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Absorbing phase transitions in the stochastic Manna model and the conserved lattice gas model with natural initial states

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The critical behaviors of absorbing phase transitions in the stochastic Manna model and the conserved lattice gas model were investigated on a square lattice, using the "natural" initial states defined recently by Basu *et al.* [1]. In Ref. [1], it has been claimed based on numerical simulations in one dimension that an independent Manna class does not exist and all the models known to belong to the Manna class are expected to show a directed percolation critical behavior after very long time.

Various critical exponents were estimated, including the exponents characterizing the density of active sites $\rho_a(t) \sim t^{-\alpha}$, the order parameter, i.e., the saturation density in the supercritical region $\rho_{\text{sat}} \sim \Delta^\beta$, the correlation time $\tau \sim |\Delta|^{-\nu_\parallel}$, the correlation length $\xi \sim |\Delta|^{-\nu_\perp}$, the survival probability $P(t) \sim t^{-\alpha'}$, the spreading distance $R(t) \sim t^{1/z}$, and the number of active sites $N(t) \sim t^\eta$, where t is the evolution time, Δ the distance from criticality, i.e., $\Delta = \rho - \rho_c$, and ρ the particle density. The results of α and $\nu_\parallel$ were found to be different from the previously reported ones obtained using the random initial states, and the rests remained the same. It was found that the known scaling relations $\nu_\parallel = \beta/\alpha$ and $z = \nu_\parallel/\nu_\perp$, one of which was known to be violated when examined using the data with random initial states, were satisfied with an excellent precision for both models. The scaling relation $d/z = \alpha + \alpha' + \eta$ also held. Thus, the data with natural initial states appeared to resolve the known unusual violation of the scaling relation. The estimates of the exponents however appeared to be significantly different from those in the directed percolation universality class, supporting that the Manna class is a unique, independent class. Some numerical results in one dimension were also presented.

[1] M. Basu, U. Basu, S. Bondyopadhyay, P.K. Mohanty, and H. Hinrichsen, Phys. Rev. Lett. 109, 015702 (2012).