Electronic Properties of Modern Materials

Date: 17/11/2015 - 19/11/2015
Location: Diamond Light Source, Oxfordshire, UK

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Aims

Advanced electronic materials are one of the most exciting research frontiers in the physical sciences. Electron-electron correlations generate ever more surprising collective states with novel symmetries, novel topologies and new types of excitations. Many of these materials interact with electric an magnetic fields in new ways, offering the prospect of disruptive technologies. Understanding and controlling such complex forms of quantum matter requires cutting-edge facilities and ground-breaking ideas.

Nicola Spaldin (Paul Scherrer Institut) discusses the topology of exotic ground states of condensed matter.

This meeting brought together physicists, chemists and materials scientists using sychrotron, neutron, and muon sources as well as low-temperature, computational and theoretical techniques to investigate magnets, superconductors, multiferroics and other advanced materials.

The meeting provided a focal point for the community of physicists, chemists and materials scientists using synchrotron, neutron, and muon sources as well as low-temperature, computational and theoretical techniques to investigate magnets, superconductors, multiferroics and other advanced materials. The meeting fostered links between the Diamond and ISIS user communities in the fields of strongly correlated electrons/magnetism/superconductivity (both physics and chemistry); showcased Diamond's capabilities in these areas; and fostered links between the theory and experimental communities.

Programme and format

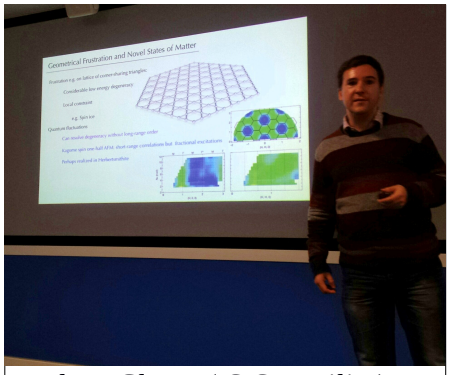
There was an exciting programme with a world-class International speakers (see attached list of Keynote and Invited speakers) plus posters which were displayed in the Diamond foyer throughout the conference. This offered many opportunities for the many participants at graduate and post-

doctoral stages (see attached list of participants) to interact informally with more senior researchers and getting maximum expose of their results.

The meeting took the format of an intensive workshop held over 3 days. Each session focused on a particular topic, with several keynote and invited talks. All the talks took place in Diamond House, meeting room G53/54. The sequential format was intended to encourage inter-disciplinarity and facilitate one-to-one discussions.

The topics covered included

- Quantum Magnetism
- Frustrated Magnetism
- Unconventional pairing in superconductors
- Multiferroic order
- Topological defects and excitations
- Topological order and quantum phase transitions



Paul McClarty (ISIS Facility) discusses geometric frustration and novel states of matter.

Balance

There was a deliberate effort to balance speakers between the fields of Physics and Chemistry – indeed the tone of the meeting was that in any typical sessions both physicists and chemists would speak. This was remarked upon by participants as particularly useful and valuable and it reflects the multi-disciplinary nature of the facilities. A similar balance was achieved throughout the meeting and, indeed, largely within specific themes of theory (1/3) vs experiment (2/3) and Diamond vs ISIS-based research – though in this respect perhaps the most remarkable observation to make are the many pieces of work that were reported that had benefited from the use of both facilities. This, again, had been a criterion in the selection of the speakers.

EPSRC involvement

Virtually all speakers presented research funded by EPSRC. EPSRC also participated directly by sending two representatives. In addition to a talk with extended questions round they also interacted informally with the community. This session was very welcome as it provided an opportunity for relaxed interaction between academics and EPSRC. The talk was placed strategically in the middle day of the conference, before the conference dinner to maximise attendance.

Keynote and Invited Speakers

- James Annett (University of Bristol)
  “Spin-orbit coupling and unconventional pairing in multiband superconductors”
- Felix Baumberger (PSI, Switzerland)
  “Fermi Pockets and Pseudogap in Lightly Doped Strontium Iridates”
- Joseph Betouras (University of Loughborough)
  “Lifshitz transitions in interacting fermions: the paradigm of sodium cobaltate”
- Alessandro Bombardi (Diamond Light Source)
  “Polarization flip and magnetic structure evolution in $GdMn_2O_5$”
- Steve Bramwell (University College, London)
  “Phase order in superfluid helium films”
- Claudio Castelnovo (University of Cambridge)
  “Critical dynamics and fi nite-time scaling in spin ice systems”
- Laurent Chapon (Institut Laue Langeving)
  “Pure magneto-chiral domain in the langasite compound $Ba_3NbFe_3Si_2O_{14}$: Can it induce ferroelectricity?”
- Lucy Clark (University of St Andrews)
  “Kagome Antiferromagnets”
- Simon Clarke (University of Oxford)
  Title TBA
- Radu Coldea (University of Oxford)
  “Unconventional magnetic order in the harmonic honeycomb iridates, implications for Kitaev physics”
- Steve Collins (Diamond Light Source)
  “X-ray Diffraction Studies of Polar Crystals and Weak Ferromagnets”
- James Dracott (EPSRC)
  Title TBA
- Matthias Eschrig (Royal Holloway, University of London)
  “The road to superconducting spintronics”
- Phillipe Ghosez (University of Liège)
  “The trilinear coupling of lattice modes : a promising pathway to achieve electric control of electronic properties in perovskites”
- Sean Giblin (Cardiff University)
  “Exploring spin ice out of equilibrium”
- Andrew Goodwin (University of Oxford)
  “Hidden order from geometric frustration: spin-liquid GGG and spin-free $AgAu(CN)_2$”
- Colin Greaves (University of Birmingham)
  “ Geometrical and chemically induced magnetic frustration”
- Thorsten Hesjedal (Oxford)
  “Topological Insulators - The Good, the Bad, and the Ugly”
- Adrian Hillier (ISIS)
  “Unconventional pairing in superconductors”
- George Jackeli (MPI for Solid State Research, Stuttgart)
  “Magnetic exchange, order and excitations in spin-orbit Mott insulators”
- Gerrit van der Laan (Diamond Light Source)

