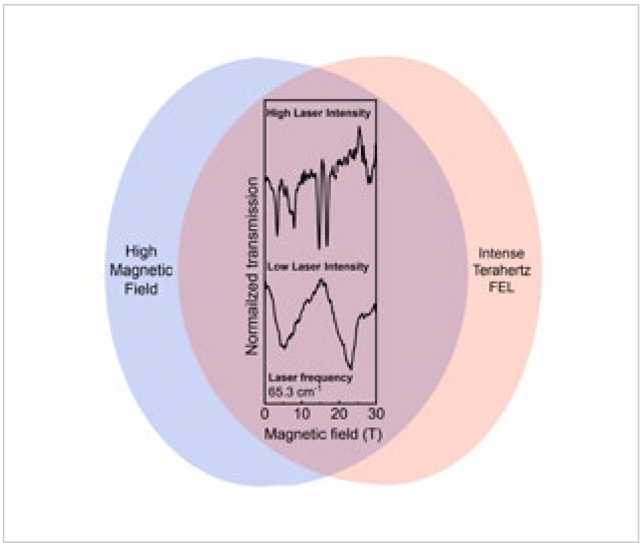
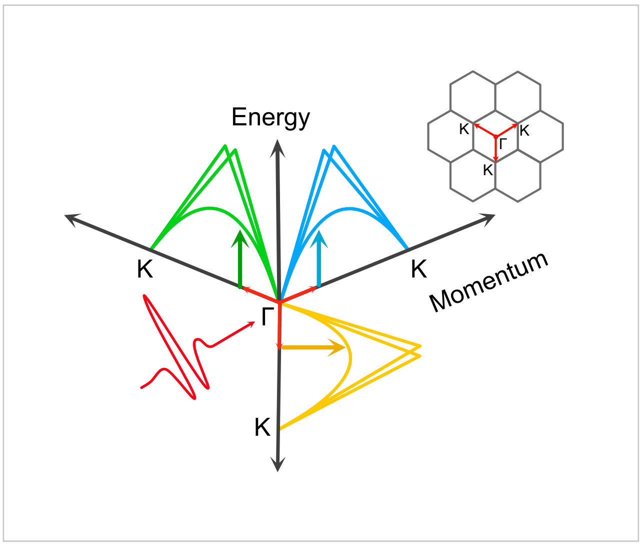
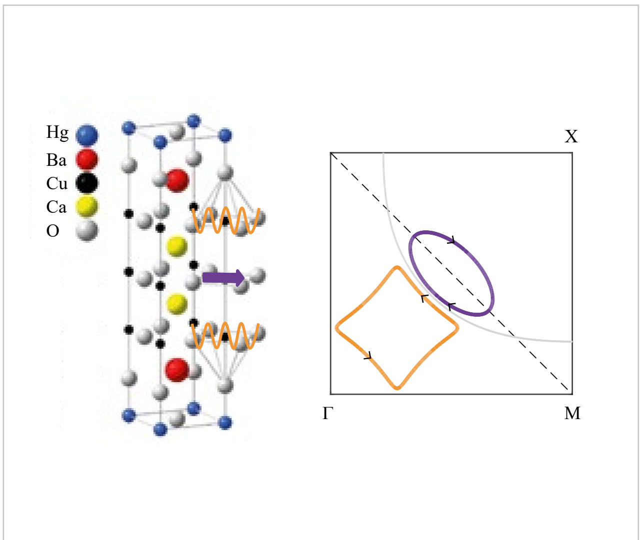
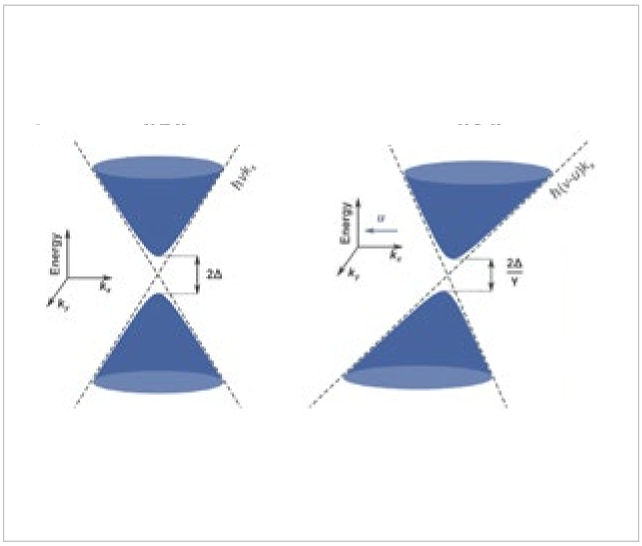
EMFLNEWS

N°2 2022









CONTENTS

DEAR READER

We look back at a very successful EMFL User Meeting, organized by the LNCMI team in Grenoble. The hybrid setting allowed both in-person and on-line participation, resulting in a large number of participants and many interesting discussions. Congratulations to Mateusz Dyksik of the Wroclaw University of Science and Technology for winning the EMFL prize for his outstanding work on novel perovskite materials in high magnetic fields. Many thanks to the entire LNCMI-Grenoble team for the excellent organization. The next User Meeting will be organized by the HFML in Nijmegen around mid-June 2023.

