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Ab initio calculations in nuclear physics

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The description of nuclei starting from the constituent nucleons and the realistic interactions among them has been a long-standing goal in nuclear physics. In addition to the complex nature of nuclear forces with two-nucleon, three-nucleon and possibly even four-nucleon components, one faces the quantum-mechanical many-nucleon problem governed by an interplay between bound and continuum states. In recent years, significant progress has been made in ab initio nuclear structure and reaction calculations based on input from QCD employing Hamiltonians constructed within chiral effective field theory. I will discuss recent breakthroughs that allow for ab initio calculations for ground states and spectroscopy of nuclei throughout the p-, sd-, and pf-shell and beyond with two- and three-nucleon interactions. I will also present new ab initio many-body approaches capable of describing both bound and scattering states in light nuclei simultaneously and discuss results for resonances in exotic nuclei, reactions important for astrophysics and fusion research.

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