Réunion thématique

Supraconductivité

Paris, 6-7 décembre 2021

GDR MEETICC

Introduction

Le but de cette réunion du GDR MEETICC est de rassembler la communauté française travaillant sur le thème de la supraconductivité et de faire le point sur les sujets d'actualités du domaine:

- supraconductivité non-conventionnelle: mécanismes, diagrammes de phases, criticalité quantiques, effets des corrélations (cuprates, supraconducteurs au fer, ruthenates, fermions lourds...),
- nouveaux matériaux supraconducteurs (nickelates...) et nouvelles techniques,
- supraconductivité à basse dimension, dispositifs,
- développements théoriques,
- supraconductivité hors-équilibre et modes collectifs.

Organisateurs

- Yann Gallais, Alain Sacuto, Maximilien Cazayous (MPQ, Université de Paris), Dorothée Colson (SPEC, CEA Saclay)
- bureau du GDR MEETICC

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Cuprates

Evidence for coexistence of charge and antiferromagnetic orders in a high T_c superconductor

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Multilayered cuprates possess not only the highest superconducting temperature transition but also offer a unique platform to study disorder-free CuO_2 planes and the interplay between competing orders with superconductivity. After a short introduction on cuprate superconductors, I'll present a recent study of quantum oscillation and Hall effect in magnetic field up to 88 T in the underdoped trilayer cuprate $HgBa_2Ca_2Cu_3O_{8+\delta}$. A careful analysis of the complex spectra of quantum oscillations strongly supports the coexistence of multiple competing orders. In particular, our interpretation implies that a metallic antiferromagnetic state extends deep inside the SC phase, a key ingredient that supports magnetically mediated pairing interaction in cuprates.

Work in collaboration with B. Vignolle (ICMCB Bordeaux), D. Colson and A. Forget (SPEC, CEA Saclay), V. Oliviero, S. Benhabib, I. Gilmutdinov, M. Massoudzadegan, M. Leroux, G.L.J.A. Rikken and D. Vignolles (LNCMI-Toulouse)

Distinguishing electronic anisotropy from nematic correlation in the cuprates

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Electronic nematic systems are those that break rotational symmetry spontaneously due to electron-electron interaction, and that develop directional properties or anisotropies below a certain temperature. Our understanding of materials close to such nematic instabilities has improved vastly in recent times due to the discovery of the iron-based superconductors, and we are well-placed to address the relevance of electronic nematicity in more complex superconductors such as the cuprates. In this context I will compare the nematic properties of the iron-based systems with that of the cuprates in order to address the question whether the underdoped cuprates exhibit nematic instability or not. In particular, I will discuss how the pseudogap in the cuprates can play an important role to produce interesting electronic anisotropic properties that may not imply large nematic correlations.

Loop currents in high-temperature superconductors

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Résumé

In many quantum materials, strong electron correlations lead to the emergence of new states of matter. In particular, the study in the last decades of the complex phase diagram of high temperature superconducting cuprates highlighted intra-unit-cell electronic instabilities breaking discrete Ising-like symmetries, while preserving the lattice translation invariance [1]. Polarized neutron diffraction experiments have provided compelling evidences supporting a new form of intra-unit-cell magnetism, emerging concomitantly with the so-called pseudogap state of these materials. This observation is currently interpreted as the magnetic hallmark of an intra-unit-cell loop current order, breaking both parity and time-reversal symmetries. In this talk, I will review the observation of this magnetoelectric state in superconducting cuprates, in the spin liquid state of hole-doped 2-leg ladder cuprates [2] or in the hole-doped Mott insulating iridates. I will also show some recent polarized neutron diffraction results in underdoped YBa2Cu3O6.6. These results indicate a local magnetic quadrupling (2x2) of the unit cell at short range, that suggests a real space picture of a mixed state of loop currents.

P. Bourges, D. Bounoua, and Y. Sidis, https://arxiv.org/abs/2103.13295 to appear in C.R. Physique (2021).

D. Bounoua et al, Comm. Phys, **2**, 123 (2020).

*Intervenant

Nouvelles approches et techniques

Manipulating matter by strong coupling to the vacuum field

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Over the past decade, the possibility of manipulating material and chemical properties by using hybrid light-matter states has stimulated considerable interest. Such hybrid light-matter states can be generated by strongly coupling the material to the spatially confined electromagnetic field of an optical resonator. Most importantly, this occurs even in the dark because the coupling involves the electromagnetic fluctuations of the resonator, the vacuum field. After introducing the fundamental concepts, examples of modified properties of strongly coupled systems, such as conductivity, superconductivity and ferromagnetism, will be given to illustrate the broad potential of light-matter states for material science.

Diamond-based quantum sensing for high-pressure superconductivity

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The nitrogen-vacancy (NV) color center is a point defect of diamond that behaves as an artificial atom with a discrete spectrum of quantum states. Due to this remarkable property, the NV center can be used as a magnetic field, pressure, and temperature solid-state quantum sensor down to the atomic scale. NV-based quantum sensing can be implemented inside a diamond anvil cell in order to investigate the magnetic and superconducting properties of high-pressure materials. Indeed, the diamond anvil cell is a table-top system that implements in laboratory conditions pressures above the megabar range, leading to the onset of specific quantum states of matter. However, confining the sample in the tiny dimension of the diamond anvil cell makes the implementation of any non-optical sensing technique highly challenging.

The magnetic sensitivity of NV centers allowed us to directly observe the Meissner effect associated to high-pressure superconducting materials inside a diamond anvil cell, at pressures up to about 50 GPa. This high-pressure sensing method is compatible with synchrotron-based characterization of the crystalline structure. I will discuss how this technique could be adapted to probe the superconductivity of metallic super-hydrides.

Exploring THz electrodynamics of superconductors with Kinetic Inductance Detectors

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Résumé

Kinetic Inductance Detectors (KIDs) are state-of-the-art detectors used for millimeter wave observations in astrophysics. They are planar resonant circuits made of superconductors deposited on an insulating substrate. The photon detection principe consists in monitoring the resonance frequency shift that is proportional to the incident power [1].

We adapt the instrumentation for astrophysics observation based on KIDs [2] to explore the electrodynamics of superconductors. We measured at 100 mK from 0 GHz up to 300 GHz with a resolution of 1GHz the electrodynamics of granular aluminum superconductors. The study has shown the emergence of strong sub-gap collective modes close to the superconductor to insulator transition [3].

In this talk, I will explain the working principle of Kinetic Inductance Detectors and I will present how they are implemented for astrophysics observations. I will describe in more detail how Kinetic Inductance Detectors can be used to explore the electrodynamics of superconductors. I will illustrate this last point by showing optical spectroscopy measurements of granular aluminum thin films with strong sub-gap responses. I will briefly discuss why such sub-gap modes are, a priori, unexpected and how we understand them. Finally, I will explain how these superconducting sub-gap modes might be useful for photon detection [4,5].

P. K. Day et al, Nature, vol. 425, 817 (2003).

A. Monfardini and G. Lagache, Nature Astronomy 5, 970 (2021).

F. Levy-Bertrand et al, Phys. Rev. B 99, 094506 (2019).

O. Dupré et al, Superconductor Science and Technology, 30, 045007 (2017).

F. Levy-Bertrand et al, Phys. Rev. Applied 15, 044002 (2021).

*Intervenant

Nouveaux matériaux SC

Nickelate superconductors

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The infinite-layer nickelates RNiO2 (R = rare-earth element) have long been discussed as candidate materials for cuprate-like high-Tc superconductivity. Thus, the recent discovery of unconventional superconductivity in hole-doped nickelate thin films has sparked a massive research interest in these systems [1,2]. The electronic properties of these nickelates display interesting analogies with the high-Tc cuprates and, at the same time, intriguing differences that deserve close attention. In this presentation we will provide an overview of the state-of-the-art in the field and discuss prospective materials within the same cuprate-like class as well as the challenge of promoting nickelate superconductivity from thin films to bulk samples.

[1] Superconductivity in an infinite-layer nickelate, Li et al., Nature, 572 624 (2019).

[2] Nickelate superconductors: an ongoing dialog between theory and experiments, A.S. Botana, F. Bernardini and A. Cano, JETP 159, 711 (2021).

New As/Se-free iron-based superconductors by topotactic fluorination of intermetallics

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Iron-based superconductors (IBSC) are made of building blocks containing iron atoms associated to a pnictogen or chalcogen element (P, As and S, Se, Te respectively)[1]. The recent discovery of superconductivity in LaFeSiH (T_c=10K) by solid-gas hydrogenation of LaFeSi, i.e. the first IBSC containing FeSi as conductive layer, has motivated the research of new IBSC by topotactic intercalation of light element in intermetallics[2]. However, fluorine insertion has remained elusive so far since the strong reactivity of this atypical element, the most electronegative one, tends to produce the chemical decomposition of intermetallic compounds.

Here, we introduce a new topochemical method to intercalate fluorine atoms into intermetallics, using perfluorocarbon reactant with iono-covalent C-F bonds. We demonstrate the potential of this novel approach with the synthesis of non-stoichiometric mixed anion (Si-F) $LaFeSiF_x$ single-crystals in which we observe the coexistence of ionic and metallo-covalent blocks in interaction through inductive effects[3]. In addition, we show the emergence of superconductivity across this series that thus extends the family of IBSC to novel FeSi-based materials beyond the conventional ferropnictides and chalcogenides.

References

[1] H. Hosono, K. Tanabe, E. Takayama-Muromachi, H. Kageyama, S. Yamanaka, H. Kumakura, M. Nohara, H. Hiramatsu, and S. Fujitsu, Sci. Technol. Adv. Mater. 16, 033503 (2016).

[2] F. Bernardini, G. Garbarino, A. Sulpice, M. Nuñez-Regueiro, E. Gaudin, B. Chevalier, M-A. Méasson, A. Cano, and S. Tencé, Phys. Rev. B, 97, 100504(R) (2018).

[3] J-B. Vaney, B. Vignolle, A. Demourgues, E. Gaudin, E. Durand, C. Labrugère, F. Bernardini, A. Cano, S. Tencé, submitted in Nature Comm. (2021).

Optical Identification of the Superconductive BandGap in Nickelate $Nd_{0.8}Sr_{0.2}NiO_2$

Rebecca Cervasio[1]*, Luca Tomarchio[2,3]*, Marine Verseils[1], Jean-Blaise Brubach[1], Salvatore Macis[2,4], Ariando Ariando[5], Pascale Roy[1], and Stefano Lupi[2,4]

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The intensive search for alternative non-cuprate high-transition-temperature (T_c) superconductor has taken a positive turn recently with the discovery of superconductivity in Nickelates by Li et al. *(Nature 572, 624–627, 2019)*. Indeed, this discovery is expected to be the basis for disentangling the puzzle behind the physics of high T_c in oxides. In the unsolved quest for the physical conditions necessary for inducing superconductivity, we report an optical study of a $Nd_{0.8}Sr_{0.2}NiO_2$ film measured using synchrotron THz and IR/VIS/UV absolute reflectance spectroscopy, at temperatures above and below the critical $T_c \sim 13$ K. In the normal state, the film is described by the Drude model for metallic transport, from which the scattering time just above T_c is determined. Below T_c, the formation of a superconducting energy gap (2Δ) at ~ 3.2 meV is extracted using a fitting algorithm based on the Mattis-Bardeen model. These results together with an estimation of the scattering time are consistent with the superconductive film being in the dirty limit. Finally, a zero-temperature value of 490 nm is extracted for the London penetration depth, which is in accordance with the type-II superconductive nature.

