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Nucleosynthesis in zero and extremely low metallicity rotating massive stars

The s-process is responsible for producing roughly half of the elements heavier than iron in the periodic table. While the dominant contribution to s-process nucleosynthesis in galactic chemical evolution (GCE) is typically attributed to the late evolutionary stages of low-mass stars, their long lifetimes make them unlikely sources for explaining the presence of heavy elements observed in the spectra of extremely metal-poor (EMP) low-mass stars, which formed shortly after the Big Bang. In contrast, massive stars ($\mathrm{M} \geq\sim 8-9\mathrm{M}_{\odot}$) are limited to producing only the weak component of the s-process, especially at low metallicity due to the lack of seeds.

A possible scenario which aims to explain this unexpected presence of heavy elements in EMP stars is that they formed out from gas clouds polluted by the supernova yields of rotating massive progenitors. Rotation at low metallicity, in fact, can considerably boost the neutron capture nucleosynthesis in massive stars through an efficient activation of the neutron sources during He and C burning stages. In this talk, I will present the main results of my recent work, discussing the effect of fast rotation in core-collapse supernova progenitors at zero and very low metallicity, with a particular focus on the nuclear reactions leading to the production of F and of the nuclei beyond Zn.

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