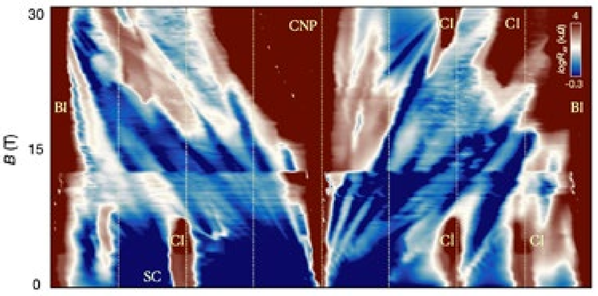
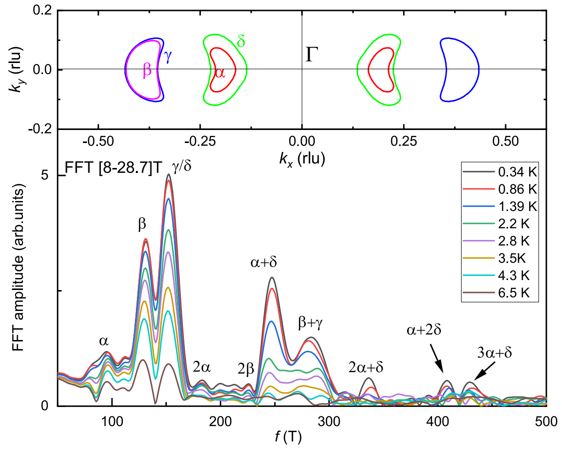
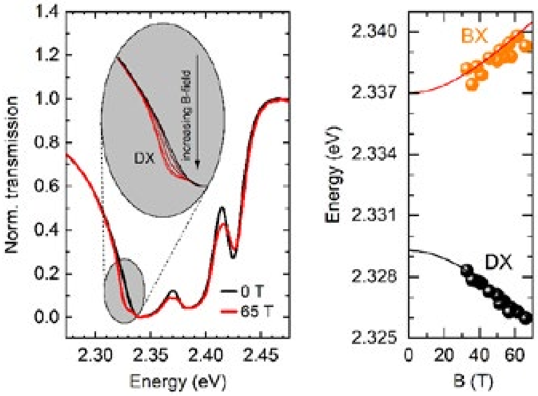
EMFL
European Magnetic Field Laboratory

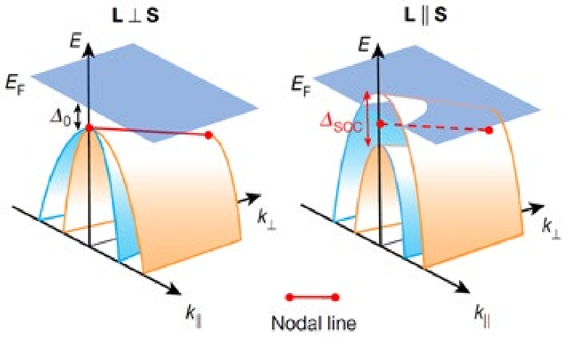
EMFLNEWS

N°1 2022









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DEAR READER

It is good to see that finally the effects of the Corona pandemic gradually disappear and that many high magnetic field activities return back to normal.

The EMFL user meeting will take place on Wednesday, June 15, 2022 in Grenoble, in a hybrid format. An exciting one-day program will be put together, with talks reporting recent scientific results, the announcement of the winner of the 2022 EMFL prize, the meeting of the user committee, and the latest news from the European high-field scene.

This EMFLNews also contains a further introduction of our regional and industrial partners, this time featuring the Research Laboratories of the Faculty of Physics in Warsaw and the company Metel B.V. specialist in high-performance metals, based in Waalwijk, the Netherlands.

Finally, the new call for magnet time is out (deadline May 15, 2022), inviting all high-field researchers to propose their experiments.

So, we hope to see you again soon in one of our EMFL facilities.

Peter Christianen
Director HFML
Chairman EMFL

MEET OUR PEOPLE

Maxime Leroux, LNCMI Toulouse

After my undergraduate years and the agrégation and master in physics from the ENS Lyon, I completed my PhD at the Institute Néel in Grenoble (CNRS and Université de Grenoble). There, I studied superconductors and charge density wave materials with Drs. Pierre Rodière and Klaus Hasselbach. I stayed in science as a postdoctoral researcher, first at Argonne National Lab in Chicago, then at the MagLab pulsed field facility in Los Alamos (USA). There, I kept working on superconductors and charge density wave materials, which have electronic properties of fundamental interest, but I also ventured into more applied topics such as high-temperature superconducting (HTS) tapes and novel magnetic skyrmion materials.

