Session 25BP

Inhomogeneous d-wave state and lattice instability in the three-band Hubbard model for high-T_c cuprates **25BP1**

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The inhomogeneous ground state of the three-band Hubbard model for high-T_c cuprates is investigated by using the variational Monte Carlo method. We evaluate the energy expectation values of the wave function with stripes, d-wave order parameter and lattice deformation in the underdoped region. It is shown that the striped state is stabilized due to the lattice deformation. It is also shown that the superconducting order parameter oscillates in accord with the non-uniform spin and charge distributions and that the superconducting condensation energy is reduced due to the inhomogeneity.

Spin-phonon coupling near the metal-insulator transition in doped $HgBa_2CuO_4$. **25BP2**

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Effects of spin and lattice modulations on the band structure of the high-T_C oxide $HgBa_2CuO_4$ are studied. Self-consistent band calculations are made for stripe-like modulations due to phonon- or spin-waves in elongated supercells. The virtual crystal approximation is used to study the effect of doping. Modulations of the potential with long-range Fourier components lead to gaps or pseudo gaps depending on the strength of the potential perturbation. The gaps appear at one band below the electron filling of the undoped supercell. The longer the wavelength is, the closer will the gap be to the position of E_F in the undoped case. There is a correlation between doping and wavelength of the modulations, since the gain in energy is optimal if the gap is at E_F for the doped system. The interaction between spin and phonon waves leads to enhanced coupling λ. The pseudogap is a consequence of the stripe modulation.

25BP3 Possible High Temperature Superconductivity in Systems with Nested Fermi Surfaces Pockets

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We propose that high T_c superconductivity can be achieved in repulsively interacting systems having nested Fermi surface pockets. The idea is that the sign change in the gap function, which is inevitable in superconductivity arising from repulsive interactions, can take place *across* the pockets, so that the gap is fully open on each pocket, resulting in a high T_c. As an example, we show using fluctuation exchange approximation that the Hubbard model on a series of dimerized lattices can exhibit $T_c \sim 0.1t$ (t is the hopping integral), which is almost an order of magnitude larger than that in the Hubbard model on a square lattice, a model for the high T_c cuprates.

25BP4 Effects of two-site correlations in the two-dimensional Hubbard model

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Electronic states of the two dimensional Hubbard model are investigated by use of the Composite Operator Method. In this paper, we present the way to incorporate the effects of two-site composite excitations as dynamical corrections to the electronic propagator. The used approximation goes well beyond the conventional two-pole approximations. The electronic structure is discussed in detail and the results are compared with those obtained by numerical simulations.

25BP5 Electron-Phonon Interaction in HTcS: Tunneling and Andreeving Experiments on HTcS oxides at High Pressure

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A short review is presented of the work, that done in collaboration with Japanese colleagues, on tunneling (superconducting and normal state) and Andreev transfer of charge in high-temperature layered cuprates. The distinctive feature of our experimental investigations is the use of High Pressure. The well distinguished phonon structure in TDOS was observed and softing of the high-frequency modes has been found also, that explains the observed rise in 2D/Tc ratio in the framework of the strong EPI model. Attention is directed mainly toward a critical analysis for EPI spectral function that was obtained from tunneling measurements in normal (self-energy corrections) and superconducting states.

Dirac Monopole and Spin Hall Conductance for Anisotropic Superconductivities **25BP6**

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Concept of the topological order is useful to characterize anisotropic superconductivities. The spin Hall conductance distinguishes superconductivities with the same symmetry. It is given by several different but equivalent topological expressions by the Berry's parametrization. They are covering degree of a surface around the Dirac' monopole, an intersection number of the Dirac's string with the surface and total vorticity of relative phase of a quasiparticle wavefunction. We have calculated the topological numbers for various anisotropic superconductivities with singlet and triplet order parameter. Quantum phase transitions for the various superconductivities are also demonstrated by these topological objects.

Transistor Doping Experiments indicate that Phenomenological Bond Order Rules are common to high T_c Superconductivity **25BP7**

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Aspects of transistor doping in $CaCuO_2$ and C_{60} are in line with expectations from bond ordering [BO] principles. A universal sequence of T_c development with hole doping is apparent, including linear portions up to an optimal BO with a slope corresponding to a radical formalism [RF], which extrapolate to T_c=0 at h=o, and a sharp peak with another linear decrease thereafter. The hallmarks of the BO filling sequence further include T_c onset at a critical BO, where an adverse BO is cooperatively transformed to a beneficial one with twice the RF slope. Mechanisms of the bond order filling are extracted from the slopes. Within the RF slope a region exists with tendencies to electonic freezing [e.g. 1/8 in $CaCuO_2$].

Relation between d-density wave of electron and staggered flux of spinon **25BP8**

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A d-density wave(ddw) order of electron in 2-dimensional t-J model is analyzed in saddle point level using the U(1) slave boson formalism. We considered not only the staggered flux(s-flux) order of spinon but also the s-flux order of holon. This analysis provides the relation between the s-flux order of spinon and the ddw order of electron. We discovered a new phase in the phase diagram. In this phase, there is a s-flux order of spinon, but no ddw order of electron.
Our results are 1) a region of electron d-density wave exists, 2) there is no coexistence of ddw and d-wave pairing(singlet-RVB), in all region of phase diagram (finite T and T=0), and 3) the ground state is a purely superconducting state.

25BP9 Difference of Electronic States between Hole- and Electron-Doped Cuprtaes

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In electron-doped high-T_c cuprates, the antiferromagnetic phase remains up to electron concentration $x\sim$0.15, while a small amount of holes is enough to kill the antiferromagnetic phase in hole-doped high-T_c cuprates. Such asymmetry causes differences in physical properties between the two types of cuprates. We study the electronic states of the electron-doped cuprates and compare them with those of hole-doped cuprates, by using numerically exact diagonalization technique for a t-J model with long-range hoppings, t' and t''. Examining the optical conductivity, spectral function, and chemical potential shift, we find remarkable differences of the electronic states between the electron- and hole-doped cuprates. The calculated results are consistent with experimental data reported recentely.

25BP10 Anisotropic superconductive transition on $CeRu_3B_2$

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The superconductivity on the valence fluctuation compound $CeRu_3B_2$ (the space group is P6/mmm, T_c=1.0 K) is meaningful, especially when it is compared with the superconductivity on $CeRu_2$. However, all of the previous experiments were done on the polycrystalline samples. We made the single crystal of $CeRu_3B_2$ and measured its resistivity and ac susceptibility for a and c axes. The measurements show the superconductivity at T_c=1.0 K as the previous experiments, but the anisotropic behavior has been observed between 1.1 K and T_c.

25BP12 Effect of anisotropic strain on the electronic properties of the pressure induced superconductor $CePd_2Si_2$

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We report resistivity and calorimetric measurements on two single crystals of $CePd_2Si_2$ pressurised up to 7.4 GPa. A weak uniaxial stress induced in the pressure cell demonstrates the sensitivity of the physics to anisotropy. Stress applied along the c-axis extends the whole phase diagram to higher pressures and enhances the superconducting phase emerging around the magnetic instability, with a 40% increase of the maximum superconducting temperature, T_c, and a doubled pressure range. Calorimetric measurements demonstrate for the first time the bulk nature of the superconductivity. Analysis of both the initial slope of the upper critical field and the normal state resistivity behaviour provides evidence about the nature of quasi-particles involved in superconductivity.

Effect of Substitution in the $(Gd_{1-x}Ca_x)Ba_2Cu_3O_y$ and $Gd(Ba_{2-x}A_x)Cu_3O_y$ (A = Ca, Sr) Superconducting Compounds **25BP13**

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Introducing Ca or Sr ion into $GdBa_2Cu_3O_y$, Ca acting as a hole dopant at the R site and a hole filler at the Ba site. T_c is linearly dependent on the orthorhombicity of the unit cell for all three series and it is also correlated to the $\angle$ O(1)-Ba-O(1) along the unit cell a-axis, which is the relative positions of the Ba and the epical O(1) sites.

