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Experimental studies on the optical spectrum of the heavy r-process nuclide Cf-254 and its neighbors

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The spontaneously fissioning isotope californium-254 is predicted to have a high impact on the brightness of electromagnetic transients associated with neutron star mergers on the timescale of 10 to 250 days, due to its 60-day half-life. [Zhu et al., AJL 863, L23 (2018)]. Experimental information on Cf-254 is scarce, owing to limited production capabilities in the laboratory. We have performed laser spectroscopy on this and neighboring isotopes at the RISIKO mass separator at Johannes Gutenberg University Mainz (JGU), Germany. For this, Cm targets were neutron-irradiated at Oak Ridge National Laboratory (ORNL), TN, USA, to breed Es-253,254. After the chemical separation at ORNL the Es fraction, which also contained some Cf-252, was shipped to JGU, via Florida State University, FL, USA, and then sent to Institut Laue-Langevin, Grenoble, France, for a second irradiation to produce more neutron-rich isotopes including, Cf-253 and Cf-254. The hyperfine structure of the 420 nm ground-state transition in Cf-253 and the isotope shift of Cf-254 in the 417 nm and 420 nm ground-state transitions were determined with high resolution down to 140 MHz. These data provide a basis for a King plot analysis of the optical spectrum of Cf-254 based on known data of lighter californium isotopes.

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