HIGH T_C UPDATE

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Theory

In conventional superconductors, the most convincing evidence of the mechanism responsible for superconductivity comes from tunneling spectroscopy, in which a clear image of the electron-phonon interaction is revealed. The observed structure in the current-voltage characteristics at the phonon energies can be used to measure the electron-phonon spectral density $\alpha^2F(\omega)$ by inverting the Eliashberg equations. J. P. Carbotte (McMaster) et al. note that in the high-T_C oxides, which have very short coherence lengths, infrared spectroscopy and inelastic neutron scattering are better methods for the investigation of the mechanism of superconductivity. In this preprint, the authors show that conducting carriers studied by means of infrared spectroscopy reveal strong coupling to a resonance structure in the spin-fluctuation spectrum seen by inelastic neutron scattering. The authors note that the coupling strength inferred from experiment is sufficient to account for high values of T_C, indicating the prominent role of spin excitations in the superconductivity of the high-T_C cuprates.

The effects of strong-coupling superconductivity on the normal-state electronic structure have been studied by Y. Yanase and K. Yamada (Kyoto). The authors explain pseudogap phenomena in the high-T_C cuprates as a precursor of strong-coupling superconductivity. They find that superconducting fluctuations, which are strongly diffusive within conventional weak-coupling theory, become propagating and have the character of preformed pairs in the strong-coupling case.

The fluctuation-exchange approximation (FLEX) has been extended by F. Schäfer et al. (Freie Universität Berlin) to include phase fluctuations self-consistently. The authors find that T_C, calculated using the Kosterlitz-Thouless criterion, is proportional to the superfluid density n_S in the underdoped regime, which is in accord with experimental findings. In this picture, T_C^* is the critical temperature at which Cooper pairs are formed; the authors find that $T_C^* > T_C$ in the underdoped regime and $T_C^* \approx T_C$ for the overdoped case.

The issues of confinement and Bose condensation for gauge models of high-T_C superconductors are studied in a preprint by N. Nagaosa (Tokyo) and P. A. Lee (MIT). The authors apply their results to study the temperature-doping (T-x) phase diagram in three regimes: (a) doping into the antiferromagnet ($x << 1$), (b) the underdoped region, in which the normal state is a pseudogap state described as d-wave pairing of fermions or a staggered flux phase, and (c) the overdoped region, in which the high-temperature phase is the strange-metal phase. The authors note that in the underdoped region there are three possible scenarios for the onset of the low-temperature superconducting phase: (i) a binding of paired fermions with bosons to form physical quasiparticles, (ii) Bose condensation of single bosons in the U(1) formulation, and (iii) pairing of two kinds of bosons in the SU(2) formulation.

Using the method of a continuous renormalization group around the Fermi surface, M. Disertori and V. Rivasseau (Ecole Polytechnique) have proved in two companion papers that a two-dimensional interacting system of fermions at low temperature T remains a Fermi liquid (analytic in the coupling constant λ) for $\lambda \leq c/|\log T|$, where c is some numerical constant. The authors note that this bound is one step towards a rigorous (nonperturbative) study of the BCS phase transition for many-fermion systems; it proves that in two dimensions the transition temperature, if any, must be nonperturbative in the coupling constant. In one paper (Part I), the authors deal with convergent contributions, and in the other (Part II), the authors deal with the renormalization of dangerous two-point subgraphs and complete the proof.

As shown in a preprint by G. Seibold and S. Varlamov (BTU Cottbus), vertex renormalization can lead to a substantial enhancement of the superconducting order parameter in a Peierls-distorted charge-density-wave (CDW) system when the chemical potential is located sufficiently inside one

of the subbands. The authors' results provide a possible explanation for the linear relationship between T_c and the incommensurability as observed in the underdoped lanthanum cuprates.

Low-energy quasiparticle states, arising from scattering by single-particle potentials in d-wave superconductors, are addressed in a paper by I. Adagideli et al. (Illinois at Urbana-Champaign). After noting that sign variations in the superconducting pair potential lead to such states in the case of planar boundary scattering, the authors use the Andreev approximation to extend this approach to general single-particle potentials, such as those due to impurities. The authors also point out the index-theoretic origin of these low-energy states by making a connection with Witten's supersymmetric quantum mechanical model.

