P107c Simulations of Inhomogeneous Metal Mixing after the first Supernovae

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Background: To model the chemical origin of old, metal-poor stars, one usually assumes that all elements that are ejected by a Pop III supernova (SN) mix homogeneously with each other. However, we see in local SN remnants that different elements are distributed inhomogeneously and simulations of the first SNe indicate that explosions can be aspherical.

Methods: We initialise our simulations with the explosion of a $40\,\mathrm{M}_\odot$ Pop III collapsar in a minihalo at $z = 15$. Due to jet of the collapsar, the initial progenitor model starts with significant deviations from spherical symmetry in its polar regions. Using Arepo and Monte-Carlo tracer particles placed in the ejecta, we trace the expansion and mixing of carbon and iron as two representative elements. The simulation is followed until the gas recollapses and second-generation stars form. The distribution of the tracer particles and their respective carbon to iron ratios are then analysed down to sub-AU scales using a new statistical model.

Results: The initial inhomogeneous distribution of carbon and iron persists during the SN expansion, which results in spatially varying [C/Fe] ratios. Depending on the time and location of second-generation star formation, the chemical composition of the resulting EMP stars can differ from the original collapsar yields.

Discussion: These results are crucial for the Stellar Archaeology community. If we can confirm incomplete mixing with further simulations, we need to adapt our interpretation of metal-poor stars. If we find that in most cases elements mix homogeneously, this would support one of the main assumptions of Stellar Archaeology.