The Totally Asymmetric Simple Exclusion Process on tracks with a shortcut in the bulk

Abstract

The one-dimensional Totally Asymmetric Simple Exclusion process (TASEP) is a paradigmatic model for understanding the rich world of non-equilibrium phenomena. It is one of the simplest models of self-driven many-particle systems with particle conserving stochastic dynamics in continuous time which describes phase transitions between three non-equilibrium stationary phases. We will consider TASEP defined on networks with a non-trivial topology, such as: (i) A long chain with a double-chain section in the bulk; (ii) A chain with a zero-length shortcut in the bulk as a model of biological transport along a twisted filament: a particle may jump with a probability $q$ between two sites which are far apart along the chain but close in real space; (iii) The case of a chain with a shortcut (bypass), which differs from (i) in that one of the branches in the double section has an arbitrary length. Since such systems cannot be solved exactly, we use both an analytic method, based on the Effective Rates Approximation (ERA) for the long segments of the network, and extensive Monte Carlo simulations. The results demonstrate a number of novel and unexpected features.