DIFFUSION OSCILLATIONS IN AC-DRIVEN SPACE-PERIODIC SYSTEMS

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Processes and phenomena in systems far from equilibrium can exhibit unexpected and unusual properties. They are ubiquitous in nature ranging from the microscale to the macroscale. The phenomenon of diffusion is one such example and plays a key role in numerous processes in physics, chemistry, biology, and engineering. For normal diffusion described by the Einstein relation for a Brownian particle, the diffusion coefficient D depends only on two parameters: it monotonically increases with increasing temperature T and decreases when the friction coefficient grows. However, under nonequilibrium conditions, the dependence of D on the system parameters may be surprising and non-monotonic.

We revisit the problem of diffusion in a driven system consisting of an inertial Brownian particle moving in a symmetric periodic potential and subjected to a symmetric time-periodic force. We reveal parameter domains in which diffusion is normal in the long time limit and exhibits intriguing giant damped quasiperiodic oscillations as a function of the external driving amplitude.

We find out that when temperature increases the diffusion coefficient increases at minima, however, it decreases at maxima within a finite temperature window. This curious behavior is explained in terms of the deterministic dynamics perturbed by thermal fluctuations and mean residence times of the particle in localized and running trajectories. We demonstrate that temperature dependence of the diffusion coefficient can be accurately reconstructed solely from the stationary probability to occupy the running trajectories

Our findings can be verified experimentally in a multitude of physical systems, including colloidal particles, Josephson junction, or cold atoms dwelling in optical lattices, to name only a few.