Abstract Submitted
for the DAMOP15 Meeting of
The American Physical Society

2e-18 total uncertainty in an atomic clock TRAVIS NICHOLSON, SARA CAMPBELL, ROSS HUTSON, GEORGE MARTI, BENJAMIN BLOOM, REES MCNALLY, WEI ZHANG, JILA, University of Colorado, MURRAY BARRETT, Centre for Quantum Technologies, National University of Singapore, MARIANNA SAFRONOVA, University of Delaware and the Joint Quantum Institute, GREGORY STROUSE, WESTON TEW, NIST, JUN YE, JILA, University of Colorado — The pursuit of better atomic clocks has advanced many research areas, providing better quantum state control, new insights in quantum science, tighter limits on fundamental constant variation, and improved tests of relativity. We present an important step towards realizing the full potential of a many-particle clock with a state-of-the-art stable laser. Here, we achieve stability of 2.2e-16 at 1 s by using seconds-long coherent interrogations of our clock transition. With this better stability, we perform a new accuracy evaluation of our clock. For the lattice ac Stark systematic, we identify the lattice laser frequency where the scalar and tensor components of the shift cancel, allowing for state independent trapping with clock shifts at the 1e-18 level. For the BBR systematic, we improve our measurement of the atoms' thermal environment using accurate radiation thermometry traceable to the NIST ITS-90 absolute temperature scale. We also directly measure the component of the strontium atomic structure that is chiefly responsible for the spectral response to room-temperature BBR. Our combined measurements have reduced the total uncertainty of the JILA Sr clock to a record 2.1e-18.

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Date submitted: 30 Jan 2015 Electronic form version 1.4