Contribution ID: **239** Type: **Plenary talk**

Manifestation of non-uniformity in nuclei – challenges using knockout reactions

Wednesday 10 July 2024 12:10 (40 minutes)

Quantum many-body systems often stabilize by creating non-uniformity in them. Clustering in nuclei is one of good examples. Since the discovery of α-decay and later prediction/observation of the Hoyle state in 12 C, nuclear physicists have investigated mechanism how clusters occur in nuclei and how they play roles in synthesis of heavier elements. So far the scope of cluster research has been mainly limited to well-developed clusters in light nuclei and cluster formation in medium to heavy nuclei remains to be understood. We have started a new research project named the ONOKORO project where we comprehensively investigate clustering in medium-to-heavy mass nuclei using (p,pX) cluster knockout reactions under normal and inverse kinematics. The research is motivated by our previous study on α clustering in 112-124 Sn conducted at Research Center for Nuclear Physics (RCNP), Osaka University [1]. Novel features of the ONOKORO project are to extend the knockout-reaction studies of clustering to 1) all the light clusters, deuteron, triton, 3 He, together with α, 2) nuclei in a long isotope chain by combining experiments for stable and unstable nuclei, 3) in a wide mass region up to A~220.

In July 2023 and April 2024, we have performed the first series of experiments for stable calcium isotopes at RCNP an obtained separation energy spectra. In parallel, we are preparing for experiments using RI beams at RIBF where a new detector telescope, TOGAXSI, specialized to inverse-kinematics cluster knockout experiments. In the seminar, I will discuss the physics background, research plans at RIBF, RCNP, and HIMAC facilities, and status of detector development for the inverse kinematics knockout experiments.

[1] J. Tanaka, Z.H. Yang et al., Science 371, 260 (2021)
[2] J. Tanaka, R. Tsuji et al., Nucl. Instrum. Methods Phys. Res. B 542, 4 (2023).

session

I. Nuclear Structure and Reactions

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Session Classification: Plenary session