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Neutron capture rates in the i and r process

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The rapid (r) and intermediate (i) neutron capture processes are critical for explaining the observed abundance patterns in stars. Both processes rely on neutron-capture rates, which remain largely unconstrained, experimentally.

For the i process, we report the first experimental constraint on the ^{139}Ba(n,γ)^{140}Ba reaction rate using radioactive ion beams (RIBs) from CARIBU at Argonne National Laboratory and the newly developed Shape method [1]. Our results reduce the dominant uncertainty in lanthanum production, a key i-process indicator, and confirm that elemental abundances in metal-poor stars are consistent with an i-process scenario at neutron densities of 10^{13} n/cm^3 [2].

For the r process, we present new measurements of neutron capture rates in neutron-rich Cs [3] isotopes, almost 10 neutrons away from the last stable Cs isotope, probing nucleosynthesis pathways “north-east” of the doubly magic Sn-132 nucleus. These data provide critical inputs for statistical Hauser-Feshbach models, enabling improved predictions of neutron-capture rates in this key r-process region.

Finally, we discuss ongoing efforts at RIB facilities such as TRIUMF (Canada) and FAIR (Germany) to further expand the experimental neutron-capture rate database for both the r and i processes.

[1] Muecher, Spyrou et al., Phys. Rev. C 107, L011602, 2023
[2] Spyrou, Muecher et al., Phys. Rev. Lett. 132, 202701, 2024
[3] Greaves, Muecher et al., in preparation

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