EMFL Annual Report 2024

EMFL

European Magnetic Field Laboratory

EMFL

European Magnetic Field Laboratory

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UKRI Engineering and Physical Sciences Research Council

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European Magnetic Field Laboratory
Annual report 2024

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Foreword

Dear Reader,

With great pleasure, we present to you the tenth annual report of the European Magnetic Field Laboratory (EMFL), highlighting various excellent scientific achievements and recent developments. In 2024, EMFL was involved in three European projects. In the project ISABEL, we strengthen our cooperation within EMFL and with our partners, both from academia and industry. The SuperEMFL project successfully generated specific knowledge and models for the design of 32+ and 40+ T all-superconducting user magnets and their possible implementation within EMFL. This project ended December 2024. In March 2024, we started the new EU Horizon-funded project "Flexibility in Research Infrastructures for global CArbon Neutrality" (FlexRICAN). This project, coordinated by ESS (European Spallation Source), has the ambitious goal of revolutionizing energy-consumption patterns within large research infrastructures across Europe. Another large research-infrastructure partner in this project is the Extreme Light Infrastructure (ELI).

We further have successfully organized and supported a series of events. In April 2024, an EMFL spring school took place in Dresden with more than 50 PhD students and postdoctoral researchers as well as 13 renowned lecturers including one Nobel laureate. In June, we held the annual EMFL User Meeting at the University of Nottingham with the traditional EMFL prize-award ceremony. In September, during the EMFL Days in Prague, all EMFL staff members had the chance to exchange ideas, discuss best practices of administrative procedures, and strengthen the common EMFL spirit. Further, EMFL supported the RHMF (International Conference on Research in High Magnetic Fields) in Nijmegen in June and the International Conference on High Magnetic Fields in Semiconductor Physics (HMF-25) in Warsaw in September.

Finally, we proudly can announce that the hybrid magnet at the LNCMI in Grenoble reached 42 T in November 2024. In 2025, the magnet will be open to users of the EMFL in the usual biannual frame of open calls for projects.

I would like to use this opportunity to thank especially all our dedicated staff and the users of the EMFL facilities for making this possible.

Jochen Wosnitza
Chairman EMFL
Director HLD

Mission

The EMFL develops and operates world class high magnetic field facilities, to use them for excellent research by in-house and external users

High magnetic fields are one of the most powerful tools available to scientists for the study, the modification, and the control of the state of matter.

The European Magnetic Field Laboratory (EMFL) was founded in 2015 and awarded the Landmark status in March 2016 during the ESFRI Roadmap presentation in Amsterdam. EMFL provides the highest possible fields (both continuous and pulsed) for its researchers. The EMFL is dedicated to unite, coordinate, and reinforce the four existing European high magnetic field facilities – the Dresden High Magnetic Field Laboratory (Germany), the Laboratoire National des Champs Magnétiques Intenses in Grenoble and Toulouse (France), and the High Field Magnet Laboratory in Nijmegen (The Netherlands) – within a single body as a world-leading infrastructure.

The missions of the EMFL are:

- to develop, construct, and operate top-level high-field magnets
- to perform excellent research in very high magnetic fields
- to act as a European user facility for the scientists of the participating countries and for other scientists
- to act as the European center of excellence for a multitude of magnetic-field-based material-characterization techniques in very high fields

Developments 2024

EMFL SPRING SCHOOL 2024

Following a two-year interval, we revived the tradition of EMFL Schools to motivate and inspire the next generation of high-magnetic-field researchers in Europe. This event took place in the Penck Hotel, a modern-art venue nestled in the historic neighborhood of Dresden, Germany, from April 15-19, 2024. The 2024 program focused on both fundamental and applied aspects of materials research. Renowned speakers covered a wide range of topics including low-dimensional semiconductors, topological matter, strongly correlated electron systems, magnetism, superconductivity, and high-magnetic-field technology. Additionally, the school's agenda featured a variety of interactive elements: a pitch session, during which each participant had two minutes to showcase their posters; a poster session for more detailed discussions; a fireside chat that delved into the personal aspects of a scientific career; and a group activity that honed participants' skills in scientific storytelling.

The event attracted significant interest, with 59 applicants out of 66 applications accepted. Ultimately, 52 participants from 17 different countries actually attended the event. This week-long inspiring experience sparked the interest of the newcomers in high-magneticfield research and, for the others, provided the tools and knowledge needed to advance their research in the realm of high magnetic fields.

EMFL USER MEETING 2024

The EMFL User Meeting 2024 took place at the University of Nottingham on 11 June; after 2017, the second time at this place. The EMFL Board of Directors has chosen this venue to underline the continuing collaboration of the UK community with EMFL, through grant agreements between EPSRC and EMFL as well as with the three host laboratories in France, The Netherlands, and Germany. Prof Amalia Patanè received a separate EPSRC grant for coordinating the UK activities connected to EMFL. She also hosted the meeting. The User Meeting included the EMFL prize ceremony (see below), two scientific sessions, in which our users highlighted some of their most recent research, the User Committee meeting, chaired by Prof Raivo Stern (NICPB, Tallinn, Estonia), and, for the first time, a session allowing industry partners to present their activities and interest in high-magnetic-field technologies. Here, John Burgoyne form Oxford Instruments plc and M'hamed Lakrimi from Siemens Magnet Technology gave inspiring talks. The meeting started with an introductory lecture by Charles Simon, chair of the EMFL Board of Directors, who presented recent developments within EMFL. The scientific talks covered a broad range of research enabled by the use of very high magnetic fields. This included magneto-hydrodynamics in stars, optical spectroscopy and transport in two-dimensional materials, all the way to unconventional superconductivity and extreme high-pressure studies of hydride superconductors. We would like to thank Amalia Patanè and all the staff at the University of Nottingham for their excellent organization and for the diverse and inspiring meeting.

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ELENA BLUNDO WINS EMFL PRIZE 2024


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During the User Meeting in Nottingham, Elena Blundo received the EMFL prize 2024. Jochen Wosnitza, chair of the EMFL prize committee, had the honor of presenting the prize in a traditional small prize ceremony. The EMFL prize was established in 2009 and recognizes outstanding achievements related to research in all disciplines utilizing high magnetic fields. Elena received her PhD in Physics in January 2023 from the Department of Physics of Sapienza University of Rome. Currently, she is a distinguished postdoc fellow at the Walter Schottky Institut, at the Technical University of Munich. The prize recognizes Elena's work related to the use of high magnetic fields in complex optical-spectroscopy experiments on two-dimensional (2D) crystals. She investigated the electronic and mechanical properties of 2D materials, such as monolayers and heterostructures of transition-metal dichalcogenides (TMDs), hexagonal boron nitride, nano-porous graphene, III-V nanowires, and perovskites. Remarkably is her research of the Moiré localization effect in TMD-based heterostructures and the development of a novel method to induce extremely high strains in TMDs that allowed her to unveil novel strain-induced effects in these materials.

RHMF 2024

The 13th International Conference on Research in High Magnetic Fields (RHMF 2024) was held in Nijmegen, the Netherlands from 7 to 11 July 2024. The conference was hosted by HFML-FELIX, Radboud University Nijmegen and attracted more than 100 participants from countries all over the world. The program consisted of 21 invited and 24 contributed lectures, as well as two very lively poster sessions on Monday and Tuesday evening, preceded by poster pitch sessions. The participants presented and discussed the latest advancements in fundamental and applied physics and related subject areas, where high magnetic fields play a crucial role, with sessions on semiconductor physics and phenomena, superconductivity, magnetism, strongly correlated electron systems, semimetals, spin liquids, topological matter, magnetoscience, high magnetic field technology, and new experimental techniques in high magnetic fields. On Wednesday afternoon, the HFML-FELIX staff guided the participants through the laboratories, showing the high-field-magnet and free-electron-laser installations, as well as the experimental infrastructure. HFML-FELIX, Radboud University, the European Magnetic Field Laboratory, and the Dutch research Council NWO sponsored the conference.


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EMFL DAYS 2024 IN PRAGUE

Every two years, the staff members from all four EMFL sites meet at some place outside their facilities to exchange ideas, discuss best practices of administrative procedures, and strengthen the common EMFL spirit. This time, the sixth meeting of the EMFL Days took place in Prague from 16 to 18 September 2024. Altogether, 110 EMFL staff members gathered in the capital city of the Czech Republic in a hotel near the center. Although the flooding in some parts of the country did prevent some people from participating, most EMFL staff arrived safely. For many participants, it was the first visit to Prague and they were able to enjoy the surrounding with a walk through the city in perfect weather conditions. The EMFL Days started on Monday afternoon by a plenary session with an opening and welcome by Jochen Wosnitza (HLD). Further, Charles Simon (LNCMI), chair of the EMFL Board of Directors, updated on the EMFL status and future plans.The invited speaker Jan Prokleska, Vice-Head of the Department of Condensed Matter Physics, Charles University and representing the Czech regional partner in the ISABEL project, presented the "MGML infrastructure in Prague".

