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Ethics of nanotechnology or... nanoethics?
Forum Physics and Society I & II
"On the way we conference"
Global mapping of greenhouse gases and air pollutants

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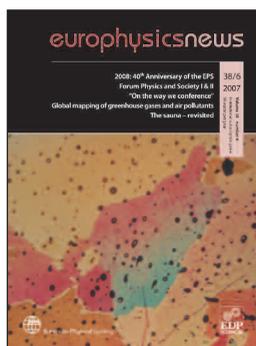
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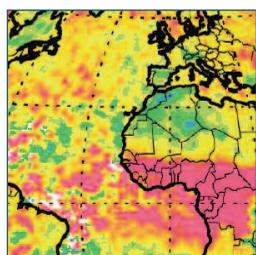
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Cover picture: PETIT Jean-Robert • Laboratoire de glaciologie et de géophysique de l'environnement (lgge) • Saint-Martin-d'Hères
Ice crystals contain tiny air bubbles that reflect the composition of the CO₂ and CH₄ past content in the atmosphere. From the evolution of the concentration of these gases along ice cores past climate variations can be inferred. © CNRS Photo Library



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The EPS answers to the EC Green Paper [EDITORIAL]

There are White Papers, Green Papers and Black Books. According to Wikipedia: “A White Paper is an authoritative report e.g. a government report outlining policy. White Papers are also used to inform customers.”

A Green Paper is less committal than a White Paper and those of the European Commission are used to “start a discussion and launch a process of consultation”. This summer, the Commission distributed the Green Paper “The European Research Area: New Perspectives”. EPS responded to the Green Paper and submitted an answer. The major arguments and positions in our answer were also used in discussions with Commissioner Potocnik and with Members of the European Parliament. I would like to repeat them here because they reflect to a large part my own positions and goals for the EPS.

- EPS is very much in favour of the ERC, the European Research Council.
- We support the guidelines behind the ERA, the European Research Area, and the ideals of a knowledge society. We understand that these are not empty symbols but rather focal points and attractors in the development of a European science and knowledge society.
- We support an appropriate balance of fundamental and applied research.
- We stress the necessity for the 3rd stage of education, the PhD phase, to remain to a large extent research oriented; we support, however, education in the frame of graduate schools.
- We are hesitant with respect to the idea of a European Institute of Technology.
- We urge the Commission to avoid any effort of centralised control and regulation. This applies specifically to those organisations engaged in and projects dealing with fundamental research. As soon as positive experience is available, the principles, which govern the work of the ERC, should also be applied to other R&D fields.
- We propose to the Commission that it makes the funding mechanisms of their projects and programmes more transparent and specifically that it provides to all applicants a reasonable predictability of their chances for support. The risks that invested time is lost should be avoided by all means.
- We warn that the funds provided by Europe for research should not lead to a proportional reduction of the national resources.
- We feel that the national science organisations should be better integrated and should play a larger role in the processes which shall lead to the ERA.
- We say that the lack of mobility within science and between science and industry has the following reasons:
 - lack of job opportunities for partners,
 - lack of international schools for children,
 - missing financial incentives when changing institutions and jumping sectors,
 - unclear situation with respect to health and social insurance,
 - cultural deficiencies in the integration of scientists abroad,
 - lack of clear strategies of re-integration after return.
- We encourage the development of structures which provide sufficient social security to young scientists in the career development phase, where they simultaneously consolidate private aspects of their lives. Specific programmes should be developed to support young female scientists in this critical period.
- EPS suggests to the Commission to consider the following propositions:
 - direct or indirect ways of support of Learned Societies such as EPS should be found; EPS and other Learned Societies of Europe are important partners for the Commission and faithful trustees of the European ideals in the European unification process;
 - financial means should be provided to translate material of national societies in important fields (such as education, statistics on professional and educational development, energy, climate, national science policies, outreach activities...) into English to make them available European-wide to encourage best practice, and share results;



- a European-central repository for scientific material produced by physics (or other scientific fields) after Europe e.g. in conferences and after workshops should be envisaged;
- means should be found to bring

newly nominated physics faculty members in contact with modern ways to teach physics (e.g. in devoted workshops).