Many activities within the ISABEL and SuperEMFL projects are in full progress. Please do not forget to fill in the survey on the user-motivated specifications for all-superconducting high-field magnets and associated instrumentation; and to consider the submission of a proposal in the EMFL secondment program (deadline September 30). We are happy to announce the launch of a new „INDUSTRY" tab on the EMFL web page. Here, you can find updates on our participation in industrial fairs and congresses, news on our collaborations with companies and our new industrial skill map. Also in this issue of EMFLNews, you find the presentation of one of our regional partners: the Universidad Autónoma de Madrid.

We wish you all a good holiday season and we hope to see you soon at one of the EMFL facilities,

Peter Christianen
Director HFML
Chairman EMFL

MEET OUR PEOPLE

Ena Osmic, HLD

I started with my PhD at the HZDR High Magnetic Field Laboratory in June 2021. I have completed my Physics studies in Leipzig, Germany, where I have experienced the fascinating world of solid-state physics for the first time. My Bachelor work was based on exploration of transport properties of natural graphite lamellae, while in my Master work, I have investigated the newly discovered MgV center in diamond and its temperature properties. After I got the chance to do my PhD at HZDR's HLD, needless to say, that it was and still is very exciting. The state-of-the-art laboratory and scientific environment is helping me not only to expand my physics knowledge and capabilities, but also to grow as a scientist and a person. My work is based on the exploration of magnetic properties of pyrochlore spin-ice compounds, where defects are intentionally produced by means of irradiation. The goal of my work with these compounds is to help unlock their new possibilities and unravel the secrets of nature that they still hold.

Ena Osmic

NONLINEAR TERAHERTZ SPECTROSCOPY ON Ga-DOPED GERMANIUM IN HIGH MAGNETIC FIELDS USING INTENSE FREE-ELECTRON LASER RADIATION

Peter Christianen, HFML Nijmegen

The development of pulsed, high-intensity terahertz free-electron lasers (FELs) has enabled the investigation of nonlinear phenomena in molecules and solids in the terahertz regime. To expand their potential, recently THz FELs were combined with high magnetic fields in some laboratories around the world. At HFML-FELIX, researchers used FLARE, a terahertz FEL, in combination with a 33 tesla DC magnet to investigate photoionization and cyclotron resonance in the gallium-doped semiconductor germanium over a wide range of THz intensities.

Nonlinear processes in hole-doped germanium (p-Ge) are relevant for the development of THz lasers and THz technology. Despite the fact that p-Ge has been studied before, also in high magnetic fields, several outstanding questions still remain, which are mostly related to the non-parabolic band structure of the valence band, the appearance of non-equidistant Landau levels, and the lack of a clear understanding of the light-induced ionization of the dopant atoms. In this study, the use of a wide range of photon energies (1.5 – 11 meV or 12 – 89 cm^{-1}) enables the investigation of the laser-frequency dependence on the onset of the THz photoionization and to distinguish different regimes.

At high photon energies (> 6.8 meV or 55 cm^{-1}), we observed both internal transitions within the Ga dopants and cyclotron resonance (CR) transitions of free holes, where the latter dominate at higher laser intensities (see figure). For energies below the lowest internal Ga transition (< 6.8 meV), multiple CR transitions are seen, corresponding to the four lowest-energy Landau-level transitions of the heavy hole and light hole subbands. The appearance of these lowest-energy CR peaks marks the onset of photoionization, which is found to be more efficient for lower FEL frequencies. With increasing FEL intensity, complex behavior of the CR signals is observed, where the heavy- (light-) hole CR peaks mostly shift to higher (lower) magnetic field with increasing radiation intensity. This is a result of the saturation of the CR transitions and an increasing occupation of the higher-energy, non-equidistant Landau levels with increasing FEL radiation intensity. This study, thus, provides new insights about the actual photoionization mechanism, the saturation of the CR transitions, and the excitation of higher-energy Landau levels. The spectroscopic technique used here offers an exciting perspective for researching nonlinear magneto-optical processes in solid-state materials.

