Scientific report

The winter school "Understanding and exploiting complexity at the nanoscale", organized at the Université Libre de Bruxelles on January 20-22, has been very successful. The school was organized via the doctoral school "COMPLEX" and has attracted a large number of students from various Belgian universities which have openly expressed their satisfaction. Researchers have also participated to the event and have fruitfully interacted with the speakers. In general, the participants seem to have greatly enjoyed the diversity of the proposed courses. The speakers greatly enjoyed their stays and gave very pedagogical and interesting lectures.

This school has shown that the statistical methods developed in statistical physics, and traditionally used to describe large chemical or physical systems, have nowadays a wide range of applications in the study of small systems and in biology.
The one hour lectures given by Pierre Gaspard, Christian Maes and Christian Van den Broeck presented recent progress in the foundations of nonequilibrium statistical mechanics of small systems. Fluctuation theorems, exact expressions for the entropy production of driven systems, universality of the efficiency at maximum power of small engines, and linear response theory of nonequilibrium steady states, were presented. Sergio Ciliberto showed in his lectures that these fundamental results can be experimentally verified, and gave us an overview of the modern technologies used to study fluctuations in small devices. Yuli V. Nazavov gave us an overview of the tools and methods used to study fluctuations in small quantum systems such as electronic quantum junctions. He also introduced us to circuit theory which plays a central role in nanoelectronics. Hugo Touchette gave highly appreciated lectures on the importance of large deviation theory for physicists. He showed, using numerous examples, that this theory, initially developed by mathematicians, can be used to rigorously treat fundamental problems in statistical physics. The lectures by Luca Peliti introduced us to the mathematical modeling of evolutionary dynamics by using tools inspired by statistical physics. He convinced us that such approaches can be very powerful, conceptually as well as experimentally, and that exiting open questions remain to be answered in this field. Finally, Francesco Zamponi gave interesting lectures on phase transitions in spin glasses and introduced us to the various solvable models used in this field. He also made some interesting connections with the large deviation theory lectures of Hugo Touchette.

The website of the conference can be found at http://homepages.ulb.ac.be/~mesposit/school.html

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