SCOOTMO RESEARCH TRAINING NETWORK Newsletter 4

Coordinator's column

This is probably the final SCOOTMO newsletter, following on from the successful and enjoyable Zaragoza meeting. As co-ordinator, the network has been a rewarding experience, providing the opportunity to work with leading European groups and meet young scientists with a wide range of backgrounds. Judging by the volume and quality of publications, the network has had some success in generating collaborative work. It is particularly pleasing to see groups working together who had not done so prior to the network. The most recent meetings have particularly highlighted how new directions such as multiferroics have grown in importance since the network began operation.

As the network moves into its' concluding phase, I'd like to thank everyone who has been involved (YR's, local co-ordinators and research staff at all nodes) for making my job easier. I wish everyone the best of luck in the future, and look forward to working with many of you again.

Matt Rosseinsky
Liverpool.

Introduction.

The sixth and final meeting of the SCOOTMO Network was held on November 19th – 20th in Zaragoza (Spain). The Hotel Zaragoza Royal was chosen as the place for The Meeting, as it offered both good accommodation and a nice place for the presentation of the talks.

The meeting was attended by nineteen network members from all research centres involved in the project. The overall number of participants reached thirty persons, including the invited speakers, professors and PhD students from the Institute of Materials Science of Aragón and the Zaragoza University. During the meeting eleven talks were presented by the SCOOTMO Young Researchers. These were dedicated to recent progress and achievements in the research centres of the Network (see abstracts below). Participants had also the possibility to attend four invited lectures given by speakers from the University of Zaragoza and also from scientific groups all over the Europe, linked to the Zaragoza group through different projects and collaborations. The abstracts of these talks are given below, in the "Invited Lectures" section. The full presentation material can be downloaded from the official SCOOTMO web page: http://home.agh.edu.pl/~scootmo/ in the "Presentations" section.

Ricardo Ibarra, from the University of Zaragoza, presented the last talk of the first day. It was a very nice introduction to the visit to the laboratories of the CSIC - Zaragoza University Institute of Materials Science (ICMA), and to the laboratories of the Aragón Institute of Nanoscience of the Zaragoza University, at the end of the first session.

The scientific discussions took place not only during the official working time of the meeting, but also during night dinners during which the participants had occasion to try the modern as well as the more traditional Spanish cuisine.

For the free time a guided tour through the old town was organised. It was really good occasion to see at least a part of the city which history goes back to the Roman Emporium. During the three hours long trip we visited the Cathedral of San Salvador, Basilica Virgen del Pilar. We also saw the remains of the Roman Theatre and the roman city walls and lots of important city buildings, including one of the most beautiful examples of the mudejar architecture: the tower of Saint Magdalena.

Invited lectures.

The invited lectures were given by scientists working on different fields of materials science and its technological applications. The abstracts of these talks are given below.

Field effect experiments on transition metal oxides

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The class of oxide compounds with perovskite type crystal structure exhibit a broad range of functional properties, such as high dielectric permittivity, piezoelectricity and ferroelectricity, superconductivity, spin polarised current, colossal magnetoresistance and ferromagnetism. The isostructural nature of this class of materials allows creating “homo” epitaxial interfaces between different perovskites, which are in principle ideal in terms of structural quality; thereby, the physical properties of such interfaces are only determined by the coupling between the properties of the single components at nanoscale level. The strong interplay of crystal, charge and spin degrees of freedom as well as the correlated character of electronic behaviour in perovskites makes the physics of interfaces very complex and originates new microscopic physical mechanisms and new macroscopic physical properties.

The application of the field-effect approach to this kind of compounds other than semiconductors has created opportunities to electrostatically modulate types of correlated electron behaviour—including oxide semiconductors, high-temperature superconductivity and colossal magnetoresistance—and potentially tune the phase transitions in such systems. Here we provide an overview of different experiments in this field and discuss the opportunities brought by the field-effect approach.

