AB INITIO THEORY OF LIGHT NUCLEI*

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A major goal in nuclear physics is to understand the stability, structure, and reactions of nuclei as a consequence of the interactions between individual nucleons. Realistic *NN* interactions, which accurately reproduce elastic scattering data, have a complicated dependence on the the relative positions, spins, isospin, and momenta of the nucleons. In addition, there is strong empirical evidence for, and theoretical expectations of, significant many-nucleon forces. These factors make the *ab initio* calculation of nuclear properties an extremely challenging many-body problem.

Tremendous progress in the solution of nuclear bound states has been made in the past few years for both few-body ($A \leq 4$) and light ($5 \leq A \leq 16$) nuclei. Recently, seven different many-body techniques were used to compute the binding energy of ^{4}He for a fairly realistic model interaction, with 0.5% or better agreement [1]. For p-shell nuclei there are currently three methods being actively pursued: Green's function Monte Carlo (GFMC), no-core shell model (NCSM), and coupled cluster expansion (CCE) [2]. These methods are currently being used to carry out a similar benchmark calculation for ^{12}C.

In addition to ground and excited state energies, many other nuclear properties, such as densities, electromagnetic moments, electroweak transitions, spectroscopic factors, and reactions of interest to both astrophysics and rare-isotope accelerator facilities, are being computed with *ab initio* methods.

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[2] B. Barrett, B. Mihaila, S. C. Pieper, and R. B. Wiringa, Nuclear Physics News **13**, 17-23 (2003).