europhysicsnews

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2000

activities special *some of the best projects of the european physical society outlined and explained*

magnetic fluids

activities

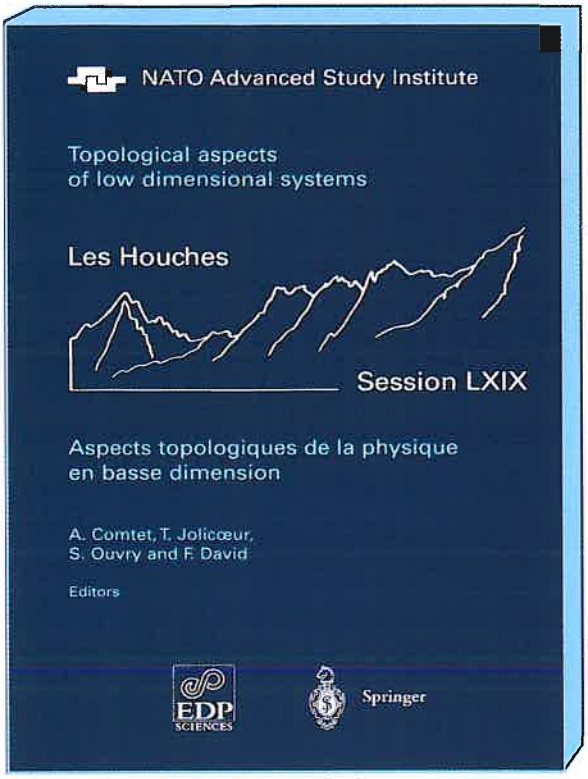
EUROPEAN PHYSICAL SOCIETY

EDP SCIENCES

Topological aspects of low dimensional systems

Les Houches summer school - Session LXIX

Scientific Editors: A. Comtet, F. David, T. Jolicœur and F. Ouvry



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The notions of fractional charge as well as fractional statistics can be interpreted by a topological interaction of infinite range. So it is natural to find in Les Houches series a school devoted to quantum Hall physics, intermediate statistics and Chern-Simons theory. This session also included some one-dimensional physics topics like the Calogero-Sutherland model and Luttinger-liquid physics.

Polymer physics is also related to topology. In this field, topological constraints may be described by concepts from knot theory and statistical physics. Hence this session also included Brownian motion theory related to knot theory.

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EDP SCIENCES

EDP Sciences

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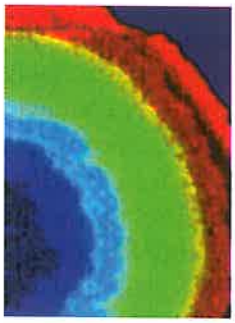

c o v e r

Convection in a magnetic fluid evolves in minutes in the same way the earth's mantle evolved in hundreds of millions of years *see page 5*

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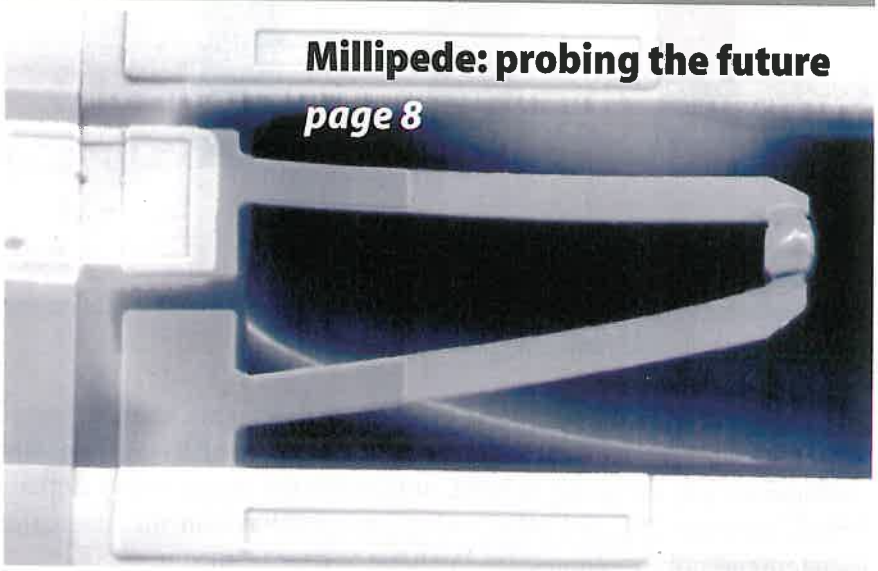

Millipede: probing the future
page 8

Europhysics News has changed publisher. EDP Sciences, a dynamic publisher of journals based in Paris, has taken over the production and will print and look for advertisements from now on. EDP, as they are known, is the journals offshoot of the French Physical Society—but has complete independence—and is expanding rapidly (you can see this for yourself as they publish a list of new acquisitions at their website www.edp-sciences.com). We took the opportunity to improve the look of the magazine—we are now full colour with new sections and new ideas. You will notice that there are now two members of staff working on the magazine (see first column on the contents page) which, let us say modestly, takes the magazine into a new era.

schedule

January/February	features issue
March/April	meetings issue
May/June	features issue
July/August	directory issue
September/October	meetings issue
November/December	features issue

We have tried to use colour to make finding things easier. The box on the right of pages should help navigation.

Don't forget this is still your magazine—much more a membership magazine than it is a money-making journal. You should send us details of any conferences you are going to hold, notices for the membership noticeboard (*see page 22*), and other comments you have on the magazine (t.chapman@univ-mulhouse.fr). We hope to hear from you. □

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Schedule
Six issues will be published in 2000. The magazine is distributed in the second week of January, March, May, July, September, November. Meetings issues are published every six months (in March and September) and a directory issue with listings of all EPS officials is published once a year (in July).

Subscriptions
Individual Ordinary Members of the European Physical Society receive *europhysics news* free of charge. Members of EPS National Member Societies receive *europhysics news* through their society, except members of the Institute of Physics in the United Kingdom and the German Physical Society who receive a bimonthly bulletin. The following are subscription prices available through EDP Sciences. **Institutions** 600 French francs or 91 euros (VAT included, European Union countries); 600 French francs or 91 euros (the rest of the world). **Individuals** 380 French francs or 58 euros (VAT included, European Union countries); 380 French francs or 58 euros (the rest of the world). Contact subscribers@edpsciences.com or visit www.epdsciences.com.

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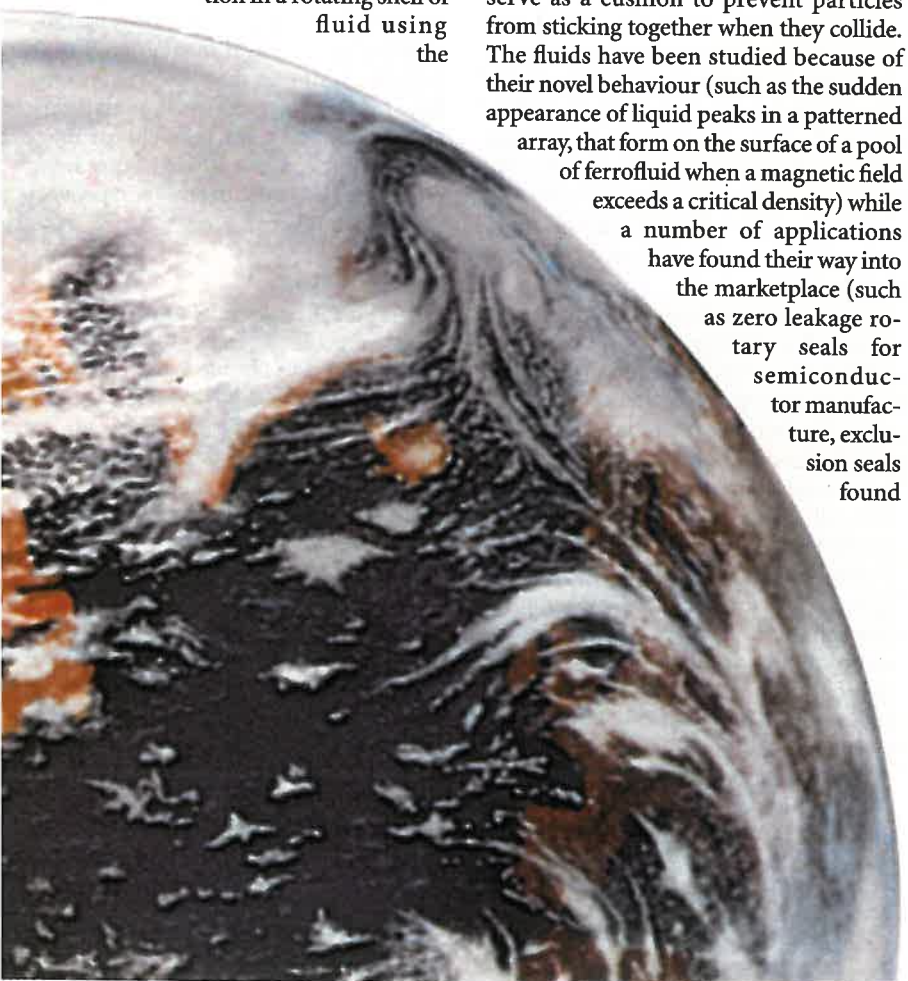
A myriad tiny magnets in fluid, trapped inside a glass ball, swirl and convect in a magnetic field mirroring the earth's liquid mantle

Magnetic Fluids: Modelling the Earth's Mantle in a Glass Ball

Ronald E. Rosensweig

In the earth's liquid mantle, thermal convection drives contifnental drift, recreating the shape of the ocean floor (as first made convincing by Alfred Wegener in 1912). In fact thermal convection is the major source of movement in the mantle, coupling the changing surface of the earth to the interior. The cross sectional sketch of the earth shown in *figure* 1 illustrates this. Because the gravitational field must be central it has previously not been possible to study mantle convection in a terrestrial laboratory. Experiments have been conducted on the space shuttle: convection in a rotating shell of fluid using the weak but central force field of an electrostatic source. But magnetic fluids offer an alternative, and the means to establish central body-force fields in the laboratory that greatly exceed the force of gravity.



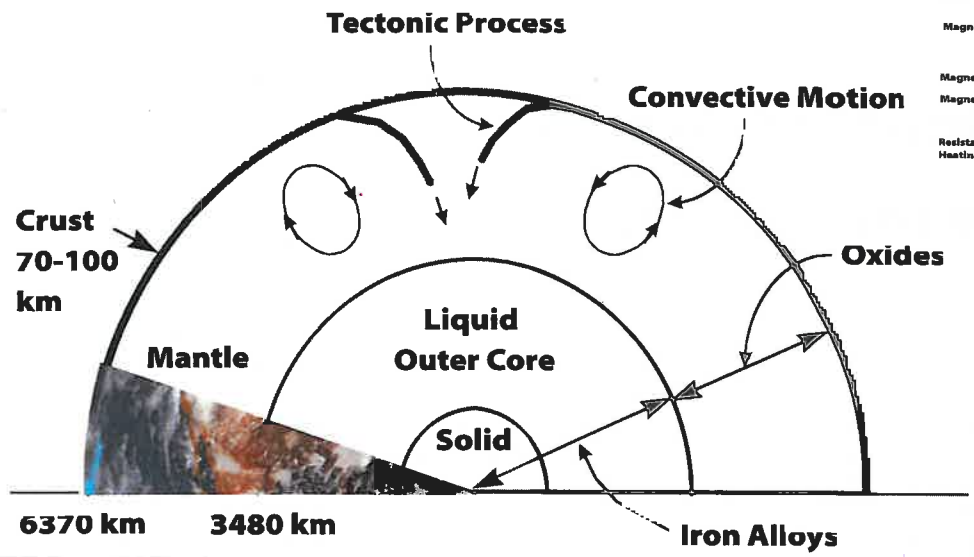
Magnetic fluids (also called ferrofluids) are colloidal dispersions of tiny magnetic particles (typically 10 nm across) in liquid carriers stabilized with one or two layers of surfactants or electrical charges on their surface. The small size of the particles gives thermal motion that prevents the particles from settling out in gravitational or magnetic fields, while the sorbed layers serve as a cushion to prevent particles from sticking together when they collide. The fluids have been studied because of their novel behaviour (such as the sudden appearance of liquid peaks in a patterned array, that form on the surface of a pool of ferrofluid when a magnetic field exceeds a critical density) while a number of applications have found their way into the marketplace (such as zero leakage rotary seals for semiconductor manufacture, exclusion seals found in nearly all computer hard disk drives, sink/float mineral separation processes, low run out hydrodynamic bearings used in laser printers to rotate scanning mirrors, and dampers for precision machinery such as stepper motors). The property of a magnetic fluid to retain its liquid flowability in the highest applied magnetic fields is key to many of its uses.

In the absence of a magnetic field, the magnetic dipolar particles in the fluid are oriented randomly due to thermal motion, and the bulk fluid is unmagnetized. In an external magnetic field **H** the particles tend to align and a net magnetization M develops. When the field is spatially non-uniform a force density $g_0 = \mu_0 M|\nabla \mathbf{H}|/\rho$ acts on the fluid in the direction of increasing field where M and **H** are magnitudes of the vectors, ρ is mass density, and μ_0 is the permeability of free space. Magnetization is temperature dependent, decreasing with an increase in temperature. In the presence of a temperature gradient in space, the resulting variation in M can induce fluid motion (analogous to density variation in buoyant convection) with cooler fluid drawn into regions of higher magnetic field and warmer fluid displaced to regions of lower field intensity. Thus, if ∇T is parallel to $\nabla \mathbf{H}$ a situation of thermal instability can develop—similar to the Rayleigh-Benard phenomenon in ordinary fluids where heated fluid is buoyant in a gravity field and is set into circulatory motion. This situation corresponds to the thermal conditions across the earth's mantle.