A preprint by M. J. Graf (Los Alamos) et al. shows that an isolated impurity in a spin-singlet $d_{x^2-y^2}$ superconductor generates a d_{xy} order parameter with locally broken time-reversal symmetry. The origin of this effect is a coupling between the $d_{x^2-y^2}$ and d_{xy} order parameter induced by spin-orbit scattering off the impurity. The signature of locally broken time-reversal symmetry is an induced orbital charge current near the impurity, which generates a localized magnetic field. The authors present a microscopic theory for the impurity-induced d_{xy} component, and discuss its spatial structure and the pattern of induced current and local magnetic field near the localized impurity spin.

According to a preprint by C. Grimaldi (EPFL) and L. Pietronero (Roma), the nonadiabatic regime of the electron-phonon interaction leads to behavior of some physically measurable quantities that is different from what is expected from the Migdal-Eliashberg theory. The authors identify the Pauli paramagnetic susceptibility χ as one of these quantities, and they show that the nonadiabatic corrections reduce χ with respect to its adiabatic limit. The authors also show that the nonadiabatic regime induces an isotope dependence of χ, which should be measurable.

It is shown in a preprint by M. Machida (JAERI and CREST) et al. that both microwave resonant absorption and multiple-branch structures in the I-V characteristics observed in intrinsic Josephson junctions are caused by dynamical breaking of charge neutrality inside the atomic-scale superconducting layers. The authors propose a Lagrangian for the time-dependent Lawrence-Doniach model incorporating this effect, and they use the resulting equations to prove that a longitudinal collective Josephson plasma mode exists and to show from numerical simulations that the branching behavior of the I-V curves can be almost completely reproduced.

According to a preprint by G. A. Levin and C. C. Almasan (Kent State), the resistive anisotropy of an anisotropic medium is determined by the ratio of the phase coherence lengths. In layered crystals where the interlayer transport is incoherent, the authors assert that the out-of-plane phase coherence length is fixed and temperature-independent. This leads to a temperature-dependent resistive anisotropy and to the coexistence of metallic in-plane and nonmetallic out-of-plane conductivities. The authors' approach provides a description of the c-axis conductivity in the highly nonclassical regime, characteristic of the layered cuprates.

A simple model for the linear temperature dependence of the electrical resistivity of layered cuprates is proposed in a preprint by T. M. Mishonov and M. T. Mishonov (Leuven). The authors model the layers as arrays of independent plane capacitors with area a_0^2, where a_0 is the lattice constant, and they calculate the in-plane electrical resistivity as being due to the scattering of charge carriers by thermal fluctuations of the electric charge in the conducting CuO_2 planes. This mechanism is analogous to Rayleigh's explanation of why the sky is blue.

An asymptotic theory has been formulated by A. Badía (Zaragoza), which allows the London penetration depth $\lambda(T)$ to be obtained from magnetic force microscopy (MFM) measurements. The method is not restricted to any particular symmetry of the applied magnetic field.

A new theoretical formulation of nonequilibrium superconducting phenomena, including singlet and triplet pairing, has been developed by M. Eschrig (Northwestern). The author starts from the general Keldysh-Nambu-Gor'kov Green's functions in the quasiclassical approximation and represents them in terms of 2×2 spin-matrix distribution functions for particle-like and hole-like excitations. The resulting transport equations for the distribution functions may be interpreted as a generalization to the superconducting state of Landau's transport equation for the normal Fermi liquid of conduction electrons. The equations are well suited for numerical simulations of dynamical phenomena.

Calculations of the rate of planar *Cu* spin-lattice relaxation in the mixed state of $YBa_2Cu_3O_{7-\delta}$ due to vortex vibrations and electron spin-flip scattering have been carried out by R. Wortis et al. (McMaster). Since both mechanisms give position-dependent rates due to the presence of vortices, the magnetization recovery is characterized by a distribution of rates. The authors find that relaxation by vortex vibrations is too slow to be a significant factor in this material. Using a semiclassical model of Doppler-shifted d-wave quasiparticles with a linear dispersion around the nodes, the authors find that their calculation of the relaxation rate from electron spin-flip scattering shows partial agreement with experiment.

$RBa_2Cu_3O_{7-\delta}$

As noted in a preprint by J. Demsar et al. (Ljubljana), time-resolved optical measurements give information on the quasiparticle relaxation dynamics in $Y_{1-x}Ca_xBa_2Cu_3O_{7-\delta}$, from which the evolution of the gap with doping and temperature can be systematically deduced. In this paper, these optical charge-channel pseudogap data are compared with the pseudogap obtained from the NMR Knight shift K_S, spin-polarized neutron scattering (SPNS), and single-particle tunneling measurements. The authors propose a simple energy-level diagram to explain the different gap magnitudes observed by different spectroscopies in $YBa_2Cu_3O_{7-\delta}$. The authors propose that the spin gap Δ_S in NMR and SPNS corresponds to a triplet local pair state, while Δ_p in the charge-excitation spectrum corresponds to the pair dissociation energy. At optimum doping and in the overdoped state, an additional T-dependent gap Δ_{BCS} becomes evident, which closes at T_c, suggesting a crossover to a more conventional BCS-like scenario for superconductivity.

