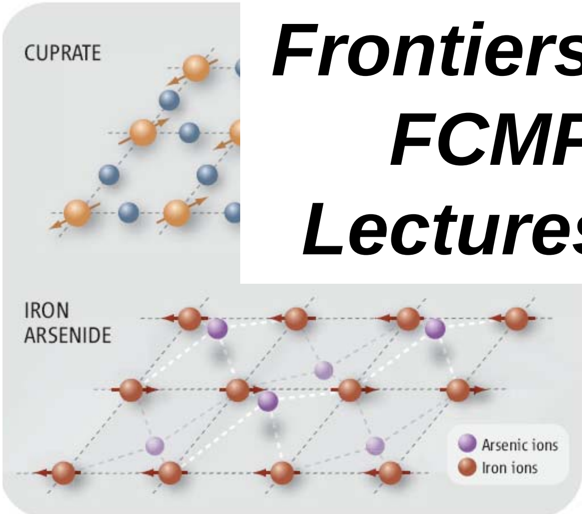
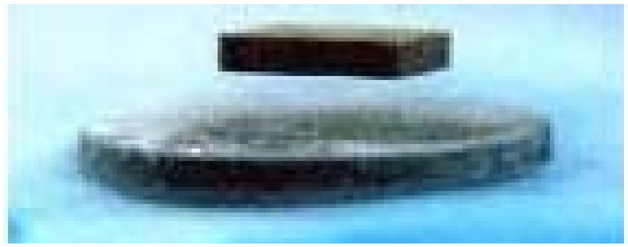
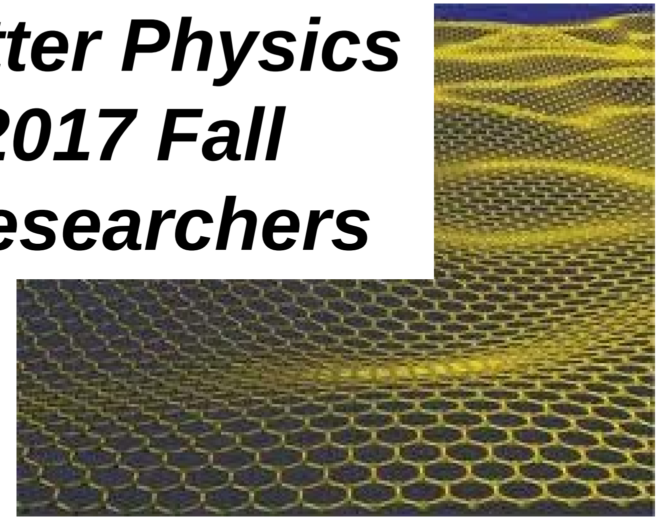
Frontiers of Condensed Matter Physics
FCMP Paris / Palaiseau 2017 Fall
Lectures by leading CMP researchers







Sep. 22 (Friday) 2:00 – 4:50 PM
Live at Columbia U Global Center (M Vavin / Edgar Quinet)
Simulcast at Ecole Polytechnique Amphi Arago

Lecture 1. 2:10 – 3:25 PM: Dirk van der Marel (U Geneva)
The color of doped $SrTiO_3$, mobile polarons and superconductivity
Lecture 2: 3:35 – 4:50 PM: Jérôme Lesueur (ESPCI)
Superconductivity in oxide heterostructures

Grad students, post-docs, senior researchers all welcome

The color of doped SrTiO3, mobile polarons and superconductivity

Dirk van der Marel

Department of Quantum Matter Physics, University of Geneva,1211 Geneva 4, Switzerland

Doped SrTiO3 is a very intriguing superconductor. The pristine material can be made ferroelectric by substitution of 18O on the oxygen sites. The RPA electronic structure calculations predict that, depending on the level of doping, one, two or three bands get occupied, at critical doping levels that have been confirmed by quantum oscillation experiments. Doping with less than 1 electron per 10'000 formula units makes the materials superconducting. Moreover, the maximum value of Tc is of the order 0.5 Kelvin regardless whether obtained in 2D interfaces or in bulk SrTiO3. The doped electrons are coupled to the lattice parameters, and from a wealth of optical and ARPES experiments it is known that this causes a factor of two mass enhancement, corresponding to the limit of large -and highly mobile- polarons. With regards to superconductivity there exists universal agreement that it pairing is mediated by electron-phonon coupling, but it is not clear which phonons are the most important ones. Recently it has been suggested that the optical phonons that soften at the para-ferro electric transition are the main culprits, on the other hand optics and ARPES data suggest strong coupling to the highest energy branch of optical phonons. Our isotope studies demonstrates a factor 1.5 enhancement of Tc, with a sign opposite to standard BCS. The effect can be due to polaronic band-narrowing, coupling to ferro-electric fluctuations or a combination of these two.

