

Neutron Science

THIS SESSION HAS BEEN ORGANISED IN COLLABORATION WITH THE
SWISS NEUTRON SCIENCE SOCIETY.

Wednesday, 06.09.2023, Room 117

Time	ID	NEUTRON SCIENCE I Chair: Gediminas Simutis, PSI Villigen
14:30	701	<p style="text-align: center;">Field-induced bound-state condensation and spin-nematic phase of $\text{SrCu}_2(\text{BO}_3)_2$ revealed by neutron scattering up to 25.9 T</p> <p style="text-align: center;"><i>Ellen Fogh¹, Maciej Bartkowiak², Frédéric Mila¹, Mithilesh Nayak¹, Bruce Normand³, Ekaterina Pomjakushina³, Oleksandr Prokhnenko², Henrik Rønnow¹</i> ¹ Ecole Polytechnique Fédérale de Lausanne ² Helmholtz-Zentrum Berlin für Materialien und Energie ³ Paul Scherrer Institute</p> <p>Chasing new states of quantum matter is a central element in condensed matter physics, motivated both by curiosity but also by the need for understanding of many-body quantum effects. One particularly interesting system is the frustrated Shastry-Sutherland model consisting of orthogonal spin pairs. The network of Cu^{2+} ions in $\text{SrCu}_2(\text{BO}_3)_2$ is topologically equivalent to this lattice and therefore presents a unique experimental testing opportunity. We study the magnetic excitations in $\text{SrCu}_2(\text{BO}_3)_2$ upon approaching the first magnetization plateau at 27 T using inelastic neutron scattering. At field values much below the transition an unexpected mode shows up. We set out to identify the nature of this new excitation.</p>
14:45	702	<p style="text-align: center;">Mapping the magnon modes of a square skyrmion lattice</p> <p style="text-align: center;"><i>Danielle Yahne¹, Wolfgang Simeth¹, Simon Flury¹, David Voneshen², Andrey Podlesnyak³, Daniel Mazzone¹, Jakob Lass¹, Christof Niedermayer¹, Stephane Raymond⁴, Sean Thomas⁵, Priscilla Rosa⁵, Marc Janoschek¹</i> ¹ Paul Scherrer Institut, ² ISIS Facility, Rutherford Appleton Laboratory ³ Spallation Neutron Source, Oak Ridge National Laboratory ⁴ Institut Laue-Langevin, ⁵ Los Alamos National Laboratory</p> <p>Intriguing topological magnetic textures, such as skyrmion lattices (SkL), have significant potential for applications to spintronic and memory devices. This potential crucially relies on finding new materials and mechanisms for SkL stabilization. So far, theory has been driving investigations of centrosymmetric SkL's, with only a few bulk material examples, namely Gd_2PdSi_3, $\text{Gd}_3\text{Ru}_4\text{Al}_{12}$, GdRu_2Si_2, and EuAl_4. Neutron scattering is an ideal probe to understand the interactions leading to SkL formation in these materials, but is practically impossible owing to the large neutron absorption of Gd and Eu. I will present recent neutron spectroscopy on a newly discovered Ce-based square-SkL, which enables a quantitative understanding of SkL stabilization mechanisms in real materials.</p>
15:00	703	<p style="text-align: center;">Frustration-induced diffuse magnetic scattering in metallic HoInCu_4</p> <p style="text-align: center;"><i>Xavier Boraley¹, Oliver Stockert², Oystein Fjellvag², Romain Sibille¹, Veronika Fritsch³, Daniel Mazzone¹</i> ¹ Paul Scherrer Institut, ² Max Plank Institute, ³ Augsburg University</p> <p>Materials with geometrical frustration are interesting study cases as they often exhibit unconventional phases of matter. While most research on frustrated materials have been performed on insulating spin systems, only little work has been done on metallic systems. Here, I will present recent neutron scattering results of the frustrated metal HoInCu_4, which features partial magnetic order where only half of the Holmium atoms exhibit long-range magnetic order, while the other half remain short-ranged. I will present diffuse magnetic scattering data as function of temperature, and discuss how they can be attributed to the magnetic nearest and next-nearest neighbor interactions.</p>
	704	cancelled

