Condensed Matter Theory Center Seminar

Monday, February 6, 2:30-3:30pm
2205 Physics Building

Sriram Ganeshan
Department of Physics and Astronomy, Stony Brook University

"Quasiparticle scattering from vortices in d-wave superconductors: Superflow and Berry phase contributions"

Abstract:
In the vortex state of a d-wave superconductor, Bogoliubov quasiparticles are scattered from magnetic vortices via a combination of two basic mechanisms: effective potential scattering due to the superflow swirling about the vortices and Aharonov-Bohm scattering due to the Berry phase acquired by a quasiparticle upon circling a vortex. First, we consider the superflow contribution by calculating the differential cross section for a quasiparticle scattering from the effective non-central potential of a single vortex. Next, we consider the Berry phase contribution, which results in branch cuts between neighbouring vortices across which the quasiparticle wave function changes sign. Here, the simplest problem that captures the physics is that of scattering from a single finite branch cut that stretches between two vortices. Such scenario can also be realized in other Dirac systems like Graphene and Topological insulators. Elliptical coordinates are natural for this two-center problem and we proceed by separating the massless Dirac equation in elliptical coordinates. The separated equations take the form of the Whittaker-Hill equations, which we solve to obtain radial and angular eigenfunctions. With these eigenfunctions in hand, we construct the exact scattering cross section via partial wave analysis. We discuss the scattering effect of each mechanism, superflow and Berry phase, and also provide direct qualitative comparison between these effects on quasiparticle transport.

References:
Sriram Ganeshan, Manas Kulkarni and Adam C. Durst, Quasiparticle scattering from vortices in d-wave superconductors. II. Berry phase contribution. Phys. Rev. B 84, 064503 (2011)

Manas Kulkarni, Sriram Ganeshan and Adam C. Durst, Quasiparticle scattering from vortices in d-wave superconductors. I. Superflow contribution. Phys. Rev. B 84, 064502 (2011)

DEPARTMENT OF PHYSICS
UNIVERSITY OF MARYLAND