Session 21CP

Neutron Scattering Study of Dispersionless Excited States in the 2D Spin Gap System $SrCu_2(BO_3)_2$ **21CP1**

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Inelastic neutron scattering experiments with high-energy resolution on 2D Shastry-Sutherland lattice $SrCu_2(BO_3)_2$ has been performed to investigate the detailed structures of higher-energy excitations around 5-7 meV, which has been previously understood to be dispersive. We report they are found to consist of several almost dispersionless two (and more)-triplet transitions.

Heat Capacity of a New S=1/2 Antiferromagnet on the Kagomé Lattice **21CP2**

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Kagomé lattice antiferromagnet is a model system for the study of geometrical frustration in magnetism. Here, we introduce a new kagomé lattice antiferromagnet $[Cu_3(titmb)_2(CH_3CO_2)_6]\cdot H_2O$. This is a quasi-two dimensional transition metal complex compound containing antiferromagnetically interacting S=1/2 Cu^{2+} ion in a kagomé layer. We have synthesized $[Cu_3(titmb)_2(CH_3CO_2)_6]\cdot H_2O$ (titmb=2, 4, 6 trimethylbenzene) and measured the heat capacity at low temperatures by a relaxation method. We have found two-peak structure in the temperature dependence of the heat capacity. The two-peak structure has been found in ^{3}He adsorbed on a graphite substrate. Our observation is the first in magnetic solids where electron spin plays an essential role. Details of the analysis will be presented.

21CP3 Magnetic Properties of $Ho_2Ru_2O_7$ and $Dy_2Ru_2O_7$ Pyrochlores

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Magnetic measurements were carried out on $Ho_2Ru_2O_7$ and $Dy_2Ru_2O_7$ pyrochlores to study the possibility of spin ice type magnetism in these systems. Curie Weiss law fits to inverse susceptibility data in the temperature range 200K-350K gave p_{eff}=9.60, θ=-4 K for the Ho and p_{eff}=10.54, θ=-8.4 K for the Dy system. The saturation magnetization at 2 K was only half the value expected for the ground state configurations of the rare earth ions. The effective near neighbour interaction was estimated to have small positive values for both the systems. This suggests that these pyrochlore systems have a magnetic behavior similar to the other spin ice systems despite the presence of the small moment bearing 4d Ru ions which themselves order into a spin glass type state at an elevated temperature of about 100 K.

21CP5 Magnetic properties of the frustrated diamond chain compound $Cu_3(CO_3)_2(OH)_2$

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We have found that the compound $Cu_3(CO_3)_2(OH)_2$ (azurite), in which Cu^{2+} ($S = 1/2$) monomers and dimers are arranged alternately along the b-axis to make an infinite chain, is regarded as an actual model material for the frustrated diamond chain model. In order to investigate magnetic properties of this material, we have measured magnetic susceptibility, high field magnetization and ^{1}H NMR on a natural mineral single crystal of azurite. The experimental results were compared with the theoretical expectation.

21CP6 Anomalous Hall Effect and Magnetoresistance of $SrFe_{1-x}Co_xO_{3-y}$

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Electrical resistivity ρ and the Hall resistivity $\rho_{\rm H}$ of $SrFe_{1-x}Co_xO_{3-y}$ have been measured as functions of temperature T and the magnetic field H. Magnetic measurements have also been carried out in detail.Because there exist several experimental indications that the sysytem has non-trivial spin structure(possibly with spin chiral order)in a certain region of x, it can be considered to be one of candidates which may present experimrntal evidence for the predicted contribution of the spin chiral order to the anomalous Hall resistivity. Here, we present experimental findings which suggest the existence for such kind of contribution. We also present the very characteristic behavior of $\Delta\rho\equiv\rho(H)$-$\rho(0)$, which can be well described based on the spin dependent tunneling model.

Magnetic Structure and the Anomslous Hall Effect of $Cu_{1-x}Zn_xCr_2Se_4$ **21CP7**

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In order to study what kind of roles spin structures of ferromagnetic conductors play in determining their Hall resistivity $\rho_{\rm H}$ or to see if the spin chiral order really contributes to the unusual behavior of anomalous Hall resistivity, we have carried out transport and neutron diffraction studies on the spinel type system $Cu_{1-x}Zn_xCr_2Se_4$,which is in the helimagnetic state at x=0, collinear ferromagnet at x ∼1.0 and presumalby in the conically ordered state in the intermediate x region. By using polycrystalline samples, it is established that the sign change of $\rho_{\rm H}$ takes place, with decreasing temperature, along with the appearance of the conical spin structure.

Detailed Studies on the Anomalous Hall Effect of Pyrochlore Molybdates **21CP8**

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Anomalous Hall registivity $\rho_{\rm H}$ of pyrochlore ferromagnet $Nd_2Mo_2O_7$, which has been reported by the present authors' group to have quite unusual magnetic field(H)- and temperature(T)-dependence has been studied by determining the spin structure as a function of H and by studying effects of impurity doping into Mo- or Nd-sites. From the H-dependent chirality of the spin system deduced by using the H-dependent spin structure, the $\rho_{\rm H}$ value expected by the chiral order mechanism proposed by Ohgushi and Nagaosa can be calculated as a function of H. The results have been compared with the observed data of $\rho_{\rm H}$, where we have found that the mechanism does not work well. We also argue the applicability of the phenomenological model proposed by the present authors' group.

Observation of Unusual Behavior in ^{55}Mn NQR for MnII site in β-Mn Metal **21CP9**

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β-Mn metal is known not to show any magnetic ordering until low temperature, which is ascribed to an itinerant nearly antiferromagnet or a spin liquid state due to the geometrical frustration at MnII site. We have observed the sudden disappearance of the MnII-NQR signal accompanying by the rapid increase of the nuclear spin-lattice relaxation rate, T_1^{-1} above about 200 K. The behavior $T_1^{-1} \propto \sqrt{T}$ below about 100 K is consistent with the self-consistent renormalization theory for itinerant nearly antiferromagnet, however, the unusual behavior described above is difficult to explain in this framework.

21CP11 Weak Coupling Approach to Chirality-driven Anomalous Hall Effect

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Anomalous Hall effect arising from non-trivial spin configuration (chirality) is studied based on the s-d model. Considering a weak coupling case, the interaction is treated perturbatively. Scattering by normal impurities is included. Chirality is shown to drive locally Hall current and leads to overall Hall effect if there is a finite uniform chirality. This contribution is independent of the conventional spin-orbit contribution and shows distinct low temperature behavior. In mesoscopic spin glasses, chirality-induced anomalous Hall effect is expected below the spin-glass transition temperature. Measurement of Hall coefficient would be useful in experimentally confirming the chirality ordering.

21CP12 Synthesis and Physical Properties of Several Pyrochlore-type 5*d* Transition-metal Oxides

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Recently, the pyrochlore oxide $Cd_2Re_2O_7$ has been reported to exhibit superconductivity at $\sim$ 1 K. Metallic pyrochlore oxides are very attractive in terms of magnetic frustration system. We have synthesized several pyrochlore oxides $Pb_2Re_2O_6$ and $Pb_2Ir_2O_7$, which are metallic compounds as well as $Cd_2Re_2O_7$. The metallic conductivity of $Pb_2Ir_2O_7$ is supressed by Ca substitution of Pb sites. We will show and discuss the syntheses of these compounds and the physical properties in detail.

21CP13 A Peierls like transition in $MgTi_2O_4$ with a S=1/2 pyrochlore lattice

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We have synthesized a powder sample of $MgTi_2O_4$ with a S=1/2 pyrochlore lattice which had been missing in the spinel oxides, and measured the magnetic susceptibility, lattice parameter, DSC and resistivity as a function of temperature. We found a novel transition from metal to spin-singlet insulator at 260 K, which was accompanied by a structural transformation from cubic to tetragonal. The transition could be closely related to the internal low dimensionality embedded in the 3-D spinel structure.

Specific Heat of Single Crystal of Spin Ice Compounds $Dy_2Ti_2O_7$ 21CP14

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$Dy_2Ti_2O_7$ and $Ho_2Ti_2O_7$ are regarded as good examples of geometrically frustrated spin systems exhibiting spin ice behaviour. We measured specific heat of single crystalline $Dy_2Ti_2O_7$ in three characteristic magnetic field direcitons [100], [110] and [111] down to 0.35 K. In magnetic field along [110] direction, we observed a peak at 1.1 K which is independent of the field strength. Since two of the four spins in each tetrahedron are perpendicular to this field direction, thie peak is attributable to the ordering of these two field-decoupled spins by spin-spin interaction.

Magnetic Properties of V-jarosite $A\mathbf{V_3(SO_4)_2(OH)_6}$ (A=Na, K) with *Kagomé* Lattice 21CP15

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We have newly synthesized V-jarosite, $NaV_3(SO_4)_2(OH)_6$ and $KV_3(SO_4)_2(OH)_6$, with *kagomé* lattice using the hydrothermal reaction method. Structural parameters were refined by powder X-ray diffraction. It was found that these compounds show a ferromagnetic behavior below 50 K and that the field dependence of magnetization has no hysterisis. Thus, it can be concluded that magnetic interactions of intralayer are ferromagnetic and those of interlayer are antiferromagnetic. Results of ^{23}Na NMR also will be presented in this report.

