A MICROSCOPIC FINITE-RANGE PAIRING INTERACTION FOR HFB CALCULATIONS IN COORDINATE SPACE

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The structure of the nucleus and the properties of extended nuclear systems strongly depend on their possible superfluid nature. In finite nuclei, nucleonic pairing has a strong influence on all low-energy properties of the system, such as masses, separation energies, deformation, individual excitation spectra and collective excitation modes. The role of pairing correlations is particularly emphasized when going toward the drip-lines because of the proximity of the Fermi surface to the single-particle continuum.

To treat pairing, one needs to specify the many-body technique used and the appropriate interaction to insert into the calculation at that chosen level of approximation. The latter depends on the situation and on the system. Perturbative methods such as the Green's function or Goldstone formalisms provide guides to the definition of the appropriate vertices. In particular, they show unambiguously that the irreducible vertex to be used in the pairing channel at lowest order is the bare nucleon-nucleon force. At the next order, the irreducible pairing vertex involves the so-called polarization diagrams.

As regards HFB calculations of finite nuclei, only phenomenological forces like the Gogny force or the (density-dependent) delta interaction have been used in the pairing channel so far. Although successful in describing low-energy nuclear structure over the (known) mass table [1], those phenomenological pairing forces lack a link to the bare nucleon-nucleon interaction. They were directly fitted to finite nuclei data and may thus renormalize beyond-mean-field effects. Also, their fits were performed where experimental data are available, which makes their extrapolation toward the drip-lines questionable.

We present a recently proposed microscopic effective pairing interaction [2]. It is introduced by recasting the gap equation written in terms of the bare force and is thus explicitly connected with it. As a matter of fact, the pairing properties provided by the realistic $AV18$ force are reproduced very accurately. This vertex is finite ranged, non local, total-momentum dependent and density dependent. Also, a natural cut-off arises in the gap equation through the proposed recasting procedure. This cut-off makes zero-range approximations of the effective vertex meaningful. Performing such an approximation, the roles of the range and of the density dependence of the interaction can be disentangled. The isoscalar and isovector density-dependences derived ab-initio provide the pairing force with a strong predictive power when extrapolated toward the drip-lines. Although finite ranged and non local, the proposed interaction makes HFB calculations of finite nuclei in coordinate space tractable. Through the two-basis method, its computational cost is of the same order as for a zero-range force. We discuss the results of the first 3D HFB calculations performed with this new microscopic pairing interaction [3].

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[3] T. Duguet, G.-F. Bertsch, B. Sabbey and P. Bonche, (in preparation).