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Herman Feshbach Prize: the Quest for a Fundamental Understanding of the Structure of Nuclei and Nucleons[1]

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The inaugural Feshbach prize recognizes lifetime contributions to understanding the structure of the basic building blocks of matter in terms of their constituents and the fundamental interactions between them. Initially this meant understanding the structure of nuclei in terms of nucleons interacting via nucleon-nucleon forces. I will describe a density functional theory for calculating nuclear properties directly from nuclear forces. It identifies mechanisms for "saturation," relates the Skyrme interaction to nuclear forces, and with two parameters characterizing experimentally unknown aspects of nuclear forces yields nuclear binding energies, single particle energies, and charge distributions close to experiment. After the discovery of quarks and QCD, the goal became understanding how the structure of nucleons and ultimately the missing physics in nuclear forces emerge from quarks interacting via QCD. I will explain the use of lattice QCD to calculate the properties of nucleons, show recent results yielding agreement with experiment for the charge and magnetization radii, magnetic moment, and quark momentum fraction, and comment on the prospects for its use to understand aspects of nuclei and nucleon-nucleon interactions.

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