

RECOMMENDATION CCTF 24-2 (2025)

Updates to the CIPM list of standard frequencies

The Consultative Committee for Time and Frequency (CCTF), at its 24th session in 2025,

considering that

- 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 $5s^2 \ ^1S_0 - 5s5p \ ^3P_0$ of the $^{115}\text{In}^+$ ion with a frequency of $f_{115\text{In}^+} = 1\ 267\ 402\ 452\ 901\ 039.07$ Hz and an estimated relative standard uncertainty of 1.8×10^{-16} ;

This radiation shall be endorsed as a secondary representation of the second;

- the unperturbed optical transition $6s^2 \ ^1S_0 - 6s6p \ ^3P_0$ of the ^{199}Hg neutral atom with a frequency of $f_{199\text{Hg}} = 1\ 128\ 575\ 290\ 808\ 154.33$ Hz and an estimated relative standard uncertainty of 2.5×10^{-16} (this radiation is already endorsed as a secondary representation of the second);
- the unperturbed optical transition $5d^{10}6s \ ^2S_{1/2} (F=0) - 5d^96s^2 \ ^2D_{5/2} (F=2)$ of the $^{199}\text{Hg}^+$ ion with a frequency of $f_{199\text{Hg}^+} = 1\ 064\ 721\ 609\ 899\ 146.95$ Hz and an estimated relative standard uncertainty of 2.5×10^{-16} (this radiation is already endorsed as a secondary representation of the second);
- the unperturbed optical transition $6s \ ^2S_{1/2} (F=0) - 5d \ ^2D_{3/2} (F=2)$ of the $^{171}\text{Yb}^+$ ion with a frequency of $f_{171\text{Yb}^+}$ (electric quadrupole) = $688\ 358\ 979\ 309\ 308.31$ Hz and an estimated relative standard uncertainty of 1.9×10^{-16} (this radiation is already endorsed as a secondary representation of the second);
- the unperturbed optical transition $6s \ ^2S_{1/2} (F=0) - 4f \ ^{13}6s^2 \ ^2F_{7/2} (F=3)$ of the $^{171}\text{Yb}^+$ ion with a frequency of $f_{171\text{Yb}^+}$ (electric octupole) = $642\ 121\ 496\ 772\ 645.18$ Hz and an estimated relative standard uncertainty of 1.7×10^{-16} (this radiation is already endorsed 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 $f_{171\text{Yb}} = 518\ 295\ 836\ 590\ 863.632$ Hz and an estimated relative standard uncertainty of 1.7×10^{-16} (this radiation is already endorsed as a secondary representation of the second);
- the unperturbed optical transition $5s \ ^2S_{1/2} - 4d \ ^2D_{5/2}$ of the $^{88}\text{Sr}^+$ ion with a frequency of $f_{88\text{Sr}^+} = 444\ 779\ 044\ 095\ 485.347$ Hz and an estimated relative standard uncertainty of 1.7×10^{-16} (this radiation is already endorsed as a secondary representation of the second);

- the unperturbed optical transition $5s^2 \ ^1S_0 - 5s5p \ ^3P_0$ of the ^{88}Sr neutral atom with a frequency of $f_{88\text{Sr}} = 429\ 228\ 066\ 418\ 007.008$ Hz and an estimated relative standard uncertainty of 1.9×10^{-16} (this radiation is already endorsed as a secondary representation of the second);
- the unperturbed optical transition $5s^2 \ ^1S_0 - 5s5p \ ^3P_0$ of the ^{87}Sr neutral atom with a frequency of $f_{87\text{Sr}} = 429\ 228\ 004\ 229\ 872.992$ Hz and an estimated relative standard uncertainty of 1.7×10^{-16} (this radiation is already endorsed as a secondary representation of the second);
- the unperturbed optical transition $4s \ ^2S_{1/2} - 3d \ ^2D_{5/2}$ of the $^{40}\text{Ca}^+$ ion with a frequency of $f_{40\text{Ca}^+} = 411\ 042\ 129\ 776\ 400.30$ Hz and an estimated relative standard uncertainty of 5.5×10^{-16} (this radiation is already endorsed as a secondary representation of the second);
- the unperturbed ground-state hyperfine transition of ^{87}Rb with a frequency of $f_{87\text{Rb}} = 6\ 834\ 682\ 610.904\ 312.9$ Hz and an estimated relative standard uncertainty of 3.4×10^{-16} (this radiation is already endorsed as a secondary representation of the second);

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

- the mean of the 3 unperturbed optical transitions $6s^2 \ ^1S_0 (F=7) - 5d6s \ ^3D_1 (F=6)$, $6s^2 \ ^1S_0 (F=7) - 5d6s \ ^3D_1 (F=7)$ and $6s^2 \ ^1S_0 (F=7) - 5d6s \ ^3D_1 (F=8)$ of the $^{176}\text{Lu}^+$ ion, denoted v_1 , v_2 and v_3 respectively, with a frequency of $f_{176\text{Lu}^+} = (v_1 + v_2 + v_3)/3 = 353\ 638\ 794\ 073\ 800.35$ Hz and an estimated relative standard uncertainty of 2.8×10^{-15} ;

that the BIPM publish in electronic form:

- the list of recommended values of standard frequencies updated accordingly
- the list of publications reporting measurements from which these values are obtained by least square fit adjustment or other means
- the output covariance matrix derived from the least square adjustment
- the list of frequency ratios derived from the least square adjustment

and informs the CIPM accordingly.