

Extending the BoOST stellar model grids

Hanno Stinshoff - recently: Cologne, Germany; soon: Torun, Poland

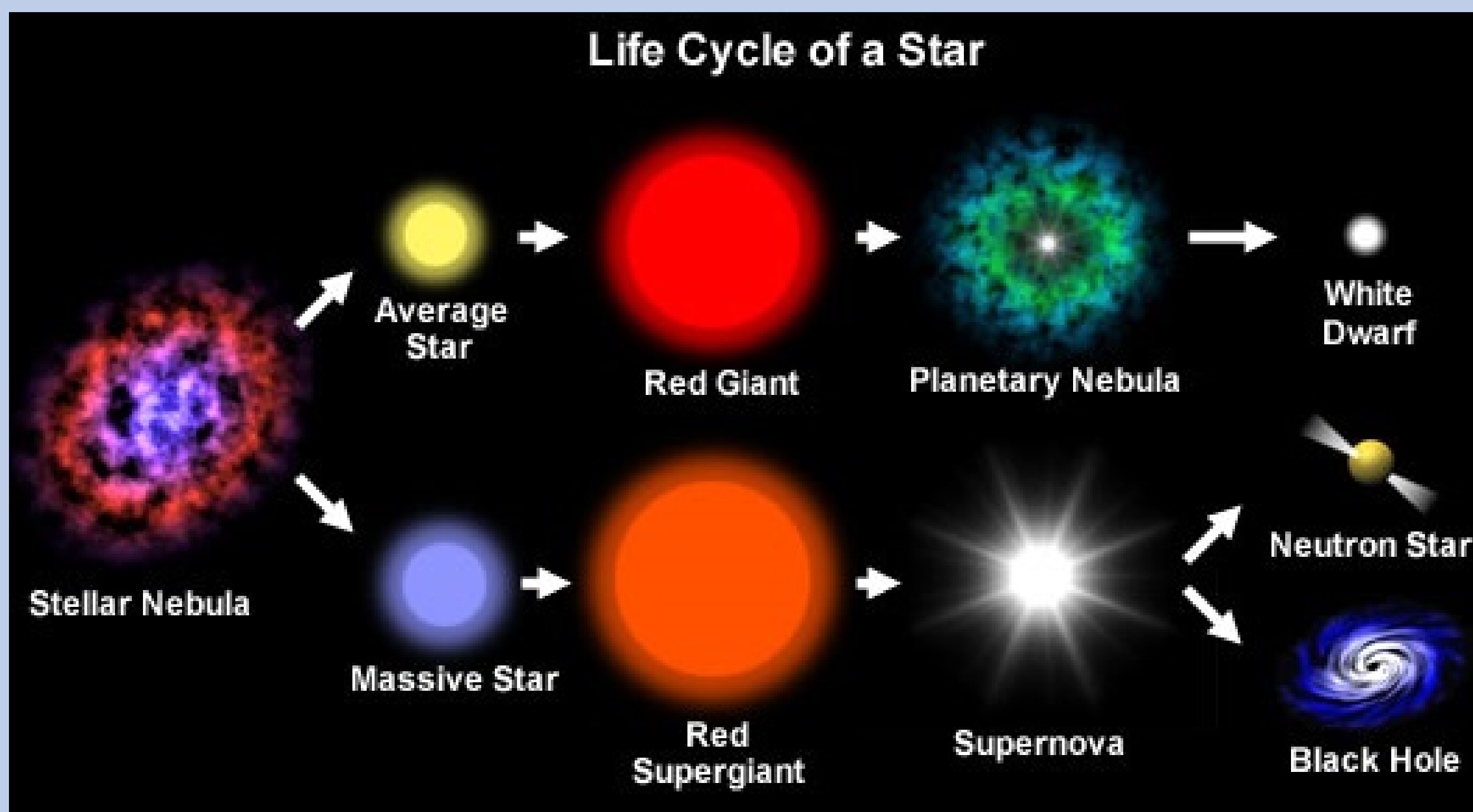


Figure 1: The differences in evolution for massive and low-mass stars, resulting in either a white dwarf or a supernova with subsequent evolution into a neutron star or a black hole [1].

