Non-Local Fluctuation Phenomena in Liquids

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Fluids in non-equilibrium (NE) steady states exhibit long-ranged fluctuations that typically extend over the entire spatial dimension of the system. They are theoretically described by fluctuating hydrodynamics, an extension of non-equilibrium thermodynamics originally developed by Landau and Lifshitz, in which dissipative fluxes are supplemented with random contributions reflecting the intrinsic stochastic nature of molecular collisions. Hence, the balance equations of fluid mechanics and non-equilibrium thermodynamics transform naturally into a set of stochastic differential equations, much in the spirit of recent developments referred to as 'stochastic thermodynamics'. In our contribution we shall review some salient features of the NE fluctuations which, being spatially long ranged, are strongly affected by buoyancy and confinement effects, both in their dynamics as in their statics (intensity). All these remarkable features of NE fluctuations have been confirmed experimentally. In addition, these long-ranged NE fluctuations induce NE Casimir pressures in confined fluid layers. Finally, we shall comment on the possibility of studying these NE fluctuations with non-equilibrium molecular dynamics. As a summary we conclude that, in contrast to fluctuations in equilibrium, NE fluctuations are always non-local and their presence profoundly affects the physics of fluids that are not in thermodynamic equilibrium.