Nuclear Structure and Response based on Correlated Realistic NN interactions *

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The Unitary Correlation Operator Method (UCOM) provides a novel scheme for carrying out nuclear structure calculations starting from realistic nucleon-nucleon (NN) interactions [1-4]. The basic idea is to describe the major short-range correlations, induced by the strong repulsive core and the tensor part of the NN potential, by a state- and configuration-independent unitary correlation operator. This can be used either to introduce correlations into a trial $A-$body state or, alternatively, to perform a unitary tranformation of an operator of interest. Applied to a realistic NN interaction, in particular, the method produces a "correlated" interaction, $\mathrm{v}_{\mathrm{UCOM}}$, which can be used as a universal effective interaction, suitable for calculations within simple configuration spaces. The UCOM has been utilized successfully, in the framework of variational calculations within Fermionic Molecular Dynamics, to describe properties of nuclei up to mass numbers $A \approx 60$[3].

Our aim in this work is to study nuclear structure and response, based on realistic interactions, without restricting ourselves to light-medium systems. This is made possible by employing the $\mathrm{v}_{\mathrm{UCOM}}$ in Hartree-Fock- and RPA-type calculations. The latter allow us to account for long-range correlations, in addition to the short-range correlations introduced via the UCOM. By using a standard HF-RPA and an extended RPA [5] method (based on the true RPA ground state), and a $\mathrm{v}_{\mathrm{UCOM}}$ extracted from the Argonne V18 potential, we study the ground-state properties (energies, radii, occupation probabilities) of various closed-shell nuclei, as well as some excited states. The performance of the $\mathrm{v}_{\mathrm{UCOM}}$ is very engouraging. A next step in our exploration will be to make use of second-order RPA [6] as well.

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