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Block JD, Sector III, Salt Lake, Kolkata 700 106

DEPARTMENTAL SEMINAR

Condensed Matter and Materials Physics

5th June, 2024 **11.30 AM** **ONLINE / FERMION**

SPEAKER

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TITLE OF THE TALK

Pinning Down A Liquid

ABSTRACT

The vortex lattice in Type II superconductors has long served as a model for understanding the interplay between interaction and disorder. Recent evidence suggests that vortex liquid states can form in conventional superconducting films when these vortex systems approach the two-dimensional limit. Crystalline defects that pin vortices play a crucial role in maintaining zero resistance in Type II superconductors. While the effects of random pinning in bulk superconductors, where vortices form crystalline or glassy states, are well-understood, the impact of random pinning on vortex liquid states is less clear. Studying these states is challenging due to the difficulties in using direct imaging tools like scanning tunneling spectroscopy (STS) to investigate the structure of rapidly moving vortices.

In this work, inspired by the density functional theory of flux lattice melting, we develop a new methodology to analyze STS images by examining the amplitude of local tunneling conductance minima formed by vortex cores. We apply this methodology to study the pinned vortex liquid in a 5 nm thick amorphous RexZr thin film. Our findings provide direct structural evidence of an inhomogeneous vortex liquid, where vortices move along a percolative network of weakly pinned sites. The dependence of this network on temperature and magnetic field helps reconcile many peculiarities observed in the transport properties of superconducting thin films. Notably, we do not observe a transition from the vortex liquid to a vortex glass state down to the lowest temperature studied (410 mK).

These findings are relevant to contemporary issues in two-dimensional superconductors, such as the existence of the Bose metal state. Furthermore, they connect to the broader problem of pinned liquids, which is significant in various systems including colloids, skyrmion lattices, liquid-crystal molecules, and lipid membranes.

References:
1. Structure and dynamics of a pinned vortex liquid in superconducting a-RexZr (x ~ 6) thin film, Phys. Rev. B 108, L180503 (2023).
2. Collective flux pinning in hexatic vortex fluid in a-MoGe thin film, J. Phys.: Condens. Matter 32, 075601 (2020).
3. Melting of the Vortex Lattice through Intermediate Hexatic Fluid in an a-MoGe Thin Film , Phys. Rev. Lett. 122, 047001 (2019).

HOST FACULTY

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