HAW14-2014-000304

Abstract for an Invited Paper
for the HAW14 Meeting of
the American Physical Society

Measurements of β-delayed neutron emission probabilities using a Paul trap[1]

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Neutrons emitted following the β decay of neutron-rich isotopes play an important role in many fields of basic and applied science. Studies of these β-delayed neutrons are needed to better understand the structure of exotic nuclei and how the isotopes synthesized in r-process environments decay back to stability to produce the isotopic abundances observed today. In addition, precise studies of fission products provides valuable information for nuclear energy and stockpile stewardship applications. However, the data available today for individual nuclei is limited - for the vast majority of neutron emitters, the energy spectrum has not been measured and some recent measurements have uncovered discrepancies in β-delayed neutron branching ratios. Radioactive ions held in an ion trap are an appealing source of activity for improved studies of this β-delayed neutron emission process. When a radioactive ion decays in the trap, the recoil-daughter nucleus and emitted particles emerge from the approximately 1-mm^3 trap volume with minimal scattering and propagate unobstructed through vacuum. These properties allow, for the first time, the momentum and energy of the emitted neutron to be precisely reconstructed from the nuclear recoil. By loading neutron-rich fission-product beams from the CARIBU facility at Argonne National Laboratory into a specially-designed radiofrequency quadrupole ion trap system, a program of β-delayed neutron spectroscopy in this largely unexplored region of the nuclear chart can be performed. This recoil-ion technique will be described and results from recent measurements at CARIBU and future prospects will be discussed.

[1]This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.