Physics Of Fluctuations Far From Equilibrium (POFFFE 2007)

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This workshop took place on July 1st-6th, 2007 and was endorsed by IUPAP as a Satellite Meeting of the XXIII International IUPAP Conference on Statistical Physics (StatPhys23, Genova, Italy, July 9th-13th, 2007).
The workshop program had its focus on the comprehensive collection of phenomena which originate from fluctuations occurring in nonlinear systems far from equilibrium. Special emphasis has been put on applications in physics, engineering sciences, chemical and biological physics. In addition, an attempt was made to feature also other fluctuation phenomena that appear to characterize the statistical physics of devices at the submicron scale.

The notion of *linear response*, which, in turn, is related to the fluctuation properties of the observable of interest, can be extended to arbitrary systems that operate far from equilibrium; the corresponding fluctuation theorem relations provide most valuable information on the role of *non-equilibrium* fluctuations (for an overview see in P. Hänggi and H. Thomas, Stochastic Processes: *Linear Response and Fluctuation Theorems*, Phys. Rep. **88**: 207—319 (1982), Chapt. V).This notion of fluctuation theorems should not be confused with the recently proposed *non-equilibrium work relations,* also termed *fluctuation theorems*. This new branch of the fluctuation theory was formalized in the *chaotic hypothesis* by Gallavotti and Cohen; independently, Jarzynski derived an interesting *equality*, which is valid for both closed and open classical statistical systems, that relates - a priori surprisingly - the difference of two equilibrium free energies to the expectation of a particularly designed, stylized non-equilibrium work functional. Prof. Ch. Van den Broeck and Prof. L. Peliti delivered an overarching review of these recent developments "beyond the second law of thermodynamics". Prof. G. Gallavotti, this year's recipient of the IUPAP Boltzmann medal, attended our meeting and reported on his interpretation of the notion of temperature in the context of the fluctuation theorems. Current research updates on this topic were presented, among others, by A. Imparato, J. M. Ortiz de Zarate, and B. Wynants.
The implications and the role of fluctuations in the design and operation (with the characteristic manipulations occurring at differing time scales) of fabricated nanodevices was addressed by several speakers such as S. Savelev, A. Wixforth, P. Talkner, D. Reguera and M. Borromeo.

A particular challenge presents the extension of the work/fluctuation theorems to *open* quantum systems: Here, in clear contrast to the classical situation, or also a closed, thermally isolated quantum case, a time-dependent non-equilibrium manipulation distinctly impacts the coupling strength to the heat bath (i.e. the "dissipation" strength) and thus the effective free energy and entropy. An entire morning session was devoted to this and related issues: The fundamental question as how to define work in a quantum context – and the extension of work theorems to

micro-canonical initial conditions – was discussed by P. Hänggi, whereas new applications of great technological potential were proposed by A. Nitzan, J. Gong, S. Kohler, M. Rey- Mazon, and L. Arrachea.

The multi-facetted role of non-equilibrium fluctuation in biological systems is attracting increasing interest. This topic occupied as well a whole session with illuminating contributions by M. Ehrenberg on fluctuations in gene expression, U. Gerland on conformational transitions in bio-molecular complexes, or also by D. Petrov with single molecule experiments in optical traps.

Finally, widespread interest seems to persist on the issue of particle diffusion in low dimensional structures: Anomalous diffusion (I. Sokolov), diffusion enhancement (B. Lindner), absolute negative mobility (J. Luczka), Levy flights (E. Lutz), ratchet effects in higher dimensions (I. Zolotaryuk) and at the cross-over between classical and quantum regime (S. Flach) raised renewed attention in the audience.

The colloquium was given by Professor L. Schimansky-Geier: He presented a most illuminating and exciting overview of the physics and applications of coupled noisy oscillators in physics and physical biology, topics that had been addressed earlier that same day by H. Park and N. Janson.

As a final remark we stress the increasing interest of scientists from the Korean Advanced Institute of Science and Technology (KAIST), namely H. Park, E. K. Lee, and J. Lee, in the activities of the MPI-PKS. Closer contacts and joint initiatives between MPI-PKS and KAIST might develop in the next future.

Augsburg, July 24 2007

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(the organizers)