Study of neutron-neutron correlation in Borromean nuclei via the (p, pn) reaction with the SAMURAI spectrometer

Y. Kubota,[*1,*2] A. Corsi,[*3] G. Authelet,[*3] H. Baba,[*2] C. Caesar,[*4] D. Calvet,[*3] A. Delbart,[*3] M. Dozono,[*1] J. Feng,[*5] F. Flavigny,[*6] J.-M. Gheller,[*3] J. Gibelin,[*7] A. Giganon,[*3] A. Gillibert,[*3] K. Hasegawa,[*8] T. Isobe,[*2] Y. Kanaya,[*9] S. Kawakami,[*9] D. Kim,[*10] Y. Kiyokawa,[*1] M. Kobayashi,[*1] N. Kobayashi,[*11] T. Kobayashi,[*8] Y. Kondo,[*12] Z. Korkulu,[*13,*2] S. Koyama,[*11] V. Lapoux,[*3,*2] Y. Maeda,[*9] F. M. Marqués,[*7] T. Motobayashi,[*2] T. Miyazaki,[*11] T. Nakamura,[*12] N. Nakatsuka,[*14,*2] Y. Nishio,[*15] A. Obertelli,[*3,*2] A. Ohkura,[*15] N. A. Orr,[*7] S. Ota,[*1] H. Otsu,[*2] T. Ozaki,[*12] V. Panin,[*2] S. Paschalis,[*4] E. C. Pollacco,[*3] S. Reichert,[*16] J.-Y. Roussé,[*3] A. T. Saito,[*12] S. Sakaguchi,[*15] M. Sako,[*2] C. Santamaria,[*3,*2] M. Sasano,[*2] H. Sato,[*2] M. Shikata,[*12] Y. Shimizu,[*2] Y. Shindo,[*15] L. Stuhl,[*2] T. Sumikama,[*8,*2] M. Tabata,[*15] Y. Togano,[*12] J. Tsubota,[*12] T. Uesaka,[*2] Z. H. Yang,[*2] J. Yasuda,[*15] K. Yoneda,[*2] and J. Zenihiro[*2]

Dineutron correlation is one of the phenomena expected to appear in neutron-drip-line nuclei. It has long been presumed that the dineutron correlation is a key ingredient to understand the binding mechanism and exotic structures of these nuclei. $E1$ strengths often deduced in previous Coulomb breakup studies have been used by employing the $E1$ cluster sum rule to characterize their correlation.[1)] However, the model dependence was not negligible owing to the ^{9}Li core excitation and the final state interactions.[2)] 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 help characterize the correlation.[3)] The opening angle between the two neutrons was reconstructed from the measured momentum vectors of all the particles.

The experiment was conducted using the SAMURAI spectrometer[4)] and the liquid hydrogen target system MINOS.[5)] The beam momentum was determined from the time of flight (TOF) between focal planes F7 and F13. The trajectory was measured by beam drift chambers (BDCs). The momentum vectors of the neutron knocked out from ^{11}Li, another emitted from the resulting ^{10}Li residue, and the recoil proton were determined from the TOF and position measured by neutron telescopes WINDS and NEBULA, and a recoil proton detector (RPD), respectively. The position and angle of ^{9}Li at the entrance and exit of the SAMURAI spectrometer were measured by forward drift chambers (FDCs). The magnetic rigidity was determined from the tracking information thus obtained. The magnetic field of the spectrometer was calculated and taken into account. The relative energy $E_{\rm rel}$ of the reaction residue ^{10}Li, the missing momentum of the knocked-out neutron in the ground-state ^{11}Li, and the opening angle $\cos\theta_Y$ of two valence neutrons in ^{11}Li were reconstructed from the obtained momentum vectors.

Figure 1 shows the $\cos\theta_Y$ dependence of $E_{\rm rel}$. Smaller $\cos\theta_Y$ values are highly favored as $E_{\rm rel}$ decreases, while the yields are evenly distributed over $\cos\theta_Y$ at a higher $E_{\rm rel}$. Because the small $E_{\rm rel}$ value corresponds to the surface region of the nucleus,[6)] this result suggests that the dineutron correlation is much more developed in the surface region. This is qualitatively consistent with the theoretical prediction.[7)]

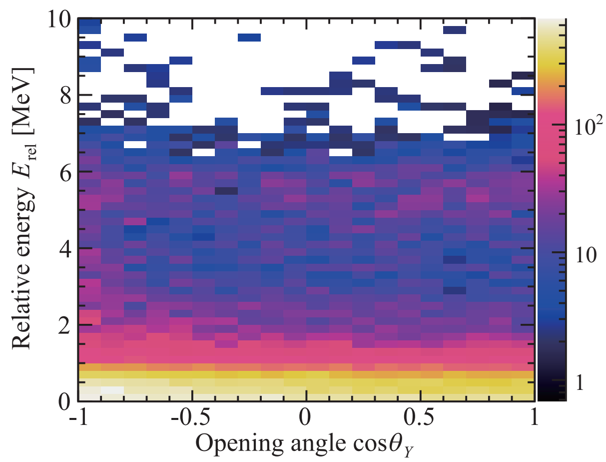

Fig. 1. $E_{\rm rel}$ vs. $\cos\theta_Y$ plot for the ^{11}Li$(p, pn)^{9}$Li + n reaction.

*1 Center for Nuclear Study, University of Tokyo
*2 RIKEN Nishina Center
*3 CEA, Saclay
*4 Department of Physics, Technische Universität Darmstadt
*5 Department of Physics, Peking University
*6 IPN Orsay
*7 LPC Caen
*8 Department of Physics, Tohoku University
*9 Department of Applied Physics, University of Miyazaki
*10 Department of Physics, Ehwa Womans University
*11 Department of Physics, University of Tokyo
*12 Department of Physics, Tokyo Institute of Technology
*13 MTA Atomki
*14 Department of Physics, Kyoto University
*15 Department of Physics, Kyushu University
*16 Department of Physics, Technische Universität München

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