Frontier Experiments with Neutrons

This session has been organised in conjunction with the Swiss Neutron Scattering Society (SGN).

Monday, 30.06.2014, Room E 230

Time	ID	I: Neutrons in Soft Matter *Chair: Sandor Balog, Uni Fribourg*
14:45	701	**Magnetically Enhanced Bicelles Delivering Switchable Anisotropy in Optical Gels** *Peter Fischer [1], Erich Windhab [1], Simon Kuster [1], Joachim Kohlbrecher [2], Marianne Liebi [3], Peter Walde [4]* *[1] IFNH, ETH Zürich, Schmelzbergstrasse 9, 8092 Zürich* *[2] LNS, Paul-Scherrer Institute, 5232 Villigen PSI* *[3] SLS, Paul-Scherrer Institute, 5232 Villigen PSI* *[4] Department of Materials, ETH Zürich, Wolfgang-Pauli-Strasse 10, 8093 Zürich* With the goal of producing smart hydrogels, magnetically alignable bicelles were embedded into a gelatin matrix, generating a temperature responsive switchable structure operable by an external magnetic field. Bicelles are a self-assembly structure based on phospholipids and complexed lanthanide ions with a disk-like shape. Magnetic alignment was caused by an anisotropic magnetic susceptibility of the molecules, leading to orientation of the molecular assembly parallel or perpendicular as studied by birefringence and SANS measurements. The magnetic orientation of the bicelles could be entirely fixed by gelation of the matrix and showed an anisotropic transfer of electromagnetic waves.
15:15	702	**2D or 3D diffusion: the matter of observation time** *Fanni Juranyi [1], Sergey Churakov [1], Thomas Gimmi [1], Tobias Unruh [2]* *[1] Paul Scherrer Institut, 5232 Villigen PSI* *[2] Forschungsneutronenquelle Heinz Maier-Leibnitz, Lichtenbergstr. 1, DE-85747 Garching* Clays are layered materials with complex hierarchical pore structure. Beside their importance in applications (waste management, filtration, food industry ...) they are often used as host materials to understand confinement effects. Water diffusion at different time and length scales plays a crucial role in this context. According to simulations the interlayer distance and particle size are the relevant length scales. Quasielastic neutron scattering was used to measure water diffusion in bi-hydrated montmorillonite as a function of observation time. The transition from a local 3D into a 2D diffusion within the interlayer could be observed for the first time.
15:30	703	**Visualising water uptake in primed canvas model systems by neutron radiography in a purposefully designed perfusion chamber** *Jaap J. Boon [1], Roel Hendrickx [1], Gert Eijkel [2], Iliyah Cernak [2], Ester S. B. Ferreira [1], Anders Kaestner [3]* *[1] SIK-ISEA, Zollikerstrasse 32, 8032 Zürich* *[2] FOM Institute AMOLF, Science Park 104, 99 NL-1098XG Amsterdam* *[3] ICON beam line, PSI, 5232 Villigen PSI* Many chemical reactions in paint are driven by moisture. Using historically accurate reconstructions and painting samples we aim to visualise and understand the kinetics of water uptake and identify preferential storage layers in the paint-support composite. A Teflon moisture perfusion chamber developed allows sample exposure to water vapor under temperature controlled conditions. Changes in water content could be monitored successfully at a spatial resolution of 15 microns in the neutron radiography set-up. Remarkably it was observed that water is preferentially taken up by specific layers in the stratigraphy and water uptake kinetics differ between canvas, sized-canvas and ground layer.