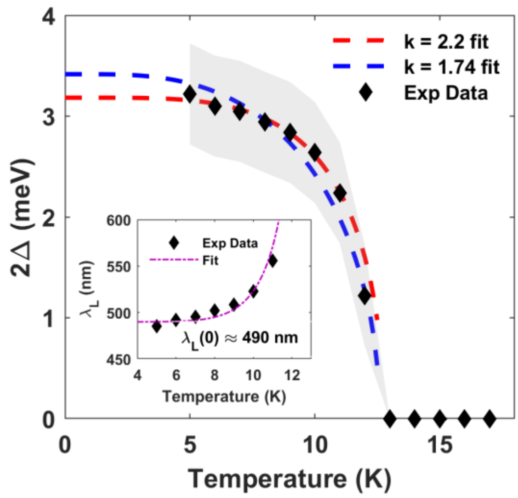

Figure 1. Gap energy and London penetration depth of $Nd_{0.8}Sr_{0.2}NiO_2$ superconductive film as function of temperature.

Universal magnetic phase in Fe based 1D superconductors : a requirement for superconductivity ?

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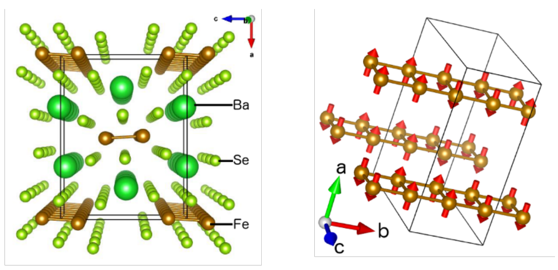
In the last years, superconductivity has been observed in iron based one dimensional compounds, namely $BaFe_2S_3$ and $BaFe_2Se_3$. Both have a centrosymmetric average space group (Cmcm and Pnma respectively) at room temperature, in which iron atoms form two distinct ladders along the b-axis (see Fig. 1). Below the Néel temperature (110K and 225(±30)K respectively), the iron spins are arranged in squares of 4 ferromagnetically ordered spins, each block being coupled antiferromagnetically to its neighbour (see Fig. 1), revealing a underlying magnentic frustration. However for both system the stacking of these magnetic ladders differs, resulting in different magnetic orders. Upon pressure, a metalization is observed and superconductivity develops below 14K above 10GPa. In this presentation we will present the pressure-temperature phase diagramm of $BaFe_2Se_3$ deduced from neutron scattering and X-ray spectroscopy. We unveiled a new high pressure magnetic phase in this compounds corresponding to the one observed in $BaFe_2S_3$. This open a way to a unique theoretical model to describe superconductivity in these one dimensional systems, based on common magnetic fluctuations.



Left : atomic structure projected along the ladder (b axis), comprised of two ladders by unit cell. Right : Magnetic structure at low temeprature for $BaFe_2Se_3$

Sr2RuO4

Is the pairing in Sr_2RuO_4 inter-orbital?

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A combination of strong Hund's coupling and strong spin-orbit coupling may lead to superconductivity through inter-orbital pairing, in which the Cooper pairs are comprised of electrons in different orbitals. In this talk, we will present evidence that such pairing may occur in Sr_2RuO_4. We will show evidence from the Hall effect measured under uniaxial stress of orbital de-coupling, an expected consequence of strong Hund's coupling. We will show that T_c is suppressed by uniaxial compression along the c axis, and explain why this is not the expected behaviour for conventional pairing. Finally, we will show evidence from muon spin rotation for a two-component order parameter, that might be most easily explained by interorbital pairing.

Towards an understanding of the pairing state of Sr_2RuO_4

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I will review the established description of the normal state of Sr2RuO4 as a `Hund's metal' and present recent progress towards a microscopic understanding of its pairing state.

[S.Käser et al., arXiv:2105.08448]

Cuprates

Charge orders and Strange metals in cuprate superconductors

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Charge orders and charge fluctuations have been ubiquitously observed in the phase diagram of Cuprate superconductors. We will review the experimental status of these various observations, differentiating the under-doped region and the optimally-doped and over-doped ones. Various theories have been advanced to explain the presence of these orders and their implication for our understanding of the pseudo-gap, from the idea of “vestigial order” to the one of “fluctuating Pair Density Wave (PDW)”. We will discuss these theoretical approaches in direct comparison with experiments. We will then introduce a proposal of “fractionalization of a PDW” in order to explain the pseudo-gap state. We will show that this idea produces a strong phenomenology, especially ARPES experiments, and giving a clue for the puzzling transport properties recently reported in the optimally doped and over-doped regions. We will then focus on the strange metal phase of those compounds and make a proposal for electric transport in this phase.

Deconstructing the spin susceptibility of $YBa_2Cu_3O_y$

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A good indication that high T_c superconductivity is a hard problem is that, after 35 years of research, we are still trying to understand basic properties of the cuprates such as the linear-in-temperature resistivity (a defining property of the *strange metal* phase) or the decrease of the spin susceptibility χ_{spin} upon cooling (an iconic, albeit not unique, signature of the *pseudogap* state).

The persistence of these questions should, however, not underplay the tremendous progress accomplished in understanding these materials. In particular, experiments performed in high magnetic field have exposed *competing orders*, *i.e.* spin and/or charge ordered states that are weakened or even precluded by superconductivity. A prominent such example is the charge-density wave in $YBa_2Cu_3O_y$ [T. Wu *et al.* Nature 477, 191 (2011)].

Here, I will present another outcome of this high-field strategy: the normal state χ_{spin} can be deconstructed, *i.e.* its different contributions can be singled out, from NMR measurements of the Knight shift in the CDW state of $YBa_2Cu_3O_y$. I will argue that the data invite an interpretation of the pseudogap in χ_{spin} as a composite phenomenon.

Absence of the superconducting collective excitations in the optically excited nonequilibrium state of underdoped $YBa_2Cu_3O_y$

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Observation of superconducting (SC) like transient response in the *c*-axis optical conductivity far above the SC transition temperature T_c in underdoped $YBa_2Cu_3O_y$ (YBCO) under intense laser pulse irradiation has attracted significant attention among the broad field of condensed matter physics [W. Hu *et al*., Nat. Mater. **13**, 705 (2014) and S. Kaiser *et al*., Phys. Rev. B **89**, 184516 (2014)]. Afterward, various theoretical and experimental studies have been devoted to elucidating its microscopic origin. However, one remaining problem is that one cannot distinguish the $1/\omega$-like SC response and the Drude response of the quasiparticle excitation with an extremely low scattering rate from the measured optical conductivity in the terahertz (THz) frequency range. To circumvent this problem, we investigated the optically induced nonequilibrium state in underdoped YBCO samples using the THz nonlinear optical responses arising from the SC collective excitations: the Higgs mode and the ac-driven Josephson current. We observed the near-infrared (NIR) pump-induced $1/\omega$-like increase in the imaginary part of the *c*-axis optical conductivity above T_c, consistent with the previous studies. Besides, we found that the NIR pump-induced change in the reflected THz pulse emerged below the pseudogap opening temperature, indicating its relevance to the pseudogap. On the other hand, neither the THz nonlinear optical response of the Higgs mode nor the ac-driven Josephson current was observed in such a optically excited state, revealing that the optically induced state exhibiting the $1/\omega$-like response is distinct from the superconductivity in equilibrium. Our results suggest that the photoexcited nonequilibrium state provides an essential clue to understanding the pseudogap.

SC 2D et mésoscopique

Tunnelling spectroscopy of few-monolayer $NbSe_2$ in high magnetic field: Ising protection and triplet superconductivity

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Triplet superconductivity are expected to arise in systems with superconducting correlations in which non-colinear magnetic fields exist, perhaps most notoriously in magnetic textures. Triplet pairs have recently been predicted to arise in superconductors with Ising (or valley Zeeman) spin-orbit coupling (ISOC), such as $NbSe_2$, due to the non-colinearity between the Ising field, which pins Cooper pair spins out-of-plane, and an applied in-plane magnetic field. Using van der Waals tunnel junctions, we perform spectroscopy of superconducting $NbSe_2$ flakes, of thicknesses ranging from 2--25 monolayers, measuring the quasiparticle density of states as a function of applied in-plane magnetic field up to 33T, the first spectroscopy measurements on TMDs at these fields. In flakes up to $\approx$ 15 monolayers thick, we find that the density of states is well-described by a single band superconductor. In these thin samples, the magnetic field acts primarily on the spin (vs orbital) degree of freedom of the electrons, and superconductivity is further protected by ISOC. We extract the superconducting energy gap as a function of the applied magnetic field from our tunnelling data. In bilayer $NbSe_2$, close to the critical field (up to 30T, much larger than the Pauli limit), superconductivity appears to be even more robust than expected if only ISOC is considered. There are two possible explanations for our data: either the predicted subdominant equal-spin, odd-parity triplet component of the order parameter, coupled to the dominant singlet component at finite field; or the existence of superconductivity in both Γ and K pockets of the Nb-derived band.

Odd-frequency pairing induced by magnetic impurities in superconductors

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Résumé

The study of magnetic impurities have received a recent resurgence of interest, fueled in part by possible sightings of topological superconductivity in chains of magnetic adatoms on superconducting substrates or the Majorana edge modes of two-dimensional topological superconductors. More than forty years ago, Berezinskii proposed that the pairing function can be odd under time exchange. It has been realized that odd-frequency pairing should appear in heterostructures made of a conventional s-wave superconductor and a ferromagnet which breaks time-reversal symmetry. Here, we will show experimental evidence of the existence of odd-ω pairing in the simplest hybrid system: a single magnetic impurity immersed in a conventional s-wave superconductor, a Pb/Si(111) monolayer. Using measurements of the local electron density of states by STM, we show explicitly how the superconducting odd-ω pairing function can be extracted [1]. [1] V. Perrin et al., Physical Review Letters 125, 117003 (2020).

*Intervenant

Fate of the superfluid density near the SIT in amorphous superconductors

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Résumé

Superconducting films of amorphous Indium Oxide (a:InO) undergo a transition to insulation upon increasing disorder, driven by the localization of preformed Cooper pairs. The continuous decrease of the critical temperature as the critical disorder approaches indicates a similarly continuous suppression of the superfluid density. In this talk I discuss the fate of the superfluid density in the vicinity of this transition to insulation. We have accurately measured the superfluid density by a systematic study of the plasmon dispersion spectrum of microwave resonators made of a:InO, combined with DC resistivity measurements, as a function of disorder. We observed that the superfluid stiffness defines the superconducting critical temperature over a wide range of disorder, highlighting the dominant role of phase fluctuations. Furthermore, we found that the superfluid density remains surprisingly finite at the critical disorder, indicating an unexpected first-order nature of the disorder-driven quantum phase transition to insulator.

