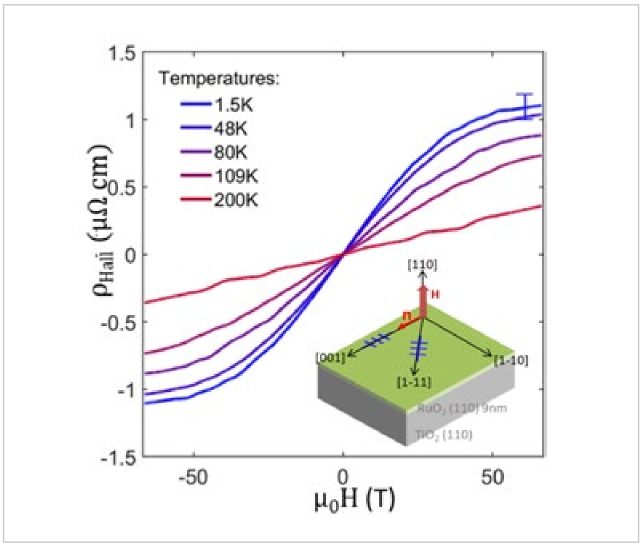
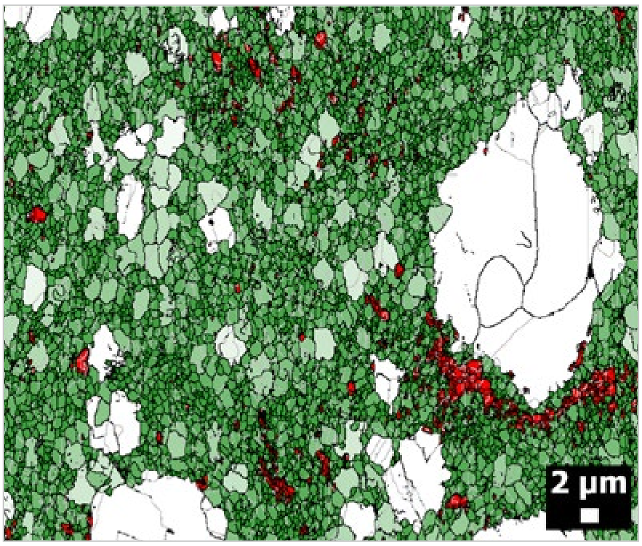
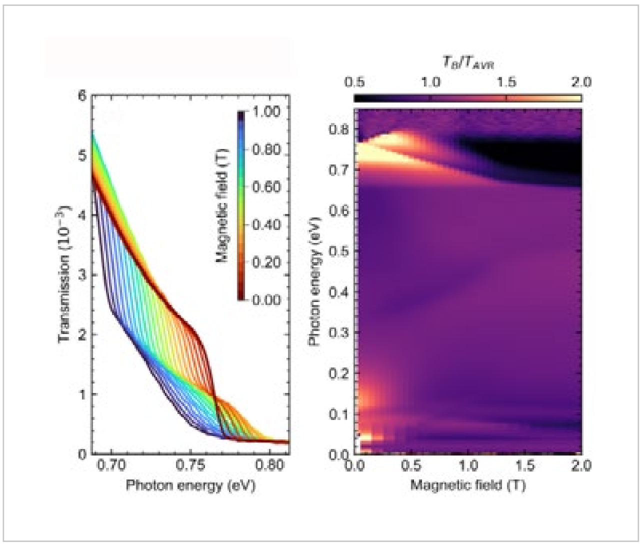
European Magnetic Field Laboratory

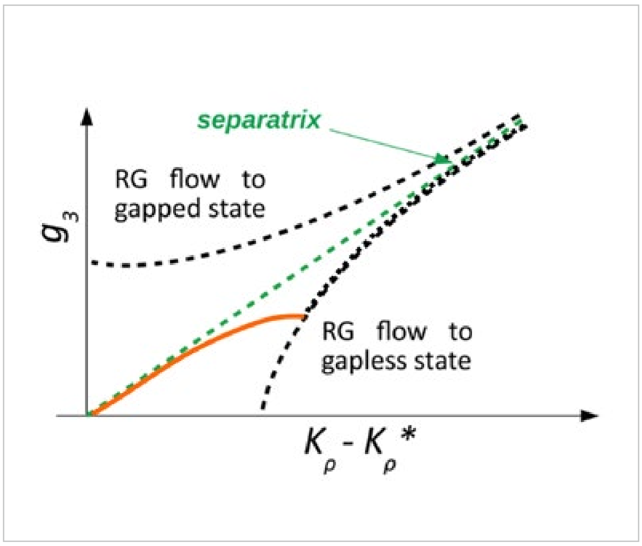
EMFLNEWS

N°4 2023









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DEAR READER

It is with great pleasure that we present to you the new edition of EMFLNews, a unique opportunity to share with you the latest exciting developments from our international laboratory. In this issue, we spotlight recent scientific achievements by our research teams. As in every issue, we also have the privilege of introducing you to a distinguished member of our laboratories, and this time, we showcase Yuriy Krupko from Grenoble.

