Gamow-Teller transitions in ^{6}He with PANDORA

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We started a program at RIBF aiming to study the spin-isospin responses of light drip line nuclei. An experiment[1)] with 5 days of beam time was approved to investigate ^{11}Li and ^{14}Be nuclei. The charge-exchange (p,n) reactions at intermediate beam energies ($E/A >$ 100 MeV) and small angles can selectively excite the Gamow-Teller (GT) states up to high excitation energies in the final nucleus. Therefore, (p,n) reactions in inverse kinematics applying the missing mass reconstruction[2,3)] provide the best and efficient tool to study the B(GT) strength values of unstable isotopes in a wide excitation energy region, without Q-value limitation. In a pilot measurement of the mentioned experiment, we studied the case of ^{6}He at HIMAC facility in Chiba to investigate the Gamow-Teller transitions in ^{6}He and commission our new plastic scintillator-based neutron detector PANDORA (Particle Analyzer Neutron Detector Of Real-time Acquisition)[4)] and its pulse shape discrimination (PSD) capability.

The secondary beam properties and details of the experimental setup are described in another contribution in this volume.[5)] By using PANDORA with our digital data acquisition system,[6)] we could detect the neutrons having kinetic energies of a few tens of keV. Neutron- and gamma-like events could be separated by defining $\mathrm{PSD_{mean}}$ value as the arithmetic mean of PSD values[1)] of two single-end read-outs of each bar. From the measured neutron time-of-flight and recoil angle (in the laboratory angle range of 75°–99°), the excitation energy of the residual nucleus can be reconstructed. Figure 1 shows the calculated kinematical correlations for the $^6\mathrm{He}(p,n)$ charge-exchange reaction at 123 MeV/nucleon energy.

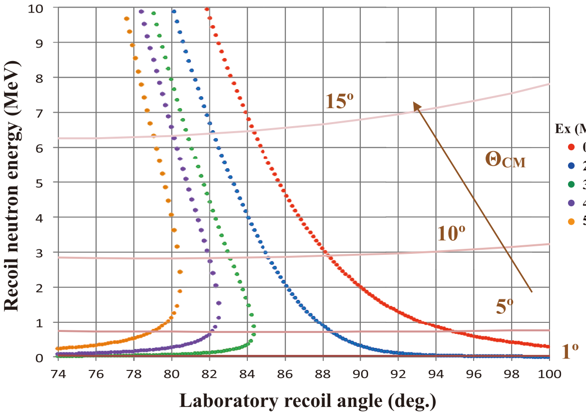

Fig. 1. Correlations between recoil neutron energy and laboratory kinematics for fixed excitation energies.

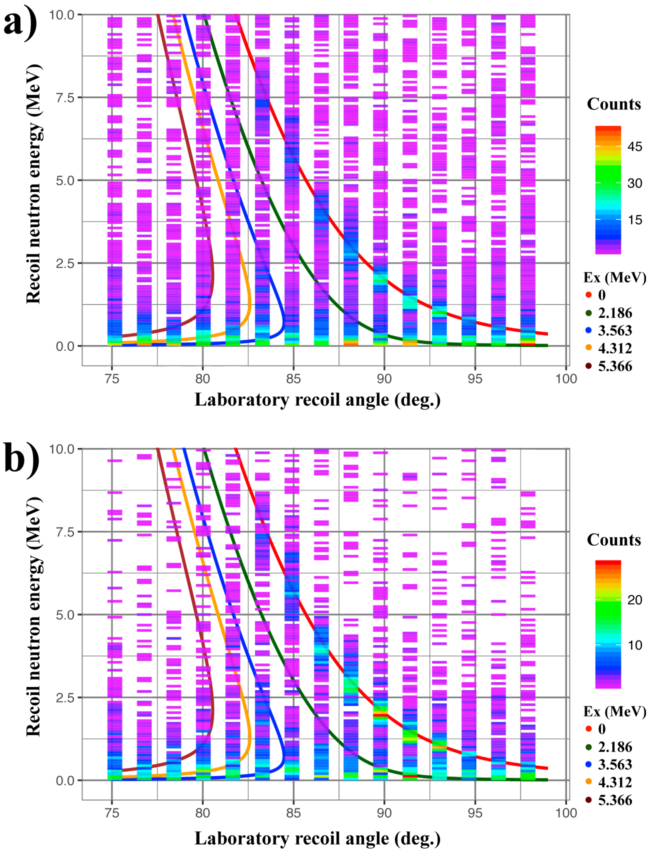

Fig. 2. Neutron spectra as functions of both recoil neutron energy and recoil angle in the $^6\mathrm{He}(p,n)$ reaction without gating on neutron-like events (a) and with gate on neutron-like events (b).

Selecting the incident ^{6}He particles and the identification of ^{6}Li reaction residue produced from the (p,n) reaction, a clear kinematical correlation can be seen on the Fig. 2 (a) scatter plot. This matches with the calculated curve and corresponds to transitions to the ground state in ^{6}Li. After gating on neutron-like events by $\mathrm{PSD_{mean}}$, the improvement of the kinematic locus in Fig. 2 (b) presents the effectiveness of PANDORA and its PSD capability. The data shown here were accumulated within 9 h. Further analysis with larger statistics is in progress.

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References

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