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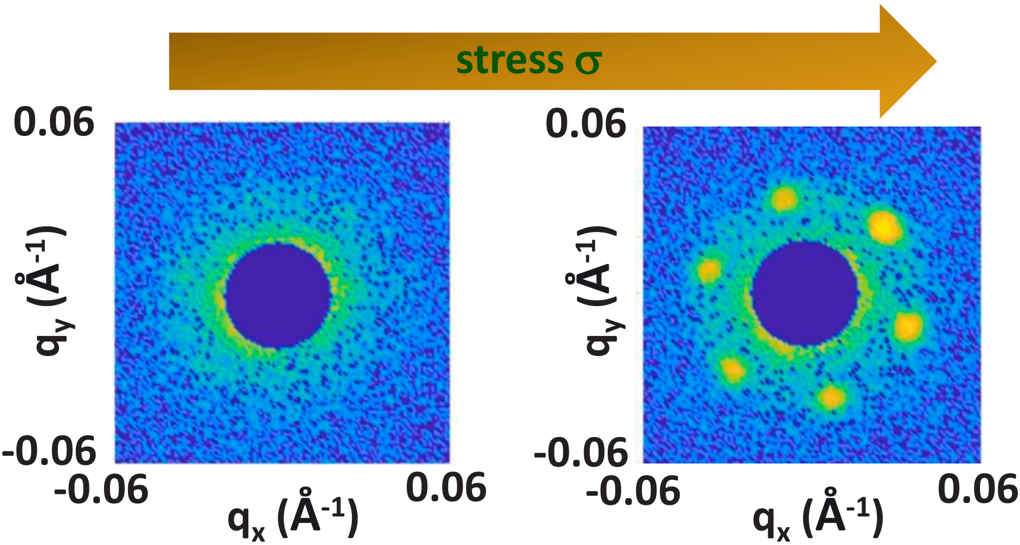
SWISS NEUTRON NEWS



Schweizerische Gesellschaft für Neutronenforschung
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On the cover

Skyrmion lattice induced by stress in MnSi, using a new uniaxial stress apparatus at PSI.

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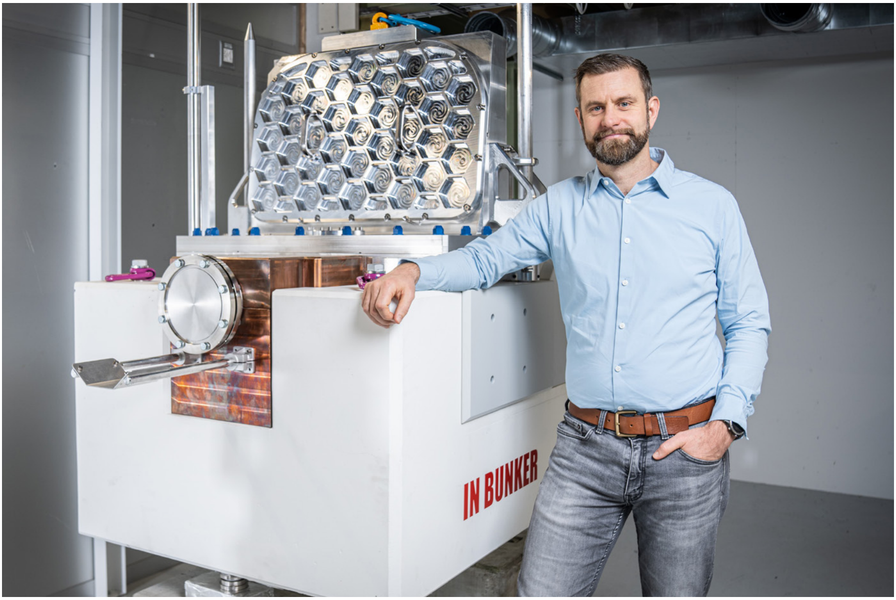

Dear fellow neutron scientists,

Between 2019 and 2020, the Paul Scherrer Institute has upgraded the neutron guide system of the Swiss Spallation Neutron Source, SINQ, to substantially improve the transport of neutrons to its suite of 17 instruments and enable new science on smaller samples and under extreme conditions. At the same time, upgrades of the instruments have also started. The new multiplexing spectrometer CAMEA has benefited from such an upgrade, which has been proven to perform at a very high level. This has quickly led to overbooking factors for CAMEA approaching 4, showcasing its increasing popularity with the user community and also that the investment in these upgrades is paying off.
It is therefore exciting to look already at the next group of upgraded instruments that is now becoming available; the upgraded powder diffractometer DMC has been available to

user since this spring, and the upgraded Selene-type reflectometer AMOR is in hot commissioning taken first users, and the small angle neutron scattering instrument SANS-LLB, which has been transferred from the LLB, has started commissioning. I am truly looking forward to learning about the first scientific success stories from this new set of instruments.

This is, however, not the last improvements to Swiss neutron facilities as two further upgrades of the thermal imaging instrument NEUTRA and the engineering diffractometer POLDI are also being currently prepared in collaboration with the Norwegian Institute for Energy Technology (IFE) and the Swiss Technology Transfer Center Anaxam. Finally, PSI has also started a project to exchange the moderator insert of the ultra-cold neutron source (UCN) to guarantee its long-term availability and at the same time improve the performance for fundamental physics experiments such as the flagship n2EDM, which aims to improve on the current best measurement of the neutron electrical dipole moment by an order of magnitude.

