Superconducting Hybrids @ Extreme

June 28 - July 2, 2021

Book of Abstracts

Hotel Patria, Štrbské Pleso, Tatry, Slovakia

NANOSCALE COHERENT HYBRID DEVICES FOR SUPERCONDUCTING QUANTUM TECHNOLOGIES

Work is supported by COST EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

COST is supported by the EU Framework Programme Horizon 2020

PROGRAM

Arrival on Sunday June 27th afternoon. Welcome drink and dinner at 18:30 h.

	Monday June 28th	**Tuesday June 29th**	**Wednesday June 30th**	**Thursday July 1st**	**Friday July 2nd**
08:45	Opening				
09:00	Roditchev	Barišić *	Eremets	Ahmad	Cren *
09:25	Hlubina *	Ayress	Shimizu	Linek	Šofranko *
09:50	Neilinger *	Marinkovic	Arita	Montemuro	Gmitra *
10:15	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break
10:30	Szabó *	Lombardi	Gabáni *	Hakonen	Bending
10:55	Cieplak	Kačmarčík *	Guinea	Bouzdin	Vaňo *
11:20	Strunk	Lang	Palau	Carreira	Martin-Vega
11:45	Raychaudhuri	Sobolewski *	Nemes-Incze*	Kochan *	Herrera Vasco
12:10	Maccari	Humbert	Calderón	Black-Schaffer	Gencer *
13:00	Lunch	Lunch	Lunch	Lunch	Lunch
14:30	Milošević	Šindler *		Cayao	
14:55	Van de Vondel	Leridon		T. Samuely *	
15:20	Fomin	Maggio-Aprile	*Networking meetings*	Makk *	*Closing, networking meetings*
15:45	Varlamov	Crisan		Skyba *	
16:10	Pokorný *	Fasano		Bužek *	
16:45	Coffee break	Coffee break		Coffee break	
17:00	*MC meeting*	*Poster I.*		*Poster II.*	
18:30	Dinner	Dinner	Dinner	Conference Dinner	

June 28 - July 2, 2021, Hotel Patria, Štrbské Pleso, Tatry, Slovakia

Superconducting Hybrids @ Extreme

MONDAY, June 28

08:45 - Opening

Superconductor-Insulator Transition, Topological states

09:00 - **Dimitri Roditchev**: Reaching the Anderson limit of superconductivity

09:25 - **Richard Hlubina**: Superconductor-insulator transition and pair breaking

09:50 - **Pavol Neilinger**: Observation of quantum corrections to conductivity of disordered MoC and NbN films up to optical frequencies

10:15 COFFEE BREAK

10:30 - **Pavol Szabó**: Zeeman effects in homogeneous, strongly disordered superconducting MoC thin films

10:55 - **Marta Cieplak**: The upper critical field and the superconductor-metal transition in ultrathin niobium films

11:20 - **Christoph Strunk**: Superfluid stiffness and resistance near the Berezinski-Kosterlitz-Thouless transition in NbN thin films

11:45 - **Pratap Raychaudhuri**: Investigation of the 2-dimensional vortex state in amorphous superconducting thin films

12:10 - **Ilaria Maccari**: Fragile glass transition in thin superconducting films

13:00 LUNCH

14:30 - **Milorad Milošević**: Enhancing superconductivity in 2D materials by beneficial defects

14:55 - **Joris Van de Vondel**: Determining the kinetic inductance of nanobridges by imbedding them in asymmetric SQUIDs

15:20 - **Vladimir M. Fomin**: Topological transitions in superconductor nanomembranes under a strong transport current

15:45 - **Andrey Varlamov**: Topological nature and the order of transition between the gap and the gapless states in the Abrikosov-Gor'kov theory

16:10 - **Vladislav Pokorný**: Evolution of Andreev bands in superconducting periodic Anderson model

16:45 COFFEE BREAK

17:00 - *MC meeting*

18:30 DINNER

TUESDAY, June 29

High-T_c Superconductors

09:00 - Neven Barišić: High-T_c cuprates – story of two electronic subsystems

09:25 - **Jake Ayress**: Incoherent transport across the strange metal regime of overdoped cuprates

9:50 - **Stefan Marinković**: Direct visualization of current-stimulated oxygen migration in $YBa_2Cu_3O_{7-\delta}$ thin films

10:15 COFFEE BREAK

10:30 - **Floriana Lombardi**: Tuning the phase diagram of HTS by studying nm thin films and nanodevices

10:55 - **Jozef Kačmarčík**: Unusual interplay between superconductivity and field induced charge order in $YBa_2Cu_3O_y$

11:20 - **Wolfgang Lang**: Unconventional vortex commensurability effects in dense pinning landscapes created by He ion irradiation of YBCO thin films

11:45 - **Roman Sobolewski**: Emission of terahertz transients from $La_{0.7}Sr_{0.3}MnO_3$ / $YBa_2Cu_3O_{7-x}$ nanobilayers excited by femtosecond optical pulses

12:10 - **Humbert Vincent**: Magnetoconductance across $YBa_2Cu_3O_7$/graphene heterojunctions

13:00 LUNCH

14:30 - **Michal Šindler**: Vortex mass in YBaCuO observed by far-infrared magnetic circular dichroism

14:55 - **Brigitte Leridon**: Doping-dependent competition between superconductivity and polycrystalline charge density waves in LSCO thin films

15:20 - **Ivan Maggio-Aprile**: Wang-McDonald vortex core states in heavily-overdoped $Bi_2Sr_2CaCu_2O_{8+\delta}$

15:45 - **Adrian Crisan**: Vortex dynamics in high magnetic fields in iron-based superconducting single crystal $BaFe_2(As_{1-x}P_x)_2$

16:10 - **Yanina Fasano**: Suppression of hyperuniformity in vortex matter in type-II superconductors induced by planar defects

16:45 COFFEE BREAK

17:00 - *Poster session I.*

18:30 DINNER

WEDNESDAY, June 30

Hydrides, High Pressures, 2D Materials

09:00 - **Mikhail Eremets**: Superconductivity near room temperature

09:25 - **Katsuya Shimizu**: High-pressure onset of superconductivity in hydrides

09:50 - **Ryotaro Arita**: Development of ab initio Migdal-Eliashberg method and its application to superconducting hydrides

10:15 COFFEE BREAK

10:30 - **Slavomír Gabáni**: Pressure effect on superconductivity in YB_6

10:55 - **Francisco Guinea**: Superconductivity in twisted graphene stacks

11:20 - **Anna Palau**: Tailoring vortex pinning and spin textures in hybrid superconducting-ferromagnetic systems

11:45 - **Peter Nemes-Incze**: Honeycomb lattice of heavy metals: evidence for topological edge states in the layered mineral jacutingaite

12:10 - **María José Calderón**: Correlated states in moiré graphene superlattices

13:00 LUNCH

14:30 - *Networking meetings*

18:30 DINNER

THURSDAY, July 1

Josephson Junctions, Ferromagnet / Superconductor Junctions, Majorana Fermions

09:00 - **Halima Giovanna Ahmad**: A novel platform for the study of unconventional phenomena in tunnel ferromagnetic Josephson junctions

09:25 - **Julian Linek**: Self-heating effects in SNS Nb-HfTi-Nb sub-μm Josephson junctions

09:50 - **Domenico Montemuro**: Enhanced superconducting properties in hybrid nanojunctions

10:15 COFFEE BREAK

10:30 - **Perti Hakonen**: Detection of single microwave photons using hybrid graphene bolometer

10:55 - **Alexander Buzdin**: Electromagnetic long ranged proximity effect in superconductor-ferromagnet structures

11:20 - **Santiago José Carreira**: Spin pumping phenomena on YBCO/Py hybrid systems

11:45 - **Denis Kochan**: Spin relaxation in superconducting graphene functionalized by magnetic impurities - interplay of resonances and Yu-Shiba-Rusinov states

12:10 - **Anika Black-Schaffer**: Supercurrent detection of Majorana fermions in nanowire junctions

13:00 LUNCH

14:30 - **Jorge Cayao**: Distinguishing trivial and topologically zero-energy states in Josephson junctions

14:55 - **Tomáš Samuely**: Yu-Shiba-Rusinov bands in hydrogenaded boron-doped diamond

15:20 - **Péter Makk**: Andreev molecule in parallel InAs nanowires

15:45 - **Peter Skyba**: Superfluid ^{3}He-B and magnonic analogue of black/white horizon

16:10 - **Vladimír Bužek**: 2nd Quantum Revolution

16:45 COFFEE BREAK

17:00 - *Poster session II.*

18:30 CONFERENCE DINNER

FRIDAY, July 2

2D Superconductivity, Heavy Fermions, Applications

09:00 - **Tristan Cren**: Unconventional superconductivity and 2x2 charge density wave in $(LaSe)_{1.14}(NbSe_2)_2$

09:25 - Ondrej Šofranko: Extremely doped bulk $NbSe_2$ system in the misfit layered compound $(LaSe)_{1.14}(NbSe_2)$

09:50 - **Martin Gmitra**: Perspectives of proximity effects in transition-metal dichalcogenides and their heterostructures

10:15 COFFEE BREAK

10:30 - **Simon Bending**: Superconducting quantum interference in twisted van der Waals heterostructures

10.55 - **Viliam Vaňo**: Artificial heavy fermions in a van der Waals heterostructure

11:20 - **Francisco Martín-Vega**: Bandstructure as a function of the magnetic field studied with very low temperature STM

11:45 - **Edwin Herrera Vasco**: Quantum confinement of heavy electrons in URu_2Si_2

12:10 - **Ali Gencer**: Advances in enabling technology for the superconducting fault current limiters

13:00 LUNCH

14:30 - *Closing, Networking meetings*

****
****

POSTER SESSION I. - TUESDAY, June 29 - 17:00

01. Bernd Aichner: Vortex commensurability effects observed in YBCO thin films with defects engineered by focused He ion beam irradiation
02. Jeroen Custers: Coexistence of superconductivity
03. Miroslav Grajcar: Josephson Junctions traveling wave parametric amplifier: simulations, theory and experiment
04. Jozef Haniš: Electronic structure of misfit layered compound $LaNbSe_3$ from first-principles
05. František Herman: Microwave response of type-II superconductors
06. Thomas Huber: Transport properties of an ultra-thin granular aluminum film
07. Samuel Kern: Transmission based characterization of superconducting metamaterial

08. Jose Antonio Moreno: Yu-Shiba-Rusinov states in 2H-$NbSe_{1.6}S_{0.4}$

09. Lea Pfaffinger: An LC-resonator technique for the investigation of the Berezinski-Kosterlitz-Thouless transition in strongly disordered superconductors

10. Zuzana Pribulová: Mo_8Ga_{41} - seemingly two-gap superconductor. Local Hall-probe magnetometry study

11. Gabriel Pristáš: T_C - enhancement in superconducting thin films under pressure

12. Peter Samuely: Extreme upper critical magnetic fields of $(LaSe)_{1.14}(NbSe_2)_{n=1,2}$ misfit dichalcogenides

13. Michal Kopčík: Zeeman driven superconductor insulator transition in strongly disordered MoC film. STM and transport studies in transverse magnetic field

09. Alexander Weitzel: An LC-resonator technique for the investigation of the Berezinski-Kosterlitz-Thouless transition in strongly disordered superconductors

14. Beilun Wu: Conductance quantization in atomic size contacts at very high magnetic fields

15. Irina Zajcewa: Transport properties of compressed $La_{1.952}Sr_{0.048}CuO_4$ thin films

POSTER SESSION II. - THURSDAY, June 29 - 17:00

16. Konstantin Yu. Arutyunov: Non-equilibrium and fluctuation phenomena in low-dimensional superconductors

17. Michal Babij: Physicochemical characterization of the $Gd_{3-x}Ca_xIr_4Sn_{13}$ single crystals

18. Július Bačkai: Superconducting phase diagrams of LuB_{12} and $Lu_{1-x}Zr_xB_{12}$ ($x \leq 0.45$) down to 50 mK

19. Martin Baránek: Complex conductivity of strongly disordered thin MoC superconducting films

20. Karol Flachbart: Penetration of magnetic field into superconducting YB_6 studied by an array of Hall probes and ac-calorimetry

21. Tamás Kalmár: NbTiN superconducting inductors in radio-frequency reflectometry

22. Zoltán Kovács-Krausz: Complex pressure response in thin nanodevices of Dirac semimetal $ZrTe_5$

23. Marek Kuzmiak: Experimental study of the superconductor - insulator transition in strongly disordered MoN ultrathin films

24. Tomáš Novotný: Phase-tunable Kondo effect in three terminal S-QD&N-S setups

25. Panch Ram: Escape rate problem in driven Josephson junctions

26. Gian Paolo Papari: Quantum interference in finite-size mesoscopic rings

27. Tamás Prok: Creating band gap and quantum point contacts in hBN encapsulated bilayer graphene

28. Nataliya Pugach: Magnonic control of superconductor - spiral magnet hybrid spin valve

29. Jazmin Aragón Sánchez: Non-Gaussian tail in the force distribution: a hallmark of correlated disorder in the host media of elastic objects

30. Hermann Suderow: Feedback driven Josephson effect in ultra small tunnel junctions

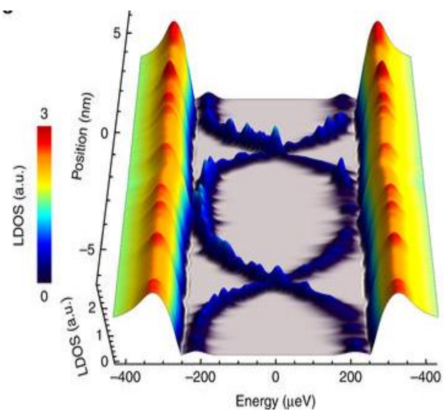
31. Lan Maria Tran: Basic physicochemical properties of GdFeAsO:Co single crystals

32. Jiawei Yan: Broadening of the in-gap-state energies at non-zero temperatures of the superconducting quantum dot: A Green’s function study

The COST Action Nanocohybri

The COST Action Nanocohybri is open to scientists from 27 European countries and collaborators all over the world. Nanocohybri kicked-off in November 2017 and will last until end of April 2021. Nanocohybri provides instruments for networking activities aimed to fulfil the objectives of the Action and managed using simple rules. Nanocohybri organizes approximately two meetings each year, promotes exchanges through short term visits and provides opportunities for young researchers to present work related to the Action in other meetings. The Management Committee approves activities following COST excellence and inclusiveness policy. All details, including time and budgetary frames as well as eligibility issues are available at the COST Vademecum.

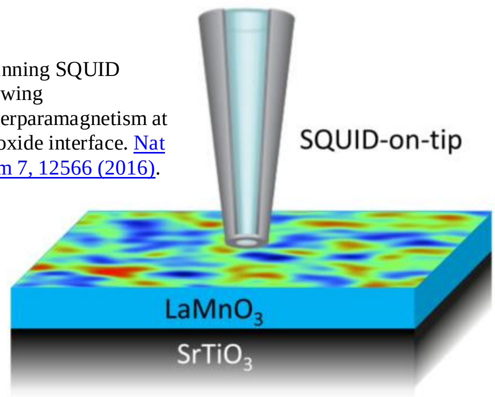
Nanocohybri is triggered by the amount of fundamental knowledge obtained in superconducting systems and the recently acquired ability to control magnetic flux, electron charge and spin in devices. Much of the topical research in this area is being carried out all over Europe in the subfields of low dimensional systems, hybrids between superconductors and magnets or semiconductors, and nanoscale engineering for current carrying applications. The scientific and methodological approaches in these fields are similar and there is an important potential for cross-fertilization. The challenge is to use the understanding achieved and control the main superconducting parameters in devices to produce radically new behaviour. The Action has three working groups:



Topological superconductivity in monolayer of Pb covering Co-Si islands, see Nat Comm 8, 2040 (2017).

NANOSCALE COHERENT HYBRID DEVICES FOR SUPERCONDUCTING QUANTUM TECHNOLOGIES

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY



Scanning SQUID showing superparamagnetism at an oxide interface. Nat Com 7, 12566 (2016).

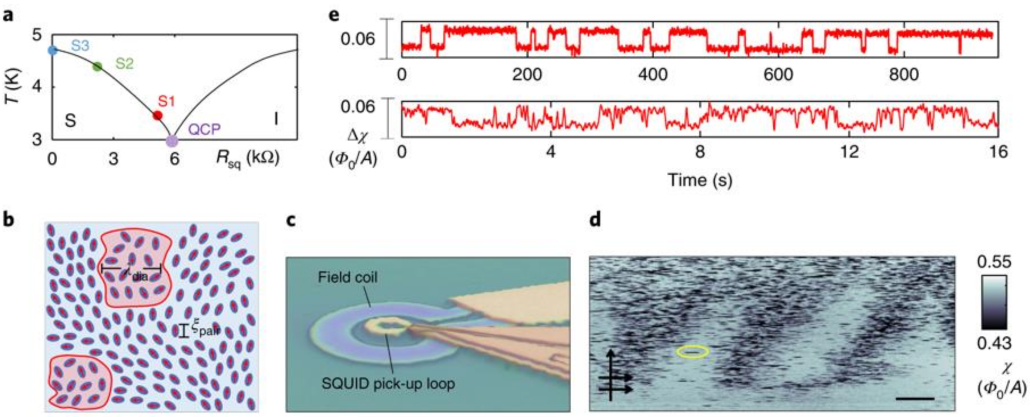
- Working group 1 (WG1). Low dimensional and hybrid systems. WG1 deals with two-dimensional and ultra-thin film superconductors. Nanofabrication techniques include lithography, controlled constrictions, exfoliation and systems capable to produce devices composed of layers of different materials. Characterization is made through photoemission spectroscopy, tunnelling microscopy, micro-Raman, quantum transport or ultrafast optics. New imaging techniques available at large-scale infrastructures (such as X-ray holography at synchrotron radiation sources) are also used. Theory analyses quantum transport from numerical studies using standard systems for superconductivity and ab-initio calculations. WG1 is lead by Brigitte Leridon.

- Working group 2 (WG2). Novel devices from hybrid interfaces. The involved groups aim to integrate materials where the Cooper pair wave function has a sign change into devices, for example cuprates or topological insulators and other materials with topologically non-trivial surface states into Josephson junction circuits. We also study superconductor/ferromagnetic hybrids in detail, looking at novel modulated phases. Techniques include microscopic bandstructure calculations and measurements of the Josephson effect using transport experiments. We use advanced microscopies, including SQUID-on-a-tip and magnetic force. WG2 is lead by Alexander I. Buzdin.

- Working group 3 (WG3). Hybrids with nanoscale vortex pinning and nanofabrication for high magnetic fields. We explore vortex pinning and current transport at low temperatures and high magnetic fields, in cuprate as well as in pnictide superconductors. We control fabrication techniques allowing to make pinning on demand and to study the collective behaviour of the vortex lattice in presence of patterned arrays of nanostructures. We also address the influence of structural or electronic distortions (such as nematicity), particularly close to quantum criticality, in the enhancement of superconducting parameters. Working methods include microscopy, correlated with transport calculations in superconductors, three-axis nanoSQUID and vortex manipulation. WG3 is lead by Dieter Kölle.

The Action's short term visits and conference grants are examined by a committee lead by Gleb Kakazei. The Action includes working groups responsible for dissemination (lead by Yonathan Anahory), collaboration with industrial partners (lead by Teresa Puig), gender monitoring (lead by Floriana Lombardi) and a virtual laboratory to promote exchanges among participants (lead by Daniela Stornaiolo).

Quantum fluctuations near criticality. Nat Phys (2018)



The Action started with a workshop entitled "Coherent superconducting hybrids and related materials", in March 2018 organized by Dimitri Roditchev and Brigitte Leridon. We continued by organizing a School on Quantum Materials and a workshop on vortex behavior in unconventional superconductors in Braga, Portugal, in October 2018. In February this year, Yonathan Anahory and Beena Kalisky organized a workshop on "Probing superconducting hybrids at the nanoscale" in Eilat, Israel. And in March, we organized, together with the COST SpinMol Action, a joint meeting entitled "Superconductivity meets molecular spins" in Lisbon. The Vortex 2019 meeting will likely be the largest meeting of the present grant period.

ABSTRACTS

REACHING THE ANDERSON LIMIT OF SUPERCONDUCTIVITY

S. Vlaic[1], T. Zhang[1], H. Aubin[1,2], S. Pons[1], A. Assouline[1], A. Zimmers[1], C. David[2],G. Rodary[2], J.–C. Girard[2], **Dimitri Roditchev**[1*]

[1]LPEM, ESPCI Paris, PSL Research University, CNRS, Sorbonne Universités, 10 rue Vauquelin, Paris, France
[2]Centre de Nanosciences et de Nanotechnologies, CNRS, Universités Paris-Saclay, C2N–Marcoussis, France

**Corresponding author: dimitri.roditchev@espci.fr*

How small can superconductors be? For isolated nanoparticles subject to quantum size effects, P.W. Anderson in 1959 conjectured that superconductivity could only exist when the electronic level spacing δ is smaller than the superconducting gap energy Δ. Here we report[1] a scanning tunneling spectroscopy study of superconducting lead (Pb) nanocrystals grown on the (110) surface of InAs. We find that for nanocrystals of lateral size smaller than the Fermi wavelength of the 2D electron gas at the surface of InAs, the electronic transmission of the interface is weak; this leads to Coulomb blockade and enables the extraction of electron addition energy of the nanocrystals. For large nanocrystals, the addition energy displays superconducting parity effect, a direct consequence of Cooper pairing. Studying this parity effect as a function of nanocrystal volume, we find the suppression of Cooper pairing when the mean electronic level spacing overcomes the superconducting gap energy, thus demonstrating unambiguously the validity of the Anderson criterion.

[1] Vlaic, Sergio; Pons, Stephane; Zhang, Tianzhen; et al. Physica C - Superconductivity and its applications 552, 34-37 (2018).
[2] Zhang, Tianzhen; Vlaic, Sergio; Pons, Stephane; et al. Phys. Rev. B 97, 21, 214514 (2018).
[3] Vlaic, Sergio; Pons, Stephane; Zhang, Tianzhen; et al. Nature Comm. 8, 14549 (2017).

SUPERCONDUCTOR-INSULATOR TRANSITION AND PAIR BREAKING

R. Hlubina*

Comenius University, Mlynská Dolina F2, 842 48 Bratislava, Slovakia

**Corresponding author: hlubina@fmph.uniba.sk*

In this talk I will review the recent studies of the homogeneously disordered superconductor MoC which were performed in collaboration of the Bratislava and Košice groups. I will start by showing that, when approaching the insulating state, robust quantum corrections to conductivity are present in this material from thermal up to optical frequencies [1], which are caused by the weak screening of Coulomb interactions among the electrons. I will also demonstrate how the combined knowledge of both the real and imaginary parts of the optical conductivity can be used to extract the absolute magnitude of such corrections, a task which can not be solved by any other means. Next I will argue that the quantum corrections suppress superconductivity and that this mechanism is directly observable by electron tunneling [2]. Finally I will demonstrate that the tunneling density of states in MoC is well described by the Dynes formula when the insulating state is approached [3]. I will also show that this formula can be derived microscopically in systems in which pair breakers with a broad distribution of pair breaking strengths are present, and I will summarize the recently developed comprehensive theory of Dynes superconductors [4]. Taken together, our results suggest that Cooper pairing in MoC is initially weakened by strong Coulomb interactions, but it is the pair-breaking processes which ultimately destroy superconductivity in this system. Since a finite concentration of pair breakers should be present in any real-world system, we believe that the discourse on the superconductor-insulator transition should take the old physics of pair breaking more seriously.

[1] P. Neilinger et al., Phys. Rev. B 100, 241106(R) (2019).
[2] B. Rabatin and R. Hlubina, Phys. Rev. B 98, 184519 (2018) and unpublished.
[3] P. Szabó et al., Phys. Rev. B 93, 014505 (2016).
[4] F. Herman and R. Hlubina, Phys. Rev. B 97, 014517 (2018) and references therein.

OBSERVATION OF QUANTUM CORRECTIONS TO CONDUCTIVITY OF DISORDERED MoC AND NbN FILMS UP TO OPTICAL FREQUENCIES

P. Neilinger[1*], S. Kern[1], J. Greguš[1], D. Manca[1], B. Grančič[1], M. Kopčík[2], P. Szabó[2], P. Samuely[2], R. Hlubina[1], M. Grajcar[1,3]

[1] Comenius University, Department of Experimental Physics, 842 48 Bratislava, Slovakia
[2]Slovak Academy of Sciences, Centre of Low Temperature Physics, Institute of Experimental Physics, Watsonova 47, 040 01 Košice, Slovakia
[3]Slovak Academy of Sciences, Institute of Physics, Dúbravská cesta, 845 11 Bratislava, Slovakia

**Corresponding author: pavol.neilinger@fmph.uniba.sk*

Thin disordered superconductors find a variety of applications in advanced quantum technologies, such as superconducting nanowire-based single-photon detectors, parametric amplifiers, and superconducting quantum bits. In spite of their broad applications, their high-frequency properties are not fully understood and there is a need for a robust characterization method of their electric properties, even in the normal state. The optical (i.e. frequency-dependent) conductivity of metals is, in the simplest case, given by the Drude formula. For strongly disordered conductors, deviations from this formula are well-known. Although theory predicts that their presence extends to much higher energies, these corrections are traditionally considered an esoteric low-energy phenomenon and have so far been experimentally proven only for <80 meV.

