Surface Diffuseness and Properties of Spherical Superheavy Nuclei*†

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In a macroscopic-microscopic description of nuclei the diffuseness of the nuclear surface is usually considered to have the same value for all nuclei [1]. However, there is evidence that this quantity can vary somewhat [2]. Since the location and size of magic number influences on the binding energy of nuclei depend on the diffuseness of the nuclear surface, it makes sense to treat the diffuseness as a degree of freedom with its final value obtained by minimization of the nuclear energy, as is done for the deformation degrees of freedom. Such a proceedure has been recently adopted in a macroscopic description of a nucleus [3].

In the work being reported here this proceedure has been extended to a full macroscopic-microscopic model and we have estimated its effect on the properties of superheavy nuclei. Properties such as single-particle energy levels and the shell correction to the nuclear energy have been considered. Spherical superheavy nuclei with the closed neutron shell at the number $N = 184$ are analyzed.

The macroscopic part of the diffuseness-dependent energy is taken from [3] and the microscopic part is the Strutinski shell correction based on the Woods-Saxon single particle potential. In both parts of the energy, the diffuseness of the neutrons and the protons are treated as variable degrees of freedom. Their equilibrium values are found by minimization of the total (macroscopic-microscopic) energy of a nucleus.

Microscopic calculations were performed for the nucleus $^{310}126$ for different values of the diffuse parameter z. We found that the shell structure of this nucleus depends strongly on z. In particular, the energy gap at $Z = 114$ decreases, while the gap at $Z = 126$ increases with increasing z.

The shell correction to the binding energy was calculated for nine even-even nuclei with the magic neutron number $N = 184$. According to the calculations these nuclei should be spherical. As expected the shell correction calculated with the diffuseness included as a degree of freedom resulted in an increase in the predicted binding energy for all the nuclei considered. Of special interest, however, is the fact that the increase was larger for $Z = 126$ than it was for $Z = 114$.

For the nucleus $^{310}126$ the value of z_{eq} increased by 12% for protons and 4% for neutrons, the shell correction increased (in absolute value) by 2.18 MeV and the macroscopic energy by 2.34 MeV. Thus the total binding energy of this nucleus is increased by 4.52 MeV with respect to the case when the diffusenesses z are fixed at the value $z_0 = 0.70$ fm.

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