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Ultraviolet Spectroscopy of the Actinium-229 beta decay: On the way to the first observation of 229mTh's radiative decay?

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A unique feature of thorium-229 is its isomer with an exceptionally low excitation energy, proposed as a candidate for future optical clocks [1]. The small decay width is expected to outperform the accuracy of current state-of-the-art atomic clocks by an order of magnitude [2]. The current best values of the excitation energy are 8.28(17)eV and 8.10(17)eV [3,4]. These were determined using two different measurement techniques whereby the isomer is populated in the alpha decay of uranium-233. The development of an optical clock requires however knowledge of the excitation energy by at least an order of magnitude more precise. Additionally, spectroscopic experiments searching for a direct signature of the radiative decay have to-date been unsuccessful, partially due to the background induced in the preceding alpha decay.

An alternative approach using the beta decay of actinium-229 is studied as a novel method to populate the isomer with high efficiency and in low background conditions [5]. Produced online at the ISOLDE facility at CERN, actinium is implanted into a large-bandgap crystal in specific lattice positions, suppressing the electron conversion decay channel of the isomer. A favorable feeding pattern significantly increases the population of the isomer compared to uranium-233 and the lower energy deposit of the beta- compared to the alpha-decay results in a reduced luminescence background.

In this contribution, a dedicated setup developed at KU Leuven for a vacuum-ultraviolet study of an actinium-229 beam implanted into a large-bandgap crystal is presented and preliminary results from a recent experimental campaign at ISOLDE showing a footprint of the radiative decay of low-energy thorium isomer are discussed.

[1] E. Peik et al., Europhys. Lett. 61, 2 (2003)
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[3] B. Seiferle et al., Nature 573, 243-246 (2019)
[4] T. Sikorsky et al., PRL 125, 142503 (2020)
[5] M. Verlinde et al., Physical Review C, 100 (2), 024315-024315

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