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# Development of transportable optical lattice clocks and applications

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An "optical lattice clock"benefits from a low quantum-projection noise (QPN) by simultaneously interrogating many atoms trapped in an optical lattice [1]. The essence of the scheme is an engineered perturbation based on the "magic frequency"protocol, which has been proven successful up to 10-18 uncertainty [2-4]. About a thousand atoms enable such clocks to achieve 10-18 stability in a few hours. This superb stability is especially beneficial for chronometric leveling [5-7], which determines a centimeter-level height difference of the clocks located at remote sites by the gravitational redshift [8].
In transportable clocks [9], the potential stability of the optical lattice clocks is severely limited by the Dick effect [10] caused by the frequency noise of a compact clock laser. We proposed a "longitudinal Ramsey spectroscopy"[11] to improve the clock stability by continuously interrogating the clock transition. Two key ingredients for the continuous clock, continuous loading of atoms into a moving lattice [12] and longitudinal excitation of the clock transition, are reported. In addition, we report our recent development of compact and accurate optical lattice clocks in collaboration with industry partners.

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