

Innovations in Strongly Correlated Electron Systems: School and Workshop

6th -17th August 2012

ICTP Trieste

Sponsored by: INTELBIOMAT (ESF); ICAM-I2CAM, University of Tokyo/RIKEN, Department of Physics, Nanjing University

Organizers: P. Coleman, A. J. Schofield, A. Chubukov, Hai-Hu Wen, H. Takagi.

Local Organiser: E. Tosatti

Summary

An international scientific meeting with associated advanced school was hosted by the ICTP in Trieste. The mission was to cover new developments in the field of strongly correlated electron systems with an emphasis on pedagogy and bringing together the key experimentalists and theorists in the field. It was an international meeting and INTELBIomat support was obtained to support European researchers to attend, participate and engage as well as to present to the school and workshop.

The format of the event was of a School for the first week where lecturers gave two open-ended lectures (often on the board but sometimes using powerpoint lasting up to 90mins). There were two subjects covered per day and then the students were divided into groups and tasked with forming an action group on each of the topics presented. This involved identifying key questions arising from the presentations and attempting to resolve them. At the end of each day the students presented their resolutions of the issues under the advice and guidance of the meeting organizers and lecturers. It meant that the students were highly engaged with the school activities. Topics covered in the lecture courses included Mott Physics, Heavy Fermions, Quantum Criticality, New Probes of Condensed Matter, Superconductivity in Iron based supervonductors and Chalcogenides. Students also had the opportunity to present work via a very active post session. A key feature of the school was the strong interaction between students and lecturers which occurred both in the poster sessions and was actively facilitated in the breaks between lectures.

In the second week, the programme was developed into a more conventional workshop which could now build on the expertise the students had developed in the first week. There was a high density of talks (each now 45 mins) with active questioning of the speakers throughout. As with the school, students participated actively and a real-time blog was maintained so participants could get an experts view and opinion of the talk as it was developing. All talks were recorded as well as their presentations to provide a lasting legacy of the activity.

With almost 200 participants, the meeting was highly successful and there was much demand for it running again in the future. The organizers were grateful for the support of INTELBIOMAT which made participation of Europeans possible.

Description of the Scientific Content of the Meeting

Picking up the main themes of the meeting and the content of the scientific discussion as follows:

Mott Physics and its influence on the cuprate phase diagram formed an initial theme on the first day. Without doubt the historical issues of understanding the cuprate superconductors still underpin many of the issues that the conference touched upon. This was first addressed in the School via the lectures of Andre-Marie Trembley in contrasting the electron and hole doped materials. Mike Norman took the conference through the physics of the Fermi arcs and quantum oscillations. The nature of the pseudogap state was similarly a theme which has been visited before. Aharon Khapitunik presented his high sensitivity Kerr measurements to give convincing evidence of time-reversal symmetry breaking in the pseudogap state and discussed its relation with loop current ideas of Varma.

Yet if Mott physics and the cuprates demonstrated the meeting's connection with the past, it was quite clear that the focus and challenge had moved forward considerably and the meeting was presented with a range of challenging materials and ever increasing sophistication for the future. A number of speakers discussed the notion of orbital physics and the idea of the Hund's metal. The interplay and interactions in systems like the pnictide superconductors were much explored. Leni Bascones presented theoretical ideas which implemented Hund's rule physics into the correlated electron problem. Some of these ideas were picked up by Girsh Blumberg in discussing a new material CaMn_2Sb_2 .

However it was primarily the iron-based superconductors where the nature of multiorbital physics was much discussed. Some of that discussion was developed by theorists like Kristjan Haule who discussed the latest results of DMFT on these problems and also in the pedagogical lectures of Rafael Fernandes. The majority of the conference talks in this area came from materials scientists and experimentalists working on the pnictides as new experimental probes are brought to bear on the problem. Sergi Borisenko discussed angle resolved photoemission (ARPES) and showed that the simple picture of two electron and a single hole like pocket was in reality more complex. Other ARPES studies by Hong Ding and also by Shik Shin discussed the role of spin and orbit. Finally the question of whether the tendency to form electronic nematic order was one that was significant. This was developed by Takasada Shibauchi and tied to the notion of quantum criticality within the superconducting dome. Yet the pnictides were not the only superconductors under consideration such as the chalcogenide systems whose superconducting properties and magnetism were considered by Minghu Fang and Natasha Perkins.

