Session 26CP

Non-linear Conductivity in the Spin-Density Wave Phase of (TMTSF-d_{12})$_2$ClO$_4$ **26CP1**

K. Nomura[a], T. Terazaki[a], A. Hoshikawa[a], N. Matsunaga[a], M. Watanabe[b], S. Nakatsuji[b], J. Yamada[b]

[a] *Division of Physics, Hokkaido University, Sapporo 060-0810, Japan*
[b] *Department of Material Science, Himeji Institute of Technology, Kamigohri 678-1201, Japan*

We have measured the non-linear conductivity in the spin-density wave (SDW) phase of (TMTSF-d_{12})$_2$ClO$_4$, which has deuterated TMTSF molecules, in order to investigate the sliding motion of SDW. We found the anion ordering at $T_{\rm AO}$=27K as a resistance drop. The rapid cooling of sample at $T_{\rm AO}$ induces the SDW phase as a ground state. In this SDW phase we have observed the non-linear electric conductivity with the threshold electric field $E_{\rm T}$, associated with the sliding of SDW. The value of $E_{\rm T}$ decreases monotonously with decreasing temperature. In addition, the SDW excess conductivity shows a sharp drop below $0.3T_{\rm SDW}$. We discuss the mechanism of SDW sliding from these results.

Pressure Effect on the Structure of an spin-Peierls Substance:MEM-[TCNQ]$_2$ **26CP2**

Kouji Ejima[a], Takayuki Tajiri[a], Hiroyuki Deguchi[a], Masaki Mito[a], Seishi Takagi[a], Kenji Ohwada[b], Hironori Nakao[c], Youichi Murakami[c]

[a] *Faculty of Engineering, Kyushu Institute of Technology, Kitakyushu 804-8550, Japan*
[b] *Sping-8, Koto Mikazuki-cho Sayo-gun Hyogo 679-5148, Japan*
[c] *Faculty of Science, Tohoku University, Sendai 980-8578, Japan*

The temperature dependence of the magnetic susceptibility of an spin-Peierls substance, MEM-[TCNQ]$_2$, shows an anomalous pressure effect. As the pressure increases, the susceptibility at low temperatures increases as if free magnetic spins are produced and it overwhelms the spin-Peierls transition. In order to clarify the pressure effect, the crystal structure of the material under pressure has been studied by using synchrotron radiation at KEK. The reflection resulting from the super lattice of the spin-Peierls state disappears under pressure and the structure is significantly affected even at room temperature.

26CP3 Effect of Charge Ordering on Spin Peierls State in Low Dimensional Electron Systems

Muneo Sugiura, Yoshikazu Suzumura

Department of Physics, Nagoya University, Nagoya 464-8602, JAPAN

The spin Peierls (SP) state in the presence of charge ordering (CO) is examined for a Peierls-Hubbard model with a quarter-filled band, a bond dimerization and a nearest-neighbor repulsive interaction (V). By applying the renormalization group method to the bosonized Hamiltonian, the SP state is calculated by varying the magnitude of V. The CO appears for large V due to the commensurability energy at quarter-filling while the SP state is enhanced by the dimerization due to effectively half-filled band. It is found that, with increasing V, the SP state is strongly reduced indicating a transition into spin density wave (SDW) state at low energy scale. We discuss the relevance to the competition between the SP state and the SDW state in organic conductors, DCNQI salt and Bechgaard salt.

26CP4 Magnetic excitations in the high-temperature phase of α'-NaV_2O_5

Tetsuo Ohama[a], Masahiko Isobe[b], Yutaka Ueda[b]

[a]*Graduate School of Science and Technology, Chiba University, Chiba 263-8522, Japan*
[b]*Institute for Solid State Physics, University of Tokyo, Kashiwa 277-8581, Japan*

The quarter-filled ladder compound α'-NaV_2O_5 exhibits a charge ordering transition at $T_c \sim 34$K. In the high-temperature phase above T_c, magnetic excitations with quasi-one dimensional character are observed, but it is not understood how the charge fluctuation affects the magnetic excitations. We measured the nuclear spin-lattice and spin-spin relaxation rates at the V sites above T_C. We will discuss the effects of the charge fluctuation on the temperature dependence of the nuclear relaxation rates.

26CP5 Ground state of antiferromagnetic Heisenberg two-leg ladder in terms of the valence-bond solid picture

Munehisa Matsumoto[a], Synge Todo[b], Chitoshi Yasuda[a], Hajime Takayama[a]

[a]*Institute for Solid State Physics, University of Tokyo, Kashiwanoha 5-1-5, Kashiwa 277-8581, Japan*
[b]*Theoretische Physik, Eidgenössische Technische Hochschule, CH-8093 Zürich, Switzerland*

We have proposed the plaquette-singlet solid (PSS) picture for the ground state of the spin-1 antiferromagnetic Heisenberg (AFH) two-leg ladder. Based on the PSS picture, we discuss the hidden order in the ground state of spin-1 AFH two-leg ladder and its correspondence to that in the ground state of spin-2 AFH chain by introducing the appropriate hidden order parameters and evaluating them by the quantum Monte Carlo method. When the bond alternation is introduced, there are quantum phase transitions and each phase can be identified with that in the dimerized spin-2 chain. We argue that the valence-bond solid picture of spin-$2S$ AFH chain can be applied to the ground state of spin-S AFH two-leg ladder.

Spin-Hole Order in the 1-D Chain Cuprate $Ca_{0.824}CuO_2$ 26CP6

Masaaki Isobe, Koji Kimoto, Eiji Takayama-Muromachi

National Institute for Materials Science, 1-1 Namiki, Tsukuba, Ibaraki 305-0044, Japan

The hole-doped edge-sharing Cu-O chain compound Ca_xCuO_2 ($x\sim$0.83) has a novel quantum electronic state where spatially modulated spin staggered moment coexists in a site with a spin-singlet ground state. It is important to solve the magnetic structure in the coexisting state, because it seems to be related to an electronic state of the under-doped region in high-T_C cuprate superconductors.

We have studied the magnetic state from a viewpoint of crystallographic features of the compound, and determined a possible spin-hole arrangement in the coexisting state by precisely analyzing local structural distortion in the CuO_2 chain using a modulated-crystal-structure analysis technique. The essential periodic sequence obtained is $\cdots\uparrow\circ\downarrow\downarrow\circ\uparrow\cdots$ ($\uparrow$ $\downarrow$: up- or down-spin, $\circ$: hole) along the chain.

Optical Absorption of $S = 1/2$ Two-Leg Spin Ladder Systems 26CP7

Nobuyasu Haga, Sei-ichiro Suga

Department of Applied Physics, Osaka University, Suita, Osaka 565-0871, Japan

We calculate the spectrums for the phonon-assisted optical absorption of the $S = 1/2$ two-leg spin ladder systems, using continued fraction method based on the Lanczos algorithm. When the interchain interaction ($J_\perp$) is larger than the intrachain interaction ($J_\parallel$); $J_\perp/J_\parallel \geq 1$, the peak structure appears in the lower energy region and the hump structure appears in the higher energy region of the spectrums along the leg. The former is caused by the $S = 0$ two-magnon bound state, and the latter is caused by the two-magnon continuum. When $J_\perp/J_\parallel < 1$, the broad peak caused by the continuum becomes dominant. We further investigate the effects of a cyclic four-spin interaction (J_{cyc}). When $J_\perp/J_\parallel = 1$ and $J_{cyc} = 0.1$, the spectral peak caused by the $S = 0$ two-magnon bound state gets large as compared to that without a cyclic four-spin interaction.

The quasi-one dimensional diffusive motion of spin solitons in the spin Peierls state of $(DMe\text{-}DCNQI)_2Li$ 26CP8

Maki Hiraoka[a], Hirokazu Sakamoto[a], Kenji Mizoguchi[a], Reizo Kato[b]

[a]*Department of Physics, Tokyo Metropolitan University, Minami Osawa, Hachioji, Tokyo, 192-0397,Japan*
[b]*RIKEN, 2-1 Hirosawa, Wako, Saitama, 351-0198, Japan*

$(DMe\text{-}DCNQI)_2Li$ is a 1/4 filled spin Peierls (SP) system with $T_{sp}\sim$ 65K. Enough below T_{sp}, it is known that Curie paramagnetism is observed. With electron spin dynamics by ESR, we found the Curie spins diffuse quasi-one dimensionally, implying existence of spin solitons which could arise from finite chain length separated by impurities. The concentration of spin solitons is estimated from the Curie spin susceptibility to be $\sim 1\%$. The spin soliton diffusion is activated by phonons and follows T^2 relation. An extent of the spin soliton is estimated to be about one unit. This narrow extent may be related to missing antiferromagnetic long range order, contrary to the doped $CuGeO_3$ case.

26CP9 Magnetization Plateaux in S=1 Organic Spin Ladder BIP-TENO

Tôru Sakai[a], Nobuhisa Okazaki[b], Kiyomi Okamoto[c], Koichi Kindo[d], Yasuo Narumi[d], Yuko Hosokoshi[e], Keiichi Katoh[e], Katsuya Inoue[e], Tsuneaki Goto[f]

[a]*Department of Physics, Tohoku University, Aramaki, Aoba-ku, Sendai 980-8578, Japan*
[b]*Faculty of Science, Himeji Institute of Technology, Kouto, Kamigori, Ako-gun, Hyogo 678-1297, Japan*
[c]*Department of Physics, Tokyo Institute of Technology, Megro-ku, Tokyo 152-8551, Japan*
[d]*KYOKUGEN, Osaka University, Toyonaka, Osaka 560-8531, Japan*
[e]*Institute for Molecular Science, Okazaki, Aichi 444-8585, Japan*
[f]*Institute for Solid State Physics, University of Tokyo, Kashiwanoha, Kashiwa, Chiba 277-8581, Japan*

We show a clear experimental evidence of the 1/4 plateau in the high-field magnetization measurement on the first-synthesized $S = 1$ organic spin ladder compound BIP-TENO. The theoretical mechanism of the plateau formation is also proposed, based on the frustration due to the long-range exchange interactions.

26CP10 Symmetry Control of the Spin Hamiltonian of the Haldane compound $\mathrm{Ni(C_2H_8O_4)_2NO_2(ClO_4)}$ under Uniaxial Pressure

Takehiro Kinoshita, Masaki Mito, Tatsuya Kawae, Kazuyoshi Takeda

Department of Applied Quantum Physics, Kyushu University, Fukuoka 812-8581, Japan

We have measured the magnetic susceptibility $\chi(T)$ of the Haldane compound $\mathrm{Ni(C_2H_8O_4)_2NO_2(ClO_4)}$ (NENP) under uniaxial pressure P. When P is applied along the uniaxial anisotropy D, the system preserves the O(2) symmetry under uniaxial pressure. For $P \perp D$, however, the system tends to crossover from the O(2) symmetry to the SU(2) symmetry, similar to the experimental results for hydrostatic pressure by Zalianyak et al.[1]. Within our experimental range of uniaxial pressure up to about 1 kbar, we have not observed any anomaly corresponding to the three-dimensional magnetic long range ordering and quantum phase transition.

