SMNA 2022 - Lecture 3 - pgStar

We are going to walk through how to customize pgStar to learn information about your stellar models in real time.

This exercise is based on the MESA Summer School exercise created in part by Frank Timmes (ASU).

Learning objectives

- How to enable pgStar using inlists and choose specific default plots.
- Editing `history*` and `profile_columns.list` to enable unique plots.
- How to customize pgStar plots to fit your science.
- How to create a grid with multiple pgstar subplots.
- How to save pgStar plots and produce movies.

Task 0 - Getting Started

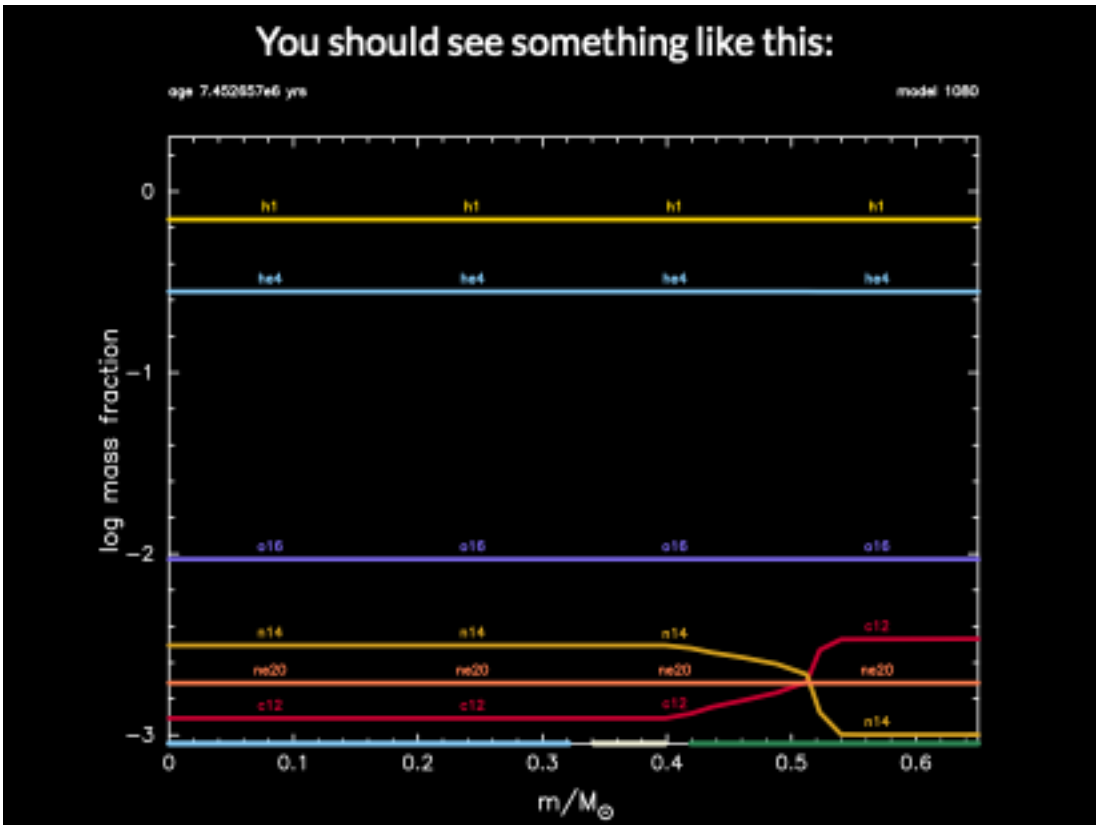
1. Download the work directory maxilab3.zip!
2. Ensure that you can compile and run work directory:

```
cd pgstar
 ./mk && ./rn
```

This example will be evolving a 2.1 $M_\odot$ star using a 49 isotope network!

Task 1 - Enabling pgStar Windows

After successfully running you should see this pgStar window appear:



Here we see an abundance profile. In the `inlist_pgstar` file the options to modify this window are labelled `Abundance_*`. We want to now enable more pgstar windows. The next we will enable will be the `Power_` window.

To enable this window set the `Power` window flag to `.true.` in `inlist_pgstar`

```
Power_win_flag = .true.
```

After enabled you should see two windows, try modifying the axis limits. Note you can modify the plot properties while the model is running!

Now do the same, set the window flags true for the `Kippenhahn`, `Production`, `Profile_Panels1`, and `Network` plots.

Once these are enabled: **spend some time making them useful**! Some options to consider:

- Show burning and more on the `Kippenhahn`.
- Add labels on `Production` and `Network`.
- Change x-axis on `Profile_Panels1` and/or change the plotted profile quantities.

Some information about the data produced by MESA:

History plots: show information in your `history_columns.list`. The name for a history item must be the same as one of the column headings in your `LOGS/history.data`.

Profile plots: show information about a current model. You can plot anything that can be in a `profile_columns.list`. You are not limited to items in your local `profile_columns.list`.

