Faculty of Physics, Adam Mickiewicz University
Institute of Molecular Physics, Polish Academy of Sciences

The European Conference
PHYSICS OF MAGNETISM 2011 (PM'11)

ABSTRACTS

Poznań, 2011

The European Conference
PHYSICS OF MAGNETISM 2011 (PM'11)
June 27-July 1, 2011
Poznań, Poland
Abstracts

Edited by: R. Micnas, B. Idzikowski, R.J. Wojciechowski, A. Szajek

The abstracts are reproduced as received from authors

Copyright © Institute of Molecular Physics, Polish Academy of Sciences
Faculty of Physics, Adam Mickiewicz University
Poznań, 2011
All rights reserved

ISBN 83-922407-6-6

Published by: Institute of Molecular Physics
Polish Academy of Sciences
M. Smoluchowskiego 17, 60-169 Poznań
phone: +48 61 8695 100; fax: +48 61 8648 524

Technical edition: Z. Śniadecki, M. Werwiński

Printed by: TOTEM S.C.
Jacewska 89, 88-100 Inowrocław, Poland

The European Conference
PHYSICS OF MAGNETISM 2011 (PM'11)

June 27-July 1, 2011
Poznań, Poland

CHAIRMEN

R. Micnas, Faculty of Physics, Adam Mickiewicz University
B. Idzikowski, Institute of Molecular Physics, Polish Academy of Sciences

PROGRAMME COMMITTEE

J. Barnaś, Poznań, Poland
O. Eriksson, Uppsala, Sweden
R. Gałązka, Warszawa, Poland
A. Jezierski, Poznań, Poland
J.A. Morkowski, Poznań, Poland
H. Puszkarski, Poznań, Poland
J. Slonczewski, Yorktown Heights, USA
P. Thalmeier, Dresden, Germany
H. Zabel, Bochum, Germany
E. Bauer, Vienna, Austria
M. Farle, Duisburg, Germany
B. Heinrich, Burnaby, Canada
D. Kaczorowski, Wrocław, Poland
A.M. Oleś, Kraków, Poland
S. Sanvito, Dublin, Ireland
F. Steglich, Dresden, Germany
C. Van Haesendonck, Leuven, Belgium
V. Cros, Palaiseau, France
M. Fiebig, Bonn, Germany
V. Janiš, Prague, Czech Republic
S. Krompiewski, Poznań, Poland
P. Prelovšek, Ljubljana, Slovenia
A. Ślebarski, Katowice, Poland
F. Stobiecki, Poznań, Poland
D. Vollhardt, Augsburg, Germany
V. Zlatić, Zagreb, Croatia

ADVISORY COMMITTEE

J. Baszyński, Poznań, Poland
K. Byczuk, Warszawa, Poland
J.C. Gómez Sal, Santander, Spain
J. Kossut, Warszawa, Poland
T. Mito, Hyogo, Japa
B. Rellinghaus, Dresden, Germany
J. Sznajd, Wrocław, Poland
R. Troć, Wrocław, Poland
M. Brando, Dresden, Germany
R.A. Cowley, Oxford, U.K.
D. Khomskii, Köln, Germany
L. Kowalewski, Poznań, Poland
M.C. Muñoz, Madrid, Spain
S. Robaszkiewicz, Poznań, Poland
H. Szymczak, Warszawa, Poland
J. Wróbel, Warszawa, Poland
B. Bułka, Poznań, Poland
R. Czajka, Poznań, Poland
M. Klaeui, Konstanz, Germany
J. Martinek, Poznań, Poland
M. Reiffers, Kosice, Slovakia
T. Ślęzak, Kraków, Poland
A. Szytuła, Kraków, Poland
M. Zwierzycki, Poznań, Poland

ORGANIZING COMMITTEE

R.J. Wojciechowski, A. Szajek (*secretaries*)

B. Andrzejewski, E. Długaszewska, I. Gościańska, P. Grzybowski, A. Kowalczyk, S. Lipiński, T. Luciński, G. Musiał, A. Pawlak, M. Pugaczowa-Michalska, P. Skusiewicz, Z. Śniadecki, **T. Toliński** (*treasurer*), M. Urbaniak, M. Werwiński

PUBLICATIONS

J. Barnaś, J. Dubowik, M. Thomas, M. Bąk

SPONSORS

INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

spinLAB

EUROPEAN UNION
EUROPEAN REGIONAL
DEVELOPMENT FUND

Faculty of Physics, Adam Mickiewicz University

Institute of Molecular Physics of the Polish Academy of Sciences

Committee of Physics of the Polish Academy of Sciences

Rector of the Adam Mickiewicz University

Program „Akademicki Poznań”

European Physical Society

SCHEDULE

Monday, June 27, 2011

14^{00}- 14^{30} **OPENING**
R. Micnas, B. Idzikowski

S.1 RECENT DEVELOPMENTS IN SPINTRONICS AND MAGNETIC SEMICONDUCTORS
Chairmen: R. Micnas, B. Idzikowski

14^{30}- 15^{00} **P. GRÜNBERG** Forschungszentrum Jülich GmbH, Jülich, Germany
From World Energy Problems to Giant Magneto Resistance and Spin Torque

15^{00}-15^{30} **A. THIAVILLE** CNRS-Université Paris-sud, Orsay, France
Domain Wall Dynamics under Short Current Pulses: Spin-Transfer Torque and Other Effects

15^{30}-16^{00} **J.K. FURDYNA** Department of Physics, University of Notre Dame, USA
Exchange Coupling in Magnetic Semiconductor Multilayers and Superlattices

16^{00}-16^{30} coffee break

S.2 NEW DIRECTIONS IN STRONGLY CORRELATED MATTER
Chairman: S. Robaszkiewicz

16^{30}-17^{00} **M. TROYER** Institut für Theoretische Physik, ETH Zürich, Zürich, Switzerland
Antiferromagnetism and Ferromagnetism of Fermionic Atoms in Optical Lattices

17^{00}-18^{45} **PARALLEL ORAL SESSIONS**
O.1 STRONGLY CORRELATED ELECTRONS AND HIGH TEMPERATURE SUPERCONDUCTIVITY
Chairman: S. Robaszkiewicz
Extended presentation: O-1-11 (A.M. Oleś)
Short presentations: O-1-12, O-1-01, O-1-13, O-1-10, O-1-15

O.2 SPIN ELECTRONICS AND MAGNETO-TRANSPORT
Chairman: S. Krompiewski
Extended presentation: O-4-06 (H.J.M. Swagten)
Short presentations: O-4-02, O-6-01, O-7-03, O-8-01, O-6-06

19^{00}- **WELCOME PARTY**

Tuesday, June 28, 2011

S.2 NEW MAGNETIC MATERIALS
Chairman: A.M. Oleś

9^{00}- 9^{30} **G.A. SAWATZKY** Max Planck-UBC Centre for Quantum Materials
University of British Columbia, Vancouver, Canada
New Magnetic Materials Based on Defects, Anion Substitution, Interfaces and Doping

9^{30}-10^{00} **R.K. KREMER** Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany
The Spin-1/2 Frustrated Helicoidal Antiferromagnetic Multiferroic System $LiCuVO_4$: Recent Results

10^{00}-10^{30} **P. HORSCH** Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany
Spin-Orbital Physics And Defect States In Doped Vanadates: $Y_{1-x}Ca_xVO_3$

10^{30}-11^{00} **I. ŠKORVÁNEK** Institute of Experimental Physics
Slovak Academy of Sciences, Košice, Slovakia
Recent Progress in FeCo-Based Soft Magnetic Nanocrystalline Alloys

11^{00}-11^{30} coffee break

S.3 SPIN ELECTRONICS
Chairman: H. Szymczak

11^{30}-12^{00} **S. MAEKAWA** Advanced Science Research Center (ASRC) and
Japan Atomic Energy Agency (JAEA), Tokai, Japan
Spin-Wave Spin-Current and Spin Seebeck Effect

12^{00}-12^{30} **M. PRZYBYLSKI** Max-Planck-Institut für Mikrostrukturphysik, Halle, Germany
Quantum Well States and Oscillatory Magnetic Anisotropy in Ultrathin Fe Films

12^{30}-13^{00} **L.W. MOLENKAMP** Physikalisches Institut (EP3)
Julius-Maximilians-Universität Würzburg, Germany
Dirac Fermions in HgTe Quantum Wells

13^{00}-14^{30} lunch break

14^{30}-16^{15} **PARALLEL ORAL SESSIONS**

O.3 NANOSTRUCTURES, SURFACES, AND INTERFACES
Chairman: B. Bułka
Extended presentation: O-5-12 (A. Ehresmann)
Short presentations: O-5-07, O-5-04, O-5-01, O-5-08, O-5-06

O.4 QUANTUM AND CLASSICAL SPIN SYSTEMS
Chairman: A. Jezierski
Extended presentation: O-6-04 (H. Szymczak)
Short presentations: O-6-05, O-2-08, O-2-06, O-2-01, O-2-03

16^{15}-16^{45} coffee break

16^{45}-18^{15} **POSTER SESSION I** (categories: 1, 4, 5)
Chairmen: A. Ehresmann, P. Horsch, S. Lipiński, M. Przybylski, K.I. Wysokiński
(Members of the PM'11 BEST POSTER AWARD Jury)

Wednesday, June 29, 2011

S.4 SPIN ELECTRONICS AND MAGNETO-TRANSPORT
Chairman: J. Barnaś

9^{00}- 9^{30} **H. OHNO** Center for Spintronics Integrated Systems and Laboratory for Nanoelectronics and Spintronics, Research Institute of Electrical Communication, Tohoku University, Sendai, Japan
Spin dynamics in nanoscale systems

9^{30}-10^{00} **T. DIETL** Institute of Physics, Polish Academy of Sciences and Institute of Theoretical Physics, University of Warsaw, Poland
Ferromagnetic Semiconductors at the Boundary of Holes' Localization

10^{00}-10^{30} **F. ALIEV** Dpto. Física de la Materia Condensada, C03 Universidad Autónoma de Madrid, 28049 Madrid, Spain
Conductance and Noise in Fully Epitaxial Magnetic Tunnel Junctions

10^{30}-11^{00} **C. LAMBERT** Department of Physics, Lancaster University, Lancaster, UK
Molecular-Scale Electronics and Mechanical Analogues of Spin Torques

11^{00}-11^{30} coffee break

S.5 LOW DIMENSIONAL QUANTUM MAGNETISM
Chairman: H. Puszkarski

11^{30}-12^{00} **D.A. TENNANT** Helmholtz-Zentrum Berlin für Materialien und Energie Institute for Complex Magnetic Materials, Berlin, Germany
Twists, Symmetries, and Topology in Quantum Magnetism

12^{00}-12^{30} **U.K. RÖßLER** Leibniz Institute for Solid State & Materials Research Dresden, Germany
Skyrmionic Matter - a New Type of Magnetic Order

12^{30}-13^{00} **H.T. DIEP** Laboratoire de Physique Théorique et Modélisation Université de Cergy-Pontoise, Cergy-Pontoise, France
Spin Resistivity in Magnetic Materials

13^{00}-13^{30} **G. KAMIENIARZ** Faculty of Physics, A. Mickiewicz University, Poznań, Poland
Anisotropy, Geometric Structure and Frustration Effects in Molecule-Based Nanomagnets

13^{30}-15^{00} lunch break

15^{00}-16^{45} **PARALLEL ORAL SESSIONS**
O.5 STRONGLY CORRELATED ELECTRONS AND HIGH TEMPERATURE SUPERCONDUCTIVITY
Chairman: J. Baszyński
Extended presentation: O-1-07 (B. Dąbrowski)
Short presentations: O-1-03, O-1-06, O-1-09, O-1-16, O-1-17

O.6 MAGNETIC STRUCTURE AND DYNAMICS

Chairman: R. Czajka

Extended presentation: O-3-14 (J. Martinek)

Short presentations: O-3-12, O-3-09, O-3-07, O-3-10, O-3-11

16^{45}-17^{15} coffee break

SESSION OF SCIENTIFIC EXHIBITIORS

Chairmen: B. Andrzejewski, M. Urbaniak

17^{15}-17^{40} **AM Technologies**

Electronic Measurement Equipment Available from Agilent Technologies

17^{40}-18^{05} **LOT-Oriel**

Instruments for Magnetic Measurements

18^{05}-18^{30} **Kurt J. Lesker Company**

The Kurt J. Lesker Company: Global Vacuum Solutions Provider;
An Overview of the Global Company and its Offerings

19^{00}- **CONCERT**

Thursday, June 30, 2011

S.6 SUPERCONDUCTIVITY, STRONGLY CORRELATED SYSTEMS AND HEAVY FERMIONS
Chairman: L. Kowalewski

9^{00}- 9^{30} **J. SPAŁEK** Institute of Physics, Jagiellonian University, Kraków, Poland
Superconductivity in Strongly Correlated Systems and Comparison to Experiment

9^{30}-10^{00} **K.I. WYSOKIŃSKI** Institute of Physics, M. Curie-Skłodowska University Lublin, Poland
Impurities and Correlations in the Boson-Fermion Model of Superconductors

10^{00}-10^{30} **M.M. MAŚKA** Institute of Physics, University of Silesia, Katowice, Poland
Mutual Enhancement of Magnetism and Fulde-Ferrell-Larkin-Ovchinnikov Superconductivity in $CeCoIn_5$

10^{30}-11^{00} **K.W. BECKER** Institut für Theoretische Physik
Technische Universität Dresden, Germany
Heavy Fermion Properties in the Kondo Lattice Model

11^{00}-11^{30} coffee break

S.7 SUPERCONDUCTIVITY AND MAGNETISM
Chairman: J.A. Morkowski

11^{30}-12^{00} **K. ROGACKI** Institute for Low Temperature and Structure Research
Polish Academy of Sciences, Wrocław, Poland
Critical Currents of Feas Based Superconductors in High Magnetic Fields: Hopes for Large Scale Applications

12^{00}-12^{30} **R. PUŹNIAK** Institute of Physics, Polish Academy of Sciences
Warszawa, Poland
Anisotropy of Superconducting State Properties in Cuprates, MgB_2, and Pnictides

12^{30}-13^{00} **D.J. SINGH** Materials Science and Technology Division
Oak Ridge National Laboratory, Oak Ridge, USA
Magnetism and Superconductivity in Iron Pnictides

13^{00}-14^{30} lunch break

14^{30}-16^{00} **POSTER SESSION II** (categories: 2, 3, 6, 7, 8)
Chairmen: A. Ehresmann, P. Horsch, S. Lipiński, M. Przybylski, K.I. Wysokiński
(Members of the PM'11 BEST POSTER AWARD Jury)

16^{00}-17^{00} **BUS TRANSPORTATION TO ROGALIN**

17^{00}-18^{30} **VISIT TO ROGALIN PALACE**

18^{30}- **BANQUET**

Friday, July 1, 2011

S.8 MAGNETIC NANOSTRUCTURES
Chairman: F. Stobiecki

9^{00}- 9^{30} **A. BARTHÉLÉMY** Université Paris-Sud, CNRS/Thales, Palaiseau, France
Towards an Electric Control of Spintronics Devices

9^{30}- 10^{00} **A. MAZIEWSKI** Faculty of Physics, University of Białystok Białystok, Poland
Engineering of Magnetic and Magnetooptical Properties of Co Based Nanostructures

10^{00}- 10^{30} **C.H. BACK** Faculty of Physics, University Regensburg, Regensburg, Germany
Non Local Magnetization Dynamics Due to Spin Pumping

10^{30}-11^{00} **J.-M. GRENÈCHE** Université du Maine, Le Mans, France
Surfaces and Grain Boundaries in Magnetic Nanostructures

11^{00}-11^{30} coffee break

S.9 KONDO SYSTEMS, HEAVY FERMIONS AND MAGNONIC CRYSTALS
Chairman: D. Kaczorowski

11^{30}-12^{00} **B. COQBLIN** Laboratoire de Physique des Solides Université Paris-Sud, Orsay, France
Kondo Lattice Models for Rare-Earth and Actinide Systems

12^{00}-12^{30} **T. TOLIŃSKI** Institute of Molecular Physics Polish Academy of Sciences, Poznań, Poland
From Heavy Fermion and Spin-Glass Behavior to Magnetic Order in CeT_4M Compounds

12^{30}-13^{00} **G. GUBBIOTTI** CNISM - Dipartimento di Fisica, Universita di Perugia, Perugia, Italy
Spin Wave Propagation Properties in Planar Magnonic Crystals

13^{00}-13^{30} **SUMMARY and CLOSING**

13^{30}-15^{00} lunch

Professor dr. hab. Bogdan Fechner (1930–2009)

We regret to inform that **Professor Bogdan Fechner**, one of the main initiators of PM conferences (along with Professor Janusz Morkowski) and co-chairman of our meetings in 1975, 1978, 1981, 1984, 1987, 1990, will no longer be with us as he has passed away on December 26, 2009.

His remembrance will be commemorated in the conference volume of ***Acta Physica Polonica* A** (issue 1, 2012).

Chairmen of PM'11

Roman Micnas, Bogdan Idzikowski

INVITED LECTURES

CONDUCTANCE AND NOISE IN FULLY EPITAXIAL MAGNETIC TUNNEL JUNCTIONS

F.G. Aliev[1], D.Herranz[1], A. Gomez-Ibarlucea[1], R. Guerrero[1], C. Tiusan[2], M. Hehn[2], and S. Andrieu[2]

[1]Dpto. Física de la Materia Condensada,
C03, Universidad Autónoma de Madrid, 28049 Madrid, Spain

[2] Institut Jean Lamour, Nancy-Université -54506 Vandoeuvre Les Nancy Cedex, France

Magnetic tunnel junctions (MTJs) are nowadays one of the most active areas of material science and spintronics. Here, we review our recent studies of conductance and low frequency noise as a function of applied bias, magnetic state and temperature in different types of MTJs [1-4].

The shot noise measurements are used to resolve between direct and sequential tunnelling [1,2]. Fully epitaxial Fe/C/MgO/Fe(001) MTJs exhibit record low Hooge factors being at least one order of the magnitude smaller than previously reported [3]. Interface engineering by using Vanadium doping of Fe electrodes allows to relax misfit defects inside MgO barrier, dramatically reducing 1/f noise and enhancing tunnelling magnetoresistance [4]. Investigation of electronic transport in epitaxial Fe(100)/MgO/Fe/MgO/Fe double magnetic tunnel junctions with soft barrier breakdown (hot spots) [5] reveals quasi-periodic changes in the resistance as a function of bias voltage which point out formation of quantum well states in the middle Fe continuous free layer. Finally, we introduce "1/f noise band spectroscopy" to characterize band structure of ferromagnetic electrodes in MTJs involved in the spin dependent tunnelling.

Collaboration with R. Villar, J. Moodera, T. Santos, Y. Tserkovnyak, F. Greullet, F. Bonell, V. Dugaev, and J. Barnas is gratefully acknowledged. The work has been supported in parts by Spanish-French Integrated Action project, Spanish MICINN and European Science Foundation (FONE-SPINTRA).

[1] R.Guerrero, et al., Phys. Rev. Lett. **97**, 0266602 (2006).
[2] R.Guerrero, et al, Appl. Phys. Lett. **91**, 132504 (2007).
[3] F.G.Aliev, et al., Appl. Phys. Lett. **91**, 232504 (2007).
[4] D.Herranz, et al., Appl. Phys. Lett. **96**, 202501 (2010).
[5] D.Herranz, et al., Phys. Rev. Lett. **105**, 047207 (2010).

NON LOCAL MAGNETIZATION DYNAMICS DUE TO SPIN PUMPING

G. Woltersdorf, O. Moszend, B. Heinrich, A. Gangwar, and C.H. Back
Faculty of Physics, University Regensburg, 93040 Regensburg

Spin pumping in magnetic nanostructures may prove to be an important effect for the investigation of pure spin currents in metallic magnetic heterostructures. Here, time resolved scanning Kerr microscopy (TRSKEM) was used to study the non-local magnetization dynamics in magnetic double layers [1]. In our experiment a microwave field was synchronized to the probe laser pulses and used to excite the magnetic moments in epitaxial Fe/Au/Fe/GaAs(001) magnetic double layers that were patterned into coplanar waveguide structures. A variable time delay between the microwave driving field and the laser pulses allows one to measure the time dependent rf-magnetization with ps time resolution. The resonance frequencies of the two magnetic films were split by several GHz due to their different interface anisotropies and film thicknesses [2]. For a thick Au spacer layer only the top Fe film can be observed by TRSKEM. This leads to a unique situation where one can resonantly excite the bottom layer while observing the response on the top layer which is tuned far from the resonance. In doing so TRSKEM allows one to observe rf-excitations originating from the coupling between the bottom and top Fe layers. This coupling can be understood in terms of the spin-pump and spin-sink model [3, 4, 5]. The TRSKEM experiment allowed us to measure the amplitude and phase of the magnetization precession with respect to the rf-driving field. The amplitude and phase of the precession of the top layer were also calculated using the Landau-Lifshitz equations of motion which includes the spin pumping coupling. Furthermore we investigate ferromagnet/normal metal bilayer systems using FMR techniques and electrical detection. Here, the ferromagnetic layer is driven into resonance and emits a pure spin current into the normal metal layer. By using the inverse spin Hall effect the pure spin current in the normal metal can be transformed into a signal that can be detected electrically.

[1] G. Woltersdorf et al., Phys. Rev. Lett. **99**, 246603 (2007)
[2] R. Urban et al. Phys. Rev. Lett. **87**, 217204(2001)
[3] Y. Tserkovnyak et al. Phys. Rev. Lett. **88**, 117601(2002)
[4] B. Heinrich et al. Phys. Rev. Lett. **90**, 187601(2003)
[5] M. Stiles and A. Zangwill Phys Rev. B. **66**, 014407(2002)
[6] O. Mosendz et al., Phys. Rev. Lett. **104**, 046601 (2010)

TOWARDS AN ELECTRIC CONTROL OF SPINTRONICS DEVICES

A. Crassous[1], J. Allibe1, V. Garcia[1,2], K.Bouzehouane[1], S.Fusil[1], E.Jacquet[1], L. Bocher[3], A.Gloter[3], C. Deranot[1], N.Mathur[2], M.Bibes[1] and A.Barthélémy[1]

[1]Unité Mixte de Physique CNRS/Thales, 1 av. A. Fresnel, 91767 Palaiseau, France

[2]University of Cambridge, Cambridge CB2 3EQ, United Kingdom

[3]Laboratoire de Physique des Solides, Universit Paris Sud, 91405 Orsay, France

Multiferroics should allow to achieve a low power electric control of spintronics devices of great interest on the route to high density data storage. One of the most suitable multiferroic material is the antiferromagnetic-ferroelectric $BiFeO_3$ due to its high ordering temperatures. To exploit its potential, $BiFeO_3$ films have been used to establish a robust exchange-bias effect [1]. Optimizations performed in order to obtain an electric control of a spin valve will be presented [2]. We will also present experiments on heterostructures combining ferroelectric tunnel barriers of $BaTiO_3$ and ferromagnetic electrodes (Fe or Co). This kind of heterostructures allows to generate, within a single device, a tunnel magnetoresistance (TMR) together with a very large tunnel electroresistance (TER) induced by the ferroelectric polarisation of the barrier. They also give rise to a unusual modulation of the spin polarisation at the interface by the ferroelectricity resulting in a large TEMR (Tunnel Electro MagnetoResistance) effect [3].

[1] H. Béa et al., Appl. Phys. Lett. 89, 242114 (2006) and Phys. Rev. Lett 100, 017204 (2008)

[2] J. Allibe et al., Appl. Phys. Lett. 95, 182503 (2009)

[3] V. Garcia et al., Nature 460, 81 (2009) and Science 327, 1106 (2010)

HEAVY FERMION PROPERTIES IN THE KONDO LATTICE MODEL

Klaus W. Becker[1] **and Steffen Sykora**[2]
[1]Technische Universität Dresden,
[2]Leibniz Institute for Solid State and Materials Research Dresden

The Kondo lattice model is often used as a starting point to discuss low-energy properties of heavy-fermion systems. It includes a band of conduction electrons, interacting via an exchange with a regular array of immobile spins. We discuss this model in the framework of a quite novel projective renormalization method (PRM). Starting from a decomposition of the Hamiltonian into a dominant kinetic energy $\mathcal{H}_0$ and a Kondo-exchange $\mathcal{H}_1$, transition operators, due to $\mathcal{H}_1$, between the eigenstates of $\mathcal{H}_0$ are successively eliminated in this method. With this analytical technique we arrive at a solvable effective Hamiltonian $\tilde{\mathcal{H}}$ which consists of conduction electrons with renormalized dispersion $\tilde{\varepsilon}_{\mathbf{k}}$ and an RKKY interaction term which is naturally generated within the renormalization procedure. Here, $\tilde{\varepsilon}_{\mathbf{k}}$ can be interpreted as quasiparticle excitation. It turns out that $\tilde{\varepsilon}_{\mathbf{k}}$ is also temperature dependent. Whereas for high temperatures it resembles the unrenormalized fermionic excitation $\varepsilon_{\mathbf{k}}$, at low temperatures a dispersionless region around the Fermi surface arises due to the formation of a singlet state. Simultaneously, we find that a large γ coefficients develops in the specific heat at low temperatures. This feature is usually traced back to a huge effective mass of heavy fermion quasiparticles. Concerning the superconducting phase we shall also discuss the symmetry of the order parameter and the large discontinuity ΔC in the specific heat at T_c.

KONDO LATTICE MODELS FOR RARE-EARTH AND ACTINIDE SYSTEMS

B. Coqblin[a]

[a]Laboratoire de Physique des Solides, CNRS - Université Paris-Sud, 91405 Orsay, France

There is a strong competition between the Kondo effect, magnetic order and eventually spin glass or frustration effect in anomalous rare-earth and actinide systems. The Kondo-magnetism competition has been extensively studied within a mean field treatment of the normal Kondo Lattice model with localized $S_f = 1/2$ spins, which is applied successfully to Cerium or Ytterbium compounds. On the other side, some actinide compounds, like UTe, Np_2PdGa_3 or UCu_2Si_2 have a large Curie temperature T_c of order 100K and present also a Kondo behavior. We have developed firstly an Underscreened Kondo Lattice (UKL) model with $S_f = 1$ spins for the 5f-electrons and we have recently improved it by deriving, by the Schrieffer-Wolff transformation, a 5f-band with a finite bandwidth. The UKL model can account for properties of some Uranium and Neptunium compounds and in particular the variation of T_c with pressure in UTe. Then, we have studied the properties of disordered Cerium alloys like $CeCu_xNi_{1-x}$ or $CeRh_xPd_{1-x}$ by considering the Kondo effect, a ferromagnetic order and a spin glass behavior described by several approaches. The van Hemmen approach gives a good explanation of the properties of Cerium alloys and we are presently developing a first description of the magnetic glass clusters which occur in both spin glass and ferromagnetic phases. Finally, we present a new description of a frustrated Kondo Lattice model, which can account for the behavior of some Ytterbium compounds under pressure.

SPIN RESISTIVITY IN MAGNETIC MATERIALS

H.T. Diep

Laboratoire de Physique Théorique et Modélisation, Université de Cergy-Pontoise, CNRS UMR 8089 2, Avenue Adolphe Chauvin, 95302 Cergy-Pontoise Cedex, France

We show in this talk recent results on the spin resistivity in magnetically ordered materials obtained by Monte Carlo simulations. We discuss its behavior as a function of temperature in various types of crystal: ferromagnetic, antiferromagnetic and frustrated spin systems. In the model used for simulations, we take into account the interaction between itinerant spins and that between lattice spins and itinerant spins. We also include a chemical potential term, as well as applied magnetic and electric fields.

We study in particular the behavior of the spin resistivity at and near the magnetic phase transition where the effect of the magnetic ordering is strongest. In ferromagnetic crystals, the spin resistivity shows a sharp peak very similar to the magnetic susceptibility. This can be understood if one relates the spin resistivity to the spin-spin correlation as suggested in a number of theories. The dependence of the shape of the peak on physical parameters such as carrier concentration, magnetic field strength, relaxation time etc. is discussed.

In antiferromagnets, the peak is not so pronounced and in some cases it is absent. Its direct relationship to the spin-spin correlation is not obvious. As for frustrated spin systems with strong first-order transition, the spin resistivity shows a discontinuity at the phase transition. Physical mechanisms for itinerant-spin scattering are discussed. For comparison, we show recent experimental results on various magnetic materials.

FERROMAGNETIC SEMICONDUCTORS AT THE BOUNDARY OF HOLES' LOCALIZATION

Tomasz DIETL
Laboratory for Cryogenic and Spintronic Research, Institute of Physics, Polish Academy of Sciences; Institute of Theoretical Physics, University of Warsaw
(dietl@ifpan.edu.pl)

The presence of localized spins exerts a strong influence on quantum Anderson-Mott localization in doped semiconductors. At the same time carriermediated interactions between the localized spins are modified or even halted by carriers' localization and the associated disorder-driven spatial fluctuations in the local density of carrier states [1,2].

The interplay of these effects is discussed for II–VI [3-5] and III–V [6- 10] diluted magnetic semiconductors. This insight is exploited to interpret the complex dependence of resistance [6-9], anomalous Hall effect [10], and magnetization [11] on temperature, magnetic field, and concentration of valenceband holes in (Ga,Mn)As. In particular, high field negative magnetoresistance results from the orbital weak localization effect [6]. The resistance maximum and the associated negative magnetoresistance near the Curie temperature are assigned to the destructive influence of preformed ferromagnetic bubbles [11] on the "antilocalization" effect driven by disorder-modified carrier–carrier interactions [5,6]. These interactions account also for the low temperature increase of resistance [6-9]. Furthermore, the sensitivity of conductance to spin splitting and to scattering by spin disorder may explain resistance anomalies at coercive fields, where relative directions of external and molecular fields change.

1. see, "Spintronics", in: *Semiconductors and Semimetals*, vol. 82, eds. T. Dietl, D.D. Awschalom, M. Kaminska, H. Ohno (Elsevier, Amsterdam, 2008).
2. T. Dietl, *J. Phys. Soc. Jpn.* **77**, (2008) 031005.
3. T. Andrearczyk, J. Jaroszyski, G. Grabecki, T. Dietl, T. Fukumura, and M. Kawasaki: *Phys. Rev. B* **72** (2005) 121309.
4. T. Dietl, T. Andrearczyk, A. Lipiska, M. Kiecana, M. Tay, and Y. Wu: *Phys. Rev. B* **76** (2007) 155312.
5. J. Jaroszynski, T. Andrearczyk, G. Karczewski, J. Wrbel, T. Wojtowicz, D. Popovi, and T. Dietl: *Phys. Rev. B* **76** (2007) 045322.
6. F. Matsukura, M. Sawicki, T. Dietl, D. Chiba, and H. Ohno: *Physica E* **21** (2004) 1032.
7. J. Honolka, S. Masmanidis, H. X. Tang, D. D. Awschalom, and M. L. Roukes: *Phys. Rev. B* **75** (2007) 245310.
8. D. Neumaier, M. Schlapps, U. Wurstbauer, J. Sadowski, M. Reinwald, W. Wegscheider, and D. Weiss: *Phys. Rev. B* **77** (2008) 041306.
9. D. Neumaier, M. Turek, U. Wurstbauer, A. Vogl, M. Utz, W. Wegscheider, and D. Weiss: *Phys. Rev. Lett.* **103**, (2009) 087203.
10. D. Chiba, A. Werpachowska, M. Endo, Y. Nishitani, F. Matsukura, T. Dietl and H. Ohno, *Phys. Rev. Lett.* **104**, (2010) 106601.
11. M. Sawicki, D. Chiba, A. Korbecka, Yu Nishitani, J. A. Majewski, F. Matsukura, T. Dietl, and H. Ohno: *Nature Phys.* **6**, (2010) 22.

EXCHANGE COUPLING IN MAGNETIC SEMICONDUCTOR MULTILAYERS AND SUPERLATTICES*

Jacek K. Furdyna

Department of Physics, University of Notre Dame, Notre Dame, Indiana, USA

The study of ferromagnetic (FM) dilute magnetic semiconductors (DMSs) continues to be of great interest because of their potential for spin-electronic device application. While there has been much progress in our understanding of DMS materials - particularly of the canonical III-V system $Ga_{1-x}Mn_xAs$ - many issues still remain unresolved. One of these is the nature of interlayer exchange coupling (IEC) in GaMnAs-based multilayers, an issue that is important from the point of view of possible spin-electronic ("spintronic") applications. Consider, for example, IEC between two magnetic layers separated by a non-magnetic spacer. The ability to manipulate such IEC enables us to control the relative direction of magnetization in one magnetic layer relative to the other, which lies at the heart of giant magnetoresistance (GMR) devices in wide use in information processing. In this connection, in the present case of GaMnAs multilayers it is important to establish under what conditions the IEC between adjacent GaMnAs layers is antiferromagnetic (AF) or ferromagnetic (FM), since manipulation of the IEC can then be directly applied to achieve GMR devices based on this material. In this talk we will describe magneto-transport, magnetization, and neutron reflectometry experiments applied to two types of GaMnAs-based structures - superlattices and tri-layers - consisnting of GaMnAs layers separated by non-magnetic GaAs spacers. These measurements serve to identify conditions under which AFM coupling will occur in such GaMnAs/GaAs multilayer systems, thus providing us the information which can be used for manipulating magnetization (and thus also GMR) in structures based on the ferromagnetic semiconductor GaMnAs.

*Collaborators: X. Liu, B. J. Kirby, J. Leiner, M. Dobrowolska, J. H. Chung, and S. Lee.

SURFACES AND GRAIN BOUNDARIES IN MAGNETIC NANOSTRUCTURES

B. Fongang, F. Calvayrac, N. Yaacoub, Y. Labaye and J.M. Greneche
Laboratoire de Physique de l'Etat Condensé LPEC, UMR CNRS 6087, Université du Maine,
Institut de Recherche en Ingnierie Moléculaire et Matériaux Fonctionnels IRIM2F, FR CNRS 2575 72085 Le Mans Cedex 9 France.

The magnetic properties of nanostructures strongly differ from those of microstructures because of the enhanced role of surfaces, grain boundaries or interfaces, according to their dimensionality. They originate fundamental problems which have to be clarified and well controlled in order to make suitable these magnetic nanostructures. We first review the main structural characteristics and relevant parameters in correlation with the chemistry and stability of these systems, and expected static and dynamic magnetic properties induced by the confinement effects.
Then, we report experimental studies on several illustrative examples from oxide nanoparticles (maghemite, magnetite and ferrites, in the as-prepared, subsequently annealed and functionalized states) and then metallic and ionic nanostructured powders. Special attention is focused on both the experimental determination and computer modelling of the structure of surface or grain boundaries. In addition to diffraction techniques and microscopies, local probe spectroscopies are effective tools to identify atomic species located at surface and grain boundaries. The role of both zero-field and in-field $^{5}7$Fe Mössbauer spectrometry is emphasized in the case of Fe based nanostructures in conjuntion with static and ac magnetic measurements, to better understand local scale and time scale structural and magnetic properties. These features are well supported by computer modelling of surface and grain boundaries effects.

FROM WORLD ENERGY PROBLEMS TO GIANT MAGNETO RESISTANCE AND SPIN TORQUE

Peter A. Grünberg[a],
Koji Ando[b], **Hitoshi Kubota**[b], **Tomohiro Taniguchi**[b] **and Shinji Yuasa**[b]
[a]Research Center Jülich, Germany
[b]AIST, Tsukuba, Japan

SPIN WAVE PROPAGATION PROPERTIES IN PLANAR MAGNONIC CRYSTALS

G. Gubbiotti[a,b], S. Tacchi[a], M. Madami[a], G. Carlotti[a]
[a]IOM-CNR, c/o Dipartimento di Fisica, Via A. Pascoli, Perugia, Italy
[b] CNISM, Unità di Perugia,Via A. Pascoli, Perugia, Italy

In recent years, Magnonic Crystals (MCs) emerged as new class of materials with periodically modulated magnetic properties where allowed bands and ranges of forbidden gaps can be recognized in the dispersion curves of spin excitations. Magnonics or magnons spintronics is the corresponding research field whose purpose is to explore spin waves to store, carry and process information.This offers an unprecedented opportunity to design and exploit a new generation of spin logic devices, filters and waveguides operating in the GHz frequency range. However, knowledge of the magnonic band structure of a specific MC is preliminary to any desired application. In this work, we use Brillouin light scattering (BLS) technique to investigate the spin wave band structure in 1D and 2D discrete and continuous MCs constituted either by ordered arrays of magnetic elements interacting via the dynamic dipolar interaction or by a continuous medium with a periodical profile of magnetic properties. The research leading to these results has received funding from the European Community (FP7/2007-2013) under Grant Agreement no. 228673 (MAGNONICS).

SPIN-ORBITAL PHYSICS AND DEFECT STATES IN DOPED VANADATES: $Y_{1-x}Ca_xVO_3$

Peter Horsch

Max-Planck-Institute for Solid State Research, D-70569 Stuttgart, Germany

Recent experimental and theoretical investigations of RVO_3 perovskites, with R= Lu, Y,...,La , have revealed the interplay between spin, charge and orbital degrees of freedom, displaying remarkable changes of magnetic and spectral properties. The t_{2g} valence electrons in these transition metal oxides lead to strong spin-orbital superexchange interactions relative to weak orbital-lattice coupling [1]. Thus the spin-orbital dynamics and the different phases of these compounds are naturally described in the frame of spin-orbital superexchange models. Focus in the talk is on the effect of doping. After a brief discussion of some of the experimental challenges, the hole-motion in a spin-orbital t-J model and the formation of spin-orbital polarons is addressed [2,3]. Next we introduce a model for generic charge defects in doped perovskites like $Y_{1-x}Ca_xVO_3$ [4]. The influence of these defects on the relative stability of the different magnetic phases will be discussed, as well as the effect of defects on optical spectra and photoemission.

[1] P. Horsch, A. M. Oleś, L.-F. Feiner, and G. Khaliullin, Phys. Rev. Lett. **100**, 167205 (2008).

[2] M. Daghofer, K. Wohlfeld, A.M. Oleś, E. Arrigoni, and P. Horsch, Phys. Rev. Lett. **100**, 066403 (2008).

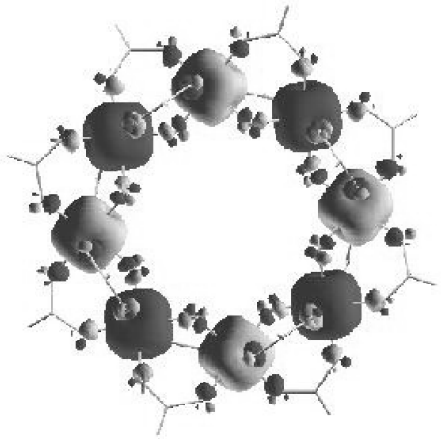
[3] K. Wohlfeld, A.M. Oleś, and P. Horsch, Phys.Rev. B **79**, 224433 (2009).

[4] P. Horsch and A.M. Oleś, (2011, to be publ.)

ANISOTROPY, GEOMETRIC STRUCTURE AND FRUSTRATION EFFECTS IN MOLECULE-BASED NANOMAGNETS

G. Kamieniarz[a], P. Kozłowski[a], M. Antkowiak[a], P. Sobczak[a], T. Ślusarski[a], D. M. Tomecka[a], A. Barasiński[b], B. Brzostowski[b], A. Drzewiński[b], A. Bieńko[c], J. Mroziński[c], F. Tuna[d], G. A. Timco[d], R. E. P. Winpenny[d]

[a]Faculty of Physics, A. Mickiewicz University, Poznań, Poland
[b]Institute of Physics, University of Zielona Góra, Poland
[c]Faculty of Chemistry, University of Wroclaw, Poland
[d]Department of Chemistry, University of Manchester, United Kingdom



Molecular nanomagnets are based on transition metal ions, which determine their magnetic properties. Magnetic shielding of the molecules by organic ligands allows the quantum effects characteristic of a single molecule to be measured in a bulk sample. In view of possible applications, precise modeling of such materials plays a very important role. In the lecture we are going to present results on anisotropy, geometric structure and frustration effects in a family of molecular rings and chains obtained by means of various complementary numerical simulations both phenomenological and ab-initio. The precise numerical results obtained can be used to test theoretical models or as guidelines for experiment.

The chromium-based molecular ring $Cr_8F_8Piv_{16}$ (abbreviated as Cr_8) is a precursor of a family of chromium nano-rings. The localization of the spin density on Cr(III) ions is shown in Figure. The Cr_7Cd complex is another member of the family. It was obtained by substituting one of the chromium centers in Cr8 with a non-magnetic Cd ion. We assume that these compounds can be modeled by the anisotropic Heisenberg Hamiltonian which yields a very good fit to susceptibility and magnetization. It is demonstrated that the best results in modeling magnetic torque of Cr_7Cd can be obtained by taking into account bond dependent exchange anisotropy. Another interesting property analyzed was magnetic frustration in a model of nine-membered chromium ring (Cr_9) with a bond defect. We specified local and global thermodynamic quantities which can serve as frustration signatures and showed how frustration depends on the magnitude of a bond defect.

The magnetic properties of the bimetallic zig-zag shaped chains with Re(IV) and Cu(II) complexes were numerically analyzed on the basis of the planar model which takes into account the site-dependent alternating directions of the local coordinate systems for the Re(IV) ions and the axial and rhombic single-ion anisotropy terms. A number of symmetries for the single-crystal susceptibility were found and the value of the rhombic anisotropy parameter accounting for some thermodynamic properties was estimated. The results of our simulations were successfully fitted to the corresponding experimental susceptibility data.

THE SPIN-1/2 FRUSTRATED HELICOIDAL ANTIFERROMAGNETIC MULTIFERROIC SYSTEM $LiCuVO_4$: RECENT RESULTS

Reinhard K. Kremer*
Max-Planck-Institut für Festkoerperforschung, Stuttgart, Germany

Lately much attention has been focused on the magnetic and especially the multiferroic properties of the helicoidal quantum antiferromagnet $LiCuVO_4$. The spin-1/2 Cu^{2+} ions of $LiCuVO_4$ form one-dimensional chains. Spin frustration in $LiCuVO_4$ brought about by competing nearest-neighbor ferromagnetic exchange J_1 and the next-nearest-neighbor antiferromagnetic exchange J_2 in these chains leads to helicoidal antiferromagnetic ordering and multiferroic behavior below about 2.5 K. I report and discuss new inelastic and elastic neutron scattering results in which we have studied the two-spinon and the four-spinon continuum and the magnetic structure with and without an electric field by polarized neutron diffraction.[1,2] I also review a recent controversy on the magnitude of the nearest-neighbor and next-nearest neighbor exchange interaction which we resolved by a careful re-investigation of the low-temperature crystal structure, the high-temperature magnetic susceptibilities and new DFT calculations.[3]

[1] M. Enderle, B. Fåk, H.-J. Mikeska, R. K. Kremer, A. Prokofiev, and W. Assmus, Phys. Rev. Lett. **104**, 237207 (2010).
[2] M. Mourigal, M. Enderle,R. K. Kremer, J. M. Law, and B. Fåk, Phys. Rev. B **83**, 100409(R) (2011).
[3] H.J. Koo, C. Lee, M.-H. Whangbo, G. J. McIntyre and R. K. Kremer, Inorg. Chem., in press.

* work done in close collaboration with M. Enderle, B. Fk, M. Mourigal, H.-J. Mikeska, H.-J. Koo, C. Lee, G. J. McIntyre, M-H. Whangbo, J. M. Law

MOLECULAR-SCALE ELECTRONICS AND MECHANICAL ANALOGUES OF SPIN TORQUES

Colin Lambert
Department of Physics, Lancaster University, UK

When a spin-polarised current impinges on a magnetic island, an imbalance between incoming and outgoing fluxes of spin angular momentum generates a spin torque on the island. In this talk, I describe a molecular-scale, mechanical analogue of this effect, which arises when an electrical current impinges on a chiral nanotube. In this case, the outgoing electron 'wind' acquires an angular momentum and by Newton's third law, cxcrts a mcchanical torquc on thc chiral nanotubc. This cffcct occurs, for cxamplc, in a double-wall carbon nanotube (CNT), in which a current flows from the outer achiral CNT to the inner chiral CNT. For reasonable area of overlap between the inner and outer CNTs, it can be shown that the current-induced torque is sufficient to overcome the mutual friction and therefore the inner CNT will rotate.

With a view to optimizing the design of such a 'windmill' and to maximizing the internal magnetic field generated by chiral currents, I present analytical results for the group-velocity components of an electron flux through chiral carbon nanotubes. Chiral currents are shown to exhibit a rich behavior and can even change sign and oscillate as the energy of the electrons is increased. It is found that the transverse velocity and associated angular momentum of electrons are a maximum for nonmetallic CNTs with a chiral angle of 18 degrees. Such CNTs are therefore the optimal choice for CNT windmills and also generate the largest internal magnetic field for a given longitudinal current. For a longitudinal current of order 10^{-4} A, this field can be of order 10^{-1} T, which is sufficient to produce interesting spintronic effects and a significant contribution to the self-inductance.

Since an electrical current can produce mechanical rotation, it is reasonable to expect that mechanical rotation of an outer CNT relative to an inner CNT can induce an electron current. When the outer tube is chiral, such devices indeed act like quantum Archimedes screws, which utilize mechanical energy to pump electrons between reservoirs. Results will be presented for the pumped charge from one end of the inner tube to the other, driven by the rotation of a chiral outer nanotube. Such a device is found to be an efficient electron pump, whose pumped charge can be greater than one electron per 360 degrees rotation.

References:

Carbon nanotube Archimedes screws, L. Oroszlany, V. Zolyomi and C. J. Lambert, ACS Nano,7363 (2010)

Oscillating chiral currents in nanotubes: A route to nanoscale magnetic test tubes, C.J. Lambert, S.W.D. Bailey, and J. Cserti, Phys. Rev. B78 233405 (2008)

Carbon Nanotube Electron Windmills: A Novel Design for Nanomotors. S.W. D. Bailey, I. Amanatidis and C. J. Lambert, Phys. Rev. Lett. 100, 256802 (2008)

SPIN-WAVE, SPIN CURRENT AND SPIN SEEBECK EFFECT

Sadamichi Maekawa
Advanced Science Research Center,
Japan Atomic Energy Agency
Tokai 319-1195, Japan

The collective magnetic excitation of spin, i.e., spin-wave (magnon), in a ferromagnetic insulator carries the spin current [1]. When the spin current is generated by the electric voltage via the spin Hall effect, it transmits the electric signal in the insulator [2]. On the other hand, when it is generated by heat, it carries the thermal energy, i.e., the Spin Seebeck effect [3]. Here, we formulate the spin current in a ferromagnetic insulator generated by electric voltage [4] and heat [5] based on the fluctuation-dissipation theory. The numerical simulation of a variety of the transmission phenomena is presented in the ferromagnetic-insulator/nonmagnetic-metal hybrids.

[1] "Concepts in Spin-Eelectronics" ed. S. Maekawa (Oxford University Press, 2006).
[2] Y. Kajiwara et al.: Nature **464**, 262 (2010).
[3] K. Uchida et al.: Nature Materials, **9**, 894 (2010).
[4] J. Ohe et al.: Phys. Rev. B (2011).
[5] H. Adachi et al.: APL **97**, 252506 (2010) and Phys. Rev. B (2011).

MUTUAL ENHANCEMENT OF MAGNETISM AND FULDE-FERRELL-LARKIN-OVCHINNIKOV SUPERCONDUCTIVITY IN $CeCoIn_5$

Maciej M. Maśka, Marcin Mierzejewski, and Andrzej Ptok
Department of Theoretical Physics, Institute of Physics, University of Silesia, 40-007 Katowice, Poland

It was predicted in the middle of the 1960s that unusual superconducting state with nonvanishing momentum of the Cooper pairs may occur at low temperatures and in strong magnetic fields [1,2]. Despite the straightforward nature of the theoretical prediction, actual observations of this state have turned out to be extremely difficult. Unambiguous experimental evidence for its formation has been reported only very recently from specific heat and magnetization measurements on $CeCoIn_5$ [3]. Moreover, recent experiments on $CeCoIn_5$ suggest an unusual interplay between superconducting and magnetic orders that gives rise to a multicomponent (magnetosuperconducting) phase [4]. We demonstrate that characteristics of $CeCoIn_5$ make this system particularly well suited for the onset of such a phase. Based on general considerations, we show that superconductivity with nonzero Cooper-pair momentum may lead to an enhancement of the spin-spin response function and, simultaneously, incommensurate spin-density wave may enhance the Cooper-pair susceptibility [5].

[1] P. Fulde and R. A. Ferrell, Phys. Rev. **135**, A550 (1964).
[2] A. I. Larkin and Yu. N. Ovchinnikov, Zh. Eksp. Teor. Fiz. **47**, 1136 (1964) [Sov. Phys. JETP **20**, 762 (1965)].
[3] H. A. Radovan, N. A. Fortune, T. P. Murphy, S. T. Hannahs, E. C. Palm, S. W. Tozer, and D. Hall, Nature (London) **425**, 51 (2003).
[4] M. Kenzelmann, T. Strässle, C. Niedermayer, M. Sigrist, B. Padmanabhan, M. Zolliker, A. D. Bianchi, R. Movshovich, E. D. Bauer, J. L. Sarrao, and J. D. Thompson, Science **321**, 1652 (2008).
[5] M. Mierzejewski, A. Ptok, and M. M. Maśka, Phys. Rev. B **80**, 174525 (2009).

ENGINEERING OF MAGNETIC AND MAGNETOOPTICAL PROPERTIES OF CO BASED NANOSTRUCTURES

A. Maziewski

Faculty of Physics, University of Białystok, Lipowa 41, 15-424 Białystok, Poland

Magnetic anisotropy of sandwiched ultrathin Co layers can be effectively tuned by properties of either an overlayer or/and underlayer. An extension of the Co thickness range with the out-of-plane magnetization component is obtained by: (*i*) an application of the vicinal substrate/buffer surface [1], (*ii*) increase of the bilayer number N in $(Co/Au)_N$ multilayer [2]. Ion irradiation is an additional powerful tool for magnetic properties modification either uniformly or in a local scale, using a focused ion beam (FIB). Usually, such treatment decreases coercivity and magnetic anisotropy of the affected structures, but recently it has been shown that ion irradiation induces also an out-of-plane magnetization component [3]. Co-based nanostructure, patterning realized by such methods as patterned buffer [4] or ion irradiation [5,6], will be discussed. Polish teams involved in reported studies realize SPINLAB project in the frame of the EU programme Innovative Economy, Priority 2.2.

1. A. Stupakiewicz, A. Maziewski, K. Matlak, N. Spiridis, M. Ślęzak, T. Ślęzak, M. Zając, J. Korecki, Phys. Rev. Lett., 101, 217202 (2008)
2. M. Tekielak, P. Mazalski, A. Maziewski, R. Schäfer, J. McCord, B. Szymański, M. Urbaniak, F. Stobiecki, IEEE Trans.Magn., 44, No. 11, 2950 (2008)
3. J. Jaworowicz, A. Maziewski, P. Mazalski, M. Kisielewski, I. Sveklo, M. Tekielak, V. Zablotskii, J. Ferré, N. Vernier, A. Mougin, J. Fassbender, A. Henschke, Appl. Phys.Lett., 95, 022502 (2009)
4. A. Wawro, A. Petroutchik, L. T. Baczewski, Z. Kurant and A. Maziewski, Europhys. Lett., 89, 37003 (2010)
5. M. Urbaniak, P. Kuświk, Z. Kurant, M. Tekielak, D. Engel, D. Lengemann, B. Szymański, M. Schmidt, J. Aleksiejew, A. Maziewski, A. Ehresmann, F. Stobiecki, Phys.Rev.Lett., 105, 067202 (2010)
6. P. Kuświk, A. Ehresmann, M. Tekielak, B. Szymański, I. Sveklo, P. Mazalski, D. Engel, J. Kisielewski, D.Lengemann, M. Urbaniak, C. Schmidt, A. Maziewski, F. Stobiecki, Nanotechnology, 22, 095302 (2011)

DIRAC FERMIONS IN HgTe QUANTUM WELLS

Laurens W. Molenkamp
Physikalisches Institut(EP3) der Universität Würzburg
Am Hubland, 97074 Würzburg, Germany

HgTe quantum wells have a linear band dispersion at low energies and thus mimic the Dirac Hamiltonian. Changing the well width tunes the band gap (i.e., the Dirac mass) from positive, through zero, to negative. Wells with a negative Dirac mass are 2-dimensional topological insulators and exhibit the quantum spin Hall effect, where a pair of spin polarized helical edge channels develops when the bulk of the material is insulating. Our transport data provide very direct evidence for the existence of this third quantum Hall effect. Wells with a thickness of 6.3 nm are zero gap Dirac systems, similar to graphene. However, zero gap HgTe wells possess only a single Dirac valley, which avoids inter-valley scattering.

MgO-CoFeB INTERFACE PERPENDICULAR ANISOTROPY FOR SPINTRONIC DEVICES

Hideo Ohno[1,2]

[1]Center for Spintronics Integrated Systems, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai 980-8577, Japan

[2]Laboratory for Nanoelectronics and Spintronics, Research Institute of Electrical Communication, Tohoku University

E-mail address: ohno@riec.tohoku.ac.jp

MgO (100)-CoFeB bcc(100) is a preferred system for making magnetic tunnel junction (MTJ), a spintronic dcvicc, bccausc it offcrs a largc tunncl magnctorcsistancc (TMR) of $> 100\%$ required for nonvolatile memory cells through symmetry filtering of wavefunctions. Integration of MTJs with CMOS in the back-end enables not only non-volatile, high density, and fast stand-alone and/or embedded RAMs, but also a possibility of non-volatile logic-in-memory CMOS VLSIs [1]. To this end, MTJs utilizing current-induced magnetization switching have been developed; first with in-plane easy axis using MgO-CoFeB and then with perpendicular easy axis. The shift from in-plane to perpendicular is a natural one because high crystalline anisotropy in perpendicular materials is advantageous for reducing cell size. In addition, current-induced switching is inherently more efficient with perpendicular easy axis. However, satisfying both high tunnel magnetoresistance (TMR) over 100% and low switching current was a formidable task, because of the mismatch between MgO (100) – CoFe(B) bcc (100) structure needed to obtain high TMR and the crystal structure of perpendicular materials. We have experimentally shown that a strong perpendicular interface anisotropy exists at the MgO-CoFeB interface [2, 3], so strong ($K_i = 1.3$ mJ/m^2) that it can overcome the demagnetization and make the easy axis perpendicular. First principle calculation by Nakamura et al. shows that the perpendicular anisotropy is due to the oxygen-iron bond that reduces contribution of in-plane crystalline anisotropy [4]. Using this perpendicular easy axis, we have shown a 40 nmϕ perpendicular MgO-CoFeB MTJ with high TMR (>100%) and low switching current of 49 μA [3]. In addition to MTJs, we have investigated current-induced domain wall motion in perpendicular MgO-CoFeB films [5], where perpendicular anisotropy is required for reducing critical current density for domain wall motion. We also report on the current induced effective fields in ultrathin perpendicular CoFeB films with MgO cap [6].

This work was supported by the FIRST program from JSPS.

[1] S. Ikeda, et al. IEEE Trans. Electron Devices, **54**, 991, 2007.
[2] M. Endo, et al. Appl. Phys. Lett., **96**, 212503, 2010.
[3] K. Nakamura et al., Phys. Rev. B, **81**, 220409(R), 2010.
[4] S. Ikeda, et al. Nature Mat., **9**, 721, 2010.
[5] S. Fukami et al. Appl. Phys. Lett. **98**, 082504, 2011.
[6] T. Suzuki et al. Appl. Phys. Lett. **98**, 142505, 2011.

QUANTUM WELL STATES AND OSCILLATORY MAGNETIC ANISOTROPY IN ULTRATHIN Fe FILMS

J. Li, Y. Z. Wu, U. Bauer, M. Dąbrowski, F. Yildiz, and M. Przybylski
Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany

In dimensionally reduced magnetic systems, such as ultrathin films, electrons can be confined perpendicular to the film plane and form quantum well states (QWS). The formation of QWS can directly alternate the electronic structure at the Fermi level and therefore result in oscillatory physical properties such as magnetic anisotropy.
In thin films grown on stepped surfaces, magnetic anisotropy can be modified in comparison to the anisotropy of films grown on atomically flat surfaces. Such a modification is often described as an additional uniaxial anisotropy with the easy magnetization axis in the film plane oriented along or perpendicular to the step direction.
I will report on large amplitude quantum oscillations of such uniaxial magnetic anisotropy in Fe films grown on Ag vicinal surfaces of high step density. I will show that the magnetic anisotropy, and easy magnetization axis, oscillates as a function of film thickness. For the Fe/Ag(1,1,6) system, at low temperatures, the anisotropy clearly oscillates with Fe thickness with a period of 5.9 ML, which is exactly the same as observed for the Fe films grown on Ag(1,1,10). This is natural since there is the same ultrathin film of Fe, grown on the same Ag(001) substrate. The oscillation amplitude, however, depends on how much the anisotropy in the film volume is modified by the steps and scales quadratically with the step density.
There are no theoretical calculations available to which we can compare our experimental results for Fe films on Ag(001) surfaces. The only available theory predicts oscillations of the magnetocrystalline anisotropy energy as a function of film thickness for fcc Co films on Cu(001). These predictions, made nearly 15 years ago, have so far not been confirmed experimentally.

ANISOTROPY OF SUPERCONDUCTING STATE PROPERTIES IN CUPRATES, MgB_2, AND PNICTIDES

R. Puzniak

Institute of Physics, Polish Academy of Sciences,
Aleja Lotnikow 32/46, PL-02-668 Warsaw, Poland

In the anisotropic Ginzburg-Landau theory, which is the most commonly applied phenomenological description of layered superconductors, the anisotropy is described by the temperature independent effective mass anisotropy (assuming $(m_i^*/m_j^*)^{1/2} = \lambda_i/\lambda_j = H_{c2}^{\|j}/H_{c2}^{\|i}$, where λ is penetration depth and H_{c2} is upper critical field). However, a temperature dependent anisotropy was observed in some superconductors, especially in MgB_2, and was explained as a consequence of the presence of two superconducting gaps. A similar temperature dependence was also observed in recently discovered iron-based superconductors, in which an evidence for two-band superconductivity was provided by several experiments, including point contact spectroscopy and ARPES. A recent study of the cuprate superconductor $SmBa_2Cu_3O_{7-\delta}$ has shown that the temperature dependence of the anisotropy is observed also for this class of the layered high-T_c superconductors. Temperature variation of the anisotropy strongly depends on the doping level and is more pronounced for the samples with lower oxygen content, i.e., for the samples with well developed pseudogap. This rises the question whether the temperature dependence of the anisotropy is a common property of all layered high-T_c superconductors and how it is linked to the gap structure.

SKYRMIONIC MATTER - A NEW TYPE OF MAGNETIC ORDER

Ulrich K. Rößler, Anna B. Butenko, Andrei A. Leonov, Alexei N. Bogdanov
IFW Dresden, POB 270116, D-01171 Dresden, Germany

In non-centrosymmetric magnets the chiral Dzyaloshinskii-Moriya (DM) exchange stabilizes tubular Skyrmions, i.e. smooth, topological, and static spin textures. Chiral Skyrmionic states may exist in many magnetic systems due to the DM-couplings as leading spin-orbit effect, if allowed by crystal symmetry or induced by broken inversion symmetry at surfaces. Skyrmionic textures are determined by the stability of localized solitonic cores and their geometrical incompatibility frustrating homogeneous space-filling. Results from phenomenological continuum theory of chiral magnets show that these spin-textures form extended states. Present understanding of the Skyrmionic magnetic states is described with a view on recent experimental observations in chiral cubic helimagnets. The multidimensional solitonic nature of the Skyrmion strings underlies unusual magnetic in such systems. The isolated Skyrmion excitations may undergo confinement near the magnetic ordering transition. In the ordered state these molecular units condense into mesophases that may appear as liquid-like or regular arrays. The existence of the particle-like Skyrmions and their variable arrangements explains the notion of 'Skyrmionic matter' that underlies exotic properties and unusually rich magnetic phase diagrams of non-centrosymmetric magnets.

CRITICAL CURRENTS OF FeAs BASED SUPERCONDUCTORS IN HIGH MAGNETIC FIELDS: HOPES FOR LARGE SCALE APPLICATIONS

Krzysztof Rogacki

Institute of Low Temperature and Structure Research, Polish Academy of Sciences, P.O. Box 1410, 50-950 Wroclaw, Poland

In addition to presenting intriguing physics, the FeAs based superconductors revive our hopes for large scale applications due to their high upper critical fields and relatively low anisotropy. An important question arises if the pinning properties of these compounds are sufficient to provide high critical currents at high magnetic fields. We will focus on the critical currents, the upper critical field, and their anisotropy in low (∼15 T) and high (up to ∼65 T) magnetic fields. The critical current densities $j_c \approx 10^6$ A/cm^2 have been measured both magnetically and by transport for the SmFeAs(O,F) single crystals in the *ab*-plane at temperatures $T \simeq 5$ K and magnetic fields $B \simeq 15$ T.[1] Our detailed studies of the superconducting magnetic and transport properties of the REFeAs(O,F) single crystals (RE = La, Sm, Nd) reveal a promising combination of high and nearly isotropic intragrain critical current densities, which is indeed promising for applications.

