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

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Since a theoretical prediction was made by Migdal,[1] a hypothetical bound state of two neutrons, *dineutron*, has attracted much attention. The neutron-neutron correlation caused by the dineutron is expected to appear in weakly bound systems, such as the Borromean nucleus ^{11}Li. There have been extensive studies to search for such a correlation in ^{11}Li. $E1$ strengths deduced from Coulomb dissociation cross sections have been used by employing the $E1$ cluster sum rule to characterize their correlation.[2] However, the model dependence was not negligible owing to the ^{9}Li core excitation and the final-state interactions.[3] The kinematically complete measurement of the quasi-free (p, pn) reaction was thus performed with Borromean nuclei ^{11}Li, ^{14}Be, and ^{17,19}B at the RIBF so as to determine the neutron momentum distributions that provide more direct information of the ground-state correlation.[4]

The measurement required a high luminosity to have as much statistics as possible. For this purpose, the 15-cm-thick liquid hydrogen target MINOS[5] was introduced. The SAMURAI spectrometer[6] contributed to minimize experimental biases originating from the geometrical acceptance. A missing-mass setup composed of the neutron detector WINDS,[7] the recoil proton detector RPD, and the gamma-ray detector array DALI2[8] was newly configured for realizing the quasi-free (p, pn) measurement.

As a measure of the dineutron correlation in ^{11}Li, the opening angle of two valence neutrons $\cos\theta_Y$ was reconstructed from momentum vectors of all the particles involved in the reaction. The obtained $\cos\theta_Y$ distribution is shown in Fig. 1. The geometrical acceptance of the experimental setup was corrected by performing a Monte-Carlo simulation. The asymmetric distribution indicates an admixture of different parity states and the dineutron correlation in ^{11}Li. The asymmetry obtained in the present work is weaker than that in the previous work employing the neutron removal reaction by using a carbon target.[9] We presume that the dineutron correlation was overestimated in the previous study because of the sensitivity of the probe; the probe used in the previous study is only sensitive to the nuclear surface, where the dineutron correlation is expected to develop.

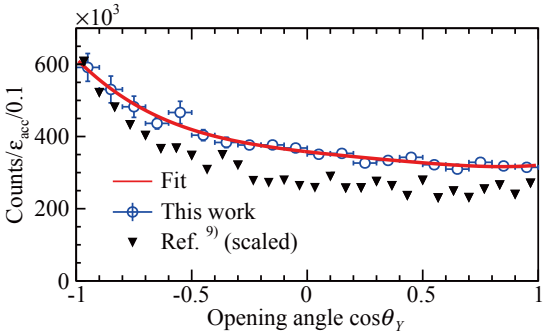

Fig. 1. Opening-angle distribution $\cos\theta_Y$ for ^{11}Li. The blue open and black closed marks represent the data taken in the present and previous works,[9] respectively.

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