Stellar Evolution Plots

Initial mass = $1.0 M_\odot$ Initial Z = 0.01

Hertzsprung-Russell and Center Temperature-Density Tracks. Age is shown in 10^9 years and Mass in $M_\odot$ units. "He Burning" (or "He Flash") indicates the break-even point for power from triple-α reactions versus total neutrino losses. For each of the marked post-ZAMS points, there is a page of plots below with profiles showing various details of the internal structure at that stage.

Properties. Radius ($R_\odot$), Luminosity ($L_\odot$), Surface Temperature, Center Temperature, Center Density, and Center Degeneracy. Numbers at right show values at end of run. Green tick marks along the age axis correspond to points on the tracks where a profile has been made. The radius corresponds to the photospheric point where the optical depth τ reaches 2/3.

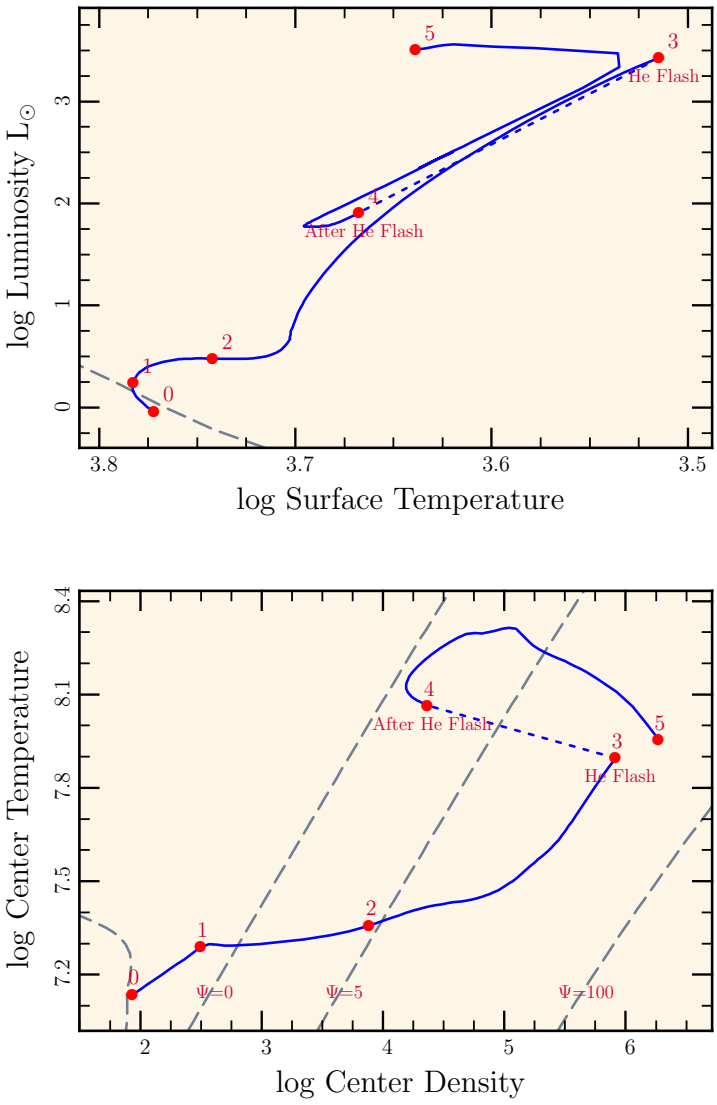
More Properties. Total Mass Fraction of Metals (Z), Power from Triple-Alpha Reactions ($L_\odot$), Power from Alpha Captures by Metals ($L_\odot$), Neutrino Power Losses ($L_\odot$), Total Mass, and Core Mass.

Convection and Burning Zones. Upper plot is extent of convection zones. Gaps between vertical lines are times between models. Lower plot shows burning zones. Burn rates are in ergs/g/sec with blue > 1 and red $> 10^3$.

Abundances, Power, and Pressure. Histories of Mass Fractions of the main elements at the center of the star, Nuclear Power generated by the most important reactions, and Neutrino Losses. Histories of Components of Central Pressure: CORR giving the (negative) corrections from non-ideal behavior, ELEC for pressure from electrons as ideal gas, ION pressure from ions as ideal gas, RAD for pressure from radiation, and TOTAL for the sum.

Profiles for the star at various key times during the evolution.

EZ — June 24, 2005



	Age	Mass
0	0.00	1.000
1	6.30	0.998
2	9.04	0.996
3	9.79	0.756
4	9.99	0.756
5	10.13	0.571

