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Exotic nuclear structure and reactions from an ab initio perspective

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Phenomena that are difficult to describe in standard many-body methods as Hartree-Fock or the shell model are regarded as exotic, like clustering of nucleons which leads to molecule like structures, or halos formed by weakly bound nucleons. These special configurations are found as ground states and excited states whenever one is close to the energy of the corresponding breakup threshold. Thus they require Hilbert spaces that know about the continuum.

An ab initio description assumes the centers of mass and the spins of the nucleons as the degrees of freedom and as the interaction among them a realistic two- and three-body potential that reproduces phase shifts and other properties of the two- and three-nucleon system.

In the Fermionic Molecular Dynamics (FMD) approach we aim at a unified microscopic description including well bound nuclei with shell structure, nuclei featuring clustering or halos, and continuum states like resonances and scattering states. We achieve this by exploiting the versatility of Gaussian wave packets.

The same microscopic effective interaction is used for all nuclei and all states, such as well bound states, halos, cluster states like the Hoyle state in ^{12}C, or even nucleus-nucleus scattering at astrophysical energies well below the Coulomb barrier.
This effective interaction is based on the V_{UCOM} interaction derived from the realistic Argonne V18 interaction by explicitly including short-range central and tensor correlations within the Unitary Correlation Operator Method (UCOM).

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