HIGH T_C UPDATE

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ARPA

Dear Subscribers,

There has been ardent response from some of you in response to our announcement in the October 1, 1999, issue informing you of the anticipated demise of *High-T_C Update,* in light of the elimination of our funding from the Department of Energy (DOE) this year. It is most heartening to learn of the depth of support for the newsletter! (See some of the warm sentiments expressed for the newsletter on page 14.)

Many of you have suggested that *High-T_C Update* become a subscription-fee-based newsletter. This is the avenue we would like to explore at this time.

To cover very basic costs of operation we will need to set subscription fees of $200 per year for individuals (with a minimum of 600 subscribers). Web access would cost the same as e-mail subscriptions and we can assign you a password to access the Web site.

Corporate or institutional subscription rates will vary based on size of the organization and number of users (please contact the editor to discuss institutional rates).

If you are interested in a fee-based subscription to the newsletter, let us know immediately. You need not send any money now, but we would like to receive your pledge for an annual subscription AS SOON AS POSSIBLE. (Please send an e-mail response to mitra@ameslab.gov). Based on your response, we will let you know whether it is feasible for the newsletter to continue publication.

WE NEED INPUT FROM YOU BY NOVEMBER 1 AT THE LATEST!

We will inform you by December 1 of our decision on whether on not to continue the newsletter.

Sincerely,
Sreeparna Mitra (Editor)
John Clem (Science Editor)

NOTA BENE:

Bi Cuprates

Remarkable details from scanning tunneling microscope (STM) studies of the effects on high-temperature superconductivity of individual impurity atoms substituted at the *Cu* site in the CuO_2 plane of $Bi_2Sr_2CaCu_2O_{8+\delta}$ *(Bi-2212)* are reported by S. H. Pan (UC-Berkeley) et al. When the STM tip was placed above an ordinary superconducting region of the sample, the differential conductance exhibited behavior consistent with d-wave superconductivity, with sharp gap peaks at roughly ±40 mV. However, when the STM tip was placed directly over any *Zn* impurity, the differential conductance showed an intense quasiparticle resonance (at Ω = -1.5±0.5 mV) with a peak up to six times greater than the normal-state conductance, while both the gap and the height of the differential conductance at the gap were strongly

suppressed. The authors found the sharp resonance peaks to be consistent with unitary scattering in a d-wave superconductor. Imaging of the local density of states at the resonance energy revealed a highly localized quasiparticle cloud with clear four-fold symmetry aligned with the d-wave gap nodes, in qualitative agreement with theory. The authors report other observations that directly validate the deductions of a variety of previous theoretical and experimental studies. The authors also found new phenomena, which cannot be explained by existing theories and thus should provide new information about high-temperature superconductivity at the atomic scale.

The gradient of the energy-integrated angle-resolved photoemission (ARPES) intensity has been used by J. Mesot (Argonne and UI-Chicago) et al. to determine the Fermi surface in *Bi-2212.* The authors show that, independent of the photon energy, the Fermi surface is a hole barrel centered at (π,π). The authors determined the superconducting gap along the Fermi surface in overdoped and underdoped samples of *Bi-2212*. As the doping increases, they found that the maximum gap increases but the slope of the gap near the nodes decreases. Though consistent with d-wave symmetry, the gap with underdoping cannot be fit by the simple $\cos k_x - \cos k_y$ form. A comparison of the ARPES data with available penetration-depth data indicates that the renormalization of the linear T suppression of the superfluid density at low temperatures due to quasiparticle excitations around the d-wave nodes is large and doping dependent.

