Non-Equilibrium Concentration Fluctuations Induced by the Soret Effect in Microgravity

Jose M. Ortiz de Zarate [C, S]
Department of Applied Physics I, Complutense University, Madrid, Spain
jmortizz@fis.ucm.es

Jan V. Sengers
Institute for Physical Science and Technology, University of Maryland, College Park, Maryland, U.S.A.

Non-Equilibrium fluctuations are spatially long-ranged. Hence, even in macroscopic systems the spontaneous thermodynamic fluctuations "feel" the boundaries and, in general, both their intensity and their dynamics depend on the boundary conditions. Here, a layer of a binary liquid mixture that is bounded by two plates maintained at two different temperatures is considered. The Soret effect induces a stationary concentration profile, and fluctuating hydrodynamics (FHD) provides a theoretical framework to study spontaneous concentration fluctuations around it. In this problem, realistic boundary conditions are no diffusion flow at the two bounding plates for the concentration fluctuations and no-slip for the velocity fluctuations. In the absence of gravity (or in microgravity) and for incompressible flow in a large-Lewis-number approximation, the FHD equations can be exactly solved, and a relatively simple analytical expression can be obtained for the time-correlation-function of the concentration fluctuations accounting for realistic boundary conditions. It turns out that, in this particular case of no gravity, the dynamics of the fluctuations is not affected by the gradient and is the same as if the system were at equilibrium at an average concentration. However, the intensity of the fluctuations is strongly affected by the presence of the gradient. The present solution for realistic boundary conditions will be compared with previous analytical results for unrealistic boundary conditions (free-slip and stationary concentration boundaries). Similarly, the current theoretical results will also be compared with available experimental information.