The directors of the three laboratories – Britta Redlich (HFML-FELIX), Charles Simon, and Jochen Wosnitza – presented the current state and future plans of their facilities. Further, Charles Simon and Xavier Chaud (LNCMI) gave overviews on the EU projects ISABEL and SuperEMFL, respectively. An informal evening program closed the day, when staff joined the entertaining and informative quiz prepared by students from HLD. Exchange of information and lively discussions started Tuesday morning during the two first sessions of workgroups. As usual, the workgroups covered the topics: i) Magnets and facilities development, ii) Instrumentation, iii) Administration/hosting users/communication, and iv) PhD/Post-Doc session. The afternoon, dedicated to an informal tour through the city of Prague, allowed enjoying the historic buildings, the bridges, and embankments. Finally, the participants joined for dinner at an authentic restaurant with typical Czech beer and food. Wednesday morning, the groups continued their work during the two last sessions and defined their vision of a common strategy for EMFL. The morning ended with a wrap-up plenary meeting, during which the groups shared the outcome of the different sessions. Looking back, the EMFL Days are ideal for exchanging information between EMFL staff, whether to discuss the development of a project and its opportunities or to stimulate ideas by creating stronger bonds and intensified dialogue between staff as well as by getting to know each other better. Indeed, the very well organized EMFL Days 2024 have been a very successful and fruitful meeting.

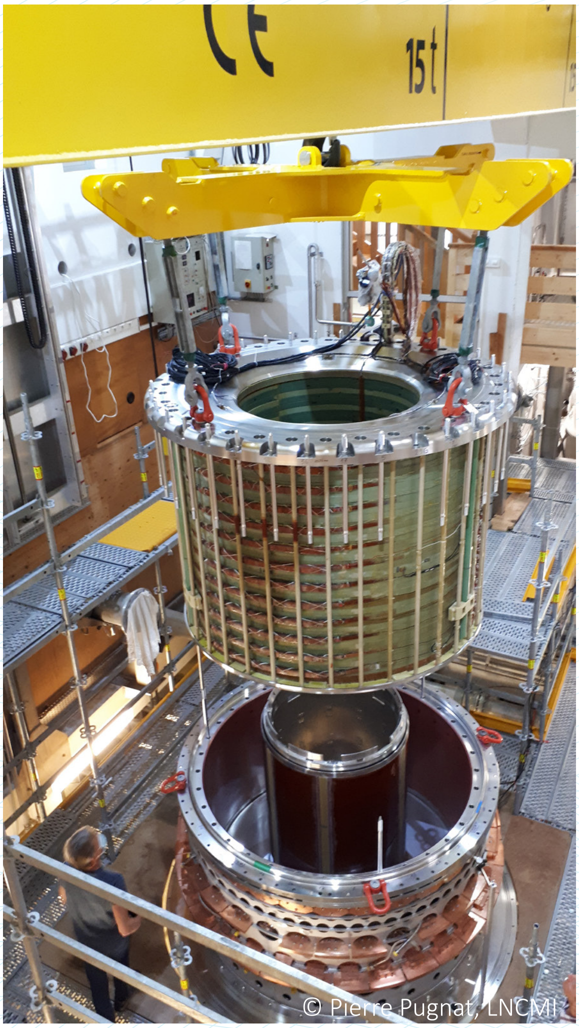
HMF-25 IN WARSAW

The 25th International Conference on High Magnetic Fields in Semiconductor Physics (HMF-25) was held in Warsaw, Poland from 16 to 20 September 2024 as a satellite conference to the International Conference on the Physics of Semiconductors (ICPS-2024, Ottawa, Canada). HMF-25 follows a series of biennial conferences, initiated by Gottfried Landwehr, in Würzburg, Germany, in 1972. Primarily focused on semiconductors and magnetic fields, the main topics of the conference have evolved with time and are now dominated, but not limited to current themes related to the physics of low-dimensional systems in conjunction with the application of magnetic fields. This workshop received support through the European Horizon 2020 project ISABEL.

LNCMI'S HYBRID MAGNET REACHES 42 TESLA

The hybrid magnet at the LNCMI in Grenoble is now reaching 42 T. This is the first time that a team of engineers and researchers achieved such high magnetic field in Europe by combining a superconducting coil and copper-alloy electromagnets. In a few months' time, LNCMI will make this magnet available to scientists at the European Magnetic Field Laboratory.

On 8 November 2024, the Equipex LASUP of the Laboratoire National des Champs Magnétiques Intenses (LNCMI, CNRS) achieved one of its objectives: The team created a continuous magnetic field of 42 T for around ten minutes in a coil with a bore of 34 mm in diameter. This achievement, the fruit of many years of dedicated work, means that the LNCMI joins the podium of the world's laboratories offering fields of more than 40 T, alongside with the US laboratory in Tallahassee and the Chinese laboratory in Hefei. Experiments with around 45 T in boreholes with a diameter of 32 mm are possible there.



Insertion of the superconducting coil of the hybrid magnet in its cryostat at LNCMI-Grenoble

The Grenoble magnet will be open to users of the EMFL in a few months' time in the usual biannual frame of open calls for projects. It will enable research teams in the need for very high magnetic fields to carry out their experiments. Today, such strong magnetic fields are essential for studying advanced materials in the fields of information technology, magnetic resonance imaging, energy materials (batteries, solar panels, etc.), and quantum technologies.

Optimized to reduce its carbon footprint, this hybrid magnet uses a superconducting part with an internal diameter of 1100 mm (8.5 T) and a resistive part (33.5 T). The resistive magnet benefits from the long-standing expertise at LNCMI, in particular in power supply, which is unique in the world because of its ability to operate for very long durations, as well as in magnetic cooling in terms of hybrid magnets cooled with pressurized superfluid helium.

European partners took part in the project, including CEA Saclay (design of the superconducting part, protection system for the superconducting coil), the French companies SDMS and CRYO DIFFUSION (production of the cryostat and cryogenic lines), and the German companies BRUKER and BILFINGER (production of the superconducting cable and the superconducting coil).

COOPERATION BETWEEN EMFL AND JAPANESE HIGH-MAGNETIC-FIELD LABS

Since many years, various fruitful collaborations and interactions exist between the Japanese high-magnetic-ield community and EMFL. In an effort to consolidate formally these common interests, the High Magnetic Field Collaboratory and EMFL signed a Memorandum of Understanding (MoU). The High Magnetic Field Collaboratory is a collaborative research organization consisting of the International MegaGauss Science Laboratory at the Institute for Solid State Physics (ISSP), University of Tokyo, the Center for Advanced High Magnetic Field Science, Graduate School of Science, Osaka University, and the High Field Laboratory for Superconducting Materials, Institute for Materials Research, Tohoku University. With the MoU, the partners strive to encourage visits of their staff members from one institution to the other, strengthen their cooperation, exchange scientific information, and promote the use of the partner facilities in their respective scientific communities.

RESEARCH FOR EUROPE'S ENERGY FUTURE - FLEXRICAN PROJECT KICK-OFF

The beneficiaries of the EU Horizon-funded "Flexibility in Research Infrastructures for global CArbon Neutrality" (FlexRICAN) project inaugurated its launch during a kick-off meeting held on March 11-12, 2024 at the European Spallation Source (ESS) in Lund, Sweden. The 3-year FlexRICAN project, coordinated by ESS, has the ambitious goal of revolutionizing energy-consumption patterns within large research infrastructures across Europe. By harnessing the diverse expertise and resources of its partners, the project´s aim is to develop sustainable energy solutions that will not only benefit the European grid but also local heating networks. The kick-off meeting was attended by representatives from leading European institutions and companies including Centre National de la Recherche Scientifique (CNRS), Helmholtz-Zentrum Dresden-Rossendorf (HZDR), European Magnetic Field Laboratory (EMFL), Stichting Radboud Universiteit, Extreme Light Infrastructure (ELI), Alfa Laval and Energy Pool, along with European Commission representative Elena Garbarino. The meeting also included a workshop session for detailed discussions on project objectives and descriptions of work packages, during which each work-package leader outlined their specific responsibilities in the five-million-euros project.

EMFL AT TRADE FAIRS AND INDUSTRIAL EVENTS

Members of the European Magnetic Field Laboratory went to various trade fairs and events in 2024 to meet our current and make contacts to future industrial partners. In July, we sponsored the workshop “Cryogenic Operations” (Cryo-Ops) in Grenoble. This three-day event welcomed around 80 participants. We were able to meet many of the cryogenics experts from around the world as well as to present our own expertise in this research area. We further used the opportunity to invite the participants to visit the Laboratoire National des Champs Magnétiques Intenses in Grenoble.

October 2024 was a busy month, with EMFL being part in two large trade fairs, one in Trieste, Italy, and one in Paris, France. Every two years, the “Big Science Business Forum” (BSBF) takes place. The third edition in Trieste, from October 1 to 4, welcomed over 1300 participants from 500 organizations. During this event, 245 exhibitors and 14 national pavilions from thirty-two countries presented their science-related expertise in 163 stands. The EMFL had a stand, where the Industrial Liaison Officer and ISABEL project manager, Inès Dupon-Lahitte, and SuperEMFL project manager, Eleonora Sartori, were able to represent the EMFL and answer the questions of interested participants. BSBF 2024 also offered a platform to allow its participants to have business-to-business (B2B) meetings. Thanks to this, it was possible to showcase the EMFL in detail to numerous Big Science actors.

Finally, the EMFL was also present at this year’s edition of the Rendez-vous Carnot in Massy, France. This event welcomed 1300 participants and, thanks to the B2B platform, allowed for more than 4000 meetings. Such fairs and events are always a great opportunity to meet new potential industry partners, but also to consolidate already existing and discuss future collaborations.