By a combination of transport and optical studies, we demonstrate that the quantum corrections are very robust in the strongly disordered MoC and NbN films, being present up to optical frequencies, thereby extending the experimental window where such corrections were found by a factor of 50 [1,2]. Knowledge of the real part of the optical conductivity - obtained from transport and optical transmission measurements, and the imaginary part of conductivity - obtained from optical ellipsometry, provides the means to identify the microscopic parameters of the conduction electron fluid and to determine the absolute magnitude of the quantum correction in the low temperature and frequency limit, which is currently not accessible in any other way.

This new methodology can be utilized to study other disordered conductors and can contribute to the understanding of their electronic properties close to the metal-insulator or superconductor – insulator transition and help to properly understand their superconducting properties.

1. P. Neilinger et al., Phys. Rev. B 100, 241106 (2019).
2. S. Kern et al., Phys. Rev. B 103, 134205 (2021).

ZEEMAN EFFECT IN HOMOGENEOUS, STRONGLY DISORDERED SUPERCONDUCTING MoC THIN FILMS

M. Kopčík,[1] **P. Szabó**,[1] M. Žemlička,[3] J. Kačmarčík,[1] P. Neilinger,[2] M. Grajcar[2] and P. Samuely[1]

[1]Centre of Low Temperature Physics, Institute of Experimental Physics, Slovak Academy of Sciences and P. J. Šafárik University, SK-04001 Košice, Slovakia
[2]Department of Experimental Physics, Comenius University, SK-84248 Bratislava, Slovakia

**Corresponding author: mkopcik@saske.sk*

Homogeneous, strongly disordered, superconducting MoC thin films were studied by means of scanning tunneling microscopy/spectroscopy and DC sheet resistance measurements at low temperatures. In perpendicular magnetic field the films transition to a bad metallic state with quantum corrections to conductivity. In tunneling spectra these corrections manifest as a dip in the density of states at the Fermi energy, which is emphasized when further increasing magnetic field. Transport measurements suggest the sample is paramagnetically limited which is corroborated by the tunneling measurements; signs of spectral splitting proportional to the magnetic field in the superconducting state. Combining the Cooper channel corrections of superconducting fluctuations (Aslamazov-Larkin, Maki-Thompson and density-of-states) in 2D and the Altshuler-Aronov diffusion channel interaction correction we demonstrate, for the first time, a remarkably accurate description of the resistance in the metallic state at low temperatures once spin splitting is accounted for in the diffusion channel correction. At the same time we are able to approximate the tunneling anomaly in the density of states using the Altshuler-Aronov model incorporating spin dependent electron-hole interaction.

THE UPPER CRITICAL FIELD AND THE SUPERCONDUCTOR-METAL TRANSITION IN ULTRATHIN NIOBIUM FILMS

Marta Z. Cieplak*, I. Zaytseva and A. Abaloszew

Institute of Physics, Polish Academy of Sciences, Al. Lotników 32/46, 02-668 Warszawa, Poland

**Corresponding author: marta@ifpan.edu.pl*

Recent studies suggests that in disordered ultrathin films superconducting (SC) state may be intrinsically inhomogeneous. Here we investigate the nature of SC state in ultrathin Nb films, of thickness d ranging from 1.2 nm to 20 nm, which undergo a transition from amorphous to polycrystalline structure at the thickness $d \simeq 3.3$ nm [1-3]. We show that the properties of SC state are very different in polycrystalline and amorphous films. The upper critical field (H_{c2}) is orbitally limited in the first case, while appears to be paramagnetically limited in the latter. The magnetic field induced superconductor-metal transition is observed, with the critical field approximately constant or decreasing as a power-law with the film conductance in polycrystalline or amorphous films, respectively. The scaling analysis indicates distinct scaling exponents in these two types of films. Negative contribution of the SC fluctuations to conductivity exists above H_{c2}, particularly pronounced in amorphous films, signaling the presence of fluctuating Cooper pairs. These observations suggest the development of local inhomogeneity in the amorphous films, in the form of proximity-coupled SC islands. On the decrease of temperature SC correlations in amorphous films evolve in anunusual fashion, suggesting the suppression of proximity-induced phase coherence by quantum fluctuations.

[1] I. Zaytseva, O. Abal'oshev, P. D lu_zewski, W. Paszkowicz, L. Y. Zhu, C. L. Chien, M. Konczykowski, and M. Z. Cieplak, Phys. Rev. B **90**, 060505 (2014).
[2] I. N. Demchenko, W. Lisowski, Y. Syryanyy, Y. Melikhov,I. Zaytseva, P. Konstantynov, M. Chernyshova, M. Z. Cieplak, Appl. Surf. Science **399**, 32 (2017).
[3] I. Zaytseva, A. Abaloszew, B. C. Camargo, Y. Syryanyy, and M. Z. Cieplak, Sci. Rep.**10**, 19062 (2020).

SUPERFLUID STIFFNESS AND RESISTANCE NEAR THE BEREZINSKI-KOSTERLITZ-THOULESS TRANSITION IN NbN THIN FILMS

A. Weitzel,[1] L. Pfaffinger,[1] T. Huber,[1] K. Kronfeldner,[1] L. Fuchs,[1] S. Linzen,[2] E. Ilichev,[2] N. Paradiso,[1] **C. Strunk,[1*]**

[1]*Institute for Experimental and Applied Physics, Regensburg University, D-93040 Regensburg, Germany*
[2]*Leibniz Institute of Photonic Technology, PO Box 100239, D-07702 Jena, Germany*

**Corresponding author: christoph.strunk@ur.de*

We investigate resistivity and kinetic inductance in ultra-thin NbN near the superconductor-insulator transition. Resistive transition is dominated by superconducting fluctuations of both amplitude and phase of the order parameter. Below the Maki-Thomson and Aslamasov-Larkin fluctuation regimes, the resistivity displays a square-root cusp divergence of the conductance expected for the Berezinski-Kosterlitz-Thouless (BKT) transition. At the same time, kinetic inductance (measured using an RLC-resonator technique) displays a sharp drop near the universal temperature T_{BKT}. Analysis of the quality factor of the resonator extends the range of the resistance measurement by several orders of magnitude and reveals saturation of the resistance, possibly resulting from finite size effects. Current voltage (*IV*) characteristics become non-linear below T_{BKT}, with a complex back-bending shape that signals a heating instability. In this regime, the *IV*-characteristics feature a peculiar negative curvature in a log-log representation, indicating a reduction of dissipation with respect to the standard power-law behavior of the *IV*-characteristics. This observation is corroborated by the observation of an unexpected increase of kinetic inductance with increasing dc current that signals a stimulation of superconductivity by the current.

INVESTIGATION OF THE 2-DIMENSIONAL VORTEX STATE IN AMORPHOUS SUPERCONDUCTING THIN FILMS

Pratap Raychaudhuri*

Tata Institute of Fundamental Research, Mumbai, India

**Corresponding author: pratap@tifr.res.in*

In this talk, I will describe our scanning tunneling spectroscopic imaging of the 2-dimensional vortex state in very weakly pinned amorphous MoGe thin films where we observe the existence of a variety of vortex liquid phases. I will show that a hexatic vortex liquid [1,2] phase that is extremely sensitive to electromagnetic perturbations [3,4] encompasses a large region of the H-T parameter space. Finally, spectroscopy of individual vortex cores reveals the presence of a soft gap, that can be explained from the zero-point quantum fluctuation of vortices [5].

[1] I. Roy et al., Phys. Rev. Lett. **122,** 047001 (2019).
[2] S. Dutta et al., J. Phys.: Condens. Matter **32**, 075601 (2020).
[3] S. Dutta et al., Phys. Rev. B **100**, 214518 (2019).
[4] S. Dutta et al., Physica C **578**, 1353740 (2020).
[5] arXiv:2102.12996

FRAGILE GLASS TRANSITION IN THIN SUPERCONDUCTING FILMS

I. Maccari[1*], L. Benfatto[2], C. Castellani[2], J. Lorenzana[2], C. De Michele[2], S.Dutta[3], P. Raychaudhuri[3], B. Pokharel[4], J. Terzic[4] and D. Popovic[4]

[1]*Department of Theoretical Physics, The Royal Institute of Technology, Stockholm SE-10691, Sweden*
[2]*Department of Physics and ISC-CNR, Sapienza University of Rome, P.le A. Moro 2, 00185 Rome, Italy*
[3]*Tata Institute of Fundamental Research, Homi Bhabha Rd, Colaba, Mumbai 400005, India*
[4]*National High Magnetic Field Laboratory, Florida State University, Tallahassee, FL 32310, USA*

**Corresponding author: ilariam@kth.se*

The melting transition in two dimensions can occur in two steps via an intermediate phase called “hexatic” phase. The 2D vortex lattice forming in type-II superconducting films is a paradigmatic system to study this two-step melting transition. In a recent work [1], by combining transport and STS imaging in amorphous MoGe, it has been shown that the hexatic state carries additional signatures in transport, with a rather strong suppression of the vortex diffusivity in the hexatic state as compared to the isotropic liquid. Here we use Monte Carlo simulations on the XY model in transverse field to study the dynamical behavior of the vortex lattice and to simultaneously characterize the solid phase via the superfluid stiffness. We show that, in analogy with previous work in soft colloids, a so-called heterogeneous dynamics emerges at the verge of the isotropic to the hexatic transition. In our case this manifest through a strong suppression of the diffusivity well reproduced by a Vogel-Fulcher-Tamman (VFT) law. The temperature T_0 where vortex diffusivity vanishes coincides with the temperature where a true solid phase is established, as characterized by a finite superfluid stiffness. These theoretical results are compared to recent magnetotransport measurements in thin MoGe films.

[1] I. Roy et al., Phys. Rev. Lett. 122, 047001 (2019).
[2] I. Maccari et al, preprint 2021

ENHANCING SUPERCONDUCTIVITY IN 2D MATERIALS BY BENEFICIAL DEFECTS

Milorad V. Milošević*

NANOlab Center of Excellence, University of Antwerp, Belgium

**Corresponding author: milorad.milosevic@uantwerpen.be*

In this talk, I will argue that selected lattice defects offer a highly promising route towards enhanced superconductivity in atomically-thin materials. To this end, I will discuss our recent density functional (perturbation) theory calculations of the electronic and vibrational properties of several representative 2D materials hosting impurities, as well as the *ab initio* results on the electron-phonon coupling and anisotropic Eliashberg calculations to accurately characterize the superconducting state. I will particularly focus on the example of hydrogen adatoms, which may greatly enhance the critical temperature (T_c) of various 2D superconductors, such as MgB_2 [1], borophene [2], as well as the newest elemental monolayer gallenene [3]. Another example is that of oxygen healing detrimental sulfur vacancies in transition metal dichalcogenides like TaS_2, thereby enhancing the electron-phonon coupling, resulting in a higher T_c [4].

[1] J. Bekaert *et al.*, Phys. Rev. Lett.**123**, 077001 (2019).
[2] Q. Li*et al.*, Science **371**, 1143 (2021).
[3] M. Petrov *et al.*, arXiv:2104.01031 (2021).
[4] J. Bekaert *et al.*,Nano Lett. **20**, 3808 (2020).

DETERMINING THE KINETIC INDUCTANCEOF NANOBRIDGES BY IMBEDDING THEM IN ASYMETRIC SQUIDS

H. Dausy, L. Nulens, B. Raes, M.J. Van Bael and **J. Van de Vondel***

Quantum Solid-State Physics, Department of Physics and Astronomy, KU Leuven, Celestijnenlaan 200D, B-3001 Leuven, Belgium

**Corresponding author: joris.vandevondel@kuleuven.be*

Superconducting nanobridges with large sheet resistances in the normal state can provide a large kinetic inductance. The unique properties of these high kinetic inductancenanobridges nanowires result in their application asscalable key elements ranging from single-photon detectors [1], to qubit readout and qubit architectures [2] or magneticmemories and sensors [3]. Despite the technical relevance and many applications of high kinetic inductancedevices, it is complicated to precisely measure the kinetic inductance value.

In this work, we study the current phase relation (CΦR) of lithographically fabricated molybdenum germanium (MoGe) nanobridges, which is intimately linked to the nanobridge kinetic inductance. We do this by imbedding the nanobridges in a SQUID. We observe that for temperatures far below Tc, the CΦR is linear as long as the condensate is not weakened by the presence of supercurrent. We demonstrate lithographic control over the nanobridge kinetic inductance, which scales with the nanobridge aspect ratio. This allows to tune the SQUID Ic(B) characteristics, including the SQUID sensitivity and the positions of the critical current maxima. These observations can be of use for the design and operation of future superconducting devices.

Acknowledgements: This work has been supported by the Research Foundation - Flanders (FWO, Belgium), with grant number G0B5315N.

[1] P.K. Day, et al., A broadband superconductingdetector suitable for use in large arrays. Nature,425817 (2003).
[2] J.E. Mooij, et al., .Josephson Persistent-CurrentQubit. Science, 2851036 (1999).
[3] J. Luomahaara, et al., Kinetic inductance magnetometer. Nature Communications, 54872 (2014).

TOPOLOGICAL TRANSITIONS IN SUPERCONDUCTOR NANOMEMBRANES UNDER A STRONG TRANSPORT CURRENT

R. O. Rezaev[1,2], E. I. Smirnova[1], O. G. Schmidt[1,3-5] and **V. M. Fomin[1,6,7*]**

[1]Institute for Integrative Nanosciences, Leibniz IFW Dresden, D-01069 Dresden, Germany
[2]Tomsk Polytechnic University, 634050 Tomsk, Russia
[3]Material Systems for Nanoelectronics, TU Chemnitz, D-09107 Chemnitz, Germany
[4]Research Center MAIN, TU Chemnitz, D-09126 Chemnitz, Germany
[5]Nanophysics, Faculty of Physics, TU Dresden, D-01187 Dresden, Germany
[6] Department of Physics and Engineering, Moldova State University, Chişinau MD-2009, Republic of Moldova
[7]National Research Nuclear University (MEPhI), 115409 Moscow, Russia

**Corresponding author: v.fomin@ifw-dresden.de*

Topological defects such as vortices and phase slips in a superconductor system manifest spatial patterns and dynamics that are closely associated with the geometric design in curved micro- and nanostructures of superconductors [1]. This study is motivated by the recent progress in fabrication of complex 3D nanoarchitectures (e.g., open nanotubes and nanohelices) by using the advanced 3D roll-up self-organization and nanowriting techniques based on focused ion beams. To simulate the superconducting properties of complex nanoarchitectures, a numerical platform has been developed based on a set consisting of the time-dependent Ginzburg-Landau equation coupled with the Maxwell equations. The topological transitions between vortex-chain and phase-slip transport regimes unveiled in curved superconductor nanostructures as a function of the applied magnetic field under a strong transport current [2] open up a possibility to efficiently tailor the superconducting properties of nanostructured materials by inducing a nontrivial topology of superconducting screening currents. We report on a topological transition between superconducting vortices and phase slips under a strong transport current in an open superconductor nanotube with a submicron-scale inhomogeneity of the normal-to-the-surface component of the applied magnetic field. When the magnetic field is orthogonal to the axis of the nanotube, which carries the transport current in the azimuthal direction, the phase-slip regime is characterized by the vortex/antivortex lifetime $\sim 10^{-14}$ s versus the vortex lifetime $\sim 10^{-11}$ s for vortex chains in the half-tubes, and the induced voltage shows a pulse as a function of the magnetic field. This non-monotonous behavior is attributed to the occurrence of a phase-slip area at such magnetic fields, when the quasi-stationary pattern of vortices changes from single to double chains in each half-turn, followed by reentrance of the superconducting state with a chain of moving vortices when the magnetic field further increases. A three-fold voltage peak occurs in an ultrathin open Nb tube of radius 400 nm at the magnetic field about 10 mT. The topological transition between the vortex-chain and phase-slip regimes determines the magnetic-field–voltage and current–voltage characteristics of curved SC nanomembranes to pursue high-performance applications in advanced electronics (e.g., as novel superconductor switching-based detectors) and quantum computing.

This work was supported by DFG project #FO 956/6-1, COST Action #CA16218 (NANOCOHYBRI), RFBR and Tomsk Region under the project #19-41-700004.

[1] V. M. Fomin, Self-rolled Micro- and Nanoarchitectures: Topological and Geometrical Effects, De Gruyter, Berlin-Boston (2021) 148 p.
[2] R. O. Rezaev, E. I. Smirnova, O. G. Schmidt andV. M. Fomin, Communications Physics 3 (2020) 144, 1-8.

TOPOLOGICAL NATURE AND THE ORDER OF TRANSITION BETWEEN THE GAP AND THE GAPPLESS STATESIN THE ABRIKOSOV-GOR'KOV THEORY

A.A. Varlamov[1*], Yuriy Yerin[1], and Caterina Petrillo[1]

[1]*CNR-SPIN, c/o Dipartimento DICII, Universitá "Tor Vergata", Viale del Politecnico 1, I-00133 Rome, Italy*
[2]*Dipartimento di Fisica e Geologia, Universitá degli Studi di Perugia, Via Pascoli, 06123 Perugia, Italy*

**Corresponding author: varlamov@ing.uniroma2.it*

It is demonstrated that the quantum phase transition between the gap and gapless superconducting m states in the Abrikosov-Gor'kov theory of superconducting alloy with paramagnetic impuritiesis of the Lifshitz type, i.e. of the $2\,{}^{1}\!/_{2}$ order. This phase transition has a topological nature and is characterized by the corresponding change of the topological invariant, namely the Euler characteristic. We study the stability of such a transition with respect to the spatial fluctuations of the magnetic impurities critical concentration n_s and show that the requirement for validity of its mean field description is unobtrusive: $\nabla \ln(n_s) \ll \xi^{-1}$(here ξ is the superconducting coherence length). Finally, we show that, similarly to the Lifshitz point, the $2\,{}^{1}\!/_{2}$ order phase transition should be accompanied by the corresponding singularities, for instance, the superconducting thermoelectric effect has a giant peak exceeding the normal value of the Seebeck coefficient by the ratio of the Fermi energy and the superconducting gap.

EVOLUTION OF ANDREEV BANDS IN SUPERCONDUCTING PERIODIC ANDERSON MODEL

V. Pokorný[1*] and P. Ram[2]

[1]*Institute of Physics, Czech Academy of Sciences, Na Slovance 2, 18221 Praha 8, Czech Republic*
[2]*Department of Condensed Matter Physics, Faculty of Mathematics and Physics, Charles University, Ke Karlovu 5, 12116 Praha 2, Czech Republic*

** Corresponding author: pokornyv@fzu.cz*

Two-dimensional systems where the surface of a superconductor is coated with a molecular layer draw recently a lot of attention as they represent ideal setups for studying the competition between magnetism and superconductivity. The physics of such system can be studied using the superconducting periodic Anderson model which describes a conduction band with superconducting (BCS) pairing hybridized with a non-dispersive band of correlated electrons. We use the dynamical mean-field theory to solve this problem by mapping the lattice model to the superconducting impurity Anderson model with a self-consistent bath. This method neglects spatial correlations between lattice sites while local quantum fluctuations are fully taken into account. We show the behavior of the in-gap Andreev bands and how the singlet-doublet (zero-pi) quantum phase transition in the local impurity model is reflected in the induced pairing in the correlated band.

HIGH-T_c CUPRATES – STORY OF TWO ELECTRONIC SUBSYSTEMS

Neven Barišić[1,2*]

[1]Institute of Solid State Physics, TU Wien, Wiedner Hauptstraße 8, 1040 Wien Austria
[2]Department of Physics, Faculty of Science, University of Zagreb, Bijenička cesta 32, HR-10000, Zagreb, Croatia

**Corresponding author: neven.barisic@tuwien.ac.at*

We have performed a thorough experimental study of $HgBa_2CuO_{4+\delta}$, which, in many respects, is a model cuprate compound. From the comparison of our measurements with data for other cuprates, we are able to separate universal behavior from compound-specific features. This exercise leads to a series of remarkable findings, the most important of which are that the effective mass and the scattering rate remain essentially unchanged across the phase diagram, and that the scattering rate is dominated by an umklapp process [1]. These novel insights enabled an accurate count of charges across the phase diagram [1,2]. The electronic system is thus found to consist of 1+p charges, where p corresponds to doping. At low dopings, within the pseudogap regime, exactly one hole is localized per planar copper-oxygen unit. Upon increasing doping and temperature, the hole is gradually delocalized and becomes itinerant. The overall behaviors are consistent with a gradual extension of Fermi arcs to a full Fermi surface, without an essential change of the underlying Fermi surface that encloses 1+p states. Finally, we have established that the itinerant Fermi-liquid holes become superconducting while the localized hole provides the glue [2].

[1] N. Barišić et al., New J. Phys. 21, 113007 (2019).
[2] D. Pelc et al., Sci. Adv. 5, eaau4538 (2019).

INCOHERENT TRANSPORT ACROSS THE STRANGE METAL REGIME OF OVERDOPED CUPRATES

J. Ayres* [1,2], M. Berben* [2], M. Čulo [2], Y.-T. Hsu [2], E. van Heumen [3], Y. Huang [3], J. Zaanen [4], T. Kondo [5], T. Takeuchi [6], J. R. Cooper [7], C. Putzke [1], S. Friedemann [1], A. Carrington [1], and N. E. Hussey [1,2]

[1]*H. H. Wills Physics Laboratory, University of Bristol, Tyndall Avenue, Bristol BS8 1TL, United Kingdom*
[2]*High Field Magnet Laboratory (HFML-EMFL) and Institute for Molecules and Materials, RadboudUniversity, Toernooiveld 7, 6525 ED Nijmegen, Netherlands*
[3]*Van der Waals-Zeeman Institute, University of Amsterdam, Postbus 94485, 1090 GL Amsterdam, Netherlands*
[4]*The Institute Lorentz for Theoretical Physics, Leiden University, PO Box 9506, 2300 RA Leiden, Netherlands*
[5]*Institute for Solid State Physics, University of Tokyo, Kashiwa-no-ha, Kashiwa, Japan*
[6]*Toyota Technological Institute, Nagoya 468-8511, Japan*
[7]*Department of Physics, University of Cambridge, Madingley Road, Cambridge, CB3 0HE, United Kingdom*

**Corresponding authors: jake.ayres@bristol.ac.uk, n.e.hussey@bristol.ac.uk*

Strange metals possess highly unconventional electrical properties, such as a linear-in-temperature (*T*) resistivity,[1,2] an inverse Hall angle[3,4] that varies as T^2 and a linear-in-field (*H*) magnetoresistance.[5,6] Identifying the origin of these collective anomalies has proved profoundly challenging, even in materials such as the hole-doped cuprates that possess a simple band structure. The prevailing dogma is that strange metallicity in the cuprates is tied to a quantum critical point at a doping *p** inside the superconducting dome.[7,8] Here, we study the high-field in-plane magnetoresistance of two superconducting cuprate families at doping levels beyond *p**. At all dopings, the magnetoresistance exhibits quadrature scaling and becomes linear at high *H/T* ratios, indicating that the strange metal regime extends well beyond *p**. Moreover, its magnitude is found to be much larger than predicted by conventional theory and is insensitive to both impurity scattering and magnetic field orientation. These observations, coupled with analysis of the zero-field and Hall resistivities, suggest that despite having a single band, the cuprate strange metal region hosts two charge sectors, one containing coherent quasiparticles, the other scale-invariant 'Planckian' dissipators.

[1] Custers, J. et al. The break-up of heavy electrons at a quantum critical point. Nature 424, 524-527 (2003).
[2] Legros, A. et al. Universal T-linear resistivity and Planckian dissipation in overdoped cuprates. Nature Phys. 15,142-147 (2019).
[3] Nakajima, Y. et al. Non-Fermi-liquid behavior in the magnetotransport of CeMIn 5 (M: Co and Rh): striking similarity between quasi-two-dimensional heavy fermion and high-T_c cuprates. J. Phys. Soc. Japan 76, 024703 (2007).
[4] Liu, R. H. et al. Anomalous transport properties and phase diagram of the FeAs-based $SmFeAsO_{1-x}F_x$ superconductors. Phys. Rev. Lett. 101, 087001 (2008).
[5] Hayes, I. M. et al. Scaling between magnetic field and temperature in the high-temperature superconductor $BaFe_2(As_{1-x}P_x)_2$. Nature Phys. 12, 916-919 (2016).
[6] Sarkar, T., Mandal, P. R., Poniatowski, N. R., Chan, M. K. & Greene, R. L. Correlation between scale-invariant normal-state resistivity and superconductivity in an electron-doped cuprate. Sci. Adv. 5, eaav6753 (2019).
[7] Keimer, B., Kivelson, S. A., Norman, M. R., Uchida, S. & Zaanen, J. From quantum matter to high-temperature superconductivity in copper oxides. Nature 518, 179-186 (2015).
[8] Michon, B. et al. Thermodynamic signatures of quantum criticality in cuprate superconductors. Nature 567, 218-222 (2019).

DIRECT VISUALIZATION OF CURRENT-STIMULATED OXYGEN MIGRATION IN $YBa_2Cu_3O_{7-\delta}$ THIN FILMS

S. Marinković[1,*], A. Fernández-Rodríguez[2], S. Collienne[1], S. Blanco Alvarez[1], S. Melinte[3], B. Maiorov[4], G. Rius[5], X. Granados[2], N. Mestres[2], A. Palau[2] and A.V. Silhanek[1]

[1]Experimental Physics of Nanostructured Materials, Q-MAT, CESAM, Université de Liège, B-4000 Sart Tilman, Belgium.
[2]Institut de Ciència de Materials de Barcelona, ICMAB-CSIC, Campus UAB, 08193 Barcelona, Spain.
[3]Institute of Information and Communication Technologies, Electronics and Applied Mathematics, Université catholique de Louvain, 1348 Louvain-la-Neuve, Belgium.
[4]Materials Physics and Applications Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, United States.
[5]Institute of Microelectronics of Barcelona (IMBCNM,CSIC), Campus UAB, 08193 Barcelona, Spain.