*Intervenant

Superconductivity at 2 K in $KTaO_3$ two-dimensional electron gases

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The two-dimensional electron gas (2DEG) at the interface between $SrTiO_3$ (STO) and $LaAlO_3$[1], displays a wide array of functionalities such as high electronic mobility, low temperature superconductivity[2] and tunable Rashba spin-orbit coupling (SOC)[3]. Understanding the physics of STO 2DEGs has challenged our community since that original discovery but also led to exciting properties for device applications into fields as diverse as power electronics, photocatalysis, spin-orbitronics[4] or topological quantum computing[5]. These latter two directions aim to specifically exploit the most unique properties of STO 2DEGs, namely Rashba SOC and 2D superconductivity. Yet, the Rashba coefficient in STO 2DEGs remains relatively small (α_R<50 meV.Å) and their superconducting T_C is low (~250 mK), hampering development towards these exciting goals.

Just like STO, $KTaO_3$ (KTO) is a quantum paraelectric material that in the bulk can be turned into a metal by minute electron doping, leading to high-mobility transport[6]. A major difference is that unlike in STO, doping does not lead to superconductivity in bulk KTO. Using ionic gating, Ueno *et al.* could demonstrate in 2004 a superconducting state in KTO (001) albeit only at 40 mK[7]. Later explorations of KTO 2DEGs did not evidence superconductivity until earlier this year when Liu *et al.* showed a superconducting 2DEG at ~2 K in (111)-oriented KTO [8]. This result was confirmed weeks later[9] and further (110)-oriented KTO 2DEGs were also found to superconducting below ~1 K[10].

In this presentation, we will demonstrate our first results on the fabrication of superconducting 2DEG based on KTO (111). In contrast to Refs.[8,9] who defined the 2DEGs by growing $LaAlO_3$ via pulsed laser deposition or Eu by molecular beam epitaxy, we do it by sputtering a simple Al thin film, which is advantageous in terms of cost and for nanofabrication and future device integration. We will present transport properties as a function of temperature, magnetic field and gate voltage and discuss the electronic structure of this new system.

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Fe SC

Nematic fluctuations in iron-based superconductors without stripe-type magnetism

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I will discuss nematic fluctuations in two types of iron-based superconductors which do not exhibit the stripe-type magnetic order that is typically associated with nematicity. $CaK(Fe_{1-x}Ni_x)_4As_4$ resembles the archetypal 122-type iron-based materials but hosts one of the few examples of the so-called spin-vortex crystal magnetic order, a non-collinear magnetic configuration that preserves tetragonal symmetry, in contrast to the more common stripe-type magnetic order. The evolution of nematic fluctuations in such an unusual case is studied via elastoresistance and elastic modulus measurements combined with phenomenological modeling and density functional theory. Despite the absence of a finite nematic order parameter, we find clear experimental signatures of considerable nematic fluctuations. We address the effect of the specific crystal symmetry of the crystal structure in determining its magnetic ground state and nematic fluctuations. In contrast, the strongly-hole doped iron-based superconductors AFe_2As_2 (A=K,Rb,Cs) exhibit no magnetic order but stand out because of their strong electronic correlations. The symmetry channel and strength of nematic fluctuations, as well as possible nematic order, in these compounds remains obscure. We address these questions using transport measurements under elastic strain and elucidate the evolution of the elastoresistance across the hole-doping series from optimal to the fully overdoped end-members. Our technical development takes into consideration the extreme thermal expansion of some of these compounds. By decomposing the strain response into the appropriate symmetry channels, we demonstrate the emergence of a giant in-plane symmetric contribution, associated with the growth of both strong electronic correlations and their strain-sensitivity, whereas nematic fluctuations are continuously weakened.

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Interplay between superconductivity and nematicity in Co-doped $BaFe_2As_2$: an elasto-Raman study

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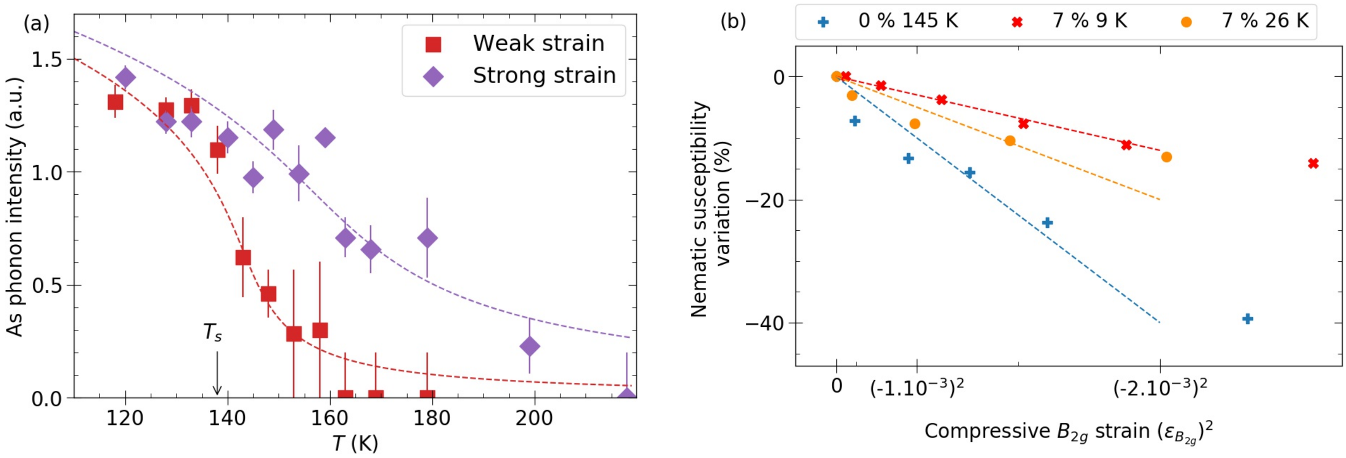
We report a Raman scattering study under tunable uniaxial strain of nematic and superconducting degrees of freedom in the iron-based superconductor $Ba(Fe_{1-x}Co_x)_2As_2$ for x = 0 and x = 0.07 (close to optimal doping). First, focusing on the parent compound, we demonstrate that the polarization resolved arsenic phonon intensity can be used to monitor the nematic order parameter as a function of both temperature and strain. Second, we show that in both the metallic and superconducting states, both compressive and tensile strains induce a suppression of the nematic fluctuations. This suppression could explain the decrease of T_c under strain observed in transport measurements. From our results, we estimate that the nemato-elastic coupling does not significantly decrease upon approaching the optimal doping, thus its role appears primordial for the emergence of the superconducting state and to explain the rather high T_c. Our elasto-Raman study illustrates the interest of combining selective anisotropic strain with a symmetry resolved probe like Raman scattering. Elasto-Raman scattering can be applied to a wide variety of quantum materials where uniaxial strain tunes electronic orders.



(a) Temperature dependence of the As phonon intensity for the parent compound under weak and strong strain, compared with an Ising behavior (dashed lines).

(b) The variation of the nematic susceptibility under compressive strain is similar for both dopings.

Quantum critical point and phase separation at finite doping in Hund metals

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"Hund metals" are multi-orbital paramagnetic metals with sizeable effects due to the intra-atomic exchange energy or Hund's coupling, and are characterised by strong, orbital-selective correlations and large fluctuating local magnetic moments. Their physics is relevant for iron-based superconductors and other materials like transition metal oxides.

A general feature found in models and realistic simulations of these materials, and corroborated by experimental data, is a frontier crossing the doping-interaction strength plane, and originating from the Mott transition point of the half-filled system, across which the aforementioned defining features are strongly enhanced.

This frontier is a cross-over at large doping while approaching half-filling it becomes a first-order transition between two metals. It features a phase separation zone ending in a quantum critical point at finite doping.

I will show that all this phenomenology is due to the first-order nature of the Mott transition and can be back-tracked to a small energy scale splitting the atomic ground-state multiplet, in this case the Hund's coupling.

I will highlight the perfect parallel with a leading scenario for the physics of the cuprates, and thus possibly a universal one for materials showing high-Tc superconductivity.

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UTe2 et Fermions Lourds

Exotic superconductivity in UTe2

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Résumé

Superconductivity in UTe2 has been discovered only in late 2018 and rapidly confirmed [1, 2]. UTe2 is paramagnetic and already in the first report [1] the possibility of spin triplet superconductivity and the importance of ferromagnetic fluctuations for the superconducting pairing has been stressed. It has been proposed that UTe2 belongs as paramagnetic end member to the family of the ferromagnetic superconductors like URhGe and UCoGe. However, rapidly it turned out that key differences in the crystal structure and by consequence on the magnetic interactions and the electronic structure make that the studies on UTe2 open new unique phenomena. The superconducting properties of UTe2 are extraordinary and I will focus in this presentation on the exceptionally huge upper critical field with field reentrant behavior, the occurrence of multiple superconducting phases in the temperature field, pressure phase diagram, the evidence of spin-triplet pairing. The different theoretical approaches will be described.

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*Intervenant

Magnetic excitation spectrum of the unconventional superconducor UTe_2

Stéphane Raymond[1], William Knafo[2], Georg Knebel[3], Paul Steffens[4], Koji Kaneko[5,6], Adrien Rosuel[3], Jean-Pascal Brison[3], Jacques Flouquet[3], Dai Aoki[7], Gérard Lapertot[3]

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The discovery of the heavy fermion superconductor UTe_2 ($T_{sc} \approx 1.6$ K) has triggered a wealth of research owing to the possible triplet and chiral nature of the superconductivity, the observation of multiple superconducting phases under magnetic field and pressure, as well as the proximity to a magnetic instability. The spin dynamics of UTe_2 was investigated by inelastic neutron scattering on a single crystal sample. In the normal state, the presence of incommensurate spin fluctuations peaked at the wave-vector $\mathbf{k_1}$=(0, 0.57, 0) is confirmed. The associated quasielastic response is characterized by a relaxation rate $\Gamma(\mathbf{k_1}) \approx 2.5$ meV. These fluctuations saturate below 15 K in possible relation with anomalies observed in bulk and NMR measurements. The low dimensional nature of the fluctuations is evidenced by the absence of correlations along the *c*-axis of the orthorhombic structure, where the signal has the characteristic signature of in-phase fluctuations of the two uranium atoms of the primitive unit cell. This peculiarity can be related to the spin ladder structure of UTe_2, where these two uranium atoms are forming the rungs. A feedback effect of superconductivity on the magnetic excitation spectrum manifests through the development below T_{sc} of an inelastic mode at $\Omega \approx 1$ meV for the wave-vector $\mathbf{k_1}$. The high ratio $\Omega/k_B T_{sc} \approx 7.2$ and the large damping of this mode contrast with the most common behaviour found for the resonance peak in heavy fermion superconductors and this suggests a strong coupling scenario.

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Chiral superconductivity in UPt_3

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Symmetry and topology are tools to describe states of quantum matter: in a superconducting state, breaking additional symmetries other than gauge symmetry is a long sought after indication for unconventional pairing.

UPt3 presents at low temperatures a strong electron mass renormalization (more than 100 times the free electron mass) due to spin fluctuations of the 5f electrons. These heavy fermions form Cooper pairs below 0.55 K.

