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Exactly solvable model of a slightly fluctuating ratchet

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We consider the motion of a Brownian particle in a sawtooth potential dichotomously modulated by a spatially harmonic perturbation. An explicit expression for the Laplace transform of the Green function of an extremely asymmetric sawtooth potential is obtained. With this result, within the approximation of small potential-energy fluctuations, the integration of the relations for the average particle velocity is performed in elementary terms. The obtained analytical result, its high-temperature, low-frequency, and high-frequency asymptotics, as well as numerical calculations performed for a sawtooth potential of an arbitrary symmetry, indicate that in such a system, the frequency-temperature controlling the magnitude and direction of the ratchet velocity becomes possible.We clarify the mechanism of the appearance of additional regions of nonmonotonicity in the frequency dependence of the average velocity, which leads to the appearance of additional ratchet stopping points. This mechanism is a consequence of the competition between the sliding time along the steep slope of the highly asymmetric sawtooth potential and the correlation time of the dichotomous noise.

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