = 'log_star_age'
History_Track2_xmin = 3.9
History_Track2_xmax = 9.1
History_Track2_yaxis_label = 'log L'
History_Track2_xaxis_label = 'log age'
```

In order to make this history plot, you also need to have the relevant quantities available in your history output, so make a copy of `history_columns.list` from the defaults:

```
cp $MESA_DIR/star/defaults/history_columns.list .
```

Uncomment the `log_star_age` line. Now run the model, and see if you can identify the effects of deuterium on the cooling track. If you want to watch the burning and abundance profiles as well, you can add this to your `pgstar`:

```
Profile_Panels3_win_flag = .true.
```

Now set the deuterium abundance to be higher. Try setting `initial_h2` to `2d-4` or even `2d-3`. Run the model again and watch the `pgstar` output. What is the effect of increasing deuterium abundance on the cooling track?