Like the physics of novel superconductors, another theme of the meeting highlighted very significant progress in a long standing field namely in spin-liquids. These long searched for states where frustration leads to a gapless paramagnetic state down to the lowest temperatures seem finally to be realized. Hide Takagi gave an introductory lecture into the range of materials which are now providing good evidence for the existence of these states. The question of how to describe them theoretically was addressed by Yong Baek Kim who discussed various descriptions and the current theoretical limitations of these ideas. One key question was the role and meaning of entanglement entropy which might serve as a diagnostic of various exotic states. Finally one should not forget the classical analogues of highly frustrated

magnets and these were discussed by Kedar Demle. The garnet Kagome material still has open questions regarding its ground state.

There was much discussion about the physics of heavy fermion compounds. A recent breakthrough in STM techniques has allowed the imaging of the formation of the heavy fermion Kondo Fermi surface and dispersion via quasiparticle scattering. Ali Yazdani gave a synopsis of his impressive work in this area. The basic ideas of quantum criticality were presented in two lectures for the students by Andy Schofield which set the context for the rich behaviour seen in the heavy fermion quantum critical metals. Colin Broholm gave a tour-de-force account of neutron scattering at very low temperatures in YbRh_2Si_2 to show the evolution from incommensurate to ferromagnetic inelastic scattering peaks as the tuning magnetic field is increased to take the system through and beyond its quantum critical point. This is sure to cast light on the vexed issue of the novel quantum criticality seen in this material. Silke Paschen described her work on $\text{Ce}_3\text{Pd}_{20}\text{Si}_6$ where she was able to place this compound on the so called “global phase diagram” of these compounds introduced by Qimiao Si. She argued that dimensionality is a tuning parameter and describes the differences between YbRh_2Si_2 and $\text{Ce}_3\text{Pd}_{20}\text{Si}_6$ as increasing the stability of the magnetically ordered state in the latter’s more three dimensional structure when compared to the more two dimensional nature of the former. In a fascinating talk, Tom Timusk demonstrated an embarrassing gap in our experimental understanding of the most basic of correlated states – the Fermi liquid. He pointed to the lack of evidence for the appropriate prefactor in the frequency dependent scattering rate when compared with the temperature dependence in the optical conductivity. The energy scales of the heavy fermions make them a prime candidates for investigating this further.

On the theoretical side, the heavy fermion systems offer plenty of scope for creative thinking about tackling the many unsolved problems associated with groundstate of the heavy fermions. Three areas were considered in particular at the meeting. Superconductivity was discussed by Piers Coleman, who suggested that the condensate should be thought of as one of condensing spins and quasiparticles forming a composite paired state. Rebecca Flint presented her ideas on the novel “hidden order” phase of URu_2Si_2 which has puzzled the community for 27 years. Based on the form of the orbitals forming the heavy fermion liquid, she argued that a hybridization transition could be expected with an “hastatic” order parameter which she characterized. In fact a deeper understanding of the nature of the hybridization term motivated Maxim Dzero’s presentation where he argued that the Kondo insulators should be topological in nature. As ever experiment still retains its power to surprise and Satoru Nakatsuji presented his work on both α - and β - YbAlB_4 (where the quantum critical state appears without tuning) which may again be a consequence of the orbital structure in the material.

There were two graphene related talks – one on the role of interactions in the bilayer compound. Oscar Vafek showed that multiple competing instabilities occur in bilayer honeycomb lattices and that an instability to a nematic state can be dominant in certain circumstances. Andrey Chubukov considered the role of interaction in the single layer graphene and showed an instability can occur to an exotic d+id superconducting state. Given the role of the Kane and Mele work in the discovery of topological insulators it is fitting here to mention the prospect of realizing a fractional topological insulator which was described by Andreas Bernevig. Critical to such states is strong spin-orbit interaction and so not

surprisingly there is considerable work on correlated materials with strong spin-orbit. Hae Yong Kee took us through her work on the irridates which have structures paralleling the ruthenate Ruddleston-Popper series but where spin-orbit plays potentially a dominant role.