Figure 1: Hertzsprung-Russell and Center Temperature-Density Tracks

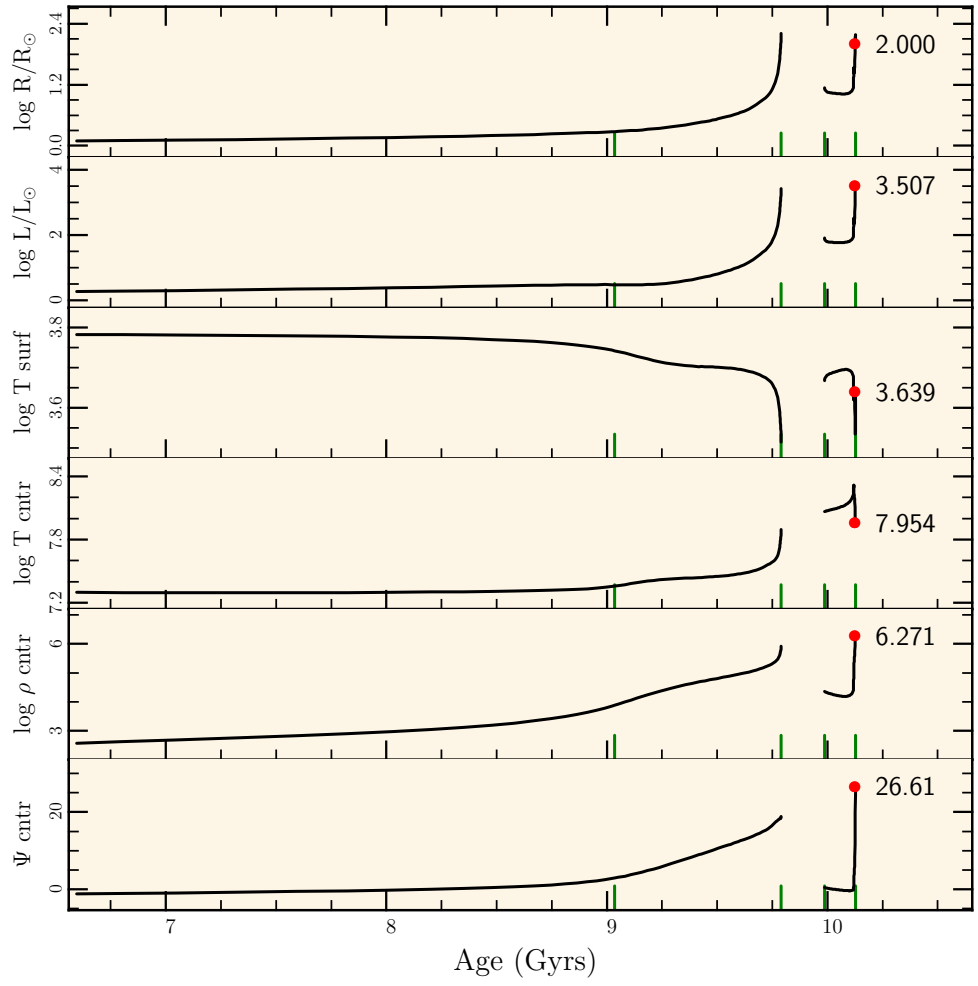


Figure 2: Some Properties

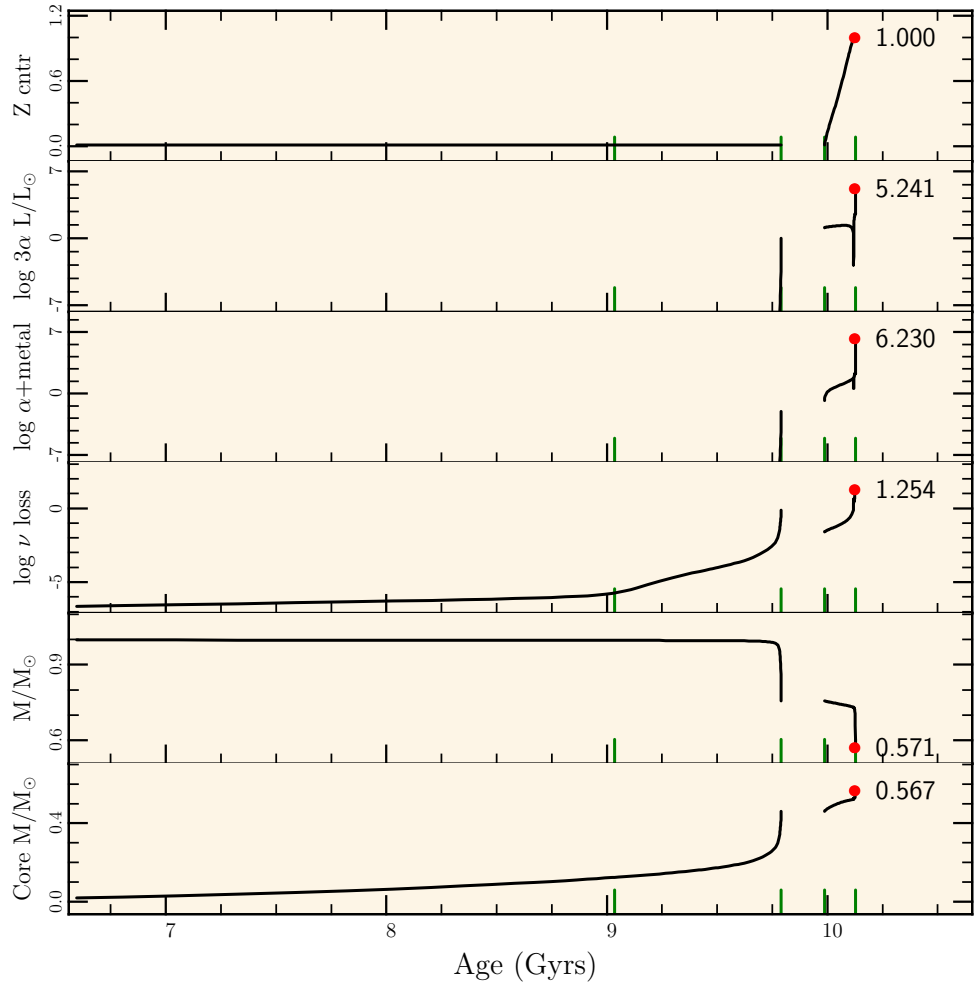


Figure 3: More Properties

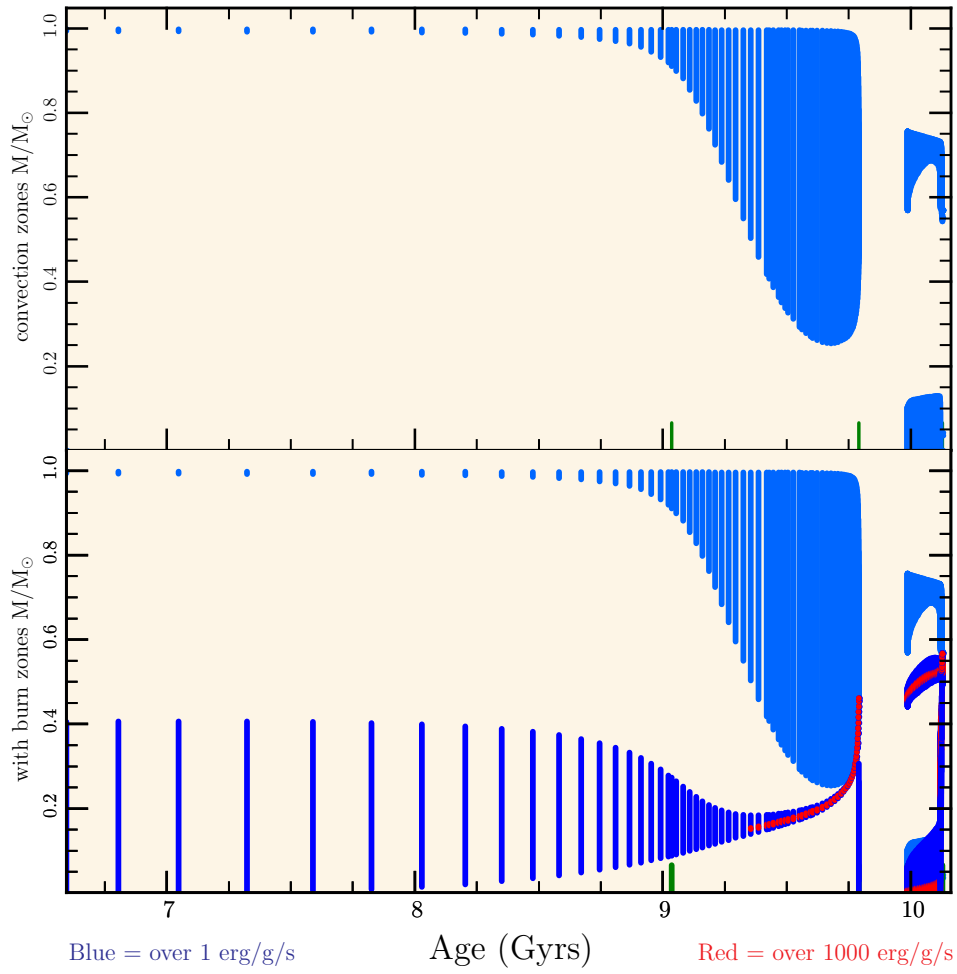


Figure 4: Convection and Burning Zones

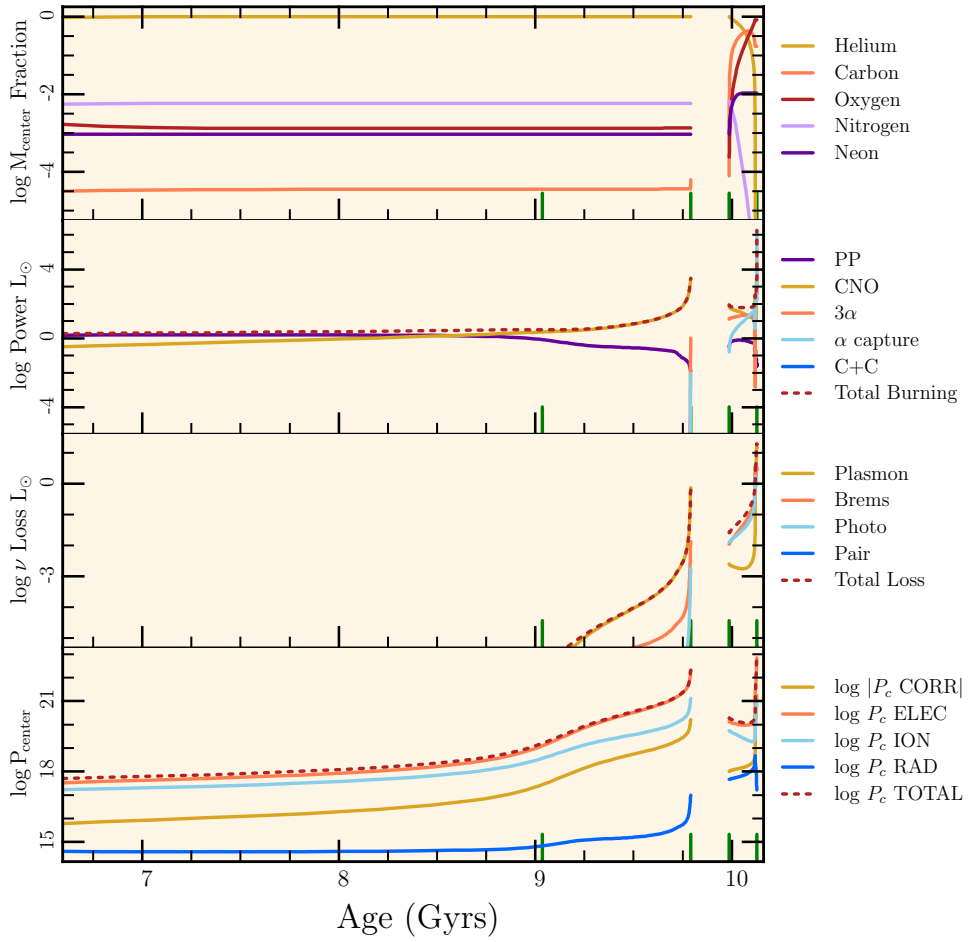


Figure 5: Abundances, Power, and Pressure

Profile Plots

The following pages have summaries of the stellar structure at various times during the evolution. On the left of each page are profiles by mass measured from the center (in units of $M_\odot$). The first shows the power sources, and the second shows composition in terms of fractional abundance by mass. The third plot shows the values of various properties as a fraction of their maximum value. The energy and entropy values are per unit mass. R_{PHOT} refers to the radius at the photosphere.

