PARIS EDGE 2010

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- Massimo Capone *(Università di Roma "Sapienza)*
- Marcelo Rozenberg (*Laboratoire de Physique des Solides – Orsay)*
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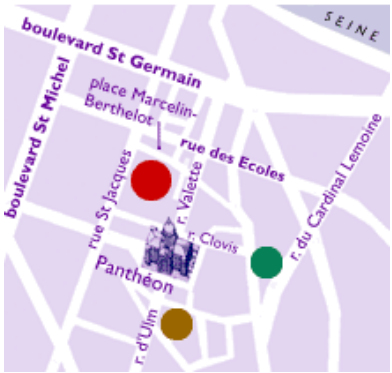
- Bernard Coqblin *(Laboratoire de Physique des Solides – Orsay)*
- Marc Gabay *(Laboratoire de Physique des Solides – Orsay)*
- Marino Marsi *(Laboratoire de Physique des Solides – Orsay)*
- Jean-Paul Pouget *(Laboratoire de Physique des Solides – Orsay)*

The conference will be held in the "Grand Amphi" of : **Laboratoire de Physique des Solides**
Bâtiment 510, Université de Paris-Sud - Orsay

The wednesday 19th afternoon session will be kindly hosted by the
Collège de France (Paris), in the Amphitheater "Maurice Halbwachs".
11, Place Marcelin-Berthelot 5th Arrondissement Paris
Metro: RER stop “Luxembourg” or “Saint Michel”
(map in the figure)



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CONFERENCE PROGRAM

May 17th ORSAY		May 18th ORSAY		May 19th PARIS	
9:30- 10:00	Conference openning - LPS / RTRA presentation				
Session 1	**Chair: H. Alloul**	**Session 3**	**Chair: V. Brouet**		*Free Morning*
10:00 - 10:40	J.C .Seamus Davis	10:00 - 10:40	I Mazin		
10:40 - 11:20	G. Kotliar	10:40 - 11:20	D Basov		
	Coffee Break		Coffee Break		
11:35 - 12:15	D. Van Der Marel	11:20 - 12:00	S Borisenko		
12:15 - 12:55	Y. Sidis	12:15 - 12:55	F Rullier-Albenque		
	Lunch		Lunch	**Afternoon Session (hosted by Collège de France)**	
Session 2	**Chair: J.P Pouget**	**Session 4**	**Chair: M. Gabay**	**Session 5**	**Chair: M. Marsi**
14:30 - 15:10	J. Mannhart	14:30 - 15:10	Vojta	14:30 -15:10	HR. Krishnamurthy
15:10 - 15:50	M. Bibes	15:10-15:50	N. Hussey	15:10 -15:50	F. Parmigiani
	Coffee Break		Coffee Break		Coffee Break
16:05 - 16:45	R. Waser	16:05-16:45	A. J. Millis	16:05 -16:45	D. Roditchev
16:45-17:25	P. Levy	16:45 -17:25	L. Balents	16:45 -17:25	T. Giamarchi
17:25 - 19:00	Poster Session (Aperitif)				
18:30	URu2Si2 Round Table				
20:00			Dinner-cruise on the Seine river (Bateau-mouche, in Paris)		

Tuesday night **excursion** RDV: 20h (Sharp! The boat leaves at 20h30 and will not wait!)

Accès: the boat leaves from the **"Port de Grenelle (Rive gauche)"**, located in the 15th arrondissement in Paris, near the Eiffel Tower.

Métro/RER : Metro station "Bir Hakeim" (line 6) or RER "Champ de Mars Tour Eiffel". Free parking available.
Follow the directions « **Port de Grenelle** » or « Port Autonome de Paris », go along the Port Autonome. building until the parking.

Telephone: +33-(0)6 20807530 , www.lecapitainefracasse.com

Monday, May 17th

9:30 Conference Opening

Laboratoire de Physique des solides presentation – Dominique Chandesris

RTRA « Triangle de la Physique » presentation – Christian Colliex

SESSION 1 - Unconventional Superconductivity : Cuprates (Chair : Henri Alloul)

10:00 – 10:40 **JC Seamus Davis** *Intra-unit-cell Electronic Nematicity of the Copper-oxide Pseudogap States*

10:40 – 11:20 **Gabriel Kotliar** *On the correlation strength of the iron pnictides and the copper oxide superconductors*

COFFEE BREAK

11:35 – 12:15 **Dirk Van Der Marel** *Comparative study of mass-renormalization and superconductivity in cuprates and SrTiO3*

12:15 – 12:55 **Yvan Sidis** *Unconventional magnetic order in the pseudogap state of high-Tc cuprates*

LUNCH

SESSION 2 – Oxides for Electronics / Oxide heterostructures (Chair : Jean-Paul Pouget)

14:30 – 15:10 **Jochen Mannhart** *Two-dimensional Electron Liquid State at Oxide Interfaces*

15:10 – 15:50 **Manuel Bibes** *Ferroelectric tunnel barriers for electronics and spintronics*

COFFEE BREAK

16:05 – 16:45 **Reiner Waser** *Redox-Based Memristive Phenomena in Transition Metal Oxides*

16:45 – 17:25 **Pablo Levy** *Hysteresis Switching Loops in Ag-manganite interfaces*

17:25 – 19:00 **Poster Session** (APERITIF)

18:30 – 19:30 ***URu2Si2 Round Table*** (Chair : Bernard Coqblin)
(with JC Seamus Davis, G Kotliar, R Lobo, A Santander-Syro, D van der Marel)

Tuesday, May 18th

SESSION 3 - Unconventional Superconductivity : Fe-superconductors (Chair : Veronique Brouet)

10:00 – 10:40 **Igor Mazin** *Experimental and computational evidence for the s+- pairing symmetry in Fe-based superconductors*

10:40 – 11:20 **Dimitri Basov** *Shedding infrared light on high-Tc superconductivity in iron pnictides*

COFFEE BREAK

11:35 – 12:15 **Sergey Borisenko** *ARPES of Fe-superconductors*

12:15 – 12:55 **Florence Rullier-Albenque** *Multiband character of the electronic structure and transport properties in the iron pnictides*

LUNCH

SESSION 4 - Unconventional Superconductivity : Cuprates / Oxides heterostructures (Chair : Marc Gabay)

14:30 – 15:10 **Matthias Vojta** *Nernst effect in symmetry-broken phases of cuprates*

15:10 – 15:50 **Nigel E. Hussey** *Dichotomy in the T-linear resistivity in hole-doped cuprates*

COFFEE BREAK

16:05 – 16:45 **Andrew J. Millis** *New physics in oxide multilayers: from orbital polarization to the potential excitonic effects*

16:45 – 17:25 **Leon Balents** *Mott physics in nickelate films: theory and experiment*

20 :00 *EXCURSION : dinner-cruise on the Seine river (Bateau-mouche, in Paris)*

Wednesday, May 19th

FREE MORNING

SESSION 5 – Out-of-equilibrium correlated systems (Chair : Marino Marsi)

14:30 – 15:10 **Hulikai Krishnamurthy** *Challenges in understanding some non-equilibrium phenomena in systems of ultra-cold trapped atoms*

15:10 – 15:50 **Fulvio Parmigiani** *Probing the ultrafast non-equilibrium electron dynamics in copper-based superconductors*

COFFEE BREAK

16:05 – 16:45 **Dimitri Roditchev** *Inhomogeneous Electric Field Driven Insulator-to-Metal Transition in GaTa4Se8: A STM/STS Study*

16:45 – 17:25 **Thierry Giamarchi** *Quantum systems in presence of nonequilibrium noise*

TALKS

Leon Balents
Kavli Institute for Theoretical Physics, University of California, Santa Barbara, USA

Mott physics in nickelate films: theory and experiment

The pseudocubic perovskite nickelates, $RNiO_3$, with R=La, Pr, Nd, etc., comprise one of the classic materials systems for studying the Mott transition. Recently, interest in these materials has revived in the context of thin film growth for engineering correlated oxide heterostructures. Films of $LaNiO_3$ produced and studied at UCSB appear to have as high or higher quality than the best "bulk" (powder) samples. I will discuss our attempts to understand the correlated metallic state in these films, and also the implications for the Mott metal-insulator transition and its concomitant magnetic and charge/lattice order in the broader family of nickelates.

