Study of Neutron-Proton Correlations & 3N Forces in ^{12}C

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The study of neutron-proton (np) correlations in nuclei is very important to understand the nuclear structure. Direct two-nucleon knockout reactions offer a powerful tool for quantitative measurements of the n-p correlations in $N = Z$ nuclei.[1,2] The measured inclusive two-nucleon knockout cross sections[3,4] show significant enhancement of np ($T = 0$ & 1) over nn and pp ($T = 1$) correlations in ^{12}C. The shell-model calculation for the two-nucleon overlaps within the p shell can reproduce the inclusive cross sections for like-nucleon pair removal, but underestimates the np-pair removal cross section by approximately a factor of two.[1] This discrepancy implies insufficient description of the $T = 0$ np interactions in the shell-model wave functions. A recent calculation using the no-core shell model that exploits modern chiral effective field theory NN+3N interactions[2] suggests that the final-state-exclusive np-knockout cross sections from ^{12}C to the $T = 0$ states can provide an immediate test of the np correlations (particularly in their $T = 0$ component) and three-nucleon forces. To investigate the nature of these forces, we therefore measured γ-residue coincidence to extract the final-state-exclusive np- and pp-removal cross sections from ^{12}C to ^{10}B and ^{10}Be.

The experiment was carried out at RIBF. The secondary ^{12}C beam (presently not available as the primary beam for SRC-use experiments) was produced by fragmentation of an ^{18}O primary beam at 250 MeV/u using a 5-mm thick Be target. The ions of interest were selected using the BigRIPS fragment separator[5] by measuring the energy loss (ΔE) and time of flight (TOF) with plastic scintillators at the intermediate foci F3 and F13. The incident angle and position of the beam on a 1.879-g/cm^2 thick Be target were determined by two drift chambers, BDC1 and BDC2. The target was surrounded by the DALI2 γ-ray spectrometer.[6] One hundred and fifty-nine crystals of DALI2 were employed with an azimuthal angular coverage from 25° to 154°. The mid-target energy of ^{12}C was approximately 190 MeV/u. Reaction products were transported to the SAMURAI spectrometer[7] and identified with the $B\rho$-ΔE-TOF method. The magnetic rigidity $B\rho$ was determined from the measured positions at the forward drift chambers, FDC1 and FDC2. ΔE and TOF were measured by using the plastic scintillator hodoscopes, HODF and HODP. Fig. 1 shows the particle identification of reaction residues. It should be noted that the reaction channels of interest were measured simultaneously because of the large acceptance of SAMURAI.

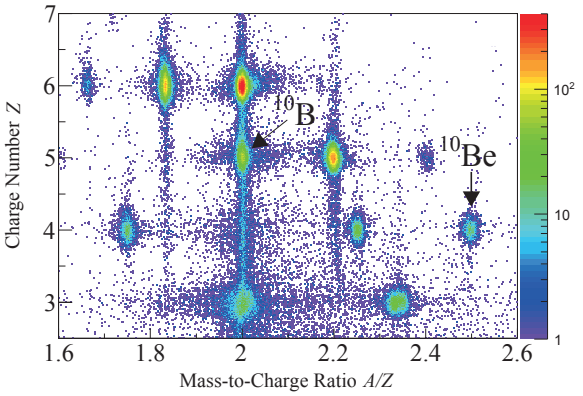

Fig. 1. Particle identification after the secondary target.

The preliminary ratio of inclusive np- to pp-removal cross sections was obtained, which is consistent with the previous result within errors.[3] Currently, the γ-ray spectrum analysis is ongoing. Further, the partial cross sections will be extracted.

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