Nature of Vortex Solid to Liquid Transition in Irradiated Samples of BSCCO **25BP14**

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Using the Differential Magneto-Optical technique, we have imaged the melting process of the vortex matter in the presence of columnar pins in $Bi_2Sr_2CaCu_2O_8$. We find that the columnar defects produce and upward shift in the melting line. The shift increases not only as one goes to lower temperatures but also with the increasing density of columns. In irradiated regions of the sample despite strong pinning, we find that the first order melting transition persists and terminates at a critical point. This critical point moves to a higher temperatures with increasing density of pins. We have discovered an sharp inflection in the curvature of the vortex solid to liquid transition line in the irradiated regions of the sample. The results are summarized in a new vortex matter phase diagram in the presence of columnar defects.

Growth of $Nd_{1-x}Ce_xBa_2Cu_3O_y$ single crystals by travelling solvent floating zone method **25BP15**

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Superconducting characteristics have been studied from the viewpoint of the annealing condition on single crystals of the $Nd_{1-x}Ce_xBa_2Cu_3O_y$ system grown by the travelling solvent floating zone (TSFZ) method. As for single crystal, it was proved that there were no impurities by the powder X-rays analysis. The rate of RE was 1.3:2:3 by EDX analysis, and the concentration of Ce was about 10 - 12%. The samples which were annealed at 850°C in an Ar atmosphere, following an anneal at 300° C in an O_2 atmosphere showed a drastic improvement of the superconducting character in the crystals, that is, T_c is quite high and the transition width DT_c becomes sharp. This result suggests the possibility that Ce replaces at the Re site in the $ReBa_2Cu_3O_y$ structure.

25BP16 Preparation of Tl-1223 and 2212 superconductor thin film and their microwave properties

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The superconductor $TlBa_2Ca_2Cu_3O_y$ (Tl-1223),with T_c(133 K) comparable to Hg-1223 which holds a record of highest T_c, is a best candidate for microwave electronic device appliations. Therefore, we have investigated microwave properties of Tl-1223 films prepared on CeO_2 buffered sapphire substrate by an *ex situ* process. The observed T_c was lower due to partial substiution of Sr for Ba and J_c was 2×10^6 A/cm^2 at 77 K. The surface resistance was measured by dielectric resonator technique with a frequency of 22 GHz. The details of these results along with those of Tl-2212 will be presented.

25BP17 Annealing effect of the irreversibility fields in (Cu, C)-12(n-1)n (n = 3, 4)

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(Cu, C)$Ba_2Ca_{n-1}Cu_nO_y$ ((Cu,C)-12(n-1)n) is a promising candidate for applications at 77 K, because it shows high-Tc($>$100 K) and high-H_{irr} due to a metallic charge reservoir layer. Polycrystalline samples (n = 3, 4) prepared under high pressure were annealed on various reduction conditions. In case of n = 4 J_c and H_{irr} were improved by the annealing while the T_c remained almost the same, which was quite different from n = 3. This difference in behaviour of samples with n = 3 and n = 4 will be discussed.

25BP18 Addition of LiF to (Cu,C)-1234 bulk superconductor

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(Cu,C)-1234 with addition of LiF has been synthesized by high-pressure technique. LiF is decreasing the synthesis temperature of the superconducting phase for the same oxygen content in the starting composition. LiF promotes the formation of the (Cu,C)-12(n-1)n, n higher than 4, and growth of larger (Cu,C)-1234 grains. Morphology and composition was analysed by SEM and EDS. Superconducting transition was measured by both transport and AC susceptibility, and critical current densities were determined by DC magnetization studies in fields up to 14 T, in the frame of critical state models.

Effects of oxygenation processes on $(Nd,Gd)_1Sr_2RuCu_2O_x$ synthesis **25BP19**

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In this work we report on the effect of oxygenation processes on the structure and composition of $GdSr_2RuCu_2O_x$ and $NdSr_2RuCu_2O_x$ compounds. By x-ray diffraction analysis, evidence of a progressive amelioration of samples composition due to the disappearance of impurities related peaks has been observed. Evolution of crystalline structure after oxygen annealing treatments has been studied too. Magnetisation measurements data in function of oxygenation are also reported.

Magnetic investigations of the high-T_c superconductor Hg-1212 **25BP20**

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The magnetic properties of several powder samples of the high-T_C superconductor Hg-1212 are investigated by means of ac and dc susceptibility measurements. The temperature dependence of irreversibility fields is determined up to 14 T using different criteria, e.g. the maximum in the imaginary part of the ac susceptibility. In case of Tl substitution the irreversibility line is clearly enhanced. The results are discussed within a depinning model developed by Matsushita. The relation of the real part to the imaginary part of the ac susceptibility shows without any free parameters a good agreement with the simple Bean-model.

Crystal growth of $La_{2-x}Ce_xCuO_4$ **25BP21**

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Single crystals of $La_{2-x}Ce_xCuO_4$ have been successfully grown by the traveling-solvent floating-zone (TSFZ) method. The optimum condition of the atmosphere on the growth was determined. The effect of the annealing atmosphere and temperature was also studied. The characterization of the crystals by scanning electron microscopy-X-ray energy dispersion spectroscopy (SEM-EDS) and magnetic susceptibility measurement is reported.

25BP22 Anisotropic Properties of $RuSr_2GdCu_2O_8$ Thin Films Epitaxially Grown on $SrTiO_3$ (100) and (110) Substrates

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For the examination of physical property dependence on the crystalline orientation direction in $RuSr_2GdCu_2O_8$ (Ru1212), in which superconductivity and a magnetic order coexist, we have tried crystalline-orientation-controlled growth of Ru1212 thin films on $SrTiO_3$ (STO) (100) and (110) substrates. 4-circle X-ray diffractometry has confirmed that Ru1212 (001) films grow epitaxially on STO (100) and Ru1212 (103) on STO (110). The results will be reported on the dependence of electrical and magnetic properties on Ru1212 crystalline orientation directions.

25BP23 Tunneling-Spectroscopic Evidence for Unconventional Pairing Interaction in $Bi_2Sr_2CaCu_2O_{8+\delta}$

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The quasiparticle density of states (DOS) is measured as a function of magnetic field up to 9 T by the short-pulse interlayer tunneling spectroscopy for slightly overdoped $Bi_2Sr_2CaCu_2O_{8+\delta}$. The tunneling spectrum in the absence of a magnetic field exhibits typically the superconducting coherence peak and the pseudogap peak. From the field dependence, it is found that little DOS is transferred from the Fermi level to the coherence peak by the superconducting condensation, but rather the coherence peak gathers DOS at energies apart from the Fermi level by 70 to 80 mev. This is totally at variance with the DOS transfer of the BCS type, implying that unconventional pairing interaction occurs in this system.

25BP24 Scanning Tunneling Microscopy Studies of High J_c NEG123 Crystals

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We have performed scanning tunneling microscope and spectroscopy (STM/STS) measurements on (Nd,Eu,Gd)$Ba_2Cu_3O_y$(NEG123) crystals grown by an oxygen-controlled-melt-growth (OCMG) process at room temperature under ultrahigh vacuum (UHV) condition. We observed a modulation structure on a cleaved surface of the samples with high J_c and high irreversible field H_{irr} more than 10 T at 77 K. This structure may be associated with an element substitution and the good J_c-B property. This work was supported by New Energy and Industrial Technology Development Organization(NEDO).

Energy gap evolution over wide temperature and hole-doping ranges in Bi2212 **25BP25**

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On the basis of tunneling experiments on Bi2212/vaccum/Bi2212 junctions fabricated using STM, we report that there exist two kinds of pseudogaps (LPG and SPG) with different characteristic energies. The LPG, which is 3 to 4 times larger than the SC gap (SCG), develops below $\sim T_{\rm max}$, where the magnetic susceptibility starts to decrease because of the development of AF spin fluctuations. On the other hand, the SPG develops progressively below the mean-field characteristic temperature $T_{\rm CO}$ for d-wave superconductors in addition to the LPG, and then evolves into the SCG at $T_{\rm C}$, suggesting that it will be some kind of precursor of superconductivity. We also report that in accordance with the SC transition, the high-energy feature of quasiparticle spectrum outside the SCG, relating to the LPG, changes from a broad hump to a clear dip and hump, in addition to the rapid growth of SCG from SPG.

