Session 26BP

Inhomogenuous Superconductivity Coexisting with SDW stripes in the Two-Dimensional Hubbard Model **26BP1**

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The superconducting and SDW condensation energy of a spatially inhomogeneous d-wave superconducting state coexisting with SDW stripes is studied by using the Variational Monte Carlo method. We calculate its size dependence for various doping rates in the two-dimensional Hubbard model. In the strong correlation system with on-site coulomb energy *U=8t*, it turns out that the coexistent state is more stable than the commensurate SDW or the homogeneous superconducting state in the under-doping region. The obtained hole-density dependence of the incommensurability of the coexisting state is in good agreement with the neutron scattering data for $La_{2-x}Sr_xCuO_4$. We also study on CDW amplitude, next-nearest hopping *t'* and transfer anisotropy.

Unambiguous relationship between the Hubbard, t-J and d-p Models in One-dimension Based on the Luttinger Liquid Theory **26BP2**

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We examine the one-dimensional (1D) d-p model in comparison with typical 1D models such as the 1D Hubbard model and the 1D t-J model using the numerical diagonalization method combined with the Luttinger liquid theory. We calculate the spin velocity v_s, the charge velocity v_c and the Luttinger liquid parameter K_ρ for each model. Using these parameters, a relationship between the models is obtained unambiguously. We find that the d-p model can be described by the Hubbard model in the wide parameter region, while it can be described by the t-J model only in the strong coupling limit.

26BP3 Strong Evidence for the Three-Dimensional Fermi Liquid Behaviour of Quasiparticles in High-$T_{\rm C}$ Cupurates

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It is generally believed that the behaviours of quasiparticles (holes) in high-$T_{\rm C}$ cupurates should be attributed to the two-dimensional(2D) electronic states in the Cu-O planes. The various anomalies of the transport coefficients for temperatures above $T_{\rm C}$ are long-standing insoluble puzzles and cause serious controversy. Here we reanalyzed the published experimental data of LSCO cupurates. We have found that the normal-state susceptibility, resistivity, Hall coefficient etc vary precisely as $T^2 \ln T$ as a function of temperature T in agreement with the prediction of the Fermi liquid model. The quasiparticles are shown to definitely behave as a 3D Fermi liquid. Various attempts to describe the system in terms of non-Fermi liquids, e.g. RVB state, seems to be erroneous.

26BP4 BCS-like Pairing Ground State on Two-Dimensional Plaquette Lattice

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We study the two-dimensional Hubbard model on the plaquette lattice as shown in the figure. At half filling, we solve the ground state *exactly* in the plaquette limit, $t_p/t \ll 1$. We are able to put down the exact wave function and determine the symmetry of these preformed pairs. It is rather surprising that the ground state is a spin liquid with preformed BCS-like electron pairs. Upon doping, these preformed pairs are no longer locked to the lattice and become mobile. The ground state changes into a superconductor. Applications for the similar technique to quasi-one-dimensional systems, such as ladders, carbon nanotubes and ribbons, are also discussed.

26BP5 Parameter Dependence of the Superconducting Condensation Energy of the Two-Dimensional Hubbard Model

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The two-dimensional Hubbard model is believed to contain essential electronic elements which give rise to the high-T_c superconductivity. The strongest material-dependence giving rise to a wide range of T_c must have been condensed in the second nearest neighbor transfer energy t'. Its evaluation and how and to what extent it enhances superconductivity stay important issues. Using the variational Monte Carlo method we have computed the t'-dependence of the superconducting condensation energy for the titled model of the size up to 20×20 with electron density ~ 0.84. The energy starts to sharply rise when t' decreases from zero to -0.10, reaching the maximum around $-0.10 \sim -0.15$ and turns to decrease, vanishing around -0.35 (in energy unit t). The rising part is in a qualitative agreement with observations.

Spectral properties of incommensurate CDW scattering in cuprates **26BP6**

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Recent STM experiments strongly support the existence of two-dimensional 'checkerboard' charge modulations in $Bi_2Sr_2CaCu_2O_{8+\delta}$. We show that the associated collective charge dynamics can also account for the peculiar features as seen in ARPES experiments. Especially the famous peak-dip hump structure of the line shape and the related kink in the dispersion can be well described by the coupling of the charge carriers to dynamical incommensurate CDW fluctuations. From a comparison with ARPES data we obtain a mode frequency which decreases towards optimal doping thus strongly supporting the existence of a quantum critical point around this concentration. Finally we extend our approach in order to include the recently observed bilayer splitting. It turns out that the coupling to incommensurate CDW modes naturally can account for the reduced splitting in the superconducting state.

Topological order in Gutzwiller-projected wave functions **26BP7**

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Gutzwiller projection allows a construction of an assortment of variational wave functions for strongly correlated systems. For quantum spin $S = 1/2$ models, Gutzwiller-projected wave functions have resonating-valence-bond structure and may represent states with topological order and with fractional quantum numbers for the excitations. Using insights obtained from field-theoretical descriptions of fractionalization in two dimensions, we construct candidate wave functions of fractionalized states by projecting specific superconducting states. We explicitly demonstrate the presence of topological order in these states.

Effect of a geometrical frustration in the doped Mott insulator **26BP8**

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The two-dimensional t-J model on the triangular lattice has been studied using high temperature expansions. By calculating the entropy and the spin-spin correlation function through twelfth order in inverse temperature, we revealed that hole doping favors a nearest-neighbor singlet formation, indicating that the resonating valence bond state is stabilized in low temperatures. On the contrary, with electron doping, we find that there exists a wide ferromagnetic region in the phase diagram, which is related to the Nagaoka's ferromagnetism, the flat band ferromagnetism and the Kanamori's ferromagnetism. It is also found that the competition between this ferromagnetic behavior and the antiferromagnetic coupling results in the large effective mass near half filling.

26BP9 Zero-energy edge states and their origin in particle-hole symmetric systems: symmetry and topology

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When a bulk system is truncated, it may support zero-energy edge states localized near the boundary. In this article, we propose a criterion to determine the existence of zero-energy edge states for a class of particle-hole symmetric systems. A loop is assigned for each system, and its topology and a symmetry play an essential role. Applications to several systems such as d-wave superconductors and graphite ribbons are demonstrated. A variants of the Jahn-Teller theorem for systems with edges is obtained, which we apply to coexistence of different order parameters near the edges in d-wave superconductors.

26BP10 ^{27}Al-Knight Shift Measurement on Heavy-Fermion Superconductor UNi_2Al_3

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We report ^{27}Al Knight-shift (^{27}K) measurement on a single-crystal UNi_2Al_3 that reveals a coexistence of superconductivity and a SDW type of magnetic ordering ($T_{\rm SDW} = 4.5$ K). The spin part of ^{27}K does not change down to 50 mK across $T_c \sim 0.9$ K. The behavior of ^{27}K reveals that UNi_2Al_3 belongs to a class of spin-triplet SC pairing state superconductor like UPt_3 and Sr_2RuO_4.
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26BP11 Fermi Surface of Ferromagnetic Superconductor URhGe

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A discovery of superconductivity at ambient pressure in the ferromagnet URhGe was reported recently. The Curie temperature is 9.5K and the ordered magnetic moment orients along the c axis. URhGe has an orthormbic crystal structure containing zigzag chains of nearest-neighbor uranium ions, which is similar to that of ferromagnetic pressure-induced superconductor UGe_2. For investigating a similarity of URhGe and UGe_2 in the Fermi surface, all-electron band calculations for ferromagnet URhGe are performed using a fully-relativistic spin-polarized LAPW method within exchange-correlation potentials in a local spin-density approximation. The shape of Fermi surface for URhGe, the contribution of the $5f$ electrons and the spin-polarization on the Fermi surface are shown as compared with those of UGe_2.

Josephson Effect in Heavy-Fermion Superconductor $CeTIn_5$ (T=Co, Ir) 26BP12

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The Josephson effect between a single crystal $CeTIn_5$ (T=Co, Ir) and an s-wave superconductor has been investigated for $CeTIn_5$-Cu-Nb junctions. Josephson critical current I_c is observed just below superconducting transition temperature T_c for $CeCoIn_5$, while the temperature below which I_c appears varies from junction to junction and I_c rises gradually at first for $CeIrIn_5$, probably reflecting a distribution of the local transition temperature in $CeIrIn_5$.

