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Towards a Microscopic Density Functional Theory for Nuclei[1]

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Density functional theory (DFT) has enjoyed spectacular success describing inhomogeneous many-electron systems in condensed matter physics and chemistry where *ab initio* methods become computationally prohibitive, as was recognized by the Nobel Prize awarded to Walter Kohn in 1998. Because of the computational limitations of *ab initio* methods in medium and heavy nuclei, DFT is the only tractable many-body method that can at present be applied across the entire table of nuclides. Remarkably simple phenomenological functionals of the Skyrme and Gogny type have enjoyed nearly four decades of impressive success describing a wide range of nuclear properties for many different mass regions. However, different parameterizations lead to uncontrolled (i.e., parameterization-dependent) extrapolations far from stability, with no reliable method to estimate the theoretical error bars. A primary objective of the SciDAC project "Building a Universal Nuclear Energy Density Functional (UNEDF)" is to develop a *microscopically-based*, energy density functional applicable to all nuclei in the form of a generalized Skyrme functional, with theoretical error bars for the different terms in the UNEDF to provide guidance for fine-tuning to data and to give controlled extrapolations away from stability. In this talk, I describe a promising route for achieving these objectives that combine recent advances in chiral effective field theory (EFT) inter-nucleon interactions, renormalization group (RG) techniques for nuclear systems, and nuclear many-body computational methods.

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