Scaling Behavior of the C-axis I-V Characteristics for Bi-2212 Single Crystal **25BP26**

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The c-axis isothermal I-V curves of BSCCO-2212 single crystal in different magnetic fields have been investigated. Following the normal scaling procedure of vortex glass theory, all of the isothermal I-V curves in the same c-axis magnetic field collapse onto two curves and the relevant scaling critical exponents are extracted. This strongly suggests the occurrence of a vortex-glass transition of c-axis direction upon decreasing temperature. The system dimensions are of the order of 3 and 2.5 in the applied c-axis magnetic fields of 0.04T and 0.1T respectively. It hints that the 2D behavior shows up at higher applied magnetic fields. This is consistent with the assumption that BSCCO-2212 single crystals are made of a series of stacks weakly coupled by intrinsic Josephson junctions.

Vortex-antivortex annihilation in underdoped $YBa_2Cu_3O_{6.354}$ **25BP27**

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Locally applied magnetic fields can be used to create vortex-antivortex pairs in superconducting films and thin crystals. These pairs typically annihilate on some timescale which depends on temperature. We use a 21μm diameter field coil integrated onto a scanning Superconducting QUantum Interference Device (SQUID) to create and observe vortex-antivortex pairs. We present measurements of the distribution of annihilation times as a function of temperature, which should allow us to determine the pinning forces for vortices in these highly underdoped samples of $YBa_2Cu_3O_{6.354}$.

25BP28 Incommensurate Properties of high-T_c superconductor $YBa_2Cu_3O_{6.93}$

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The resonance and incommensurate peaks in optimally doped high- T_c superconductor $YBa_2Cu_3O_{6.93}$ are observed by means of TOF neutron scattering technique in a wide q-E space. Overall dynamical properties around (π, π) suggest the incommensurability of $\delta \cong 0.1$ corresponds to the previous triple-axis measurement. Obtained δ=0.1 is smaller than that expected from stripe model. In the high frequency region it is also found the same type of resonance and incommensurate peaks at E=53 meV. This work was partly supported by NEDO.

25BP29 Incommensurate, dispersive, density of states modulations in $Bi_2Sr_2CaCu_2O_{8+\delta}$

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Scanning tunneling spectroscopy of $Bi_2Sr_2CaCu_2O_{8+\delta}$ reveals weak, incommensurate, spatial modulations in the tunneling conductance. When images of these energy-dependent modulations are Fourier analyzed the dispersion of their wavevectors can be determined. Comparison of the dispersions with angle-resolved photoemission indicates that quasiparticle interference, due to elastic scattering between specific regions of the Fermi surface, provides a consistent explanation for the conductance modulations.

25BP30 Reversible and irreversible behavior in La1.45Nd0.40Sr0.15CuO4 stripe phase superconductor

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Magnetization measurements for La1.45Nd0.40Sr0.15CuO4 single crystal have been performed in order to investigate the effects of spin-charge ordering on the reversible magnetization and the irreversible fields along the ab-plane and the c-axis. Moreover, the maximum pinning forces obtained from the irreversible magnetization along c and in the ab-plane were found to scales with (Hc)b for both crystallographic directions.

Evidence for Spin Density Wave in the Superconducting $YBa_2Cu_4O_8$ 25BP31

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The torque curves of $YBa_2Cu_4O_8$ show the multiple peak effects when the field direction is scanned between the c and a axes. Especially, the position of the first peak, which appears at $\theta_{ca} \simeq 90 \pm 10^\circ$, is independent of T and H. However, the first peak does not appear when the field direction is scanned between the c and b axes. This strongly indicates that the first peak at $\theta_{ca} \simeq 90 \pm 10^\circ$ comes from the CuO double chains and/or the induced anisotropy in CuO_2 planes. We propose that the electronic spin modulation along the a axis with the long period of $20a_0$ is responsible for the appearance of the first peak in the superconducting states at temperatures below 40 K. This work is partially supported by New Energy and Industrial Technology Development Organization (NEDO).

Anisotropic electromagnetic in-plane response of weakly doped $La_{2-x}Sr_xCuO_4$. 25BP32

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We report on the anisotropy of both in-plane electronic conductivity and lattice dynamics examined in the weakly doped phase of a prototypal high-T_c system $La_{2-x}Sr_xCuO_4$ (x = 0.03 and 0.04) with infrared spectroscopy. Evidence for spin stripes in these materials is well documented. Our data for phonon modes indicate that spin stripes are accompanied by quasi-static charge ordering. We also find significant anisotropy of the electronic response within the CuO_2 planes with enhancement of the conductivity along the stripe direction in the limit $T, \omega \rightarrow 0$. These results uncover a complex electronic behavior due to stripes that is beyond an idealized picture of strictly 1D charge channels embedded into AFM insulator.

Josephson Plasma in Ru- and Fe-cuprates 25BP33

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Recently, much attention has been paid to Ru- and Fe-cuprates, as the coexistence of superconductivity and ferromagnetism has been reported in some of these compounds. Here, we report the Josephson plasma of these compounds to investigate the interlayer coupling between the superconducting layers through the magnetic layers. We found that the Josephson plasma is observed at 8.5 cm^{-1} and 13 cm^{-1} for ferromagnetic $RuSr_2GdCu_2O_8$ and $RuSr_2Eu_{2-x}Ce_xCu_2O_{10}$ (x = 0.5), and it largely increases to 35 cm^{-1} and 31 cm^{-1} for non-ferromagnetic $Ru_{1-x}Sr_2GdCu_{2+x}O_8$ (x = 0.3) and $FeSr_2YCu_2O_y$, which indicates a large reduction in the Josephson coupling at the ferromagnetic RuO_2 block layers. The temperature dependence of the plasma excludes the possibility of the 0 - π phase transition in the ferromagnetic cuprates. We also discuss about the anomalous features of the plasma in the Ru-cuprates.

25BP034 Effect of heavy-ion irradiation on the pinning properties of MgB_2

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Pinning properties of MgB_2 superconductors irradiated with 5.8 GeV Pb-ions are reported. According to the TEM observation, we found that the irradiation introduces spherical amorphous defects, which is different from the case of cuprate superconductors in which columnar defects are introduced. After the irradiation, enhancement of J_c was observed at high magnetic field range. We also found a slight shift of the irreversibility lines to higher temperature. This work was supported by the New Energy and Industrial Technology Development Organization (NEDO) as Collaborative Research and Development of Fundamental Technologies for Superconductivity Applications.

25BP35 Point-contact spectroscopy of MgB_2 in high magnetic fields

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A strong experimental support for the multiband model of the superconductivity in MgB_2 is presented. Our point-contact spectroscopy data clearly reveal an existence of two distinct superconducting energy gaps. Our measurements in magnetic fields up to 1 Tesla, published in our previous paper (P.Szabo *et al.* Phys. Rev. Lett. 87, 137005 (2001)) show directly in the raw data a presence of the two superconducting gaps at all temperatures up to the same bulk transition temperature. The present contribution represents our analysis of the point-contact spectra obtained at higher magnetic fields up to 10 Tesla.

25BP36 Specific heat of ceramic and single crystal MgB_2

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The two-gap structure of MgB_2 gives rise to unusual thermodynamic properties which depart markedly from the BCS model, both in their temperature- and field-dependence. We report measurements of the specific heat up to 16 T on ceramic and single crystal samples, which demonstrate these effects in bulk. The low-temperature mixed-state specific heat reveals a field-dependent anisotropy, and points to the existence of unusually large vortices, in accord with local density-of-states measurements by scanning tunneling spectroscopy. It is finally shown that a suitable irradiation process nearly doubles H_{c2} in bulk.

Mechanical Milling of MgB_2 25BP37

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Changes in structure and magnetization of MgB_2 by mechanical milling have been examined by means of X-ray diffraction and magnetization measurements. Powder sample we used is commercially available and contains a small amount of MgO. Mechanical milling was done between 0h and 384h. The intensity of the Bragg peaks decreases and the width increases with milling. This means that the crystallite size became smaller and the strain in the crystal structure increases. All samples show the superconductive transition at $T_c = 39$K and T_c does not change by milling. The diamagnetization caused by superconductivity decreases with increasing milling time. This suggests that mechanical milling acts on not changing a superconductive property in MgB_2 but only destroying a superconductive state in MgB_2.