Dimitri Basov
Physics Department University of California - San Diego, La Jolla, California, USA

Shedding infrared light on high-T_c superconductivity in iron pnictides

In this talk, I will overview common patterns as well as contrasting trends between the two classes of high-T_c materials: pnictides and cuprates, focusing on the information generated through infrared/optical probes. Infrared methods enable experimental access to a broad range of phenomena central for the understanding of superconductivity. These include the energy gap in a superconductor, strong coupling effects responsible for pairing, the collective response of the superfluid and also allow one to quantify the strength of electronic correlations [Nature-Physics 5, 647 (2009)]. Electronic correlations appear to dominate the electromagnetic response, not only of the pnictides and cuprates, but also of several classes of exotic lower T_c materials.

Manuel Bibes
Unité Mixte de Physique CNRS/Thales associée à l'Université Paris-Sud, France

Ferroelectric tunnel barriers for electronics and spintronics

Due to the large diversity of their physical properties and the potentiality to modulate them, oxides have recently emerged as key materials to perform novel functions in electronics and, more recently, spintronics [1]. In this presentation, we will present two approaches to engineer interfaces showing novel types of functionalities of particular interest for spintronics.

First we will present results on all-manganite tunnel junctions combining manganites with two different doping levels (one being ferromagnetic-metallic and the other antiferromagnetic-insulating). A large magnetic moment (>1μB/Mn) is induced in the barrier by proximity effect. This results in a exchange splitting of the conduction band in the barrier and thus in a spin filtering phenomenon [2].

Second, we will discuss experiments carried out on tunnel junctions combining ferromagnetic electrodes and ferroelectric tunnel barriers. Aside from producing giant tunnel electroresistance effects [3], switching the ferroelectric polarization of the barriers is found to influence dramatically the amplitude of the tunnel magnetoresistance. Our results suggest that the interfacial spin-polarization can be controlled electrically and in a non-volatile fashion by the ferroelectric polarization [4], thereby providing an additional brick for the purely electrical operation of next-generation spintronics devices such as spin field effect transistors.

[1] M. Bibes and A. Barthélémy, IEEE. Trans. Electron. Dev. 54, 1003 (2007)

[2] J.S. Moodera et al, J. Phys. Condens. Matter. 19, 165202 (2007)

[3] V. Garcia et al, Nature 460, 81 (2009)

[4] V. Garcia et al, Science 327, 1106 (2010)

Sergey Borisenko
Institute for Solid State Research, IFW-Dresden, Germany

ARPES of Fe-superconductors

We have studied the electronic structure of the Fe-pnictides using angle-resolved photoemission spectroscopy. Among them is a non-magnetic LiFeAs (Tc~18K) superconductor. In LiFeAs we find a notable absence of the Fermi surface nesting, strong renormalization of the conduction bands by a factor of three, high density of states at the Fermi level caused by a Van Hove singularity, strong coupling to phonons and no evidence for either a static or fluctuating order except superconductivity with in-plane isotropic energy gaps. Our observations suggest that these electronic properties capture the majority of ingredients necessary for the superconductivity in iron pnictides [1,2].

[1] S. V. Borisenko et al., arXiv:1001.1147
[2] A. A. Kordyuk et al., arXiv:1002.3149

JC Seamus Davis
Center for Emergent Superconductivity, CMPMS, Brookhaven Nat. Lab, NY, USA.
LASSP, Physics, Cornell University, NY, USA
SUPA Physics, St. Andrews University, Scotland.

Intra-unit-cell Electronic Nematicity of the Copper-oxide Pseudogap States

In the high-transition temperature superconductors a pseudogap phase becomes predominant when the density of dopant holes is reduced towards zero. Within in this phase, it has been unclear which electronic symmetries (if any) are broken, what the identity of any associated order parameter might be, and which microscopic electronic degrees of freedom are active. We report the determination of a quantitative order parameter representing intra-unit cell nematicity - the breaking of rotational symmetry by the electronic structure within each CuO_2 unit cell. Our spectroscopic imaging scanning tunneling microscopy images of the intra-unit-cell states in underdoped $Bi_2Sr_2CaCu_2O8+\delta$ reveal strong evidence for electronic nematicity of the states close to the pseudogap energy. Moreover, we demonstrate that these phenomena arise from electronic differences between the two oxygen sites within each unit cell. If the excitations seen by inelastic neutron scattering and SI-STM in the pseudogap phase all have the same origin, we deduce that they must represent weakly magnetic states at the O sites, whose electronic structure breaks a 90° rotational at Q=0.

Thierry Giamarchi
University DPMC-MaNEP, University of Geneva, Switzerland

Quantum systems in presence of nonequilibrium noise

In one dimension interactions lead to a a physics dominated by interactions. One of the cornerstone to describe such physcis is provided by the Luttinger liquid theory, equivalent in one dimension of the Fermi liquid for the higher dimensional systems. A very interesting question is to understand what happens when such a Luttinger liquid is coupled to a dissipative environment, and how the Luttinger liquid physics is modified by the presence of such a bath. Such a situation is relevant for several experimental situations such as coupled one dimensional chains, a superconducting wire coupled to a metallic plate, and ions in cold atomic systems subjected to microwave noise. We will examine the last case, in which the noise is time dependent, and thus leads to an intrinsic out of equilibrium situation for the one dimensional system [1]

[1] E. G. Dalla Torre, E. Demler, T. Giamarchi, E. Altman, `` Quantum critical states and phase transitions in the presence of non equilibrium noise", arXiv:0908.0868 (2009).

Nigel E. Hussey
H. H. Wills Physics Laboratory, University of Bristol, Bristol, U.K.

Dichotomy in the T-linear resistivity in hole-doped cuprates"

From analysis of the in-plane resistivity $r_{ab}(T)$ of $La_{2-x}Sr_xCuO_4$, we show that normal state transport in overdoped cuprates can be delineated into two regimes in which the electrical resistivity varies approximately linearly with temperature. In the low temperature limit, the T-linear resistivity extends over a very wide doping range, in marked contrast to expectations from conventional quantum critical scenarios [1]. The coefficient of this T-linear resistivity scales with the superconducting transition temperature T_c, implying that the interaction causing this anomalous scattering is also associated with the superconducting pairing mechanism. At high temperatures, the coefficient of the T-linear resistivity is essentially doping independent beyond a critical doping p_{crit} = 0.19 at which the ratio of the two coefficients is maximal [2]. Taking our cue from earlier thermodynamic and photoemission measurements,

we conclude that the opening of the normal state pseudogap at p_{crit} is driven by the loss of coherence of anti-nodal quasiparticles at low temperatures.
[1] R. A. Cooper et al., Science 323, 603 (2009).
[2] N. E. Hussey et al., arXiV:condmat 0912.2001v1
Funding for this work provided by EPSRC (UK), the Royal Society, LNCMI-T, the French ANR IceNET and EuroMagNET.

