Session 22BP

Correlator Projection Theory of Single-Particle Dynamics in High-$T_{\rm c}$ Cuprates **22BP1**

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Single-particle dynamics around the Mott insulating phase in the 2D Hubbard model is studied with a new nonperturbative theory of correlator projection. Upon decreasing holes towards the Mott insulator from the metal, a phase separation occurs near half filling at finite temperatures, in agreement with experimental results in high-$T_{\rm c}$ cuprates. Then, strong correlation effects beyond the band picture emerge; at the first-order transition characterized by the phase separation, a large hole-like Fermi surface disappears with a downward jump of the lower Hubbard dispersion around (π, π) across the chemical potential.

Formation of Extended Coherent Hole States in Cuprates up to $T = 1200$ K **22BP2**

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The proposed microscopic model purports to explain a genesis of pseudogap manifestations in underdoped cuprates. It implies the formation of quasi-one-dimensional superconducting structure fragments with a broad distribution of local critical temperatures $T_{ci} \leq 1200$ K due to the condensation and subsequent pairing of oxygen holes under a spatially modulated Coulomb extra-potential. An analysis is based on a concept of "polymerization" of pseudo-atoms with quantized hole "orbitals" into spin-charge stripes by means of strong electron correlations and self-organization effects. The doping dependences of calculated electronic spectra composed mainly of *extended coherent states* are consistent with experimental data.

22BP3 Effect of the hole-phonon interaction on the single-hole spectral function in the t-J model

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Spectral functions of the coupled to optic phonons single hole in the t-J model are calculated using exact Diagrammatic Monte Carlo technique and subsequent analytic continuation to the real frequencies. It is shown that coupling to magnons increases the influence of the hole-phonon interaction on the hole properties: for the same parameters of the hole-phonon coupling the free hole properties are weekly renormalized while the spectral function of the hole in t-J model is drastically changed. The properties of ARPES spectra are calculated and discussed.

22BP4 Cuprate of Two-Gap Superconductivity on a Vibronicly Renormalized Spectrum Formed by doping

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A two-band model of cuprate superconductivity with interband transfer of intraband pairs between vibronicly coupled electronic components is developed. A midgap band created by doped holes evolves above the valence band. Bands overlap reached by progressive doping corresponds to the end of underdoping. At this concentration the vibronic effect is maximal and also the behaviour of the electron liquid changes. The two superconductivity gaps are vibronicly renormalized. Two normal phase pseudogaps are present at underdoping (electronic and vibronic) and there is one of vibronic nature at higher dopings. Various cuprate properties are discussed in the framework of the model.

22BP5 Pseudogap phenomenon and density waves in Cuprates

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Recently, there has been a great interest in the study of the pseudogap phase in high temperature cuprate superconductors. The angle resolved photo emission spectrum gives evidence of the fact that the pseudogap also exhibits a d-wave symmetry. Various theoretical scenarios have been proposed to understand the above phenomenon. We consider the charge-density waves as a possible explanation for the pseudogap.The phase diagrams for the order parameter and temperature with doping and also The temperature dependence of the order parameter and specific heat is also demonstrated.

Multiple-superconducting Amplitudes in Multi-layer High-T_c Cuprates **22BP006**

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We study the superconducting (SC) amplitudes in multi-layer cuprates by calculating the current in a break junction with bias voltage. The tunneling Hamiltonian is adopted between the two superconductors which have the multiple-SC amplitudes and the inter-layer hopping among the CuO_2 layers. In the lowest order of the tunneling matrix element, the conductance as a function of the voltage has several peaks, which depend on the SC amplitudes, the inter-layer hopping and the number of CuO_2 layers. By studying these dependencies, we find the way to estimate the SC amplitudes in the multi-layer cuprates. By including higher order terms of the tunneling matrix element, we obtain the sub-harmonic gap (SHG) structure in the multi-layer compounds. We discuss the peak positions and their intensities in the SHG structure in connection with the recent experimental studies.

Electron-Phonon Coupling in High Temperature Superconducting Cuprates **22BP7**

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Phonons are widely regarded as irrelevant to high-temperature superconductivity. However, recent experimental results indicate that such a belief may be ill-founded. We argue that the electron-phonon coupling in the cuprates is fundamentally different from that in simple metals because of the phonon-induced Cu-O charge transfer. With the Hubbard model we show that the strong softening around the (π, 0) zone-boundary and inversion of the LO/TO dispersions of the Cu-O bond-stretching phonons we recently observed by neutron inelastic scattering can be explained in terms of the sign-reversed Born effective charge due to the intersite charge transfer and a negative dynamic dielectric function. This mechanism allows strong electron-phonon coupling without structural instability, and can contribute significantly to the d-wave superconductivity of the cuprates.

Electronic contribution to thermal conductivity of CDW superconductors **22BP8**

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Electronic contribution $\kappa_{\rm el}$ to thermal conductivity κ of superconductors partially-gapped by charge density wave (CDW) was calculated. A dielectric gap $|\Sigma|$ is assumed to exist above and below a superconducting critical temperature T_c. It is shown that the coherence factor for $\kappa_{\rm el}$ in the pure CDW state (above T_c) is constructive, in contrast to the BCS superconductor. In the mixed state (below T_c) there is an interplay between two order parameters. Thus, the dependence $\kappa_{\rm el}(T)$ may become nonmonotonic with a maximum below T_c. This is exactly the picture observed for cuprates if one identifies the nonsuperconducting gap (*pseudogap*) with the CDW one.

22BP9 Superconductivity with Nonzero Chern Numbers

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In strongly correlated electron systems it often happens that electronic bands acquire nonzero Chern numbers, either by spin chirality or by spin-orbit coupling. It implies that the phase of the wavefunctions cannot be defined uniquely all over the Brillouin zone, and one should be careful in defining order parameters. In this presentation, we will develop a theory of condensation happening in bands with nonzero Chern numbers. We take the Haldane model (Phys.Rev.Lett.**61**(1988)2015.) on the honeycomb lattice as an example, and explain what will happen when excitonic order or superconductivity occurs in a band with a nonzero Chern number. It can also be related to quantization of Hall conductivity or spin Hall conductivity.

22BP10 Bi- and Tri-layer splittings in a new formulation for the $t-J$ model of cuprates

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A new Jordan-Wigner transformation approach for multilayer two dimensional $t-J$-models has been developed. The effective spinon hoping $\sim [(J/2) - xt]$ and implies a quantum critical point (QCP) for $x_c \sim J/2t$, *but* which is suppressed by superconductivity. In this formulation the superconductive peaks are Kondo resonances while the quasi-particle bands reflect charge fluctuations effects relative to Kondo ground state. Simulations of the ARPES data for strongly overdoped Bi2212 agree well with experiment and explain a mysterious slitting of the superconductive coherence peaks. Using the same parameters as for the bi-layers, simulations of the tri-layer ARPES agree well with experiment for the normal state. Predictions are made for the splitting of the superconductive peaks in strong over doped tri-layer samples.

22BP11 AC magnetic susceptibility measurements on UGe_2

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We have measured the ac magnetic susceptibility of the pressure induced ferromagnetic superconductor UGe_2 at pressures up to ~ 18 kbar using a dilution refrigerator. The superconductivity (SC) appears between ~ 10 kbar and ~ 16 kbar, as reported in the literature. However, we have found that the magnitude of the SC diamagnetic susceptibility strongly depends on the pressure ; it exhibits a maximum at $P_{\rm X} \sim 13$ kbar at which the SC transition temperature is maximal. On the other hand, the $P_{\rm X}$ corresponds to a pressure at which an unknown anomaly observed in the electrical resistivity and the magnetization vanishes. From these results, we will argue that the SC state in UGe_2 is inhomogeneous and the unknown anomaly is possibly related to the appearance of the SC.

Thermal expansion measurement under high pressure of UGe_2 **22BP12**

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The linear thermal expansion coefficients $\alpha_i(T)$ ($i = a, b, c$) of single crystalline UGe_2 samples have been measured in the temperature range 0.34 K$< T < 60$ K and at pressures up to ~ 1.8 GPa. The coefficients $\alpha_i(T)$ at ambient pressure show a sharp transition at $T_{\rm Curie} = 52$ K and a broad hump at around $T_x \simeq 30$ K. At around $P \simeq 0.9$ GPa, above which the superconductivity appears, we found that the anomaly at T_x becomes sharp; it looks like a phase transition discontinuity. The temperature dependence of volume at this pressure also shows a distinct change at T_x as well as at $T_{\rm Curie}$. We will report these experimental results together with those of the ac magnetic susceptibility that was measured at the same time.

