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Linking nuclear reactions and nuclear structure to predict neutron skins

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The dispersive optical model (DOM), originally conceived by Claude Mahaux[1], provides a unified description of both elastic nucleon scattering and structure information related to single-particle properties below the Fermi energy. Recent extensions of this framework have introduced a fully nonlocal implementation for ^{40}Ca[2]. For the first time properties below the Fermi energy like the charge density and the presence of high-momentum nucleons can be included in the DOM description while elastic cross section data can be represented as accurately as in the local DOM implementation.
The nonlocal DOM is furthermore capable of determining the spectral strength distribution at positive energy of orbits which are bound[3].
These distributions depend sensitively on the location of the energy of the orbit in question exhibiting a strong increase for those orbits that are very weakly bound and therefore behave like valence orbits in exotic nuclei. These spectral distributions are constrained by elastic scattering data which can therefore provide direct information about correlation effects in exotic nuclei.

Recent extensions of the nonlocal DOM to ^{48}Ca incorporate the effect of the 8 additional neutrons and allow for an excellent description of elastic scattering data of both protons and neutrons[4].
The measured charge density of this nucleus is also accurately described.
The corresponding neutron distribution constrained by all available data generates a prediction for the neutron skin of 0.249 $\pm$ 0.023 fm for this nucleus[4] which is larger than most mean-field and available ab initio results. Extensions to a nonlocal DOM implementation for ^{208}Pb are in progress.

[1] C.Mahaux and R.Sartor, $Adv.Nucl.Phys.$ 20, 1 (1991).

[2] M.H.Mahzoon $et\ al.$, $Phys.Rev.Lett.$ 112, 162503 (2014).

[3] H.Dussan $et\ al.$, $Phys.Rev.C$ 90, 061603(R) (2014).

[4] M.H.Mahzoon, Ph.D. thesis, Washington University in St. Louis (2015).

Primary author: Prof. DICKHOFF, W. H. (Washington University in St. Louis)

Presenter: Prof. DICKHOFF, W. H. (Washington University in St. Louis)

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