Gabriel Kotliar
Physics Department and Center for Materials Theory, Rutgers University, Piscataway, USA

On the correlation strength of the iron pnictides and the copper oxide superconductors

The phenomena of high temperature superconductivity in both iron prnictides and copper oxides have rekindled the need for accurate determination of their electronic normal state properties.
Realistic extensions of DMFT such as LDA+DMFT methods, while still under development, can rise up to this challenge. In this talk I will discuss results obtained in this area, comparing in broad terms the electronic structure of pnictides and cuprates. We will present recent developments that allow us to obtain not only simple pictures of the physics of this compounds, but quantitative estimates describing chemical trends in agreement with experiments.

Hulikai Krishnamurthy
Centre For Condensed Matter Theory, Indian Institute of Science, Bangalore, India

Challenges in understanding some non-equilibrium phenomena in systems of ultra-cold trapped atoms

Systems of ultra-cold trapped atoms, especially in the presence of an optical lattice, provide amazing realizations, i.e., act as "quantum emulators", of several popular model Hamiltonians of quantum condensed matter, such as the Fermi and Bose Hubbard models. Furthermore, they permit several novel experiments to be done, which would be rather difficult to do in a condensed matter context, which create and track these systems in evolving, non-equilibrium states. In this talk, I will review some of these fascinating experiments, and published efforts and the challenges involved in achieving a theoretical understanding of them, including some ongoing work of our own.

Pablo Levy
GIA and INN, CAC - CNEA,San Martin, Argentina

Hysteresis Switching Loops in Ag-manganite interfaces

Multilevel resistance states in silver - manganite interfaces are studied both experimentally and through a realistic model that includes as a main ingredient the oxygen vacancies diffusion under applied electric fields. The switching threshold and amplitude studied through Hysteresis Switching Loops are found to depend critically on the initial state. The associated vacancy profiles further unveil the prominent role of the effective electric field acting at the interfaces. While experimental results validate main assumptions of the model, the simulations allow to disentangle the microscopic mechanisms behind the resistive switching in metal - transition metal oxide interfaces.

Igor Mazin
Naval Research Laboratory, Washington, USA

Experimental and computational evidence for the s+- pairing symmetry in Fe-based superconductors

I will first review the basic theoretical arguments that led to the so-called s+- symmetry being predicted well before any experimental indications. I will discuss possible roles of phonons and of spin fluctuations, including possibility of electron-phonon coupling enhancement through magnetoelastic effects. Next I will list *negative* experimental evidence and argue that triplet pairing and d-wave pairing can be with a good degree of confidence excluded. Lastly, I will address the issue of distingushing between the s+- and a conventional s++ states, in terms of already existing and potential experiments. While the question of nodal vs. nodeless superconductivity is not immediately

related to the s+- vs. s++ choice, I will briefly discuss the fact that gap nodes seem to exist in some, but not the others, Fe-based superconductors, and possible theoretical mechanisms for that.

Jochen Mannhart
Center for Electronic Correlations and Magnetism, University of Augsburg,Germany

Two-dimensional Electron Liquid State at Oxide Interfaces

Two-dimensional electron gases based on semiconductors such as Si or GaAs have played a pivotal role in fundamental science and technology. Recent work has shown that two-dimensional electron systems can also exist at oxide interfaces [1].
Using tunneling spectroscopy we have measured the spectral density of states of the mobile, two-dimensional electron system generated at the $LaAlO_3$-$SrTiO_3$ interface. The measured density of states of the interface electron system differs qualitatively, first, from the electron systems of the materials defining the interface and, second, from the two-dimensional electron gases formed at interfaces between conventional semiconductors. As the spectroscopy results reveal, the interface electron system is an electron liquid formed by correlated electrons.
[1] A. Ohtomo et al., Nature 419, 378 (2002)

Andrew J. Millis
Department of Physics, Columbia University

New physics in oxide multilayers: from orbital polarization to the potential excitonic effects

Two recent research results are presented relating to the control of many-body phenomena in oxide superlattices. First, it is shown that chemical composition, in particular the choice of non-transition metal counterion, can be used to change both the magnitude and sign of the orbital polarization in a transition metal oxide heterostructure. Second, the potential of using oxide superlattices for creating electron-hole liquids which may give rise to novel excitonic condensates is discussed. Energetic arguments are given and potential material systems are discussed.
(The first part of the work is supported by the US Army Research Office under grant 56032PH while the second is supported by the US Department of Energy under grant ER-46169)

Fulvio Parmigiani
Department of Physics, Università degli Studi di Trieste, and Sincrotrone Trieste (Italy) Italy

Probing the ultrafast non-equilibrium electron dynamics in copper-based superconductors

In the last years, an impressive theoretical effort has been focused to investigate possible effects relating the interband optical properties of the normal and superconducting states in high-TC superconductors (HTSC) [Hirsch2000,Norman2002]. In search of an experimental evidence of such effects, continuouswave (CW) optical spectroscopies have been widely used to measure the high-energy (>1 eV) dielectric function [Molegraaf2002,Basov2004]. Unfortunately, these conventional spectroscopies failed to spot the evolution of the dielectric function, in the interband spectral region, across the superconducting transition. Here, by adopting a non-equilibrium approach to the problem, we show how the non-thermal photoinjection of excitations affects the high-energy optical properties, demonstrating a superconductivity-induced modification of distinctive interband transitions.

Dimitri Roditchev

Institut des Nanosciences de Paris, Université Pierre et Marie Curie-Paris, France

Inhomogeneous Electric Field Driven Insulator-to-Metal Transition in $GaTa_4Se_8$: A STM/STS Study

Vincent Dubost(1), Cristian Vaju(2), Laurent Cario(2), Benoit Corraze(2), Etienne Janod(2), Tristan Cren(1), François Debontridder(1) and Dimitri Roditchev(1)
(1) Institut des Nanosciences de Paris (INSP) CNRS UMR 75-88, Université Paris 6 (UPMC) 140 rue de Lourmel, 75015 Paris (France)
(2) Institut des Matériaux Jean Rouxel (IMN) Université de Nantes, CNRS 2 rue de la Houssinière, BP 32229, 44322 Nantes Cedex 3 (France)

