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Mass measurements of the heaviest elements with the SHIPTRAP mass spectrometer at GSI

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Investigating the boundaries of the nuclear chart and understanding the structure of the heaviest elements are at the forefront of nuclear physics. The existence of the superheavy nuclei is intimately linked to nuclear shell effects which counteract Coulomb repulsion and therefore hinder spontaneous fission. In the region of heavy deformed nuclei weak shell gaps arise around Z=100 and N=152 as well as around Z=108 and N=162. However, the extension of these gaps and their impact on the structure of these exotic nuclei, especially the most neutron-rich ones, is not yet fully understood, as most of the relevant nuclear systems are not experimentally addressed due to limited production capabilities, i.e. available beam-target combinations and/or corresponding low yields. Moreover, heavy and superheavy nuclides feature often metastable excited states with half-lives that can exceed the one of the ground state. Long-lived isomeric states can have excitation energies of only few tens of keV or below, therefore, their identification is challenging, especially in decay-based measurements.

On the other hand, Penning-trap mass spectrometry allows the experimental determination of the binding energy and, when applied to isotopic chains crossing shell gaps can provide information concerning the evolution of the shell gap strength without the detailed knowledge of the structure of the nuclei under study. Moreover, mass measurements with Penning traps feature sufficient resolving power to allow the separation of isomeric states when they are populated in the same reaction as the ground state. Their excitation energy can then be measured precisely.

In recent years, we have established tailored and highly sensitive experimental methods allowing us to extend the reach of Penning-trap mass spectrometry with the SHIPTRAP setup to heavy elements well beyond uranium. In this talk a review of the latest experimental campaigns will be presented.

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