An over-arching theme in the conference was the growing richness of behaviour that is being realized by experiments and that is driving developments in theory. The challenge of understanding matter away from equilibrium is one such example where the motivation is coming from cold atom experiments. Natan Andrei showed how integrable models might provide understanding of quantum quenches. Of all these developments perhaps the most surprising in recent years is the innovative connections between manybody physics and theories of classical gravity in higher dimension. In one of the highlights of the meeting, Sung-Sik Lee gave a wonderful exposition of that connection showing how it can be derived by a functional view of the renormalization group. He outlined a programme of theoretical work which, if successful, could be the key innovation for bring understanding to some of these challenging problems.

The above synopsis is a necessarily brief overview of the scientific presentations and formal discussion. These were supplemented by two poster sessions. In addition, scientific discussion was fostered by breaks in the programme and a student body tasked with running a discussion forum at the end of each day.

The most complete and detailed guide to the content and scientific discussion of the meeting is captured by the “blog” which was maintained throughout the meeting. Bloggers made a synopsis of the talk in real-time, and crucially recorded the questions and answers raised by the audience (and sometimes the lecturers) during the event. The blog also captured the dynamic nature of the presentations together with a photographic record of the talk. The full blog may be accessed here:

<http://innovationssces2012.blogspot.co.uk/2012/08/monday-august-6th.html>

In addition to the blog commentary on the conference, each talk was videoed and recorded and is available for anyone to access:

<http://www.ictp.tv/eva/smr2357.php>

Finally, the full scientific programme (attached to this report) as well as the slides of the presentations is available from the ICTP website:

http://cdsagenda5.ictp.trieste.it/full_display.php?id=a11179

The intention was always to leave these records of the meeting as a resource for the students who attended, but also to widen the access to the resources, lectures and presentations made during the meeting.

Assessment of the Impact and Future Directions of the Field

From a perspective of just two months after the meeting, it is very hard to make an accurate assessment of the impact of the meeting. However, some key themes can be drawn out.

In terms of the direction of the field, there were trends signalled which will guide the future direction. For example it is clear that orbital degrees of freedom and their coupling via spin-orbit will be important for the next generation of correlated materials. The pnictide superconductors have also motivated the study of a new class of multiband materials (Hunds metals) and we will need to make further progress in the understanding of this. Where multiple bands and interactions between them are proliferating one might ask where will the theoretical tools come from to help us understand them. The power of dynamical mean field theory to make quantitative predictions and insight was clear – yet so to was the need for imaginative ideas and frameworks which turn numerical solutions into unifying principles (examples being the hastatic order work, and fractional topological insulators). New experimental techniques – or old ones newly refined – are also going to drive the future direction. Few could have believed that STM would now be playing such a leading role in the understanding of correlated states and this is a trend which still has a long way to go.

Yet of all the trends and exciting developments which the conference presented, the intention of the organizers was that the primary impact of the meeting would be to prepare a new generation of scientists for the challenges confronting them. The attendance was remarkable and beyond expectation – with almost 200 participants registered for the meeting. In that respect alone the impact will be highly significant for many of the conference participants were attending a scientific meeting for the first time and presenting their results in the form of posters and discussion. Students were exposed to some of the latest ideas, measurements and results and made, via the structure of the discussion, to form opinions on these ideas. The mixture of pedagogical presentation to introduce the newcomers to the field, together with the latest research seminars, made students see the lectures and the wider implications of their own work in a wider context.

The International Centre For Theoretical Physics in Trieste has hosted workshops and schools since its inception. The 2012 meeting was intended to be in the spirit of a meeting first hosted in 1988 where new graduate students and expert professors came together to discuss the exciting developments in what was then the “hottest” topic – cuprate superconductivity. The students and postdocs in those early meetings are now the organizers of the 2012 conference and so the impact of the meetings in the 1980s still resonates today. The “Innovations in Strongly Correlated Electron Systems: School and Workshop” running in 2012 we hope will be every bit as influential on the field in 20 years time, as those early meetings.



