

Quantum ratchet with Lindblad rate equations

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A quantum random walk model is established on a one-dimensional periodic lattice that fluctuates between two possible states [1]. This model is defined by Lindblad rate equations that incorporate the transition rates between the two lattice states. Leveraging the system's symmetries, the particle velocity can be described using a finite set of equations, even though the state space is of infinite dimension. These equations yield an analytical expression for the velocity in the long-time limit, which is employed to analyze the characteristics of directed motion. Notably, the velocity can exhibit multiple inversions, and to achieve directed motion, distinct, nonzero transition rates between lattice states are required.

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[1] L. O. Castaños-Cervantes and J. Casado-Pascual, Phys. Rev. E 109 (2024) 054128.