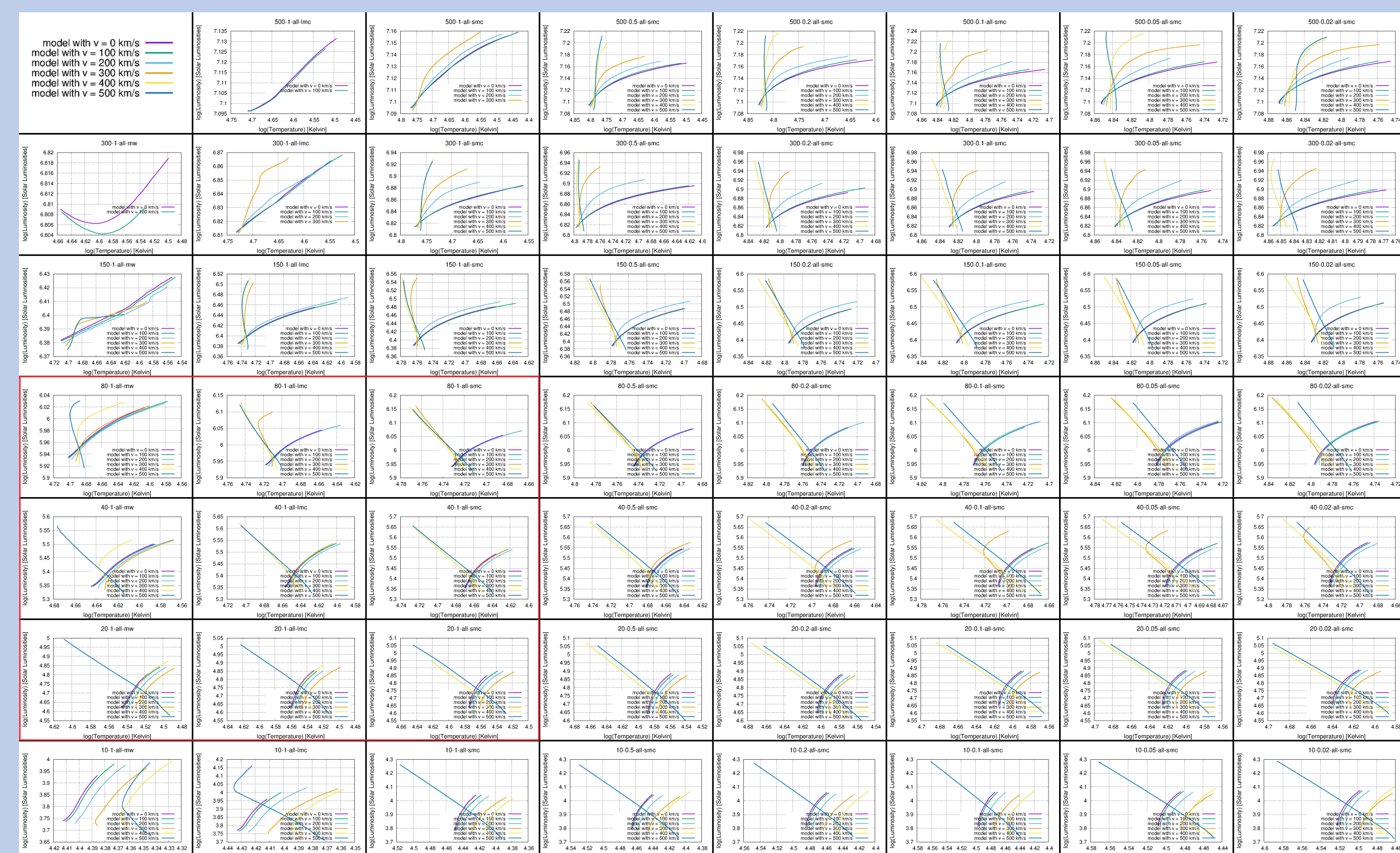


Figure 2: Bulkplot for the Hertzsprung-Russell diagrams (HRD) of all the created models. High masses are at the top, high metallicities are to the left. The HRD is a diagram of luminosity vs temperature with logarithmic scales and an inverted axis for the temperature due to historical reasons. A cutout (red rectangle) is provided in figure 3 and a short analysis below.

Massive stars

Massive stars have to be distinguished from low-mass stars due to their differences in evolution (cf. fig. 1). Those differences are dependent on various parameters like initial mass, rotational velocity and metallicity. Therefore a grid of models in that 3D-parameterspace is useful for research on them. In my masters thesis I created model sequences with the so-called Bonn-Code for a broad spectrum of input parameters (cf. the following figures), which right now reach about 60% of the main sequence.