The Abdus Salam
**International Centre
for Theoretical Physics**



Innovations in Strongly Correlated Electronic Systems: School and Workshop

Cosponsor(s): Co-sponsored by: ICAM-12CAM, INTEL BIOMAT (funded by ESF), University of Tokyo/RIKEN and
Department of Physics, Nanjing University

Organizer(s): P. Coleman, A. Chubukov, A. Schofield, Hai-Hu Wen, H. Takagi. Local Organiser: E. Tosatti
Trieste - Italy, 06 - 17 August 2012

Final programme

WEEK No. 1 - SCHOOL from 6 - 10 August 2012

Monday, 6 August 2012

6 August 2012

- 08:30 - 09:30** --- REGISTRATIION & ADMINISTRATIVE FORMALITIES at the Leonardo da Vinci Building, reception area ---
PLEASE NOTE: Participants receiving MEAL COUPONS may collect the total amount of coupons for the duration of your stay ONE DAY AFTER you have completed the ONLINE REGISTRATION with the Secretary of the activity. THE MEAL COUPONS MUST BE COLLECTED DIRECTLY FROM THE GUEST HOUSE RECEPTION DESKS AS FOLLOWS: ADRIATICO GUEST HOUSE: Tuesday to Friday, from 13.00 to 15.00 GALILEO GUEST HOSUE: Tuesday to Friday, from 10.00 to 12.00 and from 13.00 to 15.00
- 09:30 - 09:40** **OPENING REMARKS** Profs. A. Chubukov, P. Coleman, A. Schofield, H.Takagi, H-H. Wen an E. Tosatti

New Directions (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Andy SCHOFIELD

6 August 2012

- 09:40 - 10:55** **Andre-Marie TREMBLAY** / *Université de Sherbrooke, Canada*
Mott transition, Hubbard model and superconductivity: an introduction - Part I
- 10:55 - 11:15** --- Coffee Break ---
- 11:15 - 12:30** **Ali YAZDANI** / *Princeton University, U.S.A.*
Visualizing the emergence of heavy fermions and their exotic properties - Part I
- 12:30 - 14:00** --- Lunch Break ---

Monday, 6 August 2012 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Hide TAKAGI

- 14:00 - 15:15** **Andre-Marie TREMBLAY** / *Universite de Sherbrooke, Canada*
Mott transition, Hubbard model and superconductivity: an introduction - Part II
- 15:15 - 15:35** --- Coffee Break ---
- 15:35 - 16:50** **Ali YAZDANI** / *Princeton University, U.S.A.*
Visualizing the emergence of heavy fermions and their exotic properties - Part II
- 16:50 - 17:50** **Student run discussion session**
- 18:00 - 20:00** (Room: Leonardo da Vinci Building Terrace)
--- WELCOME RECEPTION ---

Tuesday, 7 August 2012

Quantum Magnetism (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Natalia PERKINS

7 August 2012

- 09:15 - 10:30** **Hide TAKAGI** / *University of Tokyo/RIKEN, Japan*
An overview of quantum spin liquid: from toy of theorists to reality - Part I
- 10:30 - 11:00** --- Coffee Break ---
- 11:00 - 12:15** **Yong-Baek KIM** / *University of Toronto, Canada*
Lightning review on quantum spin liquid - Part I
- 12:15 - 13:45** --- Lunch Break ---

Tuesday, 7 August 2012 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Hae-Young KEE

- 13:45 - 15:00** **Hide TAKAGI** / *University of Tokyo / RIKEN, Japan*
An overview of quantum spin liquid: from toy of theorists to reality - Part II

- 15:00 - 15:30 --- Coffee Break ---
- 15:30 - 16:45 **Yong-Baek KIM** / *University of Toronto, Canada*
Topological phases in quantum materials - Part II
- 16:45 - 17:45 **Student run discussion session**

Wednesday, 8 August 2012

Spectroscopy/Optics and Beyond:
Review application of optics to strongly correlated electron systems (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Andre-Marie TREMBLAY

