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Recent Progress in Building Novel Nonlocal Energy Density Functionals

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Numerous applications of nuclear DFT have shown a tremendous success of the approach, which by using a dozen-odd coupling constants allows for correct description of a multitude of nuclear phenomena. However, recent analyses indicate that the currently used models have probably reached their limits of precision and extrapolability. The question of whether these can be systematically improved appears to be one of the central issues of the present-day investigations in nuclear-structure theory. In this talk, I will present status of theoretical developments that aim to build novel nonlocal energy density functionals (EDFs).

In particular, we recently proposed [1] to use a two-body regularized finite-range pseudopotential to generate nuclear EDFs in both particle-hole and particle-particle channels, which makes them suitable for beyond-mean-field calculations. We derived a sequence of pseudopotentials regularized up to next-to-leading order (NLO) and next-to-next-to-leading order (N2LO), which fairly well describe infinite-nuclear-matter properties and finite open-shell paired and/or deformed nuclei. Solutions of the corresponding self-consistent equations were implemented in spherical and triaxial symmetries, codes FINRES4 [2] and HFODD [3], respectively.

In Landau theory of Fermi liquids, the particle-hole interaction near the Fermi energy in different spin-isospin channels is probed in terms of an expansion over the Legendre polynomials. In Ref. [4] we showed general expressions for Landau parameters corresponding to a two-body central local regularized pseudopotential and we showed results obtained for the two recent parametrizations NLO and N2LO, adjusted in Ref. [1].

In Ref. [5] we showed results of the Hartree-Fock-Bogolyubov calculations performed using these two parametrizations. We discussed properties of binding energies and pairing gaps determined in semimagic spherical nuclei. The results were compared with benchmark calculations performed for the functional generator SLyMR0 [6] and functional UNEDF0 [7].

References:

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Primary author: Prof. DOBACZEWSKI, Jacek (University of York)

Co-authors: Dr IDINI, Andrea (University of Surrey); Dr BENNACEUR, Karim (Univ Lyon, Universite Lyon 1); Dr KORTELAINEN, Markus (University of Jyväskylä)

Presenter: Prof. DOBACZEWSKI, Jacek (University of York)

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