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features special

*Towards a European research area
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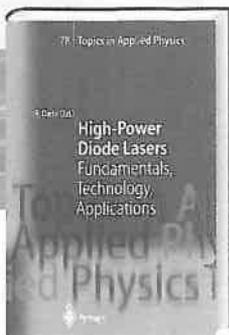
features



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R. Diehl (Ed.)

High-Power Diode Lasers

Fundamentals, Technology, Applications

A description of methods of design and fabrication of high-power diode lasers using proven semiconductor technologies. The latter include epitaxy and optical lithography, mounting on heat sinks, beam forming with micro-optics and coupling to optical fibers, and reliability testing. Direct applications of high-power diode lasers in materials processing and for pumping hitherto unknown solid-state laser systems are presented in a comprehensive fashion.

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2nd edition

B.N.J. Persson

Sliding Friction

Physical Principles and Applications

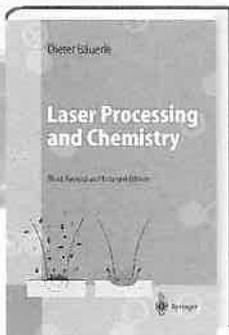
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3rd edition

D. Bäuerle

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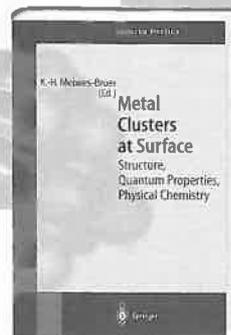
Y.M. Aliev; H. Schlüter; A. Shivarova

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K.-H. Meiwes-Broer (Ed.)

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G.H. Ristow

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2000. XIII, 161 pp. 83 figs. (Springer Tracts in Modern Physics, Vol. 164) Hardcover * **DM 159,-**; £ 55,-; FF 599,-; Lit. 175.600; öS 1161,-; sFr 144,- ISBN 3-540-66701-6

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cover
news in Europe

NEWS FROM EPS

Towards a European research area	4
Noticeboard	26
Secretary General's Report	27
Dilemma	27

NEWS FROM EUROPHYSICS LETTERS

Appearing soon	7
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euromphysics news

volume 31 • number 3

May/June 2000

features

Testing discrete symmetries in K decays	5
Unconventional quantum systems and quantized vortex lines	10
Millikan's struggle with theory	12
Old artifacts and new challenges: The future of history	16
Neutrinos from CERN to Gran Sasso	17
First data on the quark-gluon plasma reported at CERN	18
Physics school education in Finland	19
At the end of the rainbow - an understanding of nuclear matter	21
European Union R&D funding	22

activities

East-West round table	24
Agilent Technologies Prize	25
A festival of science in Montreux	28
EPAC 2000	28

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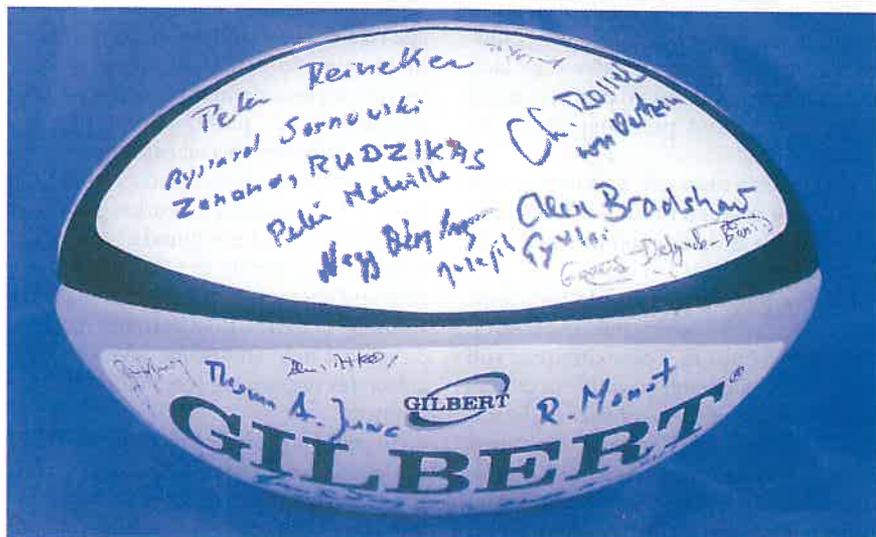
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The EPS Council expressed its thanks to Denis Weaire, member of the Executive Committee and President of the society, and captain of the team for 2 years (1997 and 1998). Thanks Denis. Go Ireland!

Towards a European research area

Comments by the Executive Committee of the EPS on the document

General remarks

The document is well written. It starts with the analysis of the situation of research in Europe in comparison with the United States and Japan, followed by the identification of general goals that should enable Europe to develop and keep the competitiveness in research, in this increasingly changing world towards globalization.

Although the goals are in general quite well identified, the document as a communication from the Commission to the Council, expresses a very general view; nevertheless it does define a general framework for action. It is the interest of the various bodies connected with research to define how political decisions can influence the reality in the laboratories.

Being aware of the problems and the goals to be met, there are a number of areas where the EPS could, and indeed should, make an input. The EPS views are listed below.

Specific remarks

1. Inevitably the document is concerned with a top-down approach. More input from the ground appears to be needed.

2. There are in Europe a number of well-founded, broadly-based Professional Societies, of which EPS is one, which could well be consulted. It is they who are in touch with, and indeed are largely composed of, the scientists (and others) who are carrying out the research which is the subject of the Document. It is in everyone's best interests that there is wide consultation.

3. It is inevitable that co-operation in research which is closely linked to wealth-creation should be very difficult - commercial competition dictates that fact. Thus, co-operation should concentrate on basic, generic and pre-competitive research.

4. For generic research, attention could usefully be devoted to national foresight programmes and common threads could be abstracted.

5. An area where the EU could very profitably work even harder concerns Central and Eastern Europe. These countries still have very considerable scientific potential, largely because of the excellence of the scientists themselves. Carefully structured help should be given to rebuild the research infrastructure of the Central and Eastern European countries where recent economic problems have led to reduc-

tions. It is vital that these countries are able to keep their best researchers who can contribute to the well being of those countries as well as to the Common European research pool of knowledge. Such help is in the best interests of Europe as a whole (see President's comments below).

6. The Public Understanding of Science is a common area that is currently supported - to a degree - by the EU. More could be done by the EU by way of working through the European Societies who would, in turn, help the many National Societies.

7. Specific activities where EPS could well be represented at Institutional level.

7.1. A Council of senior officials from scientific organizations for policy consultation (Report pp. 13 and 25).

7.2. A conference on the subject of research facilities in Europe will be organized in Strasbourg in the second half of 2000, by the Commission and ESF... (p.11).

7.3. European Science and Technology week (p. 18).

7.4. ... a European system of grants for scientist from third world countries... (p. 19).

Some specific, realistic, suggestions for EU help to the countries of Central and Eastern Europe (CEE)

by A. Wolfendale, President of the EPS

1. Conditions for CEE countries joining the EU should include a specific minimum for the Gross Expenditure on R&D/GDP ratio (1%?) for that country.

2. Specific advice should be given on how to make successful applications for funding from the Framework Programmes.

3. Every effort should be made to encourage Western European researchers to work in the countries of the CEE. There are 'centres of excellence' where unique apparatus is situated and - particularly in theory - groups with very special expertise.

4. Western European scientists benefiting from CEE researchers working in their countries should be required to itemise the help they are giving the CEE home base over and above that arising from the 'extra training' that the CEE researcher receives.

5. Special help should be given to CEE countries organizing International Conferences.

6. An analysis should be made by the EU of the loss to Europe of the take-over by non-European countries of research-based industries in CEE. Specific measures should be designed to minimise this loss.

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Testing discrete symmetries in K decays

P. DEBU – CEA Saclay – France
February 7, 2000

Discrete symmetries, P and C

When physicists try to lay down the laws that govern the processes they are studying, they use as a first guidance the most general properties of the system.

There are fundamental and universal examples. The laws of Nature are believed to be independent of the position of the observer, or of his orientation. One says that they are invariant by translation and rotation.

Consider now a simple experiment, like playing billiards. Imagine you are looking at the image of the game in a large mirror instead of looking directly at the billiard table. Would you be able to tell from the moves of the balls that you are looking at a virtual image? The answer is no. Laws of classical mechanics are obeyed by the mirror experiment. They are invariant under the transformation called Parity (P), which consists in changing the sign of spatial coordinates.

We say that classical mechanics respect the P symmetry.

Imagine that instead of looking at the billiards game in a mirror, you replace every piece of matter by antimatter. Could you tell the difference from the moves? The answer is again no. Laws of classical mechanics apply to antimatter. The operation which consists in replacing a particle by its antiparticle is called Charge Conjugation (C).

Classical mechanics respect the C symmetry.

Every particle has its corresponding antiparticle, which has the same mass but the opposite charge. This is the origin of the name Charge Conjugation. The antiparticle of the electron e^- is the positron e^+ . The antiparticle of the proton p is the antiproton \bar{p} . The proton is made of 3 quarks, 2 u quarks and 1 d quark. The antiproton is made of 3 antiquarks, 2 \bar{u} and 1 \bar{d} . The neutron is made of 3 quarks, 2 d quarks and 1 u quark. The antineutron is made of 2 \bar{d} and 1 \bar{u} . One can imagine building an antiworld from these elementary pieces. If the laws of Nature would be C symmetric, this antiworld could not be distinguished from the world we know. But they are not.

Weak interactions and violation of P and C symmetries

There are four known fundamental interactions between elementary particles. Gravitation is felt by all particles. Charged particles undergo electromagnetic interactions. The protons and the neutron are bound in nuclei by the strong interaction. Weak interactions transform quarks into one another and cause the β decays of unstable nuclei.

It was assumed for a long time that the fundamental interactions respect both P and C symmetries, but experimental observations led two theoreticians, T.D. Lee and C.N. Yang, to suggest in 1956 that P and C symmetries might be violated by the weak interactions. One year later, an experiment led by C.S. Wu, a detailed study of the β decay of Co^{60} in a magnetic field, brought indeed the proof that P symmetry was violated by weak interactions. Additional theoretical work showed that at the same time, the C symmetry was violated. However, it was also realized that the observed processes do respect the CP transformation, the one obtained by applying both the C and the P transformations. In other words, the virtual experiment obtained by looking at the original process in a mirror AND by replacing all particles by their antipartners would obey the known properties of weak interactions.

This was a very important observation.

Time reversal and CPT symmetry

There is a fundamental reason why CP symmetry plays a crucial role. It is indeed linked to the Time Reversal transformation (T).

This transformation consists in "looking" at an experiment backwards in time, like playing a movie backwards. Although, at the macroscopic level, one can immediately distinguish which is the real experiment and which is the reversed movie, this is not a priori the case at the microscopic level. Indeed, the laws of classical mechanics remain valid after Time Reversal.

Classical mechanics is an example of a

very successful theory for physics phenomena, valid for many human applications. What about the symmetry properties of the other theories? There is an important theorem, known as the CPT theorem, which states that, under very general assumptions, any theory of microscopic interactions must respect the CPT symmetry.

This means that in the present day theoretical framework of particle physics, it is believed that the laws of physics are invariant under CPT.

As a consequence, CP symmetry implies T symmetry, and vice-versa, because any CP violation should be compensated by some T violation to follow the CPT theorem.

The 1957 observation that CP symmetry still holds could be seen as a necessary consequence that microscopic phenomena obey the T symmetry.

CP violation

CP violation was discovered in 1964 in an experiment dedicated to the study of K^0 and \bar{K}^0 mesons. It was performed by J.H. Christenson, J.W. Cronin, V.L. Fitch and R. Turlay.

The K^0 is a particle made of an anti s quark (\bar{s}) and a d quark. Because weak interactions can change a strange quark into a non strange quark, both K^0 and \bar{K}^0 mesons can decay into the same final state of 2 pions, and moreover, by a succession of two weak processes, the K^0 can become a \bar{K}^0 and vice-versa!

During the propagation of the K mesons, a continuous $K^0 \leftrightarrow \bar{K}^0$ oscillation occurs. Were CP conserved, the propagating states would be the symmetric and antisymmetric states superpositions $K_1 = (K^0 + \bar{K}^0)/\sqrt{2}$ and $K_2 = (K^0 - \bar{K}^0)/\sqrt{2}$. The 2 pion state issued of a K decay being a CP even state, this decay would be allowed for the K_1 which is also a CP even state, and forbidden for the K_2 , which is CP odd.

Indeed, physicists observed both a short lived K meson, called K_S , decaying into 2 pions, and a 500 times longer lived K_L which could only undergo three body decays. The whole picture seemed consistent with the previous description.

The 1964 experimental demonstration of CP violation was the detection of K_L decays into 2 charged pions. Although this happened only rarely, about twice every thousand decays, it was a clear sign of CP violation in microscopic processes.

This came as a big surprise, but it was also soon realized, in 1967, by A. Sakharov, that CP violation is one of the necessary

conditions to explain why our universe is almost exclusively made of matter, although it starts from a symmetric state after the Big-Bang model.

This made CP violation even more fascinating.

At that time, it was necessary to introduce new types of interactions to implement CP violation in the theoretical framework. One very popular model was proposed by L. Wolfenstein in 1964. He introduced a so called superweak interaction, the strength and properties of which were such that CP violation was a small effect which could only be seen with the K mesons, and came solely through the $K^0 \leftrightarrow \bar{K}^0$ oscillation.

In 1973, M. Kobayashi and T. Maskawa showed that CP violation could also occur in weak interactions under the condition that at least 3 families of 2 quarks exist. Today, the existence of 6 quarks is established (the heaviest one, the t quark, has been discovered in 1995), but at that time, only the existence of 3 quarks was postulated. This is a noticeable theoretical insight.

The presence of three families of quarks allows the introduction of one single parameter in the theory which causes CP violation. The test of such a model requires several independent observations of CP violation.

Direct CP violation

CP violation seen with the K mesons can occur in 2 different ways.

It has been established that the K_L state is not the pure antisymmetric state K_2 , but rather an admixture of K_1 and K_2 :

$$K_L = K_2 + \epsilon K_1$$

This small impurity ($\epsilon \approx 2 \cdot 10^{-3}$) allows the K_L to decay into 2 pions. This is referred to as CP violation in the mixing. While the introduction of this ϵ parameter allows a proper phenomenological description of the observations, it brings no understanding of the origin of CP violation.

However, in the standard model of weak interactions with 3 families, CP violation can also occur directly in the decay of the K_2 itself. This is called CP violation in the decay, or direct CP violation. Contrarily, the superweak model of L. Wolfenstein does not allow such a decay.

Many experiments have been launched already in the late 60's to search for direct CP violation. It can be detected through a tiny difference between decays in 2 charged pions and 2 neutral pions. This difference is parametrized by a very small quantity ϵ' , which can be measured by using the very simple relation :

Although it is in principle possible to compute the value of ϵ'/ϵ in the standard model, it is in practice a very difficult task. Most theorists give estimates in the range of a few 10^{-4} for the ratio ϵ'/ϵ .

In 1988, a first evidence for the existence of direct CP violation was published by the NA31 collaboration at CERN [1] :

$$\epsilon'/\epsilon = (3.3 \pm 1.1) \cdot 10^{-3}$$

Later, their american competitors, E731 at FNAL, published [2]:

$$\epsilon'/\epsilon = (7.4 \pm 5.9) \cdot 10^{-4}$$

The NA31 completed their experiment and obtained in 1993 [3] :

$$\epsilon'/\epsilon = (2.3 \pm .65) \cdot 10^{-3}$$

This experimental situation, two results hardly compatible, did not allow to conclude. This led the two groups to launch more precise experiments, E832 at FNAL and NA48 at CERN.

$$\frac{\text{decay rate of } K_L \rightarrow \pi^+ \pi^-}{\text{decay rate of } K_S \rightarrow \pi^+ \pi^-} / \frac{\text{decay rate of } K_L \rightarrow \pi^0 \pi^0}{\text{decay rate of } K_S \rightarrow \pi^0 \pi^0} \approx 1 - 6\epsilon'/\epsilon$$

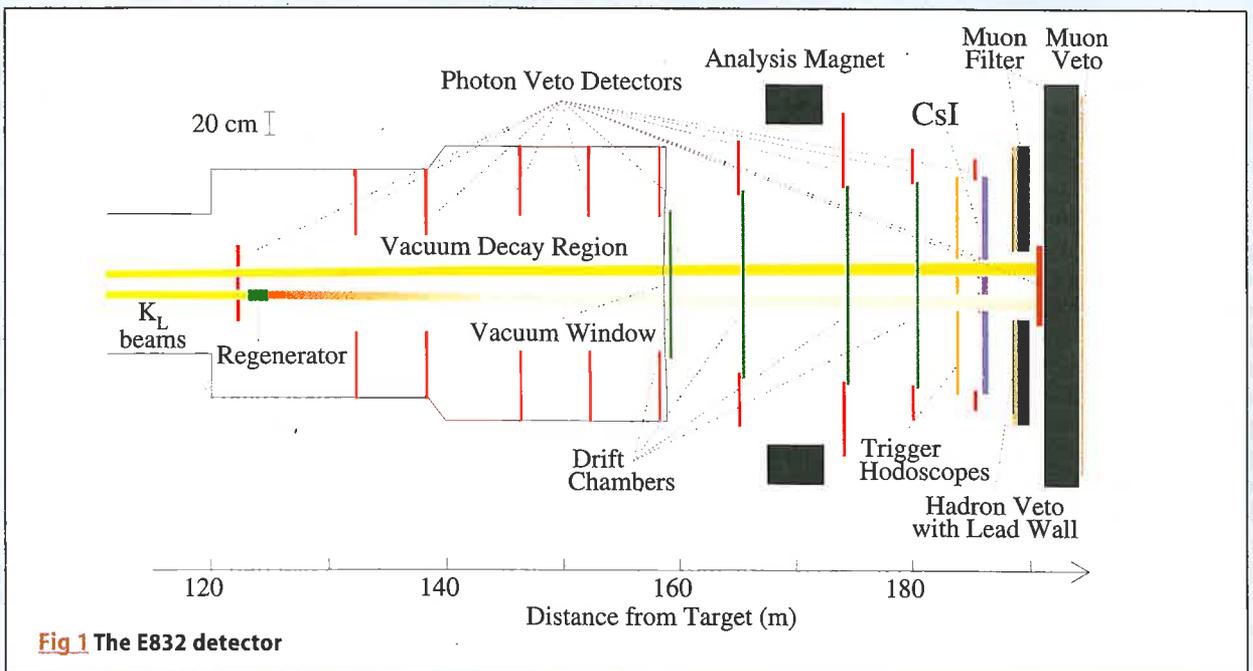


Fig 1 The E832 detector

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EUROPEAN PHYSICAL SOCIETY

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Ripple topography of ion beam eroded graphite: A key to ion-beam-induced damage tracks – S. Habenicht, W. Bolse, H. Feldermann, U. Geyer, H. Hofsäss, K. P. Lieb and F. Roccaforte