The optical conductivity in twinned single crystals of $YBa_2(Cu_{1-x}Ni_x)_3O_{6+y}$ has been determined by C. C. Homes (Brookhaven) et al. for a nominally pure system and for *Ni* concentrations of x = 0.0075 and 0.014 with oxygen dopings of = 0.60 (underdoped) and 0.95 (optimal) over a wide frequency range above and below T_c. The authors found an unusual feature in the conductivity at about 300 cm^{-1}, which is sensitive to the presence of *Ni* but not to the oxygen content. By detwinning the crystals, the authors were able to determine that the 300 cm^{-1} feature was restricted to the chains and thus that *Ni* atoms are doped into both the *CuO* chains and the CuO_2 planes. The authors present evidence that *Ni* acts either as a localization site, or an impurity scatterer and strong pair breaker, destroying the superconductivity along the chains and strongly reducing the anisotropy of the system at low frequency.

Results of electronic Raman-scattering experiments in $YBa_2Cu_3O_{6+x}$ with different doping levels x are reported by M. Opel (Garching) et al. The authors consider B_{2g} symmetry, analyze the data in terms of a memory-function approach, and obtain the dynamical relaxation rate $\Gamma(\omega,T)$ and mass-enhancement factor $1 + \lambda(\omega,T)$ for the carriers. Starting from temperatures T > 180 K, the authors extrapolate $\Gamma(\omega,T)$ and $1 + \lambda(\omega,T)$ to lower temperatures and recalculate the Raman spectra. The data at the lower temperatures show a loss of spectral weight relative to the extrapolated spectra for $T_c < T < T^*$ at all doping levels x. The loss in spectral weight is due to the opening of a pseudogap, and the observed value of T^* is similar to the pseudogap temperature found in other experiments.

Contrasting behavior of the in-plane and out-of-plane magnetoresistance (MR) in heavily underdoped nonsuperconducting, antiferromagnetic (AF) $YBa_2Cu_3O_{6+x}$ ($x \leq 0.37$) is reported by A. N. Lavrov et al. (CRIEPI). The out-of-plane MR (I || c) is positive over most of the temperature range and shows a sharp increase, by about two orders of magnitude, upon cooling through the Néel temperature T_N. A contribution associated with AF correlations is found to dominate the out-of-plane MR behavior for **H** || c from far above T_N, pointing to the key role of spin fluctuations in the out-of-plane transport. By contrast, the transverse in-plane MR (I || a or b; **H** || c) vs T is small and varies smoothly through T_N, implying that the development of the AF order has little effect on the in-plane resistivity.

A preprint by A. Hu et al. (Dresden) reports investigations of superconductivity and phase stability in solid-solution $(Nd_{0.33}Sm_{0.67})_{1+x}Ba_{2-x}Cu_3O_{7-\delta}$ powders with varying x that were synthesized in air. Two-kink superconducting transitions in the real part of the ac magnetic susceptibility were observed, which the authors discuss in terms of phase separation. Post-annealing in *Ar* resulted in a dramatic suppression of the solid solubility limits, and precipitates due to decomposition during the *Ar* treatments may act as new pinning centers.

Bi Cuprates

Systematic studies of stacks of a few ($n \leq 12$) intrinsic tunnel junctions fabricated on the surface of $Bi_2Sr_2CaCu_2O_{8+\delta}$ *(Bi-2212)* single crystals have been carried out by Y.-J. Doh et al. (POSTECH). The authors were able to tailor the number of junctions in a stack by progressively increasing the relative height of the stacks by ion-beam etching the material between stacks. The c-axis tunneling characteristics were measured *in situ* in a vacuum chamber at temperatures down to ~13 K. Using this technique in a single piece of crystal, the authors were able to exclude spurious effects arising from variations in the junction parameters. The authors found that (a) the tunneling resistance and the current-voltage curves are scaled by the surface-junction resistance, (b) the reduction in both the gap and the superconducting transition temperature of the surface conducting plane in contact with the normal metal is not caused by a variation in doping level but is caused by the proximity contact, and (c) in the low-bias region, the main features of an intrinsic junction are not affected by the presence of other junctions in the stack.

