Exploring the structure of the heaviest nuclei through precision measurements at low energy

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Over the past 50 years, research at the GSI accelerator facility in Darmstadt has significantly advanced our understanding of superheavy nuclei, leading to the discovery of six new elements. More recently, this research has expanded through pioneering experiments using Penning-trap mass spectrometry and resonance-ionization laser spectroscopy. These techniques have enabled the precise measurement of different atomic and nuclear properties of the heaviest elements. For example, enhanced studies of nuclear shell structure evolution near the predicted deformed shell gap at neutron number $N = 152$ have yielded important insights via binding energies and changes in the nuclear charge radii. To achieve these results, several online production schemes have been implemented at the GSI in Darmstadt, complemented by offline studies of long-lived actinide isotopes at the University of Mainz. Comparing our experimental results on charge radii of fermium and nobelium isotopes with state-of-the-art nuclear radius calculations based on energy-density functionals has shown that the behavior of these nuclei is largely governed by bulk nuclear properties. Another recent laser spectroscopy experiment addressed the long-lived $K_\pi = 8^-$ isomer in ^{254}No to determine its nuclear configuration, resolving a long-standing debate. In my presentation, I will highlight key findings from the recent measurement campaigns and discuss future directions in the study of superheavy nuclei at the GSI.