This edition, in particular, focuses on two aspects close to our hearts within EMFL. Firstly, we highlight our continued commitment to supporting industrial activities involving intense magnetic fields. This issue presents "SEF Technologies", a company, which manufactures coils and electromagnets used in particle accelerators. Additionally, we invite you to explore remarkable projects and achievements resulting from our collaboration with other European research infrastructures. Here, we are delighted to report about our joint workshop with synchrotrons and X-FELs at HLD in Dresden. This and all previous collaborative meetings greatly contribute to knowledge exchange and the strengthening of our ties with our European counterparts.

Furthermore, we push the opportunity to co-organize regional workshops dedicated to intense magnetic fields in various countries. This year, our user meeting will be organized in UK (Nottingham) June 11th, and next year in June with our new partner in Italy (Lecce).

We hope you will enjoy the vibrancy and achievements of EMFL as described in this issue.

On behalf of the entire team, I wish you a most enjoyable year 2024.

Charles Simon
Director LNCMI
Chairman EMFL

MEET OUR PEOPLE

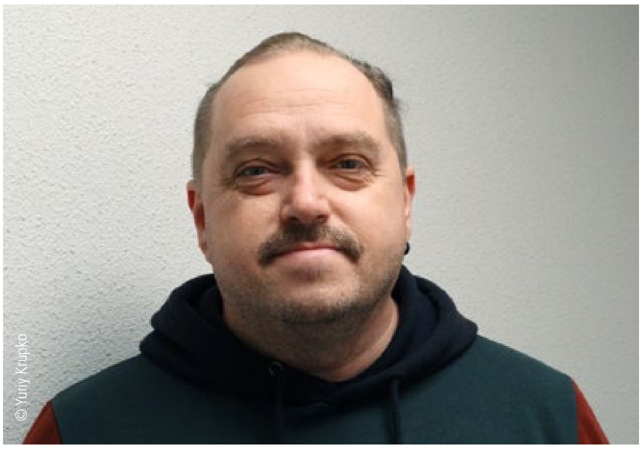
Yuriy Krupko, LNCMI-Grenoble

Hello. My name is Yuriy Krupko and I am a cryogenics engineer of LNCMI-Grenoble. As a member of the Scientific Instrumentation group, I work on the development and maintenance of the experimental infrastructure of the lab, providing permanent and visiting researchers with daily support. My domain of responsibility is the cryogenic equipment that allows to cool the experiment down to very low temperatures.

Originating from Ukraine, I did my Master diploma in Kharkiv National University, defending my thesis in Charles University of Prague, and then I came to France. Here, at LNCMI-Grenoble, I found the job of my dreams. I admire the experimentation at extreme conditions, such as high magnetic fields (we will go to 43 tesla this year!) and low temperatures in the millikelvin range. Also, I like very much the fact that LNCMI is a user-open facility, which attracts many visitors from all over the world.

Being a member of the service team, I'm driving my own technical investigation as well: the optimization of $^3He/^4He$ dilution refrigerator performance in high magnetic fields. In presence of a strong magnetic force, localized spatial maxima of the potential energy cause the formation of helium-gas bubbles, which seriously affect the heat transfer in the cryogenic system. My goal is to thoroughly understand these processes and then try to resolve emerging technical issues.

Even though I left Ukraine many years ago, my heart is deeply bound with my motherland in these tough days. I'm trying to support as much as I can Ukraine's army and volunteers, whose fighting against brutal inhuman invasion of Russian terrorists. I deeply appreciate the support and compassion of my LNCMI colleagues. We all deserve better times.



Yuriy Krupko

EMERGENT SYMMETRY IN A LOW-DIMENSIONAL SUPERCONDUCTOR ON THE EDGE OF MOTTNESS

P. Chudzinski, M. Berben, Queen's University Belfast, UK, and N. E. Hussey, HFML-FELIX

A team of researchers from HFML-FELIX, UK, USA, and China have discovered a rare phenomenon known as "emergent symmetry" in $Li_{0.9}Mo_6O_{17}$ (LMO). At room temperature, LMO is a 1D metal (Tomonaga-Luttinger liquid or TLL). As it cools down, however, the conduction electrons experience an emergent interaction that drives the system towards the insulating state. But rather than breaking a specific symmetry and transforming fully into an insulator, the electrons exploit the random nature of this interaction to evade localization and gradually approach the boundary (separatrix) between the insulating and superconducting states as temperature is lowered. At the boundary itself, the probability of the system being an insulator or superconductor are identical – this uniform state is then in effect a state of higher symmetry.

The electrical resistivity of LMO is extremely anisotropic, with a mysterious upturn below 30 K. Despite this, the longitudinal magnetoresistance (MR) is found to exhibit perfectly linear-in-temperature and isotropic behavior, along all measured directions, down to the lowest temperatures studied (≈ 2 K). According to TLL theory, it is the variation of the MR with temperature, as well as its independence on the orientation of the electrical current and magnetic field, which reveals the phenomenon of emergent symmetry (see Figure).