Due to cold flow creep, a process in which ions and vacancies diffuse through the crystal lattice, over geologic time periods the mantle rock is believed to flow like a Newtonian fluid (for which strain is directly proportional to stress). Analysis of the governing differential equations of fluid motion and energy conservation show that flow and temperature distribution are determined by the sum of the ordinary Rayleigh number Ra and the magnetic Rayleigh number Ra_m.

$$\mathbf{Ra} = \frac{g\alpha\Delta T d^3}{\kappa\nu} \qquad \mathbf{Ra_m} = \frac{g_0\beta\Delta T d^3}{\kappa\nu}$$

where $\alpha = -(1/\rho)\partial\rho/\partial T$ is the coefficient of thermal expansion $\beta = -(1/M)\partial M/\partial T$, ΔT is the temperature difference, d the layer thickness, k the thermal diffusivity, and ν the kinematic viscosity. For earth the magnetic Rayleigh number is zero while in a suitably designed model Ra_m is very much greater than Ra so that the ordinary Rayleigh number can be neglected. Thus, the similarity of earth and the



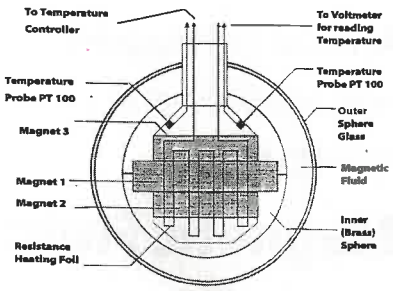


Fig 1 left Cross sectional sketch of the earth illustrating convection in the mantle

Fig 2 above The experiment: an inner brass sphere with magnets at the centre, an outer glass sphere, and a magnetic fluid sandwiched between

SOURCE ABOVE: *Physical Rev. Letters* 83 4904-7 (1999)

laboratory model requires that $(Ra)_E = (Ram)_M$ where subscript E denotes earth and M the model.

Stability analysis predicts that the heat transfer process is purely conductive until a critical value of Rayleigh number of the order of 10^3 is exceeded. It is estimated that the earth Rayleigh number is about 10^6 and hence far exceeds the critical value. Although recent advances in numerical computation are permitting calculations in this regime it is prudent to establish experimental support to validate the assumptions and the predicted behaviours.

An experimental system has been fabricated. It consists of concentric spheres with magnetic fluid in between. The outer sphere is glass of 50 millimetres inside diameter and the inner sphere is brass of 35 millimetres diameter. The inner sphere contains an electrical heater, temperature probes, and an assembly of permanent magnets (Nd-Fe-B) that are the source of the magnetic field. A simple permanent magnet is dipolar and so does not provide the desired symmetry of field. To overcome this limitation an assembly of three cylindrical magnets is configured (*figure* 2) to provide a near field over which the distribution of magnitude is reasonably uniform in all directions at a given radius from the centre. By measuring the field it was calculated that simulated gravity averaged 32 times normal gravity at the inner sphere and 6 at the outer sphere for water-based ferrofluids (glycerol-based ferrofluids produced even stronger fields). Measuring the temperature field on the spherical outer surface is accomplished with an infrared camera. The technique detects conditions over any desired hemisphere so the surface pattern of convection cells, when they are present, can be seen at a glance.

Figure 3a illustrates an equatorial view of the detected thermal pattern when a nonmagnetic liquid (*ie* water) is heated in the system. As expected, the warmest fluid (56°C, deep blue) is found at the top and the coolest fluid at the bottom (47°C, red). The neck seen at the top of the system is actually a tube which holds the inner sphere in place and carries electrical leads to the centre.

Figure 3b is a bottom polar view of the system when filled with a water-based ferrofluid. Warm fluid wells up in a convection cell at the bottom of the system transported by thermal convection in the magnetic field, with cooler fluid descending in the surrounding space. Mean value $Ra_m = 1.7 \times 10^7$ exceeds the earth value; operation of the system with the more viscous glycerol-based magnetic fluid yields lower operating values of Ra_m. At one point the convection cell displays lobes (*figure* 3c) and continues to change its morphology. Numerical models of mantle convection at high Rayleigh numbers also show convective planforms that are complex and unsteady. The experimental model offers another useful trait—the compression of the time scale by a huge factor. In theory features of convection that have taken the lifetime of the earth to evolve can be developed in short times (less than an hour) in the laboratory.

This work demonstrates the feasibility of the magnetic fluid technique and the means for observing convection cells. A refined model is planned in which the spherical symmetry of the field magnitude is more closely approached by randomly reorienting a central magnet on a time scale that is shorter than time scales of the flow. In addition, other areas of planetary and geophysical research could use magnetic fluids, *eg* the study of atmospheric circulation, ocean currents, and convection in a liquid core. □

Further reading

Behavior of the Earth—Continental and Seafloor Mobility by C.J. Allègre (Harvard University Press, Cambridge, Massachusetts, 1988) • Ferrohydrodynamics by R.E. Rosensweig (Dover republication of a work published by Cambridge University Press in 1985, 1997) • Laboratory Study of Spherical Convection in Simulated Central Gravity by R.E. Rosensweig, J. Browaeys, J-C. Bacri, R. Perzynski and A. Zebib *Physical Rev. Letters* **83** 4904-7 (1999)

The author is currently a science consultant in the United States. The work described here was conducted during a twelve month Pascal appointment awarded by the Foundation of the Ecole Normale Supèrieure in Paris

This is an edited version of an article that first appeared in the bulletin of the Société Française de Physique

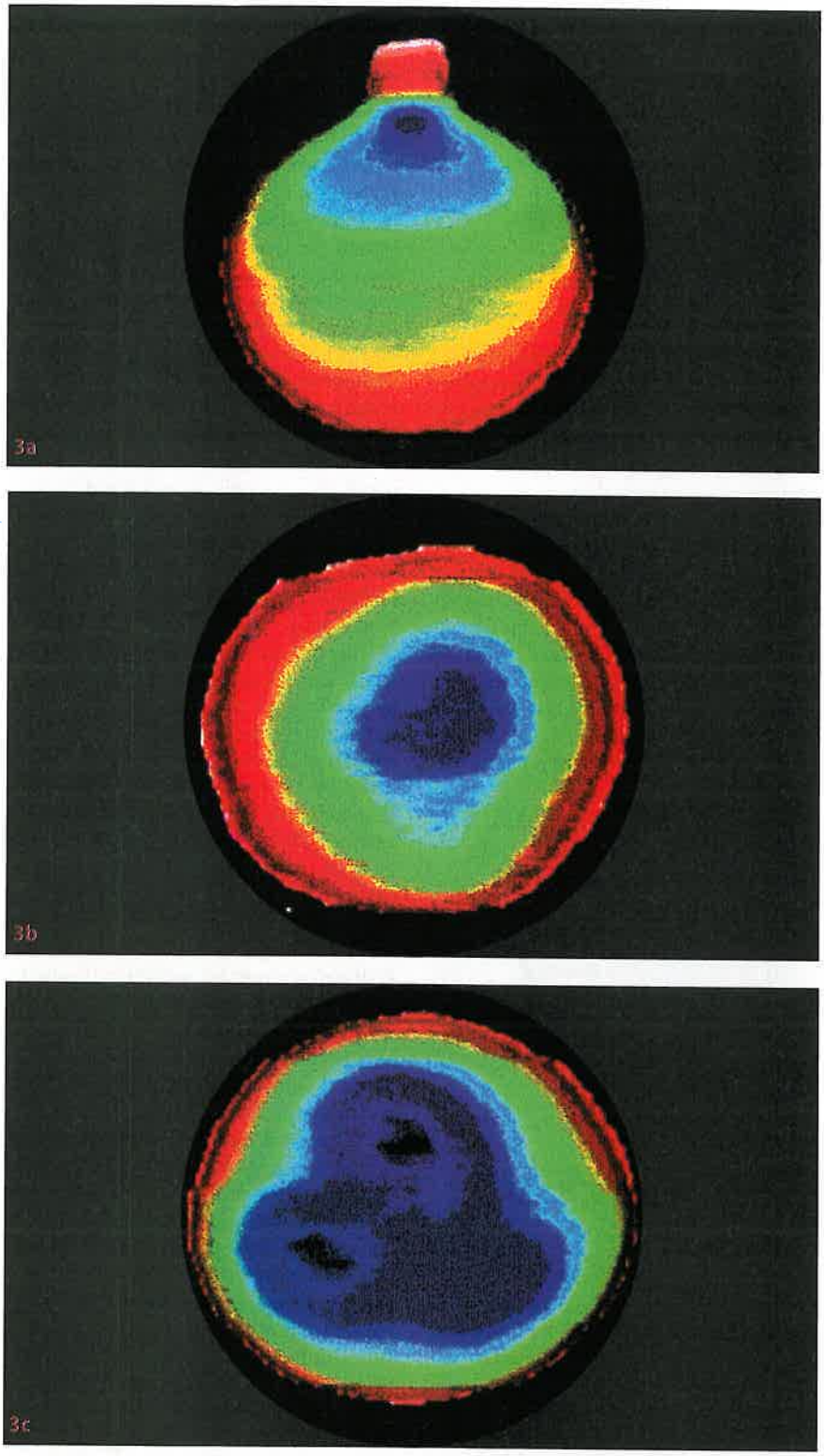
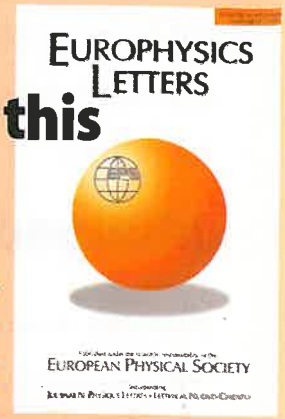


Fig 3 Infrared images colour coded to display temperature distribution at the outer spherical surface of the experiment

a Temperature when operating with nonmagnetic fluid (water). The warmest fluid is at the top, coolest at the bottom. Inner sphere temperature $T_1 = 65°C$

b The warmest fluid is at the bottom due to the convective cell shown in this polar view using aqueous based magnetic fluid in the system ($Ra_m = 1.8 \times 10^7$, $T_1 = 69°C$)

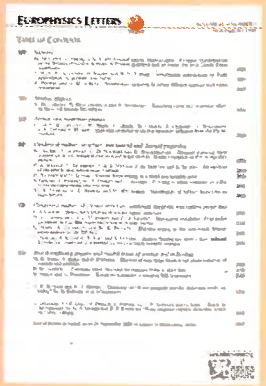
c The convective patterns are time dependent and sensitive to heating conditions; this polar view depicts a three lobed cell (compare with **b**)



Watch this Space

TO COME...

In future issues of *europhysics news* this column will be reserved for résumés of articles that have appeared in *Europhysics Letters*. Tenth in the world in terms of impact factor, this letters journal was launched more than ten years ago by the European Physical Society, the Société Française de Physique, the Società Italiana di Fisica, and the United Kingdom's Institute of Physics and is now owned by 17 national physical societies and institutes. The journal remains the scientific responsibility of the EPS—this is ensured by carefully selecting 26 co-editors in various areas of physics. Around 30 advisory editors provide additional expertise and know-how when necessary. EPL receives contributions from all over the world, and is circulated to more than 30 countries. Manuscripts are received at the editorial office in Geneva, and production of the accepted manuscripts is achieved in collaboration with the Società Italiana di Fisica in Bologna and the publisher EDP Sciences in Paris (also the publisher of *europhysics news*). Letters submitted to *Europhysics Letters* are limited to 7 journal pages, must be original and should contain non-trivial new results, ideas, concepts, experimental methods, theoretical treatments etc. and be of broad interest and importance to one or several sections of the physics community. The presentation should satisfy the specialist, yet be understandable to researchers in other fields. There are no page-charges and authors receive 50 free reprints gratis. For complete information on submission requirements and procedures please visit the EPL homepage at www.epletters.ch.



IBM is proposing a novel idea for storing data: a thousand cantilever legs crawling across the surface of a futuristic hard drive

Millipede: Probing the Future

Paul Vettiger, Switzerland

Today's data storage is dominated by the use of magnetic disks. Two-hundred million of them are installed each year as hard disk drives in PCs, laptops, servers and mainframes. The data storage density in these disks has been increasing by 60% annually over the past 10 years—more recent improvements are giving 100% growth a year. A hard disk drive (HDD) sold at the start of this millennium manages nearly 1.5 Gb/cm^2. But the world record for density in a research laboratory is currently 5.4 Gb/cm^2, and this is being pushed to higher values. However, there may be a physical limit. It has been predicted that superparamagnetic effects—the bit size at which stored information becomes volatile as a function of temperature and time—will limit the densities of current longitudinal recording media to about 15.5 Gb/cm^2. *Figure* 1 shows the density evolution in HDD products and research demonstrations. The limit, and the fast-growing density, makes it clear alternative approaches to the current longitudinal recording scheme need to be explored. Perpendicular and patterned magnetic media are currently being investigated by many research teams around the world.

For the past four years, the micro and nanomechanics group at the IBM Zurich Research Laboratory in Switzerland has been exploring an alternative storage approach based on scanning probe techniques. Mechanical scanning probe techniques, specifically scanning tunnelling (STM) and atomic force microscopies (AFM), have demonstrated the potential of mechanics at the micro/nanometer scale not only for imaging, but also for modifications and even for the precise positioning of individual atoms and molecules.

The movements of tiny mechanical components consume very little energy and can be quite fast. Micro and nanomechanical devices have become very attractive owing to the development of new micromachining techniques that allow industrial "batch" fabrication similar to silicon chip manufacturing. This has opened up the VLSI (very large-scale integration) age of micro and nanomechanics, which promises the integration of mechanics and electronics on a single chip.

