# Recommendation (1)



The CCL/CCTF Joint Working Group (JWG) for the secondary representations of the second was originally formed as a working group of the CCTF at its 15th session in 2001 (Recommendation CCTF1(2001)). It was first given the task of establishing a list of secondary representations of the second. At the suggestion of the CIPM (CIPM 2001) its terms of reference were re-formulated to include the interests of the CCL.

The JWG subsequently considered the results of its questionaire and the ongoing discussions between IEN, BNM-SYRTE, NMIJ, NIST, NPL, NRC, PTB, and VNIIFTRI.

And as a result of its sessions on 9th and 10th September 2003 and 30th March 2004 it

# Recommendation (2)



recommends

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 ($1\sigma$)
of $3 \times 10^{-15}$

and recognizes

that several optical frequency standards have been reviewed by the JWG. Although none has been proposed at this stage, the JWG believes that the rapid progress with these optical frequency standards requires that they should again be reviewed at its next meeting for their possible use as secondary representations of the second.

# Frequencies in the μ-wave regime



- $^{87}Rb$ hyperfine transition measured in an atomic fountain:

  $f_{Rb}$= 6 834 682 610.904 324(4)(7) Hz

  ($1.2 \times 10^{-15}$)

  Report to the CCL-CCTF-04-06-SYRTE.doc

- $^{199}Hg^{+}$ hyperfine transition

  $f_{Hg,mw}$ = 40 507 347 996.841 59(14)(41) Hz

  ($1.1 \times 10^{-14}$)

  D. J. Berkeland et al: Laser-Cooled Mercury Ion Frequency Standard, Phys. Rev. Lett. **80**, 2089-2092 (1998)

- $^{171}Yb^{+}$ hyperfine transition

  $f_{Yb,mw}$ =12 642 812 118.468 5(7)(6) Hz

  ($7 \times 10^{-14}$)

  Report to the CCTF-04-06.doc from CSIRO

# Frequencies in optical regime (I)



- $^{171}Yb^{+}$ optical transition (435.5 nm) $^{2}S_{1/2}(F=0)$ - $^{2}D_{3/2}(F=2)$
  of a single trapped ion:
  $\nu_{Yb}$= 688 358 979 309 311(6) Hz
  ($9 \times 10^{-15}$)
  Report to the CCL-CCTF-04-07-PTB.doc

- $^{199}Hg^{+}$ optical transition
  $f_{Hg}$ = ??? Hz
  (? x $10^{-15}$)
  Verbal Report to the CCL-CCTF-04-07 by Dr. J. Bergquist NIST

- $^{88}Sr^{+}$ optical transition (674 nm) $5s^2\ ^{2}S_{1/2}$ - $4d\ ^{2}D_{5/2}$
  of a single trapped ion:
  $\nu_{Sr}$= 444 779 044 095 510(50) Hz
  Report to the CCL-CCTF-04-07.doc (NRC, Canada)

# Frequencies in optical regime (II)



- $^{40}Ca$ optical transition (657 nm) $^1S_0$ - $^3P_1$ of a cloud of $10^7$ atoms

  $\nu_{Ca}$ = 455 986 240 494 143(5.4) Hz

  ($1.2 \times 10^{-14}$)

  Report to the CCL-CCTF-04-07-PTB.doc

- $^{40}Ca$ optical transition (657 nm) $^1S_0$ - $^3P_1$ of a cloud of $10^7$ atoms

  $\nu_{Ca}$ = (?) Hz

  (? x $10^{-14}$)

  Verbal Report to the CCL-CCTF ?

- $^1H$ optical two-photon transition 1S -2S in a beam of atoms

  $\nu_H$ = ?(?) Hz

  (? x $10^{-14}$)

  Verbal Report to the CCL-CCTF by PTB

# Frequencies in optical regime (III)



- $^{87}Sr$ optical transition (657 nm) $^1S_0$ - $^3P_1$ in an optical lattice operated at the magic wavelength

  $\nu_{Sr}$ = ??? Hz

  (uncertainty budget not available)

  Report to the CCL-CCTF-04-07.doc