My current projects still revolve around high-temperature superconductors and charge density waves. For instance, I use focused ion beams to structure single-crystalline materials into micrometer-sized samples with nanometer precision, which removes many technical roadblocks to perform experiments at very high pulsed magnetic fields, thus opening up a vast number of new possibilities.

In my current position, I enjoy performing cutting-edge research on world-class high-field magnets, all the while having the opportunity to meet leading researchers from all over the world thanks to my local-contact activities.

I also enjoy the serendipity of science, these “eureka moments” when it just clicks, for instance at the time when I realized that only the data at peak magnetic field was making any sense because, elsewhere, there was an as-yet-unknown contribution from the rate of change of magnetic field.

For the future, I am looking forward to developing new experimental setups for measurements at very high pulsed magnetic fields up to 100 T and beyond, which may enable to unlock some secrets of high-temperature superconductivity and contribute to the development of applied superconductors.


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› Maxime Leroux

RE-ENTRANT CORRELATED INSULATOR AT 2π MAGNETIC FLUX IN MAGIC-ANGLE TWISTED BILAYER GRAPHENE

Ipsita Das, Dmitri K. Efetov, ICFO Spain and Benjamin A. Piot, LNCMI Grenoble

Different interacting phases such as correlated insulators, superconductors, magnetic states, Chern insulators, strange metals, anomalous quantum Hall effect etc. have been extensively studied in the flat band of magic-angle twisted bilayer graphene (MATBG) in the last few years. However, the high-magnetic-field Hofstadter spectrum has remained unexplored so far.

In this work, an international team of ICFO (Spain), Princeton University (USA), NIMS (Japan), and LNCMI Grenoble (France) has studied the detailed magneto-transport behavior of a MATBG device with twist angle θ ~1.12° in an external magnetic field up to 31 T, corresponding to one magnetic flux quantum per moiré unit cell Φ_0. We resolve the continuous evolution of the Hofstadter spectrum from zero field to Φ_0. At Φ_0, we observe reentrant-correlated insulators at certain integer fillings of the flat band and interaction-driven Fermi-surface reconstructions, evidenced by the emergence of new sets of Landau levels (LLs). Additionally, we study the rich interaction reconstructed Hofstadter spectrum in higher-energy passive bands.

The exact theoretical study of the Bistritzer-MacDonald (BM) Hofstadter spectrum in MATBG has predicted a set of eight well-isolated low-energy flat bands at Φ_0, with comparable bandwidth but with different symmetry and topology than at zero field. Our experimental observation of enhanced resistance peaks at the band filling $\nu = +2$ and +3 close to Φ_0 verifies this prediction. New reconstructed Fermi surfaces from different integer fillings have a fully lifted degeneracy, giving rise to LLs with the sequence $\nu_L = +1, +2, +3$ from $\nu = +1$, $\nu_L = \pm2, \pm3, \pm4, \pm5$ from $\nu_L = +2$ and $\nu_L = \pm1, \pm2, \pm3, \pm4$ from $\nu = +3$. This suggests that both spin and valley degeneracies have been lifted for all the integer fillings at Φ_0 in contrast to zero-field.

To access the higher energy bands, we further tuned the carrier density beyond $\nu > 4$ up to Φ_0. The strongest LLs observed in this regime match with the largest gaps calculated from our gauge-invariant single-particle Hofstadter spectrum verifying the reentrant flat bands at Φ_0.

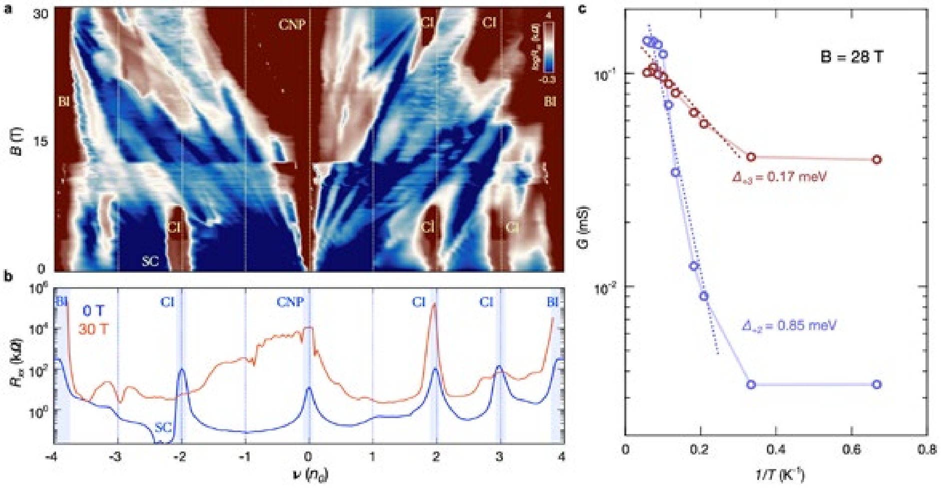

Figure: (a) Color plot of R_{xx} as a function of B and ν for the full phase space from B = 0 to B = 31 T showing all the states. (b) Line-cut of R_{xx} vs ν verifying the reentrance of resistive peaks at $\nu = +2, +3$ at B = 30 T. (c) Temperature dependence of these resistive states at B = 28 T.

