Session 21BP

Heterogeneous High Temperature Cuprate Superconductors **21BP1**

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An intriguing possibility to observe superconductivity in the cuprate superconductors above the transition temperature of the optimally doped sample is pointed out within the framework of the t-J model. The system we consider is a heterogeneous structure made of a cuprate superconductor consisting of several regions with different doping rates. This new superconductivity appears when there is a boundary between two non-superconducting regions of over- and under-doping. At such boundary, the singlet resonating valence bond order and the holon condensate can exist simultaneously because of the proximity effect, thus giving rise to the superconductivity. We discuss several realistic situations where this "boundary superconductivity"can be observed experimentally. The relevance of this phenomenon to the inhomogeneous superconducting phenomena observed in actual cuprates is also addressed.

Monte Carlo Study of Pseudo-Gap Temperature T^* within JJA Model **21BP2**

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We study pseudo-gap temperature T^* of high-T_c superconductors by a Monte Carlo simulation of anisotropic 3D Josephson Junction Array (JJA) model based on the Ginzburg-Landau theory. We investigate T^* both in the cases of zero external current and finite external current I in the JJA. It is found that the external current I depresses the pseudo-gap temperature T^* and T^* exhibits little dependence on the anisotropy between inter- and intra-layers of the 3D JJA.

21BP3 Electronic states of high-T_c cuprate in the anomalous metallic regime

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By use of the d-p model for cuprate, we investigate the density of states. The retarded propagator matrix we use is defined by several composite particles, for example, pure fermion, dressed fermion with local spin fluctuation, and one with global spin fluctuation between nearest neighbour Cu sites. The shapes of the density of states rapidly change by doping and temperature because the matrix includes some mean fields which easily change by external parameters. In this paper, we discuss metal-insulator transition near the half-filling, evolution of the coherent peak, and close relationship between spin fluctuation and the spin gap phemomena.

21BP4 Role of antiferromagnetic fluctuations on charge ordering and superconductivity as viewed through quantal phases

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With the use of nonperturbative methods which invoke the notion of quantal (Berry) phases, we investigate the role played by antiferromagnetic fluctuations on charge ordering and superconductivity for both quasi-1d and 2d electron systems. In both cases we find it essential to incorporate the full SU(2) symmetry of the spin degree of freedom. For the 2d case we arrive at an interesting duality between superconductivity and stripe order similar to that proposed by Zaanen but from a quite independent route. Experiments are interpreted in this light.

21BP5 Perturbation Analysis of Superconductivity in Hubbard Model

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We study the possible pairing states in the two- and three-dimensional single-band Hubbard models, which are the strongly correlated systems. The lattice structures are the square, simple cubic, bcc and fcc lattices. We analyze the dominant superconducting state on the basis of the third order perturbation theory with respect to Coulomb interaction. The pairing effective interaction is divided into the vertex correction term and the RPA-like term induced by the spin fluctuation. We investigate the roles of the two terms promoting the p-, d- and f-wave pairing states. We give the result that the vertex correction plays an important role for the triplet superconductivity.

The Electron-Hole Asymmetry in the Cuprate Superconductors **21BP6**

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We investigate the phase diagram in the d-p model by taking the antiferromagnetic fluctuations in the fluctuation-exchange (FLEX) approximation and taking the superconducting fluctuations in the self-consistent t-matrix approximation. Obtained phase diagrams in the hole-doped rigion and in the electron-doped region have common features, *i. e.* the antiferromagnetic state, the superconducting state and the pseudgap phenomenon. However, the antiferromagnetic state in the electron-doped region exists approximately in 3 times wider doping-range than that in the hole-doped region. It is due to the intrinsic nature of the ingap state which is the quasi-particle state in the vicinity of the charge-transfer-type Mott insulator (cond-mat/0202116). We will show the electron-hole asymmetry in several quantities, *e. g.* ω-dependent quasi-particle damping.

Superconductivity in a boson- fermion mixture with weak interaction **21BP7**

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A superconductivity in a mixture of fermions coexisting and interacting with the Cooper pairs, treated as real *composite* bosons, is examined. The equations for the fermion chemical potential, for the number of pairable *but unpaired* fermions and for the total number of bosons are obtained. Two temperatures are classified: *First*, a pseudogap temperature, T_p, determined as a one at which nonzero averages of the composite boson creation and annihilation operators are *firstly* manifested while the density of *condensed* bosons, $n_0(T)$, (i.e. bosons in a state with total zero momentum) remains negligible. *Second*, temperature of condensation, T_c, below which $n_0(T)$ *just ceases to be zero*. T_p depends as on the interaction parameter V responsible for the electron-boson transformations, as well on the boson formation energy, giving rise to the decrease of T_p with growth of V. The T_c *vs* V dependence reveals a non-monotonic behavior.

Quantum Melting of Stripes in Two Dimensions **21BP8**

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Quantum fluctuations of striped domain walls in two-dimensional incommensurate states are investigated. Both stripes with short-range and long-range interactions are considered. Mapping the quantum stripes to 3D XY model, we show that stripes melt and become a stripe liquid due to dislocations created by quantum fluctuation. This quantum melting transition is second order and characterized by the 3D XY universality class. We find that, in the case of short-range interaction, stripes melt in a large-wall-spacing (low density) region, whereas stripes with long-range interactions that fall off as power laws become a liquid in a short-wall-spacing (high density) region. These results are applied to incommensurate domain walls in two-dimensional adsorbed atoms on substrate and doped antiferromagnets, e.g. Cupper oxides.

21BP9 Electron-hole asymmetry in the electronic states of high-$T_{\rm C}$ superconductors: a variational quantum Monte Carlo study

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Motivated by recent photoemission experiments for n-type high-$T_{\rm C}$ cuprates, providing a clear microscopic evidence for the electron-hole asymmetry in the electronic structures, here we study the origin of this asymmetry and the consequences theoretically using recently developed variational quantum Monte Carlo method[1]. We first show the existence of the antiferromagnetic long range order extending away from zero doping and the asymmetry of the regions in the phase diagrams. Next we will present the momentum distribution functions as a function of doping to examine the evolution of the shape of Fermi surface. Our results will be compared with the photoemission experiments.

[1] S. Sorella, Phys. Rev. B **64**, 024512 (2001); cond-mat/0201388.

21BP11 Low field DC SQUID Nuclear Magnetic Resonance on single crystal UPt_3

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A SQUID spectrometer is being used to study high-quality single-crystals of UPt_3 in low magnetic fields by performing pulsed NMR on ^{195}Pt. The system uses a multiloop DC SQUID with Additional Positive Feedback (APF) and operates in flux-locked loop mode from DC to 3 MHz. It has an overall coupled energy sensitivity of 800 *h* and a dead time of ~ 5 μs. NMR signals from UPt_3 have been observed in both the superconducting mixed state and in the normal state. A bulk platinum marker is used to determine the magnetic field. Measurements of ^{195}Pt Knight shifts in UPt_3 are reported.

21BP12 Superconductivity in a Ferromagnet UGe_2 -Heat Capacity measurement under High Pressure-

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Recently co-existence of the superconductivity and the ferromagnetism was reported under high pressure phase (1.0-1.6 GPa) of UGe_2. In this presentation, we will show the result of our heat capacity measurements under high pressure.It was found that the superconducting peak was observed in the narrow pressure range around the critical pressure P_C^* where the another transition T^* disappeared.

Specific Heat of $CeRhIn_5$ Under Pressure to 21 kbar: Pressure-Driven Transition from Antiferromagnetism to Heavy-Fermion Superconductivity **21BP13**

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$CeRhIn_5$ has an unusual transition at a critical pressure $P_c \approx 15$ kbar. Specific-heat data show a gradual change in the zero-field "magnetic" specific-heat anomaly from one typical of antiferromagnetic ordering at ambient P to one more characteristic of a Kondo singlet ground state at 21 kbar. At 15 kbar there is a discontinuous change from an antiferromagnetic to a superconducting ground state, and evidence of a weak first-order transition. Above P_c the low-energy excitations are characteristic of superconductivity with line nodes in the energy gap, and, at intermediate P, of extended gaplessness.

Gap Structure and Anomalous Superconducting state of Quasi 2D Heavy-Fermion $CeCoIn_5$ **21BP14**

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To specify the direction of the nodes in the superconducting gap, we measured the thermal conductivity of quasi 2-D heavy ferimon $CeCoIn_5$ in a magnetic field rotating within the 2D planes. A clear fourfold symmetry of the thermal conductivity which is characteristic of a superconducting gap with nodes along the $(\pm\pi, \pm\pi)$-directions is resolved. The thermal conductivity also reveals a first order phase transition at H_{c2}. The results indicate that the symmetry most likely belongs to $d_{x^2-y^2}$, implying that the anisotropic antiferromagnetic fluctuation is relevant to the superconductivity.