The EPS has a role to play in European integration and in the development

and use of science policy to achieve this goal. Let us hope that the EC, and the EU Member States recognise the importance of science and technology in European construction. ■

Friedrich Wagner,
President of the EPS

2007 Nobel prize in Physics [PRIZES]

The 2007 Nobel Prize in Physics will be awarded to **Albert Fert** (Université Paris-Sud, Orsay, France) and **Peter Grünberg** (Forschungszentrum Jülich, Germany) for the discovery of giant magnetoresistance, or GMR for short. GMR is the process whereby a tiny magnetic field, such as that of an oriented domain on the surface of a computer hard drive can, when the proper read head is brought nearby, trigger a large change in electrical resistance, thus 'reading' the data vested in the magnetic orientation. This is the heart of modern hard drive technology and makes possible the immense hard-drive data storage industry. Fert and Grünberg pioneered the making of stacks consisting of alternating thin layers of magnetic and non-magnetic atoms needed to produce the GMR effect. GMR is a prominent example of how quantum effects (a large electrical response to a tiny magnetic input) come about through confinement (the atomic layers being so thin); that is, atoms interact differently with each other

when they are confined to a tiny volume or a thin plane.

All these magnetic interactions involve the spin of an electron. Spin is a quantum attribute that should not be associated too closely in the mind with the electron literally spinning (in the way that a top spins).

Still more innovative technology can be expected through quantum effects depending on the electron spin. Most of the electronics industry is based on manipulating the charges of electrons moving through circuits. But the electron spin might also be exploited to gain new control over data storage and processing. Spintronics is the general name for this budding branch of electronics.

The EPS is proud to have recognized the importance of this discovery by attributing its 1997 Hewlett-Packard Prize to Albert Fert and Peter Grünberg for their independent demonstrations of the GMR effect (and to Stuart Parkin for his understanding of the effect). This was announced in *Europhysics News* 28/4, 136

(1997) besides a small note asking if the 1997 Hewlett-Packard laureates would later be awarded the Nobel Prize, as did several previous HP laureates such as Klaus von Klitzing (HP 1982, Nobel Physics 1985), Gerd Binnig and Heinrich Rohrer (HP 1984, Nobel Physics 1986), Harold Kroto and Richard Smalley (HP 1994, Nobel Chemistry 1997). We must add Georg Bednorz and Alex Müller, who could not get their HP prize because they won the Nobel prize in Physics the same year 1987, the rule being not to give the HP prize to a Nobel laureate. After ten years, the answer is 'yes' and Albert Fert and Peter Grünberg can now be added to the list.

Let us recall that in the same EPN issue the story of the GMR discovery was lively described, with a touch of theory (Michael Ross, *EPN* 28/4, 114, 1997)

More will come soon in EPN on the 2007 Nobel laureates in Physics and in Chemistry. ■

Website: <http://nobelprize.org>

Max Auwärter award 2008 [CALL FOR NOMINATIONS]

The Max Auwärter award for students and young researchers is offered bi-annually by the Max Auwärter Foundation in Balzers, Principality of Liechtenstein. It is open to university and research institution based scientists up to 35 years of age who have published significant work in the field of *surface physics, surface chemistry or organic and inorganic thin films* as a **single author**.

The award includes a certificate and a prize of 10,000 € (ten thousand euro).

Applications or third party proposals should be submitted with 4 copies of the publications to be considered and the CV of the proposed recipient describing her/his previous scientific activities, by **30 April 2008** to:

O. Univ. Prof. Dr. Falko P. Netzer
Institut für Physik, Oberflächen- und

Grenzflächenphysik
Karl-Franzens Universität Graz
Universtät Plaz 5,
A-8010 GRAZ, Austria
Fax: +43 316 380 9816;

e-mail: falko.netzer@uni-graz.at

A jury appointed by the foundation Council will decide finally and indisputably about the awarding of the prize. ■

Lise Meitner Prize for Nuclear Science

of the European Physical Society, 2008 [CALL FOR NOMINATIONS]

The Nuclear Physics Board of the EPS invites nominations for the “Lise Meitner Prize” for the year 2008. The award will be given to one or several individuals for outstanding work in the fields of experimental, theoretical or applied nuclear science. The Board welcomes proposals which represent the breadth and strength of European nuclear sciences.

