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Probing proton cross-shell excitations through two-neutron removal from ³⁸Ca

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The neutron-deficient calcium isotopes have attracted considerable attention recently. Present studies are divided over the amount of proton *pf*-shell occupancy, ranging from an intact Z = 20 shell closure [1] to a considerable weakening already in the vicinity of doubly-magic ⁴⁰Ca [2,3].

Two-neutron removal, a direct reaction sensitive to the single-particle configurations and couplings of the removed neutrons in the projectile wave function, from ³⁸Ca populating states of ³⁶Ca was performed at the National Superconducting Cyclotron Laboratory. Inclusive and final-state exclusive cross sections along with longitudinal momentum distributions are compared to predictions combining eikonal reaction theory and shell-model two-nucleon amplitudes [4,5].

The results yield conclusive evidence for the need of sizeable proton cross-shell excitations into the pf shell already for the 0_1^+ and 2_1^+ states of 36 Ca [6]. These findings furthermore enable a close reproduction of additional observables. Ultimately, a schematic modification of *sd* - *pf* shell gap is introduced serving as a proxy for the magnitude of proton cross-shell excitations.

- [1] Miller et al., Nat. Phys. 15, 432 (2019).
- [2] Caurier et al., Phys. Lett. B 522, 240 (2001).
- [3] Dronchi et al., Phys. Rev. C 107, 034306 (2023).
- [3] Tostevin et al., Phys. Rev. C 74, 064604 (2006).
- [4] Simpson et al., Phys. Rev. Lett. 102, 132502 (2009).
- [5] Beck et al., Phys. Rev. C 108, L061301 (2023).

Collaboration

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