The Mott-Hubbard transition and the paramagnetic insulating state in the two-dimensional Hubbard model – F. Mancini

Distinct roles of the triplicated ZnCl₄ tetrahedra in phase soliton formation and residual commensurations in K₂ZnCl₄ – Dong Keun Oh, Young Man Kwon, Cheol Eui Lee and S. Y. Jeong

Single-particle mean kinetic energy in low-density supercritical ⁴He – D. Colognesi, C. Andreani and R. Senesi

Polycontinuous morphologies and interwoven helical networks – S. T. Hyde and S. Ramsden

Pseudo-contact angle due to superfluid vortices in ⁴He – R. Luusalo, A. Husmann, J. Kopu and P. J. Hakonen

Collapse of cavitation bubbles in blood – E. A. Brujan

Comment on "Propagator of the Fokker-Planck equation with a linear force—Lie-algebraic approach" by C. F. Lo – P. Demo, A. M. Sveshnikov and Z. Kozisek

Nucleation and growth in order-to-order transitions of a block copolymer – G. Floudas, R. Ulrich, U. Wiesner and B. Chu

Statistical mechanics of point particles with a gravitational interaction – M.-L. Chabanol, F. Corson and Y. Pomeau

π -shifted magnetoconductance oscillations in mesoscopic superconducting-normal-heterostructures – V. N. Antonov, H. Takayanagi, F. K. Wilhelm and A. D. Zaikin

Transmission and reflection of waves by an anharmonic interface – Z. Odziana and P. Zieliński

Plasmon and charge quantization effects in a double-barrier quantum wire – A. Braggio, M. Grifoni, M. Sasseti and F. Napoli

Phonon-like and singlet-particle dynamics in liquid lithium – T. Scopigno, U. Balucani, A. Cunsolo, C. Masciovecchio, G. Rocco, F. Sette and R. Verbeni

Note on irreducible approach to reducible second-class constraints – C. Bizdadea, A. Constantin and S. O. Saliu

An experimental challenge

The smallness of the quantity to be measured implies very stringent constraints on the experiments. In excess of ten millions of K to 2 pion decays must be recorded to reach an accuracy of less than 10^{-4} on ϵ'/ϵ , which is necessary to match the predicted range of values.

Intense beams of neutral particles need to be produced. Both types of mesons, K_L and K_S , must be produced and identified, and both types of decays, $\pi^+\pi^-$ and $\pi^0\pi^0$, reconstructed. Detectors must stand a flux of several hundreds kHz of particles during several months. A very powerful selection of the few percent of interesting decays must be applied to reduce the amount of data to be recorded.

The major difference between the American and the European experiment is the production and the identification of the K mesons. In the former (fig. 1), high energy protons hit a single target, and collimators are used to define 2 beams of neutral particles. One of the beams is intercepted by a block of matter which allows the production of short lived K mesons near the detector, while long lived mesons remain in the matter free beam. In the latter (fig. 2), two targets are used to produce the K mesons. One is situated about 200m upstream of the detector, so that only K_L decays can reach the detector. The second target is 100m downstream, and from which accepted K_S decays are dominant.

The most difficult decay to detect, reconstruct and disentangle from background events is the $K_L \rightarrow 2\pi^0$ decay. Both π^0 decay immediately into 2 gamma rays, so that the final state only consists in 4 neutral particles. The master piece of both the American and the European detectors is the electromagnetic calorimeter, dedicated to the detection and measurement of the energy and position of the gamma rays.

The American calorimeter (fig. 3) is an assembly of about 3100 pure CsI crystals. Showers of particles are created by the interactions initiated by the incident gamma rays, and these particles produce Cerenkov light in the crystals. The amount of light detected is a measure of the deposited energy.

The NA48 collaboration built a liquid krypton calorimeter, a tank of about 10m³ embedded in a cryostat to keep the krypton liquid. In this case, this is the ionisation of krypton atoms induced by the showers of particles which is detected by applying a high voltage between immersed electrodes. The electrode structure has a useful aperture of about 2.4m and

consists in about 26000 CuBe ribbons very precisely positioned, which define 13000 readout cells (fig. 4).

The detection and reconstruction of K decays into charged particles is made with a spectrometer consisting of 4 drift chambers and a dipole magnet. Additional counters and detector elements are used for fast detection purposes and background rejection.

Even after the online filtering of K decays by a farm of processors, both experiments have to record about 100 TByte per year at a sustained rate of a few Mbyte/s during several months!

Both teams have announced their first result obtained with a partial data set [4, 5]:

$$E832 : \epsilon'/\epsilon = (28.0 \pm 4.1) 10^{-4}$$

$$NA48 : \epsilon'/\epsilon = (14.0 \pm 74.3) 10^{-4}$$

The American result is surprisingly high in view of the previous results. Taken all together, the NA31, E731, E832 and NA48 measurements lead to the average: $\epsilon'/\epsilon = (19.2 \pm 2.5) 10^{-4}$.

While this set of results demonstrates the existence of direct CP violation, this spread of values is uncomfortable.

The additional data of E832 and NA48 should bring extremely valuable information. Moreover, a new experiment, KLOE at Frascati in Italy, has just started. It should produce another measurement of ϵ'/ϵ using a completely different technique.

If a high value of ϵ'/ϵ is confirmed, this might be an indication for sources of CP violation outside the standard model.

T violation and CPT tests with K mesons

As was mentioned in the introduction, K mesons are a superposition of K^0 and \bar{K}^0 which transform into each other during propagation.

The CPLEAR experiment at CERN was able to measure a tiny difference between the probability of a K^0 to become a \bar{K}^0 at a time t and that of the reversed process.

In this experiment, K^0 and \bar{K}^0 are produced through the reactions $p\bar{p} \rightarrow \pi^+ K^+ K^0$ and $p\bar{p} \rightarrow \pi^- K^- K^0$. The antiprotons are extracted from the Low Energy Antiproton Ring at CERN, and stopped in a hydrogen target at the center of the detector. Detecting the K^+ (resp. K^-) identifies the K^0 (resp. \bar{K}^0) production. The decays $K^0 \rightarrow \pi^- e^+ \nu_e$ and $\bar{K}^0 \rightarrow \pi^+ e^- \bar{\nu}_e$ allow the identification of the decaying K meson with the sign of the emitted electron. It is observed that the probability that a K^0 is produced initially and oscil-

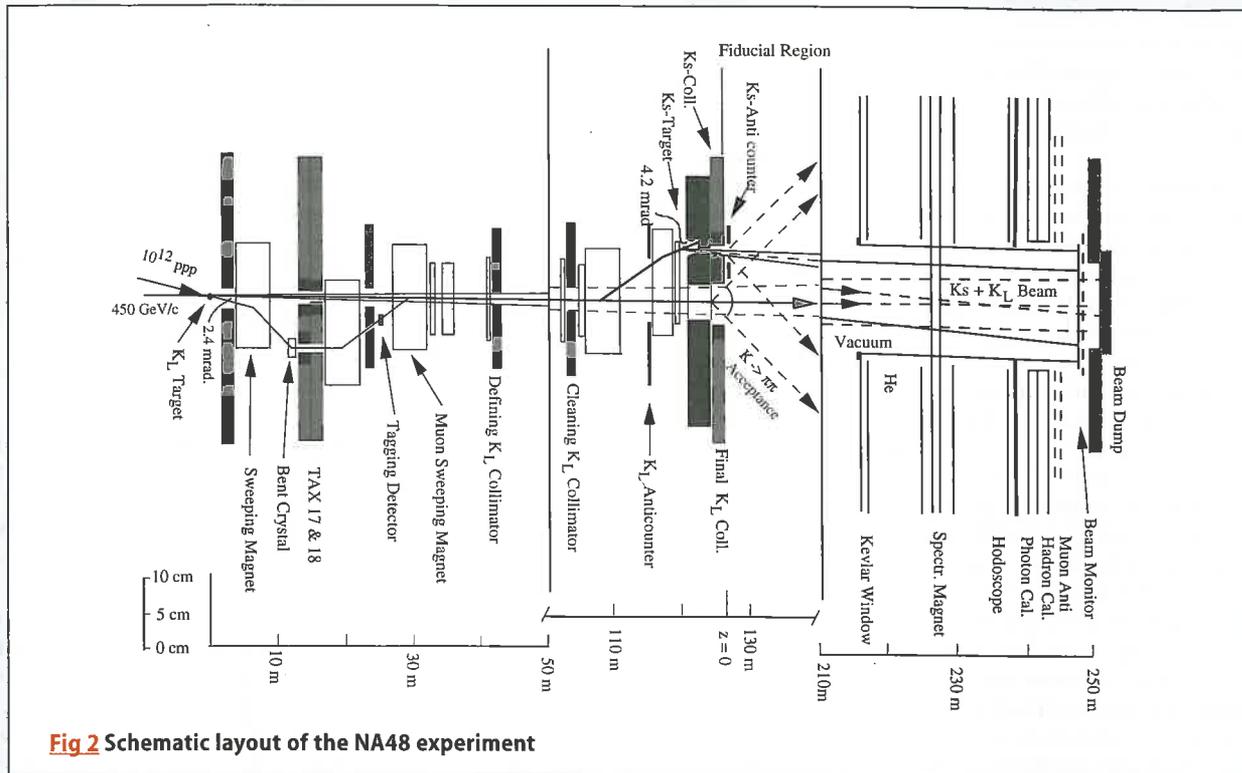


Fig 2 Schematic layout of the NA48 experiment

lates into a \bar{K}^0 decaying by emitting an electron is different from that of the process where the K^0 and \bar{K}^0 are exchanged (a positron being emitted in that case).

The relative difference is small, $(6.6 \pm 1.6) \cdot 10^{-3}$ [6], but significant. This is a direct evidence for a microscopic violation of the Time Reversal symmetry.

Another outstanding result of CPLEAR is a comparison between the masses of the K^0 and the \bar{K}^0 , $\Delta m/m = (-3 \pm 4) \cdot 10^{-18}$ [7]. This is the most precise test of the CPT symmetry, which implies that particles and antiparticles should have the same mass.

These recent results show that the K meson system provides an invaluable opportunity to test the fundamental properties of physics laws.

These opportunities are far from being exhausted. The previously mentioned KLOE experiment will pursue very detailed tests of quantum mechanics and discrete symmetries. In a longer term, experiments are proposed at BNL (Brookhaven National Laboratory), FNAL (Fermi National Laboratory near Chicago), KEK (High Energy Physics Laboratory in Japan) and CERN (European Laboratory for Particle Physics) to study rare K

decays to allow very stringent tests of CP violation and the standard model framework. Sensitivities to decay probabilities well below 10^{-10} are considered.

CP violation and B mesons

B mesons are similar to K mesons, but the b quark plays the role of the s quark. In the Standard Model, there are three families of 2 quarks : (u,d), (c,s), (t,b). Weak interactions allow transitions between up type quarks (u,c,t) and down type quarks (d,s,b). There are very precise relations between these transitions if indeed only 3 families of quarks exist. As a consequence, and because in the Standard Model CP violation arises from these transitions, CP violation processes in the K system translate into CP violation processes in the B system. This is a very strong prediction of the theory, which must be tested.

Two dedicated experiments have just started : BABAR at SLAC (Stanford Linear Accelerator Center, USA), and BELLE at KEK.

There is one big difference between B mesons and K mesons, which makes their study more difficult. The B mesons are about 10 times heavier, and thus can decay into many different channels and have a very short life time (about 10^{-12} s!). The

observation of $B \leftrightarrow \bar{B}$ oscillation and decay is quite hard. B's must be produced with sufficient energy so that the relativistic expansion of their life time let them travel for several hundred of micrometer before decaying.

The BABAR and BELLE detectors are attached to asymmetric e^+e^- colliders. The positron and electron beams have different energies. A resonant $b\bar{b}$ state is produced and decays into a pair of B mesons.

CP violation in the B system is expected to be observed in many different ways, either directly or via the $B \leftrightarrow \bar{B}$ oscillation.

Although all decay modes are rare, the expected CP violation effects can be large. A popular example is the decay $B \rightarrow J/\psi K_S$, for which the asymmetry between B and \bar{B} oscillation and decay rate could be of order 60%.

B meson production is much higher with hadronic colliders, but the selection and reconstruction of interesting decays is much more efficient at an e^+e^- collider. About thirty millions $b\bar{b}$ could be produced per year at SLAC or KEK for BABAR and BELLE, to be compared with two hundreds billions at the $p\bar{p}$ FNAL collider for each of the 2 experiments called CdF (Collider Detector at Fermilab) and D⁰. However, about one thousand

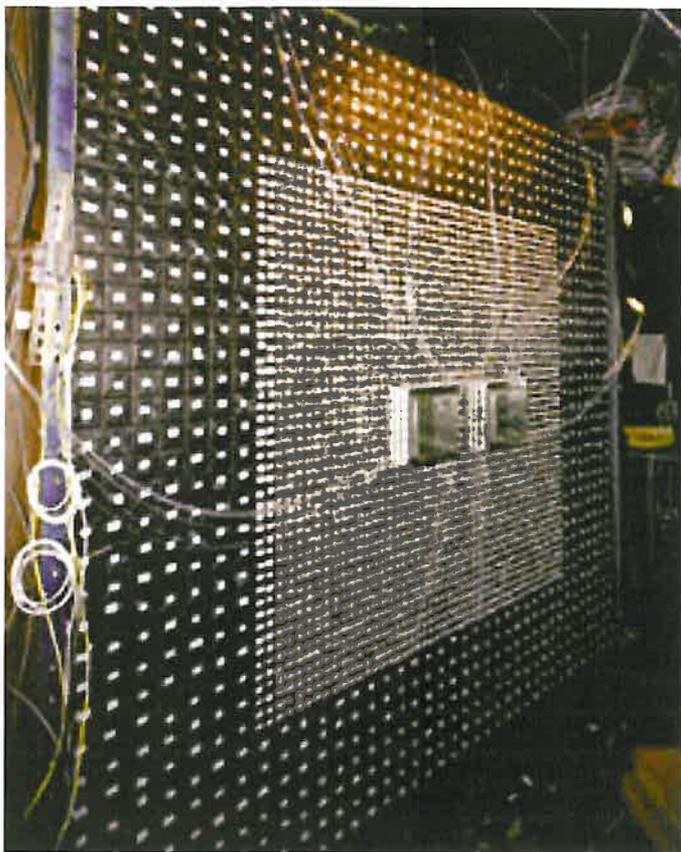


Fig 3 The E832 CsI calorimeter front face

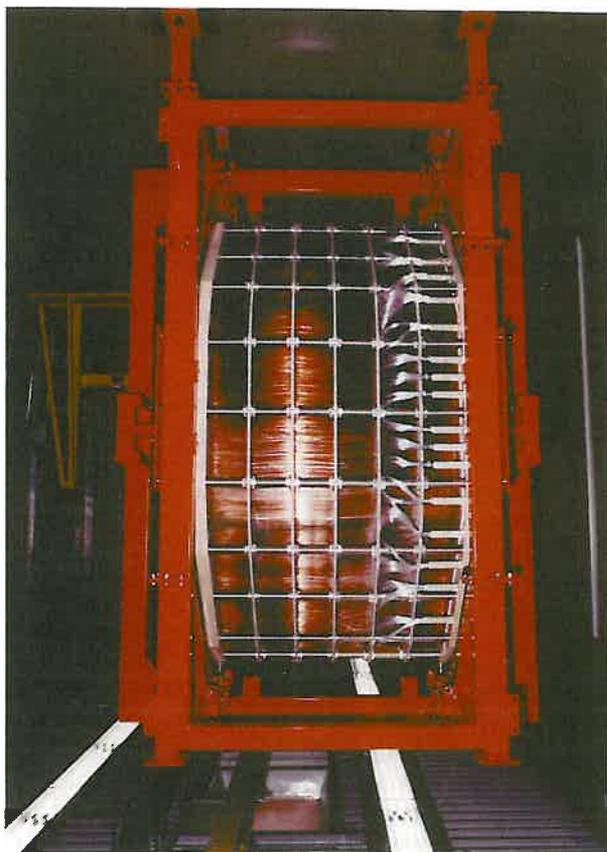


Fig 4 The electrode structure of the NA48 liquid krypton calorimeter

$B \rightarrow J/\Psi K_S$ decays can be used for analysis in the former case, and only fifteen thousands in the latter, which is relatively much less.

In spite of the very difficult extraction of interesting events, CdF has already attempted a measurement of one CP violation parameter in the B system. However, the uncertainty is too large to draw any conclusion yet. An experiment at DESY (high energy physics laboratory near Hamburg), HERA-b, is about to start, and is one of the competitors in this opening field.

In the long term, extensive studies of B physics will be performed by experiments in preparation for the Large Hadron Collider in construction at CERN, and at the BTeV dedicated program at FNAL, if it is accepted.

Conclusion

A very important experimental step has been recently reached with the demonstration of direct CP violation in K decays, as expected in the Standard Model of particle physics.

The next step is to challenge this mod-

el with the B system. First results will come very soon and with increasing precision in the following years.

In a longer term, extremely K decays could provide additional theoretically very clear tests of the standard model paradigm for CP violation and one hopes to reveal surprising effects.

In parallel with this program of refining the Standard Model confrontation with experiment, another path must be followed. Indeed, it is widely accepted that the standard explanation for the CP symmetries seen with K mesons is not at all sufficient to allow for the observed matter-antimatter asymmetry in the universe. As a consequence, one should also look for CP violation in places where it is not expected or expected to be very small. Examples are the study of charmed mesons (mesons similar to K's and B's but with a c quark instead of the s or b quark) and Λ hyperons decays, the measurement of the electric dipole moment of the neutron, the spectroscopy of the antihydrogen atom.