References:
[1] K.A. Mueller, and H. Burkard, Phys. Rev. B, 19, 3593-3602 (1979).
[2] S.E. Rowley, L.J. Spalek, R.P. Smith, M. P.M. Dean, M. Itoh, J.F. Scott, G.G. Lonzarich, and S.S. Saxena, Nat. Phys. 10, 367-372 (2014).
[3] A. S. Alexandrov, Phys. Rev. B 46, 14932 (1992).
[4] J. M. Edge, Y. Kedem, U. Aschauer, N. A. Spaldin, and A.V. Balatsky, Phys. Rev. Lett. 115, 247002 (2016).
[5] D. van der Marel, J.L.M. van Mechelen, and I.I. Mazin, Phys. Rev. B 84, 251 11 (2011).
A. Stucky, G. Scheerer, Z. Ren, D. Jaccard, J.-M. Poumirol, C. Barreteau, E . Giannini, and D. van der Marel; Scientific Reports 6, 37582 (2016).
[6] C.W. Rischau, X. Lin, C. P. Grams, D. Finck, S. Harms, J. Engelmayer, T. Lorenz, Y. Gallais, B. Fauqué, J. Hemberger and K.Behnia; Nature Physics13, 643 (2017).

Prof. Dirk van der Marel obtained his B.S. in phyics in 1982 and his Ph.D. in mathematics and natural sciences from the University of Groningen (the Netherlands) in 1985. He was a research fellow at Philips Research Laboratories in Eindhoven, then joined Delft University of Technology (the Netherlands) as Universitair Docent, later Universitair Hoofd Docent. During 1990, he was a visiting research fellow at the Max Planck Institut für Festkörperforschung in Stuttgart, returned to Delft University of Technology, and in 1992 became full professor at the University of Groningen. In 2003 he moved to the University of Geneva, where he has been active since then as a full professor in the Department of Quantum Matter Physics (DQMP). He is best known for his optical experiments on high temperature superconductors revealing the changes of kinetic energy through the superconducting phase transition, and his work on the Josephson plasmons in multilayered superconductors. He is a member of APS, NNV, SPS, EPS, and counsellor of the Swiss National Science Foundation.

Superconductivity in oxide heterostructures

Jérôme Lesueur

Physics and Materials Laboratory
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Ten years after its discovery in the group of J M Triscone in Geneva [1], superconductivity at In $LaAlO_3/SrTiO_3$ heterostructures appears as a fantastic playground.

Indeed, a gate tunable 2D superconducting electron gas is confined in a quantum well at the interface between two insulating oxides. Remarkably, the gas coexists with both magnetism and strong Rashba spin-orbit coupling. The band structure based on titanium d-orbitals is rich and complex. Therefore, charge, spin and orbital degrees of freedom are at play in these systems, which can be controlled by a gate voltage, and may lead to exotic phases such as topological superconductivity for instance.

We will first introduce the mains features of these heterostructures, and then focus on superconducting properties. We will show that the peculiar band structure at the interface plays an important role in these systems. Through DC transport measurements, we have explored the phase diagram and showed that phase fluctuations, disorder and possibly spontaneous electronic phase separation play a crucial role in these transitions [2,3]. Through AC measurements, namely resonant microwave experiments, we recently measured the superfluid stiffness and inferred the superconducting gap energy as a function of carrier density. At low doping, the system strongly departs from the BCS scenario [4].

