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Search for Two-Proton Radioactivity of 30Ar by Tracking its Decay Products

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Two-proton (2p) radioactivity is an exotic nuclear decay mode resulting in a simultaneous emission of two protons. It was predicted for a number of neutron-deficient nuclei beyond the proton drip line. The ground-state (g.s.) 2p radioactivity was discovered in the decay of 45Fe in 2002. Later, this novel decay mode was also found in the decays of 48Ni, 54Zn, and 19Mg.

In 2012, an in-flight decay experiment aimed to investigate the 2p radioactivity of a previously unknown nucleus 30Ar was performed with the fragment separator FRS of GSI. By tracking the decay products with silicon micro-strip detectors, 2p decays of 30Ar in-flight have been observed for the first time. The decay vertices were reconstructed through the measured 28S + p + p trajectories. For the calibration purpose, 2p decays of 19Mg have also been re-measured by tracking 17Ne + p + p trajectories and new data on this known 2p precursor have been obtained.

In order to deduce the nuclear structure information such as decay energy and half-life of 30Ar as well as of 19Mg, the angular correlations of decay fragments were analyzed. By comparing the measured angular p-17Ne correlations with those obtained from the corresponding Monte-Carlo simulations, the 2p decay energy of g.s. of 19Mg has been deduced and several low-lying excited states of 19Mg have been identified. The results are consistent with the previously reported data. Spectroscopic information on several low-lying states of 30Ar has been obtained as well.

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