High field ESR measurements of pyrochlore slab antiferromagnets $\mathbf{Ba_2Sn_2Ga_{3+x}ZnCr_{7-x}O_{22}}$ 21CP16

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High field ESR measurements of pyrochlore slab antiferromagnets $Ba_2Sn_2Ga_{3+x}ZnCr_{7-x}O_{22}$ have been performed in the millimeter wave region at temperature from 4.2 K to 200 K. The concentration dependence of Cr^{3+} ions was observed from $x = 0$ to $x = 5.0$. For $Ba_2Sn_2Ga_3ZnCr_7O_{22}$ ($x = 0$), the pyrochlore slab is fully filled with Cr^{3+} ions, the line width of the ESR absorption lines increased and the resonance fields shifted as the temperature was decreased. These tendencies were suppressed as the Cr^{3+} concentration was decreased.

21CP17 Mn K-edge XANES Studies on Antiferromagnetic $RMnO_3$ (R = Sc, Y) Hexagonal Manganites

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Mn K-edge x-ray absorption near-edge spectra (XANES) for the noncollinear, triangular antiferromagnets $ScMnO_3$ (T_N = 130 K) and $YMnO_3$ (T_N = 74 K) are reported. The main edge threshold energy of 6545 eV obtained from the inflection point indicates Mn^{3+} character with stoichiometric 1:1:3 composition for both compounds. Small pre-edge peaks (P) around 6539 eV are observed from 1s-3d dipole transition, which is weakly allowed through the hybridization of Mn 4p states with Mn 3d states of neighboring atoms. The hybridization is stronger in $ScMnO_3$ due to much smaller unit cell volume of 329.1 $\mathring{A}^3$ as compared with 369.9 $\mathring{A}^3$ for $YMnO_3$. Effect of sample preparation under various atmosphere (air, oxygen or argon) for $ScMnO_3$ will be discussed through XANES and magnetic studies.

21CP18 Magnetic Susceptibility of Two-dimensional $S = 1$ Spin-Gap Antiferromagnet *m*-MPYNN· BF_4 in Magnetic Fields

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We have measured magnetic susceptibility χ of *m*-MPYNN·BF_4 that is an organic spin-1 *Kagomé* antiferromagnet with an isotropic g-factor. In zero fileld, χ decreases below 0.24 K to be almost zero at the lowest temperature measured (about 40 mK), which indicates a nobel spin-gap state in two-dimensional $S = 1$ system. The spin-gap energy Δ/k_B was estimated to be 0.24 K by fitting the data below 0.5 K to the equation $\ln \chi T = -\Delta/k_B \cdot 1/T$+const. We studied the magnetic field dependence of the spin-gap state. We report the dependence of the gap energy on the magnetic field.

21CP19 Magnetic Domain Structure of Growth Temperature-Gradient $Sm_2Mo_2O_7$ Thin Film Investigated by Scanning SQUID Microscopy

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Recently spin frustrated pyrochlore $A_2B_2O_7$ has attracted much attention. In this study, we have observed the domain structure of pyrochlore molybdate $Sm_2Mo_2O_7$ epitaxial thin film fabricated with growth temperature-gradient method by a scanning SQUID microscope for the first time. The temperature dependence of domain structure has been investigated in detail.

Quantum Criticality in the Spin Tetrahedra System $\mathbf{Cu_2Te_2O_5(Br_xCl_{1-x})_2}$ **21CP20**

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Recent investigations of thermodynamic and spectroscopy properties of the s=1/2 spin tetrahedra system $\mathrm{Cu_2Te_2O_5(Br_xCl_{1-x})_2}$ show clear evidence for a proximity of this system to a quantum critical point. Especially interesting from this point of view is the evolution of a multiplet of low energy states in Raman scattering experiments for a certain value of x. The stoichiometry x tunes the unit cell volume and thereby the inter-tetrahedra coupling of the system. *Supported by DFG, INTAS and NATO*

A Massive Gauge Mechanism of the Spin Glasses **21CP21**

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In randomly frustrated vector spin systems such as Heisenberg, chirality is expected to play an important role [1]. Recently the present author [2] has proposedthat the spin-glass-phase in a high-T_c cuprate(LaSrCuO) might correspond to the quasi-two-dimensional chiral spin-glass phase. In addition, the theory of three-dimensional supercooled liquids and glasses has been introduced [3]. In this study, extending those theoretical formalisms, we will propose the effective gauge-invariant Lagrangian to discuss the microscopic mechanism of the spin glasses.
[1] K.Hukushima and H.Kawamura, Phys.Rev.E61,R1008(2000). [2] I.Kanazawa, Physica C357-360,149(2001). [3] I.Kanazawa,J.Non-Crst.Solids,293,615(2001).

Magnetic Properties of Geometrical Frustration System : Tb$Pd_{1-x}Ni_x$Al **21CP22**

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Magnetic Tb ions of the ternary are-earth intermetallic compounds Tb*X*Al (*X* = Ni and Pd) are arranged in the basal plane with a triangular coordination symmetry similar to the kagome lattice. In order to study magnetic frustration effect on these system, we have carried out experiments of X-ray diffraction, magnetic susceptibility and magnetization in Tb$Pd_{1-x}Ni_x$Al polycrystalline samples. The lattice constant *c* has a maximum at x = 0.4. On the other hand, magnetic transition temperatures T_{N1} and T_{N2}, and the paramagnetic Curie temperature θ_p show a minimum at x = 0.4, respectively. These results suggest substitutional effects on Tb$Pd_{1-x}Ni_x$Al are mainly controlled by the exchange interaction along the c-axis.

21CP23 Low Temperature Long-Range Ordering of a Classical XY Spin System with Bilinear-Biquadratic Exchange Hamiltonian

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We investigate low temperature long-range ordering of a classical planar Heisenberg spin system with bilinear and biquadratic exchange interactions, J_1 and J_2, respectively, on stacked triangular lattice by histogram Monte Carlo simulations. Focus is laid on determination of phase boundaries, order of transition, and magnetic structures in the respective phases. Negative J_1 and/or J_2 induce lattice geometry frustration that can be either relaxed or enhanced, depending on the signs and strengths of both interactions. In addition to the frustration, the interactions mutually compete. Hence, the resulting ground-state and low-temperature phase diagrams in $J_1 - J_2$ parameter space feature several long-ranged ordered phases of dipole, quadrupole, as well as mixed quadrupole and dipole/canting order.

21CP24 ESR Study of Frustrared Δ-Chain System

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$[Cu(bpy)H_2O][Cu(bpy)(mal)H_2O](ClO_4)_2$ is one of the novel one-dimensional spin system called "Δ-chain", which consists of spin trimers with ferromagnetic and antiferromagnetic competing exchange interactions. A narrow EPR absorption of Cu^{2+} and its anomalous temperture depndence were observed. The results of ESR measurements of this substance in the low temperature region will be discussed.

21CP25 Specific Heat Measurements of Pyrochlore-type $R_2Mo_2O_7$ (R=Nd-Ho)

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Specific heat measurements have been performed on pyrochlore-type $R_2Mo_2O_7$ (R=Nd-Ho) single crystals, which are ferromagnetic for R=Nd-Gd but are spin-glass-like for R=Tb-Ho. For the specimens with R=Nd-Gd, Schottky-like specific heat anomalies corresponding to the level splitting for the 4f electrons of R^{3+} are observed at low temperatures, in addition to the anomalies for the ferromagnetic ordering of the Mo^{4+} moments at $T_C \approx$50-90 K. In contrast, it is found that the specimens with R=Tb-Ho do not display a low-temperature Schottky-like anomaly, indicating that the R^{3+} moments tend to be involved in the spin-glass-like order below $T_g \approx$20 K due to R-Mo interactions. Specific heat data under magnetic fields up to 10 T are also presented and the origin of the Schottky-like anomaly is discussed.

Partially disordered states of the three-dimensional ANNNI model **21CP26**

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We analyze the three-dimensional axial next-nearest-neighbor Ising (ANNNI) model composed of two kinds of alternately stacked ferromagnetic layers with different intralayer interactions by using Monte Carlo simulation (MC). The detailed analyses of the magnetization and the spin correlations along or perpendicular to the stacked direction, assure and clarify the existence and the nature of the paramagnetic layers in some modulated phases with wave numbers, 1/4, 1/8, 3/16, etc. This is the first MC confirmation of the partially disordered states which have been predicted by previous molecular field calculation and/or observed in materials such as $CsCoCl_3$, $CuFeO_2$ and CeSb.