Observation of reentrant correlated insulators and interaction driven Fermi surface reconstructions at one magnetic flux quantum per moiré unit cell in magic-angle twisted bilayer graphene, I. Das, C. Shen, A. Jaoui, J. Herzog-Arbeitman, A. Chew, C.-W. Cho, K. Watanabe, T. Taniguchi, B. A. Piot, B. A. Bernevig, and D. K. Efetov, arXiv:2111.11341v1 (accepted for publication in Physical Review Letters).

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NESTED MAGNETIC BREAKDOWN IN QUANTUM-OSCILLATION STUDY ON WTe_2

Jasper Linnartz and Steffen Wiedmann, HFML Nijmegen

A team of researchers from HFML-FELIX, Aarhus University, and the University of Bristol has investigated the high-field electronic transport properties of the semimetal WTe_2. In quantum-oscillations measurements, they revealed peculiar magnetic-breakdown trajectories of charge carriers between nested pockets of the Fermi surface.

WTe_2 is a material with extraordinary properties. Bound by weak van der Waals interaction, two-dimensional layers can be exfoliated down to a monolayer, leading to emergent phenomena such as superconductivity and the quantum spin Hall effect. In its bulk form (as studied here), the material's resistance increases by more than 10^7 % in the presence of a high magnetic field. Moreover, bulk WTe_2 has also been identified as a type-II Weyl semimetal, which essentially means that its electronic bands form tilted Dirac cones giving rise to small electron and hole pockets containing highly mobile charge carriers. In quantum-oscillation measurements, the observed frequency of the 1/B-periodic oscillations is directly proportional to the extremal area of particular pockets of the Fermi surface. Key properties of the charge carriers such as their effective mass, quantum mobility, and nature (electrons or holes) can be determined from these experiments.

In high magnetic fields, the phenomeon of magnetic breakdown (MB) occurs, which is essentially a tunneling of charge carriers between different pockets of the Fermi surface. In quantum-oscillation measurements, MB orbits are characterized by the sum of individual areas (frequencies) of different pockets. By measuring quantum oscillations that originate from MB orbits at different tilt angles and temperatures and comparing those to band-structure calculations, it was found that the Fermi surface of WTe_2 can be explained within the model of a Matryoshka-doll nested Fermi surface of electron and hole pockets, i.e., electron and hole pockets in WTe_2 fit inside one another in precisely the same way. What is so peculiar is the fact that the onset of magnetic breakdown is solely determined by impurity scattering in contrast to magnetic-breakdown scenarios in other metallic systems, which depends exclusively on the strength of the applied magnetic field. In addition, unlike in other systems, the phenomenon of MB in this material persists upon changing the magnetic-field orientation with respect to the two-dimensional layers of WTe_2.

Fermi surface and nested magnetic breakdown in WTe_2, J. F. Linnartz, C. S. A. Müller, Yu-Te Hsu, C. Breth Nielsen, M. Bremholm, N. E. Hussey, A. Carrington, and S. Wiedmann, Phys. Rev. Res. **4**, L012005 (2022).

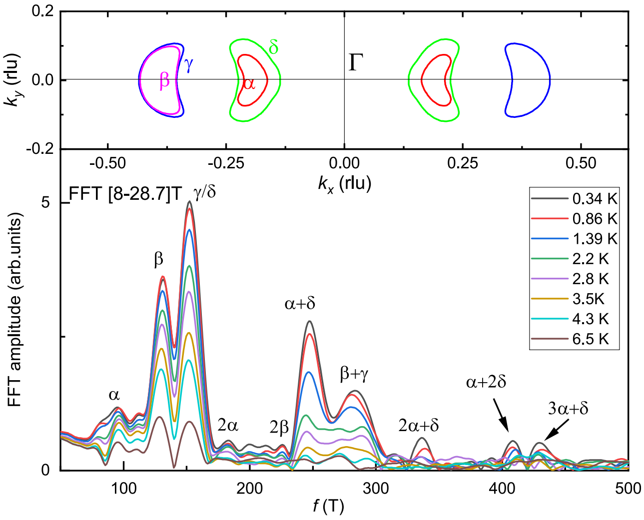

Figure: (top) Cut of the Fermi surface in the k_x-k_y plane highlighting the nested doll configuration. (bottom) Fast-Fourier transform spectrum for the field range [8–28.7 T] for different temperatures up to 6.5 K. The corresponding individual (α, β, γ, δ) and breakdown orbits (sum of individual orbits) are labeled.

