Relaxation Time for an Inhomogeneous Substance Under Gravity Near the Critical Point

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The height dependence of the relaxation time, t (Z), in inhomogeneous mixtures under gravity near the critical point is studied in this paper using a refractometry technique. Qualitative analysis of the results revealed that the height dependence of the time (t(z)) for the relaxation of the refractive index (n) gradient, dn/dZ (Z,T) (where T is temperature), to its equilibrium value is of nonmonotonic character. The maximum value of the relaxation time for the gradient of the refractive index corresponds to the height Z_o, where isotherms dn/dZ (Z,T) intersect as the system approaches equilibrium. Quantitative analysis of the results showed that the relaxation properties of dn/dZ are described not by a single relaxation time t(Z), but rather by a set of relaxation times, which characterize the inhomogeneous system as a whole under gravity near the critical point. As the level of the critical isochore Z = 0 or the height of $Z = Z_o$ is approached along the vertical coordinate of the nonhomogeneous system, the relaxation time decreases dramatically. The only level characterized by a single relaxation time, which increases when approaching the critical temperature, is the level of the critical isochore.

On the basis of the fluctuation theory of phase transitions, it was shown that at the extremum point of t(Z), properties of inhomogeneous substances correspond to the properties of homogeneous systems along three critical directions--critical isochores, critical isotherms, and the phase interface.