

# Visualization of Stellar Internal Structure during Evolution

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# Contents

## 1 Preparation Work

- Basic Parameters

## 2 Simulation process

- Simulation Process in MESA
- Visualization

## 3 Acknowledgement

## 4 End



## Basic Parameters

- The relation between metallicity  $Z$  and helium abundance  $Y$  for a zero-age main sequence star

$$Y = 0.24 + 2Z, \quad (1)$$

in MESA, `initial_z` is defaulted as 0.02. In the model of this presentation, changeable parameter `initial_y` is revised as 0.40.

- The stop conditions in `inlist_project`

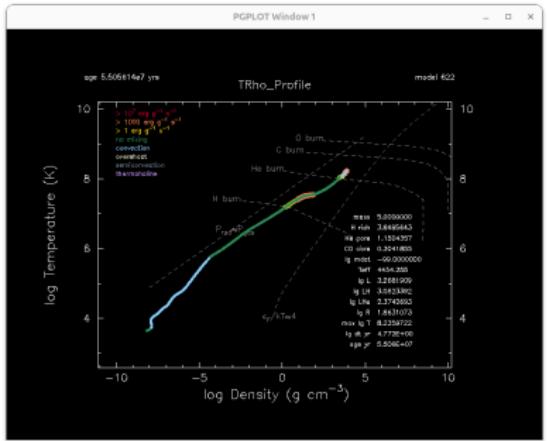
```
Lnuc_div_L_zams_limit = 0.99d0  
stop_near_zams = .true.  
xa_central_lower_limit_species(1) = 'h1'  
xa_central_lower_limit(1) = 1d-3  
are commented out.
```

- The simulations are basd on the files in `star/work`.

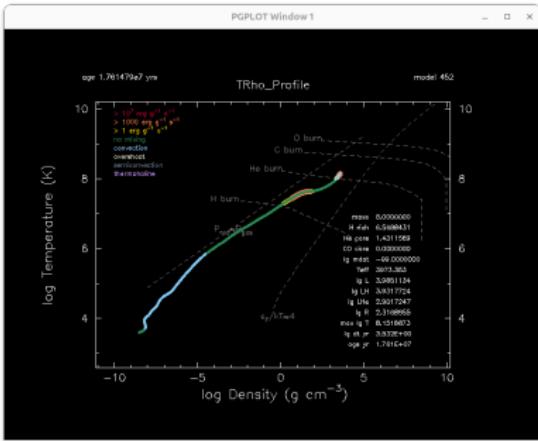


## Simulation Process in MESA

## $5 M_{\odot}$ and $8 M_{\odot}$ Stars



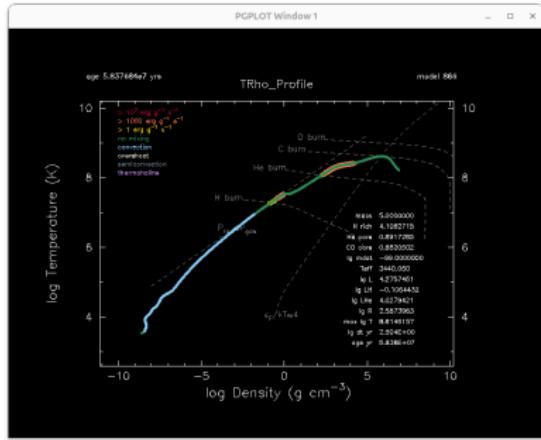
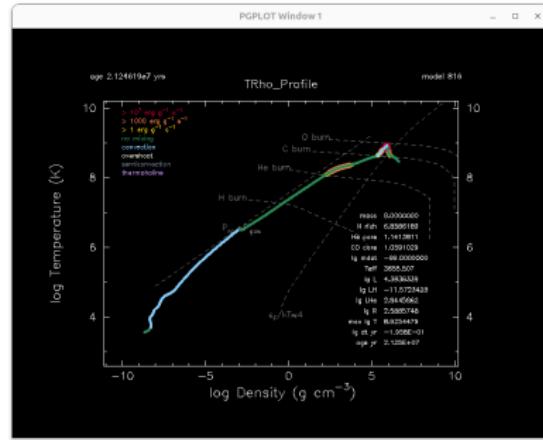
(a)  $5 M_{\odot}$   $T - \rho$



(b)  $8 M_{\odot}$   $T - \rho$

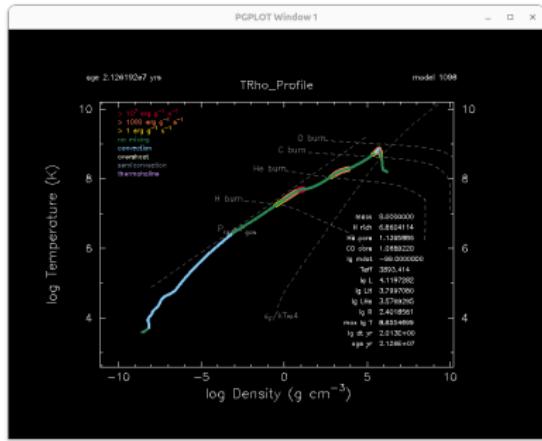
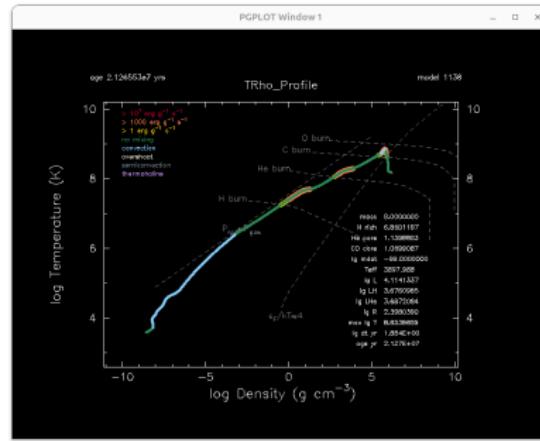