Metal–insulator transitions (MITs) belong to a class of fascinating physical phenomena, which includes superconductivity and colossal magnetoresistance (CMR) that are associated with drastic modifications of the electrical resistance. In transition metal compounds, MITs are often related to the presence of strong electronic correlations that drive the system into a Mott insulator state. In these systems the MIT is usually tuned by electron doping or by applying an external pressure. However, we recently reported that a metal-insulator transition in the Mott insulator $GaTa_4Se_8$ can be controlled also by another external perturbation, such as an electric field [1]. We found the first experimental evidence of a nonvolatile electric-pulse-induced insulator-to-metal transition and possible superconductivity in $GaTa_4Se_8$. Our scanning tunneling microscopy (STM) experiments showed that this unconventional response of the system to short electric pulses arises from a nanometer-scale electronic phase separation (EPS) generated in the bulk material.
The extreme sensitivity of the material to the electric field among with the revealed strong electromechanical coupling in $GaTa_4Se_8$ [2] allowed us a highly reproducible nanometer-resolution writing by STM. The local electric field across the STM junction was observed to have a threshold value above which the clean in-situ cleaved (100) surface of $GaTa_4Se_8$ becomes mechanically instable: At voltage biases >1.1 V, the surface suddenly inflates and comes in contact with the STM tip, resulting in nanometer-sized craters. The formed pattern can be indestructibly ‘‘read’’ by STM at a lower voltage bias, thus allowing 5 Tdots/inch^2 dense writing/reading at room temperature. The discovery of the electromechanical coupling in $GaTa_4Se_8$ might give new clues in the understanding of the electric pulse induced resistive switching recently observed in this stoechiometric Mott insulator.
[1] Vaju C, Cario L, Corraze B, et al. “Electric-pulse-driven electronic phase separation, insulator-metal transition, and possible superconductivity in a Mott insulator” Adv. Mat., 20 (14) 2760 (2008)
[2] Dubost V, Cren T, Vaju C, et al. “Electric-Field-Assisted Nanostructuring of a Mott Insulator” Adv. Funct. Mat., 19 (17) 2800-2804 (2009)

Florence Rullier-Albenque
Service de Physique de l’Etat Condensé, CEA-Saclay, France

Multiband character of the electronic structure and transport properties in the iron pnictides

Multiband effects due to the presence of several small hole and electron pockets in the Fermi surface of Fe-pnictides are of prime importance to understand the evolution of their transport properties. In this talk we will present results of systematic Hall effect and resistivity studies in the $BaFe_2As_2$ system where Fe is substituted either by Co which results in electron doping [1] or by isovalent Ru which is expected not to change the ratio between electrons and holes [2]. We will show that electrons always dominate the transport properties in undoped and Co-doped materials, while contribution of the two types of carriers are clearly evidenced in Ru-substituted $BaFe_2As_2$. Using ARPES data obtained on the same samples [3,4], we are able to propose a coherent picture of the charge transport at low T in these compounds.
[1] F. Rullier-Albenque et al., Phys. Rev. Lett. 103, 057001 (2009).
[2] F. Rullier-Albenque et al., arXiv 1003.5376
[3] V. Brouet et al., Phys. Rev. B 80, 165115 (2009).
[4] V. Brouet et al., arXiv 1002.4952.

Yvan Sidis
Laboratoire Léon Brillouin, CEA-CNRS, CEA-Saclay, France

Unconventional magnetic order in the pseudogap state of high-Tc cuprates"

One of the leading issues in high-Tc superconductors is the origin of the pseudogap phase in underdoped cuprates. Using polarized elastic neutron diffraction, we identify a novel magnetic order in the $YBa_2Cu_3O_{6+x}$ system [1]. The observed magnetic order preserves translational symmetry as proposed for orbital moments in the circulating current theory of the pseudogap state. Subsequent measurements [2] in an $YBa_2Cu_3O_{6.6}$ sample,

that displays very high oxygen order and an exceptionally sharp superconducting transition, confirm the first result. The recent observation of the same magnetic order in $HgBa_2CuO_{4+\delta}$ [3] suggests that the phenomenon is general for all cuprates (with bi-layers or single layer structures). The temperature of the transition is that expected for the pseudogap suggesting that the pseudogap is directly connected with the magnetic order. To date, it is the first direct evidence of a hidden order parameter characterizing the pseudogap phase of high-Tc cuprates. Recent measurements in $La_{2-x}Sr_xCuO_4$ reveal that a similar ordering occurs in that system for x=0.08 but is short range and bidimensional.

[1] B. Fauqué, Y. Sidis, V.Hinkov, S.Pailhès, C.T. Lin, X. Chaud and P. Bourges, Phys. Rev. Lett. **96**, 197001 (2006)
[2] H.A. Mook, Y. Sidis, B. Fauqué, V. Balédent, P. Bourges, Phys. Rev. B **78**, 020506 (2008)
[3] Y. Li, V. Balédent, N. Barisic, Y. Cho, B. Fauqué, Y. Sidis, G. Yu, X. Zhao, P. Bourges, M. Greven, Nature 455, 372 (2008)

Dirk Van Der Marel
Département de Physique de la Matière Condensée - Université de Genève, Switzerland

Comparative study of mass-renormalization and superconductivity in cuprates and $SrTiO_3$

In this talk I will discuss mass renormalization effects in cuprates and strontium titanate, the way this manifests itself in optical and photoemission spectra [1-4] and its relation to superconductivity. Mass renormalization occurs due to strong correlation, due to electron-phonon interaction and due to interaction with collective modes such as spin waves. In an optical spectrum the inverse effective mass of the charge carriers is revealed in the spectral weight of the zero-frequency mode (ZFM) of the optical conductivity, or the coherent part of the free carrier response. The incoherent part of the free carrier response shows up as a mid-infrared band.
Optical conductivity spectra of lightly electron doped $SrTi_{1-x}Nb_xO_3$ show a mid-infrared band characteristic of polarons starting at a photon energy of 100 meV [1]. A recent ARPES study from high-quality surfaces of doped $SrTiO_3$, reveals the signatures of only moderate electron-phonon coupling: a dispersion anomaly associated with the low frequency optical phonon with a λ~0.3 and a moderate overall mass enhancement coming from the higher frequency phonons [2]. Both the ARPES [2] and the optical spectra [1] show a moderate (factor ~2) mass enhancement. The many-body large-polaron theory of Devreese [3], taking into account the anisotropy of the electronic effective mass of about 25 as well as the triple degeneracy of the Ti 3d-t_{2g} conduction bands, explains qualitatively the main features of the optical spectra and the value of the mass enhancement without any adjustment of material parameters.
Unlike $SrTi_{1-x}Nb_xO_3$, the cuprates have a large (about factor of 2) mass renormalization due to strong correlation not associated in any obvious way with low lying collective degrees of freedom. An additional and strongly doping dependent mass renormalization of order 2 to 4 (decreasing with doping) is caused by coupling of the holes to a bosonic spectrum [4]. Another important difference with $SrTi_{1-x}Nb_xO_3$, is that the bosonic spectrum in the cuprates extends far above the range of phonon energies, up to 0.5 eV at optimal doping. It is therefore plausible that this spectrum represents spin fluctuations or other electronic collective modes. Whereas for STO the Fermi energy is on the order of the phonon frequencies, in the cuprates EF at optimal doping is found to be close to aforementioned spin fluctuation energy scale. It thus so appears that -for seemingly unrelated reasons- both cuprates and $SrTiO_3$ are on the brink of validity of the Migdal theorem, a condition which appears to be favourable for optimizing Tc.

