Microscopic Insights into Superconducting Transition from Type I to Type II

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Superconductors, known for their magnetic properties, can be categorized into two primary types based on their response to an externally applied magnetic field. Type I superconductors completely expel the magnetic field, while type II superconductors allow it to penetrate, resulting in a mixed state.

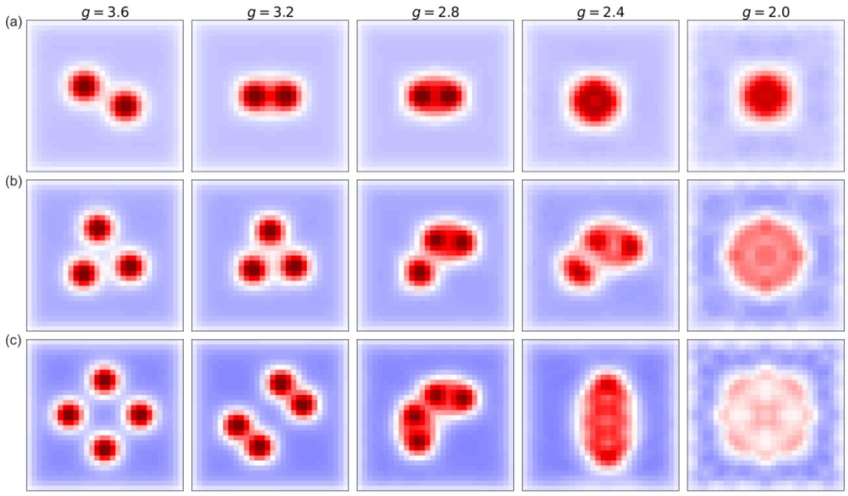

Fig. 1: *Color density plots of the spatial profile of the induced magnetic field inside the sample calculated for various values of the coupling constant g (columns) and the magnetic field (rows).*

Intriguingly, investigations on materials possessing a κ value close to one have uncovered a group of superconductors that do not easily fit into the traditional classifications. Empirical findings have demonstrated the presence of an intermediate mixed state (IMS) within these materials. The magnetic field permeates such superconductors, resulting in diverse spatial arrangements of vortices, including the co-existence of Meissner domains, vortex lattice islands, vortex clusters, and chains. Within this investigation, a convenient microscopic approach based on self-consistent computation of the Bogoliubov-de Gennes and magnetic state equations [1] is employed to reveal various phenomena, such as vortex clustering and the interactions between multiple vortices.

In this study [2], we investigate the transition of the system from type I to type II superconductivity, which involves passing through IMS. Our research reveals that intricate many-body interactions among vortices lead to the emergence of unconventional vortex patterns during this transition (Fig.1).

Bibliography

[1] Vyacheslav D. Neverov et al. Condensed Matter 9 (1), 8 (2024)
[2] Vyacheslav D. Neverov et al. Phys. Rev. B 110, 054502 (2024)