## Simulation Process in MESA

 **$5 M_{\odot}$  and  $8 M_{\odot}$  Stars**(c)  $5 M_{\odot}$   $T - \rho$ (d)  $8 M_{\odot}$   $T - \rho$

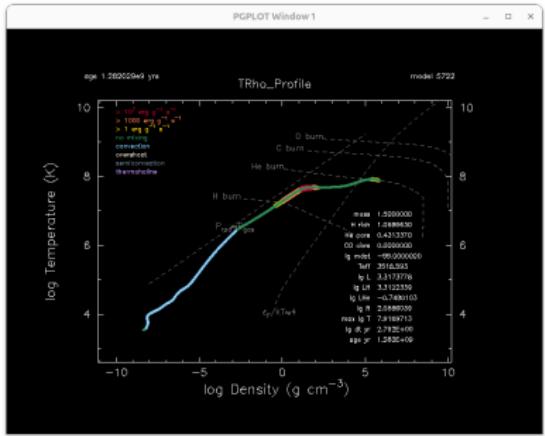
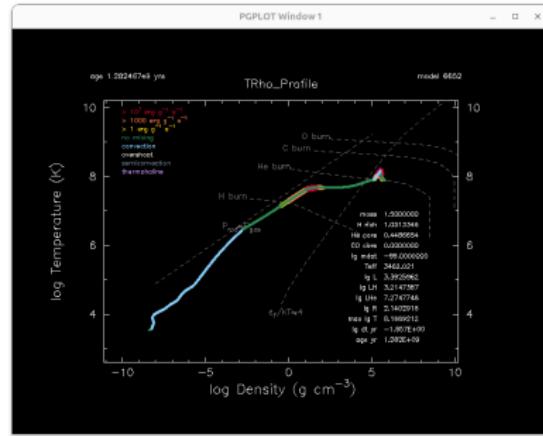


## Simulation Process in MESA

 **$5 M_{\odot}$  and  $8 M_{\odot}$  Stars**(e)  $8 M_{\odot}$   $T - \rho$  (earlier)(f)  $8 M_{\odot}$   $T - \rho$  (later)

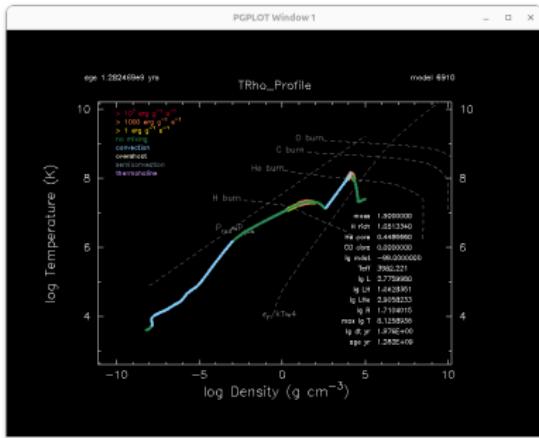
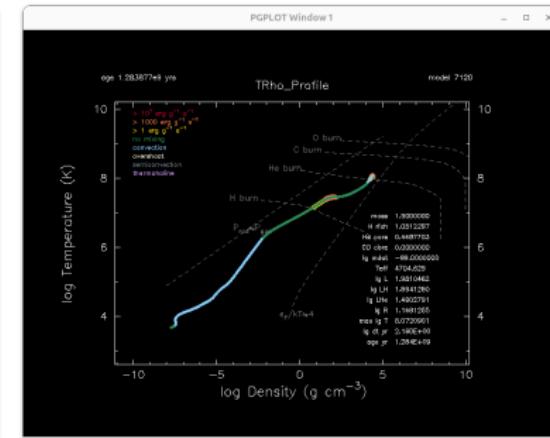


## Simulation Process in MESA

1.5  $M_{\odot}$  Star(g) 1.5  $M_{\odot}$   $T - \rho$  (just before He-flash)(h) 1.5  $M_{\odot}$   $T - \rho$  (being in the stage of He-flash)