15:45	**704**	**QENS in the GPa range and the anomalous case of hot dense water** *Livia Eleonora Bove, EPFL SB ICMP EPSL, Station 3, 1015 Lausanne* *Stefan Klotz, CNRS, IMPMC-UPMC, FR-75005 Paris* *Thierry Straessle, PSI, Villigen, 5232 Villigen* *Marek Koza, ILL, rue Horowitz, FR-38100 Grenoble* *Jose Teixeira, LLB-CEA, CEA Saclay, FR-91191 Gif sur Yvette* *Marco Saitta, UPMC, 4 place Jussieu, FR-75005 Paris* We measured the translational and rotational diffusion coefficient of water in the 400-450 K range up to ice VII crystallization (3-3.5 GPa), using techniques based on Paris-Edinburgh pressure cells [1]. We observe a striking decoupling of the two coefficients under high pressure which can be related to the residual presence of hydrogen bonds in hot dense water. Furthermore, at pressures beyond ~1 GPa we observe a clear breaking down of the Debye-Stoke-Einstein relations [3]. These results suggest that hot dense water does not behave as a simple liquid, as indicated by structural studies. [1] S. Klotz, Th. Straessle, and L. E. Bove, Appl. Phys. Lett. 103, (2013) 193504; L. E. Bove, S. Klotz and J. Philippe, patent n. 1358938 [2] C. Cavazzoni et al., Science 283, (1999) 44; T. Guillot, Science 286 (1999), 77. [3] L. E. Bove et al., Phys. Rev. Letters 111, (2013) 185901.
16:00		***Coffee Break***
		II: Neutrons for Energy Science *Chair: Martin Månsson, EPFL & PSI Villigen*
16:30	**711**	**Towards sodium ion batteries: understanding sodium dynamics on a microscopic level** *Marisa Medarde [1], Mattia Mena [2], Jorge Gavilano [2], Ekaterina Pomjakushina [1], Jun Sugiyama [3], Kazuya Kamazawa [4], Vladimir Pomjakushin [2], Denis Sheptyakov [2], Bertram Batlogg [5], Hans-Rudolf Ott [5], Martin Månsson [2], Fanni Juranyi [2]* *[1] Laboratory for Developments and Methods, Paul Scherrer Institut, 5232 Villigen PSI* *[2] Laboratory for Neutron Scattering, Paul Scherrer Institut, 5232 Villigen PSI* *[3] Toyota Central Research and Development Laboratories, Nagakute, Aichi 480-1192, Japan* *[4] Comprehensive Research Organization for Science and Society, Tokai, Ibaragi 319-1106, Japan* *[5] Laboratory for Solid State Physics, ETH Zürich, 8093 Zürich* One of the most important scientific problems faced by our society is how to convert and store clean energy. In order to achieve a significant progress in this field we need to understand the fundamental dynamical processes that govern the transfer of energy on an atomic scale. For many energy devices -such as solid-state batteries-, this means understanding and controlling the complex mechanisms of ion diffusion in solids. In this talk I will present some examples illustrating the potential of neutron scattering in this fast growing, economically relevant field. The material chosen will be Na_xCoO_2, a Na-based analogue to Li_xCoO_2, one of the most common electrode materials in Li-ion batteries.
17:00	**712**	**Neutron diffraction: a useful tool to study reaction mechanisms of lithium ion batteries** *Claire Villevieille [1], Petr Novák [1], Michael Hess [2], Peter Bleith [1], Elias Castel [1], Lucien Boulet [1], Vikram Godbole [3], Tsuyoshi Sasaki [4]* *[1] Electrochemistry Laboratory, Paul Scherrer Institute, 5232 Villigen PSI* *[2] ETH Zürich, Vladimir-Prelog-Weg 1, 8093 Zürich* *[3] Robert Bosch Battery Solutions GmbH, Heilbronner Straße 358-360, DE-70469 Stuttgart* *[4] Toyota Central R&D Labs, 42 Yokomichi, 1192 Nagakute, Japan* Lithium-ion batteries are the most widely used portable energy source because of their high energy density. The researches are focused on new high-voltage cathode and high energy anode materials in order to allow a maximum voltage output. The development of new materials requires lot of structural investigations, such as X-ray diffraction and neutron diffraction. To study in real time the crystallography of the electrode materials it is necessary to perform reliable in situ diffraction experiments that allow dependable investigations of the changes occurring upon electrochemical cycling. The results obtained with our in situ neutron cell will be further discussed.

17:15	**713**	**(p,T) parameterization of the proton-phonon coupling in proton conducting electrolytes** *Artur Braun [1], Qianli Chen [2], Jan P. Embs [3], Stuart Holdsworth [1]* *[1] EMPA, Überlandstrasse 129, 8600 Dübendorf* *[2] Department Physik, ETHZ, 8093 Zürich* *[3] PSI, 5232 Villigen PSI* Super-protonic conductivity is highly wished for solid electrolytes for ceramic fuel cells and electrolyzers. Oxygen deficient metal oxides with perovskite structure are candidates. We investigate oxygen vacancy filling by water with electro-analytical methods and ambient pressure XPS, which enable to sketch a detailed picture of the correlation of molecular and electronic structure changes, and the concomitant onset of proton conductivity. Proton phonon coupling is investigated with high (p,T) impedance spectroscopy combined with QENS. Supported with p-dependent XRD and Raman scattering we correlate proton jumping with T and find that the jump times follow a Holstein polaron relation.
17:30	**714**	**Small-Angle Neutron Scattering Study of the Structure and Morphology of Radiation-Grafted Proton-Conducting Membranes** *Gergely Nagy [1], Véronique Sproll [2], Urs Gasser [1], Sándor Balog [3], Lorenz Gubler [2]* *[1] Laboratory for Neutron Scattering, Paul Scherrer Institut, 5232 Villigen PSI* *[2] Electrochemistry Laboratory, Paul Scherrer Institut, 5232 Villigen PSI* *[3] Adolphe Merkle Institute, University of Fribourg, Rte de l'Ancienne Papeterie, 1723 Marly 1* Polymer electrolyte fuel cells using hydrogen can serve as clean and efficient energy converters. The most crucial component of these electrochemical cells is the proton conducting membrane. The proton conductivity, mechanical stability and durability of these membranes are strongly affected by the phase segregation found on the nanoscale, a topic extensively studied with various methods [1-2] such as small-angle neutron scattering an ideal technique for this class of materials [3]. [1] Balog, S. et al. (2013) Polymer 54; [2] Balog, S. et al. (2011) J. Membr. Sci. 383; [3] Balog, S. et al. (2010) Macromol. Chem. Phys. 211
17:45		
18:15		***Postersession and Apéro***
20:15		***Public Lecture***