Magnetic Properties in Spinel-Type Compounds $M\mathrm{Yb_2S_4}$ (M = Mg, Mn) **21CP27**

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The spinel-type compounds $M\mathrm{Yb_2S_4}$ (M = Mg, Mn) have been successfully prepared and magnetic susceptibility measurements have been carried out. Two types of samples for $\mathrm{MnYb_2S_4}$ have been obtained individually. The stable phase has a normal-spinel structure and the newly-found metastable phase has a modified spinel structure which is not the inverse spinel. Susceptibility data clearly show the difference between both samples of $\mathrm{MnYb_2S_4}$, which reflects the difference of the crystal field on Yb^{3+} ions. Moreover the magnitude of the F.C. susceptibility data for each sample of $\mathrm{MnYb_2S_4}$ are slightly larger than those of Z.F.C. below about 40 K, while such difference is not observed at all for $\mathrm{MgYb_2S_4}$. The crystal field analysis of the susceptibility for $\mathrm{MgYb_2S_4}$ and the structural analysis for each sample will also be presented.

Hierarchical ordering in kagomé lattice antiferromagnets, Jarosites **21CP28**

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Jarosite compounds, $\mathrm{RFe_3(OH)_6(SO_4)_2}$ [R=K, Na, NH_4], of the kagomé lattice antiferromagnets show the magnetic transition around 65 K (T_{N1}), though the ideal Heisenberg kagomé antiferromagnet has no long range order down to the zero temperature. Some jarosite samples, moreover, indicate successive transitions at T_{N1} and at a lower temperature T_{N2}. The nature of the transitions has been studied by the susceptibility and NMR experiment. The NMR indicates that R^+ in the later samples are partially substituted by H_3O^+. It is considered that the two dimensional ordering occurs at T_{N1} in the domains formed by the substitution and the three dimensional ordering between the kagomé planes occurs at T_{N2}. The hierarchical orderings can occur due to the frustration effect and the weak interplane interaction.

21CP29 Exchange Striction Model for the Spin Configuration in the Antiferromagnetic YMn_2 with the Cubic Laves Phase Structure

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By making use of the Luttinger-Tisza method on the classical spin Heisenberg model, we examine how the exchange striction affects the highly frustrated pyrochlore-type spin system in YMn_2 with the cubic Laves phase (C15) structure. The distance dependence of the exchange parameter between the nearest neighboring spin pair is taken into account. The complicated spin configuration observed in YMn_2 is deduced through energy change due to the exchange striction.

21CP30 Quantum phase transitions in the frustrated orthogonal-dimer $S = 1$ spin system

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We investigate quantum phase transitions in the orthogonal-dimer $S = 1$ spin chain by means of the exact diagonalization and the series expansion. When the ratio of the exchange couplings is varied, first-order phase transitions occur twice and the Haldane phase is induced between the dimer and the plaquette phases. The introduction of single-ion anisotropy further enriches the phase diagram. By taking into account the effect of the interchain coupling, we discuss how the distinct spin-gap phases found in the orthogonal-dimer chain are adiabatically connected to those in the two-dimensional Shastry-Sutherland model for the compounds $\mathrm{SrCu_2(BO_3)_2}$ and $\mathrm{Nd_2BaZnO_5}$.

21CP31 Quasiparticle excitations in the hole-doped Hubbard model with orthogonal-dimer structure

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We study the hole-doping effects on the half-filled Hubbard model with the frustrated linked-tetrahedra chain structure. By using the density matrix renormalization group method, we discuss how the metal-insulator transition is affected by geometrical frustration. For weak frustration, hole-doping smoothly drives the system to a metallic phase. In contrast, for small Hubbard U with strong frustration, the existence of a flat-band induces the first-order transition to a metallic phase upon hole doping, which is characterized by the discontinuity in the electron density. Furthermore, we find that for large U with strong frustration, a spin-gapped metallic phase appears, for which excitations can be described by two independent quasiparticles.

Phase diagram of ferrimagnetic system with triangular symmetry: Spin and anisotropy effects **21CP32**

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The magnetic properties of a ferrimagnetic system consisting of two triangular sublattices with different spins (S_A=$\frac{1}{2}$ and $S_B > \frac{1}{2}$) in the presence of exchange and crystal-field interactions, are investigated in terms of the effective-field theory. In particular, the effects of the crystal-field interaction in the sublattice B on the magnetic properties are examined. We find the following striking features: (i) The compensation points may exist for certain values of parameters, (ii) the total magnetization exhibits temperature dependent behaviors depending on the reduced interactions, (iii) the spin S_B plays a fundamental role. The interset of this study will be mainly the higher coordination number and the considered interactions.

Magnetization Process in Mixed Magnetic Chains $(CH_3)_2CHNH_3Cu(Cl_xBr_{1-x})_3$ over the Gapless Phase Induced by Bond Randomness **21CP33**

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The mixed compounds $(CH_3)_2CHNH_3Cu(Cl_xBr_{1-x})_3$ for $0.44 < x < 0.87$ consist of the gapless state induced by bond randomness, and the antiferromagnetic long-range order occurs around 15 K. To clarify how the antiferromagnetic ordered state is affected by the bond randomness, we performed measurements of magnetization process on these compounds up to $H = 41$ T at $T = 1.7$ K. As a result, the typical spin flop transition is observed. From the variation of the spin flop transition field with x, the most stable antiferromagnetic ordered state was found at $x \simeq 0.71$, where the bond randomness is utmost.

Magnetization and dimerization profiles of a semi-infinite two leg spin ladder or spin-1 chain **21CP34**

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We study the semi-infinite spin-1/2 two leg ladders using bosonization techniques. We show by a careful treatment of boundary conditions that spin-1/2 edge states will exist for ferromagnetic rung coupling but not for antiferromagnetic rung coupling. Using a mapping onto four non-critical Ising models on a half plane, we derive the magnetization and dimerization profiles for both cases. Extension to the spin-1 chain is also discussed.

21CP35 ^{1}H-NMR Study of the 2D Spin-Gap System *m*-MPYNN·BF_4

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The organic radical salt *m*-MPYNN·BF_4 is characterized as a spin-1 kagomé antiferromagnet and has been suggested to have a singlet ground state with a finite spin gap of 0.25 K. ^{1}H-NMR measurements for this salt have been carried out in the temperature range down to 0.05 K and under the magnetic fields up to 70 kOe. It is found that nuclear spin-lattice relaxation rate T_1^{-1} increases with decreasing temperature below about 1 K under magnetic fields below about 8 kOe. Further, a gapped magnetic state is found at higher fields. Our results are interesting from the viewpoint of the crossover between gapless and gapped regimes, which has been studied intensively for quasi 1D spin-gap systems.

21CP36 Specific Heat of $S = 1$ Quasi-1D Antiferromagnet NDMAP in Magnetic Fields

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NDMAP, $Ni(C_5H_{14}N_2)_2N_3(PF_6)$, is a quasi-one-dimensional $S = 1$ Heisenberg antiferromagnet with Haldane-gap energies of 22 K and 5.5 K for excitations polarized parallel and perpendicular to the chain c axis, respectively. We have extended the heat capacity measurements by Honda $et\ al.$ in this compound to 150 mK in temperature and 18 T in magnetic field, employing a novel relaxation calorimeter. The experiment provides an accurate determination of the exponents for the transition line for the field-assisted ordered phase. In addition, a new subtle feature has been observed in the phase diagram at around 14 T. These results will be compared with theoretical predictions on the magnetic phase diagram.

21CP37 New Low-Dimensional V-based Complex Oxides: an NMR Study

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We performed ^{31}P and ^{51}V NMR study of low-dimensional isostructural vanadates $Sr_2V_3O_9$ (T_{AF}=5K) and $Sr_2VP_2O_9$ (T_{AF}=2.8K). Large negative shift of the whole ^{51}V spectrum in comparison with $Sr_2VP_2O_9$ is an evidence of a strong correlation (coupling) between all three ^{51}V nuclei mediated by electron system. The striking feature of ^{31}P relaxation in $Sr_2VP_2O_9$ is an existence of 2 characteristic relaxation rates (R_{1short} and R_{1long}) with more then 3 orders difference between them. Moreover, the "long" relaxation curve drastically decreases below 15K. Another result is high value of "short" relaxation which exceeds in two orders of magnitude the ^{51}V relaxation rate in $Sr_2VP_2O_9$. Therefore P-ions are involved in magnetic hyperfine exchange process via the path V-O-P-O-V.

One Dimensional Spin-glass-like Behavior of the Noncollinear Ising Compound $CsDy(MoO_4)_2$? 21CP38

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Caesium dysprosium molybdate $CsDy(MoO_4)_2$ belong to the family of low-dimensional Ising compounds with rhombic symmetry of crystal lattice. At $T_c = 1.3K$ the long order magnetic phase transition in noncollinear magnetic structure take place. This transition is confirmed by neutron scattering experiments. Nevertheless, at low temperature (3.6-0.3 K)the dc susceptibility along the c-axis is largely dependent of the cooling mode: zero field cooled or field cooled. Additionally ac susceptibility and time dependent magnetisation measurement in this direction show reminiscent spin-glass behavior with anomalous long relaxation time. No anomalies are found in a- and b-directions. Possible models are discussed.

