

Magnetic fields for materials research

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Thursday, 07.09.2023, Room 115

Time	ID	MAGNETIC FIELDS FOR MATERIALS RESEARCH <i>Chair: Stefano Gariglio, Université de Genève</i>
17:00	681	<p style="text-align: center;">Present and Future scientific opportunities in EMFL (European Magnetic Field Laboratory)</p> <p style="text-align: center;"><i>Charles Simon, Laboratoire national des champs magnétiques intenses (LNCMI) CNRS, 25 avenue des Martyrs, FR-38042 Grenoble cedex 09 CNRS, 143 Avenue de Rangueil, FR-31400 Toulouse</i></p> <p>This presentation will review the present and future opportunities in EMFL for high magnetic fields experiments up to 200T in pulsed fields and 45 T in continuous fields. Some scientific examples will be shown in this presentation, as well as the procedure to request access to high magnetic fields. A fully superconducting magnet of 40 T should be also available in future. EMFL in a European facility located in four sites: Grenoble, Nijmegen, Toulouse and Dresden. EMFL is supported by the European program ISABEL to attract new users especially from Switzerland.</p>
17:30	682	<p style="text-align: center;">Landau level spectroscopy as a window into topological semimetals</p> <p style="text-align: center;"><i>Ana Akrap, Department of Physics University of Fribourg, Ch. du Musée 3, CH-1700 Fribourg</i></p> <p>A strong magnetic field confines band electrons to a discrete set of Landau levels. The material's band structure is directly linked to the energy spectrum of these Landau levels. With infrared light, we can excite transitions of carriers from one level to another, and these are called inter-Landau level transitions. Since the early 1950s, this Landau level spectroscopy has been widely employed as an extremely sensitive probe of semimetal and semiconductor band structures. I will give an overview of our recent progress on Landau level spectroscopy of Dirac and Weyl semimetals. Through advanced techniques, we can resolve intricate complexities of their bands, all while discovering new physics. I will present our new analysis of highly detailed inter-Landau level transition maps in extreme magnetic fields. I will discuss how novel approaches allows us to further exploit the rich magneto-optical spectra, and gain deep knowledge of topological semimetals.</p>
18:00	683	<p style="text-align: center;">Exploring quantum matter under extreme conditions at the SwissFEL Cristallina endstation</p> <p style="text-align: center;"><i>Alexander Steppke Laboratory for X-ray Nanoscience and Technologies, Paul Scherrer Institut, Villigen PSI, & Laboratory for Quantum Matter Research, University of Zürich</i></p> <p>Brilliant, ultrashort, and coherent X-ray free-electron laser (FEL) pulses are primarily used for investigation of dynamics at the inherent time and length scale of atoms. In addition, the unprecedented peak brilliance also allows for single-shot experiments that are not feasible at other X-ray sources. The latter will be used to image quantum many-body states under extreme conditions at the Cristallina endstation of SwissFEL's hard X-ray beamline. In particular, millisecond high magnetic field pulses will be synchronized to the femtosecond X-ray pulses, enabling X-ray diffraction at both high magnetic field strengths and low temperatures. In this talk, I will review our commissioning progress reaching magnetic field of up to and beyond 40 T, and elaborate on the path towards user operation after the commissioning phase.</p>

18:30	684	<p style="text-align: center;">Dual nature of charge carriers in the iron-based superconductor FeSe_{1-x}S_x</p> <p style="text-align: center;"><i>Matija Čulo¹, Jake Ayres², Salvatore Licciardello³, Maarten Berben³, Yu-Te Hsu³, Roemer Hinlopen², Shigeru Kasahara⁴, Yuji Matsuda⁵, Takasada Shibauchi⁶, Nigel Hussey^{2,3}</i></p> <p style="text-align: center;">¹ <i>Institut za fiziku, Bijenička cesta 46, HR-10000 Zagreb, Croatia</i></p> <p style="text-align: center;">² <i>H. H. Wills Physics Laboratory, University of Bristol, Tyndall Avenue, Bristol BS8 1TL, UK</i></p> <p style="text-align: center;">³ <i>High Field Magnet Laboratory (HFML-EMFL) and Institute for Molecules and Materials, Radboud University, Toernooiveld 7, 6525 ED Nijmegen, Netherlands</i></p> <p style="text-align: center;">⁴ <i>Research Institute for Interdisciplinary Science, Okayama University, 3-1-1 Tsushimanaka, Kita-Ku, Okayama 700-8530, Japan</i></p> <p style="text-align: center;">⁵ <i>Department of Physics, Kyoto University, Sakyo-Ku, Kyoto 606-8502, Japan</i></p> <p style="text-align: center;">⁶ <i>Department of Advanced Materials Science, University of Tokyo, Kashiwa, Chiba 277-8561, Japan</i></p> <p>The discovery of high-temperature superconductivity in materials that contain iron was accepted with surprise in the condensed matter community, since it had been widely believed that iron with a large magnetic moment is harmful to the emergence of superconductivity. Among these iron-based superconductors, FeSe_{1-x}S_x attracted a special attention because of its unique phase diagram, in which superconductivity emerges from a pure electron nematic state, therefore providing an opportunity to study the interplay between nematicity and unconventional superconductivity. The transition to the nematic state in the parent compound FeSe occurs at around 90 K and is followed by the transition to the superconducting (SC) state at around 10 K. This nematic transition can be strongly suppressed by applying a hydrostatic pressure which in turn leads to the stabilization of an antiferromagnetic state. The nematic transition can be strongly suppressed also by changing Se with S, in which case it is believed that it terminates as a nematic quantum critical point (QCP) at the critical S-substitution $x \approx 0.17$ inside the SC state. Here we present our detailed resistivity magnetoresistance and Hall effect study on FeSe_{1-x}S_x, conducted on a series of single-crystalline samples with $0 \leq x \leq 0.25$ spanning the nematic QCP, in high magnetic fields (H) up to 38 T, at very low temperatures (T) down to 300 mK and at high pressures up to 15 kbar. Our results indicate that the normal (non-SC) state of FeSe_{1-x}S_x is highly unconventional and that the charge transport there can be decomposed into two distinct components. One component exhibits the standard Fermi liquid behavior such as T_2 resistivity, H_2 magnetoresistance and H-linear Hall response. The other component shows strong signatures of strange metal behavior, the most important of which are T-linear resistivity, quadrature scaling with H-linear magnetoresistance at high H and anomalous Hall response with an exponential tail-off at high H. The strange metal component becomes very pronounced in vicinity of the nematic QCP and weakens significantly with moving away from it either by changing S-substitution, or by applying pressure. Such complex behavior possibly points towards a dual nature of charge carriers in FeSe_{1-x}S_x, triggered by the presence of quantum critical nematic fluctuations that selectively influence only certain parts of the Fermi surface.</p>
19:00		END; Transfer to Dinner
19:30		Conference Dinner