Tuesday, 01.07.2014, Room E 230

Time	ID	III: Neutron Sources & Instrumentation *Chair: Kurt Clausen, PSI Villigen*
14:30	**721**	**ESS: current status and future developments** *Ken Andersen, ESS, Lund* The European Spallation Source (ESS) in Lund, Sweden, will be the world's leading neutron facility, using a linear proton accelerator to produce 5 MW of spallation neutrons from its target. It will come on-line in 2019 and reach its full suite of 22 instruments by 2028. The science which will be performed at the ESS is enabled by the neutron instruments which are currently being designed in a coordinated effort across Europe, developing both the instrument concepts and the associated neutron technologies. An overview is given of the current status of the ESS project, source characteristics and instrument suite.

15:00	**722**	**CAMEA - a novel secondary spectrometer at RITA-II** *Henrik Rønnow [1], Felix Groitl [1], Marko Marton [2], Christof Niedermayer [2], Christian Rüegg [2]* *[1] LQM, EPFL, Station 3, 1015 Lausanne* *[2] LNS, PSI, 5232 Villigen* The novel neutron spectrometer concept CAMEA will be installed as a new back-end at the cold TAS RITA-II at the PSI, Switzerland. The design employs a series of upwards scattering analyser arcs behind each other, allowing each analyser to collect neutrons over different energy ranges and a large solid angle. Thus, in a single data-acquisition an entire constant-energy line in the horizontal scattering plane is recorded for a quasi-continuous angular coverage of about 60°. Combined, the 2-3 orders of magnitude gain in neutron detection efficiency will result in a state-of-the-art spectrometer, which will be particularly suited for extreme environments and small samples.
15:15	**723**	**Neutron imaging of spatial variation in crystalline structure by means of energy-selective methods** *Steven Peetermans, Eberhard Lehmann* *Neutron Imaging and Activation Group, Paul Scherrer Institut, 5232 Villigen PSI* Standard polychromatic neutron imaging allows for non-destructive insight in the 3D materials distribution at high spatial resolution (~50 µm). When utilizing a monochromatic beam, the cross-section of polycrystalline materials exhibits abrupt Bragg edges that can be used to study the spatial variation in crystallographic phase. In case of large crystallites (~1 mm) it features sharp peaks that can be used for grain orientation mapping. Conversely, one can employ a polychromatic beam, with the crystallites acting as monochromators themselves and grain projections are formed by the diffracted neutrons. Novel neutron imaging methods and setups are introduced, with examples and applications given.
15:30	**724**	**Adaptive optics and cryo-lenses: Neutron focusing within sample environment** *Uwe Filges, Marek Bartkowiak, Emmanouela Rantsiou, Paul Scherrer Institut, 5232 Villigen PSI* Sample sizes in the sub-mm range have become common practice in the study of novel phenomena in materials science. However, neutron scattering techniques are flux limited and experiments on sub-mm samples suffer from long measurement times or low signal to noise ratios. Modern neutron focusing techniques can provide a way to surpass these problem. We have successfully performed a powder diffraction experiment on the powder diffractometer DMC at SINQ combining a pressure cell with an integrated focusing element and a detached, adaptable, pre-focusing neutron lens. The results are compared with measurements using the standard setup of the instrument and Monte Carlo simulations.
15:45	**725**	**A technically simple broadband neutron spin filter based on dynamically polarized protons using photo-excited triplet states** *Nemanja Niketic, Tim Eichhorn, Patrick Hautle, Ben van den Brandt, Tom Wenckebach* *Paul Scherrer Institute, 5232 Villigen* The use of polarized protons as neutron spin filter is an attractive alternative to the well-established neutron polarization techniques due to the large spin-dependent neutron scattering cross section for protons. Employing optically excited triplet states for the dynamic nuclear polarization (DNP) of the protons relieves the stringent requirements of classical DNP schemes, i.e low temperatures and strong magnetic fields. Using triplet DNP a record polarization of 71% has been achieved in a naphthalene single crystal at a field of 0.36 T using a simple helium flow cryostat for cooling. This result manifests an important step towards the development of a novel and simple broadband neutron spin filter.
		IV: Award Talks *Chair: Henrik Rønnow, EPFL*
16:00	**26**	***Winner of the SGN Young Scientist Prize (i)***
16:15	**27**	***Winner of the SGN Young Scientist Prize (i)***
16:30		***Coffee Break***