Specific Heat Study on Heavy-Fermion Superconductor $PrOs_4Sb_{12}$ **21BP15**

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Thermal properties of the filled skutterudite $PrOs_4Sb_{12}$, the first Pr-based heavy-fermion superconductor with a superconducting (SC) transition temperature $T_c = 1.8$ K [1], have been studied using high-quality single crystals. At $\sim 0.9T_c$ in the SC phase, specific heat shows a kink structure, which may reflect a possible multiphase superconductivity. Obtained GL parameter κ_2 diverges with decreasing temperature indicating no paramagnetic effect being dominant. The upper critical field is slightly anisotropic (of the order of 2%). Outside of the SC phase, distinct anomaly evidencing a field-driven phase transition is found above 4 T. This phase might be due to a field-induced antiferromagnetic ordering as those in quadrupole-ordered CeB_6 and TmTe or magnetically frustrated Gadolinium Gallium Garnet.

[1] E.D. Bauer et al.: Phys. Rev. B **65** (2002) 100506(R).

21BP16 Superconductivity of YBCO/(Sr,Ca)-Cu-O/YBCO system

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The superconductivity and the dependence of Tc to oxygen and compound ratios (x) of $Sr_xCa_{0.1-x}CuO_z$ films (thickness=2200Å) sandwiched with $YBa_2Cu_3O_{7-\delta}$ (YBCO) films (1500Å) has been examined. The trilayer films were fabricated on a $SrTiO_3$ substrate by using DC magnetron sputtering in the oxygen gas (0.1 - 1.0Torr). The Tc on the resistivity of YBCO/$Sr_{0.1}CuO_z$/YBCO ranged from 55K to 91K concerning the variation of oxygen pressure. On the optimized oxygen (0.3Torr), the characteristics to (x) of $Sr_xCa_{0.1-x}CuO_z$ were examined. Then YBCO electrode by the substrate and that of top layer had Tc=72K and 19K, respectively. The dependence of Tc to (x) ranged over that of YBCO electrodes and had the optimized Tc (Tc-on=95K, Tc-end=91K) at x=0.05.

21BP17 Oxygen Ordering and Superconductivity in $RBa_2Cu_3O_{y=6.4}$ (R=Er, Yb)

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Shot quenched orthorhombic non-superconducting samples are found to transform at room temperature into bulk superconductors by means of a thermally activated oxygen rearrangement mechanism. The influence of rare earth size on the rate of the transformation is examined. The development of superconductivity is monitored in a Quantum Design MPMS SQUID magnetometer by controlled time exposure at elevated temperatures. Within one hour at 300 K in the MPMS, the materials have obtained a transition temperature T_c of 30 K. The smaller rare earth size and corresponding increased lattice pressure cause a faster transformation from an initial orthorhombic 3-fold coordinate Cu chain site into a 4-fold coordinate Cu chain site.

21BP18 Intrinsic Josephson Effect on Bi-2212 LPE Films

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We fabricated stacks of the intrinsic Josephson junctions (IJJs) on the single-crystalline $Bi_2Sr_2CaCu_2O_x$ (Bi-2212) films prepared by liquid phase epitaxy (LPE). In addition to the 3-dimensional stack design similar to the conventional whisker IJJs, we realized the planar IJJs on the LPE films grown on the step-patterned substrates. Both stacks displayed multibranched current-voltage characteristics inherent in the Bi-2212 single crystals. In order to control the critical temperature and the critical current of the films, we studied the effects of oxygen annealing and yttrium doping.

Critical Current Density for Melt-Processed Filamentary Monolithic RE123 (RE=Nd, Sm, Eu, Gd) Superconductors **21BP19**

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The filamentary monolithic RE123 (RE=Nd, Sm, Eu, Gd) precursor was prepared by a solution spinning method. The precursor was partially melted under various conditions and then oxygenated. The influence of field dependence of J_c on the initial different RE elements in the filamentary RE1123 superconductors was examined. The highest J_c values was attained for the Nd123 and Eu 123 samples partially melted in flowing 0.1%O_2+Ar and for the Sm123 and Gd123 samples partially melted in flowing 1%O_2+Ar. The field dependence of J_c for the Eu123 sample was superior to that for the other samples.

Josephson Plasma Resonance in Partially Irradiated $Bi_2Sr_2CaCu_2O_{8+y}$ **21BP20**

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We study the Josephson plasma resonance in $Bi_2Sr_2CaCu_2O_{8+y}$ (BSCCO) with inhomogeneous phase coherence caused by partial introduction of columnar defects. In these BSCCO, we observe several resonance peaks which are different from the superposition of each constituent parts. At 50K in half irradiated BSCCO, we observe a sudden change in resonance behavior at ω_{cr} = 55 GHz, from irradiated part dominating resonance below ω_{cr} to pristine part dominating resonance above ω_{cr} The sine-Gordon equation with characteristic length scale of λ_c can reproduce this behavior. The sample size and temperature dependence of ω_{cr} can also be qualitatively understood in the same scheme.

Current distribution in the welded YBCO bulk material **21BP21**

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Recently we have succeeded in joining the two monoloths of single grain YBCO superconductors by means of welding technique. We found the microstructure at the joint is largely influenced by the alignment of the sample. We got better joint for (110)/(110) than for (100)/(100) joint. Detailed measurement of the magnetic penetration was performed by mean of the magneto-optical technique. The field and current distrubution revealed larger J_c for (110)/(110) joint.
This work was supported by the New Energy and Industrial Technology Development Organization (NEDO) as Collaborative Research and Development of Fundamental Technologies for Superconductivity Applications.

21BP22 Effect of Chemical Pressure on Superconductivity of Nd($Sr_{2-x}Ba_x$)($Cu_{2.7}Mo_{0.3}$)O_z system

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Nd($Sr_{2-x}Ba_x$)($Cu_{2.7}Mo_{0.3}$)O_z(x=0-1.0) samples were synthesized and examined with respect to the chemical pressure effect. It is found that the non-superconducting phase $NdSr_2(Cu_{2.7}Mo_{0.3})O_z$ can be made superconducting by substitution Ba at the Sr site. Raman measurements indicate that the movement of the apical oxygen toward the CuO_2 planes induced by the chemical pressure is similar to that observed in Y($Ba_{2-x}Sr_x$)Cu_3O_z system. Thermoelectric power measurements show that all the samples are underdoped and hole density on the CuO_2 planes decreases as the Sr:Ba ratio raised.These results are discussed in relation to the local structural changes induced by the chemical pressure

21BP23 Annealing Effects on [BaCuO2]m/[CaCuO2]n Superlattice Thin Film

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Layer by layer deposition of thin film fabrication is very attractive technique, and it is suitable for [BaCuO2]m/[CaCuO2]n superlattice which possess CuBa2Can-1CunOx superconductor based structure. But it is difficult to obtaine superconducting superlattice thin film made by sputtering process. One reason of non-superconductivity is a lack of oxygen because of relative low oxygen partial pressure duraing sputtering process. Then we investigated several annealing on superlattice thin film in order to intruduce oxygen into superlattice structure. We try to realaize superconductivety on superlattice thin film.

21BP24 Generalized Method of Image and the tunneling spectroscopy in High-T_c Superconductors

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A generalized method of image is developed to deal with the tight-binding nature involved in the tunneling problem. In particular, we investigate the zero-bias conductance peaks (ZBCPs) that occur in the metal-d-wave superconductor junctions. The evolution of ZBCPs versus dopings is obtained. In addition, the splitting of ZBCPs in magnetic fields is found in good agreement with experiments. Finally, a conductance peak at the bias of chemical potential for tunneling into the (110) direction of the d-density wave state is predicted, providing a signature to look for in experiments.

Quasiparticle Spectra and Their Spatial Variation on $YBa_2Cu_3O_y$ by Scanning Tunneling Spectroscopy **21BP25**

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Low-temperature scanning tunneling spectroscopy studies have been performed on $YBa_2Cu_3O_y$ in magnetic fields. In zero field, spatially homogeneous superconducting gap spectra are observed over 100 nm square range, in contrast to the spatially inhomogeneous feature reported in $Bi_2Sr_2CaCu_2O_{8+\delta}$. In magnetic fields, two types of spectra are observed. One has superconducting gap almost the same as that observed in zero field. In another type of spectrum, superconducting coherence peak is suppressed and the spectrum shows localized states at $V_{\rm tip} \simeq \pm 5$ mV, representing quasiparticle density of state inside a vortex core. The spectrum form and spatial structure of low energy excitation around vortex is discussed.