The right column of plots on each page are profiles by log pressure. The first of these shows various logarithmic derivatives of T with respect to P. Where $\nabla_{actual} \sim \nabla_{rad}$, the star is radiative. Where $\nabla_{actual} \sim \nabla_{ad}$, the star is efficiently transporting energy by convection. And where $\nabla_{actual} \gg \nabla_{ad}$, the star is inefficiently transporting energy. The middle plot shows the ionization states of H and He. The last plot is essentially a repeat of the one on its left, but now emphasizes the region of the star closer to the surface. The plots also have indicators along the $logP$ axis for a few corresponding masses.

Along the right of the page are various important numeric values. Ψ_c is the central electron degeneracy. The central heat capacity at constant pressure is given by scp_c. T_{max} Mass gives the location where the maximum temperature occurs. The actual value of the maximum temperature is indicated by $logT_{max}$. L_{PP} is the total integrated power from the PP reaction chain for burning hydrogen. L_{CNO} and $L_{3\alpha}$ are the corresponding values for those reactions, and L_ν is the power being lost to neutrinos. $T_{nuclear}$ is the nuclear timescale (M/L), $T_{thermal}$ is the thermal timescale (GM^2/RL), $T_{dynamic}$ is an approximate stellar dynamic timescale $(R^3/GM)^{1/2}$, and T_{step} is the time step for the evolution code (the times are measured in years).

He-Core is the mass location where going out from the center the hydrogen abundance (XH) first has a value above a certain threshold (usually set at 15%). Similarly, C-Core is the location inside the helium core where the helium abundance (XHe) first exceeds a threshold (usually 25%), and O-Core is the location inside the carbon core where the carbon abundance (XC) first exceeds a threshold (usually 35%). A value of 0.0 indicates that the corresponding abundance is below threshold throughout.