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BRIGHTENING OF DARK EXCITONS IN 2D PEROVSKITES

Mateusz Dyksik, Wroclaw University of Science and Technology, Poland and Paulina Plochocka, LNCMI Toulouse

Optically inactive dark exciton states play an important role in light-emission processes in semiconductors because they provide an efficient nonradiative recombination channel. Understanding the exciton fine structure in materials with potential applications in light-emitting devices is, therefore, critical and has to be taken into account during the design stage for a deterministic development of future optoelectronic devices. However, detailed information concerning the exciton fine structure is missing in the case of two-dimensional (2D) perovskites, a hybrid organic-inorganic material system with outstanding optical properties.

We show that in this class of materials, the dark exciton is the lowest-lying excitation. We reach this conclusion by performing optical-spectroscopy measurements in high magnetic fields. The in-plane magnetic field mixes the bright and dark exciton states, brightening the otherwise optically inactive dark exciton (Figure panel a). This new state exhibits characteristic properties typical for dark states – the oscillator strength increases with magnetic field and its energy redshifts (panel b). Although the dark exciton is the lowest-lying excitation in 2D perovskites, these materials exhibit intense photoluminescence emission with high quantum yield even at low temperatures (panel c).

In the magneto-photoluminescence data we find a fingerprint of a non-Boltzmann distribution of the bright (BX) – dark (DX) exciton populations – the BX/DX ratio does not follow the predicted (low) temperature curve, but instead overlaps with the 30-40 K curve (panel d). We attribute this to a phonon bottleneck, which results from the weak exciton–acoustic phonon coupling in soft 2D perovskites. Hot photoluminescence is responsible for the strong emission observed in these materials, despite the substantial bright-dark exciton splitting.

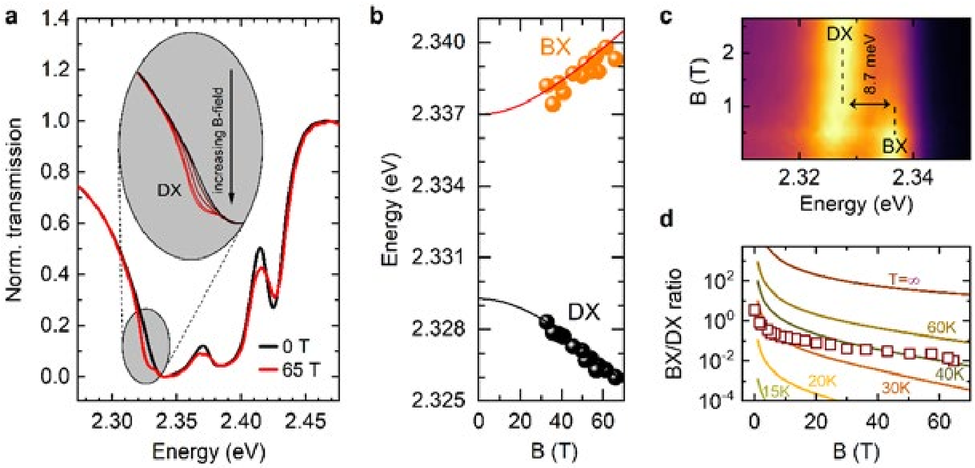

Figure: (a) Absorption spectra of $(PEA)_2PbI_4$ measured in Voigt geometry. With increasing magnetic-field strength, an additional absorption signal (DX) at the low-energy side of a bright exciton (BX) is visible. This new feature is related to the brightened dark exciton. (b) Evolution of transition energy for the DX and BX states in a magnetic field. (c) False-color map of the magneto-PL spectra. The DX dominates the emission already at 1 T. (d) BX/DX intensity ratio. Solid lines stand for the product of BX/DX oscillator-strengths ratio and Boltzmann distribution for several lattice temperatures.

Brightening of dark excitons in 2D perovskites, M. Dyksik, H. Duim, D. K. Maude, M. Baranowski, M. A. Loi, and P. Plochocka, Sci. Adv. **7**, eabk0904 (2021).