**Corresponding author: smarinkovic@uliege.be*

The past years have witnessed major advancements in all-electrical doping control on cuprates. In the vast majority of cases, the tuning of charge carrier density has been achieved via electric field effect by means of either a ferroelectric polarization or using a dielectric or electrolyte gating. Unfortunately, these approaches are constrained to rather thin superconducting layers and require large electric fields in order to ensure sizable carrier modulations. In this work, we focus on the investigation of oxygen doping in an extended region through current-stimulated oxygen migration in $YBa_2Cu_3O_{7-\delta}$ superconducting bridges [1]. The underlying methodology is rather simple and avoids sophisticated nanofabrication process steps and complex electronics. A patterned multiterminal transport bridge configuration allows us to electrically assess the directional counterflow of oxygen atoms and vacancies. Importantly, the emerging propagating front of current-dependent doping δ is probed in situ by optical microscopy and scanning electron microscopy. The resulting imaging techniques, together with photo-induced conductivity and Raman scattering investigations, reveal an inhomogeneous oxygen vacancy distribution with a controllable propagation speed permitting us to estimate the oxygen diffusivity. These findings provide direct evidence that the microscopic mechanism at play in electrical doping of cuprates involves diffusion of oxygen atoms with the applied current. The resulting fine control of the oxygen content would permit a systematic study of complex phase diagrams and the design of electrically addressable devices.

[1] S. Marinković et al. ACS Nano, 14 (2020) 11765.

TUNING THE PHASE DIAGRAM OF HTS BY STUDYING NMTHIN FILMS AND NANODEVICES

F. Lombardi[1*], E. Wahlberg[1], R. Arpaia[1,2], G. Seibold[3], E. Trabaldo[1], S. Caprara[4], U. Gran[5], L. Braichovich[2], G. Ghiringhelli[2], T. Bauch[1]

[1] *Quantum Device Physics Laboratory, Department of Microtechnology and Nanoscience, Chalmers University of Technology, SE-41296, Göteborg, Sweden*
[2]*Dipartimento di Fisica, Politecnico di Milano, I-20133 Milano, Italy*
[3]*InstitutfürPhysik, BTU Cottbus-Senftenberg - PBox 101344, D-03013, Cottbus, Germany*
[4]*Dipartimento di Fisica, Università di Roma "La Sapienza", P.le Aldo Moro 5, I-00185 Roma, Italy*
[5] *Division of Subatomic, High-Energy and Plasma Physics, Chalmers University of Technology, SE-41296, Göteborg, Sweden*

** Corresponding author: floriana.lombardi@chalmers.se*

The phase diagram of the high-T_c cuprate superconductors (HTS) is dominated by the "strange normal metal phase" that manifests in transport as a T-linear behaviour of the resistivity, at the optimal doping. This phase confined by a mysterious doping and temperature dependent pseudogap regime, characterized by various local orders and symmetry breaking states of which *Charge Density Waves* is the most prominent. The local orders are intertwined in a complex way and the consequences of the local arrangements of charge and spin on the transport properties of HTS devices remain to be clarified. Understanding the strange metal phase and how it is affected by the appearance of local orders is instrumental to disclose the mechanism for HTS:

We have developed YBCO nm thin films [1] and nanowires [2] where strain induced effects and reduced dimensionality allows to strongly modify the normal and superconducting state of the material. Using Resonant Inelastic X-ray Scattering we have discovered that the CDW is suppressed along the a-axis in nm YBCO thick films which has profound implications on the properties of nanodevices. We observe that a) the *T*-linear resistivity of underdoped nm thick YBCO films is restored [3], b) that the superconducting temperature onset is enhanced along the a-axis where CDW is suppressed and c) that the dynamics of phase slips phenomenon in nanowires become very different along the a-axis and b-axis (where CDW is still present). These effects demonstrate that strain control and nanoscale dimentions allow to manipulate the ground state of HTS which is crucial to get novel insights into the mechanism for high critical temperature superconductivity.

[1] R. Arpaia, E. Andersson … and FL Phys. Rev. Mater. 3, 114804 (2019); R. Arpaia, E. Andersson, E. Trabaldo, T. Bauch, and FL Phys. Rev. Mater 2, 024804 (2018).
[2] S. Nawaz, R. Arpaia T. Bauch and FL Phys. Rev. Lett. 110,167004 (2013).
[3] E. Walhberg, R. Arpaia ... T. Bauch and F. Lombardi arXiv:2009.08398 accepted in Science.

UNUSUAL INTERPLAY BETWEEN SUPERCONDUCTIVITY AND FIELD-INDUCED CHARGE ORDER IN $YBa_2Cu_3O_y$

J. Kačmarčík,[1,2,*] I. Vinograd,[3] B. Michon,[1,4] A. Rydh,[5] A. Demuer,[3] R. Zhou,[3] H. Mayaffre,[3] R. Liang,[6,7] W. Hardy,[6,7] D.A. Bonn,[6,7] N. Doiron-Leyraud,[4] L. Taillefer,[4,7] M.-H. Julien,[3] C. Marcenat,[8] and T. Klein[1]

[1]*Université Grenoble Alpes, CNRS, Grenoble INP, Institut Néel, F-38000 Grenoble, France*
[2]*Institute of Experimental Physics, Slovak Academy of Sciences, SK-04001 Košice, Slovakia*
[3]*Université Grenoble Alpes, INSA Toulouse, Université Toulouse Paul Sabatier, CNRS, LNCMI, F-38000 Grenoble, France*
[4]*Institut quantique, Département de physique & RQMP, Université de Sherbrooke, Sherbrooke, Québec J1K 2R1, Canada*
[5]*Départment of Physics, Stockholm University, AlbaNova University Center, SE-10691 Stockholm, Sweden*
[6]*Department of Physics and Astronomy, University of British Columbia, Vancouver, BC V6T 1Z1, Canada*
[7]*Canadian Institute for Advanced Research, Toronto, Ontario M5G 1M1, Canada*
[8]*Université Grenoble Alpes, CEA, INAC, PhELIQS, LATEQS, F-38000 Grenoble, France*

**Corresponding author: kacmarci@saske.sk*

We present a detailed study of the temperature (T) and magnetic field (H) dependence of the electronic density of states (DOS) at the Fermi level, as deduced from specific heat and Knight shift measurements in underdoped $YBa_2Cu_3O_y$. We find that the DOS becomes field independent above a characteristic field H_{DOS}, and that the $H_{DOS}(T)$ line displays an unusual inflection near the onset of the long-range 3D charge density wave order. The unusual S shape of $H_{DOS}(T)$ is suggestive of two mutually exclusive orders that eventually establish a form of cooperation in order to coexist at low T [1]. On theoretical grounds, such a collaboration could result from the stabilization of a pair-density wave state, which calls for further investigation in this region of the phase diagram.

[1] J. Kačmarčík et al., *Phys. Rev. Lett.* **121** (2018) 167002.

UNCONVENTIONAL VORTEX COMMENSURABILITY EFFECTS IN DENSE PINNING LANDSCAPES CREATED BY HE ION IRRADIATION OF YBCO THIN FILMS

W. Lang[1*], B. Aichner[1], M. Karrer[2], K. Wurster[2], G. Zechner[1], V. Misko[3,4], K. L. Mletschnig[1], M. Dosmailov[5], J. D. Pedarnig[5], F. Nori[4,6], R. Kleiner[2], E. Goldobin[2] and D. Koelle[2]

[1]Faculty of Physics, University of Vienna, Boltzmanngasse 5, A-1090 Wien, Austria
[2]Physikalisches Institut and Center for Quantum Science (CQ) in LISA⁺, UniversitätTübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany
[3]μFlow group, Department of Chemical Engineering, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
[4]Theoretical Quantum Physics Laboratory, RIKEN Cluster for Pioneering Research, Wako-shi, Saitama, Japan
[5]Institute of Applied Physics, JohannesKeplerUniversityLinz, Altenbergerstrasse 69, A-4040 Linz, Austria
[6]Physics Department, University of Michigan, Ann Arbor, Michigan48109, United States

**Corresponding author: wolfgang.lang@univie.ac.at*

Vortex commensurability effects have been thoroughly investigated in metallic superconductors with various kinds of periodic vortex pinning centers. However, these studies were limited to the weak magnetic coupling limit with pin spacings larger than the London penetration depth. In cuprate superconductors with their larger in-plane penetration depth unconventional vortex matching effects can be explored when they are patterned with dense pinning arrays created by masked or focused He^+ ion irradiation [1]. We report on the observation of a novel commensurability effect in the transverse vortex Hall signal [2]. Since the transverse voltage represents a non-dissipative contribution to vortex motion it represent a fundamentally different manifestation of commensurability effects. The Hall signal in a $YBa_2Cu_3O_{7-\delta}$ (YBCO) thin film with a square pinning array shows a remarkable peak at the matching field, which is comparable to the one observed in the critical current, and is accompanied by a polarity reversal of the Hall voltage.The results are discussed in relation to a vortex Mott insulator-to-metal transition with particle and hole like excitations. In ultradense kagomé-like pinning patterns fabricated in a helium ion microscope, a competition between vortex pinning and the elastic energy of the distorted vortex lattice leads to unusual matching effects, as revealed by transport measurements and molecular-dynamic simulations [3].

[1] B. Aichner, K. L. Mletschnig, B. Müller, M. Karrer, M. Dosmailov, J. D. Pedarnig, R. Kleiner, D. Koelle, W. Lang, Low Temp. Phys. **46** (2020) 331.
[2] G. Zechner, W. Lang, M. Dosmailov, M. A. Bodea, and J. D. Pedarnig, Phys. Rev. B **98** (2018) 104508.
[3] B. Aichner, B. Müller, M. Karrer, V. Misko, F. Limberger, K. L. Mletschnig, M. Dosmailov, J. D. Pedarnig, F. Nori, R. Kleiner, D. Koelle, and W. Lang, ACS Appl. Nano Mater., **2** (2019) 5108.

EMISSION OF TERAHERTZ TRANSIENTS FROM $La_{0.7}Sr_{0.3}MnO_3/YBa_2Cu_3O_{7-x}$ NANOBILAYERS EXCITED BY FEMTOSECOND OPTICAL PULSES

G. Chen,[1] L. Gładczuk,[2] P. Przysłupski,[2] I. Komissarov,[1] and **Roman Sobolewski**[1,3 *]

[1]*University of Rochester, RC Box 270231, Rochester, NY 14627-0231, USA*
[2]*Institute of Physics, Polish Academy of Sciences, AL. Lotników 32/46, PL-02668 Poland*
[3]*Institute of Electron Technology, AL. Lotników 32/46, PL-02668 Poland*

**Corresponding author: roman.sobolewski@rochester.edu*

Perovskite oxide materials possess a number of functionalities that are very interesting not only in the case of superconductivity, but also in spintronics. The latter include such properties as half-metallicity, mixed valence, colossal magneto-resistive effect, etc. In recent years, we have observed emergence of novel spintronic phenomena based the generation of pure spin currents through spin-orbit interaction in semiconducting and metallic systems. One of such examples is generation of sub-picosecond in duration (THz bandwidth) bursts of electromagnetic radiation at a ferromagnet/metal interface, when it is illuminated by femtosecond optical pulses [1]. The physics of this phenomenon is based on the inverse spin Hall effect. In this report, we present the very first studies on THz transient generation in $La_{0.7}Sr_{0.3}MnO_3/YBa_2Cu_3O_{7-x}$ (LSMO/YBCO) nanobilayers excited by 100-fs–wide, 800-nm wavelength optical pulses generated by a Ti:sapphire self-mode–locked, solid state laser. Both the LSMO manganite and LSMOYBCO nanobilayers were grown *in-situ*by high pressure sputtering on (100)lanthanum aluminate– strontium aluminium tantalite (commonly known as LSAT) substrates. The thickness of our LSMO films varied from 2.4 nm to 9.6 nm, and their Curie temperature was above 300 K. The thickness of YBCO films was 10 nm. Upon excitation by 100-fs optical pulses our all-oxide nanobilayers emitted at 300 K a small (below 1 mV in amplitude), but well resolved 1.1-ps–wide electromagnetic transients. The corresponding power spectrum extended above 3 THz. Results of low-temperature emissions of the THz transients including the case when YBCO is in the superconducting state, as well as comparative studies of LSMO/Auand LSMO/Ir systems will be presented.

[1] See, e.g., R. Adam, G. Chen, D. E. Bürgler, T. Shou, I. Komissarov, S.Heidtfeld, H.Hardtdegen, M. Mikulics, C. M. Schneider, and Roman Sobolewski, Appl. Phys. Lett. **114**, 212405 (2019).

MAGNETOCONDUCTANCE ACROSS $YBa_2Cu_3O_7$/GREPHENE HETEROJUNCTIONS

Humbert Vincent[1*], Kevin Seurre[1], David Perconte[1], Christian Ulysse[2], Anke Sander[1], Juan Trastoy Quintela[1], Bruno Dlubak[1], Pierre Seneor[1], Javier E. Villegas[1]

[1] *Unité Mixte de Physique, CNRS, Thales, Université Paris-Saclay, 91767, Palaiseau, France*
[2]*C2N, CNRS, Université Paris-Saclay, 91120* Palaiseau*, France*

** Corresponding author: vincent.humbert@cnrs-thales.fr*

Heterojunctions made of Dirac materials coupled with superconductors bear much fundamental interest and potential for novel superconducting electronic devices. Indeed proximity-induced superconductivity and Josephson coupling can be electrostatically tuned in these hybrid devices. Coupling with non-conventional superconductors, which have large superconducting gap and complex pairing symmetryfurther increases the interest of such heterojunctions asit opens the door to directional effects associated with the d-wave pairing and to superconducting devices operating above liquid nitrogen temperatures.

We have recently shown experimental evidence for proximity-induced d-wave superconductivity in CVD-grown graphene using planar graphene/$YBaCuO_{7-x}$ (YBCO) junctions. Such manifestation appears both in the conductance dependance with regard to the applied bias and Fermi-level tuning by a gate voltage [1,2].
Here we present magneto-conductance measurements performed at low temperature in this system by applying a magnetic field up to 1T. We find two striking effects. On the one hand, the superconducting-gap related features are progressively suppressed upon increasing the applied magnetic field. On the other hand, we find field-induced periodic oscillations of the conductance, observed only at energies below the superconducting gap. These findings will be discussed by considering the creation of superconducting vortices in the proximitized graphene, based on which we performed numerical simulations that can account for some of the observed behaviors.

[1] Perconte D., et al. "Tunable Klein-like tunneling of high-temperature superconducting pairs into graphene." *Nature Physics* 14.1 (2018).
[2] Perconte D., et al. "Long range propagation and interference of d-wave superconducting pairs in graphene." *Physical Review Letters* 125 (2020).

VORTEX MASS IN YBaCuO OBSERVED BY FAR-INFRARED MAGNETIC CIRCULAR DICHROISM

M. Šindler[1*], R. Tesař[1], J. Koláček[1], C. Kadlec[1], L. Skrbek[2] and P. Lipavský [2]

[1] *Institute of Physics, Academy of Sciences, Na Slovance 2, 182 21 Praha 8, Czech Republic*
[2] *Faculty of Mathematics and Physics, Charles University, Ke Karlovu 3, 12116 Prague 2, Czech Republic*

**Corresponding author: sindler@fzu.cz*

The resonance of far-infrared (THz) light with cyclotron motion of vortices provides a clue to estimating their effective mass. We present an experimental method of observing the magnetic circular dichroism in transmission of thin superconducting films threaded by Abrikosov vortices. We measure the transmissivity of nearly optimally doped YBa2Cu3O7−δ thin film as a function of temperature at several frequencies above the depinning frequency and below the optical gap. Our results confirm the dominant role of quasiparticle states in the vortex core and yield the diagonal fluxon mass of 2.4×10^8 electron masses per centimeter at 45 K and zero-frequency limit, and even larger off-diagonal mass of $5.3\times10^8 m_e$/cm.

DOPING-DEPENDENT COMPETITION BETWEEN SUPERCONDUCTIVITY AND POLYCRYSTALLINE CHARGE DENSITY WAVES IN LSCO THIN FILMS

S. Caprara[1], J. Lorenzana[1], M. Grilli[1] and **B. Leridon**[2,*]

[1]ISC-CNR and Department of Physics, Sapienza University of Rome, Piazzale Aldo Moro 2, I-00185, Rome, Italy
[2]LPEM, ESPCI Paris, CNRS, Université PSL, Sorbonne Universités, 10 rue Vauquelin, 75005 Paris, France

**Corresponding author: Brigitte.Leridon@espci.fr*

We report on a systematic analysis of high pulsed magnetic field resistance as function of magnetic field and temperature in a set of $La_{2-x}Sr_xCuO_4$ thin films with various doping level x. Our analysis highlights a competition between charge density waves and superconductivity which is ubiquitous between $x = 0.08$ and $x = 0.19$ and produces a double step transition. When suppressed by a strong magnetic field, superconductivity is resilient for two specific doping ranges centered around respectively $x \approx 0.09$ and $x \approx 0.19$ and the characteristic temperature for the onset of the competing charge density wave phase is found to vanish above $x = 0.19$. At $x = 1/8$ the two phases are found to coexist exactly at zero magnetic field [1]. A more precise analysis is performed at two specific doings $x = 0.08$ and $x = 0.09$, close to the superconductor/insulator transition and reveals phase diagrams that are highly consistent with a theoretical prediction, with an « avoided » quantum critical point and a low temperature filamentary superconducting phase well inside the domain of stability for CDW. This phenomenon carries some similarity with the super solid state of ^{4}He, for which it has been proposed that solid ^{4}He may acquire superfluid characteristics due to the frustration of the solid phase at the grain boundaries.

[1] S. Caprara, M. Grilli, J. Lorenzana, B. Leridon, SciPost Phys. 8, 003 (2020).
[2] B. Leridon, S. Caprara, J. Vanacken, V. Moshchalkov, B. Vignolle, R.Porwal, R. Budhani, A. Attanasi, M. Grilli and J. Lorenzana, New Journal of Physics, 22, 073025 (2020).

WANG-McDONALD VORTEX CORESTATES IN HEAVILY-OVERDOPED $Bi_2Sr_2CaCu_2O_{8+\delta}$

Ivan Maggio-Aprile*, Tim Gazdic, Christoph Renner

University of Geneva, 24 quai E.-Ansermet – 1211 Geneva - Switzerland

**Corresponding author: ivan.maggio-aprile@unige.ch*

The electronic signature of vortex cores in high-temperature cuprate superconductors has been challenging the scientific community for decades. Early experiments were suggesting that the cores in these materials were not matching the BCS expectations, one of the main argument being that the zero-bias conductance anomaly predicted for d-wave superconductors by Wang and MacDonald in 1995 [1] was absent. In 2016, we found that the previously reported subgap states in $YBa_2Cu_3O_{7-\delta}$ (Y123) were belonging to an electronic background uniformly measured across the surface [2], and could demonstrate that the vortex cores in Y123 do really present the expected BCS quasiparticle LDOS [3]. I will present here new scanning tunneling microscopy data [4] revealing that vortices observed at low magnetic field in heavily overdoped $Bi_2Sr_2CaCu_2O_{8+\delta}$do exhibit a clear d-wave electronic structure, with a zero-bias conductance peak at the vortex center that splits with increasing distance from the core. We show that previously reported unconventional electronic structures, including the low energy checkerboard charge order in the vortex halo and the absence of a zero-bias conductance peak at the vortex center, are direct consequences of short inter-vortex distance and consequent vortex-vortex interactions prevailing in earlier experiments.

[1] Y. Wang and A. H. MacDonald, Physical Review B 52, R3876 (1995).
[2] J. Bruer*et al.*, Nat. Commun. 7, 11139 (2016).
[3] C. Berthod*et al.*, Phys. Rev. Lett. 119, 237001 (2017).
[4] Tim Gazdic et al., arXiv:2103.05994, (2021).

VORTEX DYNAMICS IN HIGH MAGNETIC FIELD IN IRON-BASED SUPERCONDUCTING SINGLE CRYSTAL $BaFe_2(As_{1-x}P_x)_2$

A. Crisan[1*], A.M. Ionescu[1], L. Miu[1]

[1]National Institute of Materials Physics Bucharest,Magurele,Romania

**Corresponding author: acrisan652@gmail.com*

The discovery of iron-based superconductors (IBSs) has prompted great interest not only in their unconventional superconducting mechanism with high transition temperatures, but also in their potential for applications. The most attractive material for applications among various kinds of IBSs is the 122-type $(Ba,K)Fe_2As_2$. It has a high transition temperature T_c of ∼ 38 K for bulk, high upper critical field, H_{c2}(>700 kOe), and small anisotropy (γ<2).
We report on the DC magnetization, magnetic relaxation and multi-harmonic susceptibility response of very good quality $BaFe_2(As_{1-x}P_x)_2$ single crystals, in various conditions and cooling conditions. The AC measurements were performed using a PPMS equipment with DC fields up to 14 T, with ac field amplitude up to 15 Oe and frequency up to 1 kHz.DC measurements were performed using a DC SQUID MPMS in fields up to 9 T. We showed that isovalent optimally doped pnictide $BaFe_2(As_{0.68}P_{0.32})_2$ has a rich vortex phase diagram, with pronounced magnetic history effects. IN AC measurements, low AC field excitation leads to a Campbell regime while high AC field excitation leads to propagation of excitation deep in the crystal due to very weak pinning. We also clarified the relationship between the second magnetization peak (SMP) and the characteristic structural rhomb-to-square transition (RST) of the Bragg vortex glass in the fourfold symmetric superconductors. It was found that the (elastic) RST does not generate the SMP, but the RST can influence the pinning-dependent SMP onset field when this is close to the intrinsic RST line, through the appearance of a shoulder on the magnetic hysteresis *m*(*H*) curves [1].

[1] L. Miu, A.M. Ionescu, D. Miu, M. Burdusel, P. Badica, D. Batalu and A. Crisan,Sci. Rep., 10, (2020) 17274.

SUPPERSSION OF HYPERUNIFORMITY IN VORTEX MATTER IN TYPE-II SUPERCONDUCTORS IDUCED BY PLANAR DEFECTS

Joaquín Puig,[1] Federico Elías,[2] Jazmín Aragón Sánchez,[1] Raúl Cortés Maldonado,[1] Gonzalo Rumi,[1] Gladys Nieva,[1] Pablo Pedrazzini,[1] Alejandro B. Kolton,[2] and **Yanina Fasano**[1,*]

[1] Low Temperatures Lab & Instituto Balseiro, Centro Atómico Bariloche, Bariloche, Argentina
[2] Solid State Theory Group & Instituto Balseiro, Centro Atómico Bariloche, Bariloche, Argentina

**Corresponding author: yanina.fasano@cab.cnea.gov.ar*

Many biological, material and mathematical systems share the special property or hidden order of being hyperuniform, namely of presenting vanishing infinite-wavelength density fluctuations. This means that the density of the constituent objects is homogeneous in the large scale, as in a perfect crystal, although they can be isotropic and disordered like a liquid. This structural property can be affected by the type of disorder of the host medium where the objects are nucleated. Here we study experimentally and theoretically how planar correlated disorder in the medium affects the otherwise hyperuniform vortex structure nucleated at the surface of superconducting samples with weak point-like disorder. [1] Hyperuniform vortex structures present a structure factor that algebraically decays to zero when decreasing the reciprocal-space wave-vector **q** as a consequence of the suppression of vortex density fluctuations at large direct-space length-scales. We show that correlated disorder generated by planes of defects traversing the whole sample thickness destroys the hyperuniform hidden order of the structure. This particular type of disorder produces a structure factor that saturates for small **q** due to persisting vortex density fluctuations at large lengthscales. The originof this effect due to quenching a high-temperature vortex phase that nucleates at the planar defects and grows penetrating the rest of the sample when field-cooling the vortex structure is discussed both, experimentally and theoretically.

[1] *Hyperuniform vortex patterns at the surface of type-II superconductors*, Gonzalo Rumi, Jazmín Aragón Sánchez, Federico Elías, Raúl Cortés Maldonado, Joaquín Puig, Néstor René Cejas Bolecek, Gladys Nieva, Marcin Konczykowski, Yanina Fasano and Alejandro B. Kolton, Physical Review Research 1, 033057 (2019).

SUPERCONDUCTIVITY NEAR ROOM TEMPERATURE

M. I. Eremets*

Max Plamnck Institute for Chemistry, Mainz, 55128, Germany

Corresponding author: m.eremets@mpic.de

Superconductivity at ambient conditions is one of the most challenging and long-standing problems in condensed-matter physics. Recently, superconductivity at 203 K was discovered in H_3S at high pressure [1], breaking archaic paradigms on conventional superconductivity. In the last years, many other superconductors were discovered and T_c of ~250 K [2-4] was reached in a superhydride LaH_{10}. Even higher critical temperatures were predicted theoretically [5]. These record-breaking superconductors model atomic metallic hydrogen where high-temperature superconductivity was predicted 50 years ago [6, 7]. In this respect, I will show the most recent efforts on seeking the superconducting phase of pure hydrogen [8].

The progress towards room temperature superconductivity at moderate and ambient pressure is likely to be related to light-elements materials with strong covalent bonding.