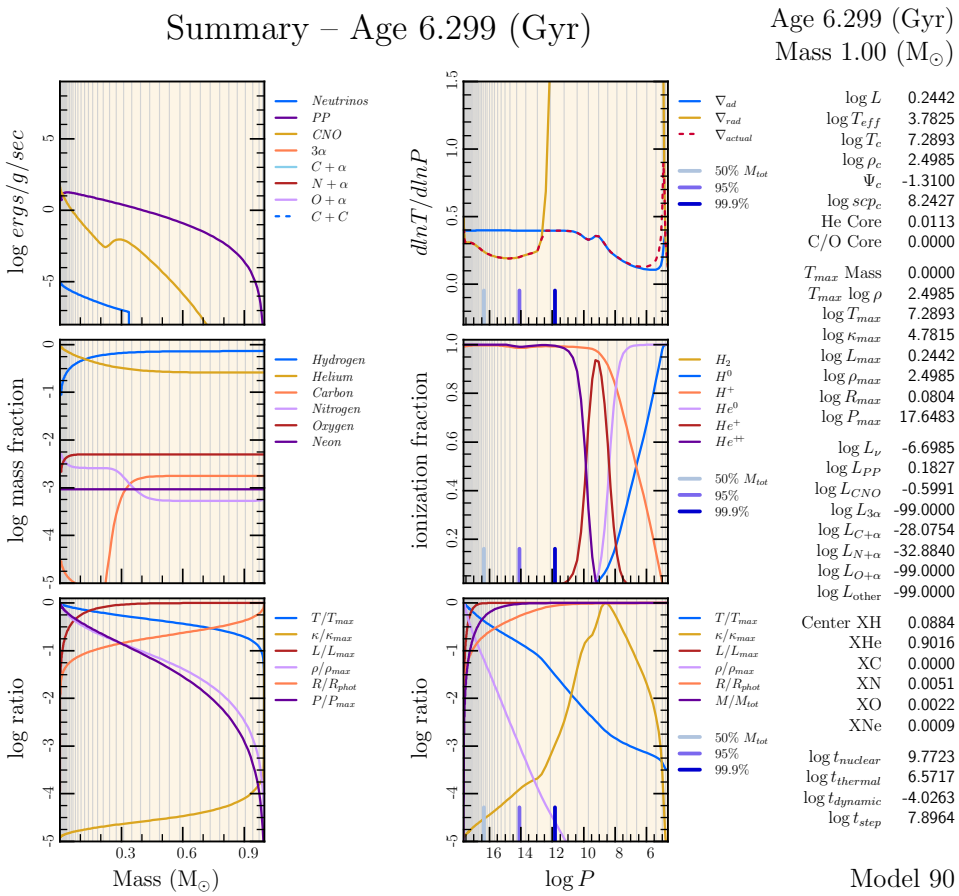


Figure 6: Profile 1

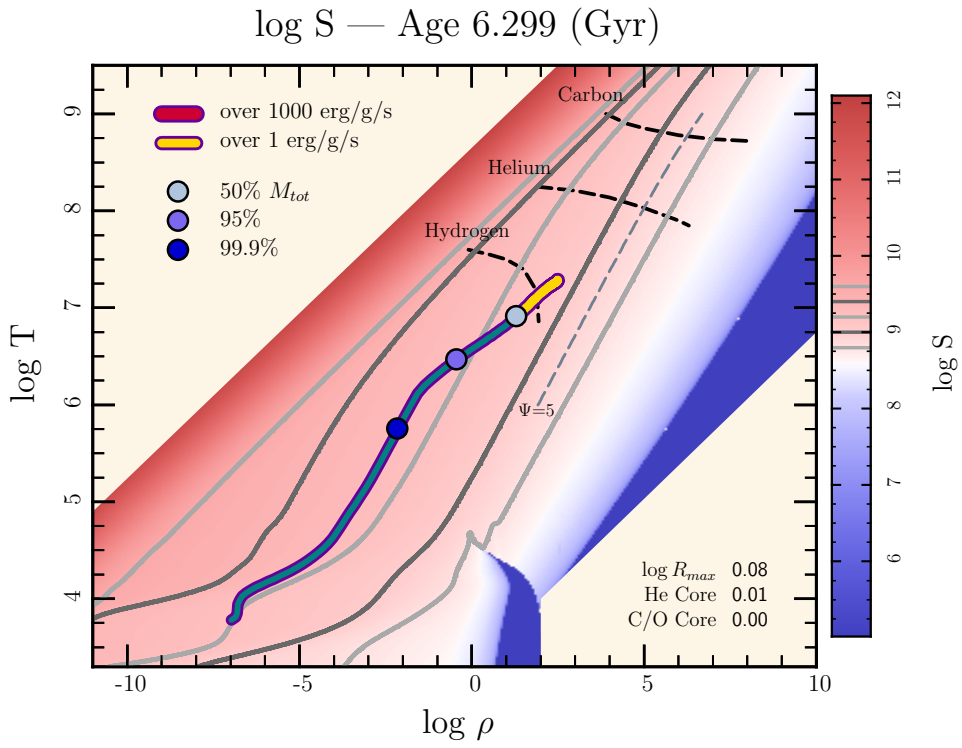


Figure 7: Entropy EOS Profile 1

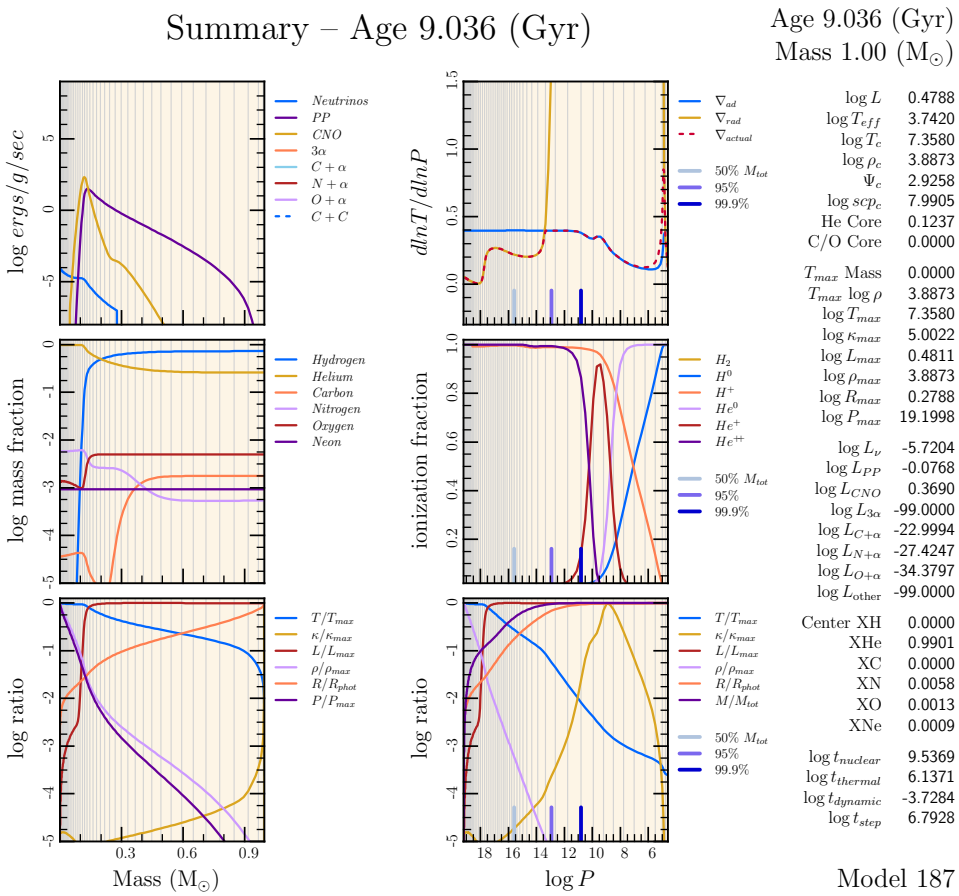


