Commun. Math. Phys. 130, 489–528 (1990)

Communications in Mathematical Physics

Rounding Effects of Quenched Randomness on First-Order Phase Transitions

Michael Aizenman[1a,b] and Jan Wehr[2b,c]

[1] Courant Institute of Mathematical Sciences, New York University, 251 Mercer St., New York, NY 10012, USA

[2] School of Mathematics, Institute for Advanced Study, Princeton, New Jersey 08540, USA

Dedicated to R. L. Dobrushin, on the occasion of his 60th birthday

Abstract. Frozen-in disorder in an otherwise homogeneous system, is modeled by interaction terms with random coefficients, given by independent random variables with a translation-invariant distribution. For such systems, it is proven that in $d = 2$ dimensions there can be no first-order phase transition associated with discontinuities in the thermal average of a quantity coupled to the randomized parameter. Discontinuities which would amount to a continuous symmetry breaking, in systems which are (stochastically) invariant under the action of a continuous subgroup of $O(N)$, are suppressed by the randomness in dimensions $d \leqq 4$. Specific implications are found in the Random-Field Ising Model, for which we conclude that in $d = 2$ dimensions at all (β, h) the Gibbs state is unique for almost all field configurations, and in the Random-Bond Potts Model where the general phenomenon is manifested in the vanishing of the latent heat at the transition point. The results are explained by the argument of Imry and Ma [1]. The proofs involve the analysis of fluctuations of free energy differences, which are shown (using martingale techniques) to be Gaussian on the suitable scale.

Table of Contents

[a] Also in the Physics Department

[b] Research partially supported by NSF grants PHY-8896163 and PHY-8912067

[c] Work done in part at Rutgers University, Department of Mathematics