NMR study on the quantum spin ladder NH_4CuCl_3 21CP39

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The two-legged quantum spin ladder system NH_4CuCl_3 shows the two-stepped plateaus in magnetization. Cu-NMR measurements have been performed in the field up to 30T to investigate the behavior of Cu-3d spins inside and outside of the plateaus. By analyzing the angle dependence of the peak shift, observed spectra were explained with a strong eqq-interaction $\nu_{\rm Q} \simeq$39MHz and with a nearly zero magnetic shift, indicating that NMR probes the singlet sites selectively. On the 1st plateau, the shift is nearly temperature independent at low temperatures below 4.2K, though the macroscopic magnetization shows a significant temperature dependence. This means that the excited triplet sites have a tendency to be immobile on the plateau region, even at high temperature 4.2K, where plateaus are not formed yet.

Mixed Spin Chains of Spins with Magnitudes $\frac{1}{2}$ and 1 21CP40

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Periodic mixed spin chains consisting of spins with magnitudes $\frac{1}{2}$ and 1 are examined by the nonlinear σ model method. There appear various disordered ground states with spin gap, depending on the period and the inhomogeneity of exchange couplings. The ground-state phase diagrams are obtained in typical cases.

21CP41 Polarized neutron scattering study of the CuO_2 chains in $Ca_2Y_2Cu_5O_{10}$

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$Ca_2Y_2Cu_5O_{10}$ is a quasi-one-dimensional magnet, which consists of the edge-sharing CuO_2 chains. This compound shows an antiferromagnetic long-range ordering below T_N=29.5 K with ferrromagnetic coupling along the chain. Previous magnetic structural analysis using unpolarized neutrons suggests that the magnetic moments are not localized at Cu sites but some of the moments also exist at oxygen sites. However, without considering the oxygen moments, a possibility that the Cu moments are just tilted from the b axis was not completely ruled out. This study using polarized neutrons confirms that the magnetic moments point along the b axis, supporting the existence of the moments at oxygen sites.

21CP42 Field-Induced Magnetic Ordering in an Alternating Heisenberg Chain F_5PNN

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We have found the field-induced magnetic ordering of the S=1/2 alternating linear Heisenberg antiferromagnet F_5PNN by measuring magnetic field dependence of specific heats. Cusp-like anomalies were observed below 0.2K between 3.5T and 6T. From the extrapolation of H vs T phase diagram to 0K, the lower critical field is expected to be at 0K about 3T and the upper about 7T and this phase diagram is expected to be almost symmetric at 0.2K at 5T. This behavior is consistent with the previously observed magnetization process in which magnetization begins to increase at about 3T and saturates at about 7T.

21CP43 ESR Study of the Charge Ordering in $(TMTTF)_2X$

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ESR studies of the quasi-one-dimensional organic conductors, $(TMTTF)_2X$, were carried out. Recently, the possibility of charge ordered states in sevral $(TMTTF)_2X$ salts is attracting much attention. To investigate the low temperature electronic states, we performed ESR measurements for a series of $(TMTTF)_2X$ salts. They are roughly divided into three groups according to the anisotropy of the ESR linewidth at low-temperatures. We discuss the possible charge ordering patterns from the microscopic point of view.

X–ray study of modulated structures of β'–$Cu_xV_2O_5$ $(x = 0.29, 0.39)$ **21CP44**

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The reduced wave vector $\boldsymbol{q}_0 = (0, 0.305, 0)$ of the modulated structure in β'–$Cu_{0.29}V_2O_5$ below 210 K was determined. For β'–$Cu_{0.39}V_2O_5$, not the single $\boldsymbol{q}$ modulation but the competition of two kinds of modulations was observed. A three–fold superlattice structure with $\boldsymbol{q}_1 = (0, 0.333, 0)$ appears below 210 K. The $\boldsymbol{q}_1$ satellite reflection intensity decreases abruptly below 175 K, where a modulated structure of $\boldsymbol{q}_2 = (0, 0.0.26 \sim 0.29, 0)$ emerges. The $\boldsymbol{b}^*$ component of $\boldsymbol{q}_2$ is temperature dependent between 140 K and 175 K. Around 140 K, the $\boldsymbol{q}_1$ intensity increases while the $\boldsymbol{q}_2$ intensity decreases abruptly. It seems that the $\boldsymbol{q}_2$ is deeply related to the phase transition at 180K confirmed by the decreases in the magnetic susceptibility and the increase in the resistivity.

Impurity-Induced Antiferromagnetic Order in Organic Spin-Peierls Compound p-CyDOV **21CP45**

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The effect of magnetic impurity (p-CyDTV) on an organic radical spin-Peierls (SP) compound p-CyDOV (T_{SP} = 15.0 K) has been studied by heat capacity measurement of (p-CyDOV)$_{1-x}$(p-CyDTV)$_x$. The antiferromagnetic transitions were observed at T_N = 0.135 K, 0.290 K, and 0.164 K for x = 0, 0.01, and 0.07, respectively. In the low doping region of x = 0 and 0.01, the antiferromagnetic order and the spin-Peierls state coexist, and at x = 0.07 the single phase of antiferromagnetic order is realized. The doping effect has been discussed on the analogy of the results for an inorganic SP compound $CuGeO_3$.

Staggered Flux State in the Two-Leg Hubbard Ladder at Half Filling **21CP46**

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We investigate the ground-state phase diagram of the half-filled Hubbard ladder with intersite Coulomb repulsion and exchange interaction by using the strong-coupling perturbation theory and the weak-coupling bosonization method. We find that the staggered flux state with long-range order appears in between the charge-density-wave state and the d-wave-pairing Mott insulating (D-Mott) state. It is also shown that the quantum phase transition between the staggered flux state and the D-Mott state is in the Ising universality class.

21CP47 Quantum Critical Point in $CuGeO_3$ Doped with Magnetic Impurities

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Using high-frequency (up to 450 GHz) ESR and low temperature specific heat measurements we find that insertion of 1% Fe and 2% Co in $CuGeO_3$ completely damp all types of long-range magnetic orders and gives rise to onset of a quantum critical point. In the critical region T <20K susceptibility and magnetic part of specific heat follow the laws $\chi \propto 1/T^{\alpha}$ and $C_m \propto T^{1-\alpha}$ with the index α <1. This result agrees with the theoretical predictions for a random dimer phase.

21CP48 Absence of the Ferro-Quadrupole Moment at Zero Temperature in One Dimension

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The absence of the quadrupole phase at zero temperature in one dimension has not been established. We prove the absence of the ferro-quadrupole moment in the ground state of the spin-S isotropic Hamiltonian with bilinear and biquadratic exchange interactions in one dimension in the certain parameter region. The existence of the ferro-quadrupole phase in a part of this parameter region is suggested in two or more dimensions by various studies. This proof is given by the Shastry inequality[1] combined with infrared bounds based on reflection positivity.

[1] J. Phys. A: Math. Gen. **25** (1992) L249

21CP49 Superspace Group Description of Single Composite Crystal $(Ca_{0.5}Y_{0.5})_{0.80}CuO_2$

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Recently, some cuprates with quasi one-dimensional CuO_2 chain have attracted much attention. They frequently form composite crystals with dual substructures. In the $(Sr_{2-x}Ca_xCu_2O_3)_{0.7}CuO_2$ series, CuO_2 chains show unique structural modulations and play as hole reservior of two-legged Cu_2O_3 ladder. Another series $(Ca_{0.5+x}Y_{0.5-x})_{0.8}CuO_2$, "$Ca_{2+z}Y_{2-z}Cu_5O_{10}$" also form composite crystal structures. To understand their magnetic properties, superspace group approach to modulated structure analysis for composite crystal is convenient. In the present study, structural propeties of single state of composite crystal $(Ca_{0.5}Y_{0.5})_{0.80}CuO_2$ have been investigated on the basis of (3+1)-dimensional superspace group.

Magnetic Properties of Two-Dimensional Mixed-Spin Systems* 21CP50

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Using Langmuir-Boldgett (LB) techniques, novel two-dimensional (2D) mixed-spin magnetic systems have been generated. Specifically, a 2D Fe-Ni cyanide-bridged network with a face-centered square grid structure has been magnetically and structurally characterized. The results indicate the presence of ferromagnetic-like exchange interactions between the Fe^{3+} ($S = 1/2$) and Ni^{2+} ($S = 1$) centers. The possibility of long-range order in this unique 2D mixed-spin system will be discussed as the competition between the magnetic and structural coherence lengths.

One-Dimensional Orbital Dynamics in $LaVO_3$ 21CP51

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The electronic properties of the perovskite $LaVO_3$ is studied theoretically, with emphasis on the spatial anisotropy in the t_{2g} orbitals of the vanadium $3d$ electrons. An effective orbital model, based on the spin structure in experiments, happens to be a quasi-one-dimensional one in terms of the pseudo-spin operator representing the orbital occupations. This model explains the peculiar behavior in the anisotropy of the optical conductivity data, and suggests the possiblity of an incommensurate orbital ordered state due to the competition between the Jahn-Teller effect and the spin-orbit interaction.