15:15	705	<p>Non-trivial effects of cation disorder on spin-ice-like compound $\text{Ho}_2\text{ScTaO}_7$</p> <p><i>Amirreza Hemmatzade ¹, Tom Fennell ¹, Igor Plokhikh ¹, Elsa Lhotel ², Arkadiy Simonov ³, Dharmalingam Prabhakaran ⁴</i> ¹ Paul Scherrer Institut, ² Institute Neel, ³ ETH Zürich, ⁴ University of Oxford</p> <p>Here we present our most recent results on the effects of charge disorder on classical spin ice. Motivated by our observations in the effects of correlated disorder in both structure and magnetism of fluoride pyrochlore compound CsNiCrF_6, we set out to study the effects of charge disorder in B-site of classical spin ice, $\text{Ho}_2\text{Ti}_2\text{O}_7$, our system of choice is $\text{Ho}_2\text{ScTaO}_7$. We identify the effects of disorder on the lattice structure, in modification of the crystal electric field potential and in the spin ice state.</p>
15:30	706	<p>Reverse Monte-Carlo modeling of artificial spin systems</p> <p><i>Artur Gregor Glavic ¹, Gavin Macaulay ^{1,2}</i> ¹ Paul Scherrer Institute, ² ETH Zürich</p> <p>Patterns of nano-scale magnets are important systems to investigate potential applications but also fundamental physics of dipole-dipole interactions. With certain frustration, artificial spin-ices can be created with highly degenerate ground states. These form only short range magnetic correlations that were predicted by Monte-Carlo simulations.</p> <p>We have used GISANS to study the magnetic correlations in a system of out-of-plane magnetized FeNi cylinders on a triangular lattice. Using the Yoneda line to extract a cut in the in-plane structure factor at various sample rotations we could gather the full 2D structure factor.</p> <p>With the application of reverse Monte-Carlo modeling and DWBA we were able to perform a model free data analysis.</p>
15:45	707	<p>Complex magnetic order and inverse magnetic melting in Ce_3TiSb_5</p> <p><i>Marc Janoschek ¹, Simon Flury ¹, Yongkang Luo ², Wolfgang Simeth ¹</i> ¹ Paul Scherrer Institut, ² Huazhong University of Science & Technology</p> <p>We report high-resolution neutron diffraction on the heavy fermion antiferromagnet Ce_3TiSb_5. Our specific heat and magnetic susceptibility measurements as a function of magnetic field reveal a phase diagram with three distinct magnetic phases. Using neutron diffraction we study the magnetic structure, and uncover a multi-k spin structure in the intermediate field phase. Magnetic multi-k structures are of current interest because they are an important ingredient for topologically non-trivial properties. Finally, our measurements demonstrate that the high-field magnetic phase exhibits inverse melting, where the magnetically ordered state becomes disordered upon cooling, which suggests that the complex magnetic order of Ce_3TiSb_5 is driven via the competition of several degrees of freedom.</p>
16:00	708	<p>Study of new strong-leg spin ladder with neutron scattering</p> <p><i>Jonas Philippe, Marc Janoschek, Daniel Mazzone, Gediminas Simutis, Paul Scherrer Institut</i></p> <p>Quantum simulators are experimentally available materials, which satisfy well-defined quantum Hamiltonians and allow the quantitative prediction of spectacular many-body effects. An example of such materials are ideal spin ladders. So far, only one strong-leg spin ladder was studied. We recently managed, thanks to a breakthrough, to grow a second strong-leg spin ladder in large crystals, and deuterate them – making a study with neutron spectroscopy achievable. Here, we present our neutron spectroscopy measurements where both time of flight and multiplexing instruments were used. We determined the excitation spectrum from which the dispersion and Hamiltonian parameters were extracted. Finally, we will discuss future work to tune this material using uniaxial pressure.</p>
16:15		
16:30		Coffee Break

