THE CHEMICAL SIGNATURE OF FIRST-GENERATION MASSIVE STARS

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Numerical simulations of structure formation in the early Universe predict the formation of stars with masses from (1) several tens to (2) several hundred to several thousand times the solar mass. The recently discovered carbon-enhanced metal-poor (CEMP) star with [Fe/H] < -7.1 and the distinctive light-element pattern of CEMP-no stars (carbon-enhanced stars that do not exhibit neutro-capture element over-abundances) can be associated with the first class of progenitors. However, no clear evidence of supernovae from super-massive stars has yet been found among the chemical compositions of Milky Way stars, the second class of expected progenitors. Until now.
After a discussion of the abundance patterns from CEMP-no stars, I report on an analysis of a newly discovered very metal-poor star, SDSS J001820.5-093939.2, which possesses elemental-abundance ratios that differ significantly from any previously known star. This star exhibits low [α-element/Fe] ratios and large contrasts between the abundances of odd and even element pairs, such as Sc/Ti and Co/Ni. Such features have been predicted by model calculations of the nucleosynthesis associated with a pair-instability supernova of a 130-260 solar-mass star, or a core-collapse supernova of an even more massive star. The result suggests that the mass distribution of first-generation stars might extend to 100 solar masses or larger, possibly up to 1000 solar masses.