Inès Dupon-Lahitte, EMFL Industrial Liaison Officer and ISABEL project manager

SuperEMFL PROJECT SUCCESSFULLY FINISHED

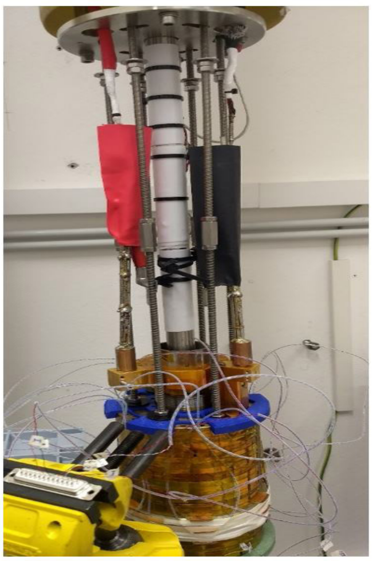
The SuperEMFL project has generated specific know-how, models, the design of 32+ and 40+ T all-superconducting user magnets (TRL 7), and a scenario for implementing such equipment within EMFL as main outcomes.

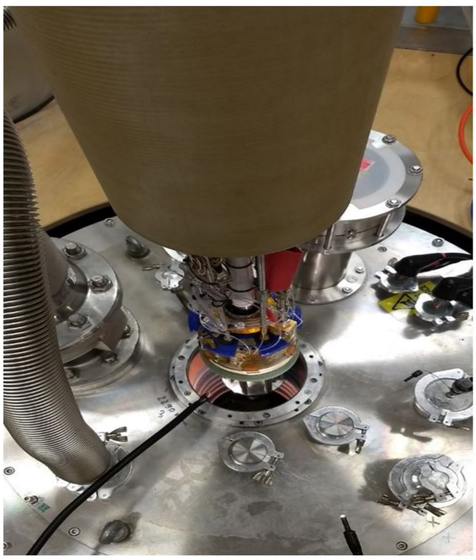
The use of HTS inserts to generate field efficiently introduces a change of paradigm. New experimental possibilities are expected, in particular long duration and very low-noise experiments. The large resulting reduction of operating costs for static high-field experiments will also considerably increase the EMFL capacity to host user experiments. The improvement of the EMFL environmental impact as well as the optimization of resources and energy are some major benefits of the project.

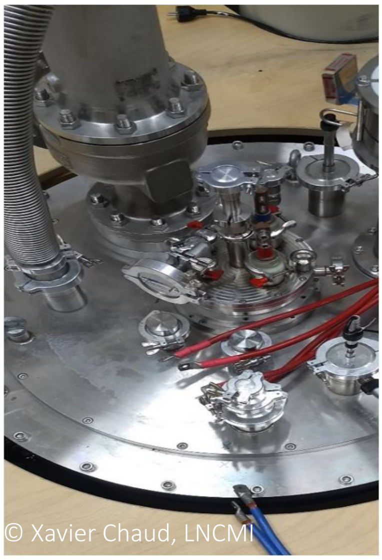
The development of HTS technology is now widely competitive with projects aiming at 40 T in Europe, the USA, and China. We are reaching other communities beyond EMFL throughout workshops and conferences, which show their strong interest by submitting their own projects to leverage the HTS technology, i.e., neutron-scattering facilities, CERN with its Muon Collider project, and the fusion community.

We expect innovation impacts by opening the magnetic-field range beyond the current limit of commercial superconducting fields, to give the industrial partners a competitive advantage, understanding and modeling the quench events in HTS magnets and opening the high magnetic fields as a research tool to the bio and life sciences. This project is a showcase for Oxford Instruments LTS outserts and for THEVA tapes.

We have trained several PhD students and post-doctoral fellows throughout SuperEMFL, increasing their skills and value on the labor market, but also helping to prepare a future generation for HTS technology that will allow Europe to play an important role in this strategic technology.







Scientific Highlights

TUNING THE PAIRING MECHANISM OF A SUPERCONDUCTOR

The discovery that superconductivity can also be induced by direct interactions between electrons, for example mediated by their magnetic properties, was a real breakthrough. However, a precise identification of this pairing mechanism remains a major challenge. In high-T_c cuprates, for example, still no consensus exists on which interactions control the formation of the Cooper pairs. Recently, EMFL scientists have shown in a collaboration of Phéliqs, Néel Institute, the LNCMI Grenoble, and Tohoku University that the strongly correlated system, UTe_2, is the first one, for which two different pairing mechanisms can lead to different superconducting (sc) states. Moreover, a magnetic field can tune, which mechanism will drive the sc state.

The team discovered that the anomaly, i.e., the specific-heat jump, which marks the transition between the normal and the sc state, broadens more than 4 times in the field-reinforced state. This is unique: in the very few other examples of superconductors displaying multiple sc phases, the sc states differ only by a change of symmetry, and in such a case, there is no remarkable change of the specific-heat anomaly. Here, in UTe_2, it is likely that the low-field spin-triplet sc phase is driven by ferromagnetic fluctuations, whereas the high-field phase with a broad specific-heat anomaly emerges from other magnetic fluctuations developing under magnetic field.

A peculiarity of the phase diagram of UTe_2 (figure) is that the field-reinforced sc state abruptly disappears above 35 T, coinciding with a first-order metamagnetic transition. The mentioned “other” magnetic fluctuations are most likely related to the emergence of the metamagnetic transition. Detailed analysis shows that a pairing mechanism controlled by the metamagnetic field could explain quantitatively the strong broadening of the specific-heat anomaly, as well as its high sensitivity to a small misalignment of the field from the b axis. However, surprisingly, the high-field phase, contrary to the low-field one, would be spin singlet. This is counterintuitive: a spin-singlet state for the Cooper pairs is usually detrimental for superconductivity at high magnetic field, because of the loss of magnetic energy due to the alignment of spins in the field. At the opposite, a triplet state allows to form Cooper pairs with spins polarized along the applied magnetic field; hence, it should be favored at high fields.

Nevertheless, this additional twist is consistent with some theoretical predictions studying precisely the competition of different pairing mechanisms in this system under pressure, where several sc phases have also been discovered.

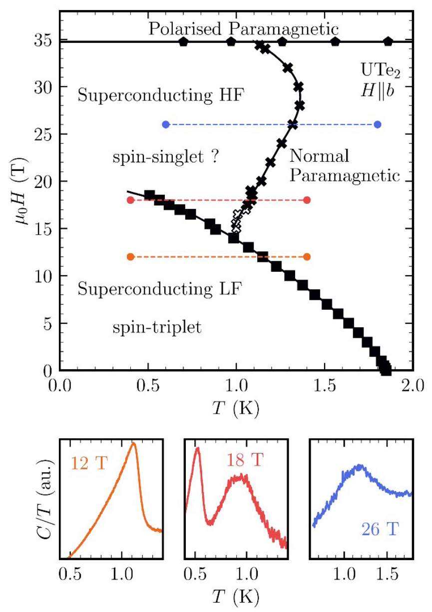


Figure 1: Two different superconducting phases in UTe_2 as observed by thermodynamic specific-heat measurements, showing the transition line between the two phases. At the bottom, the change of the specific-heat anomaly becoming very broad in the high-field phase is very clear: note the curve at 18 T, where both anomalies are successively observed.

Reference

Field-Induced Tuning of the Pairing State in a Superconductor, A. Rosuel, C. Marcenat, G. Knebel, T. Klein, A. Pourret, N. Marquardt, Q. Niu, S. Rousseau, A. Demuer, G. Seyfarth, G. Lapertot, D. Aoki, D. Braithwaite, J. Flouquet, and J.P. Brison, Phys. Rev. X **13**, 011022 (2023).

QUANTUM OSCILLATIONS IN THE SPECIFIC HEAT OF GRAPHITE REVEAL PHYSICS HIDDEN IN TEXTBOOKS

We have investigated quantum oscillations in the electronic specific heat, C_{el}, in natural graphite. The crossing of a single spin Landau level at the Fermi energy gives rise to a double-peak structure (Figure 1a). Crucially, such a double peak is not observed in other thermodynamic probes. The hole and electron spin Landau levels involved are identified by numerically diagonalizing a Hamiltonian, which describes the band structure of graphite in a magnetic field. At lower temperatures, the splitting decreases, and the double-peak structure disappears below 90 mK (Figure 1b).

Intriguingly, the double-peak structure is predicted by text book theory, $C_{el}/T = k_B{}^2 \int D(E)\,(x^2\, df/dx)\, dx$ where $f(x)=1/(1 + e^x)$, $x = E/k_BT$, and k_B is the Boltzmann constant. The specific heat depends on the convolution of the Landau-level density of states (DOS), D(E), and the kernel term $x^2\, df/dx$, which involves the first derivative of the Fermi-Dirac distribution function The usual approximation (see textbooks, such as Kittel), removing D(E) from the integral to obtain the well-known formula $C_{el} = \pi^2 D(E_F)\, k_B{}^2 T/3$, suppresses the double-peak structure which originates from the temperature-dependent splitting of the double maxima in the kernel term (Figure 1c). The calculated and predicted C_{el}/T are in excellent agreement (Figure 1d), notably they reveal the highly asymmetric DOS of three-dimensional Landau levels due to the van Hove singularity.