[1] J. L. M. van Mechelen, D. van der Marel, C. Grimaldi, A. B. Kuzmenko, N. P. Armitage, N. Reyren, H. Hagemann, and I. I. Mazin, Phys. Rev. Lett. 100, 226403 (2008).
[2] W. Meevasana, X. J. Zhou, B. Moritz, C.-C. Chen, R. H. He, S.-I. Fujimori, D. H. Lu, S.-K. Mo, R. G. Moore, F. Baumberger, T. P. Devereaux, D. van der Marel, N. Nagaosa, J. Zaanen, and Z.-X. Shen, New Journal of Physics 12, 023004 (2010).
[3] J. T. Devreese, S. N. Klimin, J. L. M. van Mechelen, and D. van der Marel, Physical Review B 81, 125119 (2010).
[4] E. van Heumen, E. Muhlethaler, A. B. Kuzmenko, H. Eisaki, W. Meevasana, M. Greven, and D. van der Marel, Phys. Rev. B 79, 184512 (2009).

Matthias Vojta
Institut fur Theoretische Physik, Universitat zu Koln, Germany

Nernst effect in symmetry-broken phases of cuprates

In a number of underdoped cuprate superconductors, signatures of broken lattice symmetry have been detected. The talk will discuss the thermoelectric response, in particular the Nernst effect, of quasiparticles in both electron-nematic and stripe phases. For stripes, we find that the Fermi surface reconstruction can significantly enhance the Nernst signal, with its sign depending on the period of the stripe order and other microscopic details. The most

striking effect of nematic order is a huge anisotropy of the Nernst signal, arising from a subtle interplay of different transport anisotropies. Together with recent experimental data, these results strengthen the proposal that YBCO displays nematic order in the pseudogap regime.

Reiner Waser
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Redox-Based Memristive Phenomena in Transition Metal Oxides

After following Moore´s law for more than four decades, the exponential performance increase of silicon based CMOS technology will run into inherent technological and physical limits by 2020. In particular, the Flash memory, widely spread used in MP3 players, cameras, and smart phones, suffers from limits in voltage scaling and endurance. A potential leap beyond these limits may emerge from redox-based switching effects encountered in oxides and higher chalcogenides. A range of systems exist in which ionic transport and redox reactions on the nanoscale provide the essential mechanisms for bistable resistive switching. One class relies on mobile cations which are easily created by electrochemical oxidation of the corresponding electrode metal, transported in the insulating layer, and reduced at the inert counterelectrode. Another important class operates through the migration of anions, typically oxygen ions, towards the anode, and the reduction of the cation sublattice in the layer locally providing metallically or semiconducting phases. In all systems, the defect structure turned out to be crucial for the switching process.
Despite exciting results obtained in recent years, huge challenges have to be met before these physical effects can be turned into industrial technology. This presentation will outline the fundamental principles, the prospects and challenges, as well as the open questions.

Round Table on URu_2Si_2

J.C. Seamus Davis *Cornell U./ Brookhaven National Lab./ St. Andrews U.*

Imaging the Fano lattice to 'hidden order' transition in URu2Si2

Within a Kondo lattice, the strong hybridization between electrons localized in real space (r-space) and those delocalized in momentum-space (k-space) generates exotic electronic states called 'heavy fermions'. In URu2Si2 these effects begin at temperatures around 55 K but they are suddenly altered by an unidentified electronic phase transition at T_o=17.5 K. Whether this is conventional ordering of the k-space states, or a change in the hybridization of the r-space states at each U atom, is unknown. Here we use spectroscopic imaging scanning tunneling microscopy (SI-STM) to image the evolution of URu2Si2 electronic structure simultaneously in r-space and k-space. Above T_o, the 'Fano lattice' electronic structure predicted for Kondo screening of a magnetic lattice is revealed. Below T_o, a partial energy gap without any associated density-wave signatures emerges from this Fano lattice. Heavy-quasiparticle interference imaging within this gap reveals its cause as the rapid splitting below To of a light k-space band into two new heavy fermion bands. Thus, the URu_2Si_2 'hidden order' state emerges directly from the Fano lattice electronic structure and exhibits characteristics, not of a conventional density wave, but of sudden alterations in both the hybridization at each U atom and the associated heavy fermion states.

Gabriel Kotliar *Rutgers University*

Hexadaecapolar condensate, hidden order and pseudogoldstone particles.

A theory of the hidden order on URu_2Si_2 will be presented.
(work in collaboration with K Haule).

R.P.S.M. Lobo *LPEM, ESPCI-ParisTech, UMPC, CNRS, Paris, France*

Optical conductivity of the Hidden order phase in URu_2Si_2

We measured the optical conductivity of an URu_2Si_2 single crystal as a function of temperature. URu_2Si_2 shows a coherent transport transformation around 70 K and a phase transition to a still unknown (hidden) order below 17 K. Below the coherence temperature we observe a consistent development of a very low frequency Drude-like peak. At the hidden order transition our results show a large spectral weight redistribution below 15 meV with an optical conductivity typical of a density wave gap. This spectral weight redistribution goes together with the appearance of a sharp peak at 5 meV. We will discuss effects of the hidden order transition on the carriers scattering rate and effective mass and compare our data with the earlier work of Bonn et al., PRL 61, 1305 (1988).

A. F. Santander-Syro

Fermi surface instability of heavy quasi-particles at the hidden-order transition of URu_2Si_2

A. F. Santander-Syro[1,2], M. Klein[3], F. L. Boariu[3], A. Nuber[3], P. Lejay[4], F. Reinert[3,5]

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The heavy-fermion semi-metal URu_2Si_2 presents an enigmatic second-order phase transition at T_o = 17.5 K to a `hidden order' state whose order parameter remains unknown after 23 years of intense research. Various transport and thermo-transport experiments point to the reconstruction and partial gapping of the Fermi surface when the hidden-order establishes. However, up to now, the question of how this transition affects the electronic structure at the Fermi surface was not directly addressed by a spectroscopic probe. We used high-resolution angle-resolved photoemission spectroscopy to study the hidden-order transition in URu_2Si_2. We discovered that a band of heavy quasi-particles shifts from $E>E_F$ at $T>T_o$ to $E<E_F$ in the ordered state [1]. The data further suggest

that the observed heavy-electron band results from the hybridization of a light hole-like conduction band with a band of localized states, pointing to the importance of the “localized-itinerant” interplay of electrons in this material. Our data provide thus the first direct evidence of a large reorganization of the electronic structure across the Fermi surface of URu_2Si_2 occurring during the hidden-order transition, and unveil a new kind of Fermi-surface instability in correlated electron systems.

[1] A. F. Santander-Syro, M. Klein, F. L. Boariu, A. Nuber, P. Lejay & F. Reinert. *Fermi surface instability at the hidden-order transition of URu_2Si_2*. Nature Physics **5**, 637 (2009).

D. van der Marel *Département de Physique de la Matière Condensée - Université de Genève, Switzerland*

TBA

POSTERS

Correlated electronic structure of Iron-based Superconductors from an LDA+DMFT perspective

Markus Aichhorn, *Ecole Polytechnique*

The discovery of high-temperature superconductivity in iron-based compounds triggered an enormous amount of research in condensed matter physics. A very intriguing property of these new compounds is the rather high flexibility concerning elemental substitutions, leading to several families of superconductors, termed '1111', '122', '11', and so on, depending on their chemical composition.
We analyze the single-particle properties of prominent iron-based superconductors using a combination of density-functional theory with a state-of-the-art many-body technique,the Dynamical Mean-Field Theory. This approach enables us to understand also these more complex materials at a first-principle level. We will show that there are significant differences in the electronic properties, when going from more weakly correlated members as LaFeAsO, to more correlated ones like FeSe. For reasonable Coulomb parameters, the properties range from Fermi-liquid like to incoherent bad-metal like.

