Appendix 2

RECOMMENDATIONS ADOPTED BY THE CIPM

RECOMMENDATION 2 (CI-2015)
Updates to the list of standard frequencies

The International Committee for Weights and Measures (CIPM),

considering

- a common list of "Recommended values of standard frequencies for applications including the practical realization of the metre and secondary representations of the second" has been established,
- the CCL-CCTF Frequency Standards Working Group (WGFS) has reviewed several candidates for updating the list,

recommends

that the following transition frequencies shall be updated in the list of recommended values of standard frequencies:

- the unperturbed optical transition $6s^2\ {}^1S_0 - 6s6p\ {}^3P_0$ of the ^{199}Hg neutral atom with a frequency of f_{199Hg} = 1 128 575 290 808 154.8 Hz and an estimated relative standard uncertainty of 6×10^{-16};
- the unperturbed optical transition $6s\ {}^2S_{1/2} - 4f^{13}\ 6s^2\ {}^2F_{7/2}$ of the $^{171}Yb^+$ ion with a frequency of f_{171Yb+} (octupole) = 642 121 496 772 645.0 Hz and an estimated relative standard uncertainty of 6×10^{-16} (this radiation is already endorsed by the CIPM as a secondary representation of the second);
- the unperturbed optical transition $6s\ {}^2S_{1/2}$ (F = 0, m_F = 0) – $5d\ {}^2D_{3/2}$ (F = 2, m_F = 0) of the $^{171}Yb^+$ ion with a frequency of f_{171Yb+} (quadrupole) = 688 358 979 309 308.3 Hz and an estimated relative standard uncertainty of 6×10^{-16} (this radiation is already endorsed by the CIPM as a secondary representation of the second);
- the unperturbed optical transition $5s\ {}^2S_{1/2} - 4d\ {}^2D_{5/2}$ of the $^{88}Sr^+$ ion with a frequency of f_{88Sr+} = 444 779 044 095 486.6 Hz and an estimated relative standard uncertainty of 1.6×10^{-15} (this radiation is already endorsed by the CIPM as a secondary representation of the second);
- the unperturbed optical transition $4s\ {}^2S_{1/2} - 3d\ {}^2D_{5/2}$ of the $^{40}Ca^+$ ion with a frequency of f_{40Ca+} = 411 042 129 776 398.4 Hz and an estimated relative standard uncertainty of 1.2×10^{-14};
- the unperturbed optical transition 1S – 2S of the ^{1}H neutral atom with a frequency of f_{1H} = 1 233 030 706 593 514 Hz and an estimated relative standard uncertainty of 9×10^{-15}.

Note: This frequency corresponds to half of the energy difference between the 1S and 2S states;

- the unperturbed optical transition $5s^2\ {}^1S_0 - 5s5p\ {}^3P_0$ of the ^{87}Sr neutral atom with a frequency of f_{87Sr} = 429 228 004 229 873.2 Hz and an estimated relative standard uncertainty of 5×10^{-16} (this radiation is already endorsed by the CIPM as a secondary representation of the second);
- the unperturbed optical transition $6s^2\ {}^1S_0 - 6s6p\ {}^3P_0$ of the ^{171}Yb neutral atom with a frequency of f_{171Yb} = 518 295 836 590 864.0 Hz and an estimated relative standard uncertainty of 2×10^{-15} (this radiation is already endorsed by the CIPM as a secondary representation of the second);

- the unperturbed ground-state hyperfine transition of ^{87}Rb with a frequency of f_{87Rb} = 6 834 682 610.904 310 Hz and an estimated relative standard uncertainty of 7×10^{-16} (this radiation is already endorsed by the CIPM as a secondary representation of the second).

and also **recommends**

that the following transition frequencies shall be included in the list of recommended values of standard frequencies:

- Absorbing molecule $^{127}I_2$, saturated absorption a_1 component, R(36) 32-0 transition.

  The values f_{a1} = 564 074 632.42 MHz

  λ_{a1} = 531 476 582.65 fm

with an estimated relative standard uncertainty of 1×10^{-10} apply to the radiation of a frequency-doubled diode DFB laser, stabilized with an iodine cell external to the laser.

- Absorbing atom ^{87}Rb $5S_{1/2}$ - $5P_{3/2}$ crossover between the d and f hyperfine components of the saturated absorption at 780 nm (D2 transition)

  The values $f_{d/f\ crossover}$ = 384 227 981.9 MHz

  $\lambda_{d/f\ crossover}$ = 780 246 291.6 fm

with an estimated relative standard uncertainty of 5×10^{-10} apply to the radiation of a tunable External Cavity Diode Laser, stabilized to the d/f crossover in a rubidium cell external to the laser.

Note: The value of the standard uncertainty is assumed to correspond to a confidence level of 68 %. However, given the limited availability of data there is a possibility that in hindsight this might not prove to be exact.