Atomically clean *Bi-2212* Josephson junctions between identical single crystals, prepared by cleaving, twisting by an angle ϕ_0 about the c axis, and stacking, have been prepared by Q. Li (Brookhaven) et al. For each bicrystal, the ratio J_c^J/J_c^S of the c-axis twist junction (J) critical current density to that across either single crystal (S) at 0.9 T_c was found to be very nearly unity, independent of ϕ_0 and the ratio A^J/A^S of the junction area to the single-crystal cross-sectional area. The authors assert that their results provide strong evidence for incoherent c-axis tunneling and that the dominant superconducting order parameter near T_c contains an isotropic s-wave component but not a $d_{x^2-y^2}$ component. The authors note, however, that the data do not rule out a second, unobserved phase transition to a d-wave state at another critical temperature below T_c.

Anomalous features in the normal-state resistivity of single-crystalline *Bi-2212* whiskers near T* ~ 250 K are reported by W. Chen et al. (Alberta). The authors interpret the features as being related to a crystal-structure transformation (or lattice distortion), as also observed in thermal and elastic property measurements.

Flux pinning in heavily *Pb*-doped *Bi-2212* crystals *($Bi_{2-x}Pb_xSr_2CaCu_2O_y$)* has been studied by J. Horvat et al. (Wollongong). In samples for which the atomic ratio of *Bi* to *Pb* atoms was 1.66:0.34, the magnetic hysteresis loops exhibited a pronounced secondary peak effect in the temperature range $20\ K < T < T_c$, yielding critical current densities J_c several times higher than for pure *Bi-2212*. The authors suggest that enhanced c-axis coupling upon *Pb* doping contributes to the increased pinning in both low and high fields, while nanometer-size amorphous regions are probably responsible for the increased pinning at higher fields.

$RBa_2Cu_3O_{7-\delta}$

Hydrostatic high-pressure studies to 17 GPa on superconducting *$YBa_2Cu_3O_x$ (Y-123)* over the full range of oxygen content x have been carried out by S. Sadewasser (Washington University) et al. The observed bell-shaped $T_c(P)$ dependencies were found to depend markedly upon the temperature at which the pressure was changed. The authors studied time-dependent relaxation processes using both T_c and the electrical resistivity at 298 K as probes, and they determined the activation volume for oxygen diffusion from the pressure-dependent activation energy and compared this with estimates from a simple hard-sphere model.

Disks of *Y-123* have been prepared by H. Fang and K. Ravi-Chandar (TCSUH) using a new seeded infiltration and growth process. The critical current density at 77 K was found to be in excess of 10^5 A/cm^2 in zero field and 2×10^4 A/cm^2 in 1.5 T, suggesting that this method is a good alternative to the melt-texturing process.

*$YBa_2Cu_3O_{7-\delta}$-Ba_2HoSbO_6 s*uperconductor-ceramic insulator composites have been studied by J. Albino Aguiar (Recife) et al. The authors found that the two components co-exist with no detectable interactions between the two phases.

Large, single-grain *$NdBa_2Cu_3O_{7-\delta}$ (Nd-123) - $Nd_4Ba_2Cu_2O_{10}$ (Nd-422)* composites up to 2 cm in diameter have been fabricated by N. Hari Babu et al. (IRC-Cambridge) using a top-seeded melt-growth technique in a controlled 1% *O_2* in *N_2* atmosphere. An exceptionally high irreversibility field (>12 T at 89 K) was observed in this material for a magnetic field applied perpendicular to the c axis, extrapolating to well over 40 T at 77 K.

Single crystals of *Nd-123* have been grown by S. Shibata et al. (SRL-ISTEC) using a horizontal Bridgman-like method under various partial *O_2* pressures (0.04-0.1%) in an *Ar* atmosphere. The authors obtained high-quality *Nd-123* single crystals with T_c = 95.0 K using *YSZ* boats. An increase of the magnetization with increasing field (i.e., a fishtail or peak effect) was observed around 77 K in magnetic fields parallel to the c axis for crystals grown under 0.06-0.1% *O_2* partial pressures but not for crystals grown under 0.04 and 0.05% *O_2* pressures. Since the amount of *Nd* substitution

on the *Ba* site is reduced with decreasing O_2 pressure, the results support the hypothesis that the peak effect in *Nd-123* is due primarily to *Nd/Ba* substitution.