Scanning probe techniques such as STM and AFM have great potential for very high storage density. Several years ago a group at IBM's Almaden Research Center in San Jose, California, pioneered micromechanical data storage based on AFM technology by using a tip integrated on a silicon cantilever and operating it over a spinning disk, similar to the setup of a magnetic storage disk drive. A read-only scheme used disks replicated from a master, and sensed 100-nm-sized features by means of an AFM cantilever as "0" and "1" at densities of up to 10 Gb/cm^2 (100 times more than that of a CD Rom). In an experimental write-once/read-only scheme, an AFM tip heated by electrical pulses generated indentations in the polycarbonate disk. These indentations represented the data bits at densities greater than 4.5 Gb/cm^2. Mechanical response times allowed read data rates of up to a few megabits per second (Mb/s).

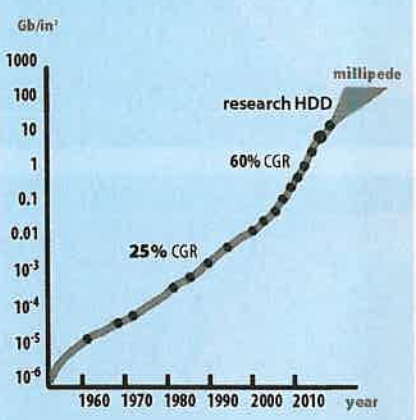


Fig 1 Over the past 50 years the density for storage on hard disk drives has increased by almost seven orders of magnitude. Disk density here is shown in the industry standard Gigabits per square inch. The conventional magnetic head decreased in size until the early nineties, when it was replaced by a magnetoresistive head. This change boosted the compound growth rate (CGR) from 25 to 60%. The millipede concept constitutes a new concept for achieving high storage densities beyond current physical limits

The low write/read data rate, which was a major drawback of this approach, has since been addressed by researchers at the IBM Zurich Research Laboratory. The 200 to 300 Mb/s data rate of today's HDD products can only be achieved or improved by the highly parallel operation of a large number of scanning probes. In other words, thousands of tips/cantilevers had to be integrated densely on a small silicon chip to serve as a write/read head.

This new concept, called the millipede, is not a modification of an existing storage technology, although the use of magnetic materials as storage media is not ruled out. The ultimate storage density is given by the tip, whereas the high data rates are a result of the massive parallel operation of such tips. The basic millipede concept is illustrated in *figure* 2. The two-dimensional cantilever array chip acts as the parallel write/read head, the storage medium being mounted on a magnetically driven scanner. In operation, the medium first approaches the array chip by means of three actuators until three sensors on the array chip detect contact between the chip and the medium. This contact is maintained during operation by three external feedback loops. Write/read operation is performed while the medium is scanned in x and y directions in a raster scan mode. The x and y scanning distances correspond to the pitch between two tips. Electronics controls the quasi-parallel operation of the array; one line is operated in parallel while the others are addressed in a time-multiplexed sequence. The photographs and scanning electron micrographs on the right of the page show the fabricated array chip with 32 by 32 (1024) integrated AFMs. The entire cantilever array is only 3 by 3 mm^2 and is electrically interfaced to the array electronics via the peripheral bonding pads.

The current approach uses the following as the storage medium: a 50-nm-thick polymer film of PMMA (polymethylmethacrylate) spin-coated on a silicon substrate. A thermomechanical process is

used for both writing and reading. During writing, the heater platform at the end of the cantilever with the tip on top is heated, which locally softens the polymer. In conjunction with the small force on the cantilever, the sharp tip forms a nanometer-sized indentation into the polymer film. For reading, a similar thermomechanical process is used. While the tip scans over an indentation, the heater platform is cooled by the smaller airgap generating a resistance change, which is detected as read-back signal. Using single cantilevers, the IBM Zurich team has demonstrated an areal storage density of 60 to 80 Gb/cm^2 by means of this thermomechanical write/read process. An array of 40-nm-sized indentations is also shown in *figure* 2.

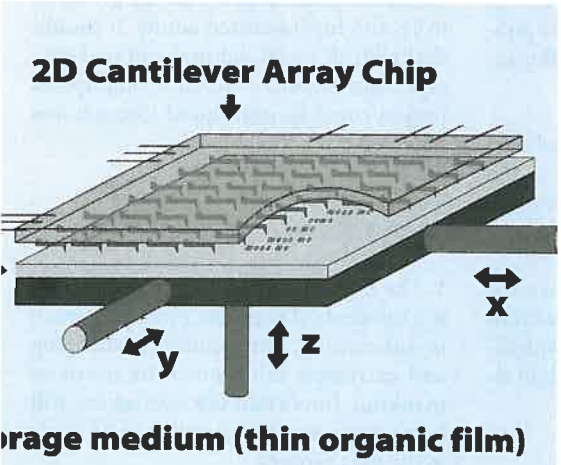


Fig 2 **Schematics of the millipede storage concept**

Right **images of the array chip and cantilever**

In addition, erasing and rewriting capabilities of polymer storage media have been demonstrated for the first time. Erasing is achieved by thermal reflow of storage fields as the medium is heated to about 150°C for a few seconds. The smoothness of the reflowed medium allows a storage field to be rewritten repeatedly. Although this erasing process does not allow single-bit erasing, it can erase larger storage areas.

Whereas densities of 60 to 80 Gb/cm^2 have been achieved with single cantilevers, the IBM Zurich team has recently demonstrated the first parallel write/read operation of a 32 by 32 array chip. Densities of up to 30 Gb/cm^2 have been reached, and the potential to match or exceed those of single cantilevers has been found.

This opens up interesting prospects for storage systems. Assuming a storage density of 80 Gb/cm^2, such a system could store 10 Gigabits of data in an area of about 3 by 3 mm^2. This demonstrates the potential for a very small-form-factor storage device because the scanner is also fabricated and integrated in silicon. In addition, the process technology developed for the array chip will even allow the fabrication of considerably larger and more densely integrated AFM arrays. The actual multiplexing electronics is based on available vendor components, but the next generation will be integrated on the array chip.

A tiny form factor, large storage density, high data rates, and low power consumption are features that make this concept very interesting for future mobile computing applications in laptops, cellular phones and watches. It is important to note that the millipede concept is not limited to polymer storage media. Provided that the write/read functionality for a given medium can be integrated on the cantilever/tip, the concept can be adapted to any medium.

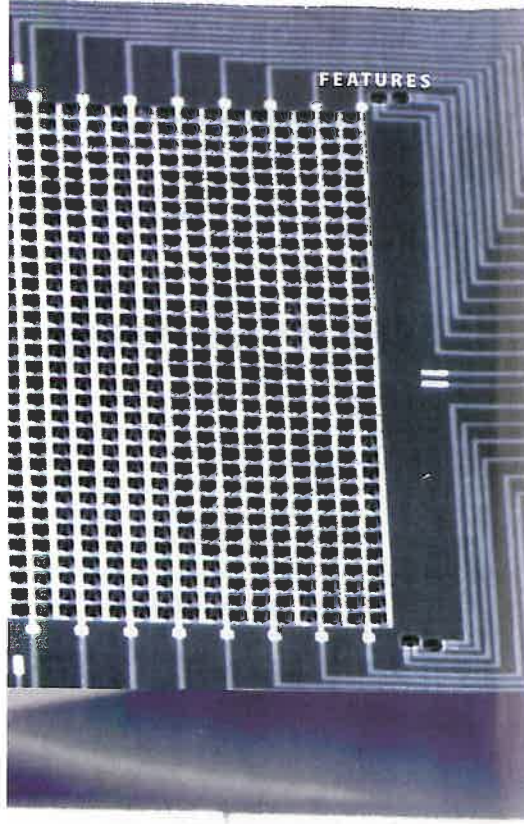
The project is still in an exploratory stage with many open questions and issues to be addressed prior to possible commercialization. However the millipede concept will find applications not only for data storage, but also for metrology, defect and quality control, imaging, nanolithography, and in other fields where nanometer-scale resolution and high throughput are essential.

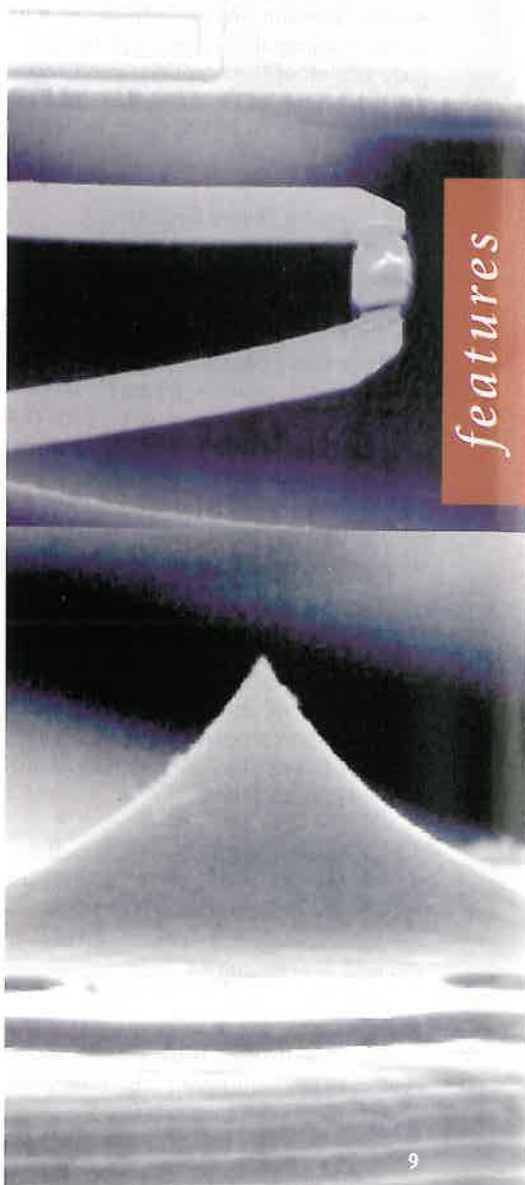
The original vision of this project was inspired by nature's millipede, whose one thousand legs operate in parallel. Hence it became the namesake of our project. □

The author is manager of the micro and nanomechanics group at IBM's Zurich Research Laboratory in Switzerland. His co-authors are: Michel Despont, Ute Drechsler, Urs Dürig, Walter Häberle, Mark I. Lutwyche, Hugo Rothuizen, Richard Stutz, Roland Widmer, Gerd Binnig

Further reading

Ultrahigh-Density Atomic Force Microscopy Data Storage with Erase Capability by G. Binnig *et al Appl. Phys. Lett.* **74** 9 1329-1331 (1999) • Ultrahigh Density, High-Data-Rate NEMS-Based AFM Data Storage System by P. Vettiger *et al J. Microelec. Eng.* **46** 1-4 11-17 (1999) • The Millipede: More than one Thousand Tips for Future AFM Data Storage by P. Vettiger *et al IBM J. Res. Develop.* (1999) in press





Last year the heads of Europe's physical societies went back to school to work out the future

Brainstorming the Future

Seventy-six physicists gathered at the prestigious and very British in character Malvern college in the United Kingdom last September to talk over the future. Physical society presidents mixed with educationalists; first they shared reports, then they broke off workshop manner to draw up action plans. Declining numbers choosing physics at university, a lack of awareness of the place of physics in society—we all know the problems, but what could such a dynamic group of minds come up with in terms of solutions? The workshop groups were divided up into public understanding of physics, physics and the human condition, physics and wealth creation, physics education and teacher training. The following is the complete version of their reports. The Executive Committee of the European Physical Society has added its own plan of action (in italics).

Physics and the Human Condition

1. The recognition of "associated" areas of physics (environmental physics, medical physics, biological physics) varies considerably between physical societies. Mainstream physics is often perceived as 'better' and 'more properly physics' than the associated areas. Status and recognition are lower in the latter and need to be improved. It is recommended that EPS gives recognition to these associated areas through the establishment of permanent structures within EPS to give credence to them.

2. EPS should hold a conference on Physics and the Human Condition to raise public and media awareness, and to show publicly that physics has relevance and concern for human issues.

Action: Under the guidance of (hopefully) A. Bárány (the workgroup chair) and through the appropriate Division or Group the possibility of a scientific conference on this topic is to be studied.

3. The message needs to be spread via the media. (The Bridges from Physics video project is relevant here.) The European Union of Science Journalists (EUSJA) may be a useful partner for EPS, EPS should encourage national societies to set up ways of helping journalists with informed analyses and reports on physics issues behind the news (natural disasters, energy problems, medical imaging, *etc*).

4. Most national societies produce lists of experts to speak to the media (or give public talks, *etc*). EPS should network this information and encourage it.

Action: The EPS encourages national societies to establish lists of experts for media advice. Any such lists made available to the EPS will be included on the EPS website.

5. It is recommended that national societies award prizes for good presentations to the public in any media either by physicists or journalists. Such awards might also be made at the European level.

Political

6. EPS should produce "position papers" on issues in public policy, science policy, surveys of science status and education to present to the European Union/ European Parliament. Some countries could use the EPS Position Papers to press their governments on support for science.

Action: EPS constituent bodies will be contacted for advice concerning the issues where position papers are necessary. Once the list of topics has been drawn up and approved by the Executive Committee, experts will be chosen to write them. Divisions may be of help in this. It is important that these position papers be drafted under the umbrella of the EPS. If the issues are open to debate, then the position papers should fairly present the different points of view.

7. EPS could create links and a dialogue with the European Union (DG12) and provide European Parliamentarians with specialist briefings. EPS should enhance the awareness of EU politicians by inviting them to contribute to Europhysics News. Similar actions should also be taken on the national level.