I-V Characteristics of YBCO Thin Film with a Periodic Array of Ni Dots **21BP26**

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Enhancing the pinning force in cuprates can be achieved by externally introduced magnetic dots. We use a novel nanochannel glass technique to create metal replica masks with submicron-size holes that have a triangular lattice pattern. With this replica mask, Ni dots with a periodic array are deposited onto the surface of YBCO thin films. The I-V characteristics of YBCO thin film strips with Ni dots are measured. They are compared with that of a bare YBCO strip without Ni dots. The results show that as the magnetic field increases the critical current value of the strip with Ni dots reduces with a much slower pace in comparison with the values obtained from the bare sample. This effect becomes more profound at temperatures close to Tc.

LT-STM observation of $YBa_2(Cu_{1-x}Zn_x)_3O_{7-\delta}$ single crystals **21BP27**

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We present low-temperature scanning tunneling microscopy measurements of the BaO layer in cold-cleaved $YBa_2(Cu_{1-x}Zn_x)_3O_{7-\delta}$ single crystals, showing the one-dimensional charge modulations at lower bias voltage. Such modulations were not observed on Zn-free samples. We consider that the observed charge modulations are closely related to the electronic local density of states in the CuO_2 plane right under the BaO layer. Spatial electronic inhomogeneity induced by Zn impurities in the CuO_2 plane seems to give the most probable interpretation for our experimental results. One-dimensional character of the charge modulations suggests that the CuO-chain layer effects on the electronic states of the CuO_2 plane.

21BP28 Tunneling Studies of Electronic State in High T_c Bi(2212)-System

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The critical temperature T_c in $Bi_2Sr_2Ca_{1-x}Y_x(Cu_{1-y}Zn_y)O_{8+z}$ (referred to BSCYCZO) has been reported to be strongly suppressed near *x* = 0.3 and *y* = 0.03 (Phys. Rev. B 57(1998)7491). To elucidate the relation between the suppression of T_c and the electronic state, the tunnel conductance *G(V)* was measured various temperatures for the planar junction fabricated on cleaved single crystal BSCYCZO. The *G(V)* for *x* = 0 and *y* = 0.03 was highly symmetric around *V* = 0 at a temperature above and below T_c = 83 K, while the *G(V)* for *x* = 0.02 and *y* = 0.03 was symmetric around *V* = 0 at a temperature above T_c = 65 K but strongly asymmetric below T_c = 65 K, where the electron excitation band was strongly enhanced in comparison with the hole band. This confirms that the destruction of symmetry in the electron and hole excitation bands strongly suppresses T_c.

21BP29 Destruction of Stripe Order by Zn-Doping and Formation of a New Phase by Ni-Doping in $La_{1.875}Ba_{0.125}Cu_{1-y}M_yO_4$ (M=Zn or Ni)

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Effects of spin substitution on the stripe order have been investigated in $La_{1.875}Ba_{0.125}Cu_{1-y}M_yO_4$ (M=Zn or Ni). Spin S=1/2 at the Cu site is substituted to S=0 by Zn-doping and to S=1 by Ni-doping. The substitution dependence of the electronic coefficient of specific heat γ in $La_{1.875}Ba_{0.125}Cu_{1-y}M_yO_4$ (M=Zn or Ni) demonstrates directly destruction of stripe order by Zn (S=0) and formation of a new phase by Ni (S=1). We discuss the destruction process of the stripe order by Zn-doping and the formation process of the new phase by Ni-doping.

21BP30 Temperature Dependence of the Hall Angle in Disordered $Y_{1-x}Pr_xBa_2Cu_3O_{7-\delta}$ Thin Films

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We have studied the behavior of carriers near the field-induced superconductor-insulator transition for different disordered $Y_{1-x}Pr_xBa_2Cu_3O_{7-\delta}$ thin films. The measurement of longitudinal and Hall resistivities was carried out in the magnetic fields. For the lower disordered film the superconducting transition appeared even at 10 T, and the temperature T dependence of Hall angle $\cot\theta_H$ was positive above T_c. While, the insulating behavior was observed for the higher disordered film, and the T dependence of $\cot\theta_H$ was negative. We discuss the behavior of carriers on the viewpoint of the localized state.

Microwave surface impedance anisotropy of $YBa_2Cu_3O_x$ single crystals with different oxygen content

21BP31

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The linear microwave response of ultra high-quality $YBa_2Cu_3O_x$ single crystals grown in $BaZrO_3$ crucibles is measured at 9.4 GHz in rf magnetic fields parallel and perpendicular to the ab-plane in the temperature range $5 \leq T \leq 200$ K. Having found the analytic solution for the magnetic field distribution on the sample surface we determine both the surface impedance $Z^{ab} = R^{ab} + iX^{ab}$ in the ab-plane and $Z^c = R^c + iX^c$ along c-axis of the crystals. For the first time the evolution of the $Z^{ab}(T)$ and $Z^c(T)$ dependences on the same sample and in a wide range of oxygen content is obtained. For $x = 6.95$ (optimum oxigen content) the temperature dependence of the c-axis superfluid density, $n_s^c(T)$, is found to be strikingly similar to $n_s^{ab}(T)$ and becomes more convex with x lowering.

Anomalous Behavior of Low- and High-Temperature Antiferromagnetic Superconductors at the vicinity of T_N

21BP32

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Recent discovery of the presence of long-range magnetic order and superconductivity in rare earth nickel borocarbides and Ru-based compounds has triggered a new series of experiments and inspired a return to the so-called coexistence phenomenon. In high temperature superconductors $REBa_2Cu_3O_7$ (RE= magnetic rare earth), screening currents are strong enough to hide an interaction between superconducting electrons and localized magnetic moments of RE ions and no sign of mutual influence has been observed at or below the antiferromagnetic ordering temperature. For these compounds, however, $RE(RE\text{-}Ba)_2Cu_3O_{7+d}$ solid solution can be obtained, where superconductivity is weakened and magnetism strengthened, and pair-breaking effects may expose.

In-plane and out-of-plane temperature dependencies of the resistivity in single crystals and films of Nd_2CuO_4

21BP33

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The temperature dependencies of the in-plane ρ_{ab}(T) and out-of-plane ρ_c(T) resistivities of two groups of Nd_2CuO_4 single crystals (films and bulk single crystals) are investigated in a temperature range 20-300 K. The aim of the present work is to study the effect of modified heated treatment and annealing conditions on transport properties of the pra-crystals Nd_2CuO_4. It was found that nonstoichionometric disorder leads to different dependencies of the resistivity both in ρ_{ab}(T) and ρ_c(T).

This work was supported by the Competition of Ural Branch of RAS for young scientists, grant No. 10.

21BP34 Coherent-to-Incoherent Crossover in Optical Conductivity of Bad-Metallic $La_{2-x}Sr_xCuO_4$

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We have investigated the in-plane charge dynamics of lightly doped $La_{1.92}Sr_{0.08}CuO_4$. The in-plane resistivity $\rho_{ab}(T)$ exhibits a typical behavior of a bad metal; it is metallic ($d\rho/dT>0$) over the entire temperature range up to 1000 K without saturation at the Mott criterion. On the other hand, the in-plane optical conductivity $\sigma_{ab}(\omega)$ deviates from a simple Drude response; it shows a slowly decaying ($\propto\omega^{-1}$) quasi-Drude behavior below a certain temperature T^*, above which it is characterized by a finite-energy peak instead of a Drude-like term. The relationship between the shift of the Drude peak and the Mott criterion indicates that the charge carriers are "dynamically" localized above T^*. The universality of the observation with respect to other compositions and other bad metals are also discussed.

21BP035 Direct measurement of the critical magnetic fields in MgB2 crystals

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Using novel techniques we have directly measured the lower and upper critical fields (Hc1(T) and Hc2(T) respectively) and the anisotropy gamma in MgB2 single crystals. Our results suggest that Hc1 is much higher than previous estimates and that consequently the Ginzburg Landau parameter kappa is very low (around 3). We also find gamma 2, independent of temperature and magnetic field.

21BP36 Fundamental mixed state parameters of superconducting MgB_2

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We report on measurements of the magnetic moment in superconducting MgB_2 single crystals by SQUID, vector VSM and torque techniques. The results indicate that MgB_2 is a clean limit superconductor of intermediate coupling strength with very pronounced anisotropy effects (γ = 4.6 at T = 0 K). Furthermore, neutron irradiation is employed to modify the defect structure of the crystals. We will show that the mixed state parameters are primarily modified by the change in the mean free path of the charge carriers.

Similarity of thermal expansion anomalies in MgB_2 and HTS oxides **21BP37**

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The measurements of thermal expansion $\alpha(T)$ of MgB_2 were carried out at low temperatures both in zero magnetic field H and at $H \approx 4T$. As for oxide high-temperature superconductors (HTS) the anomalous (negative) thermal expansion was observed for MgB_2. It was found also the strong magnetic field influence on the $\alpha(T)$. Qualitative explanation of both effects on the basis of known charge density wave properties was given. The results indicate on the similarity of the anomalous properties of MgB_2 and oxide HTS.

