Crossover Critical Phenomena in Fluids

Jan V. Sengers [C, S] and Mikhail A. Anisimov
Institute for Physical Science & Technology, University of Maryland, College Park, MD, U.S.A.

We first review our current understanding of asymptotic critical behavior in molecular fluids including some of the contributions made by Anneke Levelt Sengers. Sufficiently close to the critical point, the thermodynamic properties satisfy scaling laws with universal Ising-like scaling functions and critical exponents. The reason for universal critical behavior is that the correlation length of the critical fluctuations becomes much larger than any molecular scale. An interesting question is: How close is "close to the critical point"? [1].This question can be answered on the basis of a proper nonasymptotic theory of critical phenomena that includes the crossover from fluctuation-induced critical behavior to non-fluctuating mean-field critical behavior. It is shown that such a theory not only accounts for the complete critical behavior of Ising-like systems, but also for the critical behavior in macromolecular solutions where the correlation length of the critical fluctuations competes with a mesoscopic macromolecular length scale. The concept of crossover critical behavior also solves a long-standing puzzle, namely, how Ising-like critical behavior in molecular solutions is related to tricritical behavior in solutions of polymers with large degrees of polymerization.

[1] J.M. H. Levelt Sengers and J.V. Sengers, in *Perspectives in Statistical Physics,* edited by H.J. Raveché (North Holland, Amsterdam, 1981), pp. 239-271.