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Ultracold neutron sources for fundamental physics — status at TRIUMF and future prospects

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Ultracold neutrons (UCNs), neutrons with kinetic energies of $\lesssim 300$ neV, have the unique property of being stored in a vessel with an appropriate surface material for a time on the order of 100 s, and have been used for key experiments in fundamental physics. Originally, very cold neutrons were mechanically decelerated to obtain UCNs. In 1977, the so called super-thermal method was proposed, which utilizes the inelastic scattering of neutrons in a medium and enables a high UCN density in the source [1].

The TUCAN (TRIUMF Ultracold Advanced Neutron) collaboration has developed an accelerator-driven super-thermal UCN source using superfluid helium as a converter. The key components of the UCN source, including high-performance helium and liquid deuterium cryostats, have been developed through a joint effort between Japanese and Canadian institutes. [2, 3]. The UCN source is currently undergoing commissioning in preparation for the first beam test at TRIUMF. In parallel, a spectrometer was developed to measure neutron electric dipole moment (EDM) [4]. It is anticipated that the intense source will provide UCNs sufficient for two-orders-of-magnitude improved statistics of neutron EDM measurements over previous experiments. Recently, a decision was made to build a new research reactor in Fukui, Japan [5]. Based on technologies developed through the TUCAN source, a helium-based super-thermal UCN source is planned to be built in this future facility. Ideas for experiments using this UCN source are currently being sought; one of which is to search for the neutron-antineutron oscillation with UCNs.

In this paper presentation, I will present the principle of super thermal UCN sources, report the status of the TUCAN source at TRIUMF, and discuss the potential of the future source in Fukui.

References

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