EXCELLENCE IN SCIENCE

THE ROYAL SOCIETY

SATELLITE MEETING ON

Superconductivity at oxide interfaces

Wednesday 14 – Thursday 15 September 2011

The Kavli Royal Society International Centre, Chicheley Hall, Buckinghamshire

Organised by Professor Mark Blamire, Professor Dave Blank and Professor Judith Driscoll

- **Programme schedule**
- **Programme and abstracts**
- **Speaker biographies**
- **Notes**

The abstracts that follow are provided by the presenters and the Royal Society takes no responsibility for their content.

DAY 1				DAY 2			
09.00	Welcome by Professor Sir Peter Knight FRS Welcome and scene-setting by Professor Mark Blamire, Organiser						
SESSION 1 **Chair: Professor Mark Blamire**		**SESSION 2** **Chair: Dr Jason Robinson**		**SESSION 3** **Chair: Professor James Annett**		**SESSION 4** **Chair: Professor Judith Driscoll**	
09.15	**Professor Hans Hilgenkamp**	**13.45**	**Professor Jacobo Santamaría**	**09.00**	**Professor Elbio Dagotto**	**13.30**	**Professor Harold Hwang**
09.45	Discussion	**14.15**	Discussion	**09.30**	Discussion	**14.00**	Discussion
10.00	**Professor Gad Koren**	**14.30**	**Professor Lesley Cohen**	**09.45**	**Dr Ivan Bozovic**	**14.15**	**Professor Jérôme Lesueur**
10.30	Discussion	**15.00**	Discussion	**10.15**	Discussion	**14.45**	Discussion
10.45	Coffee	**15.15**	Tea	**10.30**	Coffee	**15.00**	Tea
11.15	**Professor Jochen Mannhart**	**15.45**	**Professor Bernhard Keimer**	**11.00**	**Professor Jak Chakhalian**	**15.30**	**Professor Mark Blamire**
11.45	Discussion	**16.15**	Discussion	**11.30**	Discussion	**16.00**	Discussion
12.00	**Professor Teresa Puig**	**16.30**	**Dr Matthias Eschrig**	**11.45**	**Dr Quanxi Jia**	**16.15**	Panel discussion/Overview (future directions)
12.30	Discussion	**17.00**	Discussion	**12.15**	Discussion		
12.45	LUNCH	**17.15**	CLOSE	**12.30**	LUNCH	**17.00**	CLOSE
		18.30	DINNER				

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Superconductivity at oxide interfaces

Organised by Professor Mark Blamire, Professor Dave Blank and Professor Judith Driscoll

Wednesday 14 – Thursday 15 September 2011
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Superconductivity in oxides is easily modified by the presence of interfaces. This workshop will bring together experts in a broad range of phenomena associated with interfaces, including strain and field-effects, the coupling of superconductivity and ferromagnetism and the interaction of interfaces and pairing symmetries, with the aim of exploring methods for enhancing and controlling superconductivity in oxide nanostructures.

Wednesday 14 September 2011

08.30 Registration & coffee

09.00 Welcome by Professor Sir Peter Knight FRS, Principal, The Kavli Royal Society Centre

Welcome by Professor Mark Blamire, University of Cambridge, UK
Introduction and scene setting for the meeting

Session 1
Chair – Professor Professor Mark Blamire, University of Cambridge, UK

09.15 Interfacing two - fundamentally different (?) - condensates; Hybrid high-Tc vs low Tc Josephson structures
Professor Hans Hilgenkamp, University of Twente and Leiden University, The Netherlands

The oxide and pnictide high-T_c superconductors differ in many essential aspects from their metallic low-T_c counterparts. This becomes especially visible when these different materials systems are interfaced with each other.

In a series of experiments we conducted in the years 2002-2009, contacts between high-T_c and low-T_c superconductors were exploited for detailed studies on the order parameter symmetry in the p- and n-doped cuprates, and to create novel 'pi-shift' devices based on Josephson structures with built-in pi-phase shifts and spontaneously formed fractional flux quanta. After giving a brief overview of these activities, and an account of the current state-of-the art, I will consider prospects for future developments on high-T_c vs. low-T_c interfaces and related structures.

09.45 Discussion

10.00 Energy scales and interface effects in SNS and SFS ramp-type junctions of high temperature superconductors with a non-superconducting cuprate or ferromagnetic barriers