An experimental study of the temperature dependence of the thermoelectric coefficient $L(T) = S(T)\sigma(T)$ in *Ag*-doped $(Bi_{1.6}Pb_{0.4})Sr_2Ca_3(Cu_{1-x}Ag_x)_4O_{12+\delta}$ *(Bi-2234),* where S(T) is the in-plane thermopower and $\sigma(T)$ is the in-plane conductivity, has been carried out by J. E. Rodríguez and A. Mariño (Colombia) in the fluctuation region above T_c. The authors found that in the mean-field region, L(T) is not affected by thermodynamic fluctuations of the superconducting order parameter. For low *Ag* concentrations, the

authors found that the experimental data for σ are fit well by the Lawrence-Doniach model for layered superconductors in the mean-field region, and that the net fluctuation contribution to L(T) is almost zero because the fluctuation contributions due to S and σ nearly cancel.

The ac losses in a silver-gold-alloy-sheathed *Bi-2223* tape have been measured by B. des Ligneris (Sherbrooke) et al. using a null calorimetric method while a dc current was superimposed upon the ac current. As expected from computer simulations, the authors observed a minimum in the ac losses as a function of the dc current, an effect the authors call the Clem valley. A reduction of ac losses of approximately 50% at the valley minimum was observed, in accord with the calculations. At lower currents, the data fit the calculated behavior with a single parameter, a Meissner current of 21.8 A. The authors found that a surface-barrier current is incompatible with the data.

Other Cuprates

Nuclear quadrupole resonance (NQR) measurements of the ^{63}Cu nuclear spin-lattice relaxation times in $YBa_2(Cu_{1-x}Ni_x)_4O_8$ (x = 0, 0.005, 0.010, and 0.020) have been carried out by Y. Itoh (SRL-ISTEC) et al. using a spin-echo technique. The authors separately obtained the ^{63}Cu NQR relaxation rate $(1/T_1)_{HOST}$ due to spin fluctuations of the host *Cu* electrons and the *Ni*-induced ^{63}Cu relaxation rate $(1/\tau_1)$. The results demonstrate that the *Ni* impurities destroy the superconducting long-range order but do not significantly affect either the pseudo spin-gap or the host *Cu* antiferromagnetic correlations.

As pointed out by P. Plibersek and P. F. Meier (Zürich), the nuclear quadrupole resonance (NQR) spectrum of strontium-doped La_2CuO_4 surprisingly resembles the NQR spectrum of La_2CuO_4 doped with excess oxygen, both spectra being dominated by a main peak and one principal satellite peak at similar frequencies. Using first-principles cluster calculations, the authors have investigated this coincidence by calculating the electric field gradient (EFG) at the central copper site of the cluster after replacing a lanthanum atom in the cluster with a strontium atom or adding an interstitial oxygen to the cluster. In each case, the EFG was increased by approximately 10%, leading unexpectedly to the explanation that the NQR spectra are only accidentally similar and that the origins are quite different. To explain the observed increase in frequency of both the main and satellite peaks in the NQR spectrum as the doping concentration is increased, the authors propose a model based on holes moving rapidly across the planar oxygen atoms.

The normal-state Ettingshausen coefficient P in $La_{2-x}Sr_xCuO_4$ (x = 0.03 - 0.35) has been measured by T. Plackowski and M. Matusiak (Wroclaw) and found to be of order 10^{-7} m^3K/J, which is characteristic of typical metals. The coefficient changes sign from positive to negative near $x \approx 0.07$. The weak variation of P with x is in contrast to the behavior of other transport coefficients for $La_{2-x}Sr_xCuO_4$, such as the thermoelectric power or the Hall coefficient, which vary by more than two orders of magnitude with *Sr* doping.

The c-axis tunneling properties of both pristine $Bi_2Sr_2CaCu_2O_{8+\delta}$ *(Bi-2212)* and its intercalate $HgBr_2Bi_2Sr_2CaCu_2O_{8+\delta}$ *(HgBr$_2$/Bi-2212)* have been measured by A. Yurgens (Chalmers) et al. in the temperature range 4.2-250 K. Lithographically patterned 7-10 unit-cell-high mesa structures of these single crystals were investigated. Clear SIS-like tunneling curves for current applied in the c direction were observed. The dynamic conductance dI/dV vs V shows sharp peaks, corresponding to a superconducting gap edge, and a dip feature beyond the gap, followed by a wide maximum, which persists up to room temperature. The shape of the temperature dependence of the c-axis resistance does not change after intercalation, suggesting that coupling between CuO_2 bilayers has little effect on the pseudogap.