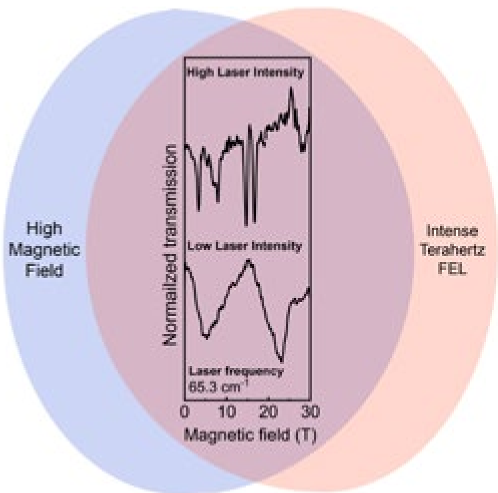


Figure: The combination of intense, pulsed THz free-electron laser radiation with high static magnetic fields provides new exciting perspectives for the investigation of nonlinear magneto-optical processes in solid-state materials.

Nonlinear terahertz transmission spectroscopy on Ga-doped germanium in high magnetic fields, B. Bernáth, P. Gogoi, A. Marchese, D. Kamenskyi, H. Engelkamp, D. Arslanov, B. Redlich, P. C. M. Christianen, and J. C. Maan, Phys. Rev. B **105**, 205204 (2022).

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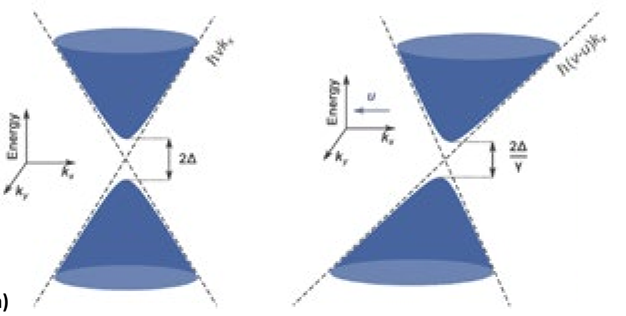
LORENTZ-BOOST-DRIVEN MAGNETO-OPTICS IN A DIRAC NODAL-LINE SEMIMETAL

Jan Wyzula, Milan Orlita, LNCMI-CNRS Grenoble and Mark O. Goerbig, LPS-CNRS Orsay

Ever since the advent of graphene and topological materials, relativistic physics has become an integral part of condensed-matter sciences. While emergent, it is important to stress that this type of relativity is pertinent beyond the dispersion of the low-energy excitations in different solids. Klein tunneling and the chiral anomaly represent well-known examples. One of the salient aspects of relativity is the particular dependence of energy on the frame of reference. For a particle of mass m moving at a speed u lower than the speed of light c, a Lorentz boost to the comoving frame of reference changes the particle's energy from E to $E/\gamma = mc^2$, in terms of the Lorentz factor $\gamma = 1/(\sqrt{1-\beta^2})$ and the rapidity $\beta = u/c$. A natural question that one may ask is whether one can observe this relativistic renormalization also in topological materials governed by the Dirac Hamiltonian, upon the replacement of c by a characteristic velocity v.

The effects of relativistic renormalization have been invoked theoretically in the past, for solid-state systems with (gapless or weakly gapped) tilted conical bands that are subjected to an externally applied magnetic field. This is because, in such a case, the motion of an electron becomes mathematically equivalent to the dynamics of a relativistic charge carrier in the crossed electric and magnetic fields. This motion is, therefore, governed by fully Lorentz-covariant Dirac and Maxwell equations. This covariant formulation, and thus the use of Lorentz transformations, allows us to calculate the energy spectrum in a reference frame where the (effective) electric field vanishes, meaning $u = 0$. This spectrum, or more directly, Landau-level spectrum becomes renormalized by the corresponding Lorentz factor calculated for the velocity parameter that describes the tilt.

Recent high-field experiments on niobium diarsenide ($NbAs_2$) — realized in a broad collaboration of researchers from Grenoble, Paris, Taipei, Brno, Zagreb, and Fribourg, and supported by theoretical modelling — show that the effects of band renormalization can be traced experimentally. $NbAs_2$ is a Dirac semimetal which hosts two nodal lines, the energy of which disperses with momentum, which are weakly gapped by spin-orbit interaction and which propagate approximately along the crystallographic a axis. The dispersion of electrons in the vicinity of these nodal lines has a form of a gapped conical band, with a tilt that depends on the choice of the particular plane in the reciprocal space. Applying the magnetic field in different directions with respect to the nodal line, we have observed, using the Landau-level spectroscopy technique, profound renormalization of the energy band gap driven by the corresponding Lorentz boost.