Electrical resistivity of CeTIn5 (T=Rh,Ir) under high pressure **22BP13**

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We have researched the superconducting natures of $CeTIn_5$ (T=Rh,Ir) under high pressure in terms of electrical resistivitiy and superconducting phase in pressure-temperature phase diagram were determined for both samples and those exist in a wide pressure range (1.5 GPa ¡ *P* ¡ 6.5 GPa :$CeRhIn_5$, 0 GPa ¡ *P* ¡ 5.2 GPa :$CeIrIn_5$).

Perturbation Theory of the Superconductivities in Heavy Fermion Systems **22BP14**

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We reformulate the Éliashberg's equation for the superconducting transition within the quasiparticle description, which takes account of the heavy electron mass. We discuss the superconductivity of heavy fermion systems by using such a renormalized formula. Both normal and anomalous self-energies are calculated up to third order with respect to the repulsive interaction. Superconducting transition temperatures ($T_{\rm c}$) are obtained by solving the Éliashberg's equation. We point out that it is reasonable to treat the electron correlation by perturbation theory based on Fermi liquid theory, in calculating $T_{\rm c}$ of typical heavy fermion superconductors.

22BP15 Effect of Magnetic Ion Ni-doping for Cu in the CuO_2 Plane on Electronic Structure and Superconductivity on Y123 Cuprate

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As an effective probe of local electron density, positron experiment was used for $YBa_2Cu_{3-x}Ni_xO_{7-y}$ system with x=0.0 to 0.4. The results indicate that at small doping region lifetime τ_1 decreases monotonically. For larger doping concentrations, τ_1 has a small increase, follows an flat section. Considering the change of T_c, the results may prove that the localization of carriers in CuO_2 planes may have enormous influence on superconductivity. The small increase of τ_1 may prove that with the increase of Ni concentration, more electrons are localized around the dopant site, resulting in the decrease of hole density. In large doping concentrations, there exits the weakening of electron localization.

22BP16 High-field magnetotransport in strained $La_{2-x}Sr_xCuO_4$ films

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We present the low-temperature normal-state transport properties of strained $La_{2-x}Sr_xCuO_4$ films achieved by suppressing superconductivity with high magnetic fields up to the megagauss range. Systematic measurements were performed on six MBE grown films with under-, optimum-, and over-doping levels (x = 0.11, 0.15, and 0.19) and also with either compressive or tensile epitaxial strain produced by two different substrates ($LaSrAlO_4$ and $SrTiO_3$). We observed that the low-temperature upturn in resistivity as seen in bulk single crystals of under- or optimum-doped $La_{2-x}Sr_xCuO_4$ is significantly suppressed by in-plane compressive strain. By interpreting the upturn as due to the Kondo effect by Cu^{2+} spins, our results indicate that the Kondo interaction is regulated by epitaxial strain.

22BP17 Lanthanoid Substitution in $Sr_2YCu_2FeO_{6+\delta}$ System

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The $Sr_2YCu_2FeO_{6+\delta}$ compound exhibits superconductivity around 50 K. We have obtained the single phase of $Sr_2LnCu_2FeO_{6+\delta}$ (Ln=Nd, Er) which substituted Ln for Y in $Sr_2YCu_2FeO_{6+\delta}$. While $Sr_2ErCu_2FeO_{6+\delta}$ exhibits superconductivity, $Sr_2NdCu_2FeO_{6+\delta}$ does not exhibit superconductivity. We have analyzed the crystal structure of $Sr_2LnCu_2FeO_{6+\delta}$ to be compared with that of $Sr_2YCu_2FeO_{6+\delta}$ using X-ray and neutron powder diffraction. These studies indicate that it is easy to substitute Cu for Fe and Sr for Ln in $Sr_2NdCu_2FeO_{6+\delta}$ than other componds.

Intra- and inter-grain critical current density in (Cu,C):1234 superconductors 22BP18

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Using DC magnetization and AC susceptibility we estimated the inter- and intra-grain critical current density Jc of high-pressure synthesized (Cu,C):1234 high-Tc superconductors, for T between 20 and 105 K and DC fields up to 14 T. Inter-grain Jc was estimated from the difference in magnetization between the as-grown sample and the finely ground one. Both Jc's resulting from magnetization studies are compared with the ones deduced from susceptibility measurements. Finally, we investigated the intra-grain Jc of neutron and heavy-ion irradiated (Cu,C):1234, which showed an impressive increase, one order of magnitude for neutron irradiation and two orders of magnitude for heavy-ion irradiation.

Magnetic Flux Trapping in Granular HTSC near Superconducting Transition 22BP19

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The temperature and field dependences of the trapped magnetic fields and of the frozen magnetoresistance of (Pb)Bi-Sr-Cu-0 ceramics and Bi-based magnetron films are investigated. It is found that in the resistive transition region of granular Bi-HTSC the trapped magnetic fields became highly inhomogeneous and alternating in sign on scale of less than 50 μm. Unlike ceramic the films have critical temperature of trapping lower than the upper temperature of magnetoresistance disappearance. The experimental results are explained by a model in which the magnetic flux is trapped in superconducting loops embedded in Josephson weak links medium. The loops nature which is essentially different for films and ceramics is discussed. Observed temperature and field dependences of trapped field are in good agreement with those calculated for normal law of the loops distribution on critical fields.

Non-ohmic resistance due to nanostructural inhomogeneity in RPrBaCuO 22BP20

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Non-ohmic resistance observed for complex cuprates $R_{1-x}\mathrm{Pr}_x\mathrm{Ba}_2\mathrm{Cu}_3\mathrm{O}_y$ (RPBCO, R =Gd, Nd, Y) with Pr-concentration x ranging from 0 to 0.8 has been investigated in reference to the nanostructural inhomogeneity. At Pr-concentration above the percolation threshold x_{pc}, where the overall superconductivity vanishes, the resistance has been found to considerably depend on the supplied current I. The dependence is classified into three types according to the range of x; firstly the resistance at around x_{pc} increases with increasing I, subsequently it becomes independent of I, and eventually the resistance at x much higher than x_{pc} changes into a decreasing function of I. A model has been given of this non-ohmic resistance in terms of a breaking process of the percolation network and a local rise in temperature due to Joule heat.

22BP21 EFFECT OF Ti SUBSTITUTIONS ON SUPERCONDUCTIVITY OF TlSr1212 CERAMICS

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Effect of Ti substitutions on superconductivity of (Tl0.8Pb0.2)(Sr2-xTix)(Ca0.9Y0.1)Cu2O7 (x = 0-0.7) and Tl(Sr2-xTix)CaCu2O7 (x = 0-0.6) ceramics have been investigated. (Tl0.8Pb0.2)(Sr2-xTix)(Ca0.9Y0.1)Cu2O7 (x=0) was observed to superconduct with Tc onset of 90 K and Tc zero of 21 K. Substitution of Ti with x=0.1-0.5 observed an increase in Tc zero to 56-62 K with Tc onset remain the same at around 90 K. Tl(Sr2-xTix)CaCu2O7 (x = 0 to 0.2) was not superconducting above 20 K but for x = 0.3 superconductivity was observed with Tc onset of 66 K and Tc zero of 34 K.

22BP22 Synthesis and Properties of $TiSr_2(RE_{1-x}Ce_x)_2Cu_2O_z$

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The result of the synthesis for $TiSr_2(RE_{1-x}Ce_x)_2Cu_2O_z$ (Ti-1222) (RE=Gd,Eu,Sm) are reported. The single phase of Ti-1222 were not synthesized under ambient and high pressure (3.5 GPa), but two phased samples with Ti-1222 and $TiSr_2RECu_2O_z$ (Ti-1212) were obtained. The crystal structures were analyzed using X-ray diffraction for both Ti-1222 and Ti-1212 phases. Resistivity measurements for the all samples showed insulating behaviors.