Harmonic susceptibilities and pinning properties of MgB_2 bulk superconductors 25BP38

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The fundamental and third harmonics of the ac magnetic susceptibility have been studied on MgB_2 bulk superconductors, obtained by reactive liquid infiltration. In particular, measurements have been performed as a function of the temperature, the dc magnetic field, the ac field amplitude and frequency. Moreover, in order to understand the pinning properties characteristic of our samples, the experimental results have been compared to susceptibility curves obtained by means of analytical and numerical calculations for the non-linear magnetic diffusion equation. In this way, information concerning the dynamical regimes which govern the vortex motion have been also evaluated.

Superconducting Properties of B on Mg Bilayer Films Sequentially Deposited at Low Substrate Temperatures 25BP40

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A simple new method for low temperature synthesis of intermetallic compound superconductor MgB_2 films is presented. In this method, bilayers are prepared by sequential evaporation of B on Mg film layer which is deposited at substrate temperatures around 523K. The formation of superconducting thin films with T_c of about 30K has been confirmed by means of this simple preparation method. The growth of MgB_2 films on various substrates including plastic ones and their superconducting properties will be reported.

25BP41 Comparative Study on Anisotropic Superconducting Properties of MgB_2

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The anisotropic superconducting properties of MgB_2 are still under debate due to the span of the anisotropic parameter $\gamma = H_{c2}^{ab}/H_{c2}^{c}$ from 1.1 to 13. In this paper, we report our comparative study of γ on single crystals and dense poly-crystals by both transport and magnetic measurements. At temperatures near T_c, the γ values for single crystals and polycrystals are about 3 and 4.5, respectively. They show weak temperature dependence. The difference may be resulted from different impurity levels in both samples. The anisotropic superconducting properties in ab-plane will also be reported.

25BP42 Electric Transport Study of Superconducting MgB_2 Wire

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Superconducting MgB_2 wires were made by painting mixture of boron fiber and magnesium powder on tungsten core. The superconducting layer of the wire is about 0.5μm in thickness and 1.5×10^{-6} cm^2 in cross-section area. Special steps have been done on the MgB_2 wires to achieve good ohmic contact. R-T curves show that T_c of the MgB_2 wire is about 39.4 K with transition width of 1.1 K. In order to reduce the self-heating effect, pulse current method has been used to study the I-V characteristics systematically in a large current range. This kind of MgB_2 wire shows a much sharp normal state-superconducting (N-S) transition in the resulted R-I curves. The results and the mechanism of vortex dynamics during the N-S transition will be discussed in the light of the existing vortex dynamics models.

25BP43 Magnetization and Irreversibility Field in Powderd MgB_2 Superconductor

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Magnetizations and AC susceptibilities were measured on powdered new superconductor MgB_2 using a SQUID magnetometer and a PPMS susceptometer at temperature range $4.5 - 40$ K under DC magnetic fields up to 14 T. Particle diameters d of powdered MgB_2 specimens are $20 < d < 30$ μm (MgB_2-20) and $50 < d < 63$ μm (MgB_2-50). Magnetization curve for MgB_2-50 sample is symmetric and larger than that for MgB_2-20 sample. Asymmetric curve for MgB_2-20 sample may be caused by the effect of surface screening current. Dependence of the irreversibility fields estimated from the width of magnetization curves and the imaginary parts of the AC susceptibilities on temperature is discussed by comparing with those of oxide superconductors.

Thermoelectric power of hot deformed MgB_2 25BP44

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The thermoelectric power and the electrical resistivity have been measured for a MgB_2 sample, textured by hot deformation, in the range from 2 K up to 800 K. The thermopower rises from 0.6 μV/K at the superconducting transition at 38.5 K to a maximum value of 7.0 μV/K at 400 K and then decreases to 5 μV/K at 800 K. The electrical resistivity exhibits only a slight negative deviation from the linear behaviour with temperatures above room temperature. The correlation between transport properties and microstructure is discussed.

Investigation of the Interaction, Induced by AC Magnetic Field, of the Vortex Lattice with Microwave in BSCCO 25BP45

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The "vortex shaking" effect where an ac magnetic field $b \parallel a - b$ in high Tc's enhances the vortex lattice relaxation towards the thermodynamic equilibrium, is investigated via the microwave dissipation induced by the ac field in BSCCO. We show, for the first time, that the ac field induces simultaneously collective motion of staircase vortices and collective motion of Josephson vortices.

Singular and Nonsingular Vortices in High-Temperature Superconductors 25BP46

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The single flux line structure in anisotropic (d+s)-wave superconductor is analyzed within the Ginzburg-Landau (GL) theory. The singular vortex structure and the angular dependence of the lower critical field H_{c1} are studied as a function of magnetic field orientation for both weak and strong anisotropy limits. The arrangement of s-wave unit vortices induced in the core is shown to strongly depend on the field orientation and in general case possesses twofold symmetry. It is shown that for magnetic field parallel to the c-axis in a certain range of GL parameters the fourfold symmetric singular vortex is unstable against the relative shift of the s- and d- wave unit vortices in the core. The gap in the resulting nonsingular vortex solution is nonzero everywhere in the center of flux line. The structure of nonsingular vortices is studied and the phase diagram of singular and nonsingular vortices is obtained.

25BP47 Vortex liquid and solid correlation in untwinned $YBa_2Cu_3O_{7-\delta}$

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Longitudinal- and inter-vortex correlation were studied in the liquid and driven solid state of an untwinned $YBa_2Cu_3O_{7-\delta}$ single crystal, using a modified pseudo flux-transformer (PFT) method with two contacts attached on each side of a plate-like sample. Pulsed currents up to 100 mA in the ab plane were used to probe the vortex solid. The magnetic field was applied both in the c-direction and parallel to the a axis. For $\mathbf{I} \parallel \mathbf{b}$ and $\mathbf{H} \parallel \mathbf{a}$ the longitudinal vortex-correlation length diverges at the melting temperature T_m, as could be expected for a rigid lattice of straight vortices. With $\mathbf{H} \parallel \mathbf{c}$, on the other hand, the measurements provide information on the inter-vortex correlation. For this field direction the correlation was finite even at temperatures well below T_m.

25BP48 The effect of Pr and Ca doping on the flux pinning and superconducting properties in $YBa_2Cu_3O_{7-\delta}$

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The effects of Pr and Ca doping on the critical current density J_c and the critical temperature T_c in $YBa_2Cu_3O_{7-\delta}$ have been investigated. The Pr doping has been found to enhance the pinning force and the J_c at 70K in magnetic field. This result indicates that the Pr ions in YBCO induce the nanometric inhomogeneities, which act as effective pinning centers in the presence of magnetic field. On the other hand, the additional Ca doping, which is expected to supply the mobile holes, does not lead to further increase in J_c.

25BP49 New Type of Low-frequency Size Effect and Peak Effect in Magnetization of Anisotropic Hard Superconductors

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The dependence of the relative ac losses $q(h_0)$ vs. the amplitude of ac magnetic field h_0 and the dc magnetization $M(H)$ of anisotropic superconducting plate-like samples has been studied using single domain textured crystals of the Y-123 system with the **c** axis laying in the sample plane and a single crystal with the preferable orientation of twins in the sample plane. Contrary to the isotropic case, two maxima in the dependence of $q(h_0)$ were observed. They are found to be related to the sequential penetration of two different components of the magnetic induction to the middle of the sample. Such a behavior leads to the appearance of additional extrema in the dc magnetization curves.

Vortex dynamics in easy flow channels and electronic structure of grain boundaries in high-T_c superconductors

25BP50

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We show that low-angle grain boundaries (GB) in high-T_c superconductors exhibit intermediate Abrikosov vortices with Josephson cores. We obtained an exact solution for the nonlinear flux flow resistivity, which describes well our transport experiments on 7° unirradiated and irradiated YBCO bicrystals. This enabled us to measure for the first time the vortex core size, and the intrinsic depairing current density on nanoscales of few GB dislocations. Our method combined with HREM data can be used to elucidate the effect of the GB atomic structure, and GB overdoping on local superconducting properties.