(a)

(b)

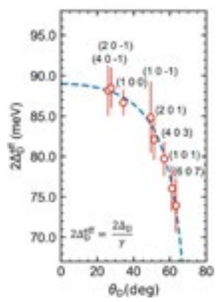


Figure: (a) Schematic band structure of a weakly gapped conical band, with the effective speed of light v, with and without tilting by an additional velocity parameter u. (b) The effective band gap deduced using Landau-level spectroscopy technique with the magnetic field applied perpendicular to different crystallographic planes of $NbAs_2$. θ_D stands for the angle between the local nodal-line direction and the applied magnetic field.

Lorentz-Boost-Driven Magneto-Optics in a Dirac Nodal-Line Semimetal, J. Wyzula, X. Lu, D. Santos-Cottin, D. K. Mukherjee, I. Mohelský, F. Le Mardelé, J. Novák, M. Novak, R. Sankar, Y. Krupko, B. A. Piot, W.-L. Lee, A. Akrap, M. Potemski, M. O. Goerbig, and M. Orlita, Adv. Sci. **2022**, 2105720.

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MAGNETOTRANSPORT SIGNATURES OF ANTI-FERROMAGNETISM COEXISTING WITH CHARGE ORDER IN A HIGH-T_C SUPERCONDUCTOR

Vincent Oliviero, David Vignolles, Cyril Proust, LNCMI Toulouse

In the last few years, high-magnetic-field studies have allowed great breakthroughs in the understanding of the physics of high-T_c cuprate superconductors. Here, we report the measurements of quantum oscillations and Hall effect in high magnetic fields up to 88 T in the underdoped trilayered cuprate $HgBa_2Ca_2Cu_3O_{8+\delta}$ (Hg1223). Multilayered cuprates possess not only the highest T_c but also offer a unique platform to study disorder-free CuO_2 planes and the interplay between competing orders with superconductivity.

Figure 1 shows the variation of the tunnel diode oscillator (TDO) circuit frequency as a function of magnetic field at doping level p=8 % (symbols) where clear quantum oscillations are visible. The inset shows the Fourier analysis of the oscillatory part of the data at 1.4 K, showing that we can isolate at least three quantum-oscillation frequencies at $F_1 \approx 350$ T, $F_2 \approx 500$ T, and $F_3 \approx 850$ T, where $F_1 \approx F_3 - F_2$. Solid lines in the main figure are the simultaneous fits in the temperature range between 1.4 and 4.2 K using the Lifshitz-Kosevich theory, that confirm the accurate determination of the frequencies.

The presence of three frequencies is explained by a scenario where an antiferromagnetic (AFM) order is present in the inner plane coexisting with a charge order in the outer plane (see Fig. 2a) resulting in the Fermi-surface reconstruction depicted in Fig. 2b. In that scenario, F_3 and F_2 correspond to electron (orange) and hole (purple) pockets, respectively. The third frequency $F_1 = F_3 - F_2$ would correspond to magnetic breakdown tunnelling between inner and outer planes.

Our interpretation implies that, in the cuprate where T_c is maximum among all superconductors, a metallic AFM state extends deep into the superconducting phase. This is reminiscent of a quantum critical point scenario observed in other unconventional superconductors, where spin fluctuations extend away from the AFM ordered state. All of the above considerations strongly suggest a magnetic pairing mechanism for cuprates. In Hg1223, the clean nature and the absence of buckling of the inner CuO_2 plane support the idea that the antiferromagnetic interaction J is large, leading to higher T_c.

Magnetotransport signatures of antiferromagnetism coexisting with charge order in the trilayer cuprate $HgBa_2Ca_2Cu_3O_{8+\delta}$, V. Oliviero, S. Benhabib, I. Gilmutdinov, B. Vignolle, L. Drigo, M. Massoud-zadegan, M. Leroux, G. L. J. A. Rikken, A. Forget, D. Colson, D. Vignolles, and C. Proust, Nat. Commun. **13**, 1568 (2022)

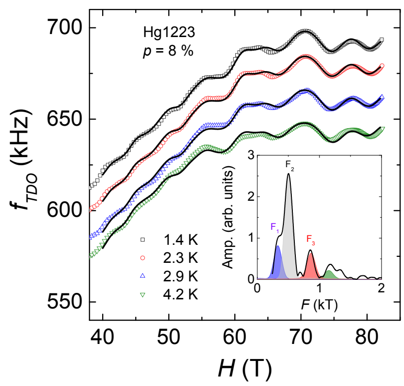

Figure 1: Field dependence of the TDO frequency in Hg1223 (p = 8 %) at different temperatures (symbols). Solid lines correspond to the fits to the data using the Lifshitz-Kosevich theory plus a polynomial background in the field range 40 ≤ H ≤ 83 T. The inset shows the Fourier analysis of the oscillatory part of the data measured at 1.4 K along with the contribution of F_1 (blue), F_2 (grey), and F_3 (red).

