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Vortex-State Electrodynamics in Superconducting Thin Films Studied by Far-Infrared Spectroscopy

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In a type-II superconductor, a magnetic field above the lower critical field creates vortices and dramatically changes the superconductor's electrodynamic response. Such changes have been observed in thin film samples by our infrared magneto-spectroscopy experiments with field normal to the film surface. The complex optical conductivity was extracted, and was compared to effective medium theories for the electrodynamic response of the vortex state. We found a good agreement between our optical data and the Maxwell Garnett theory, which treats the mixed state as having normal-metal disks (representing the vortex cores) surrounded by superconductor. Our data also show the effect of magnetic-field-induced pair breaking on the superconducting fraction outside of the vortices.

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