International Union of Pure & Applied Physics

Report of Nanoscience Working Group

General Assembly Meeting

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Abstract: The Nanoscience Working Group examined how IUPAP can facilitate the development of this rapidly expanding field. The working group composed of members representing nine IUPAP commissions met in Paris and concluded that a conference limited to between 75 and 150 people would be useful to improve the synergy between researchers in the various commissions. A number of conference topics were discussed for the first such meeting and our recommendation is that IUPAP support a conference on Bionanoscience. This meeting is proposed to take place at the Biological Research Centre in Szeged, Hungary in 2006. Future conference topics would be reviewed after such an initial meeting.

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I. Mandate

Nanoscience is a rapidly expanding field affecting a number of areas of physics. The Council of the International Union of Pure and Applied Physics at its October, 2004 meeting therefore created a Working Group to examine the connections between Nanoscience and the various fields of physics. IUPAP provided limited funds for one face to face meeting. A final report of the working group was to be made at the General Assembly in South Africa in October, 2005 addressing the following objectives.

1) Examine how Nanoscience is fitting into established IUPAP sponsored conferences

2) Are there any steps that could be taken to improve the coupling between the cold atom and the core Nanoscience communities?

3) Address whether and how IUPAP can stimulate the development of Nanoscience. For example, would a conference sponsored by multiple IUPAP commissions devoted solely to Nanoscience be desirable?

II. Membership

The membership of the Working Group was to consist of one member representing each of the commissions listed in the table below.

Commission	Representative	Institution	Country
C3 Statistical Physics	H. Orland	CEA, Saclay	France
C5 Low Temperature Physics	M. Paalanen	Helsinki University of Technology	Finland
C6 Biological Physics	P. Ormos	Biological Research Centre, Szeged	Hungary
C8 Semiconductors	E. Gornik	Vienna Technical University	Austria
C9 Magnetism	M. Coey	Trinity College, Dublin	Ireland
C10 Condensed Matter	J. Dalibard	Ecole Normale Superieure, Paris	France
C15 Atomic, Molecular & Optical Physics	W. van Wijngaarden (Chair)	York University, Toronto	Canada
C17 Quantum Electronics	R. Slusher	Bell Labs, N.J.	USA
C20 Computational Physics	R. Nieminen	Helsinki Technical University	Finland
IUPAP President	Y. Petroff (Ex officio)	ESRF, Grenoble	France

III. Deliberations

The Working Group met at École Normale Superieure in Paris, France during April 15-16, 2005. All members were able to attend except the representative of the Semiconductor Commission. Each member gave a presentation of the major Nanoscience activity in their commission and described how this research was featured at recent IUPAP sponsored meetings (See Appendices 1-8). These presentations, contained as appendices in this report, clearly show substantial ongoing Nanoscience research in each of the Commission areas which is highlighted at existing IUPAP conferences.

1) What is Nanoscience?

The group spent some time discussing how to define Nanoscience. Members were cognizant that this is no easy task but felt this would be useful in guiding IUPAP efforts in promoting this field. The obvious answer is that Nanoscience refers to the study of physical quantities/processes occurring on scales less than a few hundred nanometers. The difficulty with this definition is that it includes physics at very small distance scales. Everyone agreed that nuclear and high energy physics were not considered part of Nanoscience. Similarly, atomic physics dealing with relatively simple systems such as hydrogenic atoms was excluded. Hence, complexity/structure as well as size of less than a few hundred nanometers is an important criterion in any definition of Nanoscience.

It was concluded that beyond the above observations, it would be very difficult to make a formal written definition of Nanoscience. Moreover, the usefulness of any rigorous definition would be unlikely to facilitate research developments nor be adhered to by scientists.

2) Nanoscience/Nanotechnology

It was noted that there are existing very large meetings that focus on technological applications of Nanoscience. Members unanimously felt that it would not be productive organizing any meeting that would compete or significantly overlap with existing meetings. It was also felt that a meeting organized under IUPAP auspices should focus on the science rather than applications. A smaller meeting would also facilitate the transfer of information among physicists representing different commissions.

3) Benefit of Improved Synergy among IUPAP Commissions to Nanoscience

Nanoscience is becoming an increasingly important area of research in each commission. Understanding how quantum mechanics affects such nanosized systems is a common theme whether it be molecules, ultracold atoms or semiconductor devices. The members of the Working Group noted a number of "hot topic" research areas that straddled the boundaries of their respective commissions. For example, the increasing understanding of DNA and other biological important molecules involve researchers from Statistical Physics (C3), Biological Physics (C6), Atomic, Molecular and Optical Physics (C15), Quantum Electronics (C17) and Computational Physics (C20). A second example is the rapid developments in the field of ultracold degenerate matter which involve researchers from Statistical Physics (C3), Low Temperature Physics (C5),

Condensed Matter (C10), Atomic, Molecular & Optical Physics (C15) and Quantum Electronics (C17).

