

DAMOP19-2019-020150

Abstract for an Invited Paper
for the DAMOP19 Meeting of
the American Physical Society

Quantum Logic Spectroscopy of an Optical Clock Transition in a Cold Highly Charged Ion

STEVEN KING, Physikalisch-Technische Bundesanstalt

Spectroscopy of highly charged ions (HCI) finds applications in frequency metrology and tests of fundamental physics, such as the search for a possible variation of fundamental constants [1], violation of local Lorentz invariance [2], or probing for new long-range interactions [3].

Until now, optical spectroscopy of HCI was limited to fractional accuracies of parts-per-million, primarily due to the megakelvin temperature processes needed to produce high charge states, which leads to significant Doppler broadening. This level of fractional accuracy is twelve orders of magnitude behind modern optical atomic clocks.

Recently, we have developed methods to extract HCI from an electron beam ion trap (EBIT) and transfer them to a cryogenic linear Paul trap, where we sympathetically cool the HCI with co-trapped laser-cooled Be^+ ions [4]. We have succeeded in preparing a two-ion crystal of Ar^{13+} and Be^+ in the ground state of the trap in both axial modes of motion. The corresponding mode temperature of the order 10^{-4} K represents a reduction of ten orders of magnitude since production in the EBIT.

We present first results of coherent laser excitation of the 16 Hz wide ${}^2\text{P}_{1/2}$ to ${}^2\text{P}_{3/2}$ fine structure transition in Ar^{13+} at 441 nm using the tools of quantum logic spectroscopy. The achieved resolution improves upon the previous best measurement using in-EBIT spectroscopy [5] by more than 6 orders of magnitude. An absolute frequency measurement was performed using an optical frequency comb referenced to the SI second. This work paves the way towards spectroscopy of HCI at the level of state-of-the-art optical frequency standards.

References [1] J. C. Berengut, V. A. Dzuba, and V. V. Flambaum, Phys. Rev. Lett. 105 120801 (2010) [2] V. A. Dzuba et al., Nat. Phys. 12 4658 (2016) [3] J. C. Berengut et al., Phys. Rev. Lett. 120 091801 (2018) [4] T. Leopold et al., arXiv:1901.03082 (2019) 5 I. Dragani et al., Phys. Rev. Lett. 91 183001 (2003)