Opening address: “Shining X-Rays on Modern Materials”

- Stephen Lovesey (Diamond Light Source / STFC)
  “Ordered state of magnetic charge in the pseudo-gap phase of a cuprate superconductor $HgBa_2CuO_{4+8}$”
- Paul McClarty (ISIS)
  “Excitations in the pyrochlore magnet $Yb_2Ti_2O_7$”
- Des McMorrow (University College, London)
  “Metal insulator phase transitions in 5d transition metal oxides”
- Toby Perrings (ISIS)
  Closing address: title TBA
- Matt Rosseinsky (University of Liverpool)
  “Strategies for design of room temperature multiferroic magnetoelectric oxides”
- Nicola Spaldin (ETH Zurich)
  “Hidden Monopolar Order in Magnetoelectrics”
- Jon Taylor (European Spallation Source)
  “The role of the fermi surface in a frustrated itinerant magnet”

Outline Schedule:

	Tuesday 17 Nov	Wednesday 18 Nov	Thursday 19 Nov
09:00 - 09:30		Felix Baumberger	James Annett
09:30 - 10:00		Des McMorrow	Simon Clarke
10:00 - 10:30	***Registration***	Matthias Eschrig	Adrian Hillier
10:30 - 11:00	Gerrit van der Laan (opening address)	Thorsten Hesjedal	***Coffee break / posters***
11:00 - 11:30	Matt Rosseinsky	***Coffee break / posters***	Steve Bramwell
11:30 - 12:00	Alessandro Bombardi	George Jackeli	Joseph Betouras
12:00-12:30	Laurent Chapon	Jon Taylor	Toby Perring (closing address)
12:30 - 13:30	***Lunch / posters***	***Lunch / posters***	***Lunch / posters***
13:30 - 14:00	Nicola Spaldin	Radu Coldea	OPTIONAL TOURS
14:00 - 14:30	Steve Collins	Paul McClarty	
14:30 - 15:00	Philippe Ghosez	***Coffee break + posters***	
15:00 - 15:30	***Coffee break / posters***	Colin Greaves	
15:30 - 16:00	Stephen Lovesey	Andrew Goodwin	
16:00 - 16:30	Claudio Castelnovo	Lucy Clark	
16:30 - 17:00	Sean Giblin	James Dracott (EPSRC)	
18:30+		DINNER THE BEAR HOTEL	

Key to sessions

Frustrated magnetism
Quantum magnetism
Multiferroic order
Unconventional pairing In superconductors
Topological defects and excitations
Topological order And quantum phase transitions

Organising Committee

- D D Khalyavin, ISIS Facility
- Timur Kim **(L)**, Diamond Light Source
- Frank Kruger **(L)**, University College London, ISIS Facility & Hubbard Theory Consortium
- Emma McCabe, University of Kent
- Jorge Quintanilla **(C)**, University of Kent & Hubbard Theory Consortium
- Silvia Ramos, University of Kent
- Mark Senn, University of Oxford

(C) Meeting coordinator
(L) Local organising sub-committee

It was useful that three of the organisers (McCabe, Quintanilla and Ramos) were in a multi-disciplinary academic department with physics and chemistry under the same roof (namely SPS at Kent; Quintanilla and Ramos are physicists and McCabe is a chemist). The committee also included both theorists (Kruger, Quintanilla) and experimentalists as well as scientists based at Diamond (Timur Kim) and ISIS (Khalyavin).

Sponsors

The organisers gratefully acknowledge financial and in-kind contributions from the Diamond Light Source (£7.5k in-kind support), EPSRC (£4k grant), the Institute of Physics and the British Crystallographic Association (£1.8k in total). In addition, ISIS, Kent, and UCL provided additional in-kind contributions through the commitment of staff time and other logistics support.

IOP Institute of Physics

Magnetism Group – Superconductivity Group