Young people

8. School teachers will readily use good materials on physics and the environment, physics and medicine, *etc*. EPS could take the lead in producing such materials or could stimulate national societies to do so. Students can be motivated to study physics if it is recognised that physics provides keys for solving present and future problems in the associated areas of environment, medicine, biology, *etc*.

9. Within the European Physics Community a new and purely electronic journal should be established for the age group 14 to 18 and for interested adults. It should deal with all social, cultural and scientific aspects of physics. (The EPS biographies project could be introduced through this scheme.)

The Case for Physics Research and Wealth Creation

1. The physics community must emphasise to society at large that physics research is still exciting, intellectually challenging and extremely relevant to the needs of mankind. Important discoveries are still being made and will continue to be made in the next century.

2. We should give students, for example, the following message to encourage them to do research in physics: humane working conditions, long life expectancy, stable supplies of food and energy, increased mobility and leisure are achievements in the second-half of the 20th century which result directly from enormous increases in industrial productivity. These have been due to an astonishing rate of technological progress which is based on the achievements of basic research, and in particular physics research.

3. Physics has not only initiated new technologies but has provided the basis for important advances in the life sciences, medicine, chemistry and the geo-sciences. Moreover, physics is part of our cultural heritage: it answers the most fundamental questions as to the structure of matter, the property of materials, the birth and fate of our universe and the origin of life on our planet. It contributes to our understanding of the environment and of the place man occupies in nature. Physics is, and must remain, the Leitwissenschaft.

4. Viewed from 1999, some of the most important areas in research in the next

century will be in climate change, new energy sources and energy storage, new materials, information technology, transport, health and environment. Particularly in Europe with its limited natural resources it is essential that the industrial base is supported by a healthy scientific and technological infrastructure. We must ensure that, as in the past, this is guaranteed by a high standard of general education as well as by an adequate supply of well-qualified scientists, in particular physicists and engineers.

5. Industry and the state must continue to invest in both basic and applied research. The financing of curiosity-driven basic research and, indeed, of many areas of applied research, by government remains essential because the pressures of the market appear to prevent industry from spending money on long term projects. A healthy research and development infrastructure also requires stable, consistent government policies which are not subject to abrupt changes of course, short-sighted spending cuts and ideologically motivated influences.

6. The science, technology and innovation system plays an increasingly important role in creating wealth, thus acting as a driving force in societal development. Knowledge has acquired an external value beyond that of pure scientific values and, indeed, beyond that of unfettered, serendipitous research. This is why the political system shows more and more interest in the way we organise science. We therefore have to develop a new language which enables us to deal with these non-scientific values and criteria.

7. Instead of opposing this trend the science community should enter a dialogue with the political system on long-term support for both curiosity-driven and applications-oriented basic research. It should use its own established criteria for setting priorities, not only between different disciplines, but inside physics itself.

8. The gravest obstacles to keeping young people in physics are paradoxically the intellectual skills which they require as physicists and the high quality of the training they receive. Not only are they in demand from other branches of science and engineering, most notably in information technology, but they are also eagerly sought by banks, management consultants, insurance companies, *etc*, with the result that many can eventually achieve salaries which are several times higher than those of research physicists. PhD students' salaries or grants are usually derisory. Clear action should be taken to provide more competitive salaries for graduate students, postdocs and even perhaps young physicists in industry.

9. The major problem that prevents good students from remaining in physics in some countries is also a lack of definite career perspectives: tenure track academic positions, as well as senior research posts in industry, are very scarce, forcing students to look for employment elsewhere. To remedy this situation the organisations concerned must come up with career solutions which go beyond temporary postdoc positions.

10. Although research opportunities have diminished within large industrial companies, many new opportunities for young physicists are emerging in small and medium-sized companies in innovative, high-tec areas. They should also be made aware of the possibilities of founding their own firms; PhD courses should perhaps include training for the physicist as entrepreneur.

11. The established national Physical Societies of Western Europe and the European Physical Society must concern themselves with the problems of Central and Eastern European countries. One effective measure for which the EPS could press is the extension of EU funding programmes such as TMR to these countries, irrespective of whether they are short-listed for EU membership. This could open up graduate student and postdoc opportunities for many young physicists. It is important, however, that they eventually return to their own countries and are not used to compensate for a shortfall of physicists in Western Europe.

There are a series of issues for which EPS should produce position papers including

- The relevance of physics studies and research to society, technology and the understanding of nature
- New areas of physics research
- The necessity to fund physics research
- Physics and wealth creation
- Physics and science policy
- Improving the working conditions of physicists

Action: Competent and willing physicists are encouraged to write or have written position papers on these topics.

Public Awareness of Physics

1. The European Physical Society should become the focus for multi-way information flow in the area of public awareness throughout the countries it represents. A professionally run, highly respected and much used website is a pre-requisite. The site should integrate the information flow among the EPS countries in both educational and public awareness sectors, which are interdependent.

Action: A website allowing national societies to upload documents on issues of public awareness of physics and physics education is currently under construction

2. Each national society should look into the practicalities of setting up a regional network of trained local media representatives with good links with the Mulhouse staff and a new task force.

3. A concerted effort, driven from Mulhouse, must be made to encourage our physics colleagues in industry to work with us.

Action: The EPS is currently studying a number of initiatives—including a journal to be published by the INFM—through its Technology Group.

4. EPS should make stronger and more frequent contacts with the European Commission in Brussels with the aim of increasing understanding among physicists, to recommend measures to alleviate problems, and to improve the consideration of science among policy makers.

5. At both individual country level and EPS level, prizes should be awarded for good journalism in science and physics. EPS should work with its constituent societies to recognise, reward and publicise good work in support of public understanding.

Action: The Executive Committee is currently working on the regulations and looking for potential sponsors for such a prize.

Physics Education

1. Physics education should be an area of major attention within EPS. An Education Division should have a status equal to all the other (purely scientific) divisions. In fact, during its initial phases, the Education Division should be eligible for extra financial, managerial and secretarial sup-

port from EPS.

Action: A meeting is to be organised around EPS Council 2000 for the group to determine the structure, management and action plan for a new Physics Education Division.

2. Physics teaching in higher secondary schools is faced with an imminent and dramatic shortage of properly trained physics teachers. All countries represented at the seminar reported that physics is not always taught by those trained in university physics departments who followed this with teacher training. Ways to improve the situation include improving contacts between teachers and universities, by making mobility and exchange schemes possible at local and European level, by stimulating an influx of older physicists to become teachers and to provide them with appropriate training.

3. EPS should issue a press release about the status of high school education in physics in order that physics may continue to be a discipline with a large impact upon science, technology and society. Governments should allocate resources to avert the coming disaster: the shortage of trained physics teachers. The European Union should financially support action as European technology is at stake.

4. The Education Interdivision within EPS should be reorganised. To speed up the process, the national societies should be represented in the interdivision by someone who reports directly to the president of his national society. The reorganised interdivision should initiate the following actions: investigating the differences and similarities in physics teaching in Europe (an extension of the work done at the EU/Irish Colloquium in 1998); producing a database and statistical information concerning physics education; supporting teachers with resource material, probably at the website; ensuring that teachers are recognised as fully respected members of EPS; establishing liaison with the various national science teachers associations.

5. Regular articles about educational issues should be published in *Europhysics News*.

Policy recommendations

- Programmes for awareness of physics and/or science should have no lower and upper limits. In such programmes and in any (physics) education scheme there should be a place for "wonder and delight".
- For very young children programmes should be informal and investigational. Programmes should be aimed at observation and classification in an objective manner. There is no need for the explicit mention of physics.
- For the age group 8 to 10-years old, the aims of science education should be aimed at fascination, satisfying curiosity and enjoyment. The teachers involved should be scientifically literate.
- For the age group 11 to 14-years old, physics should come into its own. Formal teaching should not detract from "wonder and delight". The teaching at this stage should not be aimed at preparation for academic work to come. The teaching should enhance public awareness of science and physics.
- For the age group 16 to 19 physics education should be diversified. The amount of mathematics involved will depend on the content of the physics courses concerned. The excitement and relevance of modern physics should be introduced into the curriculum only if it is didactically feasible to make the points desired. In this event modern physics could replace more traditional physics.
- "Less may be more" could serve as a general consideration in syllabus development.
- Changes in the physics curriculum must be accompanied by new teacher training. Learning should be emphasised rather than teaching.
- Physics teaching at universities should follow and adapt to the secondary school physics curriculum.
- Key skills, such as communication, IT literacy and teamwork are implicitly very relevant in many aspects of physics education.

Teacher Training

1. It was agreed that EPS should change its structure in order to put education on a par with other divisional activities. Physics education can no longer be seen as a peripheral EPS activity; it must move to the centre of interest.

2. To attract young people to start training to be teachers, it is recommended that working conditions be improved in order to allow more time to develop competence and to take away some of the administrative and other non-pedagogical tasks that seem to be a great burden; to improve salaries and to pay attention to individual performance ("it should pay to become a better teacher").

3. Prospective teachers should get a good general science education and in addition have in-depth studies in at least one of the three disciplines (physics, chemistry and biology). Mathematics should be considered an essential part of the background for all physics teachers.

4. Prospective teachers should be offered courses in topics such as the history of science, epistemology, *etc*; in other words courses about science.

5. Contacts with schools should come early during the training and be well guided by competent and experienced 'mentors'.

In-service training

In-service training had the highest priority in the recommendations from the working group on teacher training.

6. In-service training should be a right for all teachers. It should come at regular intervals. It should be fully financed and it should be fully programmed as soon as a teacher starts his/her job in a school. Examples from industry where re-training or in-service training is part of the job contract between employer and employed could help in setting this up.

7. Recommendations for future action included promoting teachers' use of computers for receiving material on the Internet; supplying teachers with updated programmes and CD rom material on selected topics and new teaching methods; arranging summer schools for teachers; encouraging exchange of teachers between the EPS member countries, both in the form of electronic networks and actual exchange visits; promoting study visits and stays in physics laboratories; establishing awards for outstanding educational activities.

There are two issues for which EPS should produce position papers:
- the status of physics teachers and physics education at the secondary school level
- training and continuing education of physics teachers

Action: Competent and willing physicists are encouraged to write or have written position papers □

It's a network of institutions that award physics degrees. It's purpose is to allow students to study abroad

Mobile Physics

At the start of the 20th century it was not unusual for a young scientist to study at more than one European university. As national education systems set up more rigid curricula, and as the scientific community diversified, student mobility became less common. Several supranational organisations (UNESCO, the Council of Europe, for instance) have tried to find solutions to this. And in 1968, when the European Physical Society was founded, the exchange of physics students was fixed as one of its priorities.

In 1990 nine Swiss universities began a mobility programme, which operated solely within Switzerland. In its first year it attracted a significant percentage of physics students, and on this basis the EPS began looking into the formation of a European network, open to all institutions granting a university degree in physics. At its Athens meeting in 1992, EPS Council accepted the creation of the European Mobility Scheme for Physics Students (EMSPS). Since that time, the network has continued to expand.

At present 181 institutions in 30 countries make up the network. Of those, 135 institutions are from European Union (EU) or European Economic Area (EEA) countries, 36 are from Central and Eastern European (CEE) countries, 7 are from the Russian Federation and Ukraine and 3 are from Israel and Turkey.

The EMSPS offers a user-friendly approach to international student mobility, encouraging a physics student (normally during the second-half of their undergraduate studies) to study from one term to one year at a host institution in a different linguistic and cultural environment. Full academic recognition of the study abroad is a cornerstone of the scheme. The home institution, which grants the final degree, therefore selects the student and agrees on the choice of the host institution. The detailed programme of studies is accredited and, most importantly, the conditions for the recognition of the qualification are fixed. Records reflecting the quantity and quality of students' work can be kept according to the models developed in the pilot-project for a European Community Course Credit-Transfer System (ECTS).

The scheme is mainly for undergraduate students enrolled in first degrees (such as BSc in physics, Diplom in Physik, Licence or Maîtrise en Physique, *etc*) normally during their third year of study. Graduate students, preparing for an MSc, DEA or an equivalent, or doing course work during doctoral studies, may be accepted to take advantage of special courses not available at their home institution. Since 1993 over 1600 students have taken advantage of the network.

Participation in the EMSPS network is free of charge for home and host institutions and for participating students. Administrative costs are currently financed by grants from the EU, and the EPS. If your institution is interested in participating in the network, please fill in the application form over the page.

Although student grants (*ie* scholarships) are not a requirement to take advantage of a mobility period in one of the partner institutions, such grants are usually provided to cover living and other costs in the host country. Student grants can come from a variety of sources. The EPS provides between 10 and 20 grants per year from its budget, and is active in seeking further funds from international sponsors. Students moving within EU countries and from EU to EEA countries or vice versa, and students from some CEE countries which already adhere to the SOCRATES programme of the EU, can apply for grants via the "institutional contract" of their home university. All partner institutions are encouraged to seek funding from local and national sources to finance mobility periods for participating students.

Regular meetings—every three years—are planned among all partner institutions to compare the evolution of physics teaching at the university level in Europe. In this way, the EMSPS network will help to improve physics education and lead to a better understanding of issues facing the European physics community.

In each member institution a local co-ordinator, chosen among the physics teaching staff, manages the practical aspects of the scheme. Applications and information requests are treated rapidly thanks to personal contacts between home and host institution co-ordinators. The overall management of the EMSPS network is the task of the Mobility Committee comprised of 14 regional co-ordinators, each of whom represent either a country or a group of countries in Europe.