Superconductivity and Ferromagnetism in Oxide Film Heterostructures and Superlattices

Prof. Dr. H-U. Habermeier

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Spin-polarized tunnellig with magnetic oxide electrodes and barriers

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Spintronics is based on the ability to exploit the spin degree of freedom and promises new logic devices with enhanced functionality, higher speeds and reduced power consumption. As a consequence, the search for highly

spin-polarized sources to be implemented in spintronics devices is an active field of research. Optimal materials intended for the fabrication of spintronics devices are the so-called half-metal ferromagnets, since they present a metallic character for one of the spin-direction and are insulating for the other, thus increasing the spin polarization of the current. Large spin polarizations are observed for different materials ($La_{2/3}Sr_{1/3}MnO_3$, Sr_2FeMoO_6, Co-doped (La, Sr)TiO_3 and conductive $NiFe_2O_4$) by performing magnetotransport in tunnel junctions. The extensive analysis of the dependence of the observed tunnel magnetoresistance on the electrode/barrier interface, applied bias voltage and temperature reveals fundamental aspects of the spin-dependent tunnelling physics. However, most of the expected half-ferromagnets cannot show all the potential due to the closeness of the ferromagnetic transition to room temperature. As an alternative, novel approaches to achieve highly spin-polarized current sources rely on the fabrication of heterostructures in which a ferromagnetic insulator ultra-thin film filters unpolarized electrons coming from a non-magnetic electrode. This is based on the spin-filter effect, i. e., on the fact that the carriers sense a different barrier height depending on their spin orientation as they cross through the barrier. The analysis of the magnetotransport properties of spin-filter devices based on ferromagnetic insulators, such as $La_xBi_{1-x}MnO_3$ or $NiFe_2O_4$ is reviewed. Finally, some new materials for spintronics, such as multiferroic materials are discussed.

Pulsed laser deposition of oxide epitaxial thin films.
Recent results on $Sr_4Fe_6O_{13}$

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In the first part of this presentation I explain the basics of Pulsed Laser Deposition (PLD) of thin films. The conceptual and practical simplicity of the technique in contrast to the underlying complex physics of laser-matter interaction and thin film growth is shown. Some examples are presented of the important changes in the properties of epitaxial thin films and multilayers related to those of bulk materials. The role of epitaxial strain is stressed.

In the second part I present recent results obtained on epitaxial thin films of the mixed ionic-electronic conductor $Sr_4Fe_6O_{13\pm\delta}$. This compound, with perovkiste-related layered structure, modifies its oxygen content and superstructure as a mechanism for the relaxation of epitaxial strain [1]. Also, the total conductivity of $Sr_4Fe_6O_{13\pm\delta}$ thin films shows a strong dependence on thickness, most probably due to the effect of epitaxial strain [2].

[1] J. SANTISO *et al.*, *Applied Physics Letters* **86** (2005) 132105
[2] J. A. PARDO *et al.*, *Solid State Ionics* (in press)

Young Researchers contributions.

The Young Researchers presentations constituted the main part of the meeting. These were concentrated on progress in the different groups of the Network. The results of recent studies have been presented, and also the perspectives for the future have been pointed out. All of the talks have been widely commented and discussed by the participants. The abstracts provided by the speakers can be found below.

Research of new multiferroics : the $Bi_2Mn_{3/4}Ni_{2/3}O_6$ compound

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We presented the study performed on a polar oxide with a large magnetization synthesized at ambient pressure: the $Bi_2Mn_{4/3}Ni_{2/3}O_6$ oxide.
Multifunctional systems are an important current focus in materials researchdue to the fundamental and technological opportunities arising from coupling of distinct order parameters. For example, ferromagnetic ferroelectrics permit magnetic control of electrical polarization and associated multiple state memory applications. The design of materials with both ferroelectric polarization and ferromagnetic magnetization is complicated but a strategy to overcome this is to decouple the metal centers responsible for ferroelectricity and ferromagnetism by using separate ions to produce the required ordering.

