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Laser Spectroscopy of the Heaviest Actinides at GSI

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Laser spectroscopic measurements of optical transitions in the atomic shell are a well-established tool to study the interaction between the electron shell and the nucleus. To reach the heaviest actinides with their low production rates, the RADRIS (RAdiation-Detected Resonance Ionization Spectroscopy) method is ideally suited.

The first laser spectroscopic investigation of nobelium (Z = 102) applying this technique in a buffer gas-filled stopping cell coupled to the SHIP separator at GSI revealed the shapes and sizes of the nuclei of $^{252\text{-}254}$No [1]. Additionally it enabled high precision measurements of the first ionization potential [2].

Recent technological developments expanded the accessible isotopes, which has allowed the measurement of the ^{248,249,250,254}Fm series across the shell closure at N = 152. In addition, the total efficiency was increased and the alpha detection background level was reduced to the point where a broad search for atomic levels in the heaviest actinide element, lawrencium (Z = 103), became possible. To ensure a traceability for the conditions during the wide wavelength ranges required for this measurement, additional monitoring and documentation of numerous parameters was implemented to enable a reliable evaluation. These developments together with the most recent laser spectroscopic results will be presented.

Additionally, the development of a hypersonic gas jet for laser spectroscopy of the fusion-evaporation products will be discussed, which may improve spectral resolution by an order of magnitude and provide access to even shorter-lived isotopes.

References

[1] S. Raeder et al., PRL **120**, 232503 (2018).

[2] P. Chhetri et al., PRL **120**, 263003 (2018).