NMR/NQR study of $CeCoIn_5$ 26BP13

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$CeCoIn_5$ is the newly discovered heavy-fermion superconductor with $T_c = 2.3$ K. In order to investigate the characteristics of spin fluctuations, we have performed In-NQR and Co-NMR experiments on single crystals of $CeCoIn_5$. Our result indicates that the compound is located very close to a magnetic instability by anisotropic antiferromagnetic spin fluctuations.

Fermi surface of the Filled Skutterudite $LaOs_4Sb_{12}$ 26BP14

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The electronic bandstructure and Fermi surface (FS) are calculated for $LaOs_4Sb_{12}$, which is a reference system of a new heavy fermion superconductor $PrOs_4Sb_{12}$. [1] The calculated FS consists of two closed hole surfaces around the Γ point and a multiply connected one. The recent dHvA measurement for $PrOs_4Sb_{12}$ [2] has shown good agreement with the closed FSs topology. The mass enhancement for the cyclotron masses is estimated to be about 5, much less than 10 expected from the specific heat measurement. It indicates the multiply connected FS becomes very heavy superconducting states.

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

26BP15 Effect of Phenidone Adsorption on the Superconducting Parameters of Ceramics Bi-Pb-Sr-Ca-Cu-O

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A treatment of the Bi1.8Pb0.3Sr3-xCa1+xCu3Oz ceramics with acetone solution of phenidone (1-phenyl-3-pyrazoline) at room temperature during 50 days resulted in: (1) for the ceramics with an optimal x, we have observed a two-fold increase in critical current, (2) a high-temperature superconducting phase (with Tc = 105 K) appears in the strontium rich ceramics which was originally nonsuperconducting above 77,4 K, (3) the interaction between phenidone and the ceramics surface results in an increase in the size of a unit cell caused by evolution of labile oxygen due to oxidation of phenidone.

26BP16 A Comparative Analysis of the Superconducting and Normal-State Properties in $Tl_2Ba_2Ca_{n-1}Cu_nO_{2n+4}$ with Different n

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We have studied the effect of increasing number of copper-oxygen layers on the band spectrum parameters in the normal state for the $Tl_2Ba_2Ca_{n-1}Cu_nO_{2n+4}$ system (n=1,2,3) based on the thermopower analysis within a narrow-band model. The conduction band band is found to be slightly asymmetric, the total effective bandwidth for all the phases with $n \leq 3$ is about 100 meV and demonstrates a tendency to a band broadening with increasing n that correlates with optimization of superconducting properties. The results obtained allowed us to propose an hypothesis for the T_c variation with n in the case of near-optimally doped compositions. This can provide an important information on the nature of the band responsible for the conduction process and on the relation between the normal state and superconducting properties.

26BP17 Pressure effects on the superconductivity in $FeSr_2YCu_2O_{7+\delta}$ oxide superconductor

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We have investigated the pressure dependence of superconducting transition temperature (T_c) in $FeSr_2YCu_2O_{7+\delta}$ oxide superconductor (Fe1212). The superconducting Fe1212 samples were synthesized by solid-state reaction with multiple annealing process. The T_c-onset of this sample exhibited about 60 K at an ambient pressure. The pressure dependence of T_c was obtained about 2.1 K/GPa up to 2 GPa.

Partial Melting in Filamentary Sm-Ba-Cu-O Superconductors under Various Oxygen Atmospheres **26BP18**

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The filamentary Sm123 precursor was prepared by a solution spinning method. The precursor was partially melted in flowing 0.1%O_2+Ar and 1%O_2+Ar and oxygenated. The obtained sample showed the T_c value of around 90 K and exhibited dense and well aligned texture along the filament diameter as well as the direction of filament length. The sample melted in flowing 1%O_2+Ar showed a relatively high J_c value more than 10^4A/cm^2 over a wide partial melting temperature range of 1020°C-1050°C and the excellent reproducibility.

Critical temperature oscillation in the thermal cycle below 16 K in $Y_{0.83}Ca_{0.17}Ba_2Cu_3O_6$ sintered sample **26BP19**

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We report the evolution of a three-step incipient resistive superconducting transition in $Y_{0.83}Ca_{0.17}Ba_2Cu_3O_6$ sintered sample under high pressure. The superconductivity shows the relaxation effect in the loading and unloading process below 0.4 GPa. After quenching the sample under the relaxation process below 80 K, significant oscillation of the resistive superconducting transition is observed in the thermal cycle below $\sim$16 K, in spite of no change in the normal-state resistivity. Since there is no mobile oxygen in the present sample, the effect of oxygen rearrangement can be ignored. The observed result will be discussed by the pressure-induced Josephson coupling and charge redistribution within the CuO_2 planes.

Depression of the Superconducting Transition Temperature of $La_2CuO_{4+\delta}$ by Neutron Irradiation **26BP20**

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The aim of this work is to investigate the influence of neutron irradiation to superconductivity of the oxygen loaded $La_2CuO_{4+\delta}$, which were prepared from one single crystal of La_2CuO_4. The excess oxygen was loaded by annealing under high pressure oxygen gas. The neutron irradiation were performed at 10 K in the low temperature irradiation facility of Kyoto University Reactor. As a result, there were no signs of the raise of T_c. The depression rate of T_c by the irradiation is about -1K/10^{17}n/cm^2.

26BP21 Magnetic Flux Penetration in the Superconducting Core of Bi-2223 Tape

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Magnetic flux penetration into the superconducting core of Bi-2223 tapes is overlooked. Upon increasing magnetic field B_a applied perpendicular to the main tape plane, the "local" magneto-optical imaging shows that the flux penetrates in the core starting from its edges: first, filling regions in between grains, which are 5-30 μm large. As soon as magnetic flux has filled the regions around the grains throughout the entire core at $B_a^\star \simeq 15$ mT ($T = 15$ K), a decrease in the critical current density $J_c(B_a)$ measured separately by "global" magnetization measurements is observed. Below this field $B_a^\star$, the $J_c(B_a)$ behavior exhibits a magnetic filed independent plateau often referred to the single vortex pinning regime. The origin of the "global" J_c plateau discussed in the frame of the "local" flux penetration observed.

26BP22 (119) BSCCO superconducting films synthesized by MOCVD on vicinal (110) SrTiO3

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(119) Bi-2223 superconducting thin films have been synthesized by MOCVD. The substrate was vicinal (110) SrTiO3 with the off-angles along [110] azimuth of 10-20 degrees. As-synthesized films have been characterized by AFM and resistivity measurements versus temperature. Higher critical temperatures Tco and growth with less twins was observed for the films synthesized on the substrates with higher off-angles.

26BP23 Local Magnetic Properties of High-T_c Superconductors Probed by Scanning SQUID Microscopy

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In order to investigate the local magnetic properties in high-T_c superconductors, we have performed scanning SQUID microscopy on the ab-surfaces of $La_{2-x}Sr_xCuO_4$ and $Bi_2Sr_2CaCu_2O_y$ single crystal at various temperatures. The observed magnetic images demonstrated the spatial variations of T_c, which are strongly correlated with the vortex distribution.

Grain orientation of $YBa_2Cu_3O_x$ high-T_c superconductors studied by OIM **26BP24**

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Orientation imaging microscopy (OIM) provides a method for measuring a large number of individual grain orientations and relating them directly to the microstructural features by means of evaluating electron backscatter Kikuchi patterns in scanning electron microscopy. We investigated the grain orientation distributions of various YBCO ceramic samples prepared with different Alkali metal additions. The samples are characterized by pole figures, inverse pole figures, and grain orientation maps. Grain orientation distribution functions are obtained from the measured data. The $KClO_3$-doped samples are shown to exhibit a texture for an addition in the initial batch between 3 and 5 wt.-%. This observation explains the increased critical current density in the doped samples.

