Nonmonotonic temperature dependence of diffusion in driven periodic systems

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The spreading of a cloud of independent Brownian particles typically proceeds more effectively at higher temperatures, as it derives from the commonly known Sutherland–Einstein relation for systems in thermal equilibrium. Here, we report on a non-equilibrium situation in which the diffusion of a periodically driven Brownian particle moving in a periodic potential decreases with increasing temperature within a finite temperature window [1,2]. As the mechanism for this counterintuitive diffusive behaviour we propose the temperature dependence of transitions between certain regions in the phase space dynamics of the particle. The presented analysis is based on extensive numerical simulations of the corresponding Langevin equation describing the studied setup as well as on a simplified stochastic model formulated in terms of a three-state Markovian process.

[1] J. Spiechowicz, P. Talkner, P. Hanggi and J. Luczka, Non-monotonic temperature dependence of chaos-assisted diffusion in driven periodic systems, New J. Phys. 18, 123029 (2016)

[2] J. Spiechowicz, M. Kostur and J. Luczka, Brownian ratchets: How stronger thermal noise can reduce diffusion, in press in Chaos (2017)