

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 $f_{115\text{In}^+} = 1\,267\,402\,452\,901\,039.07\text{ Hz}$ 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 $f_{199\text{Hg}} = 1\,128\,575\,290\,808\,154.33\text{ Hz}$ 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 $5d^{10}6s\ ^2S_{1/2} (F=0) - 5d^9 6s^2\ ^2D_{5/2} (F=2)$ of the $^{199}\text{Hg}^+$ ion with a frequency of $f_{199\text{Hg}^+} = 1\,064\,721\,609\,899\,146.95\text{ Hz}$ 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) = $688\,358\,979\,309\,308.31\text{ Hz}$ 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) = $642\,121\,496\,772\,645.18\text{ Hz}$ 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 $f_{171\text{Yb}} = 518\,295\,836\,590\,863.632\text{ Hz}$ 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 $f_{88\text{Sr}^+} = 444\,779\,044\,095\,485.347\text{ Hz}$ 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 $f_{88\text{Sr}} = 429\,228\,066\,418\,007.008\text{ Hz}$ 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 $f_{87\text{Sr}} = 429\,228\,004\,229\,872.992\text{ Hz}$ 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 $f_{40\text{Ca}^+} = 411\,042\,129\,776\,400.30\text{ Hz}$ 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 $f_{87\text{Rb}} = 6\,834\,682\,610.904\,312\,9\text{ Hz}$ 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 ν_1 , ν_2 and ν_3 respectively, with a frequency of $f_{176\text{Lu}^+} = (\nu_1 + \nu_2 + \nu_3)/3 = 353\,638\,794\,073\,800.35\text{ Hz}$ 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.