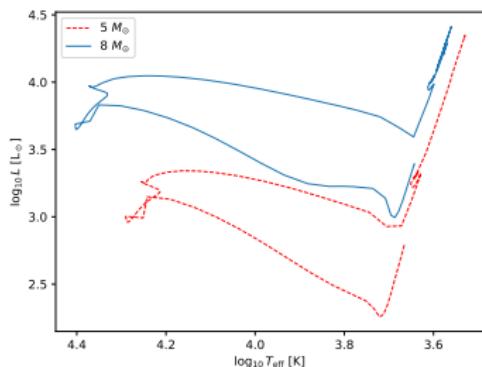


## Simulation Process in MESA

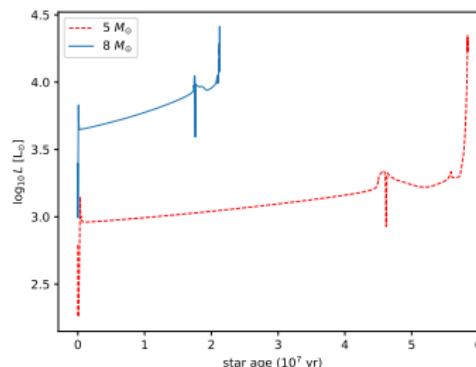
1.5  $M_{\odot}$  Star(i) 1.5  $M_{\odot}$   $T - \rho$  (in the middle stage of He-flash)(j) 1.5  $M_{\odot}$   $T - \rho$  (being in the end stage of He-flash)

## 5 $M_{\odot}$ and 8 $M_{\odot}$ Stars

- The evolution ages in simulations:  
 $5.8381 \times 10^7$  years for  $5 M_{\odot}$  star,  
 $2.1267 \times 10^7$  years for  $8 M_{\odot}$  star.

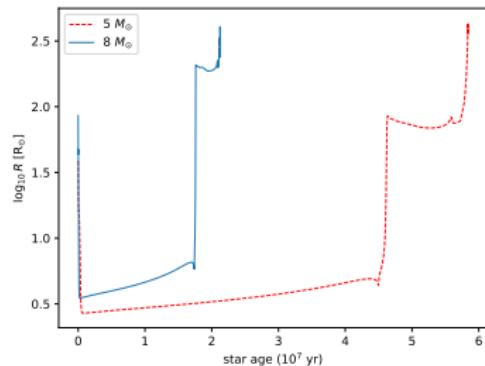


(k) H-R diagram contrast

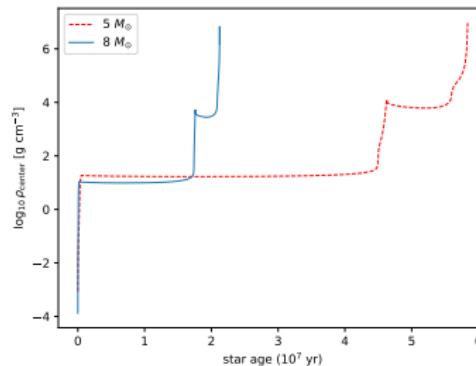


(l) Luminosity evolution contrast

## 5 $M_{\odot}$ and 8 $M_{\odot}$ Stars

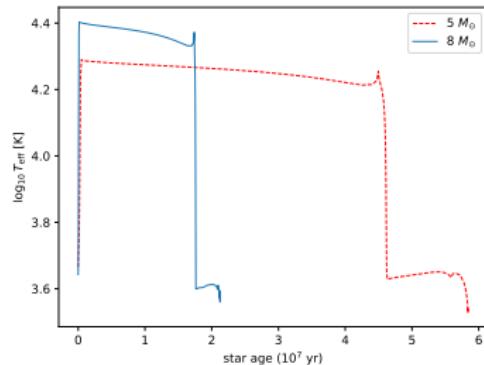


(m) Radius evolution contrast

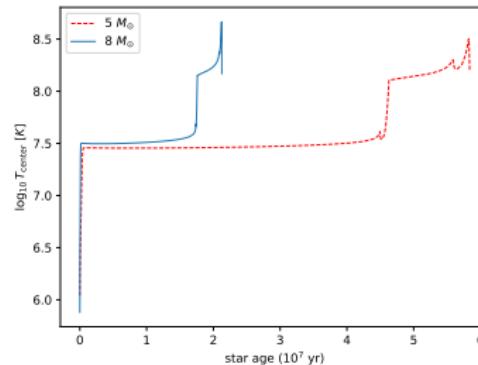


(n) Density evolution contrast

## 5 $M_{\odot}$ and 8 $M_{\odot}$ Stars



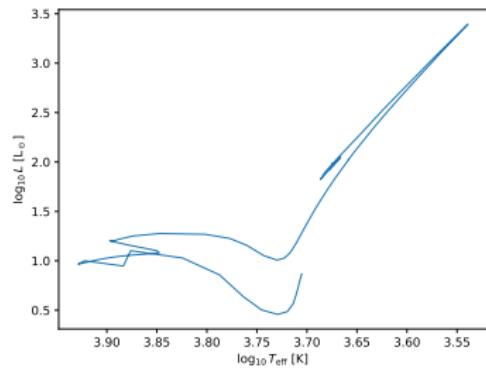
(o) Effective temperature evolution contrast



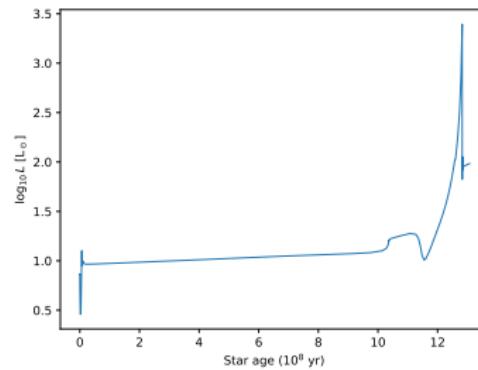
(p) Central temperature evolution contrast

# $1.5 M_{\odot}$ Star

- The evolution age in simulation:  $1.3075 \times 10^9$  years for  $1.5 M_{\odot}$  star.