$RuSr_2GdCu_2O_8$

$RuSr_2GdCu_2O_8$ (Ru-1212) is a triple perovskite containing both CuO_2 and RuO_2 layers. As noted by J. E. McCrone (IRC-Cambridge) et al., it has attracted much recent interest because it displays electronic ferromagnetism (T_{Curie} ~ 135 K) and superconductivity (T_c up to 50 K) coexisting on a microscopic scale. The authors report magnetization and magnetoresistance data that exhibit effects due to the interaction between the ferromagnetic *Ru* moments and the conduction electrons. An analysis of the high-temperature data in terms of spin-disorder-scattering theory yields a value for the exchange interaction between the *Ru* spins and the carriers in the CuO_2 planes.

Relying on the inhomogeneous (layered) crystal, electronic, and magnetic structure, W. E. Pickett (UC-Davis) et al. show theoretically how superconductivity can coexist with the ferromagnetic phase of $RuSr_2GdCu_2O_8$, as observed by Tallon and co-workers. Since the *Cu* $d_{x^2-y^2}$ orbitals couple only weakly to apical *O* p_x,p_y orbitals, which also couple only weakly to the magnetic *Ru* t_{2g} orbitals, there is sufficiently weak exchange splitting, especially of the symmetric CuO_2 bilayer Fermi surface, to allow singlet pairing. The authors find that the exchange splitting is large enough that the superconducting order parameter may be of the Fulde-Ferrell-Larkin-Ovchinnikov type. The authors also note that π-phase formation is preferred by the magnetic characteristics of $RuSr_2GdCu_2O_8$.

The crystal and magnetic structure of a sample of $RuSr_2{}^{160}GdCu_2O_8$ that orders magnetically at 133 K and exhibits a superconducting transition at 35 K has been determined by O. Chmaissem (Northern Illinois and Argonne) et al. using neutron powder diffraction. The only structural parameters that respond to the magnetic ordering at 133 K are the *Cu-Cu* distance, which defines the thickness of the CuO_2 double layer, and the buckling angle of the CuO_2 planes. Magnetic scattering consistent with the previously proposed ferromagnetic ordering of *Ru* moments perpendicular to the c axis was not observed, but the authors do not rule out ordering of *Ru* moments parallel to the c axis or itinerant ferromagnetism.

Other Cuprates

NQR ^{139}La and ^{63}Cu spin-lattice relaxation rate ($1/T_1$) measurements in a $La_{1.94}Sr_{0.06}CuO_4$ single crystal are described in a preprint by M.-H. Julien (Pavia and Ames Lab-Iowa State) et al. The slowing down of Cu^{2+} spin fluctuations was evidenced by a dramatic increase of $1/^{139}T_1$ on cooling. This and other results show that the so-called cluster spin-glass phase persists in the superconducting regime.

In all previously investigated samples of $La_{2-x}A_xCu_{1-z}B_zO_{4+y}$ (*A = Sr* or *Nd, B = Zn*) including high-T_c superconductors and insulators, and in bilayered superconducting $YBa_2Cu_3O_{6.6}$ and $Bi_2Sr_2CaCu_2O_{8+\delta}$, when sufficient numbers of holes are introduced into the two-dimensional CuO_2 square lattice, dynamic magnetic correlations become incommensurate with the underlying lattice. Magnetic correlations also become incommensurate in structurally related La_2NiO_4 when doped with *Sr* or *O*. However, W. Bao (LANL) et al. have found an exception to this rule in $La_2Cu_{1-z}Li_zO_4$, in which the magnetic correlations remain commensurate.

