MA 53: Magnetic Scattering Methods

Time: Friday 9:30–11:45 Location: H33

MA 53.1 Fri 9:30 H33

Growth and interfacial properties of FePt/Fe/NiO and FePt/NiO/Fe trilayers — •Amir Syed Mohd, Sabine Pütter, Stefan Mattauch, Alexandros Koutsioubas, and Thomas Brückel — Jülich Centre for Neutron Science JCNS, Forschungszentrum Jülich GmbH, Outstation at MLZ, Garching, Germany

The exchange coupling between different types of magnetic thin films has opened possibilities to develop functional nanostructures. This phenomenon is governed mainly by the interfacial properties and emerges as exchange bias effect [when a ferromagnet (e.g. Fe) is coupled with an antiferromagnet (e.g. NiO)] and as exchange spring effect [when a hard ferromagnet (e.g. FePt) is coupled with a soft ferromagnet (e.g. Fe)] in bilayers and multilayers [1, 2].

In this work we have deposited FePt/Fe/NiO and FePt/NiO/Fe trilayers using molecular beam epitaxy (MBE) method on MgO(001) under similar conditions. In-situ reflection high energy electron diffraction (RHEED) patterns show that the growth morphologies of Fe/NiO and NiO/Fe are different and lead to epitaxial and textured growth respectively. In order to study the interfacial properties, ex-situ x-ray reflectivity (XRR) and polarised neutron reflectivity (PNR) have been performed. XRR and PNR results indicate that deposition of NiO on Fe forms a complex structure of Fe-O at the interface as a result magnetic coupling is suppressed between Fe and NiO. The obtained results will be discussed in more detail during presentation.

[1] P. K. Manna et al., Physics Reports 535, 61 (2014). [2] N. de Sousa et al., Phys. Rev. B 82, 104433 (2010).

MA 53.2 Fri 9:45 H33

Quenching of the Resonant Magnetic Scattering by Ultra-Short Free-Electron Laser Light Pulses — •Leonard Müller[1], Magnus H. Berntsen[2], Wojciech Roseker[1], Kai Bagschik[3], Jochen Wagner[3], Robert Frömter[3], Flavio Capotondi[4], Emanuele Pedersoli[4], Michele Manfredda[4], Miltcho B. Danailov[4], Maya Kiskinova[4], Hans P. Oepen[3], and Gerhard Grübel[1] — [1]Deutsches Elektronen Synchrotron DESY, Hamburg, Germany — [2]KTH, Stockholm, Sweden — [3]University Hamburg, Hamburg, Germany — [4]Elettra Sincrotrone Trieste, Basovizza, Italy

The new free-electron laser (FEL) sources provide radiation with unprecedented parameters in terms of ultrashort pulse length, high photon flux, and coherence. These properties make FELs ideal tools for studying ultrafast dynamics in matter on a previously inaccessible level. Yet, FELs do not only probe matter, but can also drive it in highly excited states which are otherwise inaccessible.

Here, we report on a resonant magnetic scattering experiment, where the focussed FEL light pulses probe the magnetic domain system of a thin magnetic film. Both, single and double FEL pulses at different fluences are used to follow the quenching of the resonant scattering efficiency.

MA 53.3 Fri 10:00 H33

Study of the Spin-Chain cuprate Sr2CuO3 with OK-edge Resonant Inelastic X-ray Scattering — •Justine Schlappa[1,2], Umesh Kumar[3], Ke-Jin Zhou[2,4], Surjeet Singh[5,6], Vladimir N. Strocov[2], Alexandre Revcolevschi[4], Henrik M. Ronnow[7], Steve Johnston[3], and Thorsten Schmitt[2] — [1]European X-ray Free Electron Laser Facility GmbH, Hamburg, Germany — [2]Paul Scherrer Institut, Villigen, Switzerland — [3]University of Tennessee, Knoxville, USA — [4]Diamond Light Source, Oxfordshire, UK — [5]Université Paris-Sud, Orsay, France — [6]Indian Institute of Science, Education and Research, Pune, India — [7]École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

We present the study of Heisenberg Spin-1/2 chain compound Sr2CuO3 with oxygen K-edge Resonant Inelastic X-ray Scattering. The spectra reveal a range of low-energy excitations between tens of meV and 8 eV. From small-cluster exact diagonalization calculations the structures at higher energies can be assigned to dd and charge-transfer excitations, whereas the structures below 1 eV partially to spin- and phonon excitations. The photon wave length allowed accessing half of the Briolluin zone in this study.