Single panel: plots contain one graph, optionally with a 2nd y-axis.Our `Kipp` diagram is an example of a single panel plot.

Multiple panel: plots stack several graphs using the same x-axis. We will be building two custom multiple panel plots.

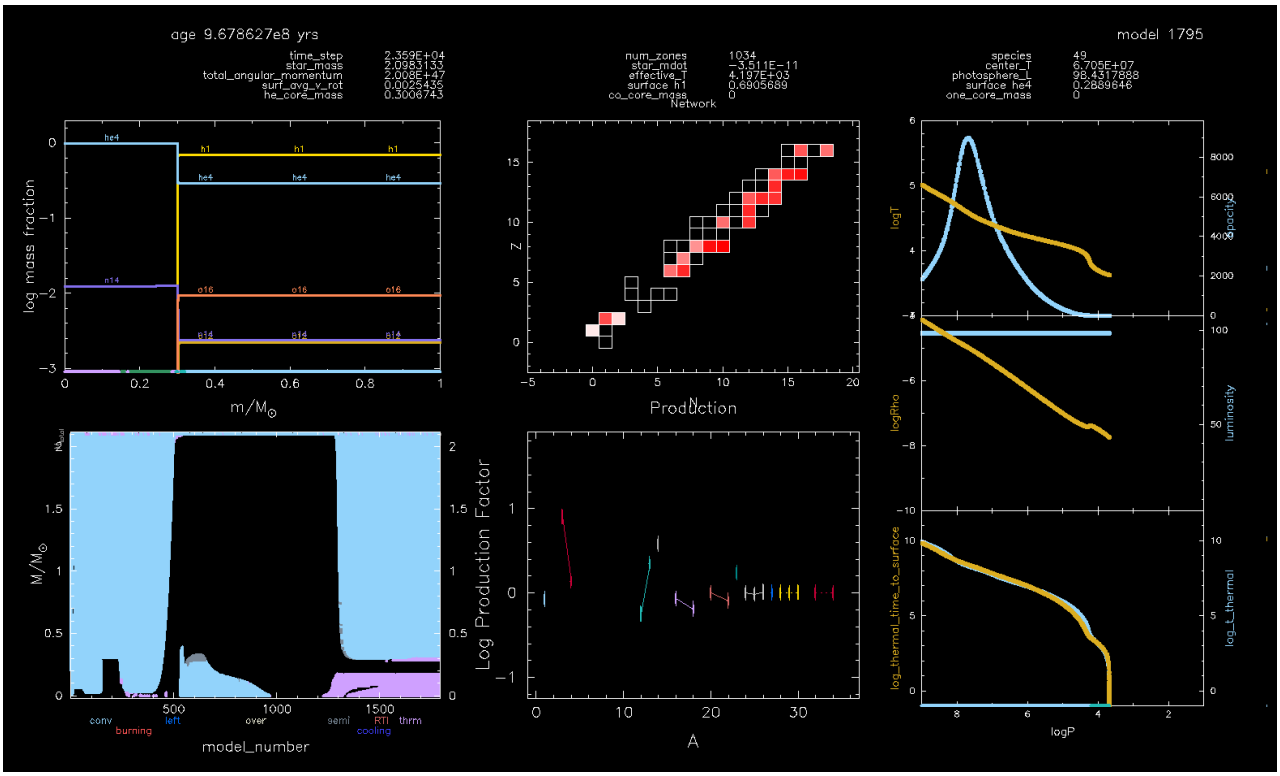
Grid plots: combine several plots in a user-specified grid layout.

Our goal is to build a custom grid plot.

Task 2 - Building a pgStar Grid Plot

1. Now, we want to disable all of our current pgstar windows. This is done by setting each window flag to `.false.`
2. Set `Grid1_win_flag = .true.` You will see a blank window with some summary text at the top.
3. Fill out the `Grid1_plot_name(2) = ''` with the corresponding individual windows we enabled earlier.

You may see something like this:



Now you can continue to modify the relevant quantities and information in your `inlist_pgstar` file to focus on the relevant properties of your stellar model.

Task 3 - Output and movies !

1. Once you have a Grid window you are happy with, you can save them (or the individual) windows using: `Grid1_file_flag = .true.` Below this flag are other relevant details that can be modified about output.

Remember a complete list of these options and even more plot types list in `$MESA_DIR/star/defaults/pgstar.defaults`.

Lastly, the MESASDK includes a script to produce movies using png frames:

```
cd $MESASDK_ROOT
images_to_movie.sh “grid1_png/*.png” summary.mp4
```

(Optional) Task 4 - Running MESA Test Suite Examples

MESA comes with test suite examples that live in `$MESA_DIR/star/test_suite`.

1. Pick a test suite. Copy the test suite to your desktop. (This is a similar step to making a new copy of `mesa/star/work` to begin with so the original directory is maintained).
2. Apply what you have learned about pgstar to enable new windows of quantities of interest for your science case.