Superconducting Gap and Pseudogap in $Bi_2Sr_2Ca_2Cu_3O_{10+\delta}$ by Short-Pulse Interlayer Tunneling Spectroscopy **26BP25**

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We have measured the superconducting gap, pseudogap and their doping dependence of trilayer high-T_c superconductor $Bi_2Sr_2Ca_2Cu_3O_{10+\delta}$ by short-pulse interlayer tunneling spectroscopy. It is found while both gaps are a little larger than those of the bilayer system and exhibit similar temperture dependence, their systematic doping dependence has revealed an anomalous relationship between T_c and the gap size, i.e., in the overdoped region, T_c does not change from its optimum value while the gap decreases with doping. This suggests that inequivalent hole doping occurs, which is supposed in multilayer systems.

Intrinsic tunneling: a look from inside on high T_c superconductors. **26BP26**

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Layered structure of high T_c superconductor, provides a unique opportunity to probe quasiparticle density of states *inside* a bulk single crystal by means of interlayer tunnelling. Here I present a systematic doping, temperature and magnetic field dependent intrinsic tunneling spectroscopy of Bi-2212. An improved resolution made it possible to simultaneously trace the superconducting gap (SG) and the pseudo-gap (PG) in a close vicinity of T_c and to analyze closing of the PG at T^*. The obtained doping phase diagram exhibits a critical doping point for the PG and a characteristic crossing of the SG and the PG close to the optimal doping. This points towards coexistence of two different and competing order parameters in Bi-2212. Experimental data indicate that the SG can form a combined (large) gap with the PG at $T < T_c$ and that the interlayer tunneling becomes progressively incoherent with decreasing doping.

26BP27 STM/STS study on $Ca_{2-x}Na_xCuO_2Cl_2$ single crystals

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To explore the evolution of electronic states from the Mott insulator to the high-T_c superconductor, we performed scanning tunneling microscopy/spectroscopy (STM/STS) on $Ca_{2-x}Na_xCuO_2Cl_2$ ($x \sim 0.08$) single crystals which show superior cleavage. Topographic images at 7 K show clear atomic images superposed on nano-scale patch-like or river-like irregular corrugations. Spectroscopic measurements revealed that low areas are semiconducting. In high areas, the density of state (DOS) near Fermi level (E_F) increases and DOS at E_F becomes finite, while gap-like feature (∼100 meV) still remains. Namely, background corrugations are originated from the electronic inhomogeneity.

26BP28 Fluctuation Conductivity of Polycrystalline Hg,Tl-1223

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Detailed resistivity measurements were made for polycrystalline $Hg_{1-x}Tl_xBa_2Ca_2Cu_3O_{8+\delta}$ with $x = 0$ and 0.2 in zero applied magnetic field and above the superconducting transition T_c. The fluctuation conductivity $\Delta\sigma$ is analyzed. Two crossover temperatures, T^* (from two to three dimensional fluctuations in the mean field region (MFR)) and T_G (from the MFR to the critical region) could be identified for each sample. All results are in agreement with the Lawrence–Doniach model. The c-axis coherence length and the interlayer coupling factor are obtainned. The choice of background resistivity and the pseudo-gap effect on $\Delta\sigma$ are discussed.

26BP29 Evidences of Static Stripe Order in $(RE)Ba_2Cu_3O_{6+x}$ Compounds

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We have recently revealed that a stabilization of the orthorhombic crystal superstructure with 2a lattice period (T_c=50K) in the $(RE)Ba_2Cu_3O_{6+x}$ compounds takes place at 300K within narrow interval 0,45¡x¡0,65 and one is accompanied by jump of lattice parameter c and appearance of a plateau in the concentration dependences of electronic,magnetic and structural ptoperties versus x,connected evidently with pinning of dynamical stripe order of holes in CuO_2 layers with the hole concentration per Cu p=1/8 for x=0,5.We assume that 2a superstructure makes stripe order static,because this crystal structure is commensurable with period of the dynamic 1D space modulated spin-charge structures in the CuO_2 layers.

AC Susceptibilites in Ag-based Hg(Pb,Bi)-1223 Superonductors **26BP30**

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Compounds of the $Hg_{1-x}Pb_xBa_2CaCu_3O_8 + d (x = 0.1 \text{ and } 0.2)$ and $Ag_y(HgBa_{1.9}Bi_{0.1}Ca_2Cu_3O_{8+d})_{1-y} (y = 0.1 \text{ and } 0.2)$ were synthesized directly from the metal oxides without using a precursor. The structural and morphological properties were investigated. AC susceptibilities and DC magnetizations were measured using a SQUID magnetometer and a PPMS susceptometer. From the magnetic data, the critical temperatures are 131K in the composites and the estimated superconducting volume reduces when Ag content increases. Critical current deinsities estimated from the magnetization. AC losses were estimated from the imaginary part of the AC susceptibilities χ'' and favorably compared with the Bean model.

The coexistence of magnetism and superconductivity in $HgBa_2Ca_4Cu_5O_y$: ^{63}Cu-NMR Study **26BP31**

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We report NMR study on five-layered $HgBa_2Ca_4Cu_5O_y$ with $T_c = 110$ K. Knight shift at ^{63}Cu site indicates that the outer pyramidal CuO_2 planes are optimally doped, while inner planar ones are significantly underdoped. The signal of the inner planes disappear below ~ 150 K due to the strong antiferromagnetic spin correlations. Nuclear spin-lattice relaxation rate, $1/T_1$ at the outer planes suggests that antiferromagnetic order occurs in the inner planes at ~ 60 K.

Strongly Correlated Superconductivity close to Mott Insulators **26BP32**

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High temperature superconductivity in doped Mott insulators like the cuprates contradicts the conventional wisdom that electron correlation opposes to superconductivity. The fullerene, which have recently found to be high-T_c superconductors, are also correlated materials. We examine a dynamical-mean-field solution of a model for electron doped fullerenes which shows how strong correlations can enhance superconductivity close to the Mott transition. We argue that the mechanism responsible for this enhancement could be common to a wider class of models, including those for cuprate superconductors.

26BP33 The magnitude and temperature dependence of pseudogap in YBCO obtained from resistance measurements

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We report the analysis of the temperature dependence of excess conductivity $\Delta\sigma$ of the underdoped YBCO epitaxial thin films at temperatures much higher than the superconducting critical temperature T_c. The excess conductivity was determined as the difference of the extrapolated normal resistivity and the measured resistivity. It was found that the temperature dependence of the excess conductivity can de described by the following relation $\Delta\sigma = A(1-T/T^*)exp(\Delta^*/T)$. It is proposed that this relation reflects the pseudogap appearance and the magnitude and temperature dependence of the pseudogap were calculated and compared with published experimental and theoretical results.

26BP034 Observation of quantum tunneling of vortices in MgB_2 superconductors

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Irreversibility lines and magnetic relaxation of MgB_2 are studied. The Large separation between irreversibility line and upper critical magnetic field for $T \to 0$ is explained by quantum tunneling of vortices. Theoretical fits are in good agreement with experimental data. A quantum correction of the relaxation rate, followed by a time dependence of the corresponding magnetic moment, is proposed leading to a simple evaluation of the energy barrier: $U_0(T,H) \sim U_{th}(T)U_H(H) \propto (1-T/T_c)^{\alpha}(\mu_0 H)^{\beta}$ with $\alpha \sim 1.5$ and $\beta \sim -2.0$.

26BP35 Third harmonic ac susceptibility measurements on MgB_2 bulk: irreversibility line and frequency dynamic behaviour

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The third harmonics of the *ac* susceptibility of MgB_2 high pressure (HP) bulk samples have been measured at the frequency of 1070 Hz as a function of the temperature for different *dc* magnetic fields. The irreversibility line (IL) has been extracted from their temperature onsets. the IL has a typical Ginsburg-Landau dependence. Others IL lines of HP samples, draw out from VSM measurements at few Hertz, have similar behaviour. This shows that the superconducting response is indipendent from the frequency and the critical state is apply. This analysis supports that the flux dynamic is not induced by the weak link properties and a strong pinning process can be supposed in these materials.

Specific heat and thermal conductivity evidence for two-gap superconductivity in MgB_2 **26BP36**

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Specific heat C(T) and thermal conductivity K(T) for MgB_2 were measured in temperature interval T=$5 - 45$K. It was found that in addition to known features near the superconducting transition at T_c ≈40K there was anomalous behavior both C(T) and K(T) near T ≈10K. At the same temperature area the negative thermal expansion of MgB_2 was observed earlier. All these anomalies at low temperatures were explained.