The EMSPS secretariat (located in Budapest) co-ordinates activities, and issues a regular EMSPS email broadcast to the members of the Mobility Committee and all local co-ordinators. Crucial support for the project comes from the computerised EMSPS database that stores information relevant to all academic and organisational matters. The database contains up-to-date information on the physics study programmes offered by partner institutions and can be consulted on-line by local co-ordinators, students and other interested parties. It can be found on the EMSPS homepage.

How do I sign up?

Whatever the motivation, whether requested by the student or suggested by the professor, study abroad can be a complicated process. The EMSPS network has tried to make it as simple as possible. The first step is to contact the home institution's local co-ordinator (participating institutions are listed over the page). Taking into account the criteria for the request (courses or research) the local co-ordinator consults the EMSPS database in order to find a compatible host institution and the name of its local co-ordinator. The local co-ordinators of both institutions will then agree on the timing of the mobility period and the contents of the student's file (a model is available on the EMSPS homepage). The student's file is sent to the host institution's local co-ordinator (with a copy sent to the EMSPS secretariat). The home institution is formally notified shortly thereafter.

At the end of the mobility period the student sends a short report to the EMSPS secretariat describing their studies abroad.

If you would like your institution to join the network please contact the EMSPS secretariat—you will become part of an expanding network working towards European integration through student mobility. Membership of the network is free of charge and open to all universities and institutions that offer a university degree in physics or a physics related subject.

The EMSPS secretariat is located at the EPS office in Budapest. Address: EMSPS Secretariat, Maria Lazar, 7 Nador utca, H-10501 Budapest, Hungary *tel* +361 317 3510 *fax* +361 317 6817 *email* mlazar@office.mta.hu *website* www.kfki.hu/~emsps

EMSPS institutions

AUSTRIA
Karl-Franzens University, Graz; Graz University of Technology; University of Innsbruck; Johannes Kepler University, Linz; University of Vienna; Technical University of Vienna

BELGIUM
University of Antwerp; Free University of Brussels; University of Ghent; Catholic University of Louvain

CZECH REPUBLIC
Masaryk University, Brno; Palacky University, Olomouc; Charles University, Prague; Czech Technical University, Prague

CROATIA
University of Zagreb

DENMARK
University of Aarhus; Royal Veterinary and Agricultural University, Copenhagen; University of Copenhagen; University of Odense

FINLAND
Helsinki University of Technology; University of Helsinki; University of Jyväskylä; University of Oulu; University of Turku

FRANCE
University of de Bretagne Occidentale; University of Bourgogne; University Joseph Fourier, Grenoble; University of Provence (Aix-Marseille I); University of Metz; University of Paris-Sud XI; University Pierre et Marie Curie, Paris; Ecole Normale Supérieure, Paris; University Louis Pasteur, Strasbourg I; University Paul Sabatier, Toulouse; National Institute of Applied Sciences; Lille Science and Technology University

GERMANY
University of Bayreuth; Free University of Berlin; Humboldt University Berlin; Ruhr University Bochum; Rheinische-Friedrich-Wilhelms-University, Bonn; Chemnitz University of Technology; Dresden University of Technology; Gerhard-Mercator-University Duisburg; Johann Wolfgang Goethe University, Frankfurt; Justus-Liebig-University Giessen; Ernst-Moritz-Arndt University, Griefswald; University of Hannover; Friedrich-Schiller University, Jena; University of Kaiserslautern; University of Kassel; University of Leipzig; University of Magdeburg; Ludwig-Maximilians University, Munich; Westfälische Wilhelms University, Munster; Carl von Ossietzky University, Oldenburg; University of Osnabrück; University of Paderborn; University of Siegen

GREECE
University of AthensAristotle University of Thessaloniki

HUNGARY
Eötvös Loránd University, Budapest; University of Budapest; Kossuth Lajos University; József Attila University

IRELAND
Cork Institute of Technology; Dublin City University

ISRAEL
Hebrew University of Jerusalem

ITALY
University of Calabria; University of Bologna; University of Catania; University of Ferrara; University of Genova; University of Lecce; University of Messina; University of Milan; University of Modena; Federico II University of Naples; University of Padua; University of Palermo; University of Parma; University of Pavia; University of Pisa; University of Trento

LITHUANIA
Vilnius University; Institute of Physics; Vilnius Pedagogical University

LATVIA
University of Latvia

MOLDOVA
Tiraspol State University; State University of Moldova

NETHERLANDS
University of Amsterdam; Free University of Amsterdam; Delft University of Technology; University of Twente; University of Groningen; University of Nijmegen

NORWAY
University of Bergen

PORTUGAL
University of Aveiro; University of Minho; University of Coimbra; Beira Interior University; University of Evora; University of Lisbon; New University of Lisbon; Technical University of Lisbon; University of Porto

ROMANIA
"Politehnica" University of Bucharest; University of Bucharest; Babes Bolyai University; University of Craiova; Iasi Al. I. Cuza University of Jassy; University of Oradea; University of Timisoara

RUSSIA
Joint Institute for Nuclear Research; Kazan State University; Moscow State University; Obninsk Institute of Nuclear Power Engineering; St. Petersburg University; St. Petersburg State Institute of Fine Mechanics & Optics

SLOVENIA
University of Ljubljana

SWEDEN
Linköping University; Lulea University of Technology; University of Umea; University of Uppsala

SLOVAC REPUBLIC
Comenius University

SPAIN
Autonomous University of Barcelona; University of Granada; Autonomous University of Madrid; University of the Balearic Islands; University of Cantabria; University of La Laguna; University of Pais Vasco; University of Valladolid

SWITZERLAND
University of Basel; University of Bern; University of Fribourg; University of Geneva; University of Lausanne; Swiss Federal Institute of Technology, Lausanne; University of Neuchatel; University of Zurich; Swiss Federal Institute of Technology, Zurich

TURKEY
University of Bilkent; University of Selauk

UKRAINE
International Centre of Physics

UNITED KINGDOM
University College of Wales; University of Bath; Queen's University of Belfast; University of Kent, Canterbury; University of Wales, Cardiff; University of Warwick; Napier University, Edinburgh; University of Strathclyde; University of Hertfordshire; University of Hull; University of Keele; University of Lancaster; University of Leicester; University of Loughborough; University of Manchester; University of Manchester Institute of Science and Technology; University of Northumbria, Newcastle; University of Reading; Brunel University, Uxbridge

EMSPS Convention

approved by the Council of the European Physical Society on 28 March 1992

Preamble

Having regard to the European Convention No. 138 of the Council of Europe on the General Equivalence of Periods of University Study of 21 June 1990, particularly its article 2,

Having regard to the UNESCO Convention on the Recognition of Studies, Diplomas and Degrees concerning Higher Education in the States belonging to the Europe Region of 21 December 1979,

Having regard to the European Community Action Scheme for the Mobility of University Students (ERASMUS) programme of 15 June 1987, particularly its action 1 and its pilot project ECTS (European Community Course Credit Transfer System),

Having regard to the agreements between the European Economic Community and the countries of the European Free Trade Association (EFTA) establishing cooperation in the field of education and training within the framework of the ERASMUS programme of 9 October 1991,

Having regard to the European Communities' TEMPUS (Trans-European Mobility Scheme for University Studies) programme of 7 May 1990,

Having regard to the aims of the European Physical Society,

Whereas the Parties to the present convention (hereinafter the Parties) declare themselves convinced of the importance of student mobility in Europe,

Whereas the Parties wish to promote closer cooperation between European Universities in the area of physics,

The Parties agree to the following:

Article 1 Aims

1) The Parties commit themselves to offer any student pursuing physics studies with a view to obtaining an academic degree registered at one institution (the home institution) the possibility of effecting a period of study (the mobility period) in another institution (the host institution).

2) The mobility period shall allow the students to acquire abroad an equivalent education in a different lingual or cultural environment or, for more advanced studies, to profit from special courses not available at their home institution.

3) The Parties commit themselves to recognise the studies undertaken and successfully completed in the host institution upon return of the student to the home institution.

Article 2 Qualification of Parties

Any institution as defined in article 1 of the Council of European Communities' decision of 15 June 1987 (87-327-CEE) as well as in article 1 of the European Convention No. 138 of the Council of Europe of 21 June 1990, as well as the European Physical Society, can be Party to the present Convention.

Article 3 Role of the home institution

1) Full academic responsibility for the student remains with the home institution. It confers the final qualification.

2) The home institution agrees to the mobility period, and approves the student's choice of host institution and study programme. It determines the conditions of recognition of the studies undertaken during the mobility period. It ensures that:

a) the student has sufficient command of the working language of the proposed host institution;
b) the student has the necessary preliminary knowledge to follow the intended study programme;
c) the study programme will allow the student a smooth reintegration upon return and recognition of the courses completed at the host institution, subject to the student's satisfactory performance.

3) Within its financial means, the home institution takes measures to facilitate the mobility programme by preparing the student, particularly with respect to the working language of the host institution.

4) Within its financial means and if it so chooses the home institution may make a mobility grant available to the student. The right of the student to benefit from national or local grants shall not be interrupted or reduced during the mobility period.

5) During the mobility period, the student remains registered at the home institution where the student continues to pay fees and to be covered by the insurances in effect at the home institution.

Article 4 Role of the host institution

1) The host institution accepts the student for the mobility period if the student's complete file is received within the agreed deadline and subject to the limits of article 9. It gives the student access to all courses offered to its own students and required in the student's study programme. It carries out the evaluations specified in the study programme.

2) Within its financial means, the host institution takes measures to facilitate the student's stay, sees to his/her integration, helps solve problems on the academic and practical levels, in particular accommodation, and helps the student to improve his/her knowledge of the host institution's working language.

3) To the extent that the home institution has not been able to offer a mobility grant, or if the grant proves to be insufficient, the host institution may offer its host students mobility grants within its own financial means.

4) The student is registered at the host institution as a mobility student. As such, the student is exempt from fees within the host institution. The host institution provides him/her with an attestation granting the same rights it offers its own students, such as use of the libraries, restaurants, *etc.*

Article 5 Conditions for the mobility period

1) To benefit from a mobility period in the present scheme, the student must have successfully completed at least the first year and normally also the second year of studies at the home institution.

2) Normally the student must also have successfully completed any prerequisite studies to the proposed course of studies prior to the mobility period.

3) The student cannot normally spend more than one year in the same host institution.

Article 6 Study programme

1) The student who wishes to benefit from a mobility period establishes the study programme in agreement with the coordinator from the home institution, nominated following article 10.

2) To assist the student in the choice of host institution and courses, each Party provides the other Parties with all the academic information necessary to put into practice the present convention.

3) This information, normally in English, includes a short general description of the institution, and its teaching and research activities. It shall contain in particular the curricula of the institution, the list of courses, a short summary of the contents of each course as well as indication of its academic level and the necessary prerequisite knowledge. It also includes details as to the examination procedure and grading scale used.

4) In order to help establish the study programme and the recognition of studies, it is recommended to follow the procedure of the ECTS programme of the European Communities and to split the syllabuses into 60 (sixty) credits per year, or equivalent. Thus the study programme established by the student and the home institution covers normally sixty credits per year.

Article 7 Recognition of studies

1) The home institution determines the requirements and the procedure for the recognition of studies. This can be done according to the course credit transfer system of the ECTS programme or by specifying which courses are to be assessed by the host institution. If the regulations of the institution do not permit to do otherwise, the assessment may be made entirely by the home institution.

2) The host institution assesses the student's knowledge as specified by the home institution using its own examination procedure and grading scale.

Article 8 Student's file

1) According to the obligations specified in article 3 of the present convention, the home institution establishes the mobility student's file which it transfers to the host institution at least four months before the beginning of the student's studies.

2) This file, normally established in English, includes:

a) personal data concerning the student;
b) the academic certificate in view;
c) information on previously completed studies and grades achieved;
d) the intended study programme;
e) the recognition requirements for the studies.

3) The file is signed by the student and by the coordinator within the home institution.

4) If the intended study programme cannot be followed or if a more suitable programme can be established, the coordinator within the host institution proposes to his/her counterpart within the home institution the appropriate amendment.

5) At the end of the student's mobility period, the host institution completes the file by indicating:

a) which courses were followed;
b) the results of the assessed courses;
c) the examination procedure and grading scale used for the assessment.

6) Thus completed, the coordinator within the host institution promptly returns the file to the home institution, signed by the coordinator.

Article 9 Student number limitation and particular conditions

1) A Party may set a limit to the number of mobility students it wants to accept. This limit should be determined at least six months before the beginning of each academic year. In such a case, the institution should not send out more students than it is prepared to accept.

2) In addition, each host institution may impose particular requirements for acceptance of mobility students, particularly of those wishing to effect a diploma or any equivalent research work. The host institution may reject an application if according to the student's file the student obviously does not have the necessary knowledge or language preparation to follow the intended study programme.

3) If the host institution does not accept a student for reasons alluded to the present article, it must upon receipt of the student's file immediately inform the home institution.

4) The Mobility Committee may set an upper limit to the number of students that any one institution may send out.

Article 10 Organization

1) Each institution appoints a coordinator, who is a member of the teaching staff of the concerned physics department.

2) The coordinator is responsible for the running of the present convention in his/her own institution.

3) A committee is formed which is responsible for the coherent administration and general financial management of the mobility scheme as outlined in the present convention. This committee, the Mobility Committee, comprises seven to fifteen members, in first instance appointed by the European Physical Society among the coordinators. The European Physical Society also nominates an additional member, and chooses a committee chairperson among all members.

4) The Mobility Committee decides on the practical organization of the mobility scheme according to this convention. In particular, it establishes the specifications regarding flow of information between the participating institutions and between institutions and the Mobility Committee. It sets relevant deadlines. It makes recommendations regarding the languages to be used for the student's file and for the information exchanged between institutions.

5) The Mobility Committee meets at least once per year. It decides on a plenary meeting of all coordinators when deemed necessary. It reports yearly to the Parties on all its activities.

