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The 229Th nuclear-clock isomer: half-life and energy determination in several different crystals

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The thorium-229 nucleus contains an isomeric state with a low excitation energy, making it accessible to laser excitation. It is presently the only known candidate for the development of a nuclear clock [1,2,3,4] which will enable testing fundamental principles in physics, such as e.g. potential variations of fundamental constants [5] or the search for ultralight dark matter candidates [6]. Moreover, practical applications like relativistic geodesy are possible [7].
The radiative decay of the thorium-229 isomer was observed at ISOLDE in a previous experiment by populating it via the beta decay of actinium-229, implanting its shorter-lived decay precursors in large bandgap crystals and observing the isomer's VUV photons in a dedicated spectrometer. A reduced uncertainty of the isomer's excitation energy (8.338±0.024 eV) and a first determination of the ionic half-life (670±102 s) in MgF_2 was reported [8]. During the July 2023 campaign seven crystals (including SiO_2, AlN, $LiSrAlF_6$) were tested, the energy was determined with better precision, and the half-life behavior of the VUV signal in the different crystals was studied. Preliminary results and ongoing analysis as well as future prospects will be discussed.

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