Nominations need to be accompanied by a completed nomination form, a brief curriculum vita(e) of the nominee(s) and a list of major publications. Letters of

support from authorities in the field that outline the importance of the work of the nominee(s) are also helpful.

Nominations will be treated as strictly confidential and although they will be acknowledged there will be no further communication from the selection committee. Nominations should be sent to:

Selection Committee Lise Meitner Prize
c/o Chairman Prof. Hartwig Freiesleben
Institut für Kern- und Teilchenphysik
Technische Universität Dresden
01069 Dresden, Germany

Phone: +49 (0)351 46335461;

Fax: +49 (0)351 46337292

E-mail: freiesleben@physik.tu-dresden.de

For the nomination form and more detailed information go to the web site of the EPS Nuclear Physics Division <http://ific.uv.es/epsnpb/> or the web site of the EPS www.eps.org (EPS Prizes, Lise Meitner Prize)

The deadline for the submission of nominations has been set for **11 January 2008**. ■

Hartwig Freiesleben,
Chairman EPS-Nuclear Physics Division

EPS Europhysics Prize [CALL FOR NOMINATIONS]

The EPS Europhysics Prize for Outstanding Achievement in Condensed Matter Physics is acknowledged internationally as one of the most prestigious awards for condensed matter physics. Many Europhysics Prize winners have subsequently been awarded the Nobel Prize in recognition of their achievements. This year has been exceptional: the Nobel Prize winners both in Physics (**Albert Fert** and **Peter Grünberg**) and in Chemistry (**Gerhard Ertl**) are previous Europhysics Prize winners. **G. Fert** and **P. Grünberg** shared the 1997 Europhysics Prize with Stuart Parkin, “*for discovery and contribution to the understanding of the Giant Magneto-Resistance effect in transition-metal multilayers and for demonstrations of its potential for technological applications*”, while Ertl shared the 1992 Prize with **Harald Ibach** and **J. Peter Toennies** for their “*pioneering studies of surface structures, dynamics and reactions through the development of novel experimental methods*”.

Nominations are now being sought for the 2008 Award. Nominations can be submitted by any individual physicist following the nomination procedures and using the nomination form on the EPS website. The EPS Europhysics Prize recognises recent work by one or more individuals in the area of physics of condensed matter,

which, in the opinion of the Society’s selection committee, represents scientific excellence. Recent work is defined to mean completed within 5 years prior to the award. The award can be given for either pure or applied research.

The EPS Europhysics Prize was originally sponsored by Hewlett Packard and then by Agilent Technologies. Agilent Technologies have recently redirected their charitable activities into a foundation focused on pre-university outreach, and so have decided with regret to end their sponsorship of the Prize. EPS very much appreciate the support and leadership which HP and Agilent have given to establish this premier prize. Recognising the importance of this Prize, the Condensed Matter Division has decided to take over sponsorship of the award, and also to broaden the remit of the Prize. Until now the Prize was awarded in recognition of work in electronic materials and devices. However, condensed matter physicists make major contributions across a very wide range of fields, and it is intended that future Prizes will be open to recognize that breadth of achievement.

Details of the nomination process can be found on the EPS website. Only complete nominations, which should be kept confidential, will be considered.

For a nomination to be complete, it must include:

- a completed nomination form from the EPS web pages
- a complete CV
- a publication list (5 pages maximum)
- an indication of the three most relevant papers to the nomination
- a description of the work justifying the nomination (2 pages maximum)
- a suggested short citation.

The **deadline** for the receipt of nominations is **7 January 2008**. Nominations should be sent to David LEE, EPS, 6, rue des Frères Lumière, BP 2136, 68060 Mulhouse Cedex, France, to the attention of the EPS Europhysics Prize Selection Committee.

