The structure of superheavy nuclei

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Super-heavy nuclei represent a tough challenge for nuclear theoreticians. These nuclei are indeed far from stability and from the region where the ingredients of nuclear models have been adjusted. Their existence is related to shell effects, whose prediction is thus crucial for the understanding of their structure. But due to the large number of nucleons, the level density is particularly high and the shell effects are more sensitive to the parameters of the model used to describe super-heavy nuclei than in any other regions of the mass table.

It is therefore particularly important to apply to the study of super-heavy nuclei models with the largest possible generality. In the last decade, several microscopic mean-field models have been applied to this region of the mass table. They share the property that their only phenomenological ingredient is an effective interaction which has been adjusted on very general properties of nuclei. Three main families of models have been used: Hartree-Fock-Bogoliubov methods with either a Skyrme interaction [1] or the Gogny force [2] and relativistic Hartree Bogoliubov (usually called relativistic mean-field) methods with an effective Lagrangian [3].

I shall review these methods and their particularities. I shall first focus on how they have been tested on nuclei close to the super-heavy region. The recent experimental results for the Nobelium isotopes ^{252}No and ^{254}No [4,5] are in this respect of particular importance. They bring data in a region close to the domain of super-heavy nuclei, where our knowledge of single-particle spectra and of pairing correlations is particularly limited. All three families of mean-field methods have been applied to these nuclei [5-7] and I shall compare their results.

I shall finally present some recent applications. I will stress the importance of a correct treatment of paring correlations; I will also focus on the different ways odd nuclei are described and on the influence of the polarization effects due to the unpaired nucleon.

References

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