# Observation of $^{9}$Li + $d$ decay channel in $^{11}$Li($p,n$) reaction

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In the SAMURAI30 experiment, we studied the Gamow-Teller (GT) giant resonance in the drip-line nucleus $^{11}$Li at 181 MeV/nucleon utilizing the missing-mass technique.[1)] The $^{11}$Li nucleus is the showcase of a two-neutron halo system, with its very extended matter distribution related to the small energy necessary to remove the neutrons. The charge-exchange $(p,n)$ reactions in inverse kinematics are efficient tools to extract the B(GT) strengths of unstable isotopes up to high excitation energies without the $Q$-value limitation.[2)] In our previous study, we demonstrated that accurate information about isovector spin-flip giant resonances can be obtained for unstable nuclei using this probe.[3)] The setup of the PANDORA low-energy neutron time-of-flight counter[4)] and SAMURAI magnetic spectrometer[5)] as well as a thick liquid hydrogen target, facilitate the performance of measurements with high luminosity.

The $\beta$ decay of $^{11}$Li is complex. The large mass difference between $^{11}$Li and its daughter $^{11}$Be ($Q$ = 20.6 MeV) implies that several decay channels to the bound and unbound states in $^{11}$Be are open. In the latter cases, the daughter breaks into fragments, and the emission of one, two, and three neutrons, $\alpha$ particles and $^{6}$He, tritons, and deuterons has been observed in several $\beta$-decay studies.[6,7)] In our previous reports[8)] on the preliminary results on GT giant resonance, the observation of these different decay channels was confirmed. Among them, the most interesting decay mode is $^{9}$Li + $d$. This channel is related to the possibility that in halo nuclei, the core and halo particles could decay, more or less independently, into different channels.[9)]

We observed a strong transition at approximately 19 MeV in the excitation energy spectrum of $^{11}$Be. The angular distribution in center-of-mass angle of the observed state indicates a strong forward peaking nature, which suggests the GT transition, as depicted in Fig. 1, in agreement with previous $\beta$-decay studies.

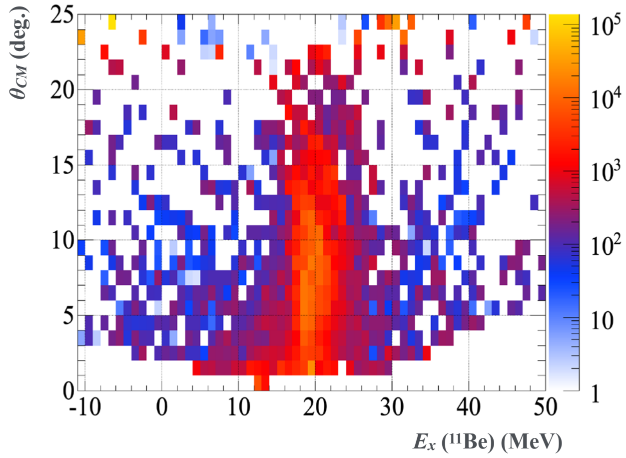


Fig. 1. Angular distribution, in the 0°–25° center-of-mass angular range, of the strong peak observed in the excitation energy spectrum of the daughter nucleus $^{11}$Be for the $^{9}$Li + $d$ decay mode.

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