MA 53.4 Fri 10:15 H33

Avoided ferromagnetic criticality in PrPtAl — •Dmitry Sokolov[1,2], Andrew Huxley[1], and Frank Krueger[3,4] — [1]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [2]School of Physics & Astronomy, The University of Edinburgh, UK — [3]ISIS, STFC, Rutherford Appleton Laboratory, Chilton, UK — [4]London Centre for Nanotechnology, University College London, London, UK

Our recent work on induced moment ferromagnet PrPtAl provided a first experimental evidence for intermediate electronic states, which precede the conventional q=0 ferromagnetism when the ferromagnetic transition temperature is close to zero. Using the neutron diffraction and synchrotron X-ray scattering we have shown that with decreasing temperature PrPtAl undergoes a transition from paramagnetic state into a doubly modulated incommensurate spin density wave (SDW), followed by a second transition at lower temperature in to a single incommensurate SDW of a different period before transitioning into a commensurate ferromagnetism at the lowest temperatures [1]. This finding represents the first new paradigm for understanding the transition from paramagnetism to ferromagnetism since the formulation of the theory of the continuous phase transitions by L. D. Landau in 1937.

[1] G. Jabbar, D. A. Sokolov, C. O' Neill, C. Stock, D. Wermeille, F. Demmel, F. Krueger, A. G. Green, F. Levy-Bertrand, B. Grenier, and A. D. Huxley, Nat. Phys. 11, 321 (2015).

15 min. break

MA 53.5 Fri 10:45 H33

Anomalous thermal decoherence in a quantum magnet measured with neutron spin-echo spectroscopy — •Felix Groitl[1,2,3], Klaus Habicht[3], Katharina Rolfs[2], Thomas Keller[4,5], and Alan Tennant[3,6] — [1]Ecole Polytechnique Federale de Lausanne, 1015 Lausanne, Switzerland — [2]Paul Scherrer Institut, 5232 Villigen, Switzerland — [3]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, 14109 Berlin, Germany — [4]Max Planck Institute For Solid State Research, 70569 Stuttgart, Germany — [5]Max Planck Society Outstation at the FRM II, 85748 Garching, Germany — [6]Technische Universität Berlin, Institut für Festkörperphysik, 10623 Berlin, Germany

The effect of temperature dependent asymmetric line roadening is investigated in $Cu(NO_3)_2{\cdot}2.5D_2O$, a model material for a 1-D bond alternating Heisenberg chain, using the high resolution neutron-resonance spin-echo (NRSE) technique. Inelastic neutron scattering experiments on dispersive excitations including phase sensitive measurements demonstrate the potential of NRSE to resolve line shapes, which are non-Lorentzian, opening up a new and hitherto unexplored class of experiments for the NRSE method beyond standard line width measurements. The particular advantage of NRSE is its direct access to the line shape in the time domain without convolution with the resolution function of the background spectrometer. This novel application of NRSE is promising and establishes a basis for further experiments on different systems, since the results for $Cu(NO_3)_2{\cdot}2.5D_2O$ are applicable to a broad range of quantum systems.

MA 53.6 Fri 11:00 H33

CAMEA - A novel multiplexing analyzer for neutron spectroscopy — •Felix Groitl[1,2], Dieter Graf[2], Jonas Birk[2], Marton Marko[2,3], Marek Bartkowiak[2], Uwe Filges[2], Christof Niedermayer[2], Christian Rüegg[2,4], and Henrik Ronnow[1,5] — [1]Ecole Polytechnique Federale de Lausanne, 1015 Lausanne, Switzerland — [2]Paul Scherrer Institut, 5232 Villigen, Switzerland — [3]Wigner Research Centre for Physics, 1525 Budapest, Hungary — [4]University of Geneva, 1211 Geneva, Switzerland — [5]University of Copenhagen, 2100 Copenhagen, Denmark