Each of these fascinating experimental challenges offers strong perspectives to deepen our understanding of fundamen-

tal (a)symmetries of Nature.

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An international team of physicists from Helsinki, Leiden, Moscow and Grenoble have observed a double-quantum vortex in superfluid helium-3 for the first time

Unconventional quantum systems and quantized vortex lines

Soon after the discovery of the ^3He superfluids in 1972 it was understood that they represented the first example of unconventional Cooper pairing among Fermi systems, namely a p-wave state with total spin $S=1$ and orbital momentum $L=1$. This led to a wide variety of new phenomena, of which one of the most important is the discovery of new vortex structures. In recent years other unconventional quantum systems have been found and have taken the centre stage. Intermetallic alloys such as the heavy fermion metals, the ceramic high-temperature superconductors, and the most recent addition, the layered superconductors of Sr_2RuO_4 type, do not fit in the conventional picture of s-wave pairing. Is it possible that unconventional vortex structures, similar perhaps to some of those in the ^3He superfluids, might also be present in these new systems?

In fact current belief holds that the superconducting state in the tetragonal Sr_2RuO_4 material is described by an order parameter of the same symmetry class as that in $^3\text{He-A}$ [1, 2], an anisotropic superfluid with uniaxial symmetry (where both time reversal symmetry and reflection symmetry are spontaneously broken). Recent advances in optical trapping and cooling of alkali atom clouds to Bose-Einstein condensates has produced Bose systems which also are described by a multi-component order parameter: The spinor representation of the hyperfine spin manifold $F=1$, for instance, would allow the presence of similar vorticity as in $^3\text{He-A}$.

Thus the existence of unconventional vorticity has moved in the centre of interdisciplinary debate: To what extent will reduced symmetry influence the structure of quantized vorticity? Vortex lines are defects of the order parameter field, which carry phase winding and circulation of the respective supercurrent. The conventional structure is built around a narrow (it singular hard vortex core) within which the order parameter deviates in magnitude from that outside. In s-wave superconductors or superfluid ^4He the order param-

eter vanishes in the center of the core. In some approximation such a core can be pictured to be a tube which has a diameter comparable to the coherence length of the superfluid state and which is filled with normal-state material.

One of the most striking realizations from ^3He research is the existence of vortices with continuous or coreless structure, sometimes also called skyrmions. In such a vortex the order-parameter amplitude remains constant throughout the whole structure. If there is a region of concentrated vorticity, as is the case in higher magnetic fields, it is called the *soft vortex core*. The phase winding around the soft core is supported by an inhomogeneous orientational distribution of the order-parameter vector within the core. These order-parameter orientations are depicted by the cones in Fig. 1 [3]. By following their flow it is seen that all possible 4π directions of the radius vector of the unit sphere are present there. This topology of the order parameter orientations ensures two quanta of circulation, which corresponds to the rotation of the cone around its symmetry axis by 4π when one follows the cones once around the outer edge of Fig. 1

Here in an anisotropic superfluid there is an extra degree of freedom available for the order parameter to make use of, namely the orientation of the orbital momentum of the Cooper pairs. The simplest possible vortex structure then becomes this doubly quantized vortex line. It also corresponds to a critical field or velocity which is an order of magnitude smaller than that of a conventional vortex with a singular hard core. The characteristic NMR signal from these two-quantum vortices has been known since 1983, but it is only recently that single-vortex sensitivity was reached and the quantization number was verified with direct measurement [4]

The first vortices have now been discovered in alkali Bose-Einstein condensates [5, 6], but it appears that these do not have perfectly continuous structure. Nor

does this appear to be the case for the vortices which have so far been identified in unconventional superconductors. In $^3\text{He-A}$ there exists also a singly-quantized vortex where a narrow singular hard core lies embedded within a much larger soft core. Such a structure also evolves in the isotropic $^3\text{He-B}$ superfluid at higher magnetic field values. Perhaps a similar object could explain why in the heavy fermion superconductor UPt_3 a three times larger flux-flow resistivity is observed parallel to the c axis compared to the perpendicular directions.

In $^3\text{He-A}$ the doubly-quantized vortex in Fig. 1 is not the only new vortex structure with perfect continuity in the order parameter amplitude. A topologically different, but also continuous structure is the vortex sheet. It consists of a folded domain-wall-like structure which separates regions with opposite orientations of the order parameter. Into this meandering wall vortex lines are confined. These form a chain of alternating circular and hyperbolic kinks, which are the two constituents of the soft core in Fig. 1, each with a 2π distribution of orientations. The vortex sheet is attached at least along two connection lines to the lateral boundaries. It is through these connection lines that the 2π vortex quanta can enter or leave the sheet. Its critical field is even lower than that of separated continuous vortex lines. The vortex sheet has been discussed in unconventional superconductors [7] in a context where an isolated vortex line would be singly quantized and the kinks in the sheet would represent half of one quantum.

The half-quantum vortex itself is an unusual object. Here the phase winding by π around this line produces a change of sign of the order parameter, which may be compensated by some extra degree of freedom, which usually is the spin. It was originally predicted to appear in $^3\text{He-A}$ [8] but has not yet been discovered there. Later it was also predicted to appear in high- T_c superconductors [9] and was some years ago found at the intersection line of three grain boundary planes [10] The half-

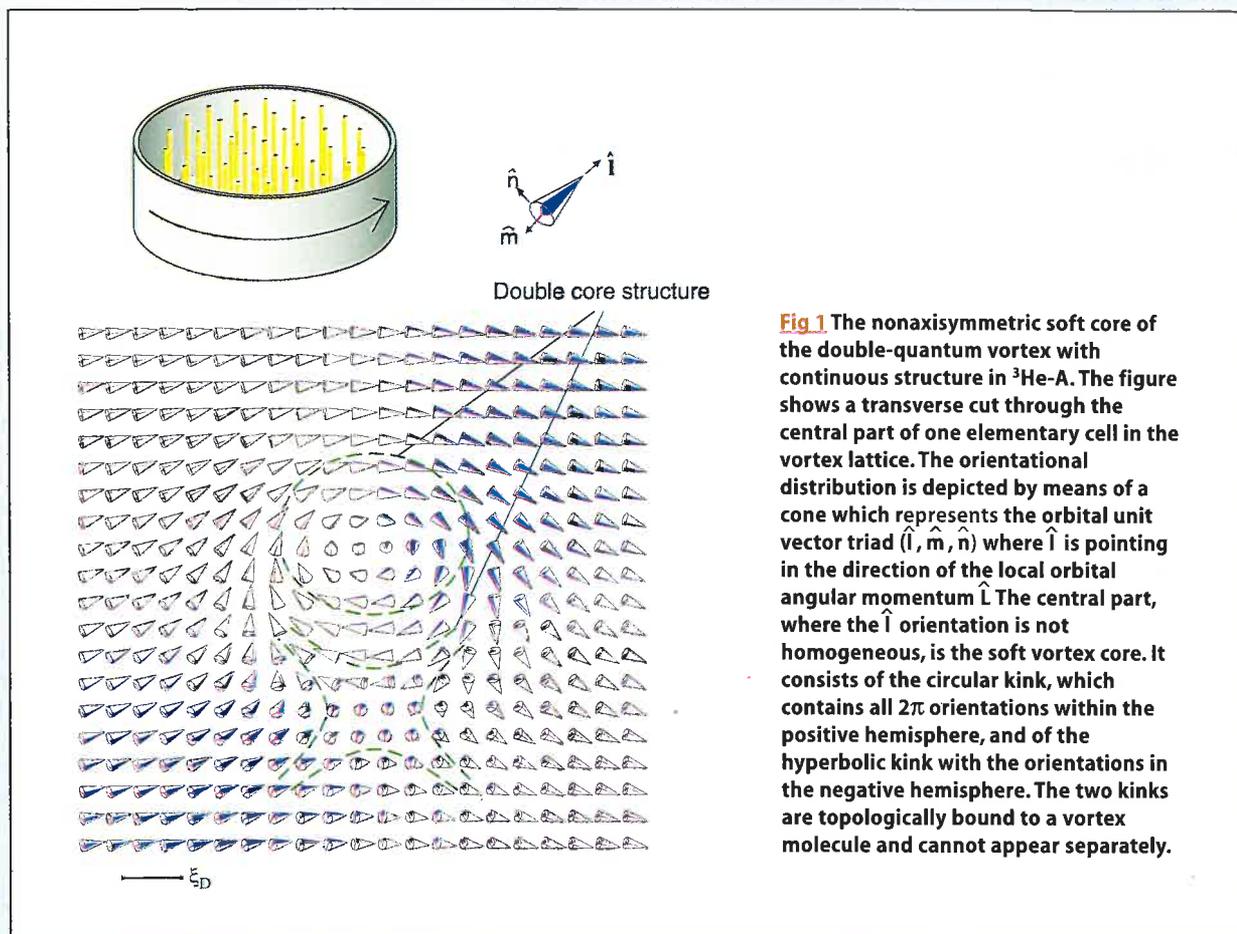


Fig 1 The nonaxisymmetric soft core of the double-quantum vortex with continuous structure in $^3\text{He-A}$. The figure shows a transverse cut through the central part of one elementary cell in the vortex lattice. The orientational distribution is depicted by means of a cone which represents the orbital unit vector triad $(\hat{l}, \hat{m}, \hat{n})$ where \hat{l} is pointing in the direction of the local orbital angular momentum \hat{L} . The central part, where the \hat{l} orientation is not homogeneous, is the soft vortex core. It consists of the circular kink, which contains all 2π orientations within the positive hemisphere, and of the hyperbolic kink with the orientations in the negative hemisphere. The two kinks are topologically bound to a vortex molecule and cannot appear separately.

quantum vortex should also exist in Bose-Einstein condensates with a hyperfine spin $F=1$ [11]

A broader understanding of quantized vorticity in different macroscopic quantum systems promises to lead to surprising consequences. The discovery of gap nodes in the spectrum of quasiparticle excitations is generally taken to be a signal for unconventional pairing in Fermi systems. An important observation from recent years is the fact that in the vicinity of these gap nodes the energy spectrum is linear and the system acquires all the attributes of relativistic quantum field theory: the analogues of Lorentz invariance, gauge invariance, general covariance, etc. all are present. Therefore fermion superfluids and superconductors on one hand and quantum field theory on the other hand show surprising conceptual similarity. This makes it possible to treat the condensed-matter quantum systems as laboratory models to study physical principles which might also be effective in high energy physics or cosmology. The first ex-

amples of such work have been seen in "cosmological" laboratory experiments. For instance, it was recently demonstrated that quantized vortex lines, or topological defects as they are known in field theory, are produced in quench-cooled transitions from the normal to the superfluid/superconducting state, which might mimic the production of cosmic strings in Big-Bang expansion [12] A second effort was related to the dynamics of vortex lines and was employed to explain the matter-antimatter asymmetry in the Early Universe [13] if it is assumed to result from the axial anomaly of relativistic field theory. Relativistic quantum field theory may just have found itself an unexpected accomplice!

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Did the great experimentalist doctor his own findings to suit his beliefs?
Perhaps not, as a close look at his beliefs reveals.

Millikan's struggle with theory

Gerald Holton

In 1916 Millikan published his experimental determination of the value of Planck's constant, with remarkable precision. It was later cited as part of his Nobel Prize award. But as a study of that paper together with Millikan's subsequent comments over the years reveal, he initially refused to accept the interpretation of the theoretical meaning of his work, as seen from the perspective of a present-day physicist. Yet, over time, Millikan adjusted his view retroactively to accept the meaning of what he had done – namely to provide crucial support for Einstein's heuristic point of view on the quantum theory of light (1905). This case also serves as a test whether scientists, as is now often alleged, as a rule arrange to obtain their results in the light of their own beliefs.

Robert A. Millikan's historic paper of 1916 in *Physical Review* on the measurement of Planck's constant (A Direct Photoelectric Determination of Planck's h ; *Physical Review* [1]) lends itself to two different yet complementary readings—first through the eyes of a physicist of today, second by an historian of science, reconstructing the dramatic meaning the paper had in its own time.

To a physicist Millikan's paper is a patient and eloquent essay on how he came to the conclusion that has been in our physics textbooks ever since: While it had been known for a long time that light falling on metal surfaces may eject electrons from them (the photoelectric effect), Millikan was the first to determine with great accuracy that the maximum kinetic energy of the ejected electrons obeys an equation equivalent to the one Einstein had proposed in 1905, namely $\frac{1}{2}mv^2 = h\nu - P$, where h is Planck's constant, ν the frequency of the incident light, and P "the work necessary to get the electron out of the metal" in Millikan's words. Moreover, Millikan determined h to have the value 6.57×10^{-27} erg-sec, "with a precision of about 0.5 per cent"—a value far better than had been obtained previously

by any other experimenter.

Several factors were responsible for the success of the experiment, performed at the Ryerson Laboratory of the University of Chicago. First of all, Millikan's use of an ingenious device he termed "a machine shop in vacuo," assembled thanks to "the skill and experience of the mechanic, Mr. Julius Pearson". Essentially, the device allowed a rotating sharp knife, controlled from outside the evacuated glass container by electromagnetic means, to clean off the surface of the metal used (sodium, potassium, lithium) before exposing it to the beam of the fairly monochromatic light coming from a quartz-mercury lamp. Second, the frequencies of light Millikan used covered a much larger span, between 2399 Å, and 5461 Å, than had been achieved previously, permitting the relation of the kinetic energy of the electron and the frequency of light to be determined with a "maximum uncertainty" of 0.5%. In addition, the kinetic energies of the photoelectrons were found by measuring the potential energy V_e of the electric field needed to stop the electrons—and there Millikan was in the excellent position of being able to confidently use the value for the charge e of the electron he had published in 1913 with unprecedented accuracy, obtained with his oil drop experiment.

Last but not least, shining through it all were Millikan's typical characteristics as experimenter and person: His penchant for experimenting in an area involving the hottest question of the day – in this case the value of a fundamental constant of nature (as he had done in his 1913 paper) and, as we would now put it, the quantum theory of light; his energetic persistence – this paper was the culmination of work he had begun in 1905; his passion for obtaining results "with very great precision" (Fig. 1) – even at the cost of some practices that are perhaps questionable from our current perspective, for instance, his frank remark that to get the curves derived from his experimental results to intersect cor-

rectly at the ordinates, he decided "simply to cut the feet off" where those curves were trailing on too far.

In short, a triumphant work by a superbly confident scientist, of highest importance in its day, and richly deserving to be cited as part of his Nobel Prize award in 1923, "for his work on the elementary charge of electricity and the photoelectric effect". If historically minded scholars look through that 1916 volume of the *Physical Review* in which Millikan's paper appeared, they will notice that physics in America at that time was still a mixed bag. One finds in the volume a number of contributions by scientists such as A.H. Compton, P.W. Bridgman, Irving Langmuir, E.C. Kemble, among others (with A.A. Michelson listed on the Board of Editors). Their papers show that the main attention was the experimental part of science, in which Americans were regarded as most interested and competent. But the volume as a whole, published in monthly parts of some 200 pages each on average, indicates that a good deal of the work going on in physics in the US in the early years of this century was still narrow and unambitious, even tending to descend to lengthy descriptions of improvements in power supplies, pumps, galvanometers, and the like.

Next, on looking at the early pages in that same volume, and the segment published two months earlier in January 1916, we come upon another article by Millikan, on the same subject, in which the very first sentence announces Millikan's opinion that "Einstein's photoelectric equation... cannot in my judgment be looked upon at present as resting upon any sort of a satisfactory theoretical foundation," even though "it actually represents very accurately the behavior" of photoelectricity (p. 18).

Indeed, knowing this, and rereading Millikan's subsequent (March 1916) paper on Planck's constant, we see more clearly that he is emphatically distancing himself throughout from Einstein's attempt in

1905 of what Millikan calls a “coupling of photo effects ... with any form of quantum theory” (p. 355). What we now refer to as the photon was, in Millikan’s view, a “bold, not to say reckless, hypothesis” – reckless both because it was contrary to such classical concepts as light being a wave propagation phenomenon, and because of the “facts of interference” (p. 355). In the background we glimpse the presence of Michelson, the “Artist of Light,” who was Millikan’s admired patron and colleague at the Ryerson Laboratory, the 1907 Nobelist, famous for his interferometers, the work carried out with their aid – and for his adherence to ether physics until his death in 1931.

So Millikan’s paper is not at all, as we might now naturally consider it to be, an experimental proof of the quantum theory of light. Although Millikan admits that the facts seem “to demand some modification of classical theory,” (p. 355) that is not what he is willing to attempt here. And in truth, Einstein himself, from the beginning, was not comfortable with the quantum theory of light, calling it, in a letter of May 1905 to his friend Conrad Habicht, “very revolutionary.” It was the only time

he so characterized any of his work, using the phrase because his was still only a “heuristic” proposal, devoid of sufficient theoretical grounding.

As it happened, Millikan was in Europe in 1912 for six months, primarily to meet the foremost physicists, and particularly to attend in Berlin Planck’s lectures on his theory of heat radiation. He also took the opportunity in June 1912 to lecture on the results of his oil drop experiment before the Deutsche Physikalische Gesellschaft. Planck was delighted with this relative newcomer who was bringing the best available value for the charge of the electron at the time, which fitted well with Planck’s own deduction of e from his formula for radiation. Two of the most important universal constants, h and e , were finding common ground through this personal encounter.

On returning to the United States, Millikan gave a lecture in December 1912 at the Cleveland joint meeting of the American Association for the Advancement of Science and the American Physical Society, in which he clearly regarded himself as the proper presenter of Planck’s theory of radiation. Millikan compared the various

forms of quantum theory then being discussed, siding with the “least concentrated,” namely that of Planck, as against “the most concentrated,” that of Einstein, which he called “radical” because it could not be reconciled with “the facts of diffraction and interference, so completely in harmony in every particular with the old theory of ether waves.” Indeed, he confessed a corpuscular theory of light was for him “quite unthinkable”. In short, Millikan’s classic 1916 paper was purely intended to be the verification of Einstein’s equation for the photoelectric effect and the determination of h , without accepting any of the “radical” implications which to us now seem so natural.

