Abstract Submitted
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The NIST $^{27}Al^+$ quantum-logic clock[1] DAVID LEIBRANDT, NIST, SAMUEL BREWER, NIST and Massachusetts Institute of Technology, JWO-SY CHEN, DAVID HUME, AARON HANKIN, NIST, YAO HUANG, NIST and Wuhan Institute of Physics and Mathematics, CHIN-WEN CHOU, NIST, TILL ROSENBAND, Harvard University, DAVID WINELAND, NIST — Optical atomic clocks based on quantum-logic spectroscopy of the $^1S_0 \leftrightarrow {}^3P_0$ transition in $^{27}Al^+$ have reached a systematic fractional frequency uncertainty of 8.0×10^{-18}, enabling table-top tests of fundamental physics as well as measurements of gravitational potential differences. Currently, the largest limitations to the accuracy are second order time dilation shifts due to the driven motion (i.e., micromotion) and thermal motion of the trapped ions. In order to suppress these shifts, we have designed and built new ion traps based on gold-plated, laser-machined diamond wafers with differential RF drive, and we have operated one of our clocks with the ions laser cooled to near the six mode motional ground state. We present a characterization of the time dilation shifts in the new traps with uncertainties near 1×10^{-18}. Furthermore, we describe a new protocol for clock comparison measurements based on synchronous probing of the two clocks using phase-locked local oscillators, which allows for probe times longer than the laser coherence time and avoids the Dick effect.

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