[1] Phys. Rev. B **57**, (1998) 5200

26CP11 Spin-Peierls Mechanism for the Non-Trivial Magnetization Plateaux in Two-Leg Spin Ladders

Kiyomi Okamoto[a], Tôru Sakai[b]

[a]*Department of Physics, Tokyo Institute of Technology, Oh-okayama, Meguro-ku, Tokyo 152-8551, Japan*
[b]*Department of Physics, Tohoku University, Aoba-ku, Sendai, 980-8577, Japan*

We propose the spin-Peierls mechanism for the non-trivial magnetization plateaux in $S = 1/2$ and $S = 1$ two-leg spin ladders. In the former case we discuss the $(1/2)M_{\mathrm{s}}$ plateau (M_{s} is the saturation magnetization), and for the latter case we discuss the $(1/4)M_{\mathrm{s}}$ and $(3/4)M_{\mathrm{s}}$ plateaux. We use the degenerate perturbation theory from the strong rung coupling limit and also the numerical diagonalization for finite systems.

Specific heat of an S=1 Quasi-1D Bond Alternating Antiferromagnet in a Magnetic Field **26CP12**

Masayuki Hagiwara[a], Naoyuki Tateiwa[b], Hiroko Aruga-Katori[a], Tatsuo C. Kobayashi[c]

[a]*RIKEN (The Institute of Physical and Chemical Research), Wako, Saitama 351-0198, Japan*
[b]*Graduate School of Engineering Science, Osaka University, Osaka 560-8531, Japan*
[c]*KYOKUGEN, Osaka University, Toyonaka, Osaka 560-8531, Japan*

Long-range-ordering (LRO) hardly occurs in Quasi-1D antiferromagnets with an excitation energy gap at zero magnetic field. But, when the energy gap closes by application of magnetic field (Hc), we expect LRO at low temperatures. In this presentation, we will report the results of specific heat measurements on the S=1 quasi-1D bond alternating antiferromagnet $Ni(C_9H_{24}N_4)NO_2(ClO_4)$ in a magnetic field. We observed a sharp peak in the specific heat above Hc at low temperatures and will discuss the field-temperature phase diagram of the peak.

ESR Study of $(C_5H_{12}N)_2CuBr_4$* **26CP13**

S. Zvyagin[a], B. C. Watson[b], Ju-Hyun Park[b], D.A. Jensen[c], A. Angerhofer[c], L.-C. Brunel[a], D.R. Talham[c], M.W. Meisel[b]

[a]*National High Magnetic Field Laboratory (NHMFL), Florida State University, Tallahassee 32310, USA.*
[b]*Department of Physics and NHMFL, University of Florida, Gainesville, FL 32611-8440, USA.*
[c]*Department of Chemistry, University of Florida, Gainesville, FL 32611-7200, USA.*

The title material[1] has been indentified as an $S = 1/2$ Heisenberg two-leg ladder.[2] ESR studies at 9, 96, and 289 GHz have been made down to 4 K. The high frequency data resolve the two inequivalent magnetic sites reported by Patyal *et al.* and indicate the presence of a spin-singlet ground state. These data and their possible interpretation will be presented.
[1] B.R. Patyal *et al.*, PRB **41** (1990) 1657. [2] B.C. Watson *et al.*, PRL **86** (2001) 5168.
*Supported, in part, by NSF DMR-0084173 for the NHMFL and ACS-PRF 36163-AC5.

The Substitution Effect of Co on the Electrical Resistivity of $Sr_{14}Cu_{24}O_{41}$ **26CP14**

Hiroshi Yoshimitsu, Masahiko Hiroi, Masayuki Kawakami

Department of Physics, Kagoshima University, Kagoshima 890-0065, Japan

We study the effect of substitution of Co for Cu on the electrical resistivity in two-legged ladder compound,
$Sr_{14}Cu_{24-x}Co_xO_{41}$.
We make single phase samples with Co concentration up to $x = 5$ by usual solid state reaction. The electrical resistivity of $Sr_{14}Cu_{24-x}Co_xO_{41}$ for all x shows semiconductive behavior. It is found, however, that for Co concentration with $x = 4, 5$ the resistivity is much smaller than that for x=0. The effect of Co substitution with $x = 5$ on resistivity is almost equal to that of Ca substitution for Sr with $y = 6$ in $Sr_{14-y}Ca_yCu_{24}O_{41}$. Magnetic susceptibility measurements are also reported. The results are compared and discussed with the cases for Ca substitution.

26CP15 Bond Spin-Density-Wave Phase in the Staggered Magnetic Field

Hiromi Otsuka

Department of Physics, Tokyo Metropolitan University, Tokyo 192-0397, Japan

We discuss a stability of the bond spin-density-wave (bond-SDW) phase observed in the one-dimensional (1D) interacting electron systems against the staggered magnetic field; a renormalization group (RG) analysis to the effective Hamiltonian implies that, due to the charge distribution in bond-SDW, the Néel correlation becomes short-range and the staggered magnetic field is irrelevant to the spin liquid part. As a result, the phase may survive in the weak field region. To realize bond-SDW and further to demonstrate its stability under the staggered magnetic field, we employ the 1D half-filled anisotropic extended Hubbard model; a numerical procedure to determine a stable region which is based upon the level-spectroscopy method is explained and used to confirm our RG argument.

26CP16 ESR Study of Sine-Gordon Excitations in $S = 1/2$ Antiferromagnetic Chain: Copper Benzoate

Takayuki Asano[a], Hiroyuki Nojiri[b], Yuji Inagaki[a], Takuo Sakon[b], Jean-Paul Boucher[c], Yoshitami Ajiro[a], Mitsuhiro Motokawa[b]

[a]*Department of Physics, Kyushu University, Fukuoka 812-8581, Japan*
[b]*Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan*
[c]*Laboratoire de Spectrometrie, Universite J. Fourier, BP 87, F-38402 Saint-Martin d'Heres Cedex, France*

We have observed directly sine-Gordon (SG) excitations and nonlinear energy gap ($E_{\rm g}(H)$) in a very wide-field (H) and -temperature ranges up to 30 T and down to 0.5 K in Copper benzoate, $Cu(C_6H_5COO)_2{\cdot}3H_2O$, which is one of the best representatives of $S = 1/2$ antiferromagnetic Heisenberg quantum chain with staggered fields. A dynamical crossover between the gapless spinon regime and the gapped SG regime is revealed by means of electron spin resonance (ESR).

26CP17 Theory of the Verwey Transition in Fe_3O_4

Hitoshi Seo[a,b], Masao Ogata[c], Hidetoshi Fukuyama[d]

[a]*Correlated Electron Research Center (CERC), AIST, Tsukuba 305-8562, Japan*
[b]*Domestic Research Fellow, Japan Science and Techonology Corporation, Kawaguchi 332-0012, Japan*
[c]*Department of Physics, University of Tokyo, Tokyo 113-0033, Japan*
[d]*Institute for Solid State Physics, University of Tokyo, Kashiwa 277-8581, Japan*

The metal-insulator transition in magnetite Fe_3O_4, the so-called Verwey transition, is re-investigated theoretically. We propose a scenario other than charge ordering, which has been considered to be its origin so far. We find that the orbital order in the t_{2g} orbitals can make the system effectively one-dimensional, so that the bond dimerization is induced due to the Peierls instability. Based on considerations of the elastic energy in the presence of such bond dimer, we claim that a complicated three dimensional pattern of bond dimer is realized in the actual compound. Reference: Phys. Rev. B **65** 085107, (2002).

Simultaneous Study of Local Magnetization and Resistivity in Phase Separated Manganites **26CP18**

Masashi Tokunaga, Yusuke Tokunaga, Tsuyoshi Tamegai

Dept. of Appl. Phys., Univ. of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan

Phase separation (PS) phenomena have been widely recognized in many transition metal oxides. In manganites with perovskite-type structure, the PS into ferromagnetic metal and antiferromagnetic (or paramagnetic) insulator can be one of the origins to cause insulator to metal transition in a percolative way. Although there have been many studies that visualize the co-existing domains, little attempts have been reported to clarify the direct relationship with their transport properties. In this study, we utilized magneto-optical imaging technique to observe ferromagnetic domains in crystals of phase-separated perovskite manganites over the whole sample surface, and studied transport properties on the same sample over wide range of temperature and magnetic field.

Mott transition in Hubbard model compound FeSi **26CP19**

N.E. Sluchanko[a], V.V. Glushkov[a], S.V. Demishev[a], H. Ohta[b], V. Moshchalkov[c]

[a]*General Physics Institute of RAS, Vavilov str., 38, Moscow, 119991, Russia*
[b]*Kobe University, 1-1 Rokkodai, Nada, Kobe 657-8501, Japan*
[c]*Laboratory Vaste-Stoffysica en Magnetisme, KULeuven, B-3001 Leuven, Belgium*

Following to the study of transport and magnetization in steady magnetic field[1] the galvanomagnetic properties of the narrow-gap semiconductor FeSi have been measured in pulsed magnetic fields up to 50T. It is shown that the Mott-Hubbard scenario of metal-insulator transition (MIT) with on-site Coulomb interaction $U \approx 3D$ (D-is the band half-width) provides the most adequate description of the low temperature anomalies in this model system. The pulsed field transport anomalies can be also interpreted in terms of the MIT in magnetic field from a regime of a strongly correlated metal to insulating state.

[1] N.E.Sluchanko et al., *JETP* **92**, 312 (2001); *Phys. Rev.* **B65**, 064404 (2002).

The ^{51}V-NMR study of Vanadium Hollandite **26CP20**

Takeshi Waki[a], Harukazu Kato[b], Yuuko Morimoto[a], Masaki Kato[a], Kazuyoshi Yoshimura[a]

[a]*Department of Chemistry, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan*
[b]*Advanced Science Research Center, Japan Atomic Energy Research Institute, Tokai, Ibaraki 319-1195, Japan*

Several vanadium compounds $A_xV_8O_{16}$ are known to belong to the Hollandite family. We have investigated the temperature variations of the resistivity and magnetic susceptibility for some of them (A=Bi, Ba, Pb), which show non-stoichiometry in x composition ($1.6 < x < 1.8$ for Bi, $1.35 < x < 1.8$ for Pb and $x=1.1$ for Ba), resulting in a wide variety of their physical properties depending on x. For example, Bi-Hollandites with $1.6 < x < 1.71$ are metallic whole temperature range, while those with $1.72 < x < 1.8$ exhibit a temperature-induced metal-insulator transition. In order to reveal their microscopic electronic states we have further performed ^{51}V-NMR experiments and will report their results.

26CP21 High-Frequency Dielectric Anomaly with Metal-Insulator Transition in $CuIr_2S_4$

Masuo Yamamoto[a], Satoru Noguchi[a], Hiroki Ishibashi[b]

[a]*Graduate School of Engineering, Osaka Prefecture University, Sakai 599-8531, Japan*
[b]*Department of Materials Science, Osaka Prefecture University, Sakai 599-8531, Japan*

$CuIr_2S_4$ has attracted much attention in the mechanism of the metal-insulator (MI) transition at 230 K, especially related to the charge-ordering (CO) state of Ir^{3+} and Ir^{4+}. In the paper, we report the electromagnetic response of $CuIr_2S_4$ at 34 GHz measured by a cavity perturbation method. Temperature dependence of both the resonance frequency and the full width at half-maximum (FWHM) of Q-curves shows the anomalies around 230 K; a large shift in the resonance frequency from metal to insulator phase and a broad peak in the FWHM. The frequency shift is opposite sense to a usual MI transition. This behavior is similar to the case of the typical CO compound $Pr_{0.5}Ca_{0.5}MnO_{3-\delta}$, which implies that the CO is accompanied with the MI transition of $CuIr_2S_4$.