Time	ID	V: Neutrons for Condensed Matter *Chair: Tom Fennell, PSI Villigen*
17:00	**731**	**Electric-field coupling with the magnetoelectric skyrmion lattice in Cu_2OSeO_3** *Jonathan White [1], Krunoslav Prsa [2], Ping Huang [2], Arash Omrani [2], Ivana Levatic [3], Ivica Zivkovic [3], Marek Bartkowiak [4], Nikola Egetenmeyer [1], Jorge Gavilano [1], Joachim Kohlbrecher [1], Gergely Nagy [1], Helmuth Berger [5], Arnaud Magrez [5], Henrik Rønnow [2]* *[1] Laboratory for Neutron Scattering, Paul Scherrer Institut, 5232 Villigen* *[2] Laboratory for Quantum Magnetism, EPFL, Station 3, 1015 Lausanne* *[3] Institute of Physics, Bijenicka 46, HR-10000 Zagreb* *[4] Laboratory for Developments and Methods, Paul Scherrer Institute, 5232 Villigen* *[5] Crystal Growth Facility, EPFL, Station 3, 1015 Lausanne* Magnetic skyrmions are spin vortex-like objects that attract great attention due to their nanometric size, topological stability, and current density driven motion. Among the known skyrmion lattice host materials, Cu_2OSeO_3 is the only magnetoelectric insulator. The open questions concerned the ability to manipulate the skyrmions using electric fields, this being more efficient than using electric currents that are subject to resistive losses. Using neutron scattering, we demonstrate that electric fields indeed couple to the skyrmions in Cu_2OSeO_3, and allow control of the skyrmion lattice orientation. The results constitute the first evidence for the electric field control of topologically-protected magnetism.
17:15	**732**	**Electric polarization and spiral magnetic order below 200 K in $YBaCuFeO_5$** *Mickaël Morin [1], Ekaterina Pomjakushina [1], Denis Sheptyakov [2], Lukas Keller [2], Juan Rodríguez-Carvajal [3], Andrea Scaramucci [4], Nicola Spaldin [4], Michel Kenzelmann [1], Kazimierz Conder [1], Marisa Medarde [1]* *[1] Laboratory for Developments and Methods, Paul Scherrer Institut, 5232 Villigen* *[2] Laboratory for Neutron Scattering, Paul Scherrer Institut, 5232 Villigen* *[3] Institut Laue-Langevin, BP 156X, FR-38042 Grenoble* *[4] Materials Theory, ETH Zürich, Wolfgang-Pauli-Strasse 27, 8093 Zürich* $YBaFeCuO_5$ constitutes a remarkable exception among magnetism-driven multiferroics. Spontaneous polarization has been recently found to develop below $T_C \approx 200$ K coinciding with a commensurate-to-incommensurate spin reorientation [1]. The observation of incommensurable order at such high temperatures is rather surprising, and its possible link to low dimensionality or geometrical frustration is presently not understood. Although the existence of the spin reorientation is known since 1995 [2] the low-temperature incommensurate magnetic structure has not yet been reported. Using neutron powder diffraction we have recently proposed a spiral model that satisfactorily describes the magnetic intensities [3]. We also discuss the role of the structure in the stabilization of the incommensurate magnetic order. [1] B. Kundys et al., Appl. Phys. Lett. 94, 072506, (2009). [2] V. Caignaert et al., J. Solid State Chem. 114, 24, (1995). [3] M. Morin et al., in preparation
17:30	**733**	**Inelastic neutron scattering reveals details on the thermal evolution of magnetic excitations in dimer systems** *Diana Lucia Quintero Castro, Helmholtz Zentrum Berlin, Hahn Meitner Platz 1, DE-14109 Berlin* In dimer systems, strong antiferromagnetic interactions couple the spins into pairs and the energy levels consists of a singlet ground state and triplet excited states. These dimer excitations are hard-core bosons with strong and short-range repulsive interactions, which scatter in a highly correlated way within a phase space that is restricted by an energy gap. Single crystal inelastic neutron scattering reveals important information on the strength of the magnetic correlation in these systems and in how the excitations behave when strong thermal fluctuations are present. Here, the case of $Sr_3Cr_2O_8$, a 3-dimensional dimer system will be presented.