Professor Gad Koren, Technion, Israel

Conductance spectra of highly transparent SNS ramp-type junctions made of superconducting $La_{2-x}Sr_xCuO_4$ electrodes and a non-superconducting $La_{1.65}Sr_{0.35}CuO_4$ barrier (N) show two prominent Andreev-like conductance peaks with gap energies Δ_1 and Δ_2 where $\Delta_2 > \Delta_1$. Both gaps scale roughly as T_C versus the doping level x. Δ_1 is due to the superconducting energy gap, while the similarity of the behavior of Δ_2 versus doping at 2 K to the Nernst results above T_C suggests a preformed pair origin for Δ_2. In similar SFS junctions with $La_{1.9}Sr_{0.1}CuO_4$ electrodes and a ferromagnetic $La_{0.67}Ca_{0.33}MnO_3$ barrier (F), the low bias conductance spectra also show the Δ_1 Andreev peak. After magnetic field cycling however, they showed the negative magnetoresistance of the barrier, and revealed a signature of superparamagnetism when the barrier thickness was 12 nm. In $YBa_2Cu_3O_y$ based SFS junctions with ferromagnetic barriers of either $SrRuO_3$ or $La_{0.67}Ca_{0.33}MnO_3$, we investigated the dependence of the conductance spectra on the number of domain walls in F, as well as the critical current dependence on the thickness of the F barrier. The results are discussed in terms of a crossed Andreev reflection effect near domain walls in F (CARE) and proximity induced triplet superconductivity in F (PITS). So far, our results suggest a stronger evidence for CARE, but cannot rule out a weak PITS effect.

10.30 Discussion

10.45 Coffee

11.15 Coexistence of superconductivity and magnetism at $LaAlO_3$-$SrTiO_3$ interfaces

Professor Jochen Mannhart, Max Planck Institute for Solid State Research, Germany

A two dimensional electronic system with novel electronic properties forms at the interface between the insulators $LaAlO_3$ and $SrTiO_3$. Samples fabricated until now have been found to be either magnetic or superconducting, depending on growth conditions. We combined transport measurements with high-resolution magnetic torque magnetometry and will report evidence of magnetic ordering of the two-dimensional electron liquid at the interface. Our results suggest that there is either phase separation or coexistence between magnetic and superconducting states. The coexistence scenario would point to an unconventional superconducting phase in the ground state.

We furthermore analyzed the ferromagnetic state within density functional theory and provide evidence that it is also generated by Ti 3d interface electrons, as is the two-dimensional electron liquid at the interface which gives rise to superconductivity.

11.45 Discussion

12.00 Incoherent interfaces and local lattice strains in solution-derived YBCO nanocomposites: a novel vortex pinning mechanism

Professor Teresa Puig, Institut de Ciencia de Materials de Barcelona, Spain

Interfaces in oxides have become one of the most relevant issues to generate, enhance and control new physical phenomena. In many of the cases, interfaces have been promoted by growing nanocomposites where each phase is properly designed to undertake a specific role. Heteroepitaxial growth has therefore become the key process in controlling the strain of the designed *semicoherent* interfaces. Epitaxial growth of high temperature superconducting nanocomposites has emerged as a solution to control and enhance the vortex pinning landscape. In this work, we will demonstrate that a not so often used type of interface, *incoherent* interfaces, give rise to a new and highly effective vortex pinning mechanism in $YBa_2Cu_3O_7$ nanocomposites, where local lattice strains precludes Cooper pair formation inducing nanoscale regions effective for core pinning of vortices. For that purpose, solution-derived epitaxial nanocomposites with randomly oriented second phase nanoparticles ($BaZrO_3$, Y_2O_3, $BaCeO_3$ and Ba_2TaYO_6) were grown. This methodology has become an excellent low cost processing option generating a *3D* ramified network of localized and highly strained nanoscale regions (mainly due to extra Cu-O chains and partial dislocations as evidenced by HRSTEM), responsible for huge quasi-isotropic pinning forces and a vanishing anisotropy of the critical currents.

12.30 Discussion

12.45 LUNCH

Session 2

Chair - Dr Jason Robinson, University of Cambridge, UK

13.45 Spin dependant transport and superconductivity at cuprate-manganite interfaces

Professor Jacobo Santamaría, Universidad Complutense de Madrid, Spain

Many complex transition metal oxides share a common perovskite structure with similar lattice parameters, allowing very different ground states (ferromagnets, superconductors, multiferroics, etc) to be brought into direct contact at highly ordered interfaces. Novel and interesting effects may result from their competition and interplay. In this talk I will discuss the competition between ferromagnetism and superconductivity at $La_{0.7}Ca_{0.3}MnO_3$ / $YBa_2Cu_3O_7$ superlattices by combined polarized neutron reflectometry, aberration corrected microscopy and atomic column resolution electron energy loss spectroscopy (STEM- EELS) and x-ray absorption with polarization analysis. We report on the magnetic anisotropy controlled modulation of the superconductivity in ferromagnet / superconductor /ferromagnet hybrids. The orientation of the magnetic field with respect to the [110] biaxial easy axes has a pronounced effect on superconductivity tracked by a strong variation of the magnetoresistance (MR). The magnetoresistance is determined by the antiparallel alignment of the manganite layers, outlining the importance of spin dependent effects. X-ray magnetic circular dichroism experiments show that *both* cuprate interfaces are magnetic with a magnetic moment induced in Cu atoms as expected from symmetric Mn-O-Cu superexchange paths. These results supply a solid footing to discuss the interplay between magnetism and superconductivity in this system in terms of the induced Cu spin polarization at both interfaces.

