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The origin of weak r-process nucleosynthesis

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The origin of the rapid neutron-capture (r-) process is a major question in astrophysics. The clue to answer this question is the chemical abundance patterns of extremely metal-poor (EMP) stars with [Fe/H] < -3, which are believed to reflect the nucleosynthesis yields of a single event. Recent high-resolution spectroscopic observations have shown that the abundance patterns of neutron-capture elements in many metal-poor stars are consistent with the solar r-process abundance pattern, indicating the universality of the r-process (e.g. Sneden et al. 2008). On the other hand, it has also been confirmed that some metal-poor stars (e.g. HD 122563; Honda et al. 2006) have an excess of light neutron-capture elements such as strontium (Sr, Z = 38) compared to heavy neutron-capture elements such as barium (Ba, Z = 56), and thus the other process that mainly produces light neutron capture elements, the weak r-process, has been proposed.

To clarify the origin of the weak r-process, we study the extremely metal-poor star SMSS J022423.27−573705.1, which has an extremely high lower limit on the [Sr/Ba] ratio as reported by Jacobson et al. (2015). Analyzing the near-ultraviolet and visible spectra obtained with VLT/UVES. we measured 26 elemental abundances. High signal-to-noise ratio observation allow us to determine the abundances of nitrogen, oxygen, zinc and barium for the first time. The abundances of neutron-capture elements were compared with the abundances of solar r-process and metal-poor stars from previous studies, and it was confirmed that the [Sr/Ba] ratio in SMSS J022423.27−573705.1 is the highest among metal-poor stars observed. We also compare the chemical abundance in SMSS J022423.27−573705.1 with theoretical nucleosynthesis models. In this talk, we summarize these results and discuss the origin of weak r-process.

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