[1] Drozdov, A.P., et al., *Conventional superconductivity at 203 K at high pressures.* Nature 2015. **525**: p. 73.
[2] Drozdov, A.P., et al., *Superconductivity at 250 K in lanthanum hydride under high pressures* Nature, 2019. **569** p. 528.
[3] Somayazulu, M., et al., *Evidence for Superconductivity above 260 K in Lanthanum Superhydride at Megabar Pressures.* Phys. Rev. Lett., 2019. **122** p. 027001.
[4] Flores-Livas, J.A., et al., *A perspective on conventional high-temperature superconductors at high pressure: Methods and materials.* Physics Reports, 2020. **856**: p. 1-78.
[5] Sun, Y., et al., *Route to a Superconducting Phase above Room Temperature in Electron-Doped Hydride Compounds under High Pressure.* Phys. Rev. Lett. , 2019. **123**: p. 097001.
[6] Ashcroft, N.W., *Hydrogen Dominant Metallic Alloys: High Temperature Superconductors?* Phys. Rev. Lett., 2004. **92**: p. 187002.
[7] Ashcroft, N.W., *Metallic hydrogen: A high-temperature superconductor?* Phys. Rev. Lett., 1968. **21**: p. 1748-1750.
[8] Eremets, M.I., et al., *Semimetallic molecular hydrogen at pressure above 350 GPa.* Nature Physics, 2019. **15** p. 1246.

HIGH-PRESSURE ONSET OF SUPERCONDUCTIVITY IN HYDRIDES

K. Shimizu[1*]

[1]*KYOKUGEN, Center for Science and Technology under Extreme Conditions, Graduate School of Engineering Science, Osaka University,1-3 Machikaneyama, Toyonaka, Osaka 560-8531, Japan*

**Corresponding author: shimizu@stec.es.osaka-u.ac.jp*

Not a few systems became superconductive under combination of low temperature and high pressure. We have focused simple elements for the candidate of superconductor and found that some elements exhibit relatively higher critical temperature, T_c at high pressure than at ambient. Lighter element is expected to show a higher T_c according to the conventional BCS theory. The example is hydrogen. The appearance of superconductivity at room temperature is predicted theoretically in the metallic phase [1]. However, experimental realization of metallic hydrogen has not yet been attained. The highest T_c in elements was found in compressed calcium [2] with 30 K at very high pressure exceeding 200 GPa. Recently, $T_c > 200$ K was reported in high-pressure phases of hydrides [3-5]. The crystal structure analysis, the detection of superconductivity, the synthesis pathway, etc. will be discussed.

This work was supported by JSPS KAKENHI Grant Number 20H05644.

[1] C. F. Richardson, N. W. Ashcroft, Phys. Rev. Lett. 78, 118 (1997).
[2] M. Sakata, et al., Phys. Rev. B 83, 220512 (2011).
[3] A. P. Drozdov, et al., Nature 525, 73 (2015).
[4] A. P. Drozdov, et al., Nature 569, 528 (2019).
[5] M. Somayazulu, et al., Phys. Rev. Lett. 122, 027001 (2019).

DEVELOPMENT OF ABINITIO MIGDAL-ELIASHBERG METHOD AND ITS APPLICATION TO SUPERCONDUCTING HYDRIDES

R. Arita[1,2*]

[1]*Department of Applied Physics, University of Tokyo, 7-3-1 Hongo Bunkyo-ku Tokyo 113-8656, Japan*
[2]*RIKEN Center for Emergent Matter Science, 2-1 Wako Hirosawa, Saitama 351-8656, Japan*

**Corresponding author: arita@riken.jp*

We formulate an efficient scheme to perform a Migdal-Eliashberg calculation considering the retardation effect from first principles. While the conventional approach based on the McMillan-Allen-Dynes formula introduces the empirical parameter μ^* (the pseudo Coulomb potential), we show that the intermediate representation of the Green's function [1] dramatically reduces the numerical cost and enables us to solve the linearized gap equation without using any empirical parameters [2]. We then apply this method to H_3S, LaH_{10}, and carbon-doped H_3S and calculated their superconducting transition temperatures (T_c's). We show that the calculated T_c's agree well with the experiments for H_3S and LaH_{10} [3,4,5,6,7]. While room temperature superconductivity has been reported for carbonaceous sulfur hydride [8], we show that the calculated T_c of carbon-doped H_3S is much lower than the experimental value [9].

[1] H. Shinaoka et al., Phys. Rev. B 96, 035147 (2017).
[2] T. Wang, Phys. Rev. B 102, 134503 (2020).
[3] A.P. Drozdov et al., Nature 525, 73 (2015).
[4] M. Somayazulu et al., Phys. Rev. Lett. 122, 027001 (2019).
[5] A.P. Drozdov et al., Nature 569, 528 (2019).
[6] W. Sano et al., Phys. Rev. B 93, 094525 (2016).
[7] I. Errea et al., Nature 578, 66 (2020).
[8] E. Snider et al., Nature 586, 373 (2020).
[9] T. Wang et al., arXiv:2014.03710.

PRESSURE EFFECT ON SUPERCONDUCTIVITY IN YB_6

S. Gabáni[1*], K. Flachbart[1], E. Gažo[1], M. Orendáč[1], G. Pristáš[1], P. Samuely[1], T. Mori[2], D. Braithwaite[3], M. Hanfland[4] and K. Kamenev[5]

[1]*Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, 04001 Košice, Slovakia*
[2]*National Institute for Materials Science, Namiki 1-1, 3050044 Tsucuba, Japan*
[3]*SPSMS, UMR-E, CEA, INAC, 17 Rue des Martyrs, 38054 Grenoble, France*
[4]*ESRF, 6 Rue Jules Horowitz, 38000 Grenoble, France*
[5]*Centre for Science at Extreme Conditions, University of Edinburgh, UK*

**Corresponding author: gabani@saske.sk*

Yttrium hexaboride YB_6 is known as a conventional type-II BCS superconductor with the second highest superconducting transition temperature (T_c < 8 K) among boron compounds after famous MgB_2 ($T_c \approx 40$ K). One of the explanations of this rather high T_c is the strong coupling of electrons with the dominant Einstein-like acoustic mode of Y ions at $\hbar\omega_E \approx 8$ meV [1]. The predicted [2, 3] and observed [4] fast initial decrease in T_c with pressure ($dT_c/dp \approx 0.55$ K/GPa) was attributed to the high Grüneisen parameter of this mode, $\gamma = -\partial \ln\omega_E / \partial \ln V \approx 9$ [2], which represents the change of the circular frequency ω_E with volume V (pressure). In order to contribute to the elucidation of the pressure effect on the Einstein-like mode, we have investigated the pressure effect on ω_E by Raman scattering up to 14 GPa. The analysis of our Raman spectra together with previous *ac*-susceptibility measurements of T_c under pressure up to 11 GPa as well as lattice parameter up to 32 GPa [5] are in accordance with the calculations [3] and provides new original information about the value of the electron–phonon coupling constant of YB_6 at ambient pressure, λ_0, and its change with pressure, $\lambda(p)$. The pressure effect on the λ calculated from the McMillan–Allen–Dynes expression for the superconducting transition temperature was determined to be $\partial \ln\lambda / \partial \ln V \cong 7.2$.

[1] P. Szabó et al., *Superconducting Science and Technology* **26** (2013) 045019.
[2] R. Lortz et al., *Physical Review B***73** (2006) 024512.
[3] Y. Xu et al., *Physical Review B***76** (2007) 214103.
[4] R. Khasanov et al., *Physical Review Letters* **97**(2006) 157002.
[5] S. Gabani et al., *Physical Review B***90** (2014) 045136.

SUPERCONDUCTIVITY IN TWISTED GRAPHENE STACKS

F. Guinea[1*,2]

[1]Imdea Nanoscience, Faraday 9, 28049 Madrid, Spain
[2]Donostia International Physics Center, Paseo Manuel de Lardizábal 4, 20018 San Sebastián, Spain.

**Corresponding author: paco.guinea@imdea.org*

The discovery of superconductivity and other electronic phases in twisted bilayer graphene has led to an intensive study of similar properties in other arrangements of two dimensional materials. These systems are based on structures on scales much larger than typical inter-atomic distances (moiré structures), and they provide a fascinating connection between microscopic and mesoscopic physics.
The origin of the unusual properties of twisted bilayer graphene, still not fully understood, is reviewed, with emphasis on new effects and interactions not encountered before in condensed matter physics. The similarities and differences with other materials with complex electronic phases will be emphasized.

TAILORING VORTEX PINNING AND SPIN TEXTURES IN HYBRID SUPERCONDUCTING-FERROMAGNETIC SYSTEMS

A. Palau[1*], A. Barrera[1], Jordi Alcalà[1], S. Martín[1], L. Balcells[1], M. Coll[1], N. Mestres[1], A. Palau[1]

[1]*Institut de Ciència de Materials de Barcelona (ICMAB-CSIC), Campus de la UAB, 08193 Bellaterra, Spain*

**Corresponding author: palau@icmab.es*

Today advances to store and analyze massive information offer huge opportunities and unprecedented benefits in business, healthcare, security, and society. The emergence of Internet of Things and Big-Data analysis offer major advantages but require to explore novel technologies for information storage and processing in a sustainable way.Multifunctional materials based on complex oxides offer unique opportunities to tune their magnetic or electric properties with multiple external inputs, thus providing the basis for realizing energy-efficient electronic devices. Among numerous outstanding properties of strongly correlated multifunctional oxides, superconducting cuprates are of special interest due to their inherent energy efficiency.
In this talk, I will present different strategies to design nanostructured high temperature $YBa_2Cu_3O_{7-x}$(YBCO) superconducting films, with local reversible carrier density modulation, able to create reconfigurable pinning landscapesfor fluxtronic device applications.Moreover, I will show that by combining YBCO with ferromagnetic structures in hybrid systems, one can manipulate magnetic textures, through superconducting stray fields or transport super-currents. Multiple volatile and non-volatile magnetic states with different magnetoresistance signal can be stabilized at remanence, and modified by applying small loss-less magnetic fields or currents. The proposed approaches open up new venues for energy-efficient information storage and manipulation [2].

[1] Palau et al. ACS Appl. Mater. Interfaces, 10 (2018)30531.
[2] Alcalà et al. Springer Nature Book, ed. By A. Gómezet al. Chapt. 6. (2021) (In press.); Rouco et al. Sci. Rep. 7 (2017)5663;A. Palau et al. Adv. Sci, 3 (2016)1600207.

HONEYCOMB LATTICE OF HEAVY METALS: EVIDENCE FOR TOPOLOGICAL EDGE STATES IN THE LAYRED MINERAL JACUTINGAITE

Konrád Kandrai[1], Péter Vancsó[1], Gergő Kukucska[2], János Koltai[2], György Baranka[1], Ákos Hoffmann[1], Áron Pekker[3], Katalin Kamarás[3], Zsolt E. Horváth[1], Anna Vymazalová[4], Levente Tapasztó[1] and **Péter Nemes-Incze**[1,*]

[1]Centre for Energy Research, Institute of Technical Physics and Materials Science, Budapest, Hungary
[2]ELTE EötvösLoránd University, Department of Biological Physics,Budapest, Hungary
[3]Wigner Research Centre for Physics, Institute for Solid State Physics and Optics, Budapest, Hungary
[4]Czech Geological Survey, Prague, Czech Republic

**Corresponding author: nemes@mfa.kfki.hu*

Quantum spin Hall (QSH) insulators are two-dimensional topological materials that have recently attracted tremendous interest, due to the promise of applications from low-power electronics to quantum computing. A major challenge in this field is the identification of large gap QSH materials, which would enable room temperature dissipationless transport in their edge states. Here we show that the layered mineral jacutingaite (Pt_2HgSe_3) realizes the QSH state, within the framework of the Kane-Mele model. Using scanning tunneling microscopy, we measure a band gap of 110 meV and identify the hallmark edge states at single layer steps on top of the bulk crystal. We identify the topological nature of the gap by calculating the $\mathbb{Z}_2$ invariant, using density functional theory. By scotch tape exfoliation, we prepare thin flakes of the material and show that it can be incorporated into heterostructures of 2D materials, using well established dry stacking techniques.

CORRELATED STATES IN MOIRÉ GRAPHENE SUPERLATICES

M.J. Calderón[1*]**,** A. Camjayi[2] and E. Bascones[1]

[1]*Instituto de Ciencia de Materiales de Madrid, ICMM-CSIC. Sor Juana Inés de la Cruz 3, 28049 Madrid (Spain).*
[2]*Universidad de Buenos Aires. Pabellón I, Ciudad Universitaria (1428) - C.A.B.A - Argentina*

**Corresponding author: mariaj.calderon@csic.es*

After the discovery of correlated insulating states in twisted bilayer graphene [1], similar phenomena have been searched in related graphene systems that form moiré lattices due to small twist angles or a small lattice mismatch. The nature of the insulating states, which appear at several integer fillings in the moiré lattice, is not clear yet.We have considered the case of the ABC graphene trilayer aligned with an underlying boron nitride (ABC/TLG-hBN) [2]. In this system, there is a single flat band whose shape and topology can be controlled by an electric field. Starting from a Wannier function representation of the effective moiré lattice [3] we have studied the nature of the correlated states, including the doping and field dependence, with special focus on their Mott character.

[1] Y. Cao et al, Nature 556, 43-50 (2018); ibid. 80-84 (2018).
[2] Chen et al, Nature Physics 15, 237 (2019). Chen et al, Nature 579, 56 (2020).
[3] Y-H. Zhang and T. Senthil, Phys. Rev. B 99, 205150 (2019).

A NOVEL PLATFORM FOR THE STUDY OF UNCONVENTIONAL PHENOMENA IN TUNNEL FERROMAGNETIC JOSEPHSON JUNCTIONS

H.G. Ahmad[1,2*], D. Massarotti[3,4], L. Di Palma[1], R. Satariano[1], R. Caruso[1,4], A. Miano[1], M. Minutillo[1], R. Capacelatro[1], G. Passarelli[1,4], L. Parlato[1,4], D. Montemurro[1], M. Arzeo[2], V. Brosco[5], A. Pal[6,7], P. Lucignano[1,4], G.P. Pepe[1,4], R. Fazio[8], M. G. Blamire[7], F. Tafuri[1,4]

[1]Dipartimento di Fisica "Ettore Pancini," Università degli Studi di Napoli Federico II, I-80125 Napoli, Italy
[2]SeeQC-eu, Via dei Due Macelli 66, 00187 Rome, Italy
[3]Dipartimento di Ingegneria Elettrica e delle Tecnologie dell'Informazione, Università degli Studi di Napoli Federico II, I-80125 Napoli, Italy
[4]Consiglio Nazionale delle Ricerche—SPIN, c/o Complesso Monte Sant'Angelo, via Cinthia, I-80126 Napoli, Italy
[5]Institute for Complex Systems, National Research Council, Via dei Taurini 19, 00185 Rome, Italy
[6]Department of Metallurgical Engineering and Materials Science, IIT Bombay, Mumbai 400076, India
[7]Department of Materials Science and Metallurgy, University of Cambridge,27 Charles Babbage Road, Cambridge CN30FS, United Kingdom
[8]International School for Advanced Studies (SISSA), Via Beirut 2-4, I-34014Trieste, Italy

**Corresponding author: halimagiovanna.ahmad@unina.it*

The coupling between the competitive superconducting and ferromagnetic order parameters in SFS Josephson junctions (JJs) is driving new fundamental physics and innovative applications in spintronics and superconducting electronics. In tunnel SFS JJs, the hysteretic magnetization of the F barrier and the low-dissipative transport mechanisms coexist, enlarging the integration of these systems also in high-coherent devices. We here discuss some exotic unconventional transport mechanisms in devices with both an insulating ferromagnetic barrier (SI_fS) [1, 2, 3, 4], or with multilayered insulating and ferromagnetic barriers (SIsFS) [5, 6, 7], including spin-triplet superconducting transport [8]. We also propose a novel platform for the study of the magnetization noise, the electrodynamics and the dissipation in these devices [9], which uses a hybrid ferromagnetic transmon qubit. The first step towards the implementation of such a novel device is searching for the best circuit designs, combinations of materials, and geometries.

[1] K. Senapati, M.G. Blamire, and Z.H. Barber, Nature Materials, 849 (2011).
[2] A. Pal, K. Senapati, Z.H. Barber, and M.G. Blamire, Advanced Materials, 25, 5581-5585 (2013).
[3] A. Pal, Z.H. Barber, J.W. Robinson, and M.G. Blamire, Nature Communications, 3340 (2014).
[4] D. Massarotti, A. Pal, G. Rotoli, L. Longobardi, M.G. Blamire, and F. Tafuri, Nature Communications, 7376 (2015).
[5] R. Caruso, D. Massarotti, V.V. Bolginov, A. Ben Hamida, L.N. Karelina, A. Miano, I. V. Vernik, F. Tafuri, V. V. Ryazanov, O. A. Mukhanov and G. P. Pepe, Journal of Applied Physics, 123 (2018).
[6] Loredana Parlato, Roberta Caruso, Antonio Vettoliere, Roberta Satariano, Halima Giovanna Ahmad, Alessandro Miano, Domenico Montemurro, Daniela Salvoni, Giovanni Ausanio, Francesco Tafuri, Giovanni Piero Pepe, Davide Massarotti, *and* Carmine Granata, Journal of Applied Physics (2020)
[7] R. Satariano, L. Parlato, A. Vettoliere, R.Caruso, H.G. Ahmad, A. Miano, L. Di Palma, D. Salvoni, D. Montemurro, C. Granata, G. Lamura, F. Tafuri, G.P. Pepe, D. Massarotti, G. Ausanio, under review in *Physical Review B* (2020)
[8] R. Caruso, D. Massarotti, G. Campagnano, A. Pal, H.G. Ahmad, P. Lucignano, M. Eschrig, M.G. Blamire, and F. Tafuri, Phys. Rev. Lett., 122 (2019).
[9] H.G. Ahmad, R. Caruso, A. Pal, G. Rotoli, G. P. Pepe, M.G. Blamire, F. Tafuri, and D. Massarotti, Phys. Rev. App., 13 (2020).

SELF-HEATING EFFECTS IN SNS Nb-HfTi-Nb sub-µm JOSEPHSON JUNCTIONS

J. Linek[1,*], R. Varga[1], K. Wurster[1], B. Müller[1], V. Morosh[2], T. Weimann[2], O.Kieler[2], R. Kleiner[1] and D. Koelle[1]

[1]*Physikalisches Institut and Center for Quantum Science (CQ) in LISA⁺, Universität Tübingen, Auf der Morgenstelle 14, 72076 Tübingen, Germany*
[2]*Department Quantum Electronics, PTB Braunschweig, Bundesallee 100, 38116 Braunschweig, Germany*

**Corresponding author: julian.linek@uni-tuebingen.de*

We report on sandwich-type Josephson junctions (JJs) based on the superconductor (S) Nb with a normal metal (N) HfTi barrier. Those offer very high critical current density j_c up to ~1 MA/cm², which provides the opportunity to strongly reduce their lateral size down to the deep sub-µm regime. Nanopatterning by electron beam lithography enables JJ dimensions and distances between different structures <100 nm. This offers, e.g., the possibility to realize advanced nanoSQUIDs [1]. Nb-HfTi-Nb JJs with moderate j_c at 4.2 K show non-hysteretic current-voltage characteristics (IVCs), which are well described by the "resistively and capacitively shunted junction" (RCSJ) model with negligible capacitance. However, upon decreasing operation temperature or increasing j_c, hysteresis in the IVCs appears, which is detrimental to SQUID operation.

The reported increased electron temperature in the barrier of Al-Cu-Al SNSJJs [2] and the resemblance of main features in the IVCs of our Nb-HfTi-NbJJs to those in constriction JJs, where hysteresis is explained by Joule heating, suggests a thermally induced hysteresis in SNSJJs. From measurements on JJs with various lateral size and j_c(adjusted by HfTi barrier thickness) at variable temperature, we determine and analyze the temperature T_H below which hysteresis appears. The good agreement of measured non-hysteretic IVCs with RCSJ simulations allows us to extract the dissipated Joule heat at the onset of hysteresis at T_H, which equals the heat flow out of the barrier. With this we are able to determine the temperature dependence of the thermal conductivities of the contributing heat-flow channels, under the simplification of one-dimensional heat flow. To test our model, cooper cooling fins were deposited on top of several JJs with different geometry. For the JJs where the Nb electrodes were expected to limit the thermal heat flow, a reduction of the hysteresis in the IVC was observed.

[1] M. J. Martínez-Pérez, D. Gella, B. Müller, V. Morosh, R. Wölbing, J. Sesé, O. Kieler, R. Kleiner, D. Koelle, ACS Nano, 10 (2016) 8308.
[2] H. Courtois, M. Meschke, J. T. Peltonen and J. P. Pekola, Phys. Rev. Lett., 101 (2008) 067002.

ENHANCED SUPERCONDUCTING PROPERTIES IN HYBRID NANOJUNCTIONS

D. Montemurro[1,2,3], D. Golubev[4], T. Bauch[1], F. Tafuri[2] and F. Lombardi[1]

[1]Quantum Device Physics Laboratory, Microtechnology and Nanoscience, Chalmers University of Technology, SE-41296, Göteborg, Sweden
[2]University of Naples Federico II, Department of Physics "E.Pancini", 80126, Naples, Italy
[3]Consiglio Nazionale delle Ricerche – SPIN, c/o Complesso Monte Sant'Angelo, via Cinthia, I- 80126, Napoli, Italy
[4]QTF Centre of Excellence, Department of Applied Physics, Aalto University, 00076 Aalto, Finland

**Corresponding author: floriana.lombardi@chalmers.se and domenico.montemurro@unina.it*

Hybrid superconducting systems composed of different materials with complementary functionalities have intensively investigated looking towards their fundamental properties and possible applications [1,2]. We show the developed fabrication procedure useful for making hybrid nanojunctions and discuss the used model for interpreting their transport properties. Our results underline the role that the interfaces play in such system and how the superconducting correlations properties of the barrier enhance the superconducting properties of the junction. The developed technology opens up to the integration of superconductors with a wide class of materials [3,4,5].

[1] F. Tafuri; Fundamentals and Frontiers of the Josephson Effect, Springer (2019).
[2] A. Barone and G. Paternò; Physics and Applications of the Josephson Effect. Wiley, (1982).
[3] Naomi Mizuno et al., 4, 2716 Nat. Com. (2013).
[4] D.Montemurro et al., Jour. of Super. and Nov. Mag. 28,3429 (2015).
[5] G.Kunakova et al., Nanoscale, 10, 19595 (2018).

DETECTION OF SINGLE MICROWAVE PHOTONS USING HYBRID GRAPHENE BOLOMETER

P. Hakonen[1*]

[1]*QTF Centre of Excellence, Department of Applied Physics, Aalto University, POB 15100, 00076 Aalto, Finland*

**Corresponding author: pertti.hakonen@aalto.fi*

Bolometers operating at low temperatures are promising for detection of itinerant microwave photons and for use in qubit readout. They benefit from a broad detection bandwidth and from low dissipation to the environment, especially in the case of graphene. However, single-microwave-photon sensitivity has been unattainable so far. To address this issue, we have experimentally demonstrated an ultrafast bolometer utilizing a hybrid SNS thermometer, a graphene Josephson junction, embedded into a high-Q microwave cavity[1]. Graphene, with its extraordinary thermal properties, offers the opportunity to reach the single-microwave-photon regime. Our device yields a noise equivalent power of 30 $zW/Hz^{1/2}$ at a thermal time constant of 500 ns and an extracted energy resolution of h×30 GHz.

We acknowledge funding from the European Research Council under Advanced Grant number 670743 (QuDeT), under Consolidator Grant number 681311 (QUESS), the European Commission through the H2020 programme project QMiCS, the Academy of Finland through its Centres of Excellence Programme and grants, the Finnish Cultural Foundation and the Vilho, Yrjö and Kalle Väisälä Foundation of the Finnish Academy of Science and Letters.

[1] R. Kokkoniemi, J.-P. Girard, D. Hazra, A. Laitinen, J. Govenius, R. Lake, I. Sallinen, V. Vesterinen, M. Partanen, J. Tan, K. W. Chan, K. Y. Tan, P. Hakonen and M. Möttönen, *Bolometer operating at the threshold for circuit quantum electrodynamics*, Nature **586** (2020) 47.

ELECTROMAGNETIC LONG RANGED PROXIMITY EFFECT IN SUPERCONDUCTOR-FERROMAGNET STRUCTURES

A. Buzdin[1*], S. Mironov[2], A. Melnikov[2] and Zh. Devizorova[3]

[1]*University of Bordeaux, LOMA UMR-CNRS 5798, F-33405, France*
[2]*Institute for Physics of Microstructures, RAS, 603950 Nizhny Novgorod, Russia*
[3]*Moscow Institute of Physics and Technology, 141700 Dolgoprudny, Russia*

Corresponding author: alexandre.bouzdine@u-bordeaux.fr

The spread of the Cooper pairs into the ferromagnet in proximity-coupled superconductor - ferromagnet (SF) structures is shown to cause a strong inverse electrodynamic phenomenon, namely, the long-range transfer of the magnetic field from the ferromagnet to the superconductor. Contrary to the previously investigated inverse proximity effect resulting from the spin polarization of superconducting surface layer, we found a very generic orbital mechanism of the magnetic moment transfer from a ferromagnet to a superconductor, which is unavoidable in S/F hybrids. It is related with the fact that the common superconducting wave function in S and F (near the interface) does not permit to exclude the vector-potential of the magnetization by gauge transformation. From the experimental point of view, this phenomenon reminds the Aharonov-Bohm effect since the current inside the attached superconductor is induced by the ferromagnetic layer, which cannot create the magnetic field in theoutside in the absence of such superconducting environment. At the same time, the true physical key point is that the wave function penetrating the ferromagnet is responsible for this effect. Let us stress that the characteristic length of the proposed inverse electrodynamic effect is of the order of the London penetration depth.

