

凝縮系物理学ゼミナール

Condensed Matter Theory Seminar

Date: 13:30-15:00, Wednesday, 24 July 2024

Title: Unidirectional superconductivity and diode effect induced by dissipation

Speaker: Mr. Akito Daido

Abstract:

Nonreciprocal phenomena are attracting much attention as the novel probe and functionality of noncentrosymmetric materials. Among them, superconducting diode effect (SDE), a phenomenon where a superconductor's critical current becomes nonreciprocal, has attracted significant interest since its report in a Nb/V/Ta superlattice [1]. SDE is important both from both fundamental and applicational viewpoints. Thus, it is an important issue to identify its mechanisms.

Generally speaking, SDE requires the time-reversal-symmetry breaking, and therefore most experimental configurations contain either external or internal magnetic fields. In this talk, we discuss another strategy to trigger SDE, by using the effective time-reversal-symmetry breaking by dissipation [2]. In such a case, the diode efficiency can reach the ideal value of 100%, which is forbidden in equilibrium systems, by driving the system out of equilibrium. We present a minimal model to probe the concept, where we consider in-plane critical currents of superconducting thin films. We apply the perpendicular electric fields, which can enter the superconductor and cause dissipation for the film thickness comparable to the electric-field penetration depth [3]. We obtain steady states by solving time-dependent Ginzburg-Landau equations and show that the SDE and the 100% SDE, which we name unidirectional superconductivity, are indeed realized in this model by the dissipation.

References :

[1] F. Ando, *et al.*, Nature, **584**, 373 (2020).

[2] A. Daido and Y. Yanase, arXiv:2310.02539.

[3] N. B. Kopnin, "Theory of Nonequilibrium Superconductivity," (Clarendon Press, 2001).