Towards a ^{229}Th nuclear optical clock

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The first laser excitation of the ^{229}Th isomer state at 8.4 eV [1] and its quick confirmation in various solid-state environments [2, 3, 4] has inspired numerous proposals for applications, focusing on a nuclear optical clock that could potentially outperform atomic clocks based on electronic transitions [5, 6] and new physics because the transition frequency is strongly influenced by both the nuclear and electromagnetic forces [7].

We provide several experiments for the development of optical nuclear clocks based on thorium ions in an ion trap and in Th-doped crystals.

Enabling the realization of a solid-state nuclear clock we demonstrate laser-induced quenching as a method of depopulating the ^{229}Th isomeric state in CaF_2. This shortens a solid-state clock interrogation cycle and improves its performance [8].

We also will report ongoing experiments for the laser excitation of the isomeric state in $229Th^{2+}$ ions and the investigation of the hyperfine structure of sympathetically cooled Th^{3+} ions confined in linear Paul traps.

References

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