Time	ID	<p style="text-align: center;">NEUTRON SCIENCE II <i>Chair: Marc Janoschek, PSI Villigen, Gediminas Simutis, PSI Villigen</i></p>
17:00	711	<p style="text-align: center;">Search for Axion-Like Dark Matter and Exotic Yukawa-Like Interaction</p> <p style="text-align: center;"><i>Ivo Schulthess, Universität Bern</i></p> <p>Despite the undoubted success of the Standard Model of particle physics, it fails to answer many longstanding questions. These include the observed dark matter and the baryon asymmetry in our universe. Many theoretical models that try to answer those questions require new particles and gauge bosons, which must be verified or excluded experimentally. In this talk, I will present the search for two such candidates. The first candidates are ultralight pseudo-scalar particles called axion-like particles (ALPs). We searched for them using a Ramsey-type apparatus for cold neutrons. A hypothetical coupling of ALPs to gluons would manifest in a neutron electric dipole moment signal oscillating in time. Twenty-four hours of data have been analyzed in a frequency range from 23 μHz to 1 kHz, and no significant oscillating signal has been found. Present dark-matter models allow for constraining the coupling of ALPs to gluons. The second candidate is an axial-vector gauge boson that could mediate a Yukawa-like interaction in the millimeter range between Standard Model fermions. We built a tabletop experiment that applies Ramsey's technique to the proton spins of hydrogen in water. We performed a proof-of-principle search for this exotic interaction and measured radio-frequency effects like the Bloch-Siegert shift and dressed spin states.</p>
17:30	712	<p style="text-align: center;">Nonreciprocal chiral magnons in multiferroic Ni_3TeO_6</p> <p style="text-align: center;"><i>Daniel Mazzone¹, Jakob Lass¹, Brigitte Decrausaz²</i> ¹ Paul Scherrer Institut, ² Universität Zürich</p> <p>The interplay among electronic charge, orbital, spin and lattice degrees of freedom in quantum materials can stabilize a variety of collective phenomena. Substantial understanding concerning the microscopic origin of these correlated quantum phases is gained through microscopic studies susceptible to the various degrees of freedom, and their dependencies on external tuning parameters. Here, we will show how the combination of various neutron spectrometers equipped with different sample environments allowed us to clarify the mechanism behind the multiferroic properties of Ni_3TeO_6. Our studies show that its non-chiral crystal structure gives rise to non-reciprocal chiral low-energy magnons, whose condensation trigger a direct coupling between the material's electric polarization and magnetic properties.</p>
17:45	713	<p style="text-align: center;">Towards higher brilliant beam for neutron scattering under very high pulsed magnetic fields</p> <p style="text-align: center;"><i>Mina Akhyani, Henrik Rønnow, EPFL</i></p> <p>Neutron scattering experiments under high pulsed magnetic fields offer valuable insights into magnetic structures of materials. However, these experiments are challenging and time-consuming due to low neutron count. To address this, we proposed the idea of a specialized source, designed to increase neutron count and improve brilliance serving only one single instrument. The main features of this source are: an spallation target station fed by an existing high-energy proton accelerator every 5 - 10 minutes, synchronized with magnetic pulses, which drastically decreases the average heat and radiation load. We investigated different target-moderator-reflector geometries and materials to achieve maximum brilliance. By an ideal neutron transfer, we can gain higher count on the sample.</p>

18:00	714	<p style="text-align: center;">Neutron beta-decay experiments</p> <p style="text-align: center;"><i>Irina Pradler, Hartmut Abele, Andreas Doblhammer, Alberto José Saavedra García Technische Universität Wien - Atomnstitut</i></p> <p>High-precision measurements of angular correlations in neutron beta decay address a number of questions which are at the forefront of particle physics. For a new generation of beta decay experiments, like the PERC currently under construction in Munich, frequency-based beta spectroscopy using the cyclotron radiation emitted by electrons in a homogeneous magnetic field have been emerging. PERC is the successor of the PERKEO-III, which established pulsed neutron beam technique. In this talk some PERKEO-III results and status update for PERC will be presented. Design study of CREScEnt experiment, a proof-of principle experiment aiming to combine the CRES technique with the signal amplification qualities of an RF cavity, will be introduced.</p>
18:15	715	<p style="text-align: center;">Neutron radiography investigations of cladding tube materials under interim dry storage conditions</p> <p style="text-align: center;"><i>Sarah Weick, Mirco Große, Conrado Roessger, Martin Steinbrück Karlsruhe Institute of Technology</i></p> <p>Zirconium alloys are used as nuclear fuel cladding material, but hydrogen is taken up by the cladding during operation and precipitates during cooling. During interim dry storage the cladding tubes are affected by mechanically and thermally induced stresses. In order to investigate zirconium and cladding tubes at similar conditions, we observe in-situ the hydrogen diffusion in dependence of its solubility and elastic tensile stresses. For this purpose, a facility is used that allows tensile tests at different temperatures when installed in neutron beamlines. It is advantageous to use Neutron Radiography for the metal zirconium, because of its very low neutron cross section that, contrarily to hydrogen, attenuates neutrons only weakly.</p>
18:30	716	<p style="text-align: center;">Imaging the Magnetization Process of Large Grain Silicon Steel using Polarized Neutrons</p> <p style="text-align: center;"><i>Alex Backs^{1,2}, Matteo Busi³, Wai Tung Lee², Dmytro Orlov¹, Simon Sebold⁴, Markus Strobl³ ¹ Lund University, ² European Spallation Source, ³ Paul Scherrer Institut ⁴ Research Neutron Source Heinz Maier-Leibnitz (FRM II)</i></p> <p>Grain-oriented silicon steels are established as high performance magnetic core materials in transformers. Their large crystal grains with strong texture gives them pronounced uniaxial magnetic properties. Polarized neutron imaging is capable of investigating the bulk magnetic properties with spatial resolution. The technique is capable sensitive to magnetic order and disorder in the form of spin rotation and depolarization, respectively. Here we present a spin-rotation analysis of the remanent state of a silicon steel-sheet and depolarization data showing the magnetization process. The experiments were performed with a custom magnetic environment, which was designed and evaluated using finite element field calculations and Monte Carlo simulations of the neutron spin evolution.</p>
18:45	717	<p style="text-align: center;">Neutron imaging investigations of the hydrogen distribution in nuclear fuel cladding tubes after simulated accidents</p> <p style="text-align: center;"><i>Mirco Große, Juri Stuckert, Martin Steinbrück, Sarah Weick, Karlsruhe Institute of Technology</i></p> <p>The reaction of hot nuclear fuel rods with steam results in production of free hydrogen. The released part of this hydrogen provide the risk of hydrogen detonation The other part is absorbed in the fuel cladding tubes made of zirconium alloys. This is the more dangerous one because it can be result in an embrittlement of the cladding tubes and with it in a destruction of the tubes by thermos-shock if an emergency cooling is initiated.</p> <p>The paper presents results of neutron imaging investigations of cladding tubes after accident simulation tests. Hydrogen concentrations were determined quantitatively with a spatial resolution of better than 50 μm.</p>