The results of Raman-scattering experiments on single crystals of $La_{2-x}Sr_xCuO_4$ as a function of temperature and doping are reported by J. G. Naeini (Simon Fraser) et al. The authors use the extended Drude model (memory function formalism) and a Kramers-Kronig transformation to obtain the temperature- and frequency-dependent scattering rate from the B_{2g} Raman response function. Comparison with results from other techniques provides a consistent picture of the pseudogap in $La_{2-x}Sr_xCuO_4$ and evidence for the existence of cold spots near $(\pm\pi/2,\pm\pi/2)$.

Two preprints by A. J. Zaleski and J. Klamut (Wroclaw) present results for the anisotropy and the temperature dependence of the penetration depth in magnetically oriented, powdered $La_{2-x}Sr_xCu_{1-y}Zn_yO_4$. The results seem to support Uemura's picture of a cross-over from Bose-Einstein to BCS-like condensation in high-temperature superconductors.

Hydrostatic pressure effects on the superconducting transition temperature T_c of the oxycarbonate cuprates *$(Cu_{0.5}C_{0.5})Ba_2Ca_{m-1}Cu_mO_X$ [(Cu,C)-12(m-1)m]* have been determined by Y. Cao et al. (TCSUH) for m = 3 and 4 with different dopings of x. In *(Cu,C)-1223,* the authors found behavior similar to that of $YBa_2Cu_3O_{7-\delta}$, in that dT_c/dP depends strongly on x, increasing from -0.7 K/GPa to +1.2 K/GPa as x decreases and the compound changes from overdoped to nearly optimally doped, consistent with the prediction of a phenomenological model for the pressure effect on T_c. In *(Cu,C)-1234,* however, contrary to the prediction, dT_c/dP depends only slightly on x and decreases from 0.75 K/GPa to 0.6 K/GPa as x decreases from nearly optimally doped to underdoped.

Vortices

A layered superconductor in a magnetic field of arbitrary orientation with respect to the conducting plane has been

considered by U. Klein (Linz) et al. The authors find that there is competition of Pauli spin-pair-breaking effects, favoring the Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) state, and orbital-pair-breaking effects, favoring the Abrikosov vortex phase. The authors calculate the actual structure of the stable states below H_{c2} by minimizing the free energy, and they find new order-parameter structures that differ from both the traditional Abrikosov and FFLO solutions. These include two-dimensional periodic structures with several zeros of the order parameter and quasi-one-dimensional structures consisting of vortex chains separated by FFLO domains.

An extensive theoretical study of vortex physics in confined geometries is reported in a paper by M. C. Marchetti and D. R. Nelson (Harvard). The authors discuss properties of vortex liquids in cuprate superconductors with columnar defects. Experiments that force the vortices to flow in confined geometries can be used to distinguish between continuous disorder-driven glass transitions of vortex matter, such as the vortex-glass or the Bose-glass transition, and nonequilibrium polymer-like glass transitions driven by interaction and entanglement. The authors discuss, for example, how the critical exponents for all six vortex liquid viscosities can be obtained.

A paper by G. W. Crabtree (Argonne) et al. describes transport experiments that probe the dynamic nature of driven vortex motion. An inhomogeneous Lorentz driving force is applied to the sample, inducing vortex velocity gradients that distinguish hydrodynamic motion of the vortex liquid from the elastic and plastic motion of the vortex solid. The authors observed elastic depinning of the vortex lattice at the critical current, and shear-induced plastic slip of the lattice at high Lorentz-force gradients.

Vortex-glass transitions induced by line-like disorder, the so-called Bose-glass transition and two types of Gaussian-splayed-glass transitions, have been studied by R. Ikeda (Kyoto) using the lowest-Landau-level approach to the Ginzburg-Landau model. For each of these transitions, the author estimates the transition point and derives critical properties of the response properties just above the transition.

The gradual evolution of the first-order vortex-melting transition into a continuous transition with the systematic addition of point disorder in $YBa_2Cu_3O_{7-\delta}$ induced by proton irradiation is described in an experimental paper by L. M. Paulius (Western Michigan and Argonne) et al. The evolution occurs via the decrease of the upper critical point and the increase of the lower critical point. The first-order melting transition occurs when the two critical points merge.