18:00 | **734**

Pressure-driven dimensionality change in a quantum magnet

Markos Skoulatos [1], Christoph Fiolka [2], Martin Mansson [1], Jonathan White [1], Karl Krämer [2], Christian Rüegg [1]
[1] Paul Scherrer Institut, 5232 Villigen PSI
[2] University of Bern, 3012 Bern

Low-dimensional quantum magnetism has long been at the center of attention in condensed matter physics mainly due to the simplicity and beauty of such physical systems. In $CuF_2(D_2O)_2$(pyz) (pyz=pyrazine) and at ambient pressure, the S=1/2 spins of Cu^{2+} ions form a 2D square lattice. Bulk properties imply that above some critical pressure the system changes dimensionality due to a complete reorientation of the Jahn-Teller axis [1,2]. We were able to directly measure such a transition for the first time ever, employing inelastic neutron scattering.

[1] G. J. Halder et al., Angew. Chem. Int. Ed. **50**, 419 (2011).
[2] S. Ghannadzadeh et al., Phys. Rev. B **87**, 241102(R) (2013).

18:15 | **735**

Magnon modes in α-$CaCr_2O_4$ measured by neutron scattering and far infrared spectroscopy

Sándor Tóth [1], Christian Rüegg [1], Bella Lake [2], Michael Schmidt [3], Joachim Deisenhofer [3]
[1] Paul Scherrer Institut, 5232 PSI Villigen
[2] Helmholtz-Zentrum Berlin, Hahn-Meitner Platz 1, DE-14109 Berlin
[3] University Augsburg, Universitätsstr. 2, DE-86159 Augsburg

α-$CaCr_2O_4$ is a spin-3/2, distorted triangular lattice Heisenberg antiferromagnet. It develops long-range magnetic order below 42 K where the angles between nearest neighbor spins are 120° on the triangular planes. This simple magnetic structure masks the complex pattern of exchange interactions [1]. The magnetic excitation spectrum measured by inelastic neutron scattering reveals unusual low energy modes with roton like minima [2,3]. We propose a magnetic Hamiltonian that can explain both the field dependent THz spectroscopy and the neutron scattering data.

[1] S. Toth, et.al.,PRB 84, 054452
[2] S. Toth, et.al.,PRL 109, 127203
[3] D. Wulferding, et.al.,JPCM 24, 435604

18:30 | **736**

Non-equilibrium spin relaxation and hysteresis in the mixed-anisotropy dipolar coupled spin-glass $LiHo_{0.50}Er_{0.50}F_4$

Julian Piatek [1], Bastien Dalla Piazza [1], Peter Babkevich [1], Ivan Kovacevic [1], Jorge Gavilano [2], Henrik Rønnow [1]
[1] Laboratory for Quantum Magnetism, EPFL, Station 3, 1015 Lausanne
[2] Laboratory for Neutron Scattering, Paul Scherrer Institut, 5232 Villigen PSI

We present a combination of bulk AC susceptibility, magnetization and magnetocaloric effect along with small angle neutron scattering (SANS) measurements on the model spin-glass $LiHo_{0.50}Er_{0.50}F_4$. The bulk measurements reveal hysteretic behaviour in all measured quantities and macroscopic relaxation of the moments from the non-equilibrium state when a magnetic field is applied along the c-axis below 100 mK. SANS measurements are used to track the microscopic spin-configuration during the hysteresis loop and relaxation. Mean-field calculations performed on a box of a million unit cells are employed to complete the interpretation of the spin configuration throughout the process.