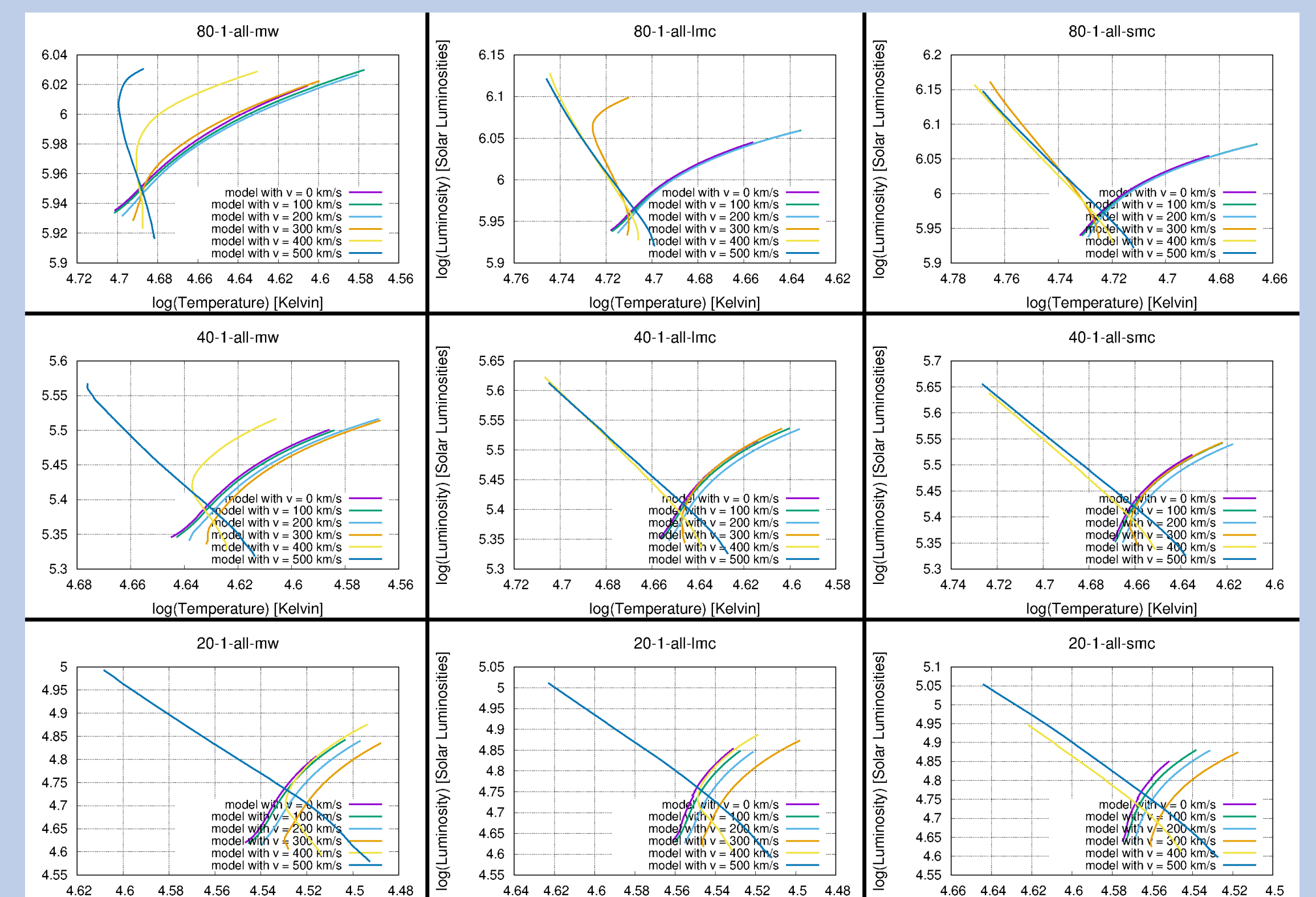


Figure 3: The cutout of the HRD bulkplot in figure 2 for the region of 80 to $20 M_{\odot}$ and metallicities from that of the Milky Way to that of the small magellanic cloud. A short analysis is provided below.

The Models - Bulkplot HRD

The models I created cover the initial masses from 10 to $500 M_{\odot}$ (massive stars), initial rotational velocities from 0 to 500 km/s and initial metallicities from Milky way (Z_{MW}) down to that of a fraction of the small magellanic cloud ($0.02Z_{SMC}$).

To present data from them the Bulkplot format was employed, which shows a given graph for all the models in a way that the high masses are at the top and the high metallicities are to the left (cf. fig. 2). The velocities are plotted in the same graph with various colours, ranging from purple (0 km/s) to dark blue (500 km/s).

Here the bulkplot for the Hertzsprung-Russell diagrams (fig. 2) and a cutout of the red rectangle region (fig. 3) of 80 to $20 M_{\odot}$ and metallicities from that of the Milky Way to that of the small magellanic cloud are depicted.

