

## Physical and Engineering Sciences (PESC)

# Highlights 2008

## Editorial

The number and quality of scientific programmes and collaborations achieved under the PESC umbrella has steadily increased in the last years. This is a very rewarding observation: it could have been feared indeed that the launching of the European Research Council (ERC) and its grant programmes would have led to a decreased interest of the scientific community in ESF's "traditional" instruments. Quite the contrary is now observed! As ERC will lead to more competition among European science and scientists, the need for cooperation and structuring is growing stronger than ever. This confirms the role of ESF, and PESC, and gives rise to greater confidence in the coherence and usefulness of the ESF's strategy and its instruments.

We wish to draw attention to some new strategic initiatives PESC explored last year. They show how PESC and ESF respond to, and shape, a changing European landscape for scientific cooperation.

First, PESC pioneered a new topic for collaborative research, "bio-inspired engineering": how understanding nature can lead to new materials and functions or to the design of new algorithms. Together with LESC (Life, Earth and Environmental Sciences Committee of the ESF) and the US National Science Foundation (NSF) an exploratory workshop was organised last June. National funding organisations were informed and integrated in the process at the PESC Core Group Round Table with Member Organisations. Already by September scientists involved presented a full-scale proposal for a European Collaborative Research (EUROCORES) programme, EuroBioSAS. Originally, this proposal was identified by ESF and national funding agencies as the pilot case to develop a new programme scheme, TOPCORES (Topical EUROCORES). Compared to EUROCORES, TOPCORES would be monitored more closely by the ESF and national funding agencies to accelerate and define more accurately the research activities.

At its October meeting the ESF Governing Council decided to develop EuroBioSAS in the tried and trusted EUROCORES scheme rather than to further the TOPCORES scheme. This is the fastest track for the programme and we look forward to launching EuroBioSAS next year. Nonetheless, PESC and LESC have broken new ground and the discussion of the TOPCORES scheme will continue.

PESC also led initiatives to establish two new temporary expert committees: Materials Sciences and Engineering (MS&E), and Computational Sci-

ences (CS). These two very interdisciplinary domains contribute to several fields in PESC's remit. As the strategic role of PESC becomes more important the full Standing Committee looks forward to engaging with dedicated scientists in these panels. These panels will have clear and time-limited missions. The goals are to develop a long-range outlook and to provide scientific advice in the fields of MS&E and CS to PESC and to Member Organisations. The MS&E committee will support PESC to provide a platform for materials science in activities that have great societal influence, like energy and the environment, or the use of Research Facilities.

The need for the second committee, CS, was identified in a Forward Look exercise: computational sciences (to be distinguished from computer sciences) have modified the way in which research is performed in many different fields of modern natural sciences. Coordinated advice on research and funding at the European level will provide national policy makers with the necessary information to structure and fund research in CS.

Both committees will operate under the strategic authority, and reviewing by, ESF standing committees.

It is clear that PESC and ESF are very healthy and lively institutions. It is therefore with pride and confidence that the current Chair hands over to the new Chair, Mats Gyllenberg, at the end of the year!

### Michel Mareschal

Chair 2002-2008 of the Standing Committee for the Physical and Engineering Sciences – PESC

### Patrick Bressler

Head of Unit, Physical and Engineering Sciences  
European Science Foundation

Highlights is an annual PESC publication that illustrates selected initiatives and activities of the past year. The briefs and stories focus on the science behind the activities. They are intended to give a picture of the independent scientific work promoted by the ESF Standing Committee for Physical and Engineering Sciences (PESC).

PESC's remit ranges from chemistry, mathematics, informatics and the computer sciences, to physics, fundamental engineering sciences, and materials sciences.

## Highlight

### Bio-inspired Engineering of Sensors, Actuators and Systems (EuroBioSAS)

This initiative has emerged following joint activities between the ESF and the US National Science Foundation (NSF) within the networking activities of “Smart Structural Systems Technology – S3T”, currently an ongoing European Collaborative Research (EUROCORES) Programme, and the Research Networking Programme “Innovative Control Technologies for Vibration Sensitive Civil Engineering Structure – CONVIB”, that terminated in 2005.

In June 2008 ESF/NSF held a US-Europe Workshop on “BioSensing and BioActuation: Interface between living and engineered systems”. At the workshop a clear consensus emerged in support of developing a new programme on this topic – see [www.esf.org/bioinspired-sens-and-act](http://www.esf.org/bioinspired-sens-and-act).

Just after the workshop, PESC held its annual Round Table meeting with representatives from ESF Member Organisations. The meeting was attended by representatives of 15 agencies from 14 countries in Europe. The primary conclusion from the meeting was that ESF should further explore how to establish a EUROCORES programme on “Biologically Inspired Engineering for Sensors and Actuators”.