The upper and lower critical points in untwinned $YBa_2Cu_3O_{7-\delta}$ crystals with dilute columnar defects have been investigated experimentally by W. K. Kwok (Argonne) et al. The authors find a convergence of the first-order melting line with a second-order Bose-glass line at the lower critical point. The lower critical point increases with columnar defect density. The columnar defects also raise the upper critical point, indicating that vortex-line meandering is a basic feature controlling its position.

Preprints by C. Boekema (San Jose State) et al. and by R. Santiago (San Jose State) et al. report μSR studies of the magnetic-field distributions in the vortex state of cuprate superconductors. The data show evidence for d-wave superconductivity. The authors make extensive use of the maximum-entropy method to analyze the μSR time-series data.

A preprint by A. Buzdin and M. Daumens (Bordeaux) shows how when defects are smaller than the London penetration depth, vortex pinning interactions can be calculated conveniently by making use of analogies to related electrostatic problems.

The magnetic response of type-II superconductors as influenced by both bulk pinning and geometric edge barriers has been thoroughly analyzed by E. H. Brandt (MPI-Stuttgart). The author stresses that even without bulk pinning and in the absence of a microscopic Bean-Livingston surface barrier for vortex penetration, superconductors of nonellipsoidal shape can exhibit a large geometric barrier for flux penetration. The author gives expressions for the first-flux-entry field H_{en} and the irreversibility field H_{rev}.

The competing roles of weak residual bulk pinning, and surface and geometrical barrier effects in YNi_2B_2C, as measured using micro-Hall probes, are discussed in a paper by S. S. James (IRC-Cambridge) et al.

A high-resolution scanning Hall probe microscope (1-2 μm spatial resolution and 30 mG field sensitivity) has been used by S. S. James (Colorado State and IRC-Cambridge) to study dendritic magnetic flux penetration into thin *Nb* strips in a slowly ramped applied field. The dendritic fingers persisted over all temperatures investigated from 0.3 to 0.95 T_c.

Films

The epitaxial growth and properties of Nd_{1+x}-$Ba_{2-x}Cu_3O_{7-\delta}$ *(NBCO)* thin films deposited using pulsed-laser deposition (PLD) are reported by C. Cantoni et al. (Oak Ridge). Thin films with T_{c0} = 93 K and J_c(H = 0, T= 77 K) = 3×10^6 A/cm^2 were reproducibly fabricated on single-crystal $LaAlO_3$ substrates. *NBCO* films also were grown on textured *Ni* substrates on which a YSZ/CeO_2 buffer-layer architecture was previously deposited by the

same PLD technique. Microstructural analysis revealed a high degree of in-plane and out-of-plane alignment for the different layers, as well as a dense morphology and low-angle grain boundaries (≤3°) for the *NBCO* films. Direct current transport measurements yielded a J_c(H = 0, T= 77 K) = 3×10^5 A/cm^2. However, at high fields (>7 T), the J_c of the *NBCO* films on *YSZ/CeO$_2$/Ni* substrates exceeded the J_c of both *YBCO* and *NBCO* films on *LaAlO$_3$*.

As reported by J. Lesueur (Orsay), *in-situ* [110] and [103] *YBCO/Pb* junctions have been made. Both show a Josephson current and Andreev bound states, but the authors have not yet seen any evidence of coupling between them. In the [110] case, the Andreev bound states are split by a surface-induced state that breaks time-reversal symmetry. The asymmetric splitting remains to be explained.

A systematic study of the charge transport and quasiparticle tunneling properties of *$Y_{1-x}Pr_xBa_2Cu_3O_{7-\delta}$* thin films has been carried out by M. Covington and L. H. Greene (Illinois-Urbana-Champaign). *Pr* doping increases the resistivity along the *CuO_2* planes and suppresses T_c, ultimately inducing a superconductor-insulator transition. The tunneling conductance is reproducible and correlated with the crystallographic film orientation.