The phonon densities of states in $La_{1.475}Nd_{0.4}Sr_{0.125}CuO_4$ and $La_{1.9}Sr_{0.1}CuO_4$ have been measured by R. J. McQueeney (Los Alamos) et al. The ~70 meV phonon band, which appears due to hole doping in $La_{1.9}Sr_{0.1}CuO_4$ is known to arise from strong electron-lattice coupling. This phonon band is strongly suppressed in the *Nd*-doped compound, for which T_c is also suppressed, suggesting a link between in-plane oxygen optical phonons and superconductivity. This suppression is attributed to hole localization, which becomes strong near the stripe-ordering condition of certain cuprates near x = 1/8 and competes with superconductivity.

Vortices

Intense pulsed current densities have been used by M. N. Kunchur (South Carolina) et al. to overcome vortex pinning in $YBa_2Cu_3O_{7-\delta}$ down to low temperatures ($T/T_c \sim 0.02$) and drive flux flow to the point of vortex instability over the entire temperature range. The critical resistivity at the point of instability ρ^* is proportional to B and shows good agreement with $\rho^* \approx 2\rho_f \approx 2\rho_n B/H_{c2}$. Contrary to some speculation, ρ_n saturates to a residual value, much like an ordinary metal, and the vortex dissipation continues to be conventional as $T \rightarrow 0$.

Lattice Monte Carlo simulations (5×10^4 hours of a single Cray node's capacity) have been used by K. Kajantie (Helsinki) et al. to study the interactions and macroscopic behavior of a large number of vortices in the three-dimensional U(1) gauge+Higgs field theory in an external magnetic field. The authors studied both type-I and type-II superconductors and obtained results relevant for superconductors,

some models of cosmic strings, and the electroweak phase transition in a magnetic field.

Activation energies for vortex motion through the vortex-free region at the surface of a superconductor in a parallel magnetic field have been calculated by G. C. Kim et al. (Pusan National). The authors also calculate magnetic relaxation for the surface barrier and find very different rates for vortex entry and exit.

The magnetic field dependence of the critical current has been studied by S. S. Banerjee (TIFR-Mumbai) et al. in single-crystal samples of the weak-pinning type-II superconductor 1H-$NbSe_2$ in the high-temperature, low-field region of the H-T phase space, in the vicinity of the reentrant peak effect. The experimental results demonstrate various pinning regimes. A collectively pinned quasi-ordered solid occurs in intermediate fields but is destabilized in favor of disordered vortex phases in either higher fields near H_{c2} or lower fields near H_{c1}. The temperature evolution of the pinning behavior demonstrates how the amorphous limit (where the correlation volume is nearly field independent) is approached near the so-called nose region of the reentrant peak-effect boundary. Moreover, the data show that the rapid approach to the amorphous limit naturally yields a peak effect (a peak in the critical current) in the high-field regime, but yields a plateau effect in the low-field regime. With increasing effective disorder, the peak effect shifts away from H_{c2} and resembles a fishtail anomaly.

Using both stability analyses of the time-independent Ginzburg-Landau equations and numerical solutions of the time-dependent Ginzburg-Landau equations, M. Ghinovker et al. (Bar-Ilan) have studied the dynamics of supercooled normal domains in type-I superconductors. In zero magnetic field, the authors find that there is an explosive nucleation of superconductivity as the temperature is lowered, leading to a metastable mixed state consisting of Abrikosov vortices and antivortices.

Using a two-coil mutual-inductance method, A. A. Pesetski and T. R. Lemberger (Ohio State) have measured the complex resistivity $\rho_V(T,B)$ of pinned vortices in c-axis pulsed-laser-deposited (PLD) $YBa_2Cu_3O_{7-\delta}$ films with magnetic fields **B** applied perpendicular to the film. At low frequencies (< 100 kHz), ρ_V is inductive and is inversely proportional to the Labusch parameter, the average vortex pinning-force constant κ_{exp}. The observed weakening of κ_{exp} with **B** is consistent with a simple model based on linear pinning defects. Adding classical thermal fluctuations to the model in a simple way explains the observed linear T dependence of ρ_V below ~15 K and provides reasonable values for the effective radius (3-8 Å) of the defects and the depth of the pinning potential. To date, however, no sufficient theory exists to explain the data between ~15 K and the vortex-glass melting temperature.