Article 11 Finances

1) The European Physical Society and the Mobility Committee endeavour to obtain the necessary funds for the operation of the scheme from third parties, notably appropriate supranational organizations, in particular in the framework of programmes of the European Community.

2) In the event that the European Physical Society or the Mobility Committee are not qualified to represent the Parties, the European Physical Society and the Mobility Committee will solicit help from other Parties, named "coordinating institutions".

3) By adhering to the present Convention, each Party authorizes the European Physical Society or the coordinating institutions to seek funds in its name from the appropriate authorities. Normally the European Physical Society manages these funds on behalf of the coordinating institution, according to the guidelines set by the Mobility Committee, and in strict application of the regulations set by the funding agencies.

4) Additionally, the Parties endeavour to obtain from third parties, particularly from their appropriate national bodies, complementary means for the financing of the scheme. They then manage these funds.

Article 12 Information between the Parties

1) Upon adherence to the present convention, each institution provides the other Parties with the following information, normally in English:

a) the curricula to which the present convention applies;
b) the limitations as to the number of host students as mentioned in article 9;
c) all practical information necessary to the student;
d) the academic information as defined in article 6, paragraphs 2 to 4;
e) name and address of its coordinator.

2) Each Party commits itself to updating this information and to notifying the other Parties of any related amendment.

Article 13 Participation in the scheme

1) Any Party wishing to participate in the scheme by adhering to the present convention makes a written request to the European Physical Society, which will pronounce judgement on the request upon advice from the Mobility Committee.

2) Any such request is supported by a complete file including particularly all the information mentioned in article 12.

3) In cases where the qualification of an institution for participation in the scheme is in doubt, the European Physical Society will seek advice, via the national physical society, from the competent authority in the country.

4) Participation becomes effective at the beginning of the first academic year following the acceptance of the request, on the condition that acceptance takes place at least twelve months beforehand.

Article 14 Entry, withdrawal

1) The present convention enters into force as soon as at least twenty-five (25) institutions have adhered to it. After three years of participation, any Party may withdraw from the present convention with twelve months' advance notice for the beginning of an academic year.

2) The present convention remains in force as long as at least twenty-five (25) institutions adhere to it.

Article 15 Arbitration

1) Any litigation arising from the present convention is submitted to arbitration, of which the decision is conclusive. The arbitrator or arbitrators are appointed by the European Physical Society upon advice from the Mobility Committee. In case of litigation between an institution and the European Physical Society or the Mobility Committee, each Party appoints an arbitrator. The two arbitrators will agree to a third arbitrator.

2) The legal jurisdiction for the arbitration is Mulhouse, France. □

European Physicist *EurPhys*

How to apply for the European Physicist qualification

Vocational qualifications exist in many professions. They are generally awarded on the basis of a combination of academic achievement and work experience.

Learned societies, and institutes covering different fields of science and technology, have established various national registers for qualified science professionals.

But qualifications do not always travel easily. The criteria used to award qualifications can differ from country to country. And a qualification awarded in one country may not be accepted in another. This can restrict the opportunities professionals have to exercise their profession where they choose.

The European Commission, the administrative body of the European Union (EU), has been active for some time in promoting the mutual recognition of academic degrees, and tries to ensure the free movement of professionals within the EU.

For physicists, the European Physical Society, with the encouragement of the EU, has created the European Register of Physicists. Its purpose is to certify that those who are registered meet specific criteria in terms of educational qualification and professional experience.

Working conditions are changing: long-term positions have become the exception rather than the rule, and self-employment, as for example, a consultant, is becoming more widespread. In this environment the professional qualification of European Physicist is an essential asset.

Requirements for admission

It is necessary to have at least seven years' experience working in physics, either in training or in a professional capacity.

The seven years should be made up of the following:

- A period of study leading to an academic qualification in physics or in a physics related area acceptable to the EPS's Committee on Professional Qualifications. This must have involved at least the equivalent of three years' full-time university education.
- At least two years' appropriate experience gained in a professional capacity after graduation. This work experience could include research and development, project management, supervision and the training of others, and safety management.
- The remaining period, which must have lasted for at least two years, and may consist of either education leading to an academic qualification, or appropriate experience involving responsibilities deemed satisfactory by the Committee on Professional Qualifications. It may also include a period of training during which the applicant has acquired the aptitude or skills needed to exercise the chosen profession in a responsible capacity.

How to apply

An application form can be obtained from the Secretariat of the European Physical Society, from many national physical societies.

The application form should be sent, together with the non-refundable application fee of 50 Swiss francs, to the Secretary of the Committee on Professional Qualifications (as indicated in the guidance notes that accompany the application form).

The Committee on Professional Qualifications evaluates each application. The Committee is assisted by independent experts familiar with the different regions in which applicants have trained and worked.

The Committee on Professional Qualifications reviews each application to ensure uniformly high standards. If the review is satisfactory, you will be invited to pay the registration fee (250 Swiss Francs) for admission to the European Register of Physicists for an initial period lasting five years.

You will be provided with a formal Certificate of Registration. Thereafter, registration will be renewable without the need to submit a new application (although you may be asked to update your first application).

To obtain an application form for admission to the European Register of Physicists please write to European Physicist, European Physical Society, 34 rue Marc Seguin, BP 2136, F-68060 Mulhouse Cedex, France
or contact us for further details on
tel +33 3 89 32 94 40 *fax* +33 3 89 32 94 49
email m.schmitt@univ-mulhouse.fr

The following is the current rollcall of European Physicists

J.E.T. Andersen, Denmark
J.C. Andress, United Kingdom
E.R. Andrew, United States
R. Balescu, Belgium
A. Barducci, Italy
P.A. Bartlett, United Kingdom
J.S. Battye, United Kingdom
P. Beckley, United Kingdom
R. Bektursunova, Kazakstan
K.S. Bromley, United Kingdom
R.W. Buckley, United Kingdom
K.H. Chadwick, Belgium
A.C. Chew, United Kingdom
R.K. Child, United Kingdom
R.C. Chivers, United Kingdom
C.L.J. Chow, United Kingdom
S.G. Clackson, Germany
N.S. Clarke, Austria
E. Crepaldi, Italy
P.M. Darbyshire, United Kingdom
T. Duby, United Kingdom
M.J. Dutch, Switzerland
H. Eckey, Germany
K.D. Ehrhardt, Germany
C.J. Evans, United Kingdom
R.H. Fenn, United Kingdom
J.A. Fernie, United Kingdom
P.J. Fleming, Ireland
C.P. Fong-Wanghai, Hong Kong
L. Garzon Ruipérez, Spain
J-P. Gaspard, Belgium
A.J. Gill, Switzerland
S. Gregson, United Kingdom
A.J. Harper, United Kingdom
R.J. Harvey, United Kingdom
J. Heijn, Netherlands
R. Hetherington, United Kingdom
J. Higinbotham, United Kingdom
D. Hobbs, Austria
A.T. Jackson, Ireland
R. Jacot Guillarmod, Switzerland
N. Keeley, United Kingdom
S.F. Keevil, United Kingdom
M. Lenski, Germany
J.N. Lillington, United Kingdom
T. Lowe, United Kingdom
C.M. Martin, United Kingdom
N. J. Mason, United Kingdom
K.J. McCarthy, Spain
P.H. Melville-Smith, United Kingdom
A. Micallef, Malta
R.D. Monk, Germany
R. Mooney, Ireland
R. Mostert, Netherlands
A.F. Mörx, Austria
P.E. Obermayer, Germany
P.R. Owen, United Kingdom
K. Papazian, Armenia
M. Peter, Switzerland
M.E. Phillips, United Kingdom
G.K. Pindoria, Japan
A. Raimondo, Switzerland
J.F. Ralph, United Kingdom
R.T. Ramos, United Kingdom
B. Rapp, Germany
A. Rau, Germnay
R.P. Reed, United Kingdom
M.C. Robbins, United Kingdom
S.C. Rutherford, United Kingdom
E. Rydygier, Poland
K.J. Schell, Netherlands
I.M.B. Scott, United Kingdom
U. Smilansky, Israel
B. Smith, United Kingdom
N. Solomey, United States
D.A. Spencer, Norway
P.P.M. Steur, Italy
P.H. Stokes, United Kingdom
L. Stringa, France
G. Sturaro, Italy
R.G. Taylor, United Kingdom
D.W. Thomas, United Kingdom
E.G. Timoshenko, Ireland
J.L. Valero, Spain
B.P. Van Milligen, Spain
R. Vardanian, Armenia
P. Wachter, Switzerland
U.P. Wallenhorst, Germany
J.G. Whittington, Germany
G.G. Wilkinson, Italy
S.R. Wilson, United Kingdom
G.P. Yick, United Kingdom
T.C.B. Yu, United Kingdom

European Physical Society

Application for Individual Ordinary Membership

constitution articles 4a), 4c) and 4d)

please return this form to
EPS, BP 2136, F-68060 Mulhouse Cedex, France

1 Personal details *please write in capital letters*

Last Name _____ Office phone + _____
First name(s) _____ Home phone + _____
Date of birth ___/___/___ Fax + _____
Nationality _____ Email _____
Full address _____

postcode _____ country _____

2 Professional details

Highest academic degree _____
Institution _____
Current position _____
Specialization _____

3 Type of membership Are you a member of one of the societies listed on the right? If you are a member of one of the national member societies, tick *yes* below and pass to question **4**. If you are a member of one of the collaborating societies listed on the right, tick *yes* below and pass to question **4**. Otherwise, tick *no* and pass to section **5**.

Yes ❑ No ❑

4 Which society are you a member of? Please underline the national member society or the collaborating society on the left. There is no need to complete section 5, pass to section **6**.

5 Please ask two Individual Ordinary Members of the European Physical Society to sign this form. Please print their names and addresses.

Signature _____ Signature _____
Name and address _____ Name and address _____

6 Address for correspondence (if different from address given in section **1**)

Address _____

postcode _____ country _____

Signature _____ **Date and place** _____

Please indicate your interests in Divisions etc on the right

National Member Societies constitution article 4b)
Albanian Physical Society **Albania**, Armenian Physical Society **Armenia**, Austrian Physical Society **Austria**, Belarusian Physical Society **Belorussia**, Belgian Physical Society **Belgium**, Union of Physicists in Bulgaria **Bulgaria**, Croatian Physical Society **Croatia**, Physical Section of the Union of Czech Mathematicians & Physicists **Czech Republic**, Danish Physical Society **Denmark**, Estonian Physical Society **Estonia**, Finnish Physical Society **Finland**, French Physical Society **France**, German Physical Society **Germany**, Hellenic Physical Society **Greece**, Eötvös Lorand Physical Society **Hungary**, Icelandic Physical Society **Iceland**, Royal Irish Academy **Ireland**, Israel Physical Society **Israel**, Italian Physical Society **Italy**, Latvian Physical Society **Latvia**, Lithuanian Physical Society **Lithuania**, Society of Physicists of Macedonia **Macedonia**, Netherlands Physical Society **Netherlands**, Norwegian Physical Society **Norway**, Polish Physical Society **Poland**, Portuguese Physical Society **Portugal**, Romanian Physical Society **Romania**, National Committee of Russian Physicists **Russia**, Slovak Physical Society **Slovakia**, Society of Mathematicians, Physicists and Astronomers of Slovenia **Slovenia**, Spanish Royal Society of Physics **Spain**, Swedish Physical Society **Sweden**, Swiss Physical Society **Switzerland**, Turkish Physical Society **Turkey**, Ukrainian Physical Society **Ukraine**, The Institute of Physics **United Kingdom**

Collaborating Societies constitution article 4d)
Europe European Optical Society, Société Française des Spécialistes d'Astronomie, Société Française d'Optique, Società Astronomica Italiana, Astronomische Gesellschaft, Deutsche Bunsen-Gesellschaft für Physikalische Chemie, Deutsche Gesellschaft für Angewandte Optik, International Society for Theoretical Chemical Physics, Nederlandse Astronomenclub, The Division for Applied Physics of the Royal Institution of Engineers, Sociedad Española de Optica, Société Suisse d'Optique et de Microscopie Electronique
World Wide American Physical Society, Australian Institute of Physics, Canadian Association of Physicists, Japan Society of Applied Physics, Physical Society of Japan

Which of the following Divisions, Sections and Groups do you wish to join? *please tick*

Divisions & Sections

- ❑ Astrophysics ○ Solar Physics
- ❑ Atomic & Molecular Physics
  - ○ Atomic Spectroscopy (EGAS) ○ Chemical Physics
  - ○ Electronic & Atomic Collisions, ○ Molecular Physics
- ❑ Condensed Matter
  - ○ Liquids, ○ Low Temperature Physics
  - ○ Macromolecular Physics, ○ Magnetism
  - ○ Semiconductors & Insulators, ○ Surfaces & Interfaces
- ❑ High Energy & Particle Physics
- ❑ Nuclear Physics
- ❑ Plasma Physics
- ❑ Quantum Electronics & Optics
- ❑ Statistical and Non-Linear Physics

Interdivisional Groups

- ❑ Accelerators
- ❑ Applied Physics & Physics in Industry
- ❑ Computational Physics
- ❑ Physics for Develoment
- ❑ Physics Education
- ❑ Experimental Physics Control Systems
- ❑ History of Physics

Recognised Journals

The journal recognition scheme aims to provide information on and set standards for physics publishing in Europe, including online publishing. The scheme is beneficial to the European Physical Society because we get our logo on some of Europe's best journals. And to the reader the logo is a stamp of quality ensuring that the journal is international in scope and free to either authors or readers, among other things. Following the exponential increase in sources of information, the EPS helps in identifying journals that are particularly relevant to the European physics community.

