

Spectroscopy of neutron-deficient californium and einsteinium isotopes

J. Konki,¹ J. Khuyagbaatar,² B. Sulignano,³ P.T. Greenlees,¹ J. Uusitalo,¹ K. Auranen,¹ F. Bisso,¹ M. Block,² R. Briselet,³ D.M. Cox,¹ A. Di Nitto,² Ch. E. Düllman,² T. Grahn,¹ K. Hauschild,⁵ A. Herzán,¹ R.-D. Herzberg,⁴ S. Juutinen,¹ E. Jäger,² J. Krier,² M. Leino,¹ A. Lightfoot,¹ A. Lopez-Martens,⁵ D. Luong,⁶ M. Mallaburn,⁷ J. Pakarinen,¹ P. Papadakis,¹ J. Partanen,¹ P. Peura,¹ P. Rahkila,¹ K. Rezynkina,⁵ P. Ruotsalainen,¹ M. Sandzelius,¹ J. Sarén,¹ C. Scholey,¹ M. Smolen,⁸ J. Sorri,¹ S. Stolze,¹ Ch. Theisen,³ A. Ward,⁴ A. Yakushev,² and V. Yakushev²

¹ Department of Physics, University of Jyväskylä, P.O. Box 35, FI-40014 Jyväskylä, Finland

² GSI, Helmholtzzentrum für Schwerionenforschung GmbH, Planckstr. 1, 64291 Darmstadt, Germany

³ CEA, Centre de Saclay, IRFU/Service de Physique Nucléaire, F-91191 Gif-sur-Yvette, France

⁴ Department of Physics, Oliver Lodge Laboratory, University of Liverpool, P.O. Box 147, Liverpool L69 7ZE, UK

⁵ CSNSM, Université Paris Sud and CNRS-IN2P3, F-91405 Orsay Campus, France

⁶ Department of Nuclear Physics, Australian National University, Canberra, Australian Capital Territory 2601, Australia

⁷ School of Physics and Astronomy, The University of Manchester, Oxford Road, Manchester M13 9PL, UK

⁸ School of Engineering, University of the West of Scotland, Paisley, PA1 2BE, UK

Experiments to study the structure and decay properties of neutron-deficient californium and einsteinium isotopes were carried out at the accelerator laboratory at JYFL. The isotopes of interest were synthesised in fusion-evaporation reactions and studied at the focal plane of the gas-filled recoil separator RITU.

Decay-spectroscopic studies of the isotopes $^{239,240}\text{Cf}$ and ^{240}Es were done using accelerated ^{34}S and ^{36}S beams impinging on $^{206,208}\text{Pb}$ and ^{209}Bi targets. In particular, the $^{209}\text{Bi}(^{34}\text{S},3n)^{240}\text{Es}$ reaction was used to produce and study the decay properties of a new isotope ^{240}Es . According to previous studies of e.g. odd-odd einsteinium isotopes [1], a significant electron-capture delayed fission [2] (ECDF) probability has been predicted for the new isotope. The analysis of the experimental data shows evidence for a relatively high ECDF probability.

In-beam spectroscopic and decay studies of the structure of californium isotopes $^{243,244}\text{Cf}$ were performed using the reactions $^{198}\text{Pt}(^{48}\text{Ca},2n/3n)^{244/243}\text{Cf}$. The rotational band built on top of the ground state in ^{244}Cf was observed by detecting the emitted prompt γ rays using the JUROGAM2 array of High-Purity germanium (HPGe) detectors.

[1] D. A. Shaughnessy et al. Phys. Rev. C **61**, 044609 (2000).

[2] A. N. Andreyev et al. Rev. Mod. Phys **85** (2013).