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High-resolution spectroscopy of fermium-255 at the RISIKO mass separator

Studies of atomic spectra through resonant laser excitation and ionization provide information on nuclear structure. Precise measurements of the hyperfine structure (HFS) give an experimental insight on the nucleus' deformation through the electric quadrupole moments and the single-particle structure through the magnetic dipole moments. However, this method is limited by low production yields and scarce knowledge on the atomic structure [1]. Nevertheless, the measurements of these observable will help to further probe the transition to the macroscopic regime and to calibrate existing nuclear models of heavy nuclei.

This work will discuss the results of our last measurement campaign, where a sample of ^{254}Es was provided by the Florida State University and the Oak Ridge National Laboratory, USA. This sample was then neutron irradiated in the high-flux research reactor at the Institute Laue-Langevin in Grenoble, France, to obtain ^{255}Es. After the irradiation, the sample underwent a chemical separation at the Department of Chemistry –TRIGA site at Mainz University, Germany, allowing an iterative separation of the decay daughter ^{255}Fm.
This process delivered nine samples consisting of 10^8 to 10^9 atoms, used to study the atomic and nuclear structure of ^{255}Fm ($Z = 100$) at the RISIKO Mass Separator at Mainz University.

High-resolution spectroscopy was performed using the Perpendicularly Illuminated Laser Ion Source and Trap (PI-LIST) together with an injection-locked Ti:sa laser system. Using two-step excitation schemes, the HFS in the ground-state transitions to the atomic levels at 25099.8 ± 0.2 cm^{-1} and at 25111.8 ± 0.2 cm^{-1} [2] were measured and the hyperfine coupling constants of these levels were determined.

[1] M. Block, et al., Recent progress in laser spectroscopy of the actinides. Progress in Particle and Nuclear Physics 116, 103,834 (2021)
[2] H. Backe, et al., Laser spectroscopic investigation of the element fermium (Z = 100). Hyperfine interactions 162(1-4), 3–14 (2005)

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