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Ab initio valence-space theory for exotic nuclei[1]

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Recent advances in ab initio nuclear structure theory have led to groundbreaking predictions in the exotic medium-mass region, from the location of the neutron dripline to the emergence of new magic numbers far from stability. Playing a key role in this progress has been the development of sophisticated many-body techniques and chiral effective field theory, which provides a systematic basis for consistent many-nucleon forces and electroweak currents. Within the context of valence-space Hamiltonians derived from the nonperturbative in-medium similarity renormalization group (IM-SRG) approach, I will discuss the importance of 3N forces in understanding and making new discoveries in the exotic *sd*-shell region. Beginning in oxygen, we find that the effects of 3N forces are decisive in explaining why ^{24}O is the last bound oxygen isotope, validating first predictions of this phenomenon from several years ago. Furthermore, 3N forces play a key role in reproducing spectroscopy, including signatures of doubly magic ^{22,24}O, and physics beyond the dripline. Similar improvements are obtained in new spectroscopic predictions for exotic fluorine and neon isotopes, where agreement with recent experimental data is competitive with state-of-the-art phenomenology. Finally, I will discuss first applications of the IM-SRG to effective valence-space operators, such as radii and $E0$ transitions, as well as extensions to general operators crucial for our future understanding of electroweak processes, such as neutrinoless double-beta decay.

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