Insalate di Matematica

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Metastability in a lattice gas with strong anisotropic interactions under Kawasaki dynamics

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Abstract

In this talk we will consider mathematical models evolving according to a stochastic dynamics in order to identify dynamical properties of real-life systems in the framework of non-equilibrium statistical mechanics. We will consider a specific problem in the general study of transitions from local minima to a global minimum, where the evolution is given by a Markov process. In particular, we analyze metastability in the context of a local version of the Kawasaki dynamics for the two-dimensional strongly anisotropic Ising lattice gas at very low temperature. Let $\Lambda \subset \mathbb{Z}^2$ be a finite box. Particles perform simple exclusion on Λ, but when they occupy neighboring sites they feel a binding energy $-U_1 < 0$ in the horizontal direction and $-U_2 < 0$ in the vertical one. Along each bond touching the boundary of Λ from the outside to the inside, particles are created with rate $\rho = e^{-\Delta\beta}$, while along each bond from the inside to the outside, particles are annihilated with rate 1, where β is the inverse temperature and $\Delta > 0$ is an activity parameter. We consider the parameter regime $U_1 > 2U_2$ also known as the strongly anisotropic regime. We take $\Delta \in (U_1, U_1 + U_2)$ and we prove that the empty (resp. full) configuration is a metastable (resp. stable) configuration. We consider the asymptotic regime corresponding to finite volume in the limit of large inverse temperature β. We investigate how the transition from empty to full takes place. In particular, we estimate in probability, expectation and distribution the asymptotic transition time from the metastable configuration to the stable configuration. Moreover, we identify the size of the critical droplets, as well as some of their properties. We observe very different behavior in the weakly ($U_1 < 2U_2$) and strongly anisotropic regimes. This is based on a joint work with F. R. Nardi.

Keywords:

Metastability · lattice gas · Kawasaki dynamics· critical droplet

"Obvious" is the most dangerous word in mathematics. - Eric Temple Bell