The initial target was the composition Bi_2MnNiO_6, but the reaction of Bi_2O_3, MnO_2, and NiO in air at ambient pressure only stabilises the $Bi_2Mn_{4/3}Ni_{2/3}O_6$ composition, corresponding to a B-site occupied by 33% Mn^{4+}, 33% Mn^{3+}, and 33% Ni^{2+}. The TEM study showed that this oxide crystallise in the $Pn2_1m$ space group with a≈5.5Å, b≈11.2Å and c≈15.5Å. The structure was solved by synchrotron single-crystal X-ray diffraction data collected on a 20 μm fragment cut from a flux-grown single crystal, which confirm the non polar symmetry. Synchrotron powder data reveal the structure to be slightly incommensurate due to a two-dimensional modulation with refined modulation vectors. The polarization arises from lone-pair-driven cooperative displacements of the Bi atoms away from the centroids of their oxygen coordination polyhedra along the *b* axis. The structure analysis was confirmed by constrained refinement of neutron powder diffraction data which revealed an essentially random Mn/Ni distribution over the four symmetry independent octahedral sites. The substitutional disorder between Mn and Ni on the magnetically active B site has a decisive effect on the physical properties.

The ac susceptibility has a frequency dependent maximum in χ' below 35K, while the 2K field-cooled dc magnetization isotherm revealed a displaced hysteresis loop with a magnetization of 3.38μB per $Bi_2Mn_{4/3}Ni_{2/3}O_6$ formula unit at 5.5T. Neutron powder diffraction at 2K reveals no magnetic Bragg scattering. These data are consistent with the material behaving as a large magnetization concentrated spin glass below 35 K with an important role played by locally ferromagnetic Mn^{4+}/Ni^{2+} interactions. The absence of ferromagnetic long-range order can be associated with the influence of the extensive B-site disorder and the resulting antiferromagnetic Ni^{2+}/Ni^{2+} e_g^2-e_g^2 and Mn^{4+}/Mn^{4+} t_{2g}^3-t_{2g}^3 superexchange couplings. The ac impedance spectra reveal a broad, structured peak in the real part of the dielectric permittivity in the 150-240°C temperature range, consistent with a ferroelectric like transition from the polar room-temperature structure to a non polar high-temperature structure, confirmed by temperature dependent X-ray powder diffraction data, which reveal a x2*a*p, x2*a*p, 2*a*p cell at higher temperature.

What's new in Caen?

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In the search of the control of magnetic/electric properties by electric/magnetic field, i.e.: magnetoelectric effect, some different materials have been studied.

Hexagonal rare earth manganites present ferroelectric (T_c~800K) and antiferromagnetic (T_c~80K) order, belonging to the so-called multiferroic materials. Our studies in a single crystal of $YMnO_3$ show a small magnetocapacitive effect also present in the paramagnetic phase, showing that magnetic order is not essential for this effect.

Other insulators like orthorhombic $RMnO_3$ or $Ni_3V_2O_8$ present an incommensurate magnetic order that brokes inversion symmetry leading to a polarization. In this compounds magnetic and ferroelectric orders take place at the same temperatures. Magnetocapacitive effect in $Ni_3V_2O_8$ has been studied showing positive and negative effects one order of magnitude bigger than YMnO3.

Synthesis of $Ca_3Co_2O_6$ doped with scandium.

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The compound $Ca_3Co_2O_6$ has been extensively studied for its very interesting physical properties, especially for its high thermoelectric power. Its crystalline structure is formed of chains of prisms and octahedras containing Co^{3+}: high spin cobalt in the prisms and low spin cobalt in the octahedras. Previous neutron diffraction studies evidenced a magnetic coupling of Co^{3+} HS leading to a ferromagnetic ordering inside the chains. It has also been shown that a ferrimagnetic ordering exists between the chains. In the present work, our purpose was to dope this compound by a very low content of scandium ($0.005 \le x \le 0.1$) in order to break the ferro- and/or the ferromagnetic coupling and to understand their propagation into the structure. As the doping content is very low, we choose the sol-gel method to synthesize our samples. It has been shown by x-ray diffraction and transmission electron microscopy that the sol-gel method leads to a high quality sample. This work is a collaboration with the CRISMAT laboratory in Caen for the physical properties characterization.