Momentum space confined coherent excitations in the superconducting state of underdoped copper oxides

Sébastien Blanc, Y. Gallais, M. Cazayous, M. A. Measson, A. Sacuto, A. Georges, G.D. Gu, J.S. Wen,Z.J. Xu and D. Colson

Conventional superconductors described by the Bardeen-Cooper-Schrieffer theory are characterized by a single energy scale, the superconducting gap, also proportional to the critical temperature T_c below which superconductivity appears. In the hole-doped high-T_c copper oxide superconductors, previous experimental works have established the existence of two distinct energy scales for doping levels below the optimal one. The origin and the significance of these two energy scales are largely unexplained, however. Here we show that these two energy scales result from the fact that coherent Bogoliubov quasiparticles exist only over a restricted region of momentum-space,in contrast to conventional superconductors in which superconductivity develops uniformly along the normal-state Fermi surface. We have conducted electronic Raman scattering experiments on (Bi-2212) and (Hg-1201) compounds for several temperatures below and above T_c. These experiments reveal that the spectroscopic peaks associated with both energy scales disappear at T_c, hence establishing that they are coherence peaks associated with excitations of the superconducting state. We show that our data can be simply explained by a d-wave superconducting state with coherent pair-breaking excitations restricted to a momentum-space region centered around the nodal points. This analysis is shown to reconcile a number of spectroscopic data obtained by Raman scattering angular resolved photoemission and scanning tunneling microscopy as well as specific heat and thermal conductivity measurements

Comparison of Fermi Surface and Band Structure measured with ARPES of $Ba(Fe_{0.65}Ru_{0.35})_2As_2$ and $Ba(Fe_{1-x}Co_x)_2As_2$

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A. Taleb-Ibrahimi, P. Le Fèvre, F. Bertran, A. Nicolaou, *CASSIOPEE beamline, Synchrotron SOLEIL, France*
D. Colson, A. Forget, F. Rullier-Albenque, *SPEC, CEA Saclay (CNRS URA 2464), France*

We present a compared investigation of the electronic structure of two families of iron pnictides, where superconductivity is achieved either by electron doping or by isovalent substitution. We observe that Co substitution leads to an electron doping of the electronic structure, in good agreement with a rigid band filling picture [1]. We also observe that Ru substitution yields a coherent electronic structure, with the same number of holes and electrons, i.e. with no induced doping [2]. However, these two numbers are about twice larger than in $BaFe_2As_2$, suggesting the absolute number of carriers is an adjustable parameter of the electronic structure. Simultaneously, we observe a large increase of the Fermi velocities, probably exceeding the increase expected in band structure calculations. These observations present interesting analogies with those observed by de Haas-Van Alphen oscillations in $BaFe_2(As_{1-x}P_x)_2$. These studies show that superconductivity can take place in quite different environment in doped and undoped superconductors.
[1] V. Brouet *et al.*, Phys. Rev. B **80**, 165115 (2009)

[2] V. Brouet *et al.*, cond-mat/1002.4952

Magneto-elastic interplay in Fe-based pnictide superconductors

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The structural and magnetic phase transitions observed in the Fe-based pnictide superconductors are studied within a Ginzburg-Landau approach. We show that the magnetoelectric coupling between the corresponding order parameters is behind the salient features observed in the phase diagram of these systems. This naturally explains the coincidence of transition temperatures observed some cases as well as the character (sometimes first-order and sometimes second-order) of the transitions. We also show that magnetoelectric coupling is a key ingredient behind the collinearity of the magnetic ordering, and propose an experimental criterion to distinguish between a pure elastic from a spin-nematic driven structural transition.

Superconducting gap and quasiparticle dynamics of $Ba(Fe_{1-x}Co_x)_2As_2$ studied by electronic Raman scattering

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We report electronic Raman scattering measurements on the iron-pnictide superconductor $Ba(Fe_{1-x}Co_x)_2As_2$ single crystals. In the superconducting state, we observe a pair-breaking peak in the B_{2g} symmetry at around 75 cm^{-1} for optimal doping (x = 0.065). A weaker pair-breaking peak is also detected at higher energy in the A_{1g} symmetry but only in the optimal doped crystal. The two superconducting gaps likely originate from two different Fermi surface sheets. Temperature dependent measurements of the superconducting gap energy do not show any shift up to T_c, a behavior close to what is found in underdoped and optimally doped cuprates and in contrast with conventionnal BCS behavior. Analysis of the low energy response in the B_{2g} symmetry indicates a strongly anisostropic gap, possibly including nodes.
Above T_c, we find that the quasiparticle dynamics depends strongly on symmetry, reflecting a band dependent quasiparticle scattering rate. Our results are in agreement with transport studies on the same crystals.

Spin rotational symmetry breaking by orbital current patterns in two-leg Cu-O Hubbard ladders

Piotr Chudzinski, *DPMC-MaNEP, University of Geneva*
Marc Gabay, *LPS, Université Paris-Sud 11, Orsay*
Thierry Giamarchi, *DPMC-MaNEP, University of Geneva*

In the weak-coupling limit, we study, as a function of doping, two-leg ladders with a unit cell containing both Cu and O atoms. For purely repulsive interactions, using bosonization and a novel RG scheme, we find that in a broad region of the phase diagram, the ground state consists of a pattern of orbital currents (OCP) defined on the top of an incommensurate density wave. The internal symmetry of the OCP is specific for the ladder structure, different than the ones suggested up to now for 2D cuprates. We focus on this OCP and look for measurable signals of its existence: we compute magnetic fields induced within the ladder and we check what kind of changes in the phase diagram one may expect due to SU(2) spin-rotational symmetry breaking. We also investigate a single impurity problem (incl. OCP): we discuss if Kondo physics is at play, and make qualitative predictions about the nature of impurity backscattering.
This enables us to show the influence of SU(2) symmetry breaking on conductivity. We estimate the value of gap opened due to the OCP, give analytic expressions for correlation functions and discuss magnetic properties of a new phase.

Searching for the Mott Kondo breakdown mechanism in the quantum critical point of heavy fermions

M. Civelli, *ILL, Grenoble*

By considering a reference theoretical model (the Periodic Anderson Model) for heavy fermion materials, we will show that a quantum critical phase transition can be described in terms of an orbital selective Mott localization of a band of heavy electrons.
These facts have experimental consequences. In particular we will show that the finite-frequency inter-band transition peak in the optical conductivity has a unique peculiar behavior close to the quantum critical point. The experimental measure of this quantity could therefore provide the smoking-gun proof of the Mott Kondo breakdown mechanism in heavy fermions, with respect to other competing scenarios.

The Heavy-Fermion Quantum Critical Point as an Orbital-Selective Mott Transition

Lorenzo De Leo, *Ecole Polytechnique*

In certain materials the balanced competition among different interactions is the source of unusual and interesting phenomena. We consider one such case: the heavy-fermion quantum critical point. Despite a strong theoretical effort in the last decades, the origin of non-Fermi liquid behavior in many heavy fermion compounds remains controversial. The observation that non-Fermi liquid behavior is usually found in the proximity of a T=0 change in the ground state strongly suggests that the origin is an underlying quantum critical point. As a matter of fact, a satisfactory microscopic theory of this QCP has been so far elusive. We present a zero temperature (dynamical) mean field theory of these systems that allows to characterize the QCP as an orbital selective Mott transition. This picture accounts for a series of experimental observations that we discuss.

