gTASEP as a model of irreversible aggregation

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The generalized Totally Asymmetric Simple Exclusion Process (gTASEP) on open chains is used to study the irreversible aggregation in the limit of a strong interaction ($p_m = 1$) between the particles. In this limit clusters of particles translate on the chain as a whole entity with the same probability p as single particles do. Two clusters, or a particle and a cluster, irreversibly aggregate whenever they become nearest neighbors. Under the balance of particle injection and ejection non-equilibrium stationary phases appear in the model [1]. The phase diagram of the gTASEP in the plane of the injection-ejection probabilities is established by means of extensive Monte Carlo simulations. It consists of three stationary phases: a multiparticle (MP), a completely filled (CF), and a mixed (MP+CF) phase. The transitions between these phases are also studied. We study the properties of the MP+CF phase by deriving exact expressions for the local density at the first site of the chain and the probability $P(1)$ of a completely jammed configuration. The unusual phase transition appearing in the system (from MP to the CF phase), characterized by jumps in both the bulk density and the current (in the thermodynamic limit), is explained by the finite-size behavior of $P(1)$. The results may contribute to a better understanding of many neurodegenerative diseases, including Alzheimer's, Parkinson's, and prion diseases since as is known they are related to intracellular aggregation and deposition of pathogenic proteins [2]. Preliminary studies of the case $p < p_m < 1$, when breaking of clusters is allowed with probability $(1 - p_m) > 0$ are also available, indicating non-trivial behavior.

References

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