14.15 Discussion

14.30 Andreev Reflection Spectroscopy – using superconductivity to prove interfaces
Professor Lesley Cohen, Imperial College London, UK

Andreev reflection at the interface between a metal and a superconductor has been used to explore bulk properties of metals and superconductors with celebrated success, for example when new exotic superconductors are discovered, or to extract the polarisation of carriers in a ferromagnet. However, the properties of the interface between metal and superconductor can affect the information that Andreev spectroscopy yields and the converse of that statement is that studying the variation in extracted parameters provides some insight into the complexity of interfacial state. We have studied planar InAs/Pb junctions which provide some clues as to the richness of these properties and we give some examples here. Mechanically driven point contact spectroscopy offers some advantage over planar junctions because the interface properties can be changed systematically with tip pressure. There is nothing specifically unique about the oxide - superconductor interface, but we give examples of systems we have studied including Mn /Al codoped ZnO, CrO_2, as well as NiPd and the spin spiral Ho. The work suggests that the Andreev spectroscopic method can be used to extract bulk properties under certain circumstances, but the information is more usually influenced by the interface in ways that we currently do not fully understand.

15.00 Discussion

15.15 Tea

15.45 Structural and electronic properties of nickel oxide superlattices
Professor Bernhard Keimer, Max Planck Institute for Solid State Research, Germany

We will describe a comprehensive experimental investigation of the influence of layer thickness, composition, and strain on the lattice structure [1], spin and orbital polarization [2], and electronic phase behavior [3] of nickelate superlattices. Recent progress on soft x-ray diffraction and reflectometry methods as a characterization tool of oxide superlattices will be emphasized.

[1] A Frano et al, unpublished
[2] E Benckiser et al, Nature Materials 10, 189 (2011)
[3] A V Boris et al, Science 332, 937 (2011)

16.15 Discussion

16.30 Unconventional superconductivity induced in half-metallic ferromagnets
Dr Matthias Eschrig, Royal Holloway University of London, UK

Superconductivity induced via interfaces into magnetic materials provides an exciting way of producing unconventional pairing states. Among them are such exotic ones like equal-spin triplet superconductivity and odd-frequency superconductivity. Both states are extremely rare in bulk materials, and the latter of the two has never been observed in nature. However, in heterostructures such pairing states have been predicted, and have been experimentally discovered in the half-metallic ferromagnetic oxide CrO_2 for the first time in 2006 in Delft. This opens the possibility to tailor superconducting states in a controlled way, by controlling the properties of interfaces. We identify the relevant processes taking place at such interfaces and responsible for creating unconventional pairing. We concentrate on strongly spin-polarized systems, with the extreme case of half-metallic ferromagnets where one spin direction is insulating and the other one metallic. We show that when spin-orbit coupling is strong in the interface region, chiral px+ipy-type triplet pairing will be induced in the half-metallic region.

17.00 Discussion

17.15 CLOSE

18.15 Pre-dinner drinks

18.30 Dinner

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Session 3
Chair – Professor James Annett, University of Bristol, UK

09.00 Computational studies of model Hamiltonians for magnetic and superconducting materials in the bulk and at interfaces
Professor Elbio Dagotto, University of Tennessee, USA

The current status of computer simulations of model Hamiltonians for Mn-oxides with the colossal magnetoresistance (CMR) and for the novel Fe-based high-Tc superconductors will be briefly reviewed. It will be shown that state-of-the-art computer simulations involving Monte Carlo studies of double-exchange models with Jahn-Teller phonons do display the CMR effect. Multiple-orbital Hubbard models for pnictides have magnetic order with the correct wavevector in the undoped-limit ground state, and pairing tendencies in several competing channels upon doping.

The presentation will continue addressing superlattices of strongly correlated materials with emphasis on results for magnetic compounds, such as large- and low-bandwidth manganites (ie LMO/SMO, LMO/CMO), and also manganites/ferroelectrics. The focus will be on the states that are stabilized at the interfaces, some of which do not have an analog in the materials that form the superlattice when they are in bulk form.

09.30 Discussion

09.45 High-temperature interface superconductivity
Dr Ivan Bozovic, Brookhaven National Laboratory, USA

We have used atomic-layer-by-layer molecular beam epitaxy to synthesize digitally cuprate thin films and heterostructures, with the goals to study the basic physics of high-temperature superconductivity (HTS) and develop HTS electronic devices.

In 2002, we reported[1] significantly enhanced critical temperature (T_c = 51.5 K) in a bilayer *M-S* film where *M* denotes a heavily overdoped, metallic but not superconducting $La_{1.55}Sr_{0.45}CuO_4$ and *S* is an optimally doped $La_{1.85}Sr_{0.15}CuO_4$ with $T_c \approx 40$ K. This was in fact due to interface superconductivity but at that time we did not have a good technique to measure the thickness of that layer.