8 August 2012

- 09:15 - 10:30 **Dmitri BASOV** / *University of California at San Diego, La Jolla, U.S.A.*
An infrared probe of electronic correlations and many body effects in solids: a case study of high-Tc pnictides and graphene - Part I
- 10:30 - 11:00 --- Coffee Break ---
- 11:00 - 12:15 **Lara BENFATTO** / *University of Rome, La Sapienza, ISC CNR, Italy*
Optical properties of correlated electron systems: basic theoretical aspects and optical sum rule - Part I
- 12:15 - 13:45 --- Lunch Break ---

Wednesday, 8 August 2012 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Elena BASCONES

- 13:45 - 15:00 **Dmitri BASOV** / *University of California at San Diego, La Jolla, U.S.A.*
An infrared probe of electronic correlations and many-body effects in solids: a case study of high-Tc pnictides and graphene - Part II
- 15:00 - 16:15 **Lara BENFATTO** / *University of Rome "La Sapienza", Italy*
Optical properties of correlated electron systems: Basic theoretical aspects and optical sum rule - Part II
- 16:15 - 16:45 --- Coffee Break ---
- 16:45 - 18:30 **Poster Session - I (to be held outside on the Terrace Level - posters may be displayed at any time and left on the boards for the full duration of your stay)**
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Thursday, 9 August 2012

Mott (Room:Leonardo da Vinci Building Main Lecture Hall)

Chairperson: Rafael FERNANDES

9 August 2012

09:15 - 10:30 **Elena BASCONES** / *Universidad Autonoma de Madrid, Spain*
Mott physics: from basic concepts to iron superconductors - Part I

10:30 - 11:00 --- Coffee Break ---

11:00 - 12:15 **Andy SCHOFIELD** / *University of Birmingham, U.K.*
Quantum criticality 1

12:15 - 13:45 --- Lunch Break ---

Thursday, 9 August 2012

Chairperson: Yong-Baek KIM

9 August 2012

13:45 - 15:00 **Elena BASCONES** / *Universidad Autonoma de Madrid, Spain*
Mott physics: from basic concepts to iron superconductors - Part II

15:00 - 15:15 --- Coffee Break ---

15:15 - 16:30 **Andy SCHOFIELD** / *University of Birmingham, U.K.*
Quantum Criticality 2

16:30 - 18:00 **Student run discussion session for Wednesday and Thursday sessions**

19:30 - 22:30 --- SOCIAL DINNER ---
DEADLINE CLOSED

Friday, 10 August 2012

Iron (Room:Leonardo da Vinci Building Main Lecture Hall)

Chairperson: Dmitri BASOV

10 August 2012

09:15 - 10:30 **Hai-Hu WEN** / *Nanjing University, China*
Materials and pairing mechanism in iron pnictides/chalcogenides: what we have learnt and what are left - Part I

10:30 - 11:00 --- Coffee Break ---

11:00 - 12:30 **The 2011 ICTP Prize in honour of Praveen Chaudhari is awarded to Ado Jorio, Departamento de Fisica, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil**
Remarks by Professor Fernando QUEVEDO, Director, ICTP 10'
Remarks by Professor Erio Tosatti on Praveen Chaudhari 10'
Award of the Prize (followed by Talk) 10'

Electronic and Vibrational Properties Graphene-Based of Systems
(Ado JORIO - Universidade Federal de Minas Gerais, Belo Horizonte, Brazil) 30'

12:30 - 14:00 --- Lunch Break ---

Friday, 10 August 2012 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Hae-Young KEE

14:00 - 15:15 **Rafael FERNANDES** / *Columbia University, New York, U.S.A.*
Interplay between superconductivity, magnetism and nematic/orbital order in the iron pnictides - Part I

15:15 - 16:30 **Hai-Hu WEN** / *Nanjing University, China*
Materials and pairing mechanism in iron Pnictides/Chalcogenides: What we have learnt and what are left - Part II

16:30 - 17:00 --- Coffee Break ---

17:00 - 18:15 **Rafael FERNANDES** / *Columbia University, New York, U.S.A.*
Interplay between superconductivity, magnetism and nematic/orbital order in the iron pnictides - Part II

