Convective stirring and acoustic spectra of near-critical xenon

I.I. Shinder C, S
Process Measurements Division, 836.02, National Institute of Standards and Technology, Gaithersburg, MD, U.S.A.
iosif.shinder@nist.gov

K.A. Gillis and M.R. Moldover

Xenon near its critical point compresses under its own weight in Earth's gravity. Sufficiently close to T_c, the density stratification that develops under isothermal conditions causes a departure of the thermophysical properties (averaged over the height) from the predicted asymptotic behavior. Previous experiments have shown that the gravity-induced density gradient may be significantly reduced by mechanical [1] or convective [2,3] stirring, thereby measurements of the asymptotic behavior may be achieved much closer to T_c than otherwise possible on Earth. In a recent series of acoustic measurements in near-critical xenon [4] (discussed in another presentation), we heated centimeter-sized cavities from below to stir the enclosed xenon, thereby reducing the density stratification in Earth's gravity. The stirring reduced the apparent equilibration time from several hours to a few minutes, and it reduced the effective temperature resolution from 60 mK to approximately 2 mK. As close as 10 mK to the critical point, the acoustic data were insensitive to a tenfold increase in heater power (above the threshold for initiating convection). Additional measurements in two small cylindrical resonators (with 8 mm and 16 mm inner diameters) confirmed the insensitivity of the data to heater power very close to the critical point (<60 mK above T_c) and far from the critical point (>400 mK above T_c). For intermediate temperatures, the resonance frequencies and half-widths showed a linear dependence on power above the threshold value, which we didn't expect.

[1] A. V. Voronel in "Phase Transitions and Critical Phenomena", edited by C. Domb and M. S. Green (Academic Press, New York, (1976) Vol. 5B, Chap. 5.
[2] D. S. Cannell, Phys. Rev. A 12, 225 (1975).
[3] M.R. Moldover, J.V. Sengers, R.W. Gammon, R.J. Hocken, Rev. Mod. Phys. 51, 79 (1979).
[4] K.A. Gillis, I.I. Shinder, and M.R. Moldover, Phys. Rev. E 72, 051201 (2005).