On the European scale, there are similar developments. The Institute Laue-Langevin is successfully implementing its endurance program, the ISIS Neutron and Muon Source (ISIS) has received £90 million funding to start its Endeavour program, and the Heinz Maier-Leibnitz Zentrum is starting discussions to initiate the MORIS upgrade program. At the same time, we are expecting that the new European flagship, the European Spallation Source, will provide its very first neutrons to instruments in 2025. Overall, this is an exciting time for Swiss neutron science with excellent prospects to have ever improving instrumentation available.

In this issue of Swiss Neutron News, you will find two articles describing recent successes using polarized neutrons and uniaxial pressure measurements, which both benefited from increased instrumentation and neutron flux at SINQ and other European neutron sources.

I wish all of you the best for the remainder of the year and was happy to see many of you at our general assembly, which took place on November 23 at PSI.

Marc Janoschek

Polarized Neutron Scattering with MuPAD at TASP

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Physicists have been using the magnetic moment (or spin) of the neutron as a powerful probe of magnetism in materials almost as soon it was discovered to have one. To make use of the neutron's spin, one must control its direction by polarizing all neutron spins along a particular direction, flipping those spins into the desired direction, and preserving that polarization as the neutron passes through the sample and into the detector. At TASP, the homegrown polarization analysis device MuPAD was built to do exactly that, and in recent years has produced a string of successful experimental results. The aim of this article is to demystify polarized neutron scattering as it can be used on TASP and demonstrate the capabilities of MuPAD for clarifying otherwise intractable questions of magnetic structures and dynamics.

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I. AN INTRODUCTION TO POLARIZED NEUTRONS

Working with polarized neutrons may seem complicated and inaccessible, but with a little thought, a touch of guidance, and a boost from the right choice of software anyone can use them to answer their more difficult scientific questions. A good place to start thinking is with the interaction between the neutron's magnetic moment (or spin) and a particular sample one is interested in measuring in the form of nuclear structure factor and / or magnetic interaction factor. Interactions between neutrons and the strong nuclear force can help separate coherent and incoherent nuclear scattering, which is useful in polymer physics and ionic liquids, but as the polarized neutron scattering device discussed in this article is hosted by a triple axis neutron instrument, most experiments performed there deal with a neutron's interaction with a sample's magnetic properties [1]. Since the late 2000s, there has been a polarization analysis device available for use on the cold neutron triple axis instrument TASP called MuPAD (Mu-metal Polarization Analysis Device) [2]. By design, MuPAD on TASP was built to study magnetism – with a particular particular focus on magnetic diffraction.

From an intuitive standpoint, it's easy to visualize magnetic diffraction through the interactions between classical representations of neutron and ion spins. As neutrons can only measure components of the magnetic moment perpendicular to the scattering vector, by selecting a particular incoming neutron spin direction one can examine a particular spin projection by looking at what percentage of neutron spins get flipped in which direction. A complete and definitive magnetic structure analysis can therefore come from polarized neutron scattering measurement (as discussed in Section III), but the real power and flexibility in what polarized neutrons can see is given by the Blume-Maleyev equations. As detailed in Ref. [2], the various parts of the correlation function accessible includes separate nuclear and magnetic contribution as well as nuclear-magnetic interference, mixed magnetic interference, and any chiral contribution. The whole set of Blume-Maleyev equations can be expanded over the three cartesian directions to produce a polarization matrix P that can be measured by controlling the direction of an incoming polarized beam and measuring changes to the outgoing polarized beam. When done solely along the diagonals (P_{xx}, P_{yy}, P_{zz}) is known as longitudinal polarimetry, and when the off diagonal components (P_{xy}, etc.) are considered the technique is known as spherical polarimetry. The former has many different applications and can be peformed on weaker signals, while the latter requires precision equipment to both polarize and shield the beam – hence MuPAD. To better understand what can be done with MuPAD, its basic principles are explained in the next section.

II. HOW MUPAD WORKS

The first step in neutron polarization analysis is (obviously) polarizing the neutron beam, but doing so in an efficient and effective manner requires some technical optimization. After passing through the guide, the neutron

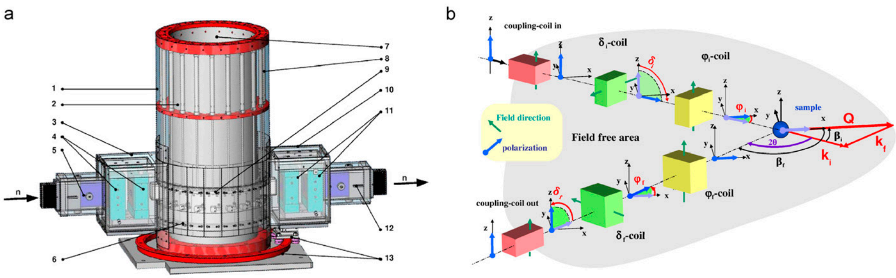

Fig. 1
Two figures from Ref. [2]. a) A schematic drawing of mupad that shows the coupling coils, precession coils, and Mu-metal shielding. b) A drawing of how a neutron travels through MuPAD for the P_{xx} component of the polarization matrix, pictured to visualize the orientation of a polarized neutron through the instrument.

beam reaches the monochromator with a random distribution of spin orientations. To perform spherical polarimetry, those spins must be ordered somehow into a single direction (typically vertically), then flipped to the selected direction. After the polarized, flipped neutron beam interacts solely with the sample, it must then be flipped back to vertical, and the non-vertical spins must be thrown out before they reach the detector. Each action performed on the neutrons requires a particular new device, the sum of which makes up MuPAD, as shown in Fig. 1.