Field-induced SDW phase diagram of $(TMTSF)_2PF_6$ at high magnetic fields 21CP52

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Magnetoresistance measurements have been carried out along the highly conducting a axis in the field-induced SDW (FISDW) phase of $(TMTSF)_2PF_6$ under 1.0GPa, with the field up to 27 T parallel to the lowest-conductivity direction c^*. We have determined the phase boundary between the last semimetallic FISDW phase with n=1 and the FISDW insulating phase with n=0 and found that the semimetallic FISDW phase existed above the transition temperature of the FISDW insulating phase at least up to 24 T.

21CP53 High field ESR measurement of diamond chain substance $Cu_3(OH)_2(CO_3)_2$

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Azurite, $Cu_3(OH)_2(CO_3)_2$ is a candidate of the model substance for diamond chain with antifferomagnetic interaction. We have performed the high field ESR measurements of azurite single crystal and the g-shift was observed below 20K. The origin of the temperature dependence will be discussed.

21CP54 Quantum Magnetic Oscillation in the Quasi-Two-Dimensional Multi-Band Systems

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In the quasi-two-dimensional multi-band systems, the formula of the quantum magnetic oscillations, which are known as the de Haas-van Alphen (dHvA) and Shubnikov de Haas (SdH) oscillations, have never been shown although many studies have been done by numerical calculations. We show analytically the formula of the quantum magnetic oscillations in the quasi-two-dimensional multi-band systems. Since the impurity scattering and unquantized reservoir density are taken in our formula, we can apply our formula to the actual quasi-two-dimensional multi-band materials such as κ-(BETD-TTF)$_2$Cu(NCS)$_2$ and Sr_2RuO_4.

21CP55 Specific heat of Cu(dmen)$_2$ Ni(CN)$_4$: quasi-one dimensional S=1/2 Heisenberg antiferromagnet .

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The quasi-one-dimensional polymeric Cu(II) material Cu(dmen)$_2$Ni(CN)$_4$ has been synthesized with the aim to design a material with the suppressed influence of hydrogen bonds . As was shown in [1] these alternative exchange paths can strongly affect the magnetic dimensionality of a similar system Cu(en)$_2$Ni(CN)$_4$. Specific heat studies of Cu(dmen)$_2$Ni(CN)$_4$ have been performed in zero magnetic field down to 100 mK. The role of hydrogen bonds, magnetic anisotropy and dipolar interactions in the observed behaviour is discussed.
[1] M. Orendáč, A. Orendáčová, J. Černák, A., Feher Solid State Commun. 94 (1995) 833.

High Magnetic Field ESR Study of Field Induced Antiferromagnetic Ordering $CsFeBr_3$ at Low Temperature

21CP56

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$CsFeBr_3$, which has the spin singlet ground state due to the large single ion anisotropy of Fe^{3+} ions, has attracted much interest from the view point of the field induced antiferromagnetic order. Submillimeter wave ESR measurements have been performed using the pulsed magnetic field up to 35T at 2K. A change of the ESR mode, which suggests the phase boundary, was observed for H//c. The magnetic nature of the high field phase will be discussed from our experimental rsults.

Proton NMR Study of a Random-Bond Ladder $Cu_2(C_5H_{12}N_2)_2(Cl_{1-x}Br_x)_4$

21CP57

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Proton NMR measurements have been performed to investigate random-bond effects in a spin-ladder system. The compounds $Cu_2(C_5H_{12}N_2)_2Cl_4$ and $Cu_2(C_5H_{12}N_2)_2Br_4$ are typical two-leg ladder systems with a spin gap. We synthesized a random mixture compound $Cu_2(C_5H_{12}N_2)_2(Cl_{1-x}Br_x)_4$ and measured the temperature dependence of ^1H spin-lattice relaxation time. The spin-gap energies are obtained by fitting the data to the activated temperature dependence. The spin-gap energies for random mixture compounds are much smaller than those for pure systems. The result suggests that the ground state of the random-bond ladder approaches to the gapless state.

Magnetization Plateaux in One-Dimensional Random Quantum Magnets

21CP58

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The effect of randomness on the magnetization plateaux in $S = 1/2$ Heisenberg chains is studied by the DMRG method. In the $S = 1/2$ Heisenberg chains with bond alternation and random sign strong bonds, the fractional plateau at the magnetization $M = (1 - p)M_s$ is induced by randomness where M_s is the saturation magnetization and p is the concentration of antiferromagnetic strong bonds. This model describes the material $(CH_3)_2CHNH_3Cu(Cl_xBr_{1-x})_3$ and experimental observation of such plateau is expected. We also consider the effect of the next nearest neighbour interaction to this model. For $p = 1$, this model has a plateau at $M_s/2$ for appropriate values of exchange parameters due to the spontanuous breakdown of translational symmetry. We demonstrate explicitly that such plateau is splitted by randomness while an additional plateau is generated at $M = (1 - p)M_s$.

21CP59 Magnetization process of an S=1 antiferromagnetic bond alternationg chain at 0.1 K

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An S=1 antiferromagnetic bond alternating chain with a critical alternating ratio of α_c=0.6 shows a gapless excitation, otherwise a spin gap is open. In order to confirm with experimental accuracy whether a compound has a gap or not, it is necessary to perform magnetic measurements in very low temperatures. Magnetization measurements on NTEAP, which shows no gap down to 1.4 K [1], have been done up to 55 T below 1 K using a pulse magnet and a dilution refrigerator. No anomaly indicating an existence of a spin gap was observed down to 0.1 K. [1] M. Hagiwara *et al.*, Phys. Rev. Lett. **80**, 1312 (1998).

21CP60 Anomalous Spin Excitations in a Coupled Spin-Pseudospin Model for Anisotropic Hubbard Ladders at Quarter Filling

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Quantum Monte Carlo method is used to study the coupled spin-pseudospin Hamiltonian in one-dimension that models the charge-ordering instability of the anisotropic Hubbard ladder at quarter filling. We calculate the temperature dependence of the uniform spin susceptibility and the spin and charge excitation spectra of the system to clarify consequences of the interplay between its spin and charge degrees of freedom. Anomalous spin dynamics in the disorder phase of a typical charge-ordered material α'-NaV_2O_5 is thereby considered.

21CP61 ESR study of DMTCNQ salt

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Electron spin resonance (ESR) experiments with 15 GHz micro wave have been done between 4.2 and 300 K for $(AsMe_4)_2DMTCNQ_3$ single crystals, where Me and DMTCNQ stand for methyl and dimethyl-tetracyano-quinodimethane, respectively. The crystal has one-dimensional structure in which the DMTCNQ molecules stack along the b-axis. Two kinds of resonance line are found. Although the main resonance line is observed in whole measured temperature range, the other resonance line appears only above 225 K. The magnetic field direction dependence of the main one reflects one-dimensional character along the b-axis. However, that of the other one does not show the one-dimensional character. The other resonance line is expected to be due to hopping conduction.

Magnetic properties of Cu(nad)$(H_2O)_2SO_4$ - new S=1/2 Heisenberg zigzag ladder ? 21CP62

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Thermodynamic properties of Cu(nad)$(H_2O)_2SO_4$ studied to 100 mK are reported. Unlike the two well-characterized S=1/2 Heisenberg zigzag ladder materials, $SrCuO_2$ and Cs_2CuCl_4 [1], in the title compound the interactions between pairs of chains are mediated by hydrogen bonds. The possibility of tuning these interactions is discussed. In addition, the comparison of structural and magnetic properties of various representatives from the class Cu(X)$(H_2O)_2SO_4$ (X=niad, en, phen) is presented.

[1] A. A. Aligia, C. D. Batista and F. H. L. Esler, Phys. Rev. B 62 (2000) 3259 and references therein.

The Self-Consistent Renormalization Theory of Spin Fluctuations for Itinerant Antiferromagnetism in Quasi-One Dimensional Metals 21CP63

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We introduce a three dimensional character to the transfer of one dimensional conduction electrons within the self-consistent renormalization theory of spin fluctuations for itinerant antiferromagnetism. We study how the three dimensional character influences the Neel temperature and the temperature dependence of the inverse staggered susceptibility at low temperatures. From these investigations, we find that the Neel temperature and the temperature dependence of the inverse staggered susceptibility are controlled by the three dimensional character.

μSR Studies of Two-Dimensional Antiferromagnets CaV_3O_7 and SrV_3O_7 21CP64

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The discontinuous change of muon-spin precession frequencies in CaV_3O_7 is observed at T = 0.2 K, indicating a possible spin reorientation. Our results suggest that CaV_3O_7 possesses the identical spin direction as isostructural SrV_3O_7 below 0.2 K, although the spin directions in two compounds are different at higher temperatures as determined by elastic neutron scattering.

