COUPLED-CLUSTER METHODS

B. Mihaila[1], *D. J. Dean, M. R. Strayer*

A major problem in nuclear physics is to understand how nuclear structure comes about from the underlying interactions between nucleons. This requires modeling nuclei as collections of strongly interacting nucleons. The starting point is the solution of the many-body Schrödinger equation for a realistic nuclear Hamiltonian.

Our aim is twofold: On one side we want to verify in a more quantitative way the claim that the quenching observed in the transverse electron scattering amplitude is indeed due to correlations. On the other side, we want to apply this description to single-nucleon knockout and double-nucleon knockout reactions. In double-nucleon knockout the scattering amplitude vanishes without correlations and without two-body (meson exchange) currents. Thus such experiments are a sensitive tool to investigate these two effects.

In a first stage we focus our attention on obtaining a realistic description for the ground state of a double-magic nucleus. We are using the $exp(\mathbf{S})$ coupled-cluster expansion to calculate the ground state of ^{16}O.[2] In our treatment we follow closely the formulation of the Bochum group.[3] However, we solve the equations entirely in configuration space, and we truncate the resulting system of equations in different ways where the significance of terms becomes more transparent.

The computation breaks down into two steps: In the first step the G-matrix interaction is calculated inside the nucleus including all the corrections. This results in amplitudes for the $2p2h$ correlations, which are implicitly corrected for the presence of $3p3h$ and $4p4h$ correlations. In the second step the mean field is calculated from these correlations and the single-particle Hamiltonian is solved to give mean-field eigenfunctions and single-particle energies. These two steps are iterated until a stable solution is obtained. Calculations are carried out entirely in configuration space where a $50\hbar\omega$ space is used.

The Hamiltonian includes a nonrelativistic one-body kinetic energy, a two-nucleon potential, and a supplemental three-nucleon potential. We have chosen the Argonne $v18$ potential as the most realistic nucleon-nucleon interaction available today. The Argonne $v18$ model is one of a new class of NN potentials that accurately fit both pp and NN scattering data up to 350 MeV with a χ^2/datum near one. This necessarily involves the introduction of charge-independence breaking in the strong force. However, the two-body part of that interaction results in over-binding and a too large saturation density in nuclear matter. Therefore, the NN potential is supplemented by a three-nucleon interaction including a long-range two-pion exchange and a short-range phenomenological component. The Urbana-IX NNN potential is adjusted to reproduce the binding energy of ^{3}H and give reasonable saturation density in nuclear matter when used with Argonne $v18$.

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[1]JIHIR guest assignee from University of New Hampshire, Durham.

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[3]J. H. Heisenberg and B. Mihaila, *Phys. Rev.* C (in press).