The analyzer system CAMEA (Continuous Angle Multiple Energy Analysis) will be installed as a new secondary spectrometer on the cold-neutron triple-axis spectrometer RITA-2 at SINQ, PSI. CAMEA is optimized for efficiency in the horizontal scattering plane enabling detailed and rapid mapping of excitations. As a novelty the design employs a series of several sequential upward scattering analyzer arcs. Each arc is set to a different, fixed final energy scattering towards position sensitive detectors. Thus, neutrons with different final energies are collected simultaneously over a large angular range. For CAMEA in a single data-acquisition several entire constant-energy lines in the horizontal scattering plane are recorded for a quasi-continuous angular coverage of about 60°. With a large combined coverage in energy and momentum, this will result in a very powerful and efficient spectrometer, which will be particularly suited for parametric studies under extreme conditions with restrictive sample environments (high field magnets or pressure cells) and for small samples of novel materials.

MA 53.7 Fri 11:15 H33

Element specific magnetization redistribution at YBa2Cu3O7-La0.66Ca0.33MnO3 interfaces — •Aurora Alberca[1,2], Miguel Angel Uribe Laverde[2], Yoah William Windsor[1], Mahesh Ramakrishnan[1], Laurenz Rettig[1], Ivan Marozau[2], Jean-Marc Tonnerre[3,4], Jochen Stahn[5], Urs Staub[1], and Christian Bernhard[2] — [1]Swiss Light Source, Paul Scherrer Institut, CH-5232 Villigen PSI, Switzerland — [2]University of Fribourg, Department of Physics and Fribourg Centre for Nanomaterials, Chemin du Musee 3, CH-1700 Fribourg, Switzerland — [3]Université Grenoble Alpes, Institut NEEL, F-38042 Grenoble, France — [4]CNRS, Institut NEEL, F-38042 Grenoble, France — [5]Laboratory for Neutron Scattering, Paul Scherrer Institut, CH-5232 Villigen PSI, Switzerland

We study the element specific magnetic depth profiles of a YBa2Cu3O7 La0.66Ca0.33MnO3 (YBCO LCMO) superlattice using soft X-ray Resonant Magnetic Reflectometry (XRMR). The element specific depth profiling capability of XRMR allows us to study the magnetic proximity effect (MPE) that is observed at the YBCO LCMO interface. MPE is characterized by the occurrence of a depleted layer on the manganite side and an induced magnetization in the YBCO. We show that the Cu moments (0.28 muB per interfacial Cu ion) reside on the YBCO side of the interface and originate from the CuO2 plane that is located at the interface.

[1] Alberca et al., Physical Review B 92 (17), 174415

MA 53.8 Fri 11:30 H33

Imaging of magnetic nanodots utilizing soft x-ray holographic microscopy — •Jochen Wagner[1], Kai Bagschik[1], Stefan Freercks[1], Carsten Thönnissen[1], André Kobs[1,2], Robert Frömter[1], Leonard Müller[2], Magnus H. Berntsen[3], Gerhard Grübel[2], and Hans Peter Oepen[1] — [1]Institut für Nanostruktur- und Festkörperphysik, Uni Hamburg, Germany — [2]DESY, Hamburg, Germany — [3]KTH Royal Institute of Technology, Stockholm, Sweden

X-ray Fourier transform holography (FTH) has become a competitive technique to investigate magnetic samples with up to sub-20 nm spatial resolution exploiting the x-ray magnetic circular dichroism [1].

We used this technique to image arrays of nanodots with perpendicular magnetization. The nanodots are structured by e-beam lithography from a (Co (0.8 nm)/Pt (0.8 nm))$_8$ multilayer film prepared by dc magnetron sputtering and ion assisted sputtering on 200 nm thick Si_3N_4 membranes. The diameter of the dots is 60 nm and the interdot spacing of the arrays varies from 100 to 160 nm.

We prepare the arrays in a state of randomized magnetization. The system is step-by-step magnetized. Averaged information about the magnetic state of the dots at different magnetic fields can be extracted from the intensity of the Bragg peaks even in single helicity holograms. By simulation the key features of the holograms can be reproduced and correlated to the magnetic state imaged by FTH.

[1] D. Stickler, et al., Appl. Phys. Lett. 96, 042501 (2010).