High-symmetry states have been long sought in quantum materials, for instance in the copper-oxide high-temperature superconductors, where they offer the prospect of a common parent state for superconducting, magnetic, and charge density wave instabilities. On general grounds, these high-symmetry states are interesting because, contrary to low-symmetry states, they are able to support a vast plethora of possible lowest-energy instabilities that may result in the exciting realization of exotic order, coexisting orders, or inhomogeneous order parameters. The notion that disorder or randomness on the interaction level can drive a system toward the boundary between metallicity and localization sheds light on this complex behavior. Notably, the notion itself is not specific to 1D systems such as LMO.

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Emergent symmetry in a low-dimensional superconductor on the edge of Mottness, P. Chudzinski, M. Berben, X. Xu, N. Wakeham, B. Bernáth, C. Duffy, R. D. H. Hinlopen, Y.-T. Hsu, S. Wiedmann, P. Tinnemans, R. Jin, M. Greenblatt, and N. E. Hussey, Science **382**, 792 (2023).

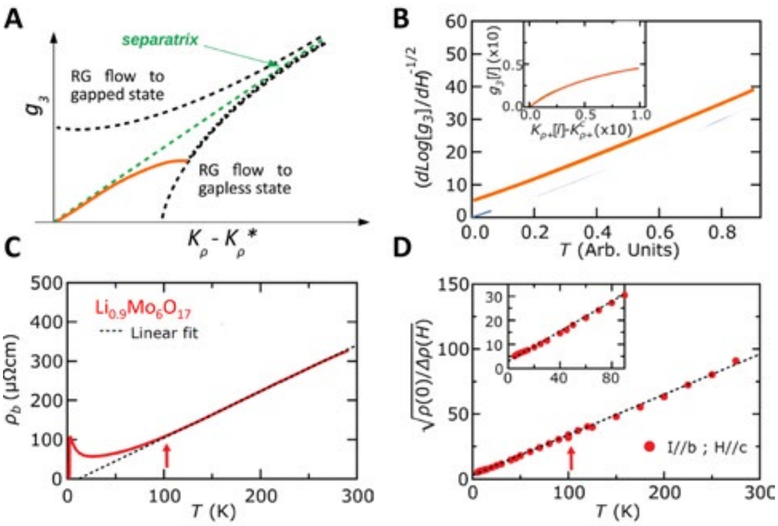

Figure: (A) Parametric plot of g_3 – the Umklapp scattering amplitude vs. $K_\rho - K_\rho^*$ - the distance to the critical point for a TLL represented as a renormalization-group (RG) flow. With lowering energy, the system moves away from the separatrix (green dashed line) and toward either a gapless, metallic state or a gapped (Mott) insulating state (black dashed lines). According to theory, the emergence of a random component in g_3 can steer the system (orange solid line) back toward to the separatrix. (B) Connection between the MR, as expressed through the derivative $d\log(g_3)/dH$ and RG flow. (Inset) Parametric plot of $g_3(l)$ flow as it gradually approaches the separatrix — the lower the line at $K_\rho - K_\rho^* \approx 0.1$, the further away the system is initially from the separatrix [green dashed line in (A)]. (Main panel) Resultant T dependence of $[d\log(g_3)/dH]^{-1/2} \propto (\rho(0)/\Delta\rho)^{1/2}$ to be compared with experiment. (C) In-chain resistivity $\rho_b(T)$, showing the deviation from linearity below 110 K (red arrow), the tendency towards an insulating state below 30 K, and superconductivity at ≈ 2 K. (D) Despite these changes in $\rho_b(T)$, $(\rho(0)/\Delta\rho)^{1/2}$ exhibits perfect linearity at all temperatures from 300 K down to 3 K (see inset).

THE SEMIMETAL THAT WASN'T THERE

D. Santos-Cottin, University of Fribourg, Milan Orlita, LNCMI-Grenoble and Ana Akrap, University of Fribourg

Weyl semimetals are an exciting new group of materials, showing unique signatures in their transport and optical behavior, inherited from their distinct topological features. The presence of nodes in the electronic band structure of Weyl semimetals makes their electrons behave as if they are massless, and this leads to a number of interesting properties. Material scientists have been searching for their experimental realizations ever since the first discoveries. One such proposed Weyl semimetal was $EuCd_2As_2$, which was described as a magnetic Weyl semimetal in various computational studies based on density functional theory (DFT) calculations, but also several experimental works.

In a magnetic Weyl semimetal, it would be possible to manipulate the topological properties using a small magnetic field. Without an external magnetic field, a small gap separates the conduction and valence bands. But in a magnetic field, the two bands overlap, creating a Weyl semimetal. In a broader context, the idea is to use the material's magnetic structure to control its topology.

However, in a new study an international research team has studied this material in great detail. Most surprisingly, the widely investigated material $EuCd_2As_2$, turned out not to be a Weyl semimetal after all, but rather a magnetic semiconductor.

These new results directly contradict about 30 published papers, both theoretical and experimental, that claimed that $EuCd_2As_2$ was a Weyl semimetal. Beyond the ground state of $EuCd_2As_2$, the main message is that the condensed-matter community has to be more careful when making conclusions mostly based on first-principle calculations.

