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Combining lattice clocks with cavity QED: Prospects for a mHz-linewidth laser DOMINIC MEISER, JUN YE, MURRAY HOLLAND, JILA, NIST, and Department of Physics, University of Colorado, Boulder, CO 80309-0440, USA — Optical atomic clocks based on ultracold alkaline-earth atoms confined in a lattice potential are competitive with the most stable and accurate time and frequency standards. The main bottleneck that prevents these clocks from achieving still better precision is the linewidth of the laser used to interrogate the clock transition. We propose to utilize the ultra-narrow atomic transition by making the atoms emit photons on that line collectively into the mode of a high Q-resonator in a laser-like fashion. A power level of order 10^{-12} W is possible, sufficient for phase-locking a slave optical local oscillator. We find that the linewidth of the radiation can be on the order of or even narrower than that of the clock transition due to collective effects. Achieving this major breakthrough will improve the stability of the best clocks by two orders of magnitude.

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