Gamow-Teller giant resonance in ^{11}Li neutron drip-line nucleus

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Recent nuclear physics studies are increasingly focused on the region far from the valley of stability, thereby leading to an increase in the intensity of available exotic isotopes. We started a program[1)] at the RIKEN Radioactive Isotope Beam Factory with the objective of measuring the spin-isospin responses of light nuclei along the neutron drip line. There are no available data on nuclear collectivity (giant resonances) on any drip-line nucleus.

In the SAMURAI30 experiment, we studied the most basic nuclear collectivity, the Gamow-Teller (GT) giant resonance, in ^{11}Li (at 181 MeV/nucleon) and ^{14}Be (at 198 MeV/nucleon) nuclei. The charge-exchange (CE) (p, n) reactions in inverse kinematics are efficient tools for extracting the B(GT) strengths of unstable isotopes, up to high excitation energies, without Q-value limitation.[2)] The uniqe setup of the Particle Analyzer Neutron Detector Of Real-time Acquisition (PANDORA)[3)] low-energy neutron counter + SAMURAI magnetic spectrometer,[4)] together with a thick liquid hydrogen target allowed us to perform such measurements with high luminosity and low background. In our previous study on ^{132}Sn, we verified that with this setup, we can extract the strength distribution of isovector spin-flip giant resonances in unstable nuclei with quality comparable to those on stable nuclei.[5)]

In the ^{11}Li$(p, n)^{11}$Be reaction, we identified clear kinematical correlations[6)] between the neutron energy and laboratory scattering angle for more than ten different decay channels of ^{11}Be: $^{10}\mathrm{Be}+n$, $^{9}\mathrm{Be}+2n$, $^{9}\mathrm{Li}+p+n$, $^{8}\mathrm{Li}+p+2n$, $^{9}\mathrm{Li}+d$, $^{8}\mathrm{Li}+t$, $^{8}\mathrm{Li}+d+n$, $^{7}\mathrm{Li}+t+n$, $^{7}\mathrm{Li}+d+2n$, $^{6}\mathrm{Li}+t+2n$, $\alpha+{}^{6}\mathrm{He}+n$ and $2\alpha+3n$.

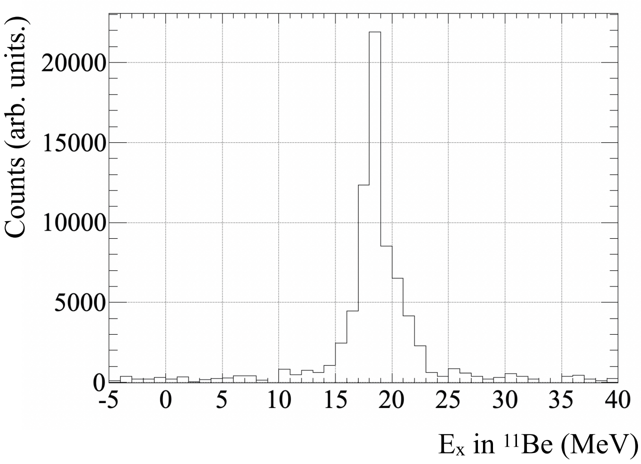

Fig. 1. Excitation energy spectrum in the 6°–8° center-of-mass system for $^{8}\mathrm{Li}+\mathrm{t}$.

The excitation-energy spectra up to approximately 40 MeV have been reconstructed. The background subtraction and acceptance correction are performed. As an example, Fig. 1 presents the excitation energy spectrum in the daughter nucleus ^{11}Be for the $^{8}\mathrm{Li}+t$ decay channel for $\theta_{\mathrm{C.M.}}$ = 6°–8°. A forward scattering peak in the 0°–10° center-of-mass system indicates a strong GT transition in all decay channles at approximately 19 MeV, below the Isobaric analogue state,[7)] which agrees well with previous beta-decay studies.[8)]

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