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Correlations in ground-state nuclei and their dependence on the neutron-proton ratio[1]

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Although a mean-field description enables an understanding of many aspects of nuclear structure, a full description of nuclei and nuclear matter requires the consideration of the correlations between the nucleons. These include short-range correlations associated with hard-core and tensor interactions and the longer-range correlations due to couplings of the nucleons to low-lying collective states and giant resonances. These correlations and their dependence on the neutron-proton ratio are investigated in Ca isotopes with the dispersive optical model developed by Mahaux. In addition to the standard optical model potential, a dispersive correction is included which then gives the correct relationship between the real and imaginary potentials due to causality. This dispersion correction allows the optical model to be used for bound single-particle states. By fitting proton elastic-scattering data, reaction cross sections, and level properties of valence hole states deduced from (e,e′p) reactions, it is shown that proton long-range correlations increase with neutron richness. Additional data is needed to determine the dependence for neutrons. The dispersive optical model is shown to allow for data-driven extrapolations to the drip-lines, but more data is presently needed to make useful predictions.

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