New measurement of ^{8}Li$(\alpha, n)^{11}$B reactions

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The ^{8}Li$(\alpha, n)^{11}$B reaction is considered to be the key reaction in the inhomogeneous Big Bang and type-II supernova nucleosyntheses, and we have been providing cross-section data[1–7] on this reaction for more than two decades. The previous results[1–7] are summarized in Fig. 1, in which the Gamow-peak widths are also drawn. The energy regions of $T_9 = 1$ and 2 are important for the Big Bang and supernova nucleosyntheses, respectively.

As shown in Fig. 1, the cross-sections obtained by the previous experiments have large differences around $E_{\rm cm} = 1.0$ MeV. The previous experiments were performed by two different methods: inclusive and exclusive. The former detected either ^{11}B[1,2] or neutron[4,6] and the latter[3,5,7] detected both ^{11}B and neutron by measuring their kinetic energies and angles. The cross-sections of the former results are five times larger than the latter ones systematically. We could estimate that the sources of the discrepancies might originate from the experimental methods, but we have no experimental fact to determine them. To solve this problem, we designed a new *inclusive* measurement, in which we measured the γ-rays emitted from ^{11}B*s. The previous experiment did not measure the γ-rays. Therefore this experiment will provide new data to understand the ^{8}Li$(\alpha, n)^{11}$B reaction. Considering that the expected γ-ray energies are between 2 and 8 MeV, we selected a large volume 3.5"×8" $LaBr_3$:Ce detector[8] provided by INFN Milano. We also installed plastic and ^{6}Li-glass scintillators to detect neutrons by covering wide energy ranges between a few ten keV to 10 MeV.

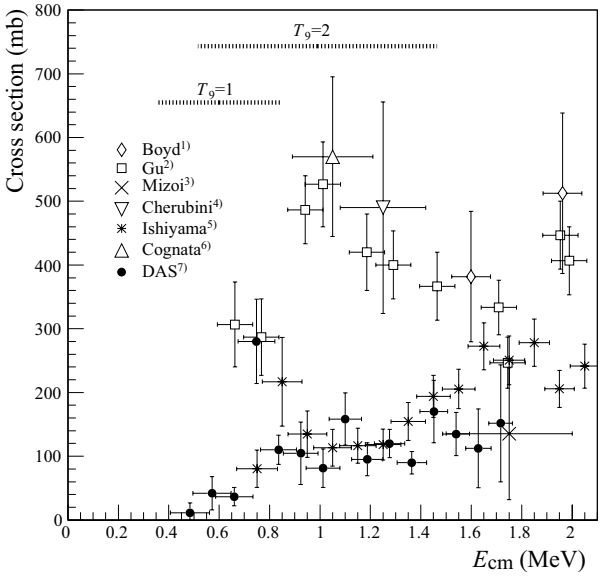

Fig. 1. Excitation functions of ^{8}Li$(\alpha, n)^{11}$B reaction.

This experiment was performed at CRIB in September 2018. We placed a gas-target cell at F3, in which ^{4}He gas was filled at a pressure of 1.0 atm. The ^{8}Li beam, whose intensity was typically 300 kHz, was produced by the ^{7}Li$(d, p)^{8}$Li reaction. The primary ^{7}Li beam had an energy of 6.0 MeV/nucleon and an intensity of 250 particle nA. The D_2-gas production target had a thickness of 1.9 mg/cm^2. The energies of ^{8}Li particles measured inside the ^{4}He-gas target were between $E_{\rm cm} = 0.9$ and 1.9 MeV.

We successfully obtained data with sufficient statistics. Although we faced difficulties in data analysis owing to the large background originating from thermal neutrons, we could identify the γ-rays emitted from ^{11}B*s. We will further present the results to solve the controversial discrepancies.

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References

1) R. N. Boyd *et al.*, Phys. Rev. Lett. **68**, 1283 (1992).
2) X. Gu *et al.*, Phys. Lett. B **343**, 31 (1995).
3) Y. Mizoi *et al.*, Phys. Rev. C **62**, 065801 (2000).
4) S. Cherubini *et al.*, Eur. Phys. J. **20**, 355 (2004).
5) H. Ishiyama *et al.*, Phys. Lett. B **640**, 82 (2006).
6) M. La Cognata *et al.*, Phys. Lett. B **664**, 157 (2008).
7) S. K. Das *et al.*, Phys. Rev. C **95**, 055805 (2017).
8) A. Gaiz *et al.*, Nucl. Instrum. Methods Phys. Res. A **729**, 910 (2013).