Concentration Fluctuations in Non-Isothermal Fluid Mixtures

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Fluctuating hydrodynamics in the context of non-equilibrium thermodynamics predicts the appearance of a major enhancement of concentration fluctuations in a fluid mixture in the presence of a temperature gradient. The intensity of these non-equilibrium fluctuations is inversely proportional to the fourth power of the wave number q of the fluctuations. Experimental evidence from light-scattering measurements for the q^{-4} dependence of the non-equilibrium concentration fluctuations will be presented. To deal with chemically reacting fluid mixtures one needs a non-equilibrium thermodynamics description that should be consistent with the law of mass action. This can be done by a new concept of mesoscopic non-equilibrium thermodynamics [1]. Fluctuating hydrodynamics in the context of mesoscopic non-equilibrium thermodynamics predicts that in a non-isothermal chemically reacting mixture, the intensity of the non-equilibrium concentration fluctuations will exhibit a crossover from a q^{-4} power law for larger wave numbers to a q^{-2} power law for smaller wave numbers. The crossover will occur at a wave number that corresponds to a wavelength equal to the penetration depth of the reaction. This prediction opens the possibility of measuring the penetration depth of a chemical reaction by light scattering [2].

[1] D. Bedeaux, I. Pagonabarraga, J.M. Ortiz de Zárate, J.V. Sengers, and S. Kjelstrup, PCCP **12**, 12780 (2010).
[2] D. Bedeaux, J.M. Ortiz de Zárate, I. Pagonabarraga, J.V. Sengers, and S. Kjelstrup, J. Chem. Phys. **135**, 124516 (2011).