The kernel term represents a spectroscopic tuning fork of width $4.8k_B T$, which can be tuned at will to resonance. Using a coincidence method, the double-peak structure in the specific heat can be used to accurately determine the Landé g-factors of quantum materials. More generally, the tuning fork can be used to reveal any peak in the fermionic density of states which crosses the Fermi energy, such as for example Lifshitz transitions in heavy-fermion compounds.

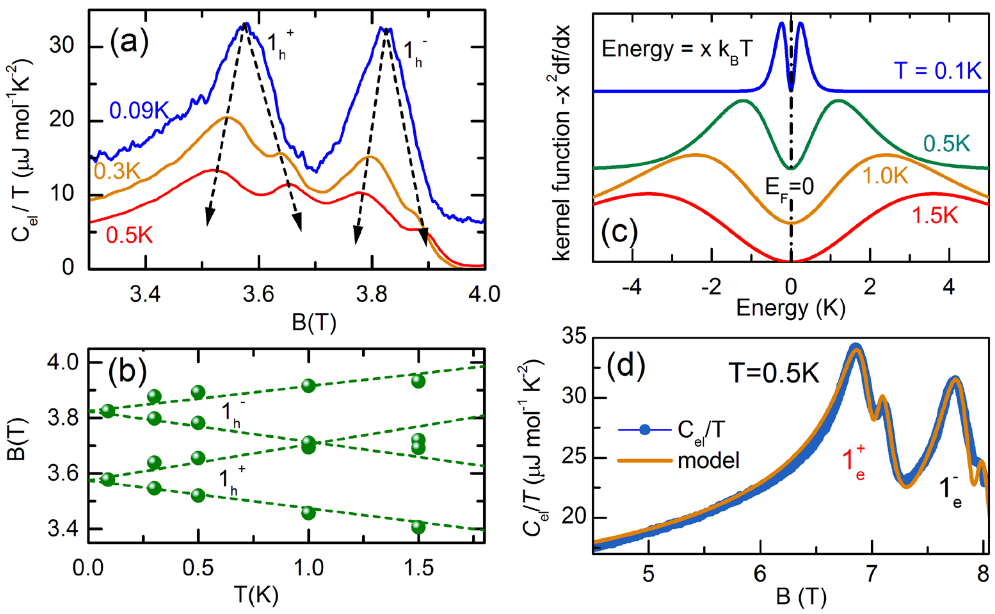


Figure: (a) Electronic specific heat divided by temperature C_{el}/T in graphite as a function of B, where the 1_h spin Landau levels cross the Fermi energy. (b) Magnetic-field position of the double-peak structure as a function of temperature. (c) The kernel term plotted versus $E = x\, k_BT$. Maxima occur at $x = \pm 2.4$ (d) Measured and calculated electronic specific heat C_{el}/T in graphite close to where the 1_e spin Landau levels cross the Fermi energy.

Reference

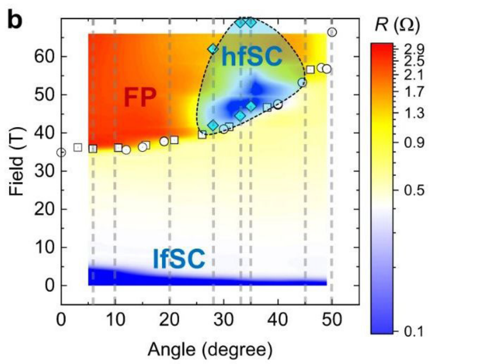
Unveiling the double-peak structure of quantum oscillations in the specific heat, Z. Yang, Y. Kohama, T. Nomura, T. Shitaokoshi, D. K. Maude, B. Fauqué, S. Kim, D. Chowdhury, Z. Pribulova, J. Kacmarcik, D. Aoki, A. Pourret, G. Knebel, T. Klein, and C. Marcenat, Nat. Commun. **14**, 7006 (2023).

POSSIBLE ORIGIN OF HIGH-FIELD REENTRANT SUPERCONDUCTIVITY IN UTe_2

The recent discovery of superconductivity (SC) in the heavy-fermion metal UTe_2 with a critical temperature of about 2 K triggered much excitement, as its critical field reaches values approaching those of high-T_c superconductors. Moreover, UTe_2 appeared very quickly as a potential candidate for topological spin-triplet SC that exhibits multiple unconventional superconducting phases under field or pressure. Spin-triplet SC is a rare phenomenon, expected to arise as a consequence of magnetic fluctuations in strongly correlated materials. It is characterized by a particularly high stability against external magnetic fields, since the Zeeman energy has no influence on the Cooper pairing. Indeed, a key characteristic of UTe_2 is an anisotropic upper critical field that exceeds the so-called Pauli limit along all field orientations.

For field aligned along the b axis, SC survives up to a metamagnetic transition at $\mu_0 H_m \approx 35$ T. The latter is associated with magnetic fluctuations that may be beneficial for the field-reinforced superconductivity surviving up to H_m. Once the field is tilted away from the b towards the c axis, a reentrant superconducting phase emerges just above H_m (see the phase diagram in Figure 1). In order to understand this remarkably field-resistant superconducting phase, an EMFL team together with researchers from Germany, France, and Japan conducted magnetic-torque and magnetotransport measurements in pulsed magnetic fields. They determined the record-breaking upper critical field of $\mu_0 H_{c2} \approx 73$ T and its evolution with angle. In their electrical-transport studies, they revealed that the normal-state Hall effect experiences a drastic suppression upon tilting the field away from the hard magnetic b axis. The minimum in the Hall effect is correlated with the maximum of H_{c2} of the high-field SC, as shown in Figure 2. This hints at a reduced band polarization above H_m in the angular range around 30° caused by a partial compensation between the applied field and an internal exchange field. This promotes the Jaccarino-Peter effect as a likely mechanism for the appearance of reentrant superconductivity above H_m.

These results provide a guide for future experiments and theory that will show more quantitatively, if and how reentrant SC may appear. Such a scenario puts specific constraints on the potential order parameter of the superconducting phase. Solving the riddle of how Cooper pairs, built by heavy quasiparticles, can survive in extreme magnetic fields will certainly help advance our fundamental understanding of unconventional superconductors.



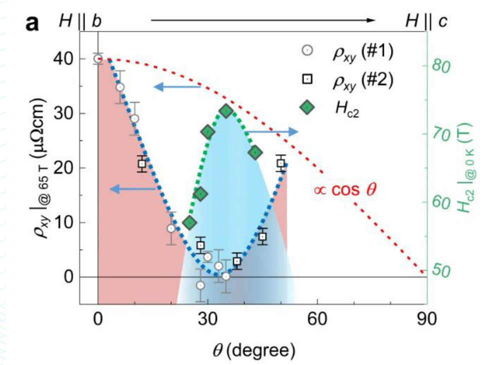


Figure 1: Contour plot created from magnetoresistance data (the color bar corresponds to the resistance in ohm). White squares and circles mark the metamagnetic transition field measured by pulsed-field torque magnetometry. Blue shaded regions indicate the superconducting phases. I

Figure 2: : Angular dependence of the normal-state Hall resistivity at 65 T and 0.7 K of two microstructure devices. The blue dashed line is a guide to the eye that highlights the observed strong suppression around 30 – 35°. Green diamonds are H_{c2} values extrapolated to zero temperature. The red dashed line follows cos θ.

Reference

Field-induced compensation of magnetic exchange as the possible origin of reentrant superconductivity in UTe_2, T. Helm, M. Kimata, K. Sudo, A. Miyata, J. Stirnat, T. Förster, J. Hornung, M. König, I. Sheikin, A. Pourret, G. Lapertot, D. Aoki, G. Knebel, J. Wosnitza, and J.-P. Brison, Nat. Commun. **15**, 37 (2024).

HIGH-FIELD NMR UNVEILS FIELD-REINFORCED SUPERCONDUCTIVITY IN UTe_2

The uranium-based superconductor UTe_2 provides an attractive platform for studying the novel physics of spin-triplet and topological superconductivity in bulk materials. Resistivity measurements performed in 2019 at LNCMI, both in continuous and pulsed fields, revealed that superconductivity in UTe_2 is significantly enhanced when the magnetic field (H) is applied along the crystallographic b axis (inset of figure). This leads to an increase of the upper critical field up to the field of a metamagnetic transition at μ_0H_m = 35 T. It was proposed that an essential ingredient for this field-reinforced superconductivity is the interplay with U-5f-electron spin fluctuations.

To confirm the presence and elucidate the nature of spin fluctuations in UTe_2, we conducted ^{125}Te-NMR experiments in high magnetic fields using specially prepared, ^{125}Te-enriched, high-quality single crystals having T_c = 2.0 K, synthetized using the molten-salt flux method discovered recently by our team. The natural abundance of ^{125}Te is only 7 %, so that our enrichment up to 99 % largely enhanced the NMR signal, allowing us to measure the field dependence of the NMR relaxation rates $1/T_1$ and $1/T_2$ up to 32 T.

