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Detecting the topological winding of superconducting nodes via Friedel oscillations

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Many topologically non-trivial systems have local topological invariants which cancel over the full Brillouin zone. Yet such systems could be platforms for non-abelian physics, for example nodal superconductors potentially hosting Majorana modes. Experimentally distinguishing signatures from local non-trivial topology to similar trivial features is not a clear-cut process. Our work extends the method developed by Dutreix *et al.*, which detects the local Berry phase of the Dirac cones in graphene. Here extended to a general Hamiltonian with chiral symmetry, the method is applicable to nodal superconductors. We have found that for two Dirac cones with a difference in topological winding there exists a theoretical ideal impurity and STM tip for which Friedel oscillations capture that winding difference. This information is accessible directly in the complex phase of the Fourier transformed local density of states. We have further derived conditions for when a physical impurity can capture the winding difference. As a proof-of-concept, we applied the conditions to the topological nodal superconductor predicted in monolayer $NbSe_2$ under an in-plane field. Furthermore, we have predicted an experiment where STM can detect the winding of each of the 12 nodes. We conclude that this method of designing impurity scattering can be a powerful tool to determine local topological invariants and superconducting symmetries in 2D systems.

Keyword-1

topological invariants

Keyword-2

STM

Keyword-3

topological superconductors

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