The absolute values of the normal-state conductivity σ_n and the low-temperature penetration depth $\lambda(0)$ have been measured by A. Pimenov (Augsburg) et al. for a number of different *$YBa_2Cu_3O_{7-\delta}$* films. The authors found a strong correlation between σ_n and λ^{-2} for different doping, oxygen reduction, and defect density, indicating that measurements of the normal-state conductivity can be used to predict the superconducting penetration depth and estimate the sample quality.

Experiments by B. J. Jönsson-Åkerman (Royal Institute of Technology-Stockholm) et al. have confirmed a recently proposed scaling relation for the nonlinear ac susceptibility response of type-II superconductors via high-precision measurements on a c-axis-oriented *$HgBa_2CaCu_2O_{6+\delta}$ (Hg-1212)* thin film.

A preprint by B. Güttler (PTB-Braunschweig) et al. reports that micro-Raman spectrometry can be used to detect *$BaCu_3O_4$* as an impurity phase in *$RBa_2Cu_3O_{7-\delta}$* thin films with a mole fraction less than 1%, a sensitivity that exceeds that of x-ray diffraction by at least an order of magnitude.

Low-temperature measurements of the resistance of superconducting ultrathin amorphous *Bi* films in a magnetic field have been carried out by J. A. Chervenak and J. M. Valles, Jr. (Brown). The authors found that in films for which the normal-state sheet resistance R_N exceeds the resistance quantum, $R_Q = \hbar/e^2$, there is no vortex solid and hence no zero-resistance state in a magnetic field.

Applications

The design and realization of an all-high-T_c dc superconducting quantum interference device (dc SQUID) are reported in a preprint by R. R. Schulz (Augsburg) et al. The device was realized with thin-film technology, in which the Josephson junctions consist of one standard junction (0-junction) and one junction with a π phase shift (π-junction). The authors compare the characteristics of the π-SQUID with those of a standard high-T_c SQUID.

The development and testing of a 100 kVA superconducting transformer made of *(Bi,Pb)-2223/Ag* tapes and operated at 77 K are described in a preprint by P. Kummeth (Siemens-Erlangen) et al. The authors note that high-temperature superconducting (HTS) transformers are promising candidates for applications in electrical power engineering because of their advantages in reduced size and weight, better efficiency, and reduced fire and environmental hazards. The nominal primary and secondary currents and voltages were 18 A and 5.6 kV, and 91 A and 1.1 kV, respectively. No-load tests, short-circuit tests, and load tests proved repeatedly that the transformer had the rated capacity. HTS winding losses of 20.6 W and iron losses of 403 W were measured.

As reported in a preprint by J. Denul (Ghent) et al., ten partners from six European countries are collaborating in the industrial Brite EuRam project MUST, which stands for multifunctional flexible high-temperature superconducting tape. The objective is to develop a cost-effective tape with J_c in the superconducting film greater than 10^6 A/cm^2 at 77 K and 0 T, using high-power sputter deposition of 0.5-1 μm thick *YBCO* films on metallic and polymer substrates. The end product will be required to withstand stresses in operation while maintaining the desired characteristics of the superconducting state. The collaborators will demonstrate commercial possibilities of this tape by the fabrication of components suitable for MRI applications, fault-current limiters, and a high-field HTS magnet (B > 2 T). Two preprints by I. Van Driessche (Ghent) et al. report related progress in the development of magnetron sputtering techniques for the deposition of *YBCO*.

