DNP17-2017-020262

Abstract for an Invited Paper
for the DNP17 Meeting of
the American Physical Society

Dissertation Award in Nuclear Physics Recipient: Nuclear structure at the Edge: Proton decay and the invariant-mass Method

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Two-nucleon decay is the most recently discovered nuclear-decay mode. For proton-rich nuclei, most multi-proton decays occur via sequential steps of one-proton emission. Direct two-proton (2p) decay was believed to occur only in even-Z nuclei beyond the proton-drip line where one-proton decay is energy forbidden. This has been observed for the ground states of around a dozen nuclei including 6Be, the lightest case, and ^{54}Zn, the heaviest case. Direct 2p decay has also recently been observed for isobaric-analog states where all possible 1p intermediates are either isospin allowed and energy forbidden, or energy allowed and isospin forbidden. For light proton emitters ($A < 12$), the lifetimes are short enough that the invariant-mass technique is ideal for measuring the decay energy, intrinsic width, and, for multi-proton decays, the momentum correlations between the fragments. I will describe recent measurements of proton emitters using the invariant-mass technique with the High-Resolution Array (HiRA). I will present a new, high-statistics measurement on the decay of the ground and excited states in ^{12}O. By measuring the momentum correlations between the decay fragments, one can observe how the decay transitions from direct to sequential as the decay energy increases. I will present data on the isobaric-analog pair ^{8}C and 8BIAS, which highlight the two known types of direct 2p decay. I will also present the first observation of ^{11}O, the mirror of the well-known halo nucleus ^{11}Li.