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Test of gravitational redshift with optical lattice clocks and their applications to relativistic geodesy

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A clock in a higher place ticks faster than one in a lower place in accordance with Einstein's general relativity. A pair of atomic clocks serve as a quantum sensor for the gravitational potential. The relativistic effects of the 450-meter height difference of a broadcasting tower, Tokyo Skytree, were measured using a pair of optical lattice clocks to verify the general theory of relativity. The 10^{-18}-level of uncertainties in the comparison of the clocks verified Einstein's general relativity with a fractional uncertainty of ~10^{-5}. Field operation of such transportable system can extend the role of atomic clocks not only to timekeeping but also to their application as gravitational potential meters to monitor spatial and temporal variations in geopotential.
In this presentation, we introduce the development of a transportable optical lattice clock and the precise measurement of the gravitational redshift in Tokyo Skytree. In addition, we will introduce our recently developed on-vehicle optical lattice clocks, which will make it a more practical tool for relativistic geodesy.

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