Superconductivity of MgB_2 wires **26BP37**

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MgB_2 superconducting conductors have been prepared in a cooper sheath by standard powder-in-tube technique. Mg + 2B powder of high purity was ball-milled under argon atmosphere. This mixture was used to fill the cooper metal tubes. Wires were manufactured by the in situ technique, diffusing Mg to B particles, resulting MgB_2 with hexagonal structure, after cold deformation. A strong evidence for high intergranular critical current densities and large bulk magnetic flux pinning in superconducting polycrystalline MgB_2 has been observed. A comparative study of the intergranular current and grain conductivity was conducted by transport and magnetic susceptibility measurements, in magnetic field up to 7 T to define the Jcmag and the direct current J_c at 4.2 K, which revealed systematic differences in the flux pinning of the wires which is in very good agreement with direct high transport current measurements.The absence of weak link nature in this material has profound a wide range of engineering applications.

Multi-gap structure of the binary superconductor MgB_2 **26BP39**

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Tunneling measurement on MgB_2 has been carried out with a break junction technique. We have obtained the largest gap of $\Delta \sim$ 9-10 meV with $2\Delta/k_BT_c \sim 5.3$. In addition to this gap, the two-gap structures have been also observed. These two-gap spectra can be fitted by a correlated two-gap model. The fitted parameters vary rather widely leaving the larger gap parameter of $\sim$ 6-7meV kept almost constant.

26BP40 Fabrication of MgB2 Thin Film by rf Magnetron Sputtering

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Fabrication of superconducting MgB2 thin film on sapphire substrates by rf magnetron sputtering has been studied. We have tried both single-target sputtering method using an Mg-excessive MgB2 target and co-sputtering of Mg and B. Argon sputtering pressure was 20 mtorr and 5 % of hydrogen gas was added to trap remanant oxygen gas in the deposition chamber. Films were made either by in-situ deposition or in-situ annealing after the room-temperature deposition. While the films by co-sputtering with in-situ annealing showed transition temperatures higher than 24 K, those by single-target sputtering or in-situ cosputtering showed no superconducting transition or very low Tc at best. Details of the fabrication procedures will be dicussed.

26BP41 Specific Heat of $Mg^{11}B_2$: Evidence for a Second Energy Gap

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We report measurements of the specific heat of $Mg^{11}B_2$, from 1 to 50 K and in magnetic fields to 9 T, and give the values of parameters relevant to the superconductivity. The superconducting-state electron contribution is dramatically different that of other superconductors, but the general features are consistent with predictions for a two-gap superconductor, and can be quantitatively represented by a two-gap model based on BCS thermodynamics. Parameters characterizing the gaps are in good agreement with some spectroscopic determinations, and also with theoretical calculations. An unusually strong magnetic field dependence of the temperature-proportional term in the electron contribution to the vortex-state specific heat is evidently another manifestation of the two gaps.

26BP42 Fabrication and critical current density in the single and multifilament MgB2 superconducting wires

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The powder in tube method has been used to fabricate Ag, Cu and Fe clad MgB_2 wires using an in-situ reaction method. For Ag clad wire J_c is improved by more than two times after the short time sintering process. J_c values of 1.2×10^5 A/cm^2 in zero field and above 10^4 A/cm^2 in 2T at 20 K have been achieved for Ag clad MgB_2 wire which is only sintered for 6 minutes at 800^{o}C. Sixteen-filament stainless steel/Fe/MgB_2 wires also were fabricated by the powder-in-tube method followed by groove rolling and a short 8min/950^{o}C heat treatment. Magnetic critical current densities of 3.4×10^5 A/cm^2 in 0.5T and about 1.9×10^5 A/cm^2 in 1T at 5 K were achieved.

Anomalous low-temperature thermal conductivity of MgB_2 **26BP43**

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The ab-plane thermal conductivity of single-crystalline MgB_2 has been measured as a function of magnetic field with orientations both parallel and perpendicular to the c-axis and at temperatures between 0.5 and 40 K. Applying a magnetic field at constant temperature first leads to a reduction of the lattice thermal conductivity and subsequently to a rapid quasi-logarithmic increase of the electronic thermal conductivity in fields far below the upper critical field H_{c2}, followed by a saturation at intermediate fields and another rapid increase in the vicinity of H_{c2}. This behavior is associated with the field-induced suppression of two superconducting energy gaps of significantly different magnitude. At temperatures well below T_c an anomalous nonlinear temperature dependence of the electronic thermal conductivity is observed in the mixed as well as in the normal state.

Vortex Phase Diagram of $YBa_2Cu_4O_8$ in $H \parallel c$ and $H \parallel b$ **26BP44**

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Vortex phase diagram of $YBa_2Cu_4O_8$ has been investigated by means of the AC susceptibility and the DC magnetization. Phase diagram in $H \parallel c$ is very different from Bi2212 and Y123 because the onset field of the magnetization peak increases rapidly as T decreases at temperatures below 40 K. The AC susceptibility and the DC magnetization measurements in $H \parallel b$ reveals that the irreversibility line is almost independent of the applied field (at ~ 40 K). We argue that there must be an additional pinning mechanism in $YBa_2Cu_4O_8$ at temperatures below 40 K compared to Bi2212 and Y123. A possible candidate for pinning centers is a spin density wave which is recently predicted by our group. This work is partially supported by New Energy and Industrial Technology Development Organization (NEDO).

Collective motion of Josephson vortices in $Bi_2Sr_2CaCu_2O_{8+\delta}$ mesa structures **26BP45**

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Collective motion of Josephson vortices generated by microwaves or by a dc magnetic field in parallel with the planes of intrinsic junctions of Bi2212 single crystals was studied. In both cases, at a low vortex density and driving current, splitting of the 'supercurrent' branch in the current-voltage characteristics (IVC) corresponding to different plasma excitation modes was observed. At a higher vortex density, generated by fields beyond $3-4$ T, the IVC merged into a single non-hysteretic curve with kinks, similar to the features caused by the theoretically predicted structural transformation of moving vortex patterns.

26BP46 Frequency Dependence of the Depinning and Irreversibility Lines in BSCCO

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Penetration of AC magnetic field in $Bi_2Sr_2CaCu_2O_{8+\delta}$ single crystals was studied using the magnetooptic technique. It was found that the apparent depinning line shifts towards higher (H, T) values with increasing field frequency. At higher frequencies irreversibility in magnetization is controlled by pinning but not by the geometrical or surface barrier. Comparison with the melting line has shown that the depinning line lies completely in the vortex liquid region. Moreover, at least in low DC fields, the vortex liquid does not become unpinned up to the critical temperature of superconductor. Therefore, contrary to general understanding, we show that pinning is the main reason of irreversibility in magnetization at higher frequencies. It was also shown that the reason why this pinning is not observed at lower frequencies (i.e., using slow measurement technique) is the giant flux creep in BSCCO.

26BP47 Preparation, scaling behavior of activation energy, and anisotropy of Hg-1212 HTS thin films

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We have successfully prepared high-quality epitaxial $(\mathbf{Hg_{0.9}Re_{0.1}})\mathbf{Ba_2CaCu_2O_{6+\delta}}$ HTS thin films without special handling during the preparation. The resistive transition have been investigated in magnetic fields up to 6 T parallel and perpendicular to the c-axis. We have determined the scaling behavior of the effective activation energy. Under variation of the angle θ between the field direction and the c-axis of the film with high angular resolution $(\Delta\theta \approx 0.1\,^\circ)$ the anisotropic properties of the vortex state and the depinning field of epitaxially grown **Hg-1212** films have been studied.The films exhibit sharp superconducting transitions at $T_c \simeq 120$ K with $\Delta T \simeq 2$ K. Also the films exhibit critical field anisotropy with a factor 7.67 with respect to the c-axis.

26BP48 High-field Paramagnetic Meissner Effect in Melt-textured YBCO

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We present systematic field-cooled magnetization measurements in five directionally solidified samples of YBCO containing different amounts of Y-211 precipitates. Fields up to 50 kOe were applied either parallel or perpendicular to the Cu-O atomic planes. Paramagnetic Meissner effect (PME) was observed at high enough fields in all of the studied samples, regardless of the field orientation. This high-field PME shows some noticeable differences when compared to the most frequently investigated low-field PME. Our results are discussed in the light of the existing models for the PME and the role of pinning by Y-211 particles is suggested.

