Ytterbium lattice clock development at RIKEN

Nils Nemitz[1,2,3], Manoj Das[1,2,3], Takuya Ohkubo[1,3,4], Masao Takamoto[1,2,3], Hidetoshi Katori[1,2,3,4]

[1]Quantum Metrology Laboratory, RIKEN, Wako, Japan
[2]RIKEN Center for Advanced Photonics, Wako, Japan
[3]Innovative Space-Time Project, ERATO, JST, Tokyo, Japan
[4]Department of Applied Physics, University of Tokyo, Tokyo, Japan

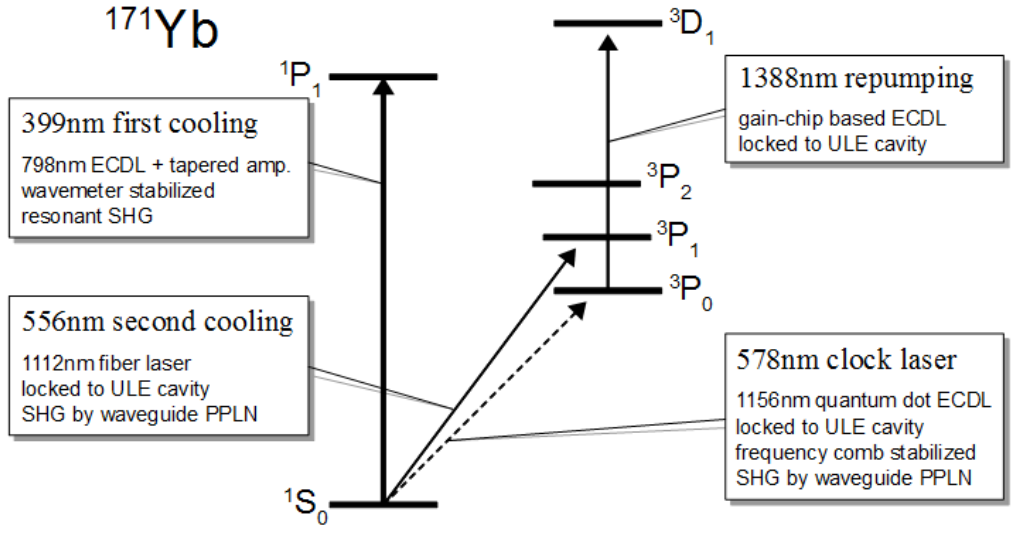
Email: Nils.Nemitz@riken.jp

RIKEN's Quantum Metrology Laboratory operates multiple optical lattice clocks. Two of these interrogate neutral strontium atoms inside a cryogenic environment to reduce frequency shifts caused by black body radiation. Comparisons reach a relative statistical uncertainty of $2 \cdot 10^{-18}$, similar to the performance reported by the JILA group[1] .

Nearly identical stability has been reported for a pair of optical lattice clocks using neutral ytterbium atoms[2] . This makes ytterbium an excellent candidate for a two-species frequency comparison at the 10^{-18} level, which might pave the way for a future redefinition of the second as well as promising new constraints on the temporal variation of fundamental constants[3]. The low nuclear spin of I = ½ in ^{171}Yb also facilitates the later implementation of advanced detection methods.

For these reasons we have started to convert one of the existing clock systems for optional operation with ytterbium. Over the last months, the required laser systems have been constructed and recently a combined strontium/ytterbium oven has been installed.

We will present the latest progress in the development of the new ytterbium frequency standard at RIKEN.



[1] B.J. Bloom, T.L. Nicholson, J.R. Williams, S.L. Campbell, M. Bishof, X. Zhang, W. Zhang, S.L. Bromley and J. Ye. "An optical lattice clock with accuracy and stability at the 10^{-18} level", Nature, DOI 10.1038/nature12941, 2014

[2] N. Hinkley, J. A. Sherman, N. B. Phillips, M. Schioppo, N. D. Lemke, K. Beloy, M. Pizzocaro, C. W. Oates, A. D. Ludlow, "An Atomic Clock with 10–18 Instability", Science, vol. 341, p. 1215, 2013

[3] S. N. Lea, "Limits to time variation of fundamental constants from comparisons of atomic frequency standards", Eur. Phys. J. Special Topics vol. 163, p. 37-53, 2008