Poster 20

Phenomenological XXZ model of the competition between superconductivity and charge order

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Filamentary superconductivity is naturally emerging as a new rich field. The highly inhomogeneous nature of the superconducting condensate has been reported in several families of low-dimensional superconductors. The mechanisms behind the fragmentation of the electronic condensate can be diverse, depending on the specific material and conditions, leading to unusual trends in transport measurements [1] and masking the hallmarks of a Berezinskii-Kosterlitz-Thouless (BKT) transition [2].

In the present contribution we focus on cuprates. We argue that there is a special doping point in their phase diagram, hereafter the $p_{O(3)}$ point, where the condensation of holes into a charge-ordered and into a superconducting phase are degenerate in energy but with an energy barrier in between [3]. We present Monte Carlo simulations of a phenomenological two-dimensional XXZ model of the problem without and with quenched disorder.

In the clean case, the presence of a barrier potential, that we introduced to lift the accidental $O(3)$ symmetry of the system, results in a first-order phase transition separating charge order and superconductivity and in the emergence of metastable regions. Such a first-order line is not completely temperature independent. Rather than exactly vertical, it shows a positive slope indicating that entropy slightly favours superconductivity over charge order. We predict that in a very clean system close to the $p_{O(3)}$ point the phenomenon of superconductivity stabilized by temperature could be seen.

In the presence of quenched disorder, filamentary superconductivity spontaneously emerges in the charge order phase as domain walls between different charge-ordered realizations. This phenomenon is reminiscent of the supersolid behaviour in ^{4}He. Contextually, when superconductivity gets suppressed near the charge order phase, BKT signatures get smeared out until they disappear. Finally, assuming weak interlayer couplings, the resulting phase diagram of the three-dimensional system is in good agreement with the typical cuprates phase diagrams.

[1] G. Venditti *et al.*, *Superfluid rigidity in 2d filamentary superconductors*, arXiv:2304.07117 (2023).

[2] G. Venditti *et al.*, *Nonlinear I–V characteristics of two-dimensional superconductors: BKT physics vs inhomogeneity*, Phys. Rev. B **100**, 064506 (2019).

[3] G. Venditti *et al.*, *Thermodynamic phase diagram of the competition between superconductivity and charge order in cuprates*, arXiv:2306.17094 (2023).