STM at very low temperatures in the borocarbides and in MgB2 **21BP38**

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We discuss very low temperature (0.4K) STM measurements in single crystals of several borocarbide materials. The magnetic superconductor TmNi2B2C (Tc=10.5K and TN=1.5K) shows clean, s-wave like spectra. But the apparently more simple, non-magnetic compounds YNi2B2C and LuNi2B2C show, surprisingly, the presence of an anomalously anisotropic superconducting gap. The consequences of our tunneling measurements concerning the pairing interaction will be discussed. We compare these results with the tunneling spectroscopy of MgB2, where we find a clear s-wave density of states.

Critical Current Density and Flux Pinning Characteristics of Powdered MgB_2 Specimens **21BP39**

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Field and temperature dependence of magnetization and also time dependent magnetization (flux creep) of powdered MgB_2 specimens have been measured by using SQUID magnetometer. Scaling plots of normalized pinning force density $F_{\rm p}/F_{\rm pmax}$ as a function of normalized flux density $B/B_{\rm max}$ in the temperature range of $25 \leq T \leq 37$K showed that a two dimensional pinning is dominant for the flux pinning. Another distinct feature is that a linear reduction of $J_{\rm c}$ with increasing temperature at temperatures lower than 30K and a quadratic decrease at higher temperatures than 30K have been observed.

21BP40 Far-Infrared Optical Reflectance Spectra in Sintered MgB_2 Ceramics

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Far-infrared optical reflectivity studies in sintered MgB_2 ceramics with a superconducting transition temperature T_c = 38 K were performed at temperatures from 5 to 47 K. A significant raise was observed in the reflectance spectra below 110 cm^{-1}, which can be attributed to the evolution of the superconducting energy gap. However, we could not observe the evolution of significant reflectance edge which is expected to be observed in the conventional isotropic s-wave superconductors. The observed results are consistent with the theoretical calculation of optical reflectance spectra for the anisotropic s-wave superconductors.

21BP41 The nonphonon superconducivity of the flat borons

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On the basis of concept of strong interaction in the same elementary cell the possibility of Cooper's instability existence in the system with hopping between cautions and anions nonetransition elements is established. The phase diagram of cooper's pairing existence depending on the degree of filling (n_p) $2p-$ and (n_s) $3s-$ shells of nonetransition elements is constructed. Eventually the solvability conditions can be written as the BSC-relation $T_c \approx t^* exp(-1/g\rho)$, where ρ is the density of states on the Fermi surface and $g-$ is the function from ϵ_s, ϵ_p, n_s, n_p and the scattering amplitudes γ_s, γ_p. If one takes $g = 0$ then it gives the condition for appearance of superconductivity. Together with the equation of state this condition defines the superconductive domains in the n_s, n_p- variables.

21BP42 Temperature and Field Dependence of MgB_2 Energy Gaps from Tunneling Spectra

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We have synthesized MgB_2/Pb planar junctions to study the temperature and field dependence of the superconducting energy gap of MgB_2. The major peak occurs at Δ of about 2 meV, and this corresponds to a $2\Delta/k_BT_c$value of 1.18. While this is significantly smaller than the BCS weak coupling value, there are features in the tunneling spectra indicating the possibility of another larger gaps. By fitting the dI/dV curves with a simple model, the larger gap is estimated to be about 4.5 times the smaller gap. Temperature dependence of both gaps are near BCS like, and start to open up at temperatures just below T_c (39K). This confirms that these gaps are indeed bulk properties of MgB_2. The junction is stable only up to a field of 3.l9T. By extrapolation, we can estimate the H_c to be about 6.2T.

Dynamic Jahn-Teller Effect and Superconductivity in MgB_2 **21BP43**

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Recent experimental observations of anomalous temperature- and magnetic field-dependence in specific heat and tunneling spectra of the newly discovered high T_c MgB_2 superconductor have suggested a possible multiple-gap nature of the superconducting state of MgB_2. We propose a novel mechanism of superconductivity in MgB_2 based on the dynamic Jahn-Teller effect of the interplay between the doubly degenerate $p\sigma$ electronic states and the E_{2g} phonon modes. The hopping motion of holes in the $p\sigma$ states of the 2D B layers is constrained by the accompanying phonons, and thereby a non-trivial superconducting state with multiple order parameters is found to arise from conventional electron-phonon interactions due to the presence of additional pairing channels. Important experimental observations including high T_c and the anomalous specific heat are explained using this theory.

Electron Transport in MgB_2, NbB_2, TiB_2, TaB_2, ZrB_2 and ZrB_{12} **21BP44**

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We report on syntheses and electron transport properties of ceramics and thin films of MgB_2 and diborides (AB_2) with ($A = Zr, Nb, Ta, Ti$), as well as of ZrB_{12}. We conclude that these diborides as well as MgB_2 samples behaves like a simple metals in the normal state, with usual Bloch-Grüneisen temperature dependence of resistivity and with Debye temperatures ($270\,K$, $480\,K, 760\,K$, $700\,K$ and $720\,K$, for ZrB_{12}, ZrB_2, NbB_2, TiB_2 and MgB_2, respectively). A clear exponential temperature dependence of $\lambda(T)$ in MgB_2 thin films ($T_c = 39\,K$) was observed at $T < T_c/2$, with an energy gap $2\Delta(0)/T_c = 1.6$. At the same time a linear $\lambda(T)$ and H_{c2}(T) dependencies ($H_{c2}(0) = 0.16\,T$) were observed for ZrB_{12}.

Critical currents of Bi: 2212 doped by Er, Fe and Ni **21BP45**

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Measurements of the irreversible magnetization, AC susceptibility and electrical resistivity of $Bi_2Sr_2Ca_{1-x}Er_x(Cu_{1-y}M_y)_2O_{8+d}$ bulk are reported. The samples were prepared by the conventional solid state reaction. Low concentration of the doping elements increase the pinning force density and shift the magnetic irreversibility line towards higher fields. The intergranular critical current density was determined from ac susceptibility data by varying the field amplitude Hac in the range from 0.4 A/m to 1000 A/m and from the irreversible part of magnetization using Bean's model. The results were discussed in terms of SIS-and SNS-type models for granular superconductors.

21BP46 Magnetic Torque in the Vortex State of $Bi_2Sr_2CaCu_2O_{8+\delta}$ Single Crystal below 30K

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The magnetic torque originating from the intrinsic pinning parallel to the CuO_2 plane and the flux pinning perpendicular to the CuO_2 plane has been measured as a function of the angle θ between the CuO_2 plane and the applied magnetic field. The amount of flux running parallel to the CuO_2 plane (Josephson vortex) was calculated from the magnetic torque as a function of θ ($0 \leq \theta \leq 90$)at 4.5K, 6K and 12K. The amount of flux pinned perpendicular to the CuO_2 plane showed saturation at about 0.5T. The depinning of the flux pinned perpendicular to the CuO_2 plane at 4.5K was studied as a function of the temperature and the applied magnetic field parallel to the CuO_2 plane.

21BP47 Critical Current Density in HTS Films with Growth-Induced Linear Defects

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J_c magnetic field dependencies are measured in YBCO films by AC susceptibility and transport current technique. Out-of-plane edge dislocations are shown to play a crucial role in J_c-behavior due to strong vortex pinning on their normal cores. In the field applied along the c-axis $J_c(H)$ is shown to have a plateau J_c = const at $H < H_{min}$ and to be approximated well at $H > H_{min}$ by $J_c(H)/J_c(0) = \alpha \log(H^\star/H)$. The fitting parameter α is almost temperature independent and $H^\star$ is proportional to $1 - T/T_c$. A model of pinning by out-of-plane edge dislocation and by mosaic domain low angle boundaries is developed.

21BP48 Effect of Thermal Neutron Irradiation in Boron-Doped Melt-Textured YBCO

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Y1.6Ba2.3Cu3.3Ox superconductors with different amounts of boron-doping have been synthesized using the MPMG technique. Undoped and boron doped samples were irradiated with thermal neutrons to study the effects of defects produced by the fission reaction, B (n,α) Li, on the pinning properties and the critical current densities. We observed that pinning properties and critical current densities were improved with thermal neutron irradiation. This improvement was stronger on boron-doped samples compared to undoped one.

Relaxation study of RE-123 materials with different types of pinning defects. 21BP49

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Total magnetic moment relaxation study is made on RE-123 samples with large-particle, point-like-disorder, and twin-boundary pinning structures. The correlation of relaxation data with M-H loop shape via $S = -d\ln M/d\ln t = \gamma_E(k_E - d\ln M/d\ln B)$ (γ_E and k_E being constants) derived by Perkins et al. [PRB 51 (1995) 8513] is documented in a wide range of temperatures and on different types of samples. Potentials and limitations of the total magnetic moment relaxation studies is discussed from the point of view to what extent different pinning mechanisms can be characterized and distinguished on this basis.