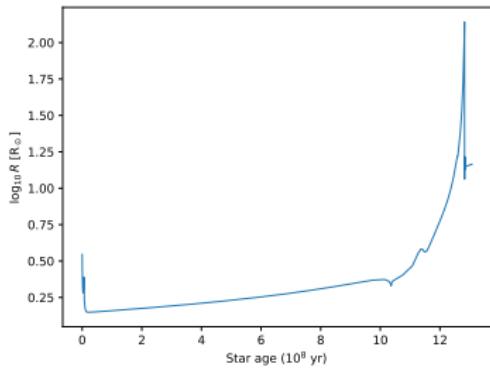


(q) H-R diagram

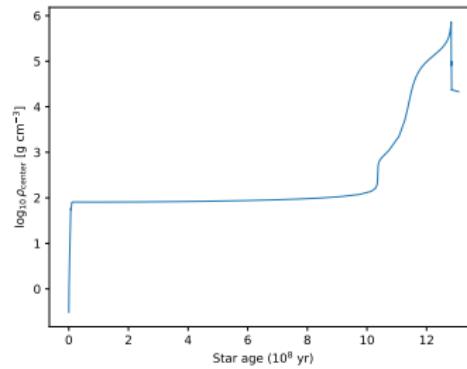


(r) Luminosity evolution

# 1.5 $M_{\odot}$ Star

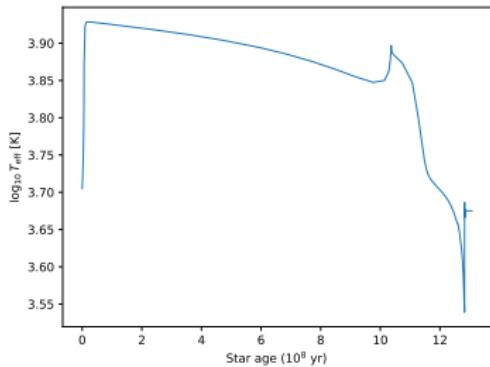


(s) Radius evolution

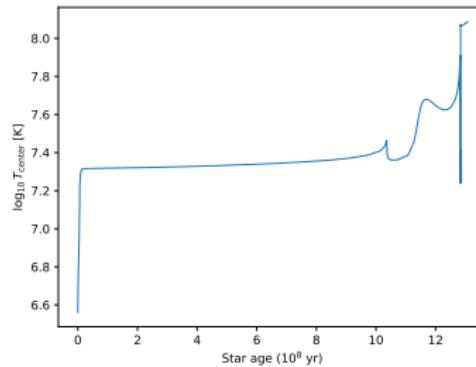


(t) Density evolution

# $1.5 M_{\odot}$ Star

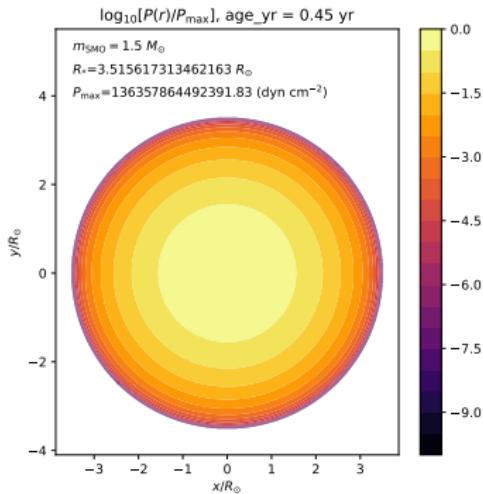


(u) Effective temperature evolution

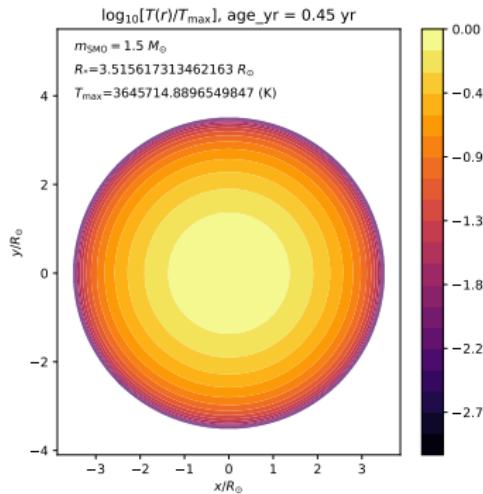


(v) Central temperature evolution