22BP23 Phonon Structure in the Tunneling Conductance of $Bi_2Sr_2CaCu_2O_8$

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The spectral function of the electron-phonon interaction α^2F has been determined for $Bi_2Sr_2CaCu_2O_8$ (Bi2212)-GaAs junction. However, it is only one clear example of α^2F, and it has been desired to confirm its reproducibility.
In this study the tunneling conductance of a mechanical Bi2212-Au junction in which a barrier is formed in Bi2212 itself. The gap edge peak is as narrow as for the GaAs junction but the phonon structures are more faint. The differences between the Au and GaAs junctions are discussed by taking into account an inhomogeneity in the gap and the scattering effect at the contact.

Temperature and Field Dependence of the Gap Structure in $Bi_2Sr_2CaCu_2O_{8+\delta}$ Studied by Short-Pulse Interlayer Tunneling Spectroscopy **22BP24**

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We measure tunneling characteristics of $Bi_2Sr_2CaCu_2O_{8+\delta}$ intrinsic junctions by a sub-microsecond pulse technique to investigate temperature and field dependence of the bulk gap structure without excess Joule heating. The conductance curve shows a peak at the superconducting gap voltage (V_p) at low temperatures, and the peak becomes broader when we increase either temperature or magnetic field that is a pair breaking parameter. However, V_p has a non-monotonic T dependence with a dip near T_c, while V_p increases monotonically with field. This difference indicates that $V_p(T)$ cannot be explained by a simple pair breaking effect, and implies the existence of two distinct superconducting and pseudo gaps.

Observation of Large Superconducting Gaps in Bi-Based Cuprates by Tunneling Spectroscopy **22BP25**

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Large superconducting gaps were observed in some tunneling spectra of $Bi_2Sr_2CaCu_2O_{8+\delta}$ (Bi2212) single crystals. This gap magnitude is about twice as much as that of the resent studies of Bi2212. Magnetic susceptibility was also measured and the results showed that the crystals retained a single phase of Bi2212. The experimental results suggest that the large gaps arise by way of Josephson effect due to the interfaces of the crystal boundary, and this indicates a possibility of device applications of Josephson junction.

STM Spectroscopy Study of High-T_c Superconductivity under Spin-Injection **22BP26**

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To study how the high-T_c order parameter (OP) evolves under the injection of spin-polarized quasiparticles, a novel STM spectroscopy technique has been performed on superconductor/ferromagnet heterostructures comprising $YBa_2Cu_3O_{7-x}$ (YBCO) and $La_{0.7}Ca_{0.3}MnO_3$ (LCMO) at 4.2K. Quasiparticle-tunneling and Andreev-reflection characteristics measured on the YBCO under spin-injection from the LCMO were analyzed with the d-wave Blonder-Tinkham-Klapwijk theory, to reveal a spectral evolution which gives direct evidence for dynamic magnetic pair-breaking. The spectral analysis also shows the d-wave OP to remain time-reversal invariant as it is suppressed by the spin-injection. These results are discussed in terms of the general search for quantum critical-points in the high-T_c phase-diagram.

22BP27 Magnetic properties of square Josephson arrays with SIS and SNS junctions

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Field dependence of magnetic moment of 100×100 SIS and SNS Josephson arrays was investigated by SQUID-magnetometer. It was found, that magnetic flux penetrated into SIS array by means of randomly distributed avalanches of tens and hundreds of flux quanta. The distribution of jumps by their size is a power function, which gives an evidence of self-organised criticality in regular Josephson structures. On SNS array the similar jumps were not observed, but penetration of a magnetic field in array was considerably asymmetric. Periodic peaks at external field, corresponding to integer and semi-integer of flux quanta per cell, were observed only while absolute field was increased, and was not observed if the field is decreased. At partial destruction of border cells the asymmetry does not changed appreciably.

22BP28 Formation of Vortex State Induced by a Small Iron Tip in YBaCuO Thin Films

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Screening effect and flux penetration of YBaCuO superconducting thin films induced by a iron coil tip have been carrier out using an x-y scanning Hall probe. The characteristics of flux distribution on the surface of thin films can provide the evidence for the flux pinning effect between the vortex and defects. Changing the applied current of the iron coil and the distance between the iron coil and the film, we obtain the magnetic field dependence of flux profile of the vortex state, which can point out the surface energy barrier for formation of vortex-antivortex pairs in the local mixed state.

22BP29 Raman scattering study of electronic and magnetic excitations in $La_{2-x}Sr_xCuO_4$

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Electronic and magnetic excitations in $La_{2-x}Sr_xCuO_4$ (x=0, 0.1, 0.113, 0.15, 0.22) have been investigated by the polarized Raman scattering in the energy region between 0 and 4000cm^{-1}. In the (a,a) polarization both magnetic and electronic excitations are allowed, while only electronic excitation for (c,c). In x$\leq$ 0.15, the intensity of (a,a) is larger than that of (c,c) due to the additional existence of the magnetic excitation, however, both spectra become the same for x=0.22. This result is the experimental evidence that dynamical magnetic fluctuation disappears in the over-doped region in $La_{2-x}Sr_xCuO_4$.

Formation of Static Stripes in Lightly-Doped $La_{2-x}Sr_xCuO_4$ as Manifested in Magnetic and Transport Properties of Untwinned Single Crystals. **22BP30**

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The doped holes in cuprates may self-organize in a stripe manner. Here we report on the anisotropy in the magnetic susceptibility χ and magnetoresistance of untwinned LSCO crystals, which is a manifestation of such hole ordering. The in-plane anisotropy of χ, found in the "paramagnetic" and "spin-glass" regions of the phase diagram, implies that antiferromagnetic domains, separated by antiphase boundaries (stripes), persist after the Néel order is destroyed by hole doping. Interestingly, upon the field-induced stripe rearrangement, the in-plane resistivity changes by as large as a factor of two, indicating that stripes can significantly affect the hole motion. Furthermore, the hysteretic behavior is observed in both resistivity and magnetic susceptibility at low temperatures, which signals the freezing of stripes upon cooling.

AC resistivity in s-wave and d-wave superconductors **22BP31**

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We model s- and d-wave disordered granular superconductors with a three-dimensional Josephson junction lattice with finite self-inductance. The current amplitude dependence of the nonlinear ac resistivity at the peak position is calculated using Langevin dynamical equations and found to be power law characterized by exponent α. The later depends on the self-inductance and current regimes. In the weak current regime α is independent of the self-inductance and $\alpha = 0.5 \pm 0.1$ for both of s- and d-wave materials. For the strong current regime the values of α become to depend on the screening. We find $\alpha \approx 1$ for some interval of inductance and it agrees with the experimental finding for d-wave ceramic superconductors.

Peculiarity in heat capacity of 90 K samples of $YBa_2Cu_3O_{6+x}$ above T_c **22BP32**

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The temperature dependence of heat capacity for the 90 K samples of $YBa_2Cu_3O_{6+x}$ with x = 0.85, 0.90 and 0.95 was investigated above T_c. For separating the heat capacity into regular and anomalous contributions the special technique was used. For all the samples the anomalies in intervals 100-200 K (T_{low}), 205-230 K (T_m) and 260-290 K (T_h) were detected. The nature of the discovered anomalies is discussed. The analysis shows, that one may consider some anomalies as a characteristic property of the 90 K samples of $YBa_2Cu_3O_{6+x}$.

22BP34 Nonlinear conductivity in $Bi_2Sr_2CuO_y$ single crystal and possible relation to stripe ordering

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Nonlinear conductivity of a $Bi_2Sr_2CuO_y$ single crystal is observed. The authors reported this nonlinear conductance in terms of weakly localized regime of Anderson localization, however, this attempt resulted that interlayer coupling between CuO_2 should be concerned to interpret the observed logarithmic behaviors ($\log T$, $\log H$, and $\log V$). We discuss the nonlinear conductivity of $Bi_2Sr_2CuO_y$ with a new approach in which a scaling relation is assumed. With this scaling relation, current-voltage characteristics of various temperatures below the transition fall into a single curve. The scaling relation is similar to those appear in Luttinger-Liquid behavior (Fisher's scaling theory). One plausible interpretation might be based on one dimensional current transport in relation to the formation of the charge stripe ordering.

