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Progress toward a Sr optical atomic clock in an optical lattice

A. D. LUDLOW, T. IDO, M. M. BOYD, M. NOTTCUTT, T. ZELEVINSKY, S. BLATT, S. FOREMAN, J. YE, JILA, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, AND THE UNIVERSITY OF COLORADO TEAM — We report our recent progress toward an optical atomic clock based on the Sr $^1S_0-^3P_0$ transition in an optical lattice. In order to probe the doubly forbidden intercombination transition, we have developed a compact and highly stabilized diode laser source at 698 nm. This laser can serve as the local oscillator for an atomic clock based on ^{87}Sr or on a newly proposed clock scheme exploiting electromagnetically induced transparency in ^{88}Sr. The diode laser is locked to an ultra high finesse cavity which has an innovative vertical mounting geometry. This geometry provides a common mode rejection of cavity length changes due to accelerations. The locked laser system exhibits in-loop frequency noise of $\sim$60mHz/$\sqrt{\text{Hz}}$ from 100 Hz to 30 kHz. In order to measure the laser linewidth, we compare this laser system with a highly stabilized Nd:YAG system which has already demonstrated a sub-hertz linewidth. We do so by phase locking an octave spanning, self-referenced femtosecond comb to a Nd:YAG laser at 1.064 μm and beating our 698 nm stabilized laser with the narrow (Hz level) comb mode at 698 nm. After having trapped, cooled, and efficiently loaded the strontium atoms into an optical lattice at the magic wavelength of ac stark shift cancellation, we report preliminary spectroscopic measurements.

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