凝縮系物理学ゼミナール
Condensed Matter Theory Seminar
Date: 13:30-15:00, Wednesday, 19 June 2024

Title: Superconducting meron phase in locally noncentrosymmetric superconductors

Speaker: Mr. Akihiro Minamide

Abstract:

Since the discovery of heavy-fermion superconductors and high-Tc superconductors, vigorous efforts have been made to extend the BCS theory and find unconventional superconducting states by incorporating additional degrees of freedom of Cooper pairs. In recent years, superconductivity in locally noncentrosymmetric crystals [1] has attracted more attention. Among them, a heavy-fermion superconductor $CeRh_2As_2$ [2] is particularly interesting in that it shows a phase transition inside the superconducting phase. This phenomenon is understood theoretically as the superconducting parity transition [3], where the even-parity superconducting state changes to the odd-parity one upon increasing the magnetic field.

Almost all the previous theoretical studies on locally noncentrosymmetric superconductors have focused on the pure Pauli limit, and the effect of the vortex lattice formation has only been treated phenomenologically [4, 5]. However, since the parity transition occurs under the magnetic field, a theory of the vortex state is required for quantitative comparison between theory and experiment.

In our study [6], theory of superconducting parity transition is extended by incorporating the vortex degree of freedom. We employ bilayer Rashba model representing locally noncentrosymmetric layered superconductors and derive the Ginzburg-Landau free energy functional. This formulation reveals parity transition and the H-T phase diagram of $CeRh_2As_2$ is quantitatively reproduced. Furthermore, a novel superconducting state with a meron (half-skyrmion) lattice pseudospin texture is predicted.

References :

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[2] S. Khim, J. Landaeta, J. Banda, N. Bannor, M. Brando, P. M. R. Brydon, D. Hafner, R. Küchler, R. Cardoso-Gil, U. Stockert, A. P. Mackenzie, D. F. Agterberg, C. Geibel, and E. Hassinger, Science **373**, 1012 (2021).

[3] T. Yoshida, M. Sigrist, and Y. Yanase, Phys. Rev. B **86**, 134514 (2012).

[4] D. Möckli, Y. Yanase, and M. Sigrist, Phys. Rev. B **97**, 144508 (2018).

[5] E. G. Schertenleib, M. H. Fischer, and M. Sigrist, Phys. Rev. Research **3**, 023179 (2021).

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