[1] P.J.W. Moll, R. Puzniak, F. Balakirev, K. Rogacki, J. Karpinski, N.D. Zhigadlo, and B. Batlogg, Nature Materials, vol. **9**, 628 (2010).

NEW MAGNETIC MATERIALS BASED ON DEFECTS, ANION SUBSTITUTION, INTERFACES AND DOPING

George A. Sawatzky
Max Planck-UBC Centre for Quantum Materials
University of British Columbia Vancouver Canada

Ideas based on theory and some experiments will be presented regarding possible new magnetic materials based on extended and point defects, interface engineering, anion substitution in oxides and hole and electron doping of oxides. The concentration will be on rather ionic oxides mostly not involving conventional magnetic elements. Special attention will also be placed on surface and interface effects involving polar surfaces as well as on the role of doped holes in O 2p in charge transfer gap oxides. O 2p holes play an extremely important role in the magnetism and superconductivity of oxides and new results will be presented regarding the ferromagnetic exchange coupling they introduce in transition metal oxides and the interplay between transport properties, magnetic order and the general phase diagrams of materials involving O 2p holes either in the so called self doped case of stoichiometric oxides or in chemically substituted systems.

MAGNETISM AND SUPERCONDUCTIVITY IN IRON PNICTIDES

David J. Singh
Materials Science and Technology Division, Oak Ridge National Laboratory
Oak Ridge, TN 37831-6114 USA

The discovery of high temperature superconductivity in iron pnictides and chalcogenides has resulted in surprising new insights into high temperature superconductivity and its relationship with magnetism. This talk provides an overview of some of what is known about the electronic structure and the interplay of magnetism and superconductivity in these materials. Similarities and contrasts with the cuprate superconductors are emphasized. The superconducting pairing is discussed within the framework of spin fluctuations. Recent discoveries and some of the many remaining challenges to understanding these materials are discussed.
This work was supported by the Department of Energy, BES, Materials Sciences and Engineering Division.

RECENT PROGRESS IN FeCo-BASED SOFT MAGNETIC NANOCRYSTALLINE ALLOYS

Ivan Škorvánek, Jozef Marcin, Jozef Kováč, Peter Švec*
Institute of Exp. Physics, Slovak Academy of Sciences,
Watsonova 47, 040 01 Kosice, Slovakia
*Institute of Physics, Slovak Academy of Sciences, Bratislava, Slovakia

The continuing interest in FeCo-based nanocrystalline alloys is motivated mainly due to their ability to combine a high saturation magnetic flux density with good magnetic softness. In order to further optimize the magnetic performance of these alloys it is important to deepen knowledge about the influence of the processing techniques that can be used to tailor their properties for specific applications. One possible way, which can be employed for this purpose, is the thermal processing under the presence of external magnetic field, called also ,,magnetic annealing". A special attention of our work is devoted to the study of the effects of the magnetic annealing in order to produce a controllable uniaxial anisotropy in the series of Fe-Co-(Nb,Mo)-B and Fe-Co-B-Cu amorphous and nanocrystalline alloys with different ratios of Fe/Co atoms. We show that the annealing without the presence of external magnetic field leads to an appreciable increase of the coercivity and the corresponding hysteresis loops often exhibit a presence of steps due to the depinnig of domain walls from the positions stabilized during the heat treatment. After annealing in transverse magnetic field one can obtain sheared loops with tunable slope and good field linearity. A heat treatment under the presence of longitudinal magnetic field results in squared hysteresis loops characterized by very low coercive field values in the range of 2 – 6 A/m. Such low coercivity values are superior to those previously reported for FeCo-based amorphous and nanocrystalline alloys. Examples of our recent work on the soft magnetic nanocrystalline alloys optimized for sensor applications will be briefly highlighted.
This work was supported by the grants VEGA 2/0209/10, APVV- 0266-10, and GDRE GAMAS.

SUPERCONDUCTIVITY IN STRONGLY CORRELATED SYSTEMS AND COMPARISON TO EXPERIMENT

J. Spałek[ab], J. Jędrak[a], and J. Kaczmarczyk[a]

[a]Institute of Physics, Jagiellonian University, 30-059 Kraków, Poland

[b]Faculty of Physics and Applied Computer Science, AGH, 30-059 Kraków, Poland

We overview first the t-J model of superconductivity in strongly correlated systems in a historical prospective, i.e., the spin-singlet pairing induced by the kinetic exchange interactions, a purely magnetic, real-space mechanism. Second, high-temperature superconductivity in the cuprate oxides is analyzed using the method developed recently in our group, the so-called statistically consistent Gutzwiller-Fukushima method for the extended t-J model [1]. The following results are compared to experiment: (i) the upper critical concentration for the disappearance of superconductivity; (ii) the doping dependence of the superconducting quasi-particle energy in the antinodal direction; and (iii) the Fermi velocity as a function of doping. The conclusion we draw is that the t-J model in the newly devised mean-field version reflects the overall features of the high-temperature superconductors, at least in the unconventional-Fermi-liquid regime. Finally, we discuss briefly the superconductivity of model heavy-fermion system within the same mechanism of pairing and in particular, our recent analysis of the phase diagram including the Fulde-Ferrell-Larkin-Ovchinnikov phase [2].

[1] J. Jędrak and J. Spałek, Phys. Rev. B **83**, 104512 (2011); ibid., **81**, 073108 (2010).
[2] J. Kaczmarczyk and J. Spałek, Phys. Rev. B **79**, 214519 (2009); J.Phys.: Condens. Matter **22**, 355702 (2010).

TWISTS SYMMETRIES AND TOPOLOGIES IN QUANTUM MAGNETISM

D.A. Tennant
Helmholtz-Zentrum Berlin für Materialien und Energie
Institute for Complex Magnetic Materials,
Hahn-Meitner-Platz 1, 14109 Berlin, Germany

In this talk I cover the physics in three of the central quantum phase transitions in 1D. First, the transverse Ising model which is realized in $CoNb_2O_6$. While this is perhaps the simplest textbook case of a quantum phase transition, a remarkable emergence of E8 symmetry arises close to the quantum critical point. This manifests itself in an octave of bound states. We observe these experimentally and in particular the interval of the first two resonances on this octave which are found to match the golden ratio 1.618 – just as predicted for the emergence of this extraordinary symmetry. I then plan to show with the example of the Heisenberg chain how we can probe the quantum critical volume experimentally and show the characteristic scaling behaviour in space and time. The third example is of a spin ladder $CaCu_2O_3$ which is near the long sought after Wess-Zumino-Novikov-Witten quantum critical point.

DOMAIN WALL DYNAMICS UNDER SHORT CURRENT PULSES: SPIN-TRANSFER TORQUE AND OTHER EFFECTS

A. Thiaville[a], J.-Y. Chauleau[a], J. Torrejon[a], J. Curiale[a,b], G. Malinowski[a], D. Lacour[c], F. Montaigne[c] and M. Hehn[c]

[a]Laboratoire de Physique des Solides, Univ. Paris-Sud, CNRS, 91405 Orsay, France
[b]Laboratoire de Photonique et nanostructures, CNRS, 91460 Marcoussis, France
[c]Institut Jean Lamour, Univ. Nancy I, 54506 Vandoeuvre-lès-Nancy, France

We have experimentally investigated the effect of the spin-transfer torque on magnetic domain walls in patterned nanostrips by high resolution magnetic force microscopy, and compared it to the micromagnetic description of the phenomena.
Experiments involve short current pulses (1 ns) applied to NiFe nanostrips. They reveal that the current pulse can also lead to a transformation of the domain wall structure, especially when the nucleated structure is metastable [1]. This transformation leads to a large domain wall displacement, called automotion. From an analytical calculation, supported by micromagnetic simulations, we also proved that, in the absence of a domain wall transformation and with no blocking of automotion, the domain wall displacement after a current pulse is directly proportional to the non-adiabaticity parameter. Finally, the role of thermal effects will be discussed [2].

1: *Magnetic domain walls displacement: automotion versus spin-transfer torque*, J.-Y. Chauleau, A. Thiaville, R. Weil, J. Miltat, Phys. Rev. B 82, 214414(7) (2010).
2: *Track heating study for current-induced domain wall motion experiments*, J. Curiale, A. Lemaître, G. Faini, and V. Jeudy, Appl. Phys. Lett. 97, 243505 (2010).

FROM HEAVY FERMION AND SPIN-GLASS BEHAVIOR TO MAGNETIC ORDER IN CeT_4M COMPOUNDS

T. Toliński[a], A. Kowalczyk[a], M. Falkowski[a], K. Synoradzki[a], G. Chełkowska[b], A. Hoser[c], and M.S. Rolls[d]

[a]Institute of Molecular Physics, PAS, Smoluchowskiego 17, 60-179 Poznań, Poland

[b]Institute of Physics, Silesian University, Katowice, Uniwersytecka 4, 40-007 Katowice, Poland

[c]Helmholtz-Zentrum, Glienicker Straße 100, D-14109 Berlin, Germany

[d]Institut Laue Langevin, 6 rue Jules Horowitz B.P. 156 F-38042, Grenoble Cedex 9, France

We report on the transitions between the ferromagnetic order, spin-glass behavior, heavy fermion and fluctuating valence state in a series of isostructural compounds CeT_4M (T = Ni, Cu; M = Al, Ga, Mn). The dilution of the T or M elements allowed us to follow the physical properties evolution employing the measurements of the heat capacity, Seebeck effect, electrical and thermal transport, magnetic susceptibility, frequency dependent ac magnetic susceptibility, magnetization relaxation, inelastic neutron scattering and also the X-ray photoemission spectroscopy. It is shown that the Mn rich compounds lean towards the spin glass behavior. For the compounds governed by the close to localization Ce 4f states the effect of the crystal electric field has been studied. It has been shown that the spin glass-like behavior can significantly influence the physics of the CeT_4M compounds.

ANTIFERROMAGNETISM AND FERROMAGNETISM OF FERMIONIC ATOMS IN OPTICAL LATTICES

Matthias Troyer
ETH Zürich, Institut für Theoretische Physik
Wolfgang-Pauli-Str. 27, 8093 Zürich, Switzerland

The accurate simulation of fermionic quantum many body problems is one of the most important challenges in theoretical physics, with huge impact especially on the understanding and design of materials. However, the exponential scaling of the Hilbert space make direct simulations impossible for all but the smallest systems and Monte Carlo simulations suffer from the negative sign problem. On the computational side the goal thus has to be to develop efficient approximate methods for fermionic systems, while on the experimental side ultracold fermionic atoms in optical lattices provide a near-perfect realization of strongly correlated systems and allow the same phases to be "simulated" using experiments. I will report on recent progress in the simulation of fermionic systems, focusing on magnetic phenomena. We can now simulate the Hubbard model in three dimensions down to the Néel temperature, substantially lower than the lowest temperature achieved in optical lattice experiment s so far - and provide accurate results for the approach to the Néel state. In shallow optical lattices the simulation and the physics become more complex, as band mixing and orbital effects become important, and multi-band models are hard to derive and simulate. Here we use density functional theory for such systems, using a new exchange correlation functional for ultracold atomic gases instead of electrons, and in our first simulations focus on the competition between paramagnetism, antiferromagnetism and ferromagnetism as the optical lattice depth and interaction strengths are independently varies.

IMPURITIES AND CORRELATIONS IN THE BOSON-FERMION MODEL OF SUPERCONDUCTORS

Jaromir Krzyszczak and Karol Izydor Wysokiński
Institute of Physics, M. Curie-Skłodowska University, ul. Radziszewskiego 10
20-031 Lublin

The boson-fermion (BF) model of superconductivity formulated in the real space has been suplemented with the Hubbard term describing strong on-site electron-electron repulsion U. This term has been treated by the Gutzwiller approximation, while mean - field like decoupling has been used for boson-fermion coupling. The effect of random point-like impurities on correlated superconductor has been studied by means of the real space Bogoliubov-de Gennes equations approach. In this approach impurities have been treated exactly, as the corresponding equations have been solved on the small cluster. The role of randomness on the local properties of superconductors crucially depends whether the fermions are correlated or not. In the later case the positive correlation between the gap magnitude observed in scanning tunneling measurements has been shown to arise from local changes of bosonic levels with respect to chemical potential [1]. However, in the correlated case the gap has been shown to be larger near the impurity sites in system without bosonic disorder. The interplay between fermionic and bosonic disorder in the correlated case has been also discussed.

[1] J. Krzyszczak, T. Domański, K.I. Wysokiński, R. Micnas and S. Robaszkiewicz *Real space inhomogeneities in High Temperature Superconductors: the perspective of the Two-Component model* J. Phys.: Condens. Matter **22**, 255702 (2010).

CONTRIBUTIONS

ABSTRACT CATEGORIES

1. Strongly Correlated Electrons and High Temperature Superconductivity

Heavy fermions and Kondo systems; Charge, orbital, and multipole orderings and excitations; Quantum phase transitions; Metal-insulator transitions; Highly correlated metals and insulators; Itinerant electron magnetism; Organic conductors; Low dimensional conductors, Correlation effects in mesoscopic systems; Multiferroics.

2. Quantum and Classical Spin Systems

Low dimensional quantum magnets; Frustrated magnets and spin liquids; Quantum phase transitions; Lattice effects and spin Peierls systems; Solitons and non-linear effects; Statistical mechanics of quantum and classical systems; Molecular magnetism; Quantum tunnelling and coherence; Quantum information; Organic and organometallic materials.

3. Magnetic Structure and Dynamics

Crystal field and anisotropy; Magnetic structure and spin waves; Dynamic phenomena; Electronic structure; Magnetic interactions; Rare-earth and actinide magnetism; Transition metal alloys and compounds; Spin glasses; Random magnets; Magnonic crystals.

4. Spin Electronics and Magnetotransport

Magnetoresistance effects; Current induced magnetization reversal; Spin injection and accumulation; Spin Hall effect, Magnetic semiconductors; Optical properties; Quantum computation.

5. Nanostructure, Surfaces, and Interfaces

Surfaces and interfaces; Films, multilayers and superlattices; Exchange interaction and anisotropy; Spin dynamics, Patterned films; Nanoparticles; Nanowires and dots.

6. Soft and Hard Magnetic Materials

Amorphous and nanocrystalline materials; Granular materials; Ferrites, garnets and microwave materials; Permanent magnets; Magnetization processes; Magneto-elastic and magnetostrictive materials; Modeling and simulations.

7. Applications

Magnetic sensors; Ferromagnetic shape-memory materials; Actuators and magnetic drives; Magnetic refrigeration; Magnetic fluids; Magnetic separation and levitation.

8. Other Topics

Biomagnetics, Magnetism in medicine, Measuring techniques and instruments, Magnetic recording and memories.

O-1-01

A MICROSCOPIC THEORY OF THE MAGNETIC RESONANCE MODE

N. M. Plakida[a,b], A.A. Vladimirov[a], D. Ihle[c]

[a]Joint Institute for Nuclear Research, Dubna, Russia

[b]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany

[c] Institut für Theoretische Physik, Universität Leipzig, Leipzig, Germany

A microscopic theory of the dynamic spin susceptibility (DSS) in the superconducting state within the t–J model is presented [1]. The spectrum of spin excitations is studied using an exact representation for the DSS within the Mori-type projection technique for the relaxation function in terms of the Hubbard operators. The self-energy is calculated in the mode-coupling approximation. The DSS reveals a resonance mode (RM) at the antiferromagnetic wave vector $\mathbf{Q} = \pi(1, 1)$ at low temperatures due to a strong suppression of the damping of spin excitations. This is explained by an involvement of spin excitations in the decay process besides the particle-hole continuum usually considered in random-phase-type approximations. The spin gap in the spin-excitation spectrum at $\mathbf{Q}$ plays a dominant role in limiting the decay in comparison with the superconducting gap which results in the observation of the RM even above T_c in the underdoped region. A good agreement with inelastic neutron-scattering experiments on the RM in YBCO compounds is found.

[1] A.A. Vladimirov, et al., Phys. Rev. B **83** (2011), arXiv:cond-mat/1006.1525.

O-1-03

MAGNETIC STRUCTURE OF ELECTRONIC INHOMOGENEITIES IN CUPRATES - COMPETITION BETWEEN STRIPES AND SPIRALS -

G. Seibold[a], R. S. Markiewicz[b] and J. Lorenzana[c]

[a]Institut für Physik, BTU Cottbus, PBox 101344, 03013 Cottbus, Germany

[b]Physics Department, Northeastern University, Boston MA 02115, USA

[c]ISC-CNR and Dipartimento di Fisica, Universitá di Roma "La Sapienza", P. Aldo Moro 2, 00185 Roma, Italy

The formation of spin and charge stripes is one of the scenarios in order to account for the formation of the pseudogap in cuprate superconductors. Whereas this kind of electronic inhomogeneity is now well established in lanthanum based cuprates the experimental situation in other compounds is less evident. Here we argue that the magnetic structure is strongly influenced by the next-nearest neighbor hopping parameter t' which distinguishes different families of cuprates. In particular our investigations, based on the unrestricted Gutzwiller approximation of the extended Hubbardd model, indicate that uniform spirals get favored by a large t'/t ratio but are unstable at small doping towards stripes and checkerboard textures with spin canting. The structure of these inhomogeneities also depends on t'/t and the associated spin currents may induce a small lattice distortion associated with local dipole moments. We discuss a new kind of stripe which appears as a domain wall of the antiferromagnetic (AF) order parameter with a fractional change of the phase of the AF order. For large $|t'/t|$ spirals can be stabilized under certain conditions in the overdoped regime which may explain the elastic incommensurate magnetic response recently observed in iron-codoped Bi2201 materials.

O-1-06

KONDO SCREENING EFFECT AND FERROMAGNETIC ORDER IN UCu_2Si_2

R. Troć[a], M. Samsel-Czekała[a] and B. Coqblin[b]

[a]Institute of Low Temperature and Structure Research, Polish Academy of Sciences, P.O. Box 1410, 50-950 Wrocław 2, Poland

[b]Laboratoire de Physique des Solides, CNRS-Université Paris-Sud, F-91405 Orsay, France

Previous bulk experiments showed that orthorhombic UCu_2Si_2 exhibits two magnetic phase transitions: it becomes a ferromagnet at $T_C = 103$ K with the moment of 1.6 μ_B/U at. [1] and above T_C it transforms to a long-period, amplitude-modulated antiferromagnet having a spin density wave-like order vanishing at $T_N = 106$ K [2]. We present here the transport properties probed on a single-crystalline sample in magnetic fields 0 and up to 8 T. To find the Kondo-like parameters, we used $ThCu_2Si_2$ as a reference of the phonon contribution into the measured $\rho(T)$ dependence. The transverse magnetoresistivity $\Delta\rho(T)/\rho_0$ shows similar anomalies as those previously observed in UGe_2 [3], pointing to a presence of strong magnetic fluctuations just around $T_C/2$. Our ferromagnetic Fermi surface calculated for UCu_2Si_2, based on spin- and orbital-polarized results of [4], using a relativistic FPLO code [5], has some quasi-2D sheets with nesting. It supports a possibility of arising superconductivity mediated by the magnetic fluctuations, like it was supposed in UGe_2 [6]. **References**: [1] R. Troć, Z. Bukowski, pssb **243**, 290 ('06); [2] F. Honda et al., J. Phys.:CM **18**, 479 ('06); [3] R. Troć, Acta Phys. Pol. B **34**, 407 ('03); [4] J.A. Morkowski et al., JAC, in print; [5] K. Koepernik, H. Eschrig, PRB **59**, 1743 ('99); [6] A.B. Shick, W.E. Picket, PRL **86**, 300 ('01).

O-1-07

MAGNETIC-ELECTRONIC PHASE DIAGRAM OF Ca DOPED $NdBaCo_2O_{5.5}$

B. Dabrowski,[a,b] S. Kolesnik,[a] and O. Chmaissem[a,b]

[a]Department of Physics, Northern Illinois University, DeKalb, IL

[b]Materials Science Division, Argonne National Laboratory, Argonne, IL

$R\mathrm{BaCo_2O_{5.5}}$ (R=rare earth and Y) undergoes a sequence of magnetic and electronic transitions between antiferromagnetic/ferrimagnetic/paramagnetic and paramagnetic insulating/metallic states with respective transition temperatures T_N(∼230-260 K)≤ T_C(∼250-290 K)≤ T_MI(∼360 K). We have synthesized a $\mathrm{Nd_{1-x}Ca_xBaCo_2O_{5.5}}$ series ($0 \le x \le 0.2$) of cation ordered [(Nd,Ca)/Ba] and oxygen vacancy ordered materials and investigated them by neutron diffraction, magnetization, electronic and thermal transport. Unlike previously studied materials with hole doping created by adding oxygen, the Ca doping does not disrupt the cation and oxygen vacancy orderings up to $x = 0.20$. We have observed that upon Ca doping T_N rapidly decreases to 0 for $x = 0.1$ and T_C increases and coincides with T_MI for $x \ge 0.12$, which slowly decreases with Ca substitution from ∼360 to ∼340 K. The enhancement of T_C to 340 K is the largest ever observed for these cobaltites. We will present magnetic-electronic phase diagram as a function of hole doping that indicates that competition between various phases leads to transition from ferromagnetic below T_MI to antiferromagnetic phase above T_MI for $x \ge 0.12$.

Work at NIU was supported by the NSF (DMR-0706610) and at ANL by the U.S. DOE under contract No. DE-AC02-06CH11357.

O-1-09

SUBSTITUTION STUDIES AND THE DUAL NATURE OF 5f ELECTRONS IN β-UB_2C

V. H. Tran[a] and P. Rogl [b]

[a]Institute of Low Temperature and Structure Research, Polish Academy of Sciences, P. O. Box 1410, 50-950 Wrocław, Poland

[b]Institute of Physical Chemistry, University of Vienna, Währingerstr. 42, A-1090 Wien, Austria

We have recently studied fundamental properties of β-UB_2C [1,2] and it was found that this compound enters a ferromagnetic state below $T_C = 74.5$ K. In addition to the ferromagnetic transition, a characteristic temperature $T^* \simeq 37$ K was found, at which both the electrical resistivity, specific heat and muon relaxation rate show anomalies. Interestingly, T_c and T^* decrease with increasing applied pressure and both are expected to reach 0 K at a critical pressure above 20 kbar [3,4]. In this contribution, we would like to investigate the effects of Th substitution for U on dual nature of 5f electrons in β-UB_2C. Therefore, we measured magnetization, specific heat and electrical resistivity on on several alloys within the solid solution $Th_xU_{1-x}B_2C$. We will show that the long-range ferromagnetic order exists in the solid solution with x $\leq$ 0.34. Above this concentration, $Th_xU_{1-x}B_2C$ show an enhancement of the electronic specific heat coefficient and effective magnetic moment, compared to the parent β-UB_2C compound.

References

1.V. H. Tran, P. Rogl, G. André, and F. Bourée, J. Phys.: Condens. Matter 18, 703 (2006).

2.V.H. Tran, P. Rogl, P. Dalmas de Réotier, and A. Yaouanc, Phys. Rev. B, 2011 (submitted)

3.V. H. Tran, R. Khan, E. Bauer, and P. Rogl, Physica B 403, 1375 (2008).

4.V. A Sidorov, et al., Program Book of the IC on SCES (Santa Fe, New Mexico, 28.06-2.7.2010).

O-1-10

BEHAVIOR OF COBALTITES UNDER PRESSURE: FACTORS CONTROLLING THE SIGN REVERSAL OF PRESSURE EFFECT

I. Fita[a,b], A. Wisniewski[a], R. Szymczak[a], R. Puzniak[a], I. O. Troyanchuk[c], D. V. Karpinsky[c], V. Markovich[d], and H. Szymczak[a]

[a]Institute of Physics, Polish Academy of Sciences, Warsaw, Poland

[b]Donetsk Institute for Physics and Technology, NAS, Donetsk, Ukraine

[c]Scientific-Practical Materials Research Centre of NAS of Belarus, Minsk, Belarus

[d]Department of Physics, Ben-Gurion University of the Negev, Beer-Sheva, Israel

Ferromagnetic perovskite cobaltites $La_{1-x}M_xCoO_3$ (M = Ca, Sr, Ba) have unusual magnetic and transport properties due to the unique feature of the Co ion to change its spin-state. Their large sensitivity to the external pressure is caused by the strong dependence of the crystal-field splitting energy $\Delta_{cf} \sim (d_{Co-O})^{-5}$ on variation in the Co-O bond length $\sim d_{Co-O}$. They demonstrate a complex dependence of pressure coefficient dT_C/dP both on doping level and on size of dopant ion. An essentially positive dT_C/dP coefficient found for Ba compound is in strong contrast to that one found for Ca and Sr cobaltites, where the dT_C/dP changes sign from negative to positive with increasing doping. We demonstrate that the sign reversal of dT_C/dP can be caused by the hole-doping and also, independently, by the lattice expansion only, realized by increasing size of dopant ion at constant hole-doping level. It is shown also that the complex pressure effect on ferromagnetic transition T_C in cobaltites can be successfully described in terms of the competing e_g-electron bandwidth W and crystal-field splitting energy Δ_{cf}, taking into account the pressure dependent steric factors.

O-1-11

SPIN-ORBITAL LIQUID ON A TRIANGULAR LATTICE

Andrzej M. Oleś[a,b] and Jiří Chaloupka[b,c]

[a] Marian Smoluchowski Institute of Physics, Jagellonian University, Reymonta 4, PL-30059 Kraków, Poland

[b] Max-Planck-Institut FKF, Heisenbergstrasse 1, D-70569 Stuttgart, Germany

[c] Department of Condensed Matter Physics, Masaryk University, Brno, Czech Republic

Strong coupling between spins and orbital degrees of freedom in strongly correlated transition metal oxides may lead to spin-orbital entanglement and to violation of the Goodenough-Kanamori rules [1]. Here we investigate the spin-orbital d^1 model for triply degenerate t_{2g} orbitals on a triangular lattice [2] which unifies intrinsic frustration of orbital interactions with geometrical frustration. Using Lanczos exact diagonalization of finite clusters we establish that the ground state of this model is characterized by pronounced valence-bond correlations which are frustrated and fluctuate strongly. The numerical results suggest that the Goodenough-Kanamori rules are violated in some cases and the spin-orbital liquid state emerges in the thermodynamic limit [3]. Finally, we provide evidence that the resonating spin-orbital liquid involves entangled states on the bonds. We argue that: (i) quantum fluctuations play a crucial role in the ground states and magnetic transitions, and (ii) effective spin exchange constants alone do not determine spin bond correlations and spin excitations in the spin-orbital liquid.

[1] A. M. Oleś, P. Horsch, L. F. Feiner, G. Khaliullin, Phys.Rev.Lett. **96**, 147205 (2006).
[2] B. Normand and A. M. Oleś, Phys. Rev. B **78**, 094427 (2008).
[3] J. Chaloupka and A. M. Oleś, Phys. Rev. B **83**, 094406 (2011).

O-1-12

FERROMAGNETISM AND SKYRMIONS IN THE "5/2" STATE OF THE FRACTIONAL QUANTUM HALL EFFECT

A. Wójs[a,b], G. Möller[b], S. H. Simon[c], and N. R. Cooper[b]

[a]Institute of Physics, Wroclaw University of Technology, 50-370 Wroclaw, Poland

[b]Cavendish Laboratory, University of Cambridge, Cambridge CB3 0HE, UK

[c]Rudolf Peierls Centre for Theor. Physics, University of Oxford, Oxford OX1 3NP, UK

We studied charged excitations of fractional quantum Hall states in the second Landau level, allowing for spin depolarization, in particular the incompressible liquid at filling factor $\nu = 5/2$, adiabatically connected to the Pfaffian state whose spin-polarized quasiparticles (QPs) obey non-Abelian quantum statistics. Using a combination of numerical studies (exact diagonalization and quantum Monte Carlo in spherical geometry), and taking account of non-zero well widths, we demonstrated that the ground state in the absence of disorder is spin-polarized, but its elementary charge excitations may involve spin reversal. Specifically, we showed that at a sufficiently low Zeeman energy and in reasonably wide structures it is energetically favorable for pairs of charge $e/4$ QPs to bind into spin textures of charge $e/2$. These textures were identified as skyrmions based on high overlaps with model skyrmion wave functions and on pair correlation functions being essentially identical to those of their polarized "parent" ground states. We also showed that Skyrmion formation at $\nu = 5/2$ is further promoted by disorder, and argue that this can lead to a depolarized ground state in realistic experimental situations. This resolves an apparent discrepancy between theoretical expectations for a polarized (Pfaffian) ground state and recent optical experiments indicating partial depolarization.

O-1-13

MICROSCOPIC APPROACH TO DILUTED MAGNETS BASED ON THE FALICOV-KIMBALL MODEL WITH HUND COUPLING

R. Lemański and J. Wrzodak

Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Okólna 2, 50-422 Wrocław, Poland

The Falicov-Kimball model supplemented with the Hund coupling term is proposed as a relevant microscopic model for studies of diluted magnets. The model describes charge and magnetic order induced by on-site, charge-, and spin-dependent interactions between itinerant electrons and localized ions. Motivated by a discovery of the rich structure of ground-state phase diagrams, containing various charge and magnetic superstructures, we analyze the energy spectrum and determine finite temperature properties of the model at half filling. The analysis is based on calculations performed on the Bethe lattice using the Dynamical Mean Field Theory (DMFT) and on finite square clusters using exact diagonalization method. For the density of magnetic ions equal to 1 or 1/2 and not too small coupling constants we show that many-electron collective excitations derived from changes in positions of the ions or inversions their spins have much lower energy than single-electron excitations. From an analysis of the excitation spectrum structure we derive effective interactions between the ions. When the coupling constants are large enough the interactions reduce to two-body forces between ions occupying the nearest-neighboring sites.

O-1-15

THE MOTT TRANSITION IN AN EXTREMELY CORRELATED ELECTRON SYSTEM

P. R. Grzybowski and R. W. Chhajlany

[1]Institute of Physics, Adam Mickiewicz University, ul. Umultowska 85, PL-61-614 Poznań, Poland

The study of strongly correlated electronic systems is the fundamental challenge of modern condensed matter theory. We consider here a theory of the Mott transition in a most basic model of extremely correlated electrons – a model that can be traced to the very large U limit of the Hubbard model. The relevant quasi-particles in the theory are projected fermions (described by Hubbard-type operators) for the considered two species of fermions and doublons. Using a Green's function decoupling scheme, we obtain self-consistent equations for the average occupancy of projected fermions and doublons, which reveal a Mott transition at zero temperature. We identify a new exact contribution to the insulating transition from an "excluded volume"-like term. This term makes the treatment distinct from the slave-boson or Gutzwiller approaches commonly used for strongly correlated systems. We emphasize that the presented simple theory is intrinsically thermal, *i.e.* it can directly be applied to non-zero temperatures. We discuss preliminary results on the behaviour of some thermodynamic quantities.

O-1-16

MAGNETIC-FIELD-INDUCED ANISOTROPY OF HYBRIDIZATION GAP IN $CeOs_4As_12$

T. Cichorek[a], L. Bochenek[a], R. Wawryk[a], Z. Henkie[a], R.E. Baumbach[b], M.B. Maple[b]

[a]Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Wroclaw, Poland

[b]Department of Physics, University of California, San Diego, USA

Previous measurements of electrical resistivity, magnetization, specific heat and thermoelectric power on high-quality single crystals of the filled skutterudite compound $CeOs_4As_{12}$ (bcc structure) revealed its semiconducting behavior that apparently originates from a hybridization between $4f$ and conduction electrons [1]. No substantial sample dependence accompanied by a lack of the low-lying phase transition allowed for detailed low-temperature ($T \gtrsim 0.07\,\mathrm{K}$) and high-magnetic field ($B \leq 14\,\mathrm{T}$) studies of a directional dependence of the electrical resistivity $\rho(T)$: At $T \lesssim 20\,\mathrm{K}$ and for $i \parallel B$, we found remarkable dissimilarities along the [001] and [111] directions, indicative of an anisotropic suppression of energy gap(s). Additionally, differences observed between the transverse and longitudinal magnetoresistivity cannot be ascribed to the Lorentz force and thus, provide a further evidence for magnetic-field-induced anisotropy of hybridization gap in $CeOs_4As_{12}$. Finally, we note a well-defined T^2 dependence of the resistivity below around $T = 1.3\,\mathrm{K}$ and in $B \geqslant 7\,\mathrm{T}$ that also highlights strongly correlated electron phenomena in $CeOs_4As_{12}$.

[1] R.E. Baumbach *et al*, PNAS 105, 17307 (2008).

O-1-17

KONDO-LATTICE BEHAVIOUR IN $CeRhSn_{1-x}In_x$ AS A FUNCTION OF CARRIER NUMBER

A. Ślebarski, M. Fijałkowski and J. Goraus

Institute of Physics, University of Silesia, 40-007 Katowice, Poland

CeRhSn has attracted special interest due to its non-Fermi liquid (NFL) behavior at the low temperatures, well described by the Griffiths-McCoy model. In contrast, for the compound CeRhIn various experimental methods unanimously revealed a NFL ground state with a high Kondo temperature of about 300 K and an intermediate-valence behaviour of Ce. To get deeper insight into the interactions responsible for the change in ground state properties between CeRhSn and CeRhIn, we performed a detailed study of the magnetic susceptibility and specific heat for the system of $CeRhSn_{1-x}In_x$ alloys. In this system the carrier concentration diminishes upon In substitution for Sn. The ground state properties are discussed as a function of variable valence electron number induced by substitution of In for Sn and of the accompanying effect of the change hybridization energy V between f-electron and conduction electron states.

P-1-01

SPECIFIC HEAT JUMP AND THERMODYNAMIC CRITICAL FIELD FOR CALCIUM UNDER THE PRESSURE AT 120 GPa

R. Szczęsniak, A.P. Durajski, M.W. Jarosik
Institute of Physics, Częstochowa University of Technology, Al. Armii Krajowej 19, 42-200 Częstochowa, Poland

The thermodynamic properties of the superconducting state in the *Pnma* phase of Calcium for the pressure value 120 GPa have been determined by using the Eliashberg model. It has been shown, that the value of the dimensionless ratio $\frac{\Delta C(T_C)}{C^N(T_C)}$ is higher than in the BCS theory. In contrast, the ratio $\frac{T_C C^N(T_C)}{H_C^2(0)}$ is smaller. The numerical results have been supplemented by the analytical approach.

P-1-02

PROPERTIES OF THE SUPERCONDUCTING STATE IN COMPRESSED SULPHUR

A.P. Durajski, R. Szczęsniak, M.W. Jarosik
Institute of Physics, Częstochowa University of Technology, Al. Armii Krajowej 19, 42-200 Częstochowa, Poland

The thermodynamic properties of the superconducting state in Sulphur under the pressure at 160 GPa were obtained. It has been proven that: (i) the Coulomb pseudopotential is equal to 0.127 for $T_C = 17$ K; (ii) the dimensionless ratios: $2\Delta(0)/k_B T_C$, $\Delta C(T_C)/C^N(T_C)$ and $T_C C^N(T_C)/H_C^2(0)$ differ from the BCS values; (iii) the ratio of the electron effective mass to the bare electron mass is high and reaches its maximum equal to ~ 1.77 for T_C.

P-1-03

ANISOTROPY AND QUASI–2D BEHAVIOR OF MAGNETOELECTRIC $LiCoPO_4$ COMPOUND

J. Wieckowski[a], M. U.Gutowska[a], A. Szewczyk[a], A. Wisniewski[a], R. Puzniak[a], R. Diduszko[a], Yu. Kharchenko[b], M. F. Kharchenko[b], and H. Schmid[c]

[a]Institute of Physics, Polish Academy of Sciences, Al. Lotnikow 32/46, 02-668 Warsaw, Poland

[b]B. Verkin Institute for Low Temperature Physics and Engineering, National Academy of Sciences of Ukraine, pr. Lenina 47, 61103 Kharkiv, Ukraine

[c]Department of Inorganic, Analytical and Applied Chemistry, University of Geneva, 30 quai Ernest-Ansermet, 1211 Geneva 4, Switzerland

The $LiCoPO_4$ olivine exhibits a unique set of physical properties, e.g., strong linear magnetoelectric effect, large uniaxial magnetic anisotropy, quasi–2D magnetic structure, and a large Li-ionic conductivity, which makes it attractive for basic and applied studies. Specific heat, magnetic torque, and magnetization of $LiCoPO_4$ olivine were measured. It was shown that near the Néel temperature, $T_N = 21.6$ K, magnetic contribution to the specific heat can be described satisfactorily by logarithmic divergence, as expected for a quasi–2D antiferromagnetic Ising system. An effect of influence of magnetic field on the magnetocrystalline anisotropy was discovered. It manifests itself as a first-order transition induced by magnetic field of 8 T at $\sim$ 9 K. Physical nature of this transition was explained and a model describing experimental dependences satisfactorily was proposed.

P-1-04

STABLE AND METASTABLE PHASES IN THE ATOMIC LIMIT OF THE EXTENDED HUBBARD MODEL

Konrad Kapcia and Stanisław Robaszkiewicz

Electron States of Solids Division, Faculty of Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland

We have studied a simple effective model of charge ordered insulators. The tight binding Hamiltonian consists of the effective on-site interaction U and the intersite density-density interaction W between nearest-neighbors. In the analysis of the phase diagrams and thermodynamic properties of this model we have adopted the variational approach, which treats the on-site interaction term exactly and the intersite interactions within the mean-field approximation. Our investigations of the general case (as a function of the electron concentration n and as a function of the chemical potential μ) have shown that a tricritical line and a critical-end-point line, a line of isolated critical points (which meet at a new multicritical point) connected with (first- and second order) transitions between stable phases are present in the phase diagram of the model. In this report we concentrate on the metastable phases and transitions between them. One finds that the first- and second order transitions between metastable phases can exist in the system. These transitions occur also in the neighborhood of second order transition between stable phases.

P-1-05

INTERPLAY BETWEEN CHARGE AND MAGNETIC ORDERINGS IN THE ZERO-BANDWIDTH LIMIT OF THE EXTENDED HUBBARD MODEL

Konrad Kapcia[a], Waldemar Kłobus[b] and Stanisław Robaszkiewicz[a]

[a]Electron States of Solids Division, Faculty of Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland

[b]Division of Quantum Electronics, Faculty of Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland

A simple effective model of charge ordered and (or) magnetically ordered insulators is studied. The tight binding Hamiltonian analyzed consists of (i) the effective on-site interaction U, (ii) the intersite density-density interaction W and (iii) intersite magnetic exchange interaction J^z (or J^{xy}) between nearest-neighbors. One shows that the systems considered can exhibit very interesting multicritical behaviors, including among others bicritical, tricritical, tetracritical and critical end points. The analysis of the model has been performed for an arbitrary electron concentration as well as an arbitrary chemical potential. The phase diagrams are shown to consist of at least 9 different states, including four homogenous phases: nonordered (NO), ferromagnetic (F), charge ordered (CO), ferrimagnetic (intermediate, I) and five types of phase separation: NO – NO, F – NO, F – F, CO – F, CO - I. The results obtained within the variational approach (which treats the on-site interaction term exactly and the intersite interactions within the mean-field approximation) are compared with rigorous results, which can be obtained in some particular cases.

P-1-06

EXACT RESULTS FOR THE ZERO-BANDWIDTH EXTENDED HUBBARD MODEL WITH INTERSITE CHARGE AND MAGNETIC INTERACTIONS

Waldemar Kłobus[a], Konrad Kapcia[b], and Stanisław Robaszkiewicz[b]

[a]Division of Quantum Electronics, Faculty of Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland

[b]Electron States of Solids Division, Faculty of Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland

The extended Hubbard model in the zero-bandwidth limit is studied. The Hamiltonian consists of (i) the effective on-site interaction U, (ii) the intersite density-density interaction W and (iii) the intersite Ising-like magnetic exchange interaction J between nearest-neighbors. We present rigorous results obtained within the transfer-matrix method for one dimensional chain in two particular cases: (a) $W = 0$ and $n = 1$ (U-J model); (b) $U \to +\infty$ and $n = 1/2$ ($W \neq 0$, $J \neq 0$). We obtain the exact formulas for the partition function and calculate the thermodynamic properties such as entropy s, specific heat c and double occupancy per site D. The system exhibits the interesting temperature dependence of c involving a characteristic two-peak structure. In both cases there are no phase transitions at finite temperatures and the only transitions occur in the ground state: in the case (a) at $U/|J| = -1$ — (anti-)ferromagnet – nonorder transition and in the case (b) at $W/|J| = 1$ — (anti-)ferromagnet – charge-order transition. Exact ground state diagrams for the U–W–J model (at half-filling) in arbitrary dimensions are also presented.

P-1-07

ON THE PHASE DIAGRAM OF THE ZERO-BANDWIDTH HUBBARD MODEL WITH INTERSITE MAGNETIC INTERACTIONS

Szymon Murawski, Konrad Kapcia, Grzegorz Pawłowski, and Stanisław Robaszkiewicz

Electron States of Solids Division, Faculty of Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland

In this report we have analyzed a simple effective model for a description of magnetically ordered insulators. The Hamiltonian considered consists of the effective on-site interaction (U) and the intersite Ising-like magnetic exchange interaction (J) between nearest neighbours. For the first time the phase diagrams of this model have been determined within Monte Carlo simulation on 2D-square lattice. They have been compared with results obtained within varational approach, which treats the on-site term exactly and the intersite interactions within mean-field approximation. We show that, depending on the values of interaction parameters and the electron concentration, the system can exhibit not only homogeneous phases: (anti-)ferromagnetic (F) and nonordered (NO), but also phase separated states (PS: F–NO).

P-1-08

KONDO CORRELATIONS IN THE PRESENCE OF RASHBA EFFECT IN DQD-AB RING SYSTEM

P. Stefański

Institute of Molecular Physics of the Polish Academy of Sciences ul. Smoluchowskiego 17, 60-179 Poznań, Poland

A device composed of double quantum dots (DQD) placed in the arms of Aharonov-Bohm (AB) ring is investigated theoretically in the presence of Rashba effect. One of the dot, strongly coupled to the leads, is in the Kondo regime. The second QD, whose charging energy is smaller than its coupling to the leads, can be considered as non-interacting. The system is mapped onto Anderson model with Kondo impurity embedded in in the "host metal" possessing nonconstant, energy and flux dependent density of states. Due to the Rashba field this generalized density of states becomes spin-dependent and this dependence can be controlled electrically by applying an external gate. Depending on the combined action of the AB field and Rashba field the Kondo level of the first quantum dot is split as if the Zeeman field were present. Moreover, due to the geometry of the device, spin-dependent quantum interference between single particle level of the non-interacting dot and the effective Kondo channel in the interacting dot takes place. The spectral density of the Kondo dot and the phase shift as a function of the Rashba field are investigated as well as the possibility of spin filtering in conductance through the device.

P-1-09

μSR INVESTIGATION OF FERROMAGNETIC $CeIn_2$

C. Rusu[a], D. Andreica[a],R. Dudric[a],R. Tetean[a], D. P. Rojas[b], J. Rodriguez Fernandez[c], J. C. Gomez Sal[c], A. Amato[d]

[a]Faculty of Physics, Babes-Bolyai University, 400084 Cluj-Napoca, Romania
[b]Departamento de Fisica. Universidad Carlos III de Madrid. 28911. Leganes, Spain.
[c]DCITIMAC, Facultad de Ciencias, Universidad de Cantabria, 39005 Santander, Spain.
[d]Laboratory for Muon-Spin Spectroscopy, Paul Scherrer Institute, 5232 Villigen-PSI, Switzerland

$CeIn_2$ is a pure ferromagnet below 22 K one of the highest ordering temperatures in ferromagnetic Kondo lattices. Macroscopic measurements [D. P. Rojas et al., Physical Review B 80 (2009) 184413] suggested that the magnetic transition in $CeIn_2$ is of first order.
We report the results of our μSR experiments on $CeIn_2$, performed at ambient pressure and under applied pressure. From the temperature dependence of the internal field at the muon site we confirm that the transition at 22 K is of first order. Our results also suggest the existence of a precursor magnetic phase above the first order ferromagnetic transition. Both the ferromagnetic transition temperature and the local field at the muon site (measured at 2 K) are increased by the external applied pressure. However, the shape of the temperature dependence of the local field at the muon site is drastically influenced by the increase of the pressure.
The results of our μSR experiments performed at temperatures above the magnetic ordering temperature, in zero and longitudinal magnetic field configurations, are also discussed.

P-1-10

GROUND-STATE PROPERTIES OF AN EXTENDED FALICOV-KIMBALL MODEL IN TWO DIMENSIONS

Hana Čenčariková

Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, 040 01 Kosice, Slovakia

A combination of the small cluster exact diagonalization technique and the own approximate numerical method has been used to study the ground-state properties of the two-dimensional Falicov-Kimball model extended by local interaction U_{ff} between localized f electrons. Phase diagrams, valence transitions as well as energy gaps have been calculated on finite clusters up to $L = 12 \times 12$ sites in the strong, intermediate and weak interaction limit of U_{ff}. In the strong and intermediate coupling limit ($U_{ff} > 2$) only the most homogeneous (insulating) and phase-separated (metallic) configurations are the ground states of the model. However, in the opposite limit ($U_{ff} \leq 2$) a new type of charge ordering corresponding to configurations with double occupied f orbitals is formed. With decreasing U_{ff} this metallic domain is further stabilized at the expense of the most homogeneous domain, while the phase separated domain remains practically unchanged. The meaning of these results for a description of real rare-earth materials is discussed.

P-1-11
MULTIPLE PHASE SLIP PHENOMENA IN 1D SUPERCONDUCTORS

Vladimir Baranov[a], Viktor Kabanov[a]
[a]Jozef Stefan Institute, Jamova 39, SI 1000 Ljubljana, Slovenia

The current-voltage (IV) characteristics of thin superconducting wires are investigated by direct numerical integration of time-dependent Ginzburg-Landau equations (TDGL) [1] for different lengths of the wire. We have discovered few universal features of the IV characteristic that are independent on the wire's length. We have demonstrated that singularities of IV curve correspond to different bifurcation points of TDGL. The voltage appearance corresponds to the saddle-node homoclinic bifurcation leading to the formation of the limit cycle with the diverging period when $j \to j_c$. The phase slip centers (PSC) are formed in the center of the wire and IV characteristic has square root singularity [2]. The second singularity corresponds to the period doubling bifurcation. In that case two PSC's are placed symmetrically with respect to the center of the wire. Further increase of the current leads to a nonuniversal behaviour depending on the length of the wire. For longer wires the third PSC may appear in the middle of the wire. In addition, we have found some narrow regions of the current where relatively simple periodic solutions coexist with the limit cycles of higher orders.

[1] L.P. Gor'kov, N.B. Kopnin, Sov. Phys. Usp., 18, 496 (1975)
[2] L.G. Aslamazov, A.I. Larkin, JETP Letters, 9, 87 (1968)

P-1-12
ANTIFERROMAGNETIC ORDERING AND KONDO EFFECT IN SINGLE-CRYSTALLINE Ce_2NiSi_3

Maria Szlawska and Dariusz Kaczorowski
Institute of Low Temperature and Structure Research, Polish Academy of Sciences, P. O. Box 1410, 50-950 Wrocław, Poland

The compound Ce_2NiSi_3 crystallizes with a disordered hexagonal structure of the AlB_2-type. Its physical properties have been studied by means of magnetization, electrical resistivity and heat capacity measurements, performed down to 0.4 K in magnetic fields up to 9 T on an oriented single-crystalline specimen. Occurrence of distinct anomalies in the bulk characteristics signal an antiferromagnetic ordering that sets in at $T_N = 3.2$ K. In the ordered state, the *ab* component of the magnetization is much larger than that taken along the hexagonal *c* axis, and exhibits a clear metamagnetic-like transition in a field of 1 T at 0.5 K. In the paramagnetic region, both components of the magnetic susceptibility follow the Curie-Weiss law with the effective magnetic moments being close to that predicted for free Ce^{3+} ions. Large negative values of the paramagnetic Curie temperature hint at significant contribution due to Kondo interactions. This latter conjecture has been supported by the observation of negative logarithmic slopes in the temperature-dependent magnetic contributions to the electrical resistivity, as well as by the finding of enhanced electronic contribution to the specific heat at low temperatures. Altogether, our experimental results suggest that Ce_2NiSi_3 is an antiferromagnetic Kondo lattice with heavy-fermion ground state.

P-1-13

COMPARATIVE STUDY OF PHASE TRANSITIONS IN Ga-, Zn-, Ni-, Ti-SUBSTITUTED La-Sr MANGANITES

A.G. Badelin[a], S.Kh. Estemirova[b], A.V. Evseeva[a], V.K. Karpasyuk[a], A.M. Smirnov[a]

[a]Astrakhan State University, 414056, Astrakhan, Russia
[b]Institute for Metallurgy UB RAS, 620016, Yekaterinburg, Russia

The aim of the study is to examine the influence of substituting ion on the position of phase boundaries "rhombohedral-orthorhombic structure" and "semiconductor-metal" in comparison with classical phase diagrams established earlier for $La_{1-c}Sr_cMnO_3$ system.

Experimental data are shown for ceramic samples of La-Sr manganites with substitution of Mn by Ga-, Zn-, Ni-, and Ti in specifically designed systems: $La_{1-c}Sr_cMn_{1-x}Ga^{3+}{}_xO_3$, $La_{1-c+x}Sr_{c-x}Mn_{1-x}Me^{2+}{}_xO_3$ (Me=Zn, Ni), $La_{1-c-x}Sr_{c+x}Mn_{1-x}Ti^{4+}{}_xO_3$. Under the condition that concentration of oxygen is stoichiometric, the content of Mn^{4+} (f.u.) is equal to the value of "c", and is independent of x in these systems.

Bulk manganites (c=0.15, 0.17, 0.19, 0.20; $0.025 \leq x \leq 0.125$ were prepared by solid state reactions in air. Then, in order to provide stoichiometric oxygen content, the samples were processed at 1223 K and corresponding partial pressure of oxygen. It was found that divalent substituting ions shifted boundary "rhombohedral-orthorhombic structure" to higher values of "c", while Ga^{3+} and Ti^{4+} shifted it in opposite direction. The regularities of the influence of substituting ions concentrations on saturation magnetization, Curie point, resistivity and magnetoresistance were established.

P-1-14

THERMODYNAMIC AND ELECTRICAL TRANSPORT PROPERTIES OF SINGLE-CRYSTALLINE Ce_2PdGa_{12}

D. Gnida and D. Kaczorowski

Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Okolna 2, 50-422 Wroclaw, Poland

High-quality single crystals of Ce_2PdGa_{12} were studied by means of magnetization, specific heat and electrical transport measurements. The compound was previously reported to crystallize with a tetragonal crystal structure, and to order antiferromagnetically at $T_N = 11$ K [1]. Our results have confirmed those findings and additionally revealed Kondo lattice character of the electronic conduction in the paramagnetic region. At low temperatures, the electronic specific heat is strongly enhanced, suggesting that Ce_2PdGa_{12} can be regarded as a heavy-fermion antiferromagnet. In the ordered state, the electrical resistivity is governed mainly by electron-magnon scattering. In line with the antiferromagnetic nature of the ground state, the field variations of both the magnetization and the electrical resistivity exhibit metamagnetic-like anomalies at some temperature-dependent critical field. Unique sharpness of the singularities observed on the magnetoresistance isotherms hints at a first-order spin-flip character of the latter transition, however the magnetization data indicates rather a spin-flop mechanism.

[1] R.T. Macaluso *et al.*, J. Solid State Chem. 178 (2005) 3547.

P-1-15

SMEARED ANTIFERROMAGNETIC PHASE TRANSITION IN $Ce_2Cu_{2-x}Ni_xIn$

A. P. Pikul[a], D. Kaczorowski[a] and P. Rogl[b]

[a]Institute of Low Temperature and Structure Research, Polish Academy of Sciences, ul. Okólna 2, 50–422 Wrocław, Poland

[b]Institute of Physical Chemistry, University of Vienna, Währingerstrasse 42, A–1090 Wien, Austria

Ce_2Cu_2In and Ce_2Ni_2In crystallize in a primitive tetragonal structure of the Mo_2FeB_2 type. The former compound orders antiferromagnetically at the Néel temperature $T_N = 5.5$ K, while the latter one is a system with fluctuating valence [1]. Here we report on low temperature physical properties of the solid solution $Ce_2Cu_{2-x}Ni_xIn$ studied by means of x-ray powder diffraction, magnetization and electrical resistivity measurements, using polycrystalline specimens. We show that partial substitution of Cu by Ni results in a monotonic decrease of the unit cell volume. Magnetic moments of Ce^{3+} ions remain well localized with increasing x up to about 1.2, while the magnetic properties of the alloys with larger Ni contents suggest non-integer valency of cerium. In the localized regime, T_N is not suppressed to absolute zero, as might be expected. Instead, the antiferromagnetic anomaly quickly broadens with increasing x, and the ordering temperature is reduced only down to about 2.2 K for $x = 0.3$. For larger x any anomaly in the physical properties of $Ce_2Cu_{2-x}Ni_xIn$ is hardly visible. In other words, partial isostructural substitution of Cu by Ni in Ce_2Cu_2In does not result in moving the system through a quantum critical point, as observed in many otherwise similar compounds.

[1] D. Kaczorowski, P. Rogl, and K. Hiebl, Phys. Rev. B 54 (1996) 9891.

P-1-16

FINITE TEMPERATURE CROSSOVER FROM MOTT INSULATOR TO BOSE GLASS STATE IN TRAPPED BOSON SYSTEM IN THE PRESENCE OF DIAGONAL DISORDER

J. Kolasiński and G. Pawłowski

A. Mickiewicz University Poznań, Faculty of Physics, ul. Umultowska 85, 61-614 Poznań

We study a finite temperature phase diagram of the ultracold atomic gas, trapped in a periodic potential with diagonal (on-site) disorder. Such system is described by the Bose-Hubbard (BH) model. Our system is a 300 sites chain lattice, with open boundary conditions, and with 90 bosons in it. In considered system there are not only two basic phases of BH model - Mott insulator (MI) and superfluid (SF) phases - but also a third phase appears, Bose glass (BG). For simulations performed with quantum Monte Carlo method, we use the worm algorithm from ALPS libraries. The analysis of the simulation results consists in checking, how the root mean square of the atomic cloud radius changes, while squeezing it with an external, quadratic potential. From the reaction we get a signal of the MI-BG crossover. By doing few diagrams of temperature vs. disorder, for different values of hopping parameter, we get a simplified, three dimensional phase structure of this system.

P-1-17

CHARGE ORDERINGS AND PHASE SEPARATIONS IN ITINERANT FERMION SYSTEMS AT HALF FILLING

W. R. Czart, P. Grzybowski, M. Nogala and S. Robaszkiewicz
Faculty of Physics, A. Mickiewicz University
ul. Umultowska 85, 61-614 Poznań, Poland

We analyse the ground state phase diagrams and thermodynamic properties of the charge orderings (CO) in narrow band materials using two effective models: (i) the spinless fermion model with repulsive intersite interaction ($W_{ij} > 0$) and (ii) the molecular crystal (MC) model with the coupling to intramolecular (crystal field) vibrations. We present results for the case of half filled bands for the hypercubic lattices of infinite dimension ($d = \infty$) and compare them with the results for $d = 2$ square latice. The calculations are performed within the (broken symmetry) HFA, which for the models with intersite interactions only, yield exact results for $d = \infty$. We focus our study on the problem of phase separations (PS) involving CO and the effects of next-nearest-neighbor hopping (t_2) on the charge ordered states in these systems. The ground state phase diagrams are evaluated for several representative cases. The results for $t_2 \neq 0$ are compared with those found for the case with nearest neighbor hopping only. The results we show here are an extension of our previous studies on the subject.

P-1-18

STUDY OF MAGNETIC CONTRIBUTION TO THE HEAT CAPACITY OF $YbCu_4Ni$

I. Čurlik[a], M. Reiffers[a,b], M. Giovannini[c]
[a]Institute of Experimental Physics, Watsonova 47, SK-040 01 Košice, Slovakia
[b]Faculty of Sciences, University of Prešov, 17.novembra, SK-080 78 Prešov, Slovakia
[c]Department of Chemistry, University of Genova, Via Dodecaneso 31, I-16146 Genova, Italy

Strong correlation between electrons, due to hybridization of f-electrons and conduction electrons, can cause a number of outstanding low temperature features. Among the rare earths, a large number of these phenomena is found for Ce- and Yb - based compounds. The interest in this topic was triggered by the investigation on the heavy fermions $YbCu_4T$ (T = Ag, Au), which crystallize in an ordered derivative of the AuBe5-type. Recently the new compounds $YbCu_4Ni$ was studied. This compound is a new heavy fermion (HF) member of the series of $YbCu_4M$ (M = metal). In this paper we present the results of study of the magnetic contribution to heat capacity of $YbCu_4Ni$ 0.4 K. We measured the temperature dependence of heat capacity of an isomorphous $LuCu_4Ni$, in order to determine the magnetic part of entropy. The Schottky anomaly fit allowed us to estimate the CEF splitting.

P-1-19

TRANSPORT AND MAGNETIC PROPERTIES OF $YbCu_4Ni$

I. Čurlik[a], Š. Máťošová[a], S. Ilkovič[b], M. Reiffers[a,b], M. Giovannini[c]

[a]Institute of Experimental Physics, Watsonova 47, SK-040 01 Košice, Slovakia

[b]Faculty of Sciences, University of Prešov, 17.novembra, SK-080 78 Prešov, Slovakia

[c]Department of Chemistry, University of Genova, Via Dodecaneso 31, I-16146 Genova, Italy

Strong correlation between electrons, due to hybridization of f-electrons and conduction electrons, can cause a number of outstanding low temperature features. Among the rare earths, a large number of these phenomena is found for Ce- and Yb - based compounds. The interest in this topic was triggered by the investigation on the heavy fermions $YbCu_4T$ (T = Ag, Au), which crystallize in an ordered derivative of the AuBe5-type. Recently the new compounds $YbCu_4Ni$ was studied. This compound is a new heavy fermion (HF) member of the series of $YbCu_4M$ (M = metal). In this paper we present the results of study of an influence of magnetic field on the temperature dependence of electrical resistivity till 0.4 K. Moreover, we extended our previous susceptibility measurements till high temperatures of 1000 K, in order to study possible mixed valence behaviour.

P-1-20

ENTANGLED SPIN-ORBITAL PHASES IN THE d^9 MODEL

Wojciech Brzezicki and Andrzej M. Oleś

Marian Smoluchowski Institute of Physics, Jagellonian University, Reymonta 4, PL-30059 Kraków, Poland

The phase diagram of the spin-orbital (SO) Kugel-Khomskii (d^9) model posed a challenging theoretical problem [1], yet it is still unknown. Here we investigate the phase diagrams of the d^9 model, depending on Hund's exchange J_H and the e_g orbital splitting E_z, for a bilayer and a monolayer square lattice using Bethe-Peierls-Weiss method with exact diagonalization of a cubic or square cluster coupled to its neighbors in ab planes by the mean-field (MF) terms. The cluster MF method confirms existence of singlet phases similar to those obtained by variational wave functions [2], and enables finite SO order parameter independent of spin and orbital ordering. For a bilayer we obtain phases with interlayer spin singlets stabilized by holes in $3z^2-r^2$ orbitals and with alternating plaquette valence-bond (PVB) as well as two new phases with SO entanglement, in addition to the antiferromagnetic (G-AF, A-AF) and ferromagnetic (FM) order. For a monolayer we obtained at temperature $T=0$: (i) the PVB phase, (ii) two AF phases with either $3z^2-r^2$ or x^2-y^2 orbitals occupied, and (iii) a FM phase. However, after including thermal fluctuations ($T>0$) we found the same entangled SO phases as for a bilayer at $T=0$. This shows that both quantum and thermal fluctuations can stabilize phases with exotic SO order while the classical spin order is destroyed.

[1] L. F. Feiner, A. M. Oleś, and J. Zaanen, Phys. Rev. Lett. **78**, 2799 (1997).

[2] A. M. Oleś, Acta Phys. Polon. A **115**, 36 (2009).

