Contribution ID: **4** Type: **Talk**

UCNA+: an upgraded experiment to measure the beta-asymmetry with polarized ultracold neutrons

Thursday 9 October 2025 13:30 (30 minutes)

Angular correlation measurements can provide high precision values for the axial coupling constant in neutron decay, a fundamental input in the determination of the beta decay rate predicted by the Standard Model of particle physics. Completed in 2018, the UCNA experiment was designed to utilize polarized ultracold neutrons to perform a high precision measurement of the beta asymmetry – the angular correlation between the polarization vector of the neutron and the momentum of the emitted electron. The achieved precision for the axial coupling constant of 0.16% ultimately was limited by a combination of statistics and uncertainties in the detector response. An effort is underway at the Area B UCN Source in the Los Alamos Neutron Science Center to upgrade the UCNA experiment. This upgrade, called UCNA+, is based on exploiting the improved UCN densities available at Los Alamos after the source upgrade in 2016 and a scintillator detector system (developed by R. Pattie at Eastern Tennessee State University) with improved light-collection and lower thresholds for detection of decay electrons. When combined with improved source scanning systems, thinner end-cap foils, and dedicated scattering measurements to accurately benchmark Monte Carlo calculations of scattering, roughly a factor of 3 or more improvement appears feasible over the previous results of UCNA. At this precision level, UCNA+ would make a significant contribution to the global uncertainties for the axial coupling constant, contributing to a value for the CKM unitarity constant Vud potentially competitive with the precision established by the superallowed nuclear decays.

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Session Classification: Science with UCN