Recently opened records of the Nobel Prize Foundation show that from 1916 on, Millikan was nominated constantly. When the award at last came to be in 1923, his Nobel address of May 23, 1924, contained passages that showed his continuing struggle with the meaning of his own achievement: “After ten years of testing and changing and learning and sometimes blundering ... this work resulted, contrary to my own expectation, in the first direct experimental proof ... of the exact validity,

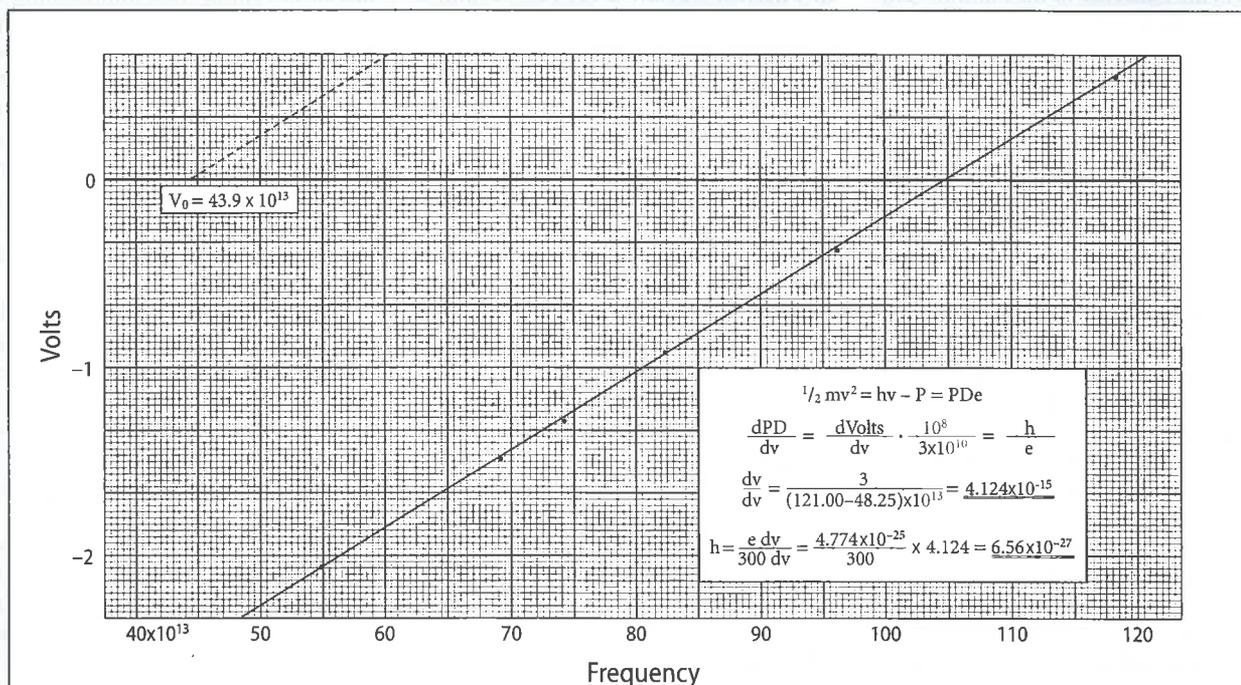


Fig 1 Taken from p. 373 of Millikan’s 1916 article, Ref. 1, it is the key figure in that paper. It shows how he calculated h from the slope of the graph plotting the observed stopping potentials versus the light frequencies. As in a similar crucial figure in his 1913 paper on finding the value of e , one notices how small the deviations of the readings are from the straight line – and how casual Millikan was about giving the units of calculated values (then still a practice among many physicists).

within narrow limits of experimental error, of the Einstein equation and the first direct photo-electric determination of Planck's h ." In fact it is difficult to find any published basis in Millikan's experimental papers of that struggle with his own expectations. His internal conflict was of a somewhat different sort, as can be read in a later passage of that same speech: "[T]he general validity of Einstein's equation is, I think, now universally conceded, and to that extent the reality of Einstein's light-quanta may be considered as experimentally established. But the conception of localized light-quanta out of which Einstein got his equation must still be regarded as far from being established." [Emphases in original.] These sentiments would not have shocked his audience in Stockholm, for Einstein had received the Nobel Prize in 1922, "especially for his discovery of the law of the photoelectric effect," excluding both relativity and quanta. Ironically, it had been Millikan's experiment which convinced the experimentalist-inclined committee in Stockholm to admit Einstein to that select circle.

Two final ironies: In 1950, at age 82, Millikan published his Autobiography. Chapter 9 is entitled simply "The Experimental Proof of the Existence of the Photon - Einstein's Photoelectric Equation." By then, Millikan had of course come to terms with the photon. Moreover, he had changed his mind about what he had done around 1916. For now, he wrote (pp. 101-102) that as the experimental data became clear in his lab, they "proved simply and irrefutably, I thought, that the emitted electron that escapes with the energy $h\nu$ gets that energy by the direct transfer of $h\nu$ units of energy from the light to the electron [emphasis in original] and hence scarcely permits of any other interpretation than that which Einstein had originally suggested, namely that of the semi-corporeal or photon theory of light itself." In the end, Millikan re-imagined the complex personal history of his splendid experiment to fit the simple story told in so many of our physics textbooks [2].

The other irony emerging from this story concerns the fact that, as one of my personal correspondents has put it so well, "In the current deconstruction of science by non-scientists, much is made of the tendency of researchers to ask the questions and analyze results in the light of their own beliefs. Millikan's paper is an excellent counter-example, being clearly a case of someone doing superlative work in establishing a result from a theory in which he himself clearly had little faith. In this

case at least, the carefully established facts spoke for themselves through a very sceptical scientist". Millikan is only one of countless examples of that sort. Planck himself, from 1900 on, was among the most conservative and hesitant of the interpreters struggling with the quantum theory. His motivation was completely orthogonal to his findings [3]. What did appeal to him about his result that now bears his name, and which Millikan was the first to measure with great precision, was Planck's hope to have found a constant of nature that would be absolute, in the sense that even extraterrestrials, despite all their differences from humans, would agree on the experimental value of h . In the meantime, we can be quite satisfied with the fact, so awkward for the "relativists," that h is found to have the same value, when measured with care or calculated from theory in Millikan's Chicago or anywhere else on this globe, regardless of environmental or social conditions, and even in the face of false initial presuppositions.

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2. In his lecture "History as Myth and Muse" (given at the University of Amsterdam, November 11, 1998), Roger H. Stuewer concluded, concerning this change of the historic record, that "even an experimental physicist as great as Millikan could be dead wrong in his theoretical views - and then also was human enough to try to hide his error much later by giving a patently false account in his autobiography" (p. 17).

3. For a brief account of that struggle, see G. Holton, Thematic Origins of Scientific Thought (Harvard University Press, 1988), pp. 156-159.

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Physics is everywhere, but how much do the citizens of Europe really know about physics?

Physics on stage

Three major European research organisations, the European Centre for Nuclear Science (CERN), the European Space Agency (ESA) and the European Southern Observatory (ESO) are collaborating together to organise a unique European-wide programme to raise the public awareness of physics and related sciences with support from the European Union. Other partners in the project are the European Physical Society and the European Association for Astronomy Education.

In 22 European countries National Steering Committees have been formed with responsibility for their own national programmes to promote national activities and to survey new and exciting educational approaches to physics. The project will culminate in November 2000 with 400 delegates converging on CERN in Geneva for the Physics on Stage festival. During this event, science teachers, science communicators, publishers, top scientists and high-level representatives of the ministries and European organisations will brainstorm future solutions to bolster physics' popularity.

The Physics on Stage festival will be part of the European Science and Technology Week, which was first launched in 1993 on the initiative of the European Commission to raise public awareness of science and technology and to ensure that the public recognises their significance in all our lives.

Luciano Maiani, the Director General of CERN writes: "Science is a critical resource for mankind and among natural sciences, physics will continue to play a crucial role, well into the century. The young people of Europe deserve the best possible physics teaching. An enormous resource of first-class teachers, teaching materials and innovative thinking exists in our countries. The Physics on Stage project will bring them together to generate a new interest in physics education which will be to the long term benefit of children all over Europe".



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Chairman: M. Elices (UPM, Spain)

Vice-Chairmen: J. Llorca (UPM, Spain) & C. Viney (UK)

SPEAKERS WILL INCLUDE

Marie-Hélène Berger (Paris, F), Jerzy Bernholc (NC State Univ., USA), Anthony R. Bunsell (Paris, F), Robert W. Cahn (Cambridge, UK), Krishan K. Chawla (Alabama, USA), Jean-Baptiste Donnet (CNRS, F), Manuel Elices (UPM, E), Prabhat K. Gupta (Ohio State Univ., USA), Hans-Ulrich Künzi (EPFL, CH), Javier Llorca (UPM, E), Ali Sayir (NASA, USA), Yves Termonia (DuPont, USA), Christopher Viney (Heriot-Watt, UK)

SCOPE OF THE CONFERENCE

High performance materials are usually composite materials and fiber-reinforced composites stand out as those which provide the best properties. The fibers are the essential components in these materials and the knowledge of their properties is critical in understanding the behaviour of the composites as well as in developing new design strategies.

The meeting will cover the current knowledge on fracture mechanics and mechanisms in ceramic, metallic, polymeric and composite fibers, as well as the available options to improve fiber strength. Fiber fracture is a paradigmatic topic in Materials Science, which is needed for interdisciplinary research. The conference will be an attractive meeting point for chemists, biologists, engineers and physicists. There will be poster sessions and short talks.

Fundamental Aspects of Surface Science

Epitaxial Growth and Nanostructures at Surfaces

Castelvecchio Pascoli, Italy, 7 - 12 October 2000

Chairmen: Klaus Kern (Stuttgart) and Bene Poelsema (Twente)

SPEAKERS WILL INCLUDE

J. Barth (Lausanne, CH), F. Besenbacher (Aarhus, DK), A. Bietsch (Zurich, CH), S.Y. Chou (Princeton, USA), K. Ensslin (Zurich, CH), R. Hayes (Endhoven, NL), P. Leiderer (Konstanz, D), P.M. Petroff (Santa Barbara, USA), G. Renaud (Grenoble, F), K.H. Rieder (Berlin, D), J. Sagiv (Rehovot, IL), M. Scheffler (Berlin, D), O. Schmidt (Stuttgart, D), P. Soukiassian (Gif-sur-Yvette, F), K. Thonke (Ulm, D), M. Trau (Brisbane, AUS), U. Valbusa (Genova, I), P. Varga (Wien, A), H. Wormeester (Twente, NL)

SCOPE OF THE CONFERENCE

The conference aims to bring together researchers interested in the applications as well as fundamental problems of nanostructures at surfaces and interfaces. We will focus on advances in the fabrication of nanometer-scale structures. Of particular interest are self-assembly and growth techniques for the lateral structuring of surfaces on the nanometer scale and the controlled fabrication of quantum nanostructures. Applications to semiconductors, metals and molecular systems will be discussed.

The topics to be addressed will include:

- Diffusion and nucleation
- Kinetics and thermodynamics of epitaxial growth
- Self-organization and nanostructures
- Nanoprocessing
- Colloidal systems

Applications to the above conferences accepted until End of June 2000

Conferences are open to researchers world-wide, whether from industry or academia. Poster sessions are planned at all events above. Participation will be limited to 100. The Registration Fee covers full board and lodging. Grants are available (through EC support from the High Level Scientific Conferences Activity), in particular for nationals from EU or Associated States under 35.

EuroConference on Frontiers in Particle Astrophysics and Cosmology

San Feliu de Guixols, Spain, 30 September - 5 October 2000

Chairman: Jose W. Furtado Valle (Valencia, Spain)

SPEAKERS WILL PROVISIONALLY INCLUDE

L. Bergstrom (Sweden), A. Dolgov (Denmark), E. Fernandez (Spain), G. Fiorentini (Italy), N. Fornengo (Italy), M.C. Gonzalez-Garcia (Spain), A. Goobar (Sweden), J. Gomez-Cadenas (Switzerland), F. Halzen (USA), M. Hirsch (Spain), S. King (UK), E. Kolb (USA), V. Martinez (Spain), A. Piepke (USA), G. Raffelt (Germany), N. Rius (Spain), J. Romao (Portugal), G. Ross (UK), D. Saez (Spain), J. Silk (UK), A. Smirnov (Italy), W. Venus (Switzerland), T. Yanagida (Japan), C. Yanagisawa (USA)

SCOPE OF THE CONFERENCE

The goals of the meeting are:

- to address the basic open issues in astrophysics and cosmology such as dark matter, CMB, primordial nucleosynthesis, inflation, baryogenesis, etc. with a special emphasis on the present leading theoretical ideas.
- to discuss the implications of the recent observations of solar and atmospheric neutrinos in terms of particle theories beyond the present Standard Model.

The physics of neutrino masses and other non-standard properties will play a central role, as it is required in order to explain the present data. The conference will address both the particle and nuclear physics aspects of neutrino physics, as well as the fascinating interplay with cosmology and astrophysics.

Quantum Optics XI: EuroConference 2000

Mallorca, Spain, 14 - 19 October 2000

Chairman: Jörg Schmiedmayer (Innsbruck, Austria)

Vice-Chairman: Klaus Mølmer (Aarhus, Denmark)

SPEAKERS WILL INCLUDE

M. Arndt (Wien, A), R. Blatt (Innsbruck, A), M. Brune (ENS, F), J. Dalibard (ENS, F), J. Denschlag (NIST, USA), T. Esslinger (München, D), R. Folman (Innsbruck, A), A. Imamoglu (UCSB, USA), Y. Imry (Rehovot, IL), D. Jin (JILA, USA), J. Jones (Oxford, UK), S. Keiding (Aarhus, DK), J. Kimble (CalTech, USA), F. Krausz (Wien, A), A. Lambrecht (ENS, F), H. Mooij (Delft, NL), T. Pfau (Stuttgart, D), P. Pillet (Paris, F), V. Sandoghdar (Konstanz, D), H. Stoof (Utrecht, NL), J. Toennies (Göttingen, D), H. Weinfurter (München, D), M. Wilkens (Potsdam, D), P. Zoller (Innsbruck, A)

SCOPE OF THE CONFERENCE

Quantum Optics XI will focus on the rapid progress in experimental technologies of quantum manipulation and the corresponding deeper understanding of the fundamental physics of quantum systems. One such rapidly growing sub-field to be discussed extensively is quantum matter wave optics, made possible by the creation of degenerate quantum gases and first demonstrations of an atom laser. Related topics like new progress in extending matter wave manipulation techniques to molecules and clusters or to the mesoscopic scale will be discussed. We will also bring together the different technologies and concept of how to implement quantum information processing.

There will be a strong emphasis on comparing the existing technologies and concepts, and discussing their future possibilities. The third part of the conference will focus on new and emerging fields like cold molecules, nano optics or ultra short pulses, X-ray and THz radiation which will open up new possibilities for quantum optics.

Old artifacts and new challenges: The future of history

by Paolo Brenni

Chairman of the Interdivisional Group for the History of Physics

During the 20th century physics has not only changed our vision of the universe but also revolutionised our way of life. The history of physics not only allows us to understand these changes but can also help us to be better prepared to face the future. The high complexity of contemporary physics, its intricate relationships with the industrial world, with the military complex and with the political arena present a challenge to historians. Their efforts can be fruitful only if supported by the collaboration of the different actors of this complicated scenario.

Some practical problems which seem to me particularly important today are presented below:

Scientific Instruments of Historical Interest

Scientific instruments, are indispensable material evidence for the historians of science. Until a few decades ago, their importance was generally underestimated by historians. They focused their attention to written documents, while considering historical instruments as antiquarian curiosities. Due to new historiographical trends paying more attention to laboratory practices, to the transmission of scientific knowledge, to experiments (and their replication), and to the role of material culture, scientific instruments have become much more interesting for historians of science. These comprise not only the more ancient instruments, but also the apparatus of the 19th century. Many collections had been rediscovered, catalogued and reordered.

But, now it is time to turn our attention to 20th century instruments, which present new challenges. In the second half of the 20th century the rise of 'big science' called for instruments (or better instrumental systems) which were huge machines. Their preservation as historical artefacts will be impractical, far too expensive and thus often impossible. Because of the very rapid progresses in electronics and computer technology they also became extremely complicated. Furthermore, the obsolescence of instruments, whose variety and typologies are today enormous if compared to the ones

of only a few decades ago, is extremely fast. Finally, the aesthetic appeal of contemporary instruments, compared to the glittering brass and glass apparatus of the past, is very poor. A lot of them are indistinguishable and hermetic boxes, difficult to display and to present in a museum. A 19th century spectroscope or a galvanometer are beautiful objects, whose function can be easily understood and explained. Unfortunately, this cannot be said of early NMR apparatus.

For the above mentioned reasons a large part of the historical heritage of late 20th century physics is in risks of being scrapped. Thus, historians and physicists must try to find a way to conserve the most important part of these heritage or at least to preserve the memory of it (by collecting written and oral documents, drawings, photographs, films, software, etc).

In this context, I propose here to strengthen the collaboration between physicists and historians of instruments. First I would like to encourage some members of the EPS, who are interested in these problems, to participate and contribute with their personal experiences to the XIX Scientific Instrument Symposium, which

"We must establish a closer co-operation between physicists and historians. Too often these two communities, notwithstanding the fact that they have a series of common interests, tend to ignore each other."

will be organised this year in Oxford (4th to 9th of September) by the Scientific Instrument Commission (SIC) of the International Union of History and Philosophy of Science (IUHPS). A special session of the Symposium will be dedicated to 20th century instrument. (See the web site: <http://www.sic.iuhps.org/conf2000/in-text.htm>)

Secondly, in my role as vice-president of the SIC and of chairman of the IGHP I would like to support and encourage every kind of project which could involve the preservation, study and the cataloguing of instruments and apparatus which have been important for the development of 20th century physics. A simple example: a group of physicists could compile a first list of apparatus, which they judge particularly relevant for the history of physics af-

ter 1945. This would establish priority in the field of museology and preservation.

