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Aggregation and Intermediate Phases in Dilute Spin Systems

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Abstract: We study a variety of dilute annealed lattice spin systems. For site diluted problems with many internal spin states, we uncover a new phase characterized by the occupation and vacancy of staggered sublattices. In cases where the uniform system has a low temperature phase, the staggered states represent an intermediate phase. Furthermore, in many of these cases, we show that (at least part of) the phase boundary separating the low-temperature and staggered phases is a line of phase coexistence – i.e. the transition is first order. We also study the phenomenon of aggregation (phase separation) in bond diluted models. Such transitions are known, trivially, to occur in the large-q Potts models. However, it turns out that phase separation is typical in bond diluted spin systems with many internal states. (In particular, a bond aggregation transition is not tied to a discontinuous transition in the uniform system.) Along the portions of the phase boundary where any of these phenomena occur, the prospects for a Fisher renormalization effect are deemed to be highly unlikely or are ruled out altogether.

1. Introduction

Annealed Dilute Systems. Annealed dilute spin systems have, traditionally, received far less attention than their quenched counterparts: From the physical perspective, it is generally agreed that the experimental realizations of dilute spin systems are better described in the quenched approximation and, from the theoretical perspective, it is generally believed that the annealed-dilute problems are not substantially different from their uniform counterparts. Although we will not be discussing the applicability of annealed-dilute spin models, let us briefly address the first issue by noting that there are a host of systems – such as alloys or multi-component fluids – that are also described by dilute spin models. In many of these cases, it can be argued that the annealed version is the appropriate choice.

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