A “BCS flavour” from Vortex Cores in a high T_c Cuprate Superconductor

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Most of the observations made by scanning tunnelling spectroscopy (STS) in the vortex cores of high-temperature cuprate superconductors (HTCS) have revealed unusual features. At first sight, these measurements suggest that the cores in these materials do not match BCS expectations: while vortices in Bi-based HTCS compounds reveal a pseudogap-like quasiparticle DOS, $YBa_2Cu_3O_{7-\delta}$ (Y123) cores exhibit a pair of electron-hole symmetric states at finite subgap energy [1]. The absence of a clear zero-bias anomaly in the conductance spectra was apparently in total contradiction with the expected signature of a d-wave BCS vortex core, raising many interrogations about the true electronic nature of the cores in these compounds.

In recent STS experiments on Y123, we found that the subgap states are not a specific signature of the vortices, but belong to an electronic background uniformly measured across the surface, whether a magnetic field is applied or not [2]. This finding led us to consider a model where the total tunnelling current is the combination of two additive channels: one associated with the quasiparticle excitations of a *d*-wave superconductor, and the other corresponding to a non-superconducting background. Comparing our data with theoretical model based on a Bogoliubov-de Gennes framework, we demonstrate that the vortex cores in Y123 really present the expected BCS quasiparticle LDOS [3]. The model provides further insight into the vortex-core structure, which is different for each vortex due to an irregular lattice and depends on the Fermi surface topology more than on the gap symmetry.

References

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