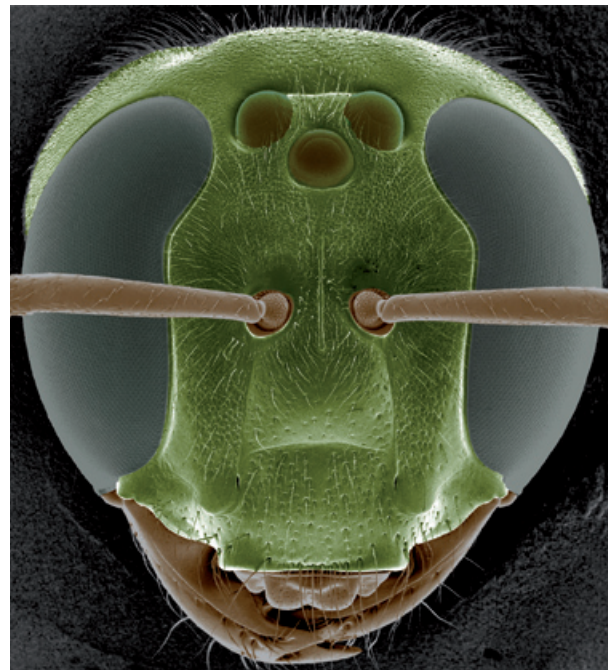
A consortium of scientists led by Dr. Graham Taylor (Oxford University, UK), proposer of the European initiative and European Co-Chair of the workshop held in June, subsequently submitted a proposal “Bio-inspired Engineering of Sensors, Actuators and Systems (EuroBioSAS)” in early September 2008. The proposal aims to develop a pan-European, and potentially US-European, collaborative research programme. The NSF’s Engineering Directorate has recently announced a 12M\$ research-funding programme under their *Emerging Frontiers in Research and Innovation (EFRI)* initiative, entitled “BioSensing and BioActuation: Interface of Living and Engineering Systems”.

The EuroBioSAS proposal exploits a unique collaborative opportunity that is not only scientifically timely, but also of great strategic relevance to Europe. Bio-inspired Engineering is fast emerging as a key European research strength.



The hawk moth (*Deilephila elpenor*) hovers in front of flowers and sucks nectar on the wing, a visually-steered behaviour in starlight (picture: the moth hovering in front of a flower). These moths were also the first nocturnal animals demonstrated to possess colour vision at night, previously thought impossible in dim light.

Courtesy of M. Pfaff, Lund University (Department of Cell and Organism Biology), Sweden



The bee (*Megalothea genalis*) lives in dense tropical rainforests in Central America and flies from its nest in search of pollen and nectar at extremely low light levels, and then uses learned visual landmarks to find its way home again to its nest (picture of the eyes).

Courtesy of E. Warrant, Lund University, Sweden

## EUROCORES

The aim of the European Collaborative Research (EUROCORES) Scheme is to enable researchers in different European countries to develop collaboration and scientific synergy in areas where European scale and scope are required to reach the critical mass necessary for top-class science in a global context. The scheme provides a flexible framework which allows national basic research-funding and -performing organisations to join forces to support excellent European research in and across all scientific areas.

Until the end of 2008, scientific coordination and networking is funded through the EC FP6 Programme, under contract no. ERAS-CT-2003-980409. As of 2009, the national funding organisations will provide the funding for the scientific coordination and networking in addition to the research funding.

- **Cold Quantum Matter – EuroQUAM**  
Research and Networking phase  
See [www.esf.org/euroquam](http://www.esf.org/euroquam)
- **Friction and Adhesion in Nanomechanical Systems – FANAS**  
Research and Networking phase  
See [www.esf.org/fanas](http://www.esf.org/fanas)
- **Fundamentals of NanoElectronics – FoNE**  
Research and Networking phase  
See [www.esf.org/fone](http://www.esf.org/fone)
- **Quantum Standards and Metrology – EuroQUASAR**  
Research and Networking phase  
See [www.esf.org/euroquasar](http://www.esf.org/euroquasar)
- **Self-Organised NanoStructures – SONS 2**  
Research and Networking phase  
See [www.esf.org/sons2](http://www.esf.org/sons2)
- **Smart Structural Systems Technologies – S3T**  
Research and Networking phase  
See [www.esf.org/s3t](http://www.esf.org/s3t)

### Highlight

#### European Quantum Standards and Metrology (EuroQUASAR) Molecule Interferometry and Metrology (MIME)

The research team of Professor Markus Arndt of the University of Vienna, project leader of “Molecule Interferometry and Metrology (MIME)”, a Collaborative Research Project within the EuroQUASAR EUROCORES, was featured on the cover page of the prestigious chemistry journal *Angewandte Chemie (Angew. Chem. Int. Ed.* 2008, 47, 6195-6198).

Professor Arndt’s international team is focusing on the development of new methods for quantum interferometry. MIME aims to explore new applications that can investigate the properties of matter and answer questions about the interface between quantum physics and physical chemistry. This task requires the contribution of experts from complementary scientific disciplines which MIME brings together, namely, quantum experimentalists, quantum theorists, chemists and experts in nanotechnology.