More recently, we studied *M-I* bilayers where *I* = La_2CuO_4, an antiferromagnetic insulator, so neither of the constituent layers is superconducting *per se*.[2] However, in bilayers we found that T_c is either ~15 K or ~30 K, depending on the layering sequence. Subsequently we explained this asymmetry as being due to long-range electrostatic interaction ('Madelung strain') with the substrate.[3]

Using RHEED, TOF-ISARS and HREELS-STEM we established that there is very little Sr interdiffusion across the interface[2] and showed by RSXRS that there is a genuine electronic effect, ie mobile charge carrier depletion and accumulation[4]. Next, we determined the thickness of the superfluid by a new technique, -doping tomography.[5] We synthesized a series of *M-I* bilayers identical in all respects except that in each one a small amount (3%) of Zn was selectively doped within a different CuO_2 plane. Zn is known to substitute for Cu without affecting the carrier density while dramatically suppressing superconductivity. We found a large depression in T_c only in the samples in which Zn dopant was placed in the second CuO_2 plane above the interface. This proved that interface HTS with $T_c = 32 \pm 4$ K occurs within a single CuO_2 plane.

Next, we showed that if such a bilayer is exposed to ozone its T_c exceeds 50 K, and that this enhanced superconductivity also originates from the interface layer about 1-2 unit cell thick, similar to what happens in *M-S* biilayers.

Once we established that a single CuO_2 plane can carry HTS, an obvious next step was to try tuning the carrier density and T_c by electric field effect. In cuprates this is a substantial technical challenge, since one needs perfect ultrathin films and huge local fields (> 10^9 V/m). The latter can be reached, though, using electrolytes or ionic liquids in the electric double-layer transistor configuration. We synthesized one-unit-cell thick epitaxial films of LSCO, fabricated double-layer transistors, and achieved very large induced changes in surface carrier density and shifts in the critical temperature by up to 30 K. This allowed a detailed study of the *S-I* quantum phase transition. Hundreds of resistance vs temperature and carrier density curves were recorded and shown to collapse onto a single function as predicted for a 2D *S-I* transition. The observed critical resistance is precisely the quantum resistance for pairs, $R_Q = h/(2e)^2 = 6.5$ k , suggestive of a phase transition driven by quantum phase fluctuations, and Cooper pair (de)localization.

1 Bozovic et al, PRL 89, 107001 (2002)
2 Gozar et al, Nature 455, 782 (2008)
3 Butko et al, Adv Mater 21,1 (2009)
4 Smadici et al, PRL 102, 107004 (2009)
5 Logvenov et al, Science 326, 699 (2009)
6 Bollinger et al, Nature 472, 458 (2011)

10.15 Discussion

10.30 Coffee

11.00 Correlated electrons at the interfaces of complex oxides

Professor Jak Chakhalian, University of Arkansas, USA

Complex oxides are a class of materials characterized by a variety of competing interactions that create a subtle balance to define the lowest energy state and lead to a wide diversity of interesting properties (eg superconductivity, exotic magnetism,...). By utilizing the bulk properties of these materials as a starting point, interfaces between different classes of complex oxides offer a unique opportunity to break the symmetries present in the bulk and alter the local environment. Utilizing our advances in oxide growth, we can now combine materials with distinctly different and even competing orders to create new materials in the form of heterostructures with atomic layer precision. The broken symmetry, strain, and altered chemical environments at the interfaces then provide a unique laboratory to manipulate this subtle balance and even create novel quantum state not attainable in bulk. Understanding of these phases however requires detailed microscopic studies of the heterostructure properties. Here I will touch on several recent examples to illustrate how the application of synchrotron radiation offers the ability to probe bulk vs interface properties to gain exclusive insight into the underlying physics.

References
J Chakhalian et al, *Nature Physics*, v2, 244 (2006)
J Chakhalian et al, *Science*, v 314, 1114, (2007)
Jian Liu et al, Physical Review B 83, 161102(R) (2011)

11.30 Discussion

11.45 Effect of interface on the transport properties of superconducting nanocomposites
Dr Quanxi Jia, Los Alamos National Laboratory, USA

Imperative for the fundamental understanding of materials is the enhancement of our capabilities to design, manipulate, and control their ultimate functionalities. Over the past several years, superior physical properties have been achieved through manipulating interfaces at the nanoscale in different materials by forming nanocomposite heterostructures. In this presentation, we review our effort in designing interfaces to create new technologically relevant superconducting nanocomposite materials. We have used high-temperature superconductors (such as YBa2Cu3O7-x) and magnetic materials (such as CoPt and TbMnO3) as our building blocks to evaluate the interface effect on superconducting properties. These materials provide unique and competing interactions which could, when combined, lead to novel and unexplored physical properties with tremendous technological relevance. We have established a set of principles that can be used to develop and design superconducting nanocomposites with desired transport properties.