SPIN PUMPING PHENOMENA ON YBCO/Py HYBRID SYSTEMS

S. J. Carreira[1*], D. Sanchez Manzano[2], M.-W. Yoo[1], K. Seurre[1], V. Rouco[2], A. Sanders[1], J. Santamaria[2] and J. E. Villegas[1]

[1]*Unité Mixte de Physique, CNRS, Thales, Université Paris-Saclay, 91767, Palaiseau, France*
[2]*Grupo de Física de Materiales Complejos (GFMC). Dpto. de Física de Materiales. Facultad de Ciencias Físicas, UCM. Plaza Ciencias, 1 28040, Madrid, Spain.*

** Corresponding author:* santiago.carreira@cnrs-thales.fr

Spin-pumping from ferromagnets into superconductors has been experimentally studied in ferromagnet/superconductor hybrids, both in pioneering [1] and in more recent work [2], by combining soft metallic ferromagnets like Py and s-wave superconductors. However, the spin injection by spin pumping into d-wave superconductors like $YBa_2Cu_3O_7$ (YBCO) has not been experimentally explored so far despite its fundamental interest, since the presence of zero-gap nodes should expectedly provide channels for spin injection and opens a path to different interfacial physics. Here we study spin pumping effects in Py/YBCO bilayers grown on $SrTiO_3$ (001) and $NdGaO_3$ (110) substrates, via ferromagnetic resonance measurements using a coplanar waveguide. The main goal is unraveling the effect of the superconductivity on the spin conductance into YBCO. This is evaluated indirectly, by analyzing the spin dynamics changes suffered by the Py across the superconducting critical temperature T_c. Regardless of the substrate used, we found that the magnetic damping of Py decreases across the superconducting transition of the YBCO [3]. This feature suggests that spin singlet superconductivity and the superconducting gap in YBCO tends to inhibit spin injection. We also found that the spin pumping efficiency within the superconducting state shows distinct features associated with the gap anisotropy of YBCO, which are a direct consequence of zero-gap nodes for particular directions in the momentum space. Besides showing the fingerprint of d-wave superconductivity in spin-pumping, our results demonstrate the potential of high-temperature superconductors for fine tuning of the magnetization dynamics in ferromagnets using k-space degrees of freedom of d-wave/F interfaces.

[1] K-R Jeon,C. Ciccarelli, A. J. Ferguson, H. Kurebayashi, L. F. Cohen, X. Montiel, M. Eschrig, J. W. A. Robinson and M. G. Blamire, Nat. Mater., 17 (2018) 499–503.
[2] L. Frangou, G. Forestier, S. Auffret, S. Gambarelli, and V. Baltz, Phys. Rev. B, 95 (2017) 054416.
[3] S. J. Carreira, D. Sanchez Manzano, K. Seurre, V. Rouco, A. Sanders, J. Santamaria and J. Villegas, (2020) arXiv:2009.03196.

SPIN RELAXATION IN SUPERCONDUCTING GRAPHENE FUNCTIONALIZED BY MAGNETIC IMPURITIES – INTERPLAY OF RESONANCES AND YU-SHIBA-RUSINOV STATES

D. Kochan[1*],M. Barth[1], A. Costa[1], K. Richter[1] and J. Fabian[1]

[1]*Institute for Theoretical Physics, University of Regensburg, 93040 Regensburg, Germany*

**Corresponding author: denis.kochan@ur.de*

Employing analytical methods and quantum transport simulations we investigate the relaxation of quasiparticle spins in single and bilayer graphene proximitized by an s-wave superconductor in the presence of resonant magnetic and spin-orbit active impurities [1]. Off resonance, the relaxation increases with decreasing temperature when electrons scatter off magnetic impurities—the Hebel-Slichter effect—and decreases when impurities have spin-orbit coupling. This distinct temperature dependence (not present in the normal state) driven by the superconducting coherence uniquely discriminates between the two scattering mechanisms. However, we show that the Hebel-Slichter picture breaks down at resonances that take into account higher order scattering effects. The emergence of Yu-Shiba-Rusinov bound states within the superconducting gap strongly redistributes the spectral weight away from magnetic resonances and causes a significant departure from the conventional Hebel-Slichter scenario. Our findings hold for generic s-wave superconductors with resonant magnetic impurities, but also, for resonant magnetic Josephson junctions and bilayer graphene.

[1] D. Kochan, M. Barth, A. Costa, K. Richter and J. Fabian, Phys. Rev. Lett.**125**, 087001 (2020).

SUPERCURRENT DETECTION OF MAJORANA FERMIONS IN NANOWIRE JUNCTIONS

O. Awoga[1], J. Cayao[1] and **A. M. Black-Schaffer**[1*]

[1]*Department of Physics and Astronomy, Uppsala University, Box 516, S-751 20 Uppsala, Sweden*

**Corresponding author: annica.black-schaffer@physics.uu.se*

In a short superconducting nanowire junction formed by a nanowire with strong spin-orbit coupling, we report the emergence of zero-energy states not only in the form of topologically protected Majorana fermions but also in the trivial phase when applying a magnetic field. The trivial zero-energy states appear due to the superconducting leads inducing a large energy shift in the nanowire, such that the junction naturally forms a quantum dot. The dot formation process is highly tunable by the width of the superconducting leads. While both the trivial and topological phases host zero-energy states, we find that only the trivial zero-energy states produce π-shift in the phase-biased supercurrent, which can thus be used as a simple tool to unambiguouslydistinguish them from Majorana fermions.

[1] O. Awoga, J. Cayao, and A. M. Black-Schaffer,Phys. Rev. Lett.,123 (2019) 117001.

DISTINGUISHING TRIVIAL AND TOPOLOGICALLY ZERO-ENERGY STATES IN JOSEPHSON JUNCTIONS

J. Cayao*

Department of Physics and Astronomy, Uppsala University, Box 516, S-751 20 Uppsala, Sweden

**Corresponding author: jorge.cayao@physics.uu.se*

In this talk I will discuss the emergence of zero-energy states in phase-biased junctions made of nanowires with Rashba spin-orbit coupling. In particular, I will show that supercurrents and critical currents allow the identification of the topological origin of such zero-energy states [1,2], going beyond standard tunnel spectroscopy experiments, while offering further tunability by virtue of the Josephson effect.

[1] O. A. Awoga, J. Cayao, A. M. Black-Schaffer, Phys. Rev. Lett. 123, 117001 (2019).
[2] J. Cayao, A. M. Black-Schaffer, arXiv:2011.10411 (2020).

YU-SHIBA-RUSINOV BANDS IN HYDROGENATED BORON-DOPED DIAMOND

T. Samuely[1*], G. Zhang[2], O. Onufriienko[1], A. Volodin[3], N. Iwahara[3], L. F. Chibotaru[3], V. V. Moshchalkov[3], P. Szabó[1], and P. Samuely[1]

[1]*Centre of Low Temperature Physics, IEP SAS & FS UPJŠ in Košice, Slovakia*
[2]*NanoSYD, MCI & DIAS, University of Southern Denmark, Sonderborg, Denmark*
[3]*INPAC, TNG & LSSPM, KU Leuven, Belgium*

**Corresponding author: tomas.samuely@upjs.sk*

In our earlier experiments on boron-doped polycrystalline diamond with hydrogenated surfaces, we discovered microscopically local coexistence of superconductivity and ferromagnetism. [1] Our more recent investigations of the local density of states, backed by theoretical modelling, indicate that the mechanism behind this startling coexistence of the two commonly antagonistic phenomena is the hybridization of Yu-Shiba-Rusinov states into bands. [2]

[1] G. Zhang, T. Samuely et al., ACS Nano 11 (2017) 5358.
[2] G. Zhang, T. Samuely et al., Sci. Adv. 6 (2020) eaaz2536.

ANDREEV MOLECULE IN PARALLEL InAs NANOWIRES

Olivér Kürtössy[1], Zoltán Scherübl[1], Gergő Fülöp[1], Thomas Kanne[2], Jesper Nygard[2], **Péter Makk[1*]** and Szabolcs Csonka[1]

[1]Department of Physics, Budapest University of Technology and Economics and Nanoelectronics 'Momentum' Research Group of the Hungarian Academy of Sciences, Budafokiút 8, 1111 Budapest, Hungary
[2]Center for Quantum Devices, Niels Bohr Institute, University of Copenhagen, 2100 Copenhagen, Denmark

**Corresonding author: makk.peter@ttk.bme.hu*

Coupling individual atoms via tunneling fundamentally changes the state of matter: electrons bound to atomic cores become delocalized resulting in a change from an insulating to a metallic state. A chain of atoms could lead tomore exotic states if the tunneling takes place via the superconducting vacuum and can inducetopologically protected excitations like Majorana or parafermions.Toward the realization of suchartificial chains, coupling a single atom to the superconducting vacuum is well studied, but thehybridization of two sites via the superconductor was not yet reported. The peculiar vacuum of theBCS condensate opens the way to annihilate or generate two electrons from the bulk resulting ina so-called Andreev molecular state.
Recently, InAs nanowire became the most promising platform to realize novel superconducting qubit concepts like Andreev-qubits, Gatemons, or Majorana box qubit. In our work, we demonstrate for the first time strong hybridization between two Andreev states via superconductor link between [1].The strong coupling of artificial atoms was achieved using a novel nanostructure, where parallel InAs nanowires are connected by an epitaxially grown superconducting link [2]. Besides the characterization of the spectrum of the Andreev molecule, we also present a minimal model, which reproduces the outlined attributes of the novel molecular state.

[1] D. Indolese, R. Delagrange, P. Makk et al., Phys. Rev. Lett., 121, 137701 (2018).
[2] S. Zihlmann, P. Makk et al., Phys. Rev. B. 7, 075419 (2019).
[3] L. Wang, ... P.Makk, et al., Nano Lett., 19, 2371 (2019).
[4] S. Zihlmann, ... , P. Makk, Phys. Rev. B., 7, 075434 (2019).

SUPERFLUID 3He-B AND MAGNONIC ANALOGUE OF BLACK/WHITE HORIZON

Peter Skyba*

Institute of Experimental Physics, SAS, Watsonova 47, 04001 Košice, Slovakia

**Corresonding author: skyba@saske.sk*

We present experimental results of an application of the superfluid 3He-B as a model system simulating a magnonic analogue of the black/white hole horizon. As an experimental and model tool simulating the properties of the black/white horizon we used the spin-precession waves propagating on the background of the spin super-currents between two Bose-Einstein condensates of magnons in form of homogeneously precessing domains. We describe experiment and provide experimental evidence of the white hole formation for spin precession waves in this system, together with observation of an amplification effect. Moreover, the estimated temperature of the spontaneous Hawking radiation in this system is about four orders of magnitude lower than the system's background temperature what makes it a promising tool to study the effect of spontaneous Hawking radiation.

2nd QUANTUM REVOLUTION

Vladimír Bužek*

Research Center for Quantum Information, Slovak Academy of Sciences, Bratislava

**Corresponding author: vladimir.buzek@savba.sk*

In my talk I will introduce an emergent field of quantum (information) technologies. After a brief historical introduction I will elucidate the transformative potential of quantum technologies with a specific emphasis on quantum key distribution (QKD). Specifically, I will describe in some detail basic principles of the QKD, the present state of the art and the Vienna-Bratislava QKD link. I will conclude my talk with a short presentation of existing quantum initiatives in Europe and the immediate plans within the Horizon Europe.

UNCONVENTIONAL SUPERCONDUCTIVITY AND 2X2 CHARGE DENSITY WAVE IN $(LaSe)_{1.14}(NbSe_2)_2$

T. Cren[1*]

[1]Institut des NanoSciences de Paris, CNRS & Sorbonne Université, 4 placeJussieu, 75251 Paris, France

**tristan.cren@sorbonne-universite.fr*

It has been recently predicted that dichalcogenides could be a plateform for generating non-conventionnal topological superconductivity, with either a chiral phase that break time reversal symmetry or a mixture of s-wave and f-wave order parameter that preserves time reversal symmetry. In order to look for uncconventionnal superconductivity we have studied the compound $(LaSe)_{1.14}(NbSe2)_2$which is a misfit transition metal dichalcogenide of the $NbSe_2$ family consisting in an alternation of 2H- $NbSe_2$ blocks and LaSe insulating monolayers. The presence of large spin orbit interaction due to the 4d electrons of Nb atoms combined with the broken inversion symmetry of the system give rise to spin-momentum locking in the out of plane direction that is favorable for unconventional pairing. We will show that the intercalated LaSe monolayers induce a huge charge transfer shifting $NbSe_2$ monolayer Fermi energy (E_F) by ~300meV. This charge transfer modifies the charge density wave (CDW) and seems to lead to possibly topological f-wave superconductivity.

EXTREMLY DOPED BULK $NbSe_2$ SYSTEM IN THE MISFIT LAYERED COMPOUND $(LaSe)_{1.14}(NbSe_2)$

Ondrej ŠOFRANKO[1, 2*], Raphaël T. LERICHE[3], Alexandra PALACIO-MORALES[3,4], Marco CAMPETELLA[3], Cesare TRESCA[3], Christophe BRUN[3], François DEBONTRIDDER[3], Pascal DAVID[3], Matteo CALANDRA[3,9,10], Tristan CREN[3], Shunsuke SASAKI[5], Laurent CARIO[5], Imad ARFAOUI[6], Geoffroy KREMER[7], Claude MONNEY[7], Thomas JAOUEN[7,8], Jozef HANIŠ[11], Martin GMITRA[11], Marek KUZMIAK[1], Pavol SZABO[1], Jozef KAČMARČÍK[1], Peter SAMUELY[1], Tomáš SAMUELY[2]

[1] *Centre of Low Temperature Physics, Institute of Experimental Physics Slovak Academy of Sciences, 04001 Košice, Slovakia*
[2] *Centre of Low Temperature Physics, Faculty of Science P. J. Šafarik University 04001 Košice, Slovakia*
[3] *Institut des NanoSciences de Paris, Sorbonne Université and CNRS-UMR 7588 Paris 75005, France*
[4] *Laboratoire de Physique des Solides Université Paris-Saclay and CNRS UMR8502 Orsay 91405, France*
[5] *Institut des Matériaux Jean Rouxel Université de Nantes and CNRS-UMR 6502 Nantes 44322, France*
[6] *Monaris, Sorbonne Université and CNRS-UMR 8233 Paris 75005, France*
[7] *Département de Physique and Fribourg Center for Nanomaterials Université de Fribourg Fribourg CH-1700, Switzerland*
[8] *Univ Rennes CNRS IPR (Institut de Physique de Rennes) - UMR 6251 Rennes F-35000, France*
[9] *Department of Physics University of Trento Provo 38123, Italy*
[10] *Graphene Labs Fondazione Istituto Italiano di Tecnologia Via Morego, Genova I-16163, Italy*
[11] Department of Theoretical Physics and Astrophysics, P. J. Šafárik University, 04001 Košice, Slovakia

**Corresponding author: sofranko@saske.sk*

Misfit layered compounds (MLCs) where quasi-quadratic atomic layer(s) are alternating with quasi hexagonal one(s) while incommensurate host a plethora of various properties. MLCs offer a large variety of possible compounds and degrees of tunability, e.g. the number of comprising layers or substitutions can continuously change doping levels. Also bulk superconductivity of MLCs can be tuned, e. g. 3D – 2D superconducting transition can be achieved by inserting more SnSe layers between $NbSe_2$ layers and thus $NbSe_2$ superconducting layers become decoupled [1]. Large anisotropy of B_{c2} is observed in few cases and in-plane B_{c2} can be significantly higher than upper Pauli limiting magnetic field [2,3]. Moreover, extremely high doping levels can be achieved via charge transfer between layers, and this might lead to rigid band shift not achievable by other means. In the cases of $(LaSe)_{1.14}(NbSe_2)_{n=1,2}$ this leads to a change of charge density wave order parameter and superconducting critical temperature in comparison with pure bulk 2H-$NbSe_2$ [4]. Also, the bulk samples exhibit 2D superconductivity and the in-plane critical magnetic field is strongly enhanced. In this work we present observation of extremely rigid band shifted $NbSe_2$ bulk system doped by LaSe layers in the $(LaSe)_{1.14}(NbSe_2)$ compound. Observed doping levels lead to $NbSe_2$ becoming insulating and LaSe layer becoming superconducting, yet keeping 2D character and features reminiscent of Ising superconductivity.

[1] M. Trahms *et al.*, Supercond. Sci. Technol. **31**, 065006 (2018).
[2] H. Bai *et al.*, Mater. Res. Express **7**, 16002 (2019).
[3] J. Kačmarčík *et al.*, Phys. B Condens. Matter **284**–**288**, 961 (2000).
[4] R. T. Leriche *et al.*, Adv. Funct. Mater. **31**, 2007706 (2020).

PERSPECTIVES OF PROXIMITY EFFECTS IN TRANSITION-METAL DICHALCOGENIDES AND THEIR HETEROSTRUCTURES

M. Gmitra[1*]

[1]Institute of Physics, P. J. Šafárik University in Košice, Slovakia

**Corresponding author: martin.gmitra@upjs.sk*

Spin-momentum locking in transition-metal dichalcogenides (TMDC) has footing in numerous optical, excitonic, transport effects and superconductivity due to Ising-pairing. Proximity effects allows to shape novel materials. Graphene on semiconducting TMDCs opens new venues for optospintronics [1] and provides route for exploring topological edge states [2,3]. Carbon nanotubes on superconducting $NbSe_2$ could be a platform for quantum computing with Majorana fermions. In the talk we discuss first-principles electronic structure of TMDC, their heterostructures and induced spin-orbit coupling proximity effects. We discuss the orbital and spin-orbital proximity effects in 1T-TaS_2. 1T-$TaS_2$is a layered TMDC showing metal-insulator transition and the sequence of different charge density wave (CDW) transformations [4]. We present electronic band structures of graphene on 1T-TaS_2 in normal state and for periodic lattice distorted David star pattern providing commensurate CDW phase. A fascinating finding is that induced proximity effects in graphene on 1T-TaS_2 are significantly influenced by the presence of the commensurate CDW in 1T-TaS_2. We also discuss electronic structure and charge doping effects in $NbSe_2$ within misfit structures $(LaSe)_{1.14}NbSe_2$ and their consequence on observed superconductivity.

The work is supported by the VEGA 1/0105/20.

[1] M. Gmitra, J. Fabian, Phys. Rev. B 92 (2015) 155403; K. Zollner, M. Gmitra, J. Fabian, Phys. Rev. Lett. 125 (2020) 196402.
[2] M. Gmitra, D. Kochan, P. Hogl, J. Fabian, Phys. Rev. B 93 (2016) 155104.
[3] T. Frank et al., Phys. Rev. Lett. 120 (2018) 156402.
[4] I. Lutsyk et al., Phys. Rev. B. 98 (2018) 195425.

SUPERCONDUCTING QUANTUM INTERFERENCE IN TWISTED VAN DER WAALS HETEROSTRUCTURES

L. Farrar[1], Aimee Nevill[1], Zhen Jieh Lim[1], G. Balakrishnan[2], Sara Dale[1] and **S. Bending[1*]**

[1]Department of Physics, University of Bath, Claverton Down, Bah BA2 7AY, UK
[2]Department of Physics University of Warwick, Coventry CV4 7AL, UK

**Corresponding author: s.bending@bath.ac.uk*

It is well established that a dissipationless supercurrent can flow across a dielectric tunnel barrier between two superconducting electrodes due to the Josephson effect. In this talk I will describe recent progress in forming both Josephson junctions and SQUIDs using a dry transfer technique to stack and deterministically misalign flakes of the van der Waals superconductor $NbSe_2$ [1, 2]. The Josephson dynamics of the resulting twisted $NbSe_2$-$NbSe_2$ junctions are foundto be sensitive to the misalignment angle of the crystallographic axes allowing control of the hysteresis in I-V characteristics. A single lithographic step has been used to shape junctions into SQUID geometries with typical loop areas of ~25 μm^2. These devices display strong I_c oscillations as a function of applied magnetic field with large stable current and voltage modulation depths. The single crystalline structure of these 2D SQUID structures, along with their low defect densities, may offer circuit components with superior performance, e.g., as qubits.

[1] N. Yabuki, R. Moriya, M. Arai, Y. Sata, S. Morikawa, S. Masubuchi and T. Machida, *Nat. Commun.* **7** (2016)10616.
[2] Liam S. Farrar *et al*., Superconducting Quantum Interference in Twisted van der Waals Heterostructures, arXiv preprint (2021) arXiv:2101.04557.

ARTIFICIAL HEAVY FERMIONS IN A VAN DER VALLS HETEROSTRUCTURE

V. Vaňo[1], M. Amini[1], S. C. Ganguli[1], G. Chen[1], J. L. Lado[1*], S. Kezilebieke[1] and P. Liljeroth[1**]

[1]*Department of Applied Physics, Aalto University, FI-00076 Aalto, Finland*

**Corresponding author: jose.lado@aalto.fi*
***Corresponding author: peter.liljeroth@aalto.fi*

Interaction between localized magnetic moments and conduction electrons leads to the well-known Kondo effect. In the case of a Kondo lattice, localized magnetic moments need to be treated collectively and quasiparticles with heavy effective mass arise. The heavy fermion systems represent one of the paradigmatic strongly correlated states of matter with complex collective ground states. They host a wide range of emergent phenomena such as quantum criticality, unconventional superconductivity or non-Fermi liquid behaviour. This intriguing phenomenology has so far only been realized in compounds containing rare-earth elements with 4f or 5f electrons. Here, we present a designer approach, where heavy fermions emerge by creating a vertical heterostructure of two vdW materials, one of them metallic and other one containing localized magnetic moments. This is the first reported 2d heavy fermion system, in which a lattice of magnetic moments and conduction electrons come from different materials. The vertical heterostructure of 1T- and 1H-$TaS_2$is studied using scanning tunneling microscopy and spectroscopy. Depending on the stacking order of the monolayers, we can either reveal the localized magnetic moments and the associated Kondo effect, or the conduction electrons with a heavy-fermion hybridization gap.Our experiments realize an ultimately tuneable platform for future experiments probing enhanced many-body correlations, dimensional tuning of quantum criticality, and unconventional superconductivity in two-dimensional artificial heavy-fermion systems.

BAND STRUCTURE AS A FUNCTION OF THE MAGNETIC FIELD STUDIED WITH VERY LOW TEMPERATURE STM

F. Martín-Vega[1*], R. Sánchez-Barquilla[1], B.Wu[1], E. Herrera[1], H. Suderow[1], J.J. Baldoví[2], M. Ochi[3], R. Arita[4], N.H. Jo[5,6], S.L. Bud'ko[5,6] and P.C. Canfield[5,6], G. Knebel[7], J.P. Brison[7], J. Flouquet[7], D. Aoki[7,8], I. Guillamón[1]

[1]Laboratorio de Bajas Temperaturas y Altos Campos Magnéticos, Unidad Asociada (UAM/CSIC), Departamento de Física de la Materia Condensada, Instituto Nicolás Cabrera and Condensed MatterPhysics Center (IFIMAC), Universidad Autónoma de Madrid, Cantoblanco, E-28049 Madrid, Spain
[2]Instituto de Ciencia Molecular (ICMol),Universitat de València,Catedrático José Beltrán Martínez n° 2,Paterna 46980, Spain
[3]Department of Physics, Osaka University, Toyonaka, Osaka 560-0043, Japan
[4]RIKEN Center for Emergent Matter Science, Wako, Saitama 351-0198, Japan
[5]Ames Laboratory, U.S. DOE, Iowa State University, Ames, Iowa 50011, USA Japan
[6]Department of Physics and Astronomy, Iowa State University, Ames, Iowa 50011, USA
[7]Univ. Grenoble Alpes, CEA, Grenoble INP, IRIG, PHELIQS, F-38000 Grenoble, France
[8]IMR, Tohoku University, Oarai, Ibaraki, 311-1313, Japan

** Corresponding author: francisco.martin@uam.es*

Scanning tunneling microscopy (STM) provides atomic scale measurements and spectroscopy (STS).In systems with defects, scattering provides quasiparticle interference, from which we can obtain the bandstructure of filled and empty states. An important advantage with respect to techniques like angular resolved photoemission is that quasiparticle interference STS can be performed as a function of the magnetic field and at very low temperatures.
The latter aspect allows to study the bandstructure with a huge resolution in energy and thus to resolve correlation effects. Furthermore, the surface itself is of great interest in systems with bulk band gaps in a topological bandstructure, because it is thought to host topologically protected edge states. Recent results on the thermodynamic properties of heavy fermion systems, such as the U based heavy fermion superconductors, $YbRh_2Si_2$ or the$CeRu_2Si_2$ family of compounds, have shown that there could be important magnetic field induced changes in the bandstructure. But there are no direct measurements of the magnetic field dependence of the bandstructure. Here we investigate the system $Ce(Ru_{0.92}Rh_{0.08})_2Si_2$. Rh doping allows for neat measurements of the bandstructure through quasiparticle interference. We directly show the opening of a hybridization gap due to the antiferromagnetic order at zero field and characterize all the magnetic field induced modifications of the hybridization gap. The quantum phase transition between antiferromagnetic and paramagnetic states can be associated to magnetic field induced shifts in the bandstructure. The Kondo hybridization gap remains open in the paramagnetic phase. We furthermore discuss induced ferromagnetism at high magnetic fields. Finally, we will also discuss results on surface states in the type-II Weyl semimetal WTe_2.

