Brezinskii-Kosterlitz-Thouless transition in disordered superconducting films

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Despite its age, the Brezinskii-Kosterlitz-Thouless (BKT) transition remains one of the most fascinating examples of topological phase transitions. Its universality class describes several phenomena ranging from the quantum metal-insulator transition in one dimension to the Columb-gas screening transition in 2D, and of course the metal-to-superfluid transition in 2D. Among real systems, the case of quasi-two-dimensional superconductors (SC) is particularly interesting because of the interplay between the vortex-unbinding transition and the electron inhomogeneity, which spontaneously emerges in thin SC films. Indeed, although the BKT transition is usually protected against disorder, its fingerprints in real system, like e.g. the universal superfluid-density jump, are often at odd with this expectation. In this work we have shown, by means of Monte Carlo simulations, that the disorder-induced granularity of the superconducting state modifies the nucleation mechanism for vortex-antivortex pairs leading to a considerable smearing of the universal superfluid-density jump as compared to the paradigmatic clean case, in agreement with experimental observations. Finally, we have extended our study in the presence of a transverse magnetic field focusing both on its effects on the fragmentation of the SC order parameter (effect partially similar to increasing the disorder strength) and on the superfluid density transition.

[1] arXiv:1702.05930 (2017) I. Maccari, L. Benfatto, C. Castellani. Broadening of the Berezinskii-Kosterlitz-Thouless transition by correlated disorder