ID de Contribution: **26** Type: **Non spécifié**

Shapes of heavy and super-heavy atomic nuclei with Skyrme Energy Density Functionals

The mean-field, or Energy Density Functional (EDF), methods allow for the study of energies and shapes of all nuclei, but the lightest ones, throughout the mass-table. These approach and their extensions such as the Random Phase Approximation (RPA) and Generator Coordinate Method (GCM) give access to observables from ground state, excited states and large-amplitude collective motion of the nuclei. Furthermore, the mean-field gives a natural interpretation of the nuclear configurations through the shapes of the system in its intrinsic frame.
It is well established that a correct description of the ground states of deformed heavy nuclei, rotational bands, isomeric states energies and fission barriers is strongly correlated with the value of the surface energy coefficient a surf and also the surface symmetry energy coefficient a ssym.
A first step in the direction of a better description of shapes of heavy nuclei was recently achieved with the construction of the SLy5sX series of Skyrme-EDFs and more specifically with the SLy5s1 parameterisation. The systematically improved agreement for deformation properties of heavy nuclei achieved with SLy5s1 compared to widely-used parameterisations such as SLy5, however, comes at the expense of a significant increase of mass residuals.
In this presentation, I will show that a slight modification of the fit protocol together with the inclusion of the often-neglected two-body contribution to the center-of-mass correction in functional greatly improve the results for shapes, barriers heights and binding energies. I will present the details of the fit protocol and show a set of selected results. It turns out that completely omitting the center-of-mass correction as sometimes done for parameterisations aiming at nuclear dynamics is similarly problematic as using the standard recipe where only the one-body part is kept. I will also discuss how the statistical error bars on the parameters of the functional propagate on calculated quantities such as fission barriers.

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