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COLOSSAL ANGULAR MAGNETO-RESISTANCE IN FERRIMAGNETIC NODAL-LINE SEMICONDUCTORS

Yurii Skourski, HLD Dresden

A group of researchers from Korea, USA, and HLD have demonstrated that topological nodal-line degeneracy of spin-polarized bands in magnetic semiconductors can induce an extremely large angular dependence in the magnetotransport. A phenomenon that the researcher called colossal angular magnetoresistance. The findings demonstrate that magnetic nodal-line semiconductors are a promising platform for realizing extremely sensitive spin- and orbital-dependent functionalities.

In ferromagnetic nodal-line semimetals, including previously reported Fe_3GeTe_2, $Co_3Sn_2S_2$, and Co_2MnGa, the band-crossing points of spin-polarized bands near the Fermi level (E_F) are protected by crystalline symmetry and form a line in momentum space. When spin-orbit coupling (SOC) is taken into account, opening and closing of the SOC gap (Δ_{SOC}) is determined by the relative orientation between the orbital angular momentum (L), fixed along a certain crystal axis, and spin direction (S), rotatable by external magnetic fields. A related but distinct behavior was expected in ferromagnetic semiconductors if the spin-polarized conduction or valence bands possess a topological nodal-line degeneracy. In such ferromagnetic nodal-line semiconductors, the SOC lifts the band degeneracy and pushes one of the bands towards E_F by $\Delta_{SOC}/2$, depending on the relative orientation of L and S (Figure 1). Therefore, when the bandgap Δ and Δ_{SOC} are comparable, spin rotation by external magnetic fields drastically modulates the bandgap and thus charge conduction, leading to the colossal angular magnetoresistance.

The researchers demonstrated this behavior successfully for the self-intercalated layered ferrimagnet $Mn_3Si_2Te_6$, both undoped and doped with Ge and Se. The resulting variation of the angular magnetoresistance with rotating magnetization exceeds a trillion percent per radian (Figure 2). Notably, the resulting angular magnetoresistance is controlled exclusively by spin rotation; pulsed-field measurements revealed no field-induced phase transitions up to at least 70 Tesla.

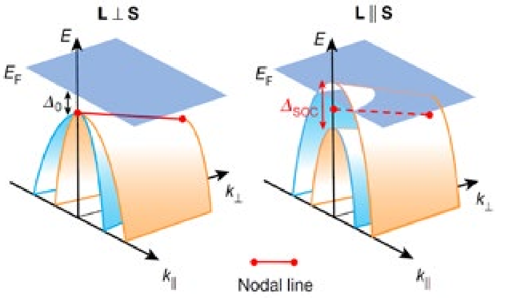

Figure 1: The electronic gap Δ remains intact for L ⊥ S in the presence of SOC, while the lifting of nodal-line band degeneracy for L ∥ S pushes one of the bands towards the Fermi level. This induces the insulator-to-metal transition, controlled by the relative orientation of S against L, resulting in a colossal angular magnetoresistance.

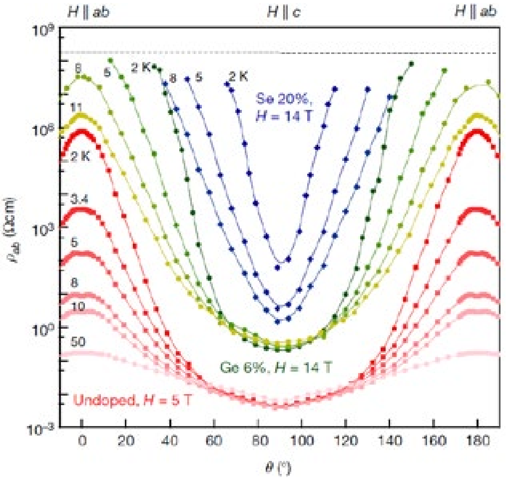

Figure 2: Angular response of ρ_{ab} for an undoped, Ge-doped, and Se-doped $Mn_3Si_2Te_6$ crystals as a function of magnetic-field orientation at different temperatures. For the doped samples, the resistivity taken at H = 14 T and low temperatures is beyond the measurement limit (dashed line) near H ∥ ab.

Colossal angular magnetoresistance in ferrimagnetic nodal-line semiconductors, J. Seo, C. De, H. Ha, J. E. Lee, S. Park, J. Park, Y. Skourski, E. S. Choi, B. Kim, G. Y. Cho, H. W. Yeom, S.-W. Cheong, J. H. Kim, B.-J. Yang, K. Kim, and J. S. Kim, Nature **599**, 576 (2021).

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OPENING OF THE 27TH CALL FOR ACCESS

Although all EMFL sites have resumed user operation, the COVID-19 crisis is still causing restrictions. Quite a number of accepted and scheduled proposals could not be performed, mainly due to travel restrictions. Nevertheless, the Board of Directors decided to stick to the regular policy that proposals will remain valid for one year. Users with older proposals, that could not be performed, are asked to resubmit them. This concerns proposals granted in the call 220 and older. This facilitates the handling of all proposals and provides maximum clarity to all users and funding agencies.