Time-reversal symmetry breaking is expected as superconductivity is not mediated by electron-phonon coupling but is predicted to be driven by spin fluctuations. UPt3 is the only material known to present three different superconducting phases [1]. The boundary between the A and the chiral B phases is crossed upon cooling in zero field at 0.5 K. In the B phase, two energetically degenerated chiral domains may coexist. Theoretical predictions propose the existence of fractional vortices and an unusual flux distribution at the domain wall separating chiral domains [2].

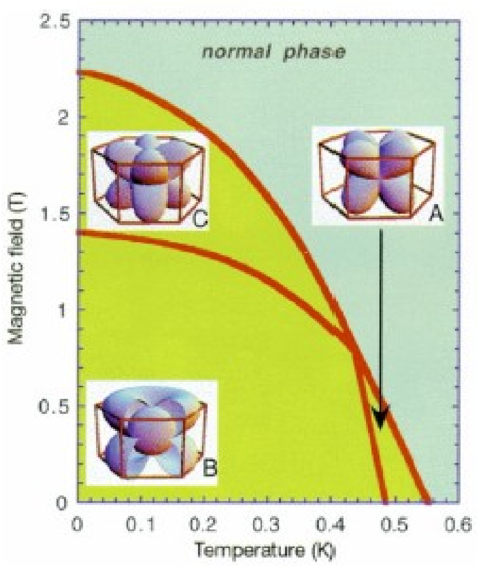

Figure 1: Phase diagram from [3].

Here, I report the observation of the alignment of the magnetic flux with the domain boundaries and the existence of half-Φ_0 structures, using a scanning SQUID microscope.

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SC et Ferroelectricité

Superconductivity and metallicity in doped $SrTiO_3$

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Strontium titanate is a wide-gap semiconductor avoiding a ferroelectric instability thanks to quantum fluctuations. This proximity leads to strong screening of static Coulomb interaction and paves the way for the emergence of a very dilute metal with extremely mobile carriers at cryogenic temperature range. Upon warming, mobility decreases by several orders of magnitude. Yet, metallicity persists above room temperature even when the apparent mean free path falls below the electron wavelength. The superconducting instability survives at exceptionally low concentrations and beyond the boundaries of Migdal–Eliashberg approximation. An intimate connection between dilute superconductivity and aborted ferroelectricity is widely suspected and has given rise to several theoretical propositions invoking the soft ferroelectric phonon mode as the driver of pairing.

Timescale of dynamic change at the gate-tunable superconducting transition in $AlO_x/SrTiO_3$ heterostructure

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Doped $SrTiO_3$ crystals exhibit a superconducting dome[1] with a maximum critical temperature around 300 mK. $SrTiO_3$ is supposed to be a ferroelectric at low temperatures. However, quantum zero point fluctuations ensure that it remains a paraelectric[2]. At 105 K, it undergoes a ferroelastic transition[3] from cubic to tetragonal symmetry. The domains become polar below 40 K. There are many interesting questions regarding the role of the structural properties of $SrTiO_3$ on the emergence of the superconducting state. A pertinent development in recent years is the realization of superconducting two-dimensional electron gases (2DEGs) in $SrTiO_3$-based heterostructures. The carrier density of such 2DEGs is tunable with an electrostatic gate voltage, leading to the observation of a superconducting dome. In low-dimensional superconductors, the presence of disorder is predicted to lead to spatial fluctuations of the order parameter. We have conducted experiments on the superconducting transition in the $AlO_x/SrTiO_3$ interface electronic system. The onset of the phase transition was probed with gate-voltage-tuning of carrier density, which in turn leads to the growth of superconducting islands. Following a change of gate voltage, a slow dynamic change of tens of seconds was observed in the resistivity close to the phase transition. This timescale is significantly larger in the superconducting state compared to the normal state. The observed timescale is consistent with the characteristic relaxation times[4] of ferroic domains in $SrTiO_3$ under an applied electric field. Our observations indicate that ferroic domains facilitate the nucleation and growth of superconducting islands. It reveals the strong impact of structural properties of the substrate on the superconducting state of the interface electronic system.

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Posters

A novel view of superconductivity

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An original version of the two-fluid model, based mainly on thermodynamics, will be presented. The conduction electrons comprise superconducting and independent electrons at thermal equilibrium. The superconducting and independent electrons are organized, respectively, as a many bound electron, BCS-like state, characterised by its chemical potential μ, and a degenerate Fermi gas of Fermi energy E_F. This comprehensive analysis accounts for the main aspects of superconductivity, namely Meissner effect (Prog.In.Electro.Res.M, 69, 69 (2018)), persistent currents (Eur.Phys.J.B, 92, 67 (2019)), superconducting to normal transition (J.Supercond.Nov.Magn., 33, 1307 (2020)), stability of the superconducting phase (J.Supercond.Nov.Magn., 34, 37 (2021)), room-temperature superconductivity (EPL, 134, 27002 (2021)) and Josephson effect (in press at J.Supercond.Nov.Magn.). The focus will be laid here on persistent currents and superconducting to normal transition.

Absence of superconductivity in bulk layered Ni^{+} doped nickelates

Nathan Bassot[1], Cyril Domingos[1], André Sulpice[1], Christophe Lepoittevin, P. Toulemonde[1]

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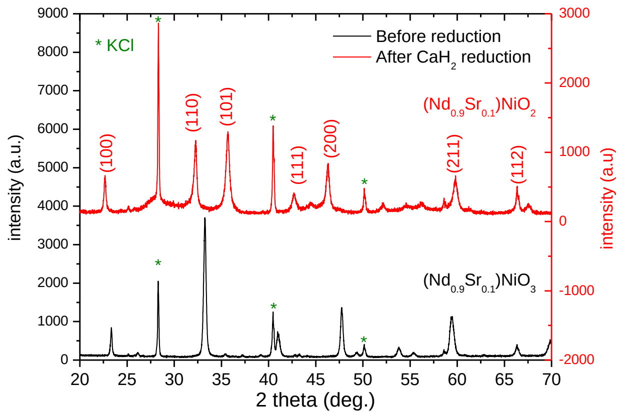
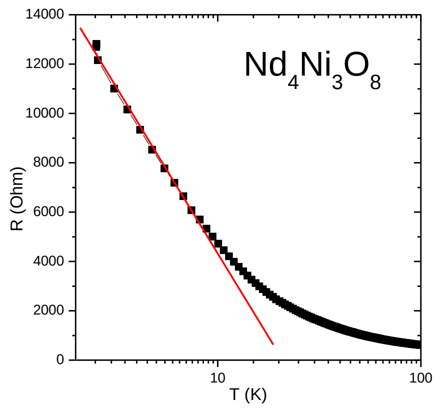
The discovery of superconductivity below T_c ~ 15 K in thin films of doped infinite layer $Nd_{1-x}Sr_xNiO_2$ nickelate two years ago has generated an enormous interest in the condensed matter community because of their great similitude with cuprates [1]. Then, superconductivity was also shown with other rare earth elements, i.e. in La and Pr based systems with maximal T_c of 10 K and 14 K respectively [2,3]. And very recently, the quintuple-layer oxide $Nd_6Ni_5O_{12}$, with five NiO_2 layers separated with rare-earth fluorite blocking slabs and not doped with Sr or Ca, was successfully grown in thin films and found superconducting at T_c ~ 13 K [4].

In parallel with other groups in the world, we have studied the analogous bulk materials of such systems. We have synthesized good quality polycrystalline samples of $(Nd_{1-x}Sr_x)NiO_2$, $(Pr_{1-x}Sr_x)NiO_2$ series and also the $(Nd_{1-x}Ca_x)NiO_2$ series doped with calcium where the filling varies from d^9 to $d^{8.7}$. Using the same topotactic chemical process, we have also obtained the reduced forms of the n = 3 members of the $La_{n+1}Ni_nO_{3n+1}$ Ruddlseden-Popper series with Ln = Nd and Pr, i.e. $Nd_4Ni_3O_8$ and $Pr_4Ni_3O_8$ oxides. Those tri-layers systems have a lower bidimensional character and present a higher doping level at $d^{8.67}$. No superconductivity was found in any of these compounds but a spin-glass like and insulating behavior at low temperature.





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Accurate modeling of FeSe with screened Fock exchange and Hund's metal correlations

Tommaso Gorni[1], Pablo Villar Arribi[2], Michele Casula[3] and Luca de' Medici[1]

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The major role played by strong correlations in iron-based superconductors (IBSC) has been widely assessed, as pointed out by the successful predictions of local magnetic moments and mass differentiations in these materials. Nevertheless, cumulating evidence shows that local interactions alone cannot capture the finer details of their electronic structure, yielding Fermi pockets way too large when compared with experiments. This issue is most striking in FeSe, where single-site dynamical mean-field theory (DMFT) predicts Fermi pockets from five to six times larger than experiments [1], hampering the theoretical description of the related electronic instabilities. On general grounds, this deficiency has been related to the treatment of non-local interactions in the theoretical modeling [2]. I will show how the interplay between non-local exchange and local interactions is responsible for the main low-energy features of FeSe by means of hybrid-DFT + slave-spin mean-field calculations (SSMF@HSE). Within this framework, a net shrinking of the Fermi pockets accompanies an overall improvement of the quasiparticle properties, as documented by the comparison with angle-resolved photoemission spectroscopy (ARPES) and transport measurements [3].

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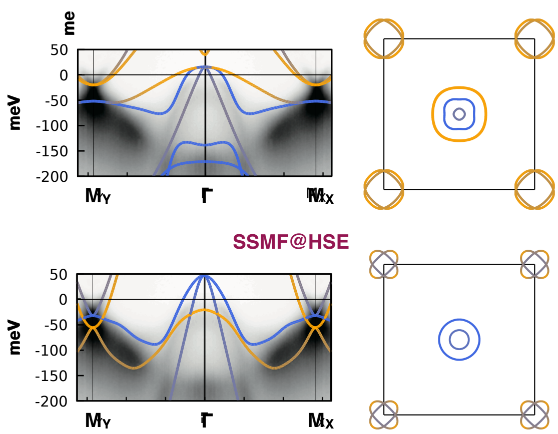

Calculated band dispersions along the $M_Y - \Gamma$ - M_X path (solid lines) on top of the corresponding ARPES dispersions (grey scale), an $k_z = 0$-Fermi surface of FeSe, shown in the 2-Fe Brillouin Zone. The xy orbital weight is represented in a colour scale going from blue (zero weight) to orange (maximum weight).

All-oxide High-Temperature Superconducting Spin-valve

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Due to their antagonistic properties, the interaction between ferromagnets and superconductors yields novel and interesting physics such as the so-called superconducting spin valve effect. This phenomenon is observed in vertical junctions made of two ferromagnetic layers sandwiching a superconductor. The term spin-valve denotes the electrical resistance change observed upon switching the relative orientations of the magnetization in the ferromagnetic layers, from parallel to antiparallel alignment, by application of magnetic field pulses. Here we demonstrate spin-valve effects in vertical junctions made of the d-wave superconductor $YBa_2Cu_3O_7$ and a half-metal $La_{0.7}Ca_{0.3}MnO_3$. Below the superconducting critical temperature, the junctions show a hysteretic magnetoresistance whose sign changes depending on the temperature and the injected current. These effects are discussed in terms of triplet Cooper pairs flow when the two ferromagnets are aligned.

