Report to the CCL/CCTF joint working group meeting from Japan

--- NMIJ/AIST ---

Question 1.1: No

Question 1.2: No

Question 1.3: No

Question 2.1: No

As the result of a joint research project between the University of Tokyo and the NMIJ/AIST, we have measured the absolute frequency of a Sr optical lattice clock. The current measurement uncertainty is $3 \times 10^{-14}$. Although this uncertainty does not meet the criterion for the secondary representation of the second, the lattice clock has a huge potential for future improvements. We report the measurement result of the Sr lattice clock in the answer to the next question.

Question 2.2: Yes

We report the activities of three optical frequency standards in Japan.

1) Sr optical lattice clock (location: the University of Tokyo)

In the lattice clock scheme, the ultracold Sr atoms were confined in periodic trapping potentials. The measured linewidth of the clock transition was $27 \text{ Hz}$ [1]. The determined ‘magic’ wavelength for the Sr lattice clock was $813.420(7) \text{ nm}$ [1]. For measuring the absolute frequency of the Sr lattice clock, we have established a transportable frequency measurement system using an optical frequency comb linked to a commercial Cs atomic clock, which is in turn linked to international atomic time (TAI) through global positioning system (GPS) time [2]. An iodine-stabilized Nd:YAG laser is used as a flywheel in the frequency measurement system. The obtained absolute frequency of the $^1S_0 - ^3P_0$ transition of $^{87}\text{Sr}$ atoms in an optical lattice is $429,228,004,229,952(15) \text{ Hz}$ (fractional uncertainty $3 \times 10^{-14}$) [1, 2].

We have a plan to measure this transition again in autumn of 2005 with improved measurement uncertainty.

References:


2) Yb optical lattice clock (location: the NMIJ/AIST)

We have started to build an Yb optical lattice clock at the NMIJ/AIST in cooperation with the University of Tokyo. The clock transition is at the wavelength of 578 nm with a natural linewidth of 10 mHz. The 'magic' wavelength of the Yb lattice clock was calculated to be around 752 nm [1]. The clock transition of two odd isotopes of Yb was measured with an uncertainty of 4.4 kHz (fractional uncertainty $8\times10^{-12}$) by the NIST team [2].

References:

3) Calcium ion trap (location: NICT)

A single Calcium ion optical frequency standard has been developed in National Institute of Information and Communications Technology (NICT). Recently, S-D electric quadrupole quantum jump signals of the single 40Ca+ ion were observed in a miniature trap. The linewidth of the developed clock laser has been narrowed to several tens Hz. The central frequency of the S-D transition will be measured soon.