Make Optical Lattice Clocks Compact and Useful for Real-world Applications

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An "optical lattice clock" proposed in 2001 benefits from a low quantum-projection noise by simultaneously interrogating many atoms trapped in an optical lattice [1]. About a thousand atoms trapped in the optical lattice allow measuring frequency at 10^{-18} precision in an average time of a few hours. This superb stability is especially beneficial for chronometric leveling [2,3], which determines a centimeter-level height difference of the clocks located at remote sites by the gravitational redshift.

We overview the progress of optical lattice clocks and address recent topics to explore real-world applications of the 18-digit-accurate clocks, including 1) compact optical lattice clocks with a volume of 250 litter developed in collaboration with industry partners, 2) chronometric leveling with transportable clocks over 500 km apart, and 3) our challenge to further improve the clock stability by developing a "longitudinal spectroscopy" that allows continuous interrogation of the clock transition [4] to improve the clock stability. We look ahead to the role of future clocks when networks of high-precision clocks are implemented in society.

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