Theoretical Analysis of Thermodynamic Measurements Near a Liquid-Gas Critical Point

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Abstract

Over the years, many ground-based studies have been performed near liquid-gas critical points to elucidate the expected divergences in thermodynamic quantities. The unambiguous interpretation of these studies very near the critical point is hindered by a gravity-induced density stratification. However, these ground-based measurements can give insight into the crossover behavior between the asymptotic critical region near the transition and the mean field region farther away. We have completed a detailed analysis of heat capacity, susceptibility and coexistence curve measurements near the ^{3}He liquid-gas critical point using the minimal-subtraction renormalization (MSR) scheme within the ϕ^4 model. This MSR scheme, using only two adjustable parameters, provides a reasonable global fit to all of these experimental measurements in the gravity-free region out to a reduced temperature of $|t| \sim 2\times10^{-2}$. Recently this approach has also been applied to the earlier microgravity measurements of Haupt and Straub in SF_6 with surprising results. The conclusions drawn from the MSR analyses will be presented. Measurements in the gravity-affected region closer to the ^{3}He critical point have also been analyzed using the recent crossover parametric model (CPM) of the equation-of-state. The results of fitting heat capacity measurements to the CPM model along the ^{3}He critical isochore in the gravity-affected region will also be presented.