Superheavy Elements – investigating the properties of exotic high-Z nuclear matter

D. Ackermann[1]*
[1]*GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64846 Darmstadt, Germany*
* *email: d.ackermann@gsi.de*

The search for the next closed proton and neutron shells beyond ^{208}Pb has yielded a number of exciting results in terms of the synthesis of new elements [1,2,3] at the upper end of the charts of nuclides, in a region of exotic high-Z nuclear matter. These superheavy elements (SHE), however, are a nuclear structure phenomenon. They owe their existence to shell effects, an energy contribution of quantum mechanical origin to the nuclear potential, without which they would not be bound.

Experimental activities in this field cover synthesis, reaction mechanism studies and nuclear structure investigations. In addition chemistry of SHE provides additional input on chemical properties and the Z assignment.

To pursue further the course of the synthesis of new elements, the irradiation of ^{248}Cm targets will be initiated at SHIP which opens the access to a discrete variety of measurements including and aiming eventually at the synthesis of element 120 in the reaction ^{54}Cr+^{248}Cm $\rightarrow$ ^{302}120*.

In recent years the development of efficient experimental set-ups, including separators and advanced particle and photon detection arrangements, allowed for more detailed nuclear structure studies for nuclei at and beyond Z=100. A review of recent achievements is given in ref. [4]. Among the most interesting features is the observation of K-isomeric states. Experimentally about 14 cases have been identified in the region of Z>96. K-isomers or indications of their existence have been found for almost all even-Z elements in the region Z=100 to 110. We could recently establish and/or confirm such states in the even-even isotopes ^{252,254}No [5]. The heaviest nucleus where such a state was found is ^{270}Ds with Z=110 as we reported in 2001 [6]. Those nuclear structure studies lay out the grounds for a detailed understanding of these heavy and high-Z nuclear systems, and contribute at the same time valuable information to the preparation of strategies to successfully continue the hunt for the localisation of the next spherical proton and neutron shells beyond ^{208}Pb.

The recent activities for both, SHE synthesis and nuclear structure investigations at GSI will be reported.

References

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