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BROWNIAN MOTION IN A BATH AFFECTED BY AN EXTERNAL HARMONIC POTENTIAL

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The Brownian motion of a particle in a bath of other particles is effectively described by the generalized Langevin equation (GLE). Following Kubo, it is usually assumed that if external forces act on the system, they do not affect the thermal force and the memory function that enter the GLE. The action of such forces is restricted to the Brownian particle (BP), leaving the bath particles unaffected by the external field. However, there are many physical situations, when not only the BP but also the bath particles are subjected to the external field. We show that for stationary systems in a harmonic potential the corresponding generalization of the Zwanzig-Caldeira-Legget theory leads to the GLE for which Kubo's fluctuation-dissipation theorem remains valid but both the memory function and the thermal force depend on the elastic constant of the confinement potential. As a result, the correlation functions describing the random motion of the BPs change in comparison with those in the original model as well. We discuss possibilities to calculate these functions and show several specific solutions for them depending on the frequency distribution of the bath oscillators and the coupling between the bath and the BP.

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