Contribution ID: **28** Type: **Poster**

Investigation of the low-energy isomer 229mTh using the beta decay of 229Ac

Thursday, 5 December 2019 12:49 (1 minute)

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 measurement of the excitation energy results in a value of 8.28(17)eV [3], whereby the isomer is populated in the alpha decay of uranium-233. The development of such a clock requires however a precision on the order of 10meV. Spectroscopic experiments searching for a direct signature of the gamma decay have to-date been unsuccessful due to the background induced in the population process of the isomer.
A new approach using the beta decay of actinium-229 is studied as a novel production method to populate the isomer with high efficiency and in low background conditions. Produced online at the ISOLDE facility, actinium is laser-ionized and implanted into a suitable crystal. Results from an experiment investigating the production of actinium and the feeding of the daughter's isomer in its beta decay are presented. Using this method, a higher isomer population yield and better background control are expected to make the vacuum-ultraviolet spectroscopy of the radiative decay and the precise determination of the isomer's excitation energy feasible.
[1] E. Peik et al., Europhys. Lett. 61, 2 (2003)
[2] C. Campbell et al., PRL 108, 120802 (2012)
[3] B. Seiferle et al., Nature 573, 243-246 (2019)

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Session Classification: Poster Session