Covariant density functional theory: nuclei at the extremes of nuclear landscape

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Density functional theory is one of few theoretical approaches which allows to describe the nuclei across full nuclear landscape. I will base my talk on the results obtained in covariant density functional theory (CDFT) which is a modern theoretical tool for the description of low-energy nuclear phenomena. In its framework the nucleus is described as a system of nucleons which interact by the exchange of different mesons and this description is based on the Dirac equation.

First, I will discuss the basic features of the CDFT. Then I will concentrate on recent progress in our understanding of global properties of covariant energy density functionals. The extremes of nuclear landscape such as two-neutron drip line and the region of superheavy nuclei will be the main focus of the discussion. Relevant physical observables are investigated in a systematic way. Theoretical uncertainties in their description and their underlying sources will be discussed next. Their assessment is important since even with new generation of experimental facilities such as FRIB and SUPERHEAVY FACTORY, almost half of the $Z \leq 120$ nuclei will be beyond experimental reach. In addition, the impact of nuclear matter constraints will be discussed. It turns out that the inaccuracies in the description of the energies of the single-particle states is one of the main sources of theoretical uncertainties. Two possible solutions to this problem, such as particle-vibration coupling and effective tensor interaction, will be discussed in detail.