Isomeric states in heavy nuclei – experimental perspectives

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Nuclear isomers continue to provide key insights into nuclear structure physics. They can be categorized as: i) spin traps the decay of which is associated with high angular momentum removal (hence the long half-lives), ii) K quantum number traps which involve transitions with large changes in the orientation of the angular momentum (though not necessarily in the magnitude), iii) shape isomers, where it is a nuclear shape change that hinders the isomer deexcitation.

Shape isomers with lifetimes > 1 ns have clearly been observed only in actinide nuclei. Their existence arises from the presence of a second minimum in the potential energy surface (PES) of the nucleus, in which the nucleus may be trapped. These isomers decay mainly by fission.

The discovery of shape isomers was of paramount importance for predictions of the existence of superheavy nuclei – it became clear that nuclei with Z>100, for which the Liquid Drop Model fission barrier almost vanishes, could be stabilized by shell effects, i.e., by exactly the same mechanism which produces the secondary PES minima in the actinides.

It is natural to consider the possibility of the occurrence of K isomers in the secondary PES minima. The superdeformed axially-symmetric shape, which is characteristic for a nucleus in the second well, is an excellent condition for the conservation of the K quantum number. In addition, K configuration could increase the stability of an isomer against fission. It is very likely that understanding the physics of K isomers in the second minimum will shed light on the existence of K isomers in superheavies - such metastable states may be more stable than the ground states of these superheavy nuclei.

Knowledge on the K isomers built on an isomeric PES minimum is very limited and in this presentation the perspectives of studies focused on such states in Polish laboratories will be discussed.