26CP22 Mott Transition in the multi-band Hubbard model in infinite dimensions

Yoshiaki Ono[a], Ralf Bulla[b], Michael Potthoff[c]

[a]*Department of Physics, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8602, Japan*
[b]*Theoretische Physik III, Institut für Physik, Universität Augsburg, D-86135 Augsburg, Germany*
[c]*Institut für Physik, Humboldt-Universität zu Berlin, D-10115 Berlin, Germany*

The Mott metal-insulator transition in the multi-band Hubbard model in infinite dimensions is studied by using the linearized dynamical mean-field theory. The critical interaction for the metal-insulator transition is obtained analytically. For the symmetric case with the orbital degeneracy M, the critical value is found to be given by $U_c = (4M + 2)\sqrt{L_2}$, where L_2 is the second moment of the non-interacting density of states. We also derive an analytic expression for the discontinuity in the chemical potential in the change from hole to electron doping, for U larger than the critical value U_c. The results are in good agreement with the numerical results obtained from the exact diagonalization method.

26CP23 Electronic Heat Capacity of $CuIr_2Se_4$ at Low Temperature

Shoichi Nagata[a], Nobuhiro Matsumoto[a], Ryo Endoh[a], Nobuo Wada[b]

[a] *Department of Materials Science and Engineering, Muroran Institute of Technology, 27-1 Mizumoto-cho, Muroran, Hokkaido, 050-8585 Japan*
[b]*Department of Physics, Division of Material Science, Graduate School of Science, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8602, Japan*

The normal thiospinel $CuIr_2S_4$ exhibits a temperature-induced metal-insulator ($M-I$) transition around 226 K with structural transformation, showing hysteresis on heating and cooling. It is important to see the difference of divalent anion between S and Se. In contrast to $CuIr_2S_4$, $CuIr_2Se_4$ remains metallic down to 0.4 K without the $M-I$ transition. Heat capacity of $CuIr_2Se_4$ has been measured over the temperature range 0.5 to 11 K. The fit of the heat capacity data to $C=\gamma T+\beta T^3$ is very good with γ=6.68 mJ mol-f.u.$^{-1}$ K^{-2} and β=4.09 mJ mol-f.u.$^{-1}$ K^{-4}, where γT is the electronic heat capacity.

Magnetoresistance of Submicron-diameter Magnetic Rings **26CP24**

Jun-Yu Ou[a], J. C. Wu[a], Lance Horng[a], S. Y. Hsu[b]

[a]*Department of Physics, National Changhua University of Education, Changhua 500, Taiwan.*
[b]*Department of Electrophysics, National Chiao Tung University, Hsinchu 300, Taiwan.*

Magnetoresistance (MR) measurements on magnetic rings having submicron-diameter at various temperatures have been carried out. The magnetic ring devices were fabricated using a standard electron beam lithography through a lift-off process. Note that non-magnetic current/voltage leads were patched on the magnetic ring in order to avoid any magnetization inhomogeneities formed in the junctions. Temperature dependent hysteresis behaviors along with jumps on the MR curves are interpreted due to formation and annihilation of magnetic vortex in the rings.

Itinerant electron ferromagnetism of $Fe_xCo_{1-x}Si$ (x=0.3, 0.4, 0.5, 0.7) under high pressure **26CP25**

Katsuya Miura[a], Mamoru Ishizuka[a], Takeshi Kanomata[b], Hironori Nishihara[c], Shoichi Endo[a], Fumihisa Ono[d]

[a]*Research Center for Materials Science at Extreme Conditions, Osaka University, Toyonaka, Osaka, 560-8531, Japan*
[b]*Department of Applied Physics, Tohoku Gakuin University, Tagajo, Miyagi, 985-8537, Japan*
[c]*Faculty of Science and Technology, Ryukoku Universitiy, Seta 1, Otsu , Shiga, 520-2194, Japan*
[d]*Department of Physics, Okayama University, Tsushima-naka, Okayama, 700-8530, Japan*

The intermetallic compound $Fe_xCo_{1-x}Si$ shows a weak itinerant ferromagnetism in the Fe concentration range of $0.2< x <0.95$. We measured ac susceptibility for $Fe_xCo_{1-x}Si$ (x=0.3, 0.4, 0.5, 0.7) under various pressures. We found that T_C decreases in direct proportion with $p^{3/4}$ with increasing pressure.

The Non-linear Susceptibility at Metamagnetic Transition in TbNiSn **26CP26**

Makoto Taki, Yoshiyuki Yamamoto, Hidenobu Hori

School of Materials Science, JAIST, 1-1 Asahidai Tatsunokuchi, Ishikawa 923-1292, Japan

The single crystal of TbNiSn is characterized by the four successive magnetic phase transitions at T_N = 18.5 K, T_3 = 7.6 K, T_2 = 6.0 K, T_1 = 2.2 K and the four multistep metamagnetic transitions along the easy axis(b-axis): critical field of H_{c1} = 0.6 T, H_{c2} = 1.5 T, H_{c3} = 4.3 T, H_{c4} = 5.3 T at 1.5 K. In addition to this TbNiSn single crystal shows a giant magnetoresistance(GMR) phenomenon near the critical fields of metamagnetic transitions. In order to clarify the origin of the GMR in this compound, we have performed the linear and non-linear AC-susceptibility of TbNiSn single crystals for b-axis in magnetic field up to 6 T at 4.2 and 1.8 K. The divergence of third higher-harmonic susceptibility was observed at H_{c4} and H_{c3} at 4.2 and 1.8 K, respectively. This suggests the spin relaxation time extremely increase around the crtical field.

26CP27 Magnetic Structure of Rare Earth Metal Polytellurides Designed by Carrier Doping

Kazuya Suzuki, Teppei Okumura, Yuji Iyeiri, Takeshi Ohsawa

Graduate School of Environment and Information Sciences, Yokohama National University, Yokohama 240-8501, Japan

We report the magnetic structures of rare earth metal polytellurides designed by carrier doping. RTe_3 consists of alternate stacking of one RTe layer and two Te layers. The ordered magnetic moment of RTe_3 lies within the layer, in contrast to that of RTe_2 having alternate stacking of one RTe and one Te layer where the magnetic moment is in the layer-stacking direction although the symmetry at the R atoms is the same. The difference originates from the effective charge in the Te layer. In R_2Te_5 consisting of the layer composite of the RTe_2 and RTe_3 unit, the magnetic ordering independently occurs in each unit and their ordered magnetic moments make an angle of nearly 90 degrees due to strong single ion anisotropy.

26CP28 Hyperfine-Enhanced Nuclear Spin Order of $PrPb_3$

Haruhiko Suzuki, Ayumi Ryu, Seiji Asada, Shumsun Nahaer, Satoshi Abe, Koichi Matsumoto, Tetsuo Kitai

Department of Physics, Kanazawa University, Kakuma-machi, Kanazawa 920-1192, Japan

The cubic compound $PrPb_3$ with the $AuCu_3$-type structure is known to undergo an antiferro-quadrupolar phase transition at 0.4K. The ground state of the trivalent Pr ion in a cubic local symmetry is a nonmagnetic doublet Γ_3. This Γ_3 doublet splits into two singlet below 0.4K. We can expect that the hyperfine-enhanced nuclear moment will be differnet among the adjacent sites. We will report the hyperfine-enhanced nuclear spin order in an antiferroquadrupolar $PrPb_3$, which can be expected at about 1mK.

26CP29 Effect of Hund coupling in one-dimensional spin-orbital system

Hyun Lee[a], Hyun Lee[a], Patrick Azaria[b], Eduardo Boulat[b]

[a] *Department of Physics, Sung Kyun Kwan University, Suwon, 440-746, South Korea*
[b] *Laboratorie de Physique Théorique des Liquides, Université Pierre et Marie Curie, 75252 Paris, France*

The 1D spin-orbital model perturbed by Hund coupling is studied by renormalization group and bosonization methods. The Hund coupling breaks the $SU(4)$ spin-orbital symmetry into $SU(2)_{\rm s} \times U(1)_{\rm o}$ at weak coupling fixed point. The one-loop renormalization group analysis shows that the Hund coupling is relevant irrespective of Coulomb repulsion. When Coulomb repulsion is larger than Hund coupling, the spin-orbital physics in strong coupling regime is described by $SO(6)$ Gross-Neveu model, where the spin and orbital excitations are gapped. When the Hund coupling is much larger than the Coulomb repulsion, the strong coupling regime is described by the two coupled $SO(3)_{\rm s} \times SO(3)_{\rm o}$ GN model with the gapped excitations.

Possible Form of Multi-polar Interaction in Cubic Lattice **26CP30**

Osamu Sakai[a], Ryousuke Shiina[a], Hiroyuki Shiba[b]

[a]*Department of Physics, Tokyo Metropolitan University, Tokyo 192-0397, Japan*
[b]*Department of Physics, Kobe University, Kobe 657-8501, Japan*

Possible form of the interaction between multi-poles, including the octupole, is studied for the three types of the cubic lattice: simple cubic, body centered and face centered lattices. It is pointed out that coupling terms can be arranged in a way similar to that of the hopping matrix between the atomic orbitals. A table for s. c. lattice by Shiina et. al. (J. Phsy. Soc. Jpn. **67** (1998) 941) is generalized for the general wave number case of the three types of lattice. Recent experimental result of TmTe is analyzed. The development of the ferromagnetic component at the anti-ferromagnetic transition under the anti-ferro type quadrupolar order phase is discussed in a general point.

Canted Order in Nuclear and Electronic Magnetism of Pr Compounds **26CP31**

Yasushi Kinoshita, Machiko Nishino, Hiroumi Ishii

Graduate School of Science, Osaka City University, Osaka 558-8585, Japan

Canted magnetic arrangements can appear when there is no center of inversion between two magnetic ions. In such a crystalline field with low symmetry, a singlet ground state is realized for Pr ions. Two typical examples are studied. The first is $PrCu_6$ studied by T. Hata et al., in which the electronic state remains paramagnetic and for the nuclear spins the Dzyaloshinsky-Moriya interaction is induced in the RKKY interaction[1]. The second is PrPtAl studied by H. Kitazawa et al. in which the canted magnetic order is induced in the electronic state. This is due to the single ion anisotropy energy whose principal axes differ each other at the two sites in the unit cell.

[1]H. Ishii and Y. Kinoshita, Phys. Rev. B63, 014415 (2000).

Magnetic Phase Transition in Pd_xCoO_2 **26CP32**

Hirotaka Okabe[a], Masanori Matoba[a], Mitsuru Itoh[b]

[a]*Department of Applied Physics and Physico-Informatics, Keio Univerity, 3-14-1 Hiyoshi, Yokohama 223-8522, Japan*
[b]*Materials and Structures Laboratory, Tokyo Institute of Technology, 4259 Nagatsuta, Yokohama 226-8503, Japan*

$PdCoO_2$ has a delafossite structure (space group $R\bar{3}m$) with alternative triangular layers of Pd, O, and Co. The Pd deficient compounds Pd_xCoO_2(x=0.65, 0.43) were prepared by the cation exchange reaction. Their magnetic susceptibility mesurements were carried out in the temperature range between 4.2K and 300K, and it was found that $Pd_{0.65}CoO_2$ has antiferromagnetic ordering with a weak ferromagnetism at 50K. Specific heat mesurements for $Pd_{0.65}CoO_2$ and $Pd_{0.43}CoO_2$ showed the λ-type anomaly at 50 and 30K, respectively, which is in good agreement with the magnetic susceptibility mesurements.