P-1-21

CHARGE, SPIN AND ORBITAL ORDER IN LAYERED NICKELATES

Krzysztof Rościszewski[1] **and Andrzej M. Oleś**[1,2]

[1] Marian Smoluchowski Institute of Physics, Jagellonian University, Reymonta 4, PL-30059 Kraków, Poland

[2] Max-Planck-Institut für Festkörperforschung, Heisenbergstrasse 1, D-70569 Stuttgart, Germany

The phenomenon of stripes in strongly correlated transition metal oxides in not fully understood. Here we study an effective model for e_g electrons and describe stripe order observed in doped, quasi-two-dimensional $La_{2-x}Sr_xNiO_4$ nickelates. The Hamiltonian contains the kinetic energy, electron interactions, crystal-field splitting and the coupling between e_g electrons and Jahn-Teller distortions. (This model was successfully used in the past to describe cuprates and, more recently, layered [1,2] and perovskite [3] manganites). We determined its ground states on 6×6 clusters using unrestricted Hartree-Fock and correlated wave functions. The experimental non-conducting ground state phases with diagonal stripes for the doping $x = 1/3$ and two-sublattice checkerboard phase for the doping $x = 1/2$ are both reproduced by the model. We show that Jahn-Teller distortions stabilize the above phase and are responsible for the coexisting charge, spin and orbital order; in their absence the charge order melts and the ground states become conducting.

[1] K. Rościszewski and A. M. Oleś, J. Phys.: Condensed Matter **19**, 186223 (2007).
[2] K. Rościszewski and A. M. Oleś, J. Phys.: Condensed Matter **20**, 365212 (2008).
[3] K. Rościszewski and A. M. Oleś, J. Phys.: Condensed Matter **22**, 425601 (2010).

P-1-22

PROPERTIES OF MANGANITES $La_{1-c+x}Sr_{c-x}Mn_{1-x}Me^{2+}_xO_3$ DEPENDING ON ELECTRON CONFIGURATION OF SUBSTITUTING DIVALENT IONS

E.P. Firsova, A.V. Evseeva, A.G. Badelin, A.M. Smirnov, V.K. Karpasyuk

Astrakhan State University, 414056, Astrakhan, Russia

We have studied the role of electron configuration of substituting divalent ions on the properties of perovskites $La_{1-c+x}Sr_{c-x}Mn_{1-x}Me^{2+}{}_xO_3$, where Me=Mg, Zn, Ni. The substituents were chosen taking into account that $Mg^{2+}(2p^6)$ ion has completely filled p-electron shell, while $Zn^{2+}(3d^{10})$ has completely filled d-shell; they have similar ionic radii (0.072 and 0.074 nm) and are diamagnetic. $Ni^{2+}(3d^8)$ has a spin magnetic moment of 2 μ_B and ionic radius 0.069 nm, while the moment of $Mn^{3+}(3d^4)$ ion is 4 μ_B, its radius is 0.0645 nm. The system of chemical compositions was designed so that the hole concentration (in formula units) is independent of substituent amount, if the content of oxygen remains constant. Several sets of coefficients c, x were chosen near phase boundary "orthorhombic-rhombohedral structure", where properties are most sensitive to composition. It was found that Curie point, saturation magnetization, and temperature dependence of resistivity vary with substituting element in manganites having identical values of c, x. For example, saturation magnetization of Mg-substituted samples with x=0.075 and c=0.15 - 0.19 is greater than of Zn-substituted one, but Curie point is roughly the same. Manganites containing Ni exhibit maximum values of magnetization and Curie point. Magnetoresistance of some Zn-substituted samples reaches -1300% at 9.2 kOe.

P-1-24

SPIN-TRIPLET PAIRING INDUCED BY HUND'S RULE EXCHANGE IN ORBITALLY DEGENERATE SYSTEMS: HARTREE-FOCK APPROXIMATION

Michał Zegrodnik, Jozef Spałek
Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, Reymonta 9, 30-059 Krakow, Poland

Spin-triplet pairing induced by the Hund's rule exchange was proposed some time ago, as well as its coexistence/competition with the ferromagnetic and orbital types of ordering within simplified models. In this work we include the effect of interband hybridization and treat the problem by starting from an extended Hubbard model for doubly degenerate band and making the simplest Hartree-Fock approximation for the parts involving the pairing and the Hubbard terms. The conditions of stability of various phases are determined as a function of both band filling and microscopic parameters. The phase diagram contains regions of stability of the spin-triplet superconducting phase coexisting with either saturated or non-saturated ferromagnetism. For comparison, phase diagram for the cases of constant density of states and that of square lattice, have been presented. The influence of hybridization on the stability of considered phases as well as the temperature dependence of magnetic moment and the superconducting gap is also provided.
One of the authors (M.Z.) acknowledges the scholarship from Interdisciplinary Ph. D. School financed by EU Program POIG. The authors acknowledge also the financial support of the Foundation for Polish Science (FNP).

P-1-25

THERMOELECTRIC POWER AND THERMAL CONDUCTIVITY OF HEAVY FERMION $CeCu_4Al$

M. Falkowski and A. Kowalczyk
Institute of Molecular Physics, Polish Academy of Sciences, Smoluchowskiego 17, 60-179 Poznań, Poland

The thermal conductivity and thermopower are discussed for the heavy fermion $CeCu_4Al$ compound. $CeCu_4Al$ is paramagnetic and follows the Curie-Weiss law with $\mu_{\rm eff} = 2.53\mu_{\rm B}$/f.u. and $\theta_{\rm p}$ = -10 K indicating on the presence of well localized magnetic moments of Ce^{3+} ions. The determined electronic specific heat coefficient $\gamma = 2.2$ Jmol^{-1}K^{-2} confirms the heavy fermion character of this compound. Thermopower is positive over the whole temperature range and below $T_{\rm max}$ = 27 K falls rapidly. Based on a simple band model the position and width of the 4f peak nearest to the Fermi level have been estimated. The measured total thermal conductivity of the $CeCu_4Al$ compound increases almost linearly with increasing temperature.
This work was supported by the funds for science in years 2009-2011 as a research project No. N N202 229537

P-1-26

THERMAL FLUCTUATIONS OF$(Tl_{0.5}Pb_{0.5})Sr_2(Ca_{0.9}Gd_{0.1})Cu_2O_z$ BULK SUPERCONDUCTORS

W. M. Woch[a], M. Chrobak[a], A. Kołodziejczyk[a], G. Gritzner[b]

[a]Solid State Physics Department, Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, Mickiewicza 30, 30-059, Krakw, Poland

[b]Institute for Chemical Technology of Inorganic Materials, Johannes Kepler University, A4040 Linz, Austria

The critical region around the superconducting transition temperature T_{c0} in the high temperature superconductors shows the competition between critical and stochastic gaussian fluctuations. In the paper the critical exponents λ of the conductivity have been calculated of the thallium based superconductors $(Tl_{0.5}Pb_{0.5})Sr_2(Ca_{0.9}Gd_{0.1})Cu_2O_z$ using the following formula [1]: $\Delta\sigma = K\varepsilon^{-\lambda}$ where $\varepsilon = (T - T_{c0})/T_{c0}$, K is a constant, $\Delta\sigma = \frac{1}{R} - \frac{1}{R_R}$ where $R_R = R0 + (dR/dT)T$. R_0 and dR/dT are constants. The dR/dT is calculated from R(T) curve in the temperature range well above the critical temperature T_{c0}. In the high temperature superconductors the short-lived Cooper pairs fluctuate in rather broad temperature region around the critical temperature mainly due to the very short coherence length. The experimental results were analyzed taking into account the stochastic gaussian fluctuations with the exponent $\lambda = 2 - d/2$ as well as the true critical fluctuations with the critical exponent $\lambda = \nu(2 + z + d + \eta)$, where $\nu = 2/3$, $z \cong 3/2$, $\eta \cong 0$ and d = 1, 2 or 3 is the dimension of the fluctuating system [2].

The critical exponent in the closest to T_{c0} temperature interval was calculated and the true critical fluctuations and the gaussian fluctuations in different temperature intervals have been determined.

[1] P. Pureur, R. Menegotto Costa, P. Rodrigues, Jr., J. Schaf, J.V. Kunzler, *Phys. Rev.* **B** 47 (1993) 11420.
[2] R. Menegotto Costa, P. Pureur, M. Gusmao, S. Senoussi, K. Behnia, *Phys. Rev.* **B** 64 2001 214513.

P-1-27

MAGNETIC FIELD EFFECT ON RESISTIVE TRANSITION OF THALLIUM BASED SUPERCONDUCTORS

W. M. Woch, A. Kołodziejczyk

Solid State Physics Department, Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, Mickiewicza 30, 30-059, Krakw, Poland

The resistive transition from a normal to the superconducting state of high temperature superconductors is almost always significantly broadened as compared to the low temperature superconductors. Especially the width of the resistive transition increases when the applied magnetic field or the large flowing current is present. The thallium based superconductors are characterized by the widening of the resistive transition below the critical temperature when the applied magnetic field is switch on.

The field-broadened resistive transition may be described by the following equation: $\Delta T = CH^m + \Delta T_0$, where the width of the resistive transition was usually defined by the formula: $\Delta T = T_{90\%} - T_{10\%}$ [1] The value of m should be 2/3, but it was found to depend on some properties of a superconductor. ΔT_0 is the width of the resistive transition at zero applied magnetic field and the coefficient C depends on the critical current at zero magnetic field and on the critical temperature.

In this paper we study the magnetic field dependence of the onset transition temperatures, the critical temperatures and the zero resistive critical temperatures of the selected thallium based superconductors.

[1] W.M. Woch, R. Zalecki, A. Kołodziejczyk, O. Heiml and G. Gritzner, *Physica C* **434** (2006) 17.

P-1-28
EXTENDED HUBBARD MODEL ON DIAMOND CHAIN

Onofre Rojas and S. M. de Souza
Departamento de Ciencias Exatas, Universidade Federal de Lavras, 3037 CEP 37200000, Lavras-MG, Brazil

Motivated due to a large number of quasi-one-dimensional organic polymers, which can be described using the Hubbard model on diamond chain, we will discuss the extended Hubbard model on diamond chain. A particular case of the extended Hubbard model on diamond chain will be considered, where the hopping terms acts on two diamond sites, and with all sites assembled by onsite Coulomb repulsion term and nearest neighbor Coulomb repulsion. In the present model we also include an external magnetic field in order to study its magnetic properties, and the chemical potential is also considered in order study particle flux with its environment. On the other hand, the decoration or iteration transformation, were widely applied to solve exactly the magnetic spin models in one-dimensional and two-dimensional lattice. This approach recently was adapted for interacting electron systems [O. Rojas and S. M. de Souza, Phys. Lett. A, 387 (2011) 1947]. Therefore using the decoration transformation for interacting electron system, we are able to solve this model exactly. The phase diagram of this model was explored at zero temperature, where we find a quite rich phase diamgram, finding several frustrated states, assuming arbitrary number of particles and under the influence of external magnetic field. The influence of frustration at low temperature for the entropy is discussed, and other thermodynamics properties also is discussed such as specific heat, magnetization and particle density.

P-1-29
SPIN-CHARGE COUPLING IN CHIRAL SPIN SYSTEMS

Jacek D. Kosowicz
Institute of Physics, Wroclaw University of Technology,
Wybrzeze Wyspianskiego 27, 50 - 370 Wroclaw, Poland

In chiral spin systems there is a coupling of charge and spin degrees of freedom. It means that there is a possibility that we can excite spin and electric degrees of freedom simultaneously by electromagnetic field. Close to the resonance both ϵ and μ can be independently negative. Magnetic field excites magnetic states and electric field excites electric states. These states are different from each other. Due to the coupling of degrees of freedom there is a possibility that frequencies of electromagnetic field (slightly below the resonance) will result in simultaneous negative values of ϵ and μ. In such a case refraction index is negative. We evaluated window of ω, where refractive index is negative in the case of triangular lattice and toys lattices (ladder, square, "tube"). We found that the window for triangular lattice is narrower than for toys lattices (square), which have equivalent model parameters (lattice constant and exchange interaction between nearest neighbours).

P-1-30
TWO KONDO IMPURITIES IN ARMCHAIR GRAPHENE NANORIBBON

S. Lipiński, D. Krychowski
Institute of Molecular Physics, Polish Academy of Sciences, Smoluchowskiego 17, 60-179 Poznań, Poland

An interplay of Kondo effect and inter-impurity correlations in the armchair graphene nanoribbon is studied. The mean field slave boson approach and the equation of motion method are used. The impurities are placed on the sites belonging either to the same or to different graphene sublattices or in the centers of lattice hexagons. Depending on the position of impurities the exchange interaction is ferromagnetic or antiferromagnetic. The relative strength of exchange interaction and Kondo coupling changes with doping and various cases of magnetic ordering or Kondo screening are observed.

P-1-31
THE MUTUAL STABILITY OF PHASES IN THE (HARD-CORE) BOSON-FERMION MODEL

M. Sidowski and S. Robaszkiewicz
Division of Electronic States of Solids,
Institute of Physics Adam Mickiewicz University,
ul. Umultowska 85, 61-614 Poznań

We present the results of investigations of a system of coexisting local pairs and itinerant electrons described by the (hard-core) boson-fermion model. The conditions of coexisting of phases such as superconducting (SC) and nonordered (normal) states, the CDW phase and the so-called charge Kondo state (CKS) are discussed. The calculations have been made within an extended mean-field approximation, and the mutual stability of the considered phases for various densities of states and the finite temperature phase diagrams of the model are also discussed.

P-1-32

STABILITY OF SUPERFLUID PHASES IN THE 2D SPIN-POLARIZED ATTRACTIVE HUBBARD MODEL

A. Kujawa-Cichy[a] and R. Micnas[a]

[a]Solid State Theory Division, Faculty of Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland

We study the evolution from the weak coupling (BCS-like limit) to the strong coupling limit of tightly bound local pairs (LP's) with increasing attraction, in the presence of the Zeeman magnetic field (h) for $d = 2$, within the spin-polarized attractive Hubbard model. The broken symmetry Hartree approximation and strong coupling expansion are used. We also apply the Kosterlitz-Thouless (KT) scenario to determine the phase coherence temperatures. For spin independent hopping integrals ($t^{\uparrow} = t^{\downarrow}$), we find no stable homogeneous polarized superfluid (SC_M) state in the ground state for the strong attraction and obtain that for a two-component Fermi system on a 2D lattice with population imbalance, phase separation is favored for a fixed particle concentration, even on the LP (BEC) side. We also examine the influence of spin dependent hopping integrals (mass imbalance) on the stability of the SC_M phase. We find a topological quantum phase transition (Lifshitz type) from the unpolarized superfluid phase (SC_0) to SC_M and tricritical points in the ($h - |U|$) and ($t^{\uparrow}/t^{\downarrow} - |U|$) ground state phase diagrams. We also construct the finite temperature phase diagrams for both $t^{\uparrow} = t^{\downarrow}$ and $t^{\uparrow} \neq t^{\downarrow}$ and analyze the possibility of occurrence of a spin polarized KT superfluid.

P-1-33

THE COEXISTENCE OF SUPERCONDUCTIVITY AND ANTIFERROMAGNETISM IN THE SINGLE BAND MODEL

K. Kucab, J. Mizia and G. Górski

Institute of Physics, University of Rzeszów, Poland

The extended Hubbard model is used to analyze the coexistence of antiferromagnetism (AF) and superconductivity (SC) in YBaCuO. While departing from the half-filled point concentration the band expands rapidly due to the hopping interaction. This expansion causes disappearance of AF already close to the half-filled point, in agreement with the experimental situation. The s-wave superconductivity disappears under the action of strong Coulomb on-site repulsion. The d-wave SC is created by the charge-charge interaction. Treating strong Coulomb on-site repulsion in the CP approximation (all other weaker interactions are treated in the Hartree-Fock approximation) pushes critical curve for this type of superconductivity further away from the half-filled point in agreement with the experimental evidence. As a result we obtain diagram for the Néel and the superconducting critical temperature which is close to the experimental outcome.

P-1-34

VARIATIONAL STUDY OF THE EXTENDED PERIODIC ANDERSON MODEL

I. Hagymási[a,b], K. Itai[a] and J. Sólyom[a]

[a]Research Institute for Solid State Physics and Optics of the Hungarian Academy of Sciences 1525 Budapest P.O. Box 49, Hungary

[b] Eötvös University, Pázmány Péter sétány 1/A, H-1117 Budapest, Hungary

We investigate the extended periodic Anderson model, where besides the standard on-site f-electron interaction ($U_f \sum_{\mathbf{j}} \hat{n}^f_{\mathbf{j}\uparrow}\hat{n}^f_{\mathbf{j}\downarrow}$) there is an on-site interaction between the conduction electrons ($U_d \sum_{\mathbf{j}} \hat{n}^d_{\mathbf{j}\uparrow}\hat{n}^d_{\mathbf{j}\downarrow}$) and another one between the doubly occupied f- and d- electron levels ($\widetilde{U}_{df} \sum_{\mathbf{j}} \hat{n}^f_{\mathbf{j}\uparrow}\hat{n}^f_{\mathbf{j}\downarrow}\hat{n}^d_{\mathbf{j}\uparrow}\hat{n}^d_{\mathbf{j}\downarrow}$). We use the modified Gutzwiller trial wave function which consists of projecting out the doubly occupied d- and f-sites with different amplitudes. The previous variational studies focused on the analytically tractable cases (e.g. weak or infinite interaction strength, weak hybridization). Our calculations do not need to assume such restrictions of the parameter regimes. Except for the Gutzwiller approximation no further approximations are applied.
The effect of the finite U_d interaction is investigated. We show that the above interaction between the doubly occupied f- and d- levels causes that the intermediate valent regime decreases and the Kondo-regime increases. The f-level occupancy as a function of the f-level energy is qualitatively in a good agreement with other numerical calculations. The variational investigation of the general d-f interaction ($U_{df} \sum_{\mathbf{j},\sigma,\sigma'} \hat{n}^f_{\mathbf{j}\sigma}\hat{n}^d_{\mathbf{j}\sigma'}$) is in progress.

P-1-35

COMPETITION BETWEEN ELECTRON-PHONON COUPLING AND SPIN FLUCTUATIONS IN SUPERCONDUCTING HOLE-DOPED CuBiSO

Luciano Ortenzi[a], Silke Biermann[b], Ole Krogh Andersen[a], I.I. Mazin[c] and Lilia Boeri[a]

[a]Max-Planck-Institut für Festkörperforschung, Heisenbergstraβe 1, D-70569 Stuttgart, Germany

[b]Centre de Physique Théorique, Ecole Polytechnique, CNRS-UMR7644, 91128 Palaiseau, France

[c]Naval Research Laboratory, 4555 Overlook Avenue SW, Washington, DC 20375, USA

CuBiSO is a band insulator, that becomes metallic upon hole doping. Both the crystal and electronic structure are similar to that of Fe-pnictides superconductors, albeit with very different electronic filling. Superconductivity was recently reported in doped $Cu_{1-x}BiSO$ and attributed to spin fluctuations as the pairing mechanism. Based on first principles calculations of the electron-phonon coupling, we argue that the latter is very strong in this material, and probably drives superconductivity. The critical temperature is however strongly depressed by the proximity to magnetism. Thus, $Cu_{1-x}BiSO$ is a quite unique compound where both a conventional phonon-driven and an unconventional triplet superconductivity are possible, and compete with each other. We argue that, in this material, it should be possible to switch from conventional to unconventional superconductivity by varying such parameters as doping or pressure.

P-1-36

MAGNETIC PROPERTIES OF $EuNiO_3$ THIN FILMS

K. Bilewska[1], J. Szade[1], P. Ruello[2], E. Wolna[1] and M. Edely[2]

[1]Institute of Physics, University of Silesia, Uniwersytecka 4, 40-007 Katowice, Poland

[2]Laboratoire de Physique de l'État Condensé, UMR CNRS 6087, Université du Maine, 72085 Le Mans, France

$RNiO_3$ (R-rare earth) is a family of compounds that in certain temperatures undergo antiferromagnetic-paramagnetic and metal-insulator phase transitions. Their properties are not yet fully understood. Correlated electron $EuNiO_3$ thin films of various thicknesses and deposited on different substrates by RF magnetron sputtering were studied. Magnetic measurements were performed with SQUID magnetometer. Curves of magnetization versus temperature and versus applied magnetic field were obtained. Results indicate that surprisingly $EuNiO_3$ thin films are not antiferromagnetic in the studied temperature regime. Instead, they turn out to have a ferro- or ferrimagnetic character and show hysteretic behaviour with the change of external field. This can be presumably a result of surface effects or charge disproportionation of nickel in those compounds which assumes the existence of nickel in two nonequivalent states- weakly magnetic $Ni^{3+\delta}$ and strongly magnetic $Ni^{3-\delta}$. Surface sensitive studies and calculations are on the way to confirm obtained experimental results.

P-1-38

METAMAGNETISM AND MAGNETIC FIELD DEPENDENCE OF QUASIPARTICLE EFFECTIVE MASS WITHIN PERIODIC ANDERSON MODEL

Olga Howczak[a] and Jozef Spałek[a,b]

[a]Marian Smoluchowski Institute of Physics, Jagiellonian University, 30-059 Kraków, Poland

[b]Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, 30-059 Kraków, Poland

We apply the extended Gutzwiller method to the periodic Anderson model subject to an applied magnetic field. Our results concerning the ferromagnetic solutions show that the applied magnetic field strongly affects the low-energy excitations in the system. We find that for large values of hybridization strength the system enters the so-called *locked heavy fermion state*. In this state the chemical potential lies in the spin-up hybridization gap and as a consequence the system is insensitive to further increase of magnetic field. We show that for a sufficiently strong magnetic field strength h_c the system leaves the locked state and becomes fully polarized. This is observed as a sudden jump in the total magnetization as well as decrease of effective mass of quasiparticles. In particular, we observe the suppression of effective mass of spin-up band by as much as 20% in the fully polarized state at fields above 60-100T.

P-1-39

COEXISTENCE OF ANTIFERROMAGNETISM AND SUPERCONDUCTIVITY WITHIN t-J MODEL WITH STRONG CORRELATIONS AND IN APPLIED ZEEMAN FIELD

Jan Kaczmarczyk[a] **and Jozef Spałek**[a,b]

[a] Marian Smoluchowski Institute of Physics,
Jagiellonian University, Reymonta 4, 30-059 Kraków, Poland

[b]Faculty of Physics and Applied Computer Science,
AGH University of Science and Technology, 30-059 Kraków, Poland

The coexistence of antiferromagnetism with superconductivity is theoretically studied within the t-J model with the Zeeman term included. The strong electron correlations are accounted for by means of the extended Gutzwiller projection method [1] within a statistically-consistent approach proposed recently [2]. The phase diagram on the band filling - magnetic field plane is obtained, and subsequently the system properties (magnetization curves, superconducting gaps, free-energy profiles) are analyzed for the band filling $n = 0.97$. In this regime the results resemble those observed recently in the heavy fermion systems $CeCo(In_{1-x}Cd_x)_5$ and $CeRhSi_3$. Namely, (a) with the increasing magnetic field the system evolves from AF+SC coexisting phase, through antiferromagnetic phase, towards normal state with nonzero spin polarization (ferromagnetic state); (b) the onset of superconducting order circumscribes antiferromagnetic magnetization. The superconducting gap has both singlet and staggered-triplet components, a consequence of its coexistence with antiferromagnetism. The work was supported by Ministry of Higher Education and Science, Grants Nos. N N202 173735 and N N202 128736.

[1] N. Fukushima, Phys. Rev. B **78**, 115105 (2008).
[2] J. Jędrak, JK., and JS., arXiv:1008.0021; J. Jędrak and JS., PRB **83**, 104512 (2011).

P-1-40

CONDUCTANCE SPECTROSCOPY OF A STRONGLY-CORRELATED SUPERCONDUCTOR

Jan Kaczmarczyk[a]**, M. Sadzikowski**[a]**, and Jozef Spałek**[a,b]

[a]Marian Smoluchowski Institute of Physics,
Jagiellonian University, Reymonta 4, 30-059 Kraków, Poland

[b]Faculty of Physics and Applied Computer Science,
AGH University of Science and Technology, Reymonta 19, 30-059 Kraków, Poland

We study theoretically the conductance of a two-dimensional junction between a normal metal and a *strongly-correlated* superconductor in Zeeman field. Depending on the field strength the superconductor is either in the Bardeen-Cooper-Schrieffer (BCS), or in the Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) state of the Fulde-Ferrell type. The strong correlations are accounted for by means of the Gutzwiller approach, what leads naturally to the emergence of spin-dependent masses (SDM) of quasiparticles when the system is spin-polarized. The case without strong correlations (with spin-independent masses) is analyzed for comparison. We study both s-wave and d-wave symmetry of the superconducting gap and concentrate on the parallel orientation of the Cooper pair momentum $\mathbf{Q}$ with respect to the junction interface. The junction conductance is presented for a series of barrier strengths (i.e. in the contact, intermediate, and tunneling limits). The situation with strong correlations differs essentially from that in the non-correlated case. Our analysis provides thus an experimentally accessible *test for the presence of strong-correlations* in superconducting state.

The work was supported by Ministry of Higher Education and Science, Grants Nos. N N202 173735 and N N202 128736.

P-1-41

ELECTRICAL AND HEAT CURRENTS IN NANOSCOPIC SYSTEM WITH FERROMAGNETIC ELECTRODES OF NON-COLLINEATR MAGNETIC MOMENTS

M. Wierzbicki and R. Świrkowicz
Faculty of Physics
Warsaw University of Technology
Koszykowa 75, 00-662 Warszawa, POLAND

Thermoelectric properties of nanoscopic system composed of a single-level quantum dot attached to ferromagnetic electrodes are studied within the non-equilibrium Green function formalism based on the equation of motion. In general, magnetic moments of both electrodes are non-collinear and form an angle θ. Electrical and heat currents flowing through the system under temperature gradient and applied bias voltage are calculated in the non-linear regime. Both charge and heat currents strongly depend on the angle θ between the magnetic moments. The junction under consideration shows typical TMR effect and the charge current is maximal in parallel configuration. Similarly, the heat current is maximal when moments in both electrodes are parallel. However, the maximal efficiency of the system increases with θ. On the other hand, the efficiency calculated for parallel arrangement of the moments considerably decreases with increase of leads' polarization.

P-1-42

LANTHANIDE CONTRACTION IN $RENi_5$ (RE=La, Ce, Nd, Sm, Eu, Gd, Tb, Yb) COMPOUNDS STUDIED WITH BAND STRUCTURE CALCULATIONS

Jerzy Goraus, Paweł Maślankiewicz
Institute of Physics, University of Silesia, ul. Uniwersytecka 4, PL-40-007 Katowice, Poland

FP-LAPW band structure calculations were performed for hexagonal $RENi_5$ (RE = rare earth) compounds in order to investigate reproducibility of lanthanide contraction by *ab initio* studies. The a and c parameters were optimised using a paraboloid fit, starting from the same initial values for all compounds studied. The trend in lattice parameters across the $RENi_5$ series obtained from the calculations was found to be in general agreement with experimental data. Comparison of results obtained by GGA and GGA+U calculations is presented for several double counting schemes.

P-1-43

TWO-CHANNEL KONDO PROBLEM IN $ZrAs_{1.58}Se_{0.39}$

L. Bochenek[a], T. Cichorek[a], A. Czulucki[b], M. Schmidt[b], G. Auffermann[b], Y. Prost[b], R. Niewa[c], F. Steglich[b] and R. Kniep[b]

[a]Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Wrocław, Poland

[b]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany

[c]Institute for Inorganic Chemistry, University of Stuttgart, Germany

Low-temperature electrical resistivity $\rho(T)$ of the closely related phases $ZrAs_{1.58}Se_{0.39}$ (3% of vacancies within the monoatomic As layers) and $ZrP_{1.54}S_{0.46}$ (the $2a$ site fully occupied with P atoms) has been investigated along the c axis down to $T \gtrsim 0.08$ K and in $B \leq 14$ T. Whereas for both systems a $-AT^{1/2}$ term in $\rho(T)$ was observed at $T \lesssim 15$ K, an influence of the magnetic field on their electrical transport was found to be *qualitatively* different: for the As-based compound, a coefficient A ($= 0.167$ $\mu\Omega$cmK$^{-1/2}$) remains virtually unchanged even in the highest available magnetic fields. For the P-based compound, however, an application of B significantly reduces the A-coefficient value from 0.038 $\mu\Omega$cmK$^{-1/2}$ ($B = 1$ T) to 0.008 $\mu\Omega$cmK$^{-1/2}$ ($B = 14$ T), *i.e.*, by factor nearly 5. These distinctly different observations indicate *qualitatively* different phenomena occurring in the material with ($ZrAs_{1.58}Se_{0.39}$) and without ($ZrP_{1.54}S_{0.46}$) broken pnictogen-pnictogen chemical bonds: a $\rho(T, B)$ behavior of the latter system is characteristic for the 3D electron-electron interaction in disordered systems, while the magnetic-field-independent $-AT^{1/2}$ term points at a two-channel Kondo problem derived from two-level states triggered by vacancies in the monoatomic As layers.

P-1-44

SPECIFIC HEAT OF THE $Ce(Ni_{1-x}Cu_x)_4Mn$ COMPOUNDS

K. Synoradzki, T. Toliński

Institute of Molecular Physics, PAS, Smoluchowskiego 17, 60-179 Poznań, Poland

Specific heat of the $Ce(Ni_{1-x}Cu_x)_4Mn$ compounds has been studied. The samples are prepared by induction melting and it is found, based on the X-ray diffraction, that all the compounds keep the $CaCu_5$-type structure. This series exhibits a transition between the ferromagnetically ordered $CeNi_4Mn$ and the spin-glass $CeCu_4Mn$ compounds [1], which is well visible in the measurements of the ac susceptibility peak as a function of the magnetic field frequency and in the magnetization relaxation. In the present research we explore the behavior of the specific heat for various x. The changes of the electronic specific heat coefficient γ are determined by analysis of the low temperature part of the $C_p(T)$ dependence. We also observe that the magnetic phase transition is only detectable after extraction of the magnetic contribution of the Mn atoms. This is carried out by substraction of the specific heat of the appropriate reference samples.

[1] T. Toliński, K. Synoradzki, Intermetallics 19 (2011) 62.

P-1-45

STRONGLY CORRELATED ELECTRON BEHAVIOUR IN CeT_2Al_8 (T=Fe, Co)

S. Ghosh[a], and A. M. Strydom[a]

[a]Physics Department, University of Johannesburg, South Africa

In the exploratory work of Koterlin *et al.* [1] anomalous behaviour in electronic and thermal transport in the ternary rare-earth aluminides CeT_2Al_8 were reported. They form in an orthorhombic crystal structure. Ce is located inside a cage comprising 20 nearest-neighbour atoms. With 44 atoms per unit cell the compounds may be classified as complex metal alloys. Here we present results of electronic and magnetic studies of the two title compounds in continuation of our investigations into competing magnetic interactions in strongly correlated electron systems. According to Mössbauer studies [2] Fe in this system does not have a magnetic moment and hence magnetic phenomena originate in essence from the Ce^{3+} ion. No magnetic ordering is detected down to 2 K in either compound. The temperature dependence of electrical resistivity $\rho(T)$ of $CeFe_2Al_8$ is reminiscent of intermediate valence. This is echoed by a strong moment suppression at $\sim$ 100 K in the magnetic susceptibility $\chi(T)$ and a considerably reduced effective moment compared to that of free Ce^{3+}. The specific heat $C_P(T)/T$ as well as $\rho(T)$ of $CeFe_2Al_8$ shows Fermi-liquid behaviour, whereas $\rho(T)$ of $CeCo_2Al_8$ reveals a Kondo exchange interaction. A non-Fermi-liquid behaviour with strong enhancement in $C_P(T)/T$ sets the ground state of $CeCo_2Al_8$ clearly apart from that of the Fe-derivative, and points to the delicately balanced magnetic interactions in these compounds.

1. M. D. Koterlin *et al.*, Sov. Phys. Solid State **31** (1989) 1826
2. I. Tamura *et al.*, J. Magn. Magn. Mater. **220** (2000) 31

P-1-46

THE FOCK TERM IN THE CHARGE ORDER PHASE OF THE EXTENDED HUBBARD MODEL

M. Bak

Faculty of Physics, A. Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland

One of the basic models in condensed matter theory, which enables an examination of many-body effects is Hubbard model. The present paper shows the results of calculations concerning an extended Hubbard model (with nearest neighbors interaction included) within mean-field approximation. The paper focuses on the charge-ordered phase. The quality of mean-field method is improved by including both Hartree and Fock terms into calculations.

P-1-47

ROLE OF THE ELECTRON CORRELATIONS IN THE INHOMOGENEOUS SUPERCONDUCTORS FROM THE BOSON-FERMION MODEL POINT OF VIEW

Jaromir Krzyszczak[a], Karol Izydor Wysokiński[a], Tadeusz Domański[a], Roman Micnas[b] and Stanisław Robaszkiewicz[b]

[a]Institute of Physics, M. Curie-Skłodowska University
ul. Radziszewskiego 10, 20-031 Lublin

[b] Faculty of Physics, A. Mickiewicz University, ul. Umultowska 85, 61-614 Poznań

To study the role of strong electronic correlations, the boson-fermion (BF) model of superconductivity, supplemented with the strong on-site electron-electron repulsion term U, has been taken into consideration. This model, formulated in real space, has been solved by the means of Gutzwiller and mean-field approximations. The real space Bogoliubov-de Gennes equations allows one to calculate local properties, such as local magnitude of the gap or the local density of states (LDOS), in presence of impurities. It has been shown that, due to electron correlations, the gap is larger near the impurity sites, contrary to the results for the same model but without U. This naturally leads to positive correlation between the values of the order parameter and the positions of impurities, as was observed in various scanning tunneling microscopy experiments performed on $Bi_2Sr_2CaCu_2O_{8+x}$ superconductors. Also, in presence of correlations, the low-energy electronic excitations in LDOS are protected against disorder.

P-1-48

ELECTRONIC PROPERTIES AND MODEL OF THE SPECTRUM FOR f ELECTRON EXCITATIONS IN $CeNi_2Si_2$

M. Koterlyn[a,b], R. Yasnitskii[a], G. Koterlyn[c], B. Morokhivskii[d]

[a] Institute of Electronics, Ivan Franko National University of L'viv,
Dragomanova Str. 50, 79005 L'viv, Ukraine

[b]Inst. of Physics, K. Wielki University, Weyssenhoffa Sq. 11, 85-072 Bydgoszcz, Poland

[c] Western Scientific Center of National Academy of Sciences of Ukraine
and Ministry of Education and Science of Ukraine, Mateyka St. 4, 79000 Lviv, Ukraine

[d] Ivan Franko Drohobych State Teacher Training University,
Ivan Franko Str.24, 82100 Drohobych, Ukraine

For $CeNi_2Si_2$ compound with unstable valence Ce, the results of an analytic description of electrical resistivity, thermoelectric power, magnetic susceptibility and an electronic component of specific heat on the basis of a model of the local structure of state density (LSSD) proposed by us earlier are presented. It is shown that LSSD near Fermi energy at low temperatures (T < 200 K) is well described by two peaks of the Lorentzian shape that are poorly separated and make a pseudogap. Under high temperatures (T > 400 K) this feature of the energy spectrum is transformed into a single peak, which significantly narrowed and shifted to energy EF. The parameters of the peaks agree qualitatively with the predictable ones in the lattice (low temperature) and impurity (high temperature) Anderson models for Kondo systems with strong orbital degeneracy of f-states. At that the best correspondence of the model to the experimental data in the range temperatures 4 – 800 K is achieved owing to considering the temperature change of only one characteristic parameter - Kondo temperature. It is found that for the description of the dynamic (electrical resistivity, thermoelectric power) and static (magnetic susceptibility, specific heat) properties of $CeNi_2Si_2$ slightly different models for the spectrum of elementary excitations of an f electron should be used.

O-2-01

MAGNETIC FIELD EFFECTS IN FRUSTRATED LOW-DIMENSIONAL MAGNETS

B. Schmidt, M. Siahatgar, and P. Thalmeier

Max-Planck-Institut für Chemische Physik fester Stoffe, 01187 Dresden, Germany

We investigate the frustrated two-dimensional $S = 1/2$ next nearest neighbor anisotropic Heisenberg antiferromagnet on a square lattice as described by the $J_{1a,b}$-J_2 model. We use spin-wave theory and exact diagonalization for finite tiles including a new method for the finite size scaling procedure. We present results obtained from the extension of our numerical method to finite magnetic fields as well as from spin-wave theory. The induced uniform and the staggered moment in the antiferromagnetically ordered phases in the presence of a magnetic field are calculated. They deviate strongly from classical behaviour depending on frustration ratio $J_2/J_{1a,b}$ and the $J_{1a,b}$ exchange anisotropy. The magnetization becomes strongly nonlinear and is suppressed from the classical value. This is due to enhanced quantum fluctuations already at moderate frustration. In contrast, applying a magnetic field H up to $H \approx (1/2)H_{\rm sat}$ stabilizes the staggered moment in the columnar (CAF) and Néel (NAF) ordered antiferromagnetic phases. This field-induced stabilization is most pronounced for frustration ratios $J_2/J_{1a,b}$ near the edges of the phase diagram where quantum fluctuations tend to destroy NAF and CAF order. For small spatial exchange anisotropy, the field dependence of the staggered moment uniquely determines the exchange parameters. This allows to derive the frustration ratio J_2/J_1 from the field dependence of magnetic neutron diffraction data. As an example we analyze recent experiments by Tsyrulin et al. on $Cu(pz)_2(ClO_4)_2$.

O-2-03

FIRST OBSERVATION OF THE SPIN ICE STATE IN A SPINEL STRUCTURE

I. Živković[a], J. Lago[b], B.Z. Malkin[c], J. Rodriguez Fernandez[d], P. Ghigna[e], P. Dalmas de Réotier[f], A. Yaouanc[f], T. Rojo[b]

[a]Institute of Physics, POB 304, HR-10 000 Zagreb, Croatia

[b]Departament of Inorganic Chemistry, Univ. del Pas Vasco, 48080 Bilbao, Spain

[c]Kazan State University, 420008 Kazan, Russia

[d]Departamento CITIMAC, Fac. Ciencias, Univ. de Cantabria, 39005 Santander, Spain

[e]Dipartimento di Chimica Fisica M. Rolla, Universit di Pavia, V.le Taramelli 16, I-27100 Pavia, Italy

[f]Institut Nanosciences et Cryognie, Commissariat à l'énergie atomique/Direction des sciences de la matiére, 38054 Grenoble, France

Spin ice systems have so far been observed exclusively in pyrochlore systems, $Ho_2Ti_2O_7$ and $Dy_2Ti_2O_7$ being the most studied examples. Spinels, with a general formula AB_2X_4, exhibit a sublattice of octaheadrally coordinated B ions that is identical to the pyrochlore lattice in titanates. We have performed an extensive investigation of the spinel compound $CdEr_2Se_4$ and found a clear signature of the spin ice state. The entropy recovered in magnetic field corresponds to (R/2)ln(3/2) (= entropy of the proton disorder in water ice), the magnetization at low temperature saturates at half of the value of the magnetic moment and the susceptibility drops to zero below the freezing temperature. Due to the different local environment of the erbium ion in the spinel structure, single-ion anisotropy is altered and calculations show that it acquires the needed Ising character. We will compare our results with the pyrochlore compounds.

O-2-06

COMPETITION BETWEEN MULTIPOLE SITE ORDERS AND NONSINGLET VALENCE BONDS IN HIGH SPIN SYSTEMS

E. Szirmai[a], M. Lewenstein[b,c] and J. Sólyom[a]

Research Institute for Solid State Physics and Optics, H-1525 Budapest, P. O. Box 49, Hungary

ICFO-Institut de Ciències Fotòniques, Mediterranean Technology Park, E-08860 Castelldefels (Barcelona), Spain

ICREA-Institució Catalana de Recerca i Estudis Avançats, Lluis Companys 23, E-08010 Barcelona, Spain

High spin models with biquadratic, bicubic and even higher order spin exchange interaction can describe complicated spin systems and their different phases including not only the usual site centered spin (dipole) order but multipole orders, too. These models in numerous cases can be simulated by high spin ultracold atom systems, and are intensively studied experimentally and theoretically. These systems can be treated within a concept that contains bond orders in addition to site centered orders leading to the appearance of nonsinglet valence bonds [1]. The mean field phase diagram is determined by comparing the ground state energies obtained from the two different concepts for special systems that can be realized experimentally with high spin ultracold atoms loaded into optical lattices.

[1] arxiv:1009.4868 (2010).

O-2-08

TUNNELING CHARGE TRANSPORT IN GRAPHENE-BASED SUPERCONDUCTOR JUNCTIONS

R.J. Wojciechowski, L. Kowalewski and M. Nogala

[a] Faculty of Physics, Adam Mickiewicz University ul.Umultowska 85, 61-614 Poznań (Poland)

We study the spin polarized electron and hole tunneling transport in a graphene-based ferromagnet (G_F)-superconductor (G_S)-ferromagnet (G_F) junction. Proximity induced spin polarization and superconductivity in a graphene sheet are assumed to be created by a superconducting and ferromagnetic electrodes placed on the top of the graphene. Using a four-dimensional version of the Dirac-Bogoliubov-de Gennes equation [1] and appropriate bounadary conditions we investigate the tunneling processses through the junctions. In particular, we present calculations of the amplitudes of normal and Andreev reflections as a function of the energy of the incident electron for a wide ranges of the model parameters, such as the strength and orientation of the exchange field, the barrier strength, the the distance between the two ferromagnetic layers are presented. The tunneling transport processes in the graphene-based double junction $G_FG_SG_F$ are compared with those in non-graphene-based junctions [2].

1. C.W. Beenakker, Phys.Rev.Lett.**97**, 067007 (2006).
2. R.J. Wojciechowski and L. Kowalewski, Acta Phys. Pol. A **118**,249 (2010).

P-2-01
APPROXIMATION FOR THE ISING MODEL

M. Błaszyk

Faculty of Physics, Adam Mickiewicz Uniwersity, 61-614 Poznań, Poland

An approximation for the Ising model is proposed. The method presented is based on endowing a small subsystem with the properties of an infinite system by modification of the subsystem's boundary. The analysis was made for a two-dimensional square lattice. When the correctness of the single spin correlation functions is conserved, the method gives results comparable with those obtained in the mean-field approximation. When the single and double spin correlations are taken into account, the results are similar to those obtained in the Kikuchi pseudo-ensemble method. The paper presents a discussion on the degree of improvement of the results resulting from taking into account the other spin correlations.

P-2-02
EPR STUDY OF THE TWO-DIMENSIONAL QUANTUM MAGNET $Cu(en)(H_2O)_2SO_4$

R. Tarasenko[a], A. Orendáčová[a], E. Čižmár[a], M. Orendáč[a], S. Zvyagin[b] and J. Wosnitza[b]

[a]Centre of Low Temperature Physics of P.J. Šafárik University and SAS, Park Angelinum 9, SK-041 54 Košice, Slovak Republic

[b]Dresden High Magnetic Field Laboratory, Helmholtz-Zentrum Dresden-Rossendorf, D-01314 Dresden, Germany

Electron paramagnetic resonance (EPR) spectra of $Cu(en)(H_2O)_2SO_4$ (CUEN)(en = ethylendiamine) single crystals were measured in the X-band range at temperatures 4 K and 300 K in magnetic fields up to 0.5 T. The angular dependence of the g-factor and EPR linewidths were studied. The analysis of the g-factor confirmed, that coordinating ligands around the Cu(II) ion form a distorted octahedron elongated along the local z axis and the distortion is maintained down to low temperatures. The increase of the linewidth observed at low temperatures can be ascribed to the onset of short-range magnetic correlations previously observed in specific heat studies [1]. The reduction of the period in the angular dependence of the linewidth observed at 4 K cannot be explained by the existence of two crystallographic non-equivalent Cu(II) positions. The analysis of the angular dependence of the linewidth suggests the potential occurence of Dzyaloshinski-Moriya interaction and anisotropic exchange coupling in CUEN.

[1] M. Kajňaková et al., Phys. Rev. B 71, (2005) 014435.

This work has been supported by projects APVV LPP-0202-09 and EuroMagNET II.

P-2-03

EXPERIMENTAL STUDY OF THE THERMAL TRANSPORT IN $CsNiF_3$ - S=1 QUANTUM CHAIN

V. Tkáč[a], A. Orendáčová[a], M. Orendáč[a], K. Tibenská[b], A. Feher[a], M. Poirier[c] and M. W. Meisel[d]

[a]Centre of Low Temperature Physics, Faculty of Science, P. J. Šafárik University, Park Angelinum 9, 041 54 Košice, Slovakia

[b]Faculty of Aeronautics, Technical University, Rampová 7, 041 21 Košice, Slovakia

[c]Regroupement Québécois sur les Matériaux de Pointe, Département de Physique, Université de Sherbrooke, Sherbrooke, Québec J1K 2R1, Canada

[d]Department of Physics and the National High Magnetic Field Laboratory, University of Florida, Gainesville, Florida 32611-8440, USA

An experimental study of the heat transport in $CsNiF_3$ single crystal has been performed in the temperature range from 2 to 13 K in a zero magnetic field, $B = 0$ T, as well as in sufficiently large magnetic fields, $B \sim 6$, 9 T, inducing ferromagnetic ground state along the hard axis c. $CsNiF_3$ represents an $S = 1$ quasi-one-dimensional XY ferromagnet with the intrachain exchange coupling $J/k_B \approx 24$ K and single ion anisotropy $D/k_B \approx 8$ K with ordering temperature $T_N = 2.7$ K. Comparison of the phonon and magnon velocities suggests that phonons are the main heat carriers in this magnetic insulator. The thermal conductivity in $B = 0$ T was analysed in the frame of a standard Debye model. The temperature dependence of the effective phonon mean free path was calculated from experimental data, and the enhancement of the phonon mean free path in $B \neq 0$ T was obtained. Several mechanisms responsible for this enhancement are discussed.

P-2-04

$[(Cu_{0.74}Ni_{0.26})_2(5,5' - dmbpy)_2(OH)(H_2O)(ac)](ClO_4)_2$ - AN UNCONVENTIONAL QUASI-TWO-DIMENSIONAL SYSTEM

P. Vrábel[a], M. Orendáč[a], M. Kajňaková[a], I. Kočanová[b], J. Černák[b]

[a]Centre of Low Temperature Physics of the Faculty of Science of P. J. Šafárik University, Park Angelinum 9, SK-041 54 Košice, Slovakia

[b]Department of Inorganic Chemistry, P. J. Šafárik University, Moyzesova 11, SK-041 54 Košice, Slovakia

The results of the investigation of magnetic susceptibility, magnetization and specific heat of the title complex are reported. The complex belongs to a class of compounds, which displays, thanks to their relation to the low-dimensional mixed spin systems, unconventional magnetic properties. Both magnetic $M(II)$ ($M = Cu$, Ni) atoms in the dinuclear unit are linked through an aqua, a hydroxo and a syn-syn acetato bridging ligand forming 2d structure through $\pi-\pi$ interactions. The investigation of the temperature dependence of susceptibility yielded $g = 2.10$, $\Theta = 4.69$ K and $C = 1.05$ emu.K/mol, respectively. This result is in strike disagreement with exchange coupling $J/k \approx 170$ K found in analogous Cu complex. The origin of the observed behaviour will be discussed. In addition, the magnetization was found to be in a good agreement with the predictions resulting from the models based on both free spins and $S = 1/2$ and $S = 1$ dimers with infinitely strong ferromagnetic interaction, respectively. Round maximum in specific heat located around 1 K suggests planar single-ion anisotropy $D/k = 2.97$ K. The work was supported by projects VEGA 1/0078/09 and 1/0089/09.

P-2-05

CHARGE TRANSPORT IN CUPRATES BY THE SPIN VORTICES: QUANTUM BROWNIAN MOTION OF VORTEX IN FRUSTRATED BACKGROUND

P. Rusek[a]

[a]Institute of Physics, Wroclaw University of Technology, Poland

In the ground state of Nd doped $La_{2-x}Sr_xCuO_4(0.02 < x < 0.05)$ the spins form spirals frustrated by magnetic dipoles located on holes. The system allows for existence of the non-Abelian Z_2 spin vortices. Due to interaction with frustrated background, their energy (mass) is finite i.e. Z_2 vortices can move. The mobile vortices carry the charge since the holes have tendency to attach to defect structure (vortices). It opens the new channel of conductivity in cuprates.
We study the quantum dynamics of the Z_2 spin vortices in the frustrated background of cuprates. We describe it in terms of the order parameter of spirals (the rotation matrix) interacting with $SO(3)$ gauge field which represents the frustrations. The relevant model for this problem is non-Abelian $SO(3)$ Higgs model. The Z_2 vortex is the localized (particle-like) solution in that model. We canonically quantized Z_2 vortex using the concept of collective coordinates and we derived the effective Hamiltonian describing quantum dynamics of a vortex. In our scenario the heavy particle (vortex) moves in a gas of magnons and gauge field quanta – quantum Brownian motion of vortex. The vortex motion is dissipative since magnons and gauge field photons are scattered by it. Our results will be used in the construction of kinetic equation (Fokker-Planck equation) for vortex and consequently the calculation of of the cuprates conductivity.

P-2-06

NON-ABELIAN VORTICES IN THE SPIN GLASS PHASE OF CUPRATES

M. Fidrysiak and P. Rusek[a]

[a]Institute of Physics, Wroclaw University of Technology, Poland

The Sr doped $La_{2-x}Sr_xCuO_4$ (LSCO) in the low doping regime, $(0.02 < x < 0.05)$, is the 2D non-collinear Heisenberg (n=3) antiferromagnet (NCHAF). In this phase the rotational symmetry of spin system is completely broken and, consequently, the order parameter is the rotation matrix or equivalently the triad of orthonormal vectors. That order parameter allows for existence of non-Abelian Z_2 spin vortices in LSCO, however, their energy (mass) is infinite i.e. Z_2 vortices cannot move. In fact the spins in LSCO are frustrated due to induced magnetic moment located on holes. We claim that interaction of Z_2 vortex with frustrations makes its energy finite i.e. the Z_2 vortices in frustrated NCHAF can move. Since the holes concentrate on defect structure (vortices), the moving vortices, with holes attached to them, carry the charge opening the new channel of conductivity in cuprates.
Representing the frustrations by a $SO(3)$ gauge fields, the relevant Lagrangian of frustrated NCHAF is the nonlinear sigma model (with the triad as the order parameter) coupled minimally to the $SO(3)$ gauge field. Within that model the Z_2 vortex solution with finite energy has been found. The distribution of frustrations, spins and spin current in the vortex is presented. The simplicity of our vortex makes it a good candidate to evaluation of vortex contribution to cuprate conductivity.

P-2-07

2D FALICOV-KIMBALL MODEL AT FINITE-TEMPERATURES

L. Dębski
Institute of Physics, Adam Mickiewicz University, 85 Umultowska Ul., Poznań 61-614, Poland

Finite-temperature properties of the 2D Falicov-Kimball model have been studied in the perturbative regime, i.e. for $t/U \ll 1$, where $t = 1$ is the hopping constant and $U = 10$ denotes the Coulomb interaction strength. In our study, we have determined the phase diagram of the model in the fourth-order of the perturbation theory, where our model constitutes the Ising model with more complicated frustrated antiferromagnetic interactions. The Monte Carlo method, Binder's cumulat and finite-size magnetization profiles were employed to investigate the phase transition lines.

P-2-08

MAGNETIC FRUSTRATION IN ODD-MEMBERED s = 3/2 SPIN RINGS WITH BOND DEFECT

P. Kozłowski, M. Antkowiak and G. Kamieniarz
Faculty of Physics, Adam Mickiewicz University, Poznań, Poland

Chromium based rings are a family of molecular magnets which has been recently enlarged by a nine-membered frustrated homometallic ring (Cr_9). Many members of this family are considered for quantum computation and as a material for efficient storage devices.

In this presentation frustration effects in models of hypothetical and existing odd-membered antiferromagnetic chromium ($s = 3/2$) rings with a bond defect are studied by means of two numerical techniques: quantum transfer matrix and exact diagonalization. In order to identify a frustrated phase we calculate the full energy spectrum of the models and a number of thermodynamic quantities at low temperature. It is shown that total and local magnetizations, nearest-neighbor spin correlations and spin fluctuations can serve as consistent frustration signatures. Magnetizations and spin-spin correlations are reduced in the frustrated phase whereas fluctuations and correlations of fluctuations increase. We also determine the dependence of the critical value of the bond defect, at which a transition to the frustrated phase takes place, on the size of the system and external magnetic field. In the systems studied bipartiteness is not opposite to frustration as there are regions in the parameter space in which the system is neither bipartite nor frustrated.

P-2-09

MULTICRITICALITY OF THE MAGNETIC BILAYER DESCRIBED BY THE BLUME-EMERY-GRIFFITHS MODEL

W. Jaworski
Quantum Physics Division
Faculty of Physics
Adam Mickiewicz University, Poznan

The Blume-Emery-Griffiths (BEG) model with its relatively simple spin-1 Ising Hamiltonian has attracted physicists dealing with a vast variety of systems. The rich phase diagrams it exhibits has been the testing ground for both analytic calculation methods and computer simulations.
This paper presents the comparison of some phase diagrams for a magnetic bilayer ($z = 5$) described by the BEG model obtained within the mean-field approximation (MFA), the Gaussian fluctuations approximation (GFA) and Monte Carlo simulation methods (MC). The main differences of these results are discussed and the attention is focused on the phase transitions which are found not only for the stable branches of the order parameters but for the metastable and unstable as well.

P-2-10

CRITICAL TEMPERATURE STUDIES OF THE ANISOTROPIC BI- AND MULTILAYER HEISENBERG FERROMAGNETS

K. Szałowski[a] and T. Balcerzak[a]
[a]Department of Solid State Physics, University of Łódź,
ul. Pomorska 149/153, 90-236 Łódź, Poland

The Pair Approximation (PA) method is applied to studies of the planar ferromagnetic systems with directional and spin-space anisotropy of interactions. The approach used allows to take into account arbitrary couplings, ranging from Ising to isotropic Heisenberg interactions, independently within each plane and for interplanar coupling. The self-consistent thermodynamic description of the model is achieved on the basis of the Gibbs energy analysis.
The study is focused on the Curie temperature, for which an extensive comparison between the bilayer (consisting of two atomic planes) and the corresponding multilayer (composed of infinite number of atomic planes) is performed. It is found that for the isotropic Heisenberg intraplanar interactions the Curie temperature decreases logarithmically with vanishing interplanar coupling. The compensation point for Heisenberg coupling at which the critical temperature is not influenced by interplanar interactions is found in the Ising bilayer system with unequal in-plane exchange integrals. It is shown that an unlimited increase in the interplanar coupling in the bilayer system always leads to the saturation of the Curie temperature with finite limiting value. A similar phenomenon exists in the multilayer system, but only with Heisenberg interactions between planes. The results of numerical calculations are discussed and presented in figures.

P-2-11

MAGNETO-THERMAL PROPERTIES OF THE ISING-HEISENBERG ORTHOGONAL-DIMER CHAIN WITH QUANTUM XXZ-TRIANGLES

Vadim Ohanyan[b] and Andreas Honecker[a]

[a]Institut für Theoretische Physik Universität Göttingen, Friedrich-Hund-Platz 1 37077 Göttingen, Germany

[b]Department of Theoretical Physics, Yerevan State University, Alex Manoogian 1, 0025, Yerevan, Armenia

We consider an exactly solvable model of orthogonal-dimer chain with Ising and Heisenberg bond. Using the modified classical transfer-matrix technique we find exact expression for partition function and, thus, for all thermodynamic functions of the system. We investigate the issue of vast variety of its ground states, especially ones with spontaneous breaking of the translational symmetry. Analyzing ground states properties we obtain several $T = 0$ ground states phase diagrams which correspond to different sets of the parameters. Depending of the values of parameters the system exhibits the magnetization curves with the following transitions between various magnetization plateau $M = 0 \to M = 1$, $M = 0 \to M = 1/2 \to M = 1$, $M = 0 \to M = 1/4 \to M = 1/2 \to M = 1$, $M = 0 \to M = 1/4 \to M = 1$, $M = 1/2 \to M = 1$ and $M = 1/4 \to M = 1/2 \to M = 1$. The general mechanism of unit cell doubling in the lattice models with block structure and left-right asymmetry is discussed. Finally, we present a comparison of the magneto-thermal properties of the underlying purely quantum model (orthogonal-dimer chain with four various couplings) and exactly solvable system with Ising and Heisenberg bonds.

P-2-12

ON NON-ISING PHASE TRANSITIONS IN THE 3D STANDARD ASHKIN-TELLER MODEL

D. Jeziorek-Knioła[a], G. Musiał[a], J. Rogiers[b] and S. Dylak[c]

[a]Faculty of Physics, Adam Mickiewicz University, ul. Umultowska 85, 61-614 Poznań, Poland

[b]Instituut voor Theoretische Fysica, Katholieke Universiteit Leuven, Celestijnenlaan 200D, 3001 Leuven, Belgium

[c]Faculty of Educational Studies, Adam Mickiewicz University, ul. Szamarzewskiego 89, 60-568 Poznań, Poland

The phase transition line in the Ising point region is studied in the 3D standard Ashkin-Teller model on a cubic lattice. This model of the multicomponent order parameter is one of the important reference points in statistical physics and it implies the interesting and complicated phase diagram. The main motivation to our study was nonuniversal behavior announced for this line [1].

The large-scale Monte Carlo simulations using the Binder and Challa like cumulants are performed. Accurate analysis [2] to exclude the latent heat inherence is applied. Specific behavior of the Challa like cumulants is discovered and its interpretation is proposed. Preliminary conclusions as to the continuous but nonising character of these phase transitions beyond the Ising point close the paper.

[1] G. Musiał, J. Rogiers, Phys. Status Solidi **B 243**, 335 (2006)

[2] G. Musiał, Phys. Rev. **B 69**, 024407 (2004)

P-2-13

BOSE-EINSTEIN CONDENSATION OF MAGNONS IN $Pb_2V_3O_9$ and $AgVOAsO_4$: INSIGHT FROM THEORY AND EXPERIMENT

A. A. Tsirlin[a] and H. Rosner[a]

[a]Max Planck Institute for Chemical Physics of Solids, 01187 Dresden, Germany

We present a comprehensive microscopic study of quasi-one-dimensional spin-gap magnets $Pb_2V_3O_9$ and $AgVAsO_4$ that feature bond-alternating spin chains and show Bose-Einstein condensation (BEC) of magnons in high magnetic fields. Using density functional theory band structure calculations combined with quantum Monte-Carlo simulations, we obtain a remarkably accurate description of the experimental data on magnetic susceptibility, magnetization isotherm, and temperature–field BEC phase diagram of $Pb_2V_3O_9$. Our results challenge the former, purely one-dimensional scenario for this compound. Sizable ferromagnetic interchain couplings in $Pb_2V_3O_9$ arise from the peculiar arrangement of spin chains perpendicular to the structural chains. These couplings are a necessary prerequisite of the BEC.

A similar approach is applied to the novel compound $AgVOAsO_4$ where interchain couplings are frustrated. We will present recent experimental data on magnetic susceptibility and electron spin resonance, as well as magnetization and heat capacity measurements in high magnetic fields. These data suggest a quasi-one-dimensional magnetic behavior, a spin gap of about 13 K, and the saturation field of 48.5 T. Above the first critical field $H_{c1} \simeq 10$ T, the spin gap is closed, and the system undergoes two successive BEC transitions evidenced by heat capacity and low-temperature magnetization measurements. Possible reasons for this unconventional behavior will be discussed.

P-2-14

ANOMALOUS STRUCTURAL PHASE TRANSITIONS IN $LiCsSO_4$; THE COMPRESSIBLE HCP ISING MODEL

A.Lehmann-Szweykowska, M.Kurzyński, R.J.Wojciechowski, M.Wiesner and B.Mróz

[a] Faculty of Physics, Adam Mickiewicz University
ul.Umultowska 85, 61-614 Poznań (Poland)

The main objective of the paper is to derive a compressible three-dimensional hcp Ising model in which planar rotations of SO_4 tetrahedrons in ferroelastic $LiCsSO_4$ are expressed as S=1/2 spin states. The spins are coupled to the acoustic phonons. Due to the anisotropy of the perpendicular axes in the basal plane, we can describe the anomalous low-temperature phase transitions in terms of two order parameters representing spin-density waves. The first order parameter corresponds to the modulated phase below the order-disorder phase transition temperature, T_C. The ground-state configuration of the modulated 'magnetically-ordered' phase is a multi-soliton lattice of domain walls which get narrower with a decreasing temperature till the lock-in point, TThe second order parameter is induced at the temperature lower than T_C and describes a collinear orientation of the planar turns of the tetrahedrons SO_4. Introduction of the spin-phonon coupling enables us to estimate the role of the phonons in maintaining the anomalous low-temperature structural phase transitions in $LiCsSO_4$. Considering then the phonons to be slow variables in the process, we can also estimate scattering of the phonons on the pseudomagnetic structure. And further, to interpret and reproduce numerically the empirically observed anomalous temperature variation of the phonon frequency as observed in Brillouin light scattering experiment.