There are many ways to polarize a neutron beam, from choosing single crystals that take advantage of the magnetic-nuclear interference term to ^{3}He spin filters to magnetized thin films that polarize the beam via total reflection [1]. Layering magnetic and nonmagnetic materials in the form of supermirror benders can improve the total reflection of neutrons and increase the efficiency of neutron polarization over a range of wavelengths (optimized for 3.19Å on TASP). A magnetic field created with currents running through coiled aluminum wires (coupling and precession coils) are used to first preserve the spin orientation and then flip the spins of the polarized neutrons in a particular direction using Larmour precession on both the incoming and outgoing axes. Both the benders and the coils allow very good control over the neutron beam polarization, but at the expense of the amount of neutrons that actually hit the detector (only about 1/3 of the neutrons are actually reflected by the benders, the rest pass through).

The previous paragraph talked about controlling the spin; but when the neutron interacts with the sample, there should be no stray field at all. A spherical polarimeter would need to shield the sample environment from the earth's magnetic field to ensure the signal comes almost purely from the sample and to preserve the polarization of the beam inside the sample space. Spherical polarimetry setups with this shielding already existed before MuPAD, but these

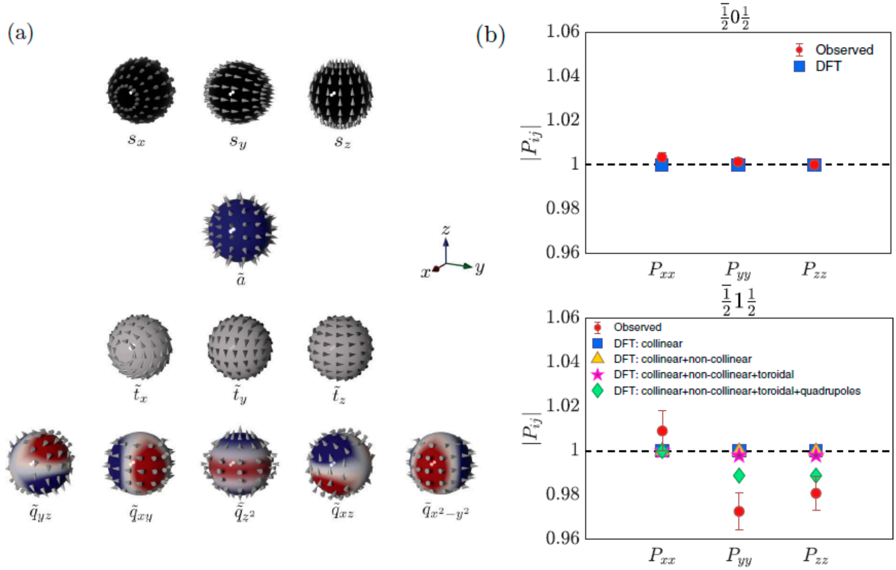

Fig. 2
Two figures from Ref. [4] a) Representations of the dipole (top row) and magnetoelectric multipole irreducible representations, shown to visualize how a neutron might interact with a more complex magnetic texture, b) The resulting components of the polarization matrix as taken by MuPAD plotted against their DFT calculated series of models (or what the data actually looks like)

relied on cryogenic fluids to put the Meissner shields into a superconducting state. MuPAD does not require any croyfluids, instead relying on Mu-metal, which is made of a nickel-ion alloy and which has an exceptionally high permeability [2]. MuPAD has been put to excellent use as a spherical polarimeter, but some recent experiments taken MuPAD beyond its design as a spherical neutron polarimeter into other areas of polarized neutron scattering. Below, the results of these experiments are discussed in the context of the relationship between their scientific questions and MuPAD on TASP's experimental capabilities.

III. UNDERSTANDING MAGNETIC STRUCTURES WITH SPHERICAL POLARIMETRY

As discussed in the introduction, the most important part of magnetic neutron diffraction is the interaction between the neutron's spin and and the magnetization density of the sample ion. In one of its simplest use cases, spherical polarimetry can distinguish between structures with identical q-vectors, as was done for $MnSc_2Si_4$ [3]. Answering difficult to understand questions about magnetic structures is MuPAD's bread and butter, but in recent years clever experimenters have used spherical polarimetry to examine one of the some of the deepest issues of symmetry breaking in magnetic neutron diffraction and to subsequently look for magnetoelectric multipolar order in magnetic materials.

Conventional magnetic diffraction isn't able to account for when the surrounding environment breaks both inversion and time reversal symmetry at the ion site, but with spherical polarization analysis one can quantify the resulting asymmetry in the magnetization density and consequently expand the analysis of magnetic order from the standard magnetic dipolar to magnetoelectric multipolar order. Researchers at ETHZ and EPFL made precise calculations of the polarization matrix for multipolar order in CuO by calculating the magnetoelastic form factor, multipole size, and multipole propagation vector from density functional theory [4]. Unusually, their analysis includes details about multipolar contributions on the oxygen sites, which are typically invisible in conventional neutron scattering, but can be seen via the P_{yy} and P_{zz} components of the polarization matrix.