In the Hertzsprung-Russell diagrams (which is a luminosity vs. temperature diagram with inverted temperature scale) you can see the bifurcation of the sequences evolving red- and rightward (towards cool temperatures) with a "normal" evolution, and blue- and leftward (towards hot temperatures) with a chemically homogeneous evolution [2]. Additionally transitional modes are presented for some sequences (cf. for example the orange line in figure 3 of the $80 M_{\odot}$, Z_{LMC} sequence).

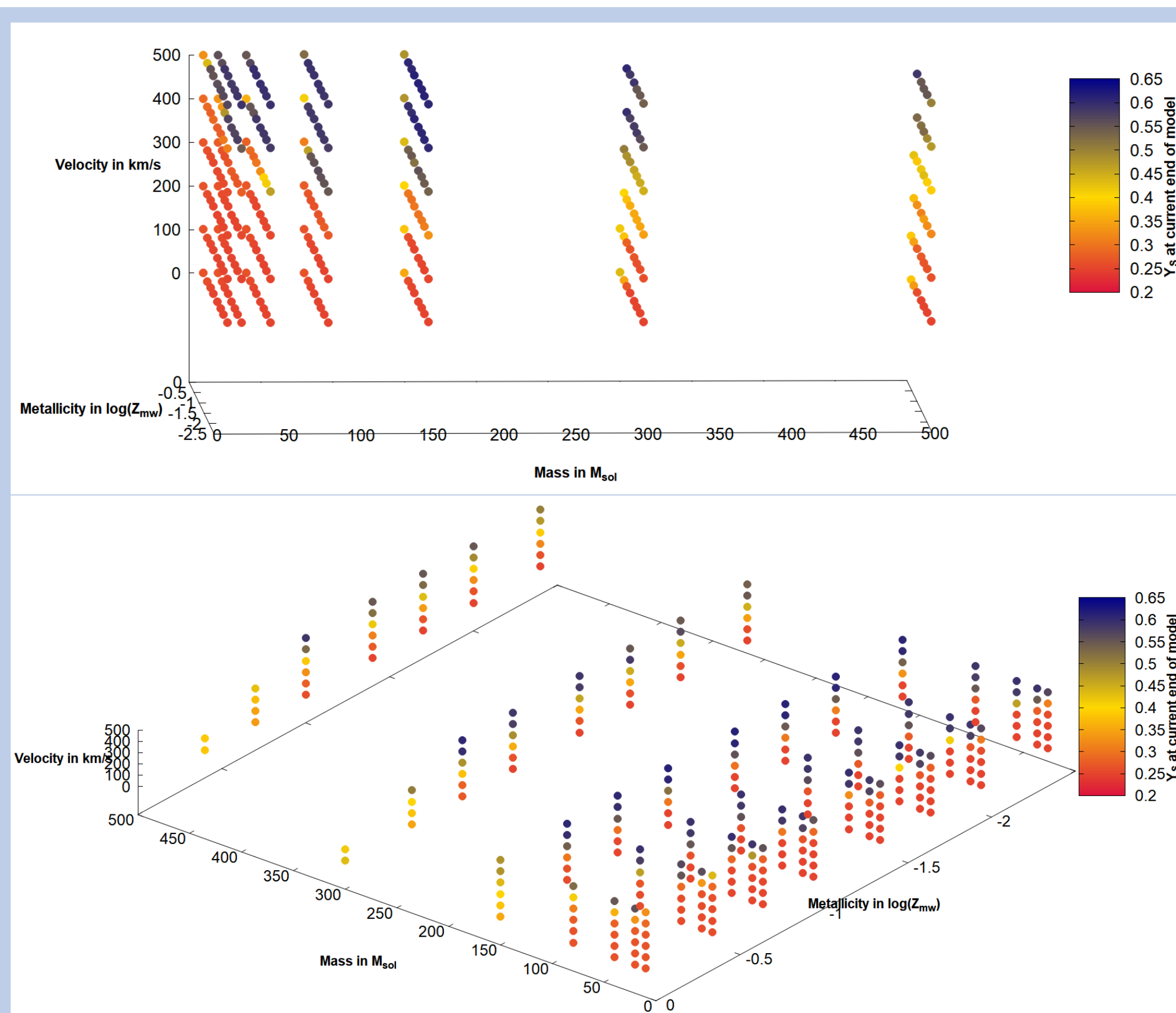


Figure 5: Plot of the surface helium mass fraction (colourcoded) vs. the three free initial parameters. High (blue) values go up to 0.65 for models that have a chemically homogeneous structure, while low (red) values of normally evolving sequences go down to around 0.25, which is due to the initial composition distribution.

