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Effective ergodicity breaking in an exclusion process with varying system length

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Abstract

Stochastic processes of interacting particles in systems with varying length are relevant e.g. for several biological applications. We try to explore what kind of new physical effects one can expect in such systems. As an example, we extend the exclusive queueing process that can be viewed as a one-dimensional exclusion process with varying length, by introducing Langmuir kinetics. This process can be interpreted as an effective model for a queue that interacts with other queues by allowing incoming and leaving of customers in the bulk. We find surprising indications for breaking of ergodicity in a certain parameter regime, where the asymptotic growth behavior depends on the initial length. We show that a random walk with site-dependent hopping probabilities exhibits qualitatively the same behavior.

Key words: Nonequilibrium physics, stochastic process, queueing theory, exclusion process, Langmuir kinetics
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1 Introduction

The exclusive queueing process (EQP) [1–5] is a queueing model that takes into account the spatial structure of the queue. In standard queueing theory, which is a well-established approach of practical relevance [6–8], the system length and the number of particles are identical, so that the density along the queue is always 1. In the EQP, particles interact with each other through an exclusion principle, i.e. they can move forward only when the target site is

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