Effects of Bath Response to External Fields on the Stochastic Motion of Tagged Particles

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Abstract. The Brownian motion (BM) of a tagged particle in a bath of other particles is effectively described by the generalized Langevin equation (GLE). As distinct from the standard Langevin equation, the GLE instead of the Stokes friction force contains a convolution of a memory kernel with the velocity of the tagged particle. The kernel is connected to the random thermal force through the second fluctuation-dissipation theorem (FDT). In the linear approximation it is usually assumed that if external forces act on the system, they do not affect the thermal force and thus the FDT. The action of such forces is restricted to the Brownian particle (BP), leaving the bath particles unaffected by the external field. However, there are a number of important physical problems, where not only the BP but also the particles that constitute the heat bath are subjected to the external field. In our talk, we show that for a stationary particle-bath system in an external harmonic potential the corresponding generalization of the Zwanzig-Caldeira-Legget model leads to the GLE for which the FDT really remains the same as in the absence of the external field but both the memory function and the thermal force depend on the elastic constant of the confinement potential. As a result, the velocity correlation functions of the BP and its mean square displacement change in comparison with those in the original model as well. When the bath consisting of charged particles is in a constant external magnetic field, the familiar Kubo's FDT is formally valid but with the memory function depending on the field magnitude. On the contrary, the electric force, which does not depend on the positions or velocities of the bath particles, does not affect the properties of the random thermal force and the memory function. We discuss possibilities of obtaining the correlation functions describing the random motion of the BPs and show several specific solutions for them depending on the spectral distribution frequencies of the bath oscillators and the coupling between the bath and the BP.

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