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Excursion Far Beyond the Proton Dripline Along Ar and Cl Isotopes

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Nuclei beyond the proton drip line have been intensively investigated in recent years, and their structure exhibited exotic features that cannot be found in particle-stable nuclei. For instance, two-proton (2p) radioactivity of elements was discovered on 45Fe. In spite of the experimental advances, most 2p-decay precursors remain unexploited though their low-excitation spectrum is expected to be discrete. This naturally causes the question: How far beyond the driplines the nuclear structure phenomena fade and are completely replaced by continuum dynamics?
In this talk, the first spectroscopic studies of the chains of 2p emitters 31,30,29Ar and their 1p-unbound subsystems 30,29,28Cl will be reported. The corresponding experiment is based on measurements of in-flight decays of the 2p emitters and tracking trajectories of their decay products by microstrip silicon detectors [1]. The lowest states in 30Ar and 29Cl point to a violation of isobaric symmetry in the structure of these unbound nuclei (i.e., the Thomas-Ehrmann shift). The 2p decay has been identified in a transition region between simultaneous 2p and sequential proton emissions from the 30Ar ground state, which is characterized by interplay of three-body and two-body decay mechanisms. Such a phenomenon, never observed before, is argued to be common in 2p-unbound nuclei and could be of interest for other disciplines dealing with few-body systems [2]. The spotted dramatic change of odd-even mass staggering in 2p-unbound nuclei calls for further systematic investigation.
Systematic studies of the ground and excited states of unbound Ar and Cl isotopes have revealed that the Thomas-Ehrmann shifts are even larger for the 29Ar and 28Cl isotopes in comparison with 30Ar and 29Cl, respectively. Predictions for even more remote isotopes 28Ar and 27Cl are provided by using the elaborated models. For these isotopes, the Thomas-Ehrmann effect is expected to be less important, as their isobaric mirror partners are located near the neutron drip line.
References:
[1] I. Mukha et. al., Phys. Rev. Lett. 115 (2015) 202501.
[2] T.A. Golubkova, X.-D. Xu, L.V. Grigorenko, I.G. Mukha, C. Scheidenberger and M.V. Zhukov, Phys. Lett. B 762, 263 (2016).

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