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Recent progress of the Laser Spectroscopy the Heaviest Actinides at GSI

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The heaviest elements are of interest to nuclear and atomic physicists due to their peculiar properties. While nuclear shell structure effects are responsible for their very existence stabilizing them against spontaneous fission, the structure of their electronic shells is affected by strong relativistic effects leading to different atomic and chemical properties compared to their lighter homologs. The atomic structure can be probed by laser spectroscopy which is a powerful tool to unveil fundamental atomic and, from the determination of subtle changes in atomic transitions, nuclear properties. The lack in atomic information on the heavy element of interest, the low production rates, and the rather short half-lives make experimental investigations challenging and demand very sensitive experimental techniques.

The transfermium element Nobelium (No, Z=102) became only accessible for optical spectroscopy in a pioneering experiment employing the RAdiation Detected Resonance Ionization Spectroscopy (RADRIS) technique coupled to the velocity filter SHIP at GSI, Darmstadt [laat]. Measurements of an atomic transition in the isotopes $^{251\text{-}255}$No as well as resolving the hyperfine splitting in ^{253,255}No gave access to nuclear moments and differential charge radii [4]. In recent measurement a novel mode of the RADRIS technique was established, where the desired nuclides are bred by radioactive decay on the capture filament extending the reach of the method to ^{255}No and, for the first time, to on-line produced Fm isotopes. In addition was an extended level search for an atomic transition of the next heavier element lawrencium (Lr, Z=103) performed. Here the laser were scanned over two predicted.

An improvement in the experimental observables can be achieved by performing laser spectroscopy not inside the high pressure buffer gas cell, but inside a hypersonic gas jet effusing from the stopping cell [Yuri]. Here the low density and cold environment improve the spectral resolution of the laser spectroscopy. For this investigation the JetRIS setup was developed at HIM in Mainz and a first online commissioning of JetRIS was performed during the last beamtime at GSI. Recent experiments of our laser spectroscopy program as well as obtained results will be discussed together an outlook to the future in view of the next beamtime campaign.

References

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