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Many-Body Perturbation Theory for *Ab Initio* Nuclear Structure

The reach of *ab initio* calculations has extended significantly over the past years. In particular systems revealing a closed-shell character can be described efficiently up to the tin isotopic chain via controlled many-body expansions like coupled-cluster theory, the in-medium similarity renormalization group or self-consistent Green's function techniques. However, the transfer of such methods to open-shell nuclei requires a highly non-trivial extension. In this talk we will discuss many-body perturbation theory (MBPT) as a light-weighted alternative and give a pedestrian introduction to MBPT based on a Hartree-Fock reference state. Low-order energy corrections for ground states of closed-shell nuclei will be discussed using state-of-the-art chiral interactions.
The conceptual simplicity of MBPT allows for a direct generalization to open-shell systems by using correlated reference states. First I will present a MBPT version using a multi-configurational reference state arising from a prior no-core shell-model calculation (NCSM). We present recent calculations of second-order energy corrections of spectra of even and odd carbon and oxygen isotopes and compare them to exact diagonalizations from large-scale NCSM calculations. Additionally, we will provide first results on the dripline physics of the fluorine isotopic chain.
In a complementary ansatz we use symmetry-broken reference states from a Hartree-Fock-Bogoliubov (HFB) calculation as starting point for the correlation expansion and reformulate MBPT in a quasiparticle setting yielding the so-called Bogoliubov MBPT (BMBPT). We present preliminary results for the oxygen chain and compare them to other state-of-the-art many-body approaches and provide an outlook on future applications of symmetry-broken many-body approaches.

Mercredi 13 Déc. 2017, 11h30

IPN, Bât. 100, Salle A015