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Probing the size of single-particle orbitals in neutron-rich calcium isotopes from quasi-free scattering missing momentum distributions

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Neutron-rich calcium isotopes show interesting features exhibiting non-canonical neutron shell closures at N=32 and N=34, while their charge radii [1] show a sharp increase after N=28 which is not reproduced by microscopic theories. Matter radii [2] from interaction cross-section measurements indicate that the increase in size of neutron-rich calcium isotopes is mainly due to neutrons and that a core swelling mechanism is at play [3].
Recently, the proton-induced neutron knockout reaction on ^{52}Ca proved to be able to quantify the size of the $p_{3/2}$ and $f_{7/2}$ neutron single-particle orbital using the analysis of the momentum distributions [4]. The result revealed a large $p_{3/2}$ neutron orbital, 0.61 fm larger compared to the $f_{7/2}$ neutron single-particle orbital, which may explain [5] the large charge radius values obtained for the neutron-rich calcium isotopes [1].
This analysis was extended to ^{53}Ca and ^{54}Ca for the neutron orbitals, giving consistent results with the first findings, as well as for ^{52}Ca, ^{54}Ca, and ^{55}Sc for the proton single-particle orbitals. The latest results will be shown in this presentation.
The nucleon knockout direct reaction proves to be a valuable tool, sensitive to the size of the single-particle orbitals - a quantity that has not been deeply explored so far for exotic beams.

References:
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Collaboration

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