26CP33 Elastic Constants of Antiferro-quadrupole Ordering System DyB_2C_2

Yuichi Nemoto[a], Tatsuya Yanagisawa[a], Koichiro Hyodo[a], Terutaka Goto[a], Shingo Miyata[b], Ryuta Watanuki[b], Kazuya Suzuki[b]

[a]*Graduate School of Science and Technology, Niigata University, Niigata 950-2181, Japan*
[b]*Graduate School of Engineering, Yokohama National University, Yokohama 240-8501, Japan*

In order to investigate antiferro-quadrupole ordering in tetragonal system DyB_2C_2, we have measured elastic constants by ultrasonic method. Characteristic softenings of the C_{44} and $(C_{11} - C_{12})/2$ corresponding to transverse modes were observed towards the transition temperature $T_Q = 24.7$ K. We propose that the CEF ground state is a pseudo quartet consisting of $E_{1/2}$ doublet and $E_{3/2}$ doublet in C_{4h} site symmetry of Dy^{3+} ion, which is consistent with the present results of the elastic constants and specific heat. The magnetic field dependence of C_{44} and phase diagram obtained by the present study are also discussed.

26CP34 Electrical and Magnetic properties of CeGa Single Crystal

Sadayoshi Koiwai, Masashi Kosaka, Nobuo Môri

Department of physics, Saitama University, Saitama 338-8570, Japan

We report on the study of the electrical and magnetic properties of CeGa with orthorhombic structure. The heat capacity has been measured in the temperature range between 0.4 K and 20 K under magnetic field up to 9 T. A sharp peak and a shoulder-like anomaly in the temperature dependent heat capacity are observed at 5.7 K and near 1 K, respectively. The sharp peak is due to the antiferromagnetic ordering transition, but the cause of the shoulder is unknown. As the magnetic field increases, the peak fades out and vanishes at about 4.2 T. The temperature of the shoulder-like anomaly is almost independent of magnetic field up to 3.5 T, but it rises suddenly above 3.5 T, crossing over T_N at about 4.2 T.

26CP35 The Magnetic Properties of Hypothetic Compounds RFe_5 (R=rare earth)

Hiroyuki Nagai, Yasushi Amako, Shingo Kawakami, Takayuki Ishii, Hiroshi Yoshie

Department of Physics, Faculty of Science, Shinshu University, Matsumoto, Japan

The intermetallic compound RFe_5, generally, cannot be prepared by common method . But we can estimate the magnetic properties of RFe_5 by extrapolating x to 1 in $R(Ni_{1-x}Fe_x)_5$. The compounds of R=Y, Gd, Tb, Dy and Ho have been investigated. These compounds crystallize in the hexagonal $CaCu_5$-type in the concentration range of x¡0.5. In the case of R=Gd the metamagnetic behavior was observed for x¿0.2, while other compounds of R=Y, Tb, Dy and Ho showed ferrimagnetic properties. The saturation magnetization of R=Tb, Dy and Ho decreased linearly with Fe concentration. The magnetic moments of Fe atoms were obtained by Mössbauer effect.

Magnetic Phase Diagram of $GdGa_{1.75}Al_{0.25}$ 26CP36

Tatsuichi Hamasaki[a], Hiroyuki Deguchi[b]

[a]*Physics Department, Kyushu Sangyo University, Fukuoka 813-8503, Japan*
[b]*Department of Electronics, Kyushu Institute of Technology, Kitakyushu 804-8550, Japan*

DC and AC magnetization of $GdGa_{1.75}Al_{0.25}$ have been measured in the magnetic field less than 5 tesla on polycrystalline material. In zero magnetic field, we have measured a specific heat and observed an antiferromagnetic transition at $T_{\rm N}$=24.0 K. A second transition has been observed at 22.9 K, immediately below $T_{\rm N}$. This transition has not been observed clearly by DC or AC magnetization measurement. A third transition has been observed at 7.7 K only by DC and AC magnetization measurements, which may be due to the change of the easy axis. Every temperature below $T_{\rm N}$ we have observed metamagnetic transitions and obtained complex H-T phase diagram. With the exception of higher third transition temperature, the magnetic structure of $GdGa_{1.75}Al_{0.25}$ is similar to that of $GdGa_2$.

De Haas-van Alphen Effect in $GdAl_3$ 26CP37

Genfu Chen, Takenori Hayakawa, Shigeo Ohara, Isao Sakamoto

Department of Electrical and Computer Engineering, Nagoya Institute of Technology, Nagoya, Japan

The light rare earth trialuminide compounds RAl$_3$ (R: La-Gd), crystallized in the hexagonal Ni_3Sn-type structure, show a variety of physical phenomena. The role of 4f electrons in determining the physical characteristics is still under investigation. Among the RAl$_3$ compounds, $GdAl_3$ is a simple model material with Gd^{3+} ion in the $^8S_{7/2}$ ground state, having no influence of crystal-field and Kondo effect. To clarify the Fermiology of $GdAl_3$ we have measured de Haas-van Alphen (dHvA) effect at temperature down to 0.3 K up to 14 T. Many kinds of dHvA branches are detected and the dHvA frequencies range from 160 T to 2300 T. The largest frequency has the cyclotron effective mass 0.72 m_0 along the [0001] direction. We have also investigated the anisotropies of electrical resistivity, Hall coefficient and thermopower in the temperature range 2 - 300 K.

On the ferromagnetism of high-spin states 26CP38

Nadejda V. Terekhina[a], Rogdai Zaitsev[b]

[a]*NIIteplopribor, Prospect Mira 95, Moscow 129085, Russia*
[b] *Russian Research Center, Kurchatov Institite, Kurchatov Sq1, 123 182 Moscow, Russia*

The possibility of ferromagnetic ordering in a generalized Hubbard model and for infinite Hubbard energy is studied. The phase diagram of the ferromagnetism existence as a function of the degree of filling of d-shall is constructed. The calculation of the points of critical densities, between which ferromagnetic instability arises, was performed in a model of semielliptic primer density of state. On the bases of the deduced criterion, ferromagnetic instability was observed inside each integer interval of variation of the d-electron density. The appearance of separate regions of ferromagnetic instability is due to the possibility of change of sign of the scattering amplitude for Fermi excitations with opposite spin projections.

26CP39 Magnetic susceptibility of substances at small Hubbard energy.

Julia V. Mikhailova

NII Teplopribor, Prospect Mira 95, Moskow 129 085, Russia

The estimation for shift of levels of a N-partial spectrum is received at small Hubbard energy. The correction to free state is obtained by perturbation method as: $\Delta E_n = U\left(S_{\max}^2 - S_n^2\right)/N$, where N - number of particles in system, $S_{max}-$ of the greatest possible spin of system, S_n- total spin of system N- of particles for n-th state. For this purpose the size was calculated $\Delta_n = \left\langle \Psi_n, \hat{H}_{int}\Psi_n \right\rangle / \langle \Psi_n, \Psi_n \rangle$, where $\hat{H}_{int} = U\sum\limits_i (n_{i\uparrow}n_{i\downarrow})$ is Hubbard interaction, Ψ_n - wave function of n-th state. At calculations it was used, that the Hamiltonian $\hat{H}_0 + \hat{H}_{int}$ commutats with the operator of a total squared spin $(\hat{S})^2$ of system. The account of thermodynamic and magnetic sizes with use of the received result is essentially determined by a type of a lattice.

26CP40 Half-metallic ferromagnet of MnBi in zinc-blende phase

Ya-Qiong Xu, Bang-Gui Liu

Institute of Physics & Center of Condensed Matters Physics, Chinese Academy of Sciences, P O Box 603, Beijing 100080, China

Full-potential linear augmented plane wave method in density-functional theory was used to predict that MnBi in zinc-blende phase is a half-metallic ferromagnet with magnetic moment 4.000 μ_B per formula. This phase is robust against volume changes up to $+20\%$ and -12% and remains qualitatively the same under various approximations. Although this phase is meta-stable, it can be realized as thin films or nanostructures through epitaxial growth on right substrates with the same crystalline structure and appropriate crystal constants. This comes as a new member in the family of the several half-metallic ferromagnets, and may be useful in spintronics and other applications.

26CP41 ESR Study on Metamagnetic Transition in $CsFeCl_3$ up to 40 T

Meiro Chiba[a], Tomoyuki Higuchi[b], Kiyofumi Kitai[b], Seitaro Mitsudo[b], Toshitaka Idehara[b], Mitsuru Toda[c], Shizumasa Ueda[d]

[a]*Department of Applied Physics, Fukui University, Fukui 910-8507, Japan*
[b]*Research Center for Development of Far Infrared Region, Fukui University, Fukui 910-8507, Japan*
[c]*Institute of Materials Structure Science, KEK, Tsukuba 305-0801, Japan*
[d]*Institute of Advanced Energy, Kyoto University, Uji, Kyoto 611-0011, Japan*

In the $S = 1$ fictitious spin system $CsFeCl_3$ an anomalous magnetization has been observed under the magnetic field around 34 T, being much higher than the saturation field. It can not be explained in terms of the fictitious spin $S = 1$. In order to clarify the nature of the metamagnetic transition, an ESR experiment was performed under magnetic fields up to 40 T. The mechanism of the metamagnetic transition is discussed under the basis of the ESR frequency-field diagram.

Field effect on itinerant electron magnetism of $Y_{1-x}Er_xCo_2$ compounds **26CP42**

Takao Nakama[a], Masafumi Tokumura[a], Kiyoharu Uchima[a], Masato Hedo[b], Yoshiya Uwatoko[b], Katsuma Yagasaki[a], Haruo Niki[a], Alexandre T. Burkov[c]

[a]*Faculty of Science, University of the Ryukyus, Okinawa 903-0213, Japan*
[b]*ISSP, University of Tokyo, Kasiwanoha 277-8581, Chiba, Japan*
[c]*A. F. Ioffe Physical-Technical Institute, Russian Academy of Sciences, St. Petersburg 194021, Russia*

Thermopower S and electrical resistivity ρ of cubic Laves phase pseudo-binary compounds $Y_{1-x}Er_xCo_2$ were measured from 2 K to 300 K in magnetic fields up to $\mu_0 H$=15 T. S and ρ show a strong field dependence in a vicinity of the magnetic ordering temperature. The reduction of the exchage magnetic field $B_{\rm exc}$ acting on Co 3d electrons by Y substitution for Er results in a separation of magnetic transition temperatures of Er and Co subsystems in $Y_{0.4}Er_{0.6}Co_2$. The collapse of the itinerant Co 3d moments of $Y_{0.4}Er_{0.6}Co_2$ is induced by applying external magnetic field about 10 T.

^{11}B NMR Study in the Tetragonal CeB_2C_2 Compound **26CP43**

Ko-ichi Magishi[a], Kuniyuki Koyama[a], Takahito Saito[a], Kiyoshi Mizuno[a], Ryuta Watanuki[b], Kazuya Suzuki[b]

[a]*Faculty of Integrated Arts and Sciences, The University of Tokushima, Tokushima 770-8502, Japan*
[b]*Graduate School of Engineering, Yokohama National University, Yokohama 240-8501, Japan*

It is known that CeB_2C_2 undergoes magnetic transitions to the antiferro-magnetic (AFM) phases at $T_{\rm N1}$ = 7.1 K and $T_{\rm N2}$ = 6.5 K. The purpose of this study is to clarify the magnetic properties and the magnetic structures in the AFM phases of CeB_2C_2 compound by means of ^{11}B NMR measurement on a single crystalline sample. In the paramagnetic state, the NMR spectrum consists of a sharp peak with satellite lines. On the other hand, in the AFM phase, the spectrum was broadened and splitted into many resonance peaks by the internal magnetic field at B sites. The more detailed experiments and analyses are now in progress. We will report those results at the presentation.

