CEE_convection_gp_11-18-2019

Yisheng Tu

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1 New work

- Figured out how to use the MESA EOS
- Independent variables: X, Z and two other (ρ, P); (ρ, E); (P, E), etc.
- Talked with Jonathan on what do we need to implement with AstroBEAR
  Format $z(x, y)$:

$$
\begin{array}{cccccc}
x_{\min} & x_{\max} & dx & & & \\
y_{\min} & y_{\max} & dy & & & \\
 & & & & & \\
 & (x_{\min} & x_{\min}+dx & \ldots & x_{\max}) \\
(y_{\min}) & z_{11} & z_{12} & \ldots & z_{1n} \\
(y_{\min}+dy) & z_{21} & z_{22} & \ldots & z_{2n} \\
\ldots & & & & \\
(y_{\max}) & z_{m1} & z_{m1} & \ldots & z_{mn}
\end{array}
$$

  We need 6 sets of these tables, and 3 others:

  - $\rho(P, T)$ (MESA)
  - $\rho(E, T)$
  - $T(\rho, P)$ (MESA)
  - $T(\rho, E)$ (MESA)
  - $E(\rho, P)$ (MESA)
  - $E(\rho, T)$
  - $C_V(\rho, E)$ (MESA)
  - $c_s(\rho, E)$ (MESA)
  - $c_s(\rho, p)$ (MESA)
- Developed script to get some MESA tables. Also written an algorithm to invert the eos table

2 Questions

- **Do we also need tables such as $\rho(P, E)$?**
- **What is the useful range for EOS tables in AstroBEAR?**

- **In the region where the EOS (inverted EOS) is not valid, what should I put there?** (Because the independent variable is always a square parameter space, so on the parameter space there can be extreme values that is out-of-range from the MESA EOS)
- **What is the most efficient algorithm to invert an EOS table?**

3 Next Step

1. Get the tabulated equation of state, for one X and Z. Put into AstroBEAR and generate one frame. Compare with MESA profile.
2. Do the same for all X and Z. Then think about $n-$dimensinal interpolation.