Documents and Archives

Another important problem is the preservation of scientific archives. Until only a few years ago correspondence, laboratory notebooks, protocols of experiments, drafts of articles, technical drawings and plans, and the like, were printed on paper. Today, most of these documents reside in magnetic memories. For the historians it will be in most cases impossible to follow in the classical way the history of a theory, a concept or an experimental project because of lack of information. Corrections, modifications, and changes which witness the evolution of an article or of a book from its draft to its definitive version, can be seen and analysed thank to the paper archives, but often disappear in the new world of software. It will be very difficult for the future historian to fully retrace and to understand the genesis of ideas.

But there is another danger. How long will our magnetic memories last? How many scientists will keep in their computer (or in their electronic archives) their scientific documents? Will the e-mail correspondence remain somewhere? The progress of computer technology is so fast that it is today almost impossible to read 'old' magnetic records because the related software and the machines able to run them are scarcely available.

I do not pretend to propose solutions to these problems but only wish to point out the necessity to seriously consider them.



Neutrinos from CERN to Gran Sasso

Around 2005 CERN will start aiming pulses of neutrinos at INFN's Gran Sasso National Laboratory, the world's largest underground laboratory deep under a mountain about an hour driving East from Rome. During the 730 km trip, some neutrinos will change flavour, and two detectors at Gran Sasso will try to detect these changed neutrinos. At that time similar experiments will be well under way in the United States and Japan. Japan started sending neutrinos from the KEK pro-

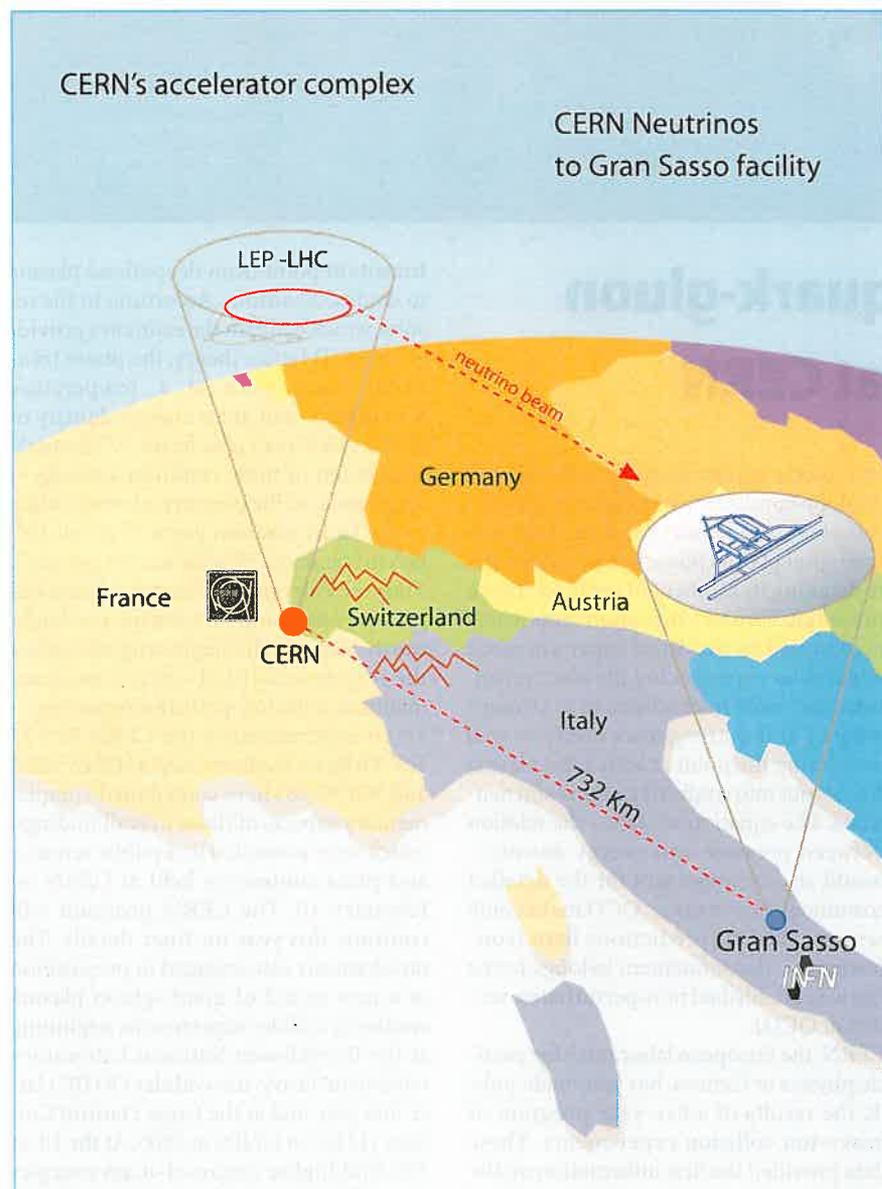
ton synchrotron in Tsukuba over a distance of 250 km to the SuperKamiokande underground detector, and the Fermi National Laboratory (Fermilab) near Chicago is gearing up to aim neutrinos at a detector in the Soudan Underground Laboratory in Minnesota, also 730 km away, in 2003. However, unlike these two experiments that try to detect a deficit of a certain flavour of neutrino—a "disappearance experiment", the CERN-Gran Sasso experiments will try to detect different neu-

trinos than those produced at CERN—those that actually changed their flavour. The CERN Council approved the 60 million Euro experiment in December, and it will be financed by INFN for more than 50%.

Neutrinos come in three flavours: electron neutrinos, muon neutrinos, and tau neutrinos. Several experiments suggest strongly that neutrinos may oscillate, that is, change from one flavour into another while travelling through space or matter. For example, less neutrinos are detected from the sun as predicted by theory—they probably escape the detectors by changing flavour. Also, the SuperKamiokande detector in Japan detects different ratios between electron and muon neutrinos produced in the atmosphere by cosmic rays if they travel over longer distances through Earth. And if neutrinos oscillate, they must have mass, according to theorists. But some particle physicists still doubt whether neutrino oscillation is a reality.

At CERN, a proton beam extracted from the SPS (Super Proton Synchrotron) will hit a graphite target, producing a variety of particles. Among them are pions that will be nudged by magnets into a beam pipe directed towards Gran Sasso. In the beam pipe they will decay into muons and muon neutrinos. The muons will be stopped while the neutrinos will travel on to Gran Sasso, whereby some of them will change into tau neutrinos. Two detectors, OPERA and ICANOE, will look for these tau neutrinos. Not only are the transformations from muon to tau neutrinos rare events, but because very few neutrinos interact with matter, scientists expect that only a few of them will be detected during a period of at least five years, says Paolo Strolin at the University of Naples. Therefore the background—events that mimic neutrino events—has to be extremely low for the experiments to be meaningful, says Stolin. The experimenters expect one such event every two years.

The great advantage of long-baseline experiments is that one controls the neutrino source and does not depend on unknown factors influencing neutrino production in the sun or by cosmic radiation, says Alessandro Bettini, Director of the Gran Sasso Laboratory. And Alessandro Pascolini of Padua University and INFN is confident that the long-baseline experiments will help settle the matter of neutrino oscillations. Especially, the positive detection of tau neutrinos at Gran Sasso will leave no doubt that neutrinos do oscillate and have mass, he says.



"CNGS: Cern Neutrinos to Gran Sasso" a new facility to explore the physics beyond the Standard Theory

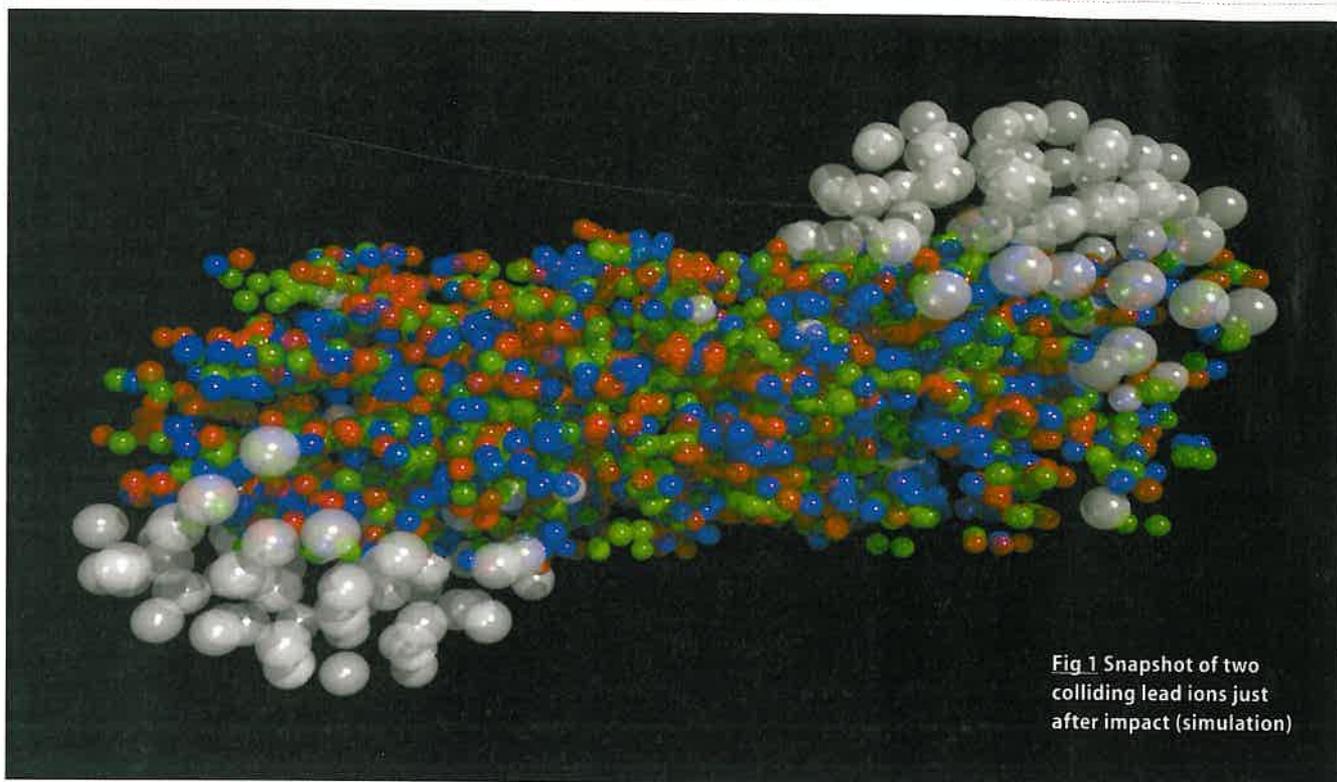


Fig 1 Snapshot of two colliding lead ions just after impact (simulation)

First data on the quark-gluon plasma reported at CERN

Our universe is expanding from an initial phase of near infinite energy density and temperature. The only “data” we have about the very beginning – the Big Bang – is the very existence of the expanding universe. A subsequent phase which begins before the femtosecond era and is believed to have prevailed until about 10 microseconds was equally hypothetical up to now: The quark-gluon plasma phase represents a state of quasi-free, deconfined quarks – the most primary form of matter governed by the strong force. The fundamental theory of the strong interaction, Quantum Chromodynamics (QCD), that predicts ‘asymptotic freedom’ at very high temperature, leads us to expect such a state of deconfined quarks. This means a drastic reduction of the extremely strong attraction mediated by gluon exchange in low temperature states. With “low” we still mean about $2 \cdot 10^{12}$ Kelvin, at which point the thermal wavelength is about equal to the mesonic sizes of about 0.5 fermi. Freedom and, therefore, quark deconfinement is thus expected to set in once the energy density steps well above this limit: confined quarks

in protons, neutrons, mesons give way to a colour-conducting quark-gluon plasma. A more detailed understanding of the cosmological plasma phase would require data detailing its moment of creation from a preceding “Grand Unification” era (which is supposed to consist of super-energetic X-particles experiencing the electromagnetic and weak interactions in as strong a manner as the strong force itself), as well as defining the point at which the plasma freezes out into confined protons and neutrons. The equation of state – the relation between pressure and energy density – would also be important for the detailed cosmological dynamics. QCD makes only semi-qualitative predictions here (confinement – deconfinement belongs to the less well established non-perturbative sectors of QCD).

CERN, the European laboratory for particle physics in Geneva, has just made public the results of a five-year program of heavy-ion collision experiments. These data provided the first information on the existence of a new deconfined phase of matter, and on the energy density and temperature that characterise the phase

transition point from deconfined plasma to confined hadrons. According to the results, which confirm the estimates provided by QCD lattice theory, the phase transition takes place at a temperature $T=175\text{MeV}$ and at an energy density of about 1 GeV per cubic fermi. A “classical” translation of these conditions results in an estimate of the pressure corresponding to the hadronization point of about 10^{32} kg/cm² (ie. about 50 solar masses per cm²). Thus the emerging experimental data has pushed cosmology an entire era backwards towards the beginning and given the fundamental QCD theory new momentum in its non-perturbative sector. Seven experiments at the CERN SPS 33 TeV Pb beam facilities (NA44/45/49/50/52 and WA 97/98) have contributed complementary aspects of those overall findings, which were presented in a public seminar and press conference held at CERN on February 10. The CERN program will continue this year for finer details. The physicists are also engaged in preparation of a new round of quark-gluon plasma studies in collider experiments beginning at the Brookhaven National Laboratory relativistic heavy-ion collider (RHIC) later this year, and at the Large Hadron Collider (LHC) of CERN in 2005. At the 10-to 300-fold higher centre-of-mass energies that will be provided here, intricate details of the equation of state of QCD matter are expected to unfold.

Physics school education in Finland

Maija Ahtee

Department of Teacher Education, University of Jyväskylä

General description of the status of physics at school

Primary school or the lower stage of the comprehensive school

The comprehensive school is divided into lower stage (years 1 to 6, average ages 7 to 12) and upper stage (years 7 to 9, average ages 13 to 15). The distribution of minimum curriculum hours over six years at the lower stage is as follows: mother tongue (Finnish or Swedish) 23.5%, mathematics 16.2%, environment and nature study (containing science and focussing mainly on biological and geographical items) 11.0% of the total of 136 hours. At the lower stage teachers are usually class teachers who teach all the subjects. The class teacher education programme leads to a Master's degree (160 study weeks (sw)) with pedagogy as its main subject, and takes in practice approximately 5 years. The programme includes also basic studies in the subjects taught in primary schools (altogether 40 sw) and specialisation in two teaching subjects (15 sw each).

However, the students in class teacher education are not selected based on their interest or abilities in mathematics and science but on their interest for example in music or physical exercises. Furthermore,

the class teacher education programme consists of very little guidance on how mathematics and science could be taught. Thus the basic studies in physics are limited to those at the upper stage of the comprehensive school. Neither mathematics nor sciences are among the popular specialisation subjects. During the years 1995-1997 from all the specialisation courses taken by the future class teachers only 10% dealt with mathematics, science or technology. Thus the class teachers as a whole have a serious deficiency in how to teach mathematics and science in a stimulating and challenging way, as well as in their content knowledge in these subjects.

The upper stage of the comprehensive school

At the upper stage, teaching of physics is in the hands of the subject teachers who have carried out at least 70 sw in their main subject (physics, mathematics or chemistry), 35 sw in the second subject and 35 sw in pedagogy, including practical teacher training. The 35 sw studies in pedagogy including practical teacher training, give the teacher trainees competence to teach in all the school forms, from primary to upper secondary and vocational schools, all the subjects in which

they have carried out the basic 35 sw studies. However, in the upper stage of the comprehensive school and in the upper secondary schools the physics teachers usually teach all the three subjects mathematics, physics and chemistry and in many cases they also take care of the needs in information technology. Most teachers (94%) are employed full-time as municipal civil servants. They participate in in-service training for a minimum of three days a year.

The latest decision concerning the distribution of hours in comprehensive school and the curricular guidelines have increased significantly the opportunities for schools and local authorities to profile teaching. Schools are free to vary the weight and grouping of individual subjects by allocating teaching resources within the general framework of government financing. At the upper stage the distribution of minimum compulsory curriculum hours over three years is: mother tongue 11.4%, mathematics 12.9%, biology and geography 10.0%, physics and chemistry 8.6% of the total of 70 hours. Thus less than a third of mathematics teaching in the comprehensive school is covered by the mathematics teacher.

Upper secondary or senior secondary schools

Recently, upper secondary education (years 10 to 12, average ages 16 to 18) has progressed towards a highly decentralised system. The responsibility for teaching arrangements, course content and the selection of teaching material, is passed to the schools, and the cooperation of the schools with vocational institutions is highly recommended. Teaching is organised into courses, each course consisting of 38 lessons of 45 minutes each. The school year is divided into five or six periods and each period has a different study plan and concentrates on a selection of subjects. The order and placement of courses are left for the schools and pupils to decide. The upper secondary school leads to the national matriculation examination which mainly takes place at the end of spring term of the third school year but it can be spread out. Upper secondary school teachers have the same academic degree as upper stage comprehensive school teachers. The teachers who teach advanced courses in physics have mainly as their principal subject either physics or mathematics and the other as the second subject.

Upper secondary school studies consist of compulsory studies, advanced studies and applied studies. The school must pro-



vide the advanced studies for the student to choose from. In physics there is one compulsory course which is the same for all the students. In addition, the school has to offer at least 7 advanced courses in physics. The students can decide how many advanced courses they want to take and in principle also in which order. The present situation is some kind of reconciliation after a long dispute on how to settle the conflict between physics for everybody and physics for those who want to continue in science related studies at the university level. An ample 60% of new students will yearly start in upper secondary schools. From them 20 to 25% will take advanced courses in physics. And from these about 20% are girls.

The matriculation examination is set and assessed nationally at the same time countrywide, twice a year in the spring and in the autumn. About half of the age group of 19 year-olds takes part in the examination. The different parts of the examination may be completed either at the same time or spread over three successive occasions. The compulsory subjects are mother tongue (Finnish, Swedish or Sámi), the second official language (Finnish or Swedish), one foreign language, and either mathematics or science and humanities. The latter comprises about 70 questions in several subjects. The student can answer the maximum of eight questions with any combination of questions and subjects. The subjects are religion, psychology, philosophy, ethics, history, civics, physics, chemistry, biology and geography. In physics alone there are 16 questions from which the student can choose. Each question is given 0 to 6 points. The total average achieved in all the physics questions varies around 3.6 points. About 20% of the students who take part in the matriculation examination answer at least one question in physics. About 10% of the students who answer the physics questions are girls. The total average of all the physics questions answered by girls is about 0.20 points less than the total average obtained by the boys.

