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Percolation Techniques in Disordered Spin Flip Dynamics: Relaxation to the Unique Invariant Measure

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Abstract: We consider lattice spin systems with short range but random and unbounded interactions. We give criteria for ergodicity of spin flip dynamics and estimate the speed of convergence to the unique invariant measure. We find for this convergence a stretched exponential in time for a class of "directed" dynamics (such as in the disordered Toom or Stavskaya model). For the general case, we show that the relaxation is faster than any power in time. No assumptions of reversibility are made. The methods are based on relating the problem to an oriented percolation problem (contact process) and (for the general case) using a slightly modified version of the multiscale analysis of e.g. Klein (1993).

1. Introduction

Adding disorder to a system of many interacting particles may in general be a highly non-trivial perturbation. The study of spin flip systems with quenched disorder is certainly not so well developed as their corresponding versions without disorder. In this paper we show how percolation techniques can be useful for investigating that part of the phase diagram in which the disordered dynamics typically forgets about initial data. In this uniqueness regime (high temperature, high noise, low density, strong magnetic field, strong bias,...) the main problem consists in circumventing the dynamical consequences of the so-called Griffiths' singularities, see Griffiths (1969). A consequence of the disorder is that there will typically be large regions on which the spins are strongly interacting. This is completely analogous to the situation in equilibrium. What is far worse here however, is that these "bad" regions should be thought of as infinitely extending in the time direction, i.e., spins there will relax only very slowly in the course of time. Depending on the size and the "badness" of these regions, the relaxation time may become arbitrarily large. Therefore we cannot expect to see *typically* an exponential decay to the invariant measure.

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