QUANTUM CONFINEMENT OF HEAVY ELECTRONSIN URu_2Si_2

E. Herrera[1*], I. Guillamón[1], V. Barrena[1], J. A. Galvis[2], W. Herrera[3], A. Levy[4], D. Aoki[5], J. Flouquet[5] and H. Suderow[1],

[1]*Laboratorio de Bajas Temperaturas y Altos Campos Magnéticos, Unidad Asociada UAM-CSIC, Departamento de Física de la Materia Condensada, Instituto Nicolás Cabrera and Condensed Matter Physics Center (IFIMAC), Universidad Autónoma de Madrid, E-28049 Madrid, Spain*
[2]*Facultad de Ingeniería y Ciencias Básicas, Universidad Central, Bogotá 110311, Colombia*
[3]*Departamento de Física. Universidad Nacional de Colombia. Sede Bogotá. 111321 Bogotá, Colombia*
[4]*Departamento de Física Teórica de la Materia Condensada, Instituto Nicolás Cabrera and Condensed Matter Physics Center (IFIMAC), Universidad Autónoma de Madrid, E-28049 Madrid, Spain*
[5] *Institut Nanosciences et Cryogénie, SPSMS, CEA-Grenoble, 17 rue des Martyrs, 38054 Grenoble, France*

**Corresponding author: edwin.herrera@uam.es*

URu_2Si_2 is a heavy fermion system which crystalizes in a tetragonal structure and where superconductivity (T_c = 1.5K) emerges inside the mysterious hidden order phase (HO). The latter consists of a still unknown type of order that appears together with a strong entropy reduction below 17.5 K. The electronic properties of the HO phase are characterized by a hot spot at q_1 = (0.6,0,0) and a gap along the c-axis due to a Fermi surface reconstruction. Here I will show recent Scanning Tunneling Microscopy experiments (STM) at very low temperatures (0.1 K). I will report on the discovery of a 1D charge modulation with a wavevector that is a moiré combination of the atomic lattice periodicity and q_1 [1]. Furthermore, I will show results at vicinal surfaces with large amounts of small atomically flat steps. There we find a new heavy fermion 2D-electron gas with an effective mass 17 times the free electron mass. I will discuss lateral quantization of 2D heavy electrons, the interaction of confined electrons with bulk superconductivity, and the behavior at atomic size defects and at steps.

[1] E. Herrera, et. al., 1D charge density wave in the hidden order state of URu_2Si_2, Communications Physics (Accepted Jan 2021) arXiv:2003.07881v2.

G-M CRYO-COOLED SUPERCONDUCTING MAGNET FOR 1.5 T MRI APPLICATION; DESIGN, MANUFACTURE AND PERFORMANCE TESTS; ADVANCES AND CHALANGES

Ali Gencer[a,b*]

[a]*Ankara University, Science Faculty, Phys. Dept., 06100-Tandogan- Ankara, Turkey*
[b]*Ankara University, Center of Excellence for SUperconductivity Research, (CESUR), 06830- Golbasi-Ankara, Turkey*

**Corresponding author:* Ali.Gencer@science.ankara.edu.tr

One of the most versatile applications of Superconductivity is by no means Magnetic Resonance Imaging (MRI), which has become one of the most established and important usable equipment for medical diagnosis of some life threatening diseases for the last 40 years. Technology has become more advanced with many sophisticated functionalities over the recent times. However, the need to use liquid helium (LHe) to cool down the superconducting magnet to the required low temperatures has become one of the most obstacles as the liquid helium prices have risen recently to a highly unaffordable price range in addition to the other cumbersome issues like availability to be mentioned in the presentation. Conduction cooling and portable use of some specialty MRI systems have become more popular with flexible use of advantages to meet the demands of patients in need of sophisticated diagnosis and treatment. In this paper, a conduction-cooled superconducting magnet system with an operating current of 164.1 A was designed to obtain a sustainable field of 1.5 T with the required homogeneity supply for more than 1 hour 20 minutes with much sufficient time than the needed scan time. The magnet was designed, manufactured and tested for some possible potential MRI applications. The superconducting magnet consists of 3 coils wound by using NbTi superconducting multi-filamentary wires on with co-axial Oxygen free Copper (OFC) former with the dimensions of 422 mm long and 102 mm ID with a room temperature bore of 60 mm. The coils were installed with a high thermal shield in a very high-vacuumed cryostat. A two stage G-M Crycooler with a cooling power of 1 W at 4 K in the second stage and 65 W in the first stage at 50 K to cool the whole system to the temperatures around 4 K from the room temperature. In this paper, design details, manufacturing, materials, instrumentation and thermal analysis in addition to the performance tests of the whole system are to be presented.

VORTEX COMMENSURABILITY EFFECTS OBSERVED IN YBCO THIN FILMS WITH DEFECTS ENGINEERED BY FOCUSED He ION BEAM IRRADIATION

Bernd Aichner[1*], Max Karrer[2], Katja Wurster[2], Vyacheslav Misko[3,4], Kristijan Luka Mletschnig[1], Meirzhan Dosmailov[5], Johannes David Pedarnig[5], Franco Nori[4,6], Reinhold Kleiner[2], Edward Goldobin[2], Dieter Koelle[2], and Wolfgang Lang[1]

[1]*Faculty of Physics, University of Vienna, Boltzmanngasse 5, A-1090 Wien, Austria*
[2]*Physikalisches Institut and Center for Quantum Science (CQ) in LISA⁺, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany*
[3]*µFlow group, Department of Chemical Engineering, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium*
[4]*Theoretical Quantum Physics Laboratory, RIKEN Cluster for Pioneering Research, Wako-shi, Saitama, Japan*
[5]*Institute of Applied Physics, Johannes Kepler University Linz, Altenbergerstrasse 69, A-4040 Linz, Austria*
[6]*Physics Department, University of Michigan, Ann Arbor, Michigan 48109, United States*

**Corresponding author: bernd.aichner@univie.ac.at*

Vortex commensurability effects can be observed in electronic transport measurements of superconducting films with a regular defect lattice when the vortex lattice matches with the defect lattice. To evoke this effect, a regular array of defects must be created in the superconductor, which is challenging for the high-temperature superconductor $YBa_2Cu_3O_{7-\delta}$ (YBCO) because in this material, structures below 100 nm can hardly be created by conventional etching techniques. We use the slightly defocused beam of a Helium-Ion-Microscope to precisely fabricate defect structures by locally suppressing the critical temperature without destroying the material's crystal structure. With this method, we have been able to create ultradense pinning lattices with lattice constants down to 40 nm. In addition, in kagomé-like patterns, we observe an unconventional commensurability effect, which is attributed to the magnetic caging of vortices[1]. Angle resolved electronic transport measurements reveal that the matching features are dominated by the artificial pinning landscape, despite of the strong intrinsic pinning in thin YBCO films [2].
These findings open the path for the realization of more complex structures and thus to intriguing possibilities for the manipulation of vortices in high-temperature superconductors.

[1] B. Aichner, B. Müller, M. Karrer, V. Misko, F. Limberger, K. L. Mletschnig, M. Dosmailov, J. D. Pedarnig, F. Nori, R. Kleiner, D. Koelle, and W. Lang, ACS Appl. Nano Mater., **2** (2019) 5108.
[2] B. Aichner, K. L. Mletschnig, B. Müller, M. Karrer, M. Dosmailov, J. D. Pedarnig, R. Kleiner, D. Koelle, W. Lang, Low Temp. Phys. **46** (2020) 331.

COEXISTENCE SUPERCONDUCTIVITY

J. Fikáček[1,2], M. Hrůzová Kratochvílová[1], S. Kambe[3], H. Sakai[3], Y. Tokunaga[3], T. Hattori[3], N. Higa[3], R.E. Walstedt[4], R. Küchler[5], M. Brando[5], and **J. Custers[1]***

[1]Charles University, Faculty of Mathematics and Physics, Dept. Condensed Matter Physics, Ke Karlovu 5, 121 16 Prague, Czech Republic
[2] Institute of Physics, Academy of Sciences of the Czech Republic, Na Slovance 2, 182 21 Prague, Czech Republic
[3]Advanced Science Research Center, Japan Atomic Energy Agency, Tokai-mura, Ibaraki 319-1195, Japan
[4]Physics Department, The University of Michigan, Ann Arbor, MI 48109, USA
[5] Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Strasse 40, D-01187 Dresden, Germany

**Corresponding author: custers@mag.mff.cuni.cz*

The emergence of superconductivity in close proximity to a magnetic quantum phase transition in heavy fermion compounds is extensively studied both experimentally and theoretically. The vast majority of heavy fermion compounds investigated exhibit only one crystallographic site for the Rare Earth or Actinide ion. Here we present results on ongoing research on Ce_3PtIn_{11} [1]. This heavy fermion compound possesses two inequivalent Ce-sites. At ambient pressure the compound exhibits two successive transitions at T_1 = 2.2K and T_N = 2K into a possible incommensurate (iAFM) and commensurate (AFM) local moment AFM state, respectively. Upon further cooling the superconductivity is found with T_c = 0.32K [1]. A careful entropy analysis conjectured the idea that the Ce2-ions are responsible for the magnetic ordering whereas the second Ce1-ions remain paramagnetic and at lower T evokes superconductivity [2].We present here our recent ^{115}In NMR/NQR, specific heat and thermal expansion data which are in support of this scenario [3] and present evidence that the superconducting state at ambient pressure results from the vicinity of the Ce1-site to a quantum critical point. The superconducting state exhibits unusual properties; in NQR we observe that the entrance in the superconducting state results in a sudden drop of $1/T_1$ suggesting a first order type of transition from the AFM state into the superconducting one. This would indicate a breaking of symmetry implying that magnetic order and superconductivity compete [3]. Far below T_c a Korringa-type of evolution of $1/T_1$ at the In-sites is observed. Such behavior can be explained by the existence of a finite density of states deep inside the superconducting phase. This is corroborated by a residual large Sommerfeld coefficient in the specific heat.
We conclude that the Ce_3PtIn_{11} harbors two quantum critical points – one close to/or at ambienet pressure and one to be reached by an applied hydrostatic pressure of p_c = 1.5GPa. Each quantum critical point can be associated with a particular Ce-site and the critical magnetic fluctuations accompanying the quantum critical points are at the origin of the Cooper-pairing.

This work was supported by the Czech Science Foundation (GAČR) Grant No. 18-23606S, the EU COST Action CA16218 and by the Czech Ministry of Education under the COST project scheme, project No. LTC18024.

[1] J. Prokleška *et al.,* Phys. Rev. B **92,** 161114(R) (2015).
[2] J. Custers*et al.,* J. Phys.: Conf. Ser. **683**, 012005 (2016).
[3] S. Kambe*et al.,* submitted to Phys. Rev. Lett. (2019).

JOSEPHSON JUNCTIONS TRAVELING WAVE PARAMETRIC AMPLIFIERS: SIMULATIONS, THEORY AND EXPERIMENT

S. Kern, P. Neilinger[1,2], A. Sultanov[3], Evgeni Il'ichev[4], Matthias Schmelz[4], Jürgen Kunert[4], Ronny Stolz[4] and **M. Grajcar[1,2*]**

[1]*Department of Experimental Physics, Comenius University, Mlynská dolina F1, 84248, Bratislava, Slovakia*
[2]*Institute of Physics, Slovak Academy of Sciences, Dúbravská cesta 9, 84511, Bratislava, Slovakia*
[3]*QTF Centre of Excellence, Department of Applied Physics, Aalto University School of Science, P.O. Box 15100, FI-00076 AALTO, Finland*
[4]*Institute of Photonic Technology, D-07702 Jena, Germany*

**Corresponding author:grajcar1@uniba.sk*

Superconducting traveling wave parametric amplifiers (TWPA) based on kinetic or Josephson nonlinear inductance are known to be broadband and low noise. A high gain of TWPA can be achieved for long and ideally matched system. In practice, the unmatched nonlinear impedance of the transmission line with finite size results in resonant character of its response, and thus limits the bandwidth of the amplifier. Nevertheless, many applications do not require wide bandwidth, which increases the total noise. Instead, wide tunability of frequency range would be preferred. We present design of 14 mm long superconducting coplanar waveguide with 2080 Josephson junctions arranged as a metamaterial with proper dispersion. The highest amplification achieved was 15 dB within 35 MHz bandwidth around central frequency f_0 = 6.2 GHz was achieved with the dynamic range of TWPA around 10dB. The f_0 can be widely tuned in frequency ranges 3.2 – 4.3 GHz and 5.1 – 6.4 GHz by pump frequency and pump power. In the first frequency region the average amplification is around 4 dB with 8 dB peak and in the second region the gain oscillates between 6 dB and 15 dB. Similar behaviour was obtained theoretically within the coupled mode theory. The properties of the stepped impedance resonator and the role of the metamaterial are studied by numerical solution of nonlinear telegrapher's wave equations utilizing the finite element method.

ELECTRONIC STRUCTURE OF MISFIT LAYERED COMPOUND $LaNbSe_3$ FROM FIRST-PRINCIPLES

J. Haniš[1], M. Campetella[2], M. Calandra[2], M. Gmitra[1*]

[1]Institute of Physics, P. J. Šafárik University in Košice, Park Angelinum 9, 040 01 Košice, Slovakia
[2]Sorbonne Université, CNRS, Institut des Nanosciences de Paris, UMR7588, F-75252, Paris, France

**Corresponding author: martin.gmitra@upjs.sk*

Misfit layer compounds are composite materials combining two-dimensional layers which preserve their own crystal symmetry. The unit cells of the two-dimensional layers can differ in most general cases in all three directions. Properties of the misfit layer compounds might be attributed to the properties of individual two-dimensional layers. In layered chalcogenides $LaSe/NbSe_2$ it is believed that superconductivity is originating from transition-metal dichalcogenide layer $NbSe_2$ in which superconductivity has been recently reported with an in-plane upper critical field of more than six times the Pauli paramagnetic limit attributed to unconventional Ising pairing [1]. Superconductivity in anisotropic $(LaSe)_{1.14}(NbSe_2)$ misfit-layer superconductor with alternating one LaSe and two $NbSe_2$ (1Q2H) layers has been observed below T_c of 1.2 K [2]. Study of specific heat and electric transport in misfit layered compound with alternating of one LaSe and one $NbSe_2$ layer (1Q1H) suggesting controversial supeconductivity behavior [3]. Here we study electronic structure of 1Q1H $LaNbSe_3$ misfit structure by means of first-principles calculations for different stackings in order to investigate interlayer bonding and doping effects on Fermi surface.

The work is supported by the VEGA 1/0105/20.

[1] X. Xi et al., Nature Physics 12, (2016) 139.
[2] P. Szabó et al., Phys. Rev. Lett. 86 (2001) 5990.
[3] P. Szabó, J. Kačmarčík, T. Samuely, P. Samuely, private communication.

MICROWAVE RESPONSE OF TYPE-II SUPERCONDUCTORS

F. Herman[1*] and R. Hlubina[1]

[1]*Department of Experimental Physics, Comenius University, Mlynská Dolina F2, 842 48 Bratislava, Slovakia*

**Corresponding author: herman2@uniba.sk*

Surface impedance of type-II superconductors is determined by their local optical conductivity $\sigma(\omega)$. Standard BCS-like theoretical descriptions of $\sigma(\omega)$, due to Mattis and Bardeen or Zimmermann et al., do not take pair-breaking processes into account. Therefore they do not provide a quantitative explanation of the microwave response, and in particular they can not predict the magnitude of the coherence peak. Here, based on the recently developed concept of Dynes superconductors which does take also the pair-breaking processes into account, we provide a simple but complete description of the microwave response of type-II superconductors, concentrating on the unexpected properties of clean superconductors which are often used as cavity materials.

TRANSPORT PROPERTIES OF AN ULTRA-THIN GRANULAR ALUMINUM FILM

T. Huber[1*], A. Moshe[2], G. Deutscher[2] and C. Strunk[1]

[1]*Institute for Experimental and Applied Physics, University of Regensburg, 93040 Regensburg, Germany*
[2]*Raymond and Beverly Sackler School of Physics and Astronomy, Tel Aviv University, Tel Aviv, Israel*

**Corresponding Author: thomas.huber@physik.uni-regensburg.de*

We measured the IV-characteristics of a 5nm thin granular aluminum film with a sheet resistance at room temperature of about 2.2kOhms. We observe a transition to a superconducting state at a transition temperature $T_c \sim 2.5$K. For temperatures $T << T_c$, we observe a zero bias feature depending on temperature and magnetic field. Our observations can be understood in terms of a disordered Josephson junction array[1,2]. For $B < B_{crit} \sim 2.5$T the grains of the film are superconducting (S) whereas for $B > B_{crit}$ the grains are resistive (N). By measuring the temperature dependence of the zero bias resistance, we see that for $B = 0$ the array stays superconducting, while for B > 0.5T the array shows an insulating behavior. This points towards a magnetic field driven superconductor-insulator-transition (B-SIT).
In the resistive state, $B > B_{crit}$, the temperature dependence of the zero bias resistance behaves thermally activated from 90mK < T < 0.7K. In the S-state, we see a $R(T)$ - dependence steeper than in the N-state, giving rise to a higher activation energy and thus an even sharper transition in to the insulating regime.
In addition, we observe an oscillatory component of the magnetoresistance $R(B)$ curves for temperatures 65mK < T < 200mK. $R(B)$ fluctuates on a magnetic field scale of ~ 300mT. An effective area with length and width of ~ 60nm can be deduced, which is at least 10 times larger than the actual granule size ~ 3-5nm.

[1] P. Delsing, C. D. Chen, D. B. Haviland, Y. Harada, T. Claeson;
"Charge solitons and quantum fluctuations in two-dimensonal arrays of small Josephson junctions;
Phys. Rev. B**50**, Nr.6, 3959-3971 (1994).
[2] P. Delsing, C. D. Chen, D. B. Haviland, T. Bergsten, T. Claeson;
"Two-dimensional arrays of low capacitance tunnel junctions: general properties, phase transitions and Hall effect";
AIP Conference Proceedings **427**, 313 (1998).

TRANSMISSION BASED CHARACTERISATION OF SUPERCONDUCTING MATERIAL

S. Kern[1*], P. Neilinger[1], D. Manca[1], E. Il'ichev[2], M. Schmelz[2], J. Kunert[2], G. Oelsner[2], R. Stolz[2] and M. Grajcar[1]

[1]*Dept. of Exp. Physics, FMFI, Comenius University, 84248 Bratislava, Slovakia*
[2]*Institute of Photonic Technology, D-07702 Jena, Germany*

**Corresponding author: kern7@uniba.sk*

Waveguides with superconducting Josephson junction-based metamaterial are widely used as parametric amplifiers in experiments on superconducting qubits and microwave circuit quantum electrodynamics.
However, the precise estimation of power entering the device is crucial for the estimation of the amplifier's gain and noise temperature. This is nontrivial when the measurement tract is not symmetrical. We present a basic framework for the analysis of the properties of such nonlinear systems and the calibration of the input power. Utilizing measurements with varied temperature and input signal power, we estimate the additional attenuation of the input line, thus demonstrating the precise calibration procedure. Moreover, the properties of the metamaterial are estimated.

YU-SHIBA-RUSINOV STATES IN 2H-$NbSe_{1.6}S_{0.4}$

Jose Antonio Moreno*, Víctor Barrena, Anita Smeets, Edwin Herrera, Isabel Guillamón and Hermann Suderow

Laboratorio de BajasTemperaturas y Altos Campos Magnéticos, Departamento de Física de la Materia Condensada, Instituto Nicolás Cabrera and Condensed Matter Physics Center (IFIMAC), Unidad Asociada UAM-CSIC, Universidad Autónoma de Madrid, E-28049 Madrid, Spain

José J. Baldoví

Instituto de Ciencia Molecular (ICMol), Universidad de Valencia, Catedrático José Beltrán 2, 46980 Paterna, Spain
Max Planck Institute for the Structure and Dynamics of Matter, Luruper Chaussee 149, D-22761 Hamburg, Germany

Jazmín Aragón Sánchez and Yanina Fasano

Instituto de Física Rosario, CONICET-UNR, Bv. 27 de Febrero 210bis, S2000EZP Rosario, Santa Fé, Argentina

Samuel Mañas and Eugenio Coronado

Instituto de Ciencia Molecular (ICMol), Universidad de Valencia, Catedrático José Beltrán 2, 46980 Paterna, Spain

**Corresponding author: josea.moreno@estudiante.uam.es*

2H-$NbSe_2$ is often regarded as a model material in the study of correlated electronic systems with Scanning Tunneling Microscopy (STM) due to the coexistence of charge density wave (CWD) order with superconductivity below 7.2K. Here we study 2H-$NbSe_{1.6}S_{0.4}$ at very low temperatures (down to 70mK) using STM and find that the substitution of Se by S leads to a significant suppression of both the CWD and the superconducting gap anisotropy. We show the gap as a function of temperature and the vortex lattice and vortex cores as a function of the magnetic field. We also show measurements of the density of states at Yu Shiba Rusinov (YSR) impurities, evidencing the creation of a finite density of states at zero energy inside the superconducting gap. We discuss the influence of S doping on the YSR states.

AN LC-RESONATOR TECHNIQUE FOR THE INVESTIGATION OF THE BEREZINSKI-KOSTERLITZ-THOULESS TRANSITION IN STRONGLY DISORDERED SUPERCONDUCTORS

L. Pfaffinger,[1]**A. Weitzel**[1], T. Huber,[1] K. Kronfeldner,[1] L. Fuchs,[1] S. Linzen,[2] E. Ilichev,[2] N. Paradiso,[1] C. Strunk[1*]

[1]*University of Regensburg, Universitätsstraße 31, 93051 Regensburg,Germany*
[2]*Leibniz-Institut für Photonische Technologien e.V., Albert-Einstein-Straße 9, 07745 Jena, Germany*

**Corresponding author: Christoph.strunk@ur.de*

In thin superconductors in the 2D limit, the transition from the superconducting to the resistive state is explained by the BKT theory, which describes the thermal unbinding of bound vortex-antivortex pairs. This topological phase transition is characterized by a universal jump of the superfluid stiffness at the unbinding temperature. We developed a LC-resonator method for the determination of the superfluid stiffness of thin films and Josephson junction arrays. The sample is positioned in series with an inductive coil and the shift in resonance frequency can be used to infer the inductance of the film, which is inversely proportional to the stiffness. We investigate the kinetic inductance of highly disordered, 3 nm thick NbN films and find a very sharp transition at the temperature expected from the universal BKT-prediction. Moreover, we observe an unexpected increase of superfluid stiffness under application of a DC current, indicating a stimulation of superconductivity with increased DC current. We compare this observation with a peculiar negative curvature in the log-log representation of current voltage characteristics, suggesting a reduction of dissipation compared to power law behavior with increasing bias current. The results demonstrate the capability of the resonator method to determine the superfluid stiffness in superconducting thin films in a quantitative and precise way.

Mo_8Ga_{41} - SEEMINGLY TWO-GAP SUPERCONDUCTOR. LOCAL HALL-PROBE MAGNETOMETRY STUDY

Z. Pribulová[1*], M. Marcin[1*], J. Kačmarčík[1], V.Yu. Verchenko[2,3], A.V. Shevelkov[2], V. Cambel[4], J. Šoltýs[4], and P. Samuely[1]

[1]*Centre of Low Temperature Physics, Institute of Experimental Physics SAS, Watsonova 47, 040 01 Košice, Slovakia*
[2]*Department of Chemistry, Lomonosov Moscow State University, Moscow, Russia*
[3]*National Institute of Chemical Physics and Biophysics, Tallinn, Estonia*
[4]*Institute of Electrical Engineering SAS, Bratislava, Slovakia*

**Corresponding author: pribulov@saske.sk , marcinm@saske.sk*

The magnetization properties of the endohedral cluster superconductor Mo_8Ga_{41} are studied by sensitive Hall-probe magnetometry. The temperature dependence of the lower critical magnetic field H_{c1} is obtained and compared to theoretical models accounting for single-gap and two-gap superconductivity. Data can be described by both models with minor differences. These results are confronted with our previous measurements which evidence that the system is inherently single-gap s-wave superconductor but minor additional phases are present also in seemingly perfect samples [1]. We discuss how presence of such additional phases with varying size of the penetration depth and H_{c1} field is reflected in magnetization measurements which could lead to misinterpretation of the multi-gap superconductivity in Mo_8Ga_{41} [2].

[1] M. Marcin et al., Sci. Rep. 9 (2019) 13552.
[2] M. Marcin et al., Supercond. Sci. Technol. 34 (2021) 035017.

T_C - ENHANCEMENT IN SUPERCONDUCTING THIN FILMS UNDER PRESSURE

G. Pristáš[1*], J. Bačkai[1,2], S. Gabáni[1], Mat. Orendáč[1], E. Gažo[1], N. Shitsevalova[3], R. Franz[4], Ch. Mitterer[4], and K. Flachbart[1]

[1]*Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, 04001 Košice, Slovakia*
[2]*Faculty of Electrical Engineering and Informatics, Technical University, Letná 9, 04200 Košice, Slovakia*
[3]*Institute for Problems of Material Science, NASU, Krzhyzhanovsky 3, 03680 Kiev, Ukraine*
[4]*Department of Materials Science, Montanuniversität Leoben, Franz-Josef-Strasse 18, 8700 Leoben, Austria*

**Corresponding author: gabriel.pristas@saske.sk*

Research at extreme conditions can reveal new unexplored regions of phase diagrams of condensed matter systems. As extreme conditions we understand very low temperatures, high magnetic fields, high pressures and two-dimensional confinement. Our previous research on Nb thin films, where we combined high pressure, low temperatures and 2D confinement, has shown a surprising result, that Nb in form of a thin film reveals different behavior under pressure in comparison with bulk Nb. Systematic studies of superconducting properties combining different extreme conditions will help to understand nature of the enhancement of T_c. In this context we plan to investigate various thin film structures, e.g. thin films of elements (e.g. Nb, Mo, V, Pd) and compounds with a well understood superconducting mechanism in bulk form (e.g. YB_6, ZrB_{12}).