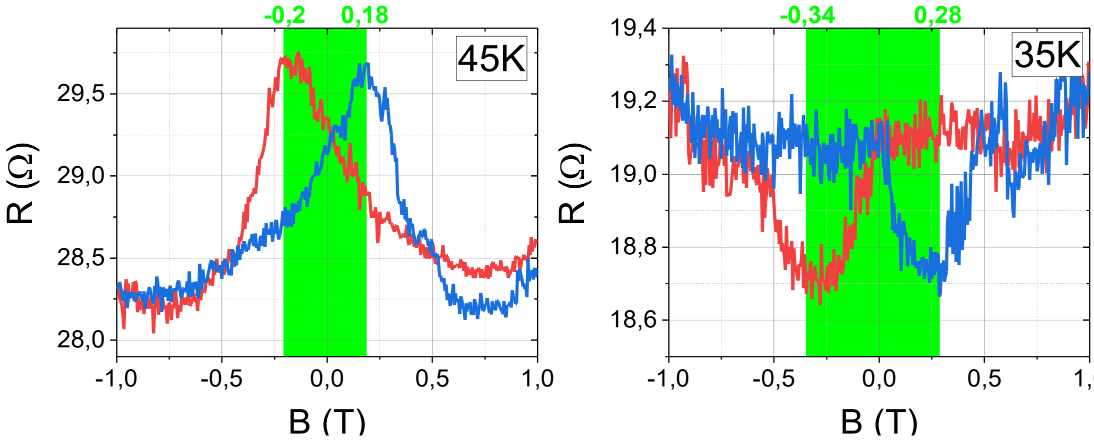

Figure : Magnetoresistance of a junction showing a reversing of the spin-valve effect while decreasing the temperature from 45K to 35K.

BCS superconductivity under a Berry curvature: when topology affects correlated phases.

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Topological phases and Electron-electron correlations are two prominent pillars of nowadays' condensed matter physics research. However, little attention has been payed to what happens when the two meet. Here, we consider BCS superconductivity in bands with a pre-existing Berry curvature. In a first step, we study a one-body problem in which we propose a generalized Peierls substitution that reproduces the well-known Karplus-Luttinger anomalous velocity. This brings us to consider two corrective terms: an emergent spin-orbit coupling term and a Darwin term, which constitute our "Berryology" . Then, we move on to a generic two-body problem in which we find that the spin-orbit coupling term induces two dipoles, one of which is associated with the relative moment of the two electrons and the other one with their center-of-mass motion. The resulting two-body Hamiltonian allows us to treat the Cooper pair. We show that the BCS instability is still present, albeit with a lowered binding energy of the Cooper pair, as compared to the absence of a Berry-curvature correction. Finally, we include the Berry-curvature corrections into the full BCS Hamiltonian. Consequently, both the zero temperature superconducting gap and the critical temperature are lowered by the Bery curvature via a weakening of the electron-phonon coupling constant. As a last step, we consider the effect of chemical doping and obtain a slightly generalized formula for the electron-phonon coupling constant.

Doping-driven pseudogap-metal-to-metal transition in correlated electron systems

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We establish that a doping-driven first-order metal-to-metal transition, from a pseudogap metal to Fermi Liquid, can occur in correlated quantum materials. To this purpose, we adopt an exact Dynamical Mean Field Theory (DMFT) solution of the dimer Hubbard Model (DHM), which is the minimal model that captures PG phenomena, namely, strong local Coulomb repulsion and non-local magnetic exchange interactions. The latter is a key feature, which is missing in the single-site DMFT solution of Hubbard model, but is present in the most interesting real material situations. Akin to the case of the Mott metal-insulator transition in the single site Hubbard model, our results suggest that the PG-metal-to-metal transition in the DHM may have universal character within correlated quantum materials. As we shall see, many unconventional properties of correlated materials are naturally realized in the solution of the model, such as a pseudogap, incoherent or bad metallicity, enhanced compressibility, and orbital selectivity. Thus, we may argue that the present PG-metal-to-metal transition may be the long-sought phenomenon where many exotic quantum states soak their roots.

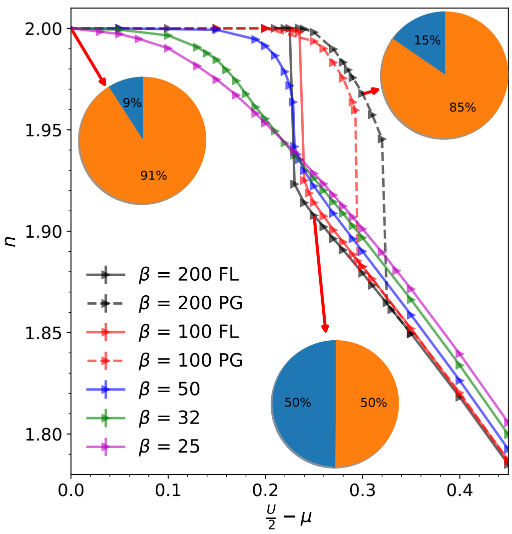

Figure 1. The electron density n as function of the renormalized chemical potential $\frac{U}{2}-\mu$. Half-filling corresponds to $n = 2$, where the system is a Mott insulator. The hysteresis behavior below $\beta = 50$ defines a PG-metal-to-metal coexistence region. Note the enhancement of the compressibility at the endpoint of the first order transition (blue line) at $\beta = 50$. The orange sector of the pie-charts indicates the relative contribution of the singlet states to the DAIM wave-function projected on the isolated dimer. The blue sector corresponds to all other states.

Electronics excitations in cuprates superconductors explored by Raman scattering

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Abstract:

Cuprates are superconducting materials with high critical temperatures, among them, we have studied the mercurates and bismuth single crystals. Here we focus on the mercury single layer of CuO_2 plane. We present a detailed Raman analysis on the under doped (UD63) and optimally doped (OP92) $HgBa_2Cu_3O_{4+d}$ compound in order to explore their electronic excitations as a function of temperature in different polarizations. Using judicious linear combinations of polarizations, we are able to extract the pure symmetries A1g, A2g, B1g and B2g and make an identification of the excitations in each symmetry.

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Evidence for coexistence of charge and antiferromagnetic orders in a high T_c superconductor

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Antiferromagnetic order close to unconventional superconductivity is a general feature of strongly correlated superconductors. In cuprates, the role of antiferromagnetism in the pairing mechanism is still under debate mainly because of the presence of the pseudogap and other competing orders. Multilayered cuprates provide a proving ground to study such orders: they possess disorder-free CuO_2 planes and an extended antiferromagnetic phase, stabilized by interlayer coupling. After an introduction on the general properties of multilayered cuprates, I will present our recent study of quantum oscillations and Hall Effect in magnetic fields up to 88 T in the underdoped tri-layered cuprate $HgBa_2Ca_2Cu_3O_{8+\delta}$, the cuprate with the highest superconducting temperature transition (T_c = 133K). A careful analysis of the complex spectra of quantum oscillations strongly supports the coexistence of multiple competing orders. Our interpretation implies that a metallic antiferromagnetic state extends deep inside the superconducting phase, a key ingredient that supports magnetically-mediated pairing interaction in cuprates.

Extremely long-range Josephson coupling across a half metallic ferromagnet in proximity with a cuprate

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The Josephson effect results from the coupling of two superconductors across a weak link or spacer –e.g. an insulator, a normal metal or a ferromagnet– to yield a phase coherent quantum state. In ferromagnets, singlet (opposite-spin) Cooper pairs decay over very short distances, and thus Josephson coupling usually requires a nanometric spacer. However, in special conditions equal-spin triplet pairs are generated that can couple superconductors across thicker ferromagnets. Triplets allowed explaining the observation of supercurrents across very thick (tens or even hundreds of nm) ferromagnets combined with conventional low-temperature superconductors. However, despite many hints of triplet superconductivity, long range Josephson effects have remained elusive in the intriguing case of unconventional high-temperature superconductors combined with half-metal ferromagnets. Here we unambiguously demonstrate extremely long range (micrometric) high-temperature Josephson coupling across the half-metallic manganite $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) combined with the superconducting cuprate $YBa_2Cu_3O_7$ (YBCO). This is shown in planar junctions which display the hallmarks of Josephson physics: i) a supercurrent modulation driven by magnetic flux quantization; and ii) quantum phase locking effects under microwave excitation (Shapiro steps) [1]. The latter, up to now elusive triplet Josephson junctions, display here an anomalous doubling of the Josephson frequency. In addition to its fundamental interest, the marriage between quantum coherent transport and full spin polarization brings unique opportunities to the field of spintronics.

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High pressure study of UTe_2 in pulsed magnetic field

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The unconventional superconductivity in the heavy-fermion paramagnet UTe_2 has recently attracted a lot of attention, particularly due to the reinforcement of superconductivity with magnetic field, and the probable spin-triplet and possibly topological nature of the superconducting order parameter. Pressure is a powerful tuning parameter in this system inducing multiple superconducting phases, changes of the magnetic anisotropy, and long range magnetic order. A challenge is now to characterize the effects of combined pressure and magnetic fields applied along variable directions in this strongly anisotropic paramagnet. Several studies under pressure in high static magnetic field have been published, but a full investigation of this system requires magnetic field higher than the maximum available static magnetic fields. Here, we present an investigation of the electrical resistivity of UTe_2 under pressure up to 3 GPa and pulsed magnetic fields up to 58T applied along the hard magnetic directions b and c. We show that, near the critical pressure, a field-enhancement of superconductivity coincides with a boost of the effective mass related to the collapse of metamagnetic and critical fields. These new elements improve our understanding of the interplay between magnetism and superconductivity, and the nature of these phases.

High sensitivity measurement of the oxygen stoichiometry of a superconducting oxide by SIMS

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Oxygen stoichiometry plays a vital role in determining the properties of thin transition metal oxide films as has been reported *e.g.* for superconductive cuprates [1], high mobility 2D electron gas at the interface between two band gap insulators [2] and also in nickelates. The recent discovery of superconductivity in $Nd_{0.8}Sr_{0.2}NiO_2$ films obtained by topotactic reduction of $Nd_{0.8}Sr_{0.2}NiO_3$ [3] renewed the need for techniques that precisely monitor the oxygen stoichiometry. This quantification is nowadays straightforward in single crystals but it has remained to be a challenge in heterostructures and thin films alike. The archetype high T_c-superconductor $YBa_2Cu_3O_{7-\delta}$ (YBCO) is a notorious example of the importance of oxygen stoichiometry in determining the transport and structural properties of a material. Various reports (*e.g.* [4]) have shown that varying the nominal oxygen content, which acts as an effective doping, allows for a precise control over the superconducting critical temperatures (T_c), the normal-state resistivity and also structural properties of YBCO.

Here, we report a high sensitivity measurement of the oxygen content performed by SIMS. We analyzed a series of YBCO films grown on $SrTiO_3$ substrates. The oxygen contents of the samples were adjusted by post-growth treatments and estimated from (i) the superconductive T_c and (ii) the *c*-lattice parameter. The SIMS analyses were performed in the secondary neutral mass spectrometry mode *i.e.* collecting the neutral sputtered particles that combine with Cs^+ ions. The oxygen contents given by SIMS agree very well with that obtained by the transport and structural properties. This result opens the way to measurements of the oxygen stoichiometry in arbitrary oxide, including superconducting nickelates.