New magnetic field scaling of NMR in cuprates

25BP51

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The magnetic field dependence of the low temperature specific heat coefficient $\gamma(T,H)$ has been shown to obey the scaling law $\gamma(T,H) = \gamma_0\sqrt{T^2+Ah}$, with $h = |H|/1\mathrm{T}$ (A. Kallio *at al*, Physica C **364-365** (2001) 43). This suggests that also other quantities such as the NMR Knight shifts $K(T,h)$ and relaxation rates $w(T,h) = (T_1T)^{-1}$ may be expressed in terms of the scaled variable $\overline{T} = \sqrt{T^2+Ah}$ in the form $K(T,h) = K_0(\overline{T})$ and $w(T,h) = w_0(\overline{T})$, where the presence of vortexes in the mixed state simply rises the effective temperature $\overline{T}$. We have tested this using the NMR-rate data on $TlSr_2CaCu_2O_{6.8}$ by G.-q. Zheng *et al* (Phys. Rev. Lett. **88** (2002) 77003-1) with $H||c$. The data points for various fields collapse to a single curve corresponding to $h = 0$, with $A = 80\mathrm{K}^2$. The curve $w(T,0)$ consists of a fermion part with added stripe contribution, which explains microscopicly the spin gap.

Anisotropic Transport Properties of $Bi_2Sr_{2-x}La_xCuO_{6+\delta}$ Single Crystals

25BP52

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In-plane and out-of-plane resistivities (ρ_{ab} and ρ_c) are measured in a series of $Bi_2Sr_{2-x}La_xCuO_{6+\delta}$ single crystals with various La concentration x (x = 0.23 - 1.02), and the anisotropy ratio ρ_c/ρ_{ab} is determined. It is found that for all concentrations $\rho_c(T)$ shows a steeply diverging behavior with lowering T that is associated with the pseudogap opening; the magnitude of the anisotropy ratio ρ_c/ρ_{ab} is observed to be enhanced to as large as 8×10^5, demonstrating that Bi-2201 is the most anisotropic material among cuprates. Detailed analysis of the temperature and doping dependences of ρ_c/ρ_{ab} reveals that not only the charge confinement but also the pseudogap are responsible for the large electrical anisotropy in $Bi_2Sr_{2-x}La_xCuO_{6+\delta}$.

25BP53 Re-appearance of antiferromagnetic ordering with Zn and Ni substitution in $La_{2-x}Sr_xCuO_4$

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The effects of Zn and Ni substitution for Cu site on spin correlation are studied for lightly doped $La_{2-x}Sr_xCuO_4$ polycrystalline samples. As for Zn substitution, the Neel ordering which disappeared with x = 0.02 was observed at around 120K again with Zn concentration of 0.08. On the other hand, it was found that the Neel ordering recovered by Ni substitution. Surprisingly T_N reached above 300K with Ni concentration of 0.2. The Neel ordering temperature was suppressed with increasing Sr concentration. However, the antiferromagnetic ordering temperature was observed even at x = 0.06 and 0.08 with Ni substitution in superconducting phase. This work was supported by NEDO.

25BP54 Pressure effect on a ferromagnetic transition temperature of $RuSr_2GdCu_2O_8$

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A number of attention has been paid for $RuSr_2GdCu_2O_8$ because of the coexistance of ferromagnetic state and superconducting state below about 30K. In order to investigate the character of the superconducting state which coexists with ferromagnetism, the pressure effect on a ferromagnetic transition temperature has been investigated. The enhancement of ferromagnetic transition temperature was observed with increasing pressure. High-pressure x-ray experiments on this material are in progress.

25BP55 Polarization-Dependent X-ray Absorption Spectroscopy of In-plane Aligned $YBa_2Cu_3O_{7-\delta}$ Thin Films

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Polarization-dependent x-ray absorption spectroscopy on the O 1s edge has been measured on a-axis oriented $YBa_2Cu_3O_{7-\delta}$ (YBCO) thin films. For normal incidence case, the x-ray absorption spectra for the electric field E of the linearly-polarized synchrotron light is parallel to b-axis or c-axis of YBCO films by rotating the plane of the sample can be obtained precisely. Furthermore, the x-ray absorption spectra for E//a-axis can be calculated from the oblique incidence with different angles. The electronic structure of CuO_2 planes and CuO_3 chains and hole concentrations on all oxygens can be investigated by the pure in-plane a-axis oriented YBCO thin films as using detwinned YBCO single crystals.

Magnetic and electrical properties of single-crystal $La_{2-x}Sr_xCu_{1-y}Ni_yO_4$ 25BP56

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We report on out-of-plane and in-plane magnetic susceptibilities of $La_{2-x}Sr_xCu_{1-y}Ni_yO_4$ (x =0.01 and 0.06, $0 \leq y \leq 0.1$) single crystals grown by TSFZ technique. Our data show that in lightly Sr doped compounds, the N$\acute{e}$el temperature T_N increases with increasing Ni concentration. This work was supported by New Energy and Industrial Technology Development Organization (NEDO).

Anomalous In-plane Anisotropy of the Resistivity on Single Crystalline 60-K $YBa_2Cu_3O_{7-\delta}$ in High Magnetic Fields 25BP57

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We have measured the in-plane anisotropy of the in-plane resistivity on 60-K $YBa_2Cu_3O_{7-\delta}$ single crystals in magnetic fields. At H= 150 kOe, the temperature dependence of the resistivity $\rho(T)$ for $H \perp I$ shows the jump near the zero-resistivity transition, while $\rho(T)$ for $H \parallel I$ the gradual behavior. Furthermore, the transition temperature of the latter is lower than that of the former, which is inconsistent with the vortex dynamics induced by the Lorentz force. We will discuss the observed anomalous behavior in terms of the phase transition of the Josephson vortex system.

Thermal Transport of $Pr_2Ba_4Cu_7O_{15-y}$ Compound under Several Annealing Conditions 25BP58

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We have investigated thermoelectric power (S), thermal conductivity and magnetoresistance (MR) of $Pr_2Ba_4Cu_7O_{15-y}$ (Pr247) compound with the alternative repetition of a single-and double chain. The value of S in Pr247 showed a metallic behavior at lower temperatures, accompanying the appearance of MR effect as well as Pr124. This finding is discussed on the basis of the metallic conduction along the CuO double chain.

25BP59 Synthesis of new Ru-based cuprate with 1232 structure, $RuSr_{2+x}SmCe_{2-x}Cu_2O_z$

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New Ru-based cuprate $RuSr_{2+x}SmCe_{2-x}$ Cu_2O_z (Ru-1232 phase) has been synthesized. Nearly the single phase can be formed in the x composition range from 0.0 to 0.2. This new phase has a tetragonal unit cell with the lattice parameters of about *a*=0.384 nm and *c*=1.70 nm. A bulk sample with *x*=0.2 shows superconductor-like slightly decreases in resistivity at about 12K and 30K. In the *M-T* dependence, the sample shows a ferromagnetic behavior at about 80K and a diamagnetic signal at about 20K. In conference, we will report the synthesis and characterization for the new Ru-1232 compound.

25BP60 Possibility of unconventional superconductivity of $\mathrm{SrTiO_{3-\delta}}$

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$\mathrm{SrTiO_{3-\delta}}$ can show metallic behavior and superconductivity at $\mathrm{T} < 200\mathrm{mK}$. Due to its low carrier concentration ($\simeq 10^{20}\mathrm{cm}^{-1}$) and huge dielectric polarisability ($\epsilon \simeq 300$) this compound is considered as a candidate for a polaronic superconducting pairing mechanism.
It is demonstrated that by variation of the annealing temperature in vacuum the transport properties of $\mathrm{SrTiO_{3-\delta}}$ can be tuned continuously from semiconducting to metallic. We present measurements of the upper critical field $\mathrm{B_{c2}(T)}$ which show near $\mathrm{T_c}$ a positive curvature. This unusual temperature dependence is consistent with a model of weakly interacting charged bosons which condense in the superconducting state (local pairing). However, measurements of current-voltage curves reveal very small critical currents of our samples. This observation is discussed in the framework of doping inhomogeneities.