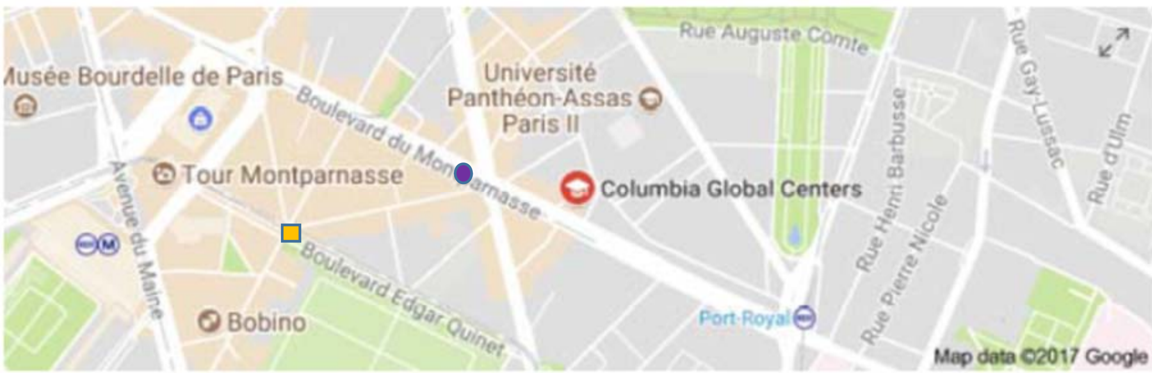
These studies, and others that we will refer to, reveals that oxide heterostructures host unusual superconducting phases.

[1] N. Reyren et al, Science 317, 1196 (2007), A. Caviglia et al, Nature 456, 624 (2008)
[2] J. Biscaras et al, Nature Materials 12, 542 (2013)
[3] N. Scopigno et al, Physical Review Letters 116, 026804 (2016)
[4] G. Singh et al, arXiv:1704.03365

[5] Reviews on the subject : S. Gariglio et al, APL Materials, 4, 060701 (2016) ; J. A Sulpizio et al, Annual Review of Materials Research 44, 117 (2014) ; H. Y Hwang et al, Nature Materials 11, 103 (2012) ; P. Zubko et al, Annual Review of Condensed Matter Physics 2, 141 (2011) ;

https://phasme.lpem.espci.fr/spip.php?rubrique1

Columbia University Global Center in Paris



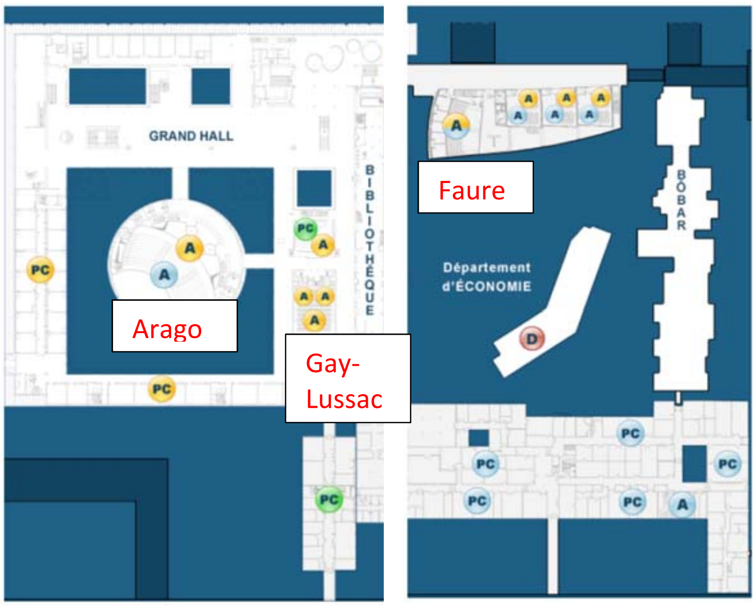
Columbia University Global Center Reid Hall:
Address: 4 Rue de Chevreuse, 75006 Paris, France (close to Metro 4 Vavin and/or Metro 6 Edgar Quinet)

Phone: +33 1 43 20 33 07

Live Lecture Location will alternate week by week between Columbia U Global Center (CUGC shown above) and Ecole Polytechnique (shown in the next page).

If you are happy to commute on RER between Palaiseau/Orsay and Paris Center, please come to the live lecture location. We will have an informal Coffee Time at 4:50 – 5:30 PM after two lectures, so that audience can enjoy direct conversation with the lecturers and other audiences. That is additional merit of coming to the live lecture location.

If you would like to save time of RER commute, you can come to simulcast projections which will be offered at the same location where the live lectures will take place in alternating weeks. When live lectures are given at CUGC, audience in Palaiseau / Orsay area have a choice to come to Ecole Polytechnique to watch the simulcast of CUGC live lectures. When the live talks are given at Ecole Polytechnique, simulcast will be offered at CUGC for audience in Paris city area.



