



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. The essence of the proposal was an engineered perturbation based on the “magic wavelength” protocol, which has been proven successful up to 10⁻¹⁸ uncertainty. About a thousand atoms enable such clocks to achieve 10⁻¹⁸ stability in a few hours of operation. This superb stability is especially beneficial for chronometric leveling, which determines a centimeter height difference of far distant sites by the gravitational redshift of the clocks.

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 under development in collaboration with industry partners, 2) demonstration of transportable clocks, and 3) our challenge to improve the stability of the clocks by “longitudinal Ramsey spectroscopy” that allows continuous interrogation of the clock transition.

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