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Multiplicity of the first stars from machine learning-based classification of stellar fossils

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We derive for the first time the multiplicity of the first stars from the abundance patterns of extremely metal-poor (EMP) stars in the Milky Way. Based on theoretical models of the chemical yields of the first supernovae, we train decision trees to classify EMP stars. This machine learning-based approach predicts if a certain abundance pattern is consistent with supernova enrichment by one or by several progenitor stars (mono- or multi-enriched). On a blind test sample, we achieve an accuracy of over 80% for individual EMP stars. By applying the trained random forest to actual observations, we find both mono- and multi-enriched EMP stars. Their relative fraction allow us to constrain the multiplicity and initial mass function of the first stars, which has significant consequences for the radiative and chemical signature of the first stars and galaxies.

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