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Random Fields, Topology, and Glassy States of Matter

EUGENE CHUDNOVSKY, CUNY-Lehman College

The debate goes on for more than forty years whether weak static random fields destroy the long-range order in condensed matter systems. A recently found answer depends on the topology of the order parameter. The n-component order parameter in d dimensions exhibits glassy behavior at $n < d + 1$, characterized by pinning of topological defects with singularities: vortices, strings, etc. At $n = d + 1$, the presence of nonsingular topological objects, such as kinks and skyrmions, leads to a weak metastability. At $n > d + 1$ topological objects are absent and the behavior of the system is fully reversible, characterized by the exponential decay of correlations in quantitative agreement with the Larkin-Imry-Ma argument. These findings have been confirmed numerically on lattices of up to one billion sites. (Research supported by the DOE Grant DE-FG02-93ER45487.)

Reference: T. C. Proctor, D. A. Garanin, and E. M. Chudnovsky, Physical Review Letters **112**, 097201 (2014).