

凝縮系物理学ゼミナール

Condensed Matter Seminar

Date: 13:30-15:00, Wednesday, 17 January 2024

Title: Nonlinear optical responses in superconductors under magnetic field

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Abstract:

Noncentrosymmetric superconductors have been attracting attention as a material platform for exotic nonreciprocal responses and transports, which occur in the presence of Cooper pairs and inversion symmetry breaking. Nonlinear conductivity plays a key role in the nonreciprocal responses. The second-order nonlinear response in superconductors was formulated based on the Bogoliubov-de Gennes Hamiltonian [1,2], and the mechanism in time-reversal (T) symmetric superconductors was clarified [3]. Although the T symmetry breaking further enriches the properties and mechanism of nonlinear responses in superconductors, it remains unexplored in spite of potential playgrounds such as superconductors under magnetic fields.

In this study, we investigate the second-order nonlinear response of two-dimensional Rashba superconductors under magnetic fields. Being influenced by quantum geometric properties in the electronic band, superconducting nonlinear responses are enhanced in close relation with the Dirac electron states. In our model, the topological superconductivities realize under a sufficiently large magnetic field [4]. We show that the nonlinear optical responses show peculiar behaviors at the topological transition. We discuss the effect of T symmetry breaking in the superconducting nonreciprocal responses from the viewpoint of symmetry, quantum geometry, and peculiar paramagnetic response.

References :

- [1] T. Xu, *et al.*, Phys. Rev. B **100**, 220501 (2019).
- [2] H. Watanabe, *et al.*, Phys. Rev. B **105**, 024308 (2022).
- [3] H. Tanaka, *et al.*, Phys. Rev. B **107**, 024513 (2023).
- [4] M. Sato, *et al.*, Phys. Rev. Lett. **103**, 020401 (2009).