Report to the 2008 General Assembly for the period 2005-2008

C6. Commission on Biological Physics

Activities

Within the reporting period, Commission C6 met for an official business meeting on August 29, 2007 in Montevideo, Uruguay. All other business was handled through email contact.

6th International Conference on Biological Physics (ICBP) in Montevideo, Uruguay
The major activity of the commission is the preparation and organization of the International Conference on Biological Physics (ICBP), a 'type A' conference that aims to showcase the entire area of biological physics. The Commission selected Uruguay as the location of the 6th ICBP in 2007 to strengthen the development of Biological Physics in developing countries in general and the fledgling activities in Latin America in particular. Commission Member Raúl Grigera (Argentina) acted as Chairman of the 6th ICBP, which was held in Montevideo, Uruguay, August 27 – 31, 2007. The total number of registered participants was 400, with a significant fraction of women (34%) and junior people (60%) attending. 55 participants were from Uruguay, Argentina (159) and Brazil (58) contributed the most attendants. Overall, 80% of the participants came from South America, 10% from Europe, 6% from the US/Canada, and 4% from Asia. There were seven plenary lectures, 20 symposia (with three invited + two contributed talks each), 300 posters and a public lecture.

The list of topics shows that the most important subfields of biological physics were represented at the 6th ICBP:

1. Single molecule studies
2. Nanotechnology and surface science
3. Biosensors and medical applications
4. Charge transfer in biomolecules and photobiology
5. Structure and dynamics of biomolecules
6. Molecular Machines
7. Physics of subcellular structures
8. Modeling of Cellular Process
9. Physics of the nervous system
10. Evolution and the origin of life
11. Complex systems in Biological Physics
12. General Biological Physics
13. Protein folding/unfolding and disordered states
14. Energy transduction
15. Membranes and Transport
16. Biological reactions, experiments and modeling
17. Radiation Biology

Abstract books were made available to all participants; the proceedings of the conference were published after peer-review in a special issue of the Journal of Biological Physics.

All attending commission members agreed that the organization of the ICBP was excellent in every respect. The number of participants was lower than for the previous two conferences, which reflects the fact that the number of local participants was lower than previously, as expected from considering the small local community in Uruguay. The total number of ~350 foreign participants matches roughly that of previous ICBP conferences. The attendance by US scientist was lower than expected, considering the closer distance and large size of the US Biological Physics community. Selecting Montevideo as the venue of the ICBP

has been an excellent choice to promote biological physics in Latin America. The President of Uruguay, Tabare Vasquez, attended the Welcome Ceremony, which underscores the appreciation that IUPAP receives for its role in fostering basic science development in Uruguay and Latin America.

Commission C6 realizes that a certain overlap exists with other large conferences such as those organized by IUPAB (International Union for Pure and Applied Biophysics), EBSA (European Biophysical Societies Association), the Biophysical Society, and other large national physics societies (e.g., APS, DPG, IoP). In these annual physics conventions, a strongly increasing presence of Biological Physics has been noticed in recent years. It is reassuring that, in this competitive environment, our meeting has established itself as the international meeting of scientists studying the physics of living systems.

The commission plans to hold the 7th ICBP in San Diego in 2010, and commission member José Onuchic agreed to act as the local chairman. A program committee will be established early on so that a large number of people participate actively in the conference. Closely related areas such as Medical Physics should continue to be represented at the ICBP.

IUPAP Young Scientist Prizes in Biological Physics

In the reporting period 2005 – 2008, Commission C6 established two IUPAP Young Scientist Prizes in Biological Physics, one for theory/computation, and another one for experimental work, which are to be awarded every three years as part of the ICBP. The commission awarded the IUPAP Young Scientist Prize in Biological Physics 2007 (experimental) to Dr. Habib Zaidi, Geneva, Switzerland, in recognition of his outstanding accomplishments in the application of biological physics in the field of medical imaging. No prize was awarded for theory/computation in 2007.