The 27th call for proposals has been launched on April 15, 2022, inviting researchers worldwide to apply for access to one of the large installations for high magnetic fields collaborating within EMFL.

The four facilities

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

run a joint proposal program, which allows full access to their installations and all accompanying scientific infrastructure to qualified external users, together with the necessary support from their scientific and technical staff.

Users may submit proposals for access to any of these installations by a unified procedure. You may find the online form for these proposals on the EMFL website.
www.emfl.eu/user

In the frame of the EU-funded ISABEL project, EMFL will continue to trial the novel **dual access** procedure. In addition, EMFL has set up a novel **first-time access** mode with the aim of lowering the barrier for researchers to start using the EMFL facilities. Prospective users are encouraged to contact a staff member of EMFL, who can support proposal preparation. Additionally, EMFL will offer reinforced on-site support and reimbursement of travel and accommodation expenses. This will allow for increasing the size and diversity of the user community.

EMFL will also introduce a novel **fast-track access** mode in the coming months, a high-priority access to EMFL facilities for rapid developments in science and technology. More information will be available on the EMFL website soon.

Please note that each experiment carried out must be followed up by a progress report and your publication record filled out online on the EMFL website. Please be aware that this information will also be made available to the Selection Committee.

To improve our user program further, your feedback to the user committee is highly appreciated.
Please find the form on the EMFL website.
https://emfl.eu/SelCom/UserCommittee/feedbackform.php

The deadline for proposals for magnet time is May 15, 2022.

A Selection Committee will evaluate all proposals. Selection criteria are scientific quality (originality and soundness), justification of the need for high fields (are there good reasons to expect new results) and feasibility of the project (is it technically possible and are the necessary preparations done). We strongly recommended contacting the local staff at the facilities to prepare a sound proposal and ideally indicate a local contact.

Please do acknowledge any support under this scheme in all resulting publications with „We acknowledge the support of the HFML-RU (or HLD-HZDR or LNCMI-CNRS), member of the European Magnetic Field Laboratory (EMFL).“ UK users should, in addition, add “A portion of this work was supported by the Engineering and Physical Sciences Research Council (grant no. EP/N01085X/1).“

- You may find more information on the available infrastructures for user experiments on the facility websites.

www.hzdr.de/hld
www.lncmi.cnrs.fr
www.ru.nl/hfml

EMFL
European Magnetic Field Laboratory

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

EMFL AT WIRE DÜSSELDORF

This year, the ISABEL team will represent EMFL at the International Wire and Tube Trade Fair 2022, which will be held in Düsseldorf from June 20-24. With great pleasure, we will share our exposition booth (in Hall 11 / 11D54) with our industrial partner – Metel.

https://www.wire-tradefair.com/vis/v1/en/exhibitors/witu2022.2708261?oid=2370198&lang=2

ANNOUNCEMENT: SYMPOSIUM „SF02-MATERIALS FOR EXTREME CONDITIONS“

The symposium will be held during the MRS Fall 2022 Meeting in Boston from November 27 to December 2.

This symposium will focus on understanding mechanical behavior, structural stability, transport properties, electronic/magnetic ordering, and exotic properties of materials under extreme environments. The major topics are the studies of materials under high pressure, high/low temperature, external electric/magnetic fields, high strain deformation, and high-strain-rate dynamic loading.

Topics will include:

- Super-hard and ultra-high-strength materials synthesized under high pressure and high field
- Energy materials, nanomaterials, composites under stress, pressure, and other extreme conditions
- Novel high-pressure materials with modified chemical bonding and composition
- High-temperature superconductors under high pressure and/or magnetic fields
- Theoretical modeling and prediction, advanced characterization, and instrumentation
- High-strength conductors, insulation, and structure materials for high-field magnets
- Material processing and first-order phase transformation in high-field magnets
- Material deformation under high-field magnets or cryogenic temperatures; High strain-rate mechanical characterization at the micro and nanoscale
- Material processes and phenomena related to extreme dynamic conditions; Microballistic studies for advanced functional and structural materials

A tutorial complementing this symposium is tentatively planned. Abstract submission will be accepted from May 16 to June 16.

https://www.mrs.org/meetings-events/fall-meetings-exhibits/2022-mrs-fall-meeting/call-for-papers/detail/2022_mrs_fall_meeting/sf02/Symposium_SF02