## Visualization

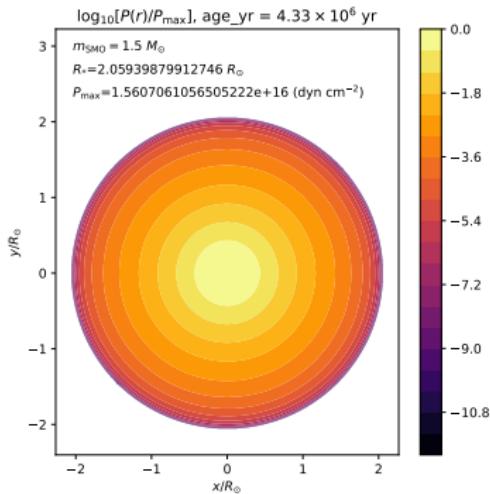
***1.5 M<sub>⊙</sub> Star***

(w) Internal pressure distribution

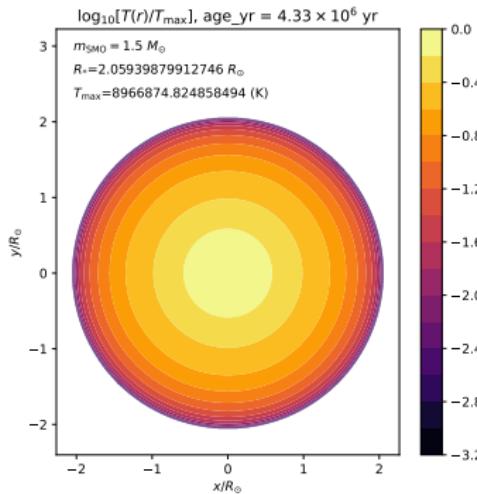


(x) Internal temperature distribution

## Visualization

***1.5 M<sub>⊙</sub> Star***

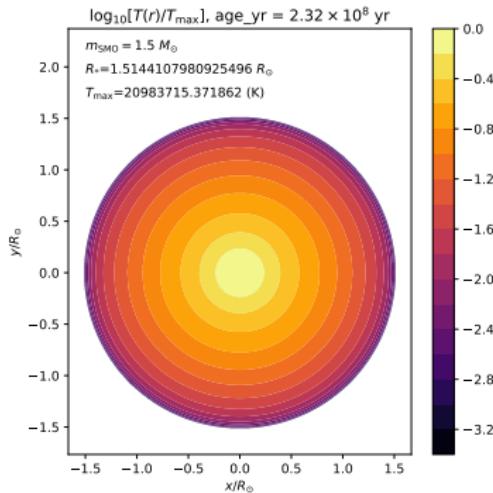
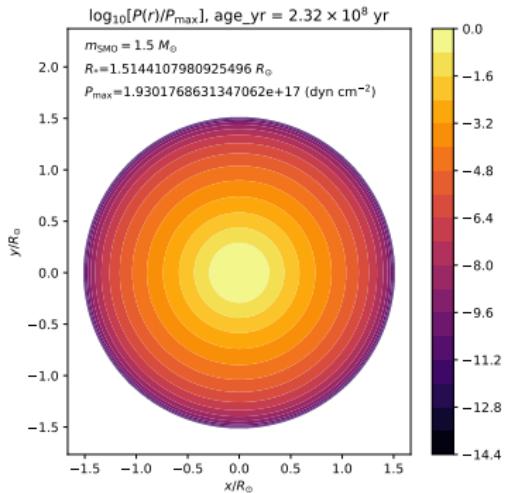
(y) Internal pressure distribution



(z) Internal temperature distribution

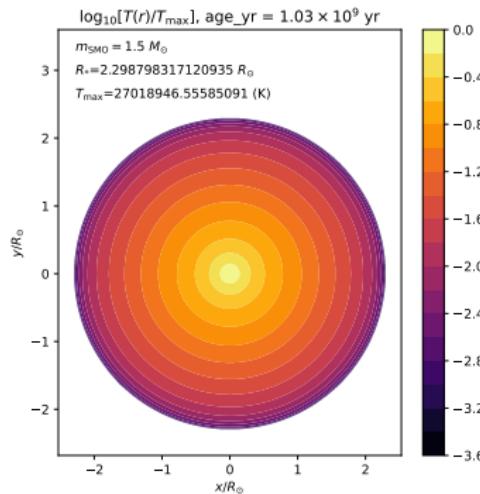
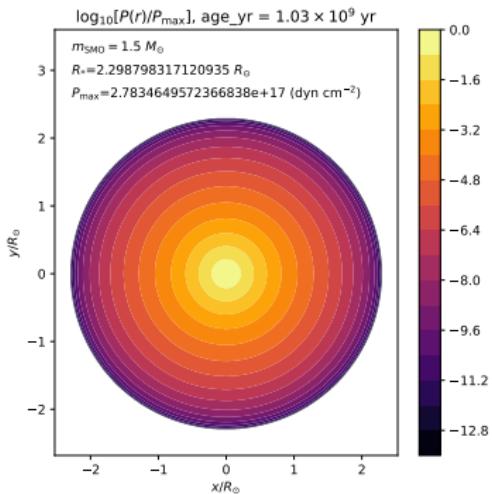
## Visualization