Pressure tuning of the exchange interactions between s-electrons in a b.c.c. lattice of sodalite cages **26CP44**

Kenji Mizoguchi[a], Tsuneaki Yamabe[a], Hirokazu Sakamoto[a], Ljiljana Damjanovic[b], Vojislav I. Srdanov[b]

[a]*Department of Physics, Tokyo Metropolitan University, Hachioji, Tokyo 192-0397, Japan*
[b]*Department of Chemistry, University of California, Santa Barbara, CA 93106, USA*

Néel and Weiss temperatures of the alkali-electro-sodalites (AES) loaded with Na or K were investigated as a function of hydrostatic pressure up to 2 GPa with a low-frequency ESR technique. The Néel temperature depends weakly, but the Weiss temperature decreases more sensitively with pressure. These pressure dependence could be well accounted for with a two-sublattice molecular field approximation. The assumption that the pressure causes a exponential decay of the transfer energies via the two-kinds of coupling windows, Hexagons and squares, is successful to reproduce the observed pressure dependence and to interpret systematically the ionic dependence with chemical pressure of 4-4.5 GPa for Na-ES.

26CP45 Zeeman-like degeneracy of the massive ferromagnetic spin-wave mode

Paulo F. Farinas[a], Kevin S. Bedell[b]

[a]*CCET, Universidade São Francisco, Itatiba, SP 13251-900, Brazil*
[b]*Department of Physics, Boston College, Chestnut Hill, Massachusetts 02167*

Hydrodynamic equations for an isotropic ferromagnetic state are derived from equations of motion. General conditions for the existence of additional collective modes (besides the known spin-waves) are stated. It is found that a recently derived massive mode carries a degeneracy with respect to chiral symmetry that may be helpful in experiments aiming to observe such a new mode.

26CP46 Critical Phenomena in Double-Exchange Systems

Yukitoshi Motome[a], Nobuo Furukawa[b]

[a]*ERATO-SSS, JST, Tsukuba, Ibaraki 305-8562, Japan*
[b]*Department of Physics, Aoyama Gakuin University, Setagaya, Tokyo 157-8572, Japan*

Critical phenomena of metallic-ferromagnetic transition are studied in double-exchange systems. A recently-developed Monte Carlo method is applied to obtain results in the thermodynamic limit through the finite-size scaling. Our results clearly show an importance of strong fluctuations in this itinerant system. The ferromagnetic transition belongs to the universality class with short-ranged interactions which is distinct from the mean-field one. The calculated critical temperature and exponents are quantitatively compared with experimental results in colossal magnetoresistance manganites. We also study phase diagram and critical phenomena in the competition between the double-exchange ferromagnetism and the superexchange antiferromagnetism. Randomness effects on this competition are discussed.

26CP47 The angular dependent magnetoresistance in α-(BEDT-TTF)$_2$KHg(SCN)$_4$

Balázs Dóra[a], Kazumi Maki[b], Mario Basletić[c], Bojana Korin-Hamzić[d]

[a]*Department of Physics, Technical University of Budapest, H-1521 Budapest, Hungary*
[b]*Max Planck Institute for Physics of Complex Systems, Nöthnitzer Str. 38, D-01187, Dresden, Germany*
[c]*Department of Physics, Faculty of Science, POB 331, HR-10001 Zagreb, Croatia*
[d]*Institute of Physics, POB 304, HR-1001 Zagreb, Croatia*

The nature of low temperature phase (LTP) of α-(ET)$_2$ salts is still elusive in spite of intensitive study of the angular dependent magnetoresistance (ADMR) about a decade ago. Here we present a new study of ADMR of α-(ET)$_2$ salts, assuming LTP is unconventional charge density wave (UCDW). In the presence of magnetic field the quasiparticle spectrum is quantized á la Landau. This gives rise to a striking ADMR in UCDW. The present model appears to account for salient aspects of many existing ADMR data of α-(ET)$_2$KHg(SCH)$_4$ remarkably well. This gives convincing support that LTP in α-(ET)$_2$ salts is UCDW.

Sub-Nanometer Domain Wall Motion: Single Pinning Centre Coercivity **26CP48**

Kostya Novoselov[a], Andre Geim[a], Dirk van den Bergen[b], Sergey Dubonos[a], Jan Kees Maan[b]

[a] *Department of Physics and Astronomy, University of Manchester, Manchester M13 9PL, UK*
[b] *High Field Magnet Laboratory, University of Nijmegen, 6525ED, Nijmegen, The Netherlands*

Nanometer-scale propagation of domain walls in garnet films has been studied by ballistic Hall micro-magnetometry. At low temperatures domain walls are found to move by nanometer-size jumps and each individual jump can be attributed to pinning on an individual defect. The jumps are reproducible for small changes of external magnetic field. At *T* above $5\ K$, the coercivity of a typical pinning center (*i.e.* magnetic field required to de-pin a domain wall) is found to be $\sim 5\ G$ and decrease with increasing temperature. This temperature dependence allows us to determine the characteristic energy and size of the pinning center. Unexpectedly, at *T* below $5\ K$ the coercivity saturates and even shows a tendency to decrease. Possible explanations for this behavior will be discussed (nuclear spin diffusion, tunnelling).

Weak ferromagnetism, compensation point and temperature induced magnetization reversal in $Ni(HCOO)_2*2H_2O$ **26CP49**

H. Kageyama[a], D.I. Khomskii[b], R.Z. Levitin[b], A.N. Vasiliev[c]

[a] *Institute for Solid State Physics, University of Tokyo, Kashiwa, Chiba 277-8581, Japan*
[b] *University of Groningen, Nijenborgh 4, 9747 AG Groningen, The Netherlands*
[c] *Physics Faculty, Moscow State University, 119992 Moscow, Russia*

In Ni(HCOO)2*2H2O the transition into weak ferromagnetic state occurs at T_N = 15.5 K. At lowering temperature an initial increase of magnetization gives way to a gradual decrease and the compensation point is observed at T_C = 8.5 K. There are two nonequivalent positions in Ni subsystem, i.e. Ni1 and Ni2. The origin of weak ferromagnetic moment is due to the tilt of easy axes of magnetization in NiO6 octahedrons belonging to each subsystem. The appearance of compensation point is related to different temperature dependencies of Ni1 and Ni2 subsystem magnetizations.

Magnetic Properties of Weak Itinerant Electron Ferromagnet Ni-Pt Alloy **26CP50**

Keiichi Koyama[a], Hiroe Sasaki[b], Takeshi Kanomata[b], Kazuo Watanabe[a], Mitsuhiro Motokawa[a]

[a] *Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan*
[b] *Faculty of Engineering, Tohoku Gakuin University, Tagajo 985-8537, Japan*

Precise magnetization measurement and high field magnetization measurement have been performed for Ni-Pt alloy in magnetic fields up to 10 kOe using a SQUID magnetometer and in magnetic fields up to 130 kOe using a VSM magnetometer, respectively, in temperature range from 5 K to 280 K. The spontaneous magnetization M_S(T) follows a $(1 - (T/T_C)^2)$-dependence below 15 K. In the temperature range from 15 K to Curie temperature (42 K), however, M_S(T) decreases with the proportional to $(1-(T/T_C)^{4/3})$. Obtained results can be explained with a new spin fluctuation theory of Takahashi.

26CP51 Field-Induced Ferromagnetic Transition in $PrInNi_4$

N. Tsujii, H. Kitazawa, H. Suzuki, M. Imai, G. Kido

National Institute for Materials Science, Tsukuba, Ibaraki 305-0047, Japan

We report on the magnetic properties of a new ternary compound $PrInNi_4$. $PrInNi_4$ has the cubic $MgSnCu_4$-type structure. Magnetization M and electrical resistivity ρ as functions of temperature T for magnetic field $H \leq 0.5$ T reveal that magnetic ordering is absent above 2 K, and the ground state is a nonmagnetic crystal field level. For $H \geq 0.7$T, M and ρ vs. T show a sharp jump at $T \simeq 3$ K. Below this temperature, M saturates around 1.5-2 $\mu_{\rm B}$. These facts indicates that $PrInNi_4$ undergoes a ferromagnetic transition at $T_c \simeq 3$ K for applied field $H \geq 0.7$ T. The sharp jump suggests that hybridization of the wave function of the crystal field levels occurs rapidly around T_c. M and ρ vs. H exhibit a nonmagnetic-ferromagnetic transition at $H_c = 0.7$ T for $T = 2$ K. This field-induced transition will be discussed in relation to the competition of the crystal field effect and the ferromagnetic exchange interaction.

26CP52 Two-scale analysis of the Hubbard model

Adolfo Avella, Ferdinando Mancini, Sergey Krivenko

Dipartimento di Fisica "E.R. Caianiello" - Unità INFM di Salerno
Università degli Studi di Salerno, I-84081 Baronissi (SA),Italy

A two-scale approach for an analysis of the Hubbard model has been developed. The dynamics has been obtained from equations of motion of fermionic composite operators, which were split in high and low frequency components. A fully self-consistent solution which exactly conserves the first spectral moments has been found. Some local and thermodynamics properties have been computed and compared fruitfully with numerical results available in literature.

26CP53 Phase Separation in Magnetically Ordered Semimetals and Half-metals

Ikhiel Korenblit

School of Physics & Astronomy, R.& B. Sackler Faculty of Exact Sciences, Tel-Aviv University, Tel-Aviv 69978, Israel

We showed that in ferromagnetic semimetals, in which the RKKY indirect exchange predominates, as e.g., in EuB_6, the magnetically ordered state at finite temperatures, T, is unstable against phase separation (PS) into regions with enhanced and suppressed ferromagnetic correlations. Considering the energy of the slightly inhomogeneous electron gas in the Hohenberg-Kohn approximation, we obtained the phase diagram in the (T,carrier concentration), and in the (magnetic field, carrier concentration) planes. The results explain qualitatively the magnetic properties of EuB_6. The same approach was used to investigate PS in the ground state of slightly doped double-exchange manganites. The scale of the PS regions is fixed by the Coulomb screening of the carriers, and it is of order of several lattice constants.

Studies of single crystal $ErCo_2$ under pressure and magnetic field **26CP54**

Jaeyoung Woo[a], Younghun Jo[b], H.C. Kim[c], A. Pirogov[b], J.-G. Park[b]

[a]*Department of Physics, Inha University, Incheon 402-751, Korea*
[b]*Department of Physics and Institute of Basic Science, SungKyunKwan University, Suwon 440-746, Korea*
[c]*Material Science Laboratory, Korea Basic Science Institute, Taejeon 305-333, Korea*

We investigated first order magnetic transition of $ErCo_2$ at 35 K by measuring resistivity and magnetization under pressures (up to 12 kbar) and magnetic fields (18 Tesla) with a single crystal sample. With increasing pressure the ferromagnetic transition moves towards lower temperatures while it increases in temperature with magnetic fields. We note that the first order nature of the magnetic transition is suppressed by pressures or fields, and it is expected to become of second order type at above 60 kbar and 20 Tesla. We will discuss this pressure or field induced transition in the nature of the magnetic transition of $ErCo_2$.

NMR Study of Two-Dimensional Ferromagnet K_2CuF_4 at Millikelvin Temperatures **26CP55**

Rui Goto, Keiichirou Nakamura, Kunihide Okada, Muneaki Fujii

Department of Physics, Kumamoto University, Kumamoto 860-8555, Japan

Two-dimensional ferromagnet K_2CuF_4 is an ideal compound in which to study two-dimensional magnetic systems because the interplane exchange coupling constant is much smaller than intraplane exchange coupling constant. We measured the temperature dependence of the NMR frequencies of the $1/2 \leftrightarrow 3/2$ transition for ^{63}Cu and ^{65}Cu nuclei in K_2CuF_4 single crystal. The NMR measurements were made by spin-echo method at zero applied magnetic field. The experimental results are discussed in the framework of the two-dimensional spin wave theory at very low temperatures.