22BP35 Electrochemical synthesis of superconductive MgB_2 from molten salts

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Superconducting bulk material of MgB_2 has been prepared by means of electrolysis on the molten salts composed of $MgCl_2$, KCl, NaCl and MgB_2O_4 [1,2]. In this paper, we report the effects of substitution of NaCl by the other alkali halides such as LiF. Superconducting properties of the samples have been evaluated from both magnetic and transport measurements.
[1] H. Abe and K. Yoshii, cond-mat/0204169; Jpn. J. Appl. Phys (2002) in press. [2] K. Yoshii and H. Abe, cond-mat/0204208; submitted to Supercond. Sci. Technol.

22BP36 Persistent Supercurrents in MgB_2

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Persistent currents were measured in rings of superconducting granular MgB_2 through observation of the self-field using a travelling Hall probe. This method is therefore contact-less. We obtained both the temperature dependence of the critical current J_c from 15 K to T_c (39 K), and the time-decay for up to 10^5 sec. The temperature dependence is similar to that observed in granular YBCO rings. The time-decay of the persistent current from the critical level is less than 1% for a time interval of 10^5 sec at temperatures between 15 and 35 K. This decay rate is much smaller than that observed in high critical current rings of YBCO films, where we find a drop of 10% at 15 K.

Infrared studies of superconducting MgB_2 thin films **22BP37**

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Reflectance of superconducting MgB_2 thin films ($T_c \approx 35$ K) has been measured in a broad spectral range from 30 to 110 000 cm^{-1}. A typical plasma edge with a minimum at about has been found at 15000 cm^{-1}. In the far-infrared region we observe a pronounced rise of the reflectance below 60 cm^{-1}, which appears below T_c and can be associated with superconducting state. The temperature-dependent complex conductivity at infrared frequencies has been determined using the Kramers-Kronig analysis. The real and imaginary parts of the conductivity below T_c also show a temperature evolution, which is characteristic for superconducting gap opening (decrease in σ_1 and rise in σ_2). `\MakeFrametrue`

Properties of MgB_2 in a two-gap superconductivity model **22BP38**

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For MgB_2 where coexist two coupled superconductivity gaps a two-band scheme has been developed. Three interaction channels have been taken into account: a pair-transfer type $\sigma - \pi$-interband repulsion, a σ-intraband effective attraction of electron-phonon nature, and a σ-intraband Coulomb interaction. By means of simultaneous fitting of T_c, heat capacity jump and zero-temperature gaps ratio the optimal values of interaction constants have been found. The T_c isotope effect exponent, the temperature dependencies of gaps and the thermodynamic characteristics (heat capacity, H_{c2} etc.) calculated without any additional free parameters agree with the experimental findings. The theoretical curve of T_c vs chemical potential reproduces qualitatively the influence of doping on superconductivity phase transition in MgB_2.

MgB_2 thin film fabrication by rf-magnetron sputtering **22BP39**

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Superconducting MgB_2 thin films on MgO and Al_2O_3 substrate were fabricated by rf magnetron sputtering. Sputtering was preformed in 50mTorr Ar atmosphere at room temperature using pure B and Mg metal target. Sputtering deposition was followed by the in-situ annealing at 923K for 5 minutes in high vacuum, to prevent the oxidizing of Mg atoms. This is essential for obtaining the high quality MgB_2 thin film. To compensate for lack of B in the sputtered thin film, we examined the arrangement of target metals. The film grown on MgO had superconducting transition temperature of 30K.

22BP40 Evidence for Superconductivity in the Boron Layers of MgB_2

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Single crystals of MgB_2 have been synthesized by the vapor transport method. We examine the superconducting anisotropy $\gamma = \sqrt{m_c/m_{ab}}$ of a metallic high-T_c superconductor MgB_2 by measuring the magnetic torque of a single crystal. The anisotropy γ does not depend sensitively on the applied magnetic field at 10 K. We obtain the anisotropy parameter $\gamma = 4.31 \pm 0.14$. The torque curve shows the sharp hysteresis peak when the field is applied parallel to the boron layers. We consider that this comes from the intrinsic pinning and is direct evidence for the occurrence of superconductivity in the boron layers. This is consistent with what the band calculations predict in the electronic states.

22BP41 Quasi-Two-Dimensional Nucleation of Superconductivity in MgB_2

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The crystal structure of MgB_2 and band structure calculations suggest that quasi-2D boron planes are responsible for superconductivity. We report on the critical fields and resistance measurements of 5.6 μm thick MgB_2 films grown on a supphire single crystalline substrate. The temperature dependence of the upper critical fields revealed 3D character of magnetic field penetration into the film. Alternatively, the resistivity measurements showed that temperature dependence of fluctuation conductivity above T_c agrees with the Aslamazov-Larkin-Maki-Thompson theory for layered superconductors. We consider this finding as an experimental evidence of quasi-two-dimensional nucleation of superconductivity in MgB_2. This work was partially supported by INTAS grant No. 99-00585 and BRHE grant No. REC-007.

22BP42 Temperature Dependence of Magnetic Torque for a Single Crystal MgB_2 in 10 kG

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A new torque magnetometer has been constructed by using a 4-K closed cycle refrigerator and a variable field permanent magnet. The temperature of a top-loading space can be controlled from 300 K down to 1.5 K. The torque sensor consists of the four piezoresistors on a silicon cantilever. The torque can be measured as an off-balance signal of the Wheatstone bridge. Single crystals of MgB_2 have been synthesized by the vapor transport method. We examine the mass anisotropy $\gamma = \sqrt{m_c/m_{ab}}$ by using the London model. We discuss the temperature dependence of γ for MgB_2 in a constant field 10 kG.

Superconductivity and Electronic Structure of $MgCNi_3$ **22BP43**

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Polycrystalline samples of $MgCNi_3$ and RNi_2B_2C (*R*=Y,Lu) were investigated by resistivity, *ac* susceptibility, *dc* magnetization and specific heat measurements. $MgCNi_3$ can be considered as the 3-D analogue of RNi_2B_2C. A WHH-like shape of $H_{c2}(T)$ is observed for $MgCNi_3$ which contrasts with the positive curvature of $H_{c2}(T)$ near T_c observed for RNi_2B_2C. The $H_{c2}(T)$ and specific heat data of of $MgCNi_3$ are discussed in terms of effective single- and multiband models as well as in terms of the symmetry of the gaps. Our analysis is based on an orbital assignment of the disjoint Fermi surface sheets.

MgB_2 Superconducting Tip for Scanning Tunneling Microscopy Study **22BP44**

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We demonstrate a simple method for the fabrication of sharp and stable MgB_2 superconducting tips. The quality of these tips have been verified by imaging the surface of a Au(111) sample using a low temperature STM operated in UHV. With the MgB_2 superconducting tip, the *I-V* characteristics of the Au(111) sample have been measured in the temperature range 4.2 – 45 K. The observed *I-V* characteristics of the sample have been discussed in this paper.

Pressure Dependence of Chiral-Glass Transition in Y-Ba-Cu-O Ceramics **22BP45**

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Ceramic high-$T_{\rm C}$ superconductors may be viewed as a weakly coupled random Josephson network containing the so-called π-junctions, and a chiral-glass transition is predicted to be occured in d-wave ceramics. In the present work, pressure dependence of the chiral-glass transition have been investigated on $YBa_2Cu_3O_{7-y}$ and $YBa_2Cu_4O_8$ ceramics. With decreasing temperature, a superconducting order occurs at first inside each grain at $T_{\rm C1}$ and furthermore among the grains at $T_{\rm C2}$ ($< T_{\rm C1}$). The $T_{\rm C2}$ increases with increase of pressure, however, the sharpness of the transition at $T_{\rm C2}$ does not change. In spite of differences in not only $T_{\rm C2}$'s but also $T_{\rm C1}$'s, the increasing rates of $T_{\rm C2}$ by pressure are nearly the same.

22BP46 Magneto optical observation of "super-cooled" disorder vortex state in $Bi_2Sr_2CaCu_2O_{8+\delta}$

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Magnetic induction profiles across the surface of a $Bi_2Sr_2CaCu_2O_{8+\delta}$ crystal were measured during field descent from above the vortex solid-solid phase transition field, B_{ss}, to zero. These profiles indicate dynamic coexistence of two vortex phases: a disordered phase in the sample interior and a quasi-ordered phase near the sample edges. The border between these two phases, marked by an abrupt change in the slope of the profiles, moves with time towards the sample's center. The break in the profiles always appears at the same induction, B_f, *below* the value of B_{ss}. We interpret this phenomenon in terms of the field dependence of the nucleation and growth of the quasi-ordered phase, and relate B_f to the transition field.

