Determination of the Boltzmann Constant by Acoustic Measurements in Argon

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The redefinition of some basic units involves the use of fundamental physical constants. In the case of the kelvin means to define it in terms of the Boltzmann constant, making it independent of any material substance, measurement technique, and temperature range. A new determination of the Boltzmann constant was performed from measurements of the speed of sound in argon at the triple point of water and extrapolation to zero pressure. A quasi-spherical cavity, whose walls are gold-coated steel, was used for the measurements. Microwave and electroacoustic traducers are located in the northern and southern parts of the cavity, respectively, so that measurements of microwave and acoustic frequencies were carried out in the same experiment. Measurements were taken at pressures from 600 kPa to 60 kPa and at 273.16 K. The internal equivalent radius of the cavity was accurately determined by microwave measurements, and the first four radial symmetric acoustic modes were simultaneously measured and used to calculate the speed of sound. We determined the Boltzmann constant k_B = (1.380647 ± 0.000 009)´10^{-23} J · K^{-1} which corresponds to a relative standard uncertainty of 6.7 parts in 10^6 . The value reported in this paper lies −1.3 parts in 10^6 below the recommended value of CODATA 2014, although still within the range consistent with it.

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