The key development for the new experiments was synthesizing high-quality samples of $EuCd_2As_2$. Previously, all the investigated samples had metal-like resistivity. The new samples showed activated behavior of the resistivity, which is characteristic of semiconductors. The ability to prepare such pure samples allowed for more accurate magnetic and electric measurements than in previous studies. To achieve cleaner crystals, their careful crystal synthesis used very pure starting materials, in particular, extremely clean europium.

Several different experimental techniques were used: electronic transport, optical spectroscopy, and excited-state photoemission spectroscopy. The goal was to determine the ground state of $EuCd_2As_2$. The material was studied at various temperatures and using infrared spectroscopy under an external magnetic field up to 16 T (see figure). All the experiments led to the same conclusion: the compound unmistakably behaves as a magnetic semiconductor – it combines antiferromagnetic behavior with activated electrical conductivity, and a band gap of 0.77 eV. An external magnetic field strongly impacts the band gap and the transport properties. Applying 2 T is enough to decrease the band gap by 125 meV. However, in contradiction to many previous studies, the material never ceases to behave as a semiconductor, even under a strong magnetic field. The coveted magnetic Weyl semimetal phase simply isn't there.

How is it possible that so many studies could get the basic properties of $EuCd_2As_2$ so wrong? One of the main reasons is that europium has electrons in its f orbitals, leading to strong electron-correlation effects. Such localized electrons become notoriously difficult for DFT to simulate. The ab-initio community has taken note of this curious discrepancy. Most importantly, the positive takeaway is the almost forgotten power of magneto-optical spectroscopy, a technique that was widely used in the past to learn about semiconductors.

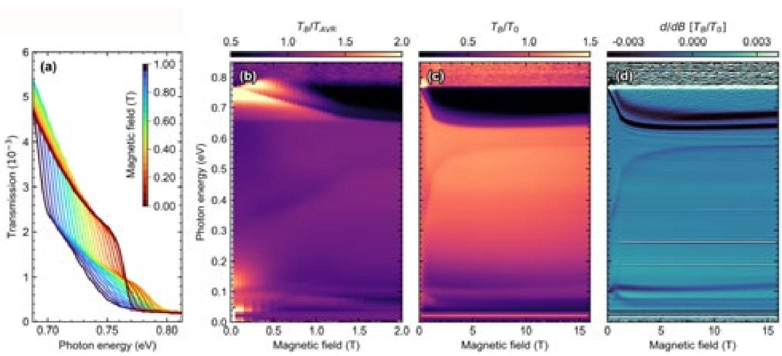

Figure: (a) Near-infrared transmission showing the interband absorption edge at low fields, B < 1 T. (b) Color plot of relative magnetotransmission, T_B/T_{AVR}, in a broad energy range and up to 2 T. (c) Magnetotransmission T_B/T_0 and (d) its first derivative, $d/dE[T_B/T_0]$, in a broad energy and magnetic field range.

$EuCd_2As_2$: A Magnetic Semiconductor, D. Santos-Cottin, I. Mohelský, J. Wyzula, F. Le Mardelé, I. Kapon, S. Nasrallah, N. Barišić, I. Živković, J.R. Soh, F. Guo, K. Rigaux, M. Puppin, J.H. Dil, B. Gudac, Z. Rukelj, M. Novak, A.B. Kuzmenko, C.C. Homes, Tomasz Dietl, M. Orlita, and Ana Akrap, Phys. Rev. Lett. **131**, 186704 (2023).

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DESIGN OF NOVEL SILVER-COPPER NANOCOMPOSITE WIRES TO BREAK THE STRENGTH-RESISTIVITY TRADE-OFF

Simon Tardieu, Florence Lecouturier-Dupouy, LNCMI Toulouse, and Christophe Laurent, Université de Toulouse

The generation of record pulsed magnetic fields above 100 T requires the use of coils wound with low-resistivity wires in order to limit the heating, and with a very high mechanical strength in order to be able to resist the Lorentz forces. LNCMI and the Centre interuniversitaire de recherche et d'ingénierie des matériaux (CIRIMAT) explore the design of novel silver-copper nanocomposite wires with the aim to break the usual strength-resistivity trade-off.

Composite powders are prepared by mixing 1 vol. % Ag nanowires (diameter 0.2 µm, length 30 µm, prepared in-house) and bimodal fine (1 µm) and large (20 µm) grain-size Cu powder with 50/50 and 75/25 in weight. The obtained composite powders are consolidated into cylinders (8 mm in diameter and 30 mm long) by spark plasma sintering (SPS). The cylinders served as starting materials for room-temperature wire drawing for the preparation of fine wires (1-0.2 mm diameter). The bimodal character of Cu is preserved after the preparation steps, namely after the preparation of the powder, the SPS cylinders, and the wires.

We show that it is possible to improve the low resistivity vs. high ultimate tensile strength (UTS) compromise of the composite wires by simply adding large grains of Cu during the composite-powder preparation step. Because they form large areas with few grain boundaries and no Ag, the larger Cu grains act as channels for good electron conduction, thus allowing to maintain a low electrical resistivity (0.45 µΩcm at 77 K). Compared to wires with only fine-grained Cu, this represents a 12 % lower electrical resistivity for the same UTS (1082 MPa at 77 K), which is provided by the finer Cu grains and the Ag nanowires. The strength-resistivity trade-off can be fine-tuned simply by adjusting the large grain / fine grain proportion.