Innovations in calculation of the polarization matrix for magnetoelectric multipoles already been discussed above, but uestions of differentiating between magnetic structures with spherical polarimetry have been made a lot more tractable with the software Mag2Pol [5]. Although the full polarization matrix can be calculated analytically for each potential model by hand, Mag2Pol has streamlined the process of visualizing each possible magnetic structure allowed by symmetry and propagation vector, and uses the magnetic dipole form factor to compute the polarization matrix elements that compare directly with and can be fitted to the results from a SNP experiment with MuPAD on TASP. With the popularization of Mag2Pol, spherical polarimetry using MuPAD has become more accessible as a technique to differentiate between magnetic structures as well as more complex asymmetries in the magnetization density.

IV. INVESTIGATING PHASE TRANSITIONS WITH DEPOLARIZATION TECHNIQUES

It is clear that measuring the components of the polarization matrix using spherically polarimetry can differentiate between difficult to distinguish magnetic structures, but information can also be gained from a carefully controlled analysis of changes in the components of the polarization matrix under different environmental conditions – in this case both temperature and uniaxial pressure. The next article in this edition of Swiss Neutron News discusses recent innovations in the implementation of uniaxial pressure at SINQ, and the experiment in this section represents a unification of innovations in applying uniaxial pressure with those in designing experiments using polarized neutrons.

The lanthanum-based cuprate superconductors will be discussed in more detail in the following article in the context of uniaxial pressure, but a brief sketch of their physics is necessary to understand why polarized neutron scattering is effective as an experimental probe. In these compounds, spin and charge stripe orders can coexist, but the extent and nature of their coupling, and whether they were competitive or cooperative

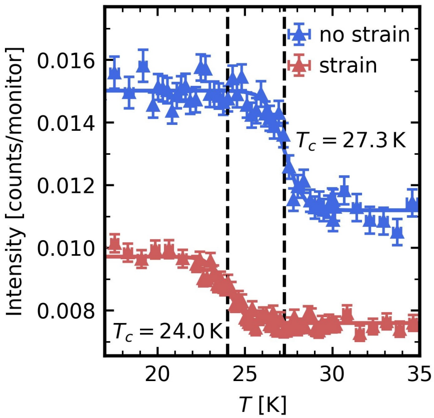

Fig. 3
The intensity of P_{y-y} of the (0,-2,0) nuclear Bragg peak with temperature for two differ-ent pressures, as described in Ref. [6]

has proved difficult to pinpoint. According to this stripe model, c-axis strain seems to suppress superconductivity, which manifests in a decreased superconducting transition temperature (T_c), but applying pressure in traditional macroscopic measurements can be difficult due to sample size and other technical constraints.

Polarized neutron scattering, while not a typical replacement for a measurement like specific heat, proves to be useful in measuring changes in T_c through the use of trapped flux in magnetic field vorticies present in the superconducting phase of $La_{1.88}Sr_{0.22}CuO_4$. Trapping this flux requires a small magnetic field of 30 gauss along the c direction (defined here as along z), applied in the form of two small magnetic coils attached to the stick around the sample and inserted into the sample space. When field cooled through the transition temperature, these magnetic field vorticies have a single direction and can be seen in a component of the polarization matrix perpendicular to their orientation along z, (P_{xx} or P_{yy}), and the relative change in these components of the polarization matrix as the sample is heated to above its superconducting temperature results in an unambiguous signal of the transition temperature. With an increase in pressure from a uniaxial pressure cell, the suppression of the onset of superconductivity can clearly be demonstrated, as shown in Fig. 3 [6]. By manipulating a magnetic feature in their sample, they were able to clearly measure the effect uniaxial pressure had on the superconducting phase transition with MuPAD.

This experiment was the first of its kind in recent history to have been done with MuPAD, and it was so impactful as to merit two separate mentions in this edition of Swiss Neutron News. The combination of magnetic coils and uniaxial pressure cell are not standard sample environments and were built in house for this experiment. Inserting any experimental setup to apply a magnetic field has to be done in a very controlled manner, as the Mu-metal loses its permeability when saturated with a magnetic field higher than 0.25 T, but for materials where domains cannot be otherwise selected (as might be possible with an electric field), inducing a magnetic feature with a very small magnetic coil is possible. A full, detailed, fitted spherical polarimetry experiment will not produce clear, absolute results in an applied magnetic field, but differences in phases can be studied with depolarization using MuPAD at TASP.

V. INELASTIC POLARIZED NEUTRON SCATTERING CAPABILITIES

As discussed in Section II, each bender throws away about two-thirds of the incoming neutrons. With both benders in the path of the neutron beam, the amount of neutrons passing through to the detector in the direct beam is 1/9 of that for unpolarized neutrons. Combining that with the fact that inelastic signals are about 1% as strong as elastic signals, the loss in neutron flux at the detector while using MuPAD has made looking at inelastic signals with polarized neutrons on TASP prohibitively difficult. But with the guide upgrade and subsequent increase in neutron flux at the monochromator, the opportunity was ripe for testing MuPAD's capabilities on massive samples with large magnetic moments that were good coherent scatterers – otherwise known as the ideal triple axis sample.

The most promising result was the differentiation of two oppositely chiral magnons using a half-polarized experimental setup. Going back to the Blume-Maleyev equations as written for an inelastic neutron cross section, there are many experimental methods to extract the magnetic chiral component, but the most effective for MuPAD turns out to be polarizing the incoming beam and measuring the resulting beam without analyzing the polarization, hence half-polarized. Two energy scans with polarization along the Q-direction (P_{x0},P_{-x0}) are then antisymmetrized to get the magnetic chiral component. For this sample, the clear difference in their handedness suggests their importance in selecting the handedness of a high field helical phase from a low field ferromagnetic phase with an increasing magnetic field [7]. Using polarized neutrons to distinguish whether a magnetic feature (elastic or inelastic) is chiral is a typical test case for polarization analysis, but it is not often done using MuPAD. With a large enough sample, magnetic scatterer, and the right energy range, MuPAD can answer questions that require inelastic longitudinal, or even spherical, polarimetry to answer questions about magnetic dynamics.

