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Nuclear structure theory with coupled-cluster techniques[1]

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Investigations of rare isotopes in the laboratory are opening the way to understand and clarify the properties of all nuclei and bulk nuclear matter. In this talk I will assess where we stand today in solving the nuclear problem and how future rare isotope facilities will impact our understanding of nuclei. One intriguing aspect of the nuclear problem concerns our ability to describe complex nuclei from the ground up using as input the basic interactions among protons and neutrons. These interactions have their roots in QCD. Success in light nuclear systems was recently demonstrated through quantum Monte Carlo and Hamiltonian diagonalization methods. Our community is also investigating various many-body techniques that will enable descriptions of medium-mass nuclei based on these same interactions. I will describe this exciting frontier of research through illustrating recent progress in the nuclear implementation of coupled-cluster methods, a quantum many-body technique that enjoys great success in quantum chemistry. After describing the basic coupled-cluster ideas, I will illustrate their power by reporting on results of ground- and excited state calculations for Oxygen and Calcium nuclei.

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