Figure 8: Profile 2

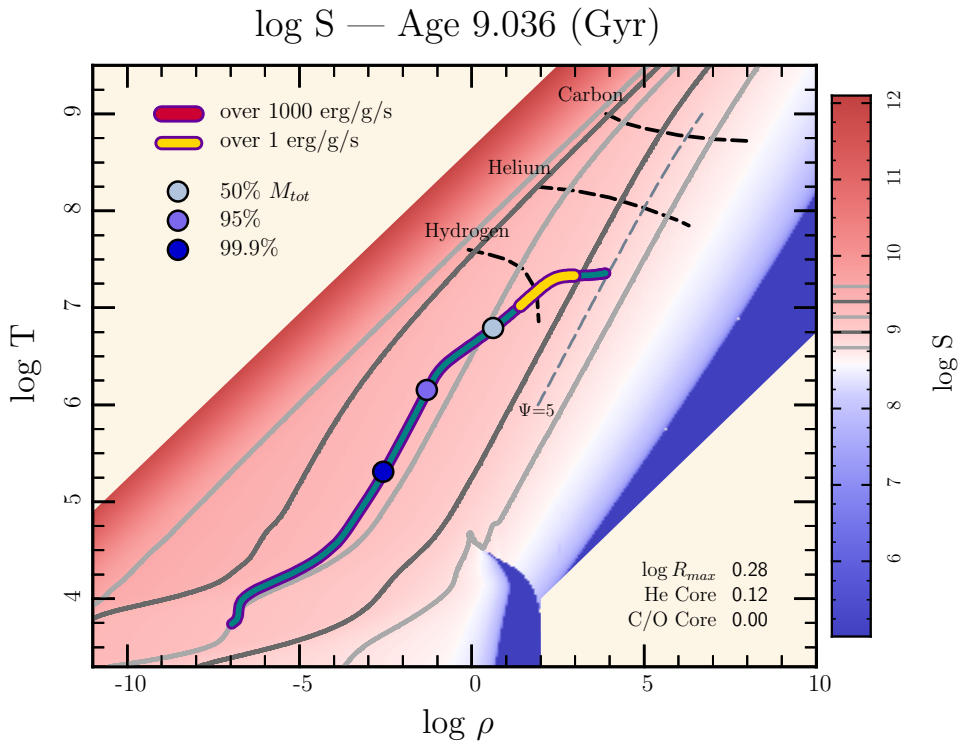


Figure 9: Entropy EOS Profile 2

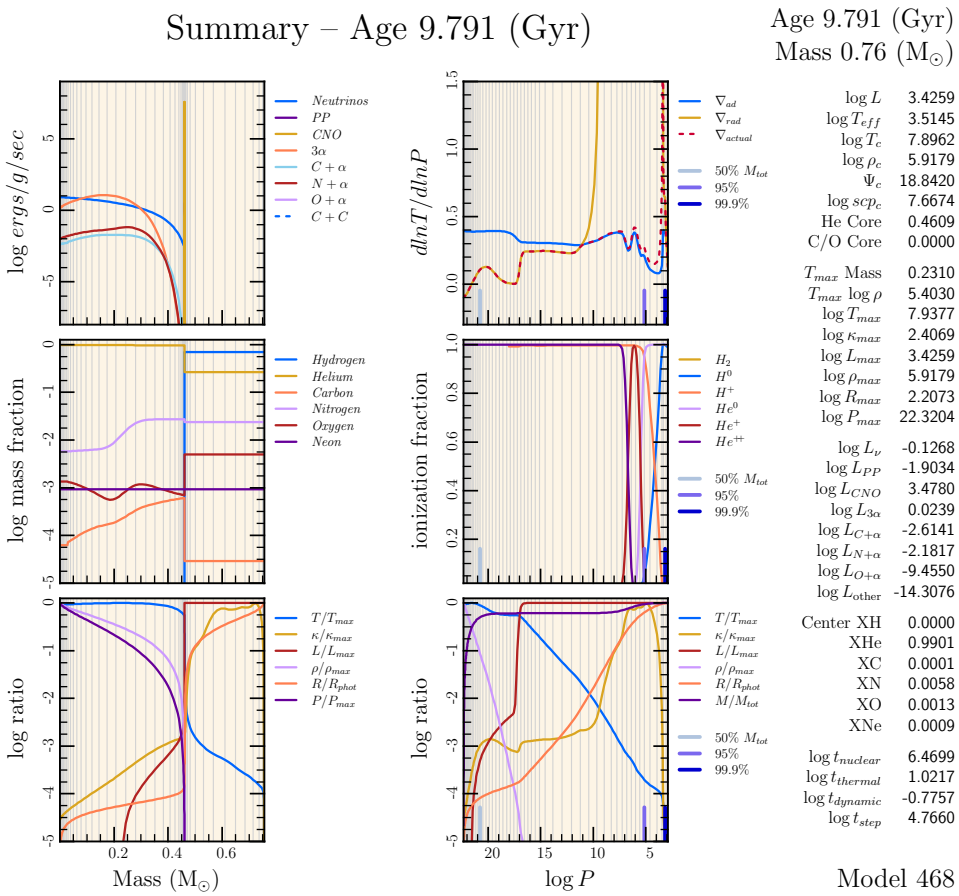


Figure 10: Profile 3

