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Nuclear Structure of the Heaviest Elements Investigated at SHIP - GSI

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The quest for the heaviest nuclei that can exist is a basic topic in natural science as their stability is characterized by a delicate interplay of short range nuclear forces acting between the nucleons (protons and neutrons) and long-range Coulomb forces acting solely between charged particles, i.e. the protons. In this sense understanding nuclear stabilitity and its limits at the upper part of the charts of nuclei ($Z > 100$) is essential to understand basic interactions. As the stability of a nucleus is strongly correlated to its structure, understanding the nuclear structure of heaviest nuclei is presently - besides synthesizing new elements - the main challenge of experimental and theoretical investigations concerning the field of Superheavy Elements (SHE).
At GSI Darmstadt an extensive program on nuclear structure investigations by means of α-γ – or α – conversion electron (CE) spectroscopy of nuclei collected in the focal plane of the velocity filter SHIP has been started about a decade ago. The project covered both: systematic investigations of single particle levels populated by α-decay in odd-mass isotopes (see e.g. [1,2,3]) as well as investigation of two- or four-quasi-particle states forming K isomers (see [4,5,6]). In addition, first results on nuclear structure from EC decay using K X-ray – γ – and γ – γ – coincidence measurements were obtained [6].
The studies were supplemented by direct mass measurements at SHIPTRAP [7] and investigation of spontaneous fission properties.
Results obtained in the element region $Z = 99$ to $Z = 110$ and also their relevance for the spontaneous fission process and expected properties of SHE at $Z > 112$ will be presented and discussed within theoretical frameworks.

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[4] B. Sulignano et al. EPJ A 33, 327 (2007)
[5] F.P. Heßberger et al. EPJ A 43, 175 (2010)
[6] S. Antalic et al. EPJ A 47 :62 (2011)
[7] E. Minaya Ramirez et al. Science 337, 1207 (2012)