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Nuclear forces and their impact on matter at neutron-rich extremes

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Recent results have shown that neutron-rich nuclei become increasingly sensitive to three-body forces, which are at the forefront of theoretical developments based on effective field theories of quantum chromodynamics. This includes the formation of shell structure, the spectroscopy of exotic nuclei, and the location of the neutron dripline. Nuclear forces also constrain the properties of neutron-rich matter, including the neutron skin, the symmetry energy, and the properties of neutron stars. We first discuss our understanding of nuclear forces based on chiral effective field theory and show how this framework makes unique predictions for many-body forces. Then, we survey results with three-nucleon forces in neutron-rich oxygen and calcium isotopes and for neutron-rich
matter, which have been explored with a range of many-body methods. This shows that there is an exciting connection of three-nucleon forces with the exploration of extreme neutron-rich nuclei at rare isotope beam facilities and with forefront observations in astrophysics.

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