VI. HOW TO MAKE MUPAD WORK FOR YOU?

In this article, a few different innovations in MuPAD experiments at TASP have been discussed. There is improved neutron flux at TASP thanks to the guide upgrade, implying that some cases which would have ordinarily been measured at another facility could be seen on TASP. For elastic scattering, we have worked with single crystals as small as 7 mg, but whose magnetic moment was very large – if you have a good sample for unpolarized neutron elastic scattering, you have a good sample for polarized neutron elastic scattering. Spherical polarimetry works best for samples with minimal issues caused by ferromagnetic sample components, but if the depolarization from the sample field is quantifiable or if one is only interested in changes in the polarization matrix, any reasonably scattering sample can be measured with MuPAD. With the recent study of magnetoelectric multipoles through polarization analysis, a new channel of research opens up into questions of multipolar ordering in various compounds. If your sample has a poorly understood magnetic component, MuPAD may be able to help you study it.

For inelastic scattering, there are very few test cases that fit well within the energy range accessible to MuPAD, but with a large enough sample and a small enough energy window, gapless magnons / magnons with small gaps and the bottoms of acoustic phonons / magnetoelastic modes would all be visible. (To be more precise in what energy window and region of reciprocal space can be measured requires a conversation with an instrument scientist and a brief look at a triple axis modeling software such as TAKIN [8].) In summary, the BlumeMaleyev equations are much more simple then they look, MuPAD can perform more than just one type of polarized neutron scattering experiment, and advances in the neutron guides have expanded the types of samples that can be studied with MuPAD on TASP.

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Exploring uniaxially stressed materials with scattering experiments

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Complex materials host rich phase diagrams that depend on the microscopic parameters. Over the last years, we have developed a series of uniaxial stress devices that enable tuning these parameters and are optimized for scattering experiments using powerful X-ray and neutron techniques. This allows us to discover, understand and control the emergent properties of strongly correlated electron systems. In this overview, some of the new instruments are presented, together with a few selected experimental examples that demonstrate their utility. In particular, we show how uniaxial stress enables the control of the charge-spin stripes in copper-based superconductors and reveal the interplay of the stripes with superconductivity and we demonstrate how skyrmion lattice can be create on-demand.

In solid state physics, the ground states and the lowenergy physics of the system are determined by the complex interplay of multiple interactions and their corresponding energy scales. The different phases can be accessed by modifying the system through external parameters such as magnetic field or pressure. However, magnetic field primarily adds a term to the electronic hamiltonian, but doesn't change the intrinsic energy scales. Hydrostatic pressure modifies the interactions, but multiple parameters are often modified, which makes the interpretation of the observations more complicated. Uniaxial stress, on the other hand, can act as a surgical tuning parameter, that primarily modifies only particular interactions. It is worthwhile mentioning here that, in general, in solid state systems the properties of materials usually depend on the direction. Therefore, it is natural to expect that uniaxial perturbations will have a strong effect in determining the ultimate fate of the system.

Indeed, over the last years, uniaxial stress has emerged as a crucial tool to reveal and understand various quantum states. As an illustration of the underlying microscopic mechanism, we show a conceptual example in Fig. 1 of uniaxial tuning of a magnetic insulator. Uniaxial stress of the sample leads to changes in the angles between the magnetic moments and the mediating ions as shown in Fig. 1a), which due to the change in orbital overlaps determine the interaction strength. As a result, multiple different phases can be accessed as illustrated by the polar phase diagram in Fig. 1b).

More generally, in many correlated-electron systems with multiple interacting degrees of freedom (charge, spin, lattice),

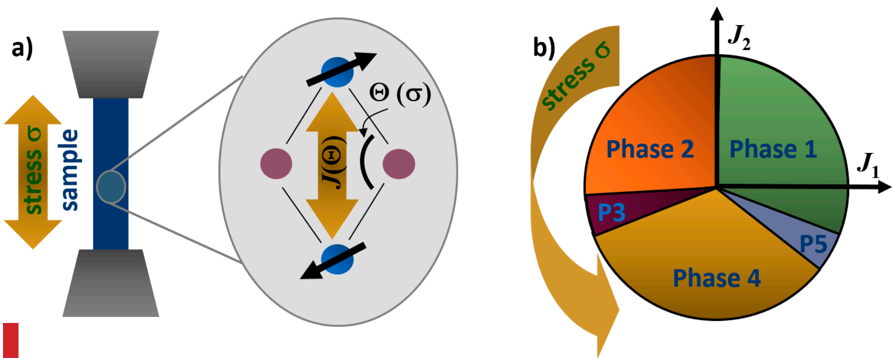

Fig. 1
Using uniaxial stress to control phases in the solid state. In a) the principle of uniaxial stress tuning is displayed, where a sample is attached to two supports, which can be pushed or pulled to induce microscopic changes. The inset shows these microscopic modifications in the case of superexchange interaction in insulators, where the interaction strength J depends on the angle between the magnetic moments and the non-magnetic anions. The modification of a particular interaction strength with respect to another interaction will drive the transition from one phase to another, like shown in the polar phase diagram in b), which is a representation of a square lattice model with competing interactions.

quantum states can be nearly degenerate and even small uniaxial stress, has been shown to modify the emergent properties substantially [1–21]. Additionally, uniaxial stress has also been proposed as a tool to stabilize exotic phases ranging from quantum spin liquids [22] to skyrmion lattices,[5, 23] which are thought to be relevant for novel spintronics and memory applications [24]. We will address some of these topics when discussing our example results achieved with our uniaxial devices.

