Superconducting Vortex with Antiferromagnetic Core

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The inelastic neutron scattering measurements on LaSrCuO samples by Lake and co−workers [1,2] provide the first evidence of local magnetic structure around superconducting vortices. We present a theoretical investigation of the magnetic and superconducting structure of a flux vortex in a dirty antiferromagnetic superconductor (AFSC) exploring the model [3,4], where itinerant electrons are carriers both of antiferromagnetic (AF) and superconducting (SC) orders of the system, and the dispersion law of electrons and holes has the properties of nesting. The mathematical formalism is based on generalized system of Gor'kov equations. Generalized equations consist of differential equations for Green's functions of normal excitations $G(\mathbf{r},_n)$ and $F_{AF}(\mathbf{r},_n)$, and Cooper−pair condensate $F_S(\mathbf{r},_n)$, each depending on Matsubara frequency $_n = \pi T(2n+1)$, n = 0, ±1, ±2,. and position arguments **r**. The equations contain SC order parameter $\Delta_S(r)$ (a spin singlet pairing), AF order parameter $\Delta_A(r)$ (a spin triplet pairing) and the vector potential **A**(r), and are supplemented by self−consistency conditions. We argue that the solution may be developed as a series of powers of the Ginzburg−Landau parameter κ. Spatial variation of the SC and AF order parameters around vortex core has been calculated numerically for different values of κ, temperature, and relation $\Delta_{S0}(r)/\Delta_{A0}(r)$, where $\Delta_{S0}(r)$ ($\Delta_{A0}(r)$) is the SC (AF) order parameter in the absence of AF (SC) pairing. We show that a superconducting vortex in AFSC has an antiferromagnetic core. The existence of superconducting vortex with antiferromagnetic cores may have nontrivial influence upon vortex dynamics and transport properties of type−II AFSC in magnetic field.

1. B. Lake *et al.,* Science **291**, 1759 (2001).
2. B. Lake *et al.,* Nature **415**, 299 (2002).
3. V. N. Krivoruchko, Zh. Eksp. Teor. Fiz. **109**, 649 (1995) [JETP **82**, 347 (1995)].
4. V.N. Krivoruchko *et al.,* J. Supercond. **12**, 155 (1999).