C5 Activity Report to the IUPAP 2008 General Assembly

OFFICERS 2006-2008

Chairman:	Mikko Paalanen, Finland
Vice-Chairman:	Kimitoshi Kono, Japan
Secretary:	Robert Hallock, USA

Members:

Tomasz Dietl, Poland
Igor Fomin, Russia
Karen Hallberg, Argentina
Moty Heiblum, Israel
Peter Kes, Netherlands
Ting-Kuo Lee, Taiwan
Paul Leiderer, Germany
Li Lu, China
George Pickett, United Kingdom
Alain Ravex, France

MAIN ACHIEVEMENTS

C5 held 2 commission meetings, sponsored 4 conferences, launched the IUPAP Young Scientist Prize in low temperature physics, and created the web-site on the IUPAP home-page. C5 was also active in the IUPAP Working Group on Nanoscience, especially in organizing its Toronto meeting in February 2008.

COMMISSION MEETINGS

Mid-term Meeting of C5:

March 5, 2007, in connection of APS 2007 March Meeting in Denver, Colorado
Present: 7 out of 13 ordinary members of C5, and the associated members of C3 and C8

Agenda:
1) Welcome by Judy Franz
2) Report on IUPAP Council and Commission Chairs Meeting in Prague, Oct. 2006
3) Report on LT24 in Orlando in 2005 by Gary Ihas
4) Progress report on LT25 in Amsterdam in 2008 by Peter Kes
5) Preproposal for organization of LT26 in Beijing in 2011 by Li Lu
6) Progress report on QFS 2007 in Kazan by Igor Fomin
7) Progress report on Ultracold NanoMatter Conference in 2008, organized in Toronto by IUPAP Working Group on Nanoscience, by Mikko Paalanen
8) IUPAP Young Investigator Prize

9) Report on Fritz London Prize and Journal of Low Temperature Physics by Horst Meyer

Final Meeting of C5:

August 9, 2008, in connection of LT25 in RAI Congress Center, Amsterdam
Present: 10 out of 13 members

Agenda:

1) Review of the minutes of the C5 mid-term Meeting in 2007
2) Preliminary report on LT25 by Peter Kes.
3) Proposal for organizing LT26 by Li Lu, Chinese Academy of Sciences
4) Members of C5 for the 2009-2011 term
5) Other C5 matters:
   - IUPAP Young Scientist Prize in Low Temperature Physics
   - C5 WEB-page (http://www.iupap.org/commissions/c5/website.html)
   - Report on QFS 2007 in Kazan
   - Report on IUPAP Working Group on Nanoscience
   - London Prize and Simon Prize

COMMISSION SPONSORED CONFERENCES

Type A
25th International Conference on Low Temperature Physics (LT25)
August 6-13, 2008, Amsterdam, The Netherlands, Chairman Peter Kes
over 1400 participants from nearly 50 countries

Type B
International Symposium on Quantum Fluids and Solids QFS 2007
August 1-5, 2007, Kazan, Russia, Chairman Murat S. Tagirov
206 participants from 15 countries

International Symposium on Quantum Fluids and Solids QFS 2006
August 1-5, 2006, Kyoto, Japan, Chairman Takeo Mizusaki
255 participants from 18 countries

Type C
7th Conference on Cryocrystals and Quantum Crystals
July 31-Aug. 5, 2008, Wroclaw, Poland, Chairman Andrzej Jezowski

IUPAP YOUNG SCIENTIST PRIZE IN LOW TEMPERATURE PHYSICS

The first IUPAP Young Scientist Prizes in low temperature physics were given at the LT25 conference in August 2008. The recipients were:

1) Dr. Dai Aoki from CEA-Grenoble, France, for his contribution in the discovery of co-existence of superconductivity and ferromagnetism in URhGe.

2) Dr. Kostya Novoselov from University of Manchester, UK, for his contribution in the discovery of graphene and for pioneering studies of its extraordinary properties.

3) Dr. Viktor Tsepelin from Lancaster University, UK, for the development of new experimental techniques and key discoveries in the fields of 3He crystals and quantum turbulence.

