Convective stirring and acoustic spectra of near-critical xenon

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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.