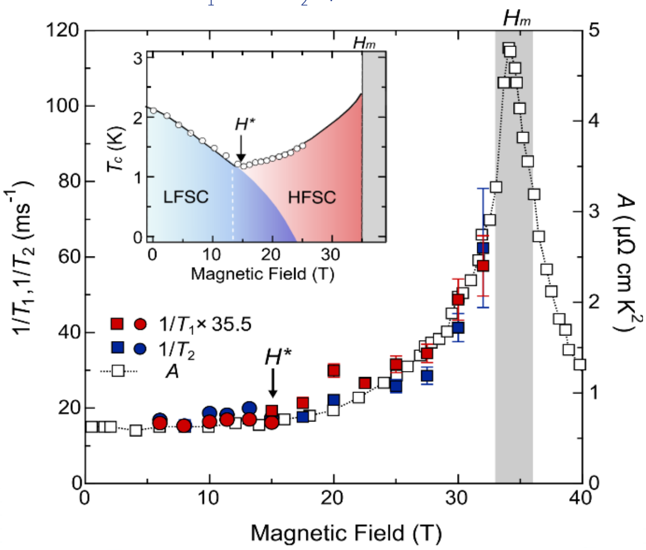


Figure: Magnetic-field dependence of $1/T_2$ and $1/T_1$ (scaled by a factor 35.5) in UTe_2 for H || b, compared to the previously published quadratic coefficient A of the low-T resistivity data. The data provide a direct signature of longitudinal spin fluctuations related to the metamagnetic transition at 35 T. Inset: Field-dependent T_c data and corresponding schematic H-T phase diagram, presenting a high-field (HFSC) as well as a low-field (LFSC) superconducting (SC) phase

The observed magnetic-field dependence of these data for H || b (figure) and the scaling between the two relaxation rates, $T_2^{-1}/T_1^{-1} \approx 36$, demonstrates that the dominant fluctuations in this material are longitudinal ones. While $1/T_1$ and $1/T_2$ are nearly field independent at lower fields, both quantities start to increase above about 15 T and show a tendency to diverge above 32 T, where the NMR spin-echo signal becomes unobservable because T_2 becomes shorter than the dead time of our NMR spectrometer. This confirms the divergence of spin fluctuations near the field-induced metamagnetic transition at H_m.

Previous macroscopic studies gave $\mu_0H^* \approx 15$ T as the characteristic field above which T_c shows an upturn and a high-field superconducting phase emerges on top of a low-field superconducting phase (inset of figure). Our NMR results show that H* is also the characteristic field above which spin fluctuations begin to develop on approaching the metamagnetic transition, confirming that these fluctuations indeed enhance the pairing interactions.

Reference

Longitudinal Spin Fluctuations Driving Field-Reinforced Superconductivity in UTe_2, T. Y. Tokunaga, H. Sakai, S. Kambe, P. Opletal, Y. Tokiwa, Y. Haga, S. Kitagawa, K. Ishida, D. Aoki, G. Knebel, G. Lapertot, S. Krämer, and M. Horvatić, Phys. Rev. Lett. **131**, 226503 (2023).

QUANTUM INTERFERENCE BETWEEN QUASI-2D FERMI-SURFACE SHEETS IN UTe_2

Scientists from the UK, USA, Czech Republic, and Germany have studied the Fermi surface of the heavy-fermion superconductor UTe_2. This material is of particular interest given its high likelihood of hosting a spin-triplet Cooper-pairing mechanism. Evidence for this stems primarily from the observation of only a small change in the NMR Knight shift on cooling through T_c, along with anisotropic upper critical fields that greatly exceed the Pauli limit in all directions.

The dimensionality of Fermi-surface sheets in triplet superconductors can have important implications regarding the possible topological properties of the superconductivity. A recent study of the magnetoconductance of UTe_2 was interpreted as indicating the presence of a 3D Fermi-surface pocket. Here, by combining high-field magnetoconductance oscillation measurements using a 70 T coil at HLD-Dresden along with measurements in the 41 T resistive magnet in Tallahassee, researchers were able to show that actually the profile of the magnetoconductance oscillations in UTe_2 can be very well described by considering quantum interference between magnetic-breakdown orbits across quasi-2D Fermi-surface sections previously identified in dHvA-effect studies. Such quantum interference effects– first observed by Stark in the 1970s in experiments on magnesium – occur when the k-space separation between Fermi-surface sheets is very small, allowing quasiparticles to tunnel across the sheets in accessible magnetic-field strengths. Furthermore, the datasets of this study were found to be incompatible with the presence of any 3D Fermi-surface pockets.

This confirmation of the quasi-2D nature of the UTe_2 Fermi surface sets the groundwork for future theoretical developments. Excitingly, the Fermi surface of UTe_2 appears to be remarkably simple, consisting exclusively of two cylindrical sheets of hole and electron type, respectively. This is markedly simpler than comparable heavy-fermion systems such as UPt_3, URhGe, etc., which possess complex multisheet Fermiologies. Despite a wealth of exotic physical phenomena at play in UTe_2, the simplicity of its electronic structure gives hope that meaningful theoretical progress at understanding this material is within our grasp.

Figure: Quantum-interference oscillations measured in a 70 T pulsed magnet at HLD by the PDO technique, alongside a rendering of the quasi-2D Fermi-surface sheets of UTe_2.

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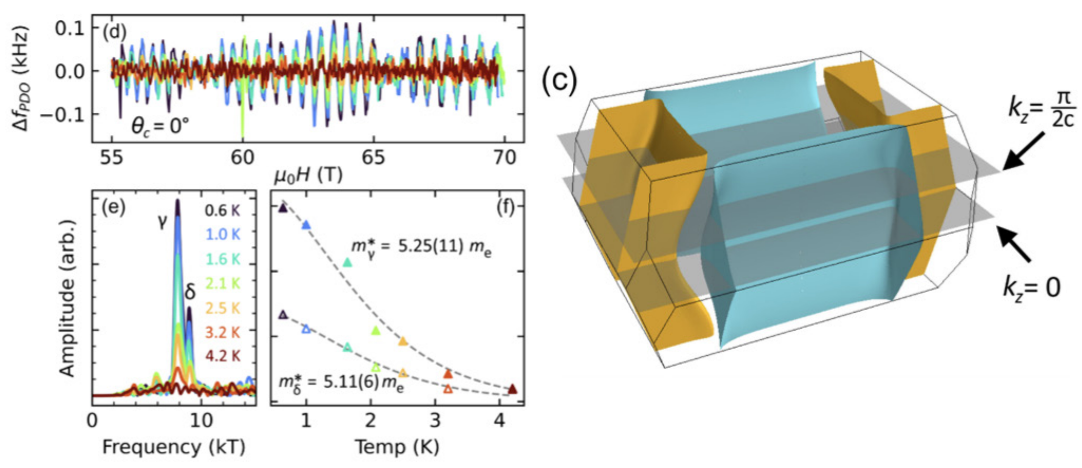


Reference

Quantum Interference between Quasi-2D Fermi Surface Sheets in UTe_2, T. I. Weinberger, Z. Wu, D. E. Graf, Y. Skourski, A. Cabala, J. Pospíšil, J. Prokleška, T. Haidamak, G. Bastien, V. Sechovský, G. G. Lonzarich, M. Vališka, F. M. Grosche, and A. G. Eaton, Phys. Rev. Lett. **132**, 266503 (2024).

STRETCHED AND COMPRESSED – QUANTUM MATERIALS UNDER EXTREME CONDITIONS

Quantum materials often exhibit remarkable sensitivity to subtle changes in their physical environment, a feature that can unlock new functionalities and drive innovative applications. One key phenomenon is magneto-elastoresistance, where the electrical resistance of a metal in a magnetic field changes when the material is stretched or compressed. However, understanding this effect can be tricky, especially in materials with complex internal structures. A team of researchers from the University of Amsterdam, Princeton University, and HFML-FELIX has investigated the material ZrSiSe, and their findings offer fresh insights into how quantum materials react to uniaxial strain.

In recent years, the use of uniaxial strain has proven to be a powerful method for exploring new phenomena in various quantum materials, including superconductors and narrow-band-gap materials, often using commercially available strain cells. One key advantage of uniaxial strain is that it can be varied continuously and, unlike chemical doping, it does not naturally introduce extra disorder into the material under investigation.

In their study, the researchers explored two key properties that a quantum material can exhibit under high magnetic fields: magnetoresistance, the change in a material's electrical resistance, and Shubnikov-de Haas quantum oscillations. They focused on ZrSiSe, a Dirac nodal-line semimetal, due to its large magnetoresistance and the known sensitivity of its Fermi surface to external tuning parameters. Magneto-elastoresistance, which refers to the change in resistance when strain is applied in a magnetic field, provides valuable insights into the electrical-transport properties of quantum materials. The researchers discovered that even a small stretch (0.27%) led to a significant change (7%) in the material's resistance in a magnetic field (figure). Their analysis revealed that this effect is primarily driven by the ease with which electric charges move through the material and that this mobility changes in direct proportion to the applied strain.

In addition, the researchers used a phenomenon called Shubnikov-de Haas oscillations to gain deeper insights into changes in the Fermi surface and the behavior of quasiparticles. This method revealed more details about how the material's electronic structure, particularly the quasiparticles located in distinct electron and hole pockets, responds to strain and magnetic fields.

These findings demonstrate not only how to precisely control, describe, and understand the electronic properties of ZrSiSe under uniaxial strain, but also highlight that the combination of uniaxial strain and high magnetic fields is a powerful tool for studying quantum materials.