Films

Narrow $YBa_2Cu_3O_{7-\delta}$ step-edge junctions (width w = 0.8-18 μm) in applied magnetic fields up to B_a ~35 mT have been studied by E. E. Mitchell et al. (CSIRO). The authors used the magnetic-field dependence of the junction critical current $I_c(B_a)$ to study the penetration of vortices into the film. At 77 K, the authors found that the junctions exhibit jumps in $I_c(B_a)$ due to the creation, annihilation, and motion of a small number of vortices close to the junction. The fields at which the jumps occur and the number of jumps measured for a particular B_a show a dependence on w; the data suggest that field enhancement affects the penetration of vortices and support a field enhancement factor that is proportional to w.

Kinetic roughening phenomena of flux fronts penetrating into superconducting thin films have been studied by R. Surdeanu et al. (Amsterdam) using a high-resolution magneto-optical technique. The roughening exponent ($\alpha = 0.64$) and growth exponent ($\beta = 0.65$) obtained from a dynamic scaling analysis of the initial stage of flux penetration and at small length scales are characteristic of static-disorder-dominated nonlinear diffusion. At large length scales, the exponent $\alpha = 0.46$ indicates a transition towards dynamic stochastic disorder, similar to the behavior of Kardar-Parisi-Zhang systems. There is a striking similarity to the behavior of combustion fronts in burning paper.

As shown by C. W. Schneider et al. (Augsburg), appropriate doping of the electrodes of high-T_c Josephson junctions provides a means to systematically adjust the junctions' electronic properties. The authors demonstrate this effect in grain-boundary junctions in bicrystalline *Ca*-doped $YBa_2Cu_3O_{7-\delta}$ films. The authors found that the critical current density at 4.2 K is strongly increased and the normal-state resistivity significantly decreased in comparison with the values obtained for equivalent junctions in undoped films.

The atomic structure and composition of interface-engineered $YBa_2Cu_3O_{7-\delta}$ edge junctions that showed good, reproducible critical currents I_c (1 σ spread in I_c of less than 8% for 100 junctions) have been investigated by J. G. Wen (SRL-ISTEC) et al. using transmission electron microscopy (TEM). The micrographs showed a thin barrier (1-2 nm) homogeneously covering the ion-milled edge of the base $YBa_2Cu_3O_{7-\delta}$ film, although there is no barrier-deposition and annealing process. The authors determined that the barrier is a *Ba*-based perovskite-like structure $(Y_{1-x}Cu_x)BaO_y$ with $x < 0.5$. Evidently a thin amorphous layer whose composition deviates from $YBa_2Cu_3O_{7-\delta}$ is formed because of preferential sputtering of *Cu;* this amorphous layer recrystallizes into the nonequilibrium phase $(Y_{1-x}Cu_x)BaO_y$ after heating to the deposition temperature.

Measurements of the magnetic penetration depth λ(T) in $YBa_2Cu_3O_{7-\delta}$ films at various δ are reported by

B. R. Boyce et al. (Ohio State). At optimal doping, the authors find that critical fluctuation effects are absent, and that $1/\lambda^2(T)$ vs T from 4 K to 0.99 T_c is well described by d-wave BCS strong-coupling theory with a gap parameter $\Delta_0(0)/k_BT_c \approx 3.3$. This implies that the T dependence of $\lambda(T)$ comes largely from single-particle excitations. As in crystals, underdoping reduces the superfluid density, $n_s(0) \propto 1/\lambda^2(0)$, without affecting the low-T slope or curvature of $\lambda(T)$. The authors show that these results, as well as heat-capacity measurements, are well described by an *ad hoc* model in which superfluid is lost from regions of the Fermi surface occupied by the pseudogap, while the low-lying excitations near the nodes remain unaffected.

A preprint by A. V. Nikulov (Chernogolovka) et al. reports a comparison of the resistive properties of $Bi_2Sr_2CaCu_2O_{8+\delta}$ *(Bi-2212)* in the mixed state with those of thin films of conventional superconductors with weak disorder (amorphous $Nb_{1-x}O_x$ films) and strong disorder ($Nb_{1-x}O_x$ films with small grain structure). The authors find that the quantitative difference between thin films with weak and strong disorder is greater than the difference between layered high-temperature superconductors and conventional superconductors, showing that the dimensionality of the system, rather than the critical temperature, is the key factor ruling fluctuation effects.

Microstructural characterizations of rolling-assisted biaxially textured substrates (RABiTS) are described in a preprint by E. Y. Sun et al. (Oak Ridge) using high-resolution transmission electron microscopy (TEM) and high-resolution analytical electron microscopy (AEM). The authors report details of their studies of RABiT substrates with a multilayer configuration *YSZ* (0.2 μm)/CeO_2 (0.9 μm)/*Ni* (125 μm).