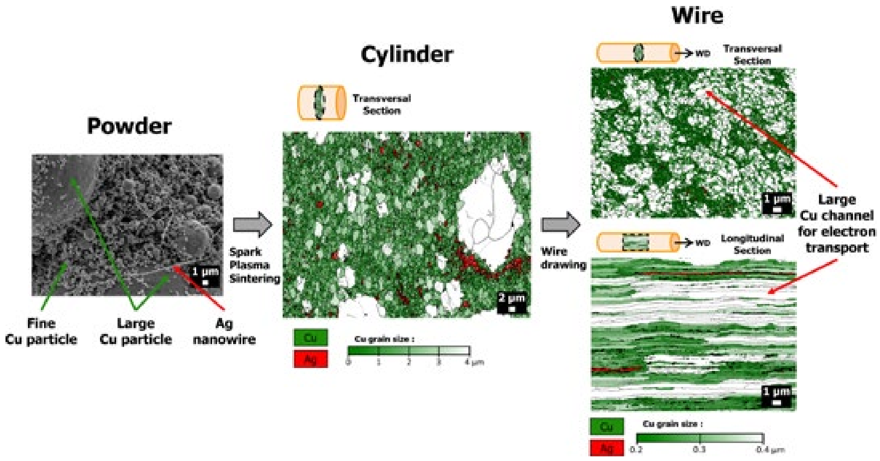

Figure 1: Representation of the method and microstructure of the powder, cylinder, and wire samples. The powder was analyzed by scanning electron microscopy and the cylinder and wires by electron backscatter diffraction.

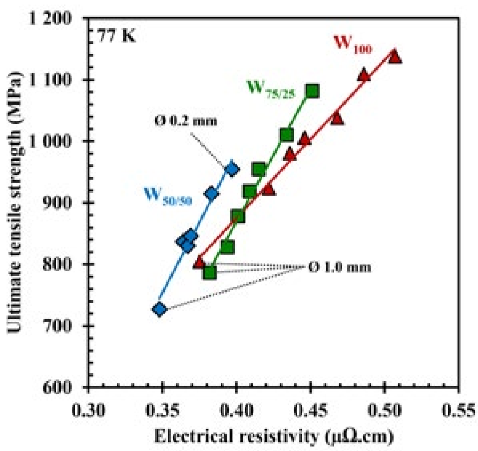

Figure 2: UTS vs. electrical resistivity at 77 K for wires with diameters from 1 to 0.2 mm for $W_{50/50}$ (◆), $W_{75/50}$ (■), and W_{100} (▲). The dotted lines are used to indicate wires with a diameter of 1 mm and the 0.2 mm wire in the case of $W_{50/50}$.

Influence of bimodal copper grain size distribution on electrical resistivity and tensile strength of silver-copper composite wires, S. Tardieu, D. Mesguich, A. Lonjon, F. Lecouturier-Dupouy, N. Ferreira, G. Chevallier, A. Proietti, C. Estournès, and C. Laurent, Mater. Today Commun. **37**, 107403 (2023).

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ANOMALOUS HALL EFFECT AT HIGH MAGNETIC FIELDS IN ALTERMAGNETIC RuO_2

Tommy Kotte, HLD

The conventional classification of magnetic materials has long been based on their distinction as either ferromagnetic or antiferromagnetic, determined by the presence or absence of a discernible net magnetic moment. In the ferromagnetic state, the break of time-reversal symmetry, coupled with spontaneous spin polarization in the electronic band structure, manifests in phenomena such as an anomalous contribution to the Hall effect or the generation of spin-polarized currents.

Traditionally, it was widely believed that these effects were exclusive to ferromagnetic states and did not manifest in ordinary collinear antiferromagnets. However, recent advancements have brought to light a new category of magnets known as „altermagnets“. These intriguing materials break time-reversal symmetry without exhibiting a net magnetic moment. Within altermagnets, a specific symmetry emerges: opposite magnetic moments are situated on crystal sublattices interconnected by rotation symmetries. This unique configuration results in alternating spin polarization in both real and momentum-space electronic structures, thereby giving rise to the aforementioned anomalous Hall and spin-current effects seen in ferromagnets.

In this study, a team of researchers from Germany, Czech Republic, New Zealand, and UK have studied at HLD the emergence of an anomalous Hall effect (AHE) in RuO_2, serving as a prototype for an altermagnet. In this material, symmetry excludes an AHE when the Néel vector points along the magnetic easy axis [001]. However, when a magnetic field is applied along the [110] direction, it induces a continuous rotation of the Néel vector towards the [110] axis, where an AHE is anticipated by theory.

Indeed, when measuring the Hall resistivity as a function of magnetic field applied along [110] (Figure), a robust nonlinear AHE contribution is observed that saturates above about 50 T. This threshold field signifies the point at which the Néel vector aligns along the [110] direction and is given by the interplay of the exchange interaction, the magneto-crystalline anisotropy, and the Dzyaloshinskii-Moriya interaction. It is important to note that the observed AHE contribution cannot be attributed to a field-induced ferromagnetic component, as this has been demonstrated to be linear and small within this field range. Instead, it purely stems from the unique topology of the RuO_2 magnetic structure.