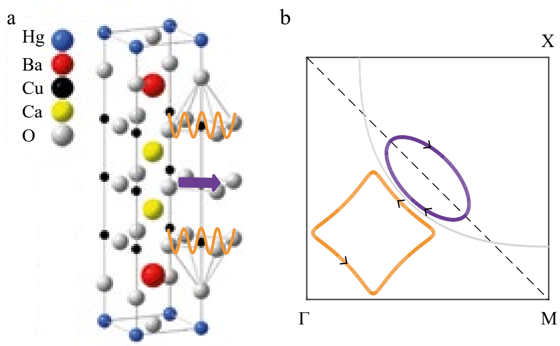

Figure 2: a) Crystallographic structure of trilayer Hg1223. We sketch the presence of AFM order in the inner plane (purple arrow) and charge order (orange wave) in the outer planes. b) Corresponding reconstructed Fermi surface in presence of AFM order in the inner plane leading to a hole pocket (purple, F_2) and charge order in the outer plane leading to an electron pocket (orange, F_3).

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MAGNON EXCITATIONS STUDIED OVER THE ENTIRE BRILLOUIN ZONE BY THz MAGNETOMETRY

Denis Gorbunov, HLD Dresden

Optical excitations in solids require conservation of momentum and energy. This applies also to magnetic excitations, when a magnon with a given momentum and energy is created / annihilated by absorbing / emitting a photon. The small photon momentum typically confines possible excitations close to the center of the Brillouin zone. For example, THz spectroscopy provides access to the magnetic transitions by focusing on the zone-center magnons. This constraint, however, can be overcome.

In a recent work, scientists from Germany, China, Switzerland, the USA, and Austria performed THz time-domain experiments of the kagome quantum magnet $Y_3Cu_9(OH)_{19}Cl_8$ (Y-kapellasite) that provided access to the entire Brillouin zone of this material through three-center magnon excitations. This mechanism is possible due to the three distinct magnetic sublattices and strong short-range correlations in the distorted kagome lattice. Y-kapellasite shows plateaus at 1/6 and 1/3 of the full magnetization as evidenced by pulsed high-field magnetization measurements at HLD.

The imaginary part of the magnetic susceptibility unveils an asymmetric broad feature with a maximum at 12 cm^{-1} at 1.6 K, which reflects multi-center magnon excitations that can expand over the entire Brillouin zone (Figure, panel a). The calculated spin density of states is gapless in zero field and becomes gapped in field (panels b and c). The simultaneous magnon excitations in the three distinct magnetic sublattices of Y-kapellasite conserve the total wavevector (panel d). These findings establish THz spectroscopy as a method to directly probe the spin density of states over the entire Brillouin zone of systems with low symmetry.

