Neutron-neutron correlation in Borromean nucleus ^{11}Li via the (p, pn) reaction

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Dineutron is a hypothetical bound state of two neutrons in a nuclear medium and spatially localized pair, which is different from the one obtained via the BCS mechanism.[1] The neutron-neutron correlation from the dineutron is expected to appear in various circumstances such as the surface of weakly bound neutron-rich systems and inner crust of the neutron stars. With the advent of RI beam facilities, extended experimental studies on the dineutron correlation on ^{11}Li have been conducted such as $E1$ strength measurement using the Coulomb breakup reaction[2] and neutron momentum measurement using the carbon-induced knockout reaction.[3] Dineutron correlation has been experimentally indicated through the smaller opening angle of two neutrons with respect to the core but its signature was integrated over the whole volume or limited region of the system owing to the methodology.[4] The kinematically complete measurement of the quasi-free (p, pn) reaction was thus performed with ^{11}Li, ^{14}Be, and ^{17,19}B to obtain the correlation angle θ_{nf} as well as the missing momentum k, which provides radial information about the neutron in its initial state.

The measurement was performed at RIBF using the SAMURAI spectrometer.[5] For higher statistics, the 15-cm-thick liquid hydrogen target MINOS[6] was used with a 200 kpps ^{11}Li beam. The (p, pn) setup composed of the neutron detector WINDS,[7] recoil proton detector, and gamma-ray detector array DALI2[8] was newly configured to realize the kinematically complete measurement.

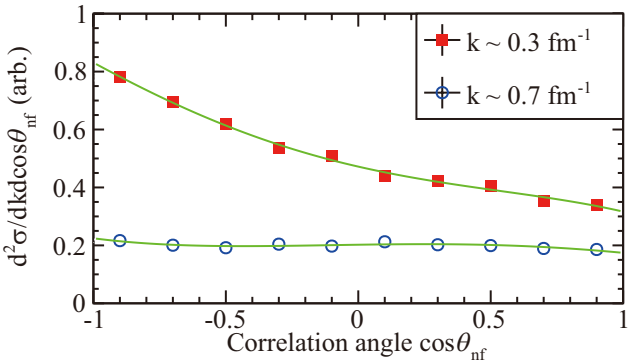

Fig. 1. $\cos\theta_{nf}$ dependence of the double differential cross-section for each missing momentum k. The horizontal and vertical axes show the correlation angle and double differential cross-section, respectively. Each spectrum is scaled for the comparison. Errors are smaller than the symbols.

Figure 1 shows the $\cos\theta_{nf}$ dependence of the double differential cross-section at $k \sim 0.3$ and 0.7 fm^{-1}, corresponding to the outer and inner part of ^{11}Li, respectively. The figure exhibits apparent k-dependence of the correlation angle. The large negative slope at $k \sim 0.3$ fm^{-1} is the signature of the dineutron correlation in this region. The slope is almost flat at $k \sim 0.7$ fm^{-1}, indicating a weak correlation. This result reveals that the dineutron correlation is favored in the outer region of ^{11}Li, which is qualitatively consistent with the theoretical predictions.[1]

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