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Domains of scaling in the three-dimensional random field Ising model

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Random field Ising model, in particular its nonequilibrium version, has been extensively used for modeling the behavior of disordered ferromagnetic materials driven by external magnetic field. To this point, for systems of finite size, two domains of disorder were identified based on the occurrence of spanning avalanches in the system.

Here we present new results clearly demonstrating the existence of the third domain of disorder, the transitional one. Applying scrutinized analyses we found that the first domain, comprising the range of disorders that are below the critical, is characterized by the onset of only the avalanches spanning all three spatial dimensions. In the second one, in which the disorders are above the effective, size-dependent, critical value, the behavior of the system is not affected by its size and all avalanches are finite and nonspanning. The third, transitional domain, spreading in between these two, is encompassing the range of disorders within which all kinds of spanning avalanches are generated in the system.

We found that each of the domains has different scaling behavior and, provided that the system parameters are tuned so that the finite-size scaling conditions are met, the data collapsing is achievable, characterized by universal scaling functions different for each domain. Our results, obtained in extensive numerical simulations of finite systems covering the wide range of sizes, could be of relevance for studies on other types of finite systems and also for experimental studies conducted on mesoscopic scale.

References

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