Negative mobility of a Brownian particle

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We study impact of inertia on directed transport of a Brownian particle under non-equilibrium conditions: the particle moves in a one-dimensional periodic and symmetric potential, is driven by both an unbiased time-periodic force and a constant force, and is coupled to a thermostat of temperature T. Within selected parameter regimes this system exhibits negative mobility, which means that the particle moves in the direction opposite to the direction of the constant force. It is known that in such a setup the inertial term is essential for the emergence of negative mobility and it cannot be detected in the limiting case of overdamped dynamics. We analyse inertial effects and show that negative mobility can be observed even in the strong damping regime. We determine the optimal dimensionless mass for the presence of negative mobility and reveal three mechanisms standing behind this anomaly: deterministic chaotic, thermal noise induced and deterministic non-chaotic. The last origin has never been reported. It may provide guidance to the possibility of observation of negative mobility for strongly damped dynamics which is of fundamental importance from the point of view of biological systems, all of which in situ operate in fluctuating environments.

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