Applications

The design, fabrication, and testing of a first-order sigma-delta modulator using a high-temperature superconducting multilayer technology with bicrystal Josephson junctions are reported in a preprint by B. Ruck et al. (Jülich). The circuit consists of a single flux quantum (SFQ) pulse generator, a Josephson transmission line, a comparator, an integrator, and an output stage. The authors report that the basic function of this device has been verified experimentally.

The development of a hybrid superconductor-magnet bearing system based on passive magnetic levitation and the flux-pinning effect of high-temperature superconductivity is reported by E. J. Lee (TCSUH) et al. The rationale lies in the unique capability of a high-temperature superconductor to enhance system stability passively without power consumption. Characterization experiments have been conducted to understand the bearing's dynamic behavior and to estimate the required motor torque for its driving system design. The authors discuss the importance of several critical design factors.

Other Activities

A preprint by H.-Y. Lee (UCLA) et al. reports a theoretical study of spin excitations in a two-dimensional p-wave superconductor as a model of the recently discovered superconductor Sr_2RuO_4. The authors calculate the polarization and spectrum of spin-wave excitations and discuss experimental consequences.

Overviews

Single-crystal growth of the high-temperature superconductor $YBa_2Cu_3O_{7-\delta}$ has been reviewed by D. K. Aswal (Shizuoka University and BARC-Mumbai) et al. The authors discuss the critical parameters and crystallization mechanisms involved in the growth of $YBa_2Cu_3O_{7-\delta}$ single crystals from self-flux with an excess of *BaO* and *CuO*. The growth of $YBa_2Cu_3O_{7-\delta}$ crystals with the aid of an alkali halide *(NaCl/KCl)* flux and the effect of silver additions also are presented. In addition, the authors briefly summarize the growth of large $YBa_2Cu_3O_{7-\delta}$ single crystals using the top-seeded solution-growth technique (72 refs.).

An overview of stripe phases in high-temperature superconductors has been prepared by V. J. Emery (Brookhaven) et al. Stripe phases are predicted and observed to occur in a class of strongly correlated materials describable as doped antiferromagnets, of which the copper-oxide superconductors are the most prominent representatives. The authors note that the existence of stripe correlations necessitates the development of new principles for describing charge transport, especially superconductivity, in these materials (44 refs.).

Ph.D. Theses

Effects associated with quasiparticle transport in clean normal/superconducting (N/S) proximity systems have been examined theoretically in the Ph.D. thesis of A. L. Fauchère (ETH Zürich). The author finds two phases in the magnetic field vs temperature (H-T) phase diagram when the N/S interface is subjected to a parallel magnetic field: a diamagnetic state (at low temperature and field) where the applied field is effectively screened, and a normal state where the magnetic field penetrates into the normal metal. The author also considers transport in Josephson junctions with unconventional superconductors in which the current-phase relation exhibits a double frequency, and he proposes a design for a quantum computer that exploits this π periodicity (186 refs.).

In the Ph.D. thesis of V. Berseth (EPFL), the author describes the results of transport experiments using nine contacts on the surface of a high-quality $YBa_2Cu_3O_{7-\delta}$ single crystal. Both guided vortex motion along twin boundaries and the mixed-state Hall effect were observed as a function of the direction of the current in the ab plane. The Hall-resistivity scaling law $\rho_{xy} = A\rho_{xx}^{\beta}$ was found to hold, with $\beta = 2$ for magnetic fields parallel to the twin boundaries and $\beta = 1.4$ for a tilted magnetic field. The author also reviews the experimental data on the mixed-state Hall effect and discusses theoretical models for the above scaling law and the sign reversal of the Hall effect (165 refs.).

Contributed by John R. Clem

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10-13 Shinonome 1-chome, Koto-ku, Tokyo 135-0062, JAPAN; telephone +81 3 3536 5707; telefax +81 3 3536 5705; e-mail jgwen@istec.or.jp.

