

**Report of the C3 Commission on Statistical Physics for 2005 – 2008**  
**Tsukuba, Japan (October 13 – 17, 2008)**

The general aims of the Commission on Statistical Physics (C3) are:

- To promote the exchange of information and views among the members of the international scientific community in the general field of Statistical Physics including:
  - a) statistical and thermodynamic methods concerning the static and dynamic properties of mesoscopic and macroscopic states of matter.
  - b) applications of statistical physics to related fields such as non-linear dynamics, turbulence, chemical kinetics, polymers, colloids, liquid crystals, non-crystalline solids, heterogeneous media, neural networks and computational physics.
- To recommend for Union sponsorship international conferences which qualify for support under Union regulations.
- To select winners of the Boltzmann medal.
- To select the winners of the Young Scientist Prize.

## **1. ACTIVITIES**

During the period 2005-2008 the C3 Commission sponsored and helped to organize the academic programme of STATPHYS 23, the 23rd IUPAP International Conference on Statistical Physics. The conference was held in Genova, Italy, from July 9 to 13, 2007. STATPHYS is the major international conference in statistical physics, and it is held in a three years cycle. The conference drew about 1200 participants from countries all over the world. It took place in the convention center Magazzini del Cotone at the old port of Genova, which provided four lecture halls for the four parallel sessions and meeting areas for discussions to facilitate interactions among participants.

The academic programme of the conference consisted of 2 Boltzmann Award Lectures, 8 plenary talks, 58 invited talks, oral contributed talks and poster presentations. Thanks to the efforts of the International Advisory Committee, the Steering Committee and the organizers the conference succeeded in providing a comprehensive survey of the most recent relevant developments in the broad area of statistical physics. The talks were divided into the following eleven topical categories of current interest in statistical physics:

- (1) General aspects of statistical physics, thermodynamics, rigorous results and exact solutions.
- (2) Phase transitions and critical phenomena (equilibrium).
- (3) Nonequilibrium systems: driven systems, transport theory, relaxation phenomena, random processes.
- (4) Pattern formation in systems out of equilibrium: growth processes, fracture, hydrodynamic instabilities, chemical reactions, etc.
- (5) Dynamical systems and turbulence.

- (6) Liquid matter and interfacial phenomena: atomic, molecular and ionic fluids, freezing, metastable liquids, wetting, surface effects, confined systems, etc.
- (7) Soft condensed matter: polymers, liquid crystals, microemulsions, foams, membranes, colloids, granular materials etc.
- (8) Quantum systems: quantum phase transitions, strongly correlated fermions; Bose-Einstein condensation, mesoscopic quantum phenomena, localization, etc.
- (9) Disordered and glassy systems: percolation systems, spin glasses, structural glasses, glass transition, etc.
- (10) Biologically motivated problems: biological networks, molecular motors, dynamics at the scale of the cell, evolution models, protein folding models, statistical modeling of biological data, etc.
- (11) Interdisciplinary topics in statistical physics: networks, econophysics, traffic flow, algorithmic problems, astrophysical applications, etc.

A particular highlight of the conference was the Boltzmann Medal Ceremony, which was conducted by Prof. M. E. Fisher. In this session, individual Boltzmann Medals were awarded to Prof. Kurt Binder from Mainz, Germany and Prof. Giovanni Gallavotti from Rome, Italy. Prof. Binder was cited for his "leading role in developing computer simulation methods and, in particular, the Monte Carlo method into a reliable and quantitative tool of statistical physics, and for his many central contributions to statistical physics in this context". Prof. Gallavotti was cited for his "fundamental contributions to our precise understanding of equilibrium and non-equilibrium statistical physics, including the development of a constructive renormalization group for phase transitions, dynamical systems, and quantum liquids".

The recently established Young Scientist Prize in Statistical Physics has been awarded for the first time. The new prize, established by the IUPAP C3 Commission, recognizes singular contributions of scientists at early stages of their career. The first prize was individually awarded to Dr. Giulio Biroli from France for his "studies of the thermodynamics and dynamical properties of the glass transition and jamming phenomena", and to Dr. Tomohiro Sasamoto from Japan for his "contributions to the study of non-equilibrium steady states by providing exact solutions to models of driven systems". It was decided by the C3 Commission that the new prize will be awarded triennially on the occasion of the STATPHYS conferences.

The plenary and invited talks focused on important recent developments in diverse areas. The plenary talks consisted of lectures on Viscous fluids and the glass transition (J. P. Bouchaud), Noise effects in bacterial behavior (S. Leibler), Phase transitions in information and communication systems (A. Montanari), Epidemic spreading in networks (A. Vespignani), Ultracold Fermi gases (R. Grimm), Entanglement entropy in quantum systems (J. Cardy), Nonequilibrium work theorems (C. Jarzynski), and Interfacial tension and wetting in colloid-polymer mixtures (H. N. Lekkerkerker). Further significant developments in each area were covered in the invited talks, and new exciting results were reported in the oral and poster presentations.

In addition to the STATPHYS 23 conference itself, 18 satellite meetings were held in the preceding week (10) and in the week following the conference (8). The meetings took place in a number of countries in Europe (Italy, Germany, Portugal and Finland). The large number of such meetings reflects the diversity of topics and research areas

covered within the STATPHYS 23 conference. These meetings provided a focal point where specific areas could be more intensely discussed in a more intimate surrounding.

The proceedings of STATPHYS 23 have been published in August 2008, in The European Physical Journal B vol. 64 no. 3-4. The meeting of the C3 Commission was held during STATPHYS 23. It was decided that the 24th International Conference on Statistical Physics, STATPHYS 24, will be held in Cairns, Australia, in July 2010.

## **2. NEW DEVELOPMENTS**

New developments in statistical physics and its applications in other disciplines have been highlighted in the STATPHYS 23 conference and in the large number of its satellite meetings. Important progress has been made in the area of non-equilibrium statistical physics where a large number of theoretical and experimental studies have contributed to the understanding of the thermodynamics of small systems (work and fluctuation theorems). Another aspect of non-equilibrium systems where considerable progress has been made is that of phase transitions and large deviations in these systems. Studies of glasses have yielded better understanding of mechanisms for the aging and slow dynamics which characterize these systems. Both areas of non-equilibrium phenomena and glassy behavior remain of great challenge in statistical mechanics and condensed matter physics. Although important progress has been made in recent years in both these areas, fundamental breakthroughs are still lacking. Other areas where new developments have been emphasized are quantum systems (condensation of cold trapped atoms, Bose-Einstein condensation, condensation of Fermi gases which exhibit BCS like pairing etc.); biologically inspired statistical mechanical problems (molecular motors, transport through membranes, protein and RNA folding, mechanical manipulation of single molecules; networks and their characteristics in biological system etc.); pattern formation (in colloids and granular matter and in complex hydrodynamic flows). Also emphasized are applications of statistical physics methods in other fields of research such information and communication systems, algorithmic problems, networks etc.

Statistical physics is a discipline which is characterized by its broad scope. By its nature it touches upon almost all other fields of physics and many areas of chemistry, biology and mathematics. This diversity is very well reflected by the relevance it has to many areas covered by almost all other Commissions of IUPAP and some Commissions of IUPAC. The C3 Commission has also been active in the Nanoscience Working Group of IUPAP.

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