### Highlight

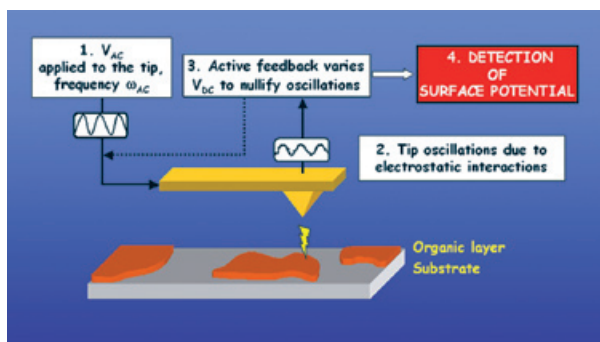
#### Fundamentals of NanoElectronics (FoNE)

The first FoNE Conference was held from 29 June to 3 July 2008 in Taormina, Italy. It brought together more than 60 scientists from the five different Collaborative Research Projects forming FoNE. Keynote talks were given by Professors J. Bird, R. Allenspach, R. Haug, G. Meier, and J. Appenzeller. The latter gave a talk on “Nanoelectronics – Why 1D offers unique opportunities to reduce power consumption”. In his talk he explained how carbon nanotubes (CNTs) can be used as Schottky barrier field-effect transistors but also how they are suited to operate in the so-called quantum capacitance limit (CQL). By combining both characteristics, CNTs can be used to reduce power consumption. This is one of the major results obtained for the future of nano-electronics.



### Highlight

#### Self-Organised NanoStructures (SONS 2) Kelvin Probe Force Microscopy (KPFM) – a new technique developed in SONS 2



Schematic representation of KPFM.  $V_{AC}$ : alternating-current voltage;  $V_{DC}$ : direct-current voltage;  $\omega_{AC}$ : alternating-current frequency;  $h$ : tip-sample distance.

“SUPRAMolecular Materials for new functional Structures (SUPRAMATES)” have developed a new technique based on a powerful type of microscopy to analyse materials and map their electrical properties at the nanoscale. The new technique, which uses Kelvin Probe Force Microscopy (KPFM), is an extension of atomic force microscopy, is 1000 times more powerful than an optical microscope, and can be used to study organic photovoltaic materials and plastic solar cells. The new technique could significantly cut the costs of renewable solar energy and make it commercially viable.



### Highlight

#### Cold Quantum Matter (EuroQUAM)

The Inaugural Conference of EuroQUAM took place in Barcelona in April 2008. The conference was attended by 122 participants, of which 110 were members of EuroQUAM. Keynote speakers from Australia, Canada and the United States addressed the conference. Following their participation in this conference the wish was expressed that active steps be taken to establish high-level contacts and collaborative links between EuroQUAM and similar structures beyond Europe.

In July EuroQUAM organised a session at the EURO-SCIENCE Open Forum (ESOF) 2008 entitled “The Amazing

World of Ultracold Matter”. This session was extremely well received and was considered one of the highlights of the event itself.

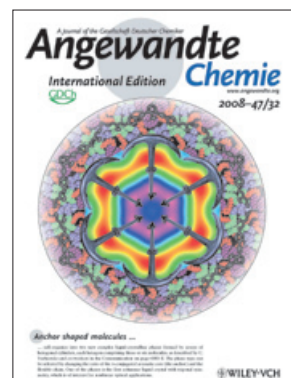
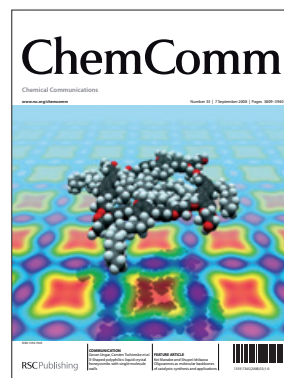
In addition, three of EuroQUAM's Principal Investigators gave lectures on: “Cold Atoms Keeping (and Revealing) Quantum Secrets”, “Cold Atom Clocks and Quantum Rulers”, and “Do we understand absolute zero?”

### Highlight

#### Self-Organised NanoStructures (SONS 2) Honeycomb Liquid Crystals with single-molecule walls discovered

The groups of Carsten Tschierske (Halle, Germany) and Goran Ungar (Sheffield, UK) from the SONS 2 Collaborative Research Project “Complexity across lengthscales in soft matter (SCALES)” have generated liquid crystalline (LC) phases made of honeycomb arrays of polygonal cylinders with single-molecule walls. To make these structures they have synthesised three series of compounds containing four flexible chains, attached to a rigid core of bolaamphiphiles whose lateral chains were changed, from being identical alkyl chains, to different alkyl chains and also to semiperfluorinated. This allowed the LC phases to be changed from monotropic (metastable) for molecules with very short alkyl chains to cylinder and hexagonal columnar phase for molecules having semiperfluorinated chains. This is the first example reported in the literature of molecules capable of forming LC phases built up by single molecule wall polygonal honeycomb lattices.

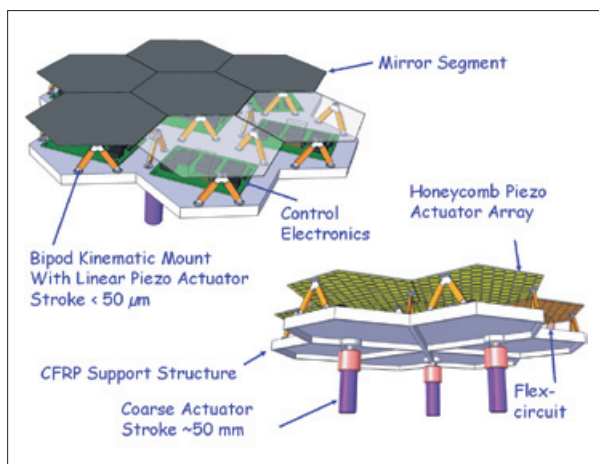
These results were covered in *Chem. Comm.*, issue 33, 2008, and in *Angewandte Chemie, Int. Ed.* Volume 47, issue 32, 2008.