21CP65 Dynamics of alternating spin chains and two-leg spin ladders with impurities

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We study the topological effects of dimer configuration on the dynamics of aligned dimers with impurites; alternating spin chains and two-leg spin ladders. The continued fraction formalism with recurrence relations is employed. The well-defined modes at high temperatures obtained beyond the conventional perturbational approaches are $\omega = 1$ and $\omega = 2$ for alternating spin chains and $\omega = 2$ for two-leg spin ladders. The frequency unit is an antiferromagnetic exchange integral between the spins in a dimer. These characteristic modes in the clean systems are strongly localized and survive in the systems with impurities of 10 $\%$ concentration or less. References are: Phys. Rev. Lett. 83 (1999) 1668, Physica B 284-288 (2000) 1541, and J. Phys. Chem. Solids 62 (2001) 373.

21CP66 Photo-Irradiation Effect on Dynamics of Charge-Density-Wave Condensate in Quasi-One-Dimensional Conductors TaS_3

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Conduction electrons in quasi-one-dimensional (Q1D) conductors condense into Charge-Density-Wave (CDW) state at low temperatures. When electric field over a threshold field $E_{\rm t}$ is applied, the depinned CDW contributes to electrical conductions, so that the current-voltage (*I-V*) characteristics exhibits a large deviation from Ohm's law. We found a new photo-irradiation effect on the *I-V* characteristics. When a laser light at 488 nm is irradiated onto the Q1D conductors TaS_3, the current is enhanced around the $E_{\rm t}$ below the transition temperature. This result indicates that the laser irradiation produces pronounced changes in the screening of CDW by uncondensed carriers, the depinning of CDW, and the normal current flow. We discuss the interplay between the CDW dynamics and the photo-excited carriers.

21CP67 High field magnetization processes of BIPNNBNO and PIMBNO at low temperature

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Organic tetraradicals BIPNNBNO and PIMBNO behave as a pair of S=1/2 and S=1 spins coupled antiferromagnetically at low temperature. These crystals are considered as a 2D and a 3D quantum spin system with spin frustration including S=1/2 and S=1 spins, respectively. We measured the magnetization processes of both crystals for 400 mK in magnetic fields up to 40 T. The magnetization of BIPNNBNO shows the existence of a spin gap. The gap is closed at 4.5 T. A 1/3 magnetization plateau and a narrow 2/3 one are found at 7-22 T and at 25 T. Above 28 T, the magnetization is completely saturated. PIMBNO seems to have a very narrow spin gap. A 1/3 plateau is observed above 8 T.

Coherent Echoes in Crystals with Tunneling Systems in Magnetic Fields **21CP68**

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At low temperatures the acoustic and dielectric properties of disordered solids are strongly influenced by the presence of atomic tunneling systems. The recent discovery of unexpected magnetic field effects in the dielectric properties of non-magnetic glasses has raised the question whether, and how, atomic tunneling systems can couple to external magnetic fields. We have investigated well-defined tunneling systems in alkali halide crystals, such as the mixed crystal $(KBr)_{1-x}(KCN)_x$, by means of coherent polarization echoes. We find a very strong non-monotonic dependence of the amplitude of spontaneous echoes in these crystals in applied magnetic fields, indicating a direct coupling of the magnetic field to atomic tunneling systems. We present the data and discuss possible origins for these intriguing phenomena.

Transient NMRON Measurements using Beta-detected ^{59}Fe **21CP69**

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Sensible systematics of electric field gradients at 3d transition metal probes in the elemental cubic ferromagnets demand extremely dilute alloys. This criteria is well matched to the use of ultra-sensitive radiative detection techniques such as transient nuclear magnetic resonance on oriented nuclei (NMRON), encompassing adiabatic fast passage and modulated adiabatic passage (MAPON). This paper reports on beta emitting ^{59}Fe as a valuable transient NMRON probe in Co(fcc) and Ni hosts following earlier success with the Fe host.

Reversible switching of magnetostriction in rare earth Ising antiferromagnets induced by small sign-variable increments of a magnetic field. **21CP70**

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Unusual behaviour of low-temperature magnetostriction for Ising metamagnet $DyAlO_3$ was found. Very small sign-variable increments of an external magnetic field were resulted in reversible switching of magnetostriction between the "field-up" and "field-down" magnetostriction curves forming a peculiar hysteresis loop. Such a behaviour is similar to that of the magnetisation curves for "hard" type-II superconductors with strong pinning. Possible mechanisms of these anomalies are discussed.
The work was supported by the RFBR, Grant No 02-02-16704.

21CP71 NMR Study of the Dihydrate Formate at Millikelvin Temperatures

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We have measured the temperature dependence of NMR spectrum and spin-spin relaxation time by pulsed NMR without the magnetid field at millikelvin temperatures using a dilution refrigerator in $Co(HCOO)_2 2H_2O$(T_N=5.1K) and $Cu(HCOO)_2 2H_2O$(T_C=0.75K). These salts have two independent sites, A and B in the unit cell and have a magnetic sandwich structure. Magnetic ions at A-site reveal, below T_C or T_N, a ferro- or antiferromagnetic order of quasi two dimensional character in a plane parallel to bc-plane, while B-site ions remain paramagnetic even at the temperature where A-site ions show a long range order. Our aim is to study the temperature dependence of the spontaneous sublattice magnetizations in A and B-site, respectively.

21CP72 Magnetic and Transport Properties of Fe-Substituted Manganites

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Specific heat, magnetoresistivity and magnetic susceptibility measurements have been performed on the polycrystalline samples of Fe-substituted manganites in the temperature range of 4 K - 300 K. The transition temperatures derived from the specific heat anomalies were in agreement with the position of the maximum slope of a.c. susceptibility. A sharp increase in resistivity below 135 K and 125 K was observed in zero field for $x = 0.10$ and 0.15 respectively. The resistivity measurements in applied magnetic field up to 8 T have revealed a colossal magnetoresistivity effect in those samples. Observed dependence of the measured resistivity on the applied external magnetic field of 8 T and on the value of measuring current will be discussed in the paper.

21CP73 Phase separation concomitant with marked metallic behavior observed in electron-doped antiferromagnetic $CaMnO_3$

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Eelectron-doped Mn^{4+}-rich compounds $Ca_{1-x}Nd_xMnO_3$ $(0 \leq x \leq 0.12)$ were investigated by means of magnetic and transport properties. Unusually strong ferromagnetic behaviors have been observed in $x = 0.05$ and 0.1 compounds. Correspondingly, the resistivities of the two samples at relatively low temperature (about 50 K) show a conspicuous change from an insulting value about 10^6 Ωcm of sample $x = 0$ to a typical metallic value ($3\times10^{-3}\Omega$cm), exceeding 9 orders of magnitude.

Specific Heat and kinetic properties of $Sm_{0.55}Sr_{0.45}MnO_3$ manganite under magnetic fields: influence of fluctuations and finite-size scaling **21CP74**

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In this Paper we report the results of the experimental studying of the specific heat, electrical resistivity and thermal conductivity of $Sm_{0.55}Sr_{0.45}MnO_3$ manganite in the temperature range 77-300 K and fields up to 26 kOe. Crossover of the specific heat from Landau behaviour in zero field to a fluctuation-induced behaviour into magnetic field of 26 kOe was observed near T_C. Temperature dependencies of the specific heat both in zero field and in strong magnetic field shows new type of hysteresis akin to ferromagnetics, origin from different values of T_C in ferromagnetic and paramagnetic states for $Sm_{0.55}Sr_{0.45}MnO_3$. Studying of the specific heat of $Sm_{0.55}Sr_{0.45}MnO_3$ manganite in magnetic fields near T_C allows us to find finite-size scaling from one to three dimensions of fluctuation space at approaching T_C.

Order Parameter to Characterize Valence-Bond-Solid States in Quantum Spin Systems **21CP75**

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We propose an order parameter to characterize valence-bond-solid (VBS) states in quantum spin chains, given by the ground-state expectation value of a unitary operator appearing in the Lieb-Schultz-Mattis argument. We show that the order parameter changes the sign according to the number of valence bonds (broken valence bonds) at the boundary for periodic (open) systems. This allows us to determine the phase transition point in between different VBS states. We demonstrate this theory in the bond-alternating Heisenberg chain and in spin-1/2,1 ladders.

Electromagnetic properties of perovskite-type cobaltites, $Ln_{0.5}Ca_{0.5}CoO_3$ (Ln = Nd, Sm) **21CP76**

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Perovskite-type cobaltite $Pr_{0.5}Ca_{0.5}CoO_3$ shows a metal-insulator transition (MIT) induced by charge ordering and spin-state conversion of cobalt ions. In this study, $Ln_{0.5}Ca_{0.5}CoO_3$ substituted by smaller rare-earth elements Ln = Nd, Sm were synthesized by precursor method using citrate acid. In order to investigate whether the MIT occurs or not, resistivities, magnetizations and heat capacities of the samples were measured in the temperature range 2-350 K. Correlation between spin state of cobalt ions and tolerance factor t is discussed.