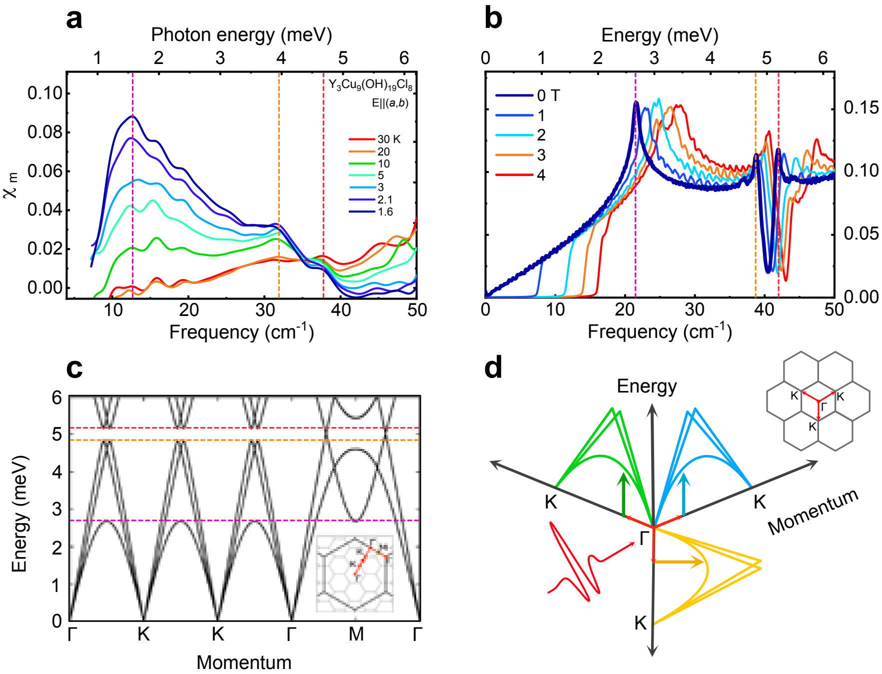

Figure: (a) Frequency-dependent imaginary part of the magnetic susceptibility; (b) Calculated spin magnon density of states; (c) Spin-wave dispersion of Y-kapellasite in zero field; (d) Three-center magnon process in momentum space.

Multi-Center Magnon Excitations Open the Entire Brillouin Zone to Terahertz Magnetometry of Quantum Magnets, T. Biesner, S. Roh, A. Razpopov, J. Willwater, S. Süllow, Y. Li, K. M. Zoch, M. Medarde, J. Nuss, D. Gorbunov, Y. Skourski, A. Pustogow, S. E. Brown, C. Krellner, R. Valentí, P. Puphal, M. Dressel, Adv. Quantum Technol. **5**, 2200023 (2022).

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RESULTS OF THE TWENTY-SEVENTH CALL FOR ACCESS

On 15 May 2022, the 27th call for access ended. After that, the ranking of the proposals for research activities requiring access to the EMFL facilities started 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.

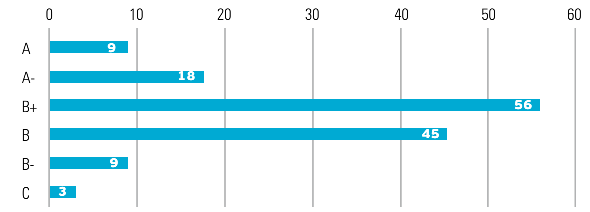
For this 27th call, 140 applications were submitted, of which 2 are proposals for dual access with regional partner laboratories and 9 proposals for first-time access to the EMFL high field facilities. These novel access procedures are defined in the EMFL-ISABEL project. The dual access was trialed for the third time whereas the first-time access was introduced at this call.

The proposals came from 23 different countries and were evaluated by the EMFL selection committee until 15 June 2022. The Selection Committee consists of 18 specialists covering the following five scientific topics:

> Metals and Superconductors (45 applications),
> Magnetism (53 applications),
> Semiconductors (33 applications),
> Soft Matter and Magnetoscience (7 applications),
> Applied Superconductivity (2 applications).

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

NEXT CALL :
Launch: October 15, 2022
Deadline: November 15, 2022

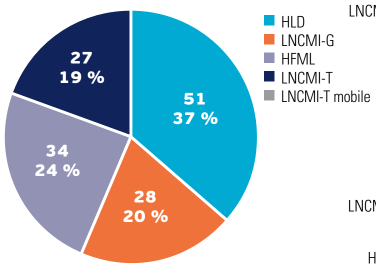


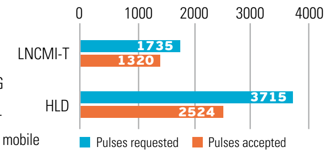
Evaluation of applications

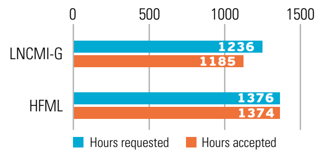
The proposals are ranked in three classes:
A (excellent proposal to be carried out),
B (should be performed but each facility has some freedom considering other constraints),
C (poorly crafted proposal, or one that does not need any of the four unique high-magnetic-field laboratories).

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.

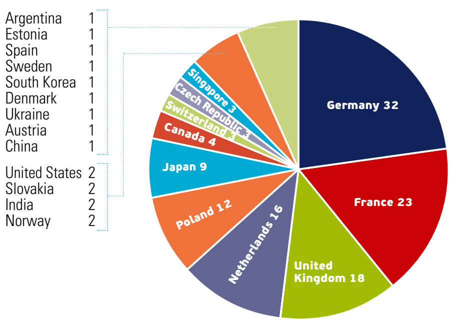
Distribution by facilities
Number of applications







Distribution by country of PI affiliation



USER MEETING IN GRENOBLE IN HYBRID FORMAT


© Alexandra Gasparini

After the online user meeting last year, it was a pleasure to see quite a number of users and staff in reality during this year's meeting. The 2022 edition of the EMFL user meeting took place in Grenoble at the LNCMI on June 15 in hybrid format. With up to 90 participants, 35 on site and 55 remotely connected, this year's meeting was once again well attended.

