Study of Gamow-Teller transitions from ^{11}Li

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The studies of dynamic properties of exotic nuclei such as giant resonances, which are manifested at high excitation energies (>10–15 MeV), are in the very early stage. No data are available on spin-isospin collectivity for nuclei with large isospin asymmetry factors, where $(N-Z)/A > 0.25$.[1)]

In the SAMURAI30 experiment, we studied the most basic nuclear collectivity, the Gamow-Teller (GT) giant resonance, in the drip-line nucleus ^{11}Li at 181 MeV/nucleon. The charge-exchange (CE) (p,n) reactions in inverse kinematics are efficient tools to extract the B(GT) strengths of unstable isotopes up to high excitation energies, without Q-value limitation.[2)]

The combined setup of Particle Analyzer Neutron Detector Of Real-time Acquisition (PANDORA)[3)] low-energy neutron counter and the SAMURAI magnetic spectrometer,[4)] together with a thick liquid hydrogen target allowed us to perform such measurements with high luminosity. In this setup, PANDORA is used for the detection of the recoil neutrons. The neutron kinetic energies are deduced by the time-of-flight technique, and SAMURAI is used for tagging the decay channel of the reaction residues. Many relevant decay channels after the CE reaction can be measured in a single magnetic rigidity setting owing to the large acceptance of SAMURAI. Such a setup was already successfully used in our first (p,n) experiment on ^{132}Sn.[5)] It was proven that we can obtain information about the strength distribution of isovector spin-flip giant resonances of unstable nuclei with quality comparable to those on stable nuclei.[5)]

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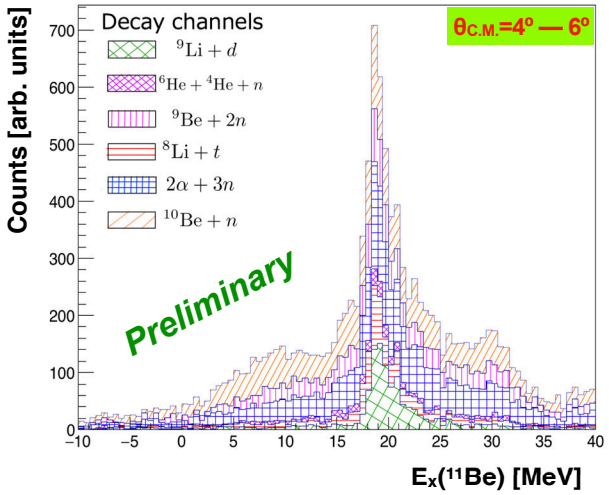

Fig. 1. Preliminary excitation energy spectrum in the 4°–6° center-of-mass system. The contributions of different decay channels are presented.

In our ^{11}Li$(p,n)^{11}$Be measurement, we successfully identified clear kinematical correlations[6)] between the neutron energy and laboratory scattering angle for the different decay channels of ^{11}Be: ^{10}Be+n, ^{9}Be+2n, α+^{6}He+n, 2α+3n, ^{8}Li+t, and ^{9}Li+d.

The reconstruction of the excitation-energy spectrum up to about 40 MeV, including the giant resonance region, is ongoing. Figure 1 presents preliminary results of the excitation energy spectra in the daughter nucleus ^{11}Be. The background subtraction and correction for the detection efficiency and acceptance are ongoing. We will derive the excitation energy spectra for $\theta_{C.M.} = 1°$–$10°$ from all decay channels. The forward scattering peaks in the 0°–8° center-of-mass system, suggest a strong GT transition at approximately 18 MeV, in agreement with previous beta-decay studies.[7)]

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