MAS21-2021-000062

Abstract for an Invited Paper
for the MAS21 Meeting of
the American Physical Society

Space-based Measurement of the Free Neutron Lifetime[1]

JACK WILSON, Johns Hopkins University Applied Physics Laboratory

Knowledge of the free neutron lifetime, τ_n, is important as, along with other neutron decay parameters, it enables the determination of the quark-mixing matrix element $|V_{ud}|$ and therefore the testing of the unitarity of the CKM matrix. Additionally, uncertainties in τ_n dominate those in predictions of primordial ^{4}He abundance from Big Bang nucleosynthesis. Historically, there have been two classes of high-precision experiments that measure τ_n. "Beam" experiments measure the activation of a cold neutron beam passing through a volume capable of trapping the created protons or electrons. The second method is the more precise "bottle" technique that involves trapping ultra-cold neutrons and measuring their decay curves directly. However, a significant disagreement, currently $> 4.5\ \sigma$, exists between the average results of these two techniques and has persisted for more than 15 years. This disagreement might be explained by an unidentified or improperly quantified systematic. However, given the direction of the disagreement the decay of neutrons to dark matter particles could also explain the observations. Recent analyses of data from the neutron spectrometers onboard NASAs Lunar Prospector and MESSENGER spacecraft have demonstrated the possibility of using a third space-based technique that might one day break the stalemate. In this talk, I will review the neutron lifetime puzzle and the space-based measurements of τ_n, describe the improvements made to the space-based technique and how it might be used in the future.

[1]This work was funded by the U.S. Department of Energy Office of Nuclear Physics (Grant No. DE-SC0019343).