Vortex lattice melting transition under the influence of the c-axis current 21BP50

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We have studied theoretically and experimentally how the c-axis current influence on the vortex lattice melting transition. Considering the renormalization of the elastic matrix by the c-axis current the mean square displacements of pancake vortices has been calculated. Using the Lindemann criterion we get the $H_c - J$ phase diagram of the vortex lattice melting transition. The experimental date have been analyzed in the frame of the developed model.

From Mott Insulator to Superconductor : An ARPES Study of the Cuprates 21BP51

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We have studied the heavily underdoped region of the cuprate phase diagram by angle-resolved photoemission (ARPES), focusing on the doping dependence of the newly synthesized compound $Ca_{2-x}Na_xCuO_2Cl_2$. We find that upon light doping, the chemical potential shifts to the top of the lower Hubbard band. In addition, by $x = 0.10$, we observe well-defined low-energy excitations which emerge near $(\pi/2, \pi/2)$ and lie along a small arc-like contour. These results are compared and contrasted to results from both $La_{2-x}Sr_xCuO_4$, where the low-lying excitations appear to be formed within the gap, as well as the electron-doped cuprate, $Nd_{2-x}Ce_xCuO_4$.

21BP52 Stripes and a two-component interpretation of NMR in cuprates

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Based on the experimental fact that the susceptibilities $\chi_\alpha(T)$ and the corresponding Knight shifts $K_\alpha(T)$ ($\alpha = c, ab$) are linearly related above certain temperature $T^*_\chi(> T_c)$, one normally draws a conclusion that a single Fermi component is operative. We show that this may not be generally valid. As a counter example we propose a two-component system were the susceptibilities are determined by a universal function $f(T)$. The model consist of a Fermi component h^+ and a Bose component B^{++} with triplet spin localized in CuO_5 sites, in chemical equilibrium with respect to reaction $B^{++} \rightleftharpoons 2h^+$, where $f(T)$ gives fraction of bosons and $1 - f(T)$ the fraction fermions. The susceptibilities above T^*_χ are given by adding the fermion and boson contributions in the form $\chi_\alpha(T) = \chi_{\alpha 0} + A_\alpha[1 - f(T)] + B_\alpha f(T)$, where $\chi_{\alpha 0}$, A_α and B_α are T-independent. Elimination of $f(T)$ shows that $\chi_c(T)$ and $\chi_{ab}(T)$ are linearly dependent.

21BP53 Superconducting condensation energy in the pseudogap regime of $La_{2-x}Sr_xCuO_4$

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We measured the electronic specific heat C_{el} of La214 over a wide doping-level p and T range and evaluated the superconducting (SC) condensation energy U_o from the result of C_{el}. The C_{el} was obtained by using the phonon term C_{ph} which was obtained on Ni-doped non-superconducting samples. We reconfirmed that the U_o agrees with the BCS value in highly-doped samples which exhibit no pseudogap, but it is markedly suppressed in the pseudogap regime (x<0.2) as well as the DOS at E_F, $N(0)$. The reduction of U_o is too large to be explained by taking into account the reduction of $N(0)$ only. To explain the experimental values of U_o in the pseudogap region, we had to introduce a new energy scale $\Delta_e(=\beta p\Delta_o)$, which play an effective SC gap, instead of Δ_o. We propose that the energy gap formed over the nodal Fermi arcs near ($\pi/2$,$\pi/2$) will play a role of the effective SC gap.

21BP54 Charge Ordering and Anomalous Elastic Properties of Cuprates Superconductors

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In cuprates superconductors an unusual (hysteretic) temperature behavior of elastic properties is frequently observed. In this work the detailed analysis of the hysteretic temperature behavior of elastic properties is given. It is shown that the hysteretic temperature dependencies of elastic properties of $YBa_2Cu_3O_{7-\delta}$ crystals are strongly anisotropic and connected to the hysteretic behavior of the module C_{3333} only. The analysis of the elastic constant tensor on the basis of a microscopic model has allowed to draw the conclusion, that the hysteretic behavior of the C_{3333} module of $YBa_2Cu_3O_{7-\delta}$ crystal is caused by temperature dependent renormalization of interaction constants of apex oxygen atoms with copper atoms and are connected to the formation of charge ordering.

The normal state scattering rate in high-T_c cuprates **21BP55**

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I present a new phenomenological model for the normal state transport properties of high-T_c cuprates. In particular, I identify a form of scattering rate that shows surprisingly good qualitative and quantitative agreement with all the normal state (magneto)-transport properties of the single-band single-layer cuprate $Tl_2Ba_2CuO_{6+\delta}$ from optimal doping through to the overdoped side of the phase diagram. The form of the scattering rate is also consistent with features seen in photoemission spectroscopy in $Bi_2Sr_2CaCu_2O_{8+\delta}$ and offers a new intuitive way to understand the evolution of the temperature dependence of the inverse Hall angle with disorder and with carrier concentration.

Raman-active c-axis plasma modes in multilayer cuprate superconductors **21BP56**

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The additional absorption peak that appears at low temperature (T) in the spectra of the c-axis conductivity of bilayer cuprate superconductors has been assigned [1,2] to the out-of-phase c-axis plasma mode (PM) [3]. Is there any Raman-active (RA) counterpart of this PM? We demonstrate that RA PMs can be expected to occur in n-layer cuprates with $n > 2$ and present compelling evidence that the peak in the low-T A_{1g} electronic continuum of the four-layer superconductor Hg-1234 [4] corresponds to such a RA PM. The related spectacular phonon anomalies [4] are explained along the lines of Ref. [1].

* In collaboration with M. Cardona (MPI Stuttgart). [1] D. Munzar *et al.*, Solid State. Commun. **112**, 365 (1999). [2] M. Grüninger *et al.*, Phys. Rev. Lett. **84**, 1575 (2000). [3] D. van der Marel and A. Tsvetkov, Czech. J. Phys. **46**, 3165 (1996). [4] V. G. Hadjiev *et al.*, Phys. Rev. B **58**, 1043 (1998).

Magnetotransport Properties of $Y_{1-x}Pr_xBa_2Cu_3O_{7-\delta}$ ($0.13 \leq x \leq 0.42$) **21BP57**

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With decreasing temperature T, the in-plane resistivity of $Y_{1-x}Pr_xBa_2Cu_3O_{7-\delta}$ ($0.2 \leq x \leq 0.42$) exhibits a crossover at T_{cr} from sublinear to overlinear. The sublinear T dependence is attributed to the increasing contribution of hot spots as the Fermi surface FS approaches the magnetic Brillouin zone when T approaches T_{cr}. For $T > T_{cr}$, the orbital magnetoconductivity $\Delta\sigma_{ab} \propto T^{-\alpha}$, where $\alpha = 4$ in $x = 0.13$ and continuously decreases to $\alpha = 3.5$ in $x = 0.42$. This change in α is also consistent with the change in FS. The magnetoresistivity $\Delta\rho(\theta) \propto \sin^2\theta$ (the angle between H and the c-axis) for $T > T_{cr}$, while a second contribution $\sin^4\theta$ appears for $T < T_{cr}$ and becomes dominant close to T_c. This contribution is consistent with the reduction in the spin fluctuations and the increase in the superconducting fluctuations.

21BP58 Zn-Induced Wipeout Effect on Cu NQR Spectra in $La_{2-x}Sr_xCu_{1-y}Zn_yO_4$

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We report a systematic study of Zn-substitution effect on Cu NQR spectrum for high T_c superconductors $La_{2-x}Sr_xCu_{1-y}Zn_yO_4$ from carrier-underdoped to -overdoped regimes (polycrystalline samples, x =0.10, 0.15, and 0.20). We observed no appreciable wipeout effect for the overdoped samples, a gradual and partial wipeout effect below about 80 K for the optimally doped ones, and very abrupt and full wipeout effect below about 40 K for the underdoped ones. The wipeout effect indicates a highly enhanced spectral weight of Cu spin fluctuations at a low frequency. We associate the wipeout effect with a Zn-induced local magnetism enhanced near the magnetic and electric instability.

21BP59 Magnetic Field Dependence of the Low-temperature Specific Heat of $MgCNi_3$

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The specific heat of a superconductor carries crucial signature of its order parameter. For example, The magnetic field dependence of $\gamma(H)$ is sensitive to the symmetry of the order parameter. The newly discovered superconductor $MgCNi_3$is predicted to be unstable to ferromagnetism, and its order parameter symmetry is of current interest. To shed light on this issue, we have measured the low-temperature specific heat of $MgCNi_3$ in *H*. Careful analysis of the data reveals a $\gamma(H) \propto H$. Together with other physical properties, the results strongly indicate that $MgCNi_3$ is a moderate-coupling BCS superconductor.

