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Absolute frequency measurement of the $^1S_0 \leftrightarrow ^3P_0$ clock transition at 578.4 nm in ytterbium CHAD HOYT, NIST, ZEB BARBER, NIST, University of Colorado, CHRIS OATES, NIST, TARA FORTIER, NIST, Los Alamos National Laboratory, SCOTT DIDDAMS, LEO HOLLBERG, NIST — We report the first precision absolute frequency measurements of the highly forbidden $(6s^2)^1S_0 \leftrightarrow (6s6p)^3P_0$ optical clock transition at 578.4 nm in two odd isotopes of ytterbium. Atoms are cooled to tens of microkelvins in two successive stages of laser cooling and magneto-optical trapping that use transitions at 398.9 nm and 555.8 nm, respectively. The resulting trapped atomic cloud is irradiated with excitation light at 578.4 nm and absorption is detected by monitoring trapped atom depletion. With the laser on resonance, we demonstrate trap depletions of more than 80 % relative to the off-resonance case. Absolute frequency measurements are made for ^{171}Yb (I=1/2) and ^{173}Yb (I=5/2) with an uncertainty of 4.4 kHz using a femtosecond-laser frequency comb calibrated by the NIST cesium fountain clock. The natural linewidth of these J=0 to J=0 transitions is $\sim$10 mHz, making them well-suited to support a new generation of optical atomic clocks based on confinement in an optical lattice. Lattice-based optical clocks have the potential to surpass the performance of the best current atomic clocks by orders of magnitude. The accurate ytterbium frequency knowledge presented here (nearly a million-fold reduction in uncertainty) will greatly expedite Doppler- and recoil-free lattice spectroscopy.

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