### Highlight

#### Smart Structural Systems Technologies (S3T) Shape Control of Membrane Reflectors (SCMeRe)

The Collaborative Research Project “Shape Control of Membrane Reflectors (SCMeRe)” deals with future space telescopes consisting of extremely large and lightweight membranes. This future technology poses challenges in terms of shape control strategies, active materials, structural stability, optical metrology and multi-physics simulation. The capability for wavefront correction offered by bimorph deformable mirrors produced by screen-



Modular assembly of segmented deformable mirrors for performing high-order adaptive optics  
Courtesy of Active Structures Laboratory, Université Libre de Bruxelles

printing of piezoelectric pastes on silicon substrates has already been demonstrated. The modular assembly of a set of such mirrors has been proposed for compensating the turbulence in the astronomical observations of future earth-borne Extremely Large Telescopes and was presented to the SPIE conference on Astronomical Instrumentation, held in Marseille, France, in June. This new approach promises to reduce cost, weight and control effort in terms of orders of magnitude when compared to state-of-the-art wavefront correction technologies. The activity will proceed with the development of methodologies for co-phasing the different segments in the aspects of gap metrology and fine actuation. Many of the concepts developed for this new approach of earth-borne adaptive optics can be directly applied to space telescopes.

### Highlight

#### Self-Organised NanoStructures (SONS 2) Self-Assembled Nanoscale Magnetic Networks (SANMAG)

Storing increasing amounts of data on increasingly small spaces is one of the prerequisites for further progress in information technology. A magnetic effect, which makes magnetic switches and logic elements conceivable on an atomic scale, has been discovered by theoretical scientists from the Research Centre of Jülich in Germany. The results of their computer simulations mean that nanowires made of transition metals could be suitable for transporting and storing magnetic information.

Lounis, Dederichs and Blügel discovered a kind of domino effect in rows of individual manganese atoms on a nickel surface. They noticed that the magnetic configuration of these nanowires differed depending on their length. Astonishingly, only one atom more or one less makes a drastic difference. When the number of atoms is odd, the orientation of the magnetic moments is antiparallel, and when the number is even, they line up in a toppled compromise position between parallel and antiparallel. Adding an atom at the end of the nanowire or taking one away simultaneously changes the magnetic configuration of the

entire cluster. Just like a row of dominoes, the magnetic moments topple over. However, this is where the analogy ends because the effect can be completely reversed in contrast to dominoes that have toppled over.

This new quantum mechanical effect, which holds for long stretches of at least 100 atoms, has been discovered using a refined version of density functional theory. The authors hope that it will be proven experimentally in the near future.

These results made the cover article in *Phys. Rev. Lett.*, 101, 107204, 2008.



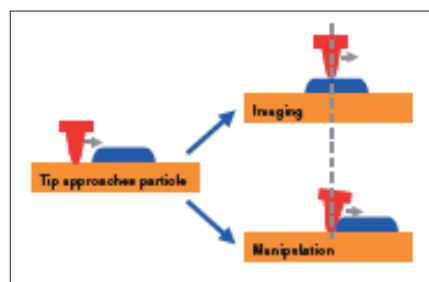
### Highlight

#### Friction and Adhesion in Nanomechanical Systems (FANAS)

#### Nanoparticle Manipulation with Atomic Force Microscopy Techniques (NANOPARMA)

The research groups of Professor A. Schirmeisen and Professor U. Schwarz of the Collaborative Research Project “Nanoparticle Manipulation with Atomic Force Microscopy Techniques (NANOPARMA)” have discovered dual behaviour when trying to push antimony islands on graphite with an AFM tip. They observed ‘superlubricity’ behaviour next to ordinary friction. The results of this research allow for a better understanding of the origin of friction.

The research has been published in *Phys. Rev. Lett.*, 101, 125505 (2008) and has been highlighted by *Physical Review Focus*.



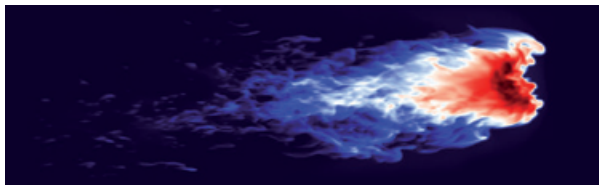
Scheme of particle manipulation experiments.