Reference: Unraveling magneto-elastoresistance in the Dirac nodal-line semi-metal ZrSiSe, J. F. Linnartz , A. Kool, J. P. Lorenz, C. S. A. Müller, M. R. van Delft, R. Singha, L. M. Schoop, N. E. Hussey, A. de Visser and S. Wiedmann, npj Quantum Mater. **9**, 63 (2024).

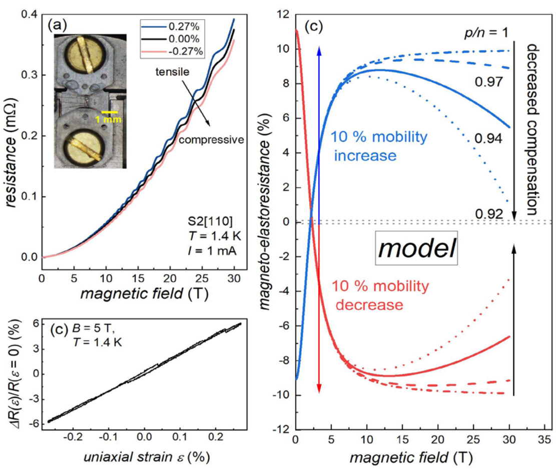


Figure: (a) Resistance under uniaxial strain (inset device) at 1.4 K. (b) Strain-induced change in electrical resistance. (c) Two-carrier model for explaining the magneto-elastoresistance.

CHARGE ORDER NEAR THE ANTIFERROMAGNETIC QUANTUM CRITICAL POINT IN THE TRILAYER HIGH-T_C CUPRATE $HgBa_2Ca_2Cu_3O_{8+\delta}$

The ubiquity of the interplay between antiferromagnetic (AFM) order, charge density waves (CDWs), and superconductivity is a general feature of hole-doped cuprates. The role of AFM order is still strongly debated, although the pairing mechanism is widely accepted to be of magnetic origin. In a recent work, we studied the trilayer cuprate $HgBa_2Ca_2Cu_3O_{8+\delta}$ (Hg1223), in which the inner CuO_2 plane is protected from out-of-plane disorder and, therefore, is extremely clean and free of distortions.

Figure 1 shows the evolution of the Hall coefficient (at 85 T). For hole doping of p = 0.118 and p = 0.101, there is a sudden sign change of the Hall coefficient below about 10 K that is not observed at lower doping. In YBCO, this sign change has been attributed to a small closed electron pocket coming from a Fermi-surface reconstruction by charge order. Here, the abruptness of the transition and its low temperature are surprising. We were able to track the Fermisurface morphology through the transition using quantum-oscillation measurements. Figure 2a shows the evolution of the quantum oscillations at different temperatures for p = 0.112. At 4.2 K, there is a strong low-frequency oscillation, whose amplitude decreases with decreasing temperature. At 1.75 K, those oscillations are weaker and small-amplitude oscillations at higher frequencies have emerged. This is inconsistent with the Lifshitz–Kosevich theory and signals a Fermi-surface reconstruction. The temperature evolution of the oscillation spectrum is visible in the Fourier analysis of the oscillatory part of the data (figure 2b).

To gain more insight in this sudden change of the Hall effect and quantum-oscillation spectrum evolution, we numerically simulated quantum oscillations of the density of states. These calculations point to a Fermi-surface reconstruction in the inner plane from an AFM state (hole pockets) to a biaxial CDW (electron pocket). A remarkable implication of our work is that AFM and CDW compete because they share the same Fermi-surface "hot spots". This coincidence is a key feature of a spin-fermion model, in which charge order is mediated by critical spin fluctuations and which supports magnetically mediated pairing interaction in cuprates.

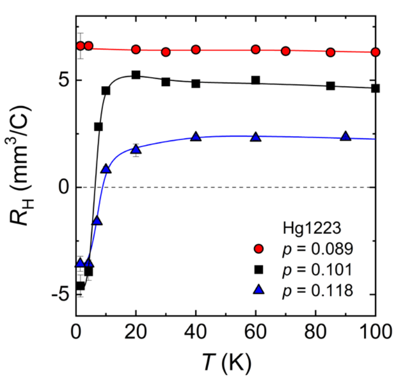
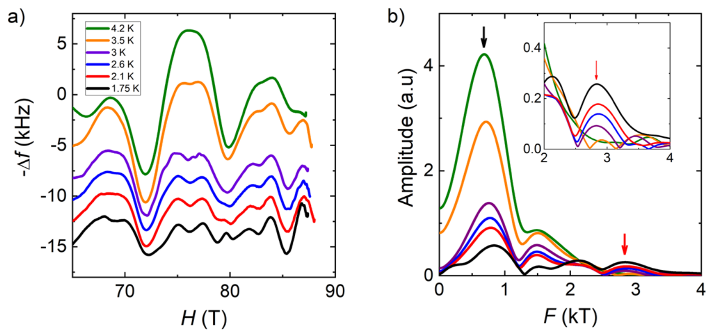


Figure 1: Temperature dependence of the normal-state Hall coefficient R_H, measured at 85 T in Hg1223 for p = 0.089, p = 0.101, and p = 0.118. At p = 0.101 and p = 0.118, R_H changes sign abruptly below 10 K, while it remains positive down to the lowest temperature for p = 0.089.

Figure 2: (a) Quantum-oscillatory signal (TDO) for p = 0.112. (b) Discrete Fourier analysis of the oscillatory signal shown in panel (a) between 70 and 87 T. The black (red) arrow marks the low (high) frequency observed at 4.2 K (1.8 K). The broadening of the Fourier transform at low frequency comes from the small number of oscillations in the field range. The inset shows a zoom of the Fourier transform between 2 and 4 kT, where one can clearly see the emergence of two peaks at F = 2100 T and F = 2800 T (red arrow).



Reference

Charge order near the antiferromagnetic quantum critical point in the trilayer high T_c cuprate $HgBa_2Ca_2Cu_3O_{8+\delta}$, V. Oliviero, I. Gilmutdinov, D. Vignolles, S. Benhabib, N. Bruyant, A. Forget, D. Colson, W. A. Atkinson, and C. Proust, npj Quantum Materials **9**, 75 (2024).

EXPERIMENTAL OBSERVATION OF REPULSIVELY BOUND MAGNONS

The importance of attractive forces, stabilizing multi-particle bound states in condensed matter is generally accepted. By contrast, multiparticle bound states stabilized by means of repulsive forces were long thought to be only theoretical constructions, due to the strong dissipative channels present in real materials.

Recently, Zhe Wang from the Department of Physics at Technical University (TU) Dortmund, in collaboration with researchers from Augsburg, Bonn, Cologne, Dresden, Geneva, and Prince George (Canada), proved experimentally the existence of repulsively bound magnons in the Ising-like spin-chain antiferromagnet $BaCo_2V_2O_8$. To demonstrate this, the team employed high-magnetic-field terahertz-spectroscopy techniques. They performed measurements in static magnetic fields up to 32 T using a Fourier-transform far-infrared spectrometer at the High Field Magnet Laboratory (HFML) in Nijmegen. The team also went to the Helmholtz-Zentrum Dresden-Rossendorf and did electron-spin-resonance experiments in pulsed magnetic fields up to 61 T at the Dresden High Magnetic Field Laboratory (HLD), employing an ELBE free electron laser as a tunable source of terahertz radiation.

The figure shows a peculiar frequency-field diagram of the observed magnetic excitations in $BaCo_2V_2O_8$. The experiments evidenced the presence of several modes, including ordinary single-magnon excitations (modes $M_{\pi/2}^{1}$, $M_{\pi/2}^{u}$, M_{π}^{1}, and M_{0}^{u}), as well as repulsively bound two-magnon (mode D_{π}, $D_{\pi/2}$) and repulsively bound three-magnon ($T_{\pi/2}$) excitations. By comparing these results of their terahertz-spectroscopy measurements to theoretical predictions for a Heisenberg–Ising (also known as XXZ) chain antiferromagnet the researchers can explain the occurrence of the multi-particle modes by repulsively bound magnon excitations. The experimental results show that these high-energy states, well separated from continua, exhibit notable dynamical responses and, despite dissipation, are sufficiently long lived to allow for an experimental observation.

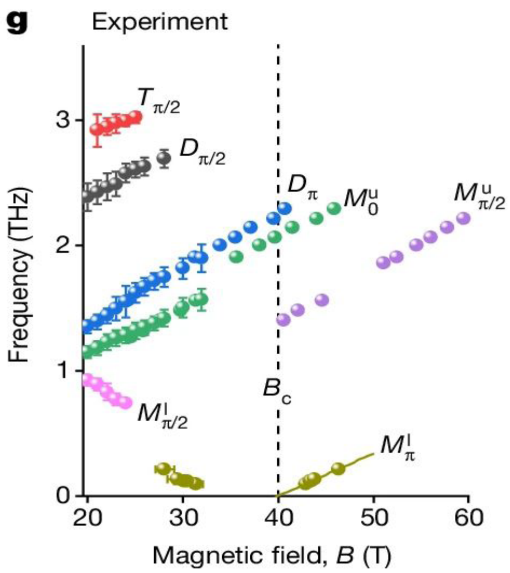


Figure: Frequency-field diagram of magnetic excitations in $BaCo_2V_2O_8$ in transverse magnetic fields. The experiment reveals the presence of single-magnon excitations (modes $M_{\pi/2}^{1}$, $M_{\pi/2}^{u}$, M_{π}^{1}, and M_{0}^{u}), as well as repulsively bound two- and three-magnon excitations (modes D_{π}, $D_{\pi/2}$, and $T_{\pi/2}$, respectively).

