Development of a Transportable Optical Lattice Clock and Its Geodetic Applications

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Atomic clocks based on optical transitions have achieved fractional uncertainties of 10^{-18}, two orders of magnitude better than caesium clocks, and discussions are currently underway to redefine the second using optical clocks. Such high-precision clocks are expected to have applications not only in frequency metrology but also in various fields such as relativistic geodesy and fundamental physics. The way time advances is affected by gravity following the general theory of relativity. A difference of 1 cm in elevation above the ground can change the 18th digit of the frequency of a clock. Accurate clocks have the potential to establish new elevation systems by connecting them with optical fiber networks, as has been realized in Europe. Furthermore, by observing a large number of atoms at a time, optical lattice clocks can reach an uncertainty of 10^{-18} with a short averaging time. Such high stability of optical lattice clocks makes it possible to detect dynamic variations in gravitational potential, such as crustal deformation and volcanic activity. To demonstrate the use of the high stability of optical lattice clocks for measurements, a remote frequency comparison between clocks 700 km apart was started to observe dynamic frequency variations due to tidal effects.

In this presentation, we introduce the development of a transportable optical lattice clock and its application to relativistic geodesy by remote frequency comparison.

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