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New Insight into the Berezinskii-Kosterlitz-Thouless Phase Transition

Abstract content

The 2d XY model exhibits an essential phase transition, which was predicted long ago — by Berezinskii, Kosterlitz and Thouless (BKT) — to be driven by the (un)binding of vortex–anti-vortex pairs. This transition has been confirmed for the standard lattice action, and for actions with distinct couplings, in agreement with universality. Here we study a highly unusual formulation of this model, which belongs to the class of topological lattice actions: it does not have any couplings at all, but just a constraint for the relative angles between nearest neighbour spins. By means of dynamical boundary conditions we measure the helicity modulus, which shows that this formulation performs a BKT phase transition as well. Its finite size effects are amazingly mild, in contrast to other lattice actions. This provides one of the most precise numerical confirmations ever of a BKT transition. Moreover we observe that the (un)binding mechanism follows the usual pattern, although free vortices do not require any energy in this formulation. Due to that observation, one should reconsider an aspect of the established picture, which estimates the critical temperature based on this energy requirement.

Summary

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