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Lattice-QCD studies of nuclei, and their electromagnetic properties

The search for predictive capabilities in the study of hadronic reactions and nuclear structure from the Standard Model, which describes the strong and electroweak interactions in nature, is a defining challenge that bridges nuclear and particle physics. In this talk I will present some of the progress made in that direction by calculations using Lattice QCD (LQCD), a systematically improvable numerical technique based on solving the fundamental theory of the strong interaction, quantum chromodynamics, in a finite volume.

Within this framework, nuclear systems up to atomic number A = 5, including systems with non-zero strangeness, have been studied over the past decade, with a range of unphysically-large values of the quark masses. These LQCD calculations have been used to provide phenomenologically-important results and to constrain nuclear effective field theories, allowing constraints on larger nuclei and on the quark-mass dependence of nuclear forces and bindings.

With LQCD studies of nuclei progressing, the first attempts to investigate nuclear structure directly from the dynamics of quarks and gluons have also been made, complementing the existing body of experimental data, phenomenological modeling, and EFT analyses. The simplest aspects of the structure of nuclei are revealed through their static responses to external probes. During the last few years, we have performed a series of calculations of the responses of light nuclei to electromagnetic and weak fields, which define the most basic aspects of nuclear structure, at heavier than physical quark masses.

In this talk, I will report on the results obtained by the Nuclear Physics with LQCD collaboration on the structure and interactions of nuclei using LQCD.

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