SELF-CONSISTENCY EFFECTS IN SUPERHEAVY NUCLEI*

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The possible existence of shell-stabilized superheavy nuclei has been a driving force behind experimental and theoretical efforts to investigate the superheavy nuclei. Unfortunately, theoretical predictions for such nuclei differ considerably [1]. In such a situation we should try to find the criteria that allow us to judge which of the theoretical models and parameterizations can provide the most reliable predictions for superheavy nuclei. For this reason we have extended the comparison of the calculated observables with experiment beyond the ground state deformations and binding energies, which are usually studied. The investigation of quasiparticle spectra in heaviest actinide odd-mass nuclei in [2] showed that the parameterizations (NLSH, NLRA1) of the relativistic mean field (RMF) theory, which are the only RMF sets predicting $Z = 114$ as a magic proton number, provide poor descriptions of single-particle states and thus cannot be considered as reliable for the study of superheavy nuclei. These investigations strongly support the RMF predictions that $N = 172$ and $N = 184$ and $Z = 120$ are the most likely candidates for neutron and proton magic shell gaps. In addition, they show that reliability of the parameterization of the mean field theory with respect of the shell structure of superheavy nuclei cannot be judged by considering only deformations, binding energies and their derivatives.

Microscopic models predict that the shell closures in superheavy nuclei are influenced by a central depression of the nuclear density distribution [3], where among the various models the RMF theory gives largest effect. Our RMF investigation of the self-consistency effects shows that the density depression strongly changes the shell structure of superheavy nuclei [4]. This result questions the predictions of the macroscopic+microscopic method, which does not take the central depression into account. The method works nicely for the heaviest actinides mainly because the energies of single-particle states have been carefully adjusted. It is also expected to provide a good description of the light deformed superheavy nuclei (A$\approx$ 265), for which the RMF gives little or no central depression. However, concerning structure of spherical superheavy nuclei, our investigation demonstrates the correlation between the size of the depression, effective mass of microscopic (Skyrme, Gogny and RMF) theory and the appearance of the $Z = 120, 126$ and $N = 172, 184$ shell closures. The work is in progress and more results will be presented.

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