25BP61 STM Spectroscopy on Ba_8Si_{46}

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Superconducting phase of silicon clathrate Ba_8Si_{46} (T_c=8 K) was studied by the electron tunneling spectroscopy using STM. The energy gap structure associated with the superconducting state was observed clearly. The differential tunneling conductance around zero bias voltage is well reduced and flat, suggesting the finite gap. On the other hand, the finite conductance inside the gap suggests the anisotropy of the gap. The functional form of tunneling spectra is explained by the model, in which the gap is assumed to be finite and has an anisotropy. According to the model, in which the gap varies depending on the direction in **k**-space, we obtain gap parameters as Δ_{min}=0.5 meV and Δ_{max}=1.5 meV. The temperature dependence of tunneling spectra will be discussed in detail.

Electronic Transport in Underdoped High-Tc Nanowires and Nanostructures **25BP62**

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We have measured the electronic properties of underdoped YBCO nanowires and nanostructures in order to study the nature of the superconducting and pseudogap regimes in the high-Tc cuprates. By investigating the material on a mesoscopic length scale, we can test for the existence of charge stripes, phase fluctuations, and other model-dependent signatures. We have fabricated a series of nanowires with different dimensions, doping levels, and orientations relative to the YBCO lattice, and measured the critical current, resistivity, current-voltage characteristics, and voltage noise, all as a function of temperature. Nanowires with widths 50-300 nm exhibit discrete, increasing and decreasing switches in the resistance as the temperature or current is varied, suggesting the formation of anisotropic conducting domains.

μSR study on multi-layered $HgBa_2Ca_4Cu_5O_y$ (Hg-1245) superconductor **25BP63**

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We report the magnetic properties of multi-layered $HgBa_2Ca_4Cu_5O_y$ (Hg-1245) superconductor below T_c ($\sim$108 K) studied by muon spin relaxation measurements. Hg-1245 has two outer five-fold CuO_2 planes(OP) and three inner four-fold CuO_2 planes(IP) and the difference of carrier concentration between OP's and IP's has been shown by NMR measurements. We have observed zero field spin precession of positive muons in Hg-1245 below 40 K and this result indicates that there coexist a antiferromagnetic state on IP and a superconducting state of OP in Hg-1245.
This work has been supported by Core Research for Evolution Science and Technology (CREST)

Study on the limiting factor of critical current in Ag-Bi2223 tapes **25BP64**

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We have fabricated the silver sheathed tapes of Ag-Bi2223 by usual process to study the factor limiting the critical current density of the tapes. Electric transport measurement of V-I characteristics was performed for the tapes immersed in liquid nitrogen with and without magnetic fields. Hysteresis loop of V-I curve was observed. A model based on polycrystalline superconductors was proposed to account for this kind of hysteresis. And it is shown that in our Ag-Bi2223 tapes the weak-links are the key factor limiting the global critical current.

25BP65 Second peak effect in SmBa2Cu3Oy

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Two SmBa1.9Cu3Oy samples (SBCO) with Y211 (Sm1 and Sm2) were fabricated by Melt-Textured Growth (MTG) method to study the effect of heat treatment in argon atmosphere on the second peak effect (SP). Magnetization-temperature (M-T) measurement at 10G field cooling shows that the sample Sm1 is of transition temperature Tc = 76K but the Sm2 has higher Tc (=90K) and irreversibility fields than Sm1. Magnetization-field function (M-H curves) at various temperatures T in fields up to 7 T was measured for the samples. The SP of the two samples was abserved and compared at a set of temperatures. Discussion of flux pinning and the effect of Ar and 211 is made

25BP66 "Dynamic fishtail" and transient vortex phases in HTS

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We utilize theoretical analysis [1], based on the Landau-Khalatnikov (LK) dynamic equation, to explain the experimentally measured time evolution of the fishtail in the magnetization curves of HTS crystals. We show that the observed time evolution is a manifestation of a dynamic coexistence of transient-disordered and ordered vortex phases. Numerical solutions of the LK equation predict phenomena observed experimentally, e.g. the absence of the fishtail at short times, its appearance at longer times, and the movement of its onset with time toward higher induction fields, approaching the limit of the solid-solid transition field.

[1] D. Giller et. al., Phys. Rev. B. 63, 220502 (2001)

25BP67 Diminished Equilibrium Magnetization in Hg-1223 and Tl-2212 Superconductors with Fission-generated Columnar Defects

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When randomly oriented columnar defects (CDs) are added to Hg-1223 and Tl-2212 superconductors, their vortex state equilibrium magnetization M_{eq} decreases substantially. M_{eq} progressively deviates from the usual London ln(B) dependence and the curves become S-shaped. Vortex-defect interactions quantitatively account for this behavior. Research at ORNL and LANL was sponsored by the US DOE.

Experimentally Characterized Reentrant Phase in Bi2212 Crystal **25BP68**

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Vortex liquid reentrant phase (RP) has been proposed theoretically for two dimensional high temperature superconductors. However, it is difficult to detect RP experimentally. We measured field-modulated microwave absorption on Bi2212 single crystals with sweeping field (H) for H//c-axis at various temperatures (T). At low T (77 K), the spectra show only a narrow ”first peak” near zero field. With increasing T (>78 K), a ”dip”, and a ”broad peak” appear gradually at higher H around 50 - 200 G. The dip and broad peak shift to the lower field with increasing T. The broad peak finally merges into the first peak at 85 K. No structure appears at T>87 K because of normal transition. The first peak, dip and broad peak correspond to Meissner, reentrant liquid and solid phases, respectively. We can draw experimentally determined reentrant phase, which is extremely similar to the theoretical one reported by Blatter.

CRITICAL STATE and TRANSPORT CRITICAL CURRENT in HTSC CERAMICS **25BP69**

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The critical current in Y-123, Bi-2212, and Bi-2223 ceramics HTSC samples in zero magnetic fields has been studied as function of temperature, sample cross-section size and form. An analysis of experimental results shows that the expression for critical current can be written as the product of two functions. One of the functions is a function of temperature only. The other is common power function of the sample cross-section area which independents on the cross-section form. This fact makes it possible to determine the critical current density and magnetic field distributions in sample.

Vortex Glass Transition of the Josephson Vortex System in LSCO Crystals **25BP70**

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Electrical resistivity has been measured under magnetic fields parallel to the CuO_2 planes in LSCO single crystals, where Josephson vortices form in the region between the CuO_2 planes. All samples don’t show the first order phase transition in the measurement. In the crystals over the wide Sr content from the under-dope to the over-dope the vortex glass melting transition is observed in the field range of 1T-17.5T. The glass transition lines strongly depend on the anisotropy of the system, that is, it is suppressed to the low field in the under-doped crystal with large anisotropic parameter. The Josephson vortex glass transition will be discussed in terms of the anisotropic parameter.

25BP071 Friedel Oscillation of Charge Profile in Superconducting Vortex

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We perform numerical microscopic calcuations on charge distributions around the superconducting vortex core by including the Poisson equation to the conventional BdG formalism. The calculations reveal that the charge distribution shows the Friedel oscillation around the vortex core and the oscillation survives over the coherence length for small $k_f\xi$. In order to understand the origin of the oscillation and study charge screening properties we calculate the charge density correlation function around the vortex core. It is found that the function is strongly position dependent and remarkably oscillates only inside the vortex core.

25BP72 Coexisting ordered and disordered vortex phases in $Bi_2Sr_2CaCu_2O_{8+\delta}$

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A high temporal resolution magneto-optical system was employed to image the induction distribution on the surface of a $Bi_2Sr_2CaCu_2O_{8+\delta}$ crystal while the external magnetic field was swept at a constant rate. These data reveal coexistence of quasi-ordered and disordered vortex phases, near the order-disorder phase transition line. The coexistence region in the B-T phase diagram narrows down with increasing temperature or decreasing sweep-rate. These observations clarify previous interpretations of phenomena associated with the fishtail, e.g. the shift of the fishtail onset to higher inductions for slower sweep-rate and the absence of the fishtail at low temperatures.

