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Vacuum Ultraviolet Spectroscopy of the low lying Thorium-229 isomer

Owing to its very low excitation energy the isomer of thorium-229 has been proposed as a candidate for a possible future frequency standard, a nuclear clock and is expected to outperform the current atomic clocks [1,2]. Currently, the best values of the excitation energy are 8.28(17) eV and 8.10(17) eV [3,4]. These were measured using two different techniques where the population of the isomer was achieved via the α-decay of uranium-229. However, a precise knowledge of the isomer excitation energy is a necessary for the development of an optical clock.

Recently, spectroscopy measurement has been possible using an alternative approach of populating the isomer via the beta decay of actinium-229 [5]. The laser ionized actinium-229 ions produced online at CERN's ISOLDE facility were implanted onto a large bandgap crystal at specific lattice positions. A favourable feeding fraction of the isomer from the beta decay of actinium-229 compared to that via the alpha decay of uranium-229 and a low beta energy compared to alpha decay leads to a significantly reduced radioluminescence. This allowed us to study the VUV-photons stemming from the radiative decay of the isomer for the first time resulting in a much precise determination of the energy and lifetime of the isomer.
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 will be presented.

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