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Observing the chemical signatures of the oldest, most metal-poor stars

ANNA FREBEL, Massachusetts Institute of Technology

In their atmospheres, oldest, most metal-poor Galactic stars retain detailed information about the chemical composition of the interstellar medium at the time of their birth shortly after the Big Bang. Extracting such stellar abundances enables us to reconstruct the onset of the chemical evolution. About 5% of metal-poor stars display in their spectrum a strong enhancement of neutron-capture elements associated with the rapid (r-) nucleosynthesis process that is responsible for the production of the heaviest elements in the Universe. This fortuity provides a unique opportunity of bringing together astrophysics, nuclear physics and laboratory astrophysics because these objects act as "cosmic lab" for these fields of study.

In order to carry out the spectroscopic chemical abundance analyses of these and other stars, atomic data is required for each absorption line to be measured in the spectrum. Only then abundances can be derived. This is of particular importance in those 'r-process' stars: Among many other elements, we find the long-lived radioactive isotopes 232Th (half-life 14 Gyr) and 238U (4.5 Gyr) in some of these rare objects. Their abundances, in combination with abundances of stable r-process nuclei, such as Eu, yield stellar ages of $\sim$ 13 billion years