Unfortunately, physicists primarily attend only the conferences sponsored by their commission which limits their exposure to a broad research perspective. This can act as an impediment to advances in a field such as Nanoscience. An IUPAP intercommission sponsored conference certainly would bring together researchers from various communities and provide an ideal forum for cross fertilization of research. A small meeting of around 100 participants as opposed to a thousand is essential as it avoids the separation of attendees into little islands of their closest research acquaintances.

4) Priority of Possible Nanoscience Meeting Topics:

The representatives of the commissions unanimously agreed on the following rankings for possible meeting topics. It was felt that the first meeting should clearly be within the generally understood confines of Nanoscience i.e. physics of things smaller than a few hundred nanometers. Nanobioscience is clearly in the purview of Nanoscience whereas Quantum Degenerate Matter (ultracold bosons/fermions) although of great scientific interest to a number of commissions is less clearly so. This along with other topics such as Nanoscale Transport may be appropriate for consideration of a later IUPAP sponsored Nanoscience meeting. The various commissions involved in these meetings are listed below. A star designates the commission that would take leadership of organizing the meeting.

i. Nanobioscience

a. C3 Statistical Physics
b. *C6 Biological Physics
c. C9 Magnetism
d. C15 Atomic, Molecular & Optical Physics
e. C17 Quantum Electronics
f. C20 Computational Physics

ii. Quantum Degenerate Matter

a. C3 Statistical Physics
b. C5 Low Temperature Physics
c. C10 Condensed Matter
d. *C15 Atomic, Molecular & Optical Physics
e. C17 Quantum Electronics
f. C20 Computational Physics

iii. Nanoscale Transport

a. C3 Statistical Physics
b. C5 Low Temperature Physics
c. C6 Biological Physics
d. C8 Semiconductors
e. *C9 Magnetism
f. C10 Condensed Matter
g. C20 Computational Physics

IV. Recommendations

The Working Group unanimously recommends the following.

i) A conference narrowly focused on one area of Nanoscience would be useful to improve the synergy between researchers in the various commissions. Meetings could be held every 2 years on a different frontier area of Nanoscience.

ii) The first meeting would be on the topic of Nanobioscience. Future conference topics would be reviewed after each meeting to respond to exciting research developments.

iii) Meetings should be small limited to between 75 and 150 people to facilitate interaction between scientists having different research backgrounds.

iv) Given the importance of Nanoscience, we recommend that IUPAP allocate $10,000 for the initial conference.

V. Nanobioscience Meeting

P. Ormos of C6, Biological Physics has kindly agreed to chair and host this meeting. The proposed details are as follows.

Location: Biological Research Centre, Szeged, Hungary

Date: Sept. 3-7, 2006

Estimated Attendance: 75 to 100 people,

Number of Talks: 35-40 lectures with half invited talks.

Tentative Membership of Organizing/Program Committee

Commission	Name	Institution
C3 Statistical Physics	H. Orland	CEA Saclay, France
C6 Biological Physics	P. Ormos (Chair)	Biological Research Centre, Szeged, Hungary
C6: Biological Physics	G. Nienhaus	Ulm, Germany
C9 Magnetism	M. Coey	Trinity College, Dublin, Ireland
C15 Atomic, Molecular & Optical Physics	C. Cisneros-Gudino	Universidad Cuernavaca, Mexico
C17 Quantum Electronics	R. Slusher	Bell Labs, USA
C20 Computational Physics	R. Nieminen	Helsinki Technical University, Finland

Tentative Invited Speakers

The following individuals have expressed interest in attending the Nanobioscience meeting.

Invited Speaker	Institution	Area of Expertise
Robert Austin	Princeton, USA	Biology with Nanostructures
D. Baker	U. Washington, Seattle, USA	Protein folding (predictions)
David Bensimon	Paris, France	DNA protein interaction
Carlos Bustamante	Berkeley, USA	Optical Tweezers
W. Eaton	National Institute of Health, USA	Single molecule protein folding
Eytan Domany	Weizmann Institute Israel	DNA and antigene chips
Michael Elbaum	Weizmann Institute Israel	Biomaterials, biomechanics
Herman Gaub	Munich, Germany	Force spectroscopy of single molecules
Joe Howared	Dresden, Germany	Motor dynamics
Christopher Jarzynski	Los Alamos, USA	Single molecule thermodynamics
Kazuhito Kinoshita	Waseda, Japan	Molecular machines
Cecile Leduc	Institut Curie Paris, France	Tubular Transport in Biomimetic Systems
Gerd Nienhaus	Ulm, Germany	Single molecule dynamics
Owe Orwar	Chalmers, Sweden	Nanochannel networks
Eva Pebay-Peyroula	JP Ebel Institute for Structural Biology Grenoble, France	Structural Proteomics
Jacques Prost	Institut Curie Paris, France	Molecular machines
Petra Schwille	Technische Universität Dresden, Germany	Single Molecule Fluorescence Methods for Cell Biology
Andrew Turberfield	Oxford, UK	DNA structures/photonic crystals
A. Zee	Univ. Calif., Santa Barbara, USA	RNA folding