In the earlier 1985 physics curriculum for the upper secondary school, the position of laboratory work was not specified. For example no extra time was allocated for practical work. Unfortunately, this was interpreted in most schools as a reason for giving up all kind of experimental work. In the new schools no facilities were reserved for physics laboratories and money was not given for equipment. However, the new 1994 curriculum stresses the experimental nature of physics and especially in

the obligatory course, the experimental method is central. Also in many physics problems in the matriculation examination the experimental view is asked. However, there are still problems with proper laboratories and equipment. In-service training projects which focus on the experimental method and use of the computer as measuring apparatus have been launched for physics teachers. A central question is still how to get the physics teachers to use demonstrations and experiments during the lessons. The general difficulty remarked by physics teachers is how to find time enough to go through all the material in the text-books and also do experimental work.

Vocational schools and institutes of technology

The vocational schools provide initial vocational training to pupils aged 16 to 19+. Vocational schools are developed towards larger, multidisciplinary institutions. Most vocational institutions operate both at secondary and post-secondary level. Institutes of technology provide only post-secondary education. Basic vocational qualifications require 2 to 3 years to complete. Basic qualifications comprise general studies, common core studies and subjects aimed at specialisation. Vocational training includes both practical training at school and on-the-job instruction. The number of new students is about 75% of the age group. This is explained by the fact that of the students matriculating from upper secondary school, about one-third go on to traditional multidisciplinary universities, universities of technology or other specialised universities, while two-thirds continue at vocational institutions or vocational high schools. The ratio of the number of new students in tertiary education in sectors in which knowledge of physics is demanded to the total number of new students is at least 30%. There are thus 10% more study places than students who have studied physics at the upper secondary schools.

Two innovations

Joint national action

Already the former Finnish government declared in its programme the necessity to raise mathematical and scientific knowledge and know-how in Finland to the international standard. Many representatives of Finnish industry have expressed their profound concern on the low level of knowledge and interest in mathematics and sciences among young people. For ex-

ample, the director general of Nokia, Jorma Ollila, made in the main Finnish newspaper in October 1999 an appeal to the authorities to continue the actions in constructing and strengthening the knowledge resources. "Those countries that will specialize in knowledge intensive fields will be successful in future."

A joint Finnish endeavour has started under the direction of the Ministry of Education and the National Board of Education. A number of different bodies such as industrial organisations, subject teacher associations and universities have taken up the challenge and started a number of supporting actions and projects which lead to the same goals. The need to develop knowledge and skills in mathematics and sciences is seen to arise from the demands of the information society, the growth of high-tech enterprises, the need to secure sustainable development, and the citizens' need to master everyday technology. The major problems are seen as follows: Too few pupils opt for physics courses in school, and the learning outcome is inadequate as regards experimental skills, too few subject teachers have majored in physics, and too few women study physics or technology. A development and information network of 25 municipalities and six teacher training schools have been created. Some of the targets and actions are as follows:

The combined intake in universities and polytechnics in the fields of natural sciences and technology will be increased; Pupils will gain sound versatile knowledge and skills in mathematics and sciences to the extent that Finland will be in the top quarter in OECD comparisons; Gender equality will be improved; Finland will take regularly part in international comparisons of educational achievement in mathematics and sciences; Pupils will be trained systematically for international mathematics and physics olympiads; The graduate school intended for mathematics, physics and chemistry teachers will be expanded; In-service training will be arranged.

According to an intermediate evaluation of the progress of the joint national action in 1999, the communities, universities and teachers have responded very well to these ideas. However, the demand of young people for a proper education for example in physics in upper secondary school has increased so much during the last years that the earlier targets have turned out to be too small. The final evaluation will be published in 2002.

The Finnish Graduate School for Mathematics, Physics and Chemistry Education

The teachers who want to continue their studies towards a doctorship in physics education need help both from the department of physics and the department of teacher education. The foundation of the graduate school was based on the idea of joining the different teaching and research departments in order to create a multidisciplinary basis needed for teaching research and teacher education in mathematics and science, as this had earlier been occasional and depended on the individual person's own activities and efforts.

The graduate school organizes seminars as well as small group gatherings which are open to all the graduate students. It also maintains the www-pages and the email lists of the graduate students and the tutors for distribution of information and creation of contacts. It makes possible for some of the graduate students to study full-time, and finances their participation to the international conferences. At the end of the year 1999, in the graduate school there were 90 graduate students, of which 17 were studying full-time, seven member universities, and 57 tutors. Since its foundation in autumn 1995, five doctor's degrees and ten licenciate examinations have been performed.

The net address of the school is <http://www.jyu.fi/tdk/kastdk/tutkijakoulu>.

The proceedings of Colloquium on Attainment in Physics at 16+ (Ed. R. Coughlan, University College Cork, Ireland) has been recently published. The Colloquium was organised by Ireland with the assistance of the European Union Socrates Programme. Detailed background papers on physics education at senior level in their countries were prepared by the nine participant countries and were reviewed by five international experts in the field of physics education. The proceedings include the experts' papers (prepared after the colloquium) on the items: curriculum issues, social issues, assessment, teacher training and an overview of issues arisen at the colloquium.

At the end of the rainbow – an understanding of nuclear matter

W. von Oertzen, Dao Tien Khoa, H.G. Bohlen
Hahn-Meitner-Institut Berlin and Fachbereich Physik, FU Berlin

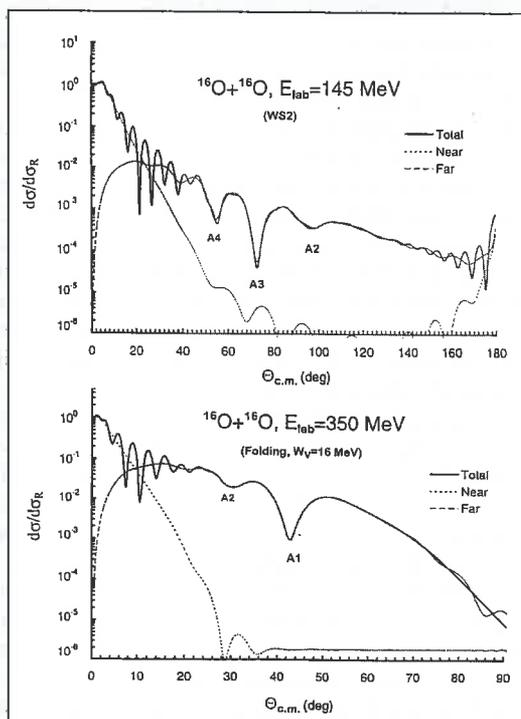
We resume and complete the discussion of rainbows from the last issue of *europhysics news* 31/2(2000), and we add missing refs. In both cases, in the refractive scattering of light and of particle waves rainbow scattering is observed. In the coloured figures on the cover and on page 5 of the cited issue the second light intensity in the left part of the figure is the secondary rainbow, which appears at a total deflection angle of 129° . The origin of the secondary rainbow is well explained in the small inserts on page 3 and 9, it originates from one more reflection in the water droplet, which gives a reversal of the ordering of colours (the corresponding deflection function is shown in Fig. B1.1). There is another remarkable detail in the colour photograph - the supernumerary rainbow. It can be identified in Fig.1 (on page 5) by the continuation of stripes of violet and pink colour inside the first rainbow. These are the higher order structures of the Airy function. The Airy function has been shown in Fig. B1.2, it gives the correct description of the scattered intensity for rainbow scattering.

Higher order Airy structures are difficult to observe in light scattering, if not a narrow band of wavelength is used, which will prevent the overlap of the coloured bands as it happens in fig.1. The higher order Airy structures are, however, well observed in nuclear scattering like in $^{16}\text{O}+^{16}\text{O}$. Inspecting Fig.2 we note that the primary rainbow located at energies of 480 MeV and 350 MeV at angles of 30° and 50° respectively, moves out of the observable angular region (beyond 90°), as we go down to energies of 145 MeV and lower. At these energies the 2nd, 3rd and 4th order Airy structures are observed. This is shown in the present Figure (referred to as Fig.3 in the previous issue) with data at an energy of $E = 124\text{MeV}$. The calculations are done

without consideration of the identity of the two ^{16}O -nuclei in order to show more clearly, 2nd and 3rd order Airy structures in the angular regions beyond 90° . These higher order Airy maxima/minima are also discussed in refs. 1, 2, 3, 4. At the low energies (below 100 MeV, ref. 4) the data are completely dominated by the 4th and higher order Airy structures. The figure in addition shows the decomposition into the "far" and "near" side contributions (left and right side from the central ray); the data show more structure than the calculation around 90° due to the Mott-interference of the spin zero ^{16}O -nuclei.

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European Union R&D funding

Do's & Don'ts

Dr. Sean McCarthy
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Introduction

The Fifth Framework Programme is the name of the European Union's Research and Development programme. The programme, which started in January 1999 has a budget of 15 billion euros and will run until 2002. Framework 6 is already under discussion and is expected to start in 2003. This article provides an overview of the Fifth Framework programme and the issues, which must be considered when applying for R&D funding.

EU R&D programmes were started in the early 1980's and the early programmes concentrated on promoting co-operation between European researchers. Since the mid-1980s the emphasis has been on the development of the 'best European science' and on using this science to support European Union policies. In 1995 the European Commission funded a range of studies to assess the impact of EU Framework programmes and the results of these studies were published in the EU Green Paper on Innovation (1). One of the main findings of these studies was that, while European scientists were found to be producing world class science, the impact of these developments were not found in European enterprises. This became known as the 'European Paradox'. Since this time the Framework programmes have stressed the importance of exploiting the results of the Framework programmes.

In 1998 the Fourth Framework programme was evaluated and the main recommendation from this evaluation was that 'the next Framework programme must be firmly based on the twin pillars of scientific excellence and social and economic relevance' (2). This article examines the range of issues, which must be considered by researchers when preparing proposals for the Fifth Framework Programme.

The Basics

The information needed to submit a proposal to the Fifth Framework Programme is found in the Framework 5 website (www.cordis.lu). This website contains the programme details, the calls for proposals, the software to prepare the proposals and the evaluation manual which will be used

by the evaluators.

The Framework 5 programme is divided into four 'thematic programmes' and three 'horizontal programmes'

Thematic Programmes

- Competitive and Sustainable Growth (2.785 beuro)
- User Friendly Information Society (3.6 beuro)
- Energy Environment and Sustainable Development (1.083 beuro)
- Quality of Life and Management of Living Resources (2.413 beuro)

Horizontal Programmes

- International Co-operation (0.475 beuro)
- Innovation and SME Involvement (0.363 beuro)
- Training and Mobility of Researchers (1.28 beuro)

Types of Proposals:

There are six main types of proposal that can be submitted by researchers. These are summarised as follows:

- Research and Technology Development Projects: This is the main category of proposal for scientific research and development projects. Over 70% of the Framework 5 budget is allocated to these type of projects.
- Demonstration Projects: This category of project is for R&D which is being transferred from the laboratory to a more real life application. The key issue here is to assess the developments needed in 'scaling up' and the funding is for the 'risk associated with scaling up'.
- Co-operative Research - This category of project is better known as CRAFT projects. In CRAFT projects companies define a problem to be solved and research groups develop technical solutions to solve the problem.

The European Commission is aware that many new research groups want to get involved so they have introduced a number of special types of proposals to help them. These include:

- Accompanying Measures: This category is used to fund workshops, conferences (up to 100 people), training courses for researchers and summer schools. This is an

ideal starting point for researchers who are not familiar with Framework 5.

- Thematic Networks: The aim of thematic networks is to allow European researchers in the same technical field to establish a network to discuss the R&D needs and to prepare strategies for future R&D. It is an ideal mechanism to meet with other European researchers and to plan future R&D projects.

- Training Fellowships These are better known as Marie Curie Fellowships. This funding is used by young researchers to spend up to two years in another member state research laboratory. The funding covers the costs of the researchers and administration costs for the host organisation.

Explaining the State of the Art

In the past, proposals were written in a general format but more and more the proposals appear like scientific publications i.e. with references to define the state of the art.

One of the biggest mistakes researchers make in proposals is that they start by telling the evaluator HOW they will undertake the research. The correct approach is first to tell the evaluator WHY you are doing the research and then tell them HOW you are going to undertake the research. The following section describes how to explain the relevance of the proposed idea to the evaluators.

Explaining the 'Relevance' of the proposal to EU economic and social policy

The greatest difficulty in writing proposals for Framework 5 is explaining why the proposed work is relevant to EU social and economic policy. This is a new arena for researchers. To explain the 'relevance' researchers must first be familiar with EU policy and the thinking behind EU policy. This is easier than it first appears as the European Commission has a database of all EU studies (25,000 documents) and these can be used to identify the areas where R&D is needed. The databases are available at <http://europa.eu.int/geninfo/info-en.htm>

Example: In 1999 a research group in University College Cork, Ireland submitted a proposal to study the link between the foods we eat and osteoporosis. In the above database the author identified a study titled 'Osteoporosis in the European Union'. One of the main recommendations in this report was that 'more research is needed on the link between the food we

eat and osteoporosis'. The group submitted the proposal and it was immediately funded.

Selecting Partners

In EU R&D programmes the consortium must include organisations from the different member states. In practice an ideal consortium will involve eight organisations from 4 or 5 member states. Other countries, which can participate, include: Central and Eastern European Countries: These are politically important as 'enlargement' of the EU is the most important political issues in the EU.

European Economic Area (Norway, Liechtenstein, Iceland).

Other countries include Israel and Switzerland

In the past year the EU has signed 'R&D Co-operation Agreements' with a number of countries. These countries can participate in Framework 5 but they cannot receive EU funding. They include the United States, Canada, Argentina, China, South Africa and Australia.

Selecting partners is a difficult issue (and reason for failure) in the Framework

5 programme. The following are some recommendations:

Beginners: Find organisations in your field that already have contracts in Framework 5 and join them in a proposal. In this way your contribution to the proposal will be limited to your scientific work and you can use the experience to learn the procedures of Framework 5. Existing contractors can be found on www.cordis.lu

Summary

EU R&D programmes are an ideal mechanism to generate funding for your research group and to establish working relationships with other researchers throughout the EU. The rules and procedures are difficult at the beginning but the European Commission has introduced mechanisms such as the Accompanying Measures and Thematic Networks to help researchers.

Your strategy for Framework 5 should be as follows:

- Produce the 'best science'
- Promote your 'best science' at EU conferences and through EU publications
- Establish personal contacts with comple-

mentary researchers in other EU institutions.

- Use Accompanying Measures and Thematic Networks to identify topics for proposals.
- Submit initial proposals as a minor partner or sub-contractor.
- In later proposals increase your involvement in the work.
- Your long term objective should be to be the co-ordinator and main contractor in Framework 5 projects.

Conclusion

EU R&D programmes will continue and the organisations who will receive funding will be those: who produce the 'best science'; who are able to explain the relevance of their work; and who have mechanisms in place to exploit their results. You must think of EU R&D programmes as a long term activity. In the beginning there will be some frustrations with rejections and in understanding the procedures. Once these are overcome the EU R&D programmes can be an ideal mechanism to work with international R&D teams and to see the results of your R&D implemented in economic and social policies.

(1) EU Green Paper on Innovation
http://europa.eu.int/en/record/green/gp9512/ind_inn.htm

(2) Five Year Assessment of the European Community RTD Framework Programme. Prepared by an independent panel chaired by Viscount E. Davignon February 1997

Note on the author:

Sean McCarthy Managing Director of Hyperion Ltd. Since 1980 Dr. McCarthy was involved in over 150 proposals to EU R&D programmes. He also acted as a proposal evaluator and in 1997 he was part of the team which evaluated the EU Innovation programme. Hyperion specialises in the development of training courses for research managers and research administrators. Since January 1999 Hyperion has trained over 2000 research managers on topics such as proposal writing for the Fifth Framework Programme, management of EU R&D contracts and the preparation of exploitation plans. Hyperion also trains researchers how to present their R&D activities to business executives, EU officials and politicians. All of Hyperion's courses are presented in co-operation with the EARMA (European Association of Research Managers and Administrators) (www.cineca.it/earma/).



East–West round table

Ireneusz Strzalkowski opening the meeting greeted participants and expressed his thanks to the EPS EWTF and the German Physical Society for the financial support enabling the PPS to organise the meeting. Then he asked Jaroslav Nadrchal to chair the session and Peter Melville to keep minutes of the meeting.

As Chair Jaroslav Nadrchal welcomed participants and explained that the meeting would concentrate on the activities of the East-West task force and related actions in the East-West relations.

Sir Arnold Wolfendale welcomed participants on behalf of the EPS and summarised relevant conclusions from the meeting held at Malvern and other views from EPS:

- There was a need for a good website to provide information from EPS with links to information from National Societies. This should also provide a guide of good practice for promoting public awareness of science.
- There is a need to reduce the proliferation of position papers (eg. case for nu-

clear energy, for more physics students, for changing curricula). Instead the EPS executive committee will write or commission the production of papers. A major use will be in negotiation with EU institutions.

- As regards training of physics teachers, each national society should name a representative who will provide the EPS secretariat with information for consolidation in Mulhouse.

- The EPS divisions, some of which are wealthy, should provide money for prizes.
- Each member of the Executive Committee has been given responsibility for specific nationalities.

Alex Bradshaw stressed that, under the EU principle of subsidiarity, National Governments should be approached by National Societies whereas the role for EPS should be in talking to the EU institutions. Particular problems arose with the DG XII programmes in networking, use of large facilities etc. In the past non-member states could participate provided they paid. These programmes should be opened to other European countries particularly those in Central & Eastern Europe.

Irving Lerch spoke on the American perspective on international collaboration. Expansion of economies depended on new technologies. Foreign governments and industry were spending more on research in the US than the US was spending elsewhere. The US is now spending as much on research in Eastern Europe as in Western Europe and Asia combined, but nearly all this was being spent in Russia. There was concern that with most of the money going to Russia, they were not represented at the table. The meeting expressed considerable uncertainty as to the best contact for Russia. Academician Keldysh had written that the Russian Physical Society now represented physicists throughout Russia, but no replies had been received from communications sent to Keldysh.

