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From ITS-90 to Thermodynamic Temperature: Hybrid SPRT Calibrations with LNE-Cnam Acoustic Gas Thermometry

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In the cryogenic temperature range between 13.8033 K and 273.16 K, eight fixed points are required by the International Temperature Scale of 1990 (ITS-90 or T_{90}) [1] to fully calibrate a standard platinum resistance thermometer (SPRT). Two of them are often no longer realized according to the prescriptions defined in the scale but by comparison with a “wire scale”: they are the two temperatures close to 17 K and 20.3 K. On the other hand, some primary methods as acoustic gas thermometry (AGT) [2] are now able to measure any thermodynamic temperature T in this range with user-adjustable spacings, as shown in Fig. 1 (left).

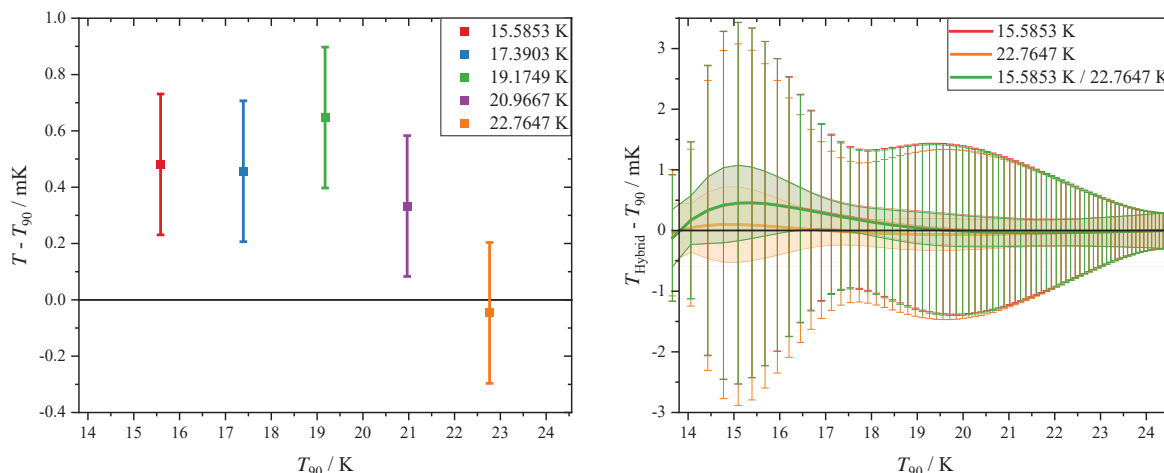


Fig. 1. Experimental determinations of $T - T_{90}$ by AGT (left) and calculated “ T_{Hybrid} ”- T_{90} differences (right); in the first case, only the uncertainty contribution from AGT is considered, while in the second one, this (lines with shaded areas) is compared with that of a typical T_{90} realization (error bars).

We investigate here the suitability of “hybrid” calculations for the temperature (T_{Hybrid}) with a SPRT carrying both ITS-90 and AGT calibrations. The ITS-90 equations are applied to a modified fixed-point set, where the two mentioned ITS-90 points are replaced by (alternative) thermodynamic temperatures close to those of the original fixed-points. Several AGT points are tested as possible replacements, by substituting them in the calculation procedure of the calibration coefficients. The results (right in Fig.1) consider different scenarios, where only one or both ITS-90 points are replaced, to find the optimal combination for the difference $T - T_{90}$ with the lowest uncertainty.

References

- [1] H Preston-Thomas 1990 Metrologia 27 3
- [2] C. Pan *et al* 2021 Metrologia 58 045006