P-2-15

VIBRATIONAL SPECTRA OF COORDINATION POLYMERS BASED ON TCE-TTF

I. Olejniczak[a], A. Łapiński[a], R. Świetlik[a], J. Olivier[b], S. Golhen[b] and L. Ouahab[b]

[a]Institute of Molecular Physics, Polish Academy of Sciences, Smoluchowskiego 17, 60-179 Poznań, Poland

[b]UMR 6226 CNRS, Université de Rennes 1, 35042 Rennes, France

Coexistence of magnetism and electrical conductivity is one of the most important directions in the synthesis of multifunctional organic-based materials. Here we present infrared and Raman spectra of the series of TCE-TTF-based isostructural polymeric salts with paramagnetic (Co^{II}, Mn^{II}), and diamagnetic (Zn^{II}, Cd^{II}) metal ions [1]. Infrared and Raman active modes are identified and assigned based on theoretical calculations for neutral and ionized TCE-TTF using density functional theory (DFT) methods. The vibrational modes related to the C=C stretching vibrations of TCE-TTF are analyzed assuming the existence of the electron-molecular vibration coupling (EMV). The presence of the antisymmetric C=C dimeric mode provides an evidence that charge transfer takes place between TCE-TTF molecules belonging to neighboring polymeric networks.

1. J. Olivier et al., Inorg. Chem. 2009, 22, 3282-3290.

P-2-16

GALOIS PROPERTIES OF THE EIGENPROBLEM OF A HEXAGONAL MAGNETIC HEISENBERG RING

Grzegorz Banaszak*, Stefan Barańczuk*, Tadeusz Lulek, Jan Milewski***, Ryszard Stagraczyński****

* Department of Mathematical and Computer Science, Adam Mickiewicz University, ul. Umultowska 87, 61-614 Poznań, Poland
e-mail: banaszak@amu.edu.pl

** Department of Physics, Adam Mickiewicz University, ul. Umultowska 85, 61-614 Poznań, Poland
e-mail: tadlulek@amu.edu.pl

*** Institute of Mathematics, Poznań University of Technology ul. Piotrowo 3A, 60-965 Poznań, Poland
e-mail: jsmilew@wp.pl

****Chair of Physics, Rzeszów University of Technology ul. Powstańców Warszawy 6. 35-959 Rzeszów, Poland

We analyse the number field theoretic properties of solutions of the eigenproblem of the Heisenberg Hamiltonian for the magnetic hexagon with the single-node spin 1/2 and isotropic exchange interactions. It follows that eigenenergies and eigenstates are expressible within an extension of the prime field $\mathbf{Q}$ of rationals of degree 2^3 and 2^4, resp. In quantum information setting, each real extension of rank 2 represents an arithmetic qubit. We demonstrate in detail some actions of the Galois group on the eigenproblem.

P-2-17

SINGLE-ION ANISOTROPY EFFECTS IN MAGNETIC SUSCEPTIBILITY OF SOME Re^{IV} AND $Re^{IV}M^{II}$ COMPLEXES

E. Babiak[a], R. Kubacik[a], Ł. Kucharski[a], P. Kozłowski[a], A. Drzewiński[b] and G. Kamieniarz[a]

[a]Faculty of Physics, A. Mickiewicz University, Poznan, Poland
[b]Institute of Physics, University of Zielona Gora, Zielona Gora, Poland

In this communication we analyse the effects of single-ion anisotropy on the zero-field susceptibility behaviour as a function of temperature for an oxalate-Re^{IV} mononuclear complex [1] and heterotetranuclear oxalato-bridged $Re^{IV}M^{II}$ (M = Mn, Fe, Ni, Cu) complexes [2]. Re^{IV} is a $5d^3$ ion which ground state in the octahedral environment is given by the $^4A_{2g}$ term and is subject to a high value of the spin-orbit coupling and the strong magnetic anisotropy. Our analysis is based on the spin Heisenberg model and takes into account both the uniaxial and rhombic single-ion anisotropy term. We calculate within the exact diagonalisation technique the single-crystal and powder susceptibility for the systems in question. We find some symmetries in the behaviour of the single-crystal susceptibilities and their substantial dependence on the value of the rhombic parameter. We demonstrate that the differences in the single-crystal data are strongly reduced for the powder sample and we estimate some new values of the model parameters from a fit to experimental data.

[1] R. Chiozzone et al., Inorg. Chem. 38, 4745 (1999)
[2] J. Martinez-Lillo et al., Inorg. Chem., 48, 3027 (2009)

P-2-18

DFT STUDY OF OCTANUCLEAR MOLECULAR CHROMIUM-BASED RING USING NEW PSEUDOPOTENTIAL PARAMETERS

B. Brzostowski[a], T. Ślusarski[b], D. Tomecka[b] and G. Kamieniarz[b]

[a]Institute of Physics, University of Zielona Góra, Poland;
[b]Faculty of Physics, A. Mickiewicz University, Poznań, Poland;

Molecular magnets play very important role in fundamental physics since these systems have shown new magnetic and electronic futures and revealed to be promising for possible applications in quantum computing and magnetoelectronics. Among these systems, there are homonuclear antiferromagnetic ring-shaped molecules formed by transition metal ions in an almost planar ring.

We present a comprehensive study of electronic and magnetic properties of $Cr_8F_8Piv_{16}$ molecular ring (in short Cr8) using the package SIESTA with several choices of chromium pseudopotential parameters. We use generalized gradient approximation (GGA) to investigate properties of Cr8 ring approximated by replacing the pivallic group by H atoms (hydrogen saturation). For different choice of chromium pseudopotential we examine the electronic and magnetic properties of Cr8 molecule. We compare the density of states, electron density maps and HOMO-LUMO energies. Also magnetic properties are studied in detail - magnetic moments and exchange interaction parameter J are presented. The influence of pseudopotential parameters on obtained results is discussed. Finally our results are compared with other theoretical approaches and experimental data.

O-3-07

EMERGENT DIMENSIONAL REDUCTION IN A MODEL FOR MANGANITES

S. Liang[b], M. Daghofer[a], S. Dong[c], C. Şen[b], and E. Dagotto[b]

[a]IFW Dresden, P.O. Box 27 01 16, D-01171 Dresden, Germany

[b]Department of Physics and Astronomy, The University of Tennessee, Knoxville, TN 37996, USA; Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, TN 32831, USA

[c]Department of Physics, Southeast University, Nanjing 211189, China

We present the results of unbiased Monte-Carlo simulations for a realistic model treating itinerant electrons coupled to localized spins in narrow-band manganites. We find that for doping fractions $x = 1/N$ ($N = 3, 4, 5\ldots$) and small Jahn-Teller coupling, the system supports 'striped' phases, where the spins in each stripe can be flipped without a physically relevant energy penalty. Consequently, the spins order only along one direction and remain disordered along the other, implying 'dimensional reduction' similar to the compass model discussed in quantum computing. The quasi-degeneracy of many states with different spin order is not related to any symmetry of the Hamiltonian, but is instead an emergent property of the low-energy states and appears to be linked to dispersionless states of the itinerant electron system. Various stripe patterns can be distinguished by their ferroelectric properties.
See also: arXiv:1102.1435

O-3-09

STRUCTURAL, MAGNETIC AND ELECTRONIC PROPERTIES OF A NEW SILICIDE MnPtSi

M. Gamza[a,b], S. Ackerbauer[a], A. Leithe-Jasper[a], W. Schnelle[a], H. Rosner[a], Yu. Grin[a]

[a]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany

[b]Institute of Materials Science, University of Silesia, Katowice, Poland

Recent results concerning giant exchange-derived magnetoelastic coupling and tricriticallity in the metamagnet MnCoSi (TiNiSi-type structure) [1] as well as intriguing magnetic properties of the isostructural compounds MnTX (T = transition metal element; X = Si, Ge) [2] stimulated the search for consecutive members of this family.
Here, we report on the crystal structure, electronic structure and magnetic properties of the new compound MnPtSi. First principles electronic structure calculations indicate an interesting spin state of Mn with a magnetic moment of $3.2\mu_B$. This finding is in agreement with the saturation magnetisation of $3\mu_B$ in the ordered state. Further, the effective moment derived from high-temperature magnetic susceptibility supports the S≈3/2 spin state of Mn. Thermodynamic measurements revealed two successive magnetic phase transitions at $T_C \approx 340$ K and $T_N \approx 326$ K. The FM to AFM transition is accompanied by a large magneto-volume effect ($\Delta V/V \sim 1.4\%$) and a change in Mn-Mn distances of up to 1%.

[1] Barcza A. *et al.*, Phys. Rev. Lett. (2010) **104** 247202
[2] Eriksson T. *et al.*, Phys. Rev. B (2005) **71** 174420 and references there in

O-3-10

SYSTEMATIC STUDIES ON THE NEW TETRAGONAL RCu$_2$Ga$_2$ (R = La, Ce, Pr, Nd and Gd) SINGLE CRYSTALS

R. Nagalakshmi[a], Ruta Kulkarni[b], S.K. Dhar[b], A. Thamizhavel[b], V. Krishnakumar[c], M. Reiffers[d], I. Čurlik[a], H. Hagemann[e], D. Lovy[e]

[a]Department of Physics, National Institute of Technology, Tiruchirappalli - 620 0015, India

[b]DCMPMS, Tata Institute of Fundamental Research, Mumbai - 400 005, India

[c]Department of Physics, Periyar University, Salem - 636 011, India

[d]Institute of Experimental Physics, Watsonova 47, SK-040 01 Košice, Slovakia

[e]Department of Physical Chemistry, University of Geneva, Geneva, Switzerland

Single crystals of tetragonal RCu$_2$Ga$_2$ (R = La, Ce, Pr, Nd and Gd), with ThCr$_2$Si$_2$ type structure (space group $I4/mmm$), have been grown by high temperature solution growth technique using Ga as flux. Heat capacity, magnetization and electrical resistivity measurements were recorded along [100] and [001] directions. Except LaCu$_2$Ga$_2$, the remaining compounds order magnetically. CeCu$_2$Ga$_2$ and PrCu$_2$Ga$_2$ undergo ferromagnetic transitions; NdCu$_2$Ga$_2$ shows antiferromagnetic transition. GdCu$_2$Ga$_2$ seems to possess spin glass and antiferromagnetic ordering behaviour. These measurements signify the presence of substantial contribution from the crystal electric field splitting of energy levels. Further we have also performed measurements of electron spin resonance (ESR) on the high quality single crystals of GdCu$_2$Ga$_2$ in paramagnetic and antiferromagnetic phases.

O-3-11

MAGNETIC PROPERTIES OF Dy$_{11}$Si$_4$In$_6$

R. Duraj[a], Yu. Tyvanchuk[b], J. Przewoźnik[c], Ya. Kalychak[b], S. Baran[d] and A. Szytuła[d]

[a]Institute of Physics, Technical University of Cracow, Kraków, Poland

[b]Inorganic Chemistry Department, Ivan Franko National Unirversity of Lviv, Lviv, Ukraina

[c]Faculty of Physics and Applied Computer Science AGH University and Technology, Kraków, Poland

[d]M. Smoluchowski Institute of Physics, Jagiellonian University, Kraków, Poland

Intermetallic Dy$_{11}$Si$_4$In$_6$ crystallize in the tetragonal Sm$_{11}$Ge$_4$In$_6$-type crystal structure (space group I4/mmm) in which the rare earth atoms occupy four different sites. The ac and dc magnetic measurements suggest the complex magnetic properties. Below T$_c$ = 52 K the ferromagnetic ordering is observed. With decrease temperature the change of the magnetic properties to the antiferro- ordering is observed. This result also from the magnetization curve measurement at 1.9 K With increase of the magnetic field the metamagnetic phase transition (H$_{cr}$ = 6.4 kOe) with hysteresis is observed. Near the Curie temperature the magnetocaloric effect with the magnetic entropy $-\Delta$S equal to 16.5 J/kg·K is observed. This value is large that observed in isostructural R$_{11}$Ge$_8$In$_2$ compounds [1].

[1] Y.Y. Janice Cheumg et al., Intermetallics: 10.1016/j.intermet. 2010.10.004.

O-3-12

EPITAXIAL GROWTHS AND MAGNETIZATION DYNAMICS OF Ni_2MnSn HEUSLER ALLOY FILMS

J. Dubowik[a], I. Gościańska[b], K. Załęski[a], H. Głowiński[a], A. Ehresmann[c], G. Kakazei[d] and S. A. Bunyaev[d]

[a]Institute of Molecular Physics, Polish Academy of Sciences, Poznań, Poland
[b]Physics Department, A. Mickiewicz University, Poznań, Poland
[c] Institute of Physics, Kassel University, Kassel, Germany
[d] IFIMUP-IN, Universidade do Porto, Portugal

Ferromagnetic resonance (FMR) has been investigated in Ni_2MnSn Heusler alloy films. The films were deposited at $673 < T < 723$ K on MgO(001) substrates by means of magnetron sputtering. Structural characterization of the films was performed by x-ray diffraction (XRD). XRD confirmed that the films were epitaxial with the lattice parameter $a = 0.605$ and $Ni_2MnSn(001)[100]||MgO(001)[110]$ relationship which matches well with $\sqrt{2}a_{MgO} = 0.6$ nm. The films had the saturation magnetization $M_S(4K) = 690$ G ($4\mu_B$ per formula unit) typical of bulk Ni_2MnSn with $L2_1$ structural order. From angular dependencies of the resonance field and the FMR linewidth as well as FMR dispersion characteristics measured with VNA-FMR the following magnetic parameters at room temperature were obtained: the spectroscopic splitting factor $g = 2.05$, the cubic magnetocrystalline anisotropy K_4 of -1×10^4 erg/cm^3 and the Gilbert damping constant α of $4 - 7 \times 10^{-3}$. A very low spin-wave stiffness $D = 90 - 100$ meVÅ is responsible for a substantial extrinsic two-magnon contribution to the linewidth of the order of 50-100 Oe in these epitaxial soft magnetic Heusler alloy films.

O-3-14

MAGNON ASSISTED LONG-RANGE SUPERCONDUCTING PROXIMITY EFFECT IN HALF-METALLIC FERROMAGNETS

J. Martinek[a], G. Ilnicki[a], S. Takahashi[b], S. Hikino[c], M. Mori[c], and S. Maekawa[c]

[a]Institute of Molecular Physics, Polish Academy of Sciences, 60-179 Poznań, Poland
[b]Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan
[c]Advanced Science Research Center, Japan Atomic Energy Agency, Tokai, Japan

Recent experiments demonstrate that even in the half-metallic fully-spin-polarized ferromagnets a long-range proximity effect is possible as in normal metals. We consider that at an interface the conversion between singlet pair and triplet one is assisted by a creation of magnon excitation. Such a triplet pair can penetrate the ferromagnet for a long distance while a singlet one cannot. Considering the thermal Bose distribution of magnons we obtain, due to destructive interference between magnons of different momentum, a short range proximity effect. We find that, in the case when a single magnon mode dominates other modes, the long-range proximity effect is possible as well. We suggest two possible scenarios in order to create a single mode behavior. First, via nonequilibrium magnons injected during the coherent precession of the magnetization by tuning the microwave frequency to the ferromagnetic resonance (FMR) frequency in a ferromagnetic Josephson junction. In the second scenario, we consider Bose-Einstein condensation (BEC) of magnons induces by the increase of the magnon chemical potential due to the superconducting proximity free energy. The BEC of magnons will induce a modulation of magnetic order (the inverse proximity effect) - spin superstructure presumably with a weak helical structure that allows for dissipationless spin current.

P-3-01

AB–INITIO STUDY OF AN INFLUENCE OF TRANSITION METAL DOPING ON ELECTRONIC STRUCTURE AND ORDERING DEGREE IN Fe_3Al ALLOY

A. Go[1] and L. Dobrzyński[1,2]

[1]Faculty of Physics, University of Bialystok, Lipowa 41, 15–424 Białystok, Poland

[2]The Soltan Institute for Nuclear Studies, 05–400 Otwock–Świerk, Poland

Fe_3Al alloy crystallizes in DO_3–type structure. In the perfectly ordered alloy there are two nonequivalent sublattices (A,C) and B, which are occupied by Fe atoms, whereas all D sites are taken by metalloid. However, experimental results indicate, that there is some disorder between B–D as well as (A,C)–D sublattices. This disorder modifies strongly electronic structure and magnetic properties. The aim of this contribution is to investigate total energy dependence of atomic exchange between B–D and (A,C)–D positions in the Fe_3Al as well as in alloys doped with transition metals using ab–initio technique. Furthermore an influence of atomic ordering on electronic structure is studied thoroughly. Decreasing of ordering degree in Fe_3Al alloy augments variety of local surroundings of atoms. It leads to more complicated densities of states and causes an increase of total magnetic moment. Doping Fe_3Al with small amount of chromium does not change ordering of alloy. However, total energies of totally ordered and partially disordered alloys are nearly the same. According to the total energy calculations, manganese entering into (A,C) position can introduce B–D type of disorder in the parent compound.

P-3-02

MAGNETIC PROPERTIES OF 2D NANO ISLANDS SUBJECT TO TRANSVERSE MAGNETIC FIELDS: EFT ISING MODEL

M. Abou Ghantous[a] and A. Khater[b]

[a] Science Program, Texas A and M University at Qatar, Education City, PO Box 23874, Doha, Qatar

[b] Laboratoire de Physique de L'Etat Condensé, UMR 6087, Université du Maine, 72085 Le Mans, France

An Ising spin effective field theory (EFT) is presented to calculate the magnetic properties of 2D nano islands on nonmagnetic substrates, subject to an applied in plane magnetic field. The system Hamiltonian contains nearest neighbor exchange interactions, single-atom magnetic anisotropies, and the transverse field, with a system model spin $S = 1$ that permits the analysis of local spin fluctuations. An *exact* EFT symbolic and numerical approach is developed for the first time to avoid approximations inherent to previous analytical treatments to diagonalize the non-diagonal Hamiltonian. Furthermore, the applicability of this exact formulation has been extended successfully to higher spin values. Our calculations yield the single site spin correlations, the magnetizations, and the isothermal susceptibilities for the nano island core and periphery domains. We investigate the effects due to the remarkably different domain anisotropies over their reduced dimensionalities, and in particular the critical influence of the applied magnetic field. Detailed theoretical results are presented for the honeycomb, square and hexagonal lattices, with numerical applications for well known mono-layer Co nano islands. The remarkable differences between the core and periphery properties in zero fields are strongly modified. In particular the applied field provokes critical discontinuities at very small temperatures for the spin correlations and magnetizations.

P-3-03

MAGNONS COHERENT TRANSMISSION AND HEAT TRANSPORT AT MAGNETIC NANO JUNCTIONS

A. Khater[a], B. Bourahla[b], and M. Abou Ghantous[c]

[a] Laboratoire de Physique de l'Etat Condensé UMR 6087, Université du Maine, 72085 Le Mans, France

[b] Laboratoire de Physique et Chimie Quantique, Université de Tizi Ouzou, 15000, Algérie

[c] Science Program, Texas A and M University at Qatar, Education City, PO Box 23874, Doha, Qatar

A general model calculation is presented for the magnons coherent transmission, and corresponding heat transport, at insulating magnetic nano junctions. The system consists of a magnetic insulating nano junction between two magnetic leads which may be treated as insulating. A Heisenberg Hamiltonian describes the magnetic order for the system. Spin dynamics is analyzed using the equations of motion for the spin precession displacements on the lattice sites, valid for the range of temperatures of interest. The coherent transmission and backscattering probabilities at a given nano junction are calculated using the matching theory, for all magnon frequencies in the lead bands and arbitrary angles of incidence, at variable temperature, and for different nano junction thicknesses. The model yields the heat transport due to the coherent transmission of magnons between the leads when maintained at slightly different temperatures. This model calculation elucidates in particular the dependence of the coherent transmission of magnons and their heat transport per magnon branch for variable nano junction thicknesses and their associated magnetic order. It is applied in particular to the Fe/Gd/Fe system with a sandwiched ferromagnetic Gd junction of varying thickness.

P-3-04

NEUTRON RESULTS ON $KEr(MoO_4)_2$ SINGLE CRYSTAL IN MODERATE MAGNETIC FIELDS

S. Matáš[a], A. Orendáčová[b], K. Prokeš[a], M. Reehuis[a] and E. Ressouche[c]

[a]Helmholtz Zentrum Berlin, Hahn Meitner Platz 1, D-14109 Berlin, Germany

[c]P. J. Šafárik University, Park Angelinum 9, 040 01 Košice, Slovakia

[d]Institut Laue Langevin, 6 rue Jules Horowitz, 38042 Grenoble Cedex 9, France

Double rare earth molybdates of composition $MR(MoO_4)_2$, where M is alkali metal and R rare earth, crystallize in variety of layered structures. Some members of this group are close to 2D Ising system. Due to the fact that energy separation between first excited state and ground state (in rare-earth double molybdates) is smaller than the cooperative Jahn-Teller (JT) interaction energy many of such systems undergo a spontaneous cooperative JT transition on cooling. The $KEr(MoO_4)_2$ system does not, however, the JT transition can be induced by applying of moderate magnetic field. We used unpolarized and polarized neutron diffractions to study the magnetization distribution in double molybdate $KEr(MoO_4)_2$ single crystal below transition temperature $T_N \sim 0.95$ K and in the paramagnetic phase at temperatures of 2 K, 20 K. The moderate external magnetic field of 1 T, 3 T and 6 T was applied along the c-crystallographic direction. Our preliminary magnetization distribution results taken on zero field cooled (ZFC) and field cooled (FC) sample were constructed by means of maximum entropy method. Magnetization density maps for FC and ZFC sample below and above transition temperature show that main magnetization contribution is related to erbium atom sites, however, non-zero magnetization signal is induced by a field and also outside of erbium sites. This can be related to some of oxygen and molybdenum atom positions.

P-3-05
AB INITIO STUDY ON THE MAGNETIC STABILITY OF Ni_2MnGe

M. Pugaczowa-Michalska[a]
[a]Institute of Molecular Physics Polish Academy of Science, Smoluchowskiego 17, 60-179 Poznań, Poland

The electronic structure, ground state magnetic properties and thermal expansion of Ni_2MnGe Heusler alloy with cubic $L2_1$-type structure have been recently studied by first-principles methods. It was theoretically found that the magnetization of Ni_2MnGe shown a linear decreases with a hydrostatic pressure.
The main aim of a present study on the above-mentioned Heusler alloy is to investigate the influence of magnetic field on electronic structure and magnetic properties of the Ni_2MnGe. In a framework of DFT (density functional theory) methods it is possible to constrain the fixed value of the total magnetic moment (M) per unit cell. This fixed-spin-moment (FSM) method has been used in the full-potential nonorthogonal local orbital minimum basis (FPLO) scheme [www.fplo.de]. Thus, a particular ferromagnetic solution was forced on Ni_2MnGe. The obtained self-consistent total energy of the alloy is a function of two variables: the volume V and the total magnetic moment M. Only the minima with respect to M are called magnetic phase, since they do not require a magnetic field to maintain them and potentially could be stabilized by an applied stress such as an epitaxial stress. The obtained results of FSM study predicts that Ni_2MnGe in $L2_1$-structure has only one magnetic solution with the total magnetic moment of about 3.7 μ_B. Thus, the studied alloy has no metastable states.

P-3-06
DIPOLE-EXCHANGE SPIN-WAVE SPECTRUM OF THE DYNAMIC MAGNONIC CRYSTAL ON TERAHERTZ FREQUENCIES

N. Yu. Grigoryeva, B.A. Kalinikos
Department of Physical Electronics and Technology, St.-Petersburg Electrotechnical University, 197376 Saint-Petersburg, Russia

The planar magnetic periodic structures (magnonic crystals) based on the magnetic thin films provide favorable possibilities in reduction of the device dimensions and in the development of novel high-frequency devices. The dynamic magnonic crystals represent a type of the structures that can be formed dynamically in ferromagnetic waveguiding system, for example, by switching on and off an external periodic magnetic field. The easy-tuning dispersion characteristics and the possibility of using highly anisotropic ferromagnetic (e.g., hexaferrite) film as a waveguiding element makes such structures very attractive for applications in terahertz signal processing.
Here we present an analytical theory of the dipole-exchange spin-wave spectrum for the dynamic magnonic crystal, which is formed on the basis of the hexaferrite film with strong uniaxial magnetic volume anisotropy by applying a small spatially-periodic magnetic field simultaneously with the uniform bias magnetic field. In constructing the theory, a strong uniaxial volume anisotropy, as well as arbitrary surface spins pinning conditions are taken into account. The theoretical investigation is illustrated by several relevant numerical calculations.

P-3-07

MAGNETIC PROPERTIES AND ELECTRONIC STRUCTURE OF $La_{1.2}Nd_{0.2}Ca_{1.6}Mn_2O_7$ AND $La_{1.2}Sm_{0.2}Ca_{1.6}Mn_2O_7$ COMPOUNDS

R. Dudric[a], S. Mican[a],C. Himcinschi[b], and R. Tetean[a]

[a]Faculty of Physics, Babes-Bolyai University, Kogalniceanu 1, 400084 Cluj Napoca, Romania

[b]Institut für Theoretische Physik, TU Bergakademie Freiberg, Leipziger Str. 23, 09596 Freiberg, Germany

Structural, magnetic, magnetocaloric and XPS studies on $La_{1.2}Nd_{0.2}Ca_{1.6}Mn_2O_7$ and $La_{1.2}Sm_{0.2}Ca_{1.6}Mn_2O_7$ are reported. The polycrystalline samples, prepared by standard ceramic reaction, are single phase with a $Sr_3Ti_2O_7$-type structure. The lattice parameters are smaller than in the parent compound $La_{1.4}Ca_{1.6}Mn_2O_7$ due to the smaller ionic radius of the substitutions atoms. The magnetic measurements were performed in magnetic fields up to 12T in the temperature range 4.2-600K. A transition from a paramagnetic state to a magnetic one occurs below room temperature. The decrease of the Curie temperature when La is substituted can be correlated with the structural changes. At temperatures below 400K the temperature dependence of the reciprocal susceptibility is not linear, probably due to appearance of clusters. The magnetic entropy changes were determined from magnetization isotherms and the relative cooling powers RCP(S) were calculated. The maximum values of entropy change occur almost around the magnetic transition temperatures and decrease when La is substituted with Nd or Sm. This effect is accompanied by the broadening of the magnetic entropy peaks, resulting in significant values for the RCP(S). The electronic structure of the two compounds is studied by analyzing the XPS valence band and core level spectra.

P-3-08

STRUCTURAL AND MAGNETIC PROPERTIES OF Co_2MnSi BASED HALF-METALS

R.O. Grasin[a], G. Radnóczi[b], R.Tetean[a]

[a]Babes-Bolyai University, Faculty of Physics, Kogalniceanu 1, 400084 Cluj Napoca, Romania

[b]Research Institute of Technical Physics and Material Sciences of HAS, 1121 Budapest Konkoly-Thege Miklós út. 29-33, Hungary

The $Co_2Mn_{1-x}R_xSi$, where R=Gd or Tb and x=0, 0.01, 0.05 and 0.1 were prepared. The crystal structure was checked by X-Ray, TEM, SAED and EDS. Magnetic measurements in fields up to 12 T and temperature range 4.2-700 K were performed.

X-ray studies revealed, in the limit of experimental errors, that the L21 structure is preserved. The TEM images and SAED shows that small, approximately 1 micrometer long, inclusions are formed in isolated places. EDS analysis, revealed a higher amount of Mn in the inclusion than in the bulk in the sample with Gd. The inclusions are non-magnetic and approximately homogeneous dispersed, and therefore are not influencing the magnetic properties of the alloys.

In the case of the compounds with Tb, the EDS results suggest that Tb is not substituting the Mn atoms. A second phase consisting on nanometer size needle structures was revealed.

All the samples are saturated in an external magnetic field of 3T. For example the magnetic moment at 4.2 K decrease from 5.07 μ_B/f.u. for undopped $Co_2Mn_{1-x}Gd_xSi$ to 4.75 for x=0.01 and 4.53μ_B/f.u. for x=0.05 suggesting an antiparallel coupling of rare earth and Mn magnetic moments.

P-3-09

OBTAINING SUBMICRON FILMS ON THE BASE OF YIG BY DROPLET EPITAXY

V.F. Shkar[a], V.V. Morenko[b]

[a]Donetsk Physicotechnical Institute, National Academy of Science of Ukraine, Donetsk, 83114 Ukraine

[b]Donetsk National University, Universitetskaya str., 24, Donetsk, 83001, Ukraine

To obtain films based on yttrium iron garnet (YIG) method was used droplet epitaxy. Initially produced solution-melt (S-M) YIG-based low lead boron-barium solvent. By rapid cooling the S-M was obtained by homogeneous glassy mass.

The technique of growing YIG film includes the following steps. In the isothermal zone of the furnace slowly introduced GGG substrate. After thermal stabilization included its rotation in two alternating directions. Next in the isothermal zone furnace is introduced loop with the glass drop of S-M. The temperature in the isothermal zone close to the temperature of growth YIG films by liquid phase epitaxy. Glassy drop of S-M melts, drips on GGG substrate, evenly spread out and begin the process of epitaxial YIG films. Discharge of residues of the drop with substrate is carried out by rotating the Stock with a large angular velocity. In conclusion, the sample was slowly removed from furnace. The magnetic and dynamic property of the films grown by droplet epitaxy does not differ from the characteristics of the films obtained by classical liquid phase epitaxy.

P-3-10

MAGNETOSTATIC WAVES IN FERRITE MAGNONIC CYSTAL-DIELECTRIC-METAL STRUCTURE

S.L. Vysotsky[a], Yu.A. Filimonov[a], E.S. Pavlov[b] and S.A. Nikitov[b]

[a] Kotel'nikov SBIRE RAS, Zelenaya str., 38, Saratov, 410019, Russia

[b] Kotel'nikov IRE RAS, Mokhovaya 11-7, Moscow, 125009, Russia

Ferrite magnonic crystal (MC) represents ferrite film with surface 1D or 2D periodic structure. While propagating in MC magnetostatic waves (MSW) interaction of incident q_{in} and reflected q_{ref} waves results in formation of forbidden gaps in MSW spectra at wavenumbers q_n satisfied Bragg condition $q = \pi n/d$, where n=1,2,..., d is structure's period. Corresponding frequency bands of increased propagating losses were experimentally found at frequency regions f_n linked with q_n by corresponding dispersion characteristics $f = f(q)$ for surface (SMSW), backward volume (BWMSW) and forward volume (FMSW) MSW.

In ferrite-dielectric-metal (F-D-M) structure the slope of dispersion curve of MSW depends on thickness of dielectric t. Note that BWMSW and FMSW are reciprocal waves in contrast to SMSW. So in MC-dielectric-metal structure decreasing of t for BWMSW and FMSW will change values of f_n corresponding to q_n satisfied Bragg condition.

In turn in case of SMSW $t = t^*$ for incident wave corresponds to $t = t^* + h$ (h is film's thickness) for reflected wave as they propagate along different surfaces of ferrite film. So at small enough t at the fixed frequency $q_{in}(t) \neq q_{ref}(t + h)$ that means that Bragg condition wouldn't be fulfilled and bands of increased propagating losses would disappear. This suggestion was experimentally justified for $t = 0$.

P-3-11
DISPERSION MANAGEMENT OF THE 2D MAGNONIC CRYSTAL STRUCTURE

Alexandr V. Sadovnikov, Svetlana E. Sheshukova
Saratov State University, Nonlinear Physics Department

In recent years, the investigations of the magnonic crystals (MC) are of great interest. These periodical structures are formed on the basis of magnetic materials in which the magnetostatic waves can propagate. The properties and wave dynamics of MC are, as yet, studied insufficiently. The waveguiding properties and possibility of soliton propagation in the nonlinear periodic ferromagnetic structures are interesting subjects of intensive exploration during past several years. In this work the processes of the electromagnetic wave propagation in the nonlinear MC was studied. The dispersion characteristics of the linear and nonlinear systems was numerically estimated. In media with a periodic modulation of parameters the dispersion characteristic consists of allowed bands separated by gaps where electromagnetic wave propagation is forbidden. The dispersion of the ferromagnetic periodic system can be obtained from the well-known dispersion relation of the unbounded in transverse section periodical structure. Taking into account the dispersion of the surface magnetostatic waves in homogeneous films the band structure for the MC can be constructed. The cut-off frequencies (on the boundaries of the band gap range) of periodical structure can be approximately estimated by this method.

P-3-12
DYNAMICS OF PULSE PROPAGATION IN NONLINEAR TRANSMISSION LINE BASED ON FERRITE FILM

Evgenii N. Beginin, Yurii P. Sharaevskii
Saratov State University, Nonlinear Physics Department, Saratov, 410012, Russia

Microstrip transmission line based on ferrite film of yttrium iron garnet can operate as a nonlinear device in which microwave signals propagate and demonstrate the following features: having a power P less than threshold power P_0, these signals are attenuated greater than signals with a power $P > P_0$. Theoretical analysis of this device has significant difficulties, since the nonlinearity is occurred due to parametric coupling between excited magnetostatic waves and other types of spin waves. The characteristics of the transmission line are studied in the framework of the proposed physical model of a two-level absorbing medium. In this model, the power of electromagnetic wave passing through the microstrip line and its absorption coefficient at the signal frequency f are described by a system of rate equations. The model includes two parameters: a relaxation time of the system and a saturation power. The values of these parameters can be found experimentally. In the frequency range 2-3 GHz, the experimental and theoretical study of the transmission of a weak sinusoidal signal and rectangular microwave pulses through the microstrip line is provided. The pulse duration and repetition period depend on their power. Good agreement is found between the theoretical model and experimental investigations.

P-3-13
MAGNETIC BEHAVIOR OF IRON IN $Er_{1-X}Zr_XFe_2$ COMPOUNDS

S.Mican[a], D. Benea[a], O. Ginsca[a], I.G.Deac[a], R.Tetean[a]
[a]Babes-Bolyai University, Faculty of Physics, RO-400084, Cluj-Napoca, Romania

The compounds $Er_{1-X}Zr_XFe_2$ with x $\leq$ 0.5 crystallize in a cubic C15 type structure. The lattice parameters decrease slightly when Zr content increases, a fact attributed to the smaller radius of the Zr ion compared to the Er one. Magnetic measurements were performed in the temperature range 4.2-700 K in external magnetic fields up to 12 T. All the compounds are ferrimagnetically ordered, the erbium and iron magnetic moments being antiparallelly oriented. The Curie temperatures and the spontaneous magnetizations, at 4.2 K, decrease when zirconium content increases. The iron magnetic moments and effective magnetic moments are little dependent on composition. The density of states (DOS) and magnetic moments are calculated using the fully relativistic Korringa-Kohn-Rostoker (KKR) band structure method. The disorder in the system has been accounted for by means of the Coherent Potential Approximation (CPA). Finally, the magnetic behaviour of iron in these compounds is analyzed.

P-3-14
THE PERMEABILITY FUNCTION ESTIMATION OF THIN MAGNONIC CRYSTALS SLABS

M. Mruczkiewicz[a], R. V. Mikhaylovskiy[b], J. W. Klos[a], M. Krawczyk[a] and V. V. Kruglyak[b]
[a]Faculty of Physics, Adam Mickiewicz University, Poznan, Poland;
[b]University of Exeter, Stocker Road, Exeter EX4 4QL, United Kingdom;

Materials with a negative refractive index (NRI) can have unusual physical properties and might allow one to construct new devices for superlensing or cloaking in future. In particular, the NRI is observed in artificial materials that possess negative permittivity and permeability simultaneously. Materials with a periodic arrangement of magnetic inclusions (so called magnonic metamaterials) have potential to fulfill this requirement. Since all metals exhibit negative permittivity at frequencies below their plasma frequency, we focus on exploration of negative permeability in the same frequency range. In particular, a strong magnetic resonance in the sub-THz frequency range can lead to the negative permeability. Hence, we investigate one-dimensional stacks of thin patterned metallic magnetic layers separated by dielectric layers. Each magnetic layer (slab) represents one- or two-dimensional binary magnonic crystal. The plane wave method is used to calculate the spin wave spectra and profiles of dynamic magnetization. From this, we are able to extract information about the relative absorption at the resonant frequencies. The method of calculation of relative absorption is elucidated. Furthermore, we calculate the effective magnetic parameters in the long wavelength approximation to derive the effective permeability of one-dimensional stacks of such slabs.
The research was supported by (FP7/2007-2013), no 228673 (MAGNONICS).

P-3-15

EFFECT OF TB/GD SUBSTITUTION ON CRYSTAL STRUCTURE AND EXCHANGE INTERACTIONS OF $Tb_xGd_{1-x}Ni_3$ INTERMETALLIC COMPOUNDS

A. Chrobak [a],A. Bajorek [a], G. Chełkowska [a]

[a]A. Chełkowski Institute of Physics, University of Silesia,Uniwersytecka 4, 40 - 007 Katowice, Poland

Intermetallic compounds of rare earth (RE) and transition (T) elements are very interesting form scientific point of view because of a mixture of localized (RE) and itinerant (T) magnetism. In the paper an influence of Tb/Gd substitution on crystal structure and exchange interactions of $Tb_xGd_{1-x}Ni_3$ (x = 0.0, 0.2, 0.5, 0.8, 1.0) polycrystalline compounds have been studied. The crystal structure of all samples was checked at the room temperature by means of X-ray diffraction (XRD). Exchange integrals of RE-RE (J_{RE-RE}), T-T (J_{T-T}) and RE-T (J_{RE-T}) atoms were evaluated from M(T) magnetization curves (2 K - 300 K, 2 T) based on the mean field theory (MFT) calculation. As it was shown the samples examined are single phase and crystallize in the $PuNi_3$ (space group R-3m) type of crystal structure. The Tb/Gd substitution causes the decrease of lattice parameters as well as the volume of the unit cell. A variation of the J_{RE-RE}, J_{T-T} and J_{RE-T} parameters in a context of the structural changes are also widely discussed.

P-3-16

MAGNETO-HISTORY EFFECT IN THE $Tb_xGd_{1-x}Ni_3$ COMPOUNDS

A. Bajorek [a],G. Chełkowska [a], A. Chrobak [a], M. Kwiecień - Grudziecka [a]

[a]A. Chełkowski Institute of Physics, University of Silesia,Uniwersytecka 4, 40 - 007 Katowice, Poland

The compounds $Tb_xGd_{1-x}Ni_3$ with a $PuNi_3$ - type structure have been obtained. The magnetic properties have been investigated by using SQUID magnetometer (Quantum Design MPMS, temperature from 1.9K to 300K and magnetic field up to 7T). The partial replacement of Gd by Tb atoms is reflected in decreasing of the ordering temperature from 115K (x=0.0) to 81K (x=1.0) as well as the increase of the saturation magnetic moment M_S from $6.93\mu_B$/f.u (x = 0.0) to $7.14\mu_B$/f.u (x = 1.0). The magnetocaloric effect (MCE) has been estimated from the family of magnetic isotherms. The magnetic entropy indicates relatively small change with the Gd/Tb substitution. A large difference of M(T) curves has been noticed between the so-called field cooling - zero field cooling (FC-ZFC) magnetization. The thermomagnetic curves are sensitive to the applied magnetic field and their origin can be understood as the domain-wall pinning effect and as the temperature dependence of coercivity.

P-3-17

MAGNETIC PROPERTIES AND MAGNETOCALORIC EFFECT OF $HoCo_{3-x}Al_x$ COMPOUNDS

A. Bezergheanu[a], C. Rusu[a], R. Grasin[a], S. Mican[a], I.G. Deac[a], and R.Tetean[a]

[a]Babes-Bolyai University, Faculty of Physics, 400084 Cluj-Napoca, Romania

The $HoCo_{3-x}Al_x$ compounds with $x = 0.4$ crystallize in a rhombohedral structure having R$\bar{3}$m space group. The lattice parameters decrease slowly when aluminium atoms substitute the cobalt atoms. This fact can be attributed to lower Al ionic radius.
The magnetic measurements were performed in external magnetic fields up to 12T in the temperature range 4.2-700K. The saturation magnetization, at 4.2 K, increases slowly as cobalt is replaced by aluminium from 5.93 μ_B/f.u. (x=0) to 6.46 μ_B/f.u. (x=0.4) in agreement with antiparallel ordering of Ho and Co sublattices. The Curie temperature decreases from 435 K (x=0) to 287 K for the compound with x=0.4.
The magnetic behaviour of cobalt was analyzed in the spin fluctuation model. The adiabatic magnetic entropy changes, $\mid \Delta S \mid$, were determined from magnetization data. Large $\mid \Delta S \mid_{max}$ values were obtained in all cases. The origin of the large magnetic entropy change could be attributed to the considerable variation of the magnetization near the transition temperature. The potential application of these compounds as working substance for magnetic refrigeration is discussed.

P-3-18

ELECTRONIC STRUCTURE AND MAGNETISM OF $YFe_{11-x}Si_xTi$ COMPOUNDS

D. Benea[a], C.B. Cizmas[b], L. Bessais[c] and V. Pop[a]

[a]Facultatea de Fizica, Universitatea Babes-Bolyai,
Str. M. Kogalniceanu 1, 400084 Cluj-Napoca, Romania

[b] Department of Physics, Transilvania University Brasov, 29 Eroilor Blvd, Brasov, Romania

[c] LCMTR, UPR209, CNRS, 218 rue Henri Dunant, B.P. 28, F-94320 Thiais, France

A detailed theoretical investigation on the electronic and magnetic properties of several $YFe_{11-x}Si_xTi$ systems in $ThMn_{12}$ tetragonal type of structure (S.G. I4/mmm, z=2) have been performed. All theoretical investigations of the electronic and magnetic properties have been done using the Korringa-Kohn-Rostoker (KKR) band structure method. The disorder in the system has been accounted for by means of the Coherent Potential Approximation (CPA). The spin resolved density of states (DOS) reflects the covalent nature of the interatomic bands. The Si for Fe substitution in $YFe_{11-x}Si_xTi$ induces a significant broadening of the Fe 8f, 8i and 8j bands, as a consequence of Si(p)-Fe(d) hybridization. The calculated magnetic moments decrease with Si content from 20.82 μ_B/f.u. for $YFe_{11}Ti$ to 15.05 μ_B/f.u. for YFe_9Si_2Ti. The SPR-KKR calculated magnetic moments are in good agreement with the corresponding values determined by magnetization measurements. Comparing calculated hyperfine fields with experimental results, it is found that the calculated and experimental hyperfine fields are correlated. The theoretical calculations predict a decrease of the hyperfine fields on all Fe sites (8i, 8j and 8f) induced by Si for Fe substitution.

P-3-19

MAGNETIC AND ELECTRONIC PROPERTIES OF $NiMn_{1-x}Ho_xSb$ COMPOUNDS

R. Grasin[a], R. Dudric[a], A. Laslo[a], L. Chioncel[b], M. Neumann[c], and R.Tetean[a]

[a]Babes-Bolyai University, Faculty of Physics, 400084 Cluj-Napoca, Romania
[b]Institute of Physics, University of Augsburg, D-86135 Augsburg, Germany
[c]University of Osnabruck, Fachbereich Physik, 49069 Osnabruck, Germany

The structural, electronic and magnetic properties of $NiMn_{1-x}Ho_xSb$ alloys and compounds have been investigated by X-ray diffraction, X-ray photoelectron spectroscopy, magnetization and magnetic susceptibility measurements and band structure calculations.
The analysis of the band structure of the doped alloy shows that the half-metallic properties are completely conserved if Ho substitute Mn atoms, this effect being determined through the coupling between the Ho(4f) spin with the Mn(3d) itinerant electron spins. We evaluate the strength of such a coupling by calculating, in an ab-initio fashion, the total energy of $Co_8Mn_7HoSi_8$ compound for a parallel and antiparallel f-d coupling. It was found that the antiparallel coupling is most favorable, the energy difference being E_F-E_{AF}=52K. The experimental magnetic moments are in rather good agreement with the calculated ones in case of ferrimagnetic ordering. In order to investigate the hybridization between the Mn and Ni 3d states and the Sb 5p states, the XPS valence band spectra were calculated and compared to the experimental spectra.

P-3-20

XPS on $La_{0.67}Sr_{0.33}Mn_{1-x}Co_xO_3$ MANGANITES

A. Vladescu[a],R. Dudric[a], I.G. Deac[a], M. Neumann[b], R. Tetean[a]

[a]Babes-Bolyai University, Faculty of Physics, RO-400084, Cluj-Napoca, Romania
[b]Osnabrück University, Barbara Str.7, Osnabrück 49069, Germany

We present the study of the polycrystalline perovskite manganites $La_{0.67}Sr_{0.33}Mn_{1-x}Co_xO_3$ by X-ray photoelectron spectroscopy (XPS). Both valence band and core level spectra were analyzed. Additionally, electric and magnetic measurements in fields up to 12 T were performed. Core level XPS is sensitive to the chemical environment and can give infomation about the oxidation state of the probed ion. The O 1s core level spectra for all the samples present two distinct peaks, one assigned to the lattice oxygen and the other to less electron-rich oxygen species. The Mn 2p core level spectra are almost identical for all investigated samples, which indicates that the Mn^{3+}/Mn^{4+} ratio does not change with the increase of Co concentration. The Co 2p main peaks are situated at about 780 eV ($2p_{3/2}$) and 795.5 eV ($2p_{1/2}$) which indicates that Co is predominantly present as Co^{3+} state. In the region of the valence band, near to the Fermi level, a strong hybridization is found between the Mn 3d states and La 4f, for the compound with x=0. As the concentration of Co increased, the Co 3d states will hybridize as well with the Mn 3d and La 4f states, forming the valence band of the investigated compound. The compounds show semiconducting behavior and negative magnetoresistance. The magnetoresistance of the system does not exceeds 18 % (sample with x=0.7 in 7 T at 195 K) being dominated by intergranular effects, but some intrinsic effects have also to be considered. No feature at the transition of the system from the paramagnetic phase in the cluster glass phase was observed.

P-3-21

ELECTRICAL RESISTIVITY AND ELECTRONIC STRUCTURE OF THE $Tb_xGd_{1-x}Ni_3$ SYSTEM

G. Chełkowska [a],A. Bajorek [a], A. Chrobak [a], M. Kwiecień - Grudziecka [a]

[a]A. Chełkowski Institute of Physics, University of Silesia,Uniwersytecka 4, 40 - 007 Katowice, Poland

In the paper the electric properties and electronic structure of the polycrystalline $Tb_xGd_{1-x}Ni_3$ intermetallic compounds are presented. The electrical resistivity ρ(T)has been examined by a standard four - probe technique. The electronic structure measurements has been performed by using XPS method.
The partial replacement of Gd by Tb atoms causes the decrease of Curie temperature T_C and the increase of the residual resistivity. According to the Matthiessen rule the scattering mechanisms in ρ(T) have been analyzed. Moreover, the reduced form of the electrical resistivity ρ_Z(T-T_o) indicates a deviation from the linearity for x>0.2. This kind of behaviour can be explained as the dependence of density of d states near by the Fermi level (E_F) which are dominated by Ni3d states. The valence band spectra as well as the core level lines have been analyzed as the influence of Tb/Gd substitution on the electronic structure.

P-3-22

THE FORMULATION OF THE EXCHANGE FIELD IN THE LANDAU-LIFSHITZ EQUATION FOR SPIN-WAVE CALCULATIONS IN TWO-DIMENSIONAL MAGNONIC CRYSTALS

M. Krawczyk, J. W. Klos, S. Mamica, M. L. Sokolovskyy and M. Mruczkiewicz

Surface Physics Division, Faculty of Physics, Adam Mickiewicz University, Umultowska 85, 61-641 Poznan, Poland

The calculation of magnonic spectra by the plane wave method (PWM) has limitations, the origin of which lies in the formulation of the effective magnetic field term in the equation of motion (the Landau-Lifshitz (LL) equations) for composite media. In the PWM the system dynamics is described in terms of plane waves (a superposition of a number of plane waves), which are continuous functions and propagate throughout the medium. Since in magnonic crystals the sought-for superposition of plane waves represents the dynamic magnetization, the magnetic boundary conditions on the interfaces between constituent materials should be inherent in the LL equations. We present the derivation of the exchange field term from the Heisenberg model in the linear approximation for magnetic composites. We discuss the magnetic boundary conditions included in the proposed formulation of the exchange field, and elucidate their effect on spin-wave modes and their spectra in two-dimensional magnonic crystals. A comparison with other formulations known from the literature allows us to clarify various kinds of exchange terms and specify magnetic systems to which they can be applied.
The research leading to these results has received funding from the European Community (FP7/2007-2013) under Grant Agreement no. 228673 (MAGNONICS).

P-3-23
MICROWAVE ABSORPTION IN $Gd_5Si_2Ge_2$ COMPOUND

P. Aleshkevych
Institute of Physics, Polish Academy of Sciences
al. Lotnikow 32/46, 02-668 Warsaw, Poland

The alternative method of calculation the magnetic entropy change $\Delta S(H,T)$ by using the microwave technique is presented. This method is based on correlation between magnetization and dependent of magnetic field the nonresonant microwave absorption in the vicinity of the first-order magnetic transition. It was found that in the narrow temperature range of around Curie temperature ($T_C = 268K$), the temperature derivatives of both magnetization and inverse of microwave absorption are proportional to each other. The $\Delta S(H,T)$ was calculated as a function of temperature at different magnetic field and was compared to the magnetic entropy change calculated from magnetic data.
This work was financially supported by European Fund for Regional Development (Contract No. UDA–POIG.01.03.01-00-058/08/00).

P-3-24
IN SITU MULTIFREQUENCY FERROMAGNETIC RESONANCE

F. M. Römer[a], K. Wagner[a], R. Narkovic[b], H. Zähres[a], R. Meckenstock[a], J. Lindner[a], M. Farle[a]
[b]Department of Physics, University of Dortmund, Otto-Hahn-Str. 4, 44227 Dortmund, Germany
[a]Faculty of Physics and Center for Nanointegration (CeNIDE), University of Duisburg-Essen, Lotharstr. 1, 47057 Duisburg, Germany

Frequency and angular dependent ferromagnetic resonance (FMR) measurements were done in ultrahigh vacuum ($p < 1 \cdot 10^{-10}$ mbar) on an uncapped 10 nm Fe/GaAs(011) film. As probe we used a coaxial semi rigid microwave cable, which is hot-wired at the end. We evaluated the anisotropy parameters and were than able to determine the Landé g-factor along all the primary crystallographic directions [100], [110] and [111], due to the fact, that for the GaAs(011) orientated crystal all primary direction lay in the film plane.
We will present our setup, the results of those measurement and the calculations of the high frequency field distribution of our probe.

P-3-25

PARAMETRIC INSTABILITY OF SURFACE MAGNETOSTATIC WAVES IN 1D FERRITE MAGNONIC CRYSTAL

S.L. Vysotsky[a], Yu.A. Filimonov[a], E.S. Pavlov[b] and S.A. Nikitov[b]

[a] Kotel'nikov SBIRE RAS, Zelenaya str., 38, Saratov, 410019, Russia

[b] Kotel'nikov IRE RAS, Mokhovaya 11-7, Moscow, 125009, Russia

Dispersion of nonlinear spin waves (SW) in ferrite films depends on the amplitude of microwave magnetization $|\vec{m}|$. At sufficiently high level of magnetization amplitude the nonlinear shift in dispersion $\delta k = k(\omega, |\vec{m}_1|) - k(\omega, |\vec{m}_2|)$ is formed ($\vec{m}_1$ and $\vec{m}_2$ correspond to nonlinear and linear propagation of spin waves, respectively).

While linear propagating in ferrite film with surface 1D or 2D periodic structure - magnonic crystal (MC) - interaction of incident SW and SW reflected from surface structure results in formation of forbidden gaps in SW spectra at the frequencies f_n corresponding to k_n satisfied Bragg condition $k = \pi n/d$, where n=1,2,..., d is period of surface structure. At increasing of magnetization level nonlinear shift in dispersion δk leads to shift of f_n. One may expect that further increasing of $|\vec{m}|$ will result in loss of synchronism of the incident and reflected spin waves while propagation along MC.

In this work the influence of the first order (three-magnon) parametric instability of surface magnetostatic wave on the Bragg resonances in 1D ferrite MC was experimentally studied. It was shown that at sufficiently high level of the supercriticality gaps in spin wave dispersion at the frequencies corresponding to Bragg resonance disappear.

P-3-26

INFLUENCE OF THE DEMAGNETIZING FIELD ON SPIN WAVE SPECTRA OF PLANAR TWO-DIMENSIONAL MAGNONIC CRYSTALS

M.L. Sokolovskyy, J.W. Klos and M. Krawczyk[a]

[a]Faculty of Physics, Adam Mickiewicz University, Poznan, Poland

Investigation of spin wave spectra in nanoscale magnetic materials has recently attracted significant attention because the possibility of miniaturization of the present microelectronic devices. Materials with periodic modulation of one or more structural parameters are promising for applications. The fundamental feature of periodic structures is the presence of forbidden frequency gaps ("band gaps") in their spectrum, in which no propagation is allowed. There are plenty of methods that describe multilayered structures. A popular analytical method for investigating the spin-wave spectrum of such kind of systems is the plane-wave method.

One of the challenges during spin wave spectra calculations is to consider the dipolar field. So far, only the dynamic magnetostatic field was included in the plane wave method. In this work we extend our previous calculations to the case of two-dimensional magnonic crystals with finite thickness and nonuniform static dipolar field inside. Different calculation results of spin wave profiles in dependence on the static demagnetizing field are shown. Varying the geometrical and material parameters of the considered structures one can achieve different profiles of the static demagnetizing field and thereby control the spectra.

The research was supported by (FP7/2007-2013), No 228673 MAGNONICS.

P-3-27

ELECTRONIC STRUCTURE OF SOME WURTZITE SEMICONDUCTORS: HYBRID FUNCTIONALS VS. AB INITIO MANY-BODY CALCULATIONS

J. Kaczkowski[a]

[a]Institute of Molecular Physics, Polish Academy of Sciences
ul. M. Smoluchowskiego 17, 60-179 Poznań, Poland

Using the first-principles projector augmented wave method the structural and electronic properties of wurtzite crystals, AlN, GaN, InN and ZnO have been calculated. The structural parameters have been calculated within different exchange-correlation approximation: DFT, DFT+U and hybrid HSE. The error in the calculated lattice constants are less than 3% within DFT and DFT+U approximations and only 0.5% within HSE. The band gap has been calculated within different GW approximations: G_0W_0, GW_0 - where the eigenvalues in Green's function (G) are updated, GW - where both Green's function and dielectric matrix are updated until self-consistency. The best agreement with experiment was obtained for the GW approximation (see table below). The DFT+U+G_0W_0 gives similar results to GW. The density of states for mentioned compounds have been calculated within DFT, DFT+U and hybrid functional approximation.

Semic.	GGA	GGA+U	HSE06	G_0W_0	U+G_0W_0	GW_0	GW	Exp.
ZnO	0.793	1.403	2.499	2.334	3.152	2.871	3.640	3.430
AlN	4.095	-	5.714	5.523	-	5.780	6.226	6.190
GaN	1.774	2.489	3.348	2.911	3.777	3.110	3.448	3.500
InN	-0.160	0.000	0.772	-	-	-	-	0.7-0.8

P-3-28

ELECTRONIC STRUCTURE AND MAGNETIC PROPERTIES OF RNi_5Sn (R=Pr, Nd) COMPOUNDS

A. Jezierski[a] **and A. Szytuła**[b]

[a]Institute of Molecular Physics, Polish Academy of Sciences, Poznań, Poland
[b]M. Smoluchowski Institute of Physics, Jagiellonian University, Kraków, Poland

Electronic structure and magnetic properties of $PrNi_5Sn$ and $NdNi_5Sn$ compounds are calculatied by ab-initio method. These compounds have $CeNi_5Sn$ type structure (space group P63/mc) and they are studied as hydrogen storage materials. We used full-potential local-orbital minimum-basis (FPLO) method within the local spin density approximation (LSDA). The band calculations were performed for two types of the exchange correlation potentials: Perdew and Wang (PW) and Perdew Burke Ernzerhof (PBE-GGA). Ab-initio calculations were performed for full-relativistic and scalar-relativistic (LSD+U) method. We present the band structure, local and total densities of states, the Fermi surfaces and theoretical XPS spectra for $PrNi_5Sn$ and $NdNi_5Sn$ compounds.The spin and orbital magnetic moments for both systems are calculated within the LSDA method.

P-3-29

RESONANT NONLINEAR FREQUENCY MULTIPLICATION IN MICROSCOPIC MAGNETIC ELEMENTS

V. Bessonov[1], R. Gieniusz[1], A. Maziewski[1], H. Ulrichs[2], V.E. Demidov[2], S.O. Demokritov[2] and S. Urazhdin[3]

[1]Faculty of Physics, University of Bialystok, Lipowa 41, 15–424 Białystok, Poland
[2]Institute for Applied Physics and Center for Nonlinear Science,
University of Muenster, Corrensstasse 2–4, 48149 Muenster, Germany
[3]Department of Physics, West Virginia University, Morgantown, WV 26506, USA

Here we report on the experimental study of nonlinear frequency multiplication in Permalloy–film ellipses subjected to intense microwave magnetic field. The ellipses had lateral dimensions of 1 by 0.5 μm and the thickness of 10 nm and were prepared by e–beam lithography on top of 1–μm–wide microwave transmission line used for the excitation of magnetization dynamics. The experiments were performed by micro–focus Brillouin light scattering spectroscopy with the spatial resolution of about 250 nm and the frequency resolution of 100 MHz.

We show that the resonant modes of the magnetic elements can be excited by applying a microwave signal at a frequency which is by a factor of two or even three smaller compared to the resonant frequency. We study the spatial characteristics of the nonlinearly excited modes and show that the double–frequency excitation is efficient for modes with anti–symmetric spatial profiles, whereas the triple–frequency excitation is efficient for modes with symmetric profiles. The latter process shows an especially high efficiency, which makes it promising for technical applications.

P-3-30

DYNAMIC OF MAGNETIZATION AND HYSTERESIS PHENOMENA IN QUASI ONE DIMENSIONAL ISING MAGNET $[(CH_3)_3NH]CoCl_3x2H_2O$

A. Cherny, A. Rykova, and E. Khatsko

B. Verkin Institute for Low Temperature Physics and Engineering of NAS of Ukraine,
47 Lenin Ave., Kharkiv, 61103, Ukraine

The processes of reversal magnetization of quasi one dimensional Ising antiferromagnet $[(CH_3)3\ NH]CoCl_3x2H_2O$ was investigated in temperature range 4.2-0.5 K in magnetic fields up to 6 kOe as well as relaxation processes.

It was shown, that the hysteresis of magnetization in magnetic field at temperatures below 2.5K is dynamical because of sharp increasing of the relaxation time up to 10^3 s and more with the temperature decreasing. The relaxation time also demonstrate a strong dependence on applied magnetic field.

The received results are described in model of relaxation processes in weakly interacting superparamagnetic particle. where relaxation processes are determine by a thermal overcoming of potential barriers. The characteristic constants of relaxation times were found, as well as the volume of magnetic domains.

P-3-31

EXCHANGE COUPLED NiFe/NiMn BILAYER STUDIED BY VECTOR NETWORK ANALYZER FERROMAGNETIC RESONANCE

H. Głowiński[a], K. Załęski[a], J. Sprada[a,b] and J. Dubowik[a]

[a]Institute of Molecular Physics Polish Academy of Sciences, ul. Mariana Smoluchowskiego 17, 60-179 Poznań, Poland

[b]Department of Physics, A. Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland

Vector network analyzer ferromagnetic (VNA-FMR) resonance allows the ferromagnetic resonance to be measured by sweeping the frequency without changing the external field. Therefore the exchange bias field H_{eb} in ferromagnet/antiferromagnet (F/AF) bilayers can be determined using Kittel's formula at different constant values of external field. We can determine back and forth coercivities from a hysteresis loop and usually the H_{eb} field is evaluated as the average value of these back and forth coercive fields. VNA-FMR measurements reveal that exchange field changes during the magnetization reversal of ferromagnetic layer, so evaluating the H_{eb} field from coercive fields, results in imprecise value. Using VNA-FMR and a procedure described in [1], we have determined the exchange bias fields H_{eb} of NiFe/NiMn bilayer at different constant values of external field. The NiFe/NiMn bilayer sample with exchange bias was prepared using magnetron sputtering with a post-deposition vacuum annealing at 1000 Oe.