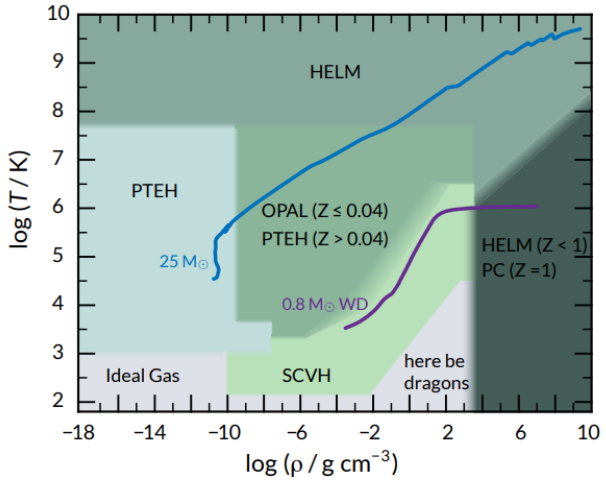
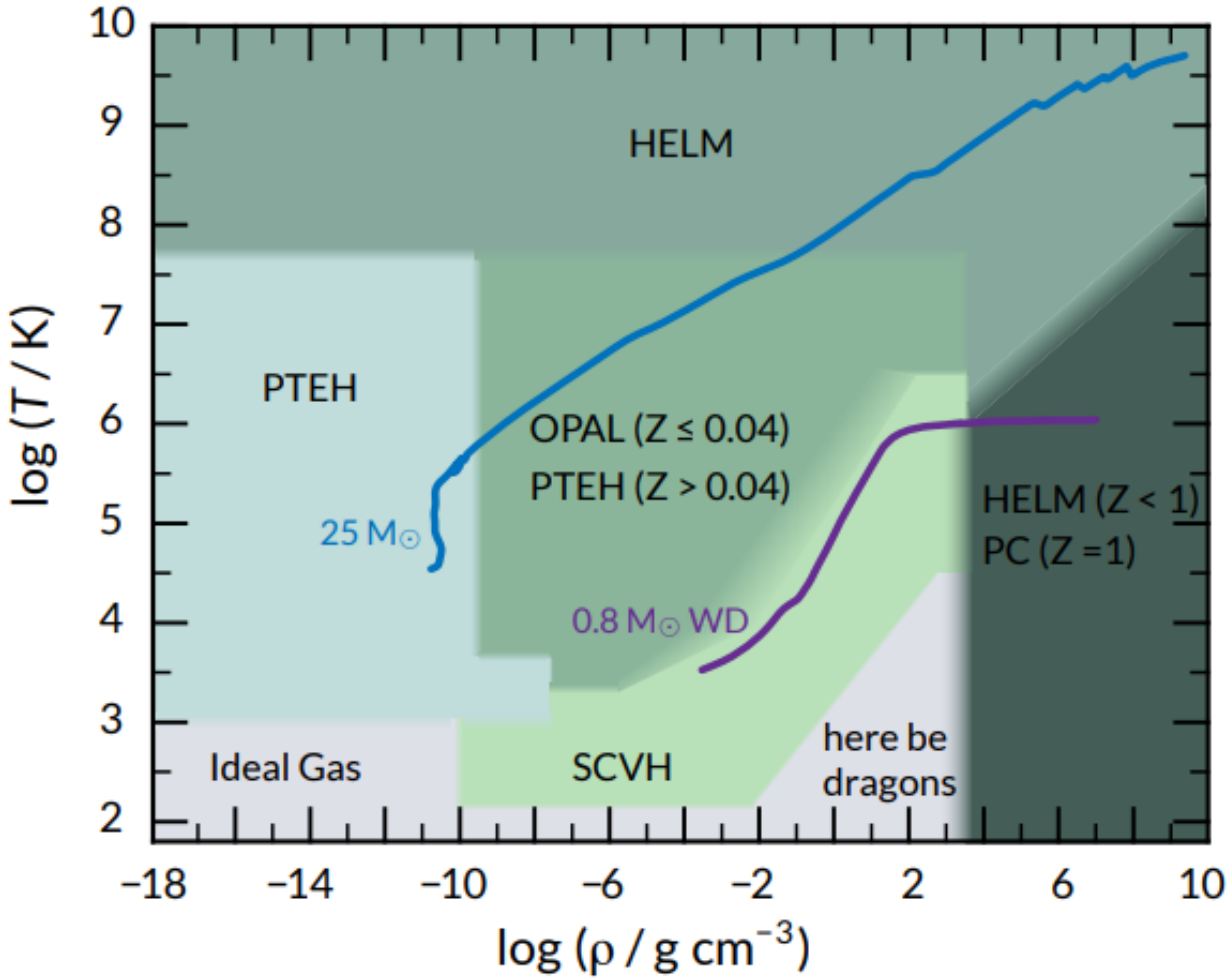


Figure 50. The $\rho - T$ coverage of the EOS used by the `eos` module. PTEH is from Pols et al. (1995), HELM is from Timmes & Swesty (2000), PC is from Potekhin & Chabrier (2010), OPAL is from Rogers & Nayfonov (2002), SCVH is from Saumon et al. (1995), and the low-density cold region in the lower left is treated as an ideal neutral gas. The region between SCVH and PC is currently problematic from input physics and numerical perspectives and treated as an ideal gas (see Chabrier et al. 2019 for a recent treatment that is not yet in `MESA`). The blue curve shows the profile of a 25 $M_\odot$ star that has reached an iron core infall speed of 1,000 km s^{-1} and the purple curve shows the profile of a 0.8 $M_\odot$ WD.


HELM
PTEH
OPAL (Z ≤ 0.04)
PTEH (Z > 0.04)
25 M⊙
0.8 M⊙ WD
HELM (Z < 1)
PC (Z = 1)
Ideal Gas
SCVH
here be
dragons
log (T / K)
log (ρ / g cm⁻³)
10
9
8
7
6
5
4
3
2
−18
−14
−10
−6
−2
2
6
10