The Models - Abundances

The created models provide a simulation of the abundances of various isotopes and elements, which facilitates the investigation on abundance anomalies in globular clusters like the presence of lithium (possibly explained by the Cameron-Fowler mechanism [3]).

It additionally enables the distinction between different evolutionary pathways like normal, chemically homogeneous and transitional evolution (cf. Bulkplot HRD).

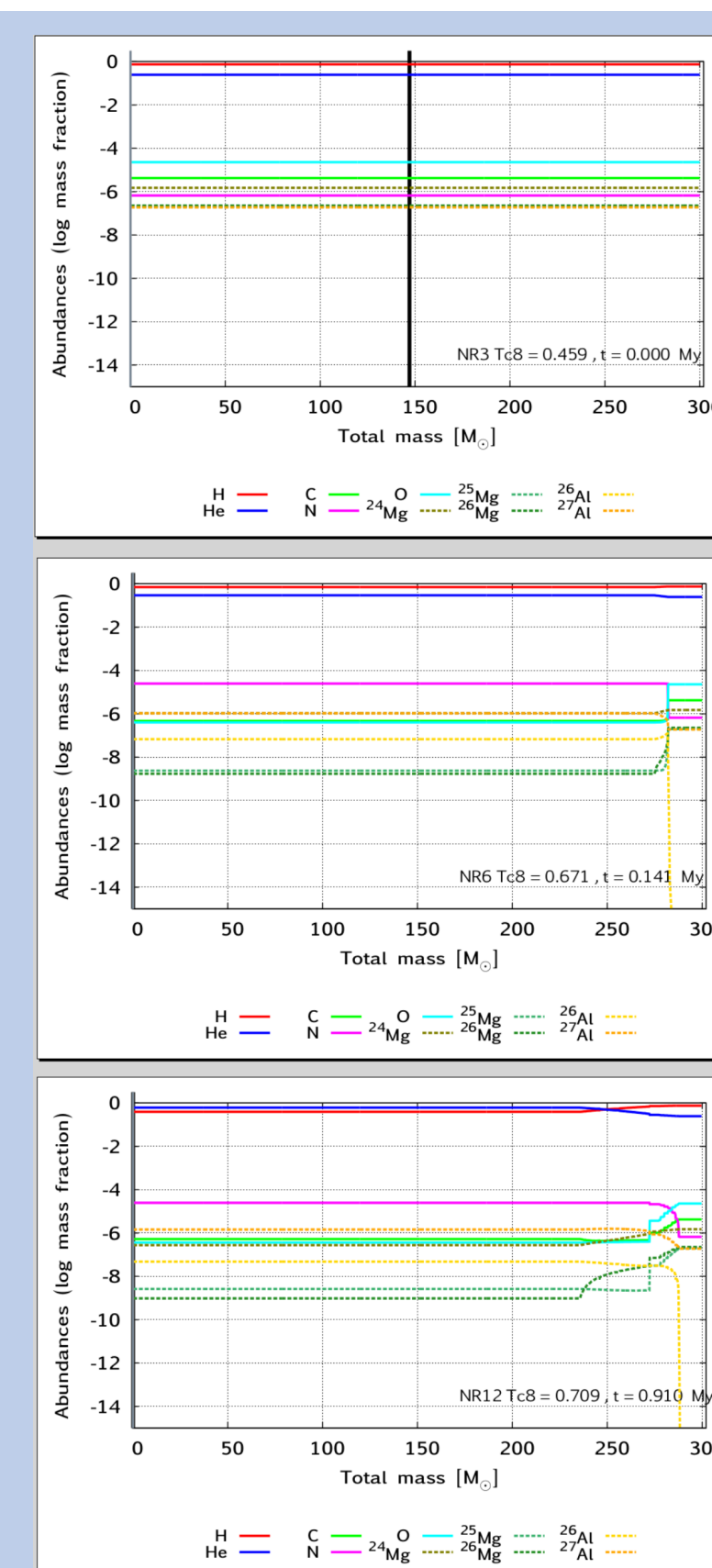


Figure 6: Plots for various isotope and element abundances vs. the mass coordinate of a model, for three different snapshots of the evolution. Due to for example the crossing point of the hydrogen and helium line one can see the border between core and envelope, which in context of the total mass can give indication of the evolutionary pathway.

The Models - Surface Helium Mass Fraction

When plotting the surface helium mass fraction of the models at the end of their current lifetime, one can see that the evolutionary pathways heavily impacts the helium levels. Chemically homogeneous evolution leads to high helium abundances (blue in fig. 5), whereas a normal evolution leaves the helium abundance more or less untouched at initial values. When plotting it against the initial parameters, one therefore can see the tendencies for such behaviours depending on the initial parameters.

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