## Research Networking Programmes (RNP)

Currently, 27 RNPs are active with a further seven under consideration.  
For a complete list see [www.esf.org/pesc/programmes](http://www.esf.org/pesc/programmes)

### Highlight

#### Computational Astrophysics and Cosmology (AstroSim) 2006-2011 Building our Universe inside a Supercomputer

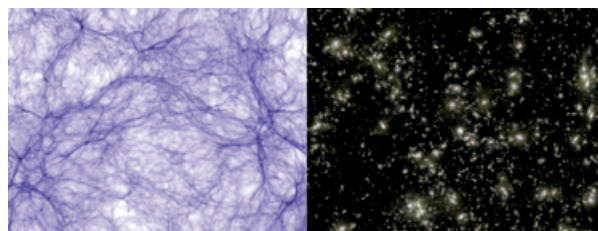


Simulation of a gas cloud moving through a low density medium.  
Courtesy of O. Agertz, Institute for Theoretical Physics, University of Zurich

The AstroSim programme originated from a gathering of the world's foremost computational astrophysicists at an ESF Exploratory Workshop. A small supercomputer was carried to a remote mountain hotel where the participants spent four days and nights testing, comparing and critically discussing the ability of standard techniques to follow fluid dynamics. Of the two standard techniques, SPH and GRID-based methods, it was found that only the latter could follow turbulence and multiphase fluid flow as shown in the simulation above of a gas cloud being disrupted as it falls onto a Galaxy. AstroSim now provides support for a dedicated code comparison website which can be used by any interested scientist to host a code test site for the community to try and discuss ([www.astrosim.net](http://www.astrosim.net)).

Earlier this year, AstroSim funded the first international conference devoted to computational astrophysics (<http://www.astrosim.net/ascona2008/>). Over 130 experts attended and discussed all aspects of the subject, from how stars form to the best techniques for parallelising codes for the next generation of supercomputers. Coherent support from AstroSim is essential to prepare algorithms and techniques for the next generation of petaflop supercomputers that will be available for research in the next few years. Some of the key questions that it is hoped to help answer with these machines are: How did the sun and solar system form? What is the nature of dark matter and dark energy? How do galaxies form and evolve?

AstroSim provides critical support for the development of simulation codes and for the analysis and visualisation of simulation data. The picture below shows the results of the world's largest astrophysics simulation carried out by Professor Romain Teyssier, CEA Saclay, using his parallel adaptive mesh code RAMSES on 6000 processors for several months. This calculation would have taken a thousand years on a single fast workstation! The left-hand panel shows the large-scale distribution of matter in the Universe, calculated by following 70 billion dark matter and gas particles, shown here when the Universe was just 10% of its current age. The right-hand panel shows



World's largest astrophysical simulation of matter distribution in the universe. (See text for description).

Courtesy of R. Teyssier, CEA Saclay, Paris and Institute for Theoretical Physics, University of Zurich

the galaxies that form by the present day in the simulation volume – a spectacular achievement, one that requires resolving a vast range of scales, gravitational clustering and the complex physics of the baryonic component that occurs during galaxy formation.

### Highlight

#### Ultrafast Structural Dynamics in Physics, Chemistry, Biology and Material Science (DYNA) 2005-2010

XVI<sup>th</sup> International Conference on Ultrafast Phenomena  
9-13 June 2008, Stresa (Lago Maggiore), Italy  
[www.ultraphenomena.org](http://www.ultraphenomena.org)

The "Ultrafast Phenomena" conferences, held every two years, are widely recognised as the premier international fora for the discussion of new work in ultrafast science and technology, a wide and rapidly-moving research field. The 2008 Ultrafast Phenomena Conference, the sixteenth in the series, was held in Stresa in June. A multidisciplinary group was brought together, sharing common interests in the generation of ultrashort pulses in the femtosecond and attosecond regimes and their applications to studies of ultrafast phenomena in physics, chemistry, material science, electronics, biology, engineering, and biomedicine. More than 370 papers were presented with an attendance exceeding 430 people: these numbers represent a record for this conference. A book of proceedings, edited by Springer in the Series "Chemical Physics", will contain all the papers presented at the meeting and it will constitute a reference for those working in this field and for those approaching it.

Major highlights at the conference:

- Significant progress in creating ever shorter pulses of light, now extending below 100 attoseconds;
- Femtosecond laser frequency comb and generation of octave-spanning Raman comb with absolute-phase control;
- Ultrafast coherent X-ray diffractive imaging with the Free-Electron Laser;
- Multidimensional spectroscopy rapidly evolving to provide new insights into quantum coherence and interactions in complex systems, also using pulse shaping, and applications to molecular monolayers;
- Dramatic advances in time-resolved electron and x-ray diffraction and spectroscopy towards detailed information on atomic and electronic structural dynamic in molecular systems and crystalline solids;
- Ultrafast energy transfer and primary processes in photosynthesis and related applications in biology.



## Exploratory Workshops

15 workshops in 2008.

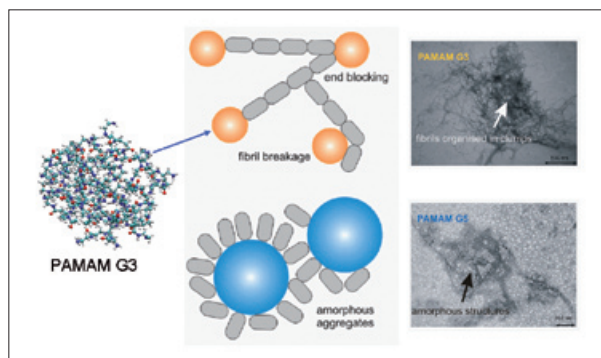
For a complete list see [www.esf.org/pesc/workshops](http://www.esf.org/pesc/workshops)

### Highlight

#### ESF Exploratory Workshop “Hyperbranched polymers as novel materials for nanoscale applications: insight from experiment, theory and simulations (HYPER-NANO)”

26-28 May 2008, Fodele, Crete, Greece

This workshop was convened by Konstantinos Karatasos (Department of Chemical Engineering, Aristotle University of Thessaloniki, Greece) and Alexey Lyulin (Department of Applied Physics, Eindhoven University of Technology and Dutch Polymer Institute, Netherlands) under the auspices of the European Polymer Federation and co-sponsored by the Dutch Polymer Institute, the Greek Ministry of Education and Religious Affairs and by the Center for Research and Technology – Hellas.