22BP47 Magnetostriction and Magnetoacoustic Measurements on YBCO Crystals

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Magnetostriction hysteresis data reveal the presence of the fishtail effect in isothermal scans. Thermal cycles in magnetic fields show the behaviour of pinning of flux lines in the different phases Bragg glass, vortex glass and vortex liquid. Ultrasonic attenuation and the relative change of sound velocity for various magnetic fields were measured. The aim is to examine the elastic behaviour of the flux line lattice. In the framework of the thermally assisted flux flow model (TAFF) the depinning temperature and the activation energy were been deduced. The measurements on pure YBCO crystals are discussed and compared with investigations on Zn doped YBCO crystals. The magnetostrictive effects are verified by supplementary AC- and DC-magnetization measurements.

22BP48 Dynamical Scaling Analysis of Susceptibility in Ceramic YBCO Superconductors

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Dynamical properties of the ceramic $YBa_2Cu_3O_{7-\delta}$ have been investigated by magnetic measurements in order to clarify the inter-grain ordering. Kawamura and Li proposed that a chiral-glass ordering might occur in d-wave ceramic superconductors. We measured the ac-susceptibilities at various frequency under zero external field and carried out a dynamic scaling analysis of the susceptibility near the inter-grain transition temperature. The results exhibit scaling behavior for the critical exponents $z\nu$=8 and β=0.5. These values are fairly close to the ones for the chiral-glass estimated by Monte Carlo simulations.

Flux Flow Excited by Ultrasonic Deformation of Flux Line Lattice in High Temperature Superconducting Ceramics **22BP49**

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To investigate the flux pinning properties in HTSC against various kinds of deformation of flux line lattice(FLL), the flux flow excited by ultrasonic deformation of FLL was measured for bulk sintered samples of $Bi_2Sr_2Ca_2Cu_3O_y$. The longitudinal, tilt and shear ultrasonic deformations, which are associated with the elastic moduli of C_{11}, C_{44} and C_{66} of FLL in isotopic superconductors, were applied to FLL. A peak of the flux flow resistivity was observed at a temperature $T_{\rm p}$ at which the dissipation of ultrasonic energy became the maximum. The differences in $T_{\rm p}$ and the peak height among the deformations were small differently from the theoretical prediction with the model of thermally assisted flux flow. The results suggest that most flux lines are bent by the pinning at insulating layers and/or grain boundaries.

A new phase in the vortex solid region in $Bi_2Sr_2CaCuO_8$ **22BP50**

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The time decay of the zero field cooled diamagnetic magnetization of Bi2212 can be explained in terms of a characteristic relaxation time τ_0, and a mean activation energy E which is proportional to the reciprocal magnetic field. We find that τ_0 becomes extremely longer to be around 10 sec at low temperatures below 15K. This low-temperature phase in the vortex solid region is directly observed by the ac susceptibility measurements in the ultra low frequency range.

Transport Measurements in YBaCaCuO **22BP51**

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Hall and longitudinal resistivities have been measured in Ca-doped YBCO thin films with different oxygen concentrations. Oxygen content has been controlled by annealing so that the same sample is modified from overdoped (as grown) to underdoped. Room temperature is sufficient to reduce the overdoping level over a few days. Our data is discussed on the frame of the nearly antiferromagnetic Fermi liquid model as presented by Stojkovic and Pines. The emphasis being on the range from overdoped to optimally doped where data and discussion is scarce.

22BP52 Zeeman Splitting of the $^{63/65}$Cu NQR Line in optimally doped HgBaCaCuO below T_c

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We report pure zero field nuclear magnetic resonance (NQR) measurements on the optimally doped three layer compound HgBaCaCuO with T_c 134 K. Above T_c two Cu line pairs are observed in the spectrum corresponding to the two inequivalent Cu lattice sites. Below T_c the Cu NQR spectrum shows a splitting of these two line pairs into six line pairs. From a multi exponential spin lattice relaxation with a dependency on the initial conditions, we find a formation of magnetic moments in the CuO layers as the origin of the line splitting. Furthermore, the magnetic moments are *oriented parallel* to the symmetry axis of the electrical field gradient tensor with magnitudes of the order of 1000 G.

22BP53 The normal state magnetic susceptibility of $La_2CuO_{4+\delta}$ with excess oxygen

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We have studied the superconducting and magnetic properties of the ceramic $La_2CuO_{4+\delta}$ with excess oxygen, which were prepared by the electrochemical oxidation. Hirayama et al. reported that the ceramic $La_2CuO_{4+\delta}$ with excess oxygen has two superconducting phases, whose T_c's are 32K (36K) of the low T_c phase and 45K of the high T_c phase, respectively. In this paper, we have measured the magnetic susceptibility of the two phases in the normal states. The temperature dependence of the magnetic susceptibility of the high T_c's phase was found to be very similar to that of the optimum doped $(LaSr)_2CuO_{4+\delta}$. However, the temperature dependence of the magnetic susceptibility of the low T_c's phase was found to include the antiferromagnetic phase and paramagnetic phase.

22BP54 Coexistence of ferromagnetism and superconductivity in Cu-rich lanthanum Cu-oxides

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The magnetization of the lightly oxygen doped Cu-rich $La_2CuO_{4+\delta}$ is measured in zero field and field cooling and in a wide temperature range (5K to 350K). The data together with the evolution of the magnetic hysteresis loop suggest that the ferromagnetism with Curie temperature of 280K coexists with superconductivity below the transition temperature $\sim$ 34K. Such coexistence occurs in the hole-rich clusters of size small than 150nm, which are electronic phase separated from the hole-poor antiferromagnetic background.

Tl, Cu-NMR study on high-$T_{\rm C}$ cuprate $TlBa_2(Y_{1-x}Ca_x)Cu_2O_7$ 22BP55

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Hole doped high $T_{\rm C}$ cuprate $TlBa_2(Y_{1-x}Ca_x)Cu_2O_7$ has wide range solution limit from the antiferromagnetic (Ca=0) to the slightly overdoped (Ca=1.0). The superconducting transition temperature $T_{\rm C}$ is raised adruptry from zero to 100K at Ca=0.6 and almost constant to Ca=1.0. The local spin susceptibility (K_S) at Cu-site (Ca=0.8) shows spin-gap-like behavior from room temperature, suggesting that Ca=0.8 is in the underdoped region. The sample of Ca=1.0, believed to be slightly overdoped, does not show any spin-gap-like behavior. $(T_1T)^{-1}$ at Tl-site for every superconducting sample shows the Curie-Weiss behavior at high temperature limit. As decreasing temperature, a clear spin gap is observed from far higher temperature than $T_{\rm C}$ even in the slightly overdoped sample (Ca=1.0).

Neutron Scattering Studies of In-Plane Longitudinal Phonons of $YBa_2Cu_3O_y$ 22BP56

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In plane longitudinal phonon of $YBa_2Cu_3O_x$(YBCO or $YBCO_x$;x=6.5, 6.7 and$\sim$7.0) with B_{2u}/B_{3u} symmetry has been measured by neutron inelastic scattering to study whether effects of dynamical "stripes" can be observed in the mode of YBCO. Along Q=(3+h,0,0), we have observed two branches with the energy dispersions between 20$\sim$34 meV, corresponding to the B_{2u} and B_{3u} modes, which are perpendicular and parallel to the CuO chains. No anomaly has been observed in their dispersion curves. Rather strong smearing has been found in the former mode with larger chain oxygen motion than that of the latter. Because the degree of the smearing depends neither on x or on the temperature T, it may not be considered as an efect of the "stripes" but due to the oxygen deficiency at the chain sites.

THz imaging of supercurrent distribution in Meisner state of LPE-BSCCO film 22BP57

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Previously, we reported terahertz (THz) imaging for supercurrent distribution in high temperature superconductor thin film. In this method, THz pulse is emitted by ultrafast supercurrent modulation caused by femtosecond optical pulse excitation, and the intensity of the THz pulse transmitted through the sample is detected to visualize the supercurrent distribution. In the present study, in order to apply this technique to thick film, we observed the THz pulse reflected from the front side of LPE-BSCCO film, and investigated the Meisner current distribution under magnetic field.

