

Measurement of the neutron lifetime using magnetically trapped ultracold neutrons in the UCNtau experiment

Free neutrons undergo beta decay with a mean lifetime of about 15 minutes. The neutron lifetime is an input for models of Big Bang nucleosynthesis and can be used to check the unitarity of the Cabibbo-Kobayashi-Maskawa matrix (which describes quark flavor mixing in weak decays). Currently there is a 4.1-sigma discrepancy between decay-in-flight neutron lifetime measurements, which count beta decay protons, and neutron trap experiments, which count surviving neutrons. The UCNtau experiment aims to perform a trap measurement with systematic corrections smaller than its statistical uncertainty. UCNtau achieves this by trapping ultracold neutrons in a magnetic bottle which eliminates losses due to interactions with the trap walls. An in-situ detector is used to count neutrons which allows for fast spectral monitoring of the trapped population. In addition, an asymmetric trap design is used to induce chaotic trajectories which allows for quick spectral conditioning of the neutron population. In this talk, the most recent UCNtau result, 877.7 ± 0.7 (stat.) $+0.4 -0.2$ (sys.) seconds [Science May 2018, arxiv:1707.01817], will be presented. Experiment design, data analysis, and Monte-Carlo simulations will be discussed. Estimates of systematic effects due heating of neutrons during storage and depolarization of trapped neutrons will be presented. Finally, the path toward a 0.3 s or lower precision lifetime measurement will be presented.