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Studies on alpha-induced astrophysical reactions using the low-energy RI beam separator CRIB

H. Yamaguchi[1], D. Kahl[1], T. Nakao[1],Y. Wakabayashi[2], S. Kubono[2], T. Hashimoto[3], S. Hayakawa[4], T. Kawabata[5], N. Iwasa[6], T. Teranishi[7], Y.K. Kwon[8], D.N. Binh[9], L.H. Khiem[9], and N.G. Duy[9]

[1] *Center for Nuclear Study, the University of Tokyo, 2-1 Hirosawa, Wako, Saitama, Japan*
[2] *The Institute of Physical and Chemical Research (RIKEN), 2-1 Hirosawa, Wako, Saitama 351-0198, Japan*
[3] *Research Center for Nuclear Physics, Osaka University,10-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan*
[4] *Laboratori Nazionali del Sud, via S. Sofia 62, 95125 Catania, Italy*
[5] *Department of Physics, Kyoto University, Kita-Shirakawa, Kyoto 606-8502, Japan*
[6] *Department of Physics, Tohoku University, Aoba, Sendai, Miyagi 980-8578, Japan*
[7] *Department of Physics, Kyushu University, 6-10-1 Hakozaki, Fukuoka 812-8581, Japan*
[8] *Institute for Basic Science, 70, Yuseong-daero 1689-gil, Yuseong-gu, Daejeon 305-811, Korea*
[9] *Institute of Physics, Vietnam Academy of Science and Technology, 18 Hong Quoc Viet, Nghia do, Hanoi,Vietnam*

Contact email: *yamag@cns.s.u-tokyo.ac.jp*

CRIB (CNS Radioisotope Beam Separator) is a low-energy RI beam separator operated by CNS, the University of Tokyo, located at RIBF of RIKEN. Results of recent astrophysical reaction studies performed at CRIB are presented.

We have been studying nuclear resonances, which may enhance astrophysical reaction rates, via proton or α resonant scattering with the thick target method in inverse kinematics. Measurements of ^{7}Li/^{7}Be+α resonant elastic scattering have been performed recently [1,2], and we will mainly discuss on their results. The excitation functions of ^{7}Li/^{7}Be+α around 180^{o} in the center-of-mass system were successfully measured with the inverse kinematics method. They provided important information on the α cluster structure in ^{11}B/^{11}C and the reaction rate of ^{7}Li(α,γ) and ^{7}Be(α,γ) at high temperature (T > 1 GK). The ^{7}Li(α,γ) reaction is relevant to the ^{11}B production in the ν-process in core-collapse supernovae. The number ratio of ^{11}B/^{7}Li, mainly determined by the ^{7}Li(α,γ) reaction rate, is considered to have a sensitivity on the neutrino mixing parameter, θ_{13} and the neutrino mass hierarchy [3]. The ^{7}Be(α,γ) reaction is one of the important reactions in the hot pp chain, and a calculation of the νp-process in core-collapse supernovae [4] has shown that the reaction may be responsible for the production of carbon as much as the triple-alpha process at high temperature. The excitation functions of the ^{7}Li/^{7}Be(α,α') inelastic scattering and the ^{7}Li/^{7}Be(α,p) reactions were also obtained in the same measurement.

Another major interest at CRIB is the direct measurement of (α, p) reactions. Direct measurements have been performed for several (α, p) reactions such as ^{11}C(α, p), ^{14}O(α, p), ^{18}Ne(α, p), ^{30}S(α, p), and ^{22}Mg(α, p), which may play important roles in the hot pp chain, the hot CNO cycle, and the αp-process. An active target system using GEM detector (GEM-MSTPC) [5] was built at CNS and used for some of these measurements, to perform a clear identification of the reaction. The status and results of these studies will also be presented.

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