[1] C. Bilzer et al., J. Appl. Phys. 106, 063918 (2009)

P-3-32

AB INITIO CALCULATIONS OF PHASE TRANSFORMATIONS IN $Ni_{50}Mn_{50-x}Sn_x$ HEUSLER ALLOYS

K. Załęski[a] and J. Dubowik[a]

[a]Institute of Molecular Physics, Polish Academy of Sciences ul. Mariana Smoluchowskiego 17, 60-179 Poznań, Poland

Ferromagnetic Shape Memory Alloys (FSMA) are characterized by martensitic transformation in a ferromagnetic state. The Ni-Mn-X (X = In, Sn, Sb) systems with an excess of Mn atoms are off-stoichiometric Heusler alloys which exhibit shape memory effect. The present study is focused on $Ni_{50}Mn_{50-x}Sn_x$ systems whith $L2_1$ structure in the high temperature austenite phase and with a lower symetry martensite phase (orthorhombic or tetragonal) at low temperatures. We present results of band structure calculations based on Full-Potential SPR-KKR-CPA [1-3]. The total energy of $L2_1$ structure as a function of volume and c/a ratio is presented. The c/a ratio calculations were done for constant, optimal unit cell volume. The total magnetic moment and its contributions as a function of c/a are also presented. For the sake of comparison the total energy as a function of c/a ratio calculated with Atomic Sphere Approximation (ASA) is presented.

[1] *The Munich SPR-KKR package, version 5.4*, H. Ebert et al.
[2] http://olymp.cup.uni-muenchen.de/ak/ebert/SPRKKR
[3] H. Ebert, *Fully relativistic band structure calculations for magnetic solids Formalism and Application, in Electronic Structure and Physical Properties of Solids*, editor: H. Dreyssé, Lecture Notes in Physics, vol. 535, p. 191, Springer Berlin

P-3-33
ELECTRONIC STRUCTURE AND MAGNETIC PROPERTIES OF THE $UPdAs_2$ COMPOUND

M. Werwiński, A. Szajek
Institute of Molecular Physics, Polish Academy of Sciences
ul. M. Smoluchowskiego 17, 60-179 Poznań, Poland

The $UPdAs_2$ compound crystallizes in a tetragonal $HfCuSi_2$-type structure with the $P4/nmm$ space group [1]. $UPdAs_2$ orders antiferromagnetically below the Néel temperature of 240 K [1]. Magnetic moments localized on uranium atoms amount to 1,69±0.05 μ_B and are oriented along the c axis with sequence $++--$ [1,2].
The electronic band structure of $UPdAs_2$ is calculated using *FP-LAPW* method (Full Potential – Linearized Augmented Plane Wave) implemented in *WIEN2k* code[3]. *GGA*, *GGA+U*, *GGA+OP* (orbital polarization) approaches are studied. The Coulomb repulsion energy "U" applied to the uranium *5f* orbital is varying from 0 to 6 eV. Supercell doubled in c axis is built to reproduce magnetic moments sequence $++--$. Initial magnetic moments on uranium atoms are assumed to be opposite. The antiferromagnetic ground state is confirmed by total energies calculations for different magnetic configurations. Results of the *GGA+OP* approach are in the best agreement with the neutron scattering measurements of magnetic moments [1]. The total magnetic moment on uranium atoms is predicted to be 1.41 μ_B per atom.
[1] A. Murasik, P. Fisher and D. Kaczorowski, *J. Phys.:Condens. Matter* **2** (1990) 3967.
[2] D. Kaczorowski et al. *Phys. Rev. B* **58** (1998) 9227.
[3] P. Blaha et al., WIEN2k_7.3, Techn. Universität Wien, Austria, 2007.

P-3-34
ELECTRONIC BAND STRUCTURE AND MAGNETIC PROPERTIES OF $La_{2/3}Pb_{1/3}MnO_3$

W. Tokarz[a], M. Kowalik[a,b], R. Zalecki[a], A. Kołodziejczyk[a]
[a]Department of Solid State Physics, Faculty of Physics and Applied Computer Science, AGH Univ. of Science and Technology, 30, Mickiewicza Str, 30-059 Cracow, Poland
[b]Department of Physics, Rzeszów University of Technology, 6, Powstańów Warszawy Str, 35-959 Rzeszów, Poland

We present a theoretical study of electric and magnetic properties in $La_{2/3}Pb_{1/3}MnO_3$ perovskite. The calculation was carried out based on first-principles density functional theory (DFT) with general gradient approximation GGA+U using Wien2K package. The P3c1 crystal structure was taken from the detailed X-ray diffraction data for the perovskite [1]. For Mn *d* electrons exact exchange energy was utilized. Density of state (DOS) was determined by modified tetrahedron method. As a result we get a valance band shift for the spin up and down density of states with the top of the latter at 1.85 eV below the Fermi energy level (E_F). We noticed that conduction band is mainly dominated by *d* spin up manganese electrons, Mn d_{xz} and d_{yz} states have two times larger contribution than $d_{x^2y^2}+d_{xy}$. We attribute this to Mn-0_6 octahedral tilting. From the same reason d_{z^2} state has no contribution to the DOS at E_F. Comparison of total DOS with ultraviolet photoemission spectroscopy (UPS) measurements shows similar features [2] especially as far as the lead spectral intensity from the 6*s* electrons at about -9.5 eV is concerned. The calculated total magnetic moment per formula unit is 3.66 μ_B. There is some discrepancy between this value and the measured magnetic moment 3.48 μ_B/fu [3].
[1] Gritzner, G., Koppe, M., Kellner, K., Przewoźnik, J., Chmist, J., Kołodziejczyk, A., Krop, K., 2005. Preparation and properties of $La_{0.67}Pb_{0.33}(Mn_{1-x}Fe_x)O_3$ compounds. Appl. Phys. A 81, 1491-1495
[2] Kowalik, M., Zalecki, R., Kołodziejczyk, A., 2010. Electronic States of Collosal Magnetoresistive Manganites $La_{0.67}Pb_{0.33}Mn_{1-x}Fe_xO_3$ from Photoemission Spectroscopy. Acta Phys. Polon. A 117, 257-260
[3] Przewoźnik, J., Kowalik, M., Kołodziejczyk, A., Gritzner, G., Kapusta, C., 2010. Magnetic and magnetotransport properties of the $(La_{0.67}Pb_{0.33})(Mn_{1-x}Fe_x)O_3$ ($0 \leq x \leq 0.1$) compounds. J. All. Comp. 497, 1723

P-3-35

HYPERFINE INTERACTION PARAMETERS IN $Fe_{28}Al_{72}$: ^{57}Fe MÖSSBAUER SPECTROSCOPY AND *AB INITIO* STUDY

A. Hanc, J. Deniszczyk, J. Kansy

Institute of Materials Science, University of Silesia, 40-007 Katowice, Poland

It is well established that physical and mechanical properties of Fe-Al alloys are related to their atomic ordering. Mössbauer spectroscopy offers a sensitive microscopic probe to identify the nature of ^{57}Fe-atom configurations responsible for various hyperfine fields observed in Fe-Al alloys. The experimental investigations of multicomponent $Fe_{28}Al_{72}$ alloys of nominal composition 71.64 at % Fe, 28 at % Al and small amounts of other additives (Mo-0.2, C-0.1, Zr-0.05, B-0.01 at%) introduced in order to improve their thermal and mechanical properties were performed with the use of X-ray powder diffraction and Mössbauer effect spectroscopy. We present a method of determining the level of long range ordering in the alloys characterized by superstructure $D0_3$. In the presented approach, the possible atomic configurations around ^{57}Fe are the basis for reconstruction of Mössbauer spectrum. The degree of ordering is expressed by a sum of populations of chosen atomic configurations characteristic for entirely ordered structure. To control the Mössbauer spectra analysis the complimentary, DFT based, quantum calculations of hyperfine parameters were performed with the use of FP-LAPW method. The hyperfine parameters obtained from the Mössbauer spectra analysis are compared with the results of *ab initio* calculations performed for the reference system Fe_3Al.

Acknowledgment: The work was supported by the Ministry of Science and High Education in Poland within Grant no. N N507 480938.

P-3-36

AB INITIO STUDY OF ELECTRONIC STRUCTURE AND MAGNETIC PROPERTIES OF $Gd(Ni_{1-x}Fe_x)_3$ ALLOYS

J. Deniszczyk[a], A. Woźniakowski[a], W. Borgieł[b]

[a]Institute of Materials Science, University of Silesia, 40-007 Katowice, Poland

[b]August Chełkowski Institute of Physics, University of Silesia, 40-007 Katowice, Poland

The electronic structure and magnetic properties of $Gd(Ni_{1-x}Fe_x)_3$ alloys were measured recently by means of different methods. The measurements indicated several intriguing properties of the alloy. In the Ni-rich region the alloys display magnetocaloric properties but with relatively low Curie temperature. Increasing the Fe contents results in a linear decrease of the saturation magnetization while the Curie temperature reach the maximum at $x \simeq 0.5$. The XPS valence band measurements reveal the presence of correlation between the magnetic properties and electronic structure near the Fermi level.

In this paper we present the theoretical investigations of the electronic and magnetic properties of $Gd(Ni_{1-x}Fe_x)_3$ alloys. The electronic structure calculations were carried out with the use of *ab initio* FP-LAPW method. The GGA-LSDA form of exchange-correlation potential was applied with addition of the enhanced Coulomb correlation term for Gd-4f states. To simulate fractional concentrations the supercell approach was implemented. Using the results of *ab-initio* calculations the many particle, generalized s-f model for disordered alloy with strongly correlated band electrons was parametrized. Applying the Coherent Potential formalism the concentration dependence of Curie temperature and electrical conductivity was determined. The theoretical results are compared with experimental data.

The work was supported by a research project N N202 200039.

P-3-37

MAGNETIC AND ELECTRONIC PROPERTIES OF DISORDERED $(Gd_{1-x}Y_x)_7Pd_3$ ALLOYS – THEORETICAL STUDY

A. Woźniakowski[a], W. Borgieł[b], J. Deniszczyk[a]

[a]Institute of Materials Science, University of Silesia, 40-007 Katowice, Poland

[b]August Chełkowski Institute of Physics, University of Silesia, 40-007 Katowice, Poland

Recently the $(Gd_{1-x}Y_x)_7Pd_3$ alloys were the subject of intensive experimental investigations due to their potential magnetocaloric applications. The Curie temperature of Gd_7Pd_3 compound is too high for magnetocaloric applications but it can be tuned to appropriate value by partial substitution of Gd atoms by non-magnetic Y ones. In the entire concentration range the $(Gd_{1-x}Y_x)_7Pd_3$ alloys crystallize in the Th_7Fe_3 structure. In the paper we present the theoretical investigations of the electronic and magnetic structure and properties of $(Gd_{1-x}Y_x)_7Pd_3$ alloys. For the purpose of the electronic structure calculations the alloying was simulated within the supercell approach, with different local atomic configurations taken into account. The *ab-initio* calculations were performed applying the FP-LAPW method with the GGA-LSDA exchange-correlation potential. For the $4f$ states of Gd the enhanced Coulomb correlation term was included. Basing on the results of *ab-initio* calculations the many particle generalized s-f model for disordered alloy with strongly correlated band electrons was parametrized. With the use of Coherent Potential Approximation formalism the concentration dependence of Curie temperature and electrical conductivity in the paramagnetic state was determined. The results of calculations concide quantitatively with available experimental data.

The work was supported by a research project N N202 032137

P-3-38

AB INITIO STUDY OF ELECTRONIC, MAGNETIC STRUCTURE AND STRUCTURAL PHASE TRANSITION OF $(Fe_{1-x}Mn_x)_2P_{1-y}Ge_y$ ALLOYS

J. Deniszczyk[a], A. Woźniakowski[a], R. Kolano[b], A. Kolano-Burian[b]

[a]Institute of Materials Science, University of Silesia, 40-007 Katowice, Poland

[b]Institute of Non-Ferrous Metals, 44-100 Gliwice, Poland

Transition-metal and rare-earth based multicomponent intermetallic alloys are subject of intensive investigations due to their potential applications for magnetocaloric devices. In the $(Fe_{1-x}Mn_x)_2P_{1-y}Ge_y$ alloys it was found that the magnetic phase transition is accompanying by the first order isostructural phase transition, modifying the lattice parameters and atomic positions. The coexistance of the two phase transition results in a high magnitude of magnetic entropy change induced by magnetic field. This feature predestined the alloy for magnetocaloric applications.

In this paper we present the results of *ab initio* electronic and magnetic structure calculations performed for $(Fe_{0.5}Mn_{0.5})_2P_{0.67}Ge_{0.33}$, $(Fe_{0.58}Mn_{0.42})_2P_{0.83}Ge_{0.17}$ and $(Fe_{0.5}Mn_{0.5})_2P$ structures. The electronic structure calculations were carried out with the use of the DFT based FP-LAPW method implemented in the WIEN2k code. The GGA-LSDA form of exchange-correlation potential was applied. To elucidate the nature of isostructural phase transition the Fixed Spin Moment approach was utilised. Total energy analysis confirmed the occurence of isostructural phase transition for the value of magnetization which concides with the observed one. Moreover calculations reveal the change of magnetic order from ferromagnetic to ferrimagnetic type accompanying the structural phase transition.

P-3-39
ON THE INTERPRETATION OF THE ANGULAR DEPENDENCE OF FMR/SWR SPECTRA IN FERROMAGNETIC THIN FILMS

Maciej Kasperski and Henryk Puszkarski
Surface Physics Division, Faculty of Physics, Adam Mickiewicz University
61-614 Poznań, Umultowska 85, Poland

A careful analysis of the reported measurements of the angular dependence of FMR and SWR spectra and their theoretical interpretation leads to the observation that a discrepancy occurs between the theory and the experiment in certain ranges, which tend to be in the vicinity of either the perpendicular or the in-plane configuration of the external magnetic field (with the field perpendicular or parallel to the film plane, respectively). We demonstrate that this discrepancy cannot be eliminated within the model proposed by Smit and Beljers [1] and commonly used in the literature for description of the ferromagnetic resonance in thin films. We hope to propose an adequate modification of this model, which allows to obtain an agreement between the theoretical description and the experimental data in the whole range of angular configuration of the external field. Finally, some resulting remarks on relation between the resonant curves and the mutual orientation of uniaxial thin film anisotropy direction and external magnetic field will be drawn too.
Ref. [1] J. Smit and H. G. Beljers, Philips Res. Rep., 10, 113, 1955.

P-3-40
THE MAGNETIC PROPERTIES OF 2D NANO ISLANDS: AN ISING SPIN MODEL

A. Khater[a] and M. Abou Ghantous[b]
[a] Laboratoire de Physique de l'Etat Condensé UMR 6087, Université du Maine, 72085 Le Mans, France
[b] Science Program, Texas A and M University at Qatar, Education City, PO Box 23874, Doha, Qatar

An Ising spin effective field theory (EFT) is developed for a detailed analysis of the magnetic properties of 2D nano islands on non-magnetic substrates. The Hamiltonian consists of nearest neighbor exchange interactions and single-atom magnetic anisotropy, with spin $S = 1$. The model is general, for different nano island lattices, and permits analysis of spin fluctuations. Our calculations yield the single site spin correlations, magnetizations, and isothermal susceptibilities for the nano island core and periphery domains which are structurally distinct. In particular we investigate the effects due to the remarkably different domain anisotropies over their reduced dimensionalities, with detailed theoretical results for the square and hexagonal lattices, and numerical applications for Co nano islands on Pt. Though both the core and the periphery domains have the same order-disorder transition temperature, the magnetization of each attains this transition differently. The temperature behaviors of the spin correlations are also fundamentally different for periphery and core domains, generating distinctly different isothermal susceptibilities. The calculated overall nano island susceptibilities do not correspond to second order phase transitions. Furthermore, our EFT Ising model correctly interprets the susceptibility data for Co nano islands on Pt without reference to a transition from a blocking state to a superparamagnetic behavior.

P-3-41

MAGNETISM OF MAGNETITE UNDER HYDROSTATIC PRESSURE

T. Kołodziej*[,1)], W. Tabiś[1)], J. Piętosa[2)], R. Puźniak[2)], A. Wiśniewski[2)], Z. Kąkol[1)], A. Kozłowski[1)]

[1]AGH University of Science And Technology, Faculty of Physics And Applied Computer Science, Al. Mickiewicza 30, 30-059 Kraków, Poland;
[2]Institute of Physics, Polish Academy of Sciences, Al. Lotników 32/46, 02-668 Warszawa, Poland

Studies of pressure impact on magnetocrystalline anisotropy and axis switching phenomenon in single crystalline Zn-doped magnetite are presented. In the Verwey phase transition at temperature $T_V \approx 124$ K, magnetite crystal structure changes from cubic $Fd\bar{3}m$ to monoclinic Cc, and this is linked to the change in magnetocrystalline anisotropy with easy axis along one of the <100> cubic directions. The unique easy axis, and simultaneously also monoclinic c axis, can be established by application of external magnetic field while cooling the sample below T_V, but can also be switched to the other <100> direction by magnetic field („axis switching" - AS). Activation energy of AS is of the same order as $k_B T_V$, what suggests common origin of both phenomena. Since pressure lowers transition temperature, it was interesting to check if activation energy follows this trend in stoichiometric and zinc doped magnetite. It has been found that activation energy of AS increases with pressure in all cases, contrary to the decrease of $k_B T_V$. The diversion of easy axis from [100] under pressure of 1.2 GPa was found. The pressure induced structure transition from inverse to normal spinel, which was reported recently, was not observed.

P-3-42

ELECTRONIC STRUCTURE AND TRANSPORT PROPERTIES OF THERMAL METAMAGNET UPdGe

M. Samsel-Czekała, R. Troć and V.H. Tran

Institute of Low Temperature and Structure Research, Polish Academy of Sciences, P.O. Box 1410, 50-950 Wrocław 2, Poland

We present results of relativistic spin- (LSDA) and orbital- (OP) polarized band structure calculations for orthorhombic UPdGe performed by the FPLO code [1]. Previous bulk experiments showed that this compound exhibits two phase transitions, at $T_C = 30$ K to ferromagnetic (FM) and at $T_N = 50$ K to amplitude-modulated antiferromagnetic states. Interestingly, a giant transverse magnetoresistivity value of -73% was found exactly at T_C and at $B = 8$ T for a polycrystalline sample [2]. Our calculated magnetic moment in the FM ground state (LSDA+OP) is in good agreement with the experimental one, concerning both its value of 1.5 B.M./U at. and orientation in a simple collinear magnetic structure along the b axis [3]. The calculated density of states (DOS), in this FM state, resembles that in halfmetals while non-magnetic (LDA) DOS is semimetallic-like. The computed Fermi surface (FS) in the FM state is typically metallic, containing four electron and hole FS sheets, whereas the non-magnetic FS is semimetallic-like (with reduced FS sheets). This is in accord with our transport measurements indicating a Kondo-like behavior of UPdGe at temperatures $T > T_N$.

References: [1] K. Koepernik, H. Eschrig, PRB **59**, 1743 (1999); [2] R. Troć, J. Alloys Compd. **442**, 34 (2007); [3] S. El-Khatib et al. J. Appl. Phys. **93**, 8352 (2003).

P-3-43
TEMPERATURE EFFECT ON THE STRUCTURE OF TRANSFORMER OIL BASED MAGNETIC LIQUIDS USING ACOUSTIC SPECTROSCOPY

J. Kúdelčík[a], P. Bury[a], J. Drga[a], M. Timko[b], P. Kopčanský[b]
[a] Department of physics, University of Žilina, Univerzitná 1, 010 01 Žilina
[b] Department of Magnetism, IEP SAS, Watsonova 47, 040 01 Košice

The changes in structural arrangement in a magnetic fluid upon the effect of an external magnetic field and temperature were studied by acoustic spectroscopy. The properties of magnetic fluid dispersed in transformer oil TECHNOL have been studied by the analysis of changes in the acoustic wave absorption coefficient. The absorption coefficient of acoustic waves was measured as a function of an external magnetic field in the range of $0 - 200\,mT$, parallel to the direction of the field and as a function of temperature of $15 - 35\,°C$ for various magnetic nanoparticles concentrations. The strong influence of the steeped magnetic field on the acoustic wave absorption coefficient was detected and its hysteresis was detected, too. When a magnetic field is swept at a constant rate, the dominant interactions between the external magnetic field and the magnetic moment of the nanoparticle occur, leading to the aggregation of magnetic nanoparticles and clusters formation. However, the temperature of magnetic fluids has very important influence on the obtained dependencies, where the mechanism of thermal motion acts against the cluster creation. The obtained dependencies of magnetic field and temperature on the investigated magnetic liquids structure are discussed.

P-3-44
MAGNETOSTATIC SPIN WAVES PROPOGATION IN TWO-DIMENSIONAL WEDGE MAGNONIC CRYSTAL

Platonov Sergey[1,2]Nikitov Sergey[1,2]
[1]Russian Academy of Sciences, Institute of Radioengineering and Electronics, Moscow, Russian Federation.
[2]Moscow Institute of Physics and Technologies, Moscow, Russian Federation

Magnonic crystals (MC) are materials with periodically modulated magnetic parameters and they are spin-wave counterpart of photonic crystals. The study of MC has been intensively growing recently, nonetheless there is no general theory of magnetostatic wave propagation in 2D periodic structures. In our work we have studied surface magnetostatic wave propagation in 2D magnetic multi-layered structure. We assume that thickness of the structure linearly depends on MC length. Such dependence upon element of the structure prevents us from applying Blochs theorem in determining the spectrum of the magnetostatic waves. We use transfer matrix method (TMM) for calculating transmission and reflection spectrum of magnonic crystal. The spectrum of magnetostatic waves in 2D MC forms band structure with forbidden gaps. We have found forbidden band gap width and position dependence on the angle of the wave vector with characteristic axes of the wedge 2D magnonic crystal. It has also been found dependence of the band gaps width and position on angular wedge parameter. For large values of the angular parameter forbidden band gaps in spectrum of magnonic crystal are blurred out due to violations of the Braggs resonance condition.

P-3-45
MECHANISMS OF GAP SOLITONS FORMATION IN PERIODIC FERROMAGNETIC STRUCTURES

Maria A. Morozova[1], Sergey A. Nikitov[2], Yurii P. Sharaevskii[1] and Svetlana E. Sheshukova[1]

[1]Saratov State University, Nonlinear Physics Department, Saratov, 410012, Russia
[2]Kotel'nikov Institute of Radio Engineering and Electronics of Russian Academy of Science, Moscow, 125009, Russia

In the present work the features of envelope soliton formation in one-dimensional periodic ferromagnetic structure (magnonic crystal) were considered. The magnonic crystals have a number of significant advantages compared to the photonic crystals - the ability to manage their properties by an external magnetic field; creating crystals with magnon bandgap at microwave frequencies (of the order of several millimeters). The nonlinear effects in ferromagnetic films appear at relatively low power levels. A model based on coupled nonlinear Schrodinger equations was used to calculate the parameter spaces corresponding to solitons, similar to Bragg solitons, with different properties. The basic mechanism of formation of Bragg-like soliton and soliton localized on the limited length of structure represents the mutual capture of pulses on forward and backward waves. These pulses move with the cumulative velocity and presence of power swapping between forward and backward waves which is defined by value coupling between the waves. Features of wave evolution depending on coupling parameter and group velocity are investigated. The parameter spaces corresponding to the formation of Bragg-like solitons and solitons localized on the limited length of structure at different ways of excitation of the periodic structure were calculated.

P-3-46
TUNEABLE MAGNETIC METAMATERIALS

Feodor Ogrin, Volodimyr Kruglyak, Alastair Hibbins

School of Physics, University of Exeter, Exeter, EX4 4QL, United Kingdom

The recent rediscovery of negative index phenomena has generated an enormous interest in the field of Electromagnetic (EM) Metamaterials. So far the attention was mostly given to non-magnetic materials, in which the structuring of metals can lead to RF currents acting as an effective magnetisation. Here we consider an alternative case of metamaterials based on magnetic materials, for which the variation of permeability is the result of magnetic dynamics. It is well known that magnetic permeability undergoes a drastic change near the resonance frequency/field and can also change sign. Although for purely magnetic systems, such as transition thin film metals, this is a natural phenomena, combining it with typical EM systems, for instance a microwave patch antennae, is not trivial. Here we considered an application of a hypothetical composite material with structurally correlated ferromagnetic elements, such as 'magnonic' medium. In which the nanostructuring removes the conductivity, whereas anisotropy is provided by the shape. We simulate a dynamic response of a microwave patch antennae, as a basic element of metamaterial, filled with the magnetic medium and show the absorption spectrum of reflection. We demonstrate the splitting of dynamic EM modes by the magnetostatic excitations and tuning the reflection spectra by the external magnetic field.

P-3-47
MAGNETIC INTERACTION BY EXCHANGE OF FIELD BOSONS

U. Köbler[a] and A. Hoser[b]
[a]Forschungszentrum Jülich, 52425 Jülich, Germany
[b]Helmholtz-Zentrum-Berlin, 14109 Berlin, Germany

The experimental indications are presented that in addition to short range Heisenberg interactions via exchange of electrons there must be another long range interaction mechanism by exchange of bosons. The bosons can be supposed to be mass less magnetic density waves, i.e. they have neither charge nor magnetic moment. Consequently, they propagate ballistic across the crystal, independent of atomistic structures. This is the reason for the observed universal temperature dependence of the order parameter. Magnons propagate atomistic, i.e. from spin to spin. According to the different propagation mechanisms magnons and field bosons have different dispersion relations. In practically all ordered magnets the dominant interaction process is by exchange of bosons. This is because the field bosons usually have lower excitation energies than magnons. Ballistic propagation means that the dispersion relation of the field bosons is a simple power function of wave vector. The big problem is that mass less particles cannot be observed using inelastic neutron scattering. Experiments on standing magnetic waves in thin ferromagnetic films allow one to directly observe the field bosons via resonance. These experiments show that the dispersion of the field quanta is $\sim q$ in three dimensions, $\sim q^2$ in two dimensions but $\sim q^{\frac{3}{2}}$ in one dimension.

P-3-48
EXCHANGE BIAS IN Ni-Mn-Sn HEUSLER ALLOY FILMS

I. Gościańska[a], K. Załęski[b], H. Głowiński[b], and J. Dubowik[b]
[a]Physics Department, A. Mickiewicz University, Poznan, Poland
[b]Institute of Molecular Physics, Polish Academy of Sciences, Poznań, Poland

Exchange bias (EB) has been recently observed in NiMn-based Heusler bulk alloys. It has been shown that it results from coexisting ferromagnetic (FM) and antiferromagnetic (AFM) phases. We report a relatively large EB effect observed for the first time in Ni-Mn-Sn thin films with different microstructure and composition. The thin film structures prepared by magnetron sputtering comprise: a MgO/$Ni_{50}Mn_{36}Sn_{14}$ (200 nm) off-stoichometric epitaxial film with clearly visible martensitic transformation at $T \approx 125$ K (sample A), a Si/$Ni_{50}Mn_{43}Sn_7$ (100 nm) film phase decomposed into (AFM) $Ni_{50}Mn_{50}$ and (FM) $Ni_{50}Mn_{25}Sn_{25}$ (sample B), and a Si/NiMn(50 nm)/$Ni_{50}Mn_{25}Sn_{25}$ (30 nm) bilayer with AFM/FM interface but without any EB near room temperature (sample C). Despite the samples differ markedly in both microstructure and composition the substantial EB is present at low temperature region $4 < T < 80$ K. The highest EB effectis observed in phase decomposed sample B with overdeveloped AFM/FM interfaces. EB decreases with increasing T approximately as $H_{EB}(T) \propto H_{\mathrm{EB}}(4\mathrm{K})/\mathrm{T}$. $H_{\mathrm{EB}}(4\ \mathrm{K})$ amounts to 190 Oe, 65 Oe and 60 Oe for sample B, A and C, respectively. Blocking temperature where the EB vanishes is 40, 50 and 80 K for sample A, C and B, respectively. The results suggest that the role of AFM/FM interfaces is small (but not negligible) in formation of EB in Ni-Mn-Sn Heusler alloy films and EB is rather related to AFM/FM interactions in nanoscale.

P-3-49

ELECTRONIC STRUCTURE AND MAGNETIC PROPERTIES OF Ce_5CuPb_3 BASED ON *AB-INITIO* CALCULATIONS

M. Stasiak[a], M. Werwiński[b], A. Szajek[b], P. Leśniak[b], W.L. Malinowski[b]

[a]Faculty of Technical Physics, Poznań University of Technology, Nieszawska 13a, 60-965 Poznań, Poland

[b]Institute of Molecular Physics, PAS, Smoluchowskiego 17, 60-179 Poznań, Poland

Ce_5CuPb_3 crystallizes in the hexagonal Hf_5CuSn_3-type structure (sp. group $P6_3/mcm$) with two different cerium sites: 4d and 6g positions. To give insight into electronic and magnetic structures of Ce_5CuPb_3 system we employed the full potential local orbital (FPLO [1]) and full potential linear augmented plane wave (FP LAPW [2]) methods. The calculations were performed with and without spin polarization. Starting from the generalized gradient approximation (GGA), we additionally tested either an orbital polarization (OP) correction [3] and the GGA+U approach [4] with Coulomb repulsion energies U varied from 0 to 6 eV within the Ce 4f electron shell.

References:

[1] K. Koepernik, H. Eschrig, Phys. Rev. B 59 (1999) 1743.

[2] P. Blaha, K. Schwarz, G. K. H. Madsen, D. Kvasnicka, and J. Luitz, *Wien2k, An Augmented Plane Wave + Local Orbitals Program for Calculating Crystal Properties* (Karlheinz Schwarz, Techn. Universität Wien, Austria), 2001. ISBN 3-9501031-1-2.

[3] O. Eriksson et al., J. Phys. Condens. Matter 1 (1989) 4005.

[4] V.I. Anisimov et al., Phys. Rev. B 48 (1993) 16929.

P-3-51

MAGNETIC FORM FACTORS AND COMPTON PROFILES OF FERROMAGNETIC GADOLINIUM

M. Pylak[a], L. Dobrzyński[a,b], H. Sormann[c]

[a]The Andrzej Sołtan Institute For Nuclear Studies, 05–400 Otwock–Świerk, Poland

[b]Faculty of Physics, University of Białystok, Lipowa 41, 15–424 Białystok, Poland

[c]Institut für Theoretische Physik-Computational Physics, Technische Universität Graz, Petersgasse 16, A-8010 Graz, Austria

Gadolinium is a rare-earth metals which crystallizes in hexagonal close-packed structure. It reveals ferromagnetic ordering with the main contribution from *4f* electrons. Localization of minority spin band near the Fermi energy, while majority one is rather deep, causes that calculations of the electronic structure of gadolinium is difficult, so e.g. reports about Fermi surface are still inconsistent. Theoretical calculations have been carried out with use of ab initio spin-polarized calculations. The full potential linearized augmented plane waves with local orbitals method, implemented in Wien2k code, was used. An influence of different directions of magnetic moment (along that c axis and parallel to the base plane) on magnetic form factors and Compton profiles was discussed. Our results are in very good agreement with experimental ones got by Moon et al. [1]

[1] R.M. Moon, W.C. Koehler, J.W. Cable and H.R. Child, Phys. Rev. B **5** (1972) 997

P-3-52
MAGNONIC CRYSTALS WITH SAW-TOOTH LIKE MODULATION OF MAGNETIC PARAMETERS

V. S. Tkachenko[a] **A. N. Kuchko**[a] **V. V. Kruglyak**[b]
[a]Donetsk National University, 24 Universitetskaya Street, Donetsk, 83001, Ukraine
[b]School of Physics, University of Exeter, Stocker Road, Exeter, EX4 4QL, UK

Magnonic band gap engineering represents an important aspect of modern research in magnonics. In this work, we study the spectrum and frequency dependence of the scattering coefficients of spin waves in magnonic crystals with saw-tooth like modulation of the uniaxial magnetic anisotropy. The corresponding profile can be visualized as a periodic sequence of layers with a linear dependence of the anisotropy strength.
We study the dependence of the magnonic spectrum and reflection coefficient upon the depth and steepness of modulation of the anisotropy and compare the results with those previously obtained for other profiles of the anisotropy modulation, with a particular attention to the size and position of the magnonic band gaps and points of full transmission of spin waves through the magnonic crystal.
The research leading to these results has received funding from the European Commission's Seventh Framework Programme (FP7/2007-2013) under grant agreement 247556 (NoWaPhen) and from the EPSRC of the UK.

P-3-53
MAGNETIC FIELD DEPENDENCE OF CRITICAL SOUND ATTENUATION IN FERROMAGNET

A. Pawlak

The temperature- and magnetic field-dependence of the sound attenuation exponent is investigated close to the critical temperature of the ferromagnetic transition using the Nelson's technique [1]. The scaling functions are given within the renormalization group formalism at one-loop order. The physical origin of peaks observed in the sound attenuation above the critical temperature is identified. We also discuss the comparison of our results with the mean-field Landau-Khalatnikov theory and experimental data.

[1] A. Pawlak and R. Erdem, Phys. Rev. B **83**, 094415 (2011)

P-3-54
SPIN-WAVE SPECTRUM OF 2D MAGNONIC CRYSTALS WITH ELLIPTICALLY SHAPED SCATTERING CENTRES

S. Mamica, M. Krawczyk, J. W. Kłos
Faculty of Physics, A. Mickiewicz University, Poznań, Poland

Magnonic crystals (MCs) are the subject of a very intensive research activity caused by their potential applications, including microwave resonators, magnonic waveguides, spin-wave emitters and filters. For example, the latest results of micromagnetic simulations indicate the occurrence of wide magnonic gaps, implying a possible application in spin-wave filters, in 2D Fe/YIG MCs. A particular role in the modeling of magnonic gaps is played by the deformation of the scattering centers in the plane of spin-wave propagation. In this study we examine the possibilities of tailoring the spin-wave spectrum of 2D MCs that could be used for fine tuning of spin-wave filter passbands. Our approach is based on Maxwell's equations for magnetostatics, solved by the plane wave method. We present the magnonic band structure of a Co/Fe MCs with scattering centres in the shape of elliptic cylinders. We find that for different filling fraction values there are specific in-plane rotation angles for which modifying the rod ellipticity can alter the position of the allowed band without changing its width, or cause a substantial shrinking of two adjacent bands without changing the width of the gap between them. Thus, an appropriate use of rods of elliptical cross section offers additional possibilities in the design of spin-wave filters with precisely adjusted passband.

This work is supported by the European Community's 7th Framework Programme (FP7/2007-2013), Grant Agreements No. 228673 (MAGNONICS).

P-3-55
MAGNONIC BAND GAPS IN MAGNETOFERRITIN-BASED NANOCOMPOSITES

S. Mamica[a], M. Krawczyk[a], M. Sokolovskyy[a], J. W. Kłos[a], W. Schwarzacher[b], J.-C. Eloi[b], M. Okuda[b]
[a]Faculty of Physics, A. Mickiewicz University, Poznań, Poland
[b]H.H. Wills Physics Laboratory, University of Bristol, Bristol, United Kingdom

Magnetoferritin is an intensively studied biomimetic magnetic nanoparticle consisting of Fe_3O_4-γ-Fe_2O_3 (magnetite/maghemite) grown inside the spherical protein cavity of apoferritin (with the internal diameter of 8 nm and the external diameter of 12 nm). A protein crystallization technique is successfully used for fabricating three-dimensional well-ordered fcc magnetoferritin crystals of the size of hundreds of micrometers. In both theoretical and experimental studies the long-range magnetic order in such crystals has been found to strongly depend on the structural order of the nanoparticles. We present the results of band structure calculations for 3D magnonic crystals with magnetoferritin nanoparticles embedded in a ferromagnetic matrix to increase the stability of the long-range magnetic order and allow the occurrence of an absolute magnonic gap. Our approach is based on Maxwell's equations for magnetostatics, solved by the plane wave method. The interparticle distance proves crucial for the modelling of magnonic gaps. In the small lattice constant range even slight changes in the lattice constant strongly affect the gap width. The gap vanishes completely for a lattice constant dependent on the exchange length in the matrix material.

This work is supported by the European Community's 7th Framework Programme (FP7/2007-2013), Grant Agreements No. 228673 (MAGNONICS).

P-3-56

STRUCTURAL AND MAGNETIC PROPERTIES OF $GdNi_{5-x}Ge_x$

W. Suski[a,b], G. Koterlyn[c], R. Gladyshevskiid[d]

[a]W. Trzebiatowski Institute of Low Temperature and Structure Research, Polish Academy of Sciences, P.O. Box 1410, 50-950 Wrocław 2, Poland

[b]International Laboratory of High Magnetic Fields and Low Temperatures, P.O. Box 4714, 50-985 Wrocław 47, Poland

[c]Western Scientific Center of National Academy of Sciences of Ukraine and Ministry of Education and Science of Ukraine, Mateyka St. 4, 79000 Lviv, Ukraine

[d]Department of Inorganic Chemistry, Ivan Franko National University of Lviv, Kyryla i Mefodiya St. 6, 79005 Lviv, Ukraine

Structural and magnetic properties have been studied for a series of $GdNi_{5-x}Ge_x$ samples (x = 0, 0.3, 0.6, 0.9). All of the samples crystallize in the hexagonal $CaCu_5$ type of crystal structure (space group $P6/mmm$). The substitution of Ge for Ni results in an increase of the lattice parameters a, c and unit-cell volume V. Magnetic measurements were performed in external magnetic fields up to 14 T in the temperature range 1.7–400 K. The saturation magnetization at 4 K is close to 6.5 μ_B/f.u. and does not depend on the composition. With increasing Ge concentration the magnetization decreases, and the Curie temperature (T_C) decreases almost linearly from 33 to 18 K for x = 0 and 0.9, respectively. In low magnetic fields (0.005 T) for alloys with x = 0.6 and 0.9 the presence of additional magnetization taking its origin in the Ni sublattice is observed. The Arrott plots show that the magnetic phase transition is of second-order in these alloys. The magnetic entropy changes, ΔS, as a function of temperature and magnetic field were calculated from isothermal magnetization curves using the Maxwell relation. The maximum values of ΔS at T_C with a magnetic field change from 0 to 5 T are 10.6, 10.9, 5.5 and 5.7 J/kg K for x = 0, 0.3, 0.6, and 0.9, respectively.

P-3-57

MAGNETISM AND MAGNETIC STRUCTURE OF Nd_7Rh_3

S. Rayaprol[a], V. Siruguri[a] A. Hoser[b], P. Henry[b] and E.V. Sampathkumaran[c]

[a]UGC-DAE Consortium for Scientific Research - Mumbai (India)

[b]Helmoltz-Zentrum Berlin (Germany)

[c] Tata Institute of Fundamental Research, Mumbai (India)

The intermetallic compound Nd_7Rh_3 crystallizes in a Th_7Fe_3 type hexagonal structure, in space group $P6_3mc$. Nd in this compound occupies three non-equivalent sites (6c, 12d and 2b) where as Rh resides at the site 12b. The magnetization studies show two antiferromagnetic (AFM) phase transitions at 32 K and 10 K, and a field induced first-order magnetic transition at a field strength of 1 Tesla at 2 K. In order to understand the magnetic behavior we have carried out neutron diffraction (ND) studies on poly-crystalline Nd_7Rh_3 at various temperatures between 2 and 45 K. ND patterns were also recorded at T = 2K in the presence of applied magnetic fields from 0 to 5 Tesla. ND experiments on Nd_7Rh_3 were carried out using wavelengths $\lambda = 1.48\AA$, $2.45\AA$ and $2.8\AA$ respectively in order to cover a larger Q-range. ND patterns of Nd_7Rh_3 do not exhibit any AFM peaks in the entire Q-range studied; instead a long-range ferromagnetic order is established, which implies that the signatures of AFM order seen in magnetization are not representative of any long-range AFM order but could possibly arise due to a ground state comprising a dominant ferromagnetic long range order competing with antiferromagnetic correlations.

P-3-58

MAGNETIC ANISOTROPY OF NANOPOWDERED $La_{0.7}Sr_{0.3}MnO_3$ MANGANITES

I. Radelytskyi[a,b] **V. Dyakonov**[a], **P. Aleshkevych**[a], **H. Szymczak**[a]

[a]Institute of Physics, PAS, 02-668 Warsaw, Al. Lotnikow 32/46, Poland

[b]Ivan Franko National University of Lviv, Faculty of Physics,
Kyrylo and Mefodiy St., 79005 Lviv, Ukraine

Magnetic properties of nanopowder $La_{0.7}Sr_{0.3}MnO_3$ manganites have been studied as a function of temperature, magnetic-field and frequency. Nanopowders with particle sizes 17, 30 and 80 nm have been synthesized by sol gel method at temperatures of 600, 700 and 900°C, respectively. Experimental results of ac magnetic susceptibility have been used to determine magnetic anisotropy constants as a function of temperature and particles sizes. The obtained results are in satisfactory agreement with other experiments performed on bulk $La_{0.7}Sr_{0.3}MnO_3$ manganites.

This work was financially supported by European Fund for Regional Development (Contract No. UDA– POIG.01.03.01-00-058/08/00).

O-4-02

Nonlinear Giant Magnetoresistance in permalloy dual spin valves: spin transfer torque and band structure effects

N. Banerjee[a] A. Aziz[a] M. Ali[b] B. J. Hickey[b] and M. G. Blamire[a]

[a]Department of Materials Science and Metallurgy, University of Cambridge Pembroke Street, Cambridge CB2 3QZ, United Kingdom.

[b]School of Physics and Astronomy, University of Leeds, Leeds LS2 9JT, United Kingdom.

The recent discovery of nonlinear current-dependent magnetoresistance in dual spin valve devices opens up the possibility for novel physics which extends the standard model of giant magnetoresistance. When the outer ferromagnetic layers of a dual spin valve are anti-parallel, the resulting accumulation of spin in the middle ferromagnetic layer (composed of permalloy) strongly modifies its bulk and interfacial spin asymmetry and resistance. Here, we examine the role of bulk spin accumulation in this nonlinear effect and show that interfacial spin accumulation alone cannot account for the observed dependence of the effect on the thickness of the middle ferromagnetic layer. We also report how the spin transfer torque acting on the middle ferromagnetic layer is modified by the nonlinear effect and can be used to better understand certain dynamical features associated with this effect. Finally, we show that varying the middle permalloy layer composition results in a significant change in the magnitude of the effect and its subsequent sign reversal with dc bias. The magnitude and sign reversal of the effect with dc bias current can be explained by modification of the gradient of the density of states at Fermi energy resulting from a change in permalloy composition.

O-4-06

NANO-ENGINEERING OF DOMAIN-WALL DEVICES USING FOCUSED ELECTRONS/IONS

H.J.M. Swagten[a], J.H. Franken[a], M. Hoeijmakers[a], J.T. Kohlhepp[a], B. Koopmans[a], E. van Veldhoven[b], D. Maas[b], P. Trompenaars[c], J.J.L. Mulders[c]

[a]Eindhoven University of Technology, Eindhoven, The Netherlands

[b]TNO Science and Industry, Delft, The Netherlands

[c]FEI Electron Optics, Eindhoven, The Netherlands

In novel domain-wall (DW) devices with perpendicular magnetic anisotropy (PMA) a number of exciting phenomena have been observed very recently, *e.g.* in strips containing ultrathin Co layers. In these devices, the use of ion or electron beams to modify the magnetic properties or to integrate additional magnetic elements, may add unique opportunities to control and tune the physics of DWs for future spin-torque-based memory devices. For some of our recent contributions, see, *e.g.*, R. Lavrijsen *et al.*, Appl. Phys. Lett. **96**, 222502 (2010), and J.H. Franken *et al.*, Appl. Phys. Lett. **98**, 102512 (2011).

In this presentation, three applications will be discussed where focused ion/electron beams are used for precise control over DWs, *viz.* (1) the anisotropy-induced tunable creation and pinning/depinning of DWs, (2) the introduction of a new oscillator concept for future GHz applications, based on anisotropy-controlled DWs, and (3) alternative control and pinning of DWs by Electron Beam Induced Deposition (EBID) of arrays of Fe-containing magnetic nanopillars.

P-4-01

OBSERVATION OF "MAGNETIC FREEZE- OUT" PHENOMENON: STUDY OF MAGNETORESISTANCE OF $Fe_{1.5}Ti_{0.5}O_{3-\delta}$ MAGNETIC OXIDE SEMICONDUCTOR

E. Chikoidze*, Y. Dumont, E. Popova, B. Berini, H. Ndilimabaka, and N. Keller

Groupe d'Etudes de la Matière Condensée , CNRS - Université de Versailles, Versailles, France

On the goal of an alternative way to realize an above 300K ferromagnetic semiconductor for intrinsic spin injection, the solid solution hematite-ilmenite $Fe_{2-x}Ti_xO_3$ appeared to be a good candidate: Curie temperature $T_C > 400$ K, intrinsically conductive due to Fe^{3+}/Fe^{2+} mixed valences [1-3]. In the presented work, we study in details the conductivity mechanism and magneto-transport electronic properties of $Fe_{1.5}Ti_{0.5}O_{3-\delta}$ thin films deposited by PLD on $Al_2O_3(0001)$ substrates, in the 100 K-500 K range with magnetic fields (Hall and planar hall configuration) up to 9 T. The zero-field transport properties are governed by the oxygen stoichiometry with a dominant Near Neighbor Hopping mechanism with activation energy around 100 meV. Magnetoresistance versus temperature dependence presents "magnetic freeze out" phenomenon, it also changes sign and has different behavior depending on the magnetic field orientation. Optical properties in visible and NIR region has been studied as well.

[1] Y. Ishikawa et al., Jpn. J. Phys. Soc. **12**, 1083 (1957); Y. Ishikawa, ibid. item **13**, 37 (1958).
[2] H. Hojo, et al., Appl. Phys. Lett. **89**, 082509 (2006).
[3] H. Ndilimabaka, et al., J. Appl. Phys. **103**, 07D137 (2008).

P-4-02

MAGNETORESISTIVE PROPERTIES OF La−Pb−Mn PEROVSKITES

I. Balasz−Muresan[a] and E. Burzo[a]

[a]Faculty of Physics, Babes−Bolyai University, Cluj−Napoca, Romania

The $La_{1-x}Pb_xMnO_3$ perovskites, with $0.24 \leq x \leq 0.40$, crystallize in a rhombohedral−type structure having $R\overline{3}c$ space group. The resistivities increase from 5 K, up to temperatures T_m, situated in the range 184 K (x=0.2) and 240 K (x=0.4). At these temperatures there is a transition from metallic to semiconducting type behaviour. The T_m values are by $\cong$ 100 K smaller than the Curie points, T_c. The activation energies at $T > T_m$+50 K can be described by an adiabatic hopping conduction mechanism. The activation energies increase from 0.112 eV (x=0.24) to 0.123 eV (x=0.4). Possible mechanisms for the metal to semiconducting transition, at lower temperatures than T_c, are analysed. The field and temperature dependences of the magnetoresistivities, MR, were studied. At 5 K and in field of 7 T, the MR values are situated between 46 % and 49 % and decrease up to 25−30 % at room temperature. The intergrain tunneling magnetoresistance as well as the intragrain contribution, respectively were analysed as function of temperature and external field. The polarizations at 5 K are situated between 0.73 and 0.85 and decrease up to $\cong$ 0.2 at room temperature. The involved mechanisms in describing magnetoresistive behaviour are discussed.

P-4-03

THERMOELECTRIC EFFECTS IN PLANAR TUNNEL JUNCTIONS

M. Wilczyński[a]

[a]Faculty of Physics, Warsaw University of Technology
ul. Koszykowa 75, 00-662 Warsaw, Poland

The selected thermoelectric effects in the planar tunnel junction consisting of the ferromagnetic layers and the nonmagnetic tunnel barrier are analyzed in the free-electron-like spin-polarized one-band model. Especially the influence of the parameters of the junction as well as the relative orientation of magnetic moments on the thermopower and the spin-transfer torque generated by the temperature difference across the tunnel junction is investigated. The thermopower can be related to the voltage drop generated by the temperature difference under the condition that the charge current vanishes. It depends on the magnetic configuration of the junction. In junctions with high barriers the thermopower is maximal in the antiparallel configuration and it can be enhanced in the junctions with strong spin splitting of the electron bands. The component of the torque studied in the present paper is oriented in the plane formed by magnetic moments and it appears in the absence of the bias voltage. Its magnitude is insensitive to the sign of the temperature difference in contrast to the bias-induced torque which strongly depends on the polarization of the bias. The studied torque is usually smaller than the torque generated by the bias, however it can be significant in the junctions with low barriers.

P-4-04

MAGNETO-RESISTANCE OF THE $YBa_2Cu_3O_{7-\delta}$ SINGLE CRYSTALS WITH A SMALL DEVIATION FROM THE OXYGEN STOICHOMETRY

R. V. Vovk[1], **V. M. Gvozdikov**[1], **M. A. Obolenskii**[1], **Z. F. Nazyrov**[1], **V.V. Kruglyak**[2]

[1] Kharkov National University, 4 Svoboda Sq., 61077 Kharkov, Ukraine, Ruslan.V.Vovk@univer.kharkov.ua,

[2] University of Exeter, Stocker road, Exeter, EX4 4QL, United Kingdom, V.V.Kruglyak@exeter.ac.uk

We study the excessive conductivity $\Delta\sigma$ as a function of temperature and angle between the magnetic field 15 kOe and the ab-plane α in untwinned $YBa_2Cu_3O_{7-\delta}$ single crystals with a small oxygen hypostoichiometry. Assuming that $\Delta\sigma \propto (T-T_c)^{-\beta}$ near the critical temperature T_c we found that the function $\chi(T) = -d(ln\Delta\sigma)/dT$ is characterized by the superconducting transition T_{c0}, vortex-lattice (VL) melting T_M, and the mean-field critical T_c temperatures. We found that: (i) the $\chi(T)^{-1}$ has a linear asymptotes $\beta_{c0}^{-1}(T - T_{c0})$ and $\beta_c^{-1}(T - T_c)$ nearby the T_{c0} and T_c with $\beta_{c0} > \beta_c = 1/2$ which means a crossover from the tree-dimensional-like (3D) behavior to the lower effective dimensionality. (ii) The transitional region $T_c - T_{c0}$ increases from 0.3K at $\alpha = 0$ to approximately 6K at $\alpha = 60^0$. (iii) The peaks at the T_M grow up and shift toward the T_{c0} with increasing α. (iv) The $\chi(T)$ displays a universal scaling in reduced coordinates. (v) The function $\Delta\sigma(T)$ displays a pseudogap behavior and the 3D-2D dimensional crossover. We relate these features with the Hikami -Larkin model for the fluctuation conductivity at $T > T_c$ and with the 3D-2D crossover on the VL melting line caused by the crossover of the upper critical magnetic field $H_{c2}(\alpha, T)$ through the elastic moduli of the VL which are polynomials of the ratio $H/H_{c2}(\alpha, T)$ at $T < T_c$.

P-4-05

HIGH TUNNEL MAGNETORESISTANCE OF Fe/NaBr/Fe MAGNETIC JUNCTION

P. Vlaic[a] and E. Burzo[b]

[a]University of Medicine and Pharmacy "Iuliu Hatieganu", Physics and Biophysics Department, 400023 Cluj-Napoca, Romania

[b]Faculty of Physics, Babes-Bolyai University, 400084 Cluj-Napoca, Romania

A first-principles study of electronic, magnetic and spin dependent transport properties of Fe/NaBr/Fe (001) magnetic tunnel junction (MTJ) is presented. The ground state electronic structure calculations are performed by means of a self-consistent Green's function technique for surface and interfaces implemented within tight-binding linear muffin-tin orbital (TB-LMTO) method in its atomic sphere approximation (ASA) and in conjunction with the coherent potential approximation (CPA) in order to describe the interdiffusion at Fe/NaBr interfaces. The spin dependent conductances are calculated by means of linear response of Kubo approach implemented within TB-LMTO-CPA formalism and including vertex corrections. The results evidence the formation of sharp Fe/NaBr interfaces and the enhancement of magnetic moments of interfacial iron atoms ($m_{Fe} \approx 2.95\ \mu_B$). A small antiferromagnetic coupling that rapidly decreases to zero with increasing barrier thickness is observed. The main contribution to the conductance in the ferromagnetic state is given by the minority spin electrons. The tunneling magnetoresistance (TMR) ratio rapidly increases with the barrier width and reach values as high as 4000 % in the asymptotic regime. Finally, a comparative study between Fe/MgO/Fe, Fe/NaCl/Fe and Fe/NaBr/Fe, respectively, MTJs is presented.

P-4-06

SPIN DEPENDENT ELECTRONIC STRUCTURE AND TRANSPORT PROPERTIES OF Fe/CaS/Fe (001) HETEROSTRUCTURE

P. Vlaic[a] and E. Burzo[b]

[a]University of Medicine and Pharmacy "Iuliu Hatieganu", Physics and Biophysics Department, 400023 Cluj-Napoca, Romania

[b]Faculty of Physics, Babes-Bolyai University, 400084 Cluj-Napoca, Romania

In this contribution an ab initio study of electronic, magnetic and spin dependent transport properties of Fe/CaS/Fe (001) magnetic tunnel junction (MTJ) is presented. The electronic structure calculations are performed by means of a self-consistent Green's function technique for surface and interfaces implemented within tight-binding linear muffin-tin orbital (TB-LMTO) method in the atomic sphere approximation (ASA). The spin dependent transport properties in the current-perpendicular-to-plane (CPP) geometry are studied by means of linear response of Kubo approach implemented within TB-LMTO formalism and including vertex corrections. A small charge transfer mainly localized at Fe/CaS interfaces and interface induced futures are reveled. The interface iron magnetic moments are enhanced ($m_{Fe}=2.9\ \mu_B$) and a small antiferromagnetic coupling that rapidly decreases to zero is evidenced. In the ferromagnetic configuration the majority spin conductance dominated by electronic states close to $\mathbf{k}_{||}=0$ decays faster than the minority spin one and almost at the same rate as both conductances in the antiferromagnetic configuration. Tunneling magnetoresistence (TMR) ratios up to 400 % are evidenced.

P-4-07

SINGLET-TRIPLET SWITCHING INDUCED BY ELECTRIC FIELD IN TRIPLE QUANTUM DOTS

Jakub Łuczak and Bogdan R. Bułka
Institute of Molecular Physics, Polish Academy of Sciences,
ul. M. Smoluchowskiego 17, 60-179 Poznań, Poland

We present theoretical studies on an artificial molecule which is constructed from three coherently coupled quantum dots (TQD). The system of TQD can be closed ($\triangle$) or open ($\wedge$) and contains four electrons, with the total spin $S = 0$ (singlet) and $S = 1$ (triplet state). In calculations we use the Hubbard model with a single orbital level at each quantum dot, taking into account Coulomb interactions. We also add a term describing influence of electric field on the system, which leads to splitting of energy levels (linear and quadratic Stark effect) and to a transition between the singlet and triplet ground state. In order to understand a nature of the transition, we analyze influence of the electric field on competition between a direct and super-exchange process. We calculate also current in the TQD system connected to electrodes and show, that Pauli spin blockade can give information about the singlet-triplet transition. A similar singlet-triplet switching effect in electric field was recently considered by Baadji et al [1] in magnetic molecules. Our studies are motivated by search for new devices in spintronics and quantum computing.

This work was supported by MNiSW (Poland) from sources for science in the years 2009-2012 and by EU project Marie Curie ITN NanoCTM.

[1] N. Baadji, M. Piacenza, T. Tugsuz, F. D. Sala, G. Maruccio and S. Sanvito, Nature Materials 8, 813 (2009).

P-4-08

DEFECT STRUCTURE AND NONLINEAR ELECTRICAL PROPERTIES OF MANGANITES $\mathbf{La_{1-c}Sr_cMn_{1-x}Ga_xO_{3+\gamma}}$

A.G. Badelin[a], V.K. Karpasyuk[a], A.M. Smirnov[a], S.Kh. Estemirova[b], A.A. Shchepetkin[b]
[a]Astrakhan State University, 414056, Astrakhan, Russia
[b]Institute for Metallurgy UB RAS, 620016, Yekaterinburg, Russia

Regularities of the influence of Ga and oxygen concentrations on the defect structure of bulk manganites $La_{1-c}Sr_cMn_{1-x}Ga_xO_{3+\gamma}$ (c=0.15, 0.17, 0.19; $0.025 \leq x \leq 0.125$) were established by using powder X-ray diffraction, modified method of unit cell volume calculation, the data on saturation magnetization, Curie point and resistivity. Structural formulae of manganites were derived. The samples synthesized at 1473 K in air had rhombohedral structure and $\gamma>0$. In order to provide stoichiometric oxygen content, the samples were annealed at 1223 K and partial pressure of oxygen 10^{-1} Pa. After annealing, some samples contained the mixture of rhombohedral and orthorhombic phases. It was found that manganites reveal negative-resistance behavior at low temperatures. Synthesized samples with c=0.15, x=0.125 exhibit N-type multi-peak current-voltage *(I-V)* characteristics, and the steepness of current growth as a function of V increases with temperature in the interval 113-133K. There are also the regions where little dependence *I(V)* takes place. The shape of current-voltage characteristics depends sensitively on the concentration of cation vacancies. Multi-peak negative-resistance behavior of manganites can be ascribed to transformation of energetic level structure and of carrier concentration in energy bands under the influence of threshold field.

P-4-09

CHARGE TRANSPORT THROUGH GRAPHENE PN AND PNP JUNCTIONS WITH SPIN-ORBIT INTERACTION

M. Rataj[a] and J. Barnaś[a]

[a] Mesoscopic Physics Division, Department of Physics, ul. Umultowska 85, 61-614 Poznań, Poland

Charge transport in graphene pn and pnp junctions is analyzed theoretically. The model assumed includes a square potential barrier (pnp junction) or a potential step (pn junction) in an infinite graphene plane. Spin-orbit coupling of both Rashba and intrinsic type is taken into account. The main focus of the work is a detailed analysis of the influence of the coupling on the linear junction conductance. First, we find the transmission probability for an arbitrary angle of incidence on the barrier (or a step), then we calculate the junction conductance as an integral over all incidence angles. The influence of spin-orbit coupling is directly related to the corresponding modifications of the relevant band structure. The intrinsic spin-orbit coupling opens an energy gap at the Dirac points, which significantly changes transmission through the junction. The Rashba coupling in turn lifts the spin degeneracy of both the conduction and valence bands, which makes transmission through the system more complex. Moreover, the Rashba coupling depends on external electric field, and this dependence has been also taken into account when considering transport through the junction.

P-4-10

SURFACE SPIN-VALVE WITH AN EXCHANGE BIAS

L.Yu. Tryputen[1], V.V. Fisun[1], O.P. Balkashin[1], Yu.G. Naidyuk[1], I.K. Yanson[1] S. Andersson[2], V. Korenivski[2], Yu.I. Yanson[3] and H. Zabel[3]

[1]Verkin Institute for Low temperature Physics and Engineering of National Academy of Sciences of Ukraine, Kharkiv, Ukraine

[2]Nanostructure Physics, Royal Institute of Technology, Stockholm, Sweden

[3]Lehrstuhl für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, Bochum, Germany

Magnetoresistance R(H) at V=0 and differential resistance R(V) (R=dV/dI) at H=0 of point contacts between nonmagnetic Cu tips and single ferromagnetic films (FM - Co) exchange-pinned by antiferromagnetic films (AFM Fe50Mn50) have been investigated. Analysis of measured R(V) and R(H) characteristics confirms recently proposed model of the point contact surface spin-valve (SSV). Magnetoresistance R(H) of SSV in the point contacts to ferromagnetic films exchange-pinned by antiferromagnets shows an exchange offset that depends on a mutual orientation of the applied magnetic field in respect to a pinned magnetization of the AFM/FM layer . We have found that switching of this ferromagnet bulk occurs at lower fields than switching of surface spin layer. Origin of such higher switching field can be caused by a higher coercivity due to morphological imperfections and defects in the contact core. In addition, it has been shown that point contact SSVs based on an amorphous alloy Co40Fe40B20 (3,6,9,20 nm) also have the same properties as spin-valves with a geometrically controlled structure. The experiments showed that an increase of an exchange bias under decreasing of CoFeB films thickness is observed both at the surface and in the SSV bulk. A negative magnetoresistance of such point-contact SSVs based on CoFeB was also observed.

