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Extended p3/2 Neutron Orbital and the N = 32 Shell Closure in 52Ca

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The ^{52}Ca(p,pn)^{51}Ca reaction was measured in inverse kinematics during the SEASTAR3 experimental campaign at the Radioactive Isotope Beam Factory (RIBF). The proton-induced quasi-free neutron knock-out reaction was performed at ~230 MeV/nucleon using MINOS, a 150-mm long liquid hydrogen target and the MINOS TPC, combined with prompt γ spectroscopy. Inclusive and exclusive cross sections to bound states of ^{51}Ca were evaluated, as well as the momentum distribution corresponding to the removal of $1f_{7/2}$ and $2p_{3/2}$ neutrons were measured. The cross sections, interpreted within the distorted-wave impulse approximation reaction framework, are consistent with a shell closure at the neutron number N = 32, found as strong as at N = 28 and N = 34 in Ca isotopes. The analysis of the momentum distributions leads to a difference of the root-mean-square radii of the neutron $1f_{7/2}$ and $2p_{3/2}$ orbitals of 0.61(23) fm, in agreement with the modified-shell-model prediction of 0.7 fm suggesting that the large root-mean-square radius of the $2p_{3/2}$ orbital in neutron-rich Ca isotopes is responsible for the unexpected linear increase of the charge radius with the neutron number.

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