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**Feb. 20 - Feb. 25, 2000:* Sixth

International Conference on Materials and Mechanisms of Superconductivity and High Temperature Superconductors (M^2S-HTSC-VI), George R. Brown Convention Center, Houston, Texas. Hosted by the Texas Center for Superconductivity at the University of Houston and sponsored by federal agencies and industry. Co-Chairs: C. W. Chu, W. K. Chu, and K. Salama. This series of meetings, established in 1988 two years after the discovery of high-temperature superconductors, is dedicated to superconductivity and related phenomena, and the host materials of these phenomena. The Conference will bring together members of the international low- and high-temperature superconductivity community to focus on recent insights into low- and high-temperature superconductor physics, materials, and devices. Emerging areas and future trends will also be highlighted. General conference topics include, but are not limited to, experimental and theoretical studies of Superconducting Materials – low temperature, high temperature, fullerite, heavy fermion, organic, new; Physical Properties – mechanisms, magnetic, electrical, optical, thermal, mechanical, acoustic; Synthesis and Processing – thin films, superlattices, thick films, bulk; and Applications – small current (SQUIDs, junctions, microwave devices) and large current (cables, transformers, motors, generators, magnetic levitation devices). **Abstract deadline, September 15, 1999.** For information, contact M^2S-HTSC-VI Conference Secretariat, Texas Center for Superconductivity, University of Houston, 3201 Cullen Boulevard, Houston, TX 77204-5932; telefax (713) 743-8216; Web site http://m2s-conf.uh.edu.

*March 31 - April 10, 2000:

Conference on Major Trends in Superconductivity in the New Millennium (MTSC 2000) and Symposium on Itinerant and Localized States in HTSC (SILS), Klosters, Kanton Graubünden, Switzerland. Scope of MTSC 2000 is on recent developments and trends in new superconducting systems with emphasis on experiments and theories which are relevant to the pairing mechanism. Besides the superconducting cuprates, conventional superconductors, organic systems, borocarbides, ruthenates, nanostructures, and fullerenes will be addressed. In order to raise the awareness for novel ideas and results in this rapidly growing field, the physics and chemistry of related materials will be included. Special emphasis on phenomena related to nanoscale phase separation and charge modulation. Symposium on Itinerant and Localized States in HTSC (SILS) will focus on large and small polaron and bipolaron effects in high-T_c materials with special emphasis on their preparative properties. MTSC 2000 is organized in close analogy to the Gordon conferences. Limited number of slots for posters. Total number of participants limited to 130 persons. Proceedings will be published in a special issue of *Journal of Superconductivity.* **Abstract and pre-registration deadline, November 15, 1999.** For more information, contact Annette Bussmann-Holder, Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, D-70569 Stuttgart, Germany; telephone +49 711 689 1679; telefax +49 711 689 1091. Or contact Vladimir Z. Kresin, Lawrence Berkeley Laboratory, University of California, 1 Cyclotron Road, Berkeley CA 94720; telephone (510) 486-6951; telefax (510) 486-5401. Information also available at Web site http://www.mpi-stuttgart.mpg.de/CONF/mtsc2000.html.

April 24 - 28, 2000:

Superconducting and Related Oxides – Physics and Nanoengineering IV, Marriott's Orlando World Center Resort and Convention Center, Orlando, Fla. Part of SPIE's 2000 AeroSense Symposium. Fourth in the series of SPIE conferences focused on basic issues in physics and materials science of high-temperature superconductors and related compounds that may be relevant for their applications in electronics, optics, and optoelectronics. Original papers are solicited on, but not limited to, the following topics: a) structural, transport, magnetic, and thermal properties of thin films of cuprates and related compounds; b) homoepitaxy, new substrate materials, epitaxial and morphological properties, interface smoothness and disorder, layer thickness fluctuations, interdiffusion, and strain; c) proximity effects, surface and interface effects, and superconductors in contact with insulators, semiconductors, normal metals, ferro- and antiferromagnets, piezoelectrics, etc.; d) search for novel high-temperature superconducting phases by atomic engineering; e) electronic structure, charge redistribution, localization, single-particle and collective excitations, and Josephson phenomena in natural and artificial superlattices; f) novel device concepts, electric field effect in heterostructures, hybrid optoelectronic devices, and cryoelectronics. **Abstract deadline, September 27, 1999** (submission via Web site strongly encouraged). Three-day exhibition. Proceedings to be published. To receive a complete call for papers by postal mail or to request an Advance Technical Program, contact SPIE, P.O. Box 10, Bellingham, WA 98227-0010; telephone (360) 676-3290; telefax (360) 647-1445; e-mail OR@spie.org; Web site http://www.spie.org/web/meetings/calls/or00/confs/OR15.html.

Sept. 17 - 22, 2000:

Applied Superconductivity Conference, Pavilion Convention Center, Virginia Beach, Va. **Abstract deadline, February 11, 2000.** More details will follow on Web site http://www.ascinc.org/.

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