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Temperature-abnormal diffusivity and weak ergodicity breaking in space-periodic systems driven by external forces

Monday, 4 September 2017 15:00 (20 minutes)

The phenomena of diffusion over a potential energy landscape play a key role in a number of processes in physics, chemistry and biology. In this talk a set of original theoretical results on diffusion enhancement of underdamped Brownian particles in symmetric space-periodic potential due to external forcing is presented [1-5].
We demonstrate that depending on the value of the constant external force in underdamped space-periodic systems dfferent functional dependences of the diffusivity on the temperature are realized. It is shown by numeric simulations of the Langevin equation that the phenomenon of diffusivity growth with the temperature decreasing ("temperature-abnormal diffusivity"- TAD) is manifested in a narrow interval of applied external forcing.
We demonstrate that weak ergodicity breaking takes place in TAD region. The correlation time tends to infinity as ~exp(+U/kBT) at T⟶0 in TAD region.
It is well-known that the double-well system is a typical classical memory device. We show that particle dynamics in underdamped space periodic systems may be considered as overdamped particle movement in effective double-well velocity space potential.
Based on the double-well model the analytical expression for diffusion coefficients in TAD region is derived. The functional dependence of TAD region width and its position on the friction coefficient and system parameters is found.
These results allow for simple experimental verification, and have practical applications – in physics of adsorbates, diffusion of interstitials, nanoparticle sorting, hydrogen energetics to name a few.

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[4] I. G. Marchenko, I. I. Marchenko, Journ. of Phys. Conf. Ser. 514, 012045 (2014).

[5] I. G. Marchenko, I. I. Marchenko, A. V. Zhiglo, arXiv:1701.01424v2 (2017).

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