Experimental study of ^{11,12}B(n,γ) reactions for r-process nucleosynthesis

JINA

Neutrino-driven winds or hot bubble models in core-collapse supernovae [1] with a short dynamic timescale of the expanding wind [2] produce fewer seed nuclei, yielding more neutrons available to be captured on light neutron-rich nuclei during α-process. This increase results in a higher ratio of neutrons to seed nuclei, suggesting a promising site for *r*-process nucleosynthesis.

We have studied the neutron-transfer reactions ^{11,12}B(d,p)^{12,13}B in inverse kinematics to obtain information about the neutron capture reactions ^{11,12}B(n,γ). The radioactive beam of ^{12}B was produced at Argonne National Laboratory. The neutron spectroscopic factors of the states in ^{12,13}B were deduced and the branching ratio of the neutron-unbound state at E_X=3.389 MeV in ^{12}B was obtained to provide the ratio of partial widths, Γ_n/Γ_γ. The reaction rates for ^{11,12}B(n,γ) are estimated for direct captures and resonant captures and compared with previous compilations in Figure 1. The astrophysical implications are discussed in Figure 2 in the *r*-process network framework using our updated reaction rates.

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[1] B.S. Meyer, G.J. Mathews, W.M. Haward, S.E. Woosley, and R.D. Hoffman, Astrophys. J. 399, 656 (1992).
[2] M. Terasawa, K. Sumiyoshi, T. Kajino, G.J. Mathews, and I. Tanihata, Astrophys. J. 562, 470 (2001).

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See the published work:
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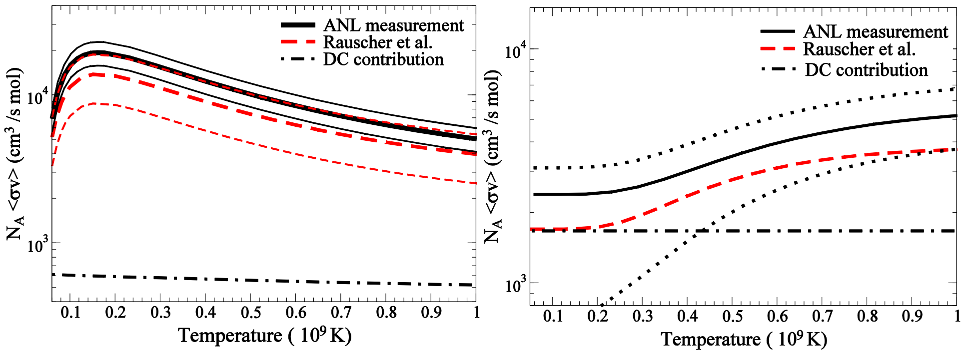

Figure 1. Total neutron capture rates on the ^{11}B (left) and ^{12}B (right) obtained from the current measurement (the thick solid line) compared with Rauscher's compilation (the dashed line). The dotted and thin solid lines are upper and lower limits for the current and Rauscher's rates, respectively. Both rates show 50 % larger than Rauscher's with reduced uncertainties.

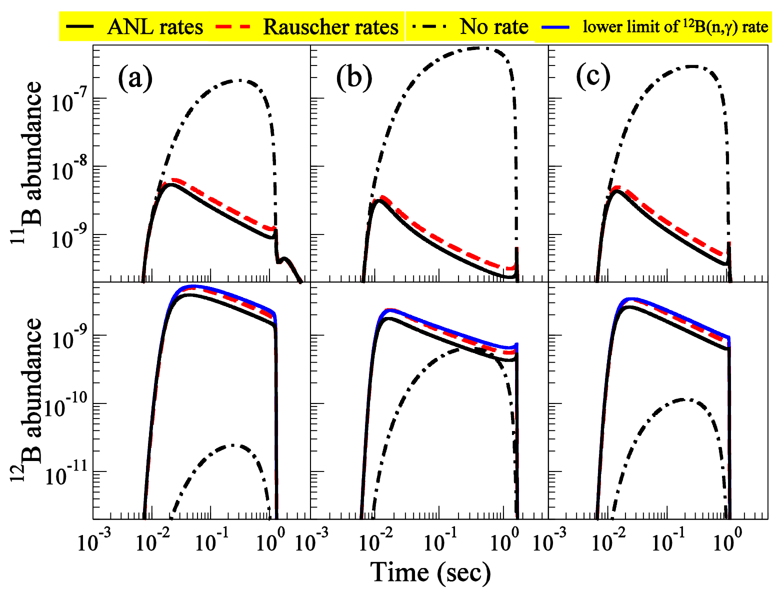

Figure 2.The abundances of ^{11}B (top) and ^{12}B (bottom) over time calculated in the *r*-process network using the ^{11,12}B(n,γ) reaction rates from the Rauscher rates (the dashed line) and the ANL rates (the thick solid line). The dashed-dotted line represents the one without including any ^{11,12}B(n,γ) reaction rates and the thin solid line the ones using the lower limit of the ^{12}B(n,γ) rate. (a),(b), and (c) correspond different astrophysical conditions. With several thousands of nuclei involved in the network, we confirmed the importance of sensitivity to the dynamic timescale and the asymptotic temperature and the need for more neutron capture data on light nuclei up to T_9 ~ 2.

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