P-4-11

$Co_{40}Fe_{40}B_{20}$/MgO/$Co_{40}Fe_{40}B_{20}$ DOUBLE WEDGE MAGNETIC TUNNEL JUNCTIONS WITH PERPENDICULAR ANISOTROPY

R. Saris[a], M. Czapkiewicz[b], W. Skowroński[b], J. Wrona[b], T. Stobiecki[b], H.J.M. Swagten[a]

[a]Eindhoven University of Technology, Den Dolech 2, Eindhoven, the Netherlands
[b]Department of Electronics, AGH University of Science and Technology, al. Mickiewicza 30, Krakow, Poland

We have investigated a $Co_{40}Fe_{40}B_{20}(t_{bottom})$/MgO(0.89)/$Co_{40}Fe_{40}B_{20}(t_{top})$, crossed double wedge ($t_{bottom}$: 0.66-1.08, t_{top}: 0.99-1.62, thickness in nm), by VSM and MOKE measurements. Therefrom we determined the perpendicular anisotropy, saturation magnetization, coercive field, remanent magnetization and saturation field as a function of the, perpendicularly crossed, thicknesses of the bottom and top CoFeB layers. The highest perpendicular anisotropy is found for the area: $0.89 < t_{bottom} < 0.96$ and $1.05 < t_{top} < 1.12$ (nm). The wafer areas most suitable for pseudo-spin valve magnetic tunnel junctions (PSV MTJs) were used to fabricate circular nanopillars with diameters of $150, 200, 280, 350$ and 400 nm. Preliminary tunnel magnetoresistance (TMR) measurements show an MR ratio of 20% and a very low Resistance-Area (RA) product of $2\,\Omega\mu m^2$. **Acknowledgements** Project supported by the Polish Ministry of Science and Higher Education grants (IP 2010037970 and NN 515544538), and the Foundation for Polish Science MPD Programme cofinanced by the EU European Regional Development Fund. We thank Singulus Technologies AG for sample deposition. Research conducted at the Dept. of Electronics, AGH in the frame the Erasmus-Socrates program.

P-4-12

INTERPLAY OF THE KONDO EFFECT AND SPIN-POLARIZED TRANSPORT IN NANOSCOPIC SYSTEMS EXHIBITING UNIAXIAL MAGNETIC ANISOTROPY

M. Misiorny,[a] I. Weymann[a] and J. Barnaś[a,b]

[a] Faculty of Physics, Adam Mickiewicz University, 61-614 Poznań, Poland
[b] Institute of Molecular Physics, Polish Academy of Sciences, 60-179 Poznań, Poland

Recently, it it has been experimentally shown that in systems with spin $S > 1/2$, such as magnetic adatoms (i.e. Fe, Co or Mn) or magnetic molecules, the Kondo effect can be tuned by modifying the systems magnetic anisotropy [1]. Hence, in this communication we address the problem of how spin-dependent tunneling through the local orbital of the system (orbital that takes part in transport through the magnetic molecule, adatom or quantum dot) and exchange coupling of conducting electrons to the localized spin of magnetic core affect the Kondo effect and tunnel magnetoresistance (TMR). Using numerical renormalization group we calculate the spectral functions and linear conductance in the Kondo regime. We show that the Kondo effect becomes suppressed due to exchange coupling between electrons tunneling through the conducting orbital and the magnetic core. The corresponding conductance also depends significantly on the uniaxial anisotropy, which in turn results in nontrivial behavior of TMR. Finally, we discuss the possibility of restoring the Kondo effect by application of an external magnetic field.

[1] A.F. Otte *et al.*, Nature Phys. **4**, 847 (2008); J.J. Parks *et al.*, Science **328**, 1370 (2010); A.S. Zyazin *et al.*, Nano Lett. **10**, 3307 (2010).
[2] M. Misiorny, I. Weymann and J. Barnaś, Phys. Rev. Lett. (in press); arXiv:1103.1128.

P-4-13

SPIN-DEPENDENT THERMOELECTRIC EFFECTS IN TRANSPORT THROUGH A SINGLE-MOLECULE MAGNET

M. Wajs,[a] M. Misiorny[a] and J. Barnaś[a,b]

[a] Faculty of Physics, Adam Mickiewicz University, 61-614 Poznań, Poland

[b] Institute of Molecular Physics, Polish Academy of Sciences, 60-179 Poznań, Poland

Motivated by recent advances in thermoelectric measurements on nanoscopic systems, in the present communication we discuss theoretical aspects of thermoelectric effects that can accompany spin-dependent transport through a single-molecule magnet. The model assumed consists of a single-molecule magnet embedded between two metallic ferromagnetic electrodes (a molecule in a magnetic tunnel junction), whose magnetic moments can be oriented either parallel or antiparallel. The key assumption of the model is that conduction electrons traversing the barrier can be scattered by a large spin of the molecule due to exchange interaction. This in turn can result in exchange of angular momentum between the spin-polarized current and the molecule. Thermoelectric effects arise when there is a temperature gradient between the electrodes. Transport of charge, spin and heat is analyzed by means of perturbative approach (Fermi golden rule) and the master equation method. Basic characteristics such as charge and thermal conductance, thermopower and spin thermopower, as well as the dimensionless figure of merit describing the thermal efficiency of the system, are discussed as a function of both uniaxial and transverse magnetic anisotropy constants representative for single-molecule magnets.

P-4-14

STUDY OF THE MAGNETOREFRACTIVE EFFECT IN MANGANITES

Yu. Sukhorukov, A. Telegin and V. Bessonov

Institute of Metal Physics UD of RAS, Ekaterinburg,620990,Russia

Magnetorefractive effect (MRE) is a magnetic-field-induced change in reflectivity and in transmission of light in magnetic materials. MRE may be used for contactless measurements of magnetoresistance (MR), to creation of magneto-electric sensors and modulators of light and so on. Magnetorefractive effect have been investigated in optimally doped lanthanum manganites with colossal MR effect for unpolarized light in the spectral range from 0.4 mkm to 27 mkm, in the magnetic field up to 10 kOe. It was showed that MRE in manganites is an optical response to the colossal MR effect in the IR-region. The MRE can reach tens of percent near the Curie temperature. The effect is connected with the magnetic-field-induced change of concentration of free charge carriers. In the visible range there was no direct correlation between MRE and colossal MR observed. For example, there was a change of the sign of the MRE spectra detected. The magnitude of the MRE was one order less in comparison with that in the IR-region. We suppose, the feature can be related with a redistribution of the optical density in the region of interband transitions. Supported by the programs of DPS RAS 09-T-2-1013, UD-SD of RAS 09-C-2-1016 and RFBR 10-02-00038, the youth scientific project of UD of RAS.

P-4-15

NON DMS RELATED FERROMAGNETISM IN DOPED AND UNDOPED OXIDES

K. Potzger [a]

[a]Helmholtz-Zentrum Dresden-Rossendorf — Bautzner Landstraße 400 — 01328 Dresden (Rossendorf)

In this paper we present our recent results on magnetic and structural properties of oxides implanted with transition metals as well as nonmagnetic ions, latter for defect generation. We focus our discussion on the formation of secondary magnetic phases in systems which are potential candidates for diluted magnetic semiconductors (DMS). Those are transition metal doped ZnO or TiO2, where Fe, Co, and Ni are the dopands used during our research. We give insight in the broad variety of secondary magnetic phases, i.e. metallic or oxidic, formed in the host materials even at low processing temperatures. In the second part, we focus on the discussion of ferromagnetic properties induced by implantation of non-magnetic ions. Such kind of ferromagnetic response, usually attributed to defects, is one of the most puzzling observations made by different groups for a large variety of oxide materials.

P-4-16

MAGNETOTRANSPORT PROPERTIES OF $La_{0.55}Ca_{0.45}MnO_3/BaTiO_3$ COMPOSITES

M. Kiss[a], A. Vladescu[a], I. Balasz[a], O. Florea[a], A. Tunyagi[a], S. Mican[a], R. Tetean[a] and I. G. Deac[a]

[a]Facultatea de Fizica, Universitatea Babes-Bolyai, Str. M. Kogalniceanu 1, 400084 Cluj-Napoca, Romania

We report the effect of $BaTiO_3$ content on the structure, magnetic and magnetotransport properties of (1-x) $La_{0.55}Ca_{0.45}MnO_3$ – x $BaTiO_3$ with $x \leq 0.8$. The samples were prepared by standard solid state technique. The x-ray and SEM analysis indicated that BTO and LCMO phases exist independently in the samples, without any sign of a new phase. The magnetic measurements do not show significant changes in Curie temperatures (T_C = 250 K), in coercivities (H_C= 0.04 T) and in the magnetic moment (m = 3.4 μ_B/Mn), suggesting the absence of interaction between the two phases. The system shows a conduction threshold at $x_c = 0.5$ where the resistivity increases substantially. The samples with $x < 0.5$ exhibit a metal - insulator transition at a temperature (T_p), that decreases with increasing BTO phase content, and is finally suppressed at x_c. The maximum magnetoresitance (MR) in 7 T was found to increase from 58 % for $x = 0$ (at 150 K) to 78 % for $x = 0.3$ (at 110 K). This work provides a promising method for increasing the magnetoresistance of manganites by composites with a proper insulator phase.

P-4-17

CONDUCTANCE STUDY OF MAGNETIC TUNNEL JUNCTIONS WITH AN ULTRATHIN MgO BARRIER

A Zaleski[a], J Wrona[a], M Czapkiewicz[a], W Skowroński[a], J Kanak[a], T Stobiecki[a]

[a]AGH University of Science and Technology, Department of Electronics
al. Mickiewicza 30, 30-059 Krakow, Poland

A magnetic tunnel junctions (MTJs) multilayer stack was studied, consisting of the following materials (thickness in nm): PtMn(16)/$Co_{70}Fe_{30}$(2.0)/Ru(0.9)/$Co_{40}Fe_{40}B_{20}$(2.3)/ /MgO t_{MgO}/$Co_{40}Fe_{40}B_{20}$(2.3). MgO barrier thickness (t_{MgO}) ranged from 0.6 to 1 nm, corresponding to a Resistance-Area (RA) products below 10 $\Omega\mu m^2$ and a Tunnel Magnetoresistance (TMR) ratio above 180 %. Stacks were prepared with varied Ar partial pressure (p_{Ar}) during MgO sputtering. Low p_{Ar} range was 1-3.8 mTorr, whilst high p_{Ar} was in the range 5.6-15 mTorr. For low tunnel barrier thickness (t_{MgO} <0.7 nm) the appearance of structural defects is very likely. An extension of equivalent circuit model [Oliver et al. J.Appl. Phys. 91 4348 (2002)] was applied to the current-in-plane tunneling measurements of the multilayer stack wafer in order to analyse effect of p_{Ar} and t_{MgO} on TMR and RA. Good agreement was achieved between the model and experimental results of the shunt resistance contribution to conductance as a function of t_{MgO} for various p_{Ar}. Our approach can be very useful for characterization of the unpatterned MTJ wafers. **Acknowledgments:** Project supported by SPINSWITCH MRTN-CT-2006-035327, the Polish Ministry of Science and Higher Education grants (IP 2010037970 and NN 515544538), and the Foundation for Polish Science MPD Programme cofinanced by the EU European Regional Development Fund.

P-4-18

INTRINSIC SPIN HALL AND SPIN NERNST EFFECTS IN SINGLE-LAYER AND BILAYER GRAPHENE

A. Dyrdał[a], and J. Barnaś [a,b]

[a]Department of Physics, Adam Mickiewicz University,
ul. Umultowska 85, 61-614 Poznań, Poland,
[b] Institute of Molecular Physics, Polish Academy of Sciences,
ul. M. Smoluchowskiego 17, 60-179 Poznań, Poland

We have considered theoretically the spin Hall and spin Nernst effects in single-layer and bilayer graphene. The relevant calculations take into account the intrinsic spin-orbit interaction. To describe electronic spectrum of both single-layer and bilayer graphene we have assumed some effective Hamiltonians which are sufficient when considering states near the Dirac points. We have also considered a more realistic electronic spectrum based on the relevant tight binding model. The corresponding contributions to both spin Hall and spin Nernst effects have been determined using the linear response theory and Green function formalism.

Our results show that the spin Hall conductivity of the bilayer graphene acquires universal and quantized values inside the energy gap, similarly as the single-layer graphene. However the spin Hall conductivity in the bilayer graphene is twice as large as that for the single-layer graphene. When the spin-orbit parameters in both atomic planes of bilayer graphene are different, the spin Hall conductivity as a function of the Fermi level is constant inside the energy gap and reveals a kink associated with the larger spin-orbit parameter. Additional peaks appear then at this point in the thermoelectric spin Nernst conductivity. We have also compared the results obtained from the effective Hamiltonians with those obtained in the tight binding model.

P-4-19

HEUSLER-LIKE SHORT RANGE ORDER in $(CoFe)_{1-x}Ge_x$: ^{59}Co NMR STUDY

M. Wójcik[a], E. Jędryka[a], S. Matt[b], M.J. Carey[b], and J.R. Childress[b]

[a]Institute of Physics, PAS, Al. Lotnikow 32/46, 02-668 Warszawa, Poland

[b] San Jose Research Center, Hitachi Global Storage Technologies, 3403 Yerba Buena Road, San Jose, California 95135, USA

Ferromagnetic alloys which show an enhanced CPP (current perpendicular to plane) magnetoresistance effect (MR) are of great current interest for application in future high density recording read heads sensors. It has recently been shown that spin valves based on $(CoFe)_{1-x}Ge_x$ alloys in the composition range around $x = 0.25$ and annealed at 245 °C exhibit MR effect enhanced relative to that observed for CoFe alloy. In order to clarify the effect of the addition of Ge to the CoFe alloy, the short range order has been studied by ^{59}Co NMR in a series of $(CoFe)_{1-x}Ge_x$ thin films ($0 \leqslant x \leqslant 0.4$) before and after annealing at 245 °C. It has been found that up to $x = 0.1$ the samples reveal the features of a disordered *bcc* alloy with Co, Fe and Ge atoms randomly distributed on bcc lattice and that annealing has only a minor effect on the atomic arrangement. On the other hand, for $0.2 \leqslant x \leqslant 0.3$ the alloys reveal a strong preference for a short range order favoring the Co local environment with 4 Ge atoms among 8 nearest neighbors on bcc lattice. This type of local environment is characteristic for highly ordered Co_2FeGe Heusler compound with $L2_1$ structure, which is known to secure a high degree of the conduction electron spin polarization and thus it can be expected to be a major source of the MR enhancement observed in CoFeGe alloys.

P-4-20

ANDREEV REFLECTION THROUGH A SPIN-SPLIT DISCRETE LEVEL OF A QUANTUM DOT COUPLED TO FERROMAGNETIC AND SUPERCONDUCTING ELECTRODES

K. Bocian[a], W. Rudziński[a] and J. Barnaś[a,b]

[a]Faculty of Physics, Adam Mickiewicz University, ul. Umultowska 85, 61-614 Poznań, Poland

[b]Institute of Molecular Physics, Polish Academy of Sciences, ul. Mariana Smoluchowskiego 17, 60-179 Poznań, Poland

The spin-dependent Andreev reflection tunneling through a quandum dot coupled to one ferromagnetic and one superconducting electrode is studied within the nonequilibrium Green function technique. Effects due to spin splitting of the dot discrete level are analyzed in both linear and nonlinear bias voltage regimes. It is shown that the coherent intradot spin rotation strongly affects the current-voltage characteristics leading to such effects as double-peak linear Andreev reflection conductance or negative differential conductance in nonequilibrium situation. New phenomena in Andreev reflection current, induced by Zeeman splitting of the dot discrete level are also discussed.

P-4-21
NON-LINEAR THERMAL CURRENT THROUGH MULTILEVEL QUANTUM DOT COUPLED TO FERROMAGNETIC ELECTRODES

M. Wierzbicki[a] **and R. Swirkowicz**[a]
[a]Faculty of Physics, Warsaw University of Technology
ul. Koszykowa 75, 00-662 Warsaw, Poland

We present studies of spin-dependent phenomena in the non-linear transport through a multilevel QD/molecule in the Coulomb blockade regime. Calculations are performed within the framework of non-equilibrium Green function formalism.Thermal current flowing through the system due to temperature gradient, significantly varies with gate voltage. It can be suppressed in a wide temperature region for voltages corresponding to the Coulomb gap. The strongest effect can be observed for molecular junctions with one of the levels weakly coupled with electrodes. Heat transfer strongly depends on the relative orientation of magnetic moments in the electrodes and in analogy to TMR the magnetothermal conductance is introduced, which describes the effect. MTC ratio is positive indicating that, similarly to the charge transport, the energy transfer is suppressed in systems with antiparalell orientation of the moments. Spin asymmetry in junctions with one electrode being a half-metallic ferromagnet, while the second is non-magnetic, significantly influences both charge and energy transport. In such systems the charge current shows spin Pauli blockade. The energy current can be suppressed when the half-metallic electrode acts as energy source.

P-4-22
SPIN THERMOELECTRIC EFFECTS IN TRANSPORT THROUGH TWO – LEVEL QUANTUM DOT COUPLED TO FERROMAGNETIC LEADS

Ł. Karwacki [a]**, P. Trocha** [a] **and J. Barnaś** [a,b]
[a]Department of Physics, Adam Mickiewicz University, 61-614 Poznań, Poland
[b]Institute of Molecular Physics, Polish Academy of Sciences, 60-179 Poznań, Poland

The spin Seebeck effect (spin version of the Seebeck effect) has been recently observed in a metallic magnet when a temperature gradient was applied [1]. This novel phenomenon enables conversion of heat currents into spin voltage, driving non-equilibrium spin currents. Such a generation of pure spin currents is of great interest for spintronics applications. Therefore, we have investigated spin thermoelectric effects in a two-level quantum dot attached to external ferromagnetic leads having different temperatures. We have calculated basic spin thermoelectric coefficients by means of the non-equilibrium Greens functions approach in the Hartree - Fock approximation. Specifically, we have calculated spin-dependent thermopower (spin-Seebeck coefficient) and charge thermopower, which measure spin and charge voltage drop across the device (when spin accumulation in the external leads becomes relevant), respectively. Moreover, the figure of merit and its spin analog are presented. The latter measures the spin-dependent thermoelectric efficiency. Our results also show that the indirect coupling between dot's levels *via* the leads can greatly influence the thermoelectric effects.

[1] K. Uchida *et al*, Nature (London) **455**, 778 (2008).

P-4-23

TRANSPORT THROUGH A KONDO QUANTUM DOT ASYMMETRICALLY COUPLED TO MAGNETIC LEADS

Krzysztof Piotr Wójcik,[a] **Ireneusz Weymann,**[a] **and Józef Barnaś**[a,b]

[a] Faculty of Physics, Adam Mickiewicz University, 61-614 Poznań, Poland

[b] Institute of Molecular Physics, Polish Academy of Sciences, 60-179 Poznań, Poland

Using the numerical renormalization group method [1,2] we study the spin-dependent transport through a single-level quantum dot coupled to ferromagnetic leads in the Kondo regime. In particular, we analyze the dependence of linear response conductance and tunnel magnetoresistance on the asymmetry between the coupling to left and right leads. In the parallel configuration of leads' magnetizations, the Kondo resonance is suppressed due to an effective exchange field that splits the dot level [2]. In the antiparallel configuration, on the other hand, the magnitude of the exchange field depends on the asymmetry factor, which gives rise to a nontrivial dependence of both the linear conductance and tunnel magnetoresistance on the asymmetry between the left and right junction. Generally, the Kondo effect in the antiparallel configuration is suppressed for asymmetric coupling. It is shown that external magnetic field can restore the unitary limit of the conductance not only in the parallel, but also in the antiparallel magnetic configuration.

[1] K. G. Wilson, Rev. Mod. Phys. **47**, 773 (1975).

[2] O. Legeza, C. Moca, A. Tóth, I. Weymann, and G. Zaránd, *Manual for the flexible DM-NRG code*, arXiv:0809.3143v1 (2008); http://www.phy.bme.hu/d̃mnrg/.

[3] M. Sindel, *et al.*, Phys. Rev. B **76**, 045321 (2007).

P-4-24

THERMOELECTRIC EFFECTS IN A DOUBLE QUANTUM DOT ATTACHED TO EXTERNAL METALLIC LEADS

P. Trocha [a] **and J. Barnaś** [a,b]

[a]Department of Physics, Adam Mickiewicz University, 61-614 Poznań, Poland

[b]Institute of Molecular Physics, Polish Academy of Sciences, 60-179 Poznań, Poland

Thermoelectric effects in a double quantum dot system coupled to normal and/or ferromagnetic metallic electrodes have been investigated theoretically by means of the non-equilibrium Green function approach. The basic thermoelectric characteristics of the system, in particular the Seebeck coefficient, electronic and thermal conductances, as well as the corresponding figure of merit (ZT) and Lorentz number have been calculated in the linear response theory and in the Hartree-Fock approximation to the electron Coulomb correlations in the quantum dots. We have found a relatively large enhancement ($ZT \gg 1$) of the thermoelectric efficiency due to quantum interference phenomena. We have also shown that the thermoelectric efficiency can be further optimized by tuning temperature of the system. In addition, we have also analyzed spin thermoelectric effects [1,2] in the system under consideration, which appear in the presence of spin accumulation. In the latter case the considerations have been focused especially on the spin thermopower (spin Seebeck coefficient) and the corresponding spin version of the figure of merit.

[1] K. Uchida *et al*, Nature (London) **455**, 778 (2008).

[2] K. Uchida *et al*, Solid State Commun. **150**, 524 (2010).

P-4-25

OPTICALLY-INDUCED NONEQUILIBRIUM SPIN CURRENTS IN SEMICONDUCTOR NANOSTRUCTURES

S. Wolski[a], V.K. Dugaev[a], Cz. Jasiukiewicz[a], A. Fantoni[b] and M. Vieira[b]

[a]Department of Physics, Rzeszow University of Technology,
al. Powstancow Warszawy 6, 35-959 Rzeszow, Poland

[b]Department of Electronics and Telecommunications,
Instituto Superior de Engenharia de Lisboa,
Rua Cons. E. Navarro 1, 1959-001 Lisbon, Portugal

One of the most important problems in modern electronics and spintronics is related to the optical manipulation of charge and spin currents in magnetic and nonmagnetic semiconductor nanostructures. Besides of the physical importance, the results of research in this direction can have various applications in spintronic devices for electronics and telecommunication.

We develop the basics of computer modelling of nonequilibrium processes in semiconductor nanostructures with multiple magnetic layers and nanoribbons, taking into account different mechanisms of spin-density and spin-current generation. The essential role in such mechanisms is related to the spin-orbit interaction.

We present the results of computer simulation for a three-layer model with magnetic p-n junction and optically excited spin density in the nonmagnetic layer. In this structure we calculated the profiles of nonequilibrium charge and spin densities as well as charge and spin currents as a function of external voltage. Our simulations include self-consistent calculation of the magnetization profile affected by the current-induced spin torque in nonequilibrium conditions.

P-4-26

CURRENT-INDUCED SPIN-TRANSFER TORQUE IN A NEEL DOMAIN WALL

P. Baláž[a], V. K. Dugaev[b], Ł. Szymczyk[a], and J. Barnaś[a,c]

[a] A. Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland

[b] Department of Physics, Rzeszów University of Technology, Al. Powstańców Warszawy 6, 35-959 Rzeszów, Poland

[c] Institute of Molecular Physics, Polish Academy of Sciences, ul. M. Smoluchowskiego 17, 60-179 Poznań, Poland

Spin polarized current flowing through a system with nonuniform magnetization leads to a local spin accumulation. This nonequilibrium spin density gives rise in turn to a spin torque exerted on the local magnetic moments. Physically, the spin torque appears due to transfer of angular momentum between the current and local magnetization. We consider the spin torque exerted on a relatively thick Neel domain wall in ferromagnetic metals. In the first step we perform transformation which removes the mangetization inhomogeneity. Then, making use of the adiabatic approximation we calculate in the linear response theory the nonequilibrium spin accumulation as well as the current-induced spin torque. We derive formulas for both the adiabatic and non-adiabatic spin torque components. Dependence of these components on both the exchange coupling of conduction electrons to the magnetization and the current polarization are analyzed and discussed.

O-5-01

INTERPLAY BETWEEN THE CORRELATIONS AND SUPERCONDUCTIVITY IN ELECTRON TRANSPORT THROUGH THE QUANTUM DOTS

T. Domański and J. Barański
Institute of Physics, M. Curie Skłodowska University, 20-031 Lublin, Poland

We explore influence of the electron correlations on nonequilibrium charge transport through the quantum dots coupled between the metallic and superconducting leads. Such nanodevices are on one hand characterized by an induced superconducting order (i.e. proximity effect) which is responsible for mixing the particle and hole excitations. On the other hand, strong repulsion between the opposite spin electrons prevents from a double occupancy of the quantum dot levels. Coulomb interactions can eventually cause a screening of the quantum dot spin leading to formation of the Kondo resonance or, in the case of multidot structures, trigger quantum interference manifested by the Fano resonances. We analyze interplay between these phenomena especially with regard to the effective transport through the quantum dots, focusing on the low energy regime dominated by the Andreev scattering processes.

O-5-04

NON LINEAR EFFECTS OF DIPOLAR CONTRIBUTIONS IN MAGNETIC QUANTUM DOTS

Jean-Claude Serge Lévy
Laboratoire Matériaux et Phénomènes Quantiques,
UMR 7162 CNRS Université Paris7 - Denis Diderot, 75013 Paris, France

Recently polar vortices were observed in magnetic dots, they are due to the competition between local exchange and long-ranged dipole-dipole interactions. Some authors also observed a frequency doubling of spin waves in such nanostructures [1] as well as other non-linear properties such as slow gyrotropic motion of vortices. These highly non-linear effects are quite localized at domain walls, i.e. at sites where magnetization direction is changing. Such a localization of non-linear effects is explained here from a Taylor expansion of dipolar interactions which results in an effective local non-linear interaction. And non linear terms occur only at the places where static magnetization is not uniform. Thus the present step proposes to observe the occurrence of non-linear effects in magnetic dots where vortices are formed. This brings new geometrical constraints for induced high frequency magnons. The effective energy picture for vortex localization is discussed in this framework and shown to be non harmonic in agreement with recent simulations on vortex gyrotropic motion.
[1] S. J. Hermsdoerfer *et al.*, Appl. Phys. Lett. **94**, 223510 (2009).

O-5-06
MAGNETIC ANISOTROPY MODIFICATIONS OF SINGLE CRYSTALLINE RIPPLED Fe

M. O. Liedke[a], M. Körner[a], K. Lenz[a], A. Shalimov[a], T. Strache[a], M. Ranjan[a], S. Facsko[a], J. McCord[a] and J. Fassbender[a]

[a]Helmholz-Zentrum Dresden-Rossendorf, Institut für Ionenstrahlphysik und Materialforschung, Bautzner Landstraße 400, 01328 Dresden, Germany

Ion erosion as a tool for nanostructuring has proven its versatility with respect to surface morphology modifications. Ion irradiation parameters, e.g. ion energy, fluence, incident angle, and sample temperature, can be varied in order to assemble self-organized periodically ordered arrays of nano-dots and ripples. Particularly, nanopatterning of magnetic materials is meaningful because not only the surface morphology is affected, but the overall magnetic properties are accordingly modified. Here we present a novel bottom-up method of magnetic film patterning, where ordered periodic MgO ripple surfaces with a wavelength on the nanometer scale, ion sculptured along a few arbitrary in-plane orientations and outstandingly fully crystalline upon ion irradiation, are coated by a magnetic Fe layer. Due to a cubic symmetry of Fe an in-plane fourfold magnetic anisotropy is induced and in addition, an uniaxial magnetic anisotropy arises due to the surface morphology. The uniaxial magnetic anisotropy orientation and strength is controlled by an arbitrarily chosen irradiation direction with respect to the sample plane and the ripple wavelength is set by the ion energy, respectively. Thus an ensemble of twofold and fourfold anisotropy is created and analyzed by ferromagnetic resonance, magneto-optic Kerr effect, and X-ray diffraction techniques. Theoretical analysis reveals both the anisotropy fields and their directions that are in agreement with the experiment. This work is supported by DFG FA314/6-1.

O-5-07
GREPHENE NANORIBBONS WITH END- AND SIDE-CONTACTED ELECTRODES

S. Krompiewski[a]

[a]Institute of Molecular Physics, Polish Academy of Sciences, ul. M. Smoluchowskiego 17, 60179 Poznań, Poland

This contribution reports on theoretical studies of electronic transport through graphene nanoribbons (GNR) in the two-terminal geometry. The method combines the Landauer-type formalism with Green's function technique within the framework of the standard tight-binding model. The aim of this study is to gain some insight on how fundamental electric current characteristics (conductance and shot noise) depend on interface conditions imposed by GNR/metal-electrode contact details. Calculations have been carried-out for both end- and side contact geometries, and metallic (zigzag-edge) as well as semiconducting (armchair-edge) GNRs. It turns out that results for side-contacted systems depend on the ratio between the free-standing GNR length to that covered by the electrode. Typically the results start converging when this ratio approaches one. In the case of ferromagnetic contacts, the giant magnetoresistance coefficient is also discussed.

Work supported by the Polish Ministry of Science and Higher Education as a research project No. N N202 199239 in years 2010-13.

O-5-08

CONTROLLED POSITIONING OF DOMAIN WALLS IN Co/Au MULTILAYERS BY He^+ ION BOMBARDMENT INDUCED LATERAL COERCIVITY GRADIENTS

M. Urbaniak[a], P. Kuświk[a], Z. Kurant[b], M. Tekielak[b], D. Engel[c], D. Lengemann[c], B. Szymański[a], M. Schmidt[a], J. Aleksjejew[a], A. Maziewski[b], A. Ehresmann[c] and F. Stobiecki[a]

[a]Institute of Molecular Physics, Polish Academy of Sciences, Poznań, Poland
[b]Laboratory of Magnetism, Faculty of Physics, University of Białystok, Poland
[c]Department of Physics and CINSaT, University of Kassel, Germany

The current trend for on-chip integration of chemical and/or biological agents detection capabilities results in designs of new systems, some of which utilize the stray fields of magnetic domains for manipulation of paramagnetic particles. In this contribution we show that the introduction of structural defects into magnetic layers having perpendicular magnetic anisotropy by means of 10 keV He^+ ion bombardment through 0-100 nm thick Au wedge can create anisotropy gradients in the Co sublayers of a $[Co(0.6\,nm)/Au(2\,nm)]_3$ sputter deposited multilayer (ML). The thickness of the wedge determines the energy and fluence of ions reaching ML. Along the bombarded stripes coercive field of Co layers changes monotonically and for certain wedge-thickness ranges almost linearly along the wedge. Within such a layer system domain walls between up and down magnetized areas can be controllably moved by an external perpendicular homogeneous magnetic field over distance of several millimeters along the surface of the structure[1]. This method and layer system is promising for a controlled magnetic particle transport within the stray fields of the moving domain walls and for sensor applications.

[1]M. Urbaniak et al., Phys. Rev. Lett **105**, 067202 (2010)

O-5-12

DOMAIN WALL MOVEMENT ASSISTED TRANSPORT OF MAGNETIC PARTICLES ON SURFACES

A. Ehresmann

Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology, University of Kassel, Germany

Superparamagnetic nanoparticle remote control by magnetic gradient fields holds promise for applications like biological cargo transport, particle sorting, or in mixers for smallest amounts of chemicals. However, long range attractive forces between their induced magnetic moments and short range unspecific interparticle interactions enhances agglomeration and poses together with an increasing ratio between particle-substrate sticking and magnetic driving forces for decreasing particle size severe problems for applications and miniaturization. Here we show that these obstacles may be dramatically reduced using exchange bias bilayers with designed magnetic domain patterns for particle transport in the stray fields of moving domain walls. Two unique characteristics of the bilayers are exploited, their asymmetric magnetization reversal and the possibility to pattern them into designed domains. Particle clustering is dramatically reduced. Magnetic fields in this scheme are considerably smaller as gradient fields necessary for conventional transport showing a route towards controlled transport of nanoparticles.

P-5-01
ELECTRONIC CONDUCTANCE VIA SODIUM CHAINS: A WAVE FUNCTION MATCHING THEORY

D. Szczęśniak[a,b] and A. Khater[a]

[a] Laboratory for Condensed Matter Physics UMR 6087, University of Maine, Ave. Olivier Messiaen, 72085 Le Mans, France

[b]Institute of Physics, Jan Długosz University in Częstochowa, Al. Armii Krajowej 13/15, 42218 Częstochowa, Poland

A model calculation is presented for the quantum transport of electrons between leads of a given element via intermediate nanojunctions made up of finite one-dimensional atomic chains of another element. The electronic conductance is calculated using the wave function matching theory, to derive the transmission and reflection scattering matrices familiar in the Landauer-Büttiker formalism. In particular, we apply our model to calculate numerically the electronic transport in mono-atomic linear sodium chains (MALSC) as nanojunctions between cesium leads. The electronic dynamics for the system are calculated using the Slater-Koster tight-binding approximation, with appropriate tight-binding parameters. Our theoretical approach is quite general for varying MALSC lengths and as a result correctly reproduces the even-odd conductance oscillation behavior. It provides, further, an efficient tool for both electronic transport calculations for a wide range of nanomaterial chain systems.

P-5-02
ELECTRON MEDIATED Mn-Mn INTERACTION IN QUANTUM DOTS

Z. Bak[a]

[a]Institute of Physics, Jan Dlugosz University of Czestochowa, 42-200 Czestochowa, al. Armii Krajowej 13/15, Poland.

We present a theoretical study of magnetic interaction in a spintronic device composed of a few semiconductor, disc-shaped quantum dots with magnetic in dot impurities. We show that gate voltage applied to the quantum dot shifts the centers of electron clouds. The exact formulas for the perturbed spin density allow us to derive an expression for the change of the strength of the $sp-d$ coupling. Estimations show that $sp-d$ exchange integral is very sensitive to the gate voltage variations. The formulas for the change of the effective exchange integrals are derived. As the spin coded qubits are elements of a the RAM memory part of the energy stored in magnetic coupling will be dissipated when the information is written or erased. The dissipated energy stemming from magnetic interactions is supplemented by the energy loss due to parasitic electric dipoles. We estimate this energy and find that it is sufficiently large to destroy quantum coherence during quantum computing. Finally, we discuss the interdot spin coupling and show effect of gate voltage operations on the spin intra- and interdot RKKY coupling.

P-5-03
RKKY COUPLING BETWEEN MAGNETIC IMPURITIES IN GRAPHENE NANOFLAKES

K. Szałowski[a]
[a]Department of Solid State Physics, University of Łódź,
ul. Pomorska 149/153, 90-236 Łódź, Poland

Graphene nanostructures offer a promising route to graphene-based spintronics and their magnetic properties attract increasing attention, exhibiting highly nontrivial physics [1]. One of the scenarios leading to the emergence of magnetism is doping of graphene with magnetic impurity atoms. The subject of our study is the Ruderman-Kittel-Kasuya-Yosida (RKKY) interaction between two magnetic impurities located in the single-layer graphene nanoflakes, mediated by the charge carriers present in the nanostructure. The study is not limited to the case of half-filling (corresponding to the equilibrium electron concentration in graphene). The paper also considers the possibility of varying the charge concentration "electron by electron" in the structures. One of the goals is to search for the configuration for which the coupling changes its character between ferro- and antiferromagnetic as a result of adding or removing a single electron from the system, in close vicinity of half-filling conditions, which would allow to control the interaction. The tight-binding approximation, exact diagonalization, and non-perturbative approach is used to describe the electronic properties. The importance of Coulomb interaction-driven correlations for RKKY interaction in graphene nanostructures is revealed by applying the Hubbard model.

[1] O. V. Yazyev, Rep. Prog. Phys. **73**, 056501 (2010).

P-5-04
MAGNETIZATION REVERSAL IN COBALT NANOCOLUMN STRUCTURES OBTAINED BY GLANCING ANGLE DEPOSITION

K. Buchta[a], **G. Trykowski**[b], **S. Biniak**[b], **Ch. Schmidt**[c], **M. Kempiński**[d], **T. Luciński** [a]
[a]Institute of Molecular Physics Polish Academy of Sciences, Smoluchowskiego 17, 60-179 Poznan, Poland
[b] Nicolaus Copernicus University, Gagarina 11, 87-100 Torun, Poland
[c] University Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, Germany
[d] Adam Mickiewicz University, Umultowska 85, 61-614 Poznan, Poland

An advanced deposition technique known as glancing angle deposition (GLAD) was used to fabricate randomly seeded magnetic cobalt nanocolumn structures. The existence of nanocolumns was confirmed by the cross-section scanning electron microscope (SEM). The surface analysis, performed via atomic force microscopy (AFM), showed that the cobalt forms elongated nanosized grains. The magnetic properties of the samples prepared by MBE were found to depend upon shape anisotropy. The evolution in the magnetization reversal mechanism as a function of film thickness was investigated. The coercivity H_C and M_R/M_S ratio (where M_R and M_S denote the remanent and saturation magnetization, respectively) were derived from the magnetic hysteresis loops as a function of the angle between the external magnetic field and the inclined columns. The direction of the easy/hard axis of the magnetization and inclination angle of columns were determined on the basis of the angular dependencies of the coercivity and the normalized remanent magnetization. A cross-over from the coherent rotation, based on Stoner Wohlfarth model, to the curling reversal mode was observed for films thicker than 30 nm.

P-5-05

CHANGES OF THE MBE-GROWN Ni-Fe/Au/Co/Au MULTILAYERS MAGNETOTRANSPORT PROPERTIES INDUCED BY THE DEPOSITION TEMPERATURE

M. Błaszyk[a], M. Kempiński[b] and T. Luciński[a]

[a]Institute of Molecular Physics Polish Academy of Sciences, Smoluchowskiego 17, 60-179 Poznań

[b]Adam Mickiewicz Univeristy, Umultowska 85, 61-614 Poznań

The vast majority of already collected information about Ni-Fe/Au/Co/Au multilayers comes from the experiments performed on the systems obtained with the magnetron sputtering at room temperature. Hence, the information about such structures (with perpendicular anisotropy of Co and in-plane anisotropy of Ni-Fe) is limited to specific deposition conditions and specific sublayers thicknesses. Therefore, it is relevant to take the additional factors, such as possible discontinuities of ferromagnetic and nonmagnetic sublayers, intermixing and interface roughness, into account. It may be achived for example by the change of the deposition method or by the substrate temperature variation. In the following, the influence of the substrate temperature (T_D) on the microstructure, electrical and magnetic properties of MBE-grown Ni-Fe/Au/Co/Au multilayers is presented. Reflection High Energy Electron Diffraction (RHEED) revealed a change in the multilayer growth mode from the 3D to locally 2D one while depositing the second repetition. Those microstructure changes were correlated with the Ni-Fe/Au and Co/Au interface alterations and giant magnetoresistance amplitude changes. Moreover, the in-situ conductance measurements denoted Co sublayers to be discontinuous within multilayers deposited at $T_D > 25°C$, and that the formation of Co grains smoothens the Au surface without continuous layer formation (for $T_D > 100°C$) or intermixing.

P-5-06

SPIN WAVES LOCALISATION IN 2D SQUARE MAGNETIC NANODOTS AND ITS INFLUENCE ON THE STABILITY OF THE LANDAU STATE

S. Mamica[a], J.-C. S. Lévy[b], M. Krawczyk[a], Ph. Depondt[c]

[a]Faculty of Physics, A. Mickiewicz University, Poznań, Poland

[b]Lab. MPQ, UMR CNRS 7162, Université Paris 7, Paris, France

[c]INSP, UMR CNRS 7588, Université Paris 6, Paris, France

We use a microscopic theory with dipolar and nearest-neighbour exchange interactions taken into account to explore spin-wave excitations in two-dimensional magnetic nanodots with the Landau state (closure domain structure) assumed as a ground state. We study the effect of a hole introduced at the centre of the dot on the spin waves localization and the ground state stability. We calculate the spin-wave frequencies vs. the dipolar-to-exchange interaction ratio d to find its range for which the assumed state is stable (no zero-frequency modes in the spectrum). The magnetization profile of the lowest-frequency mode provides us information about the character of the ground state transition. In square dots the removal of only one spin at the centre makes Landau state more stable, i.e. transition to different ground state appears for lower d (stronger exchange interactions). Increasing of the size of the hole does not result in additional stabilization. In contrary for in-plane vortex in circular dots we found strong dependence of critical d on the size of the hole. We show this effect origins from the edge roughness. The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under Grant Agreement n233552 for DYNAMAG project.

P-5-07

THE STRUCTURAL AND MAGNETIC PROPERTIES OF A γ-Fe_2O_3 NANOPOWDER SYNTHESIZED BY ATMOSPHERIC MICROWAVE TORCH

B. David,[a] O. Schneeweiss,[a] E. Šantavá,[b] and O. Jašek [c]

[a]Institute of Physics of Materials, AS CR, v.v.i., Brno, Czech Republic

[b]Institute of Physics, AS CR, v.v.i., Prague, Czech Republic

[c]Faculty of Science, Masaryk University, Brno, Czech Republic

For the synthesis of γ-Fe_2O_3 nanoparticles a microwave torch discharge ignited in Ar at atmospheric pressure has been used. A double-walled nozzle electrode enabled us to introduce separately the gases: Ar flowed in the central channel whereas the mixture of H_2/O_2 and $Fe(CO)_5$ vapour was added into the Ar discharge through the outer channel. The composition and properties of the synthesized nanopowders were studied by TEM, XRD, Raman and Mössbauer spectroscopies. For the magnetic measurements in the range 293–1073 K a vibrating sample magnetometer was employed. Heat capacity and ZFC/FC measurements were perfomed on a PPMS® device from Quantum Design.
Only the cubic γ-Fe_2O_3 phase with the mean crystallite size of 20 nm was identified by XRD in a representative sample. The total spectrum area (TSA) of the Mössbauer transmission spectrum measured on the sample in the range 4–293 K strongly decreased with increasing temperature ($TSA = 0.155$ at 5 K, $TSA = 0.026$ at 293 K). This behaviour is attributed to a bimodal particle size distribution and the chain-like morphology of very small particles (observed under TEM), which enables tilting motions of particles. We also present the high-temperature magnetic properties of the repesentative sample and describe its structural changes and phase transformations up to 1073 K.

P-5-08

SPIN WAVE RESONANCE PROFILES IN MAGNETIC MULTILAYERS

A. Urbaniak-Kucharczyk

Chair of Solid State Physics, Faculty of Physics and Applied Informatics
University of Łódź, Pomorska 149/153, 90-236 Łódź, Poland

A great number of studies have been performed on the properties of magnetic multilayers exchange coupled via metallic nonmagnetic spacer. Beside of the problem of interlayer exchange coupling, which has been investigated by means of various theoretical methods also, basic magnetic properties of multilayer systems have been examined both by experimentalists and theoretician. In particular the problem of elementary magnetic excitations in multilayers has been considered in many papers, where magnon dispersion relation or spin wave spectra have been obtained, however, little attention have been paid to the problem of the problem of magnon damping effects and its influence on the shape of spin wave resonance lines.
In presented work the relaxation equation has been used to determination spin wave profiles Fe and Co layers with Au and Cu spacers and substrate characterised by parameters corresponding to GaAs. As a result the dependence of resonance line-width on temperature and parameters characterizing the system has been obtained obtained. The influence of thickness of constituent layers, interlayer exchange coupling parameter, surface and interface magnetic anisotropy constants on the obtained spectra has been discussed. The range of parameters where surface or interface anisotropy determines the resonance line-width has been found.

P-5-09

XAS AND XMCD STUDIES OF Ga^+ IRRADIATION INDUCED CHANGES OF PT/CO/PT NANOSTRUCTURE MAGNETIC PROPERTIES

P. Mazalski[a], A. Maziewski[a], M. O. Liedke[b], J. Fassbender[b], J. McCord[b], A. Wawro[c], A. Rogalev[d], F. Wilhelm[d]

[a] Faculty of Physics, University of Białystok, Lipowa 41, 15-424 Białystok, Poland

[b] Helmholz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany

[c] Institute of Physics, Polish Academy of Sciences, 02-668 Warszawa, Poland

[d] European Synchrotron Radiation Facility (ESRF), BP 220, 38043 Grenoble Cedex, France

In the our recent paper [J. Jaworowicz et al., APL95 (2009)] we have demonstrated an elegant route to tune the magnetic anisotropy of ultrathin sputter deposited Pt/Co(d=2.6 nm)/Pt films by uniform Ga^+ ions irradiation at 30 keV. We have observed that with increasing irradiation dose the magnetization rotates from the in-plane into out-of-plane orientation and for a higher dose back into the plane. For the purpose of the present work we prepared Al_20_3/Mo/Pt/Co(d=3.3 nm)/Pt samples by molecular beam epitaxy with initial in-plane magnetization. These samples were homogeneously irradiated with Ga^+ ions with an ions dose ranging between $1*10^{14}$ and $1*10^{16}$ ions/cm^2. The irradiated samples were studied using classical magnetooptical Kerr effect, as well as Co K-edge X-ray absorption (XAS) and X-ray Magnetic Circular Dichroism (XMCD) spectroscopy techniques. From the XMCD spectra analysis [Y.S. Lee et al., PRB68 (2008); J. Bartolomé et al, PRB77 (2008)] one can deduce the existence of an ordered $L1_0$ CoPt phase for the sample, where Ga^+ irradiation has induced a preferential out-of-plane magnetization.

P-5-10

INVESTIGATION OF COBALT FILMS MODIFIED BY FLUOROALKYLSILANES

W. Szmaja,[a] M. Cichomski,[b] K. Kośla,[b] and J. Balcerski[a]

[a]Dept. of Solid State Physics, University of Łódź
Pomorska 149/153, 90-236 Łódź, Poland

[b]Dept. of Materials Technology and Chemistry, University of Łódź
Pomorska 163, 90-236 Łódź, Poland

In recent years cobalt thin films modified with organic thin films are of large interest because of their potential applications in a number of technological fields. We made the study of cobalt films 100 nm thick modified by 1H, 1H, 2H, 2H perfluorodecyltrichlorosilane (FDTS) films of various thickness. The cobalt films were thermally evaporated on naturally oxidized Si(100) substrates, and the FDTS films were grown on the cobalt surfaces by vapor phase deposition (VPD). The magnetic structure of the cobalt films modified with FDTS, revealed by magnetic force microscopy (MFM), was composed of maze stripe domains, characteristic of materials with sufficiently high perpendicular magnetic anisotropy. The domain pattern showed no directionality, i.e. the stripe domains ran in random directions in the film plane. Atomic force microscopy (AFM) imaging of the surfaces of FDTS films exhibited the presence of an agglomerate morphology. As the thickness of FDTS films was increased from about 2 nm to 30 nm, the domain width increased from typically 80–120 nm to 400–500 nm and the agglomerates varied in size from typically 30–70 nm to 150–300 nm. Note also that the cobalt films modified by FDTS had better tribological properties than the cobalt films modified by other alkylsilanes with fluorocarbon and methyl terminal groups.

P-5-11

STRUCTURAL AND MAGNETIC BEHAVIOR OF HARD MAGNETIC Sm-Co_x THIN FILMS

A.F. Takács[a] C. Prahoveanu[a], E. Dorolti[a], C. Brombacher[b], M. Albrecht[b], V. Pop[a]

[a]Faculty of Physics, Babes-Bolyai University, 400084 Cluj-Napoca, Romania
[b]Institute of Physics, Chemnitz University of Technology, D-09107 Chemnitz, Germany

Relatively thick Sm-Co films are attractive for permanent magnets as they exhibit high intrinsic coercive forces and large remanent moment values. Thin Sm-Co films, on the other side are attractive for ultrahigh density recording medium as they allow thermal stability even in nanometer ordered grains. Since room temperature deposited SmCo films are amorphous we present here a systematic investigation on the influence of thickness and annealing conditions on the magnetic properties and structural features. $SmCo_x$ ($x \leq 5$) films were deposited by magnetron sputtering on Cu and underlayers that were deposited on thermally oxidized Si wafers. We observed an increase of the coercivity with the ordering of the post-annealed film but also an increase of coercivity even when the recrystallization was not detected after annealing. The microstructural modifications of the thin films were investigated by X-ray diffraction and electron microscopy while the magnetic behavior was observed by VSM measurements. The remanent magnetization and the coercive field were deduced from hysteresis curves, performed in magnetic fields up to 10 T at room temperature.

P-5-12

PURE AND CORE-SHELL $CoFe_2O_4$ NANOPARTICLES

P. T. Thoung[a], S. Ammar[b], N. Yaacoub[c], J. M. Greneche[c], N. Nedelko[a], S. Lewińska[a], A. Ślawska-Waniewska[a]

[a]Institute of Physics, Polish Academy of Sciences, Al. Lotnikow 32/46 PL02668, Warsaw, Poland
[b]ITODYS lab., Université Paris Diderot, 75205 Paris, France
[c]Laboratoire de Physique de l'Etat Condense, UMR CNRS 6087, Université du Maine, 72085 Le Mans Cedex, France

Pure cobalt ferrite nanoparticles as well as core-shell structures composed of two magnetic materials with different characteristics ferrimagnetic $CoFe_2O_4$ core surrounded by an antiferromagnetic CoO surface layer, were prepared by a wet chemistry method. Microstructure and magnetic properties of these materials have been studied with X-ray diffraction, transmission electron microscopy, ^{57}Fe Mössbauer spectrometry and static magnetic measurements. Pure $CoFe_2O_4$ nanoparticles form agglomerates and their behaviour is dominated by the interparticle magnetostatic interactions. In turn the core/shell nanoparticles are more susceptible to thermal fluctuations as the antiferromagnetic shell effectively reduces the interparticle coupling. These particles display a superparamagnetic behavior with a single blocking temperature indicating a strong exchange coupling between magnetic moments of the core and shell.

P-5-13

Ti:Sa FEMTOSECOND LASER APPLICATION IN ULTRAFAST MAGNETO-OPTICAL AND MAGNETIZATION-INDUCED SECOND HARMONIC GENERATION TECHNIQUES FOR STUDIES OF ULTRA-THIN MAGNETIC NANO-STRUCTURES

A. Bonda, S. Uba, L. Uba
Institute of Computer Science, University of Bialystok, Lipowa 41,
PL-15-424 Bialystok, Poland

The work concerns application of titanium-sapphire femtosecond laser oscillator with 82-MHz repetition rate at 800 nm in measurements of ultrafast magneto-optical and magnetization-induced second harmonic generation (MSHG) effects. Time-resolved magneto-optical Kerr effect (TRMOKE) pump-probe method was used in investigation of ultrafast precession of magnetization in Fe/Au multilayers. Magnetization precession frequency, obtained as a function of magnetic field applied, allows determining saturation magnetization and damping factor. The MSHG effect has been used for study of ultra-thin garnet films. This method allows to determine crystallographic symmetry and hysteresis loops in an external magnetic field at 2ω laser induced frequency. The simultaneous measurements of linear and second order magneto-optical effects enable to investigate magnetic interfaces in the studied structures.

P-5-14

TEMPERATURE DEPENDENCE RESISTANCE OF A MANGANITE PEROVSKITE NANOCONSTRICTIONS

J.Baszyński[a]
[a]Institute of Molecular Physics Polish Academy of Sciences, Poznań

We have investigated a significant temperature dependence of the resistance at the perovskite nanoconstrictions obtained by break technique. The electrical transport of the perovskite point-contact (PC) was measured, using a specially built computer home-made electrical circuit, with a two-point contact method. This implies that the conductance measurement probes in the narrowest region of the point-contact, which is changed mechanically by the piezodevice, with a resolution of a few picometers. The temperature dependence of the zero-bias resistance of the PC has been evaluated from the collection of the current-voltage characteristics measured at several temperatures, between LN and 370 K. The temperature dependence resistance, below 0.9 T_C , can be described by two-term formula: aT^2 term explains the contribution of electron-electron scattering process to the resistance and $bT^{4.5}$ term may be attributed to two-magnon scattering process in the ferromagnetic region. The appearance of both contributions evidences that the metallic transport is the predominant mechanism of the conductance between the neighbouring Mn-ions at different zones of PC. In our experiments, however, the structure of the point-contact and the crystallographic orientation of the "apexes" cannot be controlled, therefore, each conductance measurement corresponds to a new magnetic arrangement.

P-5-15

METAMAGNETISM OF THE Fe_2MnGa HEUSLER ALLOY

Y. V. Kudryavtsev[a], J. Dubowik[b], N. V. Uvarov[a] and V. N. Iermolenko[a]

[a]Institute of Metal Physics, National Academy of Sciences of Ukraine, 252680, Kiev-142, Ukraine

[b]Institute of Molecular Physics, Polish Academy of Sciences, 60-179 Poznań, Poland

Magnetic properties and electronic structure of bulk and film Fe_2MnGa Heusler alloy (HA) samples have been investigated. It was verified that unlike most of full stoichiometric Heusler compounds, ferromagnetic bulk stoichiometric Fe_2MnGa with the Curie temperature of 780 K crystallizes in the ordered FCC lattice of Cu_3Au type with small amount of B2-phase. According to the results of our first-principle calculations free electron energy of ferromagnetic (FM) [$\mu_{total} = 6.78\mu_B$, $\mu_{Fe} = 2.19\mu_B$, $\mu_{Mn} = 2.55\mu_B$ and $\mu_{Ga} = -0.10\mu_B$] FCC phase is lower by about 0.06 eV than that of antiferromagnetic (AFM) phase with $L2_1$ structure. In a temperature range of 80 - 110 K a FM to AFM transition was observed with field cooling magnetization measurments. Additionally, Fe_2MnGa revealed metamagnetic behavior since increase in magnetic field suppresses the AFM spin arrangement. Depending on deposition conditions Fe_2MnGa films revealed a mixed structure: mainly BCC or FCC phases with some admixture of FCC or BCC phases, respectively. Fe_2MnGa HA films with mainly BCC structure show the same behavior as the bulk samples: the magnetization increases with decrease in temperature from the Curie temperature ($T_C \approx$300 K) up to 110 K and then abruptly decreases up to zero due to transformation to AFM phase. According to DSC analysis FM/AFM transition of Fe_2MnGa films is not accompanied with any structural changes.

P-5-16

INTERVAL IDENTIFICATION OF FMR PARAMETERS FOR SPIN REORIENTATION TRANSITION IN (Ga,Mn)As*

M.W. Gutowski[a], O. Proselkov[a], J. Sadowski[a,b], M. Sawicki[a], R. Żuberek[a]

[a]Institute of Physics, Polish Academy of Sciences, Warszawa, Poland

[b]MAX-lab, Lund University, Lund, Sweden

We report ferromagnetic resonance (FMR) in-plane studies of a 15 nm thick (Ga,Mn)As layer, deposited on (001)-oriented GaAs, in the temperature ranging from 5 K to 120 K. The behavior of the anisotropy fields, H_{eff} ($= 4\pi M - H_{2\perp}$), $H_{2\parallel}$, and $H_{4\parallel}$, has been determined using powerful but still largely unknown interval calculations. We observe the reorientation of an easy axis of the in-plane uniaxial anisotropy ($H_{2\parallel}$) from [$\bar{1}$10] to [110] direction close to the Curie temperature (T_{C}). The orientation of easy axes of biaxial anisotropy ($H_{4\parallel}$) remains unchanged while temperature changes, only its magnitude vanishes at T_{C} as the 4^{th} power of spontaneous magnetization. In order to exactly examine this reorientation we use the interval calculus. The interval approach allows us to precisely calculate *all* the resonance fields for arbitrarily oriented sample, what is intractable analytically. Using those methods we can effectively utilize full experimental information, and not only those measurements performed in special, distinguished directions, to reliably estimate the values of important physical parameters (as well as their uncertainties and correlations), not limited to anisotropy constants alone.

*This work was supported in part by EC Network SemiSpinNet (PITN-GA-2008-215368) and Polish MNiSW 2048/B/H03/2008/34 grant.

P-5-17
DARK STATES AND STARK EFFECTS IN MULTI-QUANTUM-DOT MOLECULES

S. B. Tooski and B. R. Bułka
Institute of Molecular Physics, Polish Academy of Sciences,
ul. M. Smoluchowskiego 17, 60-179 Poznań, Poland

We consider the transport properties through a ring-shaped multi-quantum-dot molecules coupled to electrodes. The effects of an in-plane applied electric field and its rotation which breaks the symmetry of the system on wave functions, occupation probabilities of molecular states, an electronic polarization, current, as well as ground and excited states are analyzed. The Stark splitting is determined by the intensity of the applied electric field and its angle with respect to the axes of the molecule. For some interference conditions, the electric field can create a so-called dark state in which the probability to find the electron in one of the dots is zero and consequentely blocking the current in the dot can occur. The stationary current in the sequential regime using master equation approach is studied. It is shown that the electric field can induce a major changes in current. In particular, we analyze the conditions for the appearance of negative differential resistance due to dark states. The circumstances to create dark states and observe negative differential resistance in multi-quantum-dot molecules due to symmetry reasons are found. Transport through such a device is also discussed, where the molecule is attached to the leads in various configurations.

P-5-18
THE TEMPERATURE DEPENDENCE OF MAGNETIZATION PROCESSES IN MBE AND SPUTTER-DEPOSITED Fe/Au LAYERED STRUCTURES

A. Polewko-Klim, S. Uba and L. Uba
Institute of Computer Science, University of Bialystok, Lipowa 41, PL-15-424 Bialystok, Poland

We investigated magnetization processes in Fe/Au layered structures prepared by MBE and sputtering techniques as a function of temperature. The hysteresis loops were measured by magneto-optical methods in the temperature range 8-315 K in an external magnetic field oriented both perpendicularly and in the sample plane. The MBE layered structures studied are composed of equal number of Fe and Au atomic layers, and sputter-deposited Fe/Au multilayered structures are prepared with comparable sublayer thicknesses to MBE films. For MBE structures studied the complex character of temperature dependence of coercivity and remanence is observed, and the spin reorientation from out-of-plane to in-plane takes place with the increase of Fe and Au sublayer thickness already for three atomic layers. The temperature dependences of magnetization processes become similar in both systems for thickest sublayers where anisotropy is of easy-plane type. The interpretation of the observed temperature-dependent magnetic characteristics and correlation with the system's structure is analyzed and discussed.

P-5-19

MAGNETIC PROPERTIES OF ZnO NANOCRYSTALS INCORPORATING Co

I. Kuryliszyn-Kudelska[a], D. Sibera[c], B. Hadzić[b], N. Romcević[b], M. Romcević[b], M. Arciszewska[a], U. Narkiewicz[c], W. Dobrowolski[a]

[a] Institute of Physics, Polish Academy of Sciences, Warsaw, Poland

[b]Institute of Physics, Belgrade University, Serbia

[c] West Pomeranian University of Technology, Institute of Chemical and Environment Engineering, Szczecin, Poland

Among the various oxide-based diluted magnetic semiconductors, transition metal doped ZnO has been the centre of interest, particularly at the nanoparticle scale. The aim of the present work was to study the magnetic properties of ZnO doped CoO (up to 50 wt. %) nanocrystalline samples prepared by two methods of synthesis. We used the microwave assisted hydrothermal synthesis and traditional wet chemistry method followed by calcination. The detailed structural characterization was performed by means of X-ray diffraction, micro-Raman spectroscopy measurements, scanning electron microscopy measurements and specific surface area measurements. For calcination method the crystalline phases of hexagonal ZnO and cubic Co_3O_4 were identified, for hydrothermal process hexagonal ZnO and cubic $ZnCo_2O_4$ phases were observed. The systematic measurements of AC magnetic susceptibility up to 180K and magnetization as a function of magnetic field (up to 9T) and temperature were performed. All samples demonstrate Curie-Weiss behavior at higher temperatures. For calcination process the increase of determined Curie-Weiss temperature with content of magnetic dopant is observed, for hydrothermal process the opposite effect is visible. We observe also differences in magnetization data for two methods of synthesis. The observed disparity in magnetic behavior for two synthesis methods will be discussed.

P-5-20

GIANT MAGNETORESISTANCE OF $[NiFe/Au/Co/Au]_N$ MULTILAYERS DEPOSITED ON FLEXIBLE SUBSTRATES

W. Gospodarczyk[a,b], M. Urbaniak[a], B. Szymański[a] and F. Stobiecki[a]

[a]Institute of Molecular Physics, Polish Academy of Sciences, Poznań, Poland

[b]Faculty of Physics, A. Mickiewicz University, Poznań, Poland

In flexible magnetoelectronics[1] it is desirable that the magnetic properties of materials used, especially the shape of magnetic and magnetoresistance hysteresis loops, vary only slightly as the sample is exposed to bending. In the presented investigation, $[NiFe/Au/Co/Au]_{10}$ multilayers (MLs) exhibiting giant magnetoresistance are sputtered on an adhesive polypropylene tape as a flexible substrate to provide conditions relevant to examination of prospective applicability of this films to flexible electronics. Co layers, due to the Co/Au surface anisotropy, possess perpendicular magnetic anisotropy. Hysteresis loops and magnetoresistance have been measured for three different systems. One of them was the ML on flat Si(100) substrate, another one was the ML on flat polypropylene substrate (silicon covered with the tape) and finally the ML wound on a cylinder with a small radius to reveal expected high bendability of the sample. The first two systems exhibit very similar properties, despite the greater surface roughness in the case of the second one. Magnetic properties of cylindrically shaped sample was found to be quasi-isotropic when external magnetic field was applied perpendicularly to the axis of the cylinder and could therefore serve as a magnetic field sensor. Mechanical stability of MLs is also discussed.