Transport losses in multifilamentary *(Bi,Pb)-2223/Ag* tapes with different filament arrangements have been measured by M. Majoros (IRC-Cambridge and Bratislava) et al. The samples were untwisted and had seven filaments, which were arranged in columns, in slanted columns, or evenly distributed across the tape cross section. The authors found that the sample with filaments stacked in columns had slightly lower normalized losses at low normalized currents ($I_0/I_c < 0.2$) but that there was no difference in the loss data for the three different filament geometries in the range $I_0/I_c > 0.2$.

Theory

The critical properties of a type-II superconductor have been investigated by J. Hove and A. Sudbø (Trondheim) using a vortex representation. Computing the gauge-field and the dual gauge-field propagators in terms of a vortex correlation function, the authors obtained $\eta_{\mathbf{A}} = 1$ and $\eta_{\mathbf{h}} = 1$ for the anomalous dimensions of both the gauge-field **A** and the dual gauge-field **h**. This provides support for a proposed dual description of the Ginzburg-Landau theory of type-II superconductors in the continuum limit, as well as for the existence of a stable charged fixed point of the theory, not in the 3DXY universality class.

The influence of a normal-state pseudogap on the c-axis and ab-plane conductivity has been investigated by T. Dahm (Dresden) et al. for spin-fluctuation-exchange scattering within the self-consistent FLEX (fluctuation-exchange) approximation. The authors find that coherent conductance can describe the c-axis conductivity in overdoped compounds, but incoherent c-axis conductance is necessary to describe the underdoped regime.

From the phase diagram of the nearly half-filled single-band two-dimensional Hubbard model, H. Kondo and T. Moriya (Science University of Tokyo) discuss the possibility of the spin-fluctuation mechanism being the common origin of superconductivity in the high-T_c cuprates and 2D organic compounds.

An approach to study the competition of $d_{x^2-y^2}$ and other subdominant complex symmetries of the gap function is proposed in a preprint by E.V.L. de Mello (Niterói). The author notes that the results may be useful to interpret some experimental data and to explain why similar experiments yield different gap symmetries.

The formation of charge domain walls in an electron-doped extended Hubbard model for the superconducting cuprates has been investigated by A. Sadori and M. Grilli (Roma). Within an unrestricted Hartree-Fock approach, extended by the introduction of slave bosons to account for strong correlations, the authors demonstrate the occurrence of stripes in the (1,1) and (1,-1) directions having one doped electron per stripe site.

A simple BCS-like model that describes unconventional superconductivity on the basis of an electron-electron attraction corresponding to a delta-shell potential has been studied by J. Quintanilla and B. L. Györffy (Bristol). The authors obtain a T_c vs doping behavior similar to that found in the high-T_c cuprates.

A fermion-boson binary mixture of unpaired electrons coexisting and interacting with Cooper pairs treated as real two-electron or two-hole bosons is proposed by V. V. Tolmachev (Moscow) as a model of superconductivity. In thermodynamic equilibrium some of these bosons are Bose-Einstein-condensed at low enough temperature.

The evolution of the neutron cross section with variable frequency ω and fixed T below T_c has been studied by Y. J. Kao (Chicago) et al. in two cuprate families. Among other findings reasonably consistent with experiments, the authors see (a) peak sharpening below T_c in $La_{2-x}Sr_xCuO_4$, (b) a continuous decrease in incommensurability as the resonance at $\approx 2\Delta$ is approached in $YBa_2Cu_3O_{7-\delta}$, and (c) the re-emergence of incommensurate peaks above the resonance frequency.

A microscopic theory for the coupling of intrinsic Josephson oscillations in layered superconductors with longitudinal c-axis phonons has been developed by Ch. Helm et al. (Regensburg). Resonances in the I-V characteristics appear at Van Hove singularities of both acoustic and optical longitudinal phonon frequencies. The theory is able to explain experimentally observed low-frequency structures which previously were not understood.

Results of numerical calculations of the (H,T) phase diagram for a thin superconducting film with an elliptic hole (antidot) are presented in a preprint by C. Meyers et al. (Bordeaux). The critical field exhibits an oscillatory behavior as a function of the magnetic field through the antidot.

