Phase-Sensitive Quasiparticle Scattering inside a Vortex Core in Unconventional Superconductors

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The elucidation of the superconducting pair potential structure is of great importance for obtaining the clue to the pairing mechanism in unconventional superconductors. The field-angle resolved thermal conductivity and specific heat measurements are powerful techniques which can detect the anisotropy of pair potential amplitude, but they cannot probe the phase in the pair potential. However, it is crucial to probe the phase of the pair potential in order to discriminate unconventional superconductivity from conventional one. Therefore, we theoretically propose that the field-angle dependence of the quasiparticle (QP) scattering rate Γ inside a vortex core can be a phase-sensitive probe. We consider the following pair potential models: a line-node s-wave and a d-wave pair potential with the same anisotropy of the pair potential amplitude, but with a sign change only for the d-wave one. Our results reveal contrasting field-angle dependence of Γ between these two pair potential models. To clarify its mechanism, we investigate the dependence of Γ on the Fermi wave vector $\mathbf{k}_{\mathrm{F}}$. We also discuss the QP scattering process on a spherical Fermi surface.