Successive Magnetic Transitions and Multi-Step Magnetization in GdBC **26CP56**

Akinori Matsumoto, Akihiro Muramoto, Satoru Noguchi

Graduate School of Engineering, Osaka Prefecture University, Sakai 599-8531, Japan

GdBC crystallizes in the orthorhombic YBC-type structure. Antiferromagnetic-like transition temperature, $T_{\rm N}$ = 45 K is inferred by the magnetic susceptibility, resistance and heat capacity measurements. Another magnetic transition may occur around $T_{\rm m}$ = 25 K, where the susceptibility shows a broad peak and the heat capacity shows a small anomaly. In the paper, we report the results of the magnetization measurements in GdBC single crystal by using a SQUID magnetometer up to 5 T and a pulsed-magnet system up to 30 T. The magnetization for $H \parallel b$ at 4.2 K shows three steps at 1, 5 and 15 T, being saturated above 23 T. The saturation moment is almost 7 $\mu_{\rm B}$/Gd. Temperature dependence of the step fields is obtained for all axes. These imply that GdBC has successive antiferromagnetic transitions with complex magnetic structures in spite of the simple spin system of Gd^{3+}.

26CP57 Magnetic phase diagram of Ce_2Fe_{17} under high pressures in high magnetic fields

Fumihiro Ishikawa[a], Tsuneaki Goto[a], Hironobu Fujii[b]

[a]*Institute for Solid State Physics, University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa 277-8581, Japan*
[b]*Faculty of Integrated Arts and Science, Hiroshima University, Higashi-Hiroshima 739-8521, Japan*

Magnetization measurements were performed on Ce_2Fe_{17} under high pressures up to 1.2 GPa and in magnetic fields up to 18 T. We determined the magnetic phase diagram in the $B-T$ plane at 0, 0.3, 0.4, 0.6, 0.9 and 1.2 GPa. At 0 GPa, five magnetic phases exist and the application of high pressure produces two additional magnetic phases. The shape of the phase diagram changes drastically with increasing pressure. The appearance of the new magnetic phases is considered to be related to the competing exchange interactions among the Fe magnetic moments.

26CP58 Effect of Berry's phase on the conduction electrons g factor in Zn

Yuri V. Sharlai, Grigorii P. Mikitik

B.Verkin Institute For Low Temperature Physics & Engineering, National Ukrainian Academy of Sciences, Kharkov 61103, Ukraine.

In metals the semiclassical quantization condition for energy levels of electrons in a magnetic field depends on Berry's phase. When the closed electron orbit in the magnetic field links to band-contacts lines, Berry's phase can be nonzero, and in this case even a small spin-orbit interaction leads to an essential difference of the conduction electron g factor from its free electron value, $g = 2$. To clarify this point, we calculate and analyze the g factor for the three-band model of the electron spectrum which can describe the so-called needles in Zn. We show that in zinc Berry's phase effect on the electron g factor is comparable with the spin-orbit contribution to it. We discuss a way of extracting Berry's phase contribution to g factor from experimental data.

26CP59 Conduction electron g factor in metals

Yuri V. Sharlai, Grigorii P. Mikitik

B.Verkin Institute For Low Temperature Physics & Engineering, National Ukrainian Academy of Sciences, Kharkov 61103, Ukraine.

We theoretically investigate the electron g factor which is experimentally determined from the de Haas-van Alphen effect. Although formulas for the g factor were first derived by Roth in 1966, they are sufficiently complicated and have not been used in practice so far. We represent the formulas in a more convenient form which also admits a simple physical interpretation. It follows from these formulas that numerous computations of the g factor performed earlier (using the local g factor method) did not take into complete account spin dynamics of a semiclassical Bloch electron moving in a magnetic field. This can lead to inaccurate results for the g factor if the spin-orbit interaction in a metal is not small. We also point out that the concept of local g factors is not generally correct for a strong spin-orbit coupling.

Magnetization and Ground State Spin Structures of Ising Spin System with Four-Spin Interaction **26CP60**

T. Iwashita[a], K. Uragami[a], K. Goto[a], T. Idogaki[b]

[a]*College of General Education, Kyushu Tokai University, Kumamoto 862-8652,Japan*
[b]*Department of Applied Quantum Physics, Kyushu University, Fukuoka 812-8581, Japan*

The magnetic properties of the spin S(=1/2 and 1) Ising systems with the bilinear exchange interaction $J_0 S_{iz} S_{jz}$ and the four-site four-spin interaction $J S_{iz} S_{jz} S_{kz} S_{lz}$ have been discussed by making use of the Monte Carlo simulation. At low temperature region, the magnetization curve has an inverse inclination and decreases with the decrease of temperature under a certain condition of the value J/J_0. This anomalous behavior is considered to be originated in the non-ferromagnetic spin structures which have a little higher energy than the one of the ground state, and the relation between the value of the magnetization at zero-temperature and the spin structure expected for the ground state has been made clear.

Enhancement of the Kondo Effect in a mechanically deformed Cu(Mn) alloy **26CP61**

Masahito Nakagawa, Yasukage Oda

Department of Material Science, Graduate School and Faculty of Science, Himeji Institute of Technology, Ako-gun, Hyogo 678-1297, Japan

We have studied the Kondo effect in mechanically deformed Cu(Mn), through measurements of the temperature dependence of the resistivity. Both the logarithmic Kondo slope at low temperature and the temperature of maximum resistivity due to spin glass transition become a little larger than not deformed one. The origin of these phenomena seems to be enhancement of the Kondo effect due to increase of Mn atoms in the neighborhood of dislocations.

Magnetic Properties of Amorphous $Mn_{100-x}Ce_x$ Alloys **26CP62**

Shinya Kikegawa[a], Takuya Matsumura[a], Shigeyuki Murayama[a], Hideaki Takano[a], Yoshihisa Obi[b]

[a]*Muroran Institute of Technology, Muroran 050-8585, Japan*
[b]*Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan*

The magnetic susceptibility and thermal expansion of amorphous(a-) $Mn_{100-x}Ce_x$ alloys for 20<x<80 fabicated by DC-sputtering have been measured. The susceptibility shows a simple Curie-Weiss behavior except its insignificant defference in between ZFC and FC states at low temperature. The thermal expansion α for a-$Mn_{100-x}Ce_x$ shows the Debey-type temperature dependence for 20<x<40, although the value is much larger than that for typical amorphous alloys. Furtermore, the α increases with increasing Ce concentration. On the other hand, a-$Mn_{100-x}Ce_x$ for 50<x<80 shows that the α decreases with increasing Ce concentration in the high temperature side, and below 100K the α shows a large increase with decreasing temperature. This would be anomalous effect of $4f$ electrons in these alloys.

26CP63 Metamagnetism of $PrCu_2X_2$(X=Si and Ge)

Toru Shigeoka[a], Yasuyuki Taneda[a], Masato Hedo[b], Yoshiya Uwatoko[b]

[a]*Faculty of Science, Yamaguchi University, Yoshida, Yamaguchi 753-8512, Japan*
[b]*Institute for Solid State Physics, University of Tokyo, Chiba 277-8581, Japan*

Magnetic behavior at low temperature has been investigated on the single crystal compounds $PrCu_2X_2$(X=Si and Ge) which are reported to have anomalous high Neel temperatures. The compound $PrCu_2Si_2$ shows a very sharp one-step metamagnetic transition in the c-axis magnetization process at low temperature, whereas $PrCu_2Ge_2$ shows a four-step metamagnetic process in the initial ascending process. The descending process changes to a one-step one. The magnetization in the descending process decreases rapidly, crosses over one of the ascending process and reaches near zero; The process is irreversible and very peculiar, which has been never seen yet. The origin will be discussed from comparison of the both compounds.

26CP64 Raman Scattering of RB_6 (R=Ca, Ce, Dy, Gd, Pr and Yb)

Norio Ogita[a], Shinji Nagai[a], Naoki Okamoto[a], Masayuki Udagawa[a], Fumihiko Iga[b], Masafumi Sera[b], Jun Akimitsu[c], Satoru Kunii[d]

[a]*Faculty of Integrated Arts & Sciences, Hiroshima University, Hiroshima 739-8521, Japan*
[b]*Graduate School of Advanced Sciences of Matter, Hiroshima University, Hiroshima 739-8526, Japan*
[c]*Department of Physics, Aoyama-Gakuin University, Tokyo 157-8521, Japan*
[d]*Department of Physics, Graduate School of Science, Tohoku University, Sendai 980-8578, Japan*

In Raman scattering spectra of RB_6, anomalous peaks have been found below 200cm^{-1} for the $R^{+3}B_6$, except for phonons and CEF excitations. Their peak intensities decrease with decreasing temperature and this temperature dependence correlates with that of the mean square displacement of R. Furthermore, their energies decrease with the increase of the cage size of B. This new excitation can be attributed to a local vibration of the R ion, which can be regarded as "rattler" in the cage of B.

26CP65 Magneto-Volume Effect in the Ground and Field Induced States of Ce_2Fe_{17}

Yoshikazu Makihara[a], Hironobu Fujii[b], Tetsuya Fujiwara[b], Kazuo Watanabe[c], Kohki Takahashi[c], Keiichi Koyama[c], Mitsuhiro Motokawa[c]

[a]*Physics Department, Kyushu Kyoritsu University, Kitakyushu 807-8585, Japan*
[b]*Faculty of Integrated Arts and Sciences, Hiroshima University, Higashi-Hiroshima 739-8521, Japan*
[c]*Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan*

X-ray diffraction measurements on Ce_2Fe_{17} have been performed in the temperature range from 8 to 300K at the magnetic fields up to 5T. A clear spontaneous linear magnetostriction is observed in the c-axis below T_N=210K in the antiferromagnet Ce_2Fe_{17} with a helical spin structure in the ground state. On the other hand, no remarkable anomaly is observed in the a-axis at the magnetic transition temperature T_t=125K. It has been found that the structural phase transition occurs in the Ce_2Fe_{17} simultaneously with the metamagnetic transition below T_t.

Ferromagnetism in Lanthanum Doped CaB_6: Is it Intrinsic? 26CP66

Takao Mori*, Shigeki Otani

Advanced Materials Laboratory, National Institute for Materials Science, Namiki 1-1, Tsukuba, 305-0044, Japan

The magnetism of flux grown single crystals of undoped and lanthanum doped $Ca_{1-x}La_xB_6$ was systematically investigated, taking especial care in the preparation and quality control of crystals. It is strongly indicated that the ferromagnetism (first reported in *Nature* by Young *et. al.*) originates from iron impurities rather than being an intrinsic effect of the lanthanum doping of CaB_6.

Density Waves in the Organic Metal α-(BEDT-TTF)$_2$KHg(SCN)$_4$ 26CP67

Masaru Kato

Department of Mathematical Sciences, Osaka Prefecture University, Sakai, Osaka, 599-8531, Japan

We have investigated possible spin and charge density waves in the organic metal α-(BEDT-TTF)$_2$KHg(SCN)$_4$. This system shows density wave like transition at $T = 8$ K, and the nature of the density wave is not clarified up to now. Using a realistic tight binding model [1] and an inhomogeneous mean-field theory, we obtained several stable density wave states. Especially, spin density wave states (SDW) are stable only for large on-site Coulomb interaction $U \geq 800$ meV. Their spin moments are tiny and inhomogeneous even in the unit cell. Also charge density waves (CDW) appear simultaneously with the SDW. We also discuss results of the electron spin resonance experiment and the possibility of CDW state.

