Acoustic and Microwave Resonance to Probe Pre-Condensation Phenomena in Argon

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The work presented here is a new experimental study on pre-condensation phenomena in an Argon gas-filled quasi-spherical cavity, i.e. the walls of the cavity are coated with a film of condensed Argon even though the saturation point is not reached. Measurement are made at a temperature near 88 K and a pressure near 108 kPa, under adiabatic conditions and using accurate metrological instruments. The effect of pre-condensation is measured by a change in the acoustic resonance properties (resonance frequencies and halfwidths) of the resonator. Simultaneously, the microwave resonances of the TE11 mode and the TM11 triplet are also measured. From the relative change of frequency of these microwave modes we extract the thickness of the condensed film. The experimental set-up is based on that we have used to determine the Boltzmann constant and represents the state of the art for control of pressure and temperature. In contrast to other experiments on pre-condensation, the gas pressure is kept constant by the use of a piston gauge and the temperature is decreased and increased only slowly. The experimental results will be compared with those obtained using an analytical model for the acoustic field in the resonator that describes the strong coupling between acoustic motion, pre-condensation processes and thermal effects in the boundary layers (Phys. Rev. E 89, 023208 (2014)). This model builds upon that developed by Mehl and Moldover (J. Chem. Phys. 77, 455 (1982)). The results of this study should be of interest for primary acoustic thermometry, studies of thermophysical properties of gases and other applications such as thermoacoustic engines or propagation in wet granular media.

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