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High-T_c superconductivity in strongly overdoped cuprates

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The recent discovery of high-T_c superconductivity in the strongly overdoped cuprates $YSr_2Cu_{2.75}Mo_{0.25}O_{7.54}$ [1] and $Ba_2CuO_{3.2}$ [2] put into question well-established notions of the phenomenology of cuprates upon which most microscopic theories of high-T_c superconductivity have been based. Indeed, the hole doping levels reached in the above compounds is as high as p = 0.46 hole/Cu, i.e. well beyond the superconducting dome of the electronic phase diagram where a Fermi liquid behavior is expected. This result suggests that a second branch of superconductivity must exist beyond the dome [3] and that both x^2-y^2 and z^2 e_g orbitals are expected to participate in the superconducting state [4] owing to the much shorter distance between the planar Cu and the apical oxygen [1].

In order to unveil the unusual structural and electronic properties of the above strongly overdoped cuprates, here we present and discuss very recent specific heat and EXAFS results [5,6] suggesting the existence of an electronic phase separation and of unusually large, even larger than 1 Å, lattice distortions at T_c, which suggests the occurrence of a lattice-driven change of the electronic structure in the superconducting state.

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Infinite-layer nickelate: Charge or magnetic excitation in function of the capping layer presence

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The recent discovery of a zero-resistance state in nickel-based compounds[1] has generated new excitement about one of the most studied, yet undisclosed, problem in condensed matter physics. Indeed, in light of possible analogies with copper-based compounds, it was already anticipated[2] that the study of infinite-layer nickelates could have helped to shed light on the still puzzling underlying mechanism(s) of unconventional superconductivity. Here we will present the grow condition of the perovskite nickelate followed by a reduction process (different if presence of a $SrTiO_3$ capping layer) to obtain the infinite-layer phase. Then, by using resonant inelastic X-ray scattering (RIXS) for $SrTiO_3$-capping-layer-free $NdNiO_2$ thin films we will report the observation of a planar commensurate charge density wave (CDW), which is quenched when the capping-layer is restored. Also, we found that the large CDW intensity strongly weakens with Sr-doping and disappears in superconducting $Nd_{0,8}Sr_{0,2}NiO_2$ thin films. On the other hand, a magnetic excitation is observed when a $SrTiO_3$ capping layer is grow on the sample, before performing the reduction, as already showed by *Lu et al*.[3] We suggest a possible correlation between the CDW intensity and a peculiar intense ~0.6 eV energy loss feature which shows up in the RIXS energy maps, and which has been already associated to Ni-Nd hybridized bands[4]. As a result, our findings suggest intertwined properties between strong Ni-Nd hybridization and CDW properties that both enter in competition with magnetic excitations and superconductivity in non-capped infinite-layer nickelate thin films.

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Laser doped Si:B – From the material to superconducting nano-devices

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Although boron doped silicon ($Si{:}B_N$) is the best-known semiconductor material, superconducting $Si{:}B_S$ is not yet a common material among the superconductivity community. A superconducting phase is observable in silicon provided that the boron concentration reaches a threshold value, which is larger than the solubility limit ($n_{B-thresh} \gtrsim 10^{20} cm^{-3} \sim n_{solubility}$). These concentrations are achievable using nanosecond laser doping [1 - 3]: a laser pulse ($\lambda = 308\,nm, t_{pulse} = 25ns, E_S \geq 0.5\,mJ/cm^2$) focused on a silicon wafer melt the substrate, over which boron atoms have been chemisorbed. The boron can diffuse in (and only in) the liquid phase before being trapped as the melted phase recrystallizes. This way, one can control the depth (d) and the incorporated concentration of dopants (C_B) by respectively modulating the incoming energy (E_S) and the number of process repetitions (N).

By realizing such superconducting layers, one can expect to implement Si:B based superconducting nanodevices [4 - 6] into more complex Si based micro-electronics systems. We are currently working on the development of $\mathrm{Si{:}B_S}$ transistors as possible elements integrable into cryogenic systems [7] or in gatemon qubits [8,9]. These transistors consist of a S/N/S Josephson junction where a semiconducting (N) Si $\sim 100\,nm$ long channel is coupled to a gate (either top or bottom gate). This will allow to modulate the supercurrent crossing the junction, thus realizing a Josephson FET. However, to ensure a full proximity effect through the channel and the presence of a non-dissipative supercurrent, the interface resistance needs to be mastered. Studies of S/N bilayers have been realized to measure such interface resistance as a function of the normal layer doping and geometry. We found an extremely low interface resistance ($R_{int}.A \sim 10^{-10} \Omega.cm^2$) which encourages us to pursue the transistors realization.

As the superconducting properties strongly depend on the material itself, the devices performances will be as well determined by the material doping distribution, disorder, and structural properties. Therefore, we studied the structural and electrical properties of several layers at both room and cryogenic temperature with respect to the doping parameters (d, C_B,N). At “small” concentration values ($n_B \sim 2.10^{21}$), transmission electron microscopy (TEM) and secondary ions mass spectrometry (SIMS) reveal nice sharp and homogeneous monolayers. However, as the incorporation is increased, one can observe accumulation of non-activated boron. These two regimes are respectively referred as “linear” and “disordered”. Surprisingly, superconductivity seems to arise and grow in between these two regimes, where X-ray diffraction (XRD) measurement shows a maximum of in-depth strain, before lowering as soon as relaxation in the in-plane axis occurs. According to previous studies [10 - 13], our monolayers act as BCS-like superconductors. We have shown that the critical temperature (T_c) can be tuned by the normal concentration of dopants. Differences between our study and previous measurements, which we attribute to the effect of the laser profile, still need to be fully understood and are currently under investigation. Finally, the nature of the interaction inducing the decrease of T_c in the disordered regime is still to be determined.

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Magnetic quantum phase transition at the pseudogap boundary in $La_{1.8-x}Eu_{0.2}Sr_xCuO_4$ in high fields

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We have performed NMR measurements in $La_{1.8-x}Eu_{0.2}Sr_xCuO_4$ for x values close to the critical hole doping p^* = 0.24 of the pseudogap phase at T = 0, in high magnetic fields intense enough to quench superconductivity. The data reveal that the non-superconducting ground state changes from an antiferromagnetic order (more precisely an incommensurate antiferromagnet that freezes like a glass and competes with superconductivity) to a fluctuating antiferromagnet. Furthermore, this quantum phase transition appears to coincide with the pseudogap boundary p^*. These results raise the question as to whether the sharp changes in electronic properties (electronic specific heat, angle-dependent magnetoresistance and electrical conductivity) observed at p^* in this class of cuprates more directly originate from the pseudogap state or from this magnetic quantum phase transition.

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On-chip Spectrometers operating at 90GHz

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In the framework of ground-based millimeter-wave astronomy, the atmospheric windows centered on 90 GHz, 150 GHz and 240 GHz are most relevant for applications ranging from galactic to cosmological advantages.

Our group has, in the past years, developed very sensitive large arrays of Lumped Element Kinetic Inductance Detectors (LEKIDs), and deployed them in a number of instruments and telescopes, i.e. NIKA2 at Pico Veleta, KISS at Teide Observatory, CONCERTO at APEX. We have in this way achieved the mapping of large areas of the Sky in intensity and polarization. We obtain low-spectral-resolution information by coupling Martin-Puplett interferometers to large field-of-view cameras.

In this work, we propose to complement this experience by developing on-chip spectrometer using KIDs. The aim is to improve, at least for small patches of the field-of-view and without affecting the overall optics, the sensitivity and spectral resolution of our future instruments. A simple slot microstrip antenna with low loss dielectric will be used to obtain a relatively wide bandwidth. We focused, for the first prototype, on the range 80 GHz to 110 GHz, i.e. the so-called '3-mm atmospheric window'. The pixels consist of superconducting Al (filters) and Ti-Al (absorber) resonators. They will couple with a single microwave transmission line feedline and readout respectively. In this poster, we outline the design, simulation, and fabrication of the first prototype.

Orbital dichotomy of Fermi liquid properties in Sr_2RuO_4 revealed by Raman spectroscopy

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We report a polarization-resolved Raman spectroscopy study of the orbital dependence of the quasiparticles properties in the prototypical multi-band Fermi liquid Sr_2RuO_4. We show that the quasiparticle scattering rate displays a ω^2 dependence as expected for a Fermi liquid. Besides, we observe a clear polarization-dependence in the energy and temperature dependence of the scattering rate and mass, with the $d_{xz/yz}$ orbital derived quasiparticles showing significantly more robust Fermi liquid properties than the d_{xy} orbital derived ones. The observed orbital dichotomy of the quasiparticles is consistent with the picture of Sr_2RuO_4 as a Hund's metal. Our study establishes Raman scattering as a powerful probe of Fermi liquid properties in correlated metals. With a view going further in this study, preliminary results based on uni-axial stain are also presented.

Overactivated transport in the localized phase of the superconductor-insulator transition

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Résumé

Beyond a critical disorder, two-dimensional (2D) superconductors become insulating. In this Superconductor-Insulator Transition (SIT), the nature of the insulator is still controversial. In particular, some systems transit to a strong insulating regime at low temperature which cannot be accounted for by conventional theories.

Here, we present an extensive experimental study on insulating NbxSi1-x in the vicinity of the SIT, as well as corresponding numerical simulations of the electrical conductivity. At low temperatures, we show that electronic transport is activated and dominated by charging energies. The sample thickness variation results in a large spread of activation temperatures, fine-tuned via disorder. We show numerically and experimentally that this originates from the localization length varying exponentially with thickness.

At the lowest temperatures, electronic transport is activated with two distinct activated regimes, which could be identified with over-activated regimes found in other systems.

I will analyze our data in light of an extensive numerical model on disordered quasi-two dimensional systems, showing that the appearance of superconducting grains among the insulating matrix may explain the stronger-than-activation behavior observed in the immediate vicinity of the SIT. Charge carriers have to overcome two competing energies – the superconducting gap and the charging energy – resulting in a larger activation energy.

*Intervenant

Quantum Diamond Magnetometry for High Pressure Superconductivity

Antoine Hilberer[1], Loïc Toraille[2], Marie-Pierre Adam[1], Baptiste Vindolet[1], Florent Occelli[2], Martin Schmidt[1], Thierry Debuisschert[3], Dorothée Colson[4], Paul Loubeyre[2] and Jean-François Roch[1]

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We report on our progress on the application of quantum diamond magnetometry (QDM) to high-pressure physics. QDM is based on nitrogen-vacancy (NV) centers that are atomic sized point defects of diamond. Due to their spin properties NV centers are versatile magnetic probes. They have been extensively used in areas as different as quantum information, biophysical sensing, quantum metrology or condensed matter physics. We recently showed that NV centers can be integrated in a diamond anvil cell (DAC) acting as in-situ quantum sensors to probe magnetic behaviors under extreme pressure.