22BP58 Observation of Spin-Gap in $Bi_{2+x}Sr_{1.6-x}La_{0.4}CuO_{6+\delta}$ by Transport Measurements

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We have measured the in-plane resistivity ρ_{ab} of $Bi_{2+x}Sr_{1.6-x}La_{0.4}CuO_{6+\delta}$ which is the single layered high-T_c superconductor. We observed the spin-gap temperature T^*, where ρ_{ab} derives from the temperature linear dependence. Furthermore, we found that T^* decreases with increasing the carrier density controlling by the annealing under various oxygen partial pressure. This systematic variation of T^* is the same tendency as the other high-T_c superconductors. However the scaling of relation between T^* and T_c which M. Oda *et al*. [Physica C **341-348** (2000) 847.] experimentally suggest is completely different from that in the others. In the presentation, we discuss the relation between T^* and T_c.

22BP59 Thermodynamic properties of MgCNi3 superconductor

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We have measured the magnetic properties on the high quality polycrystal sample of the recently discovered ternary carbide superconductor MgCNi3[1], which shows sharp superconducting transition around 8 K. The lower critical field Hc1 has been estimated through the non-linear deviation of the initial magnetization curve, and the upper critical field Hc2 measured via the superconducting transition at different applied magnetic field. Consequently the coherence length, penetration depth, and the Ginzburg-Landau parameter were calculated, respectively. The difference of the penetration depth was analyzed in an isotropic s-wave BCS description.

22BP60 Superconductivity in Electrochemically Li-intercalated Niobates with Layered Perovskite Structure

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Li-intercalated layered perovskites $Li_xAB_2Na_{n-3}Nb_nO_{3n+1}$ with n =3 and 4 (A = K, Rb, Cs; B=Ca, Sr, Ba) have been prepared by an electrochemical technique. For the $Li_xAB_2Nb_3O_{10}$ superconducting materials with a triple-layered NbO_6 octahedron, there is a relation between T_c and *a*-axis length, where T_c tends to increase up to about 6 K as the a-axis length increases. For $Li_xCsBa_2Nb_3O_{10}$ with the largest *a*-axis length, however, superconductivity does not appear. The non-superconductivity may be due to the transition from metal to insulator. In addtion, $Li_xKCa_2NaNb_4O_{13}$ shows no superconductivity.

Inelastic light scattering studies of superconducting Ru-based double perovskites 22BP61

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We report an inelastic light scattering study of double perovskite structure $Sr_2Y(Ru_{1-x}Cu_x)O_6$ systems as a function of temperature and doping (x = 0.0, 0.05, and 0.1). As the temperature is lowered, for x = 0.0, the 770 cm^{-1} A_{1g} apical oxygen phonon mode exhibits a softening and an enhancement of the linewidth in the antiferromagnetic phase. Similar anomalies are also observed for x = 0.1 when the superconducting gap opens. This suggests that a strong lattice-spin-charge coupling plays an important role in the magnetic and superconducting properties observed in these materials.

Microwave Josephson's absorption in high-temperature superconductors 22BP62

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Magnetic field dependence of Direct (DMA) and Magnetically Modulated (MMMA) Microwave Absorption of a number of Y-, Bi- and Tl- based high-temperature superconductors were measured at 4.2 K and 77 K by reconstructed X-band microwave spectrometer. It was found correlation between value of the low field maximum (LFM) of the absorption and the inter-grain critical currents of the Josephson junction system for these families of superconductors. Some results were analyzed and compared to the theoretical models of magnetoabsorption available in the literature yielding a fairly good agreement.

Elastic constant of the vortex lattice in $La_{1.875}Ba_{0.065}Sr_{0.060}CuO_4$ 22BP63

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In the stripe phase observed in La-214 system around the hole concentration of x=0.12, whether or not the superconductivity coexists with the stripe order is a controversial problem. In order to estimate the superconducting volume fraction, we measured the elastic constant under high magnetic fields by the ultrasonic technique in the stripe phase $La_{1.875}Ba_{0.065}Sr_{0.060}CuO_4$ single crystal which undergoes the structural phase transition to the low-temperature orthorhombic (Pccn) phase. The elastic constant of c_{44} mode of the vortex lattice shows the step like change below T_c=5K and the saturated value is 68% of the theoretical result. Probing with the vortex lattice, the superconducting volume fraction seems to be about two over three in the stripe phase of Pccn phase.

22BP64 Spin and Charge Inhomogeneity in the Cuprates characterized by NMR

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We prove the existence of correlated spin and charge variations in the cuprates and characterize these structures with NMR. Charge density variations are found to induce modulations of the spin susceptibility depending on the doping at two different wave vectors. The longer wave component disappears near Tc, the other, near the antiferromagnetic wave vector, grows as T is lowered and exists in the superconducting state.

22BP65 The glue is the clue: mesoscopic charge and spin ordering in HTSC

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In high temperature superconducting copper oxides (HTSC) there is accumulating evidence that mesoscale charge ordering precedes the spin ordering and persists into the superconducting phase. This scenario implies that a spatial segregation of holes takes place which reflects itself in a granularity in the local density of states. It will be described here how the charge ordering is driven by highly anharmonic lattice effects which induce polaronic level shifts on the doped holes and induce incommensurate dynamical modulations in the spatial hole distribution. The effect of the spatially modulated electron-lattice interaction driven level shift is to form the glue between the two components, spin and charge, by adjusting the spin and charge related energy levels through their mixing and substantially enhancing the superconducting transition temperature.

22BP66 Checkerboard of Quasi-Particle States Around Vortices in $Bi_2Sr_2CaCu_2O_{8+\delta}$

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We use scanning tunneling spectroscopy to image the spatial and energetic structure of the quasiparticle states surrounding quantized vortices in the high-T_c superconductor $Bi_2Sr_2CaCu_2O_{8+\delta}$. These states exhibit a four unit cell periodic "checkerboard" pattern, oriented along the copper-oxygen bond directions, with a decay length of $\sim$ 30 Å. Speculation on the possible charge density wave origin of this phenomenon has raised questions about its register to the atomic lattice, its energy dependence, and its temperature dependence. Here we report new results with high spatial and energy resolution, and we analyze the "checkerboard" phenomenon as a function of distance from the vortex core.

Point-Defects-Induced Vortex Phase Diagram in High-T_c Superconductors: Monte Carlo Simulation Study **22BP67**

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We investigated the field-temperature vortex phase diagram of high-T_c copper-oxide superconductors in the presence of dense point defects, by using a Monte Carlo simulation based on the Lawrence-Doniach model. We found a temperature-driven depinning line within the Bragg and vortex glass phases, well below the melting line. We also found a field-driven transition line from the Bragg-to-vortex glass at low temperatures, accompanied by an abrupt reduction in the interlayer vortex correlation. The complex phase boundaries are drastically controlled by the vortex pinning force of the defects, defect density, and anisotropy. These computational results explain the experimental results on BSCCO and YBCO.

Anomalous oscillation of ac susceptibility in low temperature for $Bi_2Sr_2CaCu_2O_{8+y}$ **22BP68**

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We studied magnetizations of over-doped $Bi_2Sr_2CaCu_2O_{8+y}$ single crystals. The thermoremanent magnetization shows an anomalous random oscillation in low frequency modulation field below 20K. The result indicates a random motion of the vortices, which suggest there exists a new magnetic phase in the vortex solid phase.

Extreme Smallness of the Transverse Force on Moving Vortices in $Bi_2Sr_2CaCu_2O_8$ **22BP69**

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We report the results of direct force measurements of the longitudinal (pinning and viscous) forces and the transverse ("Magnus") force on vortices along the c direction in $Bi_2Sr_2CaCu_2O_8$ single crystals. The magnetic flux is applied locally to the center of a crystal using a micro-electromagnet, thus avoiding edge-pinning and geometrical-pinning effects. The pinning and viscous forces measured by two different high-Q mechanical oscillator techniques are in good agreement, and agree with theoretical predictions. The measured transverse force on moving vortices is extremely small, in sharp contrast to recent "universal" theories, which predict the full hydrodynamic value. The data indicate that the transverse force on a moving vortex is smaller than the hydrodynamic value by a factor $\alpha \leq 0.015$.