Generation and amplification of the electromagnetic radiation by superconducting films **26BP49**

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Coherent microwave radiation has been directly detected from Nb and $GdBa_2Cu_3O_{7-x}$ films in the frequency range up to 600 MHz. The mixed state in the superconducting films has been influenced by a superposition of two alternative magnetic fields directed perpendicular to film surface. First of them, which slow varies in time, sets up the vortex structure in the film. The interaction of the vortices with planar pinning centers leads to a metastable mixed state. While the second high-frequency electromagnetic field either external or emitted by the film, if a feedback is used, provides a synchronization of Abrikosov vortex motion. The simultaneous action of the fields results in either the amplification or generation of electromagnetic radiation. Harmonic mixing of the radiation is also detected.

Order parameter and pseudogap in electron doped high-temperature superconductors **26BP50**

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Recently, renewed interest in electron-doped high-temperature superconductors (HTS) has arisen from the question whether the phase diagram is symmetric with respect to electron/hole doping. The presently contradictory experimental status in favor of d- or s-wave symmetry of the superconducting order parameter for electron doped HTS is discussed. There are only few experimental reports on the pseudogap behavior of electron doped HTS. Here, we report on the observation of two different kinds of a normal state pseudogap in the electron doped HTS $La_{2-x}Ce_xCuO_4$ and $Pr_{2-x}Ce_xCuO_4$, one on the scale of the superconducting gap energy Δ, and one on the scale of the magnetic interaction energy J. Both gaps decrease resp. vanish with increased doping.

Magnetic excitations in the spin-glass phase of $La_{2-x}Sr_xCuO_4$ **26BP051**

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Magnetic excitations of $La_{1.95}Sr_{0.05}CuO_4$ were investigated using pulsed neutron inelastic scattering over a wide range of energy up to 300meV. In contrast to the optimally doped superconductor the dynamical magnetic susceptibility χ "(ω) around (π,π) in the spin-glass phase monotonically decreases with increasing ω and nearly saturates beyond $\sim$ 50meV. We found that the energy dependence of the q-width in the latter energy region is ascribed to a two-dimensional spin-wave dispersion relation with the nearest neighbor interaction J of 108$\pm$0.6meV, which is smaller by $\sim 20\%$ than that of La_2CuO_4.

26BP52 ^{63}Cu-NMR study of single-layer high-T_c cuprate $Bi_2Sr_{2-x}La_xCuO_6$

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We present ^{63}Cu-NMR studies in single crystals of the single-layered high-T_c cuprates $Bi_2Sr_{2-x}La_xCuO_6$. In the overdoped sample $Bi_2Sr_2CuO_6$ (T_c=9 K), we find that the ground state is a Fermi liquid state. We will also present results for under- and optimally-doped samples and discuss the phase diagram of this series of materials.

26BP53 Anomalous Damping of Phonon Thermal Transport in Slightly Y- or Eu-doped La_2CuO_4 Single Crystals

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We found that slight doping (1%) of Y or Eu to the La site strongly suppress the phonon peak at $\sim$ 20 K in the thermal conductivity of La_2CuO_4. Especially, the phonon peak completely disappears in the in-plane direction and this suppression is much stronger than that observed in 1%-Sr-doped La_2CuO_4. Magnetic susceptibility measurements show that compared to La_2CuO_4, apart from nearly unchanged Néel transition around 300 K, there appear some almost-T-independent magnetic moment in Y- or Eu-doped samples. This additional moment may come from the local lattice distortion (which causes incomplete cancellation of the antiparallel Cu^{2+} spins) or from the magnetic Eu^{3+} ions. Apparently these local moments strongly scatter phonons, which suggests a strong spin-phonon coupling in the cuprates.

26BP54 Peculiar Evolution of the c-Axis Charge Transport in $La_{2-x}Sr_xCuO_4$ Single Crystals from Antiferromagnetic Insulator to Superconducting Regime

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The in-plane and the out-of-plane resistivities (ρ_{ab} and ρ_c) are measured in high-quality $La_{2-x}Sr_xCuO_4$ single crystals in the lightly- to moderately-doped region ($x = 0.01 - 0.10$). It is found that the resistivity ratio ρ_c/ρ_{ab} at moderate temperatures ($100 - 300$ K) is almost completely independent of doping for $0.01 \leq x \leq 0.05$. It is discussed that this striking doping-independence of ρ_c/ρ_{ab} is consistent with the idea that charges form a self-organized network of hole-rich paths, which also explains the unusually metallic in-plane transport in the lightly-doped region [Y. Ando, A.N. Lavrov, S. Komiya, K. Segawa, and X.F. Sun, PRL **87**, 017001 (2001)]. For $x > 0.05$, ρ_c/ρ_{ab} shows a rapid decrease, which suggests that the c-axis charge confinement becomes less effective as x is increased in the superconducting regime.

Low-Temperature Specific Heat of overdoped Bi2201 Single Crystals **26BP55**

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Low-temperature specific heat of Pb-doped $Bi_2Sr_2CuO_{6+\delta}$ single crystals with various doping states was studied. The most overdoped sample showed no evidence of superconductivity down to 0.5 K, while T_c increased up to 19 K with reducing the oxygen content. The specific heat included a linear-T term for all samples. The residual electronic specific heat coefficient γ increased with carrier density, and smoothly connected to the value of the non-superconducting sample. This behavior of γ suggests a pair breaking mechanism that develops with doping. We tentatively attribute the origin of pair breaking to impurities, because their influence on d-wave superconductors increases when T_c, and hence the energy gap, decreases. The field dependence of γ followed well the prediction for an impure d-wave superconductor.

$^{63/65}$Cu NMR Study on $Nd_{1.85}Ce_{0.15}CuO_{4+\delta}$ **26BP56**

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The title material is known as the electron-doped high-$T_{\rm C}$ superconductor, while the oxygenated sample is a semiconducting. The $^{63/65}$Cu NMR studies for a single crystal of oxygenated and reduced $Nd_{1.85}Ce_{0.15}CuO_{4+\delta}$ were performed. The NMR spectra of both samples show the single phase nature with small distribution in $\nu_{\rm Q}$. The NMR signal of the oxygenated sample disappeared around 150 K due to the magnetic ordering and below 30 K the signal was observed in a wide range of external filed. The line width of the reduced sample was narrower than that of the oxygenated sample but increased below 100 K. The electronic states of the oxygenated and reduced crystal are compared.

Coherent THz radiation from Tl-2212 thin films excited by optical laser pulse under magnetic field **26BP57**

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We observed resonant terahertz (THz) pulse radiation from $Tl_2Ba_2CaCu_2O_{8+d}$ (Tl-2212) thin films by femtosecond optical pulse excitation under a radial magnetic field of $\sim$100 Oe nearly parallel to the c-axis of the film. The observed waveform showed clear oscillations below 80 K. The frequency of the oscillations (630 GHz at 24 K) shifted to lower frequency region with increasing temperature as expected from Josephson Plasma phenomena.

26BP58 ARPES Study on Electronic Evolution in $Ca_{2-x}Na_xCuO_2Cl_2$.

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Electronic evolution from an antiferromagnetic insulator (AFI) to a high-T_c superconductor (HTS) was revealed by ARPES experiments on tetragonal $Ca_{2-x}Na_xCuO_2Cl_2$ single crystals, which were grown for the first time under high pressures ($\leq$ 5.5 GPa). In an underdoped HTC (x = 0.1), we found clear fingerprints of the parent AFI: a shadow band and a large pseudo-gap. The results are most likely described by a "chemical potential shift", which contrasts clearly with the "pinned chemical potential" reported for the prototype $La_{2-x}Sr_xCuO_4$, demonstrating that the route to a HTS is not unique.

26BP59 Superconducting transition in quasi-one-dimensional sulfide $A_XV_6S_8$ (A=In,Tl) under magnetic field

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The superconducting phase transitions of quasi-one-dimensional compound(InV_6S_8,TlV_6S_8,V_6S_8)have been studied by the measurement of AC magnetic susceptibility χ'. The χ' of powdered sample decreased stepwise, and was characterized by two transition temperatures T_{C1} and T_{C2}. The T_{C1} is considered to be the transition temperature in the grains, and T_{C2} is the inter-grain transition temperature. Under the magnetic field, T_{C2} shifted to the lower temperature even in the small field(20G). In order to see the character of inter-grain phase transition, the third harmonic component of χ' is measured.

