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Barium isotope ratio in very metal-poor stars as a key to a puzzle of light neutron-capture element synthesis at the earliest epoch.

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Aim. We determine r- to s-process contributions to Ba isotope mixture along with Ba, Eu, and Sr NLTE abundances in a sample of very metal-poor (VMP) stars. The selected stars have [Ba/H] < -2.2 and, thus, formed before the contribution from the main s-process in low and intermediate stars became significant. Some of our sample stars are enhanced in Sr with [Sr/Ba] up to 0.7. These stars gained their high Sr abundance from a poorly known process, phenomenologically called in the literature as a light element primary process (LEPP, Travaglio et al. 2004) that may appear to be, for example, a weak s-process or a weak r-process. We aim to uncover the nature of this extra Sr source via Ba r- to s- isotope ratio determinations.
Method. The abundances from the resonance Ba II 4554 and 4934 A lines are affected by the adopted Ba isotope mixture. We compute Ba isotope mixtures that correspond to different r- to s- process contributions (pure r-process, 80%/20%, 50%/50% and 20%/80%, i. e. solar ratio) and determine the corresponding abundances from the Ba II resonance lines in each sample star. In addition to that, we determine Ba abundances from weak subordinate Ba II lines, which are immune to the adopted Ba isotope mixture. After that we compare Ba abundance from the subordinate lines with those from the Ba II resonance lines.
Results. Three of our sample stars are strongly r-process enhanced, and consistent within the error bars abundances from the resonance lines and subordinate lines can be achieved with pure r-process Ba isotope mixture, while including the s-process contribution results in a larger abundance discrepancy between the subordinate and resonance lines.
We found higher s-process contribution in stars with higher [Sr/Ba] overabundance, arguing that extra Sr synthesis was due to the early s-process occurring in massive stars. Using stars with high [Sr/Ba] we estimated the [Sr/Ba] ratio produced in the early s-process and found [Sr/Ba]_earlyS = 1.1 +- 0.2. Our result suggests that variations in [Sr/Ba] ratios in VMP stars can be explained by different contributions of the r-process and the early s-process to their chemical composition.

Authors: SITNOVA, Tatyana; LOMBARDO, Linda (Goethe University Frankfurt)

Presenter: SITNOVA, Tatyana