While the above advantages of using uniaxial stress are driven by physics arguments, there is an additional practical consideration that makes the use of uniaxial tuning techniques attractive for scattering experiments. Unlike the hydrostatic pressure, in principle the sample can be open to the beam leading to high signal to noise.

Having stated the why, let us now discuss the how. Many approaches can be used to generate force and apply to the sample, ranging from using compressed gas and inflating bellows to push on the samples [25–27] to employing the piezoelectric materials [9, 11, 28, 29]. Both of these methods have been very successful, but are intrinsically hard to operate and require extensive preparation and installation times. Moreover, due to substantial structures, they may significantly contribute to the background of scattering. Finally, while both methods provide a very precise stress application, the travelling length is limited. Over the last few years, we have therefore concentrated on using mechanical application of force as the optimal approach. In the following paragraphs, three different implementations will be presented, ranging from a basic setup with an

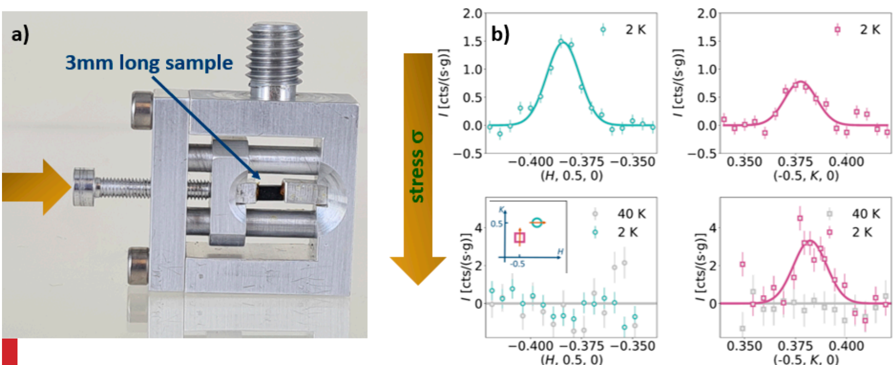

Fig. 2
Repopulation of magnetic domains in a hightemperature superconductor. The cell pictured in a) was designed in order to achieve the smallest possible background and have the pressing direction in the scattering plane. It was used to reveal the uniaxial spin-stripe in a high-temperature cuprate superconductor. By applying stress, one of the spinorder domains is completely suppressed as can be seen in the patterns in b). The inset shows the two spots in the reciprocal space, corresponding to the two-different domains, where the scans were performed. Panel b) is reproduced from [16] under creative commons license.

extremely small background to an *all-included* in-situ device with efficient control and feedback mechanisms. All of the device examples will be directly illustrated by a neutron scattering measurement driven by corresponding science cases.

As a first example, shown in Fig. 2 we studied the uniaxially stressed stripe phase of the high-temperature cuprate superconductor $La_{2-x}Sr_xCuO_4$ [16]. When holes are introduced in the antiferromagnetic parent compound La_2CuO_4 through substitution with Sr, a superconducting dome emerges. Additionally, the charges and spins have to reorganize themselves into a new equilibrium and they have been shown to order in periodic structures, with the exact details still under debate [30–47]. To disentangle the electronic arrangement, a recent hard Xray diffraction experiment was performed under uniaxial stress and has revealed that different domains that appear in an as-grown compound can be reduced to a single electronic domain upon application of meager pressure forces [14]. To disentangle the magnetic arrangement, the best approach is to use neutron scattering, apply similar uniaxial stress and perform magnetic diffraction experiments. However, as the magnetic moment in this system is small (0.1 μ_B) and small samples are needed to achieve the required stress, such an experiment is intrinsically difficult. To tackle this challenge, we have designed a cell shown in Fig. 2a that minimizes the background. Further, we employed a three-axis spectrometer ThALES at the ILL to maximally reduce the background and used its excellent focusing capabilities to achieve optimal scattering from a sample of just a few millimeters. As shown in Fig. 2b and described in detail in Ref.[16], in the as-grown samples, two families of different peaks are observed that arise from two different domains, which are approximately equally populated. When the system is stressed uniaxially, only one of the domains is preferentially populated and hence only one family of the peaks persist. The other family of peaks are completely suppressed, corresponding to the extinction of the second domain.

The example presented above is only one of the studies that have demonstrated the sensitivity of the cuprates to uniaxial stresses and the effects have been demonstrated for various families of the compounds [9, 48]. However, one of the challenges of all these studies is that different types of experiments have to be performed to access different properties. Therefore it can be complicated to compare the results between the different works, especially as it relates to the value of applied forces. Muon spin rotation and resonance techniques often can be used for that as in principle both the magnetic properties through muon spin precession and the superconducting properties through vortice measurements can be accessed. In practice, however, often the magnetic response dominates and it becomes difficult to access the superconducting properties, but auxiliary measurements by a nearby probe, such as AC-susceptibility could be used [19].