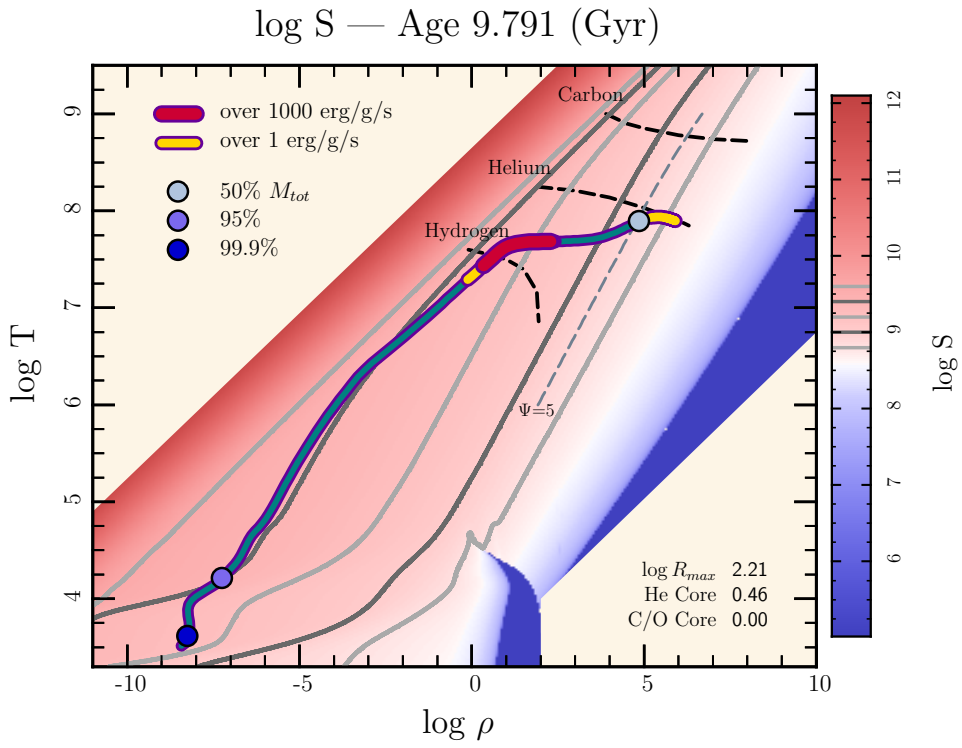


Figure 11: Entropy EOS Profile 3

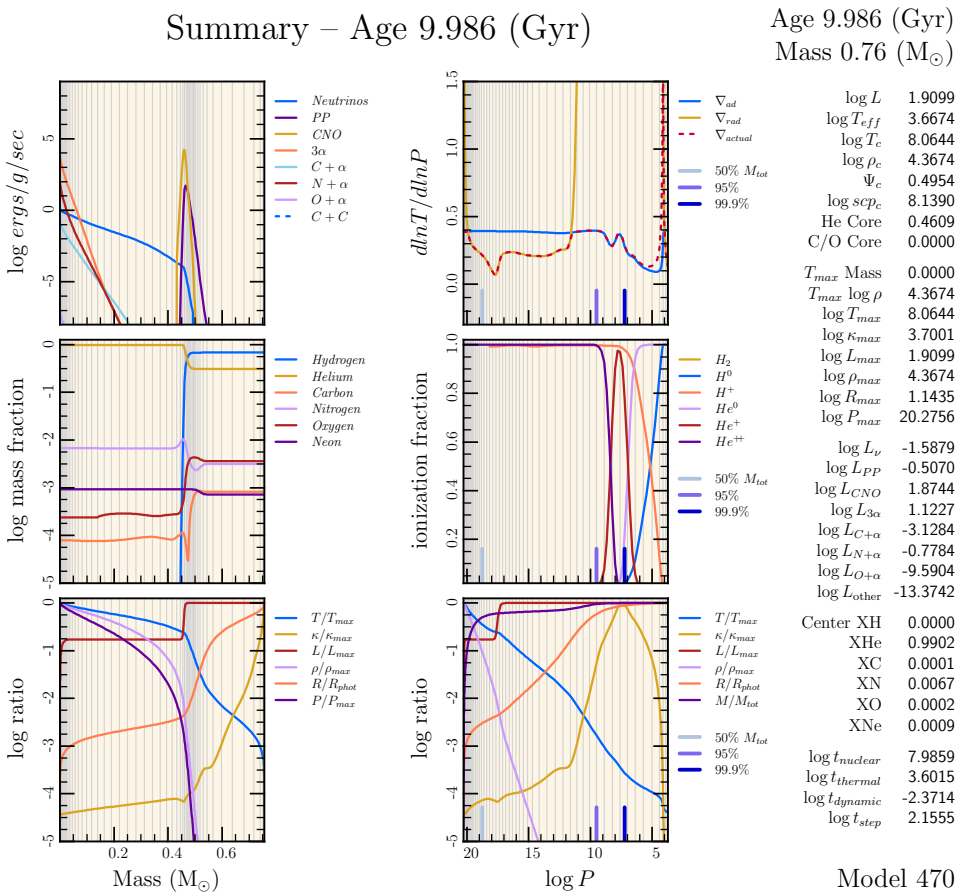


Figure 12: Profile 4

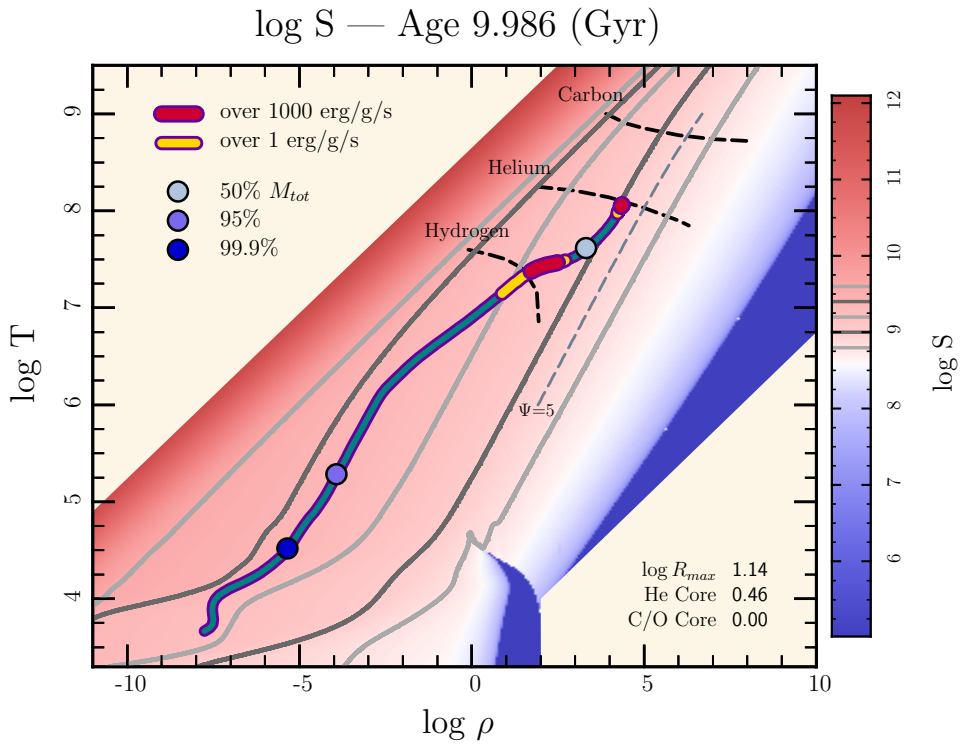