22BP70 Josephson vortex flow and pinning probed by c axis transport measurements

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We have investigated dynamical properties of Josephson vortex (JV) system probed by the c axis transport properties of $Bi_2Sr_2CaCu_2O_{8+\delta}$ mesa structures with magnetic field alignments very close to the ab plane ($|\theta| < 0.1°$). In $I-V$ characteristics, zero-resistance and single branch regions were obtained in addition to a multiple branch region which is a distinctive feature of intrinsic Josephson junctions. The zero-resistance and single branch are considered to be realized by JV pinning and JV flow, respectively. Temperature dependence of the starting current of the single branch, which is given by the pinning force of JVs, shows a peak effect at around 10 K below T_c at 5 kOe. This peak effect cannot be explained with the random pinning but requires peculiar pinning mechanisms based on the crossing lattice model.

22BP71 Purely viscous motion of the vortices in semiclassical d-wave superconductor

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We report the free flux flow (FFF) resistivity associated with a purely viscous motion of the vortices in clean d-wave superconductor Bi:2201 in the strongly overdoped regime (T_c=16 K) in the vortex state. It is found that the FFF resistivity is remarkably different from that of conventional s-wave superconductors. At low fields the FFF resistivity increases linearly with H, while at higher fields the FFF resistivity increases in proportion to $\sqrt{H}$ up to H_{c2}. On the basis of these results, the energy dissipation mechanism associated with the viscous vortex motion in "semiclassical" d-wave superconductors is discussed.

22BP72 Heavy-ion Irradiation dependence of the Superconducting properties of (Cu,C)$Ba_2Ca_3Cu_4O_{10.5-\delta}$

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For further enhancement of critical currents density J_c and irreversibility field H_{irr} of (Cu,C)-1234 (T_c=117K), we have investigated heavy-ion irradiation dependence. The polycrystalline samples were irradiated with Au^{15+} ions (240 MeV energy) at a fluence of 1×10^{11}, 2.5×10^{11} and 5×10^{11} ions/cm^2, respectibly. J_c and H_{irr} were estimated from magnetic measurement.

Effect of variation of facets size on fractional flux vortices at asymmetric grain boundaries in YBCO films **22BP73**

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We consider numerically Josephson vortices at asymmetric grain boundaries in YBCO films. The study is focused on the effect of random variations of facets size on the values of fractional flux carried by these vortices. The grain boundaries are treated as Josephson junctions with a critical current density alternating along the junctions with a typical length-scale of order of the facets size. Our numerical simulations demonstrate that the flux of the vortices varies along the junction. The values of the fractional flux are defined by the local Josephson properties of the grain boundaries.

Universality of ultra-fast flux penetration into superconducting films **22BP74**

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We report on universalities of ultra-fast flux penetration into a YBCO superconducting film exposed to a transverse magnetic field of few mT. Using a fs pump-probe magneto-optic technique we are able to investigate the magnetic flux penetration on a subnanosecond timescale. The laser pulse is focussed with a cylindrical lens onto the film, hereby heating a line above T_c. Depending on H and T we observe two different regimes how magnetic flux penetrates from this line into the superconductor: at low field gradients homogeneously propagating flux fronts are observed, whereas at high gradients dendritic flux avalanches develop.

Current-voltage characteristics of three-dimensional vortex glass **22BP75**

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The current-voltage characteristics of the three-dimensional vortex-glass model of disordered type-II superconductors with a uniformly field threading the system are studied by the Lagevin dynamics technique. In agreement with static simulations, the vortex glass phase is found to be spoiled by the screening effect. We obtained correlation length exponent $\nu \approx 3.5$. This value is considerably higher than that for the gauge-glass model.

22BP76 Vortex motion noise in amorphous $Nb_{0.7}Ge_{0.3}$ microbridges

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We investigated the voltage noise in amorphous $Nb_{0.7}Ge_{0.3}$ microbridges, which is induced by vortex motion in the mixed state. There is a remarkable difference between the noise below and above the irreversibility field B_{irr}. Below B_{irr}, in the presence of measurable pinning, the noise at small applied currents resembles shot noise, and in the regime of flux flow at larger currents decreases with increasing voltage due to a progressive ordering of the vortex motion. At magnetic fields B between B_{irr} and the upper critical field B_{c2} flux flow is present already at vanishingly small currents. In this regime the noise scales with $(1 - B/B_{c2})^2 V^2$ and has a frequency (f) spectrum of $1/f$ type. We interpret this noise in terms of the fluctuation properties of strongly driven depinned vortex systems at high vortex density.

22BP77 Vortex dynamics and upper critical fields in ultrathin Bi films

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Current-voltage (I-V) characteristics of quench condensed, superconducting, ultrathin Bi films in a magnetic field are reported. Films close to superconductor-insulator transition (SIT), show a peak in the critical current as a function of magnetic field, as well as temperature, indicating a structural transformation of the vortex solid (VS). This is contrary to the recently reported results of a absence of VS phase near SIT. Underlayers of Ge/Sb, used to make the films more homogeneous, are found to be more effective in pinning the vortices. The upper critical fields (B_{c2}) of these films are determined from the resistive transitions in perpendicular magnetic field, and are found to differ significantly from Ginzburg-Landau theory.

22BP78 Vortices in Bulk and Mesoscopic Superconductors: Variational Calculations

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A variational method is used for the analysis of the vortex structures in bulk and mesoscopic type-II superconductors. The approach is based on various trial functions for the order parameter and minimization of the Ginzburg-Landau free energy. The magnetization of bulk superconductor is calculated in the whole field range between H_{c1} and H_{c2} in the Wigner-Seitz cell approximation. The vortex phase diagram for long mesoscopic cylinders with suppressed surface superconductivity is determined under general boundary conditions. The comparison of our results with known exact solutions and asymptotics demonstrates a good accuracy of the proposed method.

Interaction effects in non-Hermitian models of vortex physics **22BP79**

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Vortex lines in superconductors in an external magnetic field slightly tilted from randomly-distributed parallel columnar defects can be modeled by a system of interacting bosons in a non-Hermitian vector potential and a random scalar potential. We develop a theory of the strongly-disordered non-Hermitian boson Hubbard model using the Hartree-Bogoliubov approximation and apply it to calculate the complex energy spectra, the vortex tilt angle and the tilt modulus of both $(1+1)$- and $(2+1)$-dimensional directed flux line systems. We construct the phase diagram associated with the flux-liquid to Bose-glass transition and discuss the effects of interaction on the nature of this transition.

Vortex Structures in the Ferromagnet–Superconnductor Bilayer **22BP80**

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Vortex structures in ferromagnet/type-II superconductor bilayer are investigated for the case when the ferromagnetic layer has domain structure and magnetic anisotropy perpendicular to the bilayer. It is found that two equilibrium vortex states can be realized: (i) Straight vortices with alternating directions corresponding to the direction of the magnetization in the ferromagnetic domains. The vortices appear near the domain centers. (ii) Vortex semi-loops, which appear near the domain walls and connect the ferromagnetic domains with opposite direction of the magnetization. These two states are separated by an energy barrier of geometrical origin. The values of the critical magnetization for the formation of these vortex structures are determined.

Study of vortex configuration in the mixed state of a-W/Si multilayers **22BP81**

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Configuration and motion of vortices have been studied on amorphous W/Si multilayers with strong (3D) and weak (quasi-2D) layer coupling through the simultaneous measurements of two components of electric fields in the film plane, E_x and E_y, as a function of current in magnetic fields of the form $(H, H, \alpha H)$, where $|\alpha| < 0.15$ and $x \parallel$ the current direction. The analysis of E_x and E_y shows that in the 3D sample a change in the vortex structure from the kinked line to the correlated straight one occurs at the vortex glass transition. In the quasi-2D sample, only the dynamics of 2D pancake vortices including the velocity drift due the Magnus force has been observed in all the temperature range measured even at $\alpha = 0$.

