# Probing quantum materials with superconducting interference

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Abstract

Quantum interference phenomena in superconductors, such as Josephson interference and Little-Parks oscillations, serve as powerful probes of phase coherence, symmetry breaking and vortex dynamics. The resulting interference patterns can encode rich information about topological states, magnetism, and other intrinsic properties of materials placed in close proximity to a superconducting system or the superconductor itself.

In this talk, I will present three examples illustrating how superconducting interference can be used to uncover novel physical phenomena in quantum materials. In one example, spin-polarized supercurrents are engineered through the superconducting proximity effect, revealing spatially localized topological edge states via Josephson interference patterns [1]. In another, an orbital-magnetic Josephson junction and a zero-field superconducting diode effect are realized in fully gate-defined magic-angle twisted bilayer graphene [2]. In the last part, I will discuss how superconducting interference provides new insights into two-dimensional superconductors within the superconducting fluctuation regime [3].

References

[1] Science Advances 9, eadg7269 (2023)
[2] Nature Communications 14, 2396 (2023)
[3] Physical Review Letters, accepted (2026)