[1]B. Y. Ahn, E. B. Duoss, M. J. Motala, X. Guo, S.-I. Park, Y. Xiong, J. Yoon, R. G. Nuzzo, J. A. Rogers, and J. A. Lewis, Science **323**, 1590 (2009)

P-5-21

MAGNETIC PROPERTIES AND MICROSTRUCTURE OF METALLIC NANOWIRES ELECTRODEPOSITTED IN POROUS TEMPLATES

M. Kuźmiński[a], M. Jönsson-Niedziółka[b], A. Leśniewski[b], N. Nedelko[a], R. Żuberek[a], K. Fronc[a] and A. Ślawska-Waniewska[a]

[a]Institute of Physics, Polish Academy of Sciences,
Al. Lotnikw 32/46, 02-668 Warszawa, Poland
[b]Institute of Physical Chemistry, Polish Academy of Sciences,
ul. Kasprzaka 44/52, 01-224, Poland

Magnetic nanowires made out of ferromagnetic metals and their alloy attracts much attention because of its potential applications and as a tool for the research of magnetic phenomena related to their specific geometry and dimensions. One of widely used method of fabrication is electrodeposition into insulating porous templates such as nanoporous polymer or alumina membranes. Nanowires made by this fast and versatile method can have high aspect ratio (e.g. length: 50 μm and diameter: 10 nm). The array of such magnetic nanowires embedded in an insulating matrix exhibit interesting magnetic properties. When nanowires are close to each other, dipolar interactions play a significant role. In the present work, magnetic properties of cobalt and nickel nanowires made by electrodeposition into polycarbonate and anodic alumina membranes with different pore diameters and densities were studied. Quasi-static and dynamic magnetic properties (e.g. magnetic hysteresis loop for various angles of the external magnetic field or ferromagnetic resonance) and its relation to structure and geometry of the nanowires array have been determined.

P-5-22

MAGNETIC BIREFRINGENCE STUDY OF THE MAGNETIC CORE STRUCTURE OF FERRITIN

M. Koralewski[a] M. Pochylski[a] Z. Mitrová[b] L. Melniková[b] J. Kováč[b] M. Timko[b] P. Kopčanský[b]

[a]Faculty of Physics, Adam Mickiewicz University,
Umultowska 85, 61-614 Poznań, Poland
[b]Institute of Experimental Physics, SAS, Watsonova 47, 040 01 Košice, Slovakia

It was shown that ferritin, the iron-storage protein, is an excellent reaction vessel for synthesis of some minerals inside its structural cage, in particular magnetite or maghemite (then it is named magnetoferritin). Discovery of biological magnetite in the human brain and relation of its presence with neurodegenerative diseases have prompted investigation of physicochemical properties of ferritin and magnetoferritin. Of particular interest is the search for methods allowing detection of magnetite inside ferritin proteins both *in vitro* and *in vivo*.

The paper presents results of magnetic birefringence measurements performed with biogenic ferritin (i.e. horse spleen ferritin) synthetic ferritin (magnetoferritin) and model nanoscale magnetite as well as some mixture modelling a heterogeneous structure of biogenic brain ferritin. TEM, crystallographical and magnetization measurements were also performed for further characterization of compounds studied. The behaviour of Δn in frame of Langevin formalism and for low field region respective Cotton-Mouton constants will be discussed. We show that magnetic birefringence can be useful for identification of magnetic core structure of biogenic ferritins, which can be of interest in biomedicine.

P-5-23

MAGNETIC PROPERTIES OF $(Ni_{80}Fe_{20}/Au/Co/Au)_N$ MULTILAYERS WITH DIFFERENT NUMBER OF REPETITIONS

A. Zasadni[a,b], B. Szymański[a], M. Schmidt[a], M. Tekielak[c], A. Maziewski[c], J. Aleksiejew[a], F. Stobiecki[a]

[a]Institute of Molecular Physics, PAS, M. Smoluchowskiego 17, 60-179 Poznań, Poland
[b]Dept. of Physics, A. Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland
[c]Faculty of Physics, University of Białystok, Lipowa 41, 15-424 Białystok, Poland

The influence of the Ti-8nm/Au-30nm buffer layer and the number of repetitions N on the magnetic properties of sputter deposited ($Ni_{80}Fe_{20}$-2nm/Au-2nm/Co-0.8nm/Au-2nm)$_N$ ($1 \leq N \leq 15$) multilayers (MLs) was studied. Magnetization reversal process was investigated for external magnetic field applied either perpendicular ($H_\perp$) or parallel ($H_{||}$) to the sample plane using vibrating sample magnetometer and magnetoresistance measurements. The MLs are characterized by in-plane and perpendicular anisotropy of NiFe and Co layers, respectively. However, for MLs deposited directly on Si the in-plane anisotropy of the first Co layer is observed. This drawback is eliminated in the MLs deposited on the buffer layer. The evolution of magnetization reversal of Co layers is observed with increasing N. For $N \leq 3$ the magnetization reversal in $H_\perp$ is characterized by a rectangular hysteresis loop. However, for larger N the shape of hysteresis loop with low remanent magnetization and high saturation field strength is observed. The influence of N on the magnetic structure of NiFe/Au/Co/Au MLs is similar to that observed in Au/Co MLs [1].

[1] M. Tekielak et al., IEEE Trans Magn., 44, 2860 (2008)

P-5-24

MAGNETIC ANISOTROPY OF Co/MgO FILM WITH Au INTERFACE

L. Gladczuk, P. Aleshkevych, A. Petroutchik and P. Przyslupski

Institute of Physics, Polish Academy of Sciences,
Al. Lotnikow 32/46, PL02-668 Warsaw, Poland

Recently there was, a lot of interest in Co/MgO/Co magnetic tunnel junctions with in-plane magnetic moments of Co electrodes. Fabrication of such heterostructure with electrodes having perpendicular anisotropy offers an extended functionality of the tunnel junction. In the present study, a Co/MgO heterostructure was deposited with Au interlayer partially covering Co electrode. The heterostructure, including a 0-3 nm Co wedge-shaped layer, was deposited by means of molecular beam epitaxy on sapphire substrate, and characterized by ferromagnetic resonance. The experiments indicate an enhancement of anisotropy for heterostructures with specific Co thickness of electrodes. A comparison of the obtained results with earlier data on Co anisotropy will be presented.

P-5-25

EXCHANGE INTERACTION BETWEEN COBALT AD-ATOMS ON ZIGZAG- EDGE GRAPHENE NANORIBBON

J. Kaczkowski, D. Krychowski, S. Lipiński and A. Jezierski
Institute of Molecular Physics, Polish Academy of Sciences, Smoluchowskiego 17, 60-179 Poznań, Poland

Based on LSD spin polarized calculations, we compare parallel and antiparallel ordering of moments of pairs of Co impurities in graphene zigzag-edge nanoribbon. Different locations with respect to nanoribbon edges are considered. The space dependence of magnetic moment distribution and local distortions are calculated. The adatom induced curvature is observed for narrow ribbons. Exchange interaction is strongly anisotropic mainly due to the existence of electron edge states. For infinitely long nanoribbons the presence of a gap in the energy spectrum results in superexchange-type exchange mechanism, whereas for finite length or for doped nanoribbons the dominate mechanism is RKKY-like. The calculations are performed employing VASP package with the projector augumented wave basis and making use of generalized gradient approximation.

P-5-26

Co/Au MULTILAYERS WITH DESIGNED COERCIVE FIELD GRADIENT

B. Szymański[a], M. Matczak[a,b], D. Lengemann[c], M. Schmidt[a], D. Engel[c], A. Ehresmann[c], F. Stobiecki[a]
[a]Institute of Molecular Physics, PAS, M. Smoluchowskiego 17, 60-179 Poznań, Poland
[b]Faculty of Technical Physics, Poznań University of Technology, Nieszawska 13a, 60-965 Poznań, Poland
[c]Institute of Physics and Centre for Interdisciplinary Nanostructure Science and Technology, University of Kassel, Heinrich-Plett-Strasse 40, D-34132 Kassel, Germany

We present the influence of a precisely tailored fluence gradient upon bombardment by 10 keV He^+ ions on magnetic properties of sputtered Ti/Au/(Co 0.8nm/Au 1nm)$_N$ multilayers (N = 1, 2, 3). The Co/Au multilayers (Mls) with chosen cobalt thickness t_{Co}= 0.8 nm show strong perpendicular anisotropy and for $N \leq 3$ a rectangular hysteresis loop in perpendicularly applied field making them attractive for various applications. Samples were irradiated in a way ensuring a precise change of the ion dose (from 0 up to 10^{15} He^+/cm^2) along the determined coordinate in the sample plane. The influence of the ion bombardment on magnetic properties of the Mls was investigated with MOKE by taking local hysteresis loops from submilimeter areas along the ion dose gradient. We show that for all investigated films the intentional bombardment by light ions induces a well determined, almost linear, gradient of coercive field. This makes the Mls very attractive for magnetic particle manipulations [1].

[1] M. Urbaniak et al., Phys. Rev. Lett. 105, 067202 (2010)

P-5-27

DOMAIN WALLS GENERATION AND POSITIONING IN He^+ ION BOMBARDED Co/Au MULTILAYERS

M. Matczak[a,b], B. Szymański[a], Z. Kurant[c], D. Lengemann[d], M. Urbaniak[a], P. Kuświk[a], M. Tekielak[c], A. Ehresmann[d], A. Maziewski[c], F. Stobiecki[a]

[a]Institute of Molecular Physics, PAS, M. Smoluchowskiego 17, 60-179 Poznań, Poland

[b]Faculty of Technical Physics, Poznań University of Technology, Nieszawska 13a, 60-965 Poznań, Poland

[c]Laboratory of Magnetism, Faculty of Physics, University of Białystok, Lipowa 41, 15-424 Białystok, Poland

[d]Institute of Physics and Centre for Interdisciplinary Nanostructure Science and Technology, University of Kassel, Heinrich-Plett-Strasse 40, D-34132 Kassel, Germany

The generation and controllable movement of a straight domain wall is very interesting for applications in spintronics and information technology (e.g., racetrack memory [1]). We report on aimed manipulation of magnetic structure in sputtered Ti/Au/$(Co/Au)_N$ (t_{Co}= 0.8 nm, t_{Au}= 1 nm, N= 1, 2, 3) multilayers. The magnetic properties of Co layers are characterized by the perpendicular anisotropy and intentionally induced coercive field (H_C) gradient along a given coordinate in the sample plane (dH_C/dx).The value of (dH_C/dx) was determined by a precise change of He^+ (10 keV) ions dose (D) along the x coordinate (dD/dx). We have demonstrated, that in the layered systems with defined (dH_C/dx) the domain wall may by positioned by an appropriate choice of magnetic field. Moreover, using alternating magnetic field with decreasing amplitude a stripe-like structure can be generated.

[1] M. Hayashi et al., Science 320, 209 (2008)

P-5-28

CHARGE AND SPIN SEEBECK EFECTS IN A MULTITERMINAL QUANTUM DOT

Karol Izydor Wysokiński

Institute of Physics, M. Curie-Skłodowska University, ul. Radziszewskiego 10 20-031 Lublin

The system composed of a quantum dot in contact to a superconductor, a ferromagnetic and a normal metal electrodes has been studied. In the limit of infinitely large superconducting gap and weak coupling between the dot and electrodes we investigate the subgap charge and spin transport *via* standard master equation technique. In this system the pure spin current flows in the normal leads under appropriate bias. Here, we are interested in the electrical and spin currents induced by the temperature difference between the electrodes. The currents as well as the corresponding thermopower coefficients have been calculated. Assuming typical values of thermal conductance we have also discussed the charge and spin thermoelectric figures of merit which characterize the efficiency of a device.

P-5-29

MAGNETISM IN DOPED TWO-DIMENSIONAL HONEYCOMB STRUCTURES OF III-V BINARY COMPOUNDS

Krzysztof Zberecki[a]

[a]Faculty of Physics, Warsaw University of Technology, ul. Koszykowa 75
00-662 Warsaw, Poland

Using first-principles plane-wave calculations systematic study of magnetic properties of doped two-dimensional honeycomb structures of III-V binary compounds have been conducted, either for magnetic or nonmagnetic dopants. Calculations show, that in some cases magnetic state is energetically more favorable. For such cases band structure, binding energies, partial density of states, mulliken charges, and electron density were calculated and analyzed in detail. The possible applications of these structures were also discussed.

P-5-30

COMPLEX MAGNETIC BEHAVIOUR OF MnSi THIN FILMS ON THE Si(111) SURFACE

B. Geisler and P. Kratzer

Fakultät für Physik, Universität Duisburg-Essen, Germany

One of the challenges in the field of spintronics is the injection of a spin-polarized electric current into a semiconductor. This can be achieved by combining the semiconducting material with a ferromagnetic one, e. g., by epitaxially growing thin films of a transition metal silicide like MnSi on top of a Si(111) surface.

We perform density functional theory calculations for thin films of MnSi on Si(111) in their ground state crystal structure, the B20 structure.

The missing inversion symmetry of this material and its complex stacking sequence lead to a wide range of possibilities to grow the thin films on the substrate. We focus on the most probable ones and discuss their thermodynamic and magnetic properties, varying thickness, termination and orientation of the layer stack. Although bulk calculations of MnSi indicate a strengthening of ferromagnetism due to the substrate-induced lattice deformations and the resulting lowering of symmetry, antiferromagnetic tendencies can be observed in some of the thin films, which seem to depend on the chosen stacking sequence. In either case, the largest magnetic moments are found close to the interface and the surface. A dense Si termination leads to significantly reduced magnetic moments in the vicinity of the surface.

Furthermore, STM images are calculated to shed some light on the atomic structure behind recently observed experimental STM images.

P-5-31

STRUCTURE DEPENDENT MAGNETIZATION REVERSAL OF NANODOTS

E. Sieczkowska[a], A. Petroutchik[a], L.T. Baczewski[a], P. Mazalski[b], A. Maziewski[b], and A. Wawro[a]

[a]Institute of Physics, Polish Academy of Sciences, Warsaw, Poland.
[b]Faculty of Physics, University of Białystok, Białystok, Poland.

Monodomain structure, stability of magnetization and switching field distribution are the properties of magnetic nanodots that are determined by the dot size and their structure depending on the fabrication methods. In this work we present the influence of the dot structure on magnetization reversal mechanism illustrated by micromagnetic simulations using object oriented micromagnetic framework (OOMMF). Two types of the dots: (i) epitaxial, with a low amount of defects (grown by molecular beam epitaxy) and (ii) defect containing (e.g. post-growth treated by ion bombardment) ones are considered. Investigated objects exhibit a single- or multi-domain stable structure, respectively upon magnetization reversal. In the epitaxial dots studied in this work the reversal magnetization is determined by a reversed domain nucleation followed by unpinned propagation of a domain wall. The simulation results are confirmed by the observations carried out by magnetic force microscopy of the dot system induced in an ultrathin Co film patterned by the structured buffer in the form of self-assembled Au islands on a Mo layer surface.

This work has been done under the project N N507 452134 granted by the Ministry of Science and Higher Education in Poland. Collaboration within the Polish National Scientific Network ARTMAG is acknowledged.

P-5-32

MAGNETICALLY INTERACTING Fe_3O_4-NANOPARTICLES WITHIN POROUS SILICON

P. Granitzer[a], K. Rumpf[a], K. Ali[b], M. Reissner[b], G. Hilscher[b], L. Cabrera[c], M. P. Morales[c], P. Poelt[d], T. Uusimaeki[d], M. Sezen[d], and M. Albu[d]

[a]Institute of Physics, Karl Franzens University Graz, A-8010 Graz, Austria
[b]Institute of Solid State Physics, Vienna Univ. of Technology, A-1040 Vienna, Austria
[c]Instituto de Ciencia de Materials de Madrid, CSIC, Cantoblanco, 28049 Madrid, Spain
[d]Institute for Electron Microscopy, Univ. of Technology Graz, A-8010 Graz, Austria

Mesoporous silicon is used as matrix for infiltration of Fe_3O_4-nanoparticles. The structure and magnetic behaviour of such composites are investigated and a correlation between the morphology of the nanocomposite (structure of the matrices, size and distribution of Fe_3O_4-particles) and the magnetic properties of the system is figured out. This system shows a superparamagnetic (SPM) behaviour at room temperature and becomes ferromagnetic (FM) at lower temperatures. The transition temperature between SPM and a blocked state depends on the particle size, their coating and on their magnetic interactions. The blocking temperature of the composite is tunable and changes due to the variation of dipolar coupling of the Fe_3O_4-particles. To gain deeper information about the stoichiometric homogeneity and spatial distribution, dual electron energy loss spectroscopy is employed. This method provides areal and volumetric densities of each element over the investigated area. Electron tomography is utilized whereas from reconstructions various parameters of the composite morphology can be obtained (size and spatial distribution of the particles and dependence of the local curvature of the pore walls with respect to the preferred docking site). These results together with the magnetic data lead to a more detailed knowledge of the Fe_3O_4/silicon nanocomposite system.

P-5-33
Ni NANOTUBES WITHIN POROUS SILICON

K. Rumpf[a], P. Granitzer[a], K. Ali[b], M. Reissner[b], G. Hilscher[b], P. Poelt[c], and M. Albu[c]

[a]Institute of Physics, Karl Franzens University Graz, A-8010 Graz, Austria
[b]Institute of Solid State Physics, Vienna Univ. of Technology, A-1040 Vienna, Austria
[c]Institute for Electron Microscopy, Univ. of Technology Graz, A-8010 Graz, Austria

Metal-nanostructures are electrodeposited within the pores of porous silicon to achieve a hybrid material with specific magnetic properties. The metal structures can be precipitated with various geometries and different spatial distributions depending on an accurate control of the deposition conditions. Also small Ni-particles (between 3 and 6 nm) can be deposited in a densely packed arrangement on the pore walls forming a quasi metal-tube. Analysis of this tube-like arrangement by TEM shows that the distribution of the Ni-particles is quite narrow, meaning a distance between the particles smaller than 10 nm. Such a close arrangement of particles assures magnetic interactions between them. Due to their size these Ni-particles are superparamagnetic but dipolar coupling between them results in a ferromagnetic behaviour of the whole system. To investigate the interface in detail EELS is employed, whereas in using multiple linear least square fitting procedure, EELS fine-structure and absolute edge energy information can be added to map the oxygen bounded in different phases (SiOx, metal-oxide). Magnetic measurements show an anisotropy between easy axis and hard axis magnetization corresponding to the behaviour of a metal-tube. This composite is an interesting candidate for integrable magnetic and magneto-optic devices and also for spin-injection from a ferromagnet into silicon.

P-5-34
QUANTUM RELATIVISIC CORBINO EFFECT IN GRAPHENE

Adam Rycerz

Marian Smoluchowski Institute of Physics, Jagiellonian University, Reymonta 4, PL-30059 Kraków, Poland

Electron transport through the Corbino disk in graphene is studied in the presence of uniform magnetic fields. At the Dirac point, we observe conductance oscillations with the flux piercing the disk area $\Phi_{\rm d}$, characterized by the period $\Phi_0 = (2h/e)\ln(R_{\rm o}/R_{\rm i})$, where $R_{\rm o}$ ($R_{\rm i}$) is the outer (inner) disk radius. The oscillations magnitude increase with the radii ratio and exceed 10% of the average conductance for $R_{\rm o}/R_{\rm i} \geq 5$ in the case of the normal Corbino setup, or for $R_{\rm o}/R_{\rm i} \geq 2.2$ in the case of the Andreev-Corbino setup. At a finite but weak doping, the oscillations still appear in a limited range of $|\Phi_{\rm d}| \leq \Phi_{\rm d}^{\rm max}$, away from which the conductance is strongly suppressed. At large dopings and weak fields we identify the crossover to a normal ballistic transport regime.

P-5-35
LATTICE OF ARTIFICIAL MAGNETIC DOMAINS IN Au/Co/Au MULTILAYERS

P. Kuświk[a], A. Ehresmann[b], M. Tekielak[c], B. Szymański[a], I. Sveklo[c], P. Mazalski[c], D. Engel[b], J. Kisielewski[c], D. Lengemann[b], M. Urbaniak[a], C. Schmidt[b], A. Maziewski[c], F. Stobiecki[a]

[a]Institute of Molecular Physics, PAS, M. Smoluchowskiego 17, 60-179 Poznań, Poland
[b]Institute of Physics and Centre for Interdisciplinary Nanostructure Science and Technology, University of Kassel, Heinrich-Plett-Strasse 40, D-34132 Kassel, Germany
[c]Laboratory of Magnetism, Faculty of Physics, University of Białystok, Lipowa 41, 15-424 Białystok, Poland

Currently, much attention is paid to patterned multilayer systems in which there exists a perpendicular magnetic anisotropy. These multilayer structures are interesting because of their potential applications in spintronics devices and in a new generation of magnetic storage media. In this field, the final goal is to fabricate patterns of individually switchable monodomain areas with negligible mutual interactions. It can be realized in Au/Co/Au multilayers by colloidal domain lithography, which is a new technique enabling modification of magnetic patterns on relatively large areas [1]. Connection of an ion irradiation process and colloidal lithography based on self-assembly of polystyrene beads enables magnetic patterning of regularly arranged cylindrical magnetic monodomains with out-of-plane magnetization. These artificial domains are separated from each other and embedded in an easy-plane anisotropy matrix. They form an almost perfect two dimensional hexagonal lattice with submicron periodicity in a continuous and flat layer system.

[1] P. Kuświk et al. Nanotechnology 22, 095302 (2011)

P-5-36
TRANSPORT PROPERTIES OF RIPPLED GRAPHENE

Maciej Zwierzycki

Institute of Molecular Physics P.A.S, Smoluchowskiego 17, 60-179 Poznań, Poland

The interest in graphene, a single plane of carbon atoms forming a honeycomb lattice, is both fundamental and practical. The peculiarity of its electronic structure, consisting near Fermi energy of a massless Dirac fermions, gives rise to the range of novel phenomena like minimal conductivity, Klein paradox, or the anomalous Quantum Hall Effect. At the same time the high (exceeding 10^5 cm^2/Vs) mobility of its carriers which number and character can be controlled either by electric or chemical doping makes graphene a potential candidate for application in ultrafast electronic devices. While it is common to describe graphene as ideally flat plane, there exists both theoretical end experimental evidence that it is most usual to find it in a rippled state. The ripples can be either induced by the substrate or formed spontaneously in suspended graphene. The lateral size of such features ranges between several and tens of nanometers with the height of up to 1 *nm*. It has been suggested that the presence of ripples could be one of the factors ultimately limiting mobility of carriers and that it may be also responsible, by introducing an effective gauge field, for the lack of weak localization observed in certain graphene samples. In the present contribution we theoretically study the transport properties of the rippled graphene starting with the simple case of one dimensional modulation. Using either single-band or the full sp^3 tight-banding Hamiltonians we compare and discuss the importance of two ripple-related mechanisms of scattering: the variation of interatomic distances and hybridization between π and σ bands of graphene.

P-5-37
ISLAND FORMATION AT α- AND β-Co/NOBLE-METAL INTERFACE

A. Walczak, T. Slusarski, A.Lehmann-Szweykowska and G. Kamieniarz

[a] Faculty of Physics, Adam Mickiewicz University
ul.Umultowska 85, 61-614 Poznań (Poland)

¿From various factors accompanying the growth of ultrathin films of α- and β-Co on Au(111) we investigate island formation using first-principle density-functional calculations. Both the empirical data and the numerical calculations indicate that Co thin films, deposited on Au(111), display a tendency to roughening at the interface. The roughening can be both spontaneous and/or stimulated by adequate geometry of the substrate (for instance, stepped wedge structure). As a result, there is observed a significant change of magnetic anisotropy. The main objective of the paper is to estimate the relation between tendency towards the spontaneous island formation and the number of Co monolayers. For a relatively small number of the monolayers (up to 6), deposited on Au, island formation is energetically preferred over the formation of homogeneous atomic films. However, this relation is not straightforward. In general, once a compact Co monolayer is formed, the tendency towards surface roughening is largely suppressed. A similar effect is observed in films capped with Au and Ag. The numerical calculations enable us to identify the driving force responsible for the result.

P-5-38
MANIPULATION OF NANO-OBJECTS BY A FORCE-FEEDBACK HAPTIC INTERFACE

A. Tunyagi[a] O. Ponta[a], I. Burda[a] and Z. Neda[a]

[a]Faculty of Physics, Babes-Bolyai University, 400084 Cluj-Napoca, Romania

In near upcoming we have much to learn about the nano-scale world, including how properties such as mechanical properties, electrical transport, and dynamics are affected by the atomic scale structure of the nano-objects and their interfaces. Nanomanipulation provides exciting insight into these problems by allowing us to probe individual nano-objects with great facility, and to combine property characterization with structural information. Advanced user interfaces will continue to play a critical role in making experiments more transparent to the user, and enabling the scientist to be virtually in the nano-scale world. The current work presents an integration of a force-feedback haptic interface SPIDAR (SPace Interface Devices for Artificial Reality) with its controller, a Scanning Probe Microscope (SPM) and a PC with high graphic facilities. This setup allows the scientist to be immersed in real time in the nano-scale world. The benefits of this are: improved perception of 3D structures, more effective exploration of the sample, the ability to observe dynamic processes in near real time, and the ability to interactively modify the surface.

P-5-39

TIME CORRELATION AND CROSS-CORRELATION OF CONDUCTANCE IN ATOMIC QUANTUM POINT CONTACTS

D. Tomaszewski,[a,b] Sz. Mackowiak,[a,b] A. Halbritter,[c] P. Makk,[c] Sz. Csonka,[c] M. Wawrzyniak[d] and J. Martinek[a]

[a]Institute of Molecular Physics, Polish Academy of Sciences, 60-179 Poznań, Poland
[b] Institute of Physics, Poznań University of Technology, 60-965 Poznań, Poland
[c]Department of Physics, Budapest Univ. of Technology and Economics, Condensed Matter Research Group, Hungarian Academy of Sciences, 1111 Budapest, Hungary
[d] Faculty of Electronics and Telecom., Poznań Univ. of Technology, Poznań, Poland

We present an innovative statistical methods for the study of stable atomic configurations in breaking nanowires. They are based on the 2D cross-correlation histogram analysis of conductance versus electrode separation traces, which is analogical to 2D correlation spectroscopy in magnetic resonance. This method can resolve conductance quantization in some transition metal nanojunctions up to high conductance values. A very regular atomic narrowing can be identified during the rupture of Ni, Fe, and V nanowires, which is absent in the majority of the metals. [1] By analyzing conductance traces as a function of time we can see some memory effects in the system. Time correlations can be found between conductance values of stable atomic configurations between different traces. We introduce effective way to describe them quantitatively.

[1] A. Halbritter, P. Makk, Sz. Mackowiak, Sz. Csonka, M. Wawrzyniak, and J. Martinek, Phys. Rev. Lett **105**, 266805 (2010).

P-5-40

AB INITO CALCULATIONS OF ELECTRON TRANSPORT THROUGH SHORT Au WIRES WITH Ag SUBSTITUTIONAL IMPURITIES

M. Wawrzyniak-Adamczewska and T. Kostyrko

Faculty of Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland

We use a density functional theory (DFT) approach, as implemented in TRANSIESTA package, to calculate electron transport properties of linear gold wires with silver impurities. The wires are attached to two identical bulk gold electrodes with either Au(111) or Au(100) surfaces. We focus our analysis on the dependence of the transmission on the impurity position in the wire. The analysis shows well pronounced transmission oscillations if the wire consists of odd number of atoms. The transmission is enhanced if the impurity occupies even site in the wire, while it is damped for odd sites. These kind of oscillations are suppressed for wires consisting of even numbers of atoms. The result shows that oscillatory behaviour does not depend on surface type. Our *ab initio* findings are explained analytically with the help of a tight-binding model calculations.

P-5-41
PHYSICAL PROPERTIES WAX BASED MAGNETIC FLUID-MODEL FOR MOLTEN ROCKS

S. Molokac[a], P. Rybar[a], M. Rybarova[a], L. Domoracka[a], D. Domoracky[a], J. Kovac[b], P. Kopcansky[b], M. Timko[b]

[a]Faculty of Mining, Ecology, Process Control and Geotechnology, TU Kosice, Letna 9, 042 00 Kosice, Slovakia

[b]Institute of Experimental Physics, SAS, Watsonova 47, 040 01 Kosice, Slovakia

It was shown that one of main advantages of wax based magnetic fluid is big interactive variation of density and viscosity due to changes of temperature and external magnetic fields. These properties allow using this magnetic fluid in simulation the injection of molten rocks into cracks in the order of temperatures lower than the temperature of molten rocks. The paper presents results of magnetization and viscosity measurements bellow and above molten temperature of wax. The failures of rock mass was replaced by a 3D model made from transparent material with defined geometry and the melt is modeled by a wax based magnetic fluid with viscosity comparable to that of molten rock in temperature range up to 1600 K. The visualization was carried out by thermo vision camera. The experimental results showed that wax based magnetic fluid fulfilled the requirements of interactive media for replacement of molten rock and acts as the suitable model fluid for verifying the results of CFD simulation (Computational Fluid Dynamics) over the experiments in the melt pushed into cracks in the infinite and limited lateral ranges.

P-5-42
THE INFLUENCE OF MORPHOLOGY ON MAGNETIC PROPERTIES OF MAGNETOSOMES

A. Hashim[a], M. Molcan[a], J. Kovac[a], H. Gojzewski[b], P. Kopcansky[a], Z. Tomori[a], M. Timko[a]

[a]Institute of Experimental Physics, SAS, Watsonova 47, 040 01 Kosice, Slovakia

[b]Institute of Physics, Poznan University of Technology, Nieszawska 13A, 60-965 Poznan, Poland

Magnetosomes are bacterial magnetic nanoparticles containing iron mineral magnetite (Fe_3O_4) or greigite (Fe_3S_4). These are small in size (20100 nm) disperse very well because they are covered with a stable biological membrane – a lipid bilayer admixed with proteins. In our experiment magnetosomes were synthesized by magnetotactic bacteria Magnetospirillum Magnetotacticum sp. AMB-1 in laboratory conditions. These bacteria produce magnetite (Fe_3O_4) bacterial nanoparticles. The cultivation process for this bacterium AMB-1 was changed. The culture medium was enriched by more amounts feric quinate (FQ magnetosomes sample) and more amount Wolfe's vitamin solution (WVS magnetosomes sample) comparing to normal culture medium (NS magnetosomes sample). The changes of cultivation process do not influence on magnetic properties of isolated magnetosomes. Soft increase of saturation moment for sample FQ to value 0,23 emu/g with compare 0,21 emu/g and 0,20 emu/g for sample WVS and NS to connect with enhancement size of magnetosomes in this sample (FQ). Soft increase of coercivity we can observe for the same sample FQ to value 4 Oe and 14 Oe for sample WVS and NS. The low values for coercivity connect with the fact that magnetosomes are still single-magnetic domain particles.

P-5-43

MAGNETIC ANISOTROPY OF ELECTRIC CONDUCTIVITY IN TRANSFORMER OIL BASED MAGNETIC FLUIDS

M. Molcan[a], P. Kopcansky[a], K. Marton[b], L. Tomco[c], S. Molokac[d], M. Timko[a]

[a]Institute of Experimental Physics, SAS, Watsonova 47, 040 01 Kosice, Slovakia
[b]Faculty of Electrical Engineering and Informatics Technical University in Kosice, 042 00 Kosice, Slovakia
[c]Faculty of Areonautic, Technical University in Kosice, 041 21 Kosice, Slovakia
[d]Faculty of Mining, Ecology, Process Control and Geotechnology, TU Kosice, Letna 9, 042 00 Kosice, Slovakia

It is well known that as a consequence of dipole - dipole interaction between magnetic particles in magnetic fluids, magnetic particles tend to attract the neighboring particles in the direction of the magnetic moment. It is expected, therefore, that the magnetic particles will form chains and chain like elongated clusters in which the particles are connected magnetically. Such structural configurations of particles result in many physical properties of magnetic fluids i.e. magnetomechanical effects, magnetooptical effects, magneto-dielectric behavior and so on. Four samples of the transformer oil (UTR40) based magnetic fluids with particles of ferrite type $FeO.Fe_2O_3$ prepared by coprecipitation method were studied. The specific conductivity of the prepared samples of different volume concentration of magnetite nanoparticles (MF1 – 0.0162, MF2 – 0.0215, MF3 – 0.0299 and MF4 – 0.03) at different orientations of electric and magnetic field was measured. Electric dipole moments are induced in electric field. The increasing of electric field increases electric dipoledipole interaction between particles and supports their agglomeration. The used volume concentration of magnete nanoparticles is sufficient to cause their aggregation. The decrease of permittivity and electrical conductivity for perpendicular and increase for longitudal mutual orientation of magnetic and electric fields was observed. This effect is known as the magnetodielectric effect. The character of this effect was similar for all concentrations.

P-5-44

POROUS NANOSTRUCTURE OF HEMATITE AND MAGNETITE

P. P. Demchenko[a,b], A. Ślawska-Waniewska[a], N. Nedelko[a], I. I. Syvorotka[c], L. O. Vasylechko[b], O. V. Bogucky[b]

[a]Institute of Physics, Polish Academy of Sciences, Al. Lotnikow 32/46 PL02668, Warsaw, Poland
[b]Lviv Polytechnic National University, 12, Bandera St., Lviv, 79013, Ukraine
[c]R&D Institute for Materials, SRC Carat, 202, Stryjska St., Lviv, 79031, Ukraine

The synergy of magnetic properties and exceptional characteristics of materials with large surface-to-volume ratio opens new possibilities for specific applications. Herein we report the synthesis of two phase nanoporous structures of α- and γ-Fe_2O_3 phases. Hematite is widely used in catalysis, photo-catalysis and sensors but the magnetic properties of hematite are unsatisfactory as it is a canted antiferromagnet with a very low saturation magnetization. In turn maghemite has a relatively low adsorption capability but displays relatively large magnetization and can be applied to magnetic separation in diverse applications. Synthesis of nanoporous materials composed of maghemite and hematite phases can thus lead to a material which combines good magnetic properties with high ability for adsorption, catalysis and photocatalysis that may find diverse applications in biomedicine, biotechnology and water treatment. In this work the microstructure and magnetic properties of hematite-magnetite composites will be presented and discussed in the context of synthesis method and post-preparation treatment.

O-6-01

MÖSSBAUER STUDY OF MAGNETIC PROPERTIES OF $Fe_{80-x}Co_xZr_7Si_{13}$ (x = 0 – 30 at.%) BORON-FREE AMORPHOUS ALLOYS

M. Kopcewicz, A. Grabias, J. Latuch[a]

Institute of Electronic Materials Technology, Wlczyska 133, Warszawa, Poland,
[a]Faculty of Materials Science and Engineering, Warsaw University of Technology, Wooska 141, Warszawa, Poland

Amorphous $Fe_{80-x}Co_xZr_7Si_{13}$ (x = 0 – 30 at.%) boron-free alloys in which boron was completely replaced by silicon as a glass forming element have been prepared by melt quenching. Conventional Mössbauer spectroscopy allowed us to estimate the hyperfine fields of the amorphous alloys. Partial substitution of iron by cobalt caused the increase of hyperfine field from about 19.5 T to 27.0 T for x=0 and x=30 alloys, respectively. The specialized rf-Mssbauer technique (the spectra were measured during exposure to the radio-frequency field of 0 to 20 Oe at 61 MHz) permitted us to estimate soft magnetic properties of the alloys. The rf field induced effects (rf-collapse and rf-sidebands) can be observed in the ferromagnetic state only. The rf-collapse, which is very sensitive to the local anisotropy field, was observed for all amorphous FeCoZrSi alloys and revealed that the amorphous alloys studied are magnetically very soft. The rf-sidebands effect, related to magnetostriction, increases with the increase of Co content. In $Fe_{50}Co_{30}Zr_7Si_{13}$ sample the rf field exposure induced partial crystallization that was attributed to mechanical deformations related to high frequency magnetostrictive vibrations induced by the rf field. The rf induced crystallization does not occur in Co-free alloys with smaller magnetostriction. The measurements of the hysteresis loop revealed that coercivity increases for higher Co content.

O-6-04

ORIGIN OF MAGNETIC ANISOTROPY OF $Gd_5Si_2Ge_2$ COMPOUND

R. Szymczak[a], **R. Kolano**[b], **A. Kolano-Burian**[b], **B.Krzymanska**[a], **P. Aleshkevich**[a], **V.P. Dyakonov**[a] **and H. Szymczak**[a]

[a]Institute of Physics, Polish Academy of Sciences, Warszawa, Poland
[b]Institute of Non-Ferrous Metals, Gliwice, Poland

The second-order anisotropy constant K_2 in polycrystalline $Gd_5Si_2Ge_2$ giant magnetocaloric material was measured as a function of temperature by the modified singular point detection technique. Although the structural, electrical, thermal, magnetic and magnetocaloric properties of the $Gd_5Si_2Ge_2$ have been rather well investigated experimentally, magnetic anisotropy of this system is almost unknown. The singularity indicating the anisotropy field was determined analyzing ac susceptibility data taking into account several features of the magnetization curve. The temperature dependence of the anisotropy fields was measured from 4.2 K up to the Curie temperature. The observed relationship between $K_2(T)/K_2(0)$ and magnetization $M(T)/M(0)$ was explained assuming dipolar origin of magnetic anisotropy in $Gd_5Si_2Ge_2$.

This work was financially supported by European Fund for Regional Development (Contract No. UDA–POIG.01.03.01-00-058/08/00).

O-6-05

MAGNETIC HYPERFINE FIELDS OF NANOPERM ALLOYS

M. Miglierini[1,2], J. Kohout[3], A. Lančok[4], K. Šafářová[2]

[1] Slovak University of Technology, Bratislava, Slovakia

[2] Centre for Nanomaterials Research, Palacky University, Olomouc, Czech Republic

[3] Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic

[4] Institute of Inorganic Chemistry of the AS CR, v. v. i., Husinec-Rez, Czech Republic

This contribution aims in characterization of magnetic hyperfine fields of $Fe_{90}Zr_7B_3$ NANOPERM nanocrystalline alloys by local probing techniques such as ^{57}Fe NMR and ^{57}Fe Mössbauer spectrometry as well as by MFM. ^{57}Fe NMR enables to distinguish a broad signal of iron located in a residual amorphous matrix and a narrow one which belongs to Fe in nanograins of the NANOPERM nanocrystalline alloy. The former coincides with the distribution of hyperfine fields obtained from ^{57}Fe Mössbauer spectroscopy. Optimization of the RF power allows discriminating the observed NMR signal of the Fe nanograins located in magnetic domains from that of the nanograins positioned in domain walls. Employing MFM, the appearance of maze-domains where the magnetization is oriented perpendicular to the ribbon plane is observed. Correlating the obtained images with the results of CEMS they are related to the overcoming of demagnetizing effects in these regions by the magnetoelastic energy due to internal stresses introduced during crystallization.

This work was supported by the grants MSM6198959218, 1M6198959201, VEGA 1/0033/10, P204/10/0035, AV0Z40320502, and SK-PL-0013-09.

O-6-06

HIGH-FIELD MAGNETIC BEHAVIOR AND ELECTRONIC STRUCTURE OF MELT-SPUN YCo_2-BASED SYSTEMS

B. Mielniczuk[a], Z. Śniadecki[a], A. Szajek[a], U.K. Rößler[b], E. Kampert[c], B. Idzikowski[a]

[a]Institute of Molecular Physics, PAS, M. Smoluchowskiego 17, 60-179 Poznań, Poland

[b]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

[c]Dresden High Magnetic Field Laboratory (HLD), Helmholtz-Zentrum Dresden Rossendorf, D-01328 Dresden, Germany

The high-field magnetic properties of structurally metastable intermetallic compounds (nanocomposites), melt-spun YCo_2, $Y_{0.9}Nb_{0.1}Co_2$ and $Y_{0.9}Ti_{0.1}Co_2$ have been investigated. Physical properties are reported from x-ray diffraction (XRD), vibrating sample magnetometry (VSM) and pulsed magnetic field measurements. The electronic structure was determined based on full potential density-functional calculations. The samples consist of single, $MgCu_2$-type phase, with changing lattice constants and mean grain size from 25 to 50 nm. The magnetic properties of examined compounds are similar to polycrystalline YCo_2, but the increase of magnetization at lower temperatures and hysteresis loops on M(H) curve shows a ferromagnetic ordering with small coercive fields. The bending of M(H) curve in field of more than 30 T may indicate the onset of a metamagnetic transition to a field-induced high-spin state. By adding Ti or Nb, the magnetization in low magnetic field increases and superposition of two hysteresis loops can be seen at low temperatures. For $Y_{0.9}Ti_{0.1}Co_2$ the calculated value of magnetic moment on Co is 1.1 μ_B/atom, and -0.9 μ_B/atom is induced on Ti atoms, with total magnetic moment value of 1.85 μ_B/f.u. Structural and chemical modifications affect the properties of YCo_2 alloy significantly.

P-6-01

DRIVEN BY STRESS AND MAGNETIC FIELD DOMAIN STRUCTURE OF THE FINITE SIZE MULTIFERROIC WITH ANTIFERROMAGNETIC ORDERING

H. Gomonay[a,b], Ie. Korniienko[a] and V. Loktev[a,b]

[a]National Technical University of Ukraine "KPI",
37 Peremogy Ave., 03056 Kyiv, Ukraine

[b]Bogolyubov Institute for Theoretical Physics NAS of Ukraine,
14-b Metrologichna str., 03143, Kyiv, Ukraine

Macroscopic properties of multiferroics, the systems that show simultaneously two types of ordering, could be controlled by the external fields of different nature. In the present paper we analyze the behavior of multiferroic with antiferromagnetic ordering under the action of the external magnetic and stress fields. Our calculations show that such a combination of fields makes it possible to separate the field influence on the different coexisting order parameters. This, in turn, opens a way to control the domain structure and macroscopic properties (such as elongation, magnetization, polarization, etc) and to produce the states with any desirable types of domains.

Simultaneous application of two fields can also increase susceptibility of the sample to one of the fields. The range of field values in which the system is sensible to the external fields can be controlled by the appropriate choice of the sample shape and corresponding shape-induced "de-" fields (destressing, depolarizing, demagnetizing, etc.).

P-6-02

COMPOSITION STRATIFICATION IN STRAINED EPITAXIAL GARNET FILMS

V. Vishnevskii, A. Nedviga, V. Berzhansky, H. Milyukova, A. Nesteruk, H. Danishevskaya

Taurida National University, V. I. Vernadsky ave. 4, Simferopol, Ukraine, 95007

High-coercive garnet films (GF) can be effectively used in thermo-magnetic recording and creating micro-traps for ultracold neutral atoms such as ^{87}Rb. Because the optimal way to increase coercivity H_c is to make film-substrate lattices mismatch Δa, stresses occurred induce misfit dislocations and the facet GFs morphology is observed. The films non-uniformity can be enlarged technologically to create special types of micro-traps. It is possible due to the composition stratification in the GF; this effect is described in detail in the report. Mainly the films of $(Bi,Lu,Sm)_3(Fe,Ga,Al)_5O_{12}$ composition were investigated, however $(Y,Tm,Gd,Bi)_3(Fe,Ga)_5O_{12}$ and $(Y,Bi)_3(Fe,Ga)_5O_{12}$ systems were analyzed too. They were grown by LPE method on $Gd_3Ga_5O_{12}$ (111)-oriented mono-crystalline substrates and characterized by $\Delta a = 0.074 - 0.103$ $\AA$, $H_c = 100 - 1000$ Oe and Curie temperature $T_c = 50 - 200$ °C. The films chemical composition distribution was investigated on SEM supplied by energy dispersion analysis (EDA). To prevent mistakes conditioned by the EDA penetrating depth (1-2 μm) only the GFs edges were analyzed. Layered films were synthesized. Significant differences in magnetic properties of their sub-layers were obtained. They are conditioned by the non-uniform distribution of garnet-forming elements occurred along the film crystallization front. Different T_c values in them allow to realize separate thermo-recording for creating through and non-through stable domain patterns and micro-traps on different levels above the GFs surface.

P-6-03

THE INFLUENCE OF LENGTH AND TENSILE STRESS ON THE MAGNETIC PROPERTIES OF PRE-TREATED AMORPHOUS FE-BASED WIRES

Semenov A.L., Gavriliuk A.A., Korzun A.Yu., Mokhovikov A.Yu., Morozov I.L.

Irkutsk State University, Irkutsk, Russia

Dynamic magnetic properties of the $F_{75}Si_{10}B_{15}$ amorphous metal wires were studied. Diameter of the wires was 140 microns. The length l of the samples ranged from 0.02 to 0.1 m. The pretreatment of the wires by dc with densities j up to 6.5×10^7 A/m^2 was carried out in air for 2 minutes. Dynamic magnetic parameters were measured by induction method. The frequency of reversal field was varied in the range of $0.5 \div 10$ kHz. Elastic tensile stresses σ in the range of $(4\div130)\times10^6$Pa were applied to the wires in the measurement process. Two clearly defined parts were observed on the curves of the residual induction depending on the length $B_r(l)$. On the first part of the curve the value of B_r increases with augmenting length from 0.02 up to 0.06m. On the second part of the curve the value of B_r is almost independent of the length ($l > 0.06$m). The maximum changes of the magnetic permeability, coercive force and B_r under the influence of σ were observed for the wire with a length less than 0.06 m. This result indicates that the core of the wire goes into single-domain state with increasing lengths of wire more than 0.06 m.

P-6-04

INFLUENCE OF TRANSITION AND RARE EARTH ELEMENTS ON MAGNETIC PROPERTIES OF Fe-Nb-B-M (M=Ni, Ag, Gd, Tb) BULK NANOCRYSTALLINE ALLOYS

G.Ziółkowski[a], A.Chrobak[a], N.Randrianantoandro[b], M.Kądziołka-Gaweł[a] and J.Klimontko[a]

[a]A. Chełkowski Institute of Physics, Silesian University, 40-007 Katowice, Uniwersytecka 4, Poland

[b]Laboratoire de Physique de lEtat Condens, UMR CNRS 6087, Universit du Maine, 72085 Le Mans cedex 9, France

Fe-based nanocrystalline materials exhibit, in a comparison with their crystalline form, unique magnetic properties. In this work we present magnetic properties of the $(Fe_{80}Nb_6B_{14})_{1-x}M_x$ (where M=Ni, Ag, Gd, Tb and x=0.1, 0.2, 0.4) bulk alloys prepared by the use of mould casting technique. The main goal of the work is to study an influence of the alloying additions of transition (Ni,Ag) and rare earth (Gd,Tb) elements on magnetic and structural properties. Magnetic measurements were curried out in the temperature range 2 K - 1100 K and magnetic field up to 7 T. Nanocrystalline character of the prepared alloys was confirmed by the XRD diffraction. Phases identification was curried out with the use of additional Msbauer measurements. It was shown that in the case of the alloy with 10 at. % of Tb the alloying addition causes a significant magnetic hardening. This behaviour occurs for the composition near the compensation point between antiferromagneticaly coupled Fe nad Tb atoms. In the presented paper other magnetic properties in a context of structural changes are widely discussed.

P-6-05

MAGNETIC AND STRUCTURAL PROPERTIES OF $Nd_2Fe_{14}B/\alpha$-Fe NANOCOMPOSITES OBTAINED BY MECHANICAL MILLING AND ANNEALING

S. Gutoiu[a], E. Dorolti[a], O. Isnard[b], I. Chicinas[c], V. Pop[a]

[a]Faculty of Physics, Babes-Bolyai University, 400084 Cluj-Napoca, Romania

[b]Institut Néel, CNRS, University Joseph Fourier de Grenoble, BP 166X, 38042 Grenoble, Cédex 9, France

[c]Materials Sciences and Technology Dept., Technical University of Cluj-Napoca, 103-105 Muncii ave., 400641 Cluj-Napoca, Romania

In exchange nanocomposite magnets, hard and soft phases are coupled via interfacial exchange interactions. The magnetic nanocomposites were obtained by mechanical milling. The structure and microstructure are resolved by two different post milling heat treatments: long time annealing at about 550°C and flash annealing (from 0.5 to 3 minutes) at higher temperature. The structural and magnetic properties of $Nd_2Fe_{14}B/\alpha$-Fe nanocomposite were studied for different soft ratios ranging from 5 to 22 wt% and different type of annealing. The structural modifications of the samples were studied by X-ray diffraction (XRD). The microstructure was checked by XRD and electron microscopy. The stiffness of the soft/hard interphase exchange coupling, the remanent magnetization, the coercive field and the exchange coupling between the hard and the soft grains were deduced from room temperature magnetic measurements, performed in magnetic fields up to 10 T.

P-6-06

STUDY OF THE EXCHANGE COUPLING IN $SmCo_5$/(Fe and Fe-Co) MAGNETIC NANOCOMPOSITES

E. Dorolti[a], O. Isnard[b], A.F. Takács[a], I. Chicinas[c], V. Pop[a]

[a]Faculty of Physics, Babes-Bolyai University, 400084 Cluj-Napoca, Romania

[b]Institut Néel, CNRS, University Joseph Fourier de Grenoble, BP 166X, 38042 Grenoble, Cédex 9, France

[c]Materials Sciences and Technology Dept., Technical University of Cluj-Napoca, 103-105 Muncii ave., 400641 Cluj-Napoca, Romania

Hard magnetic soft/hard nanocomposites have the benefit of the strong coercivity from the hard magnetic phase and the high magnetization given by the soft phase. Mechanical milling is an appropriate technique to produce hard/soft composite. The structure and microstructure are resolved by the post milling annealing. We used two different soft magnetic phases, iron and $Fe_{65}Co_{35}$ alloy respectively, in combination with $SmCo_5$ hard magnetic phase. We present a systematic research of the influence of milling and annealing conditions on the structural and magnetic properties in the composite. One of the major points of our research consists in the study of the crystallite dimension evolution vs. synthesis. The structural modifications of the samples were investigated by X-ray diffraction (XRD). The microstructure was checked by XRD and electron microscopy. The stiffness of the soft/hard interphase exchange coupling, the remanent magnetisation and the coercive field were deduced from hysteresis curves, performed in magnetic fields up to 10 Tesla at 300 K.

P-6-07

HIGH TEMPERATURE MAGNETIC PROPERTIES OF $(Sn_{1-x}Pb_x)_2P_2S_6$ CHALCOGENIDES

S. Ilkovič[a], M. Reiffers[a], V. Šebeň[a], K. Šterbáková[a], V. Burger[a], L. Parma[a], O. Čobal[b], I. Rizak[c], V. Rizak[b]

[a]Faculty of Sciences, University of Prešov, 17.novembra, SK-080 78 Prešov, Slovakia

[b]Uzgorod national university, Uzhgorod, Ukraine

[c] National aerocosmic university - KHAI, Kharkiv, Ukraine

In this contribution we present the results of study of high temperature magnetic properties (50 - 400 K) of the chalcogenides $(Sn_{1-x}Pb_x)_2P_2S_6$ where Pb content varies from 0 till 0.6. We have studied the Pb influence on the phase transition at about 335 K. Pb causes its shift towards to lower temperatures. Magnetic field till 3 T has no influence on this transition to ferroelectric state.

P-6-08

PHASE COMPOSITION AND MAGNETIC PROPERTIES OF NANOPERM THIN FILMS

K. Brzózka[a], P. Sovák[b], T. Szumiata[a], B. Górka[a], K. Hibner[a], M. Gawroński[a]

[a]Department of Physics, Technical University of Radom, Krasickiego 54, 26-600 Radom, Poland

[b]Institute of Physics, P.J. Šafárik University, Park Angelinum 9, 041 54 Košice, Slovakia

Thin films of composition $Fe_{88-x}(Zr,Nb)_7B_5(Y,Mo)_7$ are the subject of investigations. Samples of different thickness belonging to the range $(20 \div 150)$nm were produced by flash evaporation in ultra high vacuum and subsequent deposition onto a liquid nitrogen cooled substrate. The attention is fixed on the influence of Y and Mo substitution on structure and magnetic properties of the samples. The effect of film thickness is also considered. Conversion electron Mssbauer spectroscopy (CEMS) and magnetooptic Kerr effect (MOKE) were used to derive hyperfine parameters and coercive field, respectively. Almost all investigated films were stated to have two-phase structure with α-Fe nanograins embedded in an amorphous matrix. The relative content of the amorphous regions changes from about 40% to 94% and increases with yttrium concentration. A considerable part of that component has a form of paramagnetic doublet with distributed electric quadrupole interactions. It was found that phase structure of the films is correlated with their magnetic properties.

P-6-09

INFLUENCE OF PLASTIC DEFORMATION ON MAGNETIC TRANSITION IN SOFT MAGNETIC AMORPHOUS ALLOYS

J. Miškuf, K. Csach, A. Juríková

Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, 040 01 Košice, Slovakia

The influence of the intensive plastic deformation on the structure of feromagnetic amorphous alloys has been studied by means of thermoanalytical methods. It was shown, that the work of plastic deformation leads to the local heating in thin shear band layer and the dissipation of the energy causes structural changes in the region around these bands. The magnetic properties of these alloys are structural sensitive, therefore the plastic deformation influences the structural sensitive magnetic properties. In the addition, the fractographic observations of fractured surfaces have shown the manifestation of high local heating in the shear bands volume and the influence the mechanism of failure of these materials and the fracture surface morphology.

P-6-10

PREISACH IMAGES OF A SIMPLE MECHANICAL SYSTEM

M.W. Gutowski[a], Amy Chyao[b], and S. Markovskyi[a]

[a]Institute of Physics, Polish Academy of Sciences, Warszawa, Poland

[b]student, Plano East Senior High School, Plano, Texas, USA

This work is an an early stage of a larger project aiming at answering the question whether or not the Preisach map is really fingerprinting magnetic materials. More precisely, we are interested if Preisach model of magnetic hysteresis indeed contains any physics or is just a convenient modeling tool. To this extent we present a very simple mechanical system, thus fully tractable, subjected to the influence of an external force. Despite its simplicity, our model simulates nicely all the fundamental features of real magnetic materials, namely their hysteretic behavior, coercivity, remanent magnetization and saturation at high fields. Both the overall shape of major hysteresis loop as well as First Order Reversal Curves (FORC's) are reproduced quite correctly; they are very similar to those observed in modern hard magnetic materials. It is also possible to simulate convincingly the shape of hysteresis loops for soft (nanocrystalline or amorphous) materials but not their FORC's. The model essentially consists of a single, spring loaded, rigid and rotative bar with non-zero friction torque. The length of a projection of this bar onto the direction of an external force is identified with magnetization. The friction torque and the spring constant are the only freely adjustable parameters of our model. Here we investigate, and present, their influence on the inferred Preisach maps. Further work, including single and two interacting Stoner-Wohlfarth's particles, is in progress.

P-6-11
MAGNETO-OPTICAL INVESTIGATION OF DOMAIN WALL MOTION IN AMORPHOUS MAGNETIC MICROWIRES

A. Chizhik, A. Zhukov and J. Gonzalez
Universidad del Pas Vasco, San Sebastian, Spain

The intensive studies of magnetic properties of nearly zero magnetostriction Co-rich glass covered microwires are performed in relation with the giant magnetoimpedance (GMI) effect because the GMI effect is of great interest in sensor application. The origin of the GMI effect is related with the penetration depth of the skin effect. Consequently, the magneto-optical Kerr effect (MOKE) investigation on the magnetization reversal in the surface areas of such type of microwires become a particular importance for the GMI sensor application. The MOKE experiments have been directed to the study of the surface circular magnetic domain structure in the crossed circular-axial magnetic fields. This experimental field configuration has been chosen following the field configuration of GMI effect. The domain wall motion has been investigated by the MOKE modified Sixtus-Tonks method. It was found that the pulse-shape circular magnetic field induces the single circular domain wall motion along the microwire. The velocity of the circular domain wall could reach the value of about 2.5 km/cek. The bias axial magnetic field could accelerate or decelerate the domain wall motion. For the first time the axial magnetic field controlled circular domain walls motion has been studied in amorphous microwires. This motion determines basically the transversal susceptibility that in turn is the key parameter influenced on the GMI effect.

P-6-12
MAGNETIC FIELD INDUCED STRUCTURAL TRANSITIONS IN 6CHBT-BASED FRRONEMATIC DROPLETS

N. Tomašovičová[a], M. Timko[a], M. Koneracká[a], V. Závišová[a], J. Jadzyn[b] and P. Kopčanský[a]

[a]Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, 040 01 Košice, Slovakia

[b]Institute of Molecular Physics, Polish Academy of Sciences, 60179 Poznan, Poland

Ferronematics are stable colloidal suspensions of magnetic particles in nematic liquid crystals. The presence of the magnetic particles enhances the magnetic susceptibility of ferronematics, in comparison with pure liquid crystals. In this work the thermotropic liquid crystal 4-(trans-4'-n-hexylcyclohexyl)-isothiocyanato-benzene (6CHBT) was dissolved in phenyl isothiocyanate and doped with spherical magnetic nanoparticles with aim to increase the sensitivity of the liquid crystal on an external magnetic field. The volume concentration of the magnetic particles was 5×10^{-4}. The phase transition temperature from isotropic to nematic phase in the external magnetic field up to 13T was monitored by precise capacitance measurements in the capacitance cells filled with nematic sample as well as with the prepared ferronematic sample. The shift in the temperature about 9°C of the phase transition from isotropic to nematic phase via droplet state at the external magnetic field of 13T was observed in the sample doped with magnetic particles.

P-6-13

INVESTIGATION OF THE MAGNETIZATION REVERSAL PROCESS OF HIGHT REMANENCE $Nd_{10}Fe_{83}Zr_1B_6$ ALLOY IN THE AS-CAST STATE

A.E.Ceglarek, D. Płusa, M. Dośpiał, M. Nabiałek, P. Pietrusiewicz
Institute of Physics
Czestochowa University of Technology
Al. Armii Krajowej 19, 42-200 Częstochowa, Poland

In this work the $Nd_{10}Fe_{83}Zr_1B_6$ alloy in the form of ribbons obtained using the melt-spinning method was studied. On the basis of X-ray diffraction patterns the phase composition was determined. It was found, that investigated alloy was composed from α-Fe and 2/14/1 phases. Using the Bragg equation the moderate grain sizes and peak broadening originating from strain was evaluated. The moderate grain size of α-Fe and 2/14/1 phases was lesser then 20nm and 40nm, respectively. The magnetic measurements were performed using VSM with maximum applied magnetic field up to 2T. The magnetization reversal process was studied by measurement of recoil curves, which were used to determine reversible and irreversible parts of magnetization. On the basis of irreversible magnetization changes and its differential susceptibility it was found that the pinning of domain walls on structural defects and grain boundaries is the main magnetization reversal process. Further studies of interactions between grains was determined from δm plots. It was found that short range exchange interaction between grains of hard and soft phases are dominant and results in enhancement of remanence.

P-6-14

THE INVESTIGATION OF THE MAGNETIZATION REVERSAL MECHANISM IN THE Nd-Fe-B TYPE MAGNET, ALIGNED BY HOT DEFORMATION

M. Dośpiał[1],M. Nabiałek[1], M. Szota[2], W. Lipiec[3], V. I. Nizhankovskii[4], A.E. Ceglarek[1], P. Pietrusiewicz[1]
[1]Institute of Physics,[2]Institute of Materials Science, Czestochowa University of Technology, Al. Armii Krajowej 19, 42-200 Częstochowa, Poland
[3]Electrotechnical Institute, ul. M. Skłodowskiej-Curie 55/61, 50-369 Wrocław, Poland
[4]International Laboratory of High Magnetic Fields and Low Temperatures, ul. Gajowicka 95, 53-421 Wrocław, Poland

The magnetization reversal mechanism in the $Nd_{16}Fe_{78}B_6$ hot densified magnet, aligned by means of die-upset forging have been investigated. The magnetic parameters have been derived from major hysteresis loop. The magneto-crystalline anisotropy constants K_1 and K_2 using Sucksmith-Thompson relation modified by Ram and Gaunt have been calculated from the high field measurements up to 5T. These data have been used to determine the theoretical value of coercivity as a function of the angle Ψ_0 between the sample easy axis and the applied magnetic field direction. The experimental value of coercivity as a function of Ψ_0 has been determined from the demagnetization curves measured for different angles Ψ_0. It was found that the best correlation between theoretical and experimental data have been achieved for magnetization reversal mechanism controlled partially by pining of domain walls on grain boundaries and nucleation processes.