# $1.5 M_{\odot}$ Star

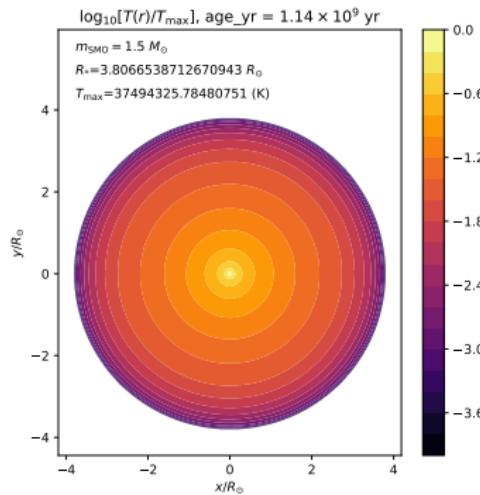
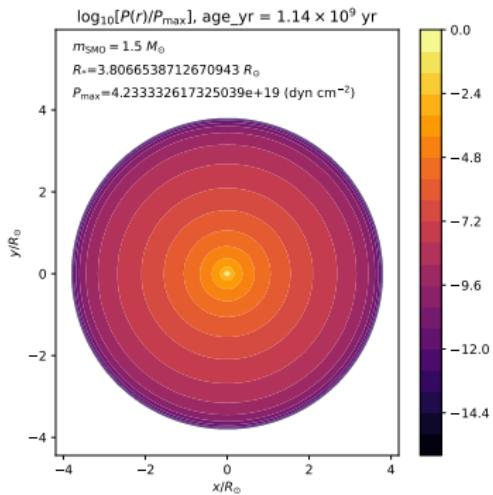


## Visualization

# 1.5 $M_{\odot}$ Star

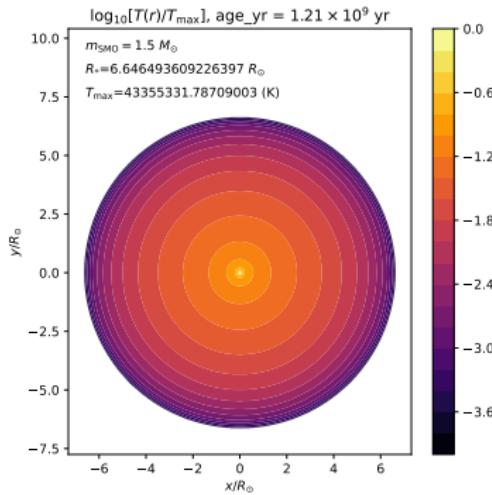
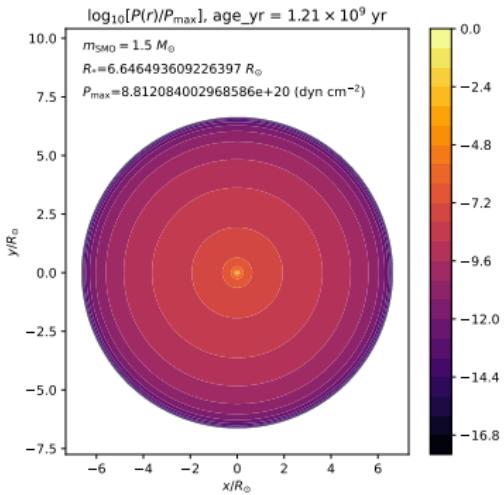


# 1.5 $M_{\odot}$ Star



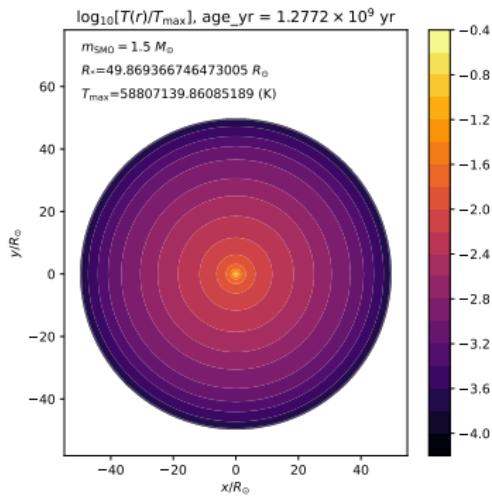
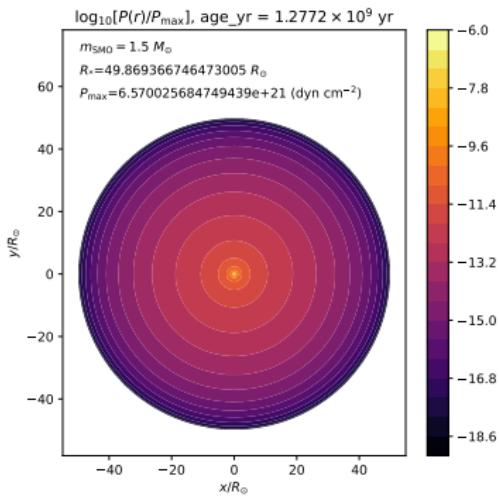
## Visualization