18:45	**737**	**Quasielastic scattering in $Tb_2Ti_2O_7$ and $Y_{1.9}Tb_{0.1}Ti_2O_7$** *Martin Ruminy [1], Ekaterina Pomjakushina [2], Michel Kenzelmann [2], Tom Fennell [1]* *[1] Laboratory for Neutron Scattering, Paul Scherrer Institut, 5232 Villigen PSI* *[2] Laboratory for Developments and Methods, Paul Scherrer Institut, 5232 Villigen PSI* The rare earth pyrochlore $Tb_2Ti_2O_7$ remains a conundrum after more than a decade. Experimentally, a spin liquid phase with strong magnetoelastic effects survives to lowest temperatures and recent neutron experiments have shown a strong spin-lattice coupling at relatively high energies [1]. The neutron spectrum of $Tb_2Ti_2O_7$ also contains significant low energy scattering, which has variously been interpreted [2,3]. Here we report on new high resolution neutron experiments on polycrystalline $Tb_2Ti_2O_7$ and $Y_{1.9}Tb_{0.1}Ti_2O_7$. We show that the quasielastic scattering in the magnetoelastic spin liquid phase of $Tb_2Ti_2O_7$ must be attributed to cooperative fluctuations of the Tb^{3+} ions and cross over to single-ion fluctuations upon diluting the magnetic lattice or warming. [1] Fennell et al., Phys. Rev. Lett. 112, 017203 (2014); [2] Bonville et al., Phys. Rev. B 84, 184409 (2011); [3] Gaulin et al., Phys. Rev. B 84, 140402(R) (2001);
19:00	**738**	**New lanthanide-copper single molecule magnets examined using inelastic neutron scattering spectroscopy** *Stefan Ochsenbein, Laboratory for Neutron Scattering, Paul Scherrer Institut, 5232 Villigen PSI* Compounds that show slow relaxation of the magnetization of purely molecular origin are called single-molecule magnets (SMMs). We report the synthesis, structure, and magnetic properties of two new molecular clusters with abbreviated formula {$TbCu_3$} and {$DyCu_3$}. The SMM behaviour of these compounds was observed in frequency-dependent *ac* magnetic susceptibility measurements and single-crystal hysteresis loops. Inelastic neutron scattering spectroscopy was used to accurately measure the *ferromagnetic* exchange interactions between the central lanthanide ion and the three copper ions, which revealed that these interactions are at the origin of the slow relaxation of the magnetization in these new mixed-metal SMMs.
19:15	**739**	**Disorder-quenched quantum criticality in cuprate superconductors?** *Johan Chang, EPFL, Station 3, 1015 Lausanne* Fermionic quantum criticality is a topical theme of condensed matter physics. On approaching a quantum critical point all length and time scales diverge according to most simple theories [1]. However, recently it has become clear that disorder may quench this quantum criticality [2]. In this presentation, the experimental situation around field-induced magnetic quantum critical points underneath the superconducting dome in cuprate materials [3] will be discussed and yet unpublished neutron scattering data will be presented. [1] S. Sachdev, Quantum phase transitions, Cambridge University Press. [2] M. Vojta, Phys. Rev. Lett. 111, 097202 (2013) [3] J. Chang et al., Phys. Rev. Lett. 102, 177006 (2009)
19:30		***END***
19:45		***Conference Dinner***

ID	**Frontier Experiments with Neutrons Poster**
751	**Science and Instrumentation Projects at the Swiss Spallation Neutron Source SINQ** *Christian Rüegg, Lab. for Neutron Scattering, PSI and University of Geneva, WHGA 149, 5232 Villigen PSI* Neutron scattering and imaging are important experimental techniques for studies in many areas of fundamental science and technology. An overview of current instruments and instrumentation projects at the Swiss Spallation Neutron Source SINQ at the Paul Scherrer Institute and for the European Spallation Source ESS will be presented. In the second part, recent results from studies of magnetic model materials will be discussed. Systems of current interest include materials with quantum critical points that can be studied in detail by neutron scattering, one-dimensional compounds with frustration, or quenched disorder.

752 **Spin waves excitations of J1-J2 zigzag chains in $SrDyO_4$**

Nicolas Gauthier [1], Michel Kenzelmann [1], Amy Poole [2], Andrea Bianchi [3], Jacques Ollivier [4]
[1] LDM, Paul Scherrer Institut, 5232 Villigen PSI
[2] LNS, Paul Scherrer Institut, 5232 Villigen PSI
[3] Département de Physique, Université de Montréal, 2900 boul. Édouard-Montpetit, Montreal H3T 1J4, Canada
[4] Institut Laue-Langevin, 6, rue Jules Horowitz, FR-38042 Grenoble

Compounds of SrR_2O_4 family (R=Dy, Ho or Er) are geometrically frustrated rare-earth magnets with strongly correlated fluctuating ground states [1]. Coexistence of two different magnetic orders, mostly short range, is observed in these compounds and can be described with the Ising zigzag chain model on two inequivalent sites [2,3]. We have studied the magnetic excitations in $SrDy_2O_4$ by inelastic neutron scattering with IN5 spectrometer. While long range order is not observed, classical spin wave theory for zigzag chains with large single-ion anisotropy describes adequately the measured spin waves from which J-values have be obtained.

[1] H. Karunadasa et al. PRB 71, 144414 (2005).
[2] O. Young et al., PRB 88, 024411 (2013).
[3] A. Poole et al., arXiv:1401.3265 [cond-mat.str-el] (2014).

753 **Domains and multiferroicity in $CuCrO_2$: a single crystal neutron diffraction study**

Matthias Frontzek, Laboratory for Neutron Scattering, Paul Scherrer Institut, WHGA 242, 5232 Villigen-PSI

In our contribution, we present a detailed study on $CuCrO_2$ single crystals using neutron diffraction in applied electric and magnetic fields. The domain population is changed only slightly by the electric field and the observed multiferroic properties arise only from a fraction of the whole crystal. Further, the sign reversal of the electric polarization through a reversed electric field is not accompanied by a domain re-distribution. This indicates a coupling of the electric polarization to the chirality of the magnetic spiral.