The presented study sheds light on the rapidly advancing field of altermagnetism and contributes to our understanding of its potential future application in spintronic devices that are resilient to magnetic field perturbations and do not require a finite magnetization.

Saturation of the anomalous Hall effect at high magnetic fields in altermagnetic RuO_2,
T. Tschirner, P. Keßler, R. D. Gonzalez Betancourt, T. Kotte, D. Kriegner, B. Büchner, J. Dufouleur, M. Kamp, V. Jovic, L. Smejkal, J. Sinova, R. Claessen, T. Jungwirth, S. Moser, H. Reichlova, and L. Veyrat, APL Mater. **11**, 101103 (2023).

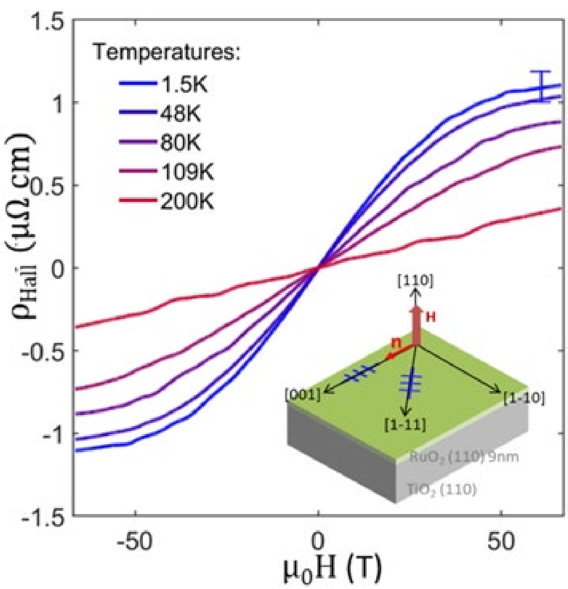

Figure: Hall resistivity of RuO_2 as a function of applied magnetic field at different temperatures. The anomalous Hall effect (AHE), which remains stable up to 100 K, is observed as an S-shaped contribution to the Hall resistivity. Inset: Geometry of the studied thin-film RuO_2 sample.

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OUTCOME OF THE THIRTIETH CALL FOR ACCESS

On 15 November 2023, the 30th call for access to the EMFL facilities ended. Mid December, the Selection Committee ranked the proposals on a competitive basis.

Our four facilities

> LNCMI - Grenoble - France: Static magnetic fields to 36 T
> HFML - Nijmegen - the Netherlands: Static magnetic fields to 38 T
> HLD - Dresden - Germany: Pulsed magnetic fields to beyond 95 T
> LNCMI - Toulouse - France: Pulsed magnetic fields of long duration to over 99 T, and on the microsecond scale to beyond 200 T

are open to users worldwide. EMFL operates a joint transnational access program, which grants full access to these installations and all associated scientific infrastructure to qualified external users, supplemented by the necessary support from the scientific and technical staff on site.

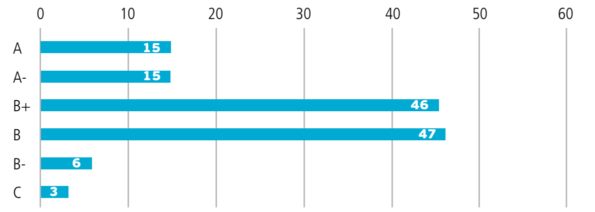
For this 30th call, 132 applications were submitted, of which 3 are proposals for dual access with regional partner laboratories, 2 for technical access, and 15 proposals for first-time access to the EMFL high-field facilities. These novel access procedures are introduced within the EMFL-ISABEL project.

The proposals came from 21 different countries and were evaluated by the EMFL Selection Committee mid December. The Selection Committee consists of 18 specialists covering the following five scientific topics:

> Metals and Superconductors (32 applications),
> Magnetism (59 applications),
> Semiconductors (26 applications),
> Soft Matter and Magnetoscience (9 applications),
> Applied Superconductivity (6 applications).

Besides of ranking the proposals, the committee members decide on the number of accepted magnet hours and number of pulses.

NEXT CALL:
Launch: April 15, 2024
Deadline: May 15, 2024



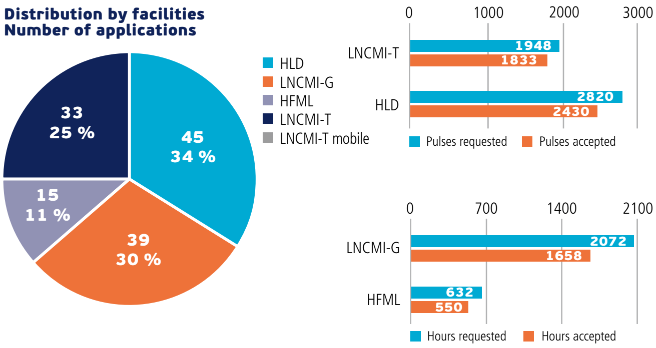
Evaluation of applications

The proposals are ranked in three classes:

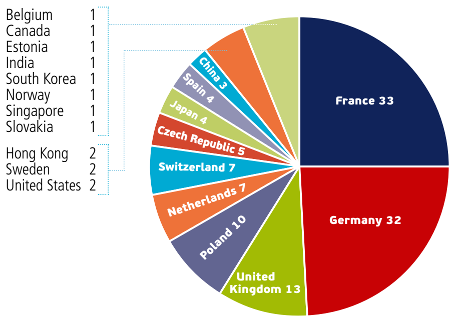
A (excellent proposal to be carried out),
B (should be performed, but each facility has some freedom considering other constraints),
C (poorly crafted proposal, or one that does not need any of the four unique high-magnetic-field facilities).