The 2008 Award will be presented at a joint session of the 22nd General Conference of the EPS Condensed Matter Division and of the 14th EPS General Council in Rome on 27 August 2008. This joint session promises to be one of the high points of what should be a very stimulating conference, which already includes plenary presentation from Nobel laureate von Klitzing, as well as a full programme of talks and presentations covering the full breadth and excitement of condensed matter physics. Regular updates of the conference details can be found at www.cmdconf.org. ■

2008: 40th Anniversary of the EPS [EVENEMENT]

“In the morning of 26 September 1968, the formal Steering Committee, other physicists and representatives of the National Societies, gathered in the Council Chamber of CERN. The Constitution of the European Physical Society was on the table before them and they were asked as individuals or as representatives of National Societies whether they wished to join the new Society. Sixty-two individual members and twenty National Societies, Academies and Groups enrolled in the EPS.” A ceremony of inauguration took place that same afternoon at the *Aula Magna* of the University of Geneva, where “The Rector of the University, Denis van Berchem, expressed his pleasure at the foundation of the EPS ... The head of the scientific section of the international department of the Swiss Ministry of Foreign Affairs, E. Valloton, conveyed sincere congratulations to all those who had taken ‘this happy initiative’ and wished the Society every success.”¹

Today, nearly forty years later, EPS comprises forty National Societies, precisely twice as many as at its founding; and Individual Members are much more numerous than the original sixty-two – a few thousand. Nonetheless, Individual Members represent still only a small segment of the ca. 100 000 physicists linked to EPS through the national Member Societies. The Constitution has

been amended several times, and was thoroughly revised at the beginning of the 21st century. EPS Council approved the new version in 2004.

Four decades of existence of a learned society are not quite the milestone as half, or even a full century (as it will be the case for the Swiss Member Society, SPS, next year). But it is well worth celebrating in these fast-moving times. The celebration of a 40th Anniversary also offers good opportunities to identify and close gaps in the recorded history of EPS, particularly with witnesses of the ‘first hour’.

Next year EPS will mark its 40th anniversary at three main events:

- at a “Festakt”, which will be held in the afternoon of Friday, 28 March 2008 in Mulhouse as part of the annual EPS Council Meeting. Many guests from academia, industry and politics will be invited to this occasion.
- at a “Festsitzung” following the 14th General Meeting, EPS14. This event will be held in the afternoon of Wednesday, 27 August 2008 in Rome, as part of the biennial meeting of the Condensed Matter Division, CMD22. This divisional conference is usually attended by up to a thousand participants.

- at a **Press Conference** scheduled on the 40th Anniversary day itself: at the time and place, where EPS was founded forty years ago, namely in the morning of 26 September 2008 in CERN’s Council Chamber.

The “Festakt” in Mulhouse at the end of March will be opened by the EPS President, Friedrich Wagner, with a reflection on ‘40 Years of EPS — Achievements and Challenges’. Two scientific talks will then follow, both looking back in time and into the future — one on climate change by Thomas Stocker (Bern) and one on cosmology by Günther Hasinger (Garching). The closing address will be given by Prof. José Mariano Gago, the Portuguese Minister of Science, Technology and Higher Education.

Musical interludes will give the “Festakt” a festive note. We hope to assemble on this day many colleagues who have won Europhysics Prizes, have been appointed Honorary Members or Fellows, or who have actively supported EPS in the past, be it as former Presidents, members of the Executive Committee or in other EPS functions. One may expect that the “Festakt” with its coffee break and ensuing Apéro, as well as the Council Dinner later in the evening and an excursion foreseen for the following day, will bring enjoyable encounters of, and conversations between old colleagues and old friends.

At the ‘EPS Afternoon’ in Rome in late August – scheduled to take place in the (air-conditioned) *Aula Magna* of the *Università La Sapienza* – the EPS President will preside over the Award Ceremony for the ‘Condensed Matter Division Europhysics Prize’ and the lecture by the award-winning physicist and then welcome two prominent speakers: Helmut Dosch (Stuttgart) with the topic “2011 — Odyssey in the Nanocosmos” and Nobel Laureate Klaus von Klitzing, who will conclude the scientific part of the “Festsitzung” with “News from the



◀ On the platform at the inauguration ceremony (left to right) Gilberto Bernardini (President of the Executive Committee of the EPS), Denis van Berchem (Rector of the University of Geneva) and E. Valloton (Representative of the Swiss Authorities).