Criteria

Recognition of Journals
approved by the EPS Executive Committee on 21 November 1999

1. Publisher
The journal is published in one of the countries whose national physical society is a full member (*ie* National Member Society) of the European Physical Society.

2. Contributions
Contributions to the journal comprise original papers or letters or review papers which are of direct interest to physicists.

3. Editorial Board
The journal has an active Editorial Board in which several countries are represented. Normally at least one-third or not less than three members, whichever is the greater, are located in countries other than the principal country.

4. Editorial Board Members
Editorial Board Members play an active role by defining editorial policy and/or selecting papers for publication.

5. Refereeing
Contributions are formally refereed for scientific content by qualified referees and, on the average, at least one-quarter of the referees acting in this capacity are located in countries other than the principal.

6. Criteria for acceptance of papers
The criteria for accepting papers for publication will be scientific merit only. No other form of discrimination is allowed.

7. Page Charges
No discrimination is exercised against any contributor.

For journals that are sold on the basis of an annual or other periodic subscription, or by the issue, or made available as part of a package, or fee elsewhere charged, no fee will be charged to the contributor(s) for submissions, including but not limited to for the administration, refereeing, editing or publishing of such submissions.

Journals that are made available entirely free of charge in paper format or by electronic or other means may charge reasonable fees for the administration, refereeing, editing or publishing of such submissions.

No discrimination is to be exercised against any contributor for submissions otherwise acceptable for publication resulting from the contributor's inability to pay such fees. In such a case, there shall be a provision for reducing or waiving such fees.

8. Languages
The journal is prepared to publish submissions made in English.

9. Announcement
The publishers agree to announce recognition in accordance with EPS norms and provide, free of charge, to the Secretary of the EPS Action Committee on Publications and Scientific Communications at the EPS Secretariat copies of the journal(s) on request. EPS will announce updated details of Recognized Journals each year in the EPS Directory published in Europhysics News, principally the Editor, Publisher, price, submission procedures, and languages.

9. Renewal
Recognition is reviewed every five years by the EPS Action Committee on Publications and Scientific Communications. □

Current list of recognised journals

Croatian Physical Society
Fizika A; Fizika B

Czech Institute of Physics
Czechoslovak Journal of Physics

EDP Sciences
Astronomy and Astrophysics (Supp.); The European Physical Journal: Applied Physics; The European Physical Journal B; The European Physical Journal D; The European Physical Journal E soft matter

Elsevier Science
Computer Physics Communications; Physica A; Physica B; Physica C

Estonian Academy of Sciences
Physics Mathematics

Institute of Physics Publishing
Classical and Quantum Gravity; Combustion Theory and Modelling; European Journal of Physics; High Performance Polymers; Inverse Problems; Journal of Micromechanics and Microengineering; Journal of Optics A: Pure and Applied Optics; Journal of Optics B: Quantum and Semiclassical Optics; Journal of Physics A: Mathematical and General; Journal of Physics B: Atomic, Molecular and Optical; Journal of Physics D: Applied Physics; Journal of Physics G: Nuclear and Particle Physics; Journal of Physics: Condensed Matter; Measurement Science and Technology; Modelling and Simulation in Material Science and Engineering; Nanotechnology; Network: Computation in Neural Systems; Nonlinearity; Physics in Medicine and Biology; Physiological Measurement; Plasma Physics and Controlled Fusion; Plasma Sources Science and Technology; Reports on Progress in Physics; Semiconductor Science and Technology; Smart Materials and Structures; Superconductor Science and Technology; Waves in Random Media

Institute of Physics Publishing and German Physical Society
The New Journal of Physics

Jagellonian Institute of Physics
Acta Physica Polonica B

John Wiley
Advanced Materials for Optics and Electronics

Kluwer
Journal of Biological Physics

Il Nuovo Cimento
Il Nuovo Cimento B; Il Nuovo Cimento C

Romanian Academy
Romanian Journal of Physics

International School for Advanced Studies, Trieste
The Journal of High Energy Particle Physics

S. Hirzel
Acustica

Slovak Academy of Sciences
Acta Physica Slovaca

Springer
Astronomy and Astrophysics; The European Physical Journal A; The European Physical Journal B

Taylor and Francis
Advances in Physics; International Journal of Electronics; International Reviews of Physical Chemistry; Journal of Modern Optics; Liquid Crystals; Molecular Physics; Philosophical Magazine A; Philosophical Magazine B; Philosophical Magazine Letters

Wiley
Annalen der Physik

The Executive Committee of EPS has begun to draft position papers to define EPS policy on issues important to physicists. If you would like the two position papers printed here to be sent to decision makers in your country or research area, please inform the Mulhouse Secretariat. If you have ideas of issues that are appropriate for other position papers, or if you are willing to draft position papers yourself, please inform the Executive Committee

National Support for Research in Physics

Position Paper

The European Physical Society (EPS) is an independent body funded by contributions from national physical societies, other bodies and individual members. It has over 80 000 members and can call on expertise in all areas where physics is involved. The declared aim of the EPS is to help physics and physicists in Europe.

1. The Aim of this Position Paper

It might appear that the case for government support for research in physics (both pure and applied) is self-evident, but experience has often shown that this area is not accorded the high priority that should be due to it.

The present "position paper" gives a balanced case for appropriate support; it is addressed to those who have responsibility for national support for physics.

The important role of research in private industry and in individual government departments (eg in defence) is not considered here.

2. The Impact of Physics

The impact of earlier research in physics on the everyday life of citizens is very considerable. The use of electricity, methods of communication, medical techniques and many other examples all stemmed from fundamental research in physics and related disciplines. The discovery of the transistor is a further example; the impact on all areas of electronics has been considerable, by way of miniaturization, speed, efficiency, *etc.*

More recently one can include lasers, nuclear magnetic resonance and x-ray imaging in the medical field and there are many other areas, too, where Physics is making a crucial input. We can guarantee that such applications will continue.

3. The International Dimension

Research is an international activity and each country has its own part to play. Prowess in research is one of the "hall marks" of an advanced (or advancing) nation (see appendix). The cultural aspect of physics should also be included—a knowledge of physics is part of the general education of a nation. Added to this is the need for every nation to have local "experts" to understand and explain to society the newest scientific achievements, wherever the discoveries have been made.

4. Pure and Applied Physics

A balance of government support between pure and applied physics research is necessary. Although the time interval between the results from pure physics research and its eventual application can be long, there is almost always an application of some sort, often in an unexpected direction.

More immediate is the use of the techniques developed in pure physics research in other areas; the application of techniques should not be underestimated.

5. The Training Aspect

The training element of physics research cannot be overstated—students trained in physics research find employment in many professions, including, increasingly, business and finance.

The training of scientists to the level of PhD of an international recognised standard also provides the manpower needed to create a national industry for technologically advanced products.

The provision of good education in science and the presence of a large number of highly skilled scientists in a nation, with the associated presence of high quality universities and research laboratories, prevents the "brain drain" of talented individuals. It also makes home institutions more attractive to foreign investment.

6. National Needs

Applied research can often be finely tuned to the needs of a particular country. Some support can be provided by industry but again most must be government-provided. Problems with energy sources and the environment are obvious examples where government-sponsored research is essential.

7. A Strong "Science Base"

Although some research techniques can be acquired (or purchased) from other countries, most can not; a strong national "science base" is a fundamental requirement for their development.

8. Political Aspects

The knowledge that a nation has such a science base and one that is stable, despite fluctuating national income, coupled with the advice provided by that base, is an important contribution to success in "political" deliberations between nations. A strong base also enables the participation in and hosting of valuable international ventures.

9. National Confidence

Discoveries by a nation's physicists can add to the confidence and pride of the nation's citizens.

10. National Research Institutes

The division of research effort between universities and national research institutes is the subject of another position paper but it can be stated here that both are needed.

Appendix

Participation in International Laboratories

There is considerable value in a nation being associated with an international laboratory (CERN, ILL, ISRF, ESA, *etc*). The access to superlative techniques and sophisticated and often fundamental experiments is invaluable. The techniques learned can often be used at home and, on a different plane, national prestige is enhanced.

The funding situation must be handled with care, however. The inevitable significant subscription—in money or in kind—must be taken from a separate government fund. Furthermore, the domestic science base must be enhanced to cover the extra cost of using the international facility (eg detectors for experiments).

7 January 2000

Physics Research: the Relationship between Universities and National Research Institutes

Position Paper

The European Physical Society (EPS) is an independent body funded by contributions from national physical societies, other bodies and individual members. It has over 80 000 members and can call on expertise in all areas where physics is involved. The declared aim of the EPS is to help physics and physicists in Europe.

1. The Aim of this Position Paper

The aim is to give a balanced view of the appropriateness of organizational arrangements for national research institutes (NRIs), particularly in those countries of Eastern Europe which, in the past, relied in part at least on supplying defence needs. We appreciate that even in Eastern Europe there are differences, country-to-country. Nevertheless, there are some common features and therefore common recommendations. (We do not consider here the important role of applied research in industry and in government ministry-owned establishments.)

2. The Role of University Research

Universities and, in a number of countries, the research institutes belonging to national academies of sciences have always been—and should continue to be—a source of much fundamental research. They are also the training ground for much of a nation's scientific "manpower". The interaction of research and teaching is vital.

3. The Role of National Research Institutes

National research institutes are, by definition, largely funded by government.

Ideally, a NRI should have 4 components.

(i) One component with a specific national task, such as nuclear technology, standards, engineering techniques, the environment, *etc.*

(ii) A division responsible for fundamental research, some of which is in the area covered by (i). Such a division must carry out fundamental research of excellence, which is competitive at the international level.

(iii) By definition, NRIs will often have a unique facility (an accelerator, a reactor, an observatory, *etc*) which is available for the whole research community in the country. The facility will need adequate, well-trained local staff.

(iv) A policy of strong co-operation with universities (and other higher education establishments) for the provision of training for research students.

It should also have a small section devoted to publicity, *viz* to make the public aware of its work and be "citizen-friendly".

Direct funding of autonomous institutions is the preferred option, peer review being used to maintain standards.

4. NRIs in Transition

With the end of the "cold war" a number of developments have occurred, as follows.

(i) In Western Europe, funds for those areas which previously benefited from the cold war (space research, nuclear physics, *etc*), have been reduced, in relative terms.

(ii) In some countries of Eastern Europe, as mentioned at the start, institutes had defence associations. Thus there has been a need to change direction.

Here, we concentrate on (ii).

It is tempting to bring about closures or "shot-gun marriages" with universities. The latter should be resisted; funding shortages will inevitably lead to serious problems for both.

We recommend that serious attention be given to keeping NRIs of adequate quality; certainly those which are predominantly concerned with fundamental research, and which have international respect, should be maintained and indeed enhanced. The needs of basic research will continue to grow and those NRIs with significant applied research efforts will have much work to do. An example of the latter concerns matters associated with the environment (pollution in various forms).

Concerning funding, there is no substitute for direct state support—certainly not for the component of a NRI that includes fundamental research. For the applied component, a small contribution might come from private industries, both national and international. The presence of good people with, as-yet, modest salary requirements makes such institutes attractive to international companies with specific requirements. It is appreciated, however, that efforts in this area have not yet proved generally effective.

5. The Role of the International Laboratories

In some subjects, principally particle physics, astronomy and condensed matter physics, the needs of experimentation are so great as to be beyond the capacity of a single nation and international laboratories are necessary. Permanent scientific staff should be kept to a minimum; cross-fertilization with university departments and NRIs, is vital. The sophisticated techniques developed must be used "at home" as well as in the international laboratories.

National funding for the international laboratories must include not only the subscription but also sums for the national science base (universities and NRIs) in order that the appropriate user-equipment can be provided.

6. Comparisons with other Countries

No two countries are alike in their possession of, and need for, NRIs and detailed descriptions are not very helpful. However, brief details of the situation in the United Kingdom are available on request (d.lee@univ-mulhouse.fr)

7 January 2000

The following position papers are in preparation:

A scientist's oath
Teachers as members of national physical societies
More support for physics teachers
The salaries of physicists
The role of physics training as a preparation for many professions

Secretary General's Report

THE EXECUTIVE COMMITTEE has approved the proposal by the Nuclear Physics Division to establish a **Lise Meitner Prize** for outstanding contributions to nuclear science. The prize is sponsored by Eurisys Measures in Lingolsheim (France).

The EPS has been invited to nominate candidate(s) for the **King Faisal Prize** for Science for 2001 which will be given in the field of physics. The closing date for nominations is 30 April 2000. If you are interested in making a nomination, and for details relating to nomination requirements, please contact David Lee at the Mulhouse Secretariat, 34 rue Marc Seguin, BP 2136, F-68060 Mulhouse Cedex.

The EPS has agreed to participate on the Scientific Advisory Committee of the **European Physical Journal**. The Committee will be consulted by the journal's steering committee for matters relating to trends in research and choice of the editors-in-chief. It is hoped that this will help the journal "in better serving the physics community in Europe and to complete a European harmonisation."

The EPS is becoming increasingly involved in questions related to science and society. The recent Malvern seminar on the future of physics (see details elsewhere in this issue) is a good example. The EPS is now to participate in a project called **Physics on Stage** organised jointly with the European Space Agency, CERN and the European Southern Observatory in November 2000. The main objectives are to catalyse a debate on physics teaching among educators, the media and politicians, and to identify the most effective, exciting and innovative methods for teaching physics. Other initiatives at a national level are also underway, such as "Science in Dialogue" organised by the German Minister for Education, which will comprise of a series of activities throughout the year designed to provide scientists with a framework for dialogue with the public.

