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Neutron lifetime measurement using magneto-gravitational trap at LANL

Beta decay of a free neutron is the simplest form of "semi-leptonic" weak interaction and is free from nuclear structure effects. Despite the simplicity of the process, its lifetime measurement remains one of the most challenging measurements, bearing different results depending on the technique ("bottle" or "beam") [1, 2]. Another critical measurement from the decay is the correlation (Ao) between the neutron's initial spin and emitted electron's momentum. Neutron lifetime and axial neutron charge determined using Ao are inputs to determine the magnitude of the Cabibbo-Kobayashi-Maskawa (CKM) matrix element (Vud) and provide a means to study physics beyond the Standard Model.

Los Alamos National Laboratory hosts the neutron lifetime experiment UCNτ by exploiting the ultra-cold neutron (UCN) beam. UCNs at LANL are produced via the down scattering of moderated spallation neutrons in a solid deuterium crystal and are polarized via transport through magnets [3]. The UCNs are then polarized and guided to be stored in a magneto-gravitational trap. The surviving neutrons are then counted using a 10B-coated-ZnS scintillator. The experiment has produced the world's most precise neutron lifetime measurement. The UCNτ experiment is undergoing further degradation to implement an elevator loading method to achieve more storage of UCNs to gain higher sensitivity limits and better precision (about three times). This contribution will discuss details of the UCNτ experiment, its analysis techniques, and expected new results.

References:

1. Golub, R., D. Richardson, and S. K. Lamoreaux, 1991, Ultra-Cold Neutrons (Adam Hilger, Bristol, England).
2. D. J. Salvat *et al.*, Phys. Rev. C89, 052501, 2014.
3. T. M. Ito *et al.*, Phys. Rev. C 97, 012501(R), 2018.

Primary author: SINGH, Maninder (Los Alamons National Laboratory)

Presenter: SINGH, Maninder (Los Alamons National Laboratory)

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