

Prof. Dr.
Hidetoshi Katori

School of Engineering, The University of Tokyo
7-3-1, Hongo, Bunkyo-ku,
Tokyo, 113-8656, Japan
Phone: +81-3-5841-6845, Fax: +81-3-5841-8760
E-mail: katori [at] amo.t.u-tokyo.ac.jp



High precision spectroscopy with optical lattice clock

The essential physics in the research of atomic clocks is found in their frequency comparison, which allows investigations of the constancy of the fundamental constants, their coupling to gravity, and the examination of the relativity. While single-ion optical clocks demonstrate supreme frequency uncertainty of 0.8×10^{-17} , the necessary averaging time as long as $\tau \approx 1 \times 10^5$ s is limited by the quantum projection noise (QPN); therefore the clocks' stability becomes a serious experimental concern for further reducing the uncertainty down to 1×10^{-18} .

An optical lattice clock was proposed to improve the clock stability as $1/\sqrt{N}$ by applying a large number N of atoms. We demonstrated the Allan standard deviation of $5 \times 10^{-16}/\sqrt{\tau}$ s that allowed to explore 1×10^{-17} uncertainty in $\tau \approx 1,600$ s, which corresponded to the QPN limit for $N \approx 1,000$ atoms, by rejecting the Dick effect. We discuss possible impacts of the synchronous clock interrogation scheme, such as investigations of the constancy of the fundamental constants and the relativistic geodesy by comparing two clocks operated in distant places.

References

- (1) Takamoto, M., Takano, T., & Katori, H., Frequency comparison of optical lattice clocks beyond the Dick limit. *Nature Photon.* 5, 288-292 (2011).
- (2) Katori, H., Optical lattice clocks and quantum metrology. *Nature Photon.* 5, 203-210 (2011).
- (3) Katori, H., Takamoto, M., Pal'chikov, V.G., & Ovsiannikov, V.D., Ultrastable optical clock with neutral atoms in an engineered light shift trap. *Phys. Rev. Lett.* 91, 173005 (2003).

CV

- 1991 – 1994 Research Associate, Department of Applied Physics, The University of Tokyo.
1994 – 1997 Visiting Scientist, Max-Planck-Institute for Quantum Optics, Garching, Germany.
1999 – 2010 Associate Professor, Engineering Research Institute, Graduate School of Engineering, The University of Tokyo.
2010 – Present Professor, Department of Applied Physics, Graduate School of Engineering, The University of Tokyo.
2010 – Present Research Director, Katori Innovative Space-Time Project, ERATO, JST.
2011 – Present Chief Scientist, Katori Quantum Metrology Laboratory, RIKEN