12.15 Discussion

12.30 Lunch

Session 4
Chair – Professor Judith Driscoll, University of Cambridge, UK

13.30 Low-dimensional superconductivity in SrTiO3 heterostructures
Professor Harold Hwang, Stanford University, USA

$SrTiO_3$ is the lowest density bulk superconductor, which incorporated in heterostructures provides an opportunity for band-structure engineering this superconducting semiconductor. The $LaAlO_3/SrTiO_3$ interface can be back-gate depleted to induce a 2D superconductor-insulator transition, which occurs via a localization transition in the dirty limit. Intriguingly, the superconducting state is found to coexist with regions of ferromagnetism on a microscopic scale. In another approach, using heterostructures of $Nb:SrTiO_3$ embedded in undoped $SrTiO_3$, we have studied the crossover from 3D to 2D superconductivity as the thickness of the doped layer is decreased. A notable feature of this structure is that the mobility strongly increases in the 2D limit, in analogy to -doping in semiconductors. This aspect suggests that a new regime of 2D superconducting phase transitions can be experimentally accessed approaching the clean limit.

14.00 Discussion

14.15 Transport properties of two-dimensional electron gas at the Mott-Insulator/Band-Insulator LaTi03/SrTiO3 interface
Professor Jérôme Lesueur, LPEM - ESPCI - CNRS – UPMC, France

Transition metal oxides display a great variety of quantum electronic behaviors where correlations often play an important role. The achievement of high quality epitaxial interfaces involving such materials gives a unique opportunity to engineer artificial materials where new electronic orders take place. It has been shown recently that a two-dimensional electron gas could form at the interface of two insulators such as LaAlO3 and SrTiO3 [1], or LaTiO3 (a Mott insulator) and SrTiO3 [2].

We present low temperature transport and magneto-transport measurements on LaTiO3/SrTiO3 hetero-structures, whose properties can be modulated by field effect using a metallic gate on the back of the substrate. The corresponding phase diagram has been investigated, and superconductivity evidenced for the first time in this system which involves a Mott insulator [3]. We will discuss the role of the confinement potential and the SrTiO3 band structure on the phase diagram, and show the specific role of the spin-orbit coupling measured by localization corrections to the magnetoconductivity. Finally, the superconducting to insulator transition will be discussed.

[1] N Reyren et al, Science 317, 1196 (2007)
[2] A Ohtomo et al, Nature 419, 378 (2002)
[3] J Biscaras et al, Nature Communications 1,89 (2010)

14.45 Discussion

15.00 Tea

15.30 Proximity effects in electron-doped cuprate heterostructures
Professor Mark Blamire, University of Cambridge, UK

The triplet state so far created in metallic superconductor / ferromagnet devices has a coherence length of around 10 nm. In a half-metallic ferromagnet, spin flip scattering is impossible and so the coherence length for a triplet state could be much longer.[1] There is evidence for this from superconductor/CrO_2/superconductor devices[2] in which the CrO_2 is a half-metal; however, such devices are highly irreproducible because of the poorly controlled interface between the superconductor and ferromagnet and the unknown nature of the spin-mixing process which is required to establish the triplet state at the interface.[3] The electron-doped cuprate superconductors such as $Pr_{2-x}Ce_xCuO_{4-d}$ (PCCO) share many similarities with the well-known hole doped materials such as $YBa_2Cu_3O_{7-d}$, but show some crucial differences, notably a considerably longer coherence length which has enabled detailed tunneling studies.[4] Here we report measurements on PCCO/$La_{0.7}Ca_{0.3}MnO_3$ device structures which show preliminary evidence for a long-range proximity effect, albeit with low reproducibility.

1. M Eschrig and T Löfwander, Nature Physics (2008)
2. R S Keizer, et al, Nature 439 (7078), 825-827 (2006)
3. M Houzet and A I Buzdin, Phys Rev B 76 (6), 060504 (2007)
4. Y Dagan, et al, Phys Rev Lett 99 (14), 147004 (2007)

16.00 Discussion

16.15 Panel discussion/Overview (future directions)

17.00 CLOSE

18.30 Dinner (for residents staying overnight on 15 September)

Biographies

Professor James Annett, University of Bristol, UK (Chair)
James Annett is head of the Theoretical Physics Group at Bristol University. He received his PhD in 1985 from Cambridge University, working in the Theory of Condensed Matter group. After a college fellowship in Cambridge, in 1987 he went to the University of Illinois at Urbana-Champaign to work on the theory of high temperature superconductivity (HTS), a subject that remains one of his main research interests today. The discovery that HTS have d-wave Cooper pairs was one of the main achievements of the work at that time. Following a period as Assistant Professor at Penn State University he moved to Bristol University in 1994. In Bristol he continues to work on unconventional superconductivity, and current interests include spin triplet paired superconductors, as well as triplet pairing induced at ferromagnet-superconductor interfaces.

Professor Mark Blamire, University of Cambridge, UK (Organiser/Speaker/Chair)
Mark Blamire leads the Device Materials Group (DMG) in the Department of Materials Science at the University of Cambridge, UK. He has worked extensively on the electronic properties and materials science of superconducting and magnetic thin film devices. Over the past five years he has led a much more focused research programme studying the nanoscale interaction of superconductivity and magnetism. This work draws together precision thin film growth and advanced nanofabrication techniques and has already resulted in groundbreaking results on the coupling of superconductors and magnets and the behaviour of ferromagnets under extreme non-equilibrium conditions.

