Questionnaire previous to the 2006 meeting of the CCL/CCTF Joint Working Group

Summary of the previous meetings

The CCTF on its 16th meeting in April 2004 recommended that the unperturbed ground-state hyperfine quantum transition of ^{87}Rb may be used as a secondary representation of the second with a frequency of f_{Rb}= 6 834 682 610.904 324 Hz and an estimated relative standard uncertainty (1σ) of 3 x 10^{-15}, and submitted this recommendation to the CIPM.

The 2005 CCL/CCTF JWG adopted three optical frequency standards for recommendation to the CCTF as secondary representations of the second:

The trapped and cooled mercury ion $^{199}Hg^+$, $5d^{10}$ 6s $^2S_{1/2}$ (F = 0) — $5d^9$ $6s^2$ $^2D_{5/2}$ (F = 2), Δm_F = 0 transition for which the value f = 1 064 721 609 899 145 Hz with a relative standard uncertainty of 3 x 10^{-15}, applies to the unperturbed quadrupole transition.

The trapped and cooled strontium ion $^{88}Sr^+$, 5s $^2S_{1/2}$ – 4d $^2D_{5/2}$ transition for which the value f = 444 779 044 095 484.6 Hz with a relative standard uncertainty of 7 x 10^{-15}, applies to the radiation of a laser stabilized to the unperturbed transition and to the centre of the Zeeman multiplet.

The trapped and cooled ytterbium ion $^{171}Yb^+$, 6s $^2S_{1/2}$ (F = 0, m_F = 0) — 5d $^2D_{3/2}$ (F =2, m_F = 0) transition for which the value f = 688 358 979 309 308 Hz with a relative standard uncertainty of 9 x 10^{-15}, applies to the unperturbed quadrupole transition.

1. Frequency sources in the microwave domain

1.1. Have you made or are you aware of new absolute frequency measurements of the Rb hyperfine transition?

Yes No√

If yes, please list the values and uncertainties obtained and refer to the publication in which they may be found. Please be sure to include measurements made in other laboratories.

1.2. Are you aware of absolute frequency measurements of other microwave standards that should be proposed as secondary representations of the second?

Yes No√

If yes, please list the values and uncertainties obtained and the method used and refer to the publication in which they may be found. Please be sure to include measurements made in other laboratories in your country.

1.3. Are you currently developing new frequency sources in the microwave domain?

Yes No√

If yes, please give a brief description of your experiment.

2. <u>Frequency sources in the optical domain</u>

2.1. Have you made or are you aware of new absolute frequency measurements of the three optical transitions adopted by the 2005 CCL/CCTF JWG?

Yes No√

If yes, please list the values and uncertainties obtained and refer to the publication in which they may be found. Please be sure to include measurements made in other laboratories.

2.2. Have you made or are you aware of new absolute optical frequency measurements suitable to serve as secondary representations of the second?

Yes No√

If yes, please list the values and uncertainties obtained and refer to the publication in which they may be found.

2.3. Are you currently developing new frequency sources in the optical domain?

Yes√ No

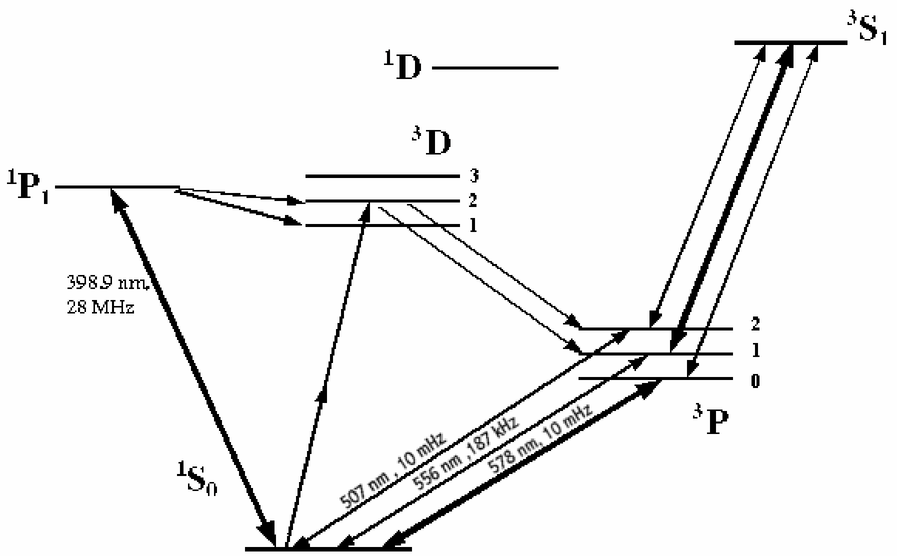
If yes, please give a brief description of your experiment.

INRIM has started the development of an optical frequency standard based on laser cooled Yb neutral atoms.

As depicted in the scheme reported, the clock transition is the $^1S_0 \rightarrow {}^3P_0$ intercombination line (578 nm, 10 mHz natural linewidth), while suitable cooling transitions are the $^1S_0 \rightarrow {}^1P_1$ (400 nm, 28 MHz, Doppler limit speed 20 cm/s) and the intercombination $^1S_0 \rightarrow {}^3P_1$ (556 nm, 187 kHz, Doppler limit speed 20 m/s).

We adopted the following experimental set up. An Yb beam is provided from a multi-channel oven at 400-450° C; we do not implement a Zeeman atomic beam slower, but we pre-cool the Yb beam just via a counter-propagating laser beam (400 nm), generated via frequency duplication from a 800 nm cw Ti:Sapphire laser. The same laser provides the cooling beams for a blu MOT. A green (556 nm) MOT will be provided from the frequency duplication of a fiber laser (1112 nm).

Presently (June 2006), the cooling radiation have been generated, and the physical structure is in progress. An optical frequency comb has been acquired and implemented, while the clock laser radiation has not yet been generated.



P.S.: In your response please would you attach a pdf copy of the publication, preprint or internal report which describes the relevant information to assess the final values and uncertainties provided, as this is extremely useful for the JWG deliberation.

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