[1] C. E. Campos *et al.*, Phys. Rev. B, **53**, 12725, (1996)

Anomalous Behavior in Quadrupolar Ordering Temperature in Pr(Pb$_{1-x}$Sn$_x$)$_3$ 26CP69

Kenji Yurue[a], Tatsuya Kawae[a], Masaki Mito[a], Masako Hitaka[a], Kazuyoshi Takeda[a], Hiroumi Ishii[b], Tetsuo Kitai[c]

[a]*Department of Applied Quantum Physics, Kyushu University, Hakozaki, Fukuoka 812-8581, Japan*
[b]*Faculty of Science, Osaka City University, Sugimoto, Osaka 558-8585, Japan*
[c]*Faculty of Engineering, Kyushu Institute of Technology, Kitakyushu 804-8585, Japan*

Specific heat measurements has been carried out in Pr(Pb$_{1-x}$Sn$_x$)$_3$ (x=0, 0.03, 0.05, 0.1 and 0.2) with a non-Kramers Γ_3 doublet in the crystal-electric-field ground state. The ordering temperature of the quadrupolar moments shows an anomalous behavior as Sn concentration increases. A sharp peak due to the quadrupolar ordering at T_Q=0.4 K in x=0 is suppressed below 0.1 K only in x=0.03. Surprisingly, the peak turns to increase at x=0.05, and shifts to higher temperatures with the Sn concentration. At x=0.2, T_Q is expected to be $\sim$0.15 K. The possible origin of this behavior is discussed.

26CP70 Dissimilar hysteresis of Ni films and its combined effect in Ni/Si/Ni/GaAs

Syed Anisul Haque, Akira Matsuo, Yoshiyuki Yamamoto, Hidenobu Hori

School of Materials Science, Japan Advanced Institute of Science and Technology (JAIST), 1-1 Asahidai, Tatsunokuchi, Nomi-gun, Ishikawa 923-1292, Japan

Dissimilar magnetization processes and coercive fields of Ni films were observed while it was separately deposited onto Si(001) and GaAs(001) substrates. By combining these two systems a multilayer of Ni/Si/Ni/GaAs is prepared. The magnetization process of this multilayer at different temperatures is observed. Because of the difference of the coercive field of Ni films, the spin reversal occurs in two phases. The Ni film on Si having low coercivity does it first, while the Ni film on GaAs does it later. This enables to achieve an antiferromagnetic spin state in the multilayer. The field range, for which the believed antiferromagnetic spin state remains, becomes larger as the temperature decreases and it almost disappears with the increase of temperature.

26CP71 Magnetic Measurement of Rare Earth Ferromagnet Gadolinium Under High Pressure

Tomoharu Iwamoto, Masaki Mito, Masako Hidaka, Tatsuya Kawae, Kazuyoshi Takeda

Department of Applied Quantum Physics, Kyushu University, Fukuoka, 812-8581, Japan

Magnetic property of rare earth ferromagnet gadolinium(Gd:Tc = 293 K) has been observed under pressures up to 15 GPa, using a miniature diamond anvil cell (DAC) installed in a SQUID system. Pressurization suppresses both the ferromagnetic moment and the transition temperature with increasing pressure. The crystal structure keeps the same symmetry below 6 GPa. We have found that the ferromagnetic signal has disappeared. The results will be discussed on the exchange interaction among the isotropic 4f-metallic system.

26CP72 Ferromagnetic ordering in doubly degenerate Hubbard model with correlated hopping

Leonid Didukh[a], Oleksandr Kramar[a], Yuriy Skorenkyy[a], Vasyl Hankevych[a,b]

[a]*Department of Physics, Ternopil State Technical University, UA-46001 Ternopil, Ukraine*
[b]*Institute for Theoretical Physics, University of Heidelberg, D-69120 Heidelberg, Germany*

The ferromagnetic ordering stabilization in the ground state of the model which describes the intra-atomic Coulomb repulsion, inter- and intra-atomic exchange interactions and correlated hopping of electrons in a doubly orbitally degenerate band is studied. The ground state energy of the model is calculated. On this base the magnetization of system as well as ferromagnetism stabilization condition are found. The correlated hopping of electrons is shown to lead to a specific translational mechanism of the ferromagnetic ordering stabilization. The peculiarity of the obtained expressions is their concentration dependence, which can explain corresponding dependence experimentally observed in transition metal compounds.

Magnetism, Structure, and Superconductivity of $Cd_2Re_2O_7$ Pyrochlore: Cd NMR and Re NQR. 26CP73

O. Vyaselev, K. Arai, K. Kobayashi, J. Yamazaki, K. Kodama, M. Takigawa, M. Hanawa, Z. Hiroi

Institute for Solid State Physics, University of Tokyo 5–1–5 Kashiwanoha, Kashiwa, Chiba 277–8581, Japan

We report Cd NMR and Re NQR on $Cd_2Re_2O_7$, the first and as yet the only superconductor among pyrochlore oxides ($T_c \simeq 1$ K). The Re NQR spectrum rules out any magnetic or charge order. Re spin–lattice relaxation rate below T_c exhibits a pronounced coherence peak and follows the weak–coupling BCS theory with nearly isotropic energy gap. The angular dependence of Cd spectrum reveals two structural phase transitions, one at 200 K and another at 120 K. Cd NMR results point to moderate ferromagnetic enhancement at high temperatures followed by rapid decrease of the density of states below 200 K, and to strong suppression of spin fluctuations below 120 K.

Ferromagnetism in Hubbard models with nearest-neighbor Coulomb repulsion 26CP74

Hiromitsu Ueda, Akinori Tanaka, Toshihiro Idogaki

Department of Applied Quantum Physics, Kyushu University, Fukuoka 812-8581, Japan

We propose a mechanism which leads to ferromagnetism in extended Hubbard models on lattices composed of triangles. We show that the ferromagnetic ground state is stabilized in the quarter filling case through a third-order electron exchange process around a triangle when both the on-site repulsive interaction and the nearest-neighbor one are much larger than the hopping terms. Numerical calculations for a one-dimensinal lattice connected by triangles give the evidence that the ground state is ferromagnetic not only in the quarter-filling case but also away from quarter-filling.
This result indicates possibilities of ferromagnetism on some other kinds of one-, two- and three-dimesional lattices composed of triangles.

Resistivity and thermopower of CaB_6 single crystal 26CP75

Katsuma Yagasaki[a], Shiko Notsu[a], Yuko Shimoji[a], Rina Kaji[b], Tetsuya Yokoo[b], Jun Akimitsu[b], Masato Hedo[c], Yoshiya Uwatoko[c]

[a]*Faculty of Science, University of the Ryukyus, Okinawa 903-0213, Japan*
[b]*Department of Physics, Aoyama-Gakuin University, Chitosedai, Setagaya-ku, Tokyo 157-8572, Japan*
[c]*Institute for Solid State Physics, University of Tokyo, Kashiwanoha, Chiba 277-8581, Japan*

The resistivity ρ and thermopower S of CaB_6 single crystal have been measured at temperatures from 2K to 1100K in magnetic field up to 15T. Temperature dependence of ρ is expressed as 1.7-th power of T for 120 K$\geq T \geq$1100 K, where $\rho_0 = 232\mu\Omega$cm. The magnitude of ρ is very large for metal and can be considered as semi metal. There are no anomalies in both of ρ and S above 400 K where it might be considered to have ferromagnetic transition. ρ and S can be fitted on the basis of free electron model by semi-metal with simple electronic pocket.

26CP76 Anomalous magnetism in $R_2Mn_3Si_5$ (R = Tb, Dy, Ho and Er) compounds

R Nirmala[a], V Sankaranarayanan[a], K Sethupathi[a], Y Yamamoto[b], H Hori[b], AV Morozkin[c]

[a]*Dept. of Physics, Indian Institute of Technology,Madras -600 036, India*
[b]*School of Material Science, Japan Advanced Institute of Science and Technology, Ishikawa, Japan*
[c]*Dept. of Chemistry, Moscow Lomonosov State University, Moscow, Russia*

As the rare earth intermetallic compounds with transition metal Mn has a special attraction by displaying anomalous magnetic character depending on the competition between R-Mn and Mn-Mn exchange interactions, new, polycrystalline, tetragonal $Sc_2Fe_3Si_5$ - type $R_2Mn_3Si_5$ (R = Tb, Dy, Ho and Er) compounds have been synthesized and characterized. Low temperature dc magnetization measurements revealed a paramagnetic to a ferromagnetic phase transition.The paramagnetic susceptibility follows Curie - Weiss law and Mn is found to carry magnetic moment in addition to rare earth. Saturation magnetization is not observed even at high fields of 7T.

26CP77 Peculiarities of spin reorientation in a thin YIG film

Ya.B. Bazaliy[a], A.I. Linnik[b], L.T. Tsymbal[b], P.E. Wigen[c]

[a]*Argonne National Laboratory, MSD, 9700 S. Cass Ave, Argonne, IL 60439, USA*
[b]*O.Galkin Donetsk Physics & Technology Institute, R.Luxemburg 72, Donetsk, 83114, Ukraine*
[c]*Ohio State University, Physics Department, 174 W.18th Ave, Columbus, OH USA*

The issue of magnetic orientation transitions in thin films combines interesting physics and importance for applications. We study magnetic transition and phase diagram of the 0.1μm thick $(YLaGd)_3(FeGa)_5O_{12}$ films grown on the GGG substrate by liquid phase epitaxy. The nature of orientation transition is determined by demagnetizing fields, material parameters and orientation of the crystal structure relative to the film plane. It is contrasted with the one for BiGa:TmIG thin films, studied in previous work by one of the authors. The phase diagram is discussed in terms of magnetic energy that includes cubic magnetocrystalline, growth induced, and shape anisotropy energies.

26CP78 Single Crystal Growth and Magnetic Susceptibility of $Tm_3Al_5O_{12}$

Junji Awaka, Tokuichi Kurimoto, Shoichi Nagata

Department of Materials Science and Engineering, Muroran Institute of Technology, 27-1 Mizumoto-cho, Muroran, Hokkaido, 050-8585 Japan

The single crystals of garnet type $Tm_3Al_5O_{12}$ have been successfully grown by a flux method. The susceptibility was measured with an rf-SQUID magnetometer over the temperature range of 2.0 to 300 K in a constant magnetic field of 10 kOe. Tm^{3+} ion has an even number of 12-electrons in the 4f shell, avoiding the Kramers doublets. The typical Van Vleck paramagetism has been manifestly observed. The detailed analysis will be presented on the basis of crystal field splitting.

Magnetism in NdPtSn **26CP79**

Blanka Janoušová[a], Vladimír Sechovský[a], Takemi Komatsubara[b], Pavel Svoboda[a]

[a]*Dept. of Electronic Structures, Charles University, 121 16 Prague 2, Czech Republic*
[b]*Dept. of Physics, Graduate School of Science, Tohoku Univ., Sendai 980-8578, Japan*

NdPtSn, similarly to other RPtSn compounds (R = light rare earth), crystallizes in the orthorhombic TiNiSi-type structure with space group *Pnma*.
We present first results of magnetization and specific-heat measurements on a single crystal of this material at temperatures down to 0.5 K and in magnetic fields up to 9 T.
The C_p vs. T dependence reflects two magnetic phase transitions, namely at 2.4 K (second-order) and at 1.9 K (first-order). The temperature dependence of susceptibility shows a maximum at around 2.7 K. An S-shape develops on magnetization curves when decreasing temperature below 3 K.
A tentative magnetic phase diagram based on magnetic and specific-heat data and will be presented.