WEEK No. 2 - WORKSHOP from 13 - 17 August 2012

Monday 13 August 2012

13 August 2012

08:30 - 09:00 --- REGISTRATION & ADMINISTRATIVE FORMALITIES in room 245, second floor, Leonardo da Vinci Building ---
PLEASE NOTE: THIS REGISTRATION IS ONLY FOR VISITORS SPECIFICALLY INVITED TO THE WORKSHOP - SECOND WEEK. Those visitors who have already attended the School - First Week, DO NOT NEED TO REGISTER AGAIN

09:00 - 09:10 **OPENING REMARKS** Profs. **A. Chubukov, P. Coleman, A. Schofield, H. Takagi, H-H. Wen and E. Tosatti**

Innovative Concepts and Techniques in Quantum Matter (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Oscar VAFEK

13 August 2012

09:10 - 10:00 **Kristjan HAULE** / *Rutgers State University, Piscataway, U.S.A.*
The physics of Hund's metals and its relevance for ruthenates, iron Pnictides and Chalcogenides

10:00 - 10:30 --- Coffee Break ---

10:30 - 11:20 **Sung-Sik LEE** / *McMaster University, Hamilton, Canada*
From renormalization group to emergent gravity: holographic description of quantum many-body systems

11:20 - 12:10 **Michael NORMAN** / *Argonne National Laboratory, U.S.A.*
Arcs versus Pockets - To d-wave or not to d-wave, that is the question

12:10 - 14:00 --- Lunch Break ---

Developments in Quantum Magnetism (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Silke PASCHEN

13 August 2012

14:00 - 14:50 **Hae-Young KEE** / *Stanford University, U.S.A.*
Theory of magnetic structure in layered iridates: spin-orbit band or Mott insulators

14:50 - 15:40 **Kedar DAMLE** / *Tata Institute of Fundamental Research, Mumbai, India*
Vacancy-induced spin textures and their interactions in a classical spin liquid

15:40 - 16:10 --- Coffee Break ---

16:10 - 17:00 **Collin BROHOLM** / *John Hopkins University, Baltimore, U.S.A.*
From incommensurate correlations to mesoscopic spin resonance in YbRh₂Si₂

17:00 - 18:00 **Student run discussion session**

Tuesday 14 August 2012

New Directions in Topological Matter (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Hai-Hu WEN

14 August 2012

09:00 - 09:50 **Andrey BERNEVIG** / *Princeton University, U.S.A.*
Fractional topological insulators

09:50 - 10:40 **Oscar VAFEK** / *Florida State University, Tallahassee, U.S.A.*
Electronic multicriticality on a honeycomb bilayer

10:40 - 11:10 --- Coffee Break ---

New Directions in Pnictides (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Andrey CHUBUKOV

14 August 2012

11:10 - 12:00 **Takasada SHIBAUCHI** / *Kyoto University, Japan*
Quantum critical point inside the superconducting dome and electronic nematic transition above the dome in BaFe₂(As_{1-x}P_x)₂

12:00 - 14:00 --- Lunch Break ---

New Directions in Pnictides (cont'd) (Room:Leonardo da Vinci Building Main Lecture Hall)

Chairperson: Andrey CHUBUKOV

14 August 2012

- 14:00 - 14:50** **Shik SHIN** / *The University of Tokyo, Japan*
Laser-ARPES study on Fe-pnictide superconductors
- 14:50 - 15:40** **Hong DING** / *CAS, Beijing, China*
Probing iron-based superconductivity by photoelectrons
- 15:40 - 16:10** --- Coffee Break ---
- 16:10 - 16:35** **Minghu FANG** / *Zhejiang University, China*
Exploration of Fe-Chalcogenide superconductors: Fe-vacancy order, new AFM ground state and superconductivity
- 16:35 - 17:00** **Natalia PERKINS** / *University of Wisconsin-Madison, U.S.A.*
Magnetism in parent Fe-chalcogenides

Wednesday, 15 August 2012

Quantum Critical Theory of Strange Metals (Room:Leonardo da Vinci Building Main Lecture Hall)