The in-person discussions during coffee and lunch breaks were particularly productive in exchanging ideas and experiences between users and EMFL staff. Another aim of the meeting was to present scientific results and to discuss about possibilities for improving the facilities' attractiveness. The meeting started with a warm welcome by Peter Christianen, chairperson of the EMFL Board of Directors and director of the HFML. Jochen Wosnitza, chair of the Selection Committee, announced this year's EMFL prizewinner, Mateusz Dyksik (see article in this edition of EMFLNews), who, afterwards, presented his work in a talk on „Excitonic properties of 2D layered perovskites revealed by magneto-spectroscopy".

The audience was then able to appreciate the excellent talks of the eight invited speakers who presented their work done as users at the EMFL facilities. Stanislaw Galeski (Max Planck Institute CPfS, Dresden) covered his high-field research on the topological semimetal $ZrTe_5$. Charis Quay (LPS Orsay) presented results on tunneling spectroscopy of few-monolayer $NbSe_2$ in high magnetic fields and Shravani Chillal (Helmholtz-Zentrum Berlin and TU Berlin) on magnetic phase diagrams of quantum magnets. Marco Bonura (University of Geneva) presented more applied results on record high upper critical field in the superconductor MgB_2. After an excellent lunch (for in-person participants), Elena Blundo (Sapienza University Rome) gave a talk on k-space direct and indirect excitons in strained WS_2 monolayers and Maciej Molas (Warsaw University) on excitons in monolayers of transition metal dichalcogenides. Touching a more exotic topic, Julien Fuchs (LULI) reported on recent advances in laboratory astrophysics using laser-driven magnetized plasmas. Finally, Michael Schmitz (Aachen University) presented results on graphene in high magnetic fields.

In the afternoon, chaired by Raivo Stern (NICPB, Tallinn, Estonia), the User Committee met to discuss critically the strengths and weaknesses of user-related issues of the EMFL and reported back to the Board of Directors. In particular, the Committee discussed the newly introduced access modes for magnet time (fast track, dual access, etc.), complementing the existing access modes.

After not being able to meet in person for 2 years, the hybrid meeting was a big success. It was a great pleasure to renew and deepen contacts in person and to include the participants in remote mode. We hope to be able to maintain this format in the future as well. The next user meeting will take place in Nijmegen, again in June, and we are looking forward to see many of you there in person.

WORKSHOP ANNOUNCEMENT*

"PERSPECTIVES WITH HIGH MAGNETIC FIELDS AT NEUTRON SOURCES"

On the 2nd-4th of November 2022, scientific and technical experts of high-field and neutron facilities will gather with the aim to identify the high-field needs of the neutron community, evaluate the technical challenges, and prepare a roadmap for developing unprecedented capabilities.

The workshop will be the occasion to present recent scientific and instrumental breakthroughs, discuss the state of the art, and identify paths toward the collaborative development of modern high-field magnets for neutron-scattering facilities.

This unique event, supported by the European project ISABEL, the CNRS, EMFL, and LENS will be held at the ILL, Grenoble (France). The number of participants being limited, we invite those interested in joining this challenging project to quickly register on the website.

https://workshops.ill.fr/event/292/

* This workshop has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871106.

EMFL PRIZE GOES TO MATEUSZ DYKSIK

After two years of rather impersonal prize ceremonies the EMFL Board of Directors was happy to hand over the EMFL prize 2022 in person to Dr. Mateusz Dyksik, who currently holds an assistant professor position at the Wrocław University of Science and Technology in Poland. The prize ceremony took place during the EMFL User Meeting in Grenoble.

Mateusz Dyksik received the award for his cutting-edge research performed at the EMFL facilities. He used optical spectroscopy to understand the fundamental electronic properties of organic-inorganic perovskites thin films and nanocrystals which have important applications in light harvesting and photovoltaics. Mateusz employed a rather unique combination of low-temperature optical spectroscopy together with high pulsed magnetic field. His work allowed to elucidate many of the exotic properties of two-dimensional perovskites.

Since 2009, a prize committee, chaired by Jochen Wosnitza, director of the Dresden High Magnetic Field Laboratory, awards the EMFL prize annually for exceptional achievements in science done in high magnetic fields.

© Amelie Pic

COLLABORATION WITH ANOTHER EUROPEAN RESEARCH INSTITUTION

Neutron diffraction in pulsed field using the CEA-CRG spectrometer IN22 at the Institut Laue-Langevin (ILL), Grenoble

In recent years, the use of high magnetic fields in conjunction with beamlines has become increasingly important. For that, a mobile pulsed-field installation, developed at LNCMI Toulouse, is available to users at the ILL neutron source.