Professor Dave Blank, University of Twente, The Netherlands (Organiser)
Professor Dave Blank received in 1991 his PhD in Physics from the University of Twente, Netherlands for his dissertation on *High-Tc thin films prepared by laser ablation: an experimental study*, under supervision of Professor Dr Horst Rogalla.

After a research fellowship at Stanford in the group of Professor Malcolm Beasley and Professor Theodore Geballe in 1998, he was appointed as associate professor and programme director on the *materials science of interfaces* in the MESA+ Institute for Nanotechnology at the University of Twente. Since October 2002 he is full professor in *Inorganic Materials Science* at the same university. From January 1, 2007 he is the Scientific Director of MESA+ Institute for Nanotechnology, University of Twente. MESA+ host over 500 scientists in 30 research groups with an annual budget over 50 MEuro.

His research is based upon growth studies, deposition and structuring techniques, and properties of complex materials, especially oxides. His research group consists of 20 PhD students, 5 postdocs and 3 scientific staff members. He has over 250 papers in refereed journals and was supervisor of 30 PhD graduations.

In 2002 he was awarded the VICI laureate of the Dutch Science Foundation for his work on *artificial materials for nanoscale devices.* He is a member of the board of governors of NanoNed, a member of the Swedish Royal Academy of Science Gothenburg and chairman of the executive Board of NanoNextNl.

In 2010 he got from the Queen the Royal decoration Knighthood of the Order of the Dutch Lion and received in 2011 the STW Simon Stevin Meester award, the highest award in the Netherlands for applied sciences.

Dr Ivan Bozovic, Brookhaven National Laboratory, USA (Speaker)
Ivan Bozovic gained his PhD in Solid State Physics 1975, Belgrade University, Yugoslavia. Since then, he has held the following positions: 1975-1985 Belgrade University (*Docent to Department Head*); 1986-8 Stanford University (*Visiting Professor*); 1989-98 Varian Research Center, Palo Alto (*Senior Scientist*); 1998-2002 Oxxel GmbH, Bremen, Germany (*Principal Scientist and CTO*); 2003- Brookhaven National Laboratory, USA (*MBE Group Leader*). He is in receipt of the following honours: Fellow of APS, Fellow of SPIE, Foreign Member of Serbian Academy of Science and Arts; recipient of SPIE Technology Award, M Jaric Prize, BNL Science and Technology Prize, Fulbright Fellowship. His research interests are: (1) Basic physics of condensed states of matter; (2) novel electronic phenomena including unconventional superconductivity (3) innovative methods of thin film synthesis and characterization for future nano-electronics; (4) mesoscopic (nano-scale) physics.

Professor Jak Chakhalian, University of Arkansas, USA (Speaker)
Jak Chakhalian obtained his PhD degree in Condensed Matter Physics from the University of British Columbia, Vancouver, Canada. He continued his postdoctoral research at Canada's national research facility TRIUMF and then at the Max Planck Institute for Solid State Research, Stuttgart, Germany. Since 2006, he is a faculty member with the Physics Department, University of Arkansas, Fayetteville, USA. Throughout his professional career his major focus has been on the physics of complex oxides with correlated electrons with particular interest to exotic magnetism and high temperature superconductivity in both bulk and nanoscale materials.

Professor Lesley Cohen, Imperial College London, UK (Speaker)
Professor L F Cohen is head of Solid State Physics within the Blackett Laboratory at Imperial College and runs the Functional Magnetism group. Her interests span superconductivity, magnetism, and transport in narrow gap semiconductors. She has published over 250 research papers. Recent research interests include the iron based superconductors, magnetocaloric materials, artificial planar spin ice and room temperature ballistic transport in nanostructures. The Functional magnetism group have built up a suite of novel characterisation tools to characterise magnetic materials over a number of years.

Professor Elbio Dagotto, University of Tennessee, USA (Speaker)
Elbio Dagotto is a Distinguished Professor of Physics at the University of Tennessee and Distinguished Scientist at the Materials Science and Technology Division of Oak Ridge National Laboratory. He received his PhD in Physics in 1985 at the Instituto Balseiro, Bariloche, Argentina.

Dagotto specializes in the study of model Hamiltonians for systems where strong correlations among the electrons play a fundamental role, mainly using computational techniques. Dagotto is Fellow of the American Association for the Advancement of Science and of the American Physical Society. He was a member of the Solid State Sciences Committee of the National Academy of Sciences and divisional editor of the Physical Review Letters. Dagotto has over 300 publications (h=62), and has directed the work of 13 graduate students and 24 postdoctoral assistants.

Professor Judith Driscoll, University of Cambridge, UK (Organiser/Chair)
Professor Driscoll has been at the University of Cambridge since 2003. She is also a Long Term visiting staff member at Los Alamos National Laboratory. She works on the materials science of functional oxide thin films and nanostructures, including superconductors, ferromagnetic, ferroelectric and multiferroics. She is a Fellow of Trinity College, Cambridge, and also a Fellow of the Institute of Physics. She has around 250 journal publications.