METEL: METALS FOR SPECIFIC INDUSTRIES

METEL Special metals and components

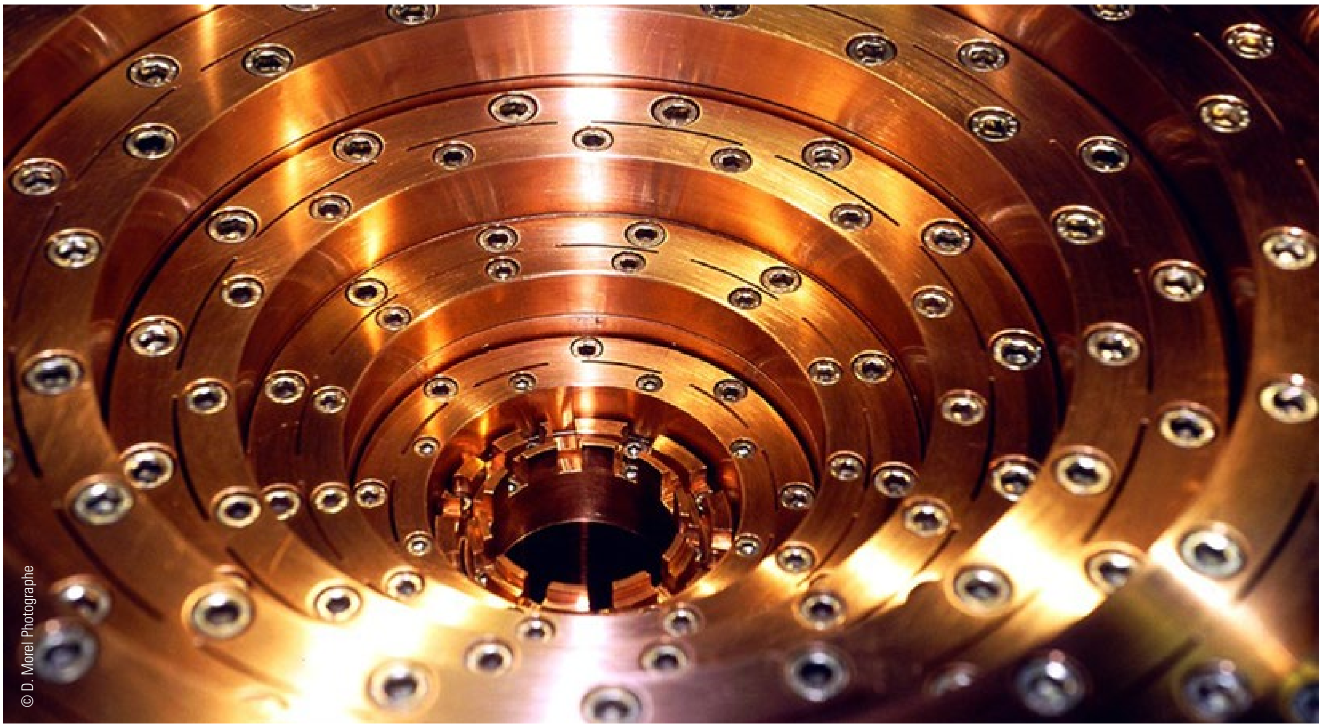
METEL IS THE SPARRING PARTNER FROM THE BEGINNING TO THE END

Starting in 2013, Metel started to specialize in high-performance and special metals. We have thus evolved into a sparring partner and distinctive supplier of special metals with high specifications for unique applications.

Many companies stick to the well-trod path and choose to work only with standard metals. This is logical, because the metal industry is specific and requires a lot of knowledge. But this gap is where Metel comes in. We provide support and advice from start to finish. We're on hand at the start of the process, in the engineering and metal selection phase. We use our specialist knowledge to help identify the metal most suitable for your application; this is often better than the more readily available standard metal. We go far beyond the "you ask, we jump" model and instead thrive as a sparring partner for companies seeking the very best solutions.

For the wire and tube exhibition, our goal is to seek new collaborations with industrial companies that use special metals such as titanium, tantalum, molybdenum, tungsten, zirconium, copper, silver and nickel alloys.

https://www.metel.nl/en/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REGIONAL PARTNER FACILITIES

The Research Laboratories of the Faculty of Physics in Warsaw

The Research Laboratories of the Faculty of Physics in Warsaw (http://www.fuw.edu.pl) are located at the University of Warsaw - the biggest university in Poland. The University belongs to the best 100 universities worldwide as far as physical sciences are concerned. The Faculty combines expertise from different areas of physical sciences. Condensed-matter research is one of the most active areas of studies present at the Faculty. A strong group of academics shares their knowledge and experience with graduate and undergraduate students in several areas of materials science. The studies are strongly supported by state-of-the-art equipment including MBE and MOCVD epitaxy systems, FIB, optical lithography, and AFM/MFM microscopes. The laboratories at the Faculty are also equipped with a helium-recovery system, which is supported by a local helium-liquefaction facility.

