T_cSAM Special Seminar

Texas Center for Superconductivity and Advanced Materials

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"$Bi_2Sr_2CaCu_2O_{8+\delta}$ c-Axis Twist Josephson Junctions: The Superior Test of Order Parameter Symmetry"

Tuesday, December 7, 2004
Room 102, University of Houston Science Center
4:00 p.m. – 5:00 p.m.

Abstract

Three c-axis twist Josephson junction experiments to test the symmetry of the superconducting order parameter have been performed on $Bi_2Sr_2CaCu_2O_{8+d}$. These are the experiments performed on bicrystals [Q. Li et al., Phys. Rev. Lett. 83, 4160 (1999)], on artificially prepared cross whiskers [Y. Takano et al., Phys. Rev. B 65, 140513 (2002); Physica C 408-410, 296 (2004)], and on naturally-formed cross whiskers [Yu. I. Latyshev et al., Phys. Rev. B 70, 094517 (2004)]. These experiments are analyzed in terms of the twist theorem for weak, first-order c-axis tunneling between two d-wave superconductors twisted 45° about the c axis, with treatments of weak, first-order c-axis tunneling matrix elements with varying amounts of coherent and incoherent components and order parameter forms, including the effects of the Fermi surface details, strong coherent tunneling, orthorhombicity, nanoscale disorder, and order parameter twisting near the physical twist junction. It is shown that in all three experiments, essentially all of the c-axis Josephson tunneling arises from an s-wave component to the superconducting order parameter, and that the overall order parameter must contain a substantial s-wave component for $T \pounds T_c$. In addition, the c-axis tunneling in the bicrystal and natural cross-whisker experiments must be strongly incoherent. New calculations for in-plane (001) tilt grain boundary junctions relevant to the IBM tricrystal and related phase-sensitive experiments will also be presented.

Bio

Prof. Richard A. Klemm is a Visiting Professor at Kansas State University. He received his Ph.D. at Harvard University in 1974 and was a Postdoctoral Fellow at Stanford Univeristy, 1974-76. He was an Assistant Professor at Iowa State University, 1976-81 and an Associate Professor at Iowa State in 1981. Prof. Klemm was at Exxon Research and Engineering in Annandale, New Jersey, 1982-86, and held visiting positions at UCSD, Ames Laboratory, and Oak Ridge National Laboratory, 1986-90. He was a Scientist at Argonne National Laboratory, 1990-2000, and held visiting positions at the Max Planck Institute for the Physics of Complex Systems, Dresden, Germany, 2001-03, and the University of North Dakota, 2003-04, before arriving at Kansas State earlier this year. Prof. Klemm's major accomplishments include synthesis of the first layered superconductor, $TaS_2(pyridine)_{1/2}$; pioneering theories of layered superconductors; field theories of quasi-one-dimensional conductors; theory and experiments on charge-density wave transport; theories of spin-glass dynamics; surface state effects in superconductors; electrodynamics of unconventional superconductors; early theories of p-wave superconductors in magnetic fields; Josephson tunneling theories; anisotropic Ginzburg-Landau models of superconducting critical fields; fluctuation effects in layered superconductors (theory and experiment); isotope effects in organic superconductors (collaboration with experimentalists); paramagnetic Meissner effect in Nb (experimental); and theories of ultrasmall nanomagnets (classical dynamics, quantum statics, and hysteresis). Other research experience includes organic chemistry synthesis and atomic hyperfine structure calculations (as an undergraduate); sample preparations for heavy fermion superconductors and charge-density wave systems; catalysis theory and experiment (proprietary); chemical kinetics calculations; and Bose-Einstein condensate theory.

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