Dr Matthias Eschrig, Royal Holloway University of London, UK (Speaker)
Dr Matthias Eschrig is a Senior Lecturer at Royal Holloway University of London, and a Senior Scientist at the Rutherford Appleton Laboratory. He has interests in correlated electron systems, magnetism, superconductivity, and ordering phenomena near surfaces and interfaces. Matthias Eschrig completed his PhD in Bayreuth, Germany in 1997 with highest honours, working with Dierk Rainer. He has held postdoctoral positions in the USA where he worked closely with the Nuclear Magnetic Resonance group at Northwestern University on the structure of superconducting vortices in cuprates, and with the Angle Resolved Photoemission Spectroscopy group at Argonne National Laboratory, where he made a pioneering link between the photoemission spectra of high-temperature superconductors and the spin resonance observed in inelastic neutron scattering spectra. He obtained his habilitation at the University of Karlsruhe, Germany, where he established a new research program on superconducting and ferromagnetic heterostructures funded by the German Research Council. Their landmark prediction of a triplet supercurrent through a half-metallic ferromagnet was subsequently confirmed by experiments in Delft. Recent research interests include the iron based superconductors and in topological materials. In 2007 and in 2009-2010 he held a visiting Professorship at the University of Konstanz.

Professor Hans Hilgenkamp, University of Twente, The Netherlands (Speaker)
Hans Hilgenkamp obtained his PhD in 1995 at the University of Twente on high-Tc dc SQUID magnetometers. Subsequently he was a post-doc at IBM Zurich and the University of Augsburg, before returning in 2000 to Twente. There, he is leading the chair Interfaces and Correlated Electron systems within the universities' MESA+ Institute for Nanotechnology since 2005. He is also a part-time professor at Leiden University and a visiting professor at the National University of Singapore. His main research interests are high-Tc superconductivity and related complex oxide thin films and heterostructures.

Professor Harold Hwang, Stanford University, USA (Speaker)
Harold Y Hwang is a Professor of Applied Physics and Photon Science (SLAC) at Stanford University. He received a BS in Physics, BS and MS in Electrical Engineering from MIT (1993), and a PhD in Physics from Princeton University (1997). He was formerly a Member of Technical Staff at Bell Labs (1996-2003), Associate Professor and Professor at the University of Tokyo (2003-2010). His current research focuses on atomic-scale synthesis of thin film complex oxide heterostructures; control of the electronic structure at interfaces and in confined geometries; low-dimensional superconductivity; and novel devices based on interface and surface states in oxides. Awards include the MRS Outstanding Young Investigator Award (2005) and the IBM Japan Science Prize (Physics, 2008).

Dr Quanxi Jia, Los Alamos National Laboratory, USA (Speaker)
Quanxi Jia is a Fellow of Los Alamos National Laboratory and a Thrust Leader at the Center for Integrated Nanotechnologies. Quanxi received his BS and MS in Electrical Engineering from Xian Jiaotong University, China, in 1982 and 1985 respectively, and his PhD in the same field from the State University of New York, Buffalo in 1991. Quanxi has authored/co-authored over 350 refereed journal articles and 8 book chapters. He has 35 US patents awarded in electronic materials and devices. Among the numerous awards and honors he has received are two prestigious R&D 100 awards, the 2005 Asian-American Engineer of the Year Award, and the Federal Laboratory Consortium for Technology Transfer Awards for

Excellence in Technology Transfer. He is a Fellow of the American Physical Society and a Fellow of the American Ceramic Society. His research interests include nanostructured materials, multifunctional materials, multilayer systems, and the development of solid-state microelectronic/electro-optic devices.

Professor Bernhard Keimer, Max Planck Institute for Solid State Research, Germany (Speaker)
Bernhard Keimer is currently Director at the Max Planck Institute for Solid State Research and Honorary Professor at the University of Stuttgart, Germany. He obtained his physics education from the Technical University of Munich and from the Massachusetts Institute of Technology, where he received his PhD degree in 1991. Before taking up his current position in 1998, he spent seven years on the faculty of Princeton University, where he was appointed Full Professor in 1997. His research group uses spectroscopic methods to explore quantum many-body phenomena in correlated-electron materials and metal-oxide heterostructures.

Professor Gad Koren, Technion, Israel (Speaker)
Professor Koren received his PhD degree in Physics from the Hebrew University of Jerusalem in 1974. After spending his post doc in the IBM Research lab in Zurich in 1974-5, he joined the Technion – Israel Institute of Technology in Haifa – where he had been ever since. He had been appointed a full professor in 1998, and awarded the Karl Stoll Chair in advanced materials in 2002. He spent a sabbatical in the University of Toronto in 1982, and a sabbatical and several summer faculty visits in the T J Watson IBM research Center in Yorktown Heights in the years 1982-1989. His main fields of interest are condensed matter physics and laser applications, where he specializes in high temperature superconductivity and magnetism using epitaxial thin films, junctions and multilayers with various ferromagnets and normal metals. He received the IBM Research division award in 1993, and granted a Minerva Center for high temperature superconductivity (1994-2008), and two Excellence Centers of the Israel Science Foundation in research and applications of high temperature superconductors (1994-8), and in tunneling phenomena in nanostructured materials and devices (2000-9).