19:00	718	<p>Investigation of hydrogen distribution in hybrid Ti-Mg implant materials using neutron tomography</p> <p><i>Richi Kumar¹, Vasil Garamus¹, Pavel Trtik², Carsten Blawert¹, Maria Serdechnova¹, Thomas Ebel¹, Wolfgang Limberg¹, Regine Willumeit-Römer¹</i> ¹ Helmholtz-Zentrum Hereon, ² Paul Scherrer Institut</p> <p>Hybrid implants consisting of a permanent Ti-based part combined with a degradable Mg part, are promising solutions to improve the biocompatibility and stability of current implants. In these implants the Ti provides high strength while temporary Mg part is used for bone stimulation or drug delivery. As Mg degrades hydrogen gas is released which ingresses into the Ti part, leading to changes in its properties. To investigate this phenomenon, sintered hybrid samples prepared using metal injection moulding were subjected to saline degradation for a period of 0 to 120 hours and neutron tomography was used to study the ingress of hydrogen in 3D after the degradation of Mg.</p>
19:15	719	<i>cancelled</i>
19:30		END

ID		NEUTRON SCIENCE POSTER
731		<p>BYO Beamline Experiment with FRAPPY</p> <p><i>Marek Bartkowiak¹, Markus Zolliker¹, Georg Brandl², Enrico Faulhaber³, Alexander Zaft²</i> ¹ Laboratory for Neutron and Muon Instrumentation (LIN), Paul Scherrer Institut ² Jülich Centre for Neutron Science (JCNS) at Heinz Maier-Leibnitz Zentrum (MLZ), Forschungszentrum Jülich ³ Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II), Technical University of Munich</p> <p>Frappy is a python framework to implement a device communication and abstraction layer for complex sample environment equipment such as cyostats, cryomagnets, furnaces, humidity chambers and for the integration of measurement devices. It is designed to build up complex setups for beamline experiments as well as for lab based measurements. It enables users of large scale facilities to integrate their own setups into the facility data acquisition work flow utilizing the sample environment communication standard SECoP. SECoP is already in use at SINQ/PSI and FRMII/MLZ and will become available at many other user facilities world wide.</p>
732		<p>CREScint: High-precision Electron Spectroscopy using Cyclotron Radiation Emissions</p> <p><i>Alberto José Saavedra García, Hartmut Abele, Andreas Doblhammer, Irina Pradler</i> <i>Technische Universität Wien - Atominstitut</i></p> <p>High-precision measurements of angular correlations in neutron beta decay are at the forefront of particle physics. For a new generation of beta decay experiments, like the PERC (Proton Electron Decay Channel) experiment under construction in Munich, frequency-based beta spectroscopy methods using the cyclotron radiation emitted by electrons in a homogeneous magnetic field have been emerging as new methods for high-precision energy measurements. The CREScint experiment is a proof-of-principle experiment aiming to combine the CRES (Cyclotron Radiation Emission Spectroscopy)-technique with the signal amplification qualities of a RF cavity, naturally compensating for the extremely weak signal power of the expected cyclotron radiation pulses.</p>
733		<p>COMSOL Simulations of the Active Magnetic Shielding of the n2EDM Experiment</p> <p><i>Sergey Ermakov, Vira Bondar, Klaus Stefan Kirch, Patrick Mullan, Nathalie Ziehl, ETH Zürich</i></p> <p>The n2EDM experiment searches for the neutron electric dipole moment, which could help understand the baryon asymmetry of the universe. To allow for high precision measurements, an active magnetic shielding (AMS) and a magnetically shielded room (MSR) for passive shielding ensure a magnetically controlled volume.</p> <p>Using the AMS coil system external magnetic fields can be compensated. The interplay between the AMS-generated fields and the mu-metal cube of the MSR is examined through COMSOL simulations. The poster discusses implementation and simulation methods and effects of the mu-metal cube on the AMS. The simulations also aim to find optimal positions for the AMS feedback sensors.</p>