In the B category, the ranking + or - serves as a recommendation to the facility. This degree of freedom is necessary to allow the facilities to consider other aspects such as available capacity and equipment necessary for the successful outcome of a project.

Distribution by facilities
Number of applications



Distribution by country of PI affiliation



SEF TECHNOLOGIES

SEF (Société d'Études et de Fabrication) is a forty years old national leader of copper-magnet manufacturing in France. The electromagnets produced by SEF are made for particle accelerators, mainly synchrotrons and linear accelerators.

The core skill of SEF lies on the great knowledge of coil manufacturing, which is entirely controlled from the winding to the final product. As well as simple coils, SEF has acquired production, design, and assembly experience for prototyping, thanks to the recent development of its engineering sector, composed of a mechanical specialist and a physicist, coupled with the expertise of technicians.

This high-level expertise allowed SEF to intensify its collaboration with several customers through the years, notably by being part of upgrading projects in accordance with a greener consumption of energy and better performances. It has also brought new clients and has extended the borders towards new domains as, for instance, the medical market with proton and radio-therapy development, or ion-implantation machines for semiconductor manufacturing.

An upgrade has also occurred inside SEF's factory walls. Indeed, to provide a fully controlled magnet assembly, SEF acquired a stretch wire bench, which helps to characterize any type of magnet. Connected with the magnetic simulation using OPERA (2D/3D), SEF conducts high-precision characterization of magnets. Another bench, based on a Hall-effect probe, which aims at performing high-resolution magnetic mapping, is also on the way to become a new asset of the company.

In the next few years, SEF will continue to broaden its horizon towards new challenges as well as new partners in innovative ways. This will be facilitated by being part of the EMFL Industrial Partners Club, and other structures, which will pave the way to bring the industrial ideas to the innovation of science.

Figure 1: SEF Technologies, Labège, France

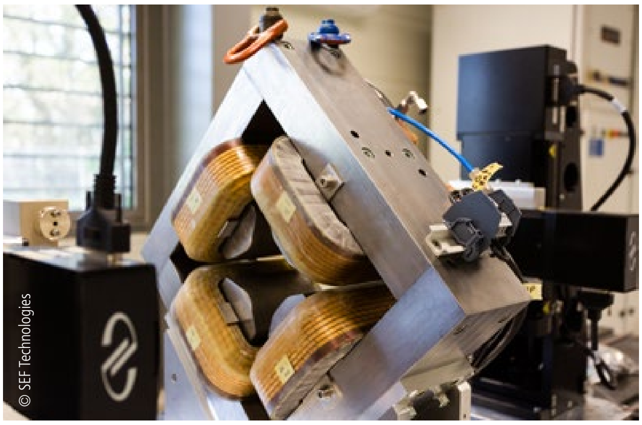


Figure 2: Stretch wire bench control of a quadrupole

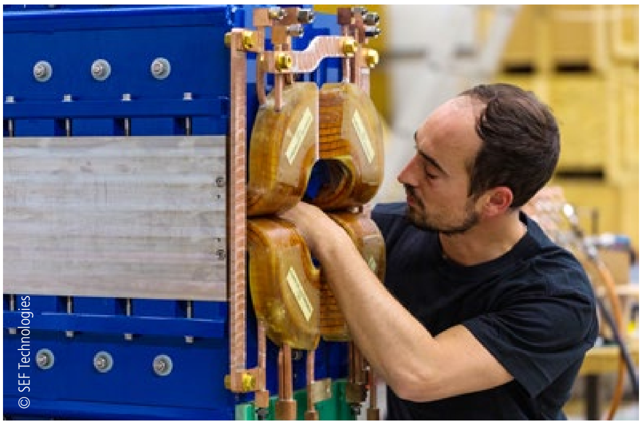


Figure 3: Quadrupole assembly

EMFL SPRING SCHOOL 2024

Date: **15 - 19 April 2024**
Venue: **Penck Hotel, Dresden, Germany**

The School aims at introducing young scientists to topical aspects of condensed-matter research. Renowned speakers will deliver lectures covering fundamental and applied aspects of their research. The school emphasizes networking to foster a sense of community among participants. The school is open primarily to young scientists, master and doctoral students, and postdoctoral researchers. Participants are expected to present a poster and will have the opportunity to showcase their research during dedicated pitch sessions.

Registration fees: The school is sponsored by EMFL through the EU project ISABEL and no fees are requested.

Selection Criteria: Participants will be selected based on the quality of their motivation letter.