754 **CAMEA – The Continuous Angle Multiple Energy Analysis Spectrometer for the European Spallation Source.**

Paul Freeman [1], Henrik Rønnow [1], Christof Niedermayer [2], Marko Marton [2]
[1] LQM, EPFL, Station 3, 1015 Lausanne
[2] Paul Scherrer Institute, 5232 Villigen PSI

The CAMEA instrument concept is a neutron spectrometer designed for optimal efficiency in the horizontal scattering plane that enables detailed and rapid mapping of excitations. This optimization is ideally suited to studies of materials under extreme environments, the complex sample environs of in-situ experiments, or concentrated studies of specific regions of reciprocal space. We will introduce the indirect geometry spectrometer CAMEA concept, and show how combining CAMEA with the time-of-flight method at the European Spallation Source produces a quantum leap in neutron instrumentation for spectroscopy. Finally we highlight the experimental capabilities of CAMEA for measuring materials under extreme conditions.

755 **Magnetic frustration, hierarchy of exchange interactions, and idle spin behavior in a 2D lattice of bow-ties.**

Romain Sibille [1], Michel Kenzelmann [1], Virginie Simonet [2], Elsa Lhotel [2], Bernard Malaman [3], Gérard Venturini [3], Thomas Mazet [3], Matthias Frontzek [1], Vladimir Pomjakushin [1], Marek Bartkowiak [1], Markus Zolliker [1], Michel François [3]
[1] Paul Scherrer Institut, 5232 Villigen PSI
[2] Institut Néel, 25 avenue des Martyrs BP 166, FR-38042 Grenoble
[3] Institut Jean Lamour, Faculté des Sciences BP 70239, FR-54506 Vandoeuvre Les Nancy

The lattice of cations interconnected by oxygen atoms in the $M_5(OH)(C_4H_4O_4)_4$ (M^{2+} = Mn, Fe, Co) metal-organic frameworks is found to form an original 2D frustrated lattice of low connectivity comprising bow-tie units. We present results from macroscopic measurements and neutron diffraction experiments. Notably, we focus on the Fe^{2+} compound that displays a quasi-orthogonal arrangement of its magnetic moments, and spin dynamics for temperatures just below the ordering transition. Moreover, these peculiarities are rationalized by a mean field analysis with direct space magnetic configuration calculations. Besides the geometry of the lattice, the hierarchy of the intraplane magnetic interactions plays a significant role in the magnetic behavior of this material.

756 The magnetic phases of $(C_5H_{12}N)_2CuCl_4$ – An inelastic neutron scattering study.

Simon Ward [1], Christian Rüegg [1], Daniel Biner [2], Karl Krämer [2], Mattia Mena [3], Des McMorrow [3]
[1] Laboratory for Neutron Scattering, Paul Scherrer Institute, 5232 Villigen PSI
[2] Department of Chemistry & Biochemistry, University of Bern, Freiestrasse 3, 3012 Bern
[3] LCN, University College London, 9 Gordon St, London WC1H 0AH, UK

The ideal strong runged 2-leg antiferromagnetic spin ladder $(C_5H_{12}N)_2CuCl_4$ is an exemplary model material with negligible inter-ladder coupling. In one dimension, the antiferromagnetic spin ladder exemplifies the collective physics of reduced dimensionality and gives rise to a rich phase diagram. This includes a quantum disordered, Luttinger Liquid (LL) and ferromagnetic phase. Of particular interest is the field induced Luttinger liquid phase, which exists only in one-dimensional systems. Presented is results from inelastic neutron scattering studys on each phase, performed on the time of flight spectrometer LET (ISIS). The spectra are compared to DMRG simulations, showing remarkable agreement. Future experiments on low dimensional system will also be discussed.

757 A versatile sample stick for neutron scattering experiments in high electric fields

Marek Bartkowiak, Laboratory for Developments and Methods, Paul Scherrer Institut, 5232 Villigen PSI
Jonathan S. White, Laboratory for Neutron Scattering, Paul Scherrer Institut, 5232 Villigen PSI

We present a versatile high voltage sample stick that fits into all cryomagnets and standard cryostats at the Swiss Spallation Neutron Source, Paul Scherrer Institut, and which provides a low effort route to neutron scattering experiments that combine electric field with low temperature and magnetic field. The stick allows for voltages up to 5 kV and can be easily adapted for different scattering geometries. We discuss the design consideration and thermal behavior of the stick, and give one example to show- case the abilities of the device.