Genesis of coexisting itinerant and localized electrons in Fe-superconductors

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We show how the general features of the electronic structure of the Fe-based high-Tc superconductors are a natural setting for a selective localization of the conduction electrons to arise. Slave-spin and dynamical mean-field calculations support this picture and allow for a comparison of the magnetic properties with experiments.
[1] L. de' Medici, S.R. Hassan, M. Capone and X. Dai, "Orbital-Selective Mott Transition out of band-degeneracy lifting", PRL 102,126401 (2009)
[2] L. de' Medici, S.R. Hassan and M. Capone, "Genesis of coexisting itinerant and localized electrons in Iron Pnictides", JSC 22, 535 (2009)

Nodal/antinodal dichotomy in the underdoped normal state of cuprates: a cluster dynamical mean-field approach

Michel Ferrero *Ecole Polytechnique*

We describe the onset of nodal/antinodal dichotomy in the normal state of cuprates within dynamical mean-field theory. The theory is based on a minimal cluster of two orbitals, each associated with a different region of momentum space [1,2]. The low-doping regime is characterized by an orbital-selective Mott transition in reciprocal space, where the antinodal electrons become pseudogapped. Calculations of the tunneling, photoemission and c-axis conductivity spectra are consistent with experiments [1,2,3].
[1] M. Ferrero et al., Europhys. Lett. 85, 57009 (2009)
[2] M. Ferrero et al., Phys. Rev. B 80, 064501 (2009)
[3] M. Ferrero et al., arXiv:1001.5051 (2010)

The anti-ferromagnetic phase of $BaFe_2As_2$ investigated with ARPES

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In this poster we will present a study of the difference in electronic structure between the paramagnetic (PM) phase and the anti-ferromagnetic (AFM) phase of the undoped $BaFe_2As_2$. The Fermi surface of the PM phase using the folded Brillouin zone is believed to have 3 circular hole pockets (where two are degenerate) around the

Γ-point and two oval electron pockets around the X-point. Band folding is expected in the AFM phase as a result of the larger unit cell due to the magnetic ordering and gap openings should in principle take place by considering hybridisation between the back-folded electron bands onto the hole bands. Band folding has been clearly observed by angle-resolved photoemission spectroscopy (ARPES), but the resulting gap openings have not yet been fully clarified. There are many reasons for this. First of all, the many different bands crossing the Fermi level lead to a complex Fermi surface of multi orbital nature. Secondly, it is necessary to investigate how these bands depend on the photon energy as some may disperse with k_z. Matrix element effects also cause some bands to be suppressed and therefore the experimental settings highly influence the obtained results. At last, the electronic structure undergoes a structural transition at a temperature close to the transition from the PM phase to the AFM phase and it is not always easy to know which changes in the electronic structure are caused by the structural reconstruction, the magnetic interactions, or maybe even both. We present data measured in different experimental conditions, which allow us to resolve two bands constituting the electron pockets, with clearly different orbital symmetries. We study how these bands evolve as a function of the temperature and the results are compared to the structures measured at the hole pocket.

NMR study of superconductivity and magnetism in pnictides

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Unconventional superconductivity has now been evidenced in a wide variety of materials, high Tc cuprates, cobaltates, heavy fermions, organic conductors. Despite their differences, all these compounds share a common unexpected feature: in all their phase diagrams, superconductivity is always adjacent to a long range magnetic ordered phase, usually antiferromagnetic. Deciding if superconductivity and AF order exclude each other or may coexist has been subject of intense debate, revived recently by the discovery of pnictides. These Fe-based materials display a spin density wave (SDW) magnetic ordering which turns into a high Temperature superconductor when doping or pressure is applied. If coexistence was to occur, this could modify the superconductivity itself and put strong constraints on possible theories for superconductivity.
We present NMR results on electron doped $Ba(Fe_xCo_{1-x})_2As_2$ high quality single crystals which demonstrate unambiguously that for x=6%, the sample experiences both full volume superconductivity and incommensurate spin density wave order on the same Fe sites. The spin density wave develops below T_{SDW}~31K and superconductivity below T_C~21K, the magnetic order being unaffected by superconductivity. Our static and dynamic ^{75}As NMR measurements allow us to *rule out for the first time any possible phase segregation*, even if it was to be nanometer sized. This is a strong support toward s+- superconductivity symmetry in these systems, as suggested by many theoretical reports. We also address the issue of the impact of the Co doping by its substitution directly inside the FeAs layer and show that it does lead to a remarkable electronic homogeneity in contrast with cuprates and many other correlated materials.

Ultrafast transient response and electronic structure of the $Ba(Fe_{1-x}Co_x)_2As_2$ superconductor

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The real-time study of out-of-equilibrium states gives access to the dynamical excitation and relaxation of electrons close to the Fermi level, tightly related to the structural and electronic properties of the material. We carried out femtosecond pump-probe reflectivity measurements on one of the novel pnictide high-Tc superconductors, namely $Ba(Fe_{1-x}Co_x)_2As_2$, studying the relaxation dynamics and especially the role of coherent optical lattice oscillations observed for the first time in an iron-pnictide material [1].
We will present a detailed analysis of these results, and with the help of Angle Resolved Photoemission measurements performed at very low photon energy on the same samples, we will show that they can provide useful insight on very important questions concerning the electronic structure of these materials, like for instance the electron-phonon coupling.

[1] B. Mansart et al., Phys. Rev. B 80, 172504 (2009)

Nonequilibrium electron spectroscopy of Luttinger liquids

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We theoretically study a Luttinger liquid (LL) driven out of equilibrium by injection of high-energy electrons. The electrons enter the LL locally, far away from any contacts, and at a fixed energy. Their spectral properties are detected at another spatial point some distance away by evaluating the average tunneling current from the LL into a resonant level with tunable energy. For energies slightly below the injection energy, the dependence of the detected current on the difference between injection and detection energies is described by a power law whose exponent depends continuously on the Luttinger parameter. In contrast, for tunneling into the chiral LL edge of a fractional quantum Hall state from the Laughlin sequence, we find that the detected current grows linearly with the energy difference, independent of the LL parameter determined by the inverse filling fraction. We develop a diagrammatic approach for the standard (non-chiral) LL which provides an intuitive physical picture for how the electrons can relax inside the wire.