Chairperson: Michael NORMAN

15 August 2012

- 09:00 - 09:50** **Piers COLEMAN** / *Rutgers State University, Piscataway, U.S.A.*
The unsolved problem of heavy fermion superconductivity
- 09:50 - 10:40** **Satoru NAKATSUJI** / *University of Tokyo, Japan*
Unconventional quantum criticality, anomalous metal with strong valence/orbital fluctuations
- 10:40 - 11:10** --- Coffee Break ---
- 11:10 - 12:00** **Silke PASCHEN** / *Vienna University of Technology, Austria*
Exploring heavy-fermion quantum criticality in the extreme 3D limit
- 12:00 - 14:00** --- Lunch Break ---

Hidden Order (Room:Leonardo da Vinci Building Main Lecture Hall)

Chairperson: Piers COLEMAN

15 August 2012

- 14:00 - 14:50** **Thomas TIMUSK** / *McMaster University, Hamilton, Canada*
The normal state of URu₂Si₂: spectroscopic evidence for an anomalous Fermi liquid
- 14:50 - 15:40** **Rebecca FLINT** / *Rutgers, the State University of New Jersey, Piscataway, U.S.A.*
Hastatic order in URu₂Si₂
- 15:40 - 16:10** --- Coffee Break ---

16:10 - 18:10 **Poster Session - II** (to be held outside on the Terrace Level - posters may be displayed at any time and left on the boards for the full duration of your stay)
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Thursday, 16 August 2012

Superconductivity and its Interplay with Charge and Spin Order (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Kedar DAMLE

16 August 2012

09:00 - 09:50 **Sergei BORISENKO** / *Institut fuer Festkoerper, Dresden, Germany*
Fermiology and order parameter of iron-based superconductors from ARPES

09:50 - 10:40 **Aharon KAPITULNIK** / *Stanford University, U.S.A.*
Time reversal symmetry breaking and charge ordering in the Pseudogap phase of high-temperature superconductors

10:40 - 11:10 --- Coffee Break ---

11:10 - 11:35 **Girsh BLUMBERG** / *Rutgers, the State University of New Jersey, Piscataway, U.S.A.*
CaMn₂Sb₂ with buckled hexagonal Mn plane structure: removal of Hund's spin blockade

11:35 - 12:00 **Maxim DZERO** / *Kent State University, U.S.A.*
Kondo semiconductors with a twist: f-orbital topological insulators

12:00 - 14:00 --- Lunch Break ---

Graphene and Non-Equilibrium (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Girsh BLUMBERG

16 August 2012

14:00 - 14:50 **Andrey CHUBUKOV** / *University of Wisconsin-Madison, U.S.A.*
Collective instabilities in doped graphene

Non-Equilibrium (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Maxim DZERO

16 August 2012

14:50 - 15:40 **Aditi MITRA** / *New York University, U.S.A.*
Quantum quenches in one-dimension: A renormalization group approach

15:40 - 16:00 --- Coffee Break ---

16:00 - 16:50 **Natan ANDREI** / *Rutgers, the State University of New Jersey, Piscataway, U.S.A.*
Quench dynamics of the interacting Bose gas in one dimension

Friday, 17 August 2012

Novel Kinds of Order (Room:Leonardo da Vinci Building Main Lecture Hall)

Chairperson: Rebecca FLINT

17 August 2012

- 09:00 - 09:50** **Massimo CAPONE** / *CNR IOM and SISSA, Trieste, Italy*
When Mott meets BCS. Molecular conductors and the search for high-Tc superconductivity
- 09:50 - 10:40** **Ryotaro ARITA** / *The University of Tokyo, Japan*
Density functional theory for superconductors and its application to layered nitride superconductors
- 10:40 - 10:50** --- Coffee Break ---
- 10:50 - 11:40** **Federico BECCA** / **Michele FABRIZIO** / *CNR IOM and SISSA, Trieste, Italy*
Localization and glassy dynamics of many-body quantum systems
- 11:40 - 12:30** **Discussion and Closing Remarks**
Prof. A. Chubukov, P. Coleman, A. Schofield, H. Takagi, H-H. Wen and E. Tosatti