Absorbing phase transition in continuous media

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The nonequilibrium absorbing phase transition of interacting particles in continuous media is studied via Monte Carlo simulations. Initially ρL^d spherical particles are distributed randomly in a cubic box of side L, and those particles which overlap with other particles are considered to be active and isolated particles are inactive. The dynamics proceed with sequential updates of active particles; an active particle is selected randomly and it repels those particles which overlap with it, with an increment of the evolution time $\Delta t = 1/N_a(t)$, where $N_a(t)$ is the number of active particles at time t. If the density of particles is larger than a critical density, i.e., if $\rho > \rho_c$, the density of active particles saturates as dynamics proceed and, if $\rho < \rho_c$, it decreases to 0 and the system falls into an absorbing state. At ρ_c, the density of active particles ρ_a decreases following the power-law behavior $\rho_a(t) \propto t^{-\alpha}$. Therefore, the system undergoes a phase transition from an active phase to one of many absorbing states. The steady-state density of active particles is considered to be an order parameter and exhibits the power-law behavior $\rho_{\rm sat} \propto (\rho - \rho_c)^\beta$, where β is the order-parameter exponent.

The critical exponents α and β were calculated in two dimensions and found to be similar to those of the lattice Manna model, suggesting that both the continuum and lattice models belong to the same universality class. This is in strict disagreement with recent observation for the same model but with parallel updates, in which the order-parameter exponent was found to be similar to that of the directed percolation universality class [1].

When the system started from the natural initial states [2], the exponent α was found to be distinct from that of the lattice Manna model generated also from the natural initial states prepared by the same method as for the continuum model. The different behaviors were interpreted using the distribution of particles; the density fluctuation of hyperuniform distribution of active and background particles [3] was found to be different for the lattice and continuum models, and the different critical behaviors of absorbing phase transition appear to be attributed to different distributions.

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