Amphithéâtre Pierre Faurre (Ecole Polytechnique)

Ecole Polytechnique Amphitheatres **(walk from Albatrans Bus 91.06B "Polytechnique Lozere" station; http://www.albatrans.net/wp-content/uploads/downloads/2015/06/Albatrans-91.06-AB-91.10-2015.pdf)**

https://www.google.fr/maps/place/Amphith%C3%A9%C3%A2tre+Pierre+Faurre+(%C3%89cole+Polytechnique)/@48.7130055,2.2071876,16.25z/data=!4m12!1m6!3m5!1s0x47e6788dd891b127:0x43c2be8ce6d1821e!2s%C3%89cole+Polytechnique!8m2!3d48.7142971!4d2.2112917!3m4!1s0x0:0x1fb2ba614105870!8m2!3d48.7124648!4d2.2106163

8/09: Amphi Faurre
15/09: Amphi Faurre
22/09: Amphi Arago (only one available)
29/09: Amphi Gay-Lussac
6/10: Amphi Gay-Lussac
13/10: Amphi Arago
20/10: Amphi Gay-Lussac
27/10: Amphi Gay-Lussac
3/11: Amphi Faurre
10/11: Amphi Gay-Lussac
17/11: Amphi Gay-Lussac
24/11: To be announced
1/12: Amphi Gay-Lussac
8/12: Amphi Faurre
15/12: Amphi Faurre

http://softs.polytechnique.fr/cpm/avant_projets/plans/plan_pc_amphis.html#

Schedules of speakers and live lecture locations: Paris-Palaiseau FCMP I in Fall 2017

Date	Location Live / (simulcast)	Lecturer 1 (2:10-3:25 PM) (8:10-9:25 AM US EST)	Lecturer 2 (3:30 – 4:45 PM) (9:30 – 10:45 AM US EST)
Sep 8	CUGC (EP)	Tomo Uemura (Columbia / EP)	Kamran Behnia (ESPCI)
Sep 15	EP (CUGC)	Stephen Blundell (Oxford)	Philippe Mendels (Orsay)
Sep 22	CUGC (EP)	Dirk van der Marel (Geneva)	Jerome Lesueur (ESPCI)
Sep 29	EP (CUGC)	Alain Sacuto (Diderot)	Bernhard Keimer (Stuttgart)
Oct 6	EP (TBA)	Sadamich Maekawa (JAEA)	Philippe Bourges (CEA-LLB)
Oct 13	CUGC (EP)	Piers Coleman (Rutgers)	Marc Gabay (Orsay)
Oct 20	EP (TBA)	JC Seamus Davis (Cornell)	Masatoshi Imada (Tokyo)
Oct 27	CUGC	Gil Lonzarich (Cambridge)	Louis Taillefer (Sherbrooke)
	Party: no simulcast	Dinner Party at CUGC after the event	
Nov 3	EP (CUGC)	Catherene Pepin (CEA)	Luca de Medici (ESPCI)
Nov 10	CUGC (EP)	Antonio Bianconi (Rome)	Marcin Konczykowski (EP)
Nov 17	EP (CUGC)	Dimitri Basov (Columbia)	Marc-Henri Julien (Grenoble)
Nov 24	CUGC (EP)	Pengcheng Dai (Rice)	Antoine Georges (EP / Simons)
Dec 1	EP (CUGC)	Andrea Cavelleri (Hamburg)	Luca Perfetti (EP)
Dec 8	CUGC (EP)	Kosmas Prassides (Tohoku)	Steve Bramwell (UCL)
Dec 15	EP	Albert Fert (CNRS-Thales)	Alessandra Lanzara (Berkeley)
	(Lecturer 3)	Naoto Nagaosa (Tokyo) 5:00 – 6:15 PM (11:00 AM-12:15 Noon US EST)	
	Party: no simulcast	Dinner Party at Ecole Polytechnique at 6:30-8:30 PM	

A different class Paris FCMP-II in Spring 2018

Jan 12	Gabe Aeppli (PSI)	Kees van der Beek (EP)
Jan 19	Andrea Gauzzi (UPMC)	Tomo Uemura (Columbia)
Jan 26	Andres Santander Syro (Orsay)	TBA

Most-likely continuing until April 2018