Using a customized optical microscope, we observe the spin dependent luminescence of diamond defects implanted at an anvil culet, allowing for a submicrometer resolution mapping of the magnetic field at the diamond anvil tip. Expulsion of magnetic field lines due to the Meissner effect in a superconductor results in a clear drop of the magnetic field in the close vicinity of the sample, where the NV sensors are located. This direct identification provides an unambiguous diagnosis of superconductivity that does not rely on questionable electrical contacts or indirect probes.

We will show recent results on the measurement of the critical temperature of a near-optimally doped mercury based cuprate (Hg1223) sample under pressures up to 30 GPa. We also demonstrated the compatibility of this method with synchrotron X-ray diffraction structural characterization. To this end, a portable QDM system was built and brought to beamline Psyché at synchrotron SOLEIL, where we performed same-sample mapping of the α-Fe to ϵ-Fe structural and magnetic transitions of iron that occur between 15 and 20 GPa. We will finally discuss how this technique can be extended to pressures above the megabar.

Scanning tunneling spectroscopy at magnetic fields of 20T in superconducting KFe_2As_2

Beilun Wu[1], Marta Fernández-Lomana , Francisco Martín-Vega , Raquel Sánchez-Barquilla[1], Edwin Herrera[1], Hermann Suderow[1], A. A. Haghighirad[2], Anna E. Böhmer[2,3] and Isabel Guillamón[1]

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KFe_2As_2 is a stoichiometric iron-based superconductor which is on the heavily hole-doped side of the family (Ba,K)Fe_2As_2. It has a critical temperature of 3.4K and an out-of-plane critical magnetic field of 1.5T. The normal phase presents a strongly renormalized band-structure, which has been associated to the proximity to a Mott insulating state. Moreover, much discussion has been raised on the symmetry and nodal structure of the superconducting gap, and on the possible existence of a nematic order in this compound. Here we present dilution refrigerator scanning tunneling microscopy results in KFe_2As_2. We show the vortex lattice and discuss the band structure from quasi-particle interference, observed at different magnetic fields up to 20T. Experiments have been made on a newly built dilution-fridge-based scanning tunneling microscope equipped with a fully superconducting magnet capable of reaching 22T, which we will also describe in detail [1].

[1] M.Fernández-Lomana, B.Wu et al., Review of Scientific Instruments 92, 093701 (2021)

Spectroscopic evidence for strong correlations between local superconducting gap and local Altshuler-Aronov density-of-states suppression in ultrathin NbN films

C. Carbillet[1], V. Cherkez[1], M.A. Skvortsov[2,3], M.V. Feigel'man[3,2], F. Debontridder[1], L.B. Ioffe[4,3], V.S. Stolyarov[1,5,6], K. Ilin[7], M. Siegel[7], D. Roditchev[1,8], T. Cren[1], and C. Brun[1]

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Disorder has various profound effects on superconducting thin films. For a large variety of materials, increasing disorder reduces electronic screening which enhances electron-electron repulsion. These fermionic effects lead to a mechanism described by Finkelstein: when disorder combined to electron-electron interactions increases, there is a global decrease of the superconducting energy gap Δ and of the critical temperature Tc, the ratio Δ/kBTc remaining roughly constant. In addition, in most films an emergent granularity develops with increasing disorder and results in the formation of inhomogeneous superconducting puddles. These gap inhomogeneities are usually accompanied by the development of bosonic features: a pseudogap develops above the critical temperature Tc and the energy gap Δ starts decoupling from Tc. Thus the mechanism(s) driving the appearance of these gap inhomogeneities could result from a complicated interplay between fermionic and bosonic effects. By studying the local electronic properties of a NbN film with scanning tunneling spectroscopy (STS) we show that the inhomogeneous spatial distribution of Δ is locally strongly correlated to a large depletion in the local density of states (LDOS) around the Fermi level, associated to the Altshuler-Aronov effect induced by strong electronic interactions [1]. By modelling quantitatively the measured LDOS suppression, we show that the latter can be interpreted as local variations of the film resistivity. This local change in resistivity leads to a local variation of Δ through a local Finkelstein mechanism. Our analysis furnishes a purely fermionic scenario explaining quantitatively the emergent superconducting inhomogeneities, while the precise origin of the latter remained unclear up to now.

[1] C. Carbillet et al. Physical Review B 102, 024504 (2020)

Study of superconductivity with the composite operator method

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This work focuses on a basis of Hubbard composite operators used to perform a strong coupling study of the Hubbard hamiltonian. Initially the technique was used in cuprates because it diagonalized the interaction part of the Hubbard model and provided one way to get superconductivity critical temperature as a function of doping. The field of cuprate has evolved a lot and questions have changed. Recent experimental discoveries such as charge order or the putative non-zero momentum particle-particle order, also called pair density wave in these materials have influenced the field and led to a new body of questions. Unfortunatly the charge order is notoriously difficult to be obtained by numerical simulations. We thus intend to revisit this question using our composite operator technique. This poster will focus on results about superconductivity as a function of doping for various bands structures for electron and hole doped cuprates.

Superconductivity in novel Crystallogenide LaFeSiO with squeezed FeSi layer

Mads F. Hansen[1,2], Jean-Baptiste Vaney[3], Christophe Lepoittevin[1,2], Fabio Bernadini[4], Etienne Gaudin[3], Vivian Nassif[5], Andre Sulpice[2], Sophie Tencé[3], Andres Cano[2] and Pierre Toulemonde[1,2].

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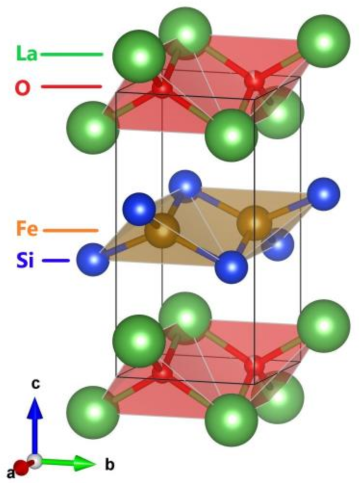
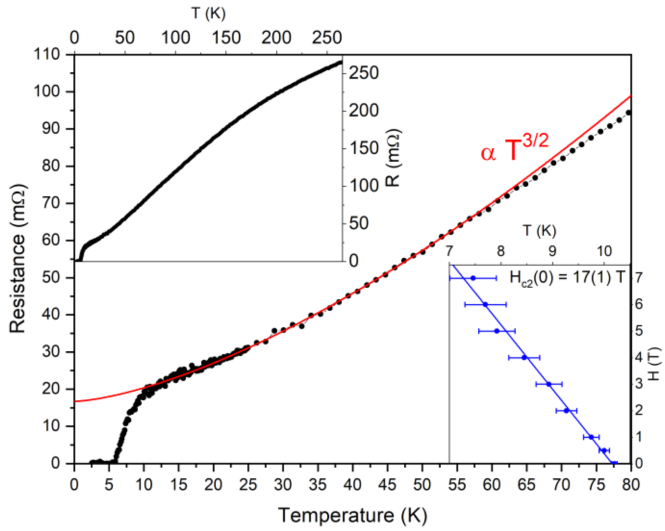
Iron-based superconductors represent a heavily researched topic since the discovery of superconductivity in $LaFeAsO_{1-x}F_x$ [1], yet a full description of the superconducting mechanism still eludes the scientific community. Several axioms have been established, two of which are: the enhanced tendency towards a ferromagnetic ground state upon substituting the pnictogen/chalcogen for a crystallogen (e.g. Si or Ge) and the optimization of T_c being correlated with the interplanar Fe-X height for X = As or Se, with the maximum being at a height corresponding to a regular tetrahedron.

Here, we present the discovery of superconductivity below T_c = 10 K in the novel compound LaFeSiO and discuss the link between the crystal structure and the superconducting properties in relation to the current axioms. LaFeSiO is isostructural to the prototype iron-based $LaFeAsO_{1-x}F_x$ and thus belongs to the subgroup “1111”. The most evident difference between two compounds is the substitution of As with Si so an enhanced tendency to ferromagnetism could be expected [2], however, superconductivity prevails. Furthermore, the FeSi layer in LaFeSiO is found to be strongly compressed compared to other “1111” compounds, making LaFeSiO very original. Considering the correlation between T_c and the Fe-X height, superconductivity should be suppressed, however, this is not the case. From theoretical calculations we find very weak magnetic tendencies and nesting properties.





[1] - Y. Kamihara et al. J. Am. Chem. Soc. 130, 3296–3297 (2008).
[2] - D. Guterding et al. Phys. Rev. Lett. 118, 017204 (2017).

Transport measurements in Megagauss fields

M. Massoudzadegan[1], I. Gilmutdinov[1], O. Portugall[1], O. Drachenko[1], N. Bruyant[1], M. Nardone[1], A. Zitouni[1], M. Barragan[1], T. Schiavo[1], M. Leroux[1], D. Vignolles[1], B. Reulet[2] and C. Proust[1]

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In this poster, I will present our recent progress toward Quantum Oscillation measurements at 150 T in semi-destructive single turn magnet, and the first results of our custom RF, low temperature, transport measurements.

In cuprates high-temperature superconductors, the origin of the pseudogap is still poorly understood but could reveal important information about high-T_c superconductivity. In hole-doped $YBa_2Cu_3O_{7-x}$, the pseudogap seems linked to stronger electronic correlations as evidenced by the larger effective mass m* and the higher T_c near p*, where the pseudogap appears in the phase diagram.
But the symmetry breaking at the critical doping p* has yet to be identified (if any). On the one hand, some reconstruction of the Fermi surface must occur between the overdoped side (p>>p*), where the Fermi Surface is a large hole pocket, and the underdoped side (p<<p*), where Quantum Oscillations have observed small Fermi Surface pockets (up to $p = 0.152 < p^*\sim0.19$). On the other hand, the Fermi surface reconstruction could stem from the Charge Density Wave (CDW) that is also present at this doping.
So, in order to find out if the pseudogap is linked to a spatial symmetry breaking leading to a reconstruction of the Fermi Surface at p*, we are aiming to measure how quantum oscillations evolve across p*.
However, measuring QO near p* requires intense magnetic fields of the order of 150 T, as superconductivity is indeed almost optimum at p*. Such fields can so far only be achieved in a Megagauss facility with semi-destructive microsecond-long field pulse presenting numerous challenges for transport measurements.

What is the 'true' pseudogap line in cuprates ?

Yves Noat[1], Alain Mauger[2], Minoru Nohara[3], Hiroshi Eisaki[4], Shigeyuki Ishida[4], and William Sacks[2]

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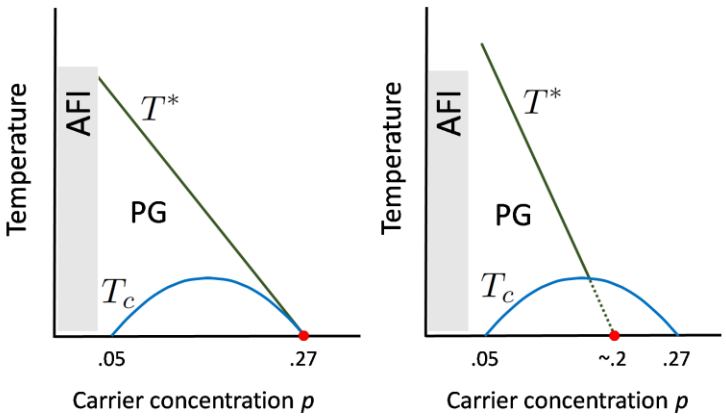
A fundamental and outstanding question has emerged in the literature of high-T_c cuprate superconductors : Does the pseudogap line cross the superconducting Tc-dome or is it tangential? Surprisingly, the interpretation of the phase diagram typically falls into one of these two camps.