Other Activities

The Josephson coupling between a conventional s-wave superconductor *(In)* and Sr_2RuO_4 has been studied theoretically by R. Jin (Penn State) et al. The authors find that the coupling is allowed in the in-plane direction but not along the c axis.

The nature of the room-temperature crystal structure distortions in $Sr_3Ru_2O_7$ has been studied by H. Shaked (Argonne) et al. The authors found that among the eight possible pure rotations of the oxygen octahedra, only one mode is consistent with the neutron data: rotation of the octahedra about the c axis. The resulting symmetry of the structure is orthorhombic.

The effects of the superconducting pair potential on impurity scattering processes in metallic carbon nanotubes have been studied theoretically by K. Harigaya (ETL and Kanazawa Institute of Technology). The author discusses the proximity effect when superconducting electrodes are connected by carbon nanotubes.

Thesis

The Genève habilitation thesis of A. Erb summarizes the author's work over the last five years, including the development of $BaZrO_3$ crucibles for the crystal growth of *123* compounds, measurements of oxygen diffusion coefficients during the oxygenation of single crystals of different *123* compounds, and an extensive study concerning the origin of the fishtail effect in *YBCO* and other rare-earth *123* compounds. The author discusses the influence of microstructural inhomogeneities on proposed vortex phase diagrams and the question of superconductivity in the *Pr-Ba-Cu-O* system, which is still a controversial subject (124 refs.).

Contributed by John R. Clem

Contents:

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COMING EVENTS

*(An * indicates a previously listed event. Also see complete listing of upcoming conferences and workshops at our Web site http://www.iitap.iastate.edu/htcu/comevents.html.)*

Feb. 10 - 11, 2000:

The 2000 Wire Development Workshop of the DOE Superconductivity Program, in St. Petersburg, Fla. Recent progress in first- and second-generation wire technology will be presented by national laboratories, wire manufacturers, and other program partners. Registration information will be available at the end of November. To be added to the program's mailing list, please contact Audrey Lamanna, Energetics, telephone (202) 479-2748, e-mail alamanna@energeticsinc.com.

Feb. 13 - 18, 2000:

Gordon Research Conference on Superconductivity – Harbortown Resort, Ventura, Calif. Session titles include new materials; pseudogap and normal state properties; stripe phases; vortex physics; applications; novel heavy electron, organic, and magnetic superconductors; condensation energy; pairing symmetry, and mechanisms; theory; and c-axis transport. For further information, contact M. Brian Maple, Conference Chair, Department of Physics – 0319, University of California at San Diego, 9500 Gilman Drive, La Jolla, CA 92093; e-mail mbmaple@ucsd.edu. Applications should be sent to Conference Application, Gordon Research Conferences, University of Rhode Island, P.O. Box 984, West Kingston, RI 02892-0984; e-mail app@grcmail.grc.uri.edu (send/request e-mail application form from this address).

April 30 - May 3, 2000:

102nd Annual Meeting & Exposition Gateway to the New Millennium, St. Louis, Mo. This is the premier international forum for ceramics. Comprehensive coverage of ceramic and materials science, engineering, technology, manufacturing, and applications. The program will include symposia and focused programs: the symposia are designed to provide multidisciplinary perspectives on the nature and impact of state-of-the-art ceramic science, engineering, and technology in key areas, and the focused programming provides forums for in-depth technical exchange on specialized topics. Symposia will include ceramics and integrated components in microelectronics, optoelectronics, wireless communications and consumer electronics; ceramics for biological, chemical, mechanical, thermal and high-radiation applications; processing of ceramics; and cross-cutting symposia. **Abstract deadline, November 15, 1999.** For information, contact The American Ceramic Society, P.O. Box 6136, Westerville, OH 43086-6136; telephone (614) 890-4700; telefax (614) 899-6109; e-mail info@acers.org. http://www.acers.org/.

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