25BP73 Influence of the columnar defect densities on the current-voltage characteristics in high-T_c superconducters

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We investigated the influence of columnar defect densities on the critical exponents estimated by the critical scaling analysis of the current-voltage characteristics in high-T_c superconductors. It is found that the dynamic critical exponent z increased with increasing columnar defect densities, systematically. The peak of z was observed near the magnetic field $B/B_\Phi = 1/3$. These results are explained by the depinning model considering the distribution of the pinning strength rather than the voltex glass model.

Vortex Liquid-Vortex Glass Transition in Pb-8.23wt In Alloy Films **25BP74**

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In order to confirm occurrence of vortex glass-vortex liquid(VG-VL) transition in the mixed state in metal superconductors, Pb-In alloy is selected. Isothermal current-voltage(J-E) characteristics for thin films evaporated on glass substrates with 8.23wtsuperconductors. A characteristic temperature where log J vs log E is linear, the static and dynamical critical exponents were determined. These exponents have reasonable values expected theoretically for the transition. The VG-VL transition was confirmed for Pb-In alloys.

Scaling and nonstationary $V - I$ curve for superconductor with flux creep **25BP75**

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Time-dependent current distributions and voltage across an initially flux-free superconductor slab biased by a current $I(t)$ are considered. The superconductor is locally described by a power-law voltage-current curve, $E \propto j^n$, and a power-law $J_c(B)$ dependence. As current increases, magnetic flux penetrates the slab from the edges and for $I = I^*$ the flux fronts meet at the center. The integral voltage-current curve $V(I)$ follows a power-law, $V \propto I^p$, with different exponents p for $I < I^*$ (partial penetration), and for $I \gg I^*$, (full penetration). At $I \gg I^*$, when the current distribution is uniform, the exponents for the local and integral voltage-current curves almost coincide. However, at $I < I^*$, i. e. for highly non-uniform current distribution, p is much smaller than n. This conclusion results from exact scaling properties of the flux density, $B(x,t) = tB[s(x,t)]$. Thus one expects a crossover in the $V(I)$ law at $I = I^*$.

Effects of the moving vortex structure interaction with longitudinal ultrasonic waves **25BP76**

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The interaction of a longitudinal ultrasonic wave (LUW) with the moving vortex structure is considered. It is shown that if the vortex structure moves this velocity V then the new collective vortex mode arises. This mode has the velocity 2V. It appears in the anomalous attenuation and in velocity of the LUW at $V = \frac{1}{2}c_l$ here c_l is the LUW velocity ignoring interaction with the vortex structure. If the velocity of the vortex structure exceeds c_l then the attenuation coefficient changes its sign, and the LUW can be amplified. The effect can be observed relatively easy with using surface acoustic waves in the periodic superconducting film structure when the electric current is passed through the film. The currents required for observation of it are estimated for the selected ultrasonic frequencies.

25BP77 Dynamical Melting and Transverse Pinning of Moving Vortices Interacting with Periodic Pinning

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Dynamical phases and phase transitions of moving vortices in clean films driven by an uniform force and interacting with periodic pinning are investigated at low temperatures by numerical simulations of a London model. Three dynamical phases are identified: moving commensurate and incommensurate vortex-lattices and moving vortex-liquid. Two dynamical transitions are reported: dynamical melting of a moving incommensurate vortex-lattice into a moving vortex-liquid and a transition from a moving vortex-liquid into a commensurate vortex-lattice where tranverse pinning occurs. The transition lines are obtained as a function of the driving force magnitude and direction for a typical vortex density.

25BP78 Hydrodynamic Instability of Flux-antiflux Interface in Hard Superconductors

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The possible mechanism of the macroturbulence instability observed in fluxline systems during remagnetization of superconductors is proposed. It is shown that when a region with flux is invaded by antiflux the interface can become unstable if there is a relative tangential flux motion. This condition occurs at the interface owing to the anisotropy of the CVC and, therefore, of the viscous motion of vortices. The phenomenon is similar to the instability of the tangential discontinuity in classical hydrodynamics.

25BP79 Controlling the motion of interacting particles: Analytical study via the nonlinear Fokker-Planck equation.

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We study a nonlinear Fokker-Planck equation that takes into account the interactions between particles. This equation has been used in the analytical study of the so-called "temperature ratchet" (when the temperature of the system is periodically varied) in both the adiabatic and sudden regimes. We have found a double current inversion with increasing particle density for a chosen asymmetric ratchet potential. These results are applicable to a variety of systems, including vortices in superconductors.

Symmetry Classes of Triplet Vortex Lattice Soluitons of the Bololiubov de-Gennes Equation in a Square Lattice **25BP80**

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We give a group theoretical classification of the triplet vortex lattice states of the two-dimensional Hubbard model with a nearest neighbor ferromagnetic exchange interaction in a uniform magnetic field. We obtain ten types of tetragonal vortex lattice states $\{G_1^A, G_2^A, G_1^B, G_2^B, G_1^E \sim G_6^E\}$ for the magnetic flux $\phi = \phi_0/p^2$ ($\phi_0 = ch/2e$ is the flux quantum, p is an integer) through a unit cell of crystal lattice. We show the configurations of the order parameters corresponding to axial phase, up spin phase, planar phase and bipolar phase. We also discuss the possibility of those phases in the triplet superconductors like Sr_2RuO_4.

Driven vortex dynamics in superconductors with asymmetric pinning sites **25BP81**

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We present recent results for a variety of superconducting samples that can rectify the applied alternating current into a net DC motion of the vortices. We theoretically compute the voltage-current curves, the vortex trajectories, and the field dependence of the critical currents. We explore these type of systems for different geometries, and experimentally-relevant parameters.

Transverse Elastic Moduli in Spin-Triplet Superconductor Sr_2RuO_4 **25BP82**

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Ultrasonic measurements have been performed on single crystalline Sr_2RuO_4 across the superconducting transition temperature T_c ($\gg$ 1.40 K). We found an indication of a jump at T_c in transverse elastic modulus C_{66}, which may arise from the coupling between the ε_{xy} strain and a superconducting order parameter(OP). It would be the first evidence from ultrasonic experiments for the spin-triplet superconductivity with a two-dimensional OP with broken time-reversal symmetry .

25BP83 Physics of Vortex Core in Chiral P-wave Superconductor

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When vorticity (the angular momentum of center of mass motion of Cooper pairs) and chirality (the angular momentum of relative motion of Cooper pairs) have an opposite sign in a chiral p-wave vortex state, total angular momentum with respect to vortex center becomes zero. In this case, self-consitently determined pair-potential reveals *locally recovery of time-reversal symmetry* near vortex center. Recovery of T-symmetry and cancellation of angular momentum make chiral p-wave vortex core similar to locally realized zero-field s-wave superconducting region. As an evidence for the similarity, we show that the Anderson's theorem holds in chiral p-wave vortex cores; the impurity scattering rate of quasiparticles by nonmagnetic impurities vanishes inside vortex cores.

25BP84 Microscopic Theory on the D-vector of Triplet Superconductor $\mathrm{Sr_2RuO_4}$

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We perform a microscopic calculation to investigate how the chiral state $\hat{d}(k) = (k_{\mathrm{x}} \pm \mathrm{i}k_{\mathrm{y}})\hat{z}$ is realized in the triplet superconductor $\mathrm{Sr_2RuO_4}$. Starting from the three band Hubbard model with spin-orbit interaction, the pairing interaction is calculated by the perturbation theory. The p-wave superconductivity is obtained in the weak coupling region. It is shown that the orbital dependent superconductivity robustly appears in $\mathrm{Sr_2RuO_4}$. The realized state is determined by comparing T_{c}. The case of the f-wave superconductivity is also investigated by assuming the pairing interaction. We find that the Hund coupling term as well as the spin-orbit interaction is necessary to lift the degeneracy. The main result is that the chiral state is realized when the p-wave superconductivity occurs with the dominant γ-band. On the contrary, an inconsistent d-vector with experiments is realized in the other cases.