Nanoscience Working Group, Nanobiophysics Meeting in Hungary

The Commission was also engaged in the Nanoscience Working Group. The Working Group organized an IUPAP sponsored, small topical meeting on Nanobiophysics, which was held in Szeged, Sept 3 – 7, 2006 and organized by Pál Ormos. About 75 people attended. The topics covered experimental methods used in nanobiophysics, interesting nanoscale biostructures, modeling, and also included areas such as magnetic subcellular nanostructures, membrane structures, membrane model systems for biological studies as well as sensor applications. The selection of topics made the meeting most informative and enjoyable even for nanoscience experts lacking a biophysics background. Truly outstanding experts presented their research; the list of lecturers was indeed most impressive.

New developments in the field

Biological physics can be broadly defined as a subfield of physics in which physicists use the specific scientific background of their discipline to make significant contributions to the exploration of biological systems. These contributions can be theoretical or experimental; they can be basic or applied sciences. The breadth and complexity of the life sciences gives biological physics a very broad scope. Biological physics thus encompasses many different subfields and has close interrelations with various other scientific disciplines, including chemistry, biology, medicine, mathematics and engineering.

Biological physics has enjoyed increasing popularity as reflected by the large number of new faculty hires in physics departments, and a variety of new funding opportunities have also become available in recent years. New developments in three topical areas are briefly discussed below.

Biomolecular structure, dynamics and function

Exploration of structure-function relationships in biomolecules remains a fundamental and important task in biological physics. Progress in this area is swift and driven by both theoretical and experimental developments. A better understanding of protein folding remains an important topic. While the physical principles are well understood, a reliable and general method for the computation of protein structure from the amino acid sequence remains to be worked out. With the advent of fast DNA sequencing, the demand for atomic-resolution structure determination without the tedious x-ray and NMR experiments is higher than ever.

Experiments using fluorescence microscopy with single molecule detection have allowed monitoring equilibrium fluctuations and non-equilibrium folding transitions, both in the unfolded and folded states. A better appreciation of the role of protein dynamics in functional processes has been achieved by time-resolved x-ray crystallography with sub-nanosecond resolution. Moreover, novel NMR experiments utilizing residual dipolar couplings (RDCs) have closed the time-resolution gap between nanoseconds and microseconds, enabling the observation of essentially all relevant time scales with a single experimental method. These techniques require sophisticated data analyses that involve atomic-scale molecular dynamics simulations.

Computational methods are also used intensely to study functional processes in proteins. Advances in this area are immense and driven by improved algorithms and the ever increasing power of computational facilities, so that very large, complex biological entities can be modeled successfully at the atomic level over time periods extending out to microseconds.

Single particle detection and manipulation

Single-particle detection and manipulation continues to be a lively and swiftly advancing field, both in regard to basic science and applications. Spectroscopy and microscopy with single-particle sensitivity have gained enormous popularity. They are a rich source of information, as biomolecules and biomolecular systems are complex entities characterized by a multi-dimensional conformational energy landscape, so that each system under study may act in a slightly different, history-dependent way. Their dynamics can be directly observed in single-molecule experiments, whereas experiments carried out on ensembles yield merely average values of the observables. The impressive experiments carried out with individual biomolecular systems provide a great deal of inspiration for the field of nanotechnology.

Study of complex systems

While the emphasis on biomolecular research is still strong, there is a tendency for researchers to move to more complex systems. This development is fostered by our continuously improving ability to acquire and process large amounts of data. Recent advances in the area of light microscopy have enabled researchers to produce images beyond the diffraction limit, thereby closing the gap between microscopy and the atomic-resolution methods. Sophisticated fluorescence labeling schemes enable biomolecular interactions to be observed within living cells in space and time, and complex signaling pathways can be explored in unprecedented detail. While the in-depth understanding of the ‘inner gears and wheels’ of cells is likely to constitute a formidable task for years to come, assessing and modeling the interaction of cells within tissues and organs is emerging, and complex functions of the brain are being modeled with newly developed theories.

Biological physics is a lively research area, and we expect a further growth in physical studies of biological systems in the coming years.

Gerd Ulrich Nienhaus, Chair