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Improving the nuclear energy density functionals: constraints from the ground state and collective excitations

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Over the past years the energy density functionals have been extensively used in nuclear physics and astrophysics research; there are more than 240 nonrelativistic Skyrme parametrizations and 260 relativistic-mean-field (RMF) models introduced so far. However, all of them are optimized mainly by the nuclear ground state data, often supplemented with pseudo-observables in order to set the nuclear matter (equation of state) properties. Recently a novel relativistic energy density functional has been constrained not only by the ground state properties of nuclei but also with the isoscalar giant monopole resonance energy and dipole transition strength in nuclei, i.e. dipole polarizability in 208Pb [1]. A unified framework of the relativistic Hartree-Bogoliubov model, random phase approximation, and χ^2 minimization protocol, based on the relativistic density-dependent point coupling interaction has been established in order to determine the DD-PCX parameterization [1]. The implementation of the experimental data on nuclear excitations allows improving the isovector channel of effective interaction as well as constraining the symmetry energy and nuclear matter incompresibility by using genuine observables on finite nuclei in the minimization protocol to constrain the effective interaction. The effective interaction DD-PCX accurately describes the nuclear ground state properties including the neutron-skin thickness, as well as the isoscalar giant monopole resonance excitation energies and dipole polarizabilities and open perspectives for further applications.

[1] E. Yuksel , T. Marketin, N. Paar, Phys. Rev. C 99, 034318 (2019)

Presenter: PAAR, Nils (Faculty of Science University of Zagreb)

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