25BP85 The 3-K phase of Sr_2RuO_4: Insights into an unconventional superconductor

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The superconducting phase of Sr_2RuO_4 realizes a chiral p-wave state with $T_c = 1.5$ K. Recently the onset of an inhomogeneous superconducting phase has been observed close to 3 K in samples with micrometer-size Ru-metal inclusions. This superconducting phase nucleates very likely on the interface between Sr_2RuO_4 and the Ru-inclusions. We analyze the properties of this phase and compare them with experimental results. One important aspect is related to frustration effects of the order parameter phase and resulting subgap quasiparticle states which are observable in tunneling spectra. Furthermore, we show that the upper critical field for the "3K-phase" provides new insights into the order parameter symmetry and may be taken as an important test experiment.

Electronic Band Structure of Sr2MoO4 **25BP86**

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The electronic energy band structure of Sr2MoO4, which is isostructural with the unconventional spin-triplet superconducting Sr2RuO4, has been calculated by using the scalar-relativistic full-potential linearized augmented plane wave (FLAPW) method within the local-density approximation in the paramagnetic case. The result of the calculation suggests that this compound is a metal and its electronic structure is similar to that of Sr2RuO4, while in Sr2MoO4 one of the Fermi surfaces has a large dispersion along kz axis. The optimization of the position of the apical oxygen suggests that the RuO6 octahedron is more flattened than the reported one.

Pinning Anomalies in Organic Layered Superconductor κ-(BEDT-TTF)$_2$X **25BP87**

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Vortices in organic superconductor κ-(BEDT-TTF)$_2$X $\{$X=Cu(NCS)$_2$, Cu[N(CN)$_2$]Br$\}$ is interesting for their anisotropic character. To investigate their dynamical behavior, ac complex susceptibility and dc electrical resistance measurement were done in the presence of vortices introduced by dc magnetic fields. In the course of experiments, we found that the dc field dependence of complex susceptibility changes drastically for moderate ac magnetic fields, i.e. the shielding effect of the system ($-\chi'$) has peak structure and dissipations (χ'') shows dip. In addition to the anomalies in the susceptibility, it turned out that the electrical resistance has a dip structure under the same dc magnetic fields. These anomalies imply that the vortices are less mobile. We believe this is the evidence for elastic softening of the vortices that enhances the effective pinning of the system.

CRYSTAL AND BAND STRUCTURES OF ORGANIC SUPERCONDUCTORS UNDER THE UNIAXIAL STRAIN **25BP88**

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The crystal structure of the organic superconductor, α-(BEDT-TTF)$_2$NH$_4$Hg(SCN)$_4$ under the uniaxial strain along each axis was studied with a unique design of X-ray apparatus. The results of the band structure calculations based on the obtained atomic coordinates suggest that the density-of-states at the Fermi level increases under the b^*- and$c$- axial strain, while it decreases under the a-axial strain. These results are consistent with the observed behaviours of the superconducting transition temperature in the framework of the BCS theory.

25BP89 Field-induced superconductor-insulator transition in layered organics

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The κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Br is known to be a quasi-two-dimensional superconductor with T_c of 11.5K. We finely tune the electronic phase of this organics so as to approach the superconductor-insulator phase boundary by combination of physical and chemical methods. Then we demonstrate that thus tuned superconducting phase is switched into the magnetic insulating phase by magnetic field. This superconductor-insulator switching is the first-order transition.

25BP90 Specific heat in the mixed state of non-magnetic borocarbides

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The temperature and magnetic field dependence of the specific heat superconducting (sc) mixed state has been measured for $Y_xLu_{1-x}Ni_2B_2C$ and $Y(Ni_{1-y}Pt_y)_2B_2C$ samples. The deviations from the usual linear-in-H law of the linear-in-T specific heat contribution $\gamma(H)\cdot T$ can be possibly ascribed to unconventional pairing and are discussed in the unitary d-wave as well as in the intermediate transition region in between dirty and clean s-wave limits. Considering the $\gamma(H)$ data, unconventional pairing cannot be ruled out.

25BP91 Evidence of Point Nodes in Superconducting Gap of Borocarbide Superconductor YNi_2B_2C

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In oder to determine the superconducting gap structure of the borocarbide superconductor YNi_2B_2C, we have measured the angular dependence of the thermal conductivity by rotating the applied magnetic field within the ab-planes. A clear fourfold symmetry, which is characteristic of a superconducting gap with nodes along the a and b axes of the crystal, is resolved. The angular variation of the thermal conductivity also provides a strong evidence of point nodes.

Magnetic and Superconducting Properties of $R_{1-x}Nd_xNi_2B_2C$ (R=Y and Er) Systems

25BP92

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The quaternary nickel borocarbides, RNi_2B_2C (R=Rare earth element), have attracted considerable attention over the past few years, because they provide an excellent opportunity to study the complex interplay of superconducting and antiferromagnetic ground state. We investigated the superconducting transition temperature, T_c, and magnetic transition temperature, T_N, for the $R_{1-x}Nd_xNi_2B_2C$ (R=Y and Er) systems. T_c and T_N curves for the R=Er system cross over at the substitution concentration x=$\sim$0.17, for which T_N=5 K, but T_c could not be observed. For the R=Y system, they did not cross over. T_c and T_N vs Nd concentration x, for the $R_{1-x}Nd_xNi_2B_2C$ systems are given and discussed.

SANS Studies of Vortex Lattice Morphology in YNi_2B_2C

25BP93

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High-resolution small-angle neutron scattering (SANS) studies of the vortex lattice (VL) in YNi_2B_2C allow us to separate Bragg scattered intensities from the multi-domain VL that exists for $B \parallel c$. Precise determination of the VL unit cell angle, β, shows that there is a finite transition width associated with the field-driven 45^o reorientation of the VL at a field H_1. Low- and high-field rhombic VL phases coexist over a finite range of applied field with no continuous distortion between the two phases. The variation in scattered intensity from each phase through the transition indicates a redistribution of domain populations between the low- and high-field vortex structures. Our data supports the notion of a first-order reorientation transition in the VL at H_1 in the presence of weak static disorder (vortex-pinning).

Pressure effect on $Ba_{1-x}K_xBiO_3$ near the composition of Metal-Semiconductor transition

25BP94

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The effect of the hydrostatic pressure up to 1 GPa to the resistivity of $Ba_{1-x}K_xBiO_3$ was investigated. Specimens were single crystals prepared by the electro-chemical method. Either the superconducting transition temperature T_c or the conductivity increases with pressure in the metallic phase. On the semiconducting sample($x \sim 0.3$), which is near the metallic phase, we found that the temperature dependence of the resistivity changes to $\frac{d\rho}{dT} > 0$ below 20 K at above 0.4 GPa. This suggests that the new conducting phase, which may be superconducting, appears in the semiconducting sample under high pressure.

25BP95 Possibility of Pressure-Induced Superconductivity by Phonon Mechanism in Palladium

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Pressure dependencies of electronic structures and lattice dynamics of Pd which is close to ferromagnetic instability at ambient pressure are investigated on the basis of the first-principles full-potential LMTO method. With increasing pressure no anomalous behavior is seen in both the electronic structure and lattice dynamics, *i.e.* the band width becomes wider and the phonon frequencies show hardening in the whole BZ. Particular attention is paid to phonon-mediated superconductivity: the transition temperature $T_{\rm c}$ without taking into account spin fluctuation effects are estimated to be $6.5 - 8.5$ K at ambient pressure and $0.5 - 1.5$ K at 50 GPa. Possibility of pressure-induced superconductivity by phonon mechanism is discussed by taking into account the spin fluctuation effects.

25BP96 Superconductivity in $Y_2PdGe_{3-x}Si_x$: interplay between Debye temperature and coupling constant

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We have studied $Y_2PdGe_{3-x}Si_x$ superconductor using magnetization and specific heat measurements. The compounds are very sensitive to changes in the honeycomb layers by Si substitution. The critical temperature shows a maximum of T_c = 3.55K near x=0.3 and decreases with further increase in Si concentration. The changes in the Debye frequency and electron-phonon coupling have combined effect to control the critical temperature.