Mechanisms of inhibiting amyloidogenesis by Poly(amidoamine) dendrimers of the 3<sup>rd</sup> (G3) and 5<sup>th</sup> (G5) generations.

Amyloidogenesis and fibril formation is responsible for the prion and Alzheimer's disease.

Schematics and photos courtesy of B. Klajnert, Department of General Biophysics, University of Lodz, Poland

Hyperbranched molecules are polymer materials which lately have been the object of growing scientific and technological interest in a wide range of fields from synthetic organic chemistry to clinical medicine. At this ESF Exploratory Workshop issues related to synthesis, characterisation and the structure-properties relation of hyperbranched systems, particularly in the framework of current as well as potential applications in nanotechnology, were discussed. The area of expertise of the participants (physicists, chemists, biologists, chemical engineers, materials scientists) covered theory, experiment and simulations in the field of hyperbranched polymers and polymeric supramolecular compounds. This allowed a rounded view of the forefront of the research performed in this topic, promoting at the same time contacts between scientists of diverse backgrounds that are active in the field. Particular emphasis at the workshop was given to the following topics:

- New hyperbranched materials: controlled synthesis and characterisation;
- Role of topology and microstructural details to physical properties;

- Recent developments in the theoretical description and simulational models for hyperbranched systems;
- Novel applications of HB molecules: problems and perspectives.

The scientific discussions that took place proved particularly beneficial, allowing a closer interaction between the participants. During these discussions two consortia were formed for a common submission of an ESF COST proposal “*Dendrimers in Biomedical Applications*” and for an FP7 proposal under the PEOPLE-ITN-2008 call, “*Separation of branched polymers*”.

## Other Initiatives

### Women in Science Meeting

In the frame of an ongoing collaboration between the European Materials Research Society (E-MRS) and the ESF, a “Women in Science” meeting was organised on 26 May during the EMRS Spring meeting.

The speakers at this event, entitled “Reaching the top: issues and challenges”, were:

- Professor Marja Makarow, Chief Executive, ESF
- Professor Cynthia Volkert, President, MRS
- Professor Mildred Dresslehaus, Professor, MIT
- Dr. Caroline Petigny, Manager, BASF.



### PESC/E-MRS/EMF joint actions continued

After last year's first World Materials Summit on Energy and Transport in Lisbon, PESC, the European Materials Research Society (E-MRS) and the European Materials Forum (EMF) will continue their joint actions in partnership with the Chinese MRS at a second summit to take place in Shanghai on 13-15 October 2009.

At this year's E-MRS Fall meeting in Warsaw in September, the PESC Head of Unit, P. Bressler presented the results of the PESC/E-MRS/EMF study on “Entrepreneurship Training in Europe for Scientists and Engineers”. This case study investigated different training models and common development schemes across Europe to teach entrepreneurial techniques and support technology start-ups.

This study is part of the ComplexEIT project funded by the European Commission as a one of the four prefiguration projects for a future European Institute of Innovation and Technology (EIT). ComplexEIT is a pilot programme dedicated to defining innovative governance and organisation models for the European Institute of Innovation and Technology (EIT) and its Knowledge and Innovation Communities (KIC) based on complex systems from the nano- to macroscale.

The overall goals of the ComplexEIT project are:

- The identification of best practices and the proposal of a multifaceted and multilevel governance model for an EIT;
- The test and evaluation of this model in the development of interregional collaboration;
- The dissemination of the results to the European innovation community.

## A Selection of Press Releases

### Europe rallies behind nanotechnology to wean world from fossil fuels

Nanotechnologies can be used to develop sustainable energy systems while reducing the harmful effects of fossil fuels as they are gradually phased out over the next century. This optimistic scenario is coming closer to reality as new technologies such as biomimetics and Dye Sensitised solar Cells (DSCs) emerge with great promise for capturing or storing solar energy, and nanocatalysis develops efficient catalysts for energy-saving industrial processes. Europe is ready to accelerate development of these technologies, as delegates heard at a conference, “Nanotechnology for Sustainable Energy”, organised by the European Science Foundation in partnership with Fonds zur Förderung der wissenschaftlichen Forschung in Österreich (FWF) and the Leopold-Franzens-Universität Innsbruck (LFUI). The Conference was held at the Universitätszentrum Obergurgl, near Innsbruck in Austria on 14-19 June 2008.