Neutron scattering can in fact be used to measure the different properties on the same samples, at exactly same stress, and even with the same instruments. As is wellknown in the neutron community, small angle scattering can teach us a lot about the superconducting vortices. But the effects of vortices can also have other, indirect effects, which we can harness. Referring to our first example, it is natural to ask: in the studies of uniaxial effects on the charge and spin order in superconductors, how much is the transition temperature modified?

To answer this question, a measurement can be designed that relies on the polarization analysis of neutrons. When a spin polarized neutron travels through a non-magnetic sample, nominally no neutrons will scatter in the spin-flip channel. However, if there are frozen magnetic moments the spin-flip channel is one of the best ways to accurately determine complicated magnetic structures. In the case of type-2 superconductors, which cuprates represent, the magnetic vortices can be frozen into the material through pinning by cooling in an applied field accross the superconducting transition. When neutrons travel through a system prepared this way, there will be extra scattering in the superconducting phase, which will drop upon entering the normal state.

In our implementation, we have built an in-situ coil around the uniaxial cell, displayed in Fig. 3a), which can be inserted into a Mu-metal chamber that ensures optimal polarization analysis, at PSI it is implemented in the MuPad device [49] that can be positioned in the TASP three-axis beamline. The in-situ coils are running upon cooling

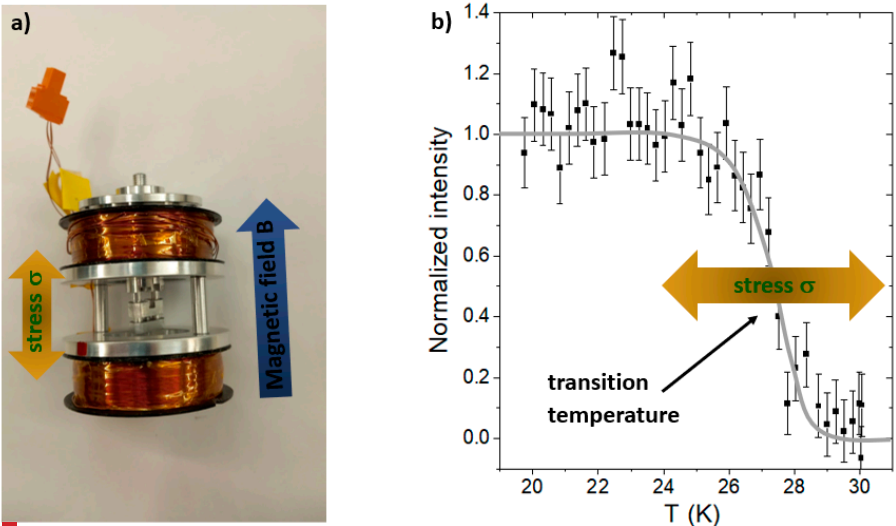

Fig. 3
Determining the superconducting transition with neutrons. In order to introduce superconducting vortices, the uniaxial stress cell has to be placed into a magnetic coil, as shown in a) for our solution, where the entire complex goes into a cryostat. Trapped vortices lead to spin-flip scattering in a polarized experiment, and as shown in b) the intensity drop can be used to determine the phase transition temperature [21].

down and are then switched off at base temperature. The incoming neutron polarization is selected to not be aligned along the cooling field and the spin-flip channel is then studied upon warming up. An example measurement of the transition temperature is shown in Fig. 3b) and results of the exact stress dependence will be published elsewhere [21].

The final uniaxial stress example in this short overview concerns a new in-situ device illustrated in and Fig. 4a). We have designed it in light of need for continuous tuning during experiments and performing "stress scans" to explore the different phases in the complex phase diagrams of strongly correlated systems. The full description of the device can be found elsewhere [50], here we only briefly outline the key features.

The precision in the application of force is achieved using microstepping to drive the spindle of a linear actuator to generate the force applied. A load cell enables continuous monitoring of the applied stress. To soften the force build up for protection of samples additional spring packages are installed, which deform at low forces and get almost fully compressed at the maximum design force of 200 N. As an illustration of the precision, 1000 microsteps of the motor only compress the sample by half a micrometer. An additional advantage of this in-situ device is

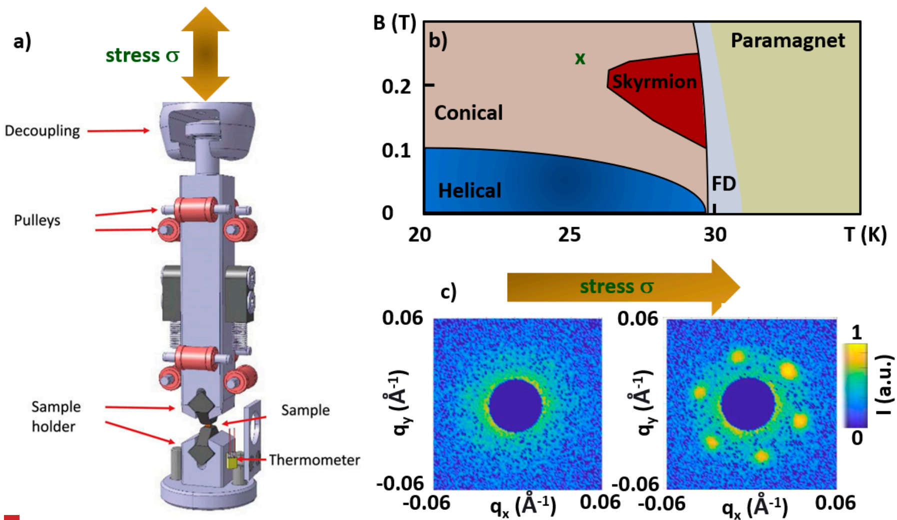

Fig. 4

Determining the superconducting transition with neutrons. In order to introduce superconducting vortices, the uniaxial stress cell has to be placed into a magnetic coil, as shown in a) for our solution, where the entire complex goes into a cryostat. Trapped vortices lead to spin-flip scattering in a polarized experiment, and as shown in b) the intensity drop can be used to determine the phase transition temperature [21].