The Executive Committee has examined the idea of creating a section of the Plasma Physics Division called **Dusty Plasmas**, and the idea will be submitted for approval at the EPS Council Meeting in Dublin (24 to 25 March 2000). If you are interested in joining the section please contact David Lee at the Mulhouse Secretariat, 34 rue Marc Seguin, BP 2136, F-68060 Mulhouse Cedex, France

The Statutes of the European Physical Society Interdivisional Group on **Accelerators** stipulate that one third of the members of the Elected Board has to be renewed every two years. Nominations must be supported by 3 members of the group. Members are elected for 6 years. Six vacancies are announced herewith. Nominations should be made on the attached form and, together with a short cv and description of the activities of the candidate, should be addressed to David Lee, European Physical Society, 34 rue Marc Seguin, BP 2136, F-68060 Mulhouse Cedex, France. The deadline for the receipt of nominations is 9 March 2000. The resulting list of candidates and ballot papers will be mailed to EPS-IGA Members who will be invited to vote by the deadline of 28 April 2000.

David Lee is the Secretary General of EPS d.lee@univ-mulhouse.fr

Conference services

A small conference team at the Mulhouse Secretariat now works to the benefit of EPS conferences. Following is an example of the services offered. For more details please contact Christine Bastian c.bastian@univ-mulhouse.fr

Pre-conference

- **Prepare & send out press releases announcing your conference—sent to journals and organisations worldwide**

Logistic support

- **Investigate conference venue, on-site vendors & services (hotels, caterers, travel agencies, *etc*)**
- **Create a mailing list targeted for your conference**
- **Design your conference announcements, posters, conference folders (by professional designer)**
- **Prepare your conference budget (registration fees, venue, mailing, *etc*)**
- **Provide enquiry service (anyone interested in the conference can contact EPS headquarters)**
- **Process advance registration, payment & send-out confirmations, receipts, letters for visas**
- **Prepare registration packets & conference material**
- **Prepare badges**
- **Prepare daily programme with coffee-breaks, meals, entertainment (schedules)**

During the conference

- **Conduct on-site registration & handle all on-site enquiries concerning conference**

Post-conference

- **Prepare attendance data**
- **Take care of abstracts printing & abstracts mailing**

Sir Arnold Wolfendale

Resolutions

At the end of the year it is common practice to think of a New Year's resolution. Sometimes the resolution is actually put into practice and our future changes course. More usually, it is quickly forgotten. However, moving to a new millennium may bring our thoughts of a "new start" into sharper focus. Perhaps this time it will be much more important to persevere with the resolution.

What about the EPS—what should my resolution for our society be? The answer is simple: to "try harder".

There is a paradox for physics in Europe, and indeed the world. At a time when the excitement for the subject has never been greater and the potential for advances are enormous, we seem to be beset with problems. There are problems with the perception of our subject by the young, and indeed the not-so-young too. There are also funding difficulties, particularly for those endeavouring to "push back the frontiers of knowledge", even more so in Eastern Europe where the rapid switch from communism to, in many cases, rather raw capitalism has had some dreadful results.

The situation is thus ripe for us to "try harder" and that is what I hope the Executive Committee of EPS is doing. I have extraordinarily talented colleagues, each of whom has a "task" which he or she is responsible for (see *europhysics news* July/August 1999 for details).

Between us we are producing position papers relating to specific problems, the initial ones being directed towards helping the Eastern European community (National Support for Research in Physics and Physics Research: The Division between University and National Research Institutes). Later ones will include The Case for Nuclear Energy, and whatever else EPS members want us to examine.

We are racking up efforts on the public understanding of physics. Only if we get the public on our side will we start to "take off", and indeed deserve to.

We are starting to beaver away in the corridors of power in Brussels. By having no narrow nationalistic objectives, we are in a good position to be listened to.

And so on... With our indefatigable Secretary General, David Lee, and his enhanced staff—to whom we express our gratitude—we are poised to fulfil our declared resolution. We will try harder and, hopefully, be more effective.

Sir Arnold Wolfendale is the President of the EPS

noticeboard

Upcoming Elections

Interdivisional Group on Accelerators
The statutes of the Interdivisional Group on Accelerators stipulate that one third of the members of the elected board is renewed every two years. Nominations must be supported by 3 members of the group. Members are elected for 6 years. Six vacancies are announced here. Nominations should include a short cv and description of the activities of the candidate, and should be addressed to David Lee, European Physical Society, 34 rue Marc Seguin, BP 2136, F-68060 Mulhouse Cedex, France. The deadline for the receipt of nominations is 9 March 2000. The resulting list of candidates and ballot papers will be mailed to IGA Members who will be invited to vote by the deadline of 28 April 2000.

— Activity Report —

Prizes, Awards

In recent years the divisions and groups of EPS have been encouraged to instigate more prizes. The present list is given below. There is still room for more, notably one relating to the public awareness of physics.

Agilent Technologies Europhysics Award
(Formerly the Hewlett Packard Europhysics Prize); Condensed Matter Division; Sponsor: Agilent Technologies
Awarded every year
Awarded for recent work by one or more individuals in the area of physics of condensed matter, specifically work leading to advances in the fields of electronic, electrical and materials engineering which, in the opinion of the selection committee, represents scientific excellence
Award Cash prize and diploma

Quantum Electronics Prize of the EPS
Quantum Electronics and Optics Division
Awarded every two years
Awarded for outstanding contributions to quantum electronics and optics in basic physics or applied sciences
Award Medal and diploma

Fresnel Prize of the EPS
Quantum Electronics and Optics Division
Awarded every two years
Awarded for outstanding contributions to quantum electronics and optics in basic physics or applied sciences—for works published before the age of 35
Award Medal and diploma

High Energy and Particle Physics Prize
High Energy and Particle Physics Division
Awarded every two years
Awarded for outstanding contributions to high energy physics in experimental, theoretical or technological areas
Award Cash prize, medal and diploma

EPS Experimental Physics Control Systems Prize
Experimental Physics Control Systems Interdivisional Group
Awarded every two years
Awarded to one or more persons not exceeding the age of 35 who have made outstanding contributions to the field of experimental physics control systems in experimental, theoretical or technological areas
Award Cash prize and diploma

EPS Accelerators Prizes
Accelerators Interdivisional Group
Two prizes awarded every two years
Awarded (1) to an individual in the early part of his/her career who has made a recent, original contribution to the accelerator field, and (2) for outstanding work in the accelerator field (with no age limit for the candidate)
Award Cash prize and diploma

Hannes Alfvén Prize
Plasma Physics Division
Awarded every year
Awarded for outstanding contributions to plasma physics in experimental, theoretical or technological areas
Award Diploma

Cecil B. Powell Memorial Medal
General EPS Prize
Awarded every three years
Awarded to an individual for the purposes of delivering a lecture in memory of C.B. Powell on the subject of physics and society
Award Medal

Lise Meitner Prize
Nuclear Physics Physics Division; Sponsor: Eurisys Measures, France
Awarded every two years
Awarded for outstanding contributions to nuclear physics in experimental, theoretical or technological areas
Award Cash Prize, medal and diploma

Prizes

Quantum Electronics
The Quantum Electronics and Optics Division would like to invite nominations from members of the EPS and other physicists in the field of quantum electronics and optics and related technologies for the Quantum Electronics Prize of the European Physical Society. The prize is awarded to one or more persons for their outstanding contributions to quantum electronics and optics in basic physics or applied sciences. Only work that exists in print can be considered.

Nominations will be treated in confidence and although they will be acknowledged there will be no further correspondence. Nominations should be sent prior to 31 March 2000 to the Selection Committee, Quantum Electronics and Optics Prize, EPS, 34 rue Marc Seguin, BP 2136, F-68060 Mulhouse Cedex, France.

Fresnel
The Quantum Electronics and Optics Division would like to invite nominations from members of the EPS and other physicists in the field of quantum electronics and optics and related technologies for the Fresnel Prize of the European Physical Society. The prize is awarded to one or more persons for their outstanding contributions to quantum electronics and optics in basic physics or applied sciences. The prize may only be awarded for works which have been published or accepted for publishing before the proposed candidate(s) has (have) reached the age of 35. The prize may only be awarded to candidate(s) who has (have) not reached the age of 37 on 1 January 2000.

Nominations will be treated in confidence, and although they will be acknowledged, there will be no further correspondence. Nominations should be sent prior to 31 March 2000 to the Selection Committee, Fresnel Prize, EPS, 34 rue Marc Seguin, BP 2136, F-68060 Mulhouse Cedex, France.

Handicap International

The 1997 Nobel Peace Prize winning association, Handicap International is calling for support from interested scientists from around the world to support their appeal to heads of state to ban the use of anti-personnel mines. More information, including the petition and signatories, is available at their website www.handicap-international.org.

The world's finance ministers met last year to draw plans against global financial crisis. We asked some econophysicists: how well did they do?

A Global Strategy

Last December, finance ministers from twenty countries met in Berlin to work out how to prevent a particular type of world crisis: financial market meltdown. The financial crisis that began in Thailand and swept across South-East Asia in 1997, and those that lead to currency devaluations in Russia the following year, and last year in Brazil, were the sort of crises that worried the finance ministers (and not the kind threatened by a year 2000 computer bug).

This inaugural meeting brought together the world's richest countries and developing countries with the aim of defining a common strategy for avoiding financial emergencies. These emergencies can spread from one country to another, as happened in South-East Asia. Preventing this might need a consensus on policy.

Top finance officials from the G7 industrial nations (Canada, France, Germany, Italy, Japan, the United Kingdom and the United States) were joined by ministers from Argentina, Australia, Brazil, China, India, Indonesia, Korea, Mexico, Russia, Saudi Arabia, South Africa and Turkey, and also the European Central Bank President, the outgoing director of the International Monetary Fund, and the head of the World Bank. The brainchild of US Treasury Secretary Lawrence Summers, the group calls themselves the Group of 20 (G20). The meeting was chaired by Canada's finance minister Paul Martin.

After meeting, the officials drew up a one-page action plan. We sent the action plan to members of the scientific committee for this year's Applications of Physics in Financial Analysis conference (to be held in Belgium in June), and to some of the speakers, too, asking for comments. Most of these "econophysicists" are sure the action plan is far too light on details. We reproduce other comments here.

They noted the importance of strengthening national balance sheets to help cushion against unexpected shocks. Econophysicists and economists are trying to understand the nature and causes of large fluctuations which come from intrinsic "noise" (rather than real economic reasons). Once these causes are understood remedies like the Tobin tax against speculation could be considered which would reduce the danger of crashes. I am old enough to remember the repeated dollar crises in the 1960s when American tourists in Paris could not exchange their dollars since a dollar devaluation was feared for the weekend. These crises where replaced by smooth (and thus more easily acceptable) variations of the dollar (after the Bretton Woods system of fixed exchange rates was abolished). Some smoothening like this should now be found again.

Dietrich Stauffer

They recognised that sound national economic and financial policies are central to building an international financial system that is less prone to crises. Well, I am glad they did. They recognised that unsustainable exchange rate regimes are a critical source of vulnerability, and that a consistent exchange rate and monetary policy is essential.

What we know is that new techniques (from physics) allow us to quickly monitor the evolution of financial data, and we don't have to wait months or years before changing policy. Even though our methods (detrended fluctuation analysis, or others like Zipf-variability, or even multifractals) are full of error bars, and have to be used with caution, these methods are nevertheless useful and have been shown to be quite good.

Marcel Ausloos

In the G20 report, globalisation is put forward as being the major vehicle for securing wealth and happiness. From the point of view of physicists working on complex systems, this forgets an essential point: that increasing interactions between sub-systems often lead to "critical points", ie major disruptions. The problems that the G20 are trying to cure may disappear, and the situation may transform into a more or less stable system on the intermediate time scale. But this would be punctuated by crises of an amplitude never before seen, due to the strong interconnection of all the economies—the modern interdependencies of the world's economies leads to a more vulnerable system.

Didier Sornette

The statement issued by the Group of 20 finance ministers and central bank governors:

Finance ministers and central bank governors of the G20 held their inaugural meeting 15 to 16 December 1999 in Berlin, Germany.

1 Ministers and governors welcomed the improvement in global economic conditions. They reaffirmed the importance of continued progress by the World Trade Organisation toward multilateral liberalisation of trade in goods and services that would bring broad-based benefits to the global economy.

2 Ministers and governors discussed the role and objectives of the G20, and ways to address the main vulnerabilities currently facing their respective economies and the global financial system. They recognised that sound national economic and financial policies are central to building an international financial system that is less prone to crises. They noted the importance of strengthening national balance sheets to help cushion against unexpected shocks. They encouraged steps to strengthen sovereign debt management and greater attention to the impact of various government policies on the borrowing decisions of private firms. They recognised that unsustainable exchange rate regimes are a critical source of vulnerability, and that a consistent exchange rate and monetary policy is essential. They discussed a range of possible domestic policy responses to the challenges of globalisation, and exchanged views on the role of the international community in helping to reduce vulnerability to crises.

3 They welcomed the important work that has been done by the Bretton Woods institutions and other bodies toward the establishment of international codes and standards in key areas, including transparency, data dissemination, and financial sector policy. They agreed that the more widespread implementation of such codes and standards would contribute to more prosperous domestic economics and a more stable international financial system. To demonstrate leadership in this area, ministers and governors agreed to undertake the completion of reports on observance of standards and codes ("Transparency Reports") and financial sector assessments, within the context of continuing efforts by the International Monetary Fund and the World Bank to improve these mechanisms. This commitment will help mobilise support for measures to strengthen domestic capacity, policies and institutions.

4 Members of the G20 asked their deputies to consider existing work in other fora (including the Financial Stability Forum) and to examine further ways to reduce vulnerabilities to crises. Deputies will report on their progress at the time of the next meeting, to be held in Canada in autumn 2000. □