Minilab 1: Almost Fully Convective

1 Starting in a Blank Work Directory

Navigate to wherever you want to do your work, and copy a default work directory there.

```
cp -r $MESA_DIR/star/work pre_ms
cd pre_ms
```

Next, copy the `inlist_pgstar` and `inlist_project` provided with this lab into this directory, replacing the default `inlist_pgstar` and `inlist_project`. The provided file for `inlist_project` contains a few basic default settings that we'll use throughout the afternoon's labs, but you'll also be editing it to add instructions.

2 Make a ZAMS Model

We're going to be running models with a variety of metallicities (`initial_z`), so we need to do some work to create ZAMS models that are ready to start out at the right metallicity. We'll also be varying the mixing length (`mixing_length_alpha`). First, in the `&star_job` section of `inlist_project`, tell the model to start on the pre-main sequence, and tell the run to save a model at the end (which we will later specify as ZAMS):

```
create_pre_main_sequence_model = .true.
save_model_when_terminate = .true.
save_model_filename = 'ZAMS.mod'
```

Next, you'll need to specify the starting parameters. On this spreadsheet, under the tab labeled "Bildsten Day 1 Minilab 1," place your name in an open slot next to a set of parameters, and add them to the `&controls` section of `inlist_project`:

```
initial_mass = <your value from the spreadsheet>
initial_z = <your value from the spreadsheet>
mixing_length_alpha = <your value from the spreadsheet>
```

Finally, add these commands to the `&controls` section of your `inlist_project` to tell this run to stop once the model has completed pre-main sequence evolution and reached ZAMS:

```
Lnuc_div_L_zams_limit = 0.99d0
stop_near_zams = .true.
```

Compile and run (`./mk && ./rn`), and at the end you'll have a ZAMS model that is ready to use.

After making your ZAMS model, please report the values from the end of the run for central temperature and central density on the spreadsheet.

3 Run Your Model

Once again, copy a default work directory to somewhere you'd like to work:

```
cp -r $MESA_DIR/star/work ms_mini1
cd ms_mini1
```

Copy the `inlist_pgstar` and `inlist_project` provided with this lab into this directory. Copy the file `ZAMS.mod` that you produced in the previous part into this work directory, and edit the `&star_job` section of `inlist_project` to start from this model:

```
create_pre_main_sequence_model = .false.
load_saved_model = .true.
saved_model_name = 'ZAMS.mod'
```

In the `&controls` section, tell the run to stop after the age reaches 10 Gyr:

```
max_age = 10d9
```

3.1 Large Time Steps

In the `&controls` section, set the time resolution to be fairly loose:

```
varcontrol_target = 1d-3
max_years_for_timestep = 1d8
```

The item `varcontrol_target` controls relative variations in the model from timestep to timestep. Generally, lower `varcontrol_target` means that the timesteps will be shorter to ensure that the model changes less in any one timestep.

Compile and run. What do you see?

3.2 Smaller Time Steps?

Experiment with the time resolution using the `max_years_for_timestep` control. How small do you need the timesteps to be for a converged result? Discuss with others at your table. Can you explain the physics behind this timescale?