[1] G. Pristáš, S. Gabáni, E. Gažo, V. Komanický, Mat. Orendáč, H. You, Thin Solid Films, 556 (2014) 470.

EXTREME UPPER CRITICAL MAGNETIC FIELDS OF $(LaSe)_{1.14}(NbSe_2)_{n=1,2}$ MISFIT DICHALKOGENIDES

P. Samuely,[1,2*] P. Szabó,[1] J. Kačmarčík,[1] A. Meerchaut,[3] L. Cario,[3] A. G. M. Jansen,[4,5] T. Cren,[6] M. Kuzmiak,[1] O. Šofranko,[1,2] T. Samuely[2]

[1]*Centre of Low Temperature Physics, Institute of Exp. Physics, Slovak Academy of Sciences, 04001 Košice, Slovakia*
[2]*Centre of Low Temperature Physics, Faculty of Science, P. J. Šafárik University, 04001 Košice, Slovakia*
[3]*Institut des Matériaux Jean Rouxel, Université de Nantes and CNRS-UMR 6502, Nantes 44322, France*
[4]*Universté Grenoble Alpes, CEA, Grenoble INP, IRIG, PHELIQS, F-38000 Grenoble, France*
[5]*Laboratoire National des Champs Magnétiques Intenses, CNRS, UGA, F-38042 Grenoble, France*
[5]*Institut des NanoSciences de Paris, Sorbonne Université and CNRS-UMR 7588, Paris 75005, France*

**Corresponding author: samuely@saske.sk*

Extreme in-plane upper critical magnetic fields $B_{c2//ab}$ strongly violating the Pauli paramagnetic limit have been observed in the misfit layer $(LaSe)_{1.14}(NbSe_2)$ and $(LaSe)_{1.14}(NbSe_2)_2$ single crystals with T_c = 1.23 K and 5.7 K, respectively. The crystals show a 2D-3D transition at the temperatures slightly below T_c with an upturn in the temperature dependence of $B_{c2//ab}$, temperature dependent huge superconducting anisotropy and a cusp-like behavior of the angular dependence of B_{c2}. As shown in our previous work [1] a strong charge transfer occurs in $(LaSe)_{1.14}(NbSe_2)_2$ which makes this compound behaving as a stack of $NbSe_2$ monolayers weakly coupled by van der Waals bonding. Then, the strong upper critical field can be attributed to the Ising coupling recently discovered in atomically thin transition metal dichalcogenides with strong spin-orbit coupling and lack of inversion symmetry. On the other hand $(LaSe)_{1.14}(NbSe_2)$ has not been a van der Waals material and probably imply a very different superconducting mechanism not related to Ising coupling. Why, is then showing a very similar behavior?

[1] R. T. Leriche, A. Palacio-Morales, M. Campetella, C. Tresca, S. Sasaki, C. Brun, F. Debontridder, P. David, I. Arfaoui, O. Šofranko, T. Samuely, G. Kremer, C. Monney, T. Jaouen, L. Cario, M. Calandra and T. Cren, *Misfit Layer Compounds: A Platform for Heavily Doped 2D Transition Metal Dichalcogenides*, Adv. Funct. Mater. **31**, 2007706 (2020).

ZEEMAN DRIVEN SUPERCONDUCTOR INSULATOR TRANSITION IN STRONGLY DISORDERED MoC FILM. STM AND TRANSPORT STUDIES IN TRANSVERSE MAGNETIC FIELD

M. Žemlička,[1,3,4] **M. Kopčík**,[1,5] P. Szabó,[1*] T. Samuely,[2] J. Kačmarčík,[1] P. Neilinger,[3] M. Grajcar,[3] and P. Samuely[1,2]

[1]*Centre of Low Temperature Physics, Institute of Experimental Physics, Slovak Academy of Sciences, 04001 Košice, Slovakia*
[2]*Centre of Low Temperature Physics, Faculty of Science, P. J. Šafárik University,04001 Košice, Slovakia*
[3]*Department of ExperimentalPhysics, ComeniusUniversity, 84248 Bratislava, Slovakia*
[4]*Institute of Science and TechnologyAustria, amCampus 1, 3400 Klosterneuburg, Austria*
[5]*Faculty of ElectricalEngineering and Informatics, TechnicalUniversity, 04001Košice, Slovakia*

**Corresponding author: pszabo@saske.sk*

Superconductor insulator transition in transverse magnetic field is studied in the highly disordered MoC film with the product of the Fermi momentum and the mean free path k_F*l close to unity. Surprisingly, the Zeeman paramagnetic effects dominate over orbital coupling on both sides of the transition. In superconducting state it is evidenced by a high upper critical magnetic field B_{c2}, by its square root dependence on temperature, as well as by the Zeeman splitting of the quasiparticle density of states (DOS) measured by scanning tunneling microscopy. At B_{c2} a logarithmic anomaly in DOS is observed. This anomaly is further enhanced in increasing magnetic field, which is explained by the Zeeman splitting of the Altshuler-Aronov DOS driving the system into a more insulating or resistive state. Spin dependent Altshuler-Aronov correction is also needed to explain the transport behavior above B_{c2}.

CONDUCTANCE QUANTIZATION IN ATOMIC SIZE CONTACTS AT VERY HIGH MAGNETIC FIELDS

Beilun Wu[1*], M. Fernández Lomana[1], Hermann Suderow[1], and Isabel Guillamón[1]

[1]*Laboratorio de BajasTemperaturas y Altos Campos Magnéticos, Unidad Asociada (UAM/CSIC), Departamento de Física de la Materia Condensada, Instituto Nicolás Cabrera and Condensed Matter Physics Center (IFIMAC),Universidad Autónoma de Madrid, E-28049 Madrid, Spain*

**Corresponding author: beilun.wu@uam.es*

The conductance through point contacts of atomic size can be explained on the basis of Landauer's formula. For example, in gold there is a single channel which is nearly fully open. Thus, when a tip and a sample of gold come together with just a single Au atom making the contact, the conductance is nearly perfectly quantized and acquires values very close to $G=G_0=h/2e^2$, with the factor of two coming from the spin degeneracy. The conductance G is much smaller when the transparency is reduced by a more complex system, such as a hydrogen based molecular complex or an organic molecule, is located between the two gold atoms. Such molecular systems are naturally present on Au surfaces and can be identified by making repeated indentation experiments and tracing the conductance down to values far below G0 after separating fully tip and sample. Typically, conduction through a molecular system leads to conductance of about $10^{-3}G_0$. Here we study systematically millions of different Au-Au contacts as a function of the magnetic field up to 20 T. We find that in Au-Au single atom point contacts, the conductance is quantized in units of $G=G_0=h/2e^2$, at all magnetic fields. Thus, we see that the magnetic field does not produce any changes in the conduction through Au atoms. We also identify conductance through molecular systems and find that the latter are considerably influenced by the application of high magnetic fields. We discuss the energy scales involved in the process and how these could be influenced by the magnetic field. Our data suggest that the field induced Zeeman splitting increases the number of conduction channels through molecular systems.

TRANSPORT PROPERTIES OF COMPRESSED $La_{1.952}Sr_{0.048}CuO_4$ THIN FILMS

I. Zajcewa[1*], R. Minikaev[1] , M. Chrobak[2,3] , E. Dobročka[4], and M. Z. Cieplak[1]

[1]*Institute of Physics, Polish Academy of Sciences, 02 668 Warsaw, Poland*
[2]*AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, Solid State Physics Department, al. A. Mickiewicza 30, 30-059, Krakow, Poland.*
[3]*AGH University of Science and Technology, Academic Center for Materials and Nanotechnology, al. A. Mickiewicza 30, 30-059 Krakow, Poland.*
[4]*Institute of Electrical Engineering SAV, Dúbravská cesta 9, 84104 Bratislava, Slovakia*

**Corresponding author:zaytseva@ifpan.edu.pl*

In thin epitaxial films superconductivity may be enhanced by the strain resulting from the lattice mismatch between the film and the substrate, while perpendicular magnetic field can induce the superconductor-insulator transition (SIT). Many recent studies reveal unusual, not yet well understood effects in thin films in the vicinity of the SIT, such as, for example, the existence of metallic intermediate phase, or the development of electronic granularity on the approach to transition. This last effect is well documented by scanning tunneling experiments in case of strongly underdoped high temperature superconductors.

In this work we study the SIT in a set of thin $La_{2-x}Sr_xCuO_4$ (LSCO) films, with thickness from 26 nm to 120 nm, grown by pulsed laser deposition on $LaSrAlO_4$ substrates. The films are deposited from non-superconducting target with x = 0.048, but in thin films the superconductivity becomes apparent as a result of large, compressive, substrate-induced strain [1]. We observe that the SIT in the LSCO films is strongly dependent both on the film thickness, and on the strain. In particular, the zero-resistive superconducting state is absent in the thinner and more strained films while the temperature dependence of the magnetoresistance and I-V characteristics resemble the behaviors for arrays of superconducting islands coupled by proximity effect. The Coulomb blockade effect is evidenced in one of the thin films in the mK temperature range.

[1] I. Zaytseva, R. Minikayev, E. Dobročka, M. Špankova, N. Bruyant, and M. Z. Cieplak, J. Appl. Phys. 127, 073901 (2020).

NON-EQUILIBRIUM AND FLUCTUATION PHENOMENA IN LOW-DIMENSIONAL SUPERCONDUCTORS

K. Yu. Arutyunov[1,2*]

[1] *National Research University Higher School of Economics, Moscow, 101000, Russia*
[2]*P. L. Kapitza Institute for Physical Problems RAS, 119334, Moscow, Russia*

**Corresponding author: karutyunov@hse.ru*

Utilization of superconducting materials for the new generation of nanoelectronic devices seems extremely tempting from the point of view of the absence of Joule heating. However, in small systems, the impact of fluctuations and/or non-equilibrium contribution can be very significant. For example, in particular case of narrow superconducting channels it has been demonstrated that quantum fluctuations of the order parameter may dramatically suppress text-book attributes of superconductivity such as zero resistivity and persistent currents [1]. Here we present our recent experiments related to fluctuation and interface phenomena in low-dimensional superconducting nanostructures.

[1] Arutyunov, K. Yu., Golubev, D. and Zaikin, A. D. Phys. Rep. 464, (2008)1.

PHYSICOCHEMICAL CHARACTERIZATION OF THE $Gd_{3-x}Ca_xIr_4Sn_{13}$ SINGLE CRYSTALS

M. Babij[1*], L.M. Tran[1]

[1]*Institute of Low Temperature and Structural Research, Polish Academy of Sciences in Wroclaw, Okolna 2, 50 422 Wroclaw, Poland*

**Corresponding author: m.babij@intibs.pl*

Among the group of stannides two of them $Gd_3Ir_4Sn_{13}$ and $Ca_3Ir_4Sn_{13}$ (calcium analogue) are very interesting because they exhibit multiple magnetic states associated with the *3d* and *4f* electrons, and superconductivity. However, until now the studies on these materials were limited to the ‘pure’ parent compounds and did not consider its solid solutions [1,2].
In this contribution we present physicochemical characterization of the synthesized single crystals of $Gd_{3-x}Ca_xIr_4Sn_{13}$ magnetic superconductors.
The single crystals obtained by Sn flux technique with typical size of 3 mm × 3 mm × 3 mm were characterized by XRD diffraction and EDS spectroscopy to confirm purity and chemical composition. DC magnetization, AC susceptibility and resistivity measurements contributed on our samples revealed superconductivity and various magnetic phases. In the case of the $Ca_3Ir_4Sn_{13}$ we observe superconductivity and itinerant magnetism. For the $Ga_3Ir_4Sn_{13}$ localized magnetism of the Gd^{3+} was present instead of superconductivity.

[1] C. Nagoshi; M. Arai, J. Phys. Soc. Jap. 75 (2006) 044710.
[2] D. G. Mazzone; M. Kenzelmann, Phys. Rev. B, 92 (2015) 024101.

SUPERCONDUCTING PHASE DIAGRAMS OF LuB_{12} AND $Lu_{1-x}Zr_xB_{12}$ ($x \leq 0.45$) DOWN TO 50 mK

J. Bačkai[1,2*], S. Gabáni[2], K. Flachbart[2], E. Gažo[2], J. Kušnír[3], M. Orendáč[2], G. Pristáš[2], N. Sluchanko[4,5], A. Dukhnenko[6], V. Filipov[6], N. Shitsevalova[6]

[1]*Faculty of Electrical Engineering and Informatics, Technical University, Letná 9, 04200 Košice, Slovakia*
[2]*Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, 04001 Košice, Slovakia*
[3]*Institute of Physics, Faculty of Science, P. J. Safarik University, Park Angelinum str.9, 04154 Košice, Slovakia*
[4]*Prokhorov General Physics Institute, Russian Academy of Sciences, Vavilov str. 38, 119991 Moscow, Russia*
[5]*Moscow Institute of Physics and Technology, Moscow Region, 141700 Russia*
[6]*Institute for Problems of Materials Science, National Academy of Sciences of Ukraine, Krzhyzhanovsky str. 3, 03142 Kiev, Ukraine*

**Corresponding author: backai@saske.sk*

It is known that lutetium dodecaboride LuB_{12} has critical temperature $T_c \approx 0,4$ K [1], whilst zirconium dodecaboride has the highest critical temperature $T_c \approx 6$ K [2] among the mentioned group of materials. In case of lutetium substitution by zirconium ions in LuB_{12}, it can be studied crossover from type-I to type-II superconductor providing a variation of the Ginzburg-Landau-Maki parameter in the limits $0.65 \leq \kappa \leq 6$, nevertheless the parental borides are type-I superconductors [3]. Both dodecaborides are also similar in their conduction band, magnetic and crystalline structure. Despite mentioned similarities it is still not clear why there is such a difference between their critical temperatures. To shed more light on this problem we performed a detailed investigation of superconducting properties of solid solutions $Lu_{1-x}Zr_xB_{12}$. The essential purpose of our work has been to obtain an evolution of concentration dependence of critical temperature T_c(x) and temperature dependences of the critical magnetic field H_c(T) for various concentration of zirconium. A rather complex experimental research of electrical resistivity, magnetization and specific heat down to 0.4 K was carried out on $Lu_{1-x}Zr_xB_{12}$ samples with concentration of zirconium $0.78 \leq x \leq 1$ in[4, 5]. We have carried out a complementary measurements of concentration $x \leq 0.45$ with a very precise *ac*-susceptibility measurements down to 50 mK.

[1] K. Flachbart et al., Journal of Low Temperature Physics 140 (2005) pp. 339-353.
[2] Y. Wang et al., Physical Review B 72 (2005) 024548.
[3] A. Azarevich et al., Physical review B 103 (2021) 104515.
[4] N.E. Sluchanko et al.,Physical Review B 93 (2016) 085130.
[5] N.E. Sluchanko et al., Acta Physisca Polonica A 131 (2017) pp. 1036-1038.

COMPLEX CONDUCTIVITY OF STRONGLY DISORDERED THIN MoC SUPERCONDUCTING FILMS

M. Baránek[1*], P. Neilinger[1,2], D. Manca[1] and M. Grajcar[1,2]

[1]*Department of Experimental Physics, Comenius University, Mlynská dolina F1, 84248, Bratislava, Slovakia*
[2]*Institute of Physics, Slovak Academy of Sciences, Dúbravská cesta 9, 84511, Bratislava, Slovakia*

**Corresponding author: martin.baranek@fmph.uniba.sk*

The non-contact broadband transmission line flip-chip spectroscopy technique is utilized to analyze the complex conductivity of strongly disordered 5 nm thin molybdenum carbide films. This is achieved by probing resonances of the mm-sized 2D kinetic MoC resonators in the GHz frequency range [1]. The temperature dependence of the resonances was analyzed by the complex conductivity of disordered superconductor [2], which relates the Dynes superconducting density of states of highly disordered superconductors to their complex conductivity. The obtained Dynes broadening parameters correspond to the ones estimated from scanning tunneling spectroscopy measurements. The resonances of the kinetic 2D resonator were simulated in an Electromagnetic Field Solver Software (Sonnet). The 2D resonances of superconducting planar resonators could be further utilized, for example, as filters in sensitive superconductive electronics, such as circuit QED. Moreover, the proper understanding of the nature of these resonances in 2D films can help to eliminate them in spectroscopic experiments and thus increase the precision of spectroscopic methods.

[1] M. Baránek, P. Neilinger, D. Manca and M. Grajcar,arXiv:2102.13483 [cond-mat.supr-con].
[2] M. Žemlička et. al., Phys. Rev. B,92 (2015) 224506.

PENETRATION OF MAGNETIC FIELD INTO SUPERCONDUCTING YB_6 STUDIED BY AN ARRAY OF HALL PROBES AND AC-CALORIMETRY

Z. Pribulová[1], J. Kačmarčík[1], M. Marcin[1], S. Gabáni[1], P. Samuely[1], N. Shitsevalova[2], T. Mori[3], N. Sluchanko[4] and **K. Flachbart[1*]**

[1]*Centre of Low Temperature Physics, Institute of Experimental Physics SAS, Watsonova 47, SK-04001 Košice, Slovakia*
[2]*Institute for Problems of Material Science, NASU, KrzhyzhanovskySt. 3, UA-03680 Kiev, Ukraine*
[3]*National Institute for Materials Science, Namiki 1-1, JP-305-0044 Tsukuba, Japan*
[4]*General Physics Institute, RAS, Vavilov St.38, RU-119991 Moscow, Russia*

Corresponding author: flachb@saske.sk

Using an array of miniature Hall-probes we have investigated for the first time the penetration of magnetic field and the pinning strength in four yttrium hexaboride (YB_6) samples having different stoichiometry and superconducting transition temperatures T_C between 7.4 K and 4.2 K.The obtained results show that except the sample with lowest T_C = 4.2 K, which exhibits weak pinning, all others show strong pinning features. Concurrently, the comparison of penetration field H_p temperature dependencies with BCS theory points in all samples to strong *s*-type pairing of charge carriers with $2\Delta/k_BT_C \approx 4$, where 2Δ is the superconducting energy gap. In addition, based on temperature and field dependencies of ac-calorimetry, some of the superconducting state parameters were determined independently and compared with results of previously published works.

NbTiN SUPERCONDUCTING INDUCTORS IN RADIO-FREQUENCY REFLECTOMETRY

T. Kalmár[1*], G. Fülöp[1], I. Lukács[2], P. Makk[1], Sz. Csonka[1]

[1]*Department of Physics, Budapest University of Technology and Economics, 1111 Budapest, Budafokiút 8., Hungary*
[2]*Department of Microsystems, Institute of Technical Physics and Materials Science, 1121 Budapest Konkoly Thege M. út 29-33., Hungary*

**Corresponding author: tkalmar95@gmail.com*

The investigation of novel nanocircuits requires measurement techniques that allow fast and non-invasive characterization. A favorable method can be radio-frequency reflectometry. In reflectometry the sample is coupled to a resonator and by measuring the reflected high-frequency signal from the circuit, the complex impedance of the device can be read out. To achieve maximum sensitivity, the internal losses of the resonator should be minimized, for which utilizing superconducting inductors in the circuit is a favorable choice. In these inductors there is an additional contribution to the total inductance, the so-called kinetic inductance, which enables us to create large inductances with a small footprint

In this poster we detail the design of a superconducting inductor set consisting of 9 pieces from 20 nH to 1μH, made of NbTiN, in a meander shape. The I_C, T_C values and L(T) characteristics were investigated in cryogenic, high-frequency measurements. The results are in agreement with GL and BCS theories of superconductivity.

We also present how the inductors were utilized to probe the quantum capacitance of a locally gated graphene sample to detect a 6 fF gate dependent capacitance change in a lock-in amplifier-based reflectometry setup.

Furthermore, we aim to employ these superconducting inductors to measure current-phase relation in Josephson junctions, characterize Majorana states or read out spin qubits.

COMPLEX PRESSURE RESPONSE IN THIN NANODEVICES OF DIRAC SEMIMETAL $ZrTe_5$

Z. Kovács-Krausz[1*], B. Fülöp[1], A. Márffy[1], B. Szentpéteri[1], B. Karpiak[2], E. Tóvári[1], P. Makk[1], S.P. Dash[2] and Sz. Csonka[1]

[1]*Department of Physics, Budapest University of Technology and Economics and Nanoelectronics 'Momentum' Research Group of the Hungarian Academy of Sciences, Hungary*
[2]*Department of Microtechnology and Nanoscience, Chalmers University of Technology, Sweden*

**Corresponding author: kkz@mail.bme.hu*

$ZrTe_5$ is a quasi-2D layered van der Waals material that has acquired significant attention and been the subject of numerous experimental studies in the past few years. Despite this, there yet appears to be no solid consensus regarding the exact nature of the material, considering the wide range of complex phenomena it appears to exhibit. Initially expected to be a topological insulator with quantum spin Hall state in the monolayer case,[1] the material was experimentally shown to exhibit properties consistent with a 3D Dirac/Weyl semimetal.[2] $ZrTe_5$ has a resistivity anomaly, presenting as a peak in the temperature dependence, and shows a change in dominant charge carrier type around this peak temperature, although this behavior is not present in few-layer samples. In addition, it maintains signatures of multi-carrier transport in nearly all conditions.[3] The majority of studies so far have focused on macroscopic sized samples, although it has been shown that crystals as thin as 80-100 nm behave similar to the bulk, the transport behavior starts changing for thinner crystals and exhibits even further changes below 40 nm.

We present detailed temperature dependent magnetotransport measurements on exfoliated $ZrTe_5$ crystals ranging in thickness from 20-150 nm. Applying hydrostatic pressure up to 2 GPa noticeably changes the magnetotransport behavior of the crystals at all thicknesses. We analyze the changing behavior of the longitudinal and transverse magnetotransport curves in the context of a multiband, multicarrier model, where one of the bands is Dirac-like. Temperature changes shift the bands with respect to the Fermi energy, altering the individual carrier concentrations and respective mobilities, and thus overall magnetoconductance. Applying pressure changes the band structure, conversely affecting the temperature dependent behavior.

[1] W. Hongming, X. Dai, Z. Fang, Phys. Rev. X, 4 (2014) 011002.
[2] Q. Li et al., Nat. Phys., 12 (2016) 550-554.
[3] J. Lu et al., Phys. Rev. B, 95 (2017) 125135.

EXPERIMENTAL STUDY OF THE SUPERCONDUCTOR – INSULATOR TRANSITION IN STRONGLY DISORDERED MoN ULTRATHIN FILMS

M. Kuzmiak[1*], F. Košuth[1], L. Faber[1], M. Kopčík[1], P. Szabó[1], J. Kačmarčík[1], V. Vaňo[1], V. Latyshev[1], V. Komanický[1] and P. Samuely[1]

[1]*Centre of Low Temperature Physics, Institute of Experimental Physics, Slovak Academy of Sciences, and P.J. Šafárik University, SK-04001 Košice, Slovakia*

Corresponding author: kuzmiak@saske.sk

We studied transport and local electronic properties of polycrystalline, strongly disordered thin films of molybdenum nitride (MoN) with thicknesses between 1.5 nm and 30 nm at temperatures down to 400 mK by means of four-probe Van der Pauw transport measurements and scanning tunneling microscopy (STM). The superconducting properties observed down to 3 nm thickness show homogeneous superconductivity and unchanged strength of the superconducting coupling indicating Fermionic Superconductor-Insulator Transition (SIT). Transport measurements performed on thin films with 1.5 and 2 nm thickness do not exhibit superconducting properties and the locally measured STM density of states (DOS) shows quasi logarithmic reduction, typical for the Altshuler-Aronov effect. However, the reduced DOS in small, typically few nm^2 areas reveals temperature dependence indicating the presence of fluctuating superconducting properties.

PHASE-TUNABLE KONDO EFFECT IN THREE TERMINAL S-QD&N-S SETUPS

P. Zalom[1], V. Pokorný[1] and **T. Novotný**[2*]

[1]Institute of Physics, The Czech Academy of Sciences, Na Slovance 2, CZ-18221 Praha 8, Czech Republic
[2]Department of Condensed Matter Physics, Faculty of Mathematics and Physics, Charles University, Prague, Ke Karlovu 5, CZ-12116 Praha 2, Czech Republic

**Corresponding author: tno@karlov.mff.cuni.cz*

We derive and apply a general scheme [1] for mapping a setup consisting of a half-filled single-level quantum dot coupled to one normal metallic and two superconducting phase-biased leads [2] onto an ordinary half-filled single impurity Anderson model with single modified tunneling density of states. The theory allows for the otherwise unfeasible application of the standard numerical renormalization group and enables us to obtain phase-dependent local spectral properties as well as phase-dependent induced pairing and Josephson current. For weakly coupled normal electrode, the spectral properties can be interpreted in terms of normal-electrode-broadened Andreev bound states with phase-dependent position analogous to the superconducting Anderson model, which coexist in the π-like phase with a Kondo peak whose phase-dependent Kondo temperature is extracted.

