Search for short-range correlation in neutron-rich systems

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A short-range correlated (SRC) nucleon pair, which refers to a pair of nucleons with a relatively large momentum, has attracted much attention for understanding the nucleon-nucleon interaction and structure of the nucleus. Indeed, SRC is considered a key factor for understanding the reduction in the occupation of shells, which has been a long-standing challenge of the shell model.

The interaction between correlated nucleons in SRC pairs is expected to be very strong and independent of the rest of the nucleus because of its tensor nature. Consequently, the distribution of high-momentum nucleons associated with SRC is expected to be similar across all nuclei. A recent study[1)] involving electron-induced knockout reaction on stable nuclei demonstrated that the fraction of high-momentum neutrons remains constant from ^{12}C to ^{208}Pb, whereas the fraction of high-momentum protons increases for neutron-rich ^{208}Pb, indicating a strong isospin dependence. This scenario has not been examined for unstable nuclei. We report on the search for SRC pairs in ^{10}Be via proton-induced deuteron knockout reaction (p, pd) in inverse kinematics to investigate the isospin dependence of SRC pairs in unstable neutron-rich systems.

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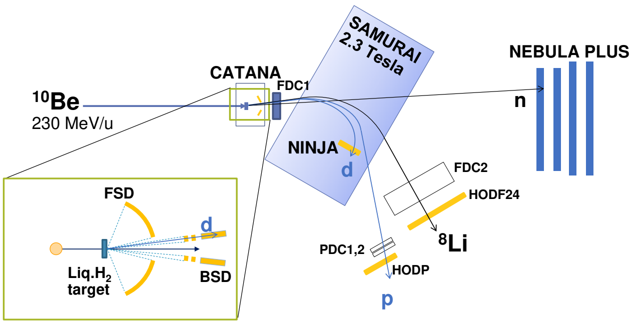

Fig. 1. Schematic of the experimental setup at SAMURAI.

The secondary beam of ^{10}Be with an energy of 230 MeV/nucleon was produced by the fragmentation reaction of a 250-MeV/nucleon primary ^{18}O beam at the BigRIPS separator. The intensity of the ^{10}Be was 2.0×10^5 Hz with a purity of 96%.

Figure 1 shows a schematic of the experimental setup at SAMURAI. A 100-mg/cm^2-thick liquid hydrogen target with a diameter of 50 mm was used to induce the (p, pd) reaction. This hydrogen target was operated in a newly introduced configuration,[2)] optimized to couple with the CATANA array in a compact geometry. The target was surrounded by a newly developed plastic scintillator-based detector called FSD and combined with the CATANA array to detect the recoiled proton and deuteron at angles of 20 to 70 degrees. In addition, a plastic scintillator-based array called BSD was located at the downstream of the CATANA array to detect recoiled particles using a ΔE-E method.

Reaction residues were transported to the SAMURAI spectrometer and identified by measuring $B\rho$, time-of-flight (TOF) and ΔE. A central magnetic field of 2.3 Tesla was applied to the SAMURAI dipole magnet. $B\rho$ was reconstructed using two drift chambers (FDC1 and FDC2) located at the entrance and exit of the SAMURAI magnet, respectively. The TOF and ΔE measurements were performed using the HODF24 hodoscope. Neutrons were detected using the large

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volume plastic scintillator array NEBULA-plus, which is an upgraded and extended version of the existing NEBULA array.

At forward angles, the respective energies of the proton and deuteron were $\sim$ 470 and 100 MeV. Two drift chambers (PDC1 and PDC2) and a plastic scintillator hodoscope HODP were used at the low-rigidity side after bending in the SAMURAI magnet. Low-energy deuteron was detected by the plastic-scintillator array NINJA[3,4] because of the overbending inside the SAMURAI magnet. Calibration runs with proton and deuteron beams were conducted in addition to the physics run. This experiment was performed together with SAMURAI-47[5] and a machine study for NEBULA-plus[6] as a campaign. The data analysis is currently ongoing.

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