21BP60 First observation of superconductivity in LaCu6 and possible applications

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We have measured the ac susceptibility and resistivity of highly pure samples of the intermetallic compound $LaCu_6$ down to ultralow temperatures. We have prepared the samples by arc melting of stoichiometric amounts of 99.99% La and 99.9999% Cu in a water-cooled copper crucible under Ar protective atmosphere and analysed them by x-ray diffraction and SQUID magnetometry. At $T \leq T_c = 0.16K$ we observe a sharp superconducting transition. Due to the manifold physical properties of isostructural $ReCu_6$ compounds (e.g. RE = Ce: heavy fermion system, RE = Pr: hyperfine enhanced nuclear spin system, RE = Nd: electronic antiferromagnet), numerous studies of interplay phenomena may become possible in the quasibinary compounds $RE_{1-x}La_xCu_6$, respectively.

Dynamic Screening and Superconductivity in Layered Intercalated Chloronitrides **21BP61**

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Experiments done on nitride chloride (Hf,Zr)NCl and related layered materials have shown that intercalation of metallic ions (Na, Li) leads to a strong enhancement of the superconducting critical temperature $T_c(\sim 25\mathrm{K})$. It is known that the electron-phonon interaction alone is unable to explain such high T_cs. We show that the strong increase in T_c is due to the pairing induced by the dynamic screened Coulomb interaction, via exchange of low energy electronic collective modes (”acoustic” plasmons). This additional coupling is specific to layered systems. We describe quantitatively the experimental findings.

Possible Superconductivity in Langmuir-Blodgett Films based on Alkylammonium-metal(dmit)$_2$ **21BP62**

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We report on the possible superconducting transition of the Langmuir-Blodgett (LB) film of ditetradecyl-dimethylammonium-Au(dmit)$_2$. The evidence has been observed as a sharp diamagnetic drop of the ac magnetic susceptibility at 3.9 K and it shifts to the lower temperature side for 0.6 K with superposing a dc magnetic field of 60 mT. The lateral resistance shows a blunt decrease with decreasing temperature below 3.9 K. The effects of stronger magnetic fields and hydrostatic pressure will be also presented.

Antiferromagnetic vortex core of $\mathrm{Tl_2Ba_2CuO_6}$ studied by ^{205} Tl-NMR **21BP63**

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Unlike conventional BCS superconductors, HTSC have strong antiferromagnetic correlations, and thus the microscopic electronic structure of HTSC is quite different from that of the conventional ones. Recently physics of vortex core of HTSC attracts great interest. Here, we report spatially-resolved NMR studies on the magnetic properties of vortex core of HTSC. The extremely large enhancement of the nuclear spin-lattice relaxation time, T_1, of the Tl site of $Tl_2Ba_2CuO_6$ is observed in the vicinity of the vortex core. The broadening of the ^{205}Tl-NMR spectrum is observed at low temperature. Based on our NMR results, we will give a clear evidence of the antiferromagnetic vortex core in $Tl_2Ba_2CuO_6$.

21BP64 Ultrafast optical response of TBCCO(2212) thin films

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Ultrafast optical response of TBCCO(2212) thin films has been investigated by means of a pump-probe technique using femtosecond optical pulse. The time-resolved pump-probe data showed a relaxation time of optically excited quasi-particles as long as 3.6ps at 4.6K. This value is an intermediate value between those for YBCO(123) and BSCCO(2212), and well explains the difference in the radiation properties of terahertz-wave pulse emitted by FOP illumination to these HTSC materials. These experimental details will be presented.

21BP65 La214 phase diagram features as a consequense of percolation over -U centers

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The mechanism of -U center formation in high-Tc superconductors (HTS) with doping is considered. It is shown that the transition of HTS from insulator to metal passes through the particular dopant concentration range where local transfer of singlet electron pairs from oxygen ions to pairs of neighboring cations (-U centers) are allowed while the single-electron transitions are still forbidden. The arising singlet hole pairs are localized in the nearest vicinity of -U center and the hole conductivity starts up at the dopant concentration exceeding the percolation threshold for chain of -U centers. In the framework of the proposed approach taking into account the partial dopant ordering the phase diagram of Ln-214 compounds is constructed. Also the mechanism of ”stripe” structure formation is considered as a consequence of the spiral ordering of AFM microdomains in spin glass phase.

21BP67 Negative Magnetoresistance in Granular HTSC with Trapped Magnetic Flux

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Magnetoresistive properties of Bi-based ceramic and film HTSC with trapped magnetic flux are investigated in the temperature region near superconducting transition. The effect of trapped field and transport current values and orientations on the field dependence of magnetoresistance ΔR(H) is studied. It was found that for the magnetic field parallel and the current perpendicular to trapping inducing field the dependence ΔR(H) is nonmonotonic and magnetoresistance turns out to be negative for small fields, H$<$H$_i$. The magnetoresistance sign inversion field H$_i$ and the maximum value of negative magnetoresistance increase linearly with the trapped magnetic field and slightly decrease with transport current. The results are explained in the framework of model of magnetic flux trapping in grains or superconductive loops embedded in weak links matrix.

Cross Field Vortex Interactions in Bi2212 Studied by Microwave Absorption **21BP68**

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We have succeeded to detect vortex reentrant phase (RP) by field (H) swept microwave absorption (MA) on Bi2212 crystal. Microwave power (P) dependence of the spectrum was investigated for H//c-axis. The broad peak (solid phase) shifts rapidly to lower H with increasing P for P<10 mW due to sample-temperature rise (by 4 K) by the stronger MA. Then it shifts gradually for higher P due to a competing effect; higher field shift of the solid phase due to stronger pinning nature of Abrikosov vortex (AV) by the microwave-field induced Josephson vortex (JVm). When H is applied along 45 deg (cross field), the dip (RP) is enhanced and the broad peak is shifted to "higher" field with increasing P. The reentrant melting is promoted owing to decoupling of 2D pancakes by JVm at the low H. Though the pinning is enhanced at the higher H because the thread-like AV is more pinned in two-dimensions by JVm and H-induced JV.

An anomalous dip in thermoelectric power of $Nd_{1-x}Pr_xBa_2Cu_3O_{7-\delta}$ **21BP69**

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The thermoelectric power, S, has been studied for sintered samples of $Nd_{1-x}Pr_xBa_2Cu_3O_{7-\delta}$ with $0 \leq x \leq 0.30$ in the temperature range from the superconducting T_c to room temperature. S increases with decreasing temperature, and has a broad maximum at T^{max} in the region around 120 K before decresing strongly when T_c is approached. Transport properties indicate a decrease of charge concentration with decreasing doping, x, from $S(x, 290K)$, $T^{max}(x)$, and the resistivity $\rho(x, 290K)$. An anomaly has been observed in $S(T)$ for $x \geq 0.20$ in the form of a dip at 78 K of order 15% of S. The origin of this feature is not known.

Crossing Lattices State Probed by c-axis Resistance **21BP70**

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In highly anisotropic layered superconductors like $Bi_2Sr_2CaCu_2O_{8+y}$ (BSCCO), the existence of crossing lattices (CL) in the vortex phase has been recently known in fields tilted from c-axis. To investigate the properties of CL state, we have measured the c-axis resistance $R_c(H)$ as a function of field in BSCCO intrinsic Josephson junctions fabricated by focused ion beam. When the field is tilted from the c-axis, Josephson-vortex flow resistance appears at low c-axis fields in the so-called lock-in state. Although the vortex flow stops when pancake vortices start to penetrate, the c-axis resistance gradually reappears in CL state with increasing field. In this regime, we observe specific features originated from CL state.

21BP71 Phase Diagram and Dynamical Matching of Josephson Vortices in Mesoscopic Layered High-T_c Superconductors

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We study Josephson vortex lattice structures and their dynamics in mesoscopic layered High-Tc superconductors. Although superconducting vortices generally form the triangular lattice due to their repulsive interaction, the behavior drastically changes for Josephson vortices in mesoscopic sample of layered High-Tc superconductors by influences from sample edges. Moreover, Josephson vortices show a unique dynamical effect due to dynamical matching with sample edges. In this paper, we clarify both their static structures and dynamical effects in mesoscopic scale by performing computer simulations on the coupled sine-Gordon equation.