A thermodynamic model to describe phase separated behaviour in $Pr_{0.46}Sr_{0.5}Mn_{0.96}Cr_{0.04}O_3$

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The compound $Pr_{0.44}Sr_{0.56}MnO_3$, which belongs to the group of manganese perovskites, exhibits a stable antiferromagnetic phase up to 30 T of external field, with a transition to the paramagnetic phase at 217 K. With a small Cr doping at the Mn site a phase separated state occurs in which minor ferromagnetic regions form within the antiferromagnetic matrix. For an amount of 4% Cr doping the compound exhibits an interesting behaviour: the field induced steps occur in the magnetisation as well as in the resistivity. These steps are reproducible, but occur only at temperatures below 5 K. This behaviour shows similarities to martensitic type transformations, but it is still not fully understood.

In order to obtain a better understanding from a macroscopic point of view, the magnetization relaxation measurements in time interval from 10 s to 10^5s were performed and the data were analysed using a dynamic model which was recently suggested for $La_{5/8-y}Pr_yCa_{3/8}MnO_3$ by Ghivelder et al (PRB 71, 184425, 2005) and further developed by Sacanell et al. (to be published in PRB). This model is based on the assumption that the phase separated system is generally far from equilibrium and does not reach equilibrium within the measurement. This means that the change of the fraction of the two coexisting phases slows down the closer the system is to the equilibrium fraction. With this approach the Ghivelder group was successful in simulating the magnetisation versus temperature curves, measured on $La_{5/8-y}Pr_yCa_{3/8}MnO_3$ under different cooling and heating regimes. In analogy to the findings on $La_{5/8-y}Pr_yCa_{3/8}MnO_3$ the present measurements indicate a blocked metastable state in $Pr_{0.46}Sr_{0.54}Mn_{0.96}Cr_{0.04}O_3$ at temperatures below 10 K. This result shows that the model can be applied to various phase separated materials.

Magnetic effects of trivalent doping (La and Nd) at the Sr site in Sr_2CrReO_6

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The presentation during previous Meeting introduced the spin electronics as a field in which the double perovskites family compounds can be widely used and the interest of these compounds in themselves. In this presentation our results on the $Sr_{2-x}Ln_xCrReO_6$ (Ln being La and Nd, and x=0.1, 0.2, 0.3, 0.5) series are presented. Substitution of divalent Sr ion with divalent La or Nd ions results in electron doping of the compound and the existence of steric effects. Presented data contain both low and high temperature magnetization measurements. On this basis we conclude about the doping influence on the ferromagnetic to paramagnetic transition temperature (T_C) and the maximum magnetization. DC measurements supported by the AC susceptibility experiments in high temperatures range (up to 800K) give us the idea about the domain wall dynamics and the relaxation processes appearing around the transition temperature. The SEM (EDAX) experiment results are also included in the presentation. Those are used to investigate the microstructure of the samples, their chemical composition and prove their quality. We present some results on the actual stoichiometry of the samples based on the EDAX experiment. On the basis of the simple ionic model of the CrRe double perovskites and the above mentioned EDAX results, the comparison of calculated and measured magnetization values is done. Finally, our future plans of experiments necessary to give the full characterization of our samples series are presented. These include XANES, EXAFS, neutron powder diffraction and transport measurements.

