Searching for universality of dineutron correlation at the surface of Borromean nuclei†

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The dineutron correlation has been systematically studied in three different Borromean nuclei near the neutron dripline, ^{11}Li, ^{14}Be, and ^{17}B, via the (p,pn) knockout reaction measured at the RIBF at RIKEN during the S018 experiment.

Secondary beams were produced using projectile fragmentation of a ^{48}Ca primary beam at 345 MeV/nucleon with a typical intensity of 400 particle nA on a Be target. Fragmentation products were separated, detected, and identified via the BigRIPS fragment separator. The cocktail beam was composed of ^{11}Li, ^{14}Be, and ^{17}B, with a percentage of 80%, 12%, and 8%, respectively. Each component impinged on the secondary target with an average energy of 246, 265, and 277 MeV/nucleon, respectively. The secondary target was the 15-cm thick liquid hydrogen target from the MINOS device.[1] The recoil neutron and proton were detected by the WINDS neutron array, and an array of plastic scintillators with a drift chamber for the proton. Apart from that, the standard SAMURAI setup was used during this experiment.

The method, introduced by Kubota *et al.*,[2] consisted of the measurement of the correlation angle between the momentum in the A-1 system (^{10}Li in the case of ^{11}Li, for example), and the momentum of the removed neutron. The correlation angle is related to the neutron configuration, in the sense that angles larger than 90° in momentum space, and therefore smaller than 90° in coordinate space, point to a compact dineutron correlation. The missing momentum of the removed neutron has also been measured and can be considered a proxy of the peripherality of the reaction.[1] Combining the two sets of information in a single plot as in Fig. 1, the dineutron correlation can be studied as a function of peripherality.

As in the case of ^{11}Li,[2] a dineutron correlation appears in the periphery of ^{14}Be and ^{17}B, but is damped compared to that for ^{11}Li. As shown in Fig. 1, we provided an upper limit of systematic error using a Montecarlo simulation. Despite the large uncertainty towards small k_y, we remark that the value of the correlation angle at the maximum is distinctly above 90°.

Experimental data have been compared to theoretical calculations combining three-body models to describe the structure of Borromean nuclei and an eikonal sudden description of the (p,pN) reaction.[3] Overall, the three-body model reproduces pretty well the experimental observables with the only exception of ^{14}Be. The damping of the dineutron correlation observed in ^{14}Be with respect to the theoretical calculation is interpreted as due to the presence of configurations with an excited core, that cannot be predicted within the three-body model.

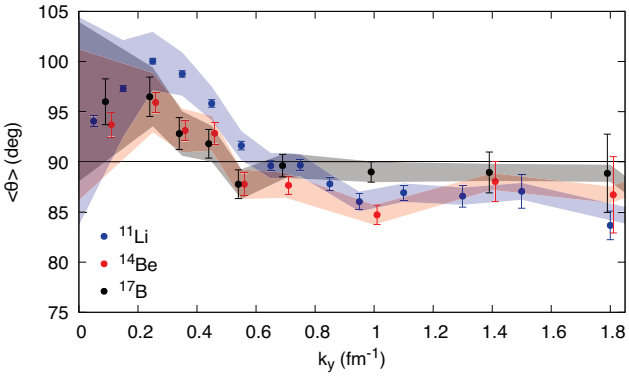

Fig. 1. Average correlation angle as a function of the momentum of the removed neutron k_y for (p,pn) reaction on ^{11}Li, ^{14}Be, and ^{17}B. The points are presented with their statistical (bars) and systematic errors (band).

This study provides the first experimental hint of the universality of dineutron correlation in the low-density surface of Borromean nuclei. We have shown that fast nucleon removal induced by high-energy quasi-free scattering is the tool of choice to reduce the effect of final-state interactions. Nevertheless, consistent measurements using different probes may help to confirm the universal character of dineutron correlation in Borromean halo nuclei.

References
1) A. Obertelli *et al.*, Eur. Phys. J. A **50**, 8 (2014).
2) Y. Kubota, A. Corsi *et al.*, Phys. Rev. Lett. **125**, 252501 (2020).
3) J. Casal, M. Gómez-Ramos, Phys. Rev. C **104**, 024618 (2021).

† Condensed from the article in Phys. Lett. B **840**, 137875 (2023)

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DOI:10.34448/RIKEN.APR.57-002