734	<p style="text-align: center;">Competition of Superconductivity and Spin-Density Wave Fluctuations around the Quantum Critical Point of $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$</p> <p style="text-align: center;"><i>Brigitte Decrausaz¹, Johan Chang¹, Daniel Mazzone²</i> ¹ Universität Zürich, ² Paul Scherrer Institut</p> <p>Correlated materials often exhibit co-existing or competing quantum phases. An open question is whether the dominant phase eliminates the other one prior to its emergence. Here, I present a high resolution time-of-flight neutron spectroscopy study on the low-energy incommensurate spin excitations of superconducting $\text{La}_{1.85\text{S}}\text{Sr}_{0.14\text{S}}\text{CuO}_4$. We find that the spin excitations observed above the superconducting transition temperature are suppressed by the emergence of a superconducting spin gap. Our results suggest that a dynamic competition between superconductivity and magnetism impedes the condensation of the spin-density wave fluctuations.</p>
735	<p style="text-align: center;">Targeted use of residual stress in electrical steel to increase energy efficiency</p> <p style="text-align: center;"><i>Tobias Neuwirth¹, Simon Sebold¹, Ines Gilch², Benedikt Schauerte³, Maximilian Plötz², Michael Schulz¹</i> ¹ Research Neutron Source Heinz Maier-Leibnitz (FRM II), ² Chair of Metal Forming and Casting (TUM) ³ Institute of Electrical Machines and Chair in Electromagnetic Energy Conversion (RWTH Aachen)</p> <p>Climate change necessitates a reduction of fossil fuel usage. Particularly, transport relies primarily on fossil fuel. Electric vehicles are key to reduce this reliance. As part of an interdisciplinary project, we aim to develop more efficient electric drives using magnetic flux guidance in the rotor by targeted residual stress instead of cutouts. Increasing the maximum achievable rotational speed of electric drives by increasing the mechanical stability. Stacked electrical steel sheets compose the rotor, in which the magnetic flux needs to be guided. Using neutron grating interferometry, we can directly visualize the magnetic flux guidance, analyze local magnetic properties in the bulk and help refine the introduction of residual stress.</p>
736	<p style="text-align: center;">Microstructural Characterization Through Grain Orientation Mapping with Laue Three-Dimensional Neutron Diffraction Tomography</p> <p style="text-align: center;"><i>Stavros Samothrakitis¹, Jan Capek¹, Camilla Buhl Larsen¹, Efthymios Polatidis¹, Marc Raventos¹, Soeren Schmidt², Markus Strobl¹, Michael Tovar³, Robin Woracek²</i> ¹ Paul Scherrer Institute, ² European Spallation Source, ³ Helmholtz Zentrum Berlin</p> <p>For polycrystalline materials, key material properties depend significantly on the texture of the crystalline microstructure. Conventional assessment of texture is either limited to surface regions or it is destructive, probing small fractions of a specimen. Only high energy X-rays and neutrons enable quantitative studies of bulk texture. Here, we report how transformative progress in Laue three-dimensional neutron diffraction tomography enables to map several hundred grains and, thus, allows grain orientation assessment in the volume of centimetre-sized samples with statistical significance. The short exposure times and non-destructive nature of Laue3DNDT will support in-situ studies, while future improvements in spatial resolution shall include more accurate grain morphology in corresponding microstructure studies.</p>