Structural and Magnetic Properties of ACr_3O_8 family

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XAS study of $LaMn_{1-x}Co_xO_3$ compounds

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A systematic study of $LaMn_{1-x}Co_xO_3$ perovskite series by means of X-ray Absorption Spectroscopy in the near-edge range and in the EXAFS range is reported. The compounds belong to the family of manganites and cobaltites, which reveal exciting magnetic and transport properties resulting from the competition of the lattice, charge, spin and orbital degrees of freedom. $LaMnO_3$ is an insulator of orthorhombic structure, which becomes antiferromagnetic below the Neel temperature of 140K. Mn is of 3+ valence and a high-spin (HS) state ($3d^4$ configuration, S = 2). $LaCoO_3$ crystallizes in a rhomboedral structure and is a diamagnetic insulator at low temperatures with a low-spin (LS) state of Co^{3+} ($3d^6$, S = 0). It undergoes a transition from LS to the intermediate spin (IS) at about 100K.

$LaMn_{1-x}Co_xO_3$ solid solution has recently attracted a considerable interest due to the appearance of a ferromagnetic (FM) ground state. However, there exist controversies on the Mn and Co ordering as well as on the valence and spin-states of these two cations and their temperature dependence. Goodenough et al. concluded in their early work that the super-exchange interaction between Mn^{3+} ions is likely to be responsible for the FM state for $0 < x < 0.5$ when static Jahn-Teller distortions are removed [1]. Blasse associated the FM interaction in the $LaMn_{0.5}Co_{0.5}O_3$ compound with the super-exchange between stabilized Co^{2+} and Mn^{4+} pairs [2]. Park et al. argued that the FM coupling results from the Mn^{3+}/Mn^{4+} coexistence but only rigid Co^{2+} valence state was assumed and observed [3]. Recent works discussed magnetic properties of $LaMn_{1-x}Co_xO_3$ in terms of competition between a positive Mn^{3+}-O-Mn^{4+}, Mn^{3+}-O-Mn^{3+}, Mn^{4+}-O-Co^{2+} and a negative Mn^{4+}-O-Mn^{4+}, Co^{2+}-O-Co^{2+}, Mn^{3+}-O-Co^{2+} super-exchange interactions, considering also a tendency to Co^{2+} and Mn^{4+} ionic ordering of the NaCl type. However, the most recent systematic neutron and magnetic data conclude the necessity of the Co^{2+}/Co^{3+} coexistence.

In order to clarify the existing discrepancies between models of magnetic interactions in $LaMn_{1-x}Co_xO_3$ a detailed study of valence states of Co and Mn has been performed by means of XAS in the near-edge range (XANES). Measurements at the K edges of Mn and Co have been carried out at the A1 beamline at HASYLAB/DESY, Hamburg. Polycrystalline powder samples of $LaMn_{1-x}Co_xO_3$ (x = 0.2; 0.4; 0.5; 0.6; 0.8, 1.0) prepared by solid state reaction and sol-gel method were measured at room temperature. The K-edges of both, manganese and cobalt, show a gradual shift to higher energies on increasing Co doping level. The analysis performed using reference samples indicates existence of mixed states of Mn^{3+}/Mn^{4+} and Co^{2+}/Co^{3+} as well as the exact nominal oxygen stoichiometry in doped samples. From the chemical shift in the K-edges spectra the averaged values of the Mn and Co oxidation states have been derived. The $L_{2,3}$-edges of manganese reveal systematic a change of density of Mn(3d) states with doping. The latter results were analysed by means of linear combination of Mn^{4+} and Mn^{3+} spectra obtained from the reference samples of MnO_2 and Mn_2O_3. The results of the two analyses are consistent and prove the existence of Co^{2+}/Co^{3+} and Mn^{3+}/Mn^{4+} mixed states. The evolution of oxygen K-edge with doping also confirms the presence of mixed valence states of cobalt and manganese in the series of the compounds studied.

The analysis of the EXAFS spectra was carried out with the FEFF8 computer program. In the Fourier transform the next neighbour oxygen shell for cobalt spectra shows a decrease of the distance from the central ion with increasing Co doping x. This corresponds to an increased oxidation level of both 3d ions and is consistent with XANES data. Same results were obtain also for Co spectra in temperature T=77K. Debey-Waller factor from cobalt spectra was determined for room temperature and for temperature 77K. There is mainly static origin of disorder in the sample. A relation of the results to the magnetic and transport properties of the materials is discussed.

