Scanning Tunneling Spectroscopy of Vortices in High Temperature Superconductors

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Abstract

The study of vortices in the high temperature superconductors $YBa_2Cu_3O_7$ and $Bi_2Sr_2CaCu_2O_8$ using scanning tunneling spectroscopy has revealed unusual vortex core spectra. Whereas in $YBa_2Cu_3O_7$ the spectra revealed one single localized state in the vortex core we find no sign of a localized state in $Bi_2Sr_2CaCu_2O_8$. The spectra in the center of a vortex in the latter compound show a gap structure which corresponds to the pseudogap structure seen in zero field above T_c. This gap structure scales with the superconducting gap as it changes from underdoped to overdoped samples. Following the evolution of the spectra starting from the BCS-like $NbSe_2$ via $YBa_2Cu_3O_7$ to $Bi_2Sr_2CaCu_2O_8$ we find an evolution where the size of the pairs decreases from about 100Å in the former to a value close to the pair-pair distance in the latter. A possible interpretation of the spectra in $Bi_2Sr_2CaCu_2O_8$ is that vortex cores in this compound are regions where only phase coherence is suppressed but carriers remain paired.