# $1.5 M_{\odot}$ Star



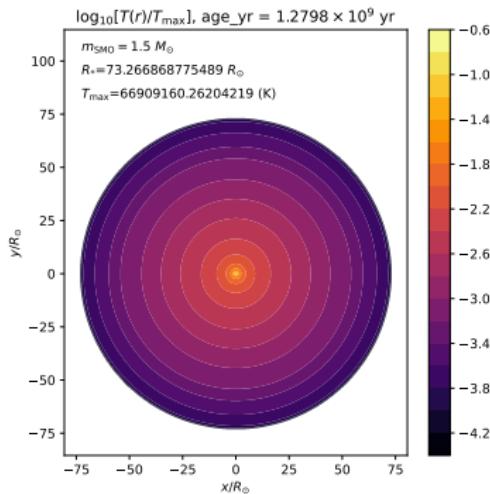
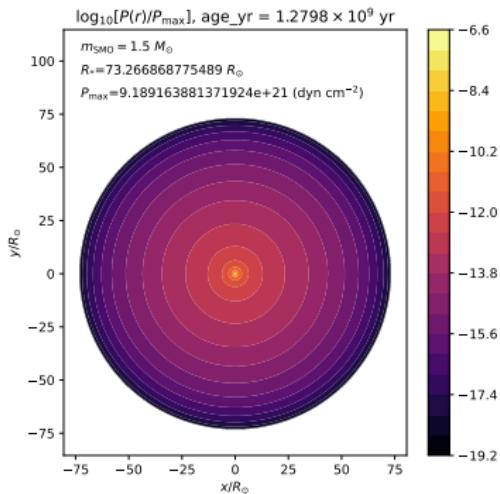
## Visualization

# 1.5 $M_{\odot}$ Star (He-flash stage)

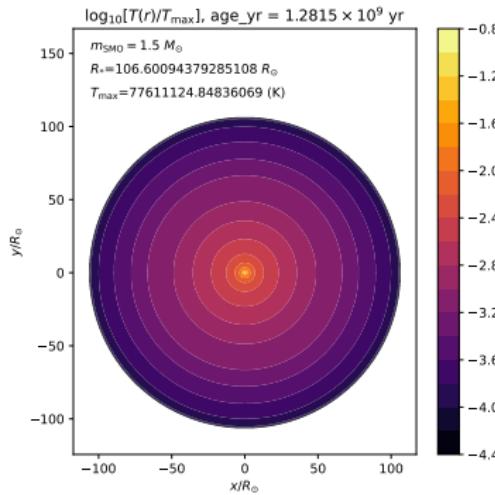
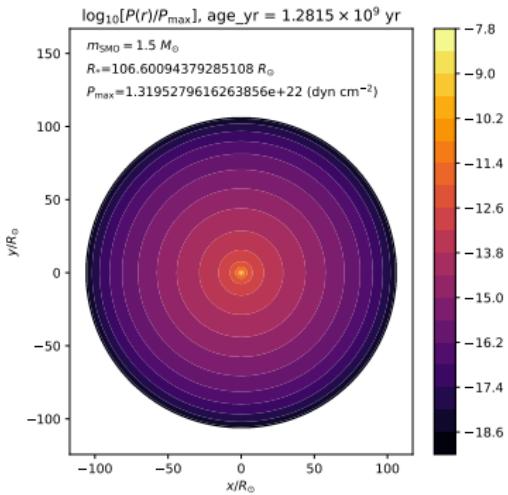




# 1.5 $M_{\odot}$ Star (He-flash stage)

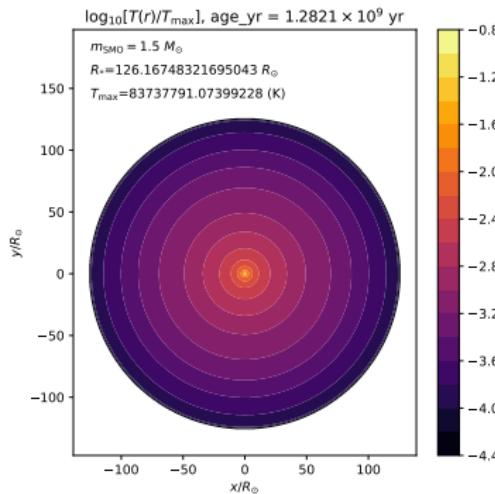
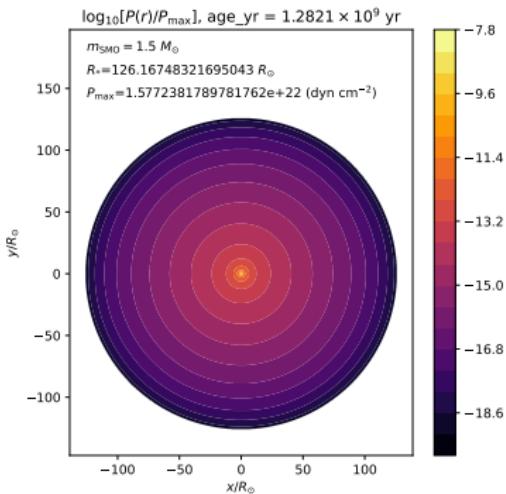


