Bureau International des Poids et Mesures

Approved by the CCTF in March 2021, active on April 13, 2022

RECOMMENDED VALUES OF STANDARD FREQUENCIES FOR APPLICATIONS INCLUDING THE PRACTICAL REALIZATION OF THE METRE AND SECONDARY REPRESENTATIONS OF THE DEFINITION OF THE SECOND

MERCURY 199 ATOM ($f \approx 1\ 129$ THz)

^{199}Hg neutral atom, $6s^2\ ^1S_0 – 6s6p\ ^3P_0$ unperturbed optical transition

1. Recommended value [1] of the frequency in the CIPM List of Frequencies

$f(^{199}Hg)$ = 1 128 575 290 808 154.32 Hz

equivalent to

$\lambda(^{199}Hg)$ = 265 637 977.759 838 97 fm,

with a relative standard uncertainty of 2.4×10^{-16}.

This radiation was endorsed by the CCTF as a secondary representation of the definition of the second [2].

2. Method to establish the recommended value

A global adjustment of all measurements of frequency ratios published in peer-reviewed publications and available to the CCL-CCTF WGFS was carried out following the methods presented in [3-7].

This adjustment determines the frequency of 14 transitions (see Figure 1) which are either already adopted as secondary representations of the second [7] or considered as candidates for SRS. It took into account 105 measurements, including 33 frequency ratios and 72 absolute frequency measurements (i.e. ratios to the ^{133}Cs frequency). A total of 483 correlations between these input measurements were estimated and considered in the adjustment. More details on the input data and the processing are provided at https://webtai.bipm.org/ftp/pub/tai/publication/wgfs/Adjustment_2021.html . The recommended value is the direct result of the adjustment, rounded as deemed adequate with respect to the recommended uncertainty.

While the results are from a global adjustment, it is of interest to note (see Figure 1) that the ^{199}Hg transition is involved in 2 measurements relative to ^{133}Cs, and in 4 frequency ratios, 3 of which are with optical transitions.

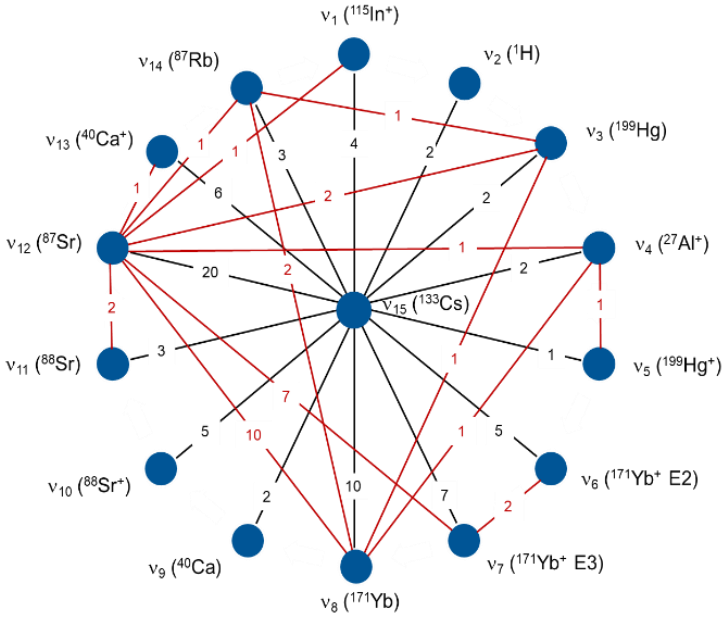

Figure 1: Representation of the 105 measureents linking 14 transitions on the circle and ^{133}Cs at the center.

3. References

[1] Consultative Committee for Time and Frequency (CCTF), 22nd meeting (session II – online), Recommendation PSFS-2 available at https://www.bipm.org/en/committees/cc/cctf/22-_2-2021
[2] Consultative Committee for Time and Frequency (CCTF): Report of the 21st meeting (8-9 June 2017), Recommendation CCTF 2 https://www.bipm.org/utils/common/pdf/CC/CCTF/CCTF21.pdf
[3] H. S. Margolis, P. Gill: Least-squares analysis of clock frequency comparison data to deduce optimized frequency and frequency ratio values; *Metrologia* **52**, 628 (2015)
[4] L. Robertsson: On the evaluation of ultra-high-precision frequency ratio measurements: examining closed loops in a graph theory framework; *Metrologia* **53**, 1272 (2016)
[5] G. Panfilo, communication to the CCL-CCTF WGFS. A new implementation of [4] was realized in MatLab at the BIPM (2020)
[6] Ch. Oates, communication to the CCL-CCTF WGFS. An independent program was developed in Mathematica at NIST (2017)
[7] F. Riehle, P. Gill, F. Arias, L. Robertsson: The CIPM List of Recommended Frequency Standard Values: Guidelines and Procedures; *Metrologia* **55**, 188-200 (2018)