the portability and applicability to a wide variety of beamline experiments and environments. The mechanical compatibility is complemented by the control software, which is implemented with the Frappy package [51] and SECoP communication protocol which allow fast integration into various experiments. It can operate on multiple beamlines at the Swiss neutron source SINQ, and it has also been successfully deployed for experiments in PETRA-III X-ray source at DESY in Germany [19, 20, 50].

One of the phases in the modern condensed matter that have garnered significant attention are magnetic skyrmions, which are topological particle-like objects in the magnetization texture. One of the challenges in studying and eventually exploiting such phases is the fact that they only exist in very narrow parts of the phase diagrams. The example shown in Fig. 4b) is inspired by the earlier experiments of the archetypical skyrmion lattice material MnSi, where uniaxial stress has been shown to enhance the pocket of the phase stability [5]. Here, we revisited earlier measurements, but instead of applying the stress and tracking the phase boundaries and properties, we start at the position where the skyrmion lattice doesn't exist and gradually apply the force. As seen in the figure, the skyrmion lattice emerges through the application of stress, with all other parameters kept constant hence we can literally "push" the system into the new phase [52].

The successes outlined above are expected to be just a taster of uniaxial tuning of materials. In multiple laboratories in Switzerland there are ongoing experiments using uniaxial tuning which target timely and relevant questions about the emergent phases in complex materials. Playing a part in this, the in-situ device presented here is open for user operation at the Swiss neutron source SINQ, with a new generation of devices already planned in the coming years.

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Announcements

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The SGN/SNSS members are kindly asked to pay their annual member fees. At the general assembly 2013 of the society, the fee has been increased from CHF 10 to **CHF 20**. It can be paid either by bank transfer or in cash during your next visit at PSI. The bank account of the society is accessible for both Swiss national and international bank transfers: Postfinance: 50-70723-6 (BIC: POFICHBE), IBAN: CH39 0900 0000 5007 0723 6.

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News from SINQ

Please visit the page https://www.psi.ch/sinq/call-for-proposals to obtain the latest information about beam cycles and the availability of the neutron instruments.

PSI together with LLB is organizing the 2nd French-Swiss Meeting SANS for Soft Matter, which will take place on January 24-25, 2024, PSI, Villigen, Switzerland. The workshop aims to bring together researchers using SANS in the fields of Soft Matter and Biophysics (and open to other fields as well), especially from the French and Swiss User Communities. The workshop is also motivated by the move of SANS-LLB from the Laboratoire Léon-Brillouin to SINQ at PSI. SANS-LLB will become part of the user program in 2024. The workshop focuses on recent and ongoing work in the fields of polymers, colloids, surfactants, gels, foams, and proteins and on applications of soft matter in food science, pharma, energy applications and other fields.

Registration of publications

Please remember to **register all publications either based on data taken at SINQ, SLS, SμS or having a PSI co-author** to the Digital Object Repository at PSI (DORA):
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The Swiss agreement with the ILL includes that ILL funds and hosts one PhD student from Switzerland.

Conferences and Workshops December 2023 and beyond

An updated list with online links can be found here:
http://www.psi.ch/useroffice/conference-calendar

December 2023

AOCNS2023: 4th Asia-Oceania Conference on Neutron Scattering
December 2-8, 2023
Donguan, China

MLZ User Meeting 2023
December 4-5, 2023
Munich, Germany

MRM2023: Advanced Materials Research Grand Meeting 2023
December 11-16, 2023
Kyoto, Japan

HIRES 2023: Synergies in HIgh RESolution Spectroscopy
December 12-15, 2023
Grenoble, France

January 2024

2nd French-Swiss Meeting SANS for Soft Matter
January 24-25, 2024
PSI, Villigen, Switzerland

February 2024

HERCULES European School 2024
February 26 - March 28, 2024
Grenoble, France

March 2024

Workshop on „Automation in Diffraction“
March 14-15, 2024
Garching, Germany

April 2024

EcatalytiX Symposium - X-rays and Electronic Operandi Techniques for Electrocatalysis
April 3-5, 2024
Strasbourg, France

Machine Learning Conference for X-Ray and Neutron-Based Experiments
April 8-10, 2024
Garching, Germany

19th Food Colloids Conference
April 14-18, 2024
Thessaloniki, Greece

June 2024

QENS/WINS 2024
June 10-14, 2024
Manchester, UK

Coherence 2024: 11th International Conference on Phase Retrieval and Coherent Scattering
June 16-20, 2024
Helsingborg, Sweden

July 2024

ICTMS 2024: International Conference on Tomography of Materials and Structures
July 1-5, 2024
Stellenbosch, South Africa

SXNS17: International Surface X-ray and Neutron Scattering Conference
July 15-18, 2024
Grenoble, France

August 2024

SRI2024: 15th International Conference on Synchrotron Radiation Instrumentation
August 26-30, 2024
Hamburg, Germany

Editorial

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