Figure 13: Entropy EOS Profile 4

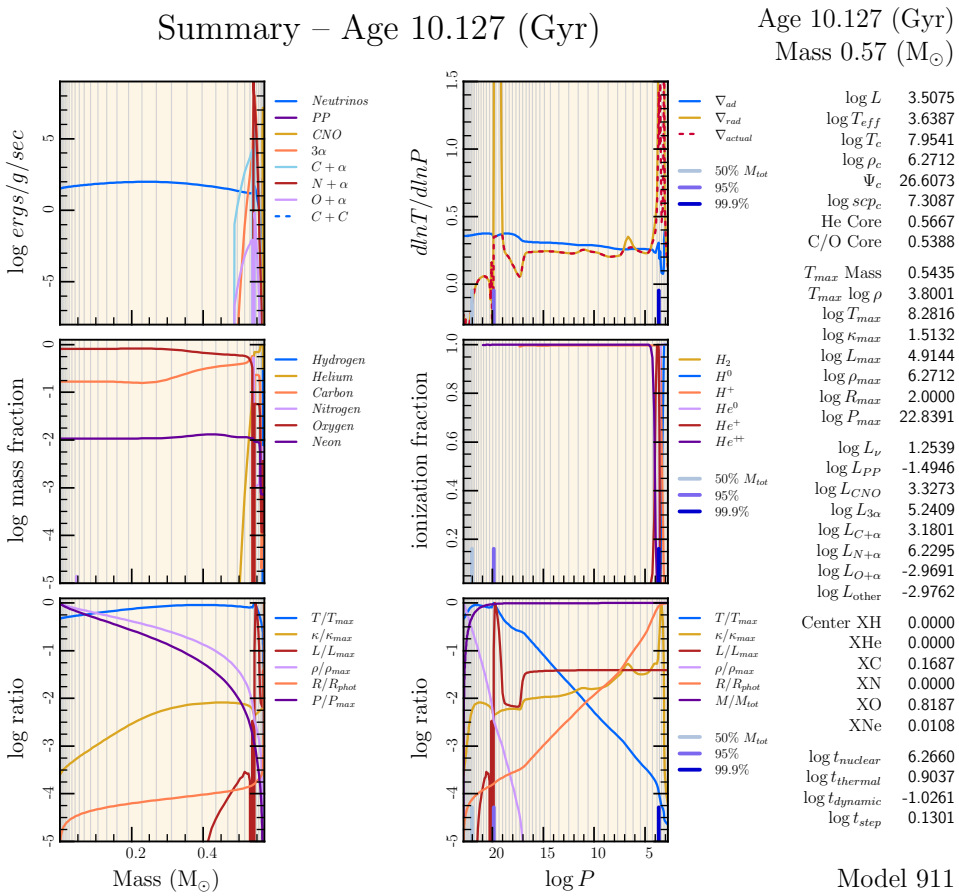


Figure 14: Profile 5

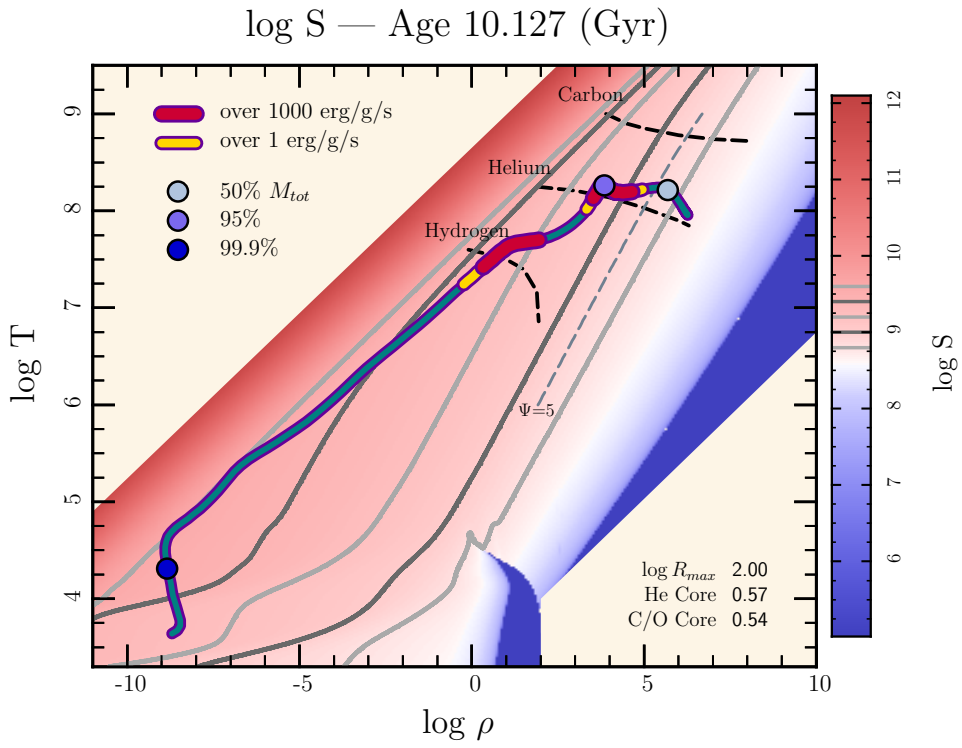


Figure 15: Entropy EOS Profile 5