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Ultraviolet Spectroscopy of the Actinium-229 beta decay: On the way to the first identification of the 229Th low-energy isomer?

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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. 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, actinium is laser-ionized and implanted into a large-bandgap crystal in specific lattice positions, suppressing the electron conversion decay channel of the isomer. A favourable feeding pattern is significantly increasing 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 significantly reduced luminescence background.

In this contribution, a dedicated setup developed at KU Leuven for the implantation of an actinium-229 beam into large-bandgap crystals and the vacuum-ultraviolet spectroscopic study of the emitted photons is presented and the preliminary results from a recent experimental campaign at ISOLDE are presented.

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[4] T. Sikorsky et al., PRL 125, 142503 (2020)
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