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Towards laser spectroscopy of longer-lived heavy nuclei with RADRIS

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The experimental determination of atomic and nuclear properties such as atomic energy levels, ionization potentials, electromagnetic moments, as well as trends in mean-square charge radii for nuclei in the region of the heaviest elements remain limited. The main challenges are low production rates in accelerator facilities and the short half-life of the fusion products. This necessitates the use of highly efficient and selective laser spectroscopy techniques. At GSI-FAIR in Darmstadt, Germany, the **RA**diation **D**etected **R**esonance **I**onization **S**pectroscopy (RADRIS) apparatus has been successfully used to study aforementioned properties in $^{245,246,248-250,254}\text{Fm}$ and $^{251-255}\text{No}$ [1,2].

For the understanding of nuclear deformation in this region it is necessary to extend these investigations to further isotopic chains, e.g. californium, where nuclei feature long lifetimes. As the detection of laser ions via their α -decay for nuclei with half-lives in the order of several to tens of hours became impractical with a single detector, a more versatile detector design of RADRIS was developed to increase the method's reach towards longer-lived nuclei. The upgraded version enables the measurement of ^{246}Cf with a half-life of 35.7 h. This data, together with previously studied long-lived Cf isotopes, allow for an investigation of charge radius trends across a long isotopic chain next to the recently published Fm chain [2,3]. Furthermore, the experimental goal is an atomic level search on Md ($Z = 101$) for which no experimental data on the excited states are known to date. Here preparatory studies with neutron deficient isotopes of the homologue elements Er ($Z = 68$) and Tm ($Z = 69$) have been performed. This talk will present the upgraded RADRIS detector architecture, showcase the newest laser spectroscopy results, using the recent measurements to illustrate the apparatus' expanded capabilities.

[1] M. Laatiaoui et al., Nature 538, 495–498 (2016)

[2] J. Warbinek et al., Nature 634, 1075–1079 (2024)

[3] F. Weber et al., Atoms, 10(2), 51 (2022)

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