MA 27: Spin Structures and Magnetic Phase Transitions

Time: Thursday 17:15–18:45 Location: H10

MA 27.1 Thu 17:15 H10

A scheme to calculate the Curie temperature for systems with induced magnetic moments with application to Co-Pt and Fe-Pd alloys — •Svitlana Polesya[1], Sergiy Mankovsky[1], Ondrej Sipr[2], Christoph Strunk[3], and Hubert Ebert[1] — [1]LMU Munchen, Dept. Physikalische Chemie, Butenandtstraße 11, D-81377 München — [2]Institute of Physics Acad. of Science, Prague, Czech Republic — [3]Institute for Exper. and Appl. Physics, University of Regensburg, Germany

The importance of including induced magnetic moments when calculating the Curie temperature of transition metal systems is shown for Pd-rich Fe-Pd alloys and Co-Pt alloys. For this binary alloys the components exhibit a different type of magnetism, i.e. spontaneous and induced. The finite temperature magnetic properties of these alloys are described using a generalised Heisenberg Hamiltonian that allows to account for the longitudinal fluctuation of induced moments of the Pd and Pt atoms. In Fe-Pd alloys with small Fe concentration the role of effective Fe-Fe interaction mediated by the induced Pd moments is crucial for the creation of ferromagnetic (FM) order. The Curie temperature T_c obtained for these alloys are in good agreement with experiment for the Fe concentration up to 15%. For the Co-Pt alloys the improvement of the T_c values with inclusion of the induced moments on Pt atoms is shown for the whole considered concentration range. The FM order in the ordered $CoPt_3$ alloy that is observed experimentally is only possible due to the FM coupling to induced Pt moments while Co-Co coupling is primarily anti-ferromagnetic.

MA 27.2 Thu 17:30 H10

Nature of the Magnetic Order and Magnetic Interactions in $BaMn_2As_2$ — •Yogesh Singh[1], Philipp Gegenwart[1], David Johnston[2], Rob McQueeney[2], Alan Goldman[2], and Bella Lake[3] — [1]1. Physikalisches Institut, Georg August Universitaet, Goettingen, Friedrich Hund Platz 1, 37077, Goettingen, Germany. — [2]Ames Laboratory and Department of Physics and Astronomy, Iowa State University, Ames, Iowa 50011, USA. — [3]Helmholtz-Zentrum Berlin für Materialien und Energie (HZB), Glienicker Straße 100, 14109 Berlin, Germany.

The recent discovery of high temperature superconductivity in several structure classes containing FeAs-layers has led to a flurry of activity not seen since the discovery of CuO-based high temperature superconductors more than 20 years ago. In an attempt to discover new materials related to these FeAs-based systems we have studied in detail the properties of $BaMn_2As_2$ which is iso-structural to tetragonal $BaFe_2As_2$. In this talk I will present our magnetic, thermal, transport, and neutron diffraction and scattering studies on polycrystalline and single crystalline samples of $BaMn_2As_2$. We find that $BaMn_2As_2$ undergoes a transition into a G-type antiferromagnetic state below $T_N = 620$ K with the ordering direction being the c axis. Our estimates of the magnetic interactions indicate that $BaMn_2As_2$ is a quasi-two-dimensional magnetic system with frustrating antiferromagnetic nearest-neighbor (J_1) and next-nearest-neighbor (J_2) in-plane interactions.

MA 27.3 Thu 17:45 H10

Weak random anisotropy in the two-dimensional limit - FeZr-based thin films and multilayers — •Andreas Liebig[1], Panagiotis Korelis[2], Gabriella Andersson[2], Manfred Albrecht[1], and Björgvin Hjörvarsson[2] — [1]Chemnitz University of Technology, Institute of Physics, Chemnitz, Germany — [2]Dept. of Physics and Material Sciences, Uppsala University, Uppsala, Sweden

We present a study on the magnetic properties of $Fe_{90}Zr_{10}/Al_{70}Zr_{30}$ amorphous multilayers, based on MOKE and SQUID magnetometry. $Fe_{90}Zr_{10}$ is an archetypical example for a reentrant ferromagnet, exhibiting spin glass phase at low temperatures and a ferromagnetic phase at intermediate temperatures.

From structural and magnetic measurements we could ensure the absence of a crystalline phase, and interlayer thicknesses of 4.5 nm yielded negligible interlayer exchange coupling. The amorphous layers can therefore be treated as magnetically decoupled, besides dipolar interactions. Consequently, the ordering temperature scales with the thickness of the magnetic layers. Furthermore, the finite thickness influences the character of the phase transition itself. For the low-temperature limit the spin-glass phase is suppressed. Above the apparent ferromagnetic ordering temperature a phase with exceedingly high magnetic susceptibility is found. Similarities with the random anisotropy two-dimensional X-Y model are discussed.