To secure your spot at the EMFL Spring School 2024, please register using the following link:
https://events.hifis.net/e/EMFLSchool2024

The registration deadline is 16 February 2024. We encourage you to register soon to ensure your participation.

EMFL USER MEETING 2024 IN NOTTINGHAM

Date: **Tuesday, 11 June 2024**
Venue: **School of Physics and Astronomy, University of Nottingham, UK**

We are pleased to invite you to the EMFL User Meeting. The meeting will be organized by Prof. Amalia Patanè, UK Director of the EMFL partnership. The meeting will examine recent advances in using and creating high magnetic fields, discuss the needs for further tools and developments, and create awareness of opportunities for collaborative research with the EMFL. Distinguished invited speakers across disciplines will report on the use of high magnetic fields for fundamental research and technologies, the development of high magnetic fields, and their integration with other research tools and techniques. The programme includes poster presentations, moderated discussions on facilities' developments and community needs. Details about the programme and registration will be updated in due course.

If you are a user of the EMFL, we invite you to send your feedback on your experience during your last visit at one of the facilities of the EMFL to the User Committee.

An online user feedback form is available at
https://emfl-users.lncmi.cnrs.fr/SelCom/User-Committee/feedbackform.php

You may also want to contact directly the User Committee via e-mail at **UserCommittee@gmail.com**

WORKSHOP "FRONTIERS OF SYNCHROTRON AND XFEL RESEARCH AT HIGH MAGNETIC FIELDS" (magX)

Helmholtz-Zentrum Dresden-Rossendorf (HZDR), 8-10 November 2023

The workshop provided a forum for 46 registered participants to present and discuss the latest research results obtained using x-ray radiation sources and high magnetic fields. During the meeting, the scientists had the excellent opportunity to discuss the current state of the art of instrumentation and explore possible collaborations between participants and research institutions. Indeed, the workshop covered topics such as:

> Current trends, challenges, and future perspectives in the field,
> X-ray scattering and spectroscopy at high magnetic fields,
> New sample materials perspectives,
> New high-field x-ray instruments and technologies.

This workshop received support through the European Horizon 2020 project ISABEL.

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RHMF 2024 IN NIJMEGEN

The 13th International Conference on Research in High Magnetic Fields (RHMF 2024) will be held in Nijmegen, the Netherlands from 7 to 11 July 2024, as a satellite conference to the International Conference on Magnetism (ICM2024, 30 June - 5 July 2024, Bologna, Italy).

The program will consist of invited and contributed lectures and posters in single sessions with sufficient time allocated to stimulate discussions and interactions between the participants. Participation of students is explicitly encouraged.

The scope of this conference covers traditional and new topics on fundamental and applied physics and related subject areas, in which high magnetic fields play a crucial role:

> Semiconductor physics and phenomena
> Superconductivity
> Magnetism
> Strongly correlated electron systems
> Low-dimensional and nano-scale materials
> Spin liquids
> Topological matter
> Magnetoscience
> High magnetic field technology
> New experimental techniques in high magnetic fields

The conference is hosted by HFML-FELIX, Radboud University Nijmegen.

Important dates:

Opening abstract submission: February 2024
Announcement invited Speakers: February 2024
Abstract submission deadline: March 29th, 2024
Abstract acceptance: April 26th, 2024

Contact details:

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6525 ED Nijmegen
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UPCOMING EVENTS

1 APS March Meeting, Minneapolis, USA, March 3-8, 2024.
https://march.aps.org/

2 DPG Spring Meeting of the Condensed Matter Section, Berlin, Germany, March 17-22, 2024.
https://berlin24.dpg-tagungen.de/

3 EMFL Spring School 2024 - Science in High Magnetic Fields, Dresden, Germany, April 15-19, 2024.
https://emfl.eu/emfl-spring-school-2024/

4 International Magnetics Conference (INTERMAG 2024), Rio de Janeiro, Brazil, May 5-10, 2024.
https://www.intermag2024.org/

5 International Conference on Science and Technology of Synthetic Electronics Materials 2024, Dresden, Germany, June 23-28, 2024.
https://icsm2024.de/

6 International Conference on Magnetism (ICM 2024), Bologna, Italy, June 30 - July 5, 2024.
https://www.icm2024.org/

7 Research in High Magnetic Fields (RHMF 2024), Nijmegen, The Netherlands, July 7-11, 2024.
https://www.hfml.ru.nl/RHMF2024/

8 International Conference on the Physics of Semiconductors (ICPS 2024), Ottawa, Canada, July 28 - August 2, 2024.
https://uottawacpd.eventsair.com/QuickEventWebsitePortal/icps2024/info

9 Applied Superconductivity (ASC 2024), Salt Lake City, USA, September 1-6, 2024.
https://www.appliedsuperconductivity.org/asc2024/

10 International Conference on Infrared, Millimeter, and Terahertz Waves, Perth, Australia, September 1-6, 2024.
https://www.irmmw-thz.org/conference/

11 International Symposium on Crystalline Organic Metals, Superconductors and Magnets (ISCOM 2024), Anchorage, USA, September 22-27, 2024.
https://sites.google.com/view/iscom2024/home

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