International Nuclear Physics Conference INPC2013: 2-7 June 2013, Firenze, Italy

Impact of nuclear structure on production and identification of superheavy nuclei

N.V. Antonenko[1]

[1] *Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, 141980 Dubna, Russia*

Contact email: *antonenk@theor.jinr.ru*

The calculations performed with the modified two-center shell model reveal quite strong shell effects at $Z = 120 - 126$ and $N = 184$ [1]. So, our microscopic-macroscopic treatment qualitatively leads to the results close to those in the self-consistent mean-field treatments. If our prediction of the structure of heaviest nuclei is correct, than one can expect the production of evaporation residues $Z = 120$ in the reactions ^{50}Ti+^{249}Cf and ^{54}Cr+^{248}Cm with the cross sections 23 and 10 fb, respectively. The $Z = 120$ nuclei with $N = 175 - 179$ are expected to have Q_α about 12.1–11.2 MeV and lifetimes 1.7 ms–0.16 s in accordance with our predictions. These Q_α are in fair agreement with predictions of Liran et al. and about 2 MeV smaller than in other microscopic-macroscopic approaches. The experimental measurement of Q_α for at least one isotope of $Z = 120$ nucleus would help us to set proper shell model for the superheavies with $Z > 118$. Note that the definition of maxima of the excitation functions provides a good test for the predictions of the models as well.

Based on the calculated one-quasiproton spectra and energies for a decays, one can explain [2] why the α-decay chain of ^{291}117 or ^{287}115 is terminated by spontaneous fission of ^{267}Db. It is shown that, in the α-decay chain of ^{293}117, the α decay of ^{281}Rg is hindered by the structure effects and because of this, the ^{281}Rg nucleus undergoes spontaneous fission instead of a decay. In addition, the number of isomeric states in the heaviest odd-Z nuclei is predicted. For the ^{282}Rg nucleus, we expect $T_\alpha \approx 25$ s and $T_{sf} \approx 110$ s, i.e., about ten times larger than for neighboring even-odd nuclei ^{283}Cn and ^{281}Ds. Thus, ^{282}Rg undergoes α decay.

Although the values of T_α found in the α-decay chains of ^{287}Fl and ^{293}Lv are quite large, one cannot completely exclude the α decays from the one-quasiparticle isomeric states in ^{287}Fl, ^{283}Cn, and ^{281}Ds [3]. For example, it is shown that the α decay of the ^{281}Ds nucleus occurs only from the ground state which can be populated with small probability in the α-decay chains of the ^{289}Fl element. The minimum of Q_α in ^{286}Fl indicates the neutron shell at $N = 172$. In other α-decay chains considered there is no minima of Q_α at $Z = 114$, which probably indicates the proton shell closure at $Z \geq 120$ as predicted with the self-consistent microscopic and microscopic-macroscopic [1] calculations.

[1] A.N. Kuzmina, G.G. Adamian, N.V. Antonenko, and W. Scheid, Phys. Rev. C 85, 014319 (2012).
[2] A.N. Kuzmina, G.G. Adamian, and N.V. Antonenko, Phys. Rev. C 85, 017302 (2012).
[3] A.N. Kuzmina, G.G. Adamian, and N.V. Antonenko, Phys. Rev. C 85, 027308 (2012).