22BP82 Nonlinear Thermomagnetic Shock Waves in Type II Superconductors

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In this work the structure of the thermomagnetic shock waves in superconductors is analyzed with an account of dissipation and dispersion effects. The effect of the dependence $jc(H)$ on the structures of the nonlinear thermomagnetic wave propagation is studied. It is shown that taking into account the nonlinear dependency of the critical current density j_c on the external magnetic field H the latter would not qualitatively change the main results, therefore the character of the equilibrium state at the phase plane remains essentially the same

22BP83 Search for Spontaneous Magnetization in Sr_2RuO_4

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μSR measurements in Sr_2RuO_4 indicate that an internal magnetic field is established below T_c, suggesting that the superconducting state breaks time-reversal symmetry. We used a micro-Hall probe (5×5 μm^2) to search for spontaneous magnetic field at the edge of chiral domains in the time-reversal symmetry breaking state. We did not detect magnetic signal larger than 0.02 G at zero field. This value is one order of magnitude smaller than the theoretical estimate, and suggests that either the spontaneous magnetization is absence or the chiral domain is smaller than 5 μm. In the latter case, history dependent measurements of the vortex pinning force strongly suggest that the chiral domains can be easily flipped.

22BP85 Search for the chiral state in Sr_2RuO_4-Ru eutectic

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Sr_2RuO_4 is a spin-triplet superconductor ($T_c = 1.5$ K) with a two-component order parameter (chiral state). Its eutectic system Sr_2RuO_4-Ru shows a superconducting transition with an enhanced onset of $\sim$3 K, though pure Ru is a superconductor with $T_c = 0.5$ K. In the Sr_2RuO_4-Ru eutectic, the interface between Sr_2RuO_4 and Ru is considered to be responsible for the enhanced superconductivity, with its order parameter represented by only one component parallel to the interface near 3 K. Consequently, it is predicted that a second transition to a chiral state occurs at a temperature between 1.5 and 3 K. In order to probe the chiral state, we have measured the ac-susceptibility of Sr_2RuO_4-Ru eutectic between 2 and 1000 Hz using a homemade ac SQUID magnetometer.

Magnetic excitations in $Ca_{2-x}Sr_xRuO_4$ near the quantum critical point

22BP86

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We have carried out inelastic neutron scattering experiments on two single crystals of $Ca_{2-x}Sr_xRuO_4$ in order to investigate the magnetic inelastic response of this system near the ferromagnetic ordering observed for x=0.5. The excitation spectrum in both samples strongly differs from that found in the spin-triplet superconductor Sr_2RuO_4 which is dominated by incommensurate peaks near (0.3,0.3,0). In $Ca_{2-x}Sr_xRuO_4$, with $x = 0.38$ and 0.52, we find still incommensurate scattering but situated much closer to the zone-center. These excitations most likely reflect the general tendency of the γ-band towards ferromagnetism and are, hence, related to the proposed mechanism for superconductivity in Sr_2RuO_4.

Electronic and structural properties of organic superconductor κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]I

22BP87

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Thermopower and X-ray diffuse scattering were measured in κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]I. Two stage superstructural transformation was shown to be responsible for the formation of the insulating state at ambient pressure as seen in thermopower measurements. The superconducting state was studied by resistance measurements under the uniaxial strain applied along the main crystallographic directions.

Vortex dynamics of organic superconductor κ-(ET)$_2$Cu[N(CN)$_2$]Br observed by ultasonic mesurements

22BP88

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Organic superconductors κ-(ET)$_2$X (X = Cu(NCS)$_2$, Cu[N(CN)$_2$]Br) show anomalous elastic properties both in the nornal and superconducting states [1]. In superconducting state, these salts shows remarkable elastic anomalies in the magnetic field, which mainly come from the interplay between the vortices and the elastic wave. We have measured the vound velocity of Cu[N(CN)$_2$]Br saltwith different experimental configurations. We will discuss the vortex dynamics of this salt by comparing with the previous work [2]

[1] T. Simizu et al., Physica B 281 & 282 (2000) 896.
[2] M. Yoshizawa et al., J. Low Temp. Phys. 105 (1996) 1745.

22BP89 Transport properties of θ-$ET_2CsM(SCN)_4$ (*M*=Zn,Co) under ultra-high pressure

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In order to investigate the electronic states of the organic conductors, θ-$ET_2CsM(SCN)_4$ (*M*=Zn,Co), under ultra-high pressure, we performed the resistance measurements up to 8GPa with the cubic anvil press. The insulating states of these salts were suppressed in this pressure range but remained at low temperatures even in 8GPa. The results were discussed in terms of anisotropic pressure dependence of transfer integrals.

22BP90 Possible change of the superconducting symmetry in the vicinity of the SC-AF transition in $NH_3A_3C_{60}$

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We have studied vertex corrections to both the intraband and interband electron-phonon couplings in the doped C_{60}. The corrections to the Migdal approximation was studied for the self energy of the anomalous Green function. On the basis of our results, we suggest a possible change of the symmetry of the superconductivity in the vicinity of the phase boundary between the superconducting and antiferromagnetic phases of $NH_3A_3C_{60}$.

22BP91 Observation of the Vortex Pinning in YNi_2B_2C by LT-STS

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We have performed scanning tunneling spectroscopy measurements on the cut or cracked surface of YNi_2B_2C. Three distinct regions which are superconducting, metallic and semiconducting were observed. The metallic and semiconducting regions are precipitates which have slightly different compositions from YNi_2B_2C. Under the magnetic field applied above T_c, the vortices were imaged in the superconducting regions as the increase in the local density of states(LDOS) at Fermi energy. When the applied magnetic field is increased at 4.2K, the LDOS was enhanced along the boundary of the semiconducting precipitates. This enhancement of the LDOS is attributed to a number of pinned vortices at the boundary.

^{11}B NMR study of vortex dynamics in $LuNi_{1.8}Pt_{0.2}B_2C$ **22BP92**

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^{11}B pulsed nuclear magnetic resonance(NMR) measurements have been performed on $LuNi_{1.8}Pt_{0.2}B_2C$ superconductor to investigate vortex dynamics. The spectra and the peak point in the superconducting state exhibit a typical local field distribution for a vortex lattice at magnetic field parallel to the c-axis. However, the linewidth of the spectrum is much smaller than expected and the transverse relaxation rate indicates significant thermal fluctuation of vortices. Temperature dependence of ^{11}B NMR spectrum, saddle-point field, linewidth, and transverse relaxation rate are measured to study the change in vortex dynamics originating from the pinning centers of Pt dopants.

Unconventional Superconductivity in YNi_2B_2C and $LuNi_2B_2C$ **22BP93**

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The superconductivity in borocarbides is considered to be of strongly anisotropic s-wave type. However both $\sqrt{H}$ dependence of the specific heat and H-linear thermal conductivity in the vortex state indicate it belongs to nodal superconductors. We have proposed recently the s+g-wave model, which can account these features. As to the precise location of the nodal points in $\Delta(\mathbf{k})$, the angular dependent magnetothermal conductivity (ADMC) is extremely useful. Also ADMC can distinguish s+g- wave from d-wave superconductivity.

Specific heat and transport measurements in irradiated (K,Ba)BiO_3 **22BP94**

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The magnetic field dependence of the thermodynamic transition line in heavy ion irradiated (K,Ba)BiO_3 single crystals has been investigated by specific heat measurements. As predicted for the Bose-Glass transition line, we show that the superconducting transition line ($H_{Cp}(T)$) strongly depends on the irradiation dose and angle between the external field and the columnar tracks. In pristine sample, $H_{Cp}(T)$ presents an anomalous positive curvature and is progressively shifted towards higher temperature as the irradiation dose is increased. $H_{Cp}(T)$ shifts back to the position of the virgin sample for $H\perp$ tracks.

22BP96 Numerical Study of Phonon Spectra in Strongly Correlated Electron Systems

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Many of the experimental observations such as inelastic neutron scattering data indicate that the phonons may play an important role in the electronic properties of superconducting cuprates. It is well known that there are anomalous behaviors in longitudinal optical oxygen bond-stretching phonon in the CuO_2 plane. In this study we examine the phonon dynamics in the electron-phonon-coupled systems. The model Hamiltonians are one-dimensional Hubbard model coupled with phonon system. We perform numerically the exact diagonalization of the Hamiltonians with truncations of phonon Hilbert space. We calculate the phonon excitation spectra and find the broad feature in the spectra in the metallic region. We also calculate the charge and spin excitation spectra and find that the feature in the phonon spectra is caused by the low energy electronic excitations.