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Evidence for electronic phase separation between orbital orderings in $SmVO_3$

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The phenomenon of electronic phase separation has been most widely studied in e_g-electron systems such as the "colossal magnetoresistance" manganites, where *orbitally ordered and disordered phases* often coexist. We have discovered a novel type of phase separation in the t_{2g}-electron system $SmVO_3$, involving the coexistence of *two orbitally ordered phases* of different symmetry below ~115 K. Magnetic exchange striction at this temperature induces a change in symmetry of the orbital ordering. However, the difference in unit cell volumes of the two phases gives rise to strain fields in transformed regions of the sample, which inhibit the phase transition taking place to completion throughout the rest of the sample. These lattice strains then stabilise a coexistence of the two types of orbital ordering down to low temperature

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Physical Properties of Bi -Manganites with $Mn^{4+} \geq 30\%$

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The bismuth based manganite perovskites $Bi_{1-x}Sr_xMnO_3$ have been recently identified as systems with an unusually high temperature of charge ordering (T_{CO}) [1-2]. The aim of this work is to examine magnetic properties (DC-susceptibility, magnetisation at 10 K), transport properties (electrical resistivity, thermopower) and the specific heat in temperature range 2.2 – 900 K of compounds $Bi_{1-x}Sr_xMnO_3$ (x = 0.3, 0.5, 0.8), cubic and hexagonal $SrMnO_3$ respectively in order to search temperatures of magnetic (T_N) and charge (T_{CO}) ordering. The main attention has given to the analysis of the specific heat to correlate transport and magnetic properties. We obtained Debye tepemratures from the fit of the low-temperature part of the specific heat ($T \leq 12$ K) in the range 240 – 480 K, which are in good agreement with the values published for the manganite perovskites. The temperature dependence of the lattice contribution to the specific heat in the high temperature region ($T \geq 20$ K) was approximated by superposition of Debye and Einstein equations with three Debye and 12 Einstein discrete vibration modes. The values of characteristic Einstein temperatures are in accordance with Raman spectra published for manganites. Proper estimation of the lattice contribution allowed us to get the contribution of charge and magnetic ordering (C_{exc}). The values of entropies connected with charge and magnetic ordering are obtained by numerical integration of C_{exc}/T dependence.

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Magnetic Correlation in Bilayer Manganite $Ca_{2.5}Sr_{0.5}GaMn_2O_8$: Crossover from Short-range 2D to Long-range 2D to Long-range 3D.

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From previous magnetic studies of neutron diffraction, magnetic susceptibility and μSR spectroscopy on the naturally layered-structure compound $Ca_{2.5}Sr_{0.5}GaMn_2O_8$, the existence of two-dimensional magnetic correlations just above the Neel temperature (~ 150 K) was proposed by Peter D. Battle *et al.* [J. Phys.: Condens. Matter **14**

(2002) 13569]. We have performed a careful neutron diffraction study over 250 – 5 K on the same compound (obtained from Dr. M. J. Rosseinsky and Dr. Peter D. Battle) using the G6-1 powder neutron diffractometer with a wavelength of 4.741 Å at LLB, France based on our accepted proposal within the European NMI3 proposal scheme. Our aim was to determine the dimensionality of the magnetic correlations present, the correlation length and also to study the possible crossover between two-dimensional and three-dimensional magnetic ordering.

We measured the diffraction patterns at 5, 70, 125, 140, 145, 150, 155, 157.5, 160, 162.5, 165, 167.5, 170, 175, 180, 185, 190, 195, 200, 205, 210, 215, and 250 K with good counting time. We were able to resolve magnetic peaks such as (100) and (001), and (110) and (011) which could not be resolved in previous neutron diffraction measurements carried out using the GEM diffractometer at ISIS, UK by Peter D. Battle *et al.* [J. Phys.: Condens. Matter **14** (2002) 13569].