Professor Jérôme Lesueur, LPEM - ESPCI - CNRS – UPMC (Speaker)
Jérôme Lesueur is a physicist, professor at Ecole Supérieure de Physique et Chimie Industrielles (ESPCI) in Paris. He is the director of the Physics and Materials Laboratory. His research deals with electronic transport properties of materials, mostly superconductors. He started his career as a CNRS member (National Center for Scientific Research), studying the Anderson localization in strongly disordered materials, and its interplay with superconductivity by transport and tunneling measurements. As an exchange visitor at Bellcore (NJ-USA), he started working on High Tc superconductors (HTSc), focusing on the symmetry of the order parameter evidenced by tunneling, and the role of disorder on superconductivity in these materials. He then moved to Paris, hired as a full professor by P G de Gennes, and started working on fluctuations in HTSc, and more generally on the physics of strongly correlated systems. In parallel with these basic studies, he developed a new technology to make reliable HTSc Josephson Junctions, suitable for applications, as for instance in THz detection. Recently, he started working on oxides interfaces, and more specifically on the properties of the high mobility two-dimensional gas which develops under certain conditions.

Professor Jochen Mannhart, Max Planck Institute for Solid State Research, Germany (Speaker)
Jochen Mannhart is a director at the Max Planck Institute of Solid State Research in Stuttgart, Germany, leading the department "Solid State Quantum Electronics".

Dr Mannhart studied Physics at the University of Tübingen (Germany), receiving his diploma in 1986 and his PhD in 1987 for imaging Josephson currents and Abrikosov vortices in Josephson tunnel junctions using electron microscopy. Subsequently, he worked as a visiting scientist at the IBM T J Watson Research

Center in Yorktown Heights and as a Research Staff Member and Manager at the IBM Zurich Research Laboratory in Rüschlikon, Switzerland. From 1996 to 2011, he was a chaired professor at the Center for Electronic Correlations and Magnetism at the University of Augsburg.

His research interests focus on the properties of interfaces in complex electronic materials. The efforts of the various teams he was working in resulted in the discovery and development of bicrystal Josephson junctions and SQUIDs, the enhancement of critical currents of high-Tc superconductors by grain alignment, which is the basis for the modern superconducting cables, the first imaging of individual atoms with subatomic resolution, and the fabrication of the first all-oxide FETs.

Jochen Mannhart has received numerous awards for his research, including the Gottfried Wilhelm Leibniz-Preis.

Professor Teresa Puig, Institut de Ciencia de Materials de Barcelona, Spain (Speaker)
Professor Teresa Puig, PhD in Physics in 1994 at University Autònoma of Barcelona, is the Head of the Department and scientific responsible of the *"Superconducting materials and large scale nanostructures group"* at the Institute of Materials Science of Barcelona (Research National Council) since 2008. She is permanent scientist at ICMAB since 2000 and, in 2009 she got the Professorship. She has conducted scientific research in four foreign countries for four years and has been principal researcher of more than 11 projects. She has more than 175 publications in the area of superconducting materials and nano-materials, 9 patents and supervised 10 PhD Thesis. She is editorial board member of *Superconducting Science and Technology (IOP)* and executive member of the *European Society of Applied Superconductivty (ESAS).* She has been awarded with the "Duran Farell" prize for Technological Research, by Gas Natural (Spain) in 2002 and the Novare-Endesa Prize for R&D in Energy by Endesa-electrical (Spain) in 2007.

Dr Jason Robinson, University of Cambridge, UK (Chair)
Dr Jason Robinson completed his doctoral research in 2007 on Josephson Pi junctions with ferromagnetic barriers in the Device Materials Group at the University of Cambridge. The following year he was elected to a prestigious Research Fellowship at St John's College, Cambridge. From October 2011, he will be a Royal Society University Research Fellow and a Teaching Fellow of St John's College. Over the past few years his research has focused on the interaction between magnetism and superconductivity in thin film multilayers and in heterostructure devices. His work in this field has led to a breakthrough in understanding and demonstrating triplet-mediated superconductivity in ferromagnets coupled to singlet superconductors.

Professor Jacobo Santamaría, Universidad Complutense de Madrid, Spain (Speaker)
Jacobo Santamaria is a Full Professor of Physics at the Physics Faculty of the Universidad Complutense de Madrid (Spain). He leads the "Complutense" Research Group of Complex Materials devoted to the study of magnetism and superconductivity of correlated oxide nanostructures. His interest focuses on interface phenomena in complex oxide superlattices. He has coauthored more than 200 publications in peer reviewed Journals. He is a Fellow of the American Physical Society and a Program Manager of Materials Sciences for the Spanish Ministry of Science and Innovation.

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