21CP77 Neutron Scattering Study of the Charge and the Magnetic Ordering in $La_{2-x}Sr_xNiO_4$

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We have observed the charge and the magnetic ordering in $La_{2-x}Sr_xNiO_4(0.28 \leq x \leq 0.46)$ by neutron scattering. In the c-plane, holes and spins order as a two dimensional system, where holes form stripes and they are inserted into the antiferromagnetic ordering. Along the c-axis, the two dimensional ordering stacks. However, the coherence along the c-axis is much weaker than that in the c-plane. We discuss how two dimensional ordering stacks and why the coherence along the c-axis becomes weak.

21CP78 Evolution of Magnetic Properties and Canted Spin Behavior of the $La_{0.7-x}Sm_xPb_{0.3}MnO_3$ Manganites

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The magnetic and transport properties of mixed-valence manganites $La_{0.7-x}Sm_xPb_{0.3}MnO_3$ (x=0, 0.1 and 0.3) are investigated. The x=0 phase is indexed in a rhombohedral structure ($R\bar{3}c$) while the rest exhibit orthorhombic symmetry (Pnma). The increase of x causes a decrease in the spin-coupling interaction between the moments of Mn. Hence, the Curie temperature decreases from 331 to 176 K. The saturated magnetization decreases from 80.07 to 78.47 emu/g due to the canted spin of the Sm moments.

21CP79 Magnetotransport and Electrical Properties of $La_{1-x}Pr_xPb_{0.3}MnO_3$

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The Pr substitution on the La site in $La_{1-x}Pr_xPb_{0.3}MnO_3$ has been studied in order to probe into the physical mechanisms of colossal magnetoresistance (CMR) behavior. The magnetic order changes from a long-range order with x=0.0 to a short-range nature with x=0.7. The ferro-paramagnetic (FM-PM) and metal-insulator (M-I) transition temperature values decrease as Pr content increase. The highest MR ratio values is 16.9% for x=0.0 against 41.6% for x=0.7 in a applied field 1T. It is suggested that the electronic configuration of the cation may play an important role in the amplitude of CMR effect.

Preparation and Physical Properties in the Double Perovskite $Ba_2Fe_{1+x}Mo_{1-x}O_6$ 21CP80

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We have prepared specimens of the double perovskite $Ba_2Fe_{1+x}Mo_{1-x}O_6$ ($x = 0.0$, 1/9, 2/9 and 1/3) from different methods and investigated their structure, magnetism, and transport behaviors. All compounds synthesized using oxides and carbonates in H_2/Ar atmosphere appear cubic structure without impurities. Those compounds show high conductivity ($\rho \sim 10^{-3}$ Ω-cm) with metallic type and reveal a ferrimagnetism $T_C \sim 340$ K and a value of $\mu_{eff} \sim 3\mu_B$ in 77 K. In contrast to those behaviors without Mo metal, the reaction of stoichiometric materials of $BaCO_3$, Fe_2O_3, MoO_3 and Mo in inert gas was found to be very dependent upon the composition x of the mixture.

NMR Study of Orbital Ordering in $RTiO_3$ (R = Y, Gd, and La) 21CP81

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Recently, the orbital degree of freedom has attracted renewed interest in strongly correlated electron systems. The $RTiO_3$ (R: rare earths) system is one of the attracting systems in the study of the orbital degree of freedom. While an orbital ordering state is observed in a ferromagnet $YTiO_3$, no orbital ordering has yet been observed in an antiferromagnet $LaTiO_3$. In this study, we have measured zero-field Ti NMR spectra of $RTiO_3$ (R = Y, Gd, and La). We have investigated the orbital state by analyzing the NMR spectra of $RTiO_3$.

Magnetic Anomalies in Pressure-induced Metallic State in V_2O_3: ^{51}V-NMR 21CP82

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We have carried out ^{51}V-NMR measurements on pure V_2O_3 at pressures of $P > 2$GPa where the antiferromagnetic insulating phase was completely suppressed. We find that the NMR spectra from a powder sample split into two peaks at the low temperature, which differs from those from single crystals. This suggests magnetic properties in P-induced metallic state in V_2O_3 is very sensitive to tiny defects.

21CP83 Charge Disproportionation and Magnetic Properties in Perovskite Iron Oxides

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Structures and magnetic properties of perovskite iron oxides have been investigated using X-ray powder diffraction measurements, magnetization measurements with SQUID magnetometer and ^{57}Fe Mössbauer spectroscopy. $Sr_3Fe_2O_7$ consists of isolated double-sheets of FeO_6 octahedra and shows a charge disproportionation reaction ($2Fe^{4+} \rightarrow Fe^{3+} + Fe^{5+}$). Co substitution into Fe sites of $Sr_3Fe_{2-x}Co_xO_7$, suppresses the charge disproportionation and induces the magnetic order from antiferromagnetic to ferromagnetic. $Sr_3Fe_{1.6}Co_{0.4}O_7$ (x = 0.4) is not an antiferromagnet but a ferromagnet. $Sr_3Fe_{1.2}Co_{0.8}O_7$ (x = 0.8) shows a uniform charge state with Fe^{4+}.

21CP84 Surface electronic and magnetic properties of Sr_2RuO_4

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The surfaces of Sr_2RuO_4 are studied by the first-principles calculations based on the density functional theory. The c(2x2) reconstruction on the surface will affect the various elctronic and magnetic properties significantly. The comparision with experimental results will be given trying to understand the STM images.

21CP85 Ferromagnetic insulating phase in $Pr_{1-x}Ca_xMnO_3$

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It is well known that a perovskite manganite shows the ferromagnetic metallic (FM-M) state by hole doping accompanied with a drastic increase of the conductivity. The FM-M state can be qualitatively ascribed to double exchange interactions mediated by doped holes. However, a lightly doped manganite often exhibits a ferromagnetic insulating (FM-I) state. An origin of the FM-I state may be attributable to a kind of charge ordered states. To reveal the origin of the FM-I state, we have performed a neutron scattering study on a single crystal of $Pr_{0.75}Ca_{0.25}MnO_3$, and found that the FM-I state should be ascribed to an orbital ordering rather than any charge orderings. The orbital ordering consists of the d$(3x^2 - r^2)$/d$(3y^2 - r^2)$ ($LaMnO_3$-type) orbital order hybridized with d$(3z^2 - r^2)$ orbitals.

Spin-State Change of Co atoms of $La_4Co_3O_{10+\delta}$ 21CP86

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$La_4Co_3O_{10+\delta}$ has the triple layered perovskite structure. The average valency of Co ions is +3 for δ=0.5. As in many other systems, the Co^{3+} ions exhibit the spin state changes [low spin state (LS;S=0) $\rightarrow$ intermediate spin state (IS;S=1) $\rightarrow$ high spin state (HS;S=2)] with increasing temperature T. We succeeded in preparing polycrystalline samples with δ=0.0, 0.3 and 0.6, and NMR measurements have been applied. For the former two, the effect of the antiferromagnetic ordering has been clearly observed in the ^{59}Co-spectra at low T, while the ordering does not exist in the latter sample. The transverse and longitudinal relaxation rates $1/T_2$ and $1/T_1$, respectively have shown the characteristic behavior of the IS $\rightarrow$ LS change with decreasing T below 150K. Various kinds of microscopic information on the T-dependence of the Co^{3+} spin state is presented.

Ultrasonic Study of Orbital and Charge Orderings in $La_{1-x}Sr_xMnO_3$($x = 1/8$) 21CP87

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$La_{1-x}Sr_xMnO_3$ ($x = 1/8$) exhibits successive structural phase transitions at $T_s = 275$ K and $T_{co} = 150$ K. The elastic constant $(C_{11} - C_{12})/2$ shows a remarkable softening above T_s, while the C_{44} shows a monotonous increase. The softening of $(C_{11} - C_{12})/2$ arises from the coupling of quadrupole of e_g orbital in Mn^{3+} ion to elastic strain. Furthermore, the $(C_{11} - C_{12})/2$ and C_{44} exhibit a pronounced softening above T_{co}, which is caused by the coupling of charge fluctuation of Mn ions to elastic strain.

Transport, Thermal and Magnetic Properties of Pyrochlore Oxides $Y_{2-x}Bi_xIr_2O_7$ 21CP88

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Various macroscopic physical properties have been studied for the pyrochlore oxides $Y_{2-x}Bi_xIr_2O_7$ which exhibits the Mott insulator to metal transition with increasing x. The phase boundary has been found to be at x=x_c $\sim$0.4, where the electronic specific heat coefficient γ has a maximum value. Results of magnetic measurements clearly show, in the low Bi-concentration region, the existence of the transition to the low temperature(T) spin glass state at T=$T_{\rm G}(x)$. Distinct anomalies observed in the T-dependence of the thermoelectric power S and the electrical resistivity ρ indicate that the transport nature couples to the spin-state rather strongly. Various experimental results are discussed in comparison with those of $Y_{2-x}Bi_xRu_2O_7$, from the view point of the nature of the Mott transition.

