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Proton-decaying, light nuclei accessed via the invariant-mass method

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Two-nucleon decay is the most recently discovered nuclear decay mode. For proton-rich nuclei, the majority of 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 ^{6}Be, 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, 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 sequential 2p decay of excited states in ^{17}Ne. Measuring the momentum correlations between the decay fragments allow us to determine the 1p intermediate state through which the decay proceeds. I will present data on the isobaric-analog pair ^{8}C and ^{8}B$_{\mathrm{IAS}}$, which highlight the two known types of direct 2p decay. I will also present the first observation of ^{17}Na, which is unbound with respect to three-proton emission. Finally I will present a new measurement on the width of the first-excited state of ^{9}C and compare to recent theoretical calculations.