Zenon Rudzikas described the situation in Lithuania and other countries in the former Soviet Union where governments were using the arguments that in the West research and teaching were combined in the universities and using this as a reason for not funding research institutes, just providing them with grants or providing the research funding through the universities. Sir Arnold Wolfendale indicated that this would be a good subject for an EPS position paper.

Jaroslav Nadrchal summarised the work of the East-West task force, on which each national society had a representative. The best known activity is supporting attendance at various EPS conferences, although it was very difficult to establish rules for grants (maximum age 35, no more than two per country). Other activities included: use of large facilities, enhancement of scientific and educational exchanges, meeting of young physicists, etc. Problems also arose for physicists where there was no national society that was a member of EPS. Sir Arnold Wolfendale suggested that IOP or DPG could help establish physical societies in those countries. Strictly speaking some of the countries lay outside Europe but the meeting unanimously recommended that physical societies in countries like Georgia, Azerbaijan, Armenia and Israel should be treated as eligible for full EPS membership.

Ales Cieply spoke of problems with Central and Eastern Europe where research institutes are nearly empty. Would it be possible for Western postgrads or post docs to be encouraged to take PhDs, or do post doc research in Prague (or elsewhere)? There is money for living costs but not for accommodation. Could this be provided from western funds?

Peter Melville spoke of the IOP activities in support of physicists in Central & Eastern Europe – provision of limited free fellowship of IOP (with benefits of Physics World, electronic journals, etc), provision for funds to enable physicists to visit Great Britain and Ireland, and substantial funding of EPS-11 and provision of grants to enable physicists from Central & Eastern Europe to attend.

The meeting commended the good work of the East-West task force and encouraged it to continue with its present activities. The meeting concluded with the signing of a collaboration agreement between the Lithuanian and Polish Physical Societies.

ФІЗИЧНИЙ КУР'ЄР

Науково-інформаційне видання
"Physical messenger"

ЖОВТЕНЬ, 1999, №3 (43)



Українське фізичне товариство
Інститут фізики НАН України

Agilent Technologies

The Agilent Technologies Europhysics Prize for the year 2000 has been granted to Paolo Carra, Gerrit van der Laan, and Gisela Schütz for their pioneering work in establishing the field of Magnetic X-ray Dichroism.

The activity in this now very important area of research was initiated by the theoretical work of Thole and van der Laan in 1985 (PRL 55,2086) in which they predicted very strong magnetic x ray dichroism at the 3d absorption edges of the rare earths. This work followed about 5 years of research by this team and others in x ray absorption spectroscopy on strongly correlated systems. They predicted that this strong effect could be used, in an element and site selective way, to determine the temperature and field dependence of the local magnetic moments for magnetic materials. The validity of this theory was proven by experiments shortly thereafter on the ferrimagnetic oxide Tb Fe Garnet again by van der Laan and Thole as principle authors (Phys Rev. B 34, 6529 1986).

These papers were quickly followed by a series of papers with detailed calculations for all the rare earths and many of the 3d transition metal compounds. (PRB 43, 13401 (1991)). The importance of this technique is that one can determine the local magnetic moment for each element in the material separately including its temperature and magnetic field dependence. Be-

cause of the extreme sensitivity of the technique it was quickly shown to have unique applications to ultra thin films and surfaces.

The first experiments were carried out using linear polarized light. Another break-through occurred with the first circularly polarized experiments by G Schütz et al. on the K edge of iron in 1988 (Phys. Rev. B 73 67 (1988)). This was the first successful experiment using circularly polarized light so that the sublattice magnetization could be directly measured. Schütz did her experiment at the K edge which exhibits only a small dichroic effect. However, her experiments opened a completely new direction since shortly after the Bell labs group (C.T.Chen and coworkers) demonstrated extremely large effects of 30% or more using circular dichroism at the L23 edges of Ni. A large number of experiments followed using circularly polarized light on a large variety of problems involving magnetic materials.

Substantial efforts were then made to improve the degree of circular polarization of the radiation at synchrotron sources and virtually all synchrotron facilities concentrated on developing magnetic circular dichroism beam lines.

A third break-through occurred in 1992 with the theoretical derivation of the so called orbital magnetic sum rule which states that the integral of the dichroic signal over the absorption edge is directly proportional to the orbital part of the magnetic moment in the ground state of the atom (PRL 68, 1943 (1992)) . This work involved the principle authors Thole, Carra and van der Laan. From this time on also Carra played a leading role in further developing the theoretical description of

x-ray magnetic dichroism. This work provided another unique application of XM-CD (x ray magnetic circular dichroism) namely the direct separation of the orbital and spin magnetic moment in magnetic materials. There is to date no other technique which can accomplish this. This caused another huge increase in the use of synchrotron radiation by a very large number of scientists in especially thin film magnetism. This because of the importance that the orbital part of the magnetic moment plays in the magnetic anisotropy of the material. The latter is of great importance in applications in magnetic recording and in magnetic reading heads.

A series of papers followed by Thole and Van der Laan providing the user community with all kinds of sum rules and polarization dependencies for also other experiments. Unfortunately B. Theo Thole died after an accident in 1996 otherwise he would certainly have been included as a recipient of this award. Thanks to these pioneers every synchrotron has a strong research program in x-ray magnetic dichroism and new developments have provided the experimenters with rapidly switchable pure circular polarization. Applications are in all areas of magnetism, thin films, surfaces, multilayers, antiferro-, ferro- and ferrimagnetic materials and even large organic and bio-molecules containing paramagnetic transition metal ions.

The selection committee expects that we are still only at the beginning of a very large field of applications of the ideas and pioneering work done by Thole , van der Laan , Schütz and Carra.

See also <http://psi-k.dl.ac.uk/psi-k/hp.html>

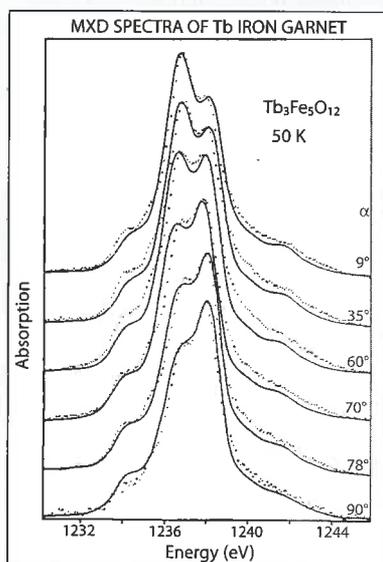


Fig 1 First observation of magnetic x-ray dichroism. Experimental M5 absorption spectra of $Tb_3Fe_5O_{12}$ at 50 K for various values of the angle between the x-ray linear polarization vector and the [111] direction of magnetization. The solid curves are theoretical fits, after PRB 34, 6529 (1986).

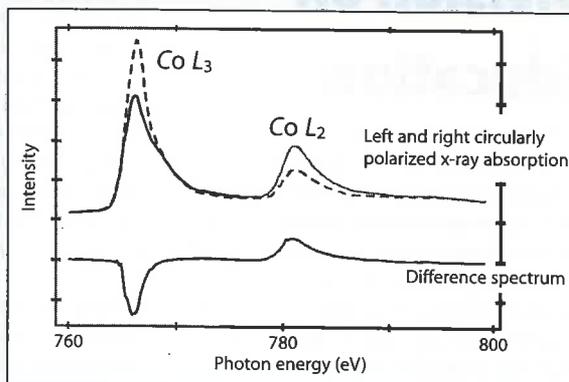


Fig 2 Early result (1992) of soft x-ray absorption with left and right circularly polarized x-rays at the Co $L_{2,3}$ edges of a CoPd multilayer with perpendicular magnetic anisotropy. The difference spectrum reveals a huge circular magnetic x-ray dichroism from which the orbital and spin magnetic moments can be obtained by applying the sum rules.

noticeboard

EGAS General Assembly & Elections

The General Assembly of the European Group on Atomic Spectroscopy (EGAS) will be held during the EGAS Conference in Vilnius on Thursday July 6, 12 h. Any delegate attending the conference is entitled to participate in the General Assembly. EGAS is managed by a Board of fifteen members, who are elected by the General Assembly at the annual conference. Each Board member is elected for a term of 3 years for a maximum of 2 terms. While a reasonable regional balance in the Board membership is sought, Board members are not elected simply to represent their own nations. There are 4 outgoing members who have reached the end of their 2nd term and are not re-eligible (Profs. Baudon, Griffith, Huber and Mannervik). One member (Fernande Vedel) is finishing her 1st term and is re-eligible. The Board recommends that she should be re-elected. In order to maintain the geographical balance, the Board particularly encourages nominations from France, the UK, the Nordic countries, Spain and Portugal. Nominations should be sent to the Secretary, Professor Fernande Vedel (e-mail: fern@frmrs12.u-3mrs.fr) no later than 1st June 2000. Board members are expected to attend the annual conferences and a Board meeting in November each year. Candidates should provide a CV and a statement that they are willing to serve if elected. If necessary, an election will be organized at the conference.

EGAS Annual conference

Marseille, July 1999 Vilnius, July 2000

Born with the EPS in 1968, the Annual conference of the European Group for Atomic Spectroscopy ((EGAS) provides a good example of the EPS conference concept – full of vitality with a broad European dimension. At last year's conference in Marseille, there were 250 participants from 26 countries. Thanks to the hard work of the local committee in obtaining the support of French institutions and the EWTF programme of the EPS more than 70 delegates could be offered some support. Young participants made up more than 25% of the attendance, in line with EGAS policy. The opening session welcomed Prof. C. Cohen-Tannoudji, who presented a wide perspective on the laser manipulation of atoms. Plenary sessions covered different aspects of atomic physics and its entanglement with other specialities, demonstrating the close association between fundamental processes (parity violation and general relativity, for example) and their applications to understanding our environment, or to imaginative implications for technical innovation. The old tradition of physics and optics in Marseille was celebrated in an evening lecture by P. Amram (Observatoire de Marseille) on the various works in instrumentation and spectroscopy of Fabry and Perot, while modern technology could be seen in the scientific exhibition, which included the exciting blue laser diode. Following the tradition, the next EGAS will be held in an University city: Vilnius (3-6 July 2000, Chairman, Prof. Z. Rudzikas, <http://www.itpa.lt/~egas32/>) Even if this site is more distant for West-seaside countries, the high quality of the planned scientific program and the elegant baroque style of the city will contribute to attract a lot of visitors as well from the West as the East. The scientific programme of the conference will cover all aspects of the structure and spectroscopy of atoms, ions (highly charged ions included) and small molecules. It will include applications to laser physics, low and high temperature plasma physics, astrophysics, medicine, industry, environment and other fields as well as developments in technology and instrumentation. Special attention will be paid to laser light interactions with atomic and molecular species, to optical lattices, to atomic tests of fundamental theories, to coherent and non-linear phenomena, ions in traps and laser manipulation of atoms, short-lived, "ultracold", "hollow" and "exotic" atoms, atomic fountains, parity non-conservation, Bose-Einstein and Fermi-Dirac condensates, quantum cryptography and teleportation.

— Activity Report — The New EPS Division on Education

The Malvern Seminar on Securing the Future of Physics, held in Malvern College in the UK in September 1999, was attended by Presidents of the various European physical societies. Much concern was expressed about the status of physics education in many European countries. It resulted in a number of recommendations, sent to the Executive Committee of the EPS. One of these recommendations was that the importance of education within the EPS would be enhanced if there was a separate Education Division instead of the existing Interdivisional Group. This recommendation was accepted by the Executive Committee and was approved at

the Council Meeting in Dublin. This new Division would replace the earlier Interdivisional Group.

It was agreed at the Council Meeting that there would be two separate sections within the Division. The first would be chaired by Professor Hendrik Ferdinande of the University of Gent (BE) and would be concerned with University Education. The second section would be chaired by Professor Gunnar Tibell of the University of Uppsala (SE) and would be responsible for pre-University Education. The latter would replace the earlier Forum on Education.

Amongst its activities, the University section would continue the successful work being achieved by the European Physics Education Network (EUPEN).

It was proposed at the Malvern Seminar that the President of each of the national physical societies should nominate a representative on physics education so that there was a

direct link between the societies and the work being done within the new Division. The representatives are currently being appointed.

Fortunately at the Council Meeting it was possible to persuade Professor Aart Kleyn, the President of the Netherlands Physical Society and chairman of the physics education group at the Malvern Seminar to be the first Chairman of the new Division. John Lewis, who was the organiser of the Malvern Seminar, the former Treasurer of the EPS and Chairman of the former Interdivisional Group on Education would continue the secretarial work involved in setting up the new division.

The new Division will continue to be supportive of the excellent work being done by the European Mobility Scheme for Physics Students (EMSPS). While certainly educational in scope, the EMSPS is working well independently, directly responsible to the EPS Executive Committee and to the Council.

Secretary General's Report

Council 2000

The EPS Council Meeting was held in Dublin, (Ireland) on March 25 and 25 2000. The Secretary General would like to express special thanks to Jeanette Cummins, Maria Lazar, and Mireille Schmidt for their hard work in making this Council meeting a success.

The President stressed the development of new EPS activities, and plans to do even more, more effectively. Voluntary help and personal involvement is very important, due to the limited resources of the Society. Progress was reported in the development of public understanding of science initiatives, and in bringing the the biographies of famous physicists to completion. The Executive Committee was thanked for their hard work over the past year. The Secretary reported on current staffing at the Mulhouse Secretariat and at the Budapest office, which has increased from 5 to 9 persons in the past year, as a result of new activities at the Secretariat, including page layout and design, computer services, and conference services. The Treasurer provided a detailed report of the financial situation of the EPS showing net positive balance of approximately Euro 10,000 at the end of 1999. The 2000 Budget was approved by Council.

In 2000, the EPS will be looking at a "Business Plan", designed to link resources to its strategy for the promotion of physics in Europe.

Executive Committee

The EPS Council elected the following persons as members of the Executive Committee: Sir Arnold Wolfendale (President), Martial Ducloy (President Elect and Vice- President) Peter Reinecker (Treasurer), Ana Maria Eiro (Vice-

Treasurer). Christophe Rossel (Secretary), Denis Jérôme (Vice-Secretary), Karel Gaemers, Dalibor Krupa, Rudolph Klein, Per-Anker Lindgard, Ryszard Sosnowski.

The Executive Committee and the Council expressed their warmest thanks to the outgoing members Denis Weaire and Giorgio Benedek.

President Elect

Martial Ducloy became the new EPS President Elect following the elections at Council. According to the EPS Constitution, the President Elect will become the next president of the EPS. (In April 2001, at the end of A. Wolfendale's term of office). M. Ducloy is the Director of Research at the CNRS and the University of Paris (Nord), specialised in non-linear optics, quantum optics and laser spectroscopy.

Move to University Campus in Mulhouse

C. Rossel, Secretary of the EPS Executive Committee reported on the current status of the planned move of the EPS Secretariat to the campus of the Université d'Haute Alsace (Mulhouse). After many meetings with national and local governmental authorities, the initial project of a full fledged institute of physics with laboratories and lecture theatres has been abandoned for financial reasons. Instead, a smaller building specifically for the EPS offices is now planned, and FRF 5 million have been allocated to this project. The difficulty is that we have received no formal notification regarding the timing of the new construction. The support of all the members of the EPS is requested to convince the national and local authorities to finish the new offices of the EPS as quickly as possible.

David Lee is the Secretary General of the EPS [email d.lee@univ-mulhouse.fr](mailto:d.lee@univ-mulhouse.fr)

The EPS Medal for the Public Understanding of Physics

The EPS has approved the creation of "The European Physical Society Medal for the Public Understanding of Physics".

Nominations are being sought from EPS Divisions and constituent societies. The deadline for nominations is 31 December 2000. Below, please find the full regulations.

Terms and Conditions

1. This Annual Medal is intended to honour an individual who has contributed greatly to the Public Understanding of Physics
2. In addition to the Medal, there is a small financial prize (Euro 500) and cover for expenses to attend a major conference at which the award will be given.
3. Nominations are invited from, and must be

endorsed by, constituent member societies and EPS divisions and interdivisional groups; normally only one candidate will be expected from each constituent society and/or EPS division or interdivisional group.

4. The judges will be the EPS Executive Committee.

5. The winner will be an individual who has, for example, contributed very considerably to "educating the Public" in the joys of Physics.

6. The closing date will be the end of the calendar year; the announcement of the winner will be made at the EPS Council meeting.

7. Nominations, limited to 4 A4 pages and accompanied by 3 supporters statements, should be sent to the EPS Headquarters in Mulhouse (for the attention of the Secretary General).

Rudolf Klein

Dilemma

Over the last decade significant numbers of young graduates from institutions in Central and Eastern Europe (CEE) have moved as post-docs to institutions in Western Europe and in North America. Post-doctoral work abroad is of course always an important part of the career of a scientist. For post-docs from CEE there is, however, often the problem of limited employment opportunities in physics after moving back to their home countries. Even if employment is found, salaries are usually low, so that even a second job might be necessary. Moreover, the equipment available for research will often not be state-of-the-art. The alternative of staying in the West has also problematic aspects. The first one is that the long-time prospects of a career as a scientist at least in some countries of Western Europe are not particularly good. It is often fairly easy for a successful post-doc to find successive positions on a temporary basis but it is in many cases quite difficult to obtain a permanent position in the West. The second aspect is related to the future of physics in the CEE countries: If all the good post-docs are employed in permanent positions in the West, an irreversible brain drain results. The permanent move of significant numbers of the best graduates from East to West will severely threaten the future of physics in the East. This cannot be in the interest of EPS with its tradition of helping physics and physicists in the East. Instead the best physicists are needed in that part of Europe to either maintain a high standard of physics education, where it still exists, or to improve it where necessary.

Pointing out this second aspect of the problem does not mean that EPS discourages the hiring of post-docs from CEE countries by Western institutions. On the contrary, a major activity of EPS in the context of East-West relations is to support the participation of young scientists from CEE in international conferences, and it is at these meetings that potential candidates for post-doc positions are often identified.

The only way out of the dilemma of providing on the one hand opportunities for young physicists from CEE in the West and maintaining on the other hand active physics research and education in the East seems to use all means to convince governments of CEE countries that their future depends also on the availability of well-trained physicists. This can only be accomplished by improving the working conditions of physicists in those countries.