Quantum Hall Effect.” A number of congratulatory addresses and greetings conveyed by officials and sponsors from academia and politics will lead over to a reception on the magnificent terrace of the *Aula Magna*.²

The **Press Conference** in September 2008 will be held jointly with CERN, and will focus on the remarkable goals that can be – and have been – achieved in physics, and in science in general, if the proponents evaluate, plan and carry out projects within a European framework. Such endeavours must, however, be well embedded in, and supported by related national governments and organisations. The EPS Executive Committee will take the opportunity of this Press Conference to hold their fall meeting in 2008 at CERN at the same time.

Beyond these events, next year’s issues of Europhysics News will feature many accounts describing activities and developments of the first 40 years of EPS. Accordingly, EPS members, who have held

office or were otherwise involved with EPS, such as previous staff members, are being asked to contribute articles to this journal. In addition, unsolicited contributions are very much welcome! Indeed, the readers of this journal are encouraged to write up anecdotal accounts, or to concisely describe significant moments in the history of EPS that they witnessed.³ Please submit them to the Editor of Europhysics News. We firmly plan to use the three special events described above to gather additional testimony in the form of interviews with players of times past.

In this way, we hope to do justice to the development of EPS over its first four decades. We hope to add to the record on the history of EPS — with some invaluable items to be conveyed by people of the ‘first hour’. This will be essential, when a history of EPS will be written to mark the 50th anniversary of this remarkable enterprise of a European learned society. Let us well re-

member that from its outset in times of the Cold War, EPS reached across the iron curtain, and contributed in its own way to the development of the Europe of today! ■

Berndt Feuerbacher & Martin C.E. Huber

¹ These quotes, have been saved in the archives of CERN, and can now also be found in the history section of the EPS web site.

² EPS14 thus marks a break with previous tradition: up to EPS13 – held in Bern in 2005 to celebrate the centenary of Einstein’s *annus mirabilis* – the General Meeting always took place as a session within a general physics conference. As it is becoming more and more difficult to attract young physicists and, particularly, students to a general conference, the Executive Committee has decided – after much deliberation – to schedule EPS14 as part of a more focused, yet large divisional conference, such as CMD22.

³ If you estimate that your intended contribution will exceed 300 words, it will be advisable to enquire with the EPN Editor, Claude.Sebenne@impmc.jussieu.fr, before starting to write.

14th General Conference of the European Physical Society [INVITATION]

The 14th General Conference of the European Physical Society will take place within the 22nd General Conference of its Condensed Matter Division. The whole event will be held at the University “La Sapienza”, Rome, Italy from 25 to 29 August 2008. See www.cmdconf.org

The afternoon of Wednesday, 27 August 2008 will be devoted to:

- the 14th General Meeting of the European Physical Society (13:30-14:15 hrs) with
 - President’s Report
 - Secretary’s Report
 - Treasurer’s Report
- EPS14, a “Festsitzung” celebrating the 40th Anniversary of EPS (14:30-18:30 hrs) with
 - Welcome by the EPS President

- Award of the Condensed Matter Division Europhysics Prize. *Prize Lecture*

- Helmut Dosch, MPI für Metallforschung.

- “2011 — *Odyssey in the Nanocosmos*”

- Klaus von Klitzing, Nobel Laureate, MPI für Festkörperforschung. “*News from the Quantum Hall Effect*”

- a brief interlude with Congratulatory Messages on the occasion of the 40th Anniversary of EPS, followed by
- a Reception on the Terrace of the *Aula Magna* (as of 18:30 hrs)

All Members of EPS are cordially invited to attend the General Meeting, the “Festsitzung” and the Reception. No registration fee will be charged for the events of this afternoon. ■

FP7 grants

For those of you interested in applying for FP7 grants, Sean McCarthy and his team have put together a comprehensive website with an online tutorial, a list of helpful websites together with an overview of the fundamentals of Framework 7. www.hyperion.ie/fp7-fundamentals.htm