

New astrophysical site for r-, i- and s-processes in black-hole forming supernova

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Taka Kajino(1-3) and Zhenyu He(1,3)

1 Beihang University, 2 National Astronomical Observatory of Japan, 3 University of Tokyo

The slow and intermediate neutron-capture processes, s- and i-processes, are believed to occur only in asymptotic giant branch stars to provide half of heavy atomic nuclei $90 \leq A$ in the Milky Way. We found, for the first time, that the collapsar which is an explosion of single massive star collapsing to a black hole is an astrophysical site for s- and i-processes [1] as well as rapid neutron capture process, r-process [2]. We show significant roles of several neutron-capture reactions on unstable nuclei near the stability line for the i-process as well as those on extremely neutron-rich nuclei for the r-process. We propose that the pronounced odd-even effect in the mass abundance pattern near rare earth elements in metal-deficient halo stars could be a piece of observational evidence [1,3].

[1] Z. He, M. Kusakabe, T. Kajino, S.-G. Zhou, H. Koura, & S. Chiba, submitted (2022).

[2] Y. Yamazaki, Z. He, T. Kajino, G. J. Mathews, M. A. Famiano, X.-D. Tang, J.-R. Shi, ApJ. 933 (2022), 112.

[3] Z. He, M. Kusakabe, T. Kajino, S.-G. Zhou, H. Koura, & S. Chiba, in preparation (2022).

Primary author: Prof. KAJINO, Taka (Beihang University / NAOJ / University of Tokyo)

Presenter: Prof. KAJINO, Taka (Beihang University / NAOJ / University of Tokyo)

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