Confirming Time-reversal Symmetry of a Directed Percolation Phase Transition in a Model of Neutral Evolutionary Dynamics[1]
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— Reaction-diffusion processes, such as branching-coalescing random walks, can be used to describe the underlying dynamics of nonequilibrium phase transitions. In an agent-based, neutral model of evolutionary dynamics, we have previously shown that our system undergoes a continuous, nonequilibrium phase transition, from extinction to survival, as various system parameters were tuned. This model was shown to belong to the directed percolation (DP) universality class, by measuring the critical exponents corresponding to correlation length $\xi_\perp$, correlation time $\xi_{||}$, and particle density β. The fourth critical exponent that defines the DP universality class is β', which measures the survival probability of growth from a single seed organism. Since DP universality is theorized to have time-reversal symmetry, it is assumed that $\beta = \beta'$. In order to confirm the existence of time-reversal symmetry in our model, we evaluate the system growth from a single asexually reproducing organism. Importantly, the critical exponent β' could be useful for comparison to experimental studies of phase transitions in biological systems, since observing growth of microbial populations is significantly easier than observing death.

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