Non-linear single-particle-response of glassforming systems to external fields

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Glassy dynamics of viscous liquids are characterized by a drastic slowing down of dynamical properties, while structural and thermodynamic quantities only show a weak gradual change. Recently, various independent studies have revealed that the interplay of the glass transition with external fields provides a wealth of new phenomena yet to be explored. There is hope that the understanding of the non-linear response of glassforming systems to external fields leads to new insight into the nature of the glass transition . In this work, we study the behavior of single particles in a supercooled liquid under the influence of an external force. Our model system is a 50:50 binary mixture whose particles interact via a Yukawa potential.

$$V_{\alpha\beta}(r) = \varepsilon_{\alpha\beta} d_{\alpha\beta} \exp[-\kappa(r - d_{\alpha\beta})]/r \qquad (1)$$

By choosing slightly different potentials between A and B particles we prevent the system from crystallizing. In the equilibrated system, we add a constant force field to one of these particles which as a consequence will be accelerated. After some time, this particle reaches a steady state. In this state we measure characteristic properties of the particle and the surrounding like the steady state velocity, the friction coefficient, mean square displacements and correlation functions in dependence of the external force and system temperature. We observe that for low temperatures and high enough force fields the particle leaves the linear response regime and enters the non-linear regime. Here, the friction coefficient is not constant any more. For even higher forces all curves reach a second plateau and fall on top of each other. This work also allows to check new theoretical approaches for the micro-rheology of glassforming systems in the framework of mode coupling theory.