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Towards the Lifetime Measurement of the $^{229m}Th^{3+}$ Nuclear Clock Isomer

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The elusive Thorium Isomer (^{229m}Th) with its unusually low-lying first excited state (8.19 ± 0.12 eV or $\lambda = 150.4 \pm 2.2$ nm) represents the so far only candidate for the realization of an optical nuclear clock, potentially capable to outperform even state-of-the-art optical atomic clocks. Moreover, possible applications of a nuclear clock are not limited to time keeping, but reach into many other fields from geodesy to dark matter research. Considerable progress was achieved in recent years on the characterization of the thorium isomer, from its first identification, the determination of its lifetime in neutral charge state and of the isomeric hyperfine structure to recent direct decay measurements. While the identification of the nuclear resonance with laser spectroscopic precision is still awaited, a measurement of the ionic lifetime of the isomer (theory prediction: 10^3-10^4 s) is being prepared by our group. A cryogenic Paul trap is the core of this setup, providing long enough storage time for the ^{229m}Th ions. Prior to targeting the ionic lifetime by hyperfine spectroscopy, sympathetic laser cooling using $^{88}Sr^+$ ions will be applied to the stored ions. The talk will present the status of the commissioning of the setup for $^{229m}Th^{3+}$ ion generation, cryogenic storage, laser cooling and spectroscopic studies. This work was supported by the European Research Council (ERC): Grant agreement No. 856415.

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