Within the framework of the ISABEL project, EMFL and ILL reinforced their collaboration and defined the access procedure using this equipment. Researchers will submit their proposal at the ILL User Portal (https://www.ill.eu/users) and choose the IN22 sample environment. The equipment can only be used with support from LNCMI staff, who provides and operates the power supply. Therefore, an LNCMI staff member will be included in the proposal and experimental team. We especially recommend that users who wish to submit a proposal and use this equipment should contact Fabienne Duc (LNCMI, Toulouse, fabienne.duc@lncmi.cnrs.fr) before the final submission in order to determine the feasibility of the work.

You may find more information at:
https://emfl.eu/find-experiment/neutrons/

REGIONAL PARTNER FACILITIES

Universidad Autonoma Madrid, Low Temperature and High Magnetic Field Laboratory

This laboratory belongs to the Universidad Autonoma in Madrid and hosts several high-magnetic-field systems, mostly dedicated to Scanning Tunneling Microscopy (STM).

The lab houses several superconducting magnets up to 22 T in a variety of configurations. Magnets have either 50 or 80 mm bore diameter and are mostly equipped with dilution-refrigerator inserts, in which the available sample space is of approximately 44 or 70 mm diameter. There is one magnet reaching 22 T and two magnets reaching 17 T. Other more usual magnets are run by the staff of the laboratory, including a vector magnet (5-1-1 T), one 13 T magnet, and two 10 T magnets.

STM head made of nonmetallic Shapal mounted on the low-temperature stage of a dilution refrigerator before insertion into a high-field magnet.

Dilution refrigerator being inserted inside the cold 22 Tesla magnet.

The research carried out by the laboratory is focused on investigating surfaces of quantum materials using STM. The in-house-built electronic STM control allows measurements of the I-V characteristics with <8 μeV resolution in voltage and a wide range of accessible currents at temperatures well below 100 mK. With this equipment, the laboratory offers the possibility to conduct density of states measurements with an extremely high resolution in energy, covering studies in superconductors, semimetals, and magnets presenting phenomena characterized by small electronic energies. These include research on pnictides and high-temperature superconductors, heavy-fermion physics, topological surface states, magnetism, and Landau-quantization studies. The surfaces are conditioned by in-situ cleaving at cryogenic vacuum, and there is experience in measuring some ex-situ surfaces evaporated using standard methods.

Other than STM studies of surfaces, the equipment is very well suited to make transport studies in devices as a function of magnetic field and temperature. To this end, the laboratory operates a rotating stage with a large number of available wiring options. The superconducting high-field magnets are all equipped with persistent mode switches, allowing for long-term experiments.

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Overall view of the 22 Tesla magnet. Magnets in the lab are located inside a pit, allowing for the use of long cryostats and for a near to zero residual magnetic field in the lab space.

UPCOMING EVENTS

1 Joint European Magnetic Symposia (JEMS), Warsaw, Poland, July 24-29, 2022. HYBRID
https://jems2022.pl/

2 International Conference on Strongly Correlated Electron Systems (SCES 2022), Amsterdam, The Netherlands, July 24-29, 2022.
https://www.sces2022.org/

3 29th International Conference on Low Temperature Physics (LT29), Sapporo, Japan, August 18-24, 2022. HYBRID
http://www.lt29.jp

4 IRMMW-THz 2022, 47th International Conference on Infrared, Millimeter, and Terahertz Waves, Delft, The Netherlands, August 28 - September 2, 2022. HYBRID
https://www.irmmw-thz2022.tudelft.nl/

5 DPG Spring Meeting of the Condensed Matter Section, Regensburg, Germany, September 4-9, 2022. SHIFTED
https://regensburg22.dpg-tagungen.de/

6 EMFL summer school, Kerkrade, Netherlands, September 21-25, 2022.
https://emfl.eu/emfl-summer-school/

7 International Symposium on Crystalline Organic Metals, Superconductors and Magnets (ISCOM 2022), Le Pouliguen, France, September 25-30, 2022.
https://iscom2022.sciencesconf.org/

8 Applied Superconductivity (ASC 2022), Honolulu, Hawaii, October 23-28, 2022.
https://www.appliedsuperconductivity.org/asc2022/

9 67th Annual Conference on Magnetism and Magnetic Materials (MMM 2022), Minneapolis, USA, October 31 - November 4, 2022.
https://magnetism.org/

10 Spectroscopies of Novel Superconductors (SNS) 2022, Bangalore, India, December 12-16, 2022.
https://snsbangalore.iisc.ac.in/

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