26BP60 Impossibility of superconducting state in multiwall carbon nanotubes

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Magnetic susceptibility χ of pristine and brominated arc-produced sample of multiwall carbon nanotubes was measured from 4.2 to 400 K. It was shown that an additional contribution $Delta\chi(T)$ to $\chi(T)$ is dominated by quantum correction to χ for interaction electrons (interaction effects-IE) at T below 50 K for both samples. The IE shows a crossover from two-dimensional to three-dimensional behaviors at B = 5.5 T. The effective interaction between electrons for interior layers of nanotubes is repulsive and the electron-electron interaction λ_c was estimated to be $\lambda_c \sim 0.26$ for pristine sample and did not change with bromination. This result shows that superconductivity is impossible in multiwall carbon nanotubes.

Palladium-hydrogen system as a possible room temperature superconductor **26BP61**

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A phenomenological description of resistivity (ρ), for high loaded (1:1) palladium-hydrogen (Pd-*H*) system at T=300K has been developed. Experimental data at 300K, show a ρ value less of the pure Pd and a T_c greater than 9K reported in literature. This approach uses a parallel model of two processes: i) ρ has a linear raising with the concentration (ξ=H/Pd), due to the increases of relative Pd lattice volume; ii) ρ as an exponential decreasing versus ξ, due to a superconducting fluctuation at very high ξ in Pd-*H*. At ξ_c (ξ_c(300K)=1.6) the superconducting state is produced. *LTSC* inverse isotopic effect for $0.6 \leq \xi \leq 0.96$, changes in normal *HTSC* isotopic effect at $\xi \approx 1$.

Superconsuctivity and In-plane Resistivity in $La_{2-x}Sr_xCuO_4$ **26BP62**

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The correlation between the in-plane resistivity (ρ_{ab}) and the superconducting transition temperature (T_c) has been investigated in $La_{2-x}Sr_xCuO_4$ under anisotropic pressure up to 8.0 GPa. The pressure suppresses the orthorhombic distortion and stabilizes the tetragonal lattice which enhances the superconductivity. In the underdoped samples, the inter-layer compression brings about some kind of localization of ρ_{ab} at low temperatures. The collapse of two-dimensional (2D) metallic state probed by ρ_{ab} kills the superconductivity. On the other hand, the overdope boundary for the superconductivity is discussed in terms of the 2-3D crossover of the electronic state.

Thermal conductivity in $HgBa_2Ca_4Cu_5O_y$ (Hg-1245) **26BP63**

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As the temperature is lowered below T_c (107K), a sharp increase in the thermal conductivity κ, having a maximum at about 60K, is observed in this compound as shown in various cuprate superconductors. In this compound, however, a distinct features that the enhancement of κ below T_c is comparatively broad and has some structure are noted. This behavior in κ may be related to a special case of this compound in which there coexist a superconducting CuO_2 planes and antiferromagnetic ordered CuO_2 planes in the unit cell, indicated for the first time from the experiments of NMR and μSR[1].

[1]K.Tokiwa et al., The 23^{th} LT Conference 2002.

26BP64 Dip Effect and Surface Barrier in Single Crystal YBa2Cu3Ox

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Measurement was made of ac susceptibility (acs) as a function of temperature T for a YBa2Cu3O6.993 single crystal at in dc fields (H). Dip effect was observed in the experimental ac susceptibility curves. By comparing the acs result with transport experiment in references, it is shown that the dip effect (DP) is in fact the second peak effect (SPE) of critical current density jc. It is also identified that the SPE in jc(H) is just the one observed in jc(T). Carefully measurement of acs in lower dc fields shows signal indicating the transition of flux pinning mechanism. We discussed the experimental in details.

26BP65 Sequence of transitions from 2D to 3D superconductivity in YBa2Cu3O6+x

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Using high-resolution SQUID magnetometer we observed a sequence of transitions from 2D to 3D superconducting state on YBa2Cu3O6+x single-crystals. The transitions reflect the layered structure of material and clearly do not originate in non-homogeneous sample with multiple phases with varying Tc or vortex matter. While both transitions at temperature around 92 K have width only 10 mK and show sudden appearance of phase coherence in 2D CuO2 layers and CuO2-Y-CuO2 sandwiches, the third transition at temperature about 87 K reflects appearance of the weak coupling between sandwiches through the Ba-CuO-Ba barriers.

26BP66 Effects of electron irradiation on the vortex order-disorder transition in $La_{2-x}Sr_xCuO_4$ crystals

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The vortex order-disorder phase transition line in $La_{0.937}Sr_{0.063}CuO_4$ exhibits a steep concave decrease throughout the whole temperature range. This unusual behavior is explained postulating that in $La_{0.937}Sr_{0.063}CuO_4$, both thermal and disorder-induced fluctuations take part in destabilizing the vortex lattice. Irradiation of the samples with electrons causes a significant decrease in both the magnitude of the transition field and the curvature of the transition line. These results are interpreted as caused by the enhanced role of disorder-induced fluctuations as compared with thermal fluctuations.

Study of c-axis I-V Characteristics of Misaligned Tl-2212 Film **26BP67**

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A 5 μm width micro-bridge was patterned on misaligned Tl-2212 film deposited on $SrTiO_3$ substrate. The c-axis and in-plane I-V characteristics of the Tl-2212 micro-bridge have been measured in different temperatures and fields. The hysteretic I-V characteristics have RSJ like behavior, and can be well fitted if thermal fluctuations and interlayer capacitance are taken into account. The temperature dependence of the c-axis critical current can be well described by the Ambegaokar-Baratoff theory. The c-axis quasi-particle tunnelling I-V characteristics in different temperature show obvious scaling behavior as well as the in-plane I-V characteristics, which could be explained by existing flux dynamics models.

Vortex Phases in Single Crystals of $Bi_2Sr_2CaCu_2O_{8+\delta}$ Near ab-plane Studied by c-axis and In-plane Resistivity Measurements **26BP68**

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Both the in-plane and out-of-plane resistivity measurements have probed the vortex lattice melting transition in the single crystals of $Bi_2Sr_2CaCu_2O_{8+\delta}$, indicating the crossing lattice structure in the wide angular and temperature ranges. However, the drastic difference in behavior was observed in magnetic fields applied close to the ab-plane, suggesting the complex melting transition of the vortex-lattice into the vortex-smectic phase, which, at higher temperatures, may melt into the vortex-liquid phase via the second-order phase transition. The observed behavior may be interpreted also as the possible indication of the transition from the crossing vortex-lattice to the tilted vortex-lattice near the ab-plane.

Suppression of Surface Barriers in Single Crystals of $Bi_2Sr_2CaCu_2O_{8+\delta}$ by In-plane Magnetic Fields **26BP69**

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The in-plane resistivity measurements were performed on the several $Bi_2Sr_2CaCu_2O_{8+\delta}$ single crystals, characterized by different electric contact geometries including the Corbino contact configuration, which discards the surface barriers. In the platelet samples, the non-linear behavior of resistivity was observed well above the vortex lattice melting transition in the vortex liquid phase, across a wide temperature range and magnetic fields applied along the c-axis. The resistance has been measured at the various magnetic field orientations, with the constant out-of-plane component. It was found that the in-plane magnetic fields strongly suppress the non-Ohmic behavior of resistivity, i.e., the surface barrier effect.

26BP70 Local Permeability Studies of Vortex States in $Bi_2Sr_2CaCu_2O_{8+y}$ under Tilted Fields

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In a strongly anisotropic superconductor $Bi_2Sr_2CaCu_2O_{8+y}$, vortices generated by tilted fields form two orthogonal lattices of pancake and Josephson vortices, $i.e.$, crossing lattices. Owing to the attractive interactions between these two lattices, various forms of ground state can be realized. Some of the ground states in the crossing-lattices state have been reported by anomalies in irreversible magnetization and direct observations by scanning Hall probe microscopy. We apply local permeability measurements using a micro-Hall probe to explore the phase diagram and the nature of ground states of vortex solid at high temperatures and under tilted fields. In addition to the vortex-lattice melting transition, we find a clear step in the real part of permeability at fields with almost constant in-plane component.

