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# High precision spectroscopy of pionic atoms in tin isotopes by (d, 3He) reaction at RIBF

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We conducted high-precision pionic atom spectroscopy experiments at RIBF using the (d, 3He) reaction. A pionic atom is a system in which π- mesons are deeply bound to the atomic orbitals of nuclei by attractive Coulomb forces and repulsive strong forces.

Evaluation of the partial restoration of chiral symmetry in finite density has been successfully performed at GSI and RIBF. Both experiments showed that the quark condensation, an order parameter of chiral symmetry, is reduced by about 40% in normal nuclear density compared to vacuum (T. Nishi, K. Itahashi et al., Nature Phys. (2023) doi:10.1038/s41567-023-02001-x).

We aim to investigate the density dependence of quark condensation. In order to search density region as wide as possible, we take advantage of long isotope chain of tin. High-statistics measurements were performed on 6 nuclei (112, 115, 117, 119, 122, 124Sn) by using a high-intensity primary beam at RIBF and BigRIPS as a spectrometer with a large-angle acceptance. Since the effective density region which these pionic atoms probe is limited, the experimental resolution must be improved in order to extract the density dependence of quark condensation precisely. We estimate that the binding energies and widths of the pionic atoms can be determined with unprecedented accuracy by applying dispersion-matching optics to BigRIPS and reconstructing 3He trajectories using a low-pressure 3-layer staggered MWDC.

In this presentation, we will report on the current status of data analysis of this measurement performed in June 2021 and introduce future plans of systematic research on pionic atoms using inverse kinematics.

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