21BP72 The Fluctuations of a local magnetic field in underdoped cuprates

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Nuclear magnetic-nuclear resonance and muon spin resonance experiments show that in underdoped cuprates, on cooling from T_c, divergent behaviour of the relaxation rates(glassy spin-freezing) occurs [1]. Recently the rpresent author [2] has proposed the chiral-like spin-glass mechanism in underdoped cuprates. More recently Mooke $et.al.$ [3] by means of inelastic neutron scattering measurements in underdoped superconducting(YBCO) detected longitudinal with respect to c-axis magnetic moments of unkown origin, with the fluctuation of a local magnetic field. In this study, we will propose the origin of the fluctuations of a local magnetic field due to the chiral-like spin-glass mechanism.
[1] M.H.Julien et.al. Phys.Rev.B63,144508(2001). [2] I.Kanazawa, Physica C 357-360,149(2001). [3] H.A.Mook $et.al.$ Phys.Rev.B64,012502(2001).

21BP73 Apparent non-scaling of pinning force data in Bi-based high-T_c superconductors

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The scaling of the normalized volume pinning forces, $F_{\rm p}/F_{\rm p,max}$, versus a reduced field $h = H_{\rm a}/H_{\rm scale}$ has proven to be a very informative tool to study the origin of the flux pinning in superconductors. Remarkably, on (Pb,Bi)$_2$Sr$_2$Ca$_2$Cu$_3$O$_{10+\delta}$ (Bi-2223) and Bi$_2$Sr$_2$CaCu$_2$O$_{8+\delta}$ (Bi-2212) data were mostly analyzed only in a narrow temperature range around 77 K). Here, we present a study of the pinning forces in various Bi-2223 samples at temperatures between 18 K and 80 K. The measurements clearly reveal that there is an apparent non-scaling of the pinning force data; instead, two different temperature regimes can be recognized, which are in direct relation to the second step in the $m(T)$ curves as reported earlier.

Vortex solid-to-liquid transition in underdoped $YBa_2Cu_3O_{7-\delta}$ single crystals with $B \parallel ab$ 21BP74

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From studies of ab-plane and c-axis resistivity in underdoped single crystals of $YBa_2Cu_3O_{7-\delta}$, a nearly magnetic field independent vortex solid-to-liquid transition is found at high magnetic fields $B \parallel ab$. Experimentally, the vortex solid-to-liquid transition appears to occur almost simultaneously for the two orientations despite the fact that the Lorentz force is directed along the ab-planes for the c-axis resistivity and across the layers for the ab-plane resistivity. Thus, in moderately anisotropic layered materials, the intrinsic pinning due to the layering does not lead to a total decoupling of the layers. Instead it suggests a collectively pinned vortex lattice with suppressed thermal fluctuations along the c-axis.

Dislocation Mechanisms in Crystalline and Flux-Line Lattices 21BP75

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The remarkable finding of this work is the strict identity of dislocation dynamics in crystalline lattices (CL) and the kinetics of flux penetration into low- and high-temperature superconducting films. This is confirmed by every detail of their common features: surface and size effects, the same sigmoidal form of temperature-, stress and stress-field sweep rate dependences of the mean paths of dislocations and magnetic structures, the same scaling of H_{c1} and H_{c2} for FLL and for the starting and yield stresses in CL [1] etc. This corroborates the strict correlation between the properties of CL and their FLL, the vital role of deformation work-hardening in the origin of superconductivity [1].

1. V.P. Kisel et al., Proc. Symp. Micro-Nanocryogenics, Aug. 1-3, 1999, Finland, Res.Rep. 3/99,pp 48-51; cond-mat/0009648; Uzbek J. of Physics, 2, No 1., 89 (2000).

Critical fields and flux-flow resistances in strongly disordered ultra-thin superconducting films 21BP76

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Strongly disordered ultra-thin films of *Bi* and *Sn*, (< 100Å) produced by quench-condensation, are well known systems that show Insulator-Superconductor transition. Some aspects of the transition and the nature of the superconducting state are weakly dependent on the material and substrate, but we find that the critical field (H_{c2}) of *Bi* and *Sn* films of comparable resistance show different temperature dependences. For *Sn* the mean field H_{c2} is seen to vary with tempearature as $H_{c2}(T) = H_{c2}(0)(1 - (\frac{T}{T_c})^2)$, whereas for *Bi* it is found to be $H_{c2}(T) = H_{c2}(0)(1 - \frac{T}{T_c})^\alpha$ with $\alpha \approx 1.14$. In films with low sheet resistance we find a dissipationless vortex solid regime. The flux-flow resistance calculated from the *I-V* traces taken in several magnetic fields show a much faster field-dependence than existing theories predict.

21BP77 Guided vortex motion in Nb films on facetted substrate surfaces

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Anisotropy of the pinning force in superconductor can cause a guiding effect on the vortices, which leads to the appearance of new components in the galvanomagnetic properties of the sample. In this case one can observe an additional odd magnetoresistive component with respect to magnetic field reversal. Furthermore, an even contribution to the Hall voltage is observed. Guided motion of vortices in Nb films on facetted $\alpha - Al_2O_3$ $(10\bar{1}0)$ was found by measuring the longitudinal and transversal resistivities of three films with transport current directed parallel, perpendicular and at an angle 45^0 with respect to the facet ridges. Field inversion was used to separate the even and odd components of the measured magnetoresistivities to obtain contributions caused by the guided vortex motion.

21BP78 A Critical-Current Jump Triggered by Vortex-Lattice Screw Dislocations

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The energy of vortex-lattice screw dislocations is computed numerically by basing upon the isotropic London approximation, where the Burgers vectors of two adjacent slip planes are antiparallel. The results of computation are applied to the Larkin-Ovchinnikov pinning theory. The present modified pinning model predicts that, for sufficiently strong pinning, a vortex lattice stably possesses screw dislocations with the slip-plane spacing nearly equal to the vortex-lattice constant. In a superconducting film, penetration of such screw dislocations triggers vortex-line bending accompanying a discontinuous jump of the critical current. This prediction is compared with the critical-current jump observed in amorphous Nb_xGe films.

21BP79 Transformation from flux tube array to labyrinthine pattern in the intermediate state of superconducting Indium

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Magnetic flux structures in Type I superconductors are observed by the magneto-optical imaging technique using a CdMnTe semimagnetic quantum well heterostructure as a probe. A superconducting 10 micrometer thick Indium plate is submitted to a perpendicular applied magnetic field. At low field, the flux is arranged in flux tubes. There size, corresponding to 500 flux quanta, is observed to remain constant when the field is increased. At higher field, the tubes merge to form a labyrinthine pattern. This transformation seem not to be predicted by conventional intermediate state models.

STM Imaging of Vortex Structures in NbN Thin Films **21BP080**

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We report on imaging of the vortex structure in NbN thin films (~ 50 nm) by using low temperature scanning tunnelling microscopy and spectroscopy (LT-STM/STS) technique at 4.2 K. The NbN thin films were prepared by rf-sputtering method. In order to avoid oxidation and to obtain the smooth surface, very thin films of amorphous (a)- Mo_3Ge and Au were covered immediately after deposition of NbN thin film. The top surface is a superconducting everywhere in zero fields and vortices are imaged up to 1.2 T. The vortices show a disordered structure in all the field region measured, indicating the strong pinning effects in the NbN thin films. The field dependence of the vortex structure and the pinning properties are discussed comparing the results of the weak pinning material such as a-Mo_3Ge thin films.

Zero-bias conductance peak in disordered ferromagnetic metal/$d_{x^2-y^2}$ wave superconductor junction **21BP81**

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We investigate numarically the spin-polarized tunnleing effect in ferromagneic metal / insulator / $d_{x^2-y^2}-$wave superconductor (FM/I/d-wave SC) junctions.

Mean field approach to dynamical melting and transverse pinning of moving vortex lattices interacting with periodic pinning **21BP82**

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Dynamical melting and transverse pinning of moving vortex-lattices in clean superconducting films with periodic pinning are studied by a mean-field treatment of Langevin's equations for the whole vortex-lattice, assuming elastic flow. Vortex displacements due thermal fluctuations and to the periodic pinning force are calculated by a perturbative solution of the mean-field equations of motion. The dynamical melting temperature is obtained using Lindemann's criterion. Transverse pinning is demonstrated for motion along the periodic pinning high-symmetry directions and the critical force is estimated.

21BP83 Scanning Tunneling Spectroscopy of Sr_2RuO_4

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We will present preliminary results of scanning tunneling spectroscopy studies of the spin-triplet superconductor Sr_2RuO_4 with an ultra-low temperature scanning tunneling microscope which operates at temperatures below 100 mK and in magnetic fields up to 6 T. Single crystals of Sr_2RuO_4 are cleaved along the ab plane at 8 K in an ultra-high vacuum (UHV) chamber, and then transferred to the STM chamber without braking the UHV environment. We found that the resultant surfaces are clean and flat from the low energy electron diffraction studies. Spatial information of the quasiparticle density of states, i.e., the superconducting gap structure, near the quantized vortices in magnetic fields will be reported.