Reference

Experimental observation of repulsively bound magnons, Z. Wang, C.-M. Halati, J.-S. Bernier, A. Ponomaryov, D. I. Gorbunov, S. Niesen, O. Breunig, J. M. Klopf, S. Zvyagin, T. Lorenz, A. Loidl, and C. Kollath, Nature **631**, 760 (2024).

PROBING BERRY CURVATURE IN A MAGNETIC TOPOLOGICAL INSULATOR USING MAGNETO-OPTICS

Magnetic circular dichroism (MCD) is a widely known phenomenon with a long history in physics that dates back to the original experiments carried out by Faraday, dealing with the interaction of light with matter subjected to an externally applied magnetic field. It refers to preferential absorption of one of two circular polarizations of light propagating in the direction of the magnetic field. In solids, MCD often arises as a direct consequence of the Zeeman splitting of electronic bands. However, it can also originate purely from orbital effects, such as the cyclotron motion of electrons.

Recently, a broad consortium of researchers from USA, Austria, Belgium, and France performed infrared MCD studies on thin bulk layers of $MnBi_2Te_4$. This material had previously been identified as the very first experimentally realized intrinsic antiferromagnetic topological insulator, characterized by a significant exchange-driven gap in its surface states. Moreover, $MnBi_2Te_4$ may host a diverse range of magnetic and topological phases, depending on specific parameters such as strain, layer thickness, and applied magnetic field. As a result, $MnBi_2Te_4$ has emerged as a platform for experimentally exploring intriguing theoretical predictions for this class of materials, including the quantum anomalous Hall effect and the axion insulator phase.

In this study, the team investigated MCD in thin $MnBi_2Te_4$ films at low temperatures within the infrared spectral range, around the absorption edge for interband transitions that bring electrons across the bulk band gap. The MCD signal, absent at low magnetic fields in the antiferromagnetic state of $MnBi_2Te_4$, emerged during the magnetic-field-driven phase transition to the canted ferromagnetic state (figure). This observation was attributed to the abrupt onset of Berry curvature as $MnBi_2Te_4$ transitions from an antiferromagnetic topological insulator to a doped Chern insulator. These findings highlight the potential of MCD as an effective probe for exploring Berry curvature in other emerging magnetic topological materials.

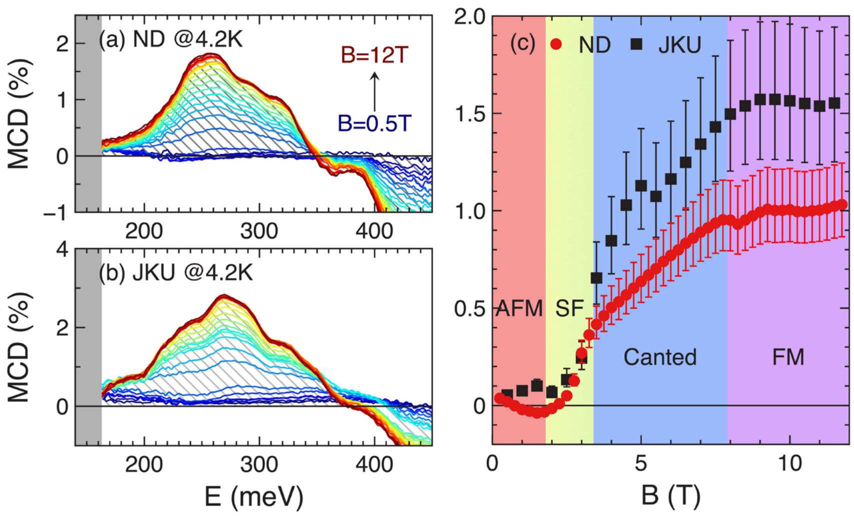


Figure : MCD signal for two different MnBi2Te4 samples [(a) "ND" and (b) "JKU"] as a function of energy for selected magnetic fields. (c) Spectrally integrated MCD signal for both samples as a function of magnetic field in antiferromagnetic (AFM), spin-flop (SF), canted, and ferromagnetic (FM) phases.

Reference

Probing Berry curvature in magnetic topological insulators through resonant infrared magnetic circular dichroism, S.-K. Bac, F. Le Mardelé, J. Wang, M. Ozerov, K. Yoshimura, I. Mohelský, X. Sun, B. A. Piot, S. Wimmer, A. Ney, T. Orlova, M. Zhukovskyi, G. Bauer, G. Springholz, X. Liu, M. Orlita, K. Park, Y.-T. Hsu, and B. A. Assaf, Phys. Rev. Lett. **134,** 016601 (2025).

ORGANISATIONAL STRUCTURE

EMFL's objective, without profit aim, is to unite world-class high magnetic field facilities and to make them available for excellent research by users. More specifically, EMFL is responsible for the management of access, networking and coordination activities of the high-field facilities in Europe.

Sebastian Schmidt

Amalia Patanè

Council

The Council is the highest governing body of EMFL and consists of the

EMFL Member representatives. The council does:

- appoint and dismiss the Directors and approve the candidacy of the executive manager,
- admit and dismiss EMFL Members,
- approve the progress report, annual accounts, and the budget, presented by the Board of Directors,
- amend the statutes and approve the vision, mission, and definition of values of the association,
- discuss and develop strategic, scientific, and technical plans of the EMFL.

Adam Babiński

Sylvain Ravy

The Council consists of:

Prof. Sebastian Schmidt (HZDR, President of the EMFL Council since May 15, 2024)
Prof. Amalia Patanè (University of Nottingham)
Prof. Adam Babiński (University of Warsaw)
Dr. Sylvain Ravy (CNRS, President of the EMFL Council until May 15, 2024)
Prof. José M. Sanders (RU/NWO-I)
Dr. Pierre Védrine (CEA-IRFU)
Prof. Giuseppe Maruccio (University of Salento, since 29.02.2024)

José M. Sanders

Pierre Védrine

Giuseppe Maruccio

Board of Directors

The Board of Directors, composed of the laboratory directors, where needed seconded by an executive manager has the following tasks:

- define the vision and mission,
- execute the strategic operation,
- prepare the budget, the annual accounts, and the progress report.

The Board of Directors consists of:

Dr. Charles Simon (LCNMI, Chair)
Prof. Jochen Wosnitza (HLD)
Prof. Britta Redlich (HFML-FELIX)

Jochen Wosnitza

Charles Simon

Britta Redlich

Strategic Advisory Committee

The Strategic Advisory Committee evaluates the research activities of the high-magnetic-field facilities operated by the Host Members of the EMFL and gives advice on future research and technological activities.

To achieve this, the Strategic Advisory Committee will:
- Evaluate the research activities of the high-magnetic-field facilities operated by the host members of the EMFL.
- Evaluate the strategic plans of EMFL.
- Report its advice to the Board of Directors.

The Strategic Advisory Committee members are:

Dr. Massimo Altarelli (Chair), MPI for the Structure and Dynamics of Matter, Hamburg, Germany
Dr. Ziad Melham, Oxford Quantum Solutions, UK
Dr. Amina Taleb, SOLEIL, France
Prof. Georg Maret, SciKon, University of Konstanz, Germany
Prof. Andrew Harrison, Diamond Light Source, UK
Prof. Andzrej Wysmolek, University of Warsaw, PL
Dr. Gabriel Chardin, APC Laboratory (Astroparticles and Cosmology), University of Paris

User Committee

In order to represent the interests of the high-field user community, members (all external to the infrastructures) are elected for a period of three years by the user community during the annual User Meeting. The chairman of the User Committee reportS to the Board of Directors on behalf of the users. During the User Meetings the User Committee reports to the users and collects the feedback.

Raivo Stern (Chair)	NICPB, Tallinn	NMR/ESR
Ashish Arora	IISER	(Magneto)-optics of 2D semiconductors
Mathias Dörr	TU Dresden	Magnetism
Karel Prokes	Helmholtz-Zentrum Berlin	Magnetism
Carsten Putzke	MPI	for the Structure and Dynamics of Matter
Antonio Polimeni	Sapienza Università di Roma	Optics/Semiconductors
Alexandre Pourret	IMAPEC-PHELIQS-INAC CEA	Magnetism/Superconductivity
Vassil Skumryev	ICREA, Barcelona	Magnetism/Magnetic materials
Stan Tozer	NHMFL	Magnetism/Superconductivity
Maciej Molas	University of Warsaw	Optics/Semiconductors

Selection Committee

The task of the EMFL selection committee is to ensure that from the proposed experiments only those that are of excellent scientific quality and clearly benefit from the access to a high-field facility are performed in the EMFL facilities.

The Selection Committee evaluates the scientific proposals on the following three criteria:

- scientific quality and originality of the proposal;
- necessity for the use of the infrastructure;
- track record and past performance of the user group.

