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The first matter cycle in the Universe: from Population III to extremely metal-poor stars

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We investigate the formation of extremely metal-poor (EMP) stars that are observed in the Galactic halo and neighboring ultra-faint dwarf galaxies. Their low metal abundances ($[\mathrm{Fe/H}] < -3$) indicate that their parent clouds were enriched by a single or several supernovae (SNe) from the first (Pop III) stars. In this study, we perform numerical simulations of the formation sequence of a EMP star through the feedback effects from a Pop III star. We for the first time employ a metal/dust properties calculated consistently with the progenitor model. In a minihalo (MH) with mass 1.77×10^6 $\mathrm{M}_\odot$, a Pop III star with mass 13 $\mathrm{M}_\odot$ forms at redshift $z = 12.1$. After its SN explosion, the shocked gas falls back into the central MH internally enriching itself. The metallicity in the recollapsing region is 2.6×10^{-4} $\mathrm{Z}_\odot$ ($[\mathrm{Fe/H}] = -3.42$). The recollapsing cloud undergoes cooling by HD, CO, and OH molecules and heating along with H_2 formation. Eventually by grain growth and dust cooling, knotty filaments appear in the central 100 au region with the help of turbulence driven by the SN, leading to the formation of low-mass EMP stars surviving until the present day.

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Talk/Poster

Talk

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