26BP71 Multiple components of the order parameter induced around the $d_{x^2-y^2}$-wave vortex core

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On the basis of the Bogoliubov de Gennes theory for the two-dimensional extended Hubbard model, the vortex structure of $d_{x^2-y^2}$-wave superconductors is analyzed. Multiple components of the order parameter are induced around the $d_{x^2-y^2}$-wave vortex core: extended s-wave, $p_x \pm \mathrm{i}p_y$-wave components. The $p_x + \mathrm{i}p_y$-wave component has +2 winding at the core and -1 winding in the middle of nearest vortices, and the $p_x - \mathrm{i}p_y$-wave component has -1 winding in the middle of next nearest vortices. We also study these induced order parameters and the induced spin-triplet-$d_{x^2-y^2}$-wave component when the antiferromagnetism(or checkerboard or stripe) is induced at the vortex core.

26BP72 Ac Magnetic Flux Profile of Melt-textured Sm-Ba-Cu-O Superconductor

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We have investigated the ac magnetic flux profile of melt-textured Sm-Ba-Cu-O superconductor using the ac inductive method. The ac penetration depth increases with increasing the dc magnetic field up to 0.75 T at 77 K. However, further increase up to 2.5 T leads to the decrease of the ac penetration depth. This suggests that the penetration of ac field is affected by the field-induced pinning due to the Sm-rich clusters.

Disorder Dependence of Vortex Core States in $Bi_2Sr_2CaCu_2O_x$ Studied by Low Temperature Scanning Tunneling Spectroscopy **26BP073**

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The vortex cores in underdoped $Bi_2Sr_2CaCu_2O_x$ have been measured at 6K in 8T by scanning tunneling spectroscopy. In these cores, we have observed the enhancement of the quasiparticle density of states at the energies of about $\pm$9meV. The strength of the enhancement has been found to depend on the degree of microscopic disorder in the sample. The possible reason for the disorder dependence of the vortex core states will be discussed.

Dynamics of Vortex Motion in High-T_c Superconductor $La_{1-x}Sr_xCuO_4$ **26BP74**

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Transient thermoelectric effect (TTE) and transient Nernst effect (TNE) have been measured for $La_{0.86}Sr_{0.14}CuO_4$ crystals. The TTE and TNE signals closely related to vortex motion are observed; the former consists of two components with delay times of ms and ms, while the latter has merely slow one. We suppose that the fast and slow components result in the motions of free vortex and collective vortices, respectively.

Plastic vortex flow in current-driven disordered Josephson junction networks **26BP75**

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Current-driven dynamics of superconducting phases of Josephson junction networks (JJNs) in a magnetic field is studied using numerical simulations. For JJNs with positional disorder, plastic depinning of vortices occurs at a certain threshold current and then there appear plastic flow and elastic flow states with increasing current. For strong disorder we find that dynamics of the plastic flow is governed by a nucleation effect of vortex-antivortex pairs and then the threshold current of the plastic flow regime shows a certain scaling behavior. We discuss the scaling properties for some types of networks. In addition, from an analysis of phase coherence, we find that there appears a dynamical critical behavior in the plastic flow state. We discuss its universal aspects by comparison with other related phase models.

26BP76 Nonlinear Response in the Vortex State of Unconventional Superconductors

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The magnetic field (H) dependence of the density of states in the vortex state of the unconventional superconductors is discussed. The Doppler-shifted quasiparticle spectrum seemingly explain the $\sqrt{H}$-dependence of the specific heat coefficient as Volovik ('93) showed. In this paper it is shown that the Doppler shift is invalid in the unconventional superconductors, and only the suppression of the amplitude of the superconducting gap can induces the finite density of states near the Fermi level as in the conventional (s-wave) superconductors. The invalidness of the Doppler shift originates from the neglect of the nonlocal effect. The nonlocal effect eliminates the nonanalytic dependence on the superfluid velocity of the local density of states and therefore the superfluid velocity cannot induce the finite density of states near the Fermi level. The thermal conductivity is also discussed based on this theory.

26BP77 Measurement of AC Losses in Superconducting Tapes subjected to both AC Transport Current and Magnetic Field using a Bolometric technique

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AC losses have been measured on HTS tapes in presence of both AC current and AC magnetic field, by using an extended bolometric technique. Tapes as long as 10 cm are thermally anchored at its ends to the 77 K bath , and are placed in a chamber where the spurious effects due to thermal instabilities are strongly reduced. The AC power losses are rapidly obtained by measuring the resulting temperature gradient between the centre and the extremities of the sample, with a sensitivity of $\sim$1 μW/cm. In this way, the losses can be measured at various frequencies, phases and amplitudes of the AC current (up to $\sim$40A) and field (up to $\sim$600 mT), which are in fact completely independent of each other.

26BP78 Vortex dynamics in mesoscopic strips

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Flux penetration and vortex patterns in narrow superconducting strips are studied. The edge barrier, vortex-vortex interactions, and the position dependent effective flux are calculated assuming the high-κ limit and strip width $\xi \ll W \ll \Lambda$, where Λ is the effective penetration depth and ξ the coherence length. Vortex penetration and time-evolution inside the sample, as an external magnetic field is looped, are simulated by numerically solving the coupled Langevin equations of motion. The edge barrier shows to have an important role on the system dynamics and, in particular, on the commensurability effects in a regular array of columnar defects. We also simulate transport measurements for a current applied along the strip. The effects of quenched disorder are also discussed.

Vortex lattice structures in tetragonal BCS superconductors **26BP79**

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We investigate vortex lattice structures of tetragonal BCS superconductors in the clean limit for the case $H||c$. Using recently developed by us expansion in the "distance" from the $H_{c2}(T)$ curve [1] we are able to account for nonlocality of interactions in the vortex lattice and access a considerable portion of the superconducting region of T-H plane, far away from T_c. Anisotropies of Fermi surface and pairing s-wave interactions are assumed to be small and treated as perturbations. Application of the results to vortex lattice transformations [2] in borocarbide superconductors are discussed.

[1] A. Knigavko and F. Marsiglio, cond-mat/0201018;
[2] M. R. Eskildsen *et al.*, Phys. Rev. Lett. **86**, 5148 (2001).

Theoretical Study on Vortex Lattices in Tetragonal Superconductors **26BP80**

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We investigate vortex lattices in tetragonal and cubic superconductors based on the quasiclassical theory. In these superconductors, the band structure has a fourfold symmetry depending on the crystal structure. Thus it is possible that a square vortex lattice becomes stable under a magnetic field. In borocarbides, the superconducting gap has an anisotropy. When the gap anisotropy has a fourfold symmetry, a square vortex lattice becomes stabilized in a high field. Each fourfold anisotropy of the gap and the band structure stabilizes two kinds of square vortex lattices. We consider two kinds of orientations of vortex lattices rotated by 45 degree from the other. We compare the free energy of four kinds of vortex lattices. The free energy is obtained by the self-consistent calculation solving Eilenberger equations numerically. We show the field and the temperature phase diagram of vortex lattices by this study.

Phase transition in vortex matter driven by bias current **26BP81**

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The phase transition in vortex matter subjected to external magnetic field and bias current are described by the generalized Ginzburg-Landau equations with additional convective and effective field terms. Analytical and numerical solutions of this equation provide the interface between ordered and disordered vortex phases. The location of this interface boundary depends non-monotonically on the strength of a bias current. We predict a sudden extention of the disordered vortex state across the entire sample at some critical value of the bias current.

26BP82 Specific Heat of the Spin-Triplet Superconductor Sr_2RuO_4 with Nonmagnetic Impurities

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We report the substitution effect of $nonmagnetic$ Ti^{4+} for Ru^{4+} on the specific heat of $Sr_2Ru_{1-x}Ti_xO_4$ from x = 0 (spin-triplet superconductor) to 0.09 (magnetically ordered phase with glassy behavior) via magnetic instability point at $x_c \sim 0.025$. We found that specific heat divided by temperature C_P/T around x_c deviates from the conventional Fermi-liquid behavior seen in pure Sr_2RuO_4 and shows the logarithmic behavior at x_c. Such critical enhancement is attributable to the diverging two-dimensional antiferromagnetic fluctuation, which arises mainly from the nesting within one of the Fermi-surface sheets.