Xavier Chaud	LNCMI-G	Applied Superconductors
Jens Hänisch	KIT	Applied Superconductors
Andries den Ouden	HFML-FELIX	Applied Superconductors
Toomas Rõõm	NICPB	Magnetism
Mathias Doerr	IFP	Magnetism
Yuri Skourski	HLD	Magnetism
Uli Zeitler	HFML-FELIX	Magnetism
Tony Carrington	Univ. Bristol	Metals and Superconductors
Mark Kartsovnik	WMI	Metals and Superconductors
Alix McCollam	Univ. College Cork	Metals and Superconductors
Ilya Sheikin	LNCMI-G	Metals and Superconductors
Duncan Maude	LNCMI-T	Semiconductors
Amalia Patanè (until 13.10.2024)	Univ. Nottingham	Semiconductors
Marta De Luca (since 14.10.2024)	Sapienza Univ. Rome	Semiconductors
Ana Akrap	Univ. Fribourg	Semiconductors
Steffen Wiedmann	HFML-FELIX	Semiconductors
Alban Potherat	Coventry University	Soft Matter and Magnetoscience
Hans Engelkamp	HFML-FELIX	Soft Matter and Magnetoscience
Anne-Lise Daltin	Univ. Reims	Soft Matter and Magnetoscience

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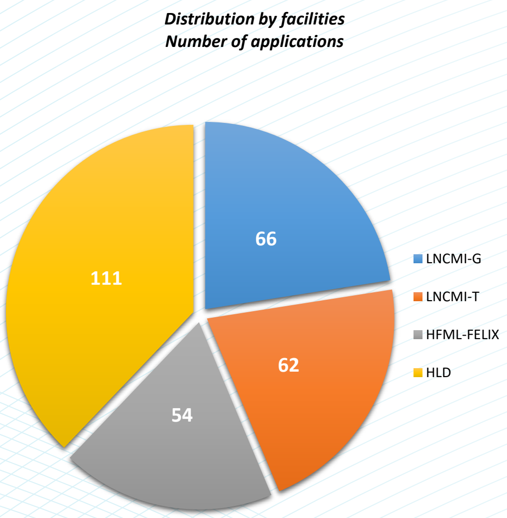
User Access

In 2024, 293 applications from 25 different countries were submitted to the EMFL facilities. This includes projects submitted at the 31th and 32th call for proposals closed in May and November 2024 and those going through the novel fast-track access procedure developped within the EMFL-ISABEL project as well as applications asking for the use of high magnetic fields in combination with advanced sources (ILL, ESRF, LULI, FELIX, CLF ...).

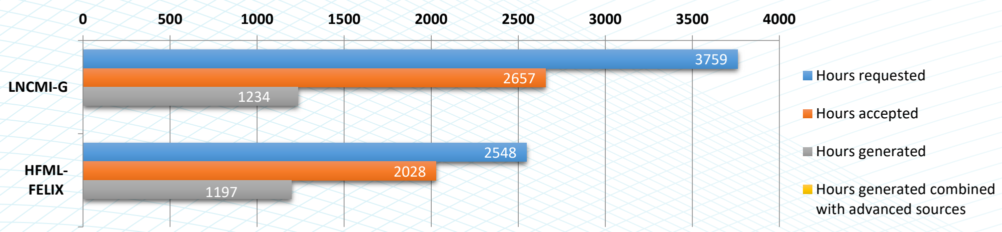
The EMFL Selection Committee (see page 27) has evaluated the proposals, covering five types of scientific topics:

- Metals and Superconductors
- Magnetism
- Semiconductors
- Soft Matter and Magnetoscience
- Applied Superconductivity

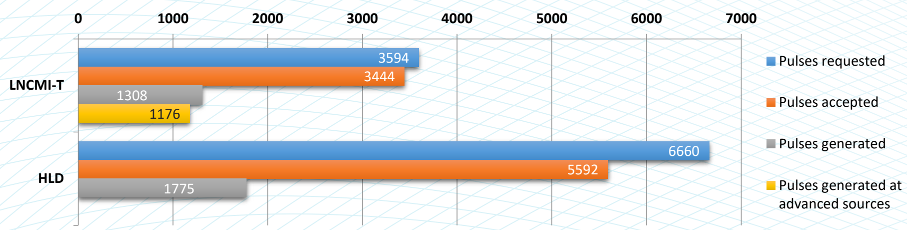


Access to magnetic fields in combination with advanced sources can be gained also via the proposal submission procedure of these infrastructures after evaluation of the feasibility by EMFL scientists or engineers.

DC Facilities



Pulsed facilities

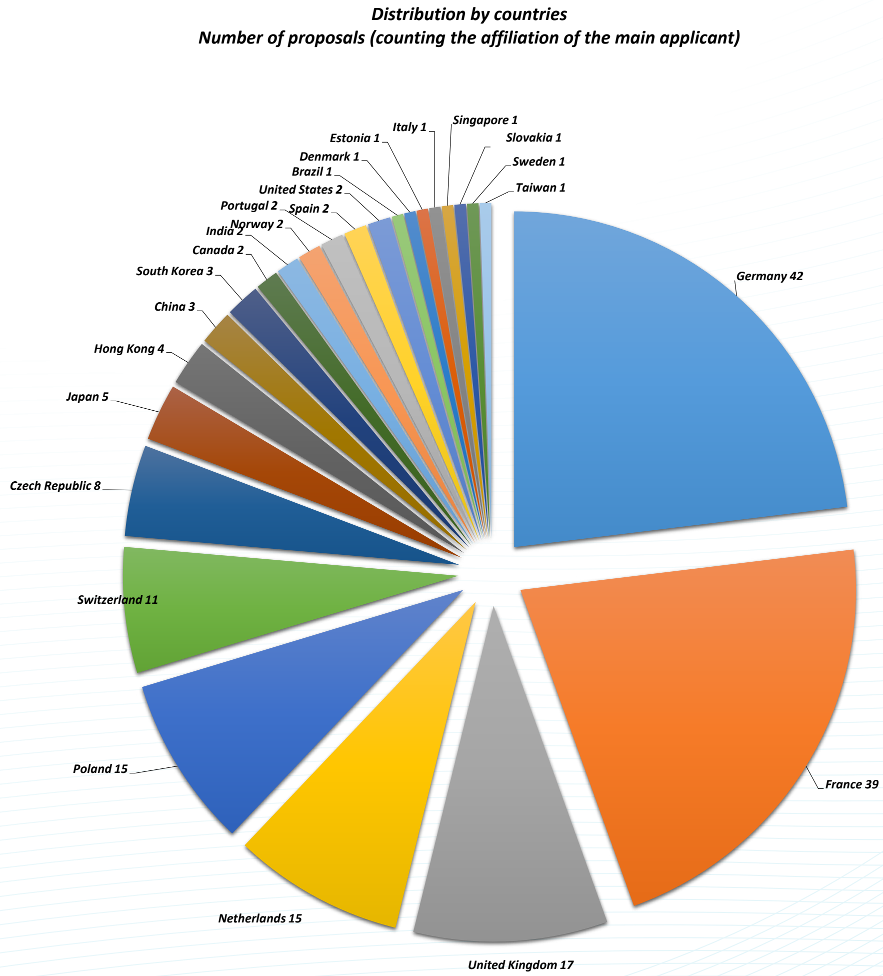


Evaluation of applications

Projects are classified in three categories:
A (excellent proposal to be performed),
B (should be carried out, but each facility has some freedom considering other constraints),
C (inadequate proposal or one that does not need any of the four unique high magnetic field laboratories).

In the B category, the ranking + or - serves as a recommendation to the facility. This freedom within the B category is necessary to allow the facilities to consider other aspects such as, for instance, available capacity and equipment necessary for a successful project. Besides of ranking the proposals the Selection Committee recommends on the number of accepted magnet hours or number of pulses.

Information about the proposal application procedure can be found at
https://emfl.eu/apply-for-magnet-time/



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Thesis defences 2024

- Beat Valentin Schwarze, Untersuchung der Fermiflächen topologischer Semimetalle
  HLD, FWHE, Dresden, Germany, 4 June 2024

- Samy Lalloz, De la diffusion á la propagation d'ondes en magnétohydrodynamique bas-Rm : études théorique et expérimentale.
  Doctorat de l'Universit´e Grenoble-Alpes en cotutelle avec Coventry University, U.K.
  Thése soutenue le 26 mars 2024

- Nikodem Solowski, Hybrid Excitons in MoSe2/MoS2 van der Waals Heterostructure.
  Doctorat de l'Université de Toulouse
  Thése soutenue le 24 septembre 2024

- Swaroop Palai, Exploring Structural and Optical Properties of TMDC Heterostructures Using Atomic Force Microscopy Ironing.
  Doctorat de l'Universit´e de Toulouse
  Thése soutenue le 8 octobre 2024

- Maria Sara Raju, Effets magnéto-chiraux : de l'étude d'une molécule-aimant aux origines de l'homochiralité moléculair.
  Doctorat de l'Université Grenoble-Alpes
  Thése soutenue le 10 octobre 2024

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Finances 2024	
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EU-Project ISABEL	65.6
EU-Project FlexRICAN	0.7
Expenditures	
Networking (incl. EMFL Days, school and workshops)	106.9
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Administration	55.7
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Publisher:
European Magnetic Field Laboratory AISBL

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HLD, LNCMI, HFML-FELIX, Vincent Moncorgé, Pierre Pugnat, LNCMI, Xavier Chaud, LNCMI

Published April 2025

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