Special attention of the researchers at the Faculty is given to studies of low-dimensional semiconductor nanostructures, including optical properties of quantum dots and recently emerged two-dimensional materials. The well-established expertise at the Faculty is supported by modern characterization techniques, which are open to external users within the ISABEL project under the dual-access scheme.

The available **optical-characterization techniques** include: reflectivity and transmission, Raman-scattering spectroscopy, photoluminescence spectroscopy (PL, PLE) with a variety of lasers: 325 nm, 405 nm, 425 nm, 457 nm, 488 nm, 515 nm, 532 nm, 561 nm, 575-625 nm (tunable), 647 nm, 685 nm, 700-860 nm (tunable), and 808 nm. Typical signal detection is made using Si CCD cameras (400-1000 nm). An InGaAs detector (up to 1700 nm), detection by using a streak camera (S1 or S20 cathode with temporal resolution down to 3 ps) or by using an APD (quantum efficiency higher than streak camera, temporal resolution down to 50 ps) are also available. Ultrafast pump-probe spectroscopy can be performed, time-resolved PL with excitations using femtosecond laser near 400 nm, or between 600 and 950 nm (tunable), photon correlations using Si APDs can also be measured.

Superconducting magnets can provide magnetic fields with optical access:

- 16 T magnet for experiments in Faraday configuration,
- 10 T magnet for experiments in Faraday or Voigt configuration,
- 3 T two-coil vector magnet allowing smooth transition from Faraday to Voigt geometry or in-plane rotation of the magnetic field in the Voigt geometry.

Each magnet is equipped with a variable-temperature insert (VTI) allowing measurements from room temperature down to pumped helium (about 1.5 K). Persistent switches at superconducting coils allow for extended stay at a single field in addition to regular field-sweep measurements.

The investigated samples are by default probed locally using a NA > 0.5 lens or objective, which corresponds to a spot of 1-2 µm. The samples should not be larger than about 8 mm x 8 mm. Voltage control for gated samples is also available.

Dr Tomasz Kazimierczuk (Tomasz.Kazimierczuk@fuw.edu.pl) and Dr Maciej Molas (Maciej.Molas@fuw.edu.pl) can provide more information on optical measurements.

Electrical-characterization techniques available at the Faculty include Hall-effect measurements for metallic to semiconducting samples and low-current measurements (down to pA).

The available setups include an Oxford Instruments cryostat with a variable temperature insert (1.5 K – 300 K) and a magnetic field of (12 T), and a dilution refrigerator, Oxford Instruments Kelvinox, providing a temperature range (20 mK - 1 K) and a magnetic field of 16 T. Probes with rotators are available in both setups, enabling variation of a sample plane with respect to the magnetic field.

Dr Marta Borysiewicz (Marta.Gryglas@fuw.edu.pl) can provide further information on electric-transport measurements.

© Jarosław Rybusinski, University of Warsaw

UPCOMING EVENTS

1. EMFL User Meeting, Grenoble, June 15, 2022.
   https://emfl.eu/emfl-user-meeting-2022/

   HYBRID

2. International Conference on the Physics of Semiconductors (ICPS), Sydney, Australia, June 27-30, 2022.
   https://www.icps2022.org/

3. International Conference on Magnetism (ICM), Shanghai, China, July 3-8, 2022.
   http://www.icm2021.com/

   CANCELED

4. 13th International Conference on Materials and Mechanisms of Superconductivity & High Temperature Superconductors (M2S-2022), Vancouver, Canada, July 17-22, 2022.
   https://www.m2s-2022.com/

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

   HYBRID

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

7. 29th International Conference on Low Temperature Physics (LT29), Sapporo, Japan, August 18-24, 2022.
   http://www.lt29.jp

   HYBRID

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

   HYBRID

9. DPG Spring Meeting of the Condensed Matter Section, Regensburg, Germany, September 4-9, 2022.
   https://www.dpg-physik.de/aktivitaeten-und-programme/tagungen/fruehjahrstagungen/2022

   SHIFTED

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

11. 67th Annual Conference on Magnetism and Magnetic Materials (MMM 2022), Minneapolis, USA, October 31- November 4, 2022.
    https://magnetism.org/

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

13. Materials Research Society (MRS) Fall 2022 Meeting Boston, USA, November 27 - December 2, 2022.
    https://www.mrs.org/meetings-events/fall-meetings-exhibits/2022-mrs-fall-meeting

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