MA 27.4 Thu 18:00 H10

Low-energy excitations in the three-dimensional random-field Ising model — Martin Zumsande[1,2] and •Alexander K. Hartmann[3] — [1]Institute of Theoretical Physics, University of Göttingen — [2]Max-Planck Institut fof Physics of Complex Systems, Dresden — [3]Institute of Physics, University of Oldenburg

The random-field Ising model (RFIM), one of the basic models for magnetic alloys exhibiting quenched disorder, can be studied numerically [1] with the help of efficient ground-state algorithms [2]. In this study [3], we extend these algorithm by various methods in order to analyze low-energy excitations for the three-dimensional RFIM with Gaussian distributed disorder as a function of the disordered strength, i.e. in the ferromagnetic phase, in the paramagnetic phase and right at the phase transition. These excitations appear in the form of clusters of connected spins. We analyze several properties of these clusters. Also we show that the stiffness exponent θ, describing the scaling of the energy of the excitations, is related to the distribution of cluster radii via $P(R) \sim R^{-\theta}$. Our results support the validity of the droplet-model description for the RFIM.

[1] A.K. Hartmann, *Practical Guide to Computer Simulations*, (World Scientific, 2009)
[2] A.K. Hartmann and Heiko Rieger, *Optimization Algorithms in Physics*, (Wiley-VCH, 2001)
[3] M. Zumsande and A.K. Hartmann, to appear in Eur. Phys. J. B

MA 27.5 Thu 18:15 H10

Magnetic Spin Configuration in $Fe_{50}Pt_{50-x}Rh_x$ alloys — •J. Fenske[1], D. Lott[1], G.J. Mankey[2], W. Schmidt[3], K. Schmalzl[3], E. Tartakowskaya[4], and A. Schreyer[1] — [1]GKSS Research Centre — [2]The University of Alabama, MINT Center — [3]Juelich Research Centre — [4]Institute for Magnetism, National Ukrainian Accademy of Science

FePt-based alloys are typically the material of choice for magnetic information storage media. The high magnetic moment of Fe gives a large magnetization and the large atomic number of Pt results in a high magnetic anisotropy. This combination enables the written bits to be smaller than ever before. One way to control the magnetic properties in these materials is through the introduction of a third element into the crystal matrix e.g. Rh. When Rh is added to replace Pt in the equiatomic alloy, new magnetic phases emerge. Bulk samples of $Fe_{50}Pt_{50-x}Rh_x$ studied by magnetization measurements refer to three different phase transitions with increasing temperature: (I) An antiferromagnetic (AF) - paramagnetic (PM) transition for $30< x <14.25$, (II), an AF - ferromagnetic (FM) transition for $14.25< x <9.5$ and, (III), a FM - PM transition $9.5< x <0$ [1]. Here we present results on a series of 200nm $Fe_{50}Pt_{50-x}Rh_x$ films with different Rh concentrations. These films were examined by neutron diffraction in dependence of temperature and magnetic field. By the use of polarized and unpolarized neutron diffraction we could develop a detailed model of the magnetic spin structure in these thin films. [1] S. Yuasa, H. Miyajima and Y. Otani, J. Phys. Soc. Jpn. 63 (8), 1994

MA 27.6 Thu 18:30 H10

Skyrmion textures in noncentrosymmetric cubic helimagnets — •Andrey A. Leonov, Alexei N. Bogdanov, and Ulrich K. Rössler — IFW Dresden, P.O.B. 270116, D-01171 Dresden

In noncentrosymmetric magnetic systems, chiral Dzyaloshinskii-Moriya (DM) interactions give rise to one-dimensional (cycloids and conical helices), two-dimensional (baby-Skyrmions), and three-dimensional (Hopfions) modulated and localized structures with a fixed sense of rotation. Within the standard phenomenological (Dzyaloshinskii) theory [1], which includes only basic isotropic interactions the conical phase is a global minimum. Other modulated textures exist only as metastable states. Detailed numerical analysis on two dimensional models shows that bound Skyrmion states arise as hexagonal lattices of $\pm\pi$-Skyrmions or square staggered lattices of $\pi/2$-Skyrmions. In real materials additional magnetic couplings (for example, uniaxial

or exchange anisotropy) can render Skyrmionic states into thermodynamically stable phases. The transitions between different Skyrmionic and other modulated phases is generally first order, which should be discernible as hysteresis of magnetization processes. The model results show that diverse Skyrmionic textures may underlie the exotic magnetic phenomena of "partial order" or the field-driven "A-phase" observed in MnSi and other cubic helimagnets.

[1] U.K.Rößler, A.N.Bogdanov, C.Pfleiderer, Nature (London) **442**, 797 (2006); U. K. Rößler, A. A. Leonov, A. N. Bogdanov, J. Phys., in press; arXiv: 0907.3651v2 (2009).