Surface localization of the dineutron in ^{11}Li[†]

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A unique aspect of nuclei with respect to other fermionic many-body systems is the emergence of a spatially compact two-neutron pair, *dineutron*,[1)] which is completely different from the Bardeen-Cooper-Schrieffer-(BCS)-like pairings that appear in momentum space. The dineutron correlation is presumed to be important for elucidating the stabilities and exotic structures of neutron drip-line nuclei, as well as the infinite nuclear matter. Studies on the dineutron formation and the density dependence of ^{11}Li are crucial because it has a halo structure: the matter density gradually varies from the saturated core to the very low-density tail where only valence neutrons exist. It allows the study of the density-dependent properties of the dineutron correlation.

The quasifree (p, pn) reaction was employed to probe the entire volume of ^{11}Li with the least effect of absorption. The measurement was performed at RIBF using the SAMURAI spectrometer,[2)] combined with the 15-cm-thick liquid hydrogen target MINOS[3)] and dedicated (p, pn) setup.

The strength of the dineutron in ^{11}Li was evaluated by using the correlation angle θ_{nf}, which is the angle between the momentum vectors of two valence neutrons. The spatially compact dineutron should have an angle larger than 90°. Figure 1 shows that the mean value of

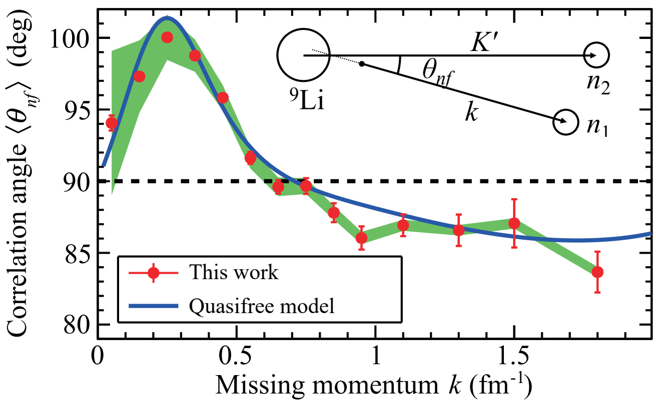

Fig. 1. Mean values of the correlation angle. Black dashed line shows the expected $\langle\theta_{nf}\rangle$ value for the two uncorrelated neutrons. Inset shows a schematic of θ_{nf} in ^{11}Li.

θ_{nf} clearly depends on the missing momentum k, which is the measure of the radial position of the two neutrons in ^{11}Li. The peak structure of $\langle\theta_{nf}\rangle$ at $k \sim 0.3$ fm^{-1} can be interpreted as the localization of the dineutron, which is maximized at $r \sim 3.6$ fm from the center of the ^{9}Li core. The quasi-free model[4)] well reproduces the experimental data.

The result implies that the dineutron correlation is prominent only around the ^{9}Li core surface where the density is $10^{-3} \lesssim \rho/\rho_0 \lesssim 10^{-2}$, and it becomes weaker at the tail of the halo, where the density is extremely low. It is consistent with the Hartree-Fock-Bogoliubov calculation[5)] for infinite nuclear matter. If this is a universal characteristic of the dineutron correlation, it should appear at the low-density surface of any neutron-rich nuclei. Future (p, pn) experiments should investigate the nature of the dineutron correlation in nuclei of interest, such as ^{6}He, ^{16}C, and ^{24}O.

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† Condensed from the article in Phys. Rev. Lett. **125**, 252501 (2020)

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