P-6-15

THE STRUCTURE AND THERMAL STABILITY OF $Fe_{61}Co_{10}Y_8Me_1B_{20}$ (Me = Nb, Zr, W) AMORPHOUS RIBBONS

M. Nabialek[a], P. Pietrusiewicz[a], M. Dospial[a], M. Szota[b], P. Bragiel[c], A. E. Ceglarek[a]

[a]Institute of Physics, [b]Institute of Materials Science, Czestochowa University of Technology, Al. Armii Krajowej 19, 42-200 Czestochowa, Poland

[c]Institute of Physics, Jan Dlugosz University, 42-200 Czestochowa, Al. Armii Krajowej 13/15, Poland

$Fe_{61}Co_{10}Y_8Me_1B_{20}$ (Me = Nb, Zr, W) amorphous alloys were produced by rapid quenching on rotating copper wheel. Structure of samples in the as-cast state was examined using X-ray diffractometer (XRD), transmission Mössbauer spectroscope and scanning electron microscopy (SEM). On the basis of performed measurements, it was found that all investigated samples were amorphous trough their volume. Investigation of the thermal stability of amorphous alloys was studied using differential scanning calorimeter (DSC). These measurements showed that addition of one percent of transition metal to alloy composition causes migration of initial crystallization temperature, towards higher temperatures. Thermomagnetic measurements, carried out using the Faraday magnetic weight, showed that performed changes in alloy composition have large impact on Curie temperature, which changes in the range from 545 to 565 K depending on the doped element. The magnetic parameters like coercivity field H_C and saturation of the magnetization M_S were carried out, from the hysteresis loops, using vibrating sample magnetometer (VSM).

P-6-16

INFLUENCE OF ANNEALING ON RELAXATION PROCESSES IN CLASSICAL, AMORPHOUS ALLOYS

P. Pietrusiewicz[a], M. Nabialek[a], M. Dospial[a], M. Szota[b], A. E. Ceglarek[a]

[a]Institute of Physics, Czestochowa University of Technology, Al. Armii Krajowej 19, 42-200 Czestochowa, Poland

[b]Institute of Materials Science, Czestochowa University of Technology, Al. Armii Krajowej 19, 42-200 Czestochowa, Poland

In this work, the influence of annealing on relaxation processes of Fe-based, amorphous alloy, was investigated. Samples in the form of ribbons were produced by rapid quenching of liquid alloy onto rotating, copper wheel. In order to perform the relaxation process the investigated $Fe_{61}Co_{10}Y_8Ni_1B_{20}$ alloys were subjected to annealing at 700 K for 1 h, and then in 770 K for 3,5 h. Structure of the samples was examined by X-ray diffraction measurements (XRD). It was found, that the material in the as-cast state and after thermal treatment was amorphous. The relaxation process in amorphous alloys is connected with conglomeration of structural defects in amorphous materials, which are related with the presence of point an linear defects. Because of absence of direct, analysis method of the structural defects in amorphous alloys, it was necessary to use indirect method (according to the Kronmüller's theory) which involves the analysis of the approach to ferromagnetic saturation.

P-6-17

MAGNETIC PROPERTIES AND PHASE CONSTITUTION OF THE NANOCRYSTALLINE $(Nd_{10}Fe_{67}B_{23})_{100-x}Nb_x$ (where x=1,2,3,4) ALLOY RIBBONS

M. Szwaja, K. Pawlik, J. J. Wysłocki, P. Gębara

Institute of Physics, Częstochowa University of Technology, Al. Armii Krajowej 19, 42-200 Częstochowa, Poland

The magnetic properties and phase constitution of the $(Nd_{10}Fe_{67}B_{23})_{100-x}Nb_x$ (where x=1,2,3,4) alloy ribbons were investigated. The base alloys were prepared by arc-melting under an Ar atmosphere the high purity elements with pre-alloyed Fe-B. The ribbon samples were obtained by controlled atmosphere melt-spinning technique. In order to generate the nanocrystalline microstructure, the ribbon samples were annealed at various temperatures (from 923K to 1023K) for 5min. The aim of present work was to determine the influence of addition of Nb and annealing conditions on the phase constitution and magnetic properties of the ribbon samples. In as-cast state, ribbon samples were fully amorphous and soft magnetic. Subsequent annealing resulted in an evolution of the phase constitution together with change of their magnetic properties.

Work supported by the research projects: No NN 507 372735 in years 2008-2011 by Polish Ministry of Science and Higher Education and No NN 507 240840 in years 2011-2014 financed by National Science Centre.

P-6-18

PHASR CONSTITUTION AND MAGNETOCALORIC PROPERTIES OF THE $LaFe_{11.0}Co_{0.8}Si_{1.1}Ga_{0.1}$

P. Gębara[a], P. Pawlik[a], I. Škorvánek[b], J. Marcin[b], J. J. Wysłocki[a], M. Szwaja[a]

[a]Institute of Physics, Częstochowa University of Technology, Al. Armii Krajowej 19, 42-200 Częstochowa, Poland

[b]Institute of Experimental Physics, SAS Watsonowa 47 043 33 Kosice, Slovakia

Phase constitution and magnetocaloric properties of the $LaFe_{11.0}Co_{0.8}Si_{1.1}Ga_{0.1}$ alloy ribbons were investigated. Sample was obtained by arc - melting followed by melt - spinning to ribbon. All process was carried out under the low pressure Ar atmosphere. Subsequently the ribbon samples were annealed at 1323K for 24 hours. X-ray diffraction studies carried out on annealed samples and revealed coexistence two crystalline phases: dominant cubic $NaZn_{13}$ - type and minor bcc α-Fe phase. Furthermore, the magnetic measurements at various temperatures allowed to study the magnetic entropy changes for investigated samples.

Work supported by the research project No. NN 507 233 040 in years 2011 - 2014 financed by National Science Centre.

P-6-19

HEAT CAPACITY OF AMORPHOUS $Y_xCe_{50-x}Cu_{42}Al_8$ ($0 \leq x \leq 50$) ALLOYS

Z. Śniadecki[a], Š. Máťošová[b], M. Reiffers[b,c], B. Idzikowski[a]

[a]Institute of Molecular Physics, Polish Academy of Sciences,
M. Smoluchowskiego 17, 60-179 Poznań, Poland

[b]Institute of Exp. Physics, Slovak Academy of Sciences,
Watsonova 47, 040 01 Kosice, Slovakia

[c]Faculty of Sciences, University of Prešov, 17. novembra, SK-080 78 Prešov, Slovakia

Heat capacity results for as-quenched $Y_xCe_{50-x}Cu_{42}Al_8$ ($0 \leq x \leq 50$) amorphous alloys in the temperature range 1.7–200 K are presented to discuss Y-Ce substitution effect. Samples in the shape of ribbons were synthesized by a single-roller rapid quenching technique in argon atmosphere. The $Y_xCe_{50-x}Cu_{42}Al_8$ alloys exhibit a significant glass forming ability. There is also the evidence of paramagnetic/superparamagnetic behavior with the ordering of Ce moments (for samples with $0 \leq x \leq 40$) even at low temperatures. The effective magnetic moment of Ce decreases with increasing Y content. The main aim of the study reported here is the determination of specific heat and the influence of Y by Ce substitution effect on the effective Sommerfeld coefficient γ_{eff}. While there is no long range ordering in investigated amorphous alloys, the properties may vary between each composition due to the differences in short range order but also as a consequence of the magnetic ordering of Ce ions. With increasing applied magnetic field the Schottky type maximum appears, which moves to higher temperatures with magnetic field increasing up to 9 T as usually connected with crystal field splitting. There is a significant low temperature upturn in $CT^{-1}(T^2)$ dependence, which is more intense for $Ce_{50}Cu_{42}Al_8$ alloy. The low temperature extrapolation of $CT^{-1}(T^2)$ yields close to 1.2 J/molK^2, which is similar to other heavy fermion Ce-compounds e.g. $CeCu_4Al$ [1]. The magnitude of this upturn depends strongly on the composition and vanishes for $Y_{50}Cu_{42}Al_8$ alloy which possess no magnetic ions. Electronic heat capacity coefficient γ_{eff} increases with the substitution of Y by Ce atoms, which implies that the alloys with Ce content $x > 20$ have the tendency to a heavy fermion behaviour due to increasing hybridisation effect of Ce 4f-electrons.

[1] M. Reiffers et al., Acta Phys. Pol. **113** (2008) 423

P-6-20

GLASS FORMING RANGES IN Y-Cu-Al TERNARY SYSTEM CALCULATED USING SEMI-EMPIRICAL MODELS

Z. Śniadecki, J. W. Narojczyk, B. Idzikowski

Institute of Molecular Physics, Polish Academy of Sciences, M. Smoluchowskiego 17,
60-179 Poznań, Poland

A method based on the semi-empirical Miedema's and geometric model was used to calculate the glass forming ranges and glass forming abilities (GFA) in Y-Cu-Al ternary sytem and its sub-binaries. The formation enthalpies of amorphous alloys, of their crystalline (solid solution) counterparts and the difference between both energies were calculated indicating compositions close to Y-Al and Y-Cu sub-binaries as those with the highest GFA. From the normalized entropy change $\frac{S_\sigma}{k_B}$, the highest GFA was also predicted for sub-binaries close to Y-Cu. In both cases Y atoms play an important role, due to their significant atomic radius and highly negative interfacial enthalpies with other constituents. The ΔP_{HS} parameter, which takes into account both, the enthalpy and entropy changes, indicates the range with highest GFA in the region of $Y_{40}Cu_{31}Al_{29}$ alloy. The calculated results are in well agreement with experimental and other theoretical results.

P-6-21

STRUCTURAL AND THERMAL PROPERTIES OF AMORPHOUS $Gd_{65}Fe_{20-y}Co_yAl_{10}X_5$ (X = Si, B, Al) ALLOYS

Z. Śniadecki[a], S. Pączek[b], B. Idzikowski[a], J. Marcin[c], J. Kováč[c], I. Škorvánek[c]

[a]Institute of Molecular Physics, Polish Academy of Sciences, M. Smoluchowskiego 17, 60-179 Poznań, Poland

[b]Faculty of Applied Physics and Mathematics, Technical University of Gdańsk, Narutowicza 11/12, 80-952 Gdańsk, Poland

[c]Institute of Exp. Physics, Slovak Academy of Sciences, Watsonova 47, 040 01 Kosice, Slovakia

GdFeAl-based amorphous or nanocrystalline alloys are subject of extensive investigations because of their promising application as new magnetic refrigerants. Amorphous $Gd_{65}Fe_{20-y}Co_yAl_{10}Si_5$ (y = 5, 10, 15), $Gd_{65}Fe_{10}Co_{10}Al_{10}B_5$ and $Gd_{65}Fe_{10}Co_{10}Al_{15}$ ribbons were prepared by melt-spinning method. The structural and thermal properties were investigated using X-ray diffraction (XRD) and differential scanning calorimetry (DSC). The XRD analysis revealed that as-quenched Gd-Fe-Co-Al-X (X = Si ,B, Al) alloys possess amorphous structure. Two distinct diffuse diffraction peaks are visible. For some compositions additional peaks belonging to *hcp*-Gd grains are present, similarly as reported recently for Gd-Al-Mn system [1]. DSC curves were collected at different constant heating rates from 10 to 50 K/min. Crystallization temperatures T_x of Gd-Fe-Co-Al-X samples range from 290 to 340^{0}C. Activation energies of crystallization E_a were calculated from the Kissinger relation. The thermal stability of amorphous phase was found to be highest for $Gd_{65}Fe_{10}Co_{10}Al_{15}$ alloy where E_a reaches 345±20 kJ/mol.

[1] S. Gorsse, B. Chevalier, G. Orveillon, Appl. Phys. Lett. **92** (2008) 122501

P-6-22

MAGNETIC EVIDENCE OF SHOCK-INDUCED MICROSTRUCTURAL MODIFICATIONS IN THE MORASKO-POLAND METEORITE

B. Idzikowski[1], J. Kováč[2], P. Diko[2], W.T.J. Stankowski[3] and A. Muszyski[3]

[1]Institute of Molecular Physics, Polish Academy of Sciences, M. Smoluchowskiego 17, 60-179 Poznań, Poland

[2]Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, 040 01 Košice, Slovak Republic

[3]Institute of Geology, Adam Mickiewicz University, Dzięgielowa 27, 61-680 Poznań, Poland

The Morasko meteorite is composed of an (Fe, Ni)-alloy (about 98 wt.%) and of FeS nodules (about 2 wt.%). Shock-induced metamorphism resulting from hypervelocity impacts strongly depends on the shock conditions, especially pressure and temperature. Some dislocations and twins as evidence of plastic deformation were found in different pieces of the Morasko-Poland meteorite. The iron-nickel alloys smithereens extracted from this cosmic material were investigated by optical metallographic techniques to separate shocked and impact-unchanged parts. Differences in the shape of magnetization versus temperature lines for those two samples are clearly related to structural modifications introduced during the impact. The influence of laboratory furnace temperature-induced shocks introduced by short annealings at 1200^{0}C on impact-unchanged parts of the meteoritic material on its microstructure and magnetic behavior is discussed. Laboratory and natural shocks do not share exactly identical characteristics; in particular, it concerns the shock temperature and its duration. Therefore, the laboratory annealing represented a test of the influence of the shock metamorphism on the textural evolution, magnetism and other processes in meteoritic materials.

P-6-23

THERMOMAGNETIC AND CALORIMETRIC PHASE TRANSITIONS EVIDENCE IN AMORPHOUS $Fe_{81}Zr_7B_{12}$ AND $Fe_{61}Ni_{20}Zr_7B_{12}$ RIBBONS

Z. Śniadecki[1], J. Kováč[2], S.A. Kostyrya[1], and B. Idzikowski[1]

[1]Institute of Molecular Physics, Polish Academy of Sciences
M. Smoluchowskiego 17, 60-179 Poznań, Poland

[2]Institute of Experimental Physics, Slovak Academy of Sciences,
Watsonova 47, Košice, Slovakia

Comparison of magnetic phase transitions temperatures of $Fe_{81}Zr_7B_{12}$ and $Fe_{61}Ni_{20}Zr_7B_{12}$ alloys measured with two different methods was the aim of the present work. The alloys were produced by a melt spinning technique. They have been studied in the glassy state by VSM measurements as a function of temperature. The results were compared with the differential scanning calorimetry (DSC) traces and supported by XRD phase analysis. The x=0 ribbon has been heated continuously at a pace of 10 K/min up to 800^0C and that with x=60 at a pace of 50 K/min up to 750^0C. For the first alloy with x=0 at about 550^0C, the onset of the crystallization process observed through thermomagnetic measurements and differential scanning calorimetry. The XRD investigation of isothermally treated $Fe_{61}Ni_{20}Zr_7B_{12}$ ribbons has indicated a formation of a bcc structure at 520^0C and that of fcc-(Fe, Ni) + borides at 700^0C. The unit cell length for the fcc structure amounts to 3.578 Å and for bcc - 2.876 Å (as calculated from the (311) and (211) lines, respectively). For the $Fe_{61}Ni_{20}Zr_7B_{12}$ alloy one could notice that a cooling subsequent to the crystallization has led to magnetization of about zero at room temperature.

O-7-03

MAGNETIC FIELD SENSING PROPERTIES OF TUNNEL MAGNETORESISTANCE DEVICES WITH PERPENDICULAR ANISOTROPY

P. Wiśniowski[a], J. Wrona[a], W. Skowroński[a], T. Stobiecki[a], S. Cardoso[b] and P. P. Freitas[b]

[a]Department of Electronics, AGH University of Science and Technology
al. Mickiewicza 30, 30-059 Kraków, Poland
[b]INESC-MN and IN-Institute of Nanoscience and Nanotechnology
Rua Alves Redol, 9-1, 1000-029 Lisbon, Portugal

Sensing characteristics; sensitivity, nonlinearity and hysteresis of exchange biased tunnel magnetoresistance (TMR) devices with out-of-plane magnetization in CoFeB sensing layer were studied. The perpendicular magnetization of the layer was achieved by thinning CoFeB. The devices show bipolar and unipolar resistance versus magnetic field curves for magnetic field applied in-plane and out-of-plane, respectively. For both field configurations devices with hysteresis below 1% of the full scale (FS) and linearity below 1% FS were demonstrated. The sensing characteristics of the devices depend on CoFeB electrodes thickness. The sensitivity and hysteresis increase with increasing CoFeB electrode thickness. The TMR devices with perpendicular anisotropy show potential for sensing magnetic field with good linearity, ultra low hysteresis and variable sensing range. **Acknowledgments:** This work was supported by National Science Centre grant. WS thanks the Foundation for Polish Science MPD Programme cofinanced by the EU European Regional Development Fund. We thank Singulus Technologies AG for samples deposition.

P-7-01

THE SCANER OF MAGNETIC INHOMOGENEITIES BASED ON SUBMICRON YIG FILM

V.F. Shkar[a] I.G. Salkov[b]

[a]Donetsk Physicotechnical Institute, National Academy of Science of Ukraine,
Donetsk, 83114 Ukraine
[b]Donetsk National University, Donetsk, Ukraine

As it's known from the theory, dependence of polar angle of magnetisation of an one-domain film on a normal magnetic field for its some directions there are local minima. For a film in a vortical state [1] presence of these minima (as the special case) leads to absorption of high-frequency energy in a zero magnetic field [2]. It gives the possibility to construct the probe for the magnetic field scanner which allows to measure the magnetic field distribution from the micron dimensions objects.
Now magnetisation distributions with about 1 microns resolution are obtained. The further improvement of the probe construction will give the possibility to scan domain wall and magnetic vortexes.

[1] V.F. Shkar and V.N. Varyukhin, Iron-yttrium garnet films with magnetic vortices // JETP Letters Vol. 88, No. 4, P. 271-274, 2008
[2] V.F. Shkar and V.N. Varyukhin, Magnetic resonance and self-sustained oscillations in an iron-yttrium garnet film in a vortex state // JETP Letters Vol. 92, No. 5, P. 338-342, 2010

P-7-02

LARGE MAGNETOCALORIC EFFECT IN $NdNi_4Si$ COMPOUND

M. Falkowski, T. Toliński and A. Kowalczyk

Institute of Molecular Physics Polish Academy of Sciences, 60-179 Poznań, Poland

On the basis of the thermodynamic approach, we report the magnetocaloric properties of the ternary ferromagnetic $NdNi_4Si$ compound with magnetic phase transition temperature T_C at 8 K, the saturated magnetic moment in $H = 9$ T equal $1.5\mu_B$/f.u. at 4.2 K and crystallizing in hexagonal $CaCu_5$-type structure (P6/mmm space group). The magnetocaloric effect was calculated in terms of the isothermal magnetic entropy change ΔS_M as well as the adiabatic temperature change ΔT_{ad} using the heat capacity data. Within the second order phase transition large values of these parameters have been observed.

P-7-03

DC AND AC CHARACTERIZATION OF MAGNETIC FIELD SENSORS WITH ULTRATHIN MAGNESIUM OXIDE TUNNEL BARRIERS

M. Arikan[a], S. Ingvarsson[a], M. Carter[b] and G. Xiao[c]

[a] Science Institute, University of Iceland, Dunhagi 3, Reykjavik IS107, Iceland

[b] Micro Magnetics Inc., 617 Airport Road, Fall River, Massachusetts, 02720, USA

[c] Physics Department, Brown University, Providence, Rhode Island, 02912, USA

We have studied the magnetoimpedance of micron sized magnetic tunnel junction (MTJ) sensors with 1.7 nm magnesium oxide (MgO) tunnel barrier [1]. Both DC and AC properties of the sensors were measured by means of tunneling magnetoresistance (TMR) and AC impedance spectroscopy between 100 Hz and 40 MHz as a function of applied external magnetic in the sensing direction. The results have basic scientific importance and should affect the design of novel sensing devices. Two different kinds of sensor were investigated in this work: Single and multiple-MTJ sensors. In the first case, the sensors included only one tunnel junction. The structure of the magnetic tunnel junctions is as follows [2] (thicknesses in nanometers): Ta(5)/Ru(30)/Ta(5)/$Co_{50}Fe_{50}$(2)/IrMn(15)/ $Co_{50}Fe_{50}$(2)/Ru(0.8)/$Co_{40}Fe_{40}B_{20}$(3)/ MgO(1.7)/$Co_{40}Fe_{40}B_{20}$(3)/Ta(5)/ Ru(10). They were sputter deposited on thermally oxidized Si wafer substrates. Measured DC resistances of the sensors are on the order of 1 kΩ with very high TMR values between 118% and 137%. The samples were also measured by frequency dependent AC impedance spectroscopy. A simple RLC circuit model used to fit the data. The results are in agreement with DC measurements. Contrary to the previous reports in the literature [3, 4], we didn't observe field dependent spin-capacitance despite excellent agreement in other parameters such as interface capacitance. We attribute this discrepancy to the size of our samples and reach a conclusion that limits the applicability of the spin-capacitance concept to large area devices. In the second part of this work, we have measured multiple-MTJ sensors based on the same structure given above [5]. Each sensor had 24 MTJs, connected in series in a serpentine shape. The DC resistances were on the order of 1 to 10 kΩ with TMR values between 89.5% and 140.9%. AC measurements agreed very well with DC results and the data was modeled by using a simple RLC circuit. Unlike the single junction devices, we observed non-zero magnetocapacitance and magnetoinductance besides magnetoresistance. We explain this as a result of the sensor geometry. We show that magnetocapacitance can be used to detect the DC magnetic fields and give the sensitivity of our devices.

[1] S. Ingvarsson et al., *Appl. Phys. Lett.* **96**, 232506 (2010).
[2] X. Liu et al., *Appl. Phys. Lett.* **89**, 023504 (2006).
[3] P. Padhan et al., *Appl. Phys. Lett.* **90**, 142105 (2007).
[4] H. Kaiju et al., *J. Appl. Phys.* **91**, 7430 (2002).
[5] M. Arikan, S. Ingvarsson, M. Carter and G. Xiao, to be submitted.

P-7-04

THERMOGRAVIMETRIC STUDY OF THE DECOMPOSITION OF BSA-COATED MAGNETIC NANOPARTICLES

K. Csach, A. Juríková, J. Miškuf, M. Koneracká, V. Závišová, M. Kubovčíková, and P. Kopčanský

Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, 040 01 Košice, Slovakia

Magnetic nanoparticles used in biomedicine have to be biocompatible, what can be achieved by the modification of the magnetic particle surface with an appropriate biocompatible substance. In the work protein bovine serum albumin (BSA) was chosen to modify the surface of magnetic nanoparticles. The BSA-coated magnetic nanoparticles with different input weight ratios of BSA to the magnetite Fe_3O_4 were prepared and thermally characterized using thermogravimetric analysis. The adsorption of the biocompatible material BSA on magnetic nanoparticles in wide range of concentration was confirmed. The activation energy of thermal decomposition of complex was estimated.

P-7-05

THERMAL ANALYSIS OF MAGNETIC NANOPARTICLES MODIFIED WITH DEXTRAN

A. Juríková, K. Csach, J. Miškuf, M. Koneracká, V. Závišová, M. Kubovčíková and P. Kopčanský

Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, 040 01 Košice, Slovakia

Magnetic fluids are stable colloidal suspensions of magnetic nanoparticles dispersed in a liquid carrier. Due to their magnetic properties and fluidity they offer some attractive possibilities in biomedicine. They can be used as therapeutical agents against wide range of tumours and amyloid-related diseases. In order to be used for biomedical purposes they have to be stable and biocompatible, and so the magnetic nanoparticles are modified by an additional biocompatible substance such as poly(D,L-lactide-co-glycolide) polymer, polyethylene glycol, polysaccharide polymer dextran or bovine serum albumin protein. Thermoanalytical methods - differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA) are very useful tool in the thermal characterization of these complex systems. In the work the thermal behaviour of the magnetic nanoparticles modified with polysaccharide dextran with different weight ratios to the magnetite Fe_3O_4 was investigated using DSC and TGA methods. The adsorption of dextran on magnetic nanoparticles has been confirmed and the influence of the dextran amount in magnetic fluid on the thermal decomposition of dextran has been determined. The results have shown that magnetite catalyses the thermal decomposition of dextran, the adsorbed dextran shows lower initial decomposition temperatures in comparison with the free one.

P-7-06

PHYSICAL PROPERTIES OF $Zr_{50}Cu_{40-x}Al_{10}Pd_x$ BULK GLASSY ALLOYS

M. Wencka[a], J. Dolinšek[b] and Y. Yokoyama[c]

[a]Institute of Molecular Physics, Polish Academy of Sciences, Smoluchowskiego 17, 61-179 Poznań, Poland

[b]J. Stefan Institute, University of Ljubljana, Jamova 39, SI-1000 Ljubljana, Slovenia

[c]Institute for Materials Research, Tohoku University, Katahira 2-1-1, Aobaku, Sendai 980-8577, Japan

We performed a study of the magnetic properties, the specific heat, the electrical resistivity and the hydrogen diffusion constant for a series of compositions $Zr_{50}Cu_{40-x}Al_{10}Pd_x$ (x=0-7 at.%). The compounds are nonmagnetic, conducting alloys, where the Pauli spin susceptibility of the conduction electrons is the only source of paramagnetism. The low-temperature specific heat indicates an enhancement of the conduction-electron effective mass m^* below 5 K, suggesting that the $Zr_{50}Cu_{40-x}Al_{10}Pd_x$ BGAs are not free-electron-like compounds. The electrical resistivities of the $Zr_{50}Cu_{40-x}Al_{10}Pd_x$ BGAs amount to about 200 $\mu\Omega$cm and show a small, negative temperature coefficient with an increase from 300 K to 2 K of 4%. The hydrogen self-diffusion constant D in hydrogen-loaded samples shows classical over-barrier-hopping temperature dependence and is comparable with others such systems.

[1] M. Wencka, M. Jagodič, A. Gradišek, A. Kocjan, Z. Jagličić, P.J. McGuiness, T. Apih, Y. Yokoyama, J. Dolinšek, J. Alloys Compd. 504 (2010), 16-21.

P-7-07

DIELECTRIC PROPERTIES OF POLYMER DISPERSED LIQUID CRYSTAL DOPED WITH MAGNETIC PARTICLES

O.V. Kovalchuk[a,b], Z. Mitróová[c], N. Tomašovičová[c], M. Koneracká[c], V. Závišová[c], M. Timko[c], L. Tomčo[d], J. Jadzyn[e], O.P. Gornitska[a], V.M. Bykov[b], T.M. Kovalchuk[b], I.P. Studenyak[f] and P. Kopčanský[a]

[a]National Aviation University, Cosmonaut Komarov 1, 03058 Kyiv, Ukraine

[b]Institute of Physics, NASU, Prospect Nauky 46, 03028 Kyiv, Ukraine

[c]Institute of Experimental Physics, SAS, Watsonova 47, 040 01 Košice, Slovakia

[d]Faculty of Aeronautics, Technical University, Rampova 7, 04 121 Košice, Slovakia

[e]Institute of Molecular Physics, PAS, M. Smoluchowskiego 17, 60 179 Poznan, Poland

[f]Uzhgorod National University, Pidhirna 46, 88000 Uzhgorod, Ukraine

The large scale study of dispersion of nematic liquid crystal in a polymer matrix (PDLC) began after it was shown that these systems can be used to create electro-optical devices of a new type. The prepared samples consisted of liquid crystal 6CHBT dispersed in polyvinyl alcohol and were doped with spherical or rod-like magnetic particles. Due to doping of PDLC with magnetic particles the significant changes in the effective value of the permitivity were observed in the frequency range 10^{-1} Hz - 10^2 Hz. In this frequency range the conductivity of PDLC has two components: the ion, caused by transfer of ions in liquid crystal and the electron, caused by transfer of electrons inside polymer. The presence magnetic particles in PDLC increases the ion component of the conductivity as well as the electron component of the conductivity.

P-7-08

MAGNETIC-FIELD INDUCED ISOTROPIC-NEMATIC PHASE TRANSITION IN PDLC DOPED WITH MAGNETIC NANOPARTICLES

Z. Mitróová[a], N. Tomašovičová[a], M. Timko[a], M. Koneracká[a], L. Tomčo[b], J. Jadzyn[c], T. Palewski[d] and P. Kopčanský[a]

[a]Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, 040 01 Košice, Slovakia

[b]Faculty of Aeronautics, Technical University, Rampova 7, 04 121 Košice, Slovakia

[c]Institute of Molecular Physics, Polish Academy of Sciences, 60179 Poznan, Poland

[d]International Laboratory of High Magnetic Fields and Low Temperatures, Polish Academy of Sciences, Gajowicka str.95, Wroclaw, Poland

The polymer dispersed liquid crystals (PDLC) are a novel class of optical composites made from polymer and liquid crystal materials in an appropriate ratio. In this work we studied PDLC which consists of liquid crystal 4-(trans-4'-n-hexylcyclohexyl)-isothiocyanatobenzene (6CHBT) microdroplets dispersed in a polyvinyl-alcohol and doped with single waled carbon nanotubes functionalized with Fe_3O_4 nanoparticles (SWCNT/Fe_3O_4). The volume concentration of the particles was 2×10^{-3}. The phase transition temperature from isotropic to nematic phase in the external magnetic field up to 12T was monitored by precise capacitance measurements in the capacitance cells filled with prepared sample. The shift in the temperature about 0.2°C of the phase transition from isotropic to nematic phase at the external magnetic field of 12T was observed.

P-7-09

MAGNETIC PROPERTIES OF BIOCOMPATIBILE MAGNETIC FLUID AFTER ELECTRON IRRADIATION

N. Tomašovičová[a], I. Haysak[b], M. Koneracká[a], J. Kováč[a], M. Timko[a], V. Závišová[a], A. Okunev[b], A. Parlag[b], A. Fradkin[b] and P. Kopčanský[a]

[a]Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, 040 01 Košice, Slovakia

[b]Uzhgorod National University, Kapitulna 9A, 880 00 Uzhgorod, Ukraine

Magnetic fluids for biomedical applications mainly consist of nano sized iron oxide particles Fe_3O_4 or γ-Fe_2O_3 coated with biocompatibile polymer suspended in carrier liquid, usually water at neutral pH or physiological salinity. The radiation stability of biocompatibile magnetic fluids after electron irradiation with electron energy 8MeV was studied. The magnetic particles in the water-based magnetic fluids were sterically stabilized by natrium oleate to prevent their agglomeration and consequently the adsorption of poly-ethylene-glycol (PEG) was carried out to improve the biocompatibility of the magnetic particles. Two sets of samples were prepared. The first set of the samples was with different molar weight of PEG (Mw = 400, 1000, 10 000 and 20 000) at the constant weight ratio of PEG/Fe_3O_4 = 0.25 and the second one was with different weight ratio of PEG/Fe_3O_4 and constant molar weight of PEG (Mw = 1000). The samples were irradiated with 20Gy. The same reduction of saturated magnetization (about 10%) after electron irradiation with 20Gy was observed for all prepared samples.

P-7-10

PRESENCE OF MAGNETIC FLUIDS LED TO THE INHIBITION OF INSULIN AMYLOID AGGREGATION

K. Siposova[a,b], A. Antosova[a], M. Koneracka[a], V. Zavisova[a], P. Kopcansky[a], and Z. Gazova[a]

[a]Institute of Experimental Physics, SAS, Kosice, Slovakia

[b]Department of Biochemistry, Faculty of Sciences, P. J. Safarik University, Kosice, Slovakia

The magnetic properties as well as the size distribution of magnetic fluids containing magnetic nanoparticles stabilized electrostatically with perchloric acid (MF1) or sterically with sodium oleate (MF2 - MF4) dispersed in water (MF1, MF2 and MF3) or in physiological saline solution (MF4) and consequently functionalized by bovine serum albumin (MF2) or dextran (MF3) are presented. The MFs showed superparamagnetic behaviour without hysteresis loop at room temperature. The morphology and particle size distribution observed by transmission electron microscopy, scanning electron microscopy confirmed spherical shape of magnetic nanoparticles with core magnetic diameter $D_{MAG} = 10$ nm. The hydrodynamic diameters of the prepared MFs considering the magnetic core and the coating were found of 26 nm and 63 nm for MF1 and MF2, for MF3 and MF4 the diameters were equal to 65 nm and 80 nm, respectively. We investigated ability of MFs to affect insulin amyloid aggregation causing serious problems in the treatment of diabetes by insulin injection or by insulin pumps. Interaction of MFs with insulin amyloid aggregation led to decreasing of insulin fibrillization depending on the magnetic fluid properties.

P-7-11

MAGNETOCALORIC EFFECT IN MELT-SPUN $Gd_{65}Fe_{20-y}Co_yAl_{10}X_5$ (X = Si, B) ALLOYS

J. Marcin[a], J. Kováč[a], I. Škorvánek[a], S. Pączek[b], Z. Śniadecki[c], B. Idzikowski[c]

[a]Institute of Exp. Physics, Slovak Academy of Sciences, Watsonova 47, 040 01 Kosice, Slovakia

[b]Faculty of Applied Physics and Mathematics, Technical University of Gdańsk, Narutowicza 11/12, 80-952 Gdańsk, Poland

[c]Institute of Molecular Physics, Polish Academy of Sciences, M. Smoluchowskiego 17, 60-179 Poznań, Poland

Recently developed Gd(Fe,Mn)Al-based glassy alloys prepared by melt-spinning are good candidates for magnetic refrigerants at temperatures around 150 K [1]. In this work, we report on beneficial effect of partial Co substitution for Fe on magnetocaloric properties of melt-spun $Gd_{65}Fe_{20-y}Co_yAl_{10}X_5$ (X = Si, B) alloys. The magnetic entropy changes, ΔS_M, were calculated from the magnetization versus applied field dependences measured by SQUID magnetometer in the temperature range from 5 to 250 K. The value of the magnetic entropy change found in $Gd_{65}Fe_{10}Co_{10}Al_{10}B_5$ ribbon in the magnetic field change from 0 to 5 T at 150 K is $\Delta S_M = 7.02$ J/kgK. This ΔS_M value is higher than that reported for its Co-free $Gd_{65}Fe_{20}Al_{10}B_5$ counterpart [1], where the ΔS_M reached under the same conditions 5.17 J/kgK. The values of refrigeration capacity, RC, were determined as the area below the ΔS_M peak with the integration limits corresponding to the temperatures at its half maximum. The RC value at 5 T for $Gd_{65}Fe_{10}Co_{10}Al_{10}B_5$ ribbon was calculated to be 766 J/kg, which is slightly higher that that reported for the Co-free alloy. The enhanced values of magnetic entropy changes and the high refrigeration capacity make these Co-substituted glassy alloys promising magnetic refrigerants in temperature range of 80–180 K.

[1] Y.K. Fang, C.H. Lai, C.C. Hsieh, X.G. Zhao, H. W. Chang, W.C. Chang W.Li, J. Appl. Phys. **107** (2010) 09A901

O-8-01

SIGN REVERSAL OF THE BOSON-BOSON INTERACTION POTENTIAL FOR THE PLANAR BOSE-FERMI MIXTURES UNDER SYNTHETIC MAGNETIC FIELD

T. P. Polak[a]

[a]Adam Mickiewicz University of Poznań, Faculty of Physics, Umultowska 85, 61-614 Poznań, Poland

Abstract We study the mutually coupled, strongly interacting bosonic and non-interacting fermionic, species of unequal masses in the regime were the retardation effects are an important part of the physics. A cloud of neutral atoms experiences a synthetic magnetic field because of a vector potential that imposes a phase shift on the constituents. The magnetic field causes the oscillations of the magnitude and sign of the effective interaction between bosons from repulsive to attractive in contrast to the static case. We show that the dynamics for the gaseous Bose-Fermi mixtures when reaching the quantum-Hall regime becomes highly nontrivial.

P-8-01

ELECTRON TRANSPORT PROPERTIES CALCULATED FROM FERMI SURFACE AND BOLTZMANN EQUATION IN DISORDERED HALF-HEUSLER THERMOELECTRICS

K. Kutorasinski, J. Tobola and S. Kaprzyk

AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, al. Mickiewicza 30, 30-059 Krakow, Poland

The half-Heusler phases still belong to an interesting class of thermoelectric materials. The Green function Korringa-Kohn-Rostoker methodology [1,2] with the coherent potential approximation was used to calculate electronic, magnetic and transport properties in chemically disordered compounds that exhibit metal-semiconductor-metal crossovers. The transport function within the Boltzmann approach, was originally implemented and calculated with the use of velocities and life-times of electrons determined on the complex energy Fermi surfaces. The computed Onsager coefficients allowed to derive electron transport coefficients as thermopower or electrical resistivity. In particular the aforementioned procedure was applied to (Ti,Zr,Hf)Fe_{1-x}(Ni,Pt)$_x$Sb compounds that experimentally revealed tunable electron transport properties with high Seebeck coefficient and metal-semiconductor-metal crossovers accompanied by a change of carrier types [3]. Additionally the critical crossover concentrations was compared with experimental datas. One of us (K.K.) acknowledges the partial support by the EU Human Capital Operation Program, Polish Project No. POKL.04.0101-00-434/08-00.

[1] Bansil et al., Phys. Rev. B 60, 13396 (1999).
[2] Stopa et al., J. Phys.: Condens. Matter 16, 4921 (2004).
[3] Tobola et al., J. Alloys Compd. 383 (2004) 328.

P-8-02

MAGNETIC AND NONMAGNETIC DOPANTS IN Mg_2Si THERMOELECTRIC MATERIAL STUDIED WITH KKR-CPA METHOD

P. Zwolenski, J. Tobola and S. Kaprzyk

Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, Cracow, Poland

Mg_2X ($X = \{Si,\ Ge,\ Sn\}$) compounds are widely considered as promising thermoelectric materials. Appropriate doping enhances thermoelectric performance and it is of prime interest to investigate the influence of impurity states on electron transport properties. Some magnetic and nonmagnetic dopants diluted in anti-fluorite structure Mg_2Si semiconductor were studied from electronic density of states and dispersion curves using the Korringa-Kohn-Rostoker method with the coherent potential approximation. The site preference of impurity was examined in view of the formation energy. The charge conductivity n- or p-type was determined from the Fermi level position at the conduction or valence band edges, respectively. Furthermore, the effect of semiconductor-metal crossover on thermopower was studied from the Fermi surfaces. The Seebeck coefficient was estimated from the Mott's formula with the use of computed velocities and lifetimes of electrons. The transition metal impurities diluted in Mg_2Si were found to exhibit a large spin-polarization of d-states, being however closer to half-metallic ferromagnetism than to diluted magnetic semiconductivity. One of us (P.Z.) acknowledges the partial support by the EU Human Capital Operation Program, Polish Project No. POKL.04.0101-00-434/08-00.

P-8-03

ZERO-TEMPERATURE PHASE DIAGRAM OF BOSE-FERMI GASEOUS MIXTURES IN OPTICAL LATTICES

T. P. Polak[a] and T. K. Kopeć[b]

[a]Adam Mickiewicz University of Poznań, Faculty of Physics, Umultowska 85, 61-614 Poznań, Poland

[b]Institute for Low Temperatures and Structure Research, Polish Academy of Sciences, POB 1410, 50-950 Wroclaw 2, Poland

We study the ground state phase diagram of a mixture of bosonic and fermionic cold atoms confined on two- and three-dimensional optical lattices. The coupling between bosonic fluctuations and fermionic atoms can be attractive or repulsive and has similarities with electron-phonon coupling in crystals. We investigate behavior of the mixtures in the limit, where the Bogoliubov sound velocity that dictates bosonic dynamics is comparable to the Fermi velocity, hence the retardation effects are important part of the physics. The dynamic Lindhard response function of the fermionic density to changes in the bosonic number of particles above some critical frequency can alter the sign and in consequence the inter-species interaction between particles becomes repulsive in contrast to the static limit (instantaneous and always attractive). Considering the above we show that the structure of the phase diagrams crucially depends on the difference in masses of the bosons and fermions. We discuss the situations where integrating out fermionic field provides an additional interaction that can decrease or increase bosonic coherence.

P-8-04

SYNTHETIC MAGNETIC FIELD EFFECTS ON NEUTRAL BOSONIC CONDENSATES IN QUASI THREE-DIMENSIONAL ANISOTROPIC LAYERED STRUCTURES

T. A. Zaleski[a] and T. P. Polak[b]

[a]Institute for Low Temperatures and Structure Research, Polish Academy of Sciences, POB 1410, 50-950 Wroclaw 2, Poland

[b]Adam Mickiewicz University of Poznań, Faculty of Physics, Umultowska 85, 61-614 Poznań, Poland

We discuss a system of dilute Bose gas confined in a layered structure of stacked square lattices (slab geometry). Derived phase diagram reveals a non-monotonic dependence of the ratio of tunneling to on-site repulsion on artificial magnetic field applied to the system. The effect is reduced when more layers are being added, which mimics a two- to quasi three-dimensional geometry crossover. Furthermore, we establish a correspondence between anisotropic infinite (quasi three-dimensional) and isotropic finite (slab geometry) systems that share exactly the same critical values, which can be an important clue for choosing experimental setups that are less demanding, but still leading to the identical results. Finally, we show that the properties of the ideal Bose gas in three-dimensional optical lattice can be closely mimicked by finite (slab) systems, when the number of two-dimensional layers is larger than ten for isotropic interactions or even less, when the layers are weakly coupled.

P-8-05

RELATION BETWEEN STRUCTURE AND MAGNETIC PROPERTIES OF MICROSTRUCTURED $PrAlO_3$

B. Andrzejewski[a], D. A. Pawlak[b], T. Klimczuk[c] and S. Turczyski[b]

[a]Institute of Molecular Physics, Polish Academy of Sciences, Smoluchowskiego 17, 60-179 Poznań, Poland

[b]Institute of Electronic Materials Technology, Wólczyńska 133, 01-919 Warsaw, Poland

[c]Faculty of Applied Physics and Mathematics, Gdańsk University of Technology, Narutowicza 11/12, 80-952 Gdańsk, Poland

The influence of structuring the matter on the magnetic properties have been studied in the case of praseodymium-aluminium perovskite ($PrAlO_3$). To find differences, both the $PrAlO_3$ crystal and its structured version in the form of a micron-sized and submicron-structure, have been investigated and compared. It is shown that proper structuring the material and embedding it in a matrix of another material, in this case $PrAl_{11}O_{18}$, leads to suppression of low temperature phase transitions in a $PrAlO_3$. This behavior is related to $PrAl_{11}O_{18}$ matrix, which mechanically restricts expansion of the $PrAlO_3$ microrods and thus suppresses the phase transitions.

P-8-06
SYNTHESIS AND CHARACTERIZATION OF MAGNETOFERRITIN

Z. Mitróová, L. Melníková, J. Kováč, M. Timko, and P. Kopčanský
Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, 040 01 Košice, Slovakia

The paper presents detailed experimental study of the synthesis and characterization a bioinorganic magnetic molecule - magnetoferritin. Addition of increments of Fe(II) to anaerobic solutions of apoferritin, at pH = 8.6 and 65°C, followed by stoichiometric amounts of the oxidant results in the formation of magnetoferritin. Product was determined spectrophotometrically. The amount of iron was measured at $\lambda = 450$ nm and the content of protein was detected by modified Bradford method at $\lambda = 595$ nm. Magnetoferritin with loading of iron atom per protein molecule was in the range from 300 to 2000. The structural characterization of the inorganic cores was determined by TEM and X-ray diffraction. Hydrodynamic diameter of the nanoparticles was determined by non-invasive back scatter technology. Magnetic properties were investigated by a SQUID magnetometer. The thermomagnetic curves measured after cooling the sample in zero field and under the presence of the measurement field show superparamagnetic behavior with the blocking temperature T_b around 25 K. The magnetization loops measured below T_b (at 2 K) have the hysteresis with coercive field from 16 to 36 kA/m depend on the concentration of the magnetic nanoparticles.

P-8-07
PHYSICAL PROPERTIES OF MAGNETITE NANOPARTICLES COVERED BY 11-MERCAPTOUNDECANOIC ACID

M.Timko[a], P. Kopcansky[a], M. Antalik[a], M. Simsikova[b], E. Valusova[a], J. Kovac[a]
[a]Institute of Experimental Physics, SAS, Watsonova 47, 040 01 Kosice, Slovakia
[b]Department Biochemistry, Moyzesova 11, Faculty of Sciences UPJS, 041 54 Kosice, Slovakia

For application of magnetite nanoparticles in biomedicine the biocompatible surface is required. In this contribution the new method of nanoparticle preparation and characterization their physical properties is given. Magnetite nanoparticles were synthesized sol gel method by the precipitation of water solution $FeCl_2/FeCl_3$ with NH_4OH in the presence of 11-mercaptoundecanoic acid. The presence of covalent binding of mercaptoundecanoic acid by thiol bridge was checked by FTIR spectroscopy. Zeta potential revealed that magnetite nanoparticles were negative charged at alkaline pH range. Negative charges on the magnetite nanoparticle surface support the tight interaction with positively charged protein cytochrome c. Magnetic measurements revealed that the prepared magnetite nanoparticles shows superparamagnetic behavior without remanence and coercivity at room temperature. FC and ZFC measurements at magnetic field 100 Oe confirmed the existence the blocking temperature.

P-8-08
MAGIC OF THE HAMMOND ORGAN FOR UNDERSTANDING OF PHYSICAL PHENOMENA

Jacek Styszyński[a], Krzysztof Kaczała[b], Grzegorz Musiał[b]
[a]Instytut Fizyki, Uniwersytet Szczeciński, Poland
[b]Wydział Fizyki, UAM, Poland

Our paper discovers the mystery of the Hammond organ and of its characteristic sound for understanding of physical phenomena. Mechanism of generation of the tone is explained using the electromagnetic induction low and construction of the main tone generator of the B3 model is presented, being the very attractive tool for context teaching of acoustics, magnetism and physics of electromagnetic phenomena. Music and its sources are the attractors of listener attention. The latter is the condition for learning more details which belong to the most complex parts of physics. After completing the physical basis more technical details could be explained like the role of drawbars and obtaining of the vibrato, chorus percussion and "key-click" effects which enrich the context of the scientific knowledge. The interesting demonstration of the Doppler effect is the presentation of construction of a Leslie speaker. To see all these phenomena together, the original Hammond tone-wheel exhibit will be shown which explains the generation of the pitch (a sine wave) in this instrument as well as the creation of the desired sound by mixing up to nine pitches. The poster will be illustrated live by the musician Andrzej Sajdak, who will play jazz on Hammond Suzuki XK-3c instrument and by Paweł Więsik, who will present some technical details.

Acknowledgments: We are grateful to Andrzej Sajdak and Paweł Więsik from Hammond Poland for providing us with the original Hammond tone-wheel exhibit, unpublished materials on the Hammond organ and for the live performance during the conference. We thank also Stanisław Dylak for useful comments and discussion.

Postdeadline abstract: P-3-59

THE EFFECT OF PLATINUM BUFFER ANNEALING ON THE MAGNETIC PROPERTIES OF COBALT WEDGE

U. Guzowska[1] , V.D. Bessonov[1,2], R. Gieniusz[1], Z. Kurant[1], A. Maziewski[1], G. Gubbiotti[3], L.T. Baczewski[4], A. Wawro[4]

[1]Faculty of Physics, University of Białystok, Lipowa 41, Białystok, Poland
[2]Institute of Metal Physics,
UD RAS 620990, S.Kovakevskaya str. 18, Ekaterinburg, Russia
[3]Istituto Officina dei Materiali (CNR-IOM),
Sede di Perugia, c/o Dipartimento di Fisica, Via A. Pascoli, Perugia, Italy
[4]Institute of Physics, Polish Academy of Sciences,
Al. Lotników 32/46, Warszawa, Poland

The following nanostructures, produced by molecular beam epitaxy, were studied: sapphire substrate (i) Mo(20 nm)/Pt(20 nm) buffer; two types of Pt bufferes were used – Pt as deposited and Pt annealed at the temperature of 1030°C (ii) cobalt wedge (with thickness range 0–3 nm) or Co flat film (iii) Pt(5 nm) cover layer.

The Brillouin Light Scattering in the backscattering configuration and polar magnetooptical Kerr effect techniques were used to investigate the influence of platinum buffer annealing on magnetic properties of cobalt wedges.

A cobalt sample with as deposited Pt buffer was characterized by phase transition from the easy magnetization plane to the perpendicular easy magnetization axis for the cobalt thickness d_{CO} about 2 nm.

In the sample with the annealed platinum buffer the increase of Co thickness range with the out-of-plane magnetization state was observed up to d_{CO}=3nm.

INDEX OF AUTHORS

INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

spinLAB

EUROPEAN UNION
EUROPEAN REGIONAL
DEVELOPMENT FUND

National Centre of Magnetic Nanostructures for Applications in Spin Electronics – SPINLAB

Project nr POIG 02.02.00-00-020/09 is realized in the framework of the "Operational Programme Innovative Economy 2007-2013, Priority II R&D Infrastructure, Measure 2.2. Support for development of research infrastructure of scientific entities"

The aim of the project is to establish "National Centre of Magnetic Nanostructures for Applications in Spin Electronics – SPINLAB" as well as to provide the participants of the Centre with world-class facilities indispensable for conducting state-of-the-art collaborative research in spin electronics.

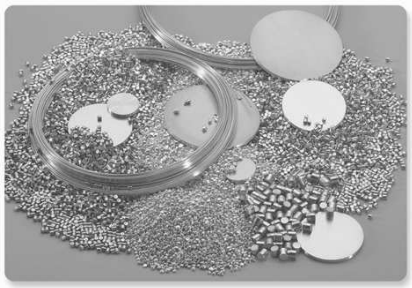
The project is co-financed by European Union from its European Regional Development Found. The new facilities are envisaged to improve the already existing collaboration between the leading national partners that have complementary scientific equipment and knowledge of the nanotechnology of magnetic structures and spintronics.

The project participants (listed below) conduct research in the field of theory, experiments and applications of magnetic nanostructures.

Participants:

- Institute of Molecular Physics, Polish Academy of Sciences, Poznań – coordinator
- Institute of Physics, Polish Academy of Sciences, Warszawa
- AGH University of Science and Technology, Faculty of Electrical Engineering, Automatics, Computer Science and Electronics, Department of Electronics, Kraków
- Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Kraków
- Adam Mickiewicz University, Faculty of Physics, Poznań
- University of Białystok, Faculty of Physics, Białystok

Comprehensive *Vacuum* Solutions



Vacuum Mart™ Division

Manufacturing Division

Materials Division

Process Equipment Division

For all your vacuum requirements: Contact the Kurt J. Lesker Company today!

Kurt J. Lesker Company

www.lesker.com

Kurt J. Lesker Company Ltd.
Europe
+44 (0) 1424 458100
saleseu@lesker.com

Kurt J. Lesker Canada Inc.
Canada
416.588.2610
800.465.2476
salescan@lesker.com

Kurt J. Lesker Company
United States
412.387.9200
800.245.1656
salesus@lesker.com

Kurt.Lesker (Shanghai) Trading Company
科特·莱思科(上海)商贸有限公司
Asia
+86 21 50115900
saleschina@lesker.com

AM Technologies is a Polish Company, authorized distributor of Test & Measurement world leading suppliers, specialized in selling wide range of measurement products and related services.

Today AM Technologies product portfolio includes:

- ***Agilent Technologies*** general purpose instrumentation, RF and microwave test systems, telecommunication analyzers for testing digital transmission, protocols and networks, cellular network test products, SS7 and fiber network monitoring systems;
- ***Fluke Calibration*** precision instruments for electrical calibration, temperature and pressure; apparatus for calibration of pressure;
- ***Cascade Microtech*** probing stations;
- ***MI Technologies*** (formerly Scientific Atlanta) Antenna and RCS measurement systems;
- ***Grintek***, ***Sysdel*** *and* ***TCI*** special purpose measurement equipments;
- ***JDSU***, ***IXIA, Keynote SIGOS*** measurement solutions for telecommunication;
- ***Microlease*** short and long term rental of measurement equipment for telecommunication;
- EMC test facilities;
- Consultancy, dedicated measurement software and custom systems.

The company supports Polish educational institutions. AM Technologies is also the member of EMC Committee Polish Academy of Science, as well as Support for Radiocommunication and Multimedia Development Foundation.

The company has implemented PN-EN ISO 9001:2009 and AQAP 2110:2009 International Standards as well as Import/Export Control procedures. AM Technologies is also certified to supply strategic products and systems to the Polish Government.

AM Technologies Polska Sp. z o.o. , Al. Jerozolimskie 146C, Jerozolimskie Business Park, 02-305 Warszawa, tel. (+48 22) 532 28 00, faks (+48 22) 532 28 28, e-mail: info@amt.pl, http://www.amt.pl

LOT-Oriel group is one of the most powerful European suppliers of scientific instrumentation, optics and components, manufactured by companies all over the world.

A dedicated team of more than 100 highly qualified sales engineers, service engineers and clerical staff is supported by state of the art infrastructure in order to provide fast, flexible and reliable consultation and service to our customers and partners. LOT-Oriel GmbH & Co. KG in Darmstadt is the European Headquarters and main office of the operation.

For almost 40 years, LOT-Oriel created an unsurpassed European network, highly appreciated expertise and an efficient, dedicated organization to serve the demands of challenging markets for components as well as for sophisticated instrumentation.

We are selling products of LOT and many well-known manufacturers since 1970. LOT stands for Laser, Optics, Technology.

Since November 2007, the European LOT-Oriel Group belongs to Quantum Design. Together with our partner company from San Diego, USA with officies in Asia and South America we provide a worldwide sales and service network.

Magnetism and magnetic characterization is a key application, where we want to offer the best systems commercially available. Different types of magnetometer starting from classic VSM system to the extremely fast and ultra-sensitive SQUID magnetometer MPMS-SQUID-VSM. In addition offers LOT specialized products like the Kerr magnetometer Nanomoke, for investigation of magnetic surfaces.

We cordially invite to visit our booth at Physics of Magnetism PM’11 conference, and our web page at www.lot-oriel.com .

Advanced Thermophysical Properties Testing

Material Characterization through precise measurements over the broadest temperature range for:

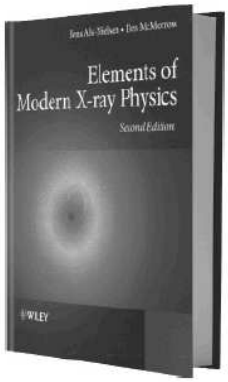
- ceramics and glasses
- polymers and composites
- metals and alloys
- insulating materials
- multi-layer systems

NETZSCH

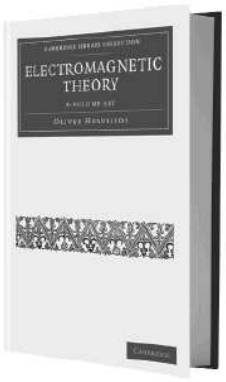
NETZSCH-Gerätebau GmbH
Wittelsbacherstraße 42
95100 Selb, Germany
Tel.: +49 9287 881-0
Fax: +49 9287 881 505
at@netzsch.com
www.netzsch.com

ABE-IPS
books online journals

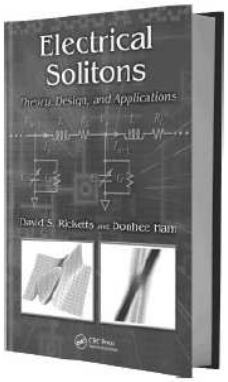
Literatura naukowa z całego świata
ABE-IPS
ul. Grzybowska 37A, 00-855 Warszawa
tel. +48 22 654 06 75 | fax +48 22 652 07 6
info@abe.pl | www.abe.pl



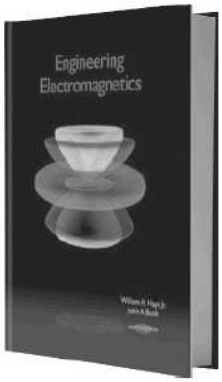
Elements of Modern X-ray Physics, 2nd Edition
by Jens Als-Nielsen, Des McMorrow
Wiley, 2011



Electromagnetic Theory 3 Volume Set
by Oliver Heaviside
CUP, 2011



Electrical Solitons: Theory, Design, and Applications
by David S. Ricketts, Donhee Ham
Wiley, 2010



Engineering Electromagnetics
by William H. Hayt, Jol A. Buck
McGraw-Hill, 2011

Advertising materials with your logo

Reklamowygadzet.pl is a solution you need.

We had the great honour to deliver You
laptop bags with imprints.

We hope You enjoy and use them every day.

We offer a wide range of advertising accessories
which you can match to your business!

**We specialise in delivering
promotional materials to conferences.**

What you need?
pens
pendrives
conference folders
laptop bags
calendars
mugs
mobile phone straps
paper or eco bags

WE CAN PUT YOUR LOGO ON EVERYTHING.

Please contact us:
Wojciech Wrociński
+48 508 556 952
reklamowygadzet@reklamowygadzet.pl

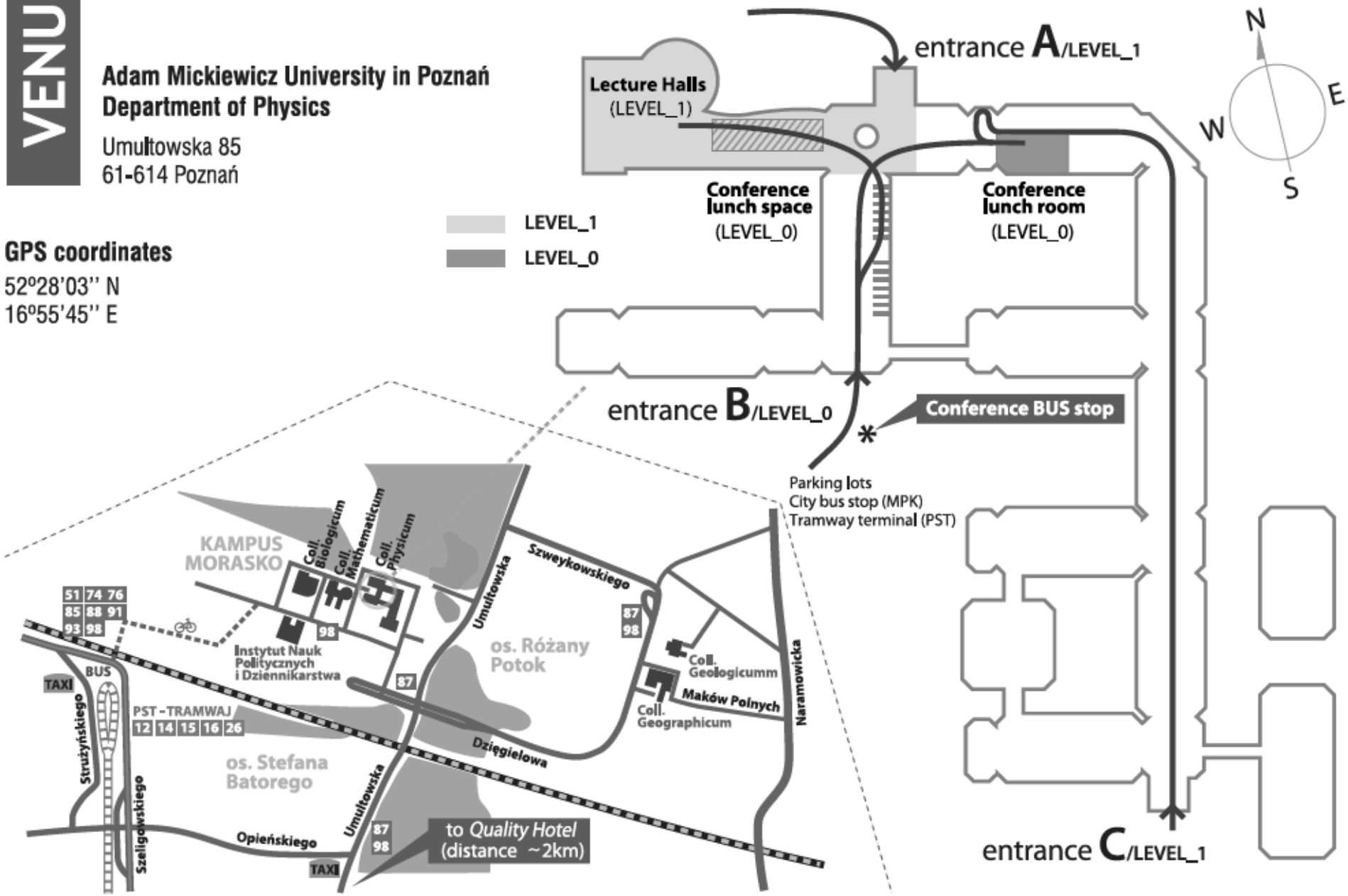
The European Conference PHYSICS OF MAGNETISM 2011 (PM'11)

VENUE

Adam Mickiewicz University in Poznań
Department of Physics

Umultowska 85
61-614 Poznań

GPS coordinates
52º28'03'' N
16º55'45'' E



VENUE close-up

Wireless Connection

How to connect to our network?

- you should find in your network manager wireless network called **PM11**
  (*e.g.* from tray)
- choose network above
- during authorization write down the password: **welcome!**
  (security type WPA-PSK, TKIP)

Jak przyłączyć się do naszej sieci?

- proszę odnaleźć w menadżerze sieci sieć bezprzewodową o nazwie **PM11**
  (np. w pasku programów rezydentnych)
- wybrać powyższą sieć
- w trakcie autoryzacji wpisać hasło: **welcome!**
  (typ klucza WPA-PSK, TKIP)