Will Acoustic Gas Thermometry Lead to a New Temperature Scale?

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We used a quasi-spherical cavity as an acoustic and microwave resonator to measure the thermodynamic temperatures, T, of the triple points of mercury, argon, neon, and equilibrium hydrogen, and to measure the difference T - T90, in the range 7 to 273 K (T90 is the temperature on the International Temperature Scale of 1990 ITS-90). In the range 7 to 24.5 K, we achieve uncertainties that are comparable to, or smaller than, those achievable using the interpolating constant volume gas thermometer as currently defined on the ITS-90. In the range 90 to 273 K, the present results for T - T90 obtained using a helium-filled, copper-walled, quasi-spherical cavity agree with earlier results obtained using argon-filled, steel-walled, or aluminum-walled, spherical cavities. The agreement confirms our understanding of both acoustic and microwave cavity resonators, and demonstrates that resonators function as primary thermometers spanning wide temperature ranges. The mutually consistent acoustic thermometry data from several laboratories imply that the values of (T - T90)/T90 are 5 times larger than the uncertainty of T/T90 near 150 and 400 K. They also imply that the derivative dT/dT90 is too large by approximately 10^{-4} near 273.16 K and that dT/dT90 has a discontinuity of $4 \cdot 10^{-5}$ at 273.16 K. Thus, a new temperature scale based on acoustic gas thermometry could be significantly more accurate than ITS-90.