Nitrogen production in population III stars

Sophie Tsiatsiou[1], Cyril Georgy[1], Sylvia Ekström[1], Georges Meynet[1]

[1]University of Geneva

sofia.tsiatsiou@unige.ch

The first stars in the Universe have inherited their composition from primordial nucleosynthesis, so they have no metals. Previous studies showed that they should have been rotating fast.

Aim → Study how the production of primary N is affected due to high rotation in the pop III stars.
Grids of pop III stars with *zero*, *average*, and *high rotation*. All the models have been computed using Geneva code (GENEC) in the mass range of $9M_{\odot} \leqslant M_{ini} \leqslant 120M_{\odot}$.
Rotational mixing of the chemical elements is mainly due to shear turbulence.

1. Shear turbulence at the border of the He-burning core is a key process to bring C into the H-burning shell and produce primary N.

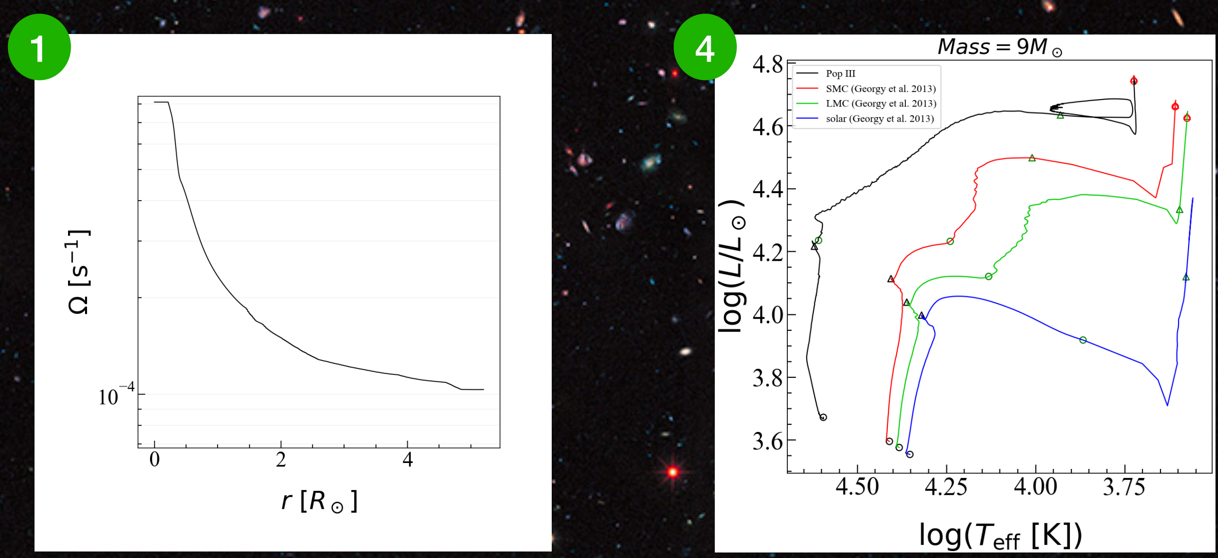

Figure 1: Left panel: The evolution of the angular velocity $\Omega(r)$ at the end of He-burning phase for the $20M_{\odot}$ model. Right panel: HR diagram for $9M_{\odot}$ models with different metallicities.

2. The contraction is in part the cause of the Ω gradient that drives the shear turbulence that brings carbon into the H-shell and produce the primary nitrogen.
3. In pop III stars the contraction is less strong than on models with even a small initial content of heavy elements.
4. This is because in pop III stars H-burning occurs at higher temperatures which are near the temperatures that are needed for the 3α-process.
5. Therefore we would expect much less production of primary N in the pop III models than in models with higher metallicities.
6. However, in the case that the pop III stars are fast rotating models, they may produce a significant amount of primary N.

