Non-hydrodynamic Collective Modes in Liquids: Theory and Simulations

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Non-hydrodynamic, or sometimes called *kinetic*, modes in liquids are the collective processes derived by fluctuations of non-conserved quantities, and therefore not predicted by hydrodynamic theory. Examples of non-hydrodynamic processes in liquids are structural relaxation, shear and heat waves, optic-like excitations in binary liquid mixtures etc. On macroscopic length scales the non-hydrodynamic processes cannot be observed because of their non-zero lifetime, however beyond hydrodynamic region they sufficiently contribute to the shape of various spectral functions. We review recent analytical and simulation results obtained in the studies of collective dynamics and generalized transport coefficients of simple and many-component liquids within the approach of Generalized Collective Modes (GCM) [1,2]. In particular, our main focus is on manifestation of non-hydrodynamic collective modes on the shape of dynamical structure factors and current spectral functions in liquid metallic alloys, molten salts and simplest molecular liquids. Analytical solutions of simplified dynamical models will be presented for several non-hydrodynamic propagating and relaxation processes like heat waves, optic modes [3,4] and structural relaxation [5]. A comparison of our theoretical and simulation results with recent IXS scattering experiments on liquid metallic alloy NaK [6] and molten salt NaI [7] will be shown.

References

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