Neutron skin thickness in the Skyrme EDF models

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Thanks to the new radioactive beam facilities, the experimentally known region of the nuclear landscape will be pushed towards more and more exotic nuclei. New experimental data on nuclei with large proton or neutron excess will undoubtedly put current theoretical models to the test. Therefore, it is crucial to quantify predictive power of the models used to describe atomic nucleus. Some of the interesting quantities, to test the models and their uncertainties, are the predicted limits of the nuclear landscape [1] and predictions related to the neutron skin thickness [2].

To cover the entire nuclear landscape, the microscopic tool of the choice is the nuclear density functional theory (DFT). In nuclear DFT, the effective interaction is parameterized by the energy density functional (EDF). Because EDF parameters have to be optimized to the empirical input, they also contain certain uncertainties. These uncertainties propagate to the observables calculated within the model.

A method to assess the predictive power of the DFT models is to calculate either the systematic or statistic error of some observable, predicted by the model. With well-calibrated Skyrme-EDFs we found neutron drip-line to be rather well defined [1]. As expected, the systematic deviation in two-neutron drip-line increases towards heavier nuclei. This is linked to the isovector part of the EDF, which is not so well constrained as the isoscalar one. The situation is similar with the statistical error.

With the neutron skin thickness, both, the systematic and statistical error increase towards neutron drip line [2]. This is shown in Fig. 1a, where neutron skin thickness and statistical model error for Zr isotopic chain has been plotted. Again, this behavior is directly linked to the larger theoretical uncertainties related to the isovector part of the Skyrme-EDFs. The major contributor to the statistical error here is the density dependent part of the symmetry energy. Concerning the recent PREX experiment of the neutron skin thickness in ^{208}Pb, we have found that current theoretical uncertainties are smaller compared to the experimental error bar, see Fig. 1b. This is consistent with findings of Ref. [3].

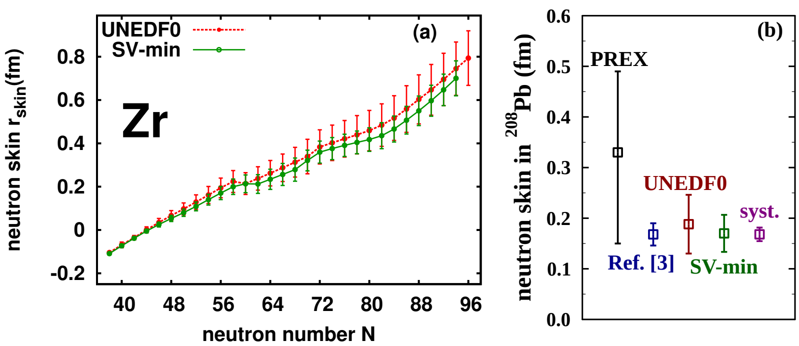

Figure 1: *(a) Predicted neutron skin thickness and statistical model error in Zr isotopes, and (b) in ^{208}Pb together with experimental PREX result and systematic model error of Ref. [3] and this work.*

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