

凝縮系物理学ゼミナール

Condensed Matter Seminar

Date: 13:30-15:00, Wednesday, 31 May 2023

Title: Resistivity in Quantum Vortex Liquid of Clean Two-Dimensional Superconductor

Speaker: Mr. Nunchot Naratip (Condensed Matter Theory Group)

Abstract:

Discussions on a possible quantum phase in thin superconducting films under an out-of-plane magnetic field have been ongoing for three decades. Most experiments focused on highly disordered samples. More recently, clean superconducting thin films have also been studied [1]. In both cases, by tuning the magnetic field, regions of flat resistivity curves and fan-shaped resistivity curves in the quantum liquid regime at low temperatures were reported. They were interpreted as the so-called quantum metallic state and a critical behavior of a superconductor-insulator transition (SIT), respectively. The former is not provided in the original theory of SIT proposed by M. P. A. Fisher [2]. Therefore, a revision of the theoretical understanding may need to be considered.

However, it has recently been shown that filtering external radiation from film samples can eliminate quantum metallic behavior [3]. This means that it is not appropriate to interpret the region of flat resistivity curves as a quantum metallic state. Furthermore, the theoretical studies [4] of a clean thin superconducting film based on renormalized fluctuation theory have shown that in the quantum liquid regime, the fluctuation conductivity is insulating at zero temperature by quantum fluctuations even if the fluctuation dynamics is metallic. This implies an "apparent" SIT in the quantum liquid regime. However, detailed calculations based on this theory have not yet been performed. In particular, the vortex lattice melting line, which is necessary to define the vortex liquid regime, had not yet been carefully investigated within the scope of the theory.

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References:

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