In order to clarify this contradiction, we have revisited the experimental magnetic susceptibility and knight shift of four different compounds of the cuprate family. We show that two terms in the magnetic susceptibility dominate the experimental findings, the 2D antiferromagnetic lattice contribution and secondly, the electronic 'Pauli' contribution.

From precise fits of the data, we show that two characteristic temperature scales exist, the pseudogap temperature, T*, associated with the Pauli term, and the characteristic temperature of magnetic correlations, T_{max}. In this way we can propose a comprehensive phase diagram that resolves the contradiction mentioned previously.

We show that a pseudogap persists in the normal state throughout the phase diagram, in agreement with the existence of hole pairs, or 'pairons', above T_c. Our results suggest that T_{max} has been misinterpreted as the pseudogap temperature.

Figure: Schematic of the two generic phase diagrams



Half-filled planes of ~4a x 4a interacting bipolarons: a key for understanding high Tc superconductivity

M. Hennion[1], A. Ivanov[2], S. Petit[1], B. Hennion[1]
[1]*Laboratoire Léon Brillouin CEA-Saclay, Gif-sur-Yvette, France*
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In pseudo-cubic $La_{7/8}Sr_{1/8}MnO_3$ excitations specific of charges coupled to the orbitals and spin states of Mn^{3+} ions and to the ionic vibrations have allowed us to characterize charge inhomogeneities. At T<Tco, Tco=159K (CO is the charge-order transition), they reveal hole-rich domains of 4a size along the three MnO bond directions which define columns of built-in cubes of side 4a. In this structure, all the planes are equivalent. They consist of a bi-axial order of 4a x 4a hole-rich domains (4e+) alternating, in plane and from plane to plane, with hole-poor ones. They are further intertwined with a spin density wave of period 4a. At T>Tco, the excitations reveal that this charge order pattern is driven by the pinning of 2D bipolarons, AF paired, with a ξ~0.83 4a size value. They interact along the MnO bonds through a distance equal to their size. They define 2D half-filled bands of bipolarons, unstable at the wave-vector q~0.275. In the CuO planes, which exhibit a similar lattice and orbital structure, this quantitative description of bipolarons (size and distance) provides the origin of the 1/8 anomaly and a key for understanding high Tc superconductivity.

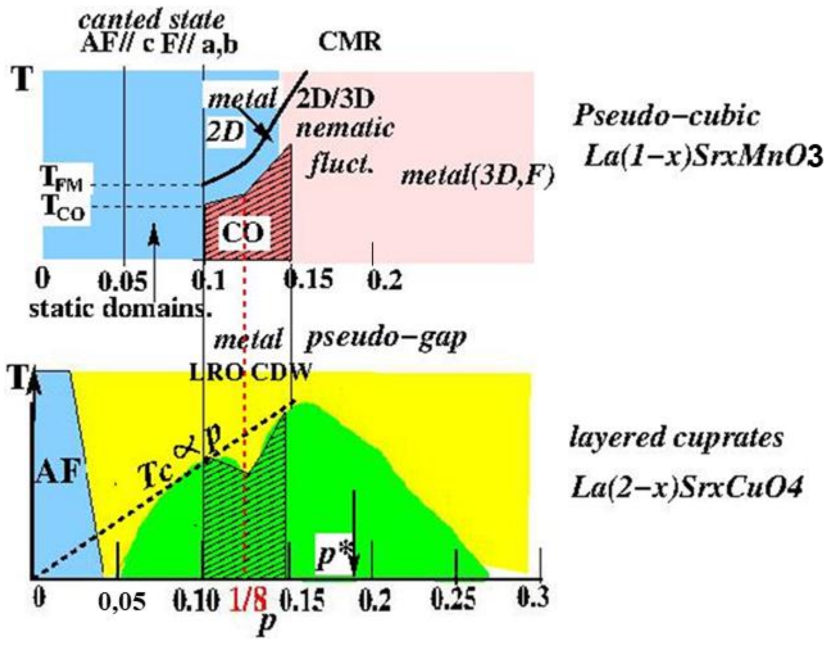

Figure: Comparison of the phase diagrams of the pseudo-cubic $La_{(1-x)}Sr_xMnO_3$with the layered cuprate $La_{(2-x)}Sr_xCuO_4$, illustrating the common doping range where a charge order occurs.

Superconductor-Insulator Transition in space charge doped one unit-cell $Bi_2Sr_2CaCu_2O_{8+x}$

Fang WANG[1,2], Johan BISCARAS[1], Andreas ERB[3], Abhay SHUKLA[1]

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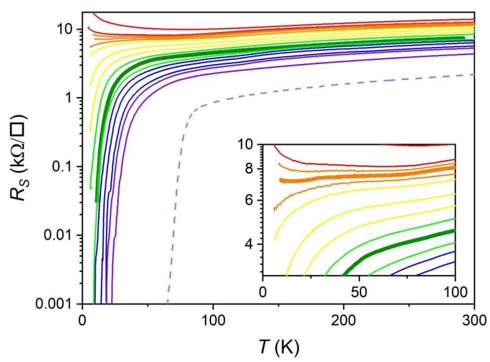
The superconductor-insulator transition (SIT) in two dimensions is a continuous quantum phase transition at absolute zero temperature driven by external parameters like disorder, magnetic field, or carrier concentration. Such transitions have been induced in a variety of two dimensional superconductors by tuning different external parameters and studied with a finite-size scaling analysis. There is however not much uniformity in the findings as both the superconducting systems and the tuning parameters are diverse. In this project, we first fabricated high quality of one unit-cell BSCCO-2212 samples with anodic bonding technique, an original method of exfoliation developed in our laboratory for preparing high quality 2D crystals from layered bulk materials. Then we revealed the SIT in the fabricated one unit-cell $Bi_{2.1}Sr_{1.9}CaCu_2O_{8+x}$ by space charge doping, which in an effective field effect electrostatic doping technique. We determined the related critical parameters and develop a reliable way to estimate doping in the non-superconducting region, a crucial and central problem in these materials. Finite-size scaling analysis yields a critical doping of 0.057 holes/Cu, a critical resistance of ~ 6.85 kΩ and a scaling exponent product $\nu z \sim 1.57$. These results, together with earlier work in other materials, provide a coherent picture of the SIT and its bosonic nature in the underdoped regime of emerging superconductivity in high critical temperature superconductors.



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Liste des participants

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- Antezak Alexandre
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- Bag Soumen
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- Barisic Lovro Anto
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- Simon Florian
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- Thomas Christopher Thomas
- To Le Hong Hoang
- Toulemonde Pierre
- Van Der Beek Cornelis Jacominus
- Verseils Marine
- Vignolle Baptiste
- Vignolles David
- Villegas Javier
- Witt Hugo
- Wu Beilun

Notes

Programme de la réunion thématique “Supraconductivité” du GDR MEETICC, Paris 6-7 décembre 2021

09:00 - 09:15	**Accueil - Informations (Amphi Buffon)**	**09:00 - 10:20**	**Session Cuprates – Animateur : Marcello Civelli**
09:15 - 10:45	**Session Cuprates** – Animateur : Alain Sacuto	09:00 - 09:30	*Catherine Pépin, CEA Saclay*
09:15 - 09:45	*Cyril Proust, LNCMI - CNRS, Toulouse*	09:30 - 10:00	*Marc-Henri Julien, LNMCI Grenoble*
09:45 - 10:15	*Indranil Paul, LMPQ, Univ. Paris, CNRS*	10:00 - 10:20	*Kota Katsumi, The University of Tokyo*
10:15 - 10:45	*Philippe Bourges, Laboratoire Léon Brillouin, CEA Saclay*	**10:20 - 10:50**	**Pause café (Hall devant Amphi Buffon)**
10:45 - 11:15	**Pause café (Hall devant Amphi Buffon)**	**10:50 - 12:30**	**Session supra 2D et mésoscopique - Animateur :**
11:15 - 14:30	**Session Nouvelles Approches et Techniques** - Animateur : Yann Gallais	10:50 - 11:20	*Charis Quay, LPS, Université Paris-Saclay*
11:15 - 11:45	*Thomas Ebbesen, Université de Strasbourg*	11:20 - 11:40	*Pascal Simon, LPS, University Paris Saclay*
11:45 - 12:15	*Jean-François Roch, LuMIn, ENS Paris Saclay*	11:40 - 12:10	*Benjamin Sacépé, Institut Néel CNRS*
12:15 - 14:00	**Déjeuner (Hall devant Amphi Buffon)**	12:10 - 12:30	*Srijani Mallik, Unité mixte de physique CNRS/Thalès*
14:00 - 14:30	*Florence Levy-Bertrand, Institut Néel, CNRS*	**12:30 - 14:00**	**Déjeuner (Amphi Buffon)**
14:30 - 16:10	**Session Nouveaux matériaux supraconducteurs - Animatrice : Dorothée Colson**	**14:00 - 15:20**	**Session Supra au fer**
14:30 - 15:10	*Andrés Cano, Institut Néél, CNRS - Baptiste Vignolle, ICMCB Bordeaux*	14:00 - 14:30	*Anna Böhmer, IQMT, Karlsruhe Institute of Technology*
15:30 - 15:50	*Sophie Tencé, CNRS, Université de Bordeaux, ICMCB*	14:30 - 14:50	*Jean-Côme Philippe, MPQ Univ. Paris*
15:30 - 15:50	*Rebecca Cervasio, AILES/Synchrotron SOLEIL*	14:50 - 15:20	*Luca de' Medici, LPEM, ESPCI Paris*
15:50 - 16:10	*Victor Balédent, Laboratoire de Physique des Solides, Univ. Paris Saclay*	**15:20 - 15:50**	**Pause café (Hall devant Amphi Buffon)**
16:10 - 16:40	**Pause café (Hall devantAmphi Buffon)**	**15:50 - 17:00**	**UTe_2 et Fermions Lourds (Amphi Buffon)**
16:40 - 17:40	**Session Sr_2RuO_4 (Amphi Buffon) - Indranil Paul**	15:50 - 16:20	*Alexandre Pourret, Univ. Grenoble Alpes, CEA Grenoble*
16:40 - 17:10	*Clifford Hicks, University of Birmingham, Max Planck Institute Dresden*	16:20 - 16:40	*Stephane Raymond, CEA-Grenoble*
17:10 - 17:40	*Antoine Georges, Collège de France, Flatiron Institute*	16:40 - 17:00	*Pablo Garcia Campos, Institut Néél - CNRS*
17:40 - 20:30	**Poster session, puis banquet-cocktail (Hall devant Amphi Buffon),**	**17:00 - 17:50**	**SC et Ferroelectricité (Amphi Buffon)**
		17:00 - 17:30	*Kamran Behnia, LPEM, ESPCI Paris*
		17:30 - 17:50	*Shamashis Sengupta, Laboratoire de Physique des 2 Infinis, Univ. Paris Saclay*