The temperature-dependent diffraction study has allowed us to establish that a short-range 2D antiferromagnetic correlation between Mn spins develops in the *ac* plane around 190 K. With decreasing temperature it gradually transforms to a 2D long-range correlation. A clear saw tooth type Bragg peak has been observed over 160–165 K indicating a pure 2D long-range nature of the Mn spins in the *ac* plane. With further decreasing of temperature the 2D long-range antiferromagnetic correlation gradually disappears and a 3D long-range antiferromagnetic correlation develops over 150–160 K. At $T < 150$ K only a pure 3D long-range antiferromagnetic correlation is found as already observed by Dr. M. J. Rosseinsky and co-workers [Peter D. Battle *et al.*, J. Phys.: Condens. Matter **14** (2002) 13569].

NMR and XAS studies of Fe-Mo double perovskites

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Mössbauer study of perovskites

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New people in the Network.

During last year three new persons joined the Network. They have entered the groups of Oslo, Prague and Zaragoza. For two of them the first meeting was the one held in Oslo, as they joined the SCOOTMO project in January 2005. The most recent member of the Project (Michaela Kuepferling) joined us in September 2006, so the Zaragoza meeting was her first meeting. A short biographical note of these three persons, is given below.

Nicolas Créon

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Nicolas Créon was born in Brive-la-Gaillarde. He went in Limoges to study chemistry at the University and obtained a master degree in Material Sciences in 2001. In 2004, he finished a PhD in Material Chemistry in Caen, supervised by Maryvonne Hervieu. His thesis was devoted to the synthesis and the characterization of complex transition metal oxides. The materials studied presented cationic or anionic ordering described by the modulated or composite approach. He is proficient in various synthesis methods, transmission electron microscopy, x-ray and neutron diffraction. In January 2005, Nicolas Créon joined the group of Helmer Fjellvåg in the University of Oslo as research fellow.

Michaela Kuepferling

Institute of Physics of the Academy of Science in Praha, Czech Republic.

Michaela Kuepferling graduated from the University of Technology in Vienna, Austria. Her PhD studies were performed in the field of hard magnetic materials at the Department of Solid State Physics. This period included a training in preparation of magnetic materials of three months at the materials research center CIMAV in Chihuahua, Mexico, and a training in electron structure calculations of two weeks at the Institute of Physics of the Academy of Science in Praha, Czech Republic. The thesis with the title "Rare Earth substituted Hexaferrites" was successfully defended in July 2005. From September 2005 to November 2005 she was working as Post Doc within the SCOOTMO project at the Institute of Physics of the Academy of Science in Praha, Czech Republic, in the field of phase separated manganese perovskites. Since December 2005 she has a Post Doc position at the IEN, Torino, Italy, working on soft magnetic materials and the magnetocaloric effect.

Jan Michalik

Instituto de Ciencia de Materiales de Aragón, CSIC-Universidad de Zaragoza, Facultad de Ciencias.

Jan Michalik was born in 1980 in Krakow, Poland where he spent his childhood.
He studied at the AGH –University of Science and Technology in Cracow, and received a MSc degree in physics in 2004. His degree work at Faculty of Physics and Nuclear Techniques was based on the investigation of hyperfine interactions on ^{119}Sn nuclei in $(La_{0.67}Ca_{0.33})(Mn_{0.99}Sn_{0.01})O_6$ probed by Mossbauer spectroscopy.
Soon after he got married to Monika and for short time they lived happily together in their hometown.
He continued his work in Cracow as a PhD student for half a year. In January 2005 he have left Cracow and joined the Zaragoza research group as a PhD student. His work in the group is connected with investigation on the double perovskites family compounds, namely Sr_2CrReO_6, with different level of electron doping. Moreover he is taking various doctorate courses on the solid state physics and magnetism, as well as some complementary courses.