Measuring the Neutron Lifetime Using Magnetically Trapped Ultracold Neutrons

P. R. Huffman

North Carolina State University, Raleigh, NC 27695, USA

An accurate measurement of the neutron beta-decay lifetime is important for both tests of the Standard Model of electroweak interactions and understanding the creation of matter during the Big Bang. Previous measurements of the neutron lifetime have been limited in accuracy by certain systematic uncertainties. We describe a new technique for measuring the lifetime whereby ultracold neutrons (UCN) are produced through inelastic scattering of 0.89 nm neutrons with phonons in superfluid $^4$He and confined within a superconducting magnetic trap. The trapped neutrons are detected when they decay; charged decay electrons ionize helium atoms in the superfluid resulting in scintillation light that is recorded in real time using photomultiplier tubes. The advantages of this technique over previous experiments are continuous detection of scintillations from decay electrons and the elimination of wall losses and betatron oscillations. Analysis indicates that systematic errors due to neutron losses should be controllable to $10^{-5} \tau_n$. We are in the process of upgrading our apparatus by constructing a larger, deeper magnetic trap and are implementing techniques to substantially reduce backgrounds. Recent trapping data and prospects for improvement will be discussed. Work in collaboration with F. H. DuBose, R. Golub, E. Korobkina, C. M. O’Shaughnessy, G. L. Palmquist, P. -N. Seo, (NCSU), J. M. Doyle, L. Yang, (Harvard), K. J. Coakley, H. P. Mumm, A. K. Thompson, G. L. Yang, (NIST), S. K. Lamoreaux (LANL).

Sorting category: Ec Materials, techniques, and applications

Keywords: magnetic trapping, neutron lifetime

INVITED PAPER

LT2430