凝縮系物理学ゼミナール
Condensed Matter Seminar
Date: 13:30-15:00, Wednesday, 23 June 2021

Title: Theory of the intrinsic superconducting diode effect
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Abstract:

Nonreciprocal transport is attracting attention as a new functionality of matter [1,2]. An example is the magnetochiral anisotropy (MCA), which has been observed in various materials form (semi)conductors to superconductors. MCA is the inequivalence of the resistance of the rightward current R(j) and that for the leftward current R(-j), where both R(±j) usually take finite values.

On the other hand, such a drastic situation is possible in superconductors that either one of R(±j) vanishes while the other remains finite. Such a *superconducting diode effect* (SDE) has recently been observed in the Nb/V/Ta superlattice without an inversion center and is controlled by the applied inplane magnetic field [3]. SDE is a promising building block of the dissipationless electric circuits, and is a fascinating phenomenon manifesting the interplay of the inversion breaking and superconductivity.

One of the remaining issues is to identify suitable materials providing the best performance; however, the mechanisms to cause SDE have not been clarified, preventing the progress in the material search.

In this work, as a first step of the theoretical research on SDE of bulk materials, we propose the intrinsic mechanism to cause SDE by studying the nonreciprocity in the depairing current. We clarify the temperature scaling of the nonreciprocal depairing current near the critical temperature and point out its significant enhancement at low temperatures. It is also found that the nonreciprocal critical current shows sign reversals upon increasing the magnetic field.These behaviors are understood by the nonreciprocity of the Landau critical momentum and the crossover of the helical superconductivity.The intrinsic SDE unveils the rich phase diagram and functionalities of noncentrosymmetric superconductors.

Reference:

[1] Y. Tokura and N. Nagaosa, Nat. Commun. 9, 3740 (2018).
[2] T. Ideue and Y. Iwasa, Annu. Rev. Condens. Matter Phys. 12, 201 (2021).
[3] F. Ando et al., Nature 584, 373 (2020).