## Visualization

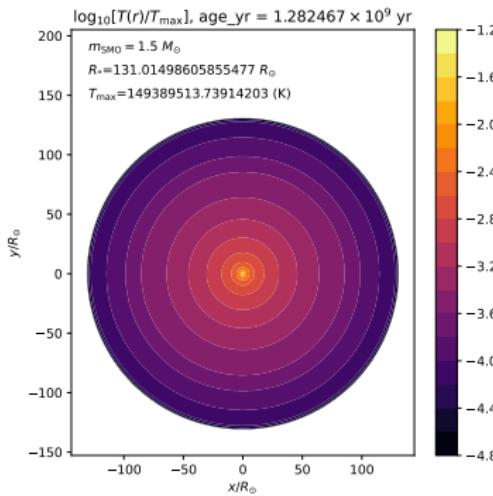
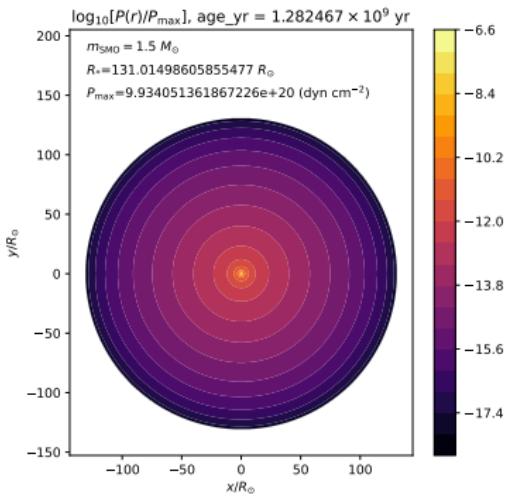
 **$1.5 M_{\odot}$  Star (He-flash stage)**



# 1.5 $M_{\odot}$ Star (He-flash stage)

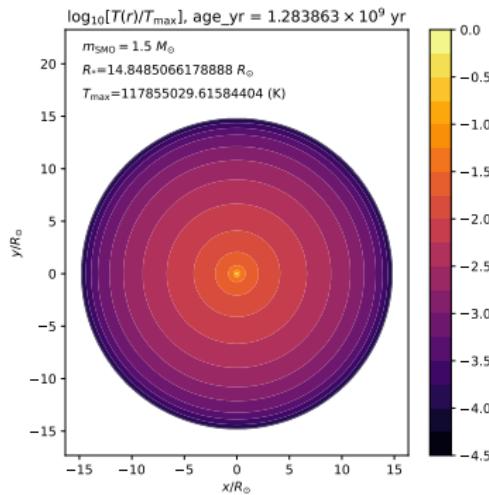
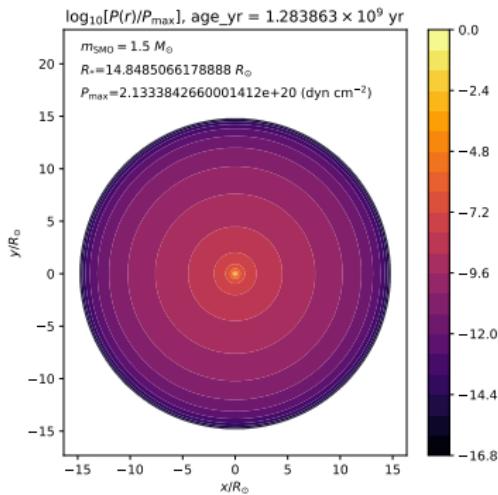


# 1.5 $M_{\odot}$ Star (He-flash stage)

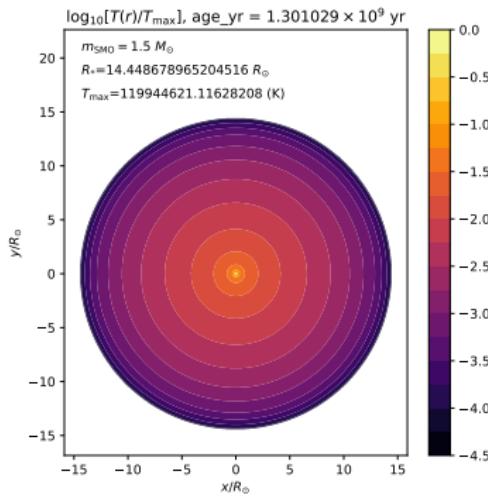
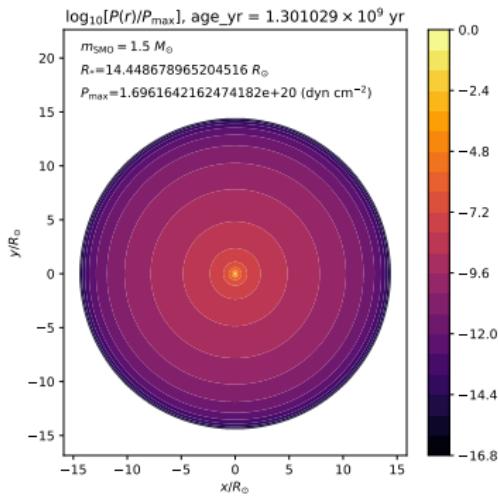




# $1.5 M_{\odot}$ Star (He-flash stage)



# 1.5 $M_{\odot}$ Star (He-flash stage)



## Acknowledgement

Thanks for the companionship throughout the semester!



Figure 1: The evil aliens

# Thank You and Happy Python Year!