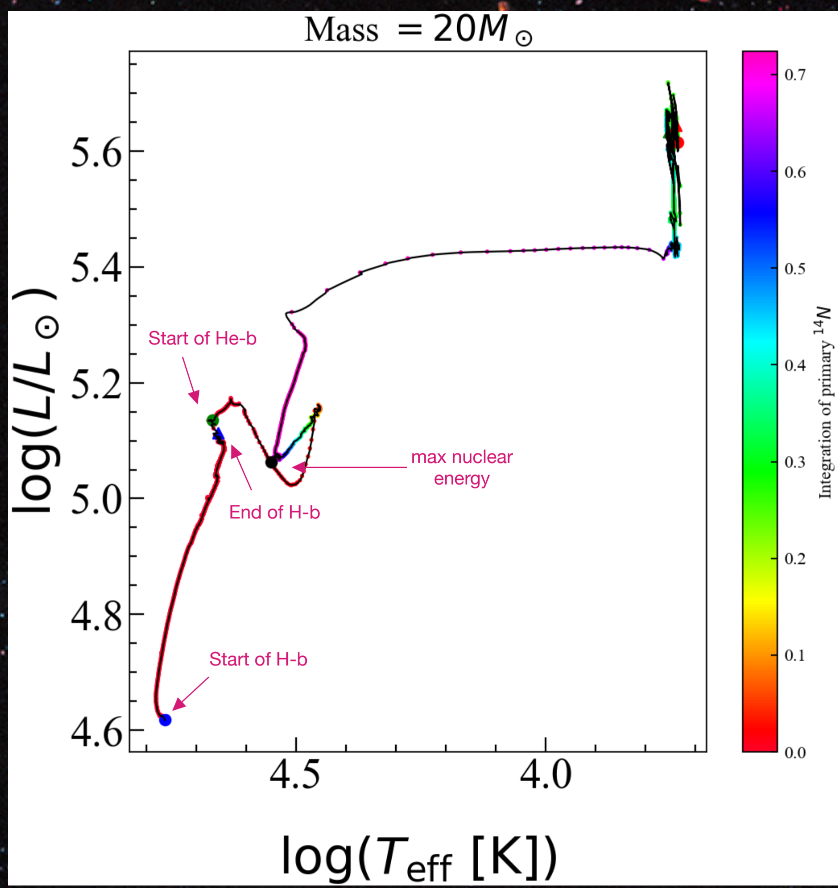

Figure 2: HR diagram with the integrated amount of N during its evolution.

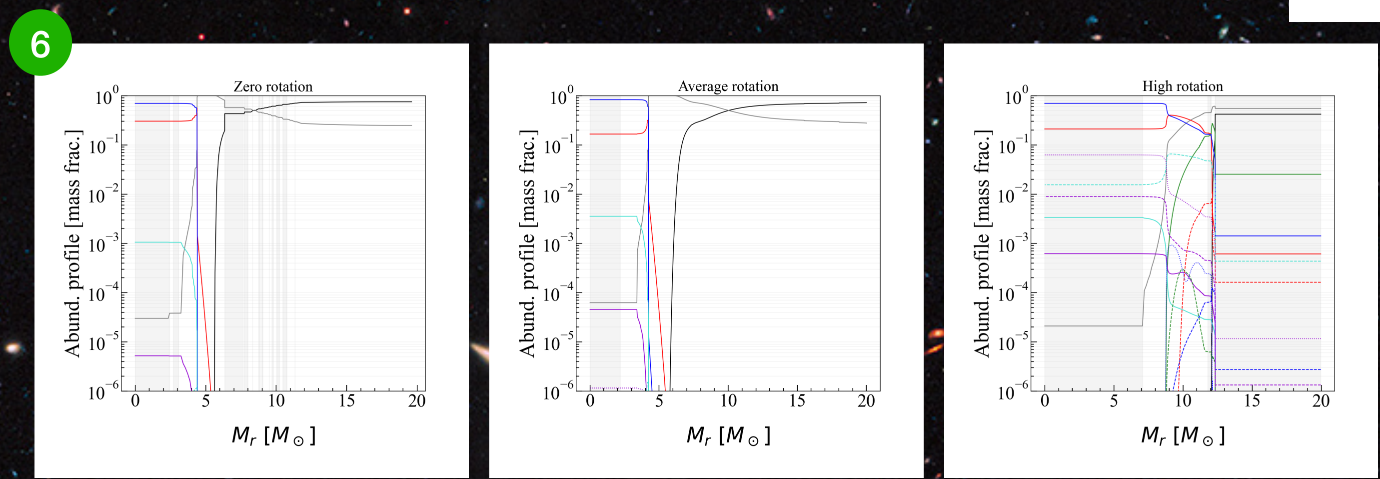

Figure 3: The chemical structure of the $20M_{\odot}$ model at the end of He-burning phase from the core to the surface. The grey shaded areas are the convective regions of the star. The green line corresponds to N. (Zero rotation and average rotation from Murphy et al. (2021))

UNIVERSITÉ DE GENÈVE