$2D$ soliton-vortices in Heisenberg-Maxwell sigma model **26CP80**

Igor L. Bogolubsky[a], Alla A. Bogolubskaya[b]

[a]*Laboratory of Information Technologies, Joint Institute for Nuclear Research, 141980 Dubna, Moscow region, Russia*
[b]*Laboratory of Information Technologies, Joint Institute for Nuclear Research, 141980 Dubna, Moscow region, Russia*

Stable string-like topological soliton analogues of Abrikosov-Nielsen-Olesen vortex defects in Ginzburg-Landau (abelian Higgs) theory are found within U(1) gauged extension of the easy-axis Heisenberg antiferromagnet model. Their energy does not exceed that of Belavin-Polyakov solitons in isotropic ferromagnet.

Fermi surfaces of YFe_2 and YNi_2 **26CP81**

K. Nakada[a], H. Shimizu[b], H. Yamada[b]

[a]*Graduate School of Science and Technology, Shinshu University, Matsumoto 390-8621, Japan*
[b]*Faculty of Science, Shinshu University, Matsumoto 390-8621, Japan*

The FLAPW electronic structures and Fermi surfaces of YFe_2 and YNi_2 with a cubic Laves phase structure are calculated in the non-magnetic state. Calculated results of the density-of-states are compared with the previous ones. Angular dependence of the extremal cross-sectional areas of the Fermi surfaces of these compounds are also calculated.

26CP82 MULTIPLE MAGNETIC TRANSITIONS IN $Gd_5Rh_4Ge_{10}$ SINGLE CRYSTAL

S. Ramakrishnan[a], G. J. Nieuwenhuys[b], J. A. Mydosh[c]

[a] *Tata Institute of Fundamental Research, Homi Bhabha Road, Mumbai-400 005, India*
[b] *Kamerlingh Onnes Laboratory, University of Leiden, The Netherlands*
[c] *Kamerlingh Onnes Laboratory, University of Leiden, The Netherlands*

We report the observation of quadruple magnetic transitions in a single crystal of $Gd_5Rh_4Ge_{10}$ at 14 K, 8.5 K, 7 K and 6 K via resistivity, susceptibility and heat-capacity studies. At least two of these transitions at 6 K and 7 K are completely suppressed in a field of 5 T applied along the c-axis while they are marginally suppressed for the same field along the a-axis. Multiple ordering in Gd based compounds is rare occurrence due to the S state nature of Gd ion and we provide a plausible scenario to explain these transitions.

26CP83 Magnetism in RMn_4Al_8 (R = Sm, Tb, Dy and Ho) Compounds : Possible role of Mn

R Nirmala[a], V Sankaranarayanan[a], K Sethupathi[a], T Geethakumary[b], MC Valsakumar[b], Y Hariharan[b], AV Morozkin[c]

[a] *Dept. of Physics, Indian Institute of Technology,Madras -600 036, India*
[b] *Material Sciences Division, IGCAR, Kalpakkam, India*
[c] *Dept. of Chemistry, Moscow Lomonosov State University, Moscow, Russia*

The magnetic nature of $ThMn_12$ - type, RMn_4Al_8 compounds is intricate and not yet completely understood. AC magnetic susceptibility studies on RMn_4Al_8 (R = Sm, Tb, Dy and Ho) compounds show a distinct paramagnetic to antiferromagnetic transition at temperatures less than 10 K. The shortest Mn-Mn distance being 25.8 nm, a quasi- 1-D antiferromagnetic interactions along Mn- chains of the unit cell can occur and the site occupancies of Mn atoms also might explain their magnetic behaviour.

26CP84 Electronic structure and magnetism of FeGe with a B20-type structure

H. Yamada[a], K. Terao[a], H. Ohta[b], E. Kulatov[c]

[a] *Faculty of Science, Shinshu University, 3-1-1 Asahi, Matsumoto, Nagano 390-8621, Japan*
[b] *Molecular Photoscience Research Center, Kobe University, 1-1 Rokkodai, Nada, Kobe 657-8501, Japan*
[c] *General Physics Institute, Russian Academy of Science, Moscow, 117942, Russia*

Electronic structures of FeGe with a B20-type crystal structure are calculated by a self-consistent LMTO method. A ferromagnetic state is obtained with the magnetic moment of about 1 μ_B per Fe at the observed lattice constant, being consistent with the observed induced moment. It is shown at smaller lattice constants that a non-magnetic semiconducting state with a very narrow band-gap becomes stable, where a magnetic field-induced metamagnetic transition takes place from a non-magnetic state (semiconductor) to a ferromagnetic one (metal), similar to that in FeSi with the same crystal structure.

Incommensurate Magnetic Structure in Copper Metaborate 26CP85

G. Petrakovskii[a], K. Sablina[a], M. Popov[a], B. Roessli[b], J. Schefer[b], B. Ouladdiaf[c], M. Boehm[c]

[a] *Institute of Physics SB RAS, 660036 Krasnoyarsk, Russia*
[b] *Paul Scherrer Institute, CH-5232, Villigen, Switzerland*
[c] *Institut Laue-Langevin, 38042 Grenoble, Cedex 9, France*

The results on the magnetic susceptibility, magnetization, specific heat, neutron scattering and μSR of the tetragonal copper metaborate single crystal are presented. The easy plane magnetic commensurate structure with the spontaneous moment was determined in the temperature range 21-10 K. The incommensurate magnetic ground state of this crystal was observed at the temperatures below 10 K until 0.15 K. It is shown the existence of a third magnetic transition below 1.8 K. The external magnetic field induces the phase transition from the incommensurate to commensurate structure. A phenomenological theory of the incommensurate magnetic structure was developed.

Effects of Structural Defects on Ferromagnetism of $(La_{1-x}Ca_xO)Cu_{1-x}Ni_xS$ 26CP86

K. Takase[a], T. Shimizu[a], K. Makihara[a], Y. Takahashi[a], Y. Takano[a], K. Sekizawa[a], Y. Kuroiwa[b], S. Aoyagi[b], A. Utsumi[b]

[a] *College of Science and Technology, Nihon University, Tokyo 101-8308, Japan*
[b] *Department of Physics, Okayama University, Okayama 700-8530, Japan*

We have studied the effect of structural defects on magnetic properties of $(La_{1-x}Ca_xO)Cu_{1-x}Ni_xS$. The magnetization for stoiciometric system containing less defects decreases linearly against magnetic field with negative declination and shows diamagnetism. Any ordered phase is not observed down to 2 K. It should be noted that the ferromagnetic behavior is observed for non-stoichiometric system containing structural defects at low magnetic field. Samples belonging to the latter system exhibit a well-defined hysteresis loop at room temperature. The Curie temperature increases with x. This ferromagnetism may be attributed to carriers induced by Ni and or S deficiencies.

Magnetization and transport properties in Heusler-type Fe_2TiSn compound 26CP87

Miho Nakabayashi[a], Kazunori Fukuda[a], Hiroyuki Kitagawa[a], Yuh Yamada[a], Shugo Kubo[a], Akiyuki Matsushita[b]

[a] *Department of Materials Science, Shimane University, 1060 Nishikawatsu, Matsue 690-8504, Japan*
[b] *National Research Institute for Metals, 1-2-1 Sengen, Tsukuba 305-0047, Japan*

Magnetic and transport properties of Heusler-type $Fe_{3-x}Ti_xSn$ (x = 0.9, 0.95, 1.0, 1.05 and 1.1) compounds have been investigated with DC magnetization, thermoelectric power and resistance measurements. The electrical resistivity of $Fe_{3-x}Ti_xSn$ compounds with x = 1, 1.05 and 1.1 exhibit metallic behavior. On the other hand, $Fe_{2.05}Ti_{0.95}Sn$ compound (x = 0.95) exhibits semiconductor-like behavior above the Curie temperature. These results suggest that the $Fe_{2.05}Ti_{0.95}Sn$ compound should be a semimetal with a pseudgap in the density of states at the Fermi level.

26CP88 Neutron scattering study in ternary intermetallic compounds $Nd_3Pd_{20}Ge_6$ and $Pr_3Pd_{20}Si_6$

Yoshihiro Koike[a,b], Naoto Metoki[a], Noriaki Kimura[c], Haruyoshi Aoki[c], Takemi Komatubara[c]

[a] *Advanced Science Research Center, JAERI, Tokai, Ibaraki 319-1195, Japan*
[b] *Japan Science and Technology Corporation, Kawaguchi, Saitama 332-0012, Japan*
[c] *Center for Low Temperature Science, Tohoku University, Sendai 980-8577, Japan*

High-field and low-temperature neutron scattering experiments have been performed in ternary intermetallic compounds $Nd_3Pd_{20}Ge_6$ and $Pr_3Pd_{20}Si_6$. $Nd_3Pd_{20}Ge_6$ exhibits the antiferromagnetic ordering on $8c$ site with the propagation vector Q = $\langle 111 \rangle$ below $T_{\rm N1}$ = 1.8 K, while $4a$ site ordered antiferromagnetically with the Q = $\langle 001 \rangle$ below $T_{\rm N2}$ = 0.5 K, respectively. We present the magnetic structure and H-T phase diagram of this compound. We also report the ground state and the crystalline electric field level scheme in $Pr_3Pd_{20}Si_6$ clarified by the neutron inelastic spectra obtained under magnetic field.

26CP89 Itinerant metamagnetic properties of MnSi under high pressures

Masaki Yamada[a], Tsuneaki Goto[a], Takeshi Kanomata[b]

[a] *Institute for Solid State Physics, University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa 277-8581, Japan*
[b] *Faculty of Engineering, Tohoku Gakuin University, Tagajo 985-8537, Japan*

Magnetization measurements of an itinerant d-electron magnet MnSi have been carried out under high pressures up to P =1.7 GPa, high magnetic fields up to B =9 T and low temperatures down to T =1.4 K. For P <1.2 GPa, the magnetic transition is of the second-order at the transition temperature T_c. It is changed to be of the first-order for 1.2 GPa< P <1.5 GPa. The magnetic order vanishes at the critical pressure P_c =1.54 GPa. A metamagnetic transition (MT) is observed for P ≥1.5 GPa. It is found that the temperature T_0, at which MT disappears, decreases with increasing pressure. Different types of magnetic phase diagrams of MnSi are determined in the three pressure ranges from these observed results.

26CP91 Ferromagnetic Carbon with Enhanced Curie Temperature

Vladimir N. Narozhnyi[a,b], Karl-Hartmut Müller[a], Dieter Eckert[a], Angelika Teresiak[a], Lothar Dunsch[a], Valerii A. Davydov[b], Ludmila S. Kashevarova[b], Alexandra V. Rakhmanina[b]

[a] *Institut für Festkörper- und Werkstofforschung Dresden e.V., 270116, D-01171 Dresden, Germany*
[b] *Institute for HighPressure Physics, Russian Academy of Sci., Troitsk, Moscow Reg., 142190, Russia*

The discovery of a ferromagnetic form of carbon [T.L. Makarova et al., Nature 413 (2001) 716] gives a new perspective in the investigation of magnetic materials. The existence of a ferromagnetic state with the very high Curie temperature $T_{\rm C} \approx 500$ K for a material with only s- and p-electrons as well as the nature of its underlying interaction are of great fundamental interest. Here we report on the observation of the ferromagnetically ordered state in a material obtained by high-pressure high-temperature treatment of the fullerene C_{60}. It has a saturation magnetization more than four times larger than that reported previously. From our data we estimated the considerably higher value of $T_{\rm C} \approx 820$ K.