758 HEIMDAL: A time-of-flight neutron powder diffractometer at ESS Lund for in-situ/in-operandi materials science studies

Jürg Schefer [1], Mogens Christensen [2], Sonja Holm [3], Mad Bertelsen [3], Kim Lefmann [3]
[1] Paul Scherrer Institut, Laboratory for Neutron Scattering, 5232 Villigen PSI
[2] University of Aarhus, Chemistry Departement&iNano, DK-8000 Aarhus
[3] University of Copenhagen, Nanoscience Center, DK-2100 Copenhagen

Developing new materials is of paramount importance to combat future such as energy demands. In-situ and in-operandi investigations will be in the focus of such investigations. The instrument HEIMDAL proposed for the European spallation neutron source ESS will offer here perfect prospects, as the instrumental resolution of this powder diffractometer can widely be adapted and take full advantage of the broad pulse of ESS (2.86 ms) offering highest intensity, or using a fraction of the pulse for highest resolution. A thermal and a cold guide pointing to the same virtual source allow to combine NPD and SANS in one instrument with optimal optics for both.

759 General linear spin wave theory of incommensurate magnetic structures (SpinW Matlab library)

Sándor Tóth, Paul Scherrer Institut, WHGA-150, 5232 PSI Villigen
Bella Lake, Helmholtz-Zentrum Berlin, Hahn-Meitner Platz 1, DE-14109 Berlin

I present a simple and general method to calculate spin-spin correlation function using linear spin wave theory [1]. The general method can be applied to complex lattices with non-collinear ground states and arbitrary spin-spin exchange matrices, anisotropies, g-tensors and external magnetic field. SpinW is a Matlab library, that is developed to apply the above method. It is available to download from https://wiki.helmholtz-berlin.de/spinw.

[1] S. Toth, B. Lake, arXiv:1402.6069

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Investigation on the low temperature distorted phase of $MgCr_2O_4$

Shang Gao [1], Oksana Zaharko [1], Martin Ruminy [1], Tom Fennell [2], Vladmir Tsurkan [3], Christian Rüegg [1,4]
[1] LNS, Paul Scherrer Institut, 5232 Villigen PSI
[2] INS, Paul Scherrer Institut, 5232 Villigen PSI
[3] Dept. Phys., Uni. Augsburg, Universitätsstrasse 2, DE-86159 Augsburg
[4] Dept. Phys, Uni. Genève

Using x-ray synchrotron and neutron diffraction together with inelastic neutron scattering, we investigate the properties of the low temperature distorted phase of $MgCr_2O_4$. Powder synchrotron diffraction shows that the LT structure belongs to the Fddd space group, which is consistent with magnetic resonance measurements on the related $ZnCr_2O_4$ compound. Magnetic structure is solved from single crystal neutron diffraction data with both symmetry analysis and simulated annealing methods. Finally, spin wave dispersion was measured on both hot and cold neutron triple-axis spectrometers. Fitting the dispersion with linear spin wave theory reveals a significant contribution of further-neighboring interactions.

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ZEBRA: The new neutron single-crystal diffractometer at SINQ optimized for small samples and extreme conditions

Oksana Zaharko [1], Katharina Fromm [2], Christian Rüegg [1,3], Jürg Schefer [1], Matti Forster [4], Alex Bollhalder [4], Ulrich Sigrist [5]
[1] Paul Scherrer Institut, Laboratory for Neutron Scattering, 5232 Villigen PSI
[2] University of Fribourg, Department of Chemistry, 1700 Fribourg
[3] University of Geneva
[4] Paul Scherrer Institut, Laboratory for Methods and Developments, 5232 Villigen PSI
[5] Paul Scherrer Institut, LOG, 5232 Villigen PSI

ZEBRA is a new single crystal neutron diffractometer at SINQ optimized for parametric studies on small samples and for crystallographic investigations with an extended q-range. The construction will start in 2014 and commissioning is expected for 2017. ZEBRA will be capable of resolving future scientific challenges emerging in systems available as small crystals only and requiring extreme sample environments. The scientific projects in focus include the unconventional magnetic phases in frustrated magnets, Mott-insulating states in strongly spin-orbit coupled iridates, interplay of magnetism and superconductivity in unconventional superconductors, structure property relations in functional metal-organic and perovskite materials. To provide these new capabilities the instrument needs to achieve a high peak-to-background ratio.

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The First Neutron Laue Diffractometer in Germany

Gail N. Iles, Susan Schorr, Helmholtz-Zentrum Berlin, Hahn-Meitner Platz 1, DE-14109 Berlin

The Fast Acquisition Laue Camera for Neutrons (FALCON) in Berlin is a versatile Laue diffractometer offering variable sample-to-detector distance, a full range of sample environments, and incorporating a rotating transmission detector to generate a full map of reciprocal space. FALCON, as a new-build instrument, enters user service in 2015 offering the opportunity to study samples from fields such as low-temperature magnetism, high-temperature structural phase transitions, in-situ kinetics and point-defect analysis in compound semiconductors. We present here the technical details of this unique instrument and invite users to submit proposals for Laue diffraction experiments in the HZB 2015-I round.