21CP89 Transport, Thermal and Magnetic Properties of $Bi_3Os_3O_{11}$ and $Bi_3Ru_3O_{11}$

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Transition metal oxides $Bi_3T_3O_{11}$(T=Ru and Os), which consist of the linkage of TO_6 octahedra have been synthesized and their magnetic susceptibilities χ, specific heats C and electrical resistivities ρ and thermoelectric powers S have been measured. For T=Os, ρ decreases rather rapidly with decreasing temperature T after having a maximum at $\sim$100 K. Similar rapid decrease has also been observed for T=Ru. Although no anomalous behavior has been observed in the ρ-T curves below 50 K, their thermoelectric powers and the Hall coefficients exhibit anomalous T-dependence in the low T region, indicating that a certain type of phase transition exists.

21CP90 Two-Steps Magnetic Phase Transition in Doped $Lu_{1-x}A_xFeO_3$ (A=Ca, Sr)

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The effect of Ca and Sr substitution for Lu on polycrystalline samples of $LuFeO_3$ has been studied by means of X-ray diffraction, specific heat and magnetization measurements. $Lu_{1-x}Ca_xFeO_3$ for $x \leq 0.2$ and $Lu_{1-x}Sr_xFeO_3$ for $x \leq 0.1$ crystallize into the same orthorhombic structure as $LuFeO_3$. The peak od the specific heat caised by antiferromagnetic transition for $Lu_{0.9}Ca_{0.1}FeO_3$ and $Lu_{0.9}Sr_{0.1}FeO_3$ is seen around 590K and 620K (T_N), respectively. The magnetization of both samples show two steps of increase around 530K and T_N. $M-H$ measurements indicate that the phase below 530K is ferromagnetic.
These typical changes of the specific heat and magnetization suggest the exsistence of the two-steps magnetic phase transition in doped $Lu_{1-x}A_xFeO_3$ (A=Ca, Sr) system.

21CP91 Photo-induced effect on the electron-spin resonance in $La_{0.5}Pr_{0.5}CrO_3$

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$La_{0.5}Pr_{0.5}CrO_3$ undergoes a spin-canted antiferromagnetic transition at 261 K. We found that the X-band electron spin resonance(ESR) signal is drastically enhanced with the light illumination of near-infrared laser around Neel temperature. The photon energy is 1.17 eV. The temperature dependence of the photo-induced ESR intensity obeys a thermal activation type with the energy 130 meV. We report the incident illumination power dependence of ESR intensity, switching characteristics and discuss a possible mechanism of the present photo-excitation effect starting from the comparative ESR study on $La_{0.5}Pr_{0.5}CrO_3$ with various content of Pr.

Magnetic properties of $LaSrCoNiO_4$ 21CP92

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It is well-known that a perovskite type oxide $LaCo_{0.5}Ni_{0.5}O_3$ shows metallic and ferromagnetic behavior, while $LaNiO_3$ and $LaCoO_3$ show Pauli paramagnetism and diamagnetism, respectively, at low temperatures. On the other hand, there is no report on the magnetic properties of layered perovskite type oxides $LnAECoNiO_4$ (Ln, rare-earth element; AE, alkaline-earth element). In the present study, DC magnetizations, AC magnetic susceptibilities, and heat capacities of $LaSrCoNiO_4$ polycrystalline sample prepared by a conventional solid-state reaction method were measured. The sample showed deviation from Curie-Weiss law below about 500 K and spin-glass behavior below about 20 K. The magnetic properties will be discussed in connection with the valence and spin states of transition metal ions.

Local Magnetic Properties and Spin State of $YBaCo_2O_{5.5}$: ^{59}Co NMR Study 21CP93

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Complex phenomena due to spin, charge, and orbital degrees of freedom have attracted much attention in $3d$ transition metal oxides. $YBaCo_2O_{5.5}$, a new cobalt oxide with an oxygen-deficient and A-site ordered perovskite structure, was recently reported to undergo a metal-insulator transition at 297 K. Furthermore it has a paramagnetic to week ferromagnetic transition at 290 K and a week ferromagnetic to antiferromagnetic one at 270 K. Our ^{59}Co NMR results will be presented to discuss the local magnetic properties and the Co^{3+} spin state of $YBaCo_2O_{5.5}$.

Theory on Electronic Structure and Phase Transitions in V_2O_3 21CP94

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The electronic structure and phase transitions in pure and Cr doped V_2O_3 are studied in relation to the $3d$ spin-orbit interaction and the monoclinic lattice distortion. A finite-size cluster model consisting of V ions is studied within the many-body point of view. No orbital ordering is expected to be present in the antiferromagnetic insulating (AFI) phase and instead of this a large orbital magnetic moment $\sim 0.7\mu_{\rm B}$ exists. In the AFI and paramagnetic insulating (PI) phases, Jahn-Teller like lattice instability causes tilting of the nearest-neighbor V ion pairs from the corundum c-axis and this lead to large difference in the $3d$ orbital occupation between the metallic and insulating phases. To investigate the AFI to PI transition in Cr doped system, a model spin-lattice Hamiltonian is also proposed. The transition is found to be a simultaneous order-disorder transition of the magnetic moments and the tilting of the V ion pairs.

21CP95 Electrical conduction through bond percolation in $Nd_{0.67}Sr_{0.33}MnO_3$

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We report our analysis of the resistivity (ρ), data on $Nd_{0.67}Sr_{0.33}MnO_3$ polycrystalline samples as a function of preparative conditions using a bond percolation model for a random mixture of metallic (ρ_1) and insulating (ρ_2) regions. Assuming polaronic transport above and below the metal-insulator (M-I) transition, ρ(T) is analysed using the expression for resistivity in two-phase systems based upon an effective medum treatment given by $4\rho_1\rho_2/((3p-1)\rho_1+(2-3p)\rho_2)+[((3p-1)\rho_1+(2-3p)\rho_2)^2+8\rho_1\rho_2]^{0.5}$ (p is the fraction of metallic regions). We show that the above expression can be used to fit the resistivity above and below the M-I transition and that the percolation increases with decrease in oxygen defieciency. Our analysis suggests that for oxygen defiecient compounds the M-I transition which occurs at a lower temperatre than the ferromagnetic transition arises due to a percolation of the metallic regions.

21CP96 Magnetic phase diagram and electronic phase separation of low carrier density manganites

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A detailed study on magnetic phase diagram and electronic phase separation (PS) has been performed in a mean field approximation for low carrier density (n) manganites. It has been shown that, with increasing n, the magnetic state changes from G-type AF, canted G-type AF, C-type AF and F state for stronger superexchange interaction J between localized spins. For weaker values of J, C-type AF disappears. CE-type AF at n=0.5 is realized for stronger values of J and existence of the on-site Coulomb repulsion. The PS is rather dependent of the values of Hund coupling, and it washes away the canted G-type AF. The CE-type AF and C-type AF, however, are stable against the PS. Observed n-dependence of magnetization may well be explained by taking into account weaker Hund coupling or n-dependence of J.

21CP97 Critical Phenomena in Helical Magnet β-MnO_2: X-ray Magnetic Scattering Study

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It has been theoretically expected that the critical phenomena of helical magnetism is drastically different from those of collinear antiferromagnetism due to the existence of *chiral* degree of freedom. In order to verify this prediction, we have carried out an X-ray magnetic scattering measurement on a typical helical magnet, β-MnO_2 using a synchrotron radiation. We will show the temperature dependence of the scattering intensity and compare the obtained critical exponent β with the theoretical prediction.

Magnetic Anisotropy of Nd_2CuO_4 Induced by Magnetic Field at T$\sim$4.2K

21CP98

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In Mott, charge-transfer insulator Nd_2CuO_4 of I4/mmm structure, non-collinear $\vec{M}$(Cu) antiferromagnetic vectors of neighbor CuO planes are ordered along [100], [010] axis, T_N(Cu)$\sim$255K, T_N(Nd)$\sim$1.5K. While, at T$\geq$1.8K and $\vec{H}$ orientation in (001) plane, sample field M_x(H,T) dependence, measured along $\vec{H}$, is determined by saturation of $\vec{M}$(Nd) with M_0(Nd)$\sim$1.38μ_B, at $\vec{H}$ orientation at angles $\leq 0.5^0$ with respect to [100] axis in (001) plane additionally, sample weak linear field M_y^*(H,T) dependence, measured perpendicular to $\vec{H}$ in (001) plane, suddenly changes and nonlinear, having maximum, M_y(H,T) dependence arises in H$\geq H_c$(T). $M_y/M_x \leq 10^{-2}$. Fields H_c(T) decrease from H$\sim$42 to 22.5, 18.3, 16.4$\mp$1kOe at T increase from 1.7, to 4.2, 6, 8K. At T$\sim$1.7K appeared M_y(H,T) dependence has maximum in H$\sim$45.7kOe, after which, at saturation of $\vec{M}$(Nd) along $\vec{H}$, M_y(H,T) nonlinearly decreases to it's 'zero' value.