New electronic orderings in misfit cobaltates investigated by ARPES

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Cobaltates are a family of transition-metal oxides where metallic CoO_2 planes are intercalated with different structures, acting as charge reservoirs. Sodiumcobaltates are extensively studied since the discovery of an exotic superconducting phase in $Na_xCoO_2{:}H_2O$. Moreover, they offer the possibility to investigate the evolution of the electronic properties from the Mott-insulator limit (x=0) to the band insulator one (x=1). Surprisingly, signatures of strong correlations appear very far from the Mott-insulator limit for x>0.7, where good metallicity coexists with Curie-Weiss susceptibility and high thermoelectric power [1,2]. In the same doping limit, NMR and anomalous scattering experiments detect a charge order on the Co sites, with an organization dictated by the Na ordering. I will present a study, performed by angle resolved photoemission (ARPES) on a parent family of compounds, the misfit cobaltates. We have measured many compounds with a doping x>0.7, showing the same exotic metallic properties as Na cobaltates. I will show that signatures of strong correlations are present in the ARPES spectra of misfits and that they yield the reduced bandwidth observedalso in Na cobaltates [2]. By estimating the number of metallic carriers in different misfit phases by mean of Fermi surface mappings we detected the same deviation from a rigid-band filling picture as in Na cobaltates, consistent with a progressive charge localization. At the same time, STM measurements of one misfit compound show the presence of a 'striped' surface with modulations as large as many unit cells, which question for a possible electronic origin. This work proves that, despite the very different 3D environment for the CoO_2 planes in misfits and Na cobaltates, a very similar physics develops in both families of cobaltates. [1]

[1] M.L. Foo et al. Phys. Rev. Lett. 92 247001 (2004)
[2] M.Lee et al. Nature Materials 5 537 (2006)
[3] A. Nicolaou et al. Phys. Rev. Lett. 104 056403 (2010)
[4] A. Nicolaou et al. Europhys. Lett. 89 37010 (2010)

Optical properties across metal-insulator transition in $(SrMnO_3)_n/(LaMnO_3)_{2n}$ superlattices

A. Perucchi, L. Baldassarre, A. Nucara, P. Calvani, C. Adamo, D.G. Schlom, L. Maritato, S. Lupi

Recent progresses in the growth of atomic-scale multilayers are opening new exciting possibilities in the design of material's properties. The so-called electronic reconstruction effect can give rise to new 2D metallic states at the interface between a band and a Mott insulator as $SrTiO_3$ and $LaTiO_3$. Manganite superlattices with alternating layers of insulating anti-ferromagnets (AFI) $SrMnO_3$ (SMO) and $LaMnO_3$ (LMO) have been recently studied as well. Thanks to electronic reconstruction, metallicity and ferromagnetism can be induced in these nano-structures. We report here on infrared measurements of the $(SrMnO_3)_n/(LaMnO_3)_{2n}$ superlattices, as a function of Temperature (T), and for four different n values (n=1,3,5,8). Our data display a clear optical signature for the MIT observed as a function of temperature for SLs of short enough period. This provides the first optical characterization of a Double-Exchange driven FM-PI transition in the absence of random disorder

Andrès Santander-Syro

TBA

Time-Dependent Mean Field Theory for Quench Dynamics in Hubbard Model

Marco Schirò *SISSA, Trieste*

A variational description of quantum dynamics in strongly correlated electron systems out of equilibrium is introduced using a time dependent Gutzwiller ansatz. We consider the simplest case of a sudden change of the interaction (quantum quench) in the fermionic Hubbard model and find, in the limit of infinite lattice connectivity, an extremely rich behaviour. At half-filling a dynamical transition between small and large quantum quench regimes occurs, at a critical interaction quench, where purely exponential relaxation emerges.

Finite doping signatures of the Mott transition in the two-dimensional Hubbard model

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(1) Université de Sherbrooke
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Experiments on layered materials call for a study of the influence of short-range spin correlations on the Mott transition. To this end, we solve the cellular dynamical mean-field equations for the Hubbard model on a plaquette with continuous-time quantum Monte Carlo. The normal state phase diagram as a function of temperature T, interaction strength U and filling n reveals that upon increasing n towards the insulator, there is a surface of first-order transition between two metals at non-zero doping. For T above the critical end line there is a maximum in scattering rate.

Vortex pinning as a probe for disorder in iron pnictide superconductors

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The role of microscopic and mesoscopic disorder in iron pnictide superconductors is at the focus of attention, because quasi-particle scattering by the disorder imposes rather severe limits on the type of superconducting order that may be realised in these materials. In particular, it has been proposed that s-wave superconductivity with a sign-change of the order parameter between gaps on different Fermi surface sheets is particularly sensitive to pair-breaking mediated by interband scattering.
The pinning of vortex lines by the very same disorder is a sensitive probe for the kind of disorder that characterizes superconducting materials. In particular, the statistics of pinning, i.e. the number of pins per vortex line, can be inferred from the field dependence of the critical current density, while the vortex-defect interaction determines the temperature dependence of jc.
In this poster, we show that charge-doped iron pnictide superconductors are characterized by the superposition of two pinning mechanisms. The first is so-called strong pinning by extended defects, that leads to a low-field peak of j_c, followed by a by a power-law decrease $j_c \sim B^{-\alpha}$ with $0.5 < \alpha < 0.65$. Analysis of data on the investigated crystals of the (1111) group of materials shows that, most likely, one is dealing with a heterogeneity of the doping level on the scale of several to several dozen nm.
The second pinning mechanism in charge-doped iron pnictide superconductors is characterized by a low-field constant j_c and a transition to a disordered vortex lattice above the second peak field H_{on}. This behaviour is characteristic of weak collective pinning in the single vortex limit. Analysis of the temperature dependence, as well

as of the magnitude of j_c yield compelling evidence for pinning through the quasiparticle scattering mechanism (mean free path variations), with effective pin densities that are in very good agreement with the dopant atom concentration. The weak collective pinning contribution is conspicuously absent in isovalently doped materials such as $BaFe_2(As_{1-x}P_x)_2$. We therefore conclude that weak collective pinning in the iron pnictide superconductors is mediated by quasiparticle scattering off charged defects.
Finally, analysis of the elementary pinning force allows one to estimate the mean free path, as well as the scattering phase angle d of the atomic scale disorder. We consistently find disorder in the positions of charged dopant atoms (or vacancies) to be responsible for relatively weak scattering close to the Born limit, with sin d ~ 0.2.

Magnetotransport spectroscopy of high-TC superconductor/ferromagnetic microjunctions

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In recent years, extensive efforts have been devoted to the study of superconducting(S)/ferromagnetic(F) heterostructures. Among others, a number of novel physical phenomena have been observed in high-Tc superconducting YBCO/F heterostructures, such as unexpected long-range proximity effects [1], giant magnetoresistance [2], and superconductivity-induced rearrangements of the magnetic state [3]. The microscopic mechanisms behind these effects are under debate, and include different types of charge and spin transport processes across the YBCO/F interface. Particularly interesting is the possibility of triplet superconducting correlations induced in the F layers [4, 5]. Determining the electronic density of states nearby the interfaces might be key in order to understand the nature of the S/F interactions. With this motivation, we have fabricated vertical YBCO/F junctions (of areas down to 8 μm^2) using optical lithography and ion etching. We measured and analyzed the current-perpendicular-to-plane differential conductance across YBCO/F interfaces having different F: LCMO (full spin polarization, in-plane magnetic anisotropy) and Co/Pt superlattices (lower spin polarization, out-of-plane magnetic anisotropy). For YBCO/LCMO interfaces, the differential conductance shows salient features such as a prominent zero-bias conductance peak and periodic oscillations as a function of the bias voltage. In the case of YBCO/(Co/Pt) interfaces, we study the leakage of the superconducting order parameter into the F layer as a function of its thickness. We will discuss the origin of the observed behaviors in regard of proximity effects.

[1] Z. Sefrioui et al. Phys. Rev. B 67, 214511 (2003)
[2] V. Peña et al., Phys. Rev. Lett. 94, 057002 (2005).
[3] J. Hoppler et al., Nature Materials 8, 315 (2009).
[4] A.F. Volkov et al., Phys. Rev. Lett. 102, 077002 (2009)
[5] T. K. Khaire et al., Phys. Rev. Lett. 104, 137002 (2010)

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