21BP84 Nuclear Magnetic Relaxation Rate in the Vortex State of a Chiral p-Wave Superconductor

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Recently the site-selective NMR method for vortex cores in type-II superconductors was revealed to be a powerful experimental tool for investigating the electronic structure inside vortex cores related to the pairing symmetry. We theoretically study the site-selective relaxation rate T_1^{-1} inside a vortex core in a chiral p-wave superconductor within the framework of the quasiclassical theory of superconductivity. We find that T_1^{-1} inside the vortex core depends on whether the vorticity and chirality are parallel or antiparallel, i.e., on the sense of the chirality of the Cooper pair. Numerical results for T_1^{-1} are presented to show typical features of the difference in T_1^{-1} between the two chiral states $\hat{k}_x \pm i\hat{k}_y$.

21BP85 Josephson Effect in s-wave / p-wave / s-wave superconductor junction

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Anomalous behavior of Josephson current in Pb/Sr_2RuO_4/Pb was studied both theoretically and experimentally. The calculated results of temperature dependence of Josephson current in s-wave / p-wave / s-wave superconductor junction show nonmonotonic behavior depending on the thickness of the p-wave superconductor. This behavior was also observed by experiment of Pb/Sr_2RuO_4/Pb junction, and obtained results are one of the evidence of triplet superconductivity on Sr_2RuO_4. However, in the previous theoretical study, the effects of barrier potential at the interface and spin-orbit coupling are not considered. In this paper, we calculate the Josephson current including these effects.

Two dimensional superconductivity with strong spin-orbit interaction **21BP86**

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We consider superconductivity confined at a two-dimensional interface with a strong surface spin-orbit (Rashba) interaction. This system is special in that the superconducting order parameter can no longer be classified by singlet or triplet. We evaluate the spin susceptibility and consider the magneto-electric effects of this sytem, using simple arguments. We explain physically the results previously obtained by Edelstein, and by Gorkov and Rashba. Furthermore, we show the existence of an additional magneto-electric effect, that an in-plane Zeeman field can induce a supercurrent flow.

Quantum Vortex Liquid State in the Quasi Two Dimensional Organic Superconductor κ-(BEDT-TTF)$_2$Cu(NCS)$_2$ **21BP87**

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We report the transport properties in the quantum vortex liquid (QVL) state of the layered organic superconductor κ-(BEDT-TTF)$_2$Cu(NCS)$_2$. In QVL the low resistance state appears below about 1 K. The finite resistivity remains in the low resistance state even at $T \sim 0$. It is noted that a weak non-linear behavior is found in the low resistance state. Such non-linearity is not observed in the high resistance state and the thermal vortex liquid region above 1 K. These transport properties are similar to the short range vortex order state discussed as the *vortex slush* phase in the High-T_c oxide. We will also mention about an insulating behavior in QVL near the upper critical field at $T \sim 0$.

Phase diagram of partially deuterated κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Br **21BP88**

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The phase diagram of κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Br around the metal-insulator (MI) boundary controlled by partially deuteration and by cooling rate through the 80 K anomaly has been investigated by resistivity measurements under magnetic fields. According to approach to the critical region of MI transition from the metallic side by the progressive deuteration and by the increase of cooling rate, a) in addition to the deuteration and the cooling rate dependence of the resistance maximum, the hump structure of resistance, observed at 33 K in the partially deuterated sample for slowly cooled, is shifted towards a lower temperature, b) the temperature of the resistance jump with the hysteresis of resistance increases. Our results suggest that these anomalies are related to the phase separation of the metallic and insulator phase around the MI boundary.

21BP89 Thermal conductivity of the antiferromagnetic conductor κ-(BETS)$_2$FeBr$_4$ in the low-field and field-induced superconducting states

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The thermal conductivity study of the low-field and field-induced superconducting states of the antiferromagnetic organic conductor κ-(BETS)$_2$FeBr$_4$ is presented. Both the antiferromagnetic state with T_N = 2.3 K and the superconducting state with T_c= 1.1 K are shown to be of bulk nature. The magnetic pair-breaking is shown to be responsible for field and orientation dependence of thermal conductivity and for unusual anisotropy of the upper critical fields in the low-field state. In the parallel fields above 10 T the thermal conductivity shows formation of a re-entrant superconducting state due to a Jaccarino-Peter effect.

21BP90 Mechanism of High Temperature Superconductivity in Intercalated Fullerides

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Intercalation of polyatomic molecules into a superconductor can strongly affect the properties of the compound. The recent observation of high T_cs in hole-doped C_{60} fullerides intercalated with CHX_3 (X=Cl,Br) molecules is explained by the additional contribution to the pairing arising from the interaction of holes with the vibrational manifold of the intercalated molecules. The observed large shift in T_c upon Cl→Br substitution (80K→ 117K) is described by the "softening" of the molecule's vibrational spectrum and is calculated in good agreement with the experiment. We suggest to observe site-selective isotope effect and that intercalation of CHI_3 molecules will increase the critical temperature to $T_c \simeq 140$K [A.B., V.Z.K., Eur.Phys.J.B **26**, 3 (2002).] We also present band structure calculations within DFT using DMol^3.

21BP091 Effect of Pressure on the Superconducting Properties of $Y_{0.5}Ho_{0.5}Ni_2B_2C$

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In the rare earth borocarbide RNi_2B_2C, the antiferromagnetism is well known to coexist with superconductivity. In the present work, we attempted to measure the electrical resistance and lattice spacings under high pressure to make clear the interplay of antiferromagnetism and superconductivity under high pressure. It is found that the superconducting transition temperature T_C decreases with increasing pressure and the tetragonal $ThCr_2Si_2$ structure is stable up to 10 GPa at room temperature.

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Specific Heat Study of Magnetic Superconductor $ErNi_2B_2C$ Single Crystal under Magnetic Fields

21BP92

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The low temperature specific heat C_p was measured in a borocarbide magnetic superconductor $ErNi_2B_2C$ single crystal. In the absence of magnetic fields, both antiferromagnetic and weak ferromagnetic transitions were clearly observed as peaks in C_p at T_N and T_{WF}, respectively. Under magnetic fields parallel to the [110] direction, T_N monotonically decreases with increasing field, while T_{WF} increases at low fields and decreases above 1 T. This reentrant behavior of T_{WF} is reasonably explained by assuming the competition between crystalline magnetic anisotropy and the weak ferromagnetism arising from the magnetic moment at the antiferromagnetic domain wall.

Superconductivity and Thermal Conductivity of $LuNi_2B_2C$ under Apllied Magnatic Fields

21BP93

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The superconductivity and thermal conductivity of the nickel borocarbide compounds $LuNi_2B_2C$ system has been systematically studied, together with other systems of RNi_2B_2C (R=Y or rare earth). Temperature and applied magnetic field dependences of the superconductivity and thermal conductivity have been measured in the temperature range from 4.2 K to 25 K, under the applied magnetic field range from 0 to 80 kOe. The thermal conductivity in zero magnetic field showed clear changes at its superconducting transition temperature, and the magnetic field dependence of the thermal conductivity showed characteristic changes at the lower and the upper critical fields at temperatures below T_c.

Synthesis of the Electron-Doped Bismuth Oxide $Ba_{0.6}Bi_{0.4}BiO_{3-x}$

21BP94

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The electron-doped bismuth oxide $Ba_{0.6}Bi_{0.4}BiO_{3-x}$ has been successfully synthesized by the two-step heating method. Stoichiometric mixed powders of BaO_2 and Bi_2O_3 were heated in a flowing gas of N_2 at 800°C for 12 hours. The reacted samples were heated at 400°C first in a flowing gas of O_2 for 24 hours and then under O_2 of high pressures at 400°C for 96 hours. It crystallized in the pseudo-cubic symmetry. From the XRD and ICP analyses, the substitution of Bi for Ba has been confirmed. From the iodometric titration, the oxygen content $3-x$ has been estimated as 2.92. The product has been found to remain an insulator. This may be due to the oxygen vacancy and/or the tilt of the BiO_6 octahedron.

21BP95 Phase state diagram of high-T_c Ba-K-Bi-O

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The magnetic behavior of Ba-K-Bi-O single crystals below T_c was investigated. The magnetic moment hysteresis loop were examined with the help of a small Hall detector. The complex analysis of data on temperature dependencies of the residual magnetic moment and H_{c1}, obtained from the magnetic experiments, and the resistive superconducting transition curves give rise to the following picture: at T_c=30 K the transition to the continuos superconducting phase takes place, while at T*=17 K one more transition happens - to spatially inhomogeneous superconductor- insulator state, that also could be destroyed either by temperature or by magnetic field.