[1] Peter Zalom, Vladislav Pokorný, and TomášNovotný, Phys. Rev. B 103, 035419 (2021).
[2] T. Domański, M. Žonda, V. Pokorný, G. Górski, V. Janiš, and T. Novotný, Phys. Rev. B 95, 045104 (2017).

ESCAPE RATE PROBLEM IN DRIVEN JOSEPHSON JUNCTIONS

Panch Ram[1*] and Tomáš Novotný[1]

[1]*Department of Condensed Matter Physics, Faculty of Mathematics and Physics, Charles University, Ke Karlovu 5, CZ-121 16 Praha 2, Czech Republic*

**Corresponding author: panchram@karlov.mff.cuni.cz*

Josephson effect in a superconductor-insulator-superconductor (SIS) junction is a macroscopic quantum tunneling phenomenon where Cooper pairs tunnel through an insulating barrier without any applied voltage [1, 2]. When a Josephson junction is operated in the zero-voltage state with a non-zero bias current (dc and ac) the phase difference between the macroscopic wave functions of two superconductors acts as a particle subject to a tilted-washboard potential. The phase particle stuck in this potential can escape via thermal exciton or it can tunnel quantum mechanically. At a very small temperature, the quantum tunneling process dominates [3, 4, 5].
I will present on our theoretical study of the escape (tunneling) rate problem for the phase particle in the current biased Josephson junction (CBJJ). We develop a quantum mechanical Green's function method for the static case (dc bias current) and calculate the spectral function that gives the position and width of resonances which relate to the tunneling rate. Then we also add a radio-frequency harmonic driving term (ac bias current) and derive via the Floquet-Green's function formalism the corresponding tunneling rate out of the ground-state which shows a strong resonant enhancement when the drive frequency matches the excitation energy of the junction.

[1] B. D. Josephson, Phys. Lett. **1** (7), 251–253 (1962).
[2] B. D. Josephson, Rev. Mod. Phys. **46** (2), 251–254 (1974).
[3] R. F. Voss, R. A. Webb, Phys. Rev. Lett. **47**, 265 (1981).
[4] J. M. Martinis et al. Phys. Rev. Lett. **55**, 1543 (1985).
[5] Christian Kraglund Andersen and Klaus Mølmer, Phys. Rev. A **87**, 052119 (2013).

QUANTUM INTERFERENCE IN FINITE-SIZE MESOSCOPIC RINGS

G.P. Papari[1*] and F.M. Fomin[2]

[1] *Dipartimento di Fisica, Università di Napoli "Federico II," via Cinthia, I-80126 Napoli, Italy*
[2] *CNR-SPIN, UOS Napoli, via Cinthia, I-80126 Napoli, Italy*

**Corresponding author: gianpaolo.papari@unina.it*

In the last decades, magnetoresistance (MR) oscillations of mesoscopic rings have been addressed through models attempting to relate the resistance/conductance to the magnetic dependent dynamics of phase coherent particles flowing through the sample. In particular, experiments on MR oscillations of non-superconducting mesoscopic rings, which we can gather within the phenomenology of Aharonov-Bohm effect, have received enormous attention and the oscillation of conductance have been solved through an approach based on Buttiker-Landauer formula where the number of transmitted particles is flux dependent [1]. Instead, the historical evolution of MR oscillations acquired on superconducting mesoscopic rings are known as Little-Parks effects [2] and the oscillation of resistance is interpreted as an oscillation of the critical temperature of the sample, meaning that the magnetic field B tends to lower the number per unit volume of paired particles, inducing the degradationof the superconducting stiffness. In this talk, we will propose a different scenario where the resistance/conductance of mesoscopic ring display a sinusoidal MR oscillation as consequence of the topology of the system. We have developed a model within the Ginzburg-Landau theory, to describe the order parameter of a superconducting mesoscopic ring with a finite size. The last ingredient along with the not simply connection of the sample, provide the least conditions to describe the phenomenon of MR oscillations by means of the interference of probe supercurrents resulting in the manipulation of the trajectories of paired particles flowing through the mesoscopic ring. Since this model does not require the lowering of paired particles density to justify the resistance oscillations, the dominant interpretation based on the oscillation of the critical temperature becomes unphysical.

[1] S. Washburn, in *Mesoscopic Phenomena in Solids*, B. L. Altshuler, P. A. Lee, and R. A. Webb, eds. (Elsevier Science Publishers B.V., 1991, 1991).
[2] M. Tinkham, Phys. Rev. **129**, 2413 (1963).

CREATING BAND GAP AND QUANTUM POINT CONTACTS IN hBN ENCAPSULATED BILAYER GRAPHENE

T. Prok[1*], E. Tóvári[1], P. Makk[1] and Sz. Csonka[1]

[1]*Department of Physics, Budapest University of Technology and Economics and Nanoelectronics 'Momentum' Research Group of the Hungarian Academy of Sciences, Budafoki ut 8, 1111 Budapest, Hungary*

**Corresponding author*: tamas.prok@gmail.com

Quantum point contacts (QPCs) are constrictions in a ballistic two-dimensional conductor where quantized conductance channels can be observed due to size quantization. They are among the cornerstones of mesoscopic physics. Quantum point contacts (QPCs) can be used to study electron correlations in one-dimensional systems, moreover, they are essential components in complex devices: for instance, they can serve as beam splitters in electron optics experiments or charge detectors for zero-dimensional quantum dots. When paired with superconducting contacts, a Josephson junction with a single, highly transmissive conducting channel can be created, in which Andreev bound states can form: these are promising candidates for the realization of qubits.
A QPC requires an adiabatical transition between the constriction and its surroundings and, compared to its size, similar or longer phase decoherence length, mean free path, and comparable or smaller Fermi wavelength. Single-layer graphene encapsulated in hexagonal boron nitride (hBN), while meeting many of these conditions, lacks a band gap, making it difficult to form a QPC. In contrast to gapless single-layer graphene, in bilayer graphene (BLG) we can tune a band gap via the displacement field created by top gate and back gate voltages. Therefore, it is possible to create insulating regions with local gate electrodes, or define constrictions in the electron gas in BLG.
We have fabricated high-mobility bilayer graphene Hall bars with local top gate structures for QPCs. They are equipped with a graphite backgate which screens the electrostatic potential of charged impurities, and serves an atomically flat substrate for the hBN/BLG/hBN heterostructure. By careful selection of all gate voltages we have successfully opened a band gap, and studied the gate and magnetic field dependence of the conductance in the vicinity of this working point. While the expected quantum Hall physics of an n-n'-n junction is reproduced in high magnetic field, the features expected of conductance quantization in low field were not observed. This we attribute to the excessive size of one of the top gates, tuning a larger area of graphene than necessary.

MAGNONIC CONTROL OF SUPERCONDUCTOR - SPIRAL MAGNET HYBRID SPIN VALVE

N. Pugach[1,2*], N. Gusev[3,4], D. Dzheparov[2], and V. Belotelov[1,3,4]

[1]*Lomonosov Moscow State University, Leninskie Gory, 1 (2), GSP-2 Moscow 119991, Russia*
[2]*HSE University, Moscow 101000, Russia*
[3]*Russian Quantum Center, BolshoyBulvar 30 b.1, Moscow 121205, Russia*

**Corresponding author: pugach@magn.ru*

We propose a control method of bilayer superconducting spin valve (SSV) non-perturbing superconductivity and suitable for energy saving cryogenic electronics. This SSV consists of a superconducting layer and a helimagnetic layer of B20 family compounds, namely Nb and spiral antiferromagnetic MnSi. Thanks to unique properties of B20 family magnets – noncollinear (in general helicoidal) magnetic order and cubic crystal lattice, there are few ground state magnetic configurations with different directions of the magnetic spiral, divided by a potential barrier [1]. Supercurrent in such a bilayer is controlled by the spiral vector reorientation in the MnSi layer, which leads to a change in the critical temperature of the Nb superconducting layer [2] due to proximity effect.

The switching is proposed to be carried out by a several hundred ps in duration magnetic field pulse of several kOe of magnitude. Such a pulse does not destroy the superconducting state of the Nb layer by itself but leads to the excitation of magnons in the MnSi layer, which triggers the process of reorientation of the magnetic spiral. After the completion of this process, the supercurrent in the Nb layer terminates. Inverse switching returns the spiral to the initial state, opening the valve and turning on the superconducting state. The system can be switched there and back by a magnetic field of opposite signs along one direction in the layers plane, which allows easy control.

The switching time is estimated as several nanoseconds, which coincides with the time scales of the STT-MRAM recording time. Such SSV may be used as an element of superconducting memory for energy-efficient digital and quantum electronics [3].

The numerical experiments were financially supported by the Russian Ministry of Education and Science, Megagrant project N 075-15-2019-1934, the visualization of spin distributions was supported by the Mirror Laboratories collaboration project of the HSE University.

[1] Grigoriev, S. V., et al., Physical Review B 76 (2007) 092407.
[2] Pugach, N. G., et al. Applied Physics Letters 111 (2017) 162601.
[3] N. Gusev, D. Dzheparov, N. Pugach, and V. Belotelov (in press).

NON-GAUSSIAN TAIL IN THE FORCE DISTRIBUTION: A HALLMARK OF CORRELATED DISORDER IN THE HOST MEDIA OF ELASTIC OBJECTS

J. Aragón Sánchez[1*], G. Rumi[1] and R. Cortés Maldonado[1], N.R.Cejas Bolecek[1], J. Puig[1], P. Pedrazzini[1], G. Nieva[1], M.I. Dolz[2], M. Konczykowski[3], C.J. van der Beek[4], A.B.Kolton[1], Y. Fasano[1]

[1]*Centro Atómico Bariloche and Instituto Balseiro, CNEA, CONICET and Universidad Nacional de Cuyo, 8400 San Carlos de Bariloche, Río Negro, Argentina*
[2]*Universidad Nacional de San Luis and Instituto de Física Aplicada, CONICET, 5700 San Luis, Argentina*
[3]*Laboratoire des Solides Irradiés, CEA/DRF/IRAMIS, Ecole Polytechnique, CNRS, Institut Polytechniquede Paris, 91128 Palaiseau, France*
[4]*Centre de Nanosciences et de Nanotechnologies, CNRS, Université Paris-Saclay, 91120 Palaiseau, France*

**Corresponding author: jazmin.aragon@ib.edu.ar*

Inferring the nature of disorder in the media where elastic objects are nucleated is of crucial importance for many applications but remains a challenging basic-science problem. Here we propose a method to discern whether weak-point or string-correlated disorder dominates based on characterizing the distribution of the interaction forces between objects mapped in large fields-of-view. We illustrate our proposal with the case-study system of vortex structures nucleated in type-II superconductors with different pinning landscapes. Interaction force distributions are computed from individual vortex positions imaged in thousands-vortices fields-of-view in a two-orders-or-magnitude-wide vortex-density range. Vortex structures nucleated in point-disordered media present Gaussian distributions of the interaction force components. In contrast, if the media have dilute and randomly distributed correlated disorder, these distributions present non-Gaussian algebraically-decaying tails for large force magnitudes. We propose that detecting this deviation from the Gaussian behavior is a fingerprint of strong disorder, in our case originated from a dilute distribution of correlated centers.

FEEDBACK DRIVEN JOSEPHSON EFFECT IN ULTRA SMALL TUNNEL JUNCTIONS

Víctor Barrena[1], Samuel Díaz[2], Marta Fernández Lomana[1], David Perconte[1], Edwin Herrera[1], Beilun Wu[1], Isabel Guillamón[1], Alfredo Levy Yeyati[2] and **Hermann Suderow[1*]**

[1]Laboratorio de Bajas Temperaturas, Departamento de Física de la Materia Condensada, Instituto Nicolás Cabrera and Condensed MatterPhysics Center (IFIMAC), Unidad Asociada UAM-CSIC, Universidad Autónoma de Madrid, E-28049 Madrid, Spain
[2]Departamento de Física Teórica de la Materia Condensada, Instituto Nicolás Cabrera and Condensed MatterPhysics Center (IFIMAC), Universidad Autónoma de Madrid, E-28049 Madrid, Spain

**Corresponding author: hermann.suderow@uam.es*

The Josephson effect is the consequence of coupling between two superconducting electrodes and consists of a Cooper pair current flowing between two superconductors at zero bias voltage V=0 and coherent emission of microwave photons at a finite bias voltage V≠0. Here we show that a Josephson junction coupled to a circuit element with feedback has a large bias range above the critical current where the junction periodically flows back to the V=0 state from the V≠0 branch. We discuss the parameter range for the new oscillatory behavior with a RCSJ model modified by a feedback. We measure the resulting low frequency AC oscillations in atomic size ultra small vacuum tunnel junctions of Pb-Pb, Al-Al and Pb-$NbSe_2$ obtained by using superconducting tips in a Scanning Tunneling Microscope.

BASIC PHYSICOCHEMICAL PROPERTIES OF GdFeAsO:Co SINGLE CRYSTALS

Paweł Górniak[1,2], Michał Babij[1], Andrzej Zaleski[1], Masashi Tanak[3], Yoshihiko Takano[4], **Lan Maria Tran[1*]**

[1]Institute of Low Temperature and Structural Research, Polish Academy of Sciences in Wroclaw, ul. Okolna 2, 50-422 Wroclaw, Poland
[2]Wrocław University of Science and Technology, WybrzeżeWyspiańskiego 27, 50-370 Wrocław, Poland
[3]Graduate School of Engineering, Kyushu Institute of Technology, 1-1 Sensui-cho, Tobata, Kitakyushu 804-8550, Japan
[4]National Institute for Materials Science (NIMS), 1 2 1 Sengen, Tsukuba 305-0047 Japan

**Corresponding author: l.m.tran@intibs.pl*

We have grown several compositions of GdFeAs:Co using the salt flux method. In the literature, the polycrystalline samples were found to exhibit (depending on the Co-concentration) 3d and 4f magnetism, as well as superconductivity [1-3]; therefore bringing close resemblance to the $EuFe_2As_2$:Co.
While in general iron based superconductors have relatively small anisotropy of physical properties, neverthelesscompounds with f-electron magnetic ions (e.g. $EuFe_2As_2$:Co) exhibit a strong dependence on the direction of applied magnetic field [4, 5 and references therein].
We think that similar phenomenon should occur in the GdFeAsO:Co with the Gd^{3+} ion. In this contribution we present the basic physicochemical characterization of single crystals of GdFeAsO:Co.

[1] T. Shang et al., Phys. Rev. B 87 075148 (2013).
[2] G.K. Selvan et al., Supercond. Sci. Technol. 28 015009 (2015).
[3] T. Shang et al., Phys. Rev. B 91, 125106 (2015).
[4] L.M. Tran et al., Phys Rev B 98 104412 (2018).
[5] L.M. Tran, Investigation of the coexistence of superconductivity and magnetism in substituted EuFe2As2, lmt. Wrocław 2017, ISBN 978-83-948287-0-7, eISBN 978-83-948287-1-4.

BROADENINGOF THE IN-GAP-STATE ENERGIES AT NON-ZERO TEMPERATURES OF THE SUPERCONDUCTING QUANTUM DOT: A GREEN'S FUNCTION STUDY

Jiawei Yan* and Václav Janiš

Institute of Physics of the Czech Academy of Sciences, Na Slovance 1999/2, 182 00 Praha 8, Czech Republic

**Corresponding author: yan@fzu.cz*

A single quantum dot attached to two superconducting leads has recently raised great interest due to its novel physics and potential application in nanoelectronics and quantum computing. Here, we employ our recently developed many-body perturbation theory [1] to study the spectral properties of the superconducting quantum dot in the weak coupling regime. We determine the dynamical self-energy on the dot from the Schwinger-Dyson equation with the two-particle vertex calculated from the reduced parquet equations of Ref. [2]. The one-particle Green function in the Schwinger-Dyson equation must be used fully self-consistently with the resulting self-energy. This is the only way to guarantee analytic properties of the Green functions and physical consistency. Consequently, the zero-temperature poles due to the in-gap states of the one-particle propagator are broadened to bands by thermal fluctuations at non-zero temperatures.

[1] V Janiš, J Yan, arXiv preprint arXiv:2102.13035.
[2] V Janiš, P Zalom, V Pokorný, and A Klíč Phys. Rev. B 100, 195114 (2019).

List of Participants

Name	Country	Contribution	Page
Ahmad, Halima Giovanna	Italy	***TALK - 35 _ THURSDAY - 09:00***	47
Aichner, Bernd	Austria	***POSTER 01 _ TUESDAY - 17:00***	68
Arita, Ryotaro	Japan	***TALK - 29 _ WEDNESDAY - 09:50***	41
Arutyunov, Konstantin	Russia	***POSTER 16 _ THURSDAY - 17:00***	83
Ayress, Jake	United Kingdom	***TALK - 15 _ TUESDAY - 09:25***	27
Barišič, Neven	Austria & Croatia	***TALK - 14 _ TUESDAY - 09:00***	26
Babij, Michal	Poland	***POSTER 17 _ THURSDAY - 17:00***	84
Bačkai, Julius	Slovakia	***POSTER 18 _ THURSDAY - 17:00***	85
Baránek, Martin	Slovakia	***POSTER 19 _ THURSDAY - 17:00***	86
Bending, Simon	United Kingdom	***TALK - 51 _ FRIDAY - 10:30***	63
Black-Schaffer, Anika	Sweden	***TALK - 42 _ THURSDAY - 12:10***	54
Buzdin, Alexander	France	***TALK - 39 _ THURSDAY - 10:55***	51
Bužek, Vladimír	Slovakia	***TALK - 47 _ THURSDAY - 16:10***	59
Calderón, María José	Spain	***TALK - 34 _ WEDNESDAY - 12:10***	46
Carreira, Santiago José	France	***TALK - 40 _ THURSDAY - 11:20***	52
Cayao, Jorge	Sweden	***TALK - 43 _ THURSDAY - 14:30***	55
Cieplak, Marta Z.	Poland	***TALK - 05 _ MONDAY - 10:55***	17
Cren, Tristan	France	***TALK - 48 _ FRIDAY - 09:00***	60
Crisan, Adrian	Romania	***TALK - 25 _ TUESDAY - 15:45***	37
Custers, Jeroen	Czech Republic	***POSTER 02 _ TUESDAY - 17:00***	69
Eremets, Mikhail	Germany	***TALK - 27 _ WEDNESDAY - 09:00***	39
Fasano, Yanina	Argentina	***TALK - 26 _ TUESDAY - 16:10***	38
Flachbart, Karol	Slovakia	***POSTER 20 _ THURSDAY - 17:00***	87
Fomin, Vladimir M.	Rep. of Moldova	***TALK - 11 _ MONDAY - 15:20***	23
Gabáni, Slavomír	Slovakia	***TALK - 30 _ WEDNESDAY - 10:30***	42
Gencer, Ali	Turkey	***TALK - 55 _ FRIDAY - 12:10***	67
Gmitra, Martin	Slovakia	***TALK - 50 _ FRIDAY - 09:50***	62
Grajcar, Miroslav	Slovakia	***POSTER 03 _ TUESDAY - 17:00***	70
Guinea, Francisco	Spain	***TALK - 31 _ FRIDAY - 10:55***	43
Hakonen, Perti	Finland	***TALK - 38 _ THURSDAY - 10:30***	50
Haniš, Jozef	Slovakia	***POSTER 04 _ TUESDAY - 17:00***	71
Herman, František	Slovakia	***POSTER 05 _ TUESDAY - 17:00***	72
Herrera Vasco, Edwin	Spain	***TALK - 54 _ FRIDAY - 11:45***	66
Hlubina, Richard	Slovakia	***TALK - 02 _ MONDAY - 09:25***	14
Huber, Thomas	Germany	***POSTER 06 _ TUESDAY - 17:00***	73
Kačmarčík, Jozef	Slovakia	***TALK - 18 _ TUESDAY - 10:55***	30
Kalmár, Tamás	Hungary	***POSTER 21 _ THURSDAY - 17:00***	88
Kern, Samuel	Slovakia	***POSTER 07 _ TUESDAY - 17:00***	74
Kochan, Denis	Germany	***TALK - 41 _ THURSDAY - 11:45***	53
Kopčík, Michal	Slovakia	***POSTER 13 _ TUESDAY - 17:00***	80

Name	Country	Contribution	Page
Kovács-Krausz, Zoltán	Hungary	***POSTER 22 _ THURSDAY - 17:00***	89
Kuzmiak, Marek	Slovakia	***POSTER 23 _ THURSDAY - 17:00***	90
Lang, Wolfgang	Austria	***TALK - 19 _ TUESDAY - 11:20***	31
Leridon, Brigitte	France	***TALK - 23 _ TUESDAY - 14:55***	35
Linek, Julian	Germany	***TALK - 36 _ THURSDAY - 09:25***	48
Lombardi, Floriana	Sweden	***TALK - 17 _ TUESDAY - 10:30***	29
Maccari, Ilaria	Sweden	***TALK - 08 _ MONDAY - 12:10***	20
Maggio-Aprile, Ivan	Switzerland	***TALK - 24 _ TUESDAY - 15:20***	36
Makk, Péter	Hungary	***TALK - 45 _ THURSDAY - 15:20***	57
Marinković, Stefan	Belgium	***TALK - 16 _ TUESDAY - 09:50***	28
Martín-Vega, Francisco	Spain	***TALK - 53 _ FRIDAY - 11:20***	65
Milošević, Milorad	Belgium	***TALK - 09 _ MONDAY - 14:30***	21
Montemuro, Domenico	Italy	***TALK - 37 _ THURSDAY - 09:50***	49
Moreno, Jose Antonio	Spain	***POSTER 08 _ TUESDAY - 17:00***	75
Neilinger, Pavol	Slovakia	***TALK - 03 _ MONDAY - 09:50***	15
Nemes-Incze, Péter	Hungary	***TALK - 33 _ WEDNESDAY - 11:45***	45
Novotný, Tomáš	Czech Republic	***POSTER 24 _ THURSDAY - 17:00***	91
Palau, Anna	Spain	***TALK - 32 _ THURSDAY - 11:20***	44
Panch, Ram	Czech Republic	***POSTER 25 _ THURSDAY - 17:00***	92
Papari, Gian Paolo	Italy	***POSTER 26 _ THURSDAY - 17:00***	93
Pfaffinger, Lea	Germany	***POSTER 09 _ TUESDAY - 17:00***	76
Pokorný, Vladislav	Czech Republic	***TALK - 13 _ MONDAY - 16:10***	25
Prok, Tamas	Hungary	***POSTER 27 _ THURSDAY - 17:00***	94
Pribulová, Zuzana	Slovakia	***POSTER 10 _ TUESDAY - 17:00***	77
Pristáš, Gabriel	Slovakia	***POSTER 11 _ TUESDAY - 17:00***	78
Pugach, Natalia	Russia	***POSTER 28 _ THURSDAY - 17:00***	95
Raychaudhuri, Pratap	India	***TALK - 07 _ MONDAY - 11:45***	19
Roditchev, Dimitri	France	***TALK - 01_ MONDAY - 09:00***	13
Samuely, Peter	Slovakia	***POSTER 12 _ TUESDAY - 17:00***	79
Samuely, Tomáš	Slovakia	***TALK - 44 _ THURSDAY - 14:55***	56
Sanchez, Jazmin Aragon	Argentina	***POSTER 29 _ THURSDAY - 17:00***	96
Shimizu, Katsuya	Japan	***TALK - 28 _ WEDNESDAY - 09:25***	40
Sobolewski, Roman	United States	***TALK - 20 _ TUESDAY - 11:45***	32
Skyba, Peter	Slovakia	***TALK - 46 _ THURSDAY - 15:45***	58
Strunk, Christoph	Germany	***TALK - 06 _ MONDAY - 11:20***	18
Suderow, Hermann	Spain	***POSTER 30 _ THURSDAY - 17:00***	97
Szabó, Pavol	Slovakia	***TALK - 04 _ MONDAY - 10:30***	16
Šofranko, Ondrej	Slovakia	***TALK - 49 _ FRIDAY - 09:25***	61
Šindler, Michal	Czech Republic	***TALK - 22 _ TUESDAY - 14:30***	34
Tran, Lan Maria	Poland	***POSTER 31 _ THURSDAY - 17:00***	98
Van de Vondel, Joris	Belgium	***TALK - 10 _ MONDAY - 14:55***	22
Vaňo, Viliam	Finland	***TALK - 52 _ FRIDAY - 10:55***	64
Varlamov, Andrey	Italy	***TALK - 12 _ MONDAY - 15:45***	24

Name	Country	Contribution	Page
Vincent, Humbert	France	***TALK - 21 _ TUESDAY - 12:10***	33
Weitzel, Alexander	Germany	***POSTER 09 _ TUESDAY - 17:00***	76
Wu, Beilun	Spain	***POSTER 14 _ TUESDAY - 17:00***	81
Zajcewa, Irina	Poland	***POSTER 15 _ TUESDAY - 17:00***	82
Yan, Jiawei	Czech Republic	***POSTER 32 _ THURSDAY - 17:00***	99

Organizers:

Pavol Szabó – *IEP SAS, Košice, Slovakia* .... pszabo@saske.sk
Peter Samuely – *IEP SAS, Košice, Slovakia* .... samuely@saske.sk
Jozef Kačmarčík – *IEP SAS, Košice, Slovakia* .... kacmarci@saske.sk
Tomáš Samuely – *FS UPJŠ, Košice, Slovakia* .... tomas.samuely@upjs.sk
Hermann Suderow – *UAM, Madrid, Spain* .... hermann.suderow@uam.es
Irene González Martín – *UAM, Madrid, Spain* .... irene.gonzalezm@uam.es