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Searching for Experimental Verification of the Oscillation of Electron Capture Decay Probability

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A group from Gesellschaft für Schwerionenforschung (GSI) last year published an observation of time oscillations of the electron capture decay rate of stored hydrogen-like ions of ^{142}Pm and ^{140}Pr.(Phys. Lett. B **664**, 162 (2008)). They proposed that the oscillating decay rate was caused by interference between momentum states of the ion caused by neutrino mass and flavor mixing. This hypothesis has been controversial, with several authors arguing either that neutrino mixing can or cannot be responsible. If neutrino mixing is responsible for the decay rate oscillations, then it should be possible to detect these oscillations in a simpler experiment without using stored hydrogenic ions, by observing an electron capture decay rate with an appropriate experiment time structure. If this were possible, it could revolutionize the study of neutrino mixing by allowing much simpler experiments to make precise measurements of mass differences and mixing angles. At LBNL, we performed an experiment to search for oscillations in electron capture rate using ^{142}Pm produced with a time short compared to the oscillation period, and counting ^{142}Nd K_α x-rays from the daughter. The decay time spectrum is well-described by a simple exponential, and we observed no statistically significant decay rate oscillations at a level much lower than proposed. A literature search for previous experiments that might have been sensitive to the reported modulation uncovered a candidate in ^{142}Eu. A reanalysis of that published data shows no decay rate oscillation. A recent experiment at Munich also did not observe decay rate oscillations in decays of ^{180}Re. Other potential explanations for the GSI decay oscillation data have been proposed, including quantum beats by nearly degenerate initial parent ion states and Thomas precession in the stored ions. I will discuss the status of experimental results, and possibilities for experimental confirmation of the various models. This work was supported by the Director, Office of Science, Office of Nuclear Physics, U.S. Department of Energy under Contract No. DE-AC02-05CH11231.