26BP83 Field dependence of Vortex structure in $p_x \pm ip_y$-wave superconductors

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To understand the vortex states in Sr_2RuO_4, we investigate differences of the vortex structure for two chiral pairings $p_x \pm ip_y$. We calculate the pair potential, the internal field, the local density of states, and free energy in the vortex lattice state based on the quasiclassical Eilenberger theory, and analyze the magnetic field dependence. The induced opposite chiral component of the pair potential plays an important role in the vortex structure. It produces $\sqrt{H}$-behavior of the zero-energy density of states at higher field. We also calculate the vortex structure based on the Ginzburg-Landau theory, and discuss the transition from $p_x + ip_y$-wave superconducting domain to stable $p_x - ip_y$-wave superconducting domain under magnetic field.

26BP84 Theory of Superconducting Mechanism and Gap Structure of Sr_2RuO_4

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We discuss a superconducting mechanism and gap structure of the spin-triplet superconductor Sr_2RuO_4 on the basis of the three-band repulsive Hubbard model. The effective pairing interaction is derived within the third order perturbation for the on-site Coulomb energy, and the transition temperature is estimated by solving the Éliashberg equation. Here we take into account the full momentum-frequency dependences of the order parameter. As a result, we may conclude that the spin-triplet superconductivity is a natural result of electron correlations. The derived order parameter possesses the anisotropic p-wave symmetry, and take the maximum value on the main band γ. We are planning to analyse the experimental results of physical quantities including specific heat below T_c, and investigate the consistency of the theoretical in-plane gap anisotropy with the experimental results, following the elementary BCS theory.

Coreless vortices in p-wave superconductors **26BP85**

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Simulations of a three component time dependent Ginzburg-Landau (Abelian Higgs) model reveals that the dominant topological defects are vector vortices rather than conventional Abrikosov (Nielsen-Olesen) vortices or skyrmions. We describe in detail these vortices in the steady state and discuss their possible role in the dynamics. In particular we conclude that the vector vortices have a superconducting core distinct from the superconducting bulk state. The profile of the vector order parameter and the magnetic field are calculated.

Non-saturating upper critical field of organic superconductor κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Cl **26BP86**

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The upper critical field of the organic superconductor κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Cl shows non-saturating behavior toward 0 K under the magnetic field applied strictly parallel to the superconducting plane. The inclination angle dependence of the upper critical field from the plane is discussed in terms of the interplay between the orbital pair-breaking effect and the Pauli paramagnetic effect in addition to vortex dynamics. The relation to the spatially modulated order-parameter state predicted by Fulde-Ferrell and Larkin-Ovchinnikov is argued.

Vortex Lattice Anisotropy in Conducting Plane in Organic Superconductors **26BP87**

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Vortex structure in organic superconductors $\kappa-(\mathrm{BEDT-TTF})_2\mathrm{CuN(CN)_2Br}$ (for the first time) and $\kappa-(\mathrm{BEDT-TTF})_2\mathrm{Cu(NCS)_2}$ has been investigated by using decoration technique at the magnetic fields region up to 23 Oe. Quantitative analysis of high quality vortex lattice (VL) images shows the VL anisotropy which can be treated as a penetration depth anisotropy. Mutual orientation of vortex and crystal lattices is discussed.

26BP88 Development of AC susceptibility technique under high pressure and its application to organic superconductor

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The pressure-temperature phase diagram is one of the most important information for unraveling the mechanism of the organic superconductors. Then we developed an experimental technique that made the measurement of AC susceptibility under high pressure up to 35kbar possible. In the present work, we investigated bulkly nature of the organic superconductor, κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Br, under pressure.

26BP89 How to determine pairing symmetry of quasi-1D organic superconductors through magneto-tunneling spectroscopy

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We propose that pairing symmetry of quasi-1D superconductors (TMTSF)$_2X$ can be experimentally identified from tunneling spectroscopy in the presence of magnetic field, where the effect of magnetic field is treated in terms of the Doppler shift.

26BP090 Tunneling spectroscopy of superconducting $Li_{0.48}(THF)_{0.3}HfNCl$

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Tunneling measurements on the electron-doped layered superconductor $Li_{0.48}(THF)_{0.3}HfNCl$ (THF;C_4H_8O) with $T_c \approx 26$K have been carried out. Science the surface of this compound is very reactive, we have employed $insitu$ break junction to obtain unaffected junction interface. The result shows the gap value of $2\Delta \approx 9$ - 11 meV. This leads to the gap ratio $2\Delta/k_BT_c$ up to ~ 5, which is much larger than the BCS value.

Anomalous Quasiparticle Excitations in $Y(Ni_{1-x}Pt_x)_2B_2C$ 26BP91

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The magnetic field distribution in the vortex state of $Y(Ni_{1-x}Pt_x)_2B_2C$ has been probed by μSR. At low fields the vortex core radius $\rho_v(H)$ in x = 0 sample decreases with increasing H much steeper than what is expected from the $\sqrt{H}$ behavior of the Sommerfeld constant $\gamma(H)$, strongly suggesting that the anomaly in $\gamma(H)$ primarily arises from the quasiparticle excitations outside the vortex cores.

Upper critical field and critical current anisotropy in RNi_2B_2C thin films 26BP92

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Orientation-dependent measurements of superconducting properties such as the upper critical field H_{c2} and the critical current density J_c have been performed on epitaxial thin films of the non-magnetic borocarbide compound YNi_2B_2C and the magnetic $HoNi_2B_2C$. These quantities are seen to vary in a highly anisotropic manner both out-of-plane and within the basal plane of the borocarbide unit cell, presenting a complex behaviour partly in agreement with and partly contradicting that reported for bulk samples. Comparison of the form of the anisotropy for the different properties and comparison between the measurements on the magnetic and non-magnetic sample allow conclusions to be drawn regarding the physical origin of the anisotropies.

H-T Phase Diagram and Magnetic Structure in $ErNi_2{}^{11}B_2C$ 26BP93

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By magnetization and neutron scattering measurements, we studied a weak ferromagnetic superconductor $ErNi_2{}^{11}B_2C$. We are going to present the best fit models of magnetic structure and H-T phase diagram.

26BP94 A new infrared excitation in semiconducting $Ba_{1-x}K_xBiO_3$ single crystals

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We report optical reflectivity measurements on $Ba_{1-x}K_xBiO_3$ (x = 0, 0.15) single crystals in the frequency range 70-30000 cm^{-1} and at different temperatures in an attempt to understand the transport mechanism in the semiconducting phase before it undergoes semiconductor-metal transition. For x = 0.15, we find a new peak (peak3) in ϵ_2, in addition to already reported two peaks (peak 1 and peak 2), at around 1280 cm^{-1} (at 400 K). The peak 1 is attributed to an excitation across charge density wave energy gap of Bi 6s electrons from Bi^{3+} to Bi^{5+} and that of peak 2 is from Bi^{4+} to Bi^{5+}. We notice, with temperature increasing from 50 K to 400 K, the spectral weight of (i) peak 3 increases, (ii) optical phonons decreases, (iii) total ir transition shifts towards higher frequency. The results are explained in terms of a new excitation of small polarons taking in to account the strong Bi 6s electrons-phonon interaction.

26BP95 Evidence for high temperature superconducting phases in Pd-H system

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New superconducting phases with high T_c have been found in the palladium-hydrogen (Pd-*H*) system, in addition to well-known low T_c for this material. Infact as reported in literature, the T_c of Pd-*H* is a function of ξ=H/Pd, when the 0.6$\leq \xi \leq$0.96 the T_c is in 0K$\leq T_c \leq$9K range. Resistance measurements of Pd-*H* system with the stoichiometric ratio, $\xi \geq$0.96, versus temperature in a DC magnetic field have been done. These measurements show a critical temperature T_c ranges of: 30K$\leq T_c \leq$60K. Moreover, superconducting phases up to T_c=273K probably occur when the $\xi \geq$1. A critical superconducting current density of $6 * 10^4 A/cm^2$ has been measured at 77K with $H_{DC} = 0T$.