NEW DEVELOPMENTS IN LOW TEMPERATURE PHYSICS

For the field of experimental low temperature physics, the ability to conduct research has been damaged by the dramatic increase in the price of liquid helium. In the United States for example, the price of liquid helium has approximately doubled over the past two years. This has led to a reduction in activity in many laboratories as the funding agencies have not quickly increased support in proportion.

The increase in price of liquid helium has accelerated interest in the development and use of alternative cooling systems. In particular, pulse tube coolers are now available that will allow cryostats with modest cooling needs to operate dilution refrigerators without the need for repeated refills of liquid helium from external supply sources.

Solid helium research has seen a dramatic resurgence. Torsional oscillator experiments have been interpreted to show that solid helium may undergo a transition to a state in which some of the atoms in the container do not follow the motion of the container, e.g. may be “supersolid.” The observation is robust, but the interpretation is controversial. The shear modulus of solid helium undergoes a similar signature with respect to temperature. Experiments that should be expected to cause helium to flow give conflicting results. Theory predicts that a perfect solid cannot show supersolid behavior, but novel superfluid-like behavior should be seen in various defects that can exist in the solid, and vorticity may play a significant role. And, recently there have been reports of unusual mass decoupling in films of pure 4He on graphite surfaces as well as 3He-4He mixture films on solid hydrogen surfaces. These may be other examples of unusual superfluid-like behavior.

There is continued interest in superfluid turbulence, where there has been progress in the use of very sensitive ultra-cold detectors as well as the use of injected ions. Interesting progress is being made in understanding how quantum turbulence resembles classical turbulence. New evidence shows that turbulence can develop by the entanglement of vortex rings. It now appears possible to control the transition to quantum turbulence in 4He.

High temperature and unconventional superconductivity continues to show progress. Over the past few years we have seen new work on the coexistence of superconductivity and ferromagnetism in the Uranium compounds. Discovery of superconductivity in layered iron-arsenic compounds may lead to a new generation of high temperature superconductors and holds great promise. There has also been strong progress in the possible use of layered transition metal oxide materials as the basis for the discovery of new superconductors. The visualization via STM of the electronic states of high transition temperature materials continue to provide new insights into the pairing that takes place in such materials. There is also emerging new work that shows that in a two dimensional superconducting system with patterned holes, pairing may exist in the insulating state.

Graphene has been a very hot topic due to the ability to readily create atomically thin sheets of carbon, which has given rise to investigation in a number of settings via many techniques. These thin sheets, unknown until a few years ago, reveal remarkable electronic and optical properties, which are only beginning to be understood and explored. There has also been continuing progress in the area of carbon nanotubes where there have been developments in the study of the spin and orbital motion of electrons, which have implications for spintronics applications.

There has been progress in the area of quibits, where it now seems possible to communicate quantum information between qubits using photons. Thus emerges the possibility of using superconducting integrated circuits to carry out experimental studies in quantum optics. In addition, small Josephson junctions are being used to study quantum coherence in ways not possible previously.

Device-driven research continues to show remarkable new results. The use of SQUID detection has allowed the possibility of very low magnetic field magnetic imaging (MRI) with the ability to resolve structures to a higher degree than previously possible. There has also been work in the area of nano-mechanical resonators, which may allow future study of squeezed states in a mechanical system. In addition, there continues to be work on nanomagnets, which show self-assembly properties and unusual temperature dependence to the magnetization.

Ultra-cold gasses continue to see dramatic progress due to the unprecedented ability of the realm of cold-atom physics to manipulate atoms and their environment. Optical superlattices have allowed studies of superexchange interactions and open the possibility of further investigation of the dynamical behavior of quantum spin systems. Such cold gas experiments have allowed unprecedented opportunity to study quantum degenerate Fermi gasses and the realization of superfluidity with unusual interactions. Also in this area it has been possible to create controlled disorder and subsequently directly observe localization phenomena in one dimension, with the expectation that this can be extended to higher dimensions.