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46Ar: a bubble nucleus?

Deviations from the typical liquid-drop-like saturated density of the nucleus are a focal point in the exploration of nuclear structure. Phenomena of nucleon localization, such as clustering or bubble structures, provide a distinctive perspective on the macroscopic consequences of nuclear interaction. Experimental evidence of a depletion of the proton distribution in the core region of the nucleus was first claimed in 34Si and is driven by the presence of a sub-shell closure in combination with an empty s1/2 orbital [1].
We exploited a proton-transfer direct reaction to probe the wavefunction of 46Ar, extrapolating the probability of population of the d3/2 hole-state relative to the s1/2 in 47K. The experiment, performed at the Spiral 1 facility in GANIL with a post-accelerated radioactive 46Ar beam impinging on a high-density cryogenic 3He target relied on a state-of-the-art experimental setup for a precise reconstruction of the kinematics of the reaction. The heavy reaction fragment was identified by the high-acceptance magnetic spectrometer, VAMOS [2], while the high-granularity silicon DSSSD detector, MUGAST [3], allowed the measurement of the angular distribution of the light ejectile while also performing particle identification. The AGATA [4] gamma-ray tracking germanium array measured the gamma rays produced by the decay of the 47K excited states.
The experimental results point to an empty s1/2 orbital and are well reproduced by ab initio calculations. The comparison of theory and data constitutes a strong indication of the bubble phenomenon in this nucleus.

References
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Collaboration

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