A festival of science in Montreux

The 18th General Conference of the EPS Condensed Matter Division took place during the 3rd week of March in the lakeside city of Montreux, Switzerland. Organized jointly with the Swiss and the Japanese Physical Societies, this meeting was a great success, with the participation of about 1300 physicists from 42 nations within Europe and from overseas. For the week of 13 to 17 March, Montreux, famous for its Jazz Festival, was the pole of attraction for another kind of music. Listening to scientists, distinguished professors, researchers and students, all sharing their ideas and results with enthusiasm, may have sounded like a virtual concert of modern music to non expert ears. The dense scientific program of plenary talks, focus sessions and 31 mini-colloquia including both oral and poster presentations, provided the latest research on many aspects of contemporary condensed matter physics. A wide variety of topics, such as high temperature superconductivity, magnetism and transport in nano-structured systems, self organization of atoms at surfaces, electrooptical properties of

semiconductors and polymers, quantum computing, new types of lasers, and even on biological motors and DNA dynamics, were addressed. The organization of mini-colloquia, started in Grenoble in 1998, along with the dedicated involvement and work of experts in the respective fields, seems to be the key for a large attendance, particularly younger researchers, and hence the scientific success of this type of CMD conference. After a week of intense work, particularly manifest in the persistent attendance of the poster sessions often well beyond the official closing time, the meeting ended on Friday with the award ceremony of the Agilent Technologies Europhysics Prize (formerly the Hewlett Packard Europhysics Technologies Prize) to Gerrit van der Laan (Daresbury) Paolo Carra (Grenoble) and Gisela Schütz (Würzburg) for their pioneering work on x-ray magnetic dichroism. (See article page). On Friday afternoon, more than 200 participants went to visit the impressive installations of CERN, the world's largest high-energy physics laboratory located outside Geneva. Montreux will cer-

tainly be remembered by all participants for its charming location, the early-spring sunshine and the exciting scientific atmosphere during the meeting. There is great hope that the spirit of Montreux may be transferred to the next conference of this series, CMD-19, to be held in April 2002 at Brighton, UK.



left to right: Gerrit van der Laan, Gisela Schütz and Paolo Carra

EPAC 2000

The EPAC2000 Prize to a person in the early part of his or her career for a recent, significant, original contribution to the accelerator field is awarded to **Pantaleo Raimondi from SLAC.**

Pantaleo has made a significant contribution to understanding the effects which, in a practical real-life situation, can be optimised at the interaction point of an e⁺/e⁻ collider to improve the luminosity. Through a deep appreciation of beam diagnostics and error analysis he applied numerous inventive techniques in beam based alignment and beam optics to the Stanford Linear Collider which resulted in a threefold increase in its luminosity. An important breakthrough has been his analysis of the beam-beam deflection scan data in the flat beam situation; with proper allowance for beam disruption effects and from measuring the energy loss profile during the scan he was, uniquely, able to estimate the individual transverse and longitudinal beam sizes at the interaction point.

He was also able to apply similar techniques to LEP during a visit to CERN in 98/99. He introduced a new algorithm to

allow simultaneous correction of the measured momentum dispersion as well as the closed orbit position. This resulted in smaller beam sizes at collision with a corresponding increase in LEP luminosity. He also suggested a way of using the LEP correctors to allow the energy to be increased by 0.2 GeV.

The Prize is merited for the significant improvement this innovative work has had on the performance of existing colliders, and the expectation that future colliders can be designed with increased confidence that the required performance can be attained through the application of his techniques.

The EPAC2000 Prize to an individual for outstanding work in the accelerator field, with no age limit, is awarded to **Eberhard Keil from CERN.**

For his profound knowledge and great experience in all aspects of accelerator physics, Eberhard is widely known and highly respected throughout the entire accelerator world. He has made seminal con-

tributions in a multitude of topics which include instabilities, beam-beam effects, and his ability to act as a bridge between theory and the ultimate realisation of an accelerator. By translating theory in a comprehensible way he has been able to convince others that the desired goals can be reached. In this way he has played an important role in the management of major scientific decisions relating to accelerator based facilities. The accelerator community is greatly indebted to Eberhard's endeavours and the award of the Prize recognises this.



Pantaleo Raimondi



Eberhard Keil

Assistant Professor in Physics

The *Swiss Federal Institute of Technology Zurich (ETHZ)* invites applications for the position of an Assistant Professor in Physics (Experimental Particle Physics) at the Institute of Particle Physics (IPP). The long-term focus area of research of the IPP is on the construction and operation of the CMS experiment at the CERN Large Hadron Collider (LHC). The IPP is involved in the various aspects of the experiment, such as in the electromagnetic calorimeter (ECAL), the magnet, the inner tracking detector, and the data acquisition system. The new professor is expected to strengthen the participation of the IPP in the ECAL project during the construction phase and startup of the data taking of the CMS experiment. A participation in the data analysis of presently running experiments is encouraged.

The new professor is expected to participate in teaching physics in all departments of ETHZ, including propaedeutic physics and specialized particle physics courses up to the level of the ETH diploma.

This assistant professorship appointment will be made on a three years basis with a possibility of renewal for three additional years.

Applicants are asked to send their curriculum vitae, list of publications, names of at least three references, and a short overview of their research interests to the **President of ETH Zurich, Prof. Dr. O. Kübler, ETH Zentrum, CH-8093 Zurich, no later than June 30, 2000**. The ETHZ specifically encourages female candidates to apply with a view towards increasing the proportion of female professors.

General information on ETH Zurich and its Department of Physics is available on "<http://www.phys.ethz.ch>". Questions referring to this position should be mailed to Prof. Felicitas Pauss, CH-8092 Zurich (E-mail: pauss@particle.phys.ethz.ch).



The Faculty of Science (Mathematisch-naturwissenschaftliche Fakultät) of the University of Zurich invites applications for a full

Professorship in Theoretical Astrophysics

in the Institute of theoretical physics. The new professor will establish an active research program in astrophysics or cosmology. She or he will find a stimulating environment with important experimental activity in solar and stellar high energy astrophysics and dark matter searches at ETH and PSI. Collaboration with these groups and other theorists is expected.

The new professor will participate in the teaching of theoretical physics at all levels and supervise diploma and PhD students.

Candidates with a recognised scientific record in theoretical astrophysics or cosmology are asked to send their curriculum vitae, list of publications, and a summary of their research interests to the Dean of the Faculty of Science (Mathematisch-naturwissenschaftliche Fakultät), **Prof. Dr. K. Brassel, University of Zurich, Winterthurerstrasse 190, CH-8057 Zurich** by **June 30, 2000**. Please visit our website at <http://www-theorie.physik.unizh.ch>.

The University encourages female candidates to apply with a view towards increasing the proportion of female professors.

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The three laboratories **Kernfysisch Versneller Instituut (KVI)** at Groningen, **Institut für Kernphysik** at Forschungszentrum Jülich and **The Svedberg Laboratory (TSL)** at Uppsala jointly offer the means for research in the fields of nuclear and medium-energy hadron physics with proton and heavy-ion beams in a wide energy range at their accelerators AGOR, COSY and the Gustav-Werner Cyclotron/CELSIUS, respectively. They have united their efforts in this research field in the framework of LIFE (Light-Ion Facility Europe). Scientists from member states of the European Union and from associated countries are entitled to apply for support to use the beams and facilities of these institutes through contracts signed with the European Commission in the framework of the Access to Research Infrastructures action of the Improving Human Potential (IHP) Programme. Proposals will be reviewed by the International Programme Advisory Committees of the respective laboratories and by a joint LIFE Facility Co-ordination Group. Approved projects dealing with research meant for publication in the open literature will be given access to beam lines, experimental equipment, infrastructure, etc. free of charge. The scientists concerned will also be eligible for financial support through the IHP programme to cover their travel and subsistence expenses.

Information about the individual laboratories, available equipment, proposal forms and deadlines, and other procedures is available from **KVI**: A.M. van den Berg, tel.: +31 50 363 3629, fax: +31 50 363 4003, e-mail: berg@kvi.nl or at home page: <http://www.kvi.nl/>; **COSY**: D. Grzonka, tel.: +49 2461 61 4402, fax: +49 2461 3930, e-mail: d.grzonka@fz-juelich.de or at home page: <http://www.fz-juelich.de/ikp/>; **TSL**: H. Calén, tel.: 46 18 471 3846, fax: +46 18 471 3833, e-mail: calen@tsl.uu.se or at home page: <http://www.tsl.uu.se/>.

Characterisation of Surfaces and Interfaces (COSI)

University of Liverpool, UK

The Large Scale Facility EU grant for surface science in Liverpool has been extended for a further six months until September 2000.

Applications are particularly welcome from research groups who has not previously used the facility, who wish to characterise surfaces or interfaces.

Equipment available includes:

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For further information, please contact:

Barbara Keffe, Surface Science Research Centre, University of Liverpool, Liverpool L69 3BX, UK.

☎ +44 151 794 3541, Fax +44 151 708 0662
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The Faculty of Science of the University of Bern invites applications for the position of a full professorship in Theoretical Physics

opening March 1, 2001 at the Institute of Theoretical Physics, University of Bern, Switzerland. Candidates should have a strong research record in the area of quantum field theories with applications in particle and/or condensed matter physics. The current research activities at the institute include effective field theories, nonperturbative methods in quantum field theory and unified field theories of particle physics. The successful candidate is expected to strengthen at our institute the interaction between these research fields and to participate in the teaching and supervision of students.

The University of Bern encourages women to apply for this position.

Letters of application, including a curriculum vitae, a publication list, copies of the most important publications and a brief outline of past and future research should be sent to the address below by **June 15, 2000**.

Prof. A. Pfiffner, Dean of the Faculty of Science, Sidlerstr. 5, CH-3012 Bern.

For further information you may contact Prof. P. Hasenfratz, hasenfra@itp.unibe.ch.

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Professor in Experimental Solid State Physics

The *Swiss Federal Institute of Technology Zurich (ETHZ)* invites applications for the position of a Professor in Experimental Solid State Physics.

The new professor is expected to lead an effort of cutting edge research in fundamental solid state physics. The focus should be in the investigation of interfaces, surfaces, and/or the study of the physical properties of small structures, possibly including combinations of organic and inorganic materials. The newly established research group is expected to quickly gain international reputation. It should collaborate with other groups of the department of physics as well as with neighboring disciplines present at ETHZ. The nearby Paul Scherrer Institute in Villigen offers possibilities in using its neutron and synchrotron radiation sources.

The new professor will participate in teaching physics in all departments of ETHZ and at all levels. This includes undergraduate physics classes, lab courses and specialized solid state physics courses up to the level of the ETH diploma.

Please submit your application together with a curriculum vitae and a list of publications to the **President of ETH Zurich, Prof. Dr. O. Kübler, ETH Zentrum, CH-8092 Zurich, no later than June 30, 2000**. The ETHZ specifically encourages female candidates to apply with a view towards increasing the proportion of female professors.

General information about ETH Zurich and its Department of Physics is available via "www.phys.ethz.ch".

ASTERIX REDIVIVUS

The iodine kilojoule laser system ASTERIX transferred from Max-Planck-Institut für Quantenoptik in Garching to the PALS Research Centre in Prague offers its beam time to European scientists again.

The access will be supported by the

European Community - Access to Research Infrastructures action of the Improving Human Potential Programme.

For the laser parameters, deadlines and instructions how to apply for access, please, refer to the PALS web site

www.pals.cas.cz

N O R D I T A

Copenhagen

ASSISTANT PROFESSOR in

THEORETICAL CONDENSED MATTER PHYSICS

NORDITA, the Nordic Institute for Theoretical Physics, has an opening for an assistant professor in theoretical condensed matter physics starting on or about January 2001. Preference will be given to candidates with a promising research record who are no more than six years beyond their PhD degree. The initial appointment will be for three years, with a possibility of renewal up to a total of six years.

NORDITA is supported by the five Nordic countries, Denmark, Finland, Iceland, Norway and Sweden, and is located on the premises of the Niels Bohr Institute of Copenhagen University. Research at the institute is carried out in astrophysics and cosmology, complex systems (including biological physics), condensed matter physics, particle physics and the physics of hadrons and nuclei. There are good opportunities to carry out cross-disciplinary studies. Members of the institute interact with scientists at the Niels Bohr Institute for Astrophysics, Physics and Geophysics of the University of Copenhagen, and at other scientific centres in the Nordic countries.

The full announcement text may be found at <http://www.nordita.dk/Adm/Position/>.

Paul Hoyer, hoyer@nordita.dk
Director, NORDITA

The deadline for applications is **15 June 2000**.

European Physical Society

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

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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.

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

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National Member Societies constitution article 4b)

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Collaborating Societies constitution article 4d)

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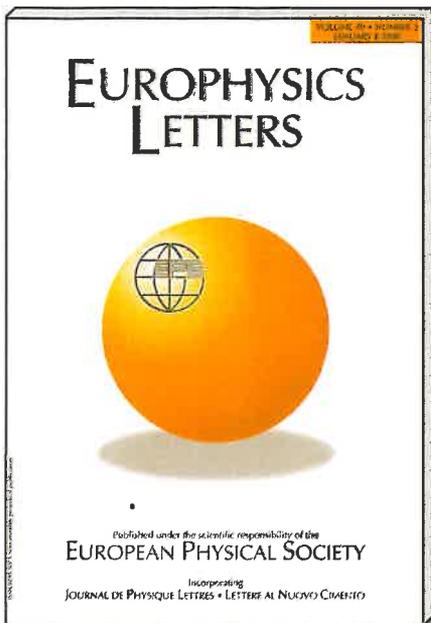
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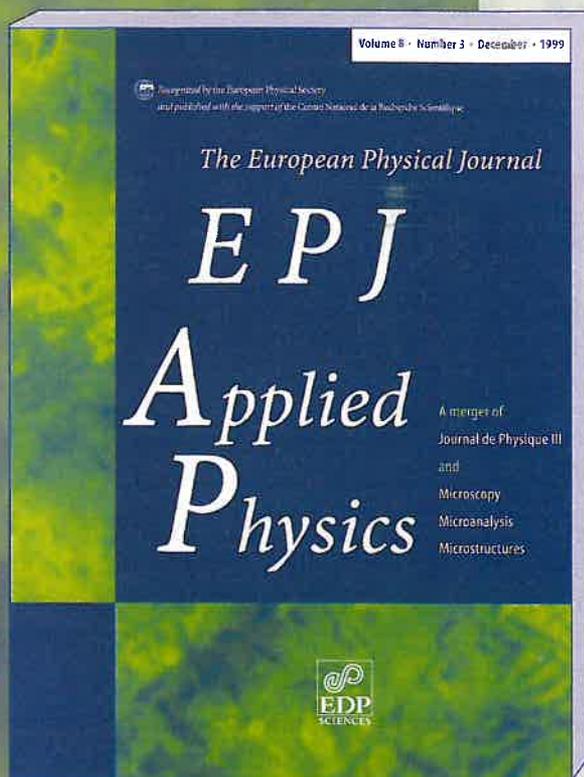
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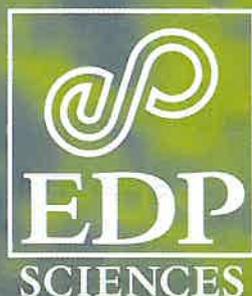
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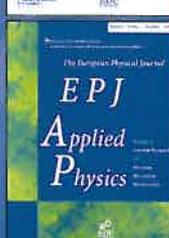
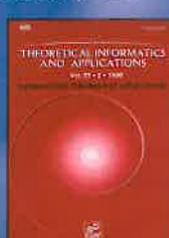
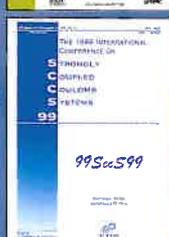
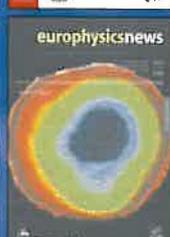
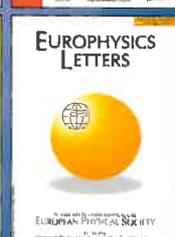
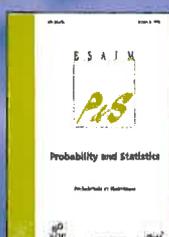
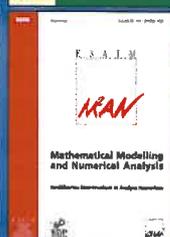
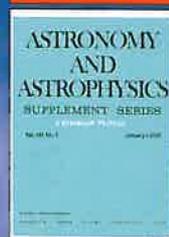
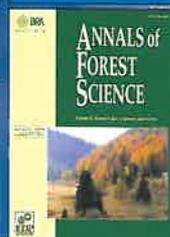
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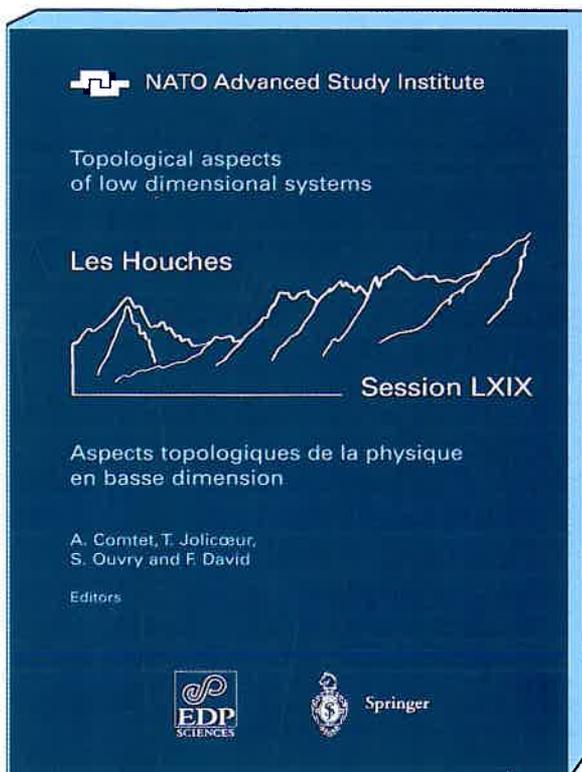
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