Progress in 3n System Studies and the Next Steps: New Multineutron Experiments

K. Miki[1,2]
[1] *Tohoku University, Sendai, Miyagi, Japan and*
[2] *RIKEN Nishina Center, Wako, Saitama, Japan*

The observations of peak structures in the excitation energy spectra of the four-neutron system have stimulated renewed interest in multineutron systems from both experimental and theoretical perspectives. A central issue is to understand the origin of these peaks and to clarify whether any systematic behavior exists across systems with different neutron numbers. Addressing these questions is essential for improving our understanding of neutron-rich few-body systems and nuclear interactions under extreme conditions.

Among multineutron systems, the three-neutron (3n) system is one of the most fundamental and serves as a crucial starting point for exploring multineutron correlations. It is generally expected that such fragile systems are best produced in reactions involving small momentum transfer. However, in the case of the 3n system, previous experiments have not sufficiently covered the low momentum transfer region, leaving important aspects unexplored. To address this, we performed a measurement of the $^{3}\mathrm{H}(t, {}^{3}\mathrm{He})3n$ reaction at 170 MeV/u using the SHARAQ spectrometer at RIKEN RIBF [1]. This experiment, employing both triton beam and tritium target, constitutes the first realization of intermediate-energy RI-RI scattering. To ensure sufficient statistics despite the small cross sections, we developed and employed a tritiated titanium target with unprecedented thickness. In this talk, we will present the results of this experiment, and also report on a complementary measurement of the isospin-symmetric $^{3}\mathrm{He}({}^{3}\mathrm{He}, t)3p$ reaction conducted at RCNP. Together, these studies provide a comprehensive view of the $T = 3/2$ three-nucleon systems.

In addition, we are planning a new experiment at the SAMURAI facility at RIBF, where knockout reactions will be used to investigate the systematics of multineutron correlations. This experiment will also aim to directly detect the emitted neutrons, providing new insights into the internal structure and dynamics of multineutron systems. An overview of this upcoming program and its future outlook will also be discussed.

[1] K. Miki, K. Kameya, D. Sakai, R. Urayama *et al.*, Phys. Rev. Lett. **133** (2024) 012501.