

Coarsening and Persistence in 1-D arrowhead model system

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We have studied a system of stochastically reorienting left- and right-pointing arrowheads ($<$ and $>$) in one dimension. A typical configuration can be $\dots <<>>><>><>><>><<>>>>\dots$. The kinetics involves lateral flipping of an arrowhead around its vertex and displacement along the line. The arrowheads can not overlap or cross each other due to hardcore interaction between them. Our study includes the static properties and the dynamics of approach to the steady state. The equilibrium state of our system approaches an orientationally ordered state as the density increases. The spatial extent of this order is quantified by the correlation length. Using transfer matrix formalism it is shown that the correlation length diverges exponentially with increase in arrowhead density. It can be seen from a typical configuration above that there are two types of domain walls, $><$ (A) and $<>$ (B).

In the very high density limit, the displacement of an arrowhead is ineffective so kinetics is reduced to move of flipping only. Thus, owing to non-overlap constraint due to hardcore interaction, A -type domain walls can diffuse and B -type walls are static. In time, the approach to the ordered state is described by a coarsening process governed by the kinetics of domain wall annihilation $A + B \rightarrow 0$, quite different from $A + A \rightarrow 0$ kinetics pertinent to the Glauber-Ising model.

The survival probability of a finite set of walls is analytically shown to decay exponentially in time, in contrast to the power law decay known for $A + A \rightarrow 0$.

In the thermodynamic limit with a finite density of walls, coarsening as a function of time is studied by simulation. It is observed that the number of domain walls falls as $t^{-\frac{1}{2}}$. The fraction of persistent arrowheads is found to decay as a power law $t^{-\theta}$ where θ is close to $1/4$, quite different from the exact value $3/8$ for the Ising case. The global persistence also decays with same power $\theta=1/4$. In a generalization where the B -type walls can diffuse slowly, θ varies continuously, increasing with increasing diffusion constant.

[1] M. Kim, S.-C. Park and J.D. Noh, Phys. Rev. E **87**, 012129 (2013).

[2] Y. Kantor and M. Kardar, Phys. Rev. E **79**, 041109 (2009).

[3] M.E. Fisher, J. Stat. Phys. **34**, 667 (1984).

[4] Derrida et. al., Phys. Rev. Lett. **75**, 751 (1995).

[5] Majumdar et. al., Phys. Rev. Lett. **77**, 3704 (1996).