### European group aims to make maths teaching more rigorous and inspiring

An attempt to re-energise mathematics teaching in Europe is being made in a new project examining a range of factors thought to influence achievement. Mathematics teaching is as vital as ever both in support of key fields, such as life sciences, alternative energy development, or information technology, and also through its unique ability to develop widely applicable problem-solving skills. It should be highly relevant not just for the elite few but for all people in education.

The new project was discussed at a workshop “The Relevance of Mathematics Education”, organised by the European Science Foundation, which brought together experts in different areas of mathematics education. The workshop was held in Cambridge, UK on 7-10 January 2008.

### Europe, Japan join forces to map out the future of intelligent robots

The field of robotics could be poised for a breakthrough, leading to a new generation of intelligent machines capable of taking on multiple tasks and moving out of the factory into the home and general workplace. The great success of robots so far has been in automating repetitive tasks in process control and assembly, yielding dramatic cuts in production, but the next step towards cognition and more human-like behaviour has proved elusive. It has been difficult to make robots that can truly learn and adapt to unexpected situations in the way humans can, while it has been equally challenging trying to develop a machine capable of moving smoothly like any animal. There is still no robot capable of walking properly without jerky, slightly unbalanced movements.

But significant progress has been made over the last few years, and the stage was set for a push towards a new generation of intelligent machines at a conference bringing together young scientists in both Europe and Japan. The Frontier Science Conference for Young Researchers on “Experimental Cognitive Robotics”, jointly organised by the ESF and the Japan Society for the Promotion of Science (JSPS), was targeted at young researchers actively working in the fields of cognitive science and robotics and was held on 9-15 March 2008 in Kanagawa, Japan.

### Multitasking nanotechnology

Tiny electronically-active chemicals can be made to form ordered layers on a surface, thanks to research supported through the EUROCORES programme SONS 2 (Self-Organised NanoStructures).

These nanostructured layers may one day be used to build the components of electronics devices, such as transistors and switches, for a future generation of powerful computers based on molecules rather than silicon chips.



Confocal microscope image of a self-assembled monolayer of a polychlorotriphenyl methyl radical patterned on a quartz surface. This multifunctional molecule behaves as an electroactive switch with optical and magnetic response.

### Europe gets together to harness quantum physics

The long-cherished goal of applying the strange properties of quantum mechanics to the macroscopic world we inhabit has been brought closer by a series of recent developments. The exciting progress was made in the important field of quantum optics and discussed at a high-level conference organised by the European Science Foundation in collaboration with the Fonds zur Förderung der wissenschaftlichen Forschung in Österreich (FWF) and the Leopold-Franzens-Universität Innsbruck (LFUI).



The ESF-FWF Conference in Partnership with LFUI, on “Quantum Optics: From Photons and Atoms to Molecules and Solid State Systems”, was held in February 2008 at the Universitätszentrum Obergurgl, near Innsbruck, Austria.

### **Finding out what the big bang and ink jets have in common: ESF workshop tackles the mathematics of singularities**

It often turns out there is more to commonplace everyday events than meets the eye. The folding of paper, or fall of water droplets from a tap, are two such events, both of which involve the creation of singularities requiring sophisticated mathematical techniques to describe, analyse and predict. On the positive side, there is much in common between many such singular events across the whole range of scales, from microscopic interactions to the very formation of the universe itself during the Big Bang. In the past these seemingly unconnected events involving singularities have tended to be studied in isolation by different scientists with relatively little interaction or exchange of ideas between them.

A workshop, “Singularities in Mechanics: Description and Formation”, organised by the ESF in Paris on 21-25 January 2008, represented one of the first attempts to unify the field of singularities by bringing together experts in the different fields of application from astronomy to nanoscience, to develop common mathematical approaches.

### **Search in the “quantum haystack” rewarded: Innsbruck Physicists of the EUROCORES Programme EuroQUAM achieve breakthrough with fermionic quantum gasses**

Researchers at the Institute for Quantum Optics and Quantum Information (IQOQI) at the Austrian Academy of Sciences (ÖAW) have recently ventured into uncharted physics territory. The team of Professor Rudolf Grimm and Dr. Florian Schreck succeeded in finding so-called Feshbach resonances in a quantum gas mixture of two fermionic elements and, in cooperation with US and Dutch physicists, in characterising them. This feat opens up a new area for researching fundamental issues of quantum physics.

### **Europeans unite to tap early universe for secrets of fundamental physics**

The future of fundamental physics research lies in observing the early universe and developing models that explain the new data obtained. The availability of much higher resolution data from closer to the start of the universe is creating the potential for further significant theoretical breakthroughs and progress resolving some of the most difficult and intractable questions in physics. But this requires much more interaction between astronomical theory and observation, and in particular the development of a new breed of astronomer who understands both.

This was the key conclusion from an Exploratory Workshop organised by the European Science Foundation bringing together experts in cosmology, astrophysics and particle physics. The workshop, “Astrophysical Tests

of Fundamental Physics” was held on 26-30 March 2008 in Porto, Portugal.

**For the complete press releases see [www.esf.org/media-centre](http://www.esf.org/media-centre)**

## **Publications**



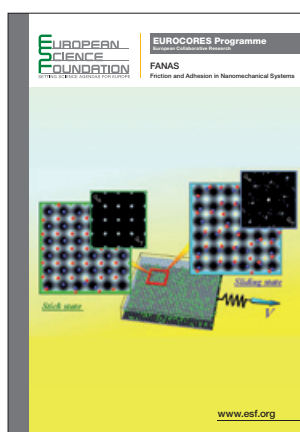
### **Smart Structural Systems Technologies (S3T)**

An ESF EUROCORES Programme



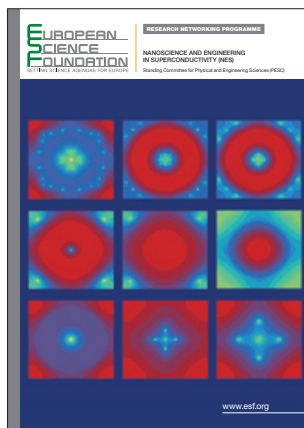
### **Cold Quantum Matter (EuroQUAM)**

An ESF EUROCORES Programme

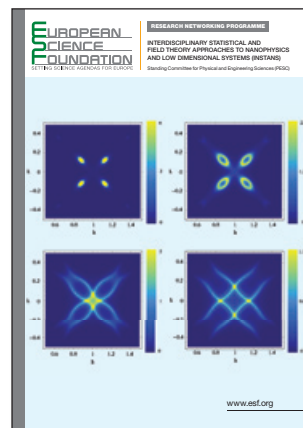


### **Friction and Adhesion in Nanomechanical Systems (FANAS)**

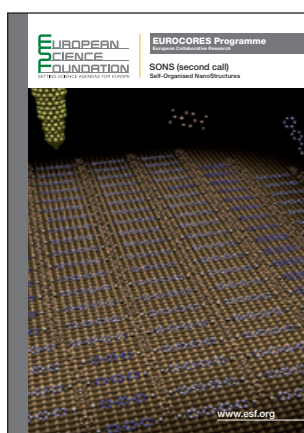
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**Nanoscience and Engineering in Superconductivity (NES)**  
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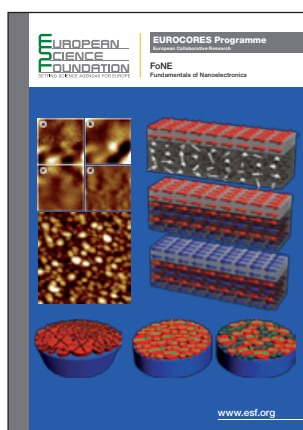
**Interdisciplinary Statistical and Field Theory Approaches to Nanophysics and Low Dimensional Systems (INSTANS)**  
An ESF Research Networking Programme



**Self-Organised NanoStructures (SONS second call)**  
An ESF EUROCORES Programme



**Harmonic and Complex Analysis and its Applications (HCAA)**  
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**Fundamentals of Nanoelectronics (FoNE)**  
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**Computational Astrophysics and Cosmology (AstroSim)**  
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All the PESC publications are downloadable from:  
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**Nomination pending**
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- **Eléonore Piémont**, Administrator – EUROCORES Coordination
- **Dr. Farzam Ranjbaran**, Science Officer – EUROCORES Coordination
- **Catherine Werner**, Senior Administrator – Research Networking Programmes



## Forthcoming Meetings

### December 2008

- As part of the “Pris au piège: pièges à particules” exhibition, showcasing of one of the experiments in the programme EuroQUAM  
“A magneto-optic trap to obtain a cloud of cold atoms”  
<http://www.palais-decouverte.fr/index.php?id=%20%20357>  
Palais de la découverte, Paris, France,  
7 October – 14 December 2008
- MINEMA: Workshop at Middleware 2008  
[www.esf.org/minema](http://www.esf.org/minema)  
Leuven, Belgium, 1-5 December 2008
- Self-Organised NanoStructures (SONS 2):  
Session during the MRS meeting, Boston, US,  
1-5 December 2008
- EuroQUASAR: Workshop on “Precision measurements with atoms, molecules and photons”  
Florence, Italy, 11-12 December 2008
- FoNE: Workshop on Spico-SPINTRA and SPINCURRENT  
Palermo, Sicily, Italy, 15-18 December 2008

### March 2009

- MINEMA: Winter School  
[www.esf.org/minema](http://www.esf.org/minema)  
Göteborg, Sweden, 23-27 March 2009
- INSTANS: School on Nonequilibrium Phenomena in Mesoscopic Physics  
[www.esf.org/instans](http://www.esf.org/instans)  
Capri, Italy, 30 March – 3 April 2009

### April 2009

- EuroQUAM: participating in the Faraday Discussion 142: Cold and Ultracold Molecules,  
<http://www.rsc.org/ConferencesAndEvents/RSCConferences/FD142/index.asp>  
Durham, United Kingdom, 15-17 April 2009

### Standing Committee Meetings 2009

- 17 April 2009
- 15-16 October 2009

### 2009 Round Table Meeting with Member Organisations

- 15-16 June 2009

**Highlights** is edited and published by the ESF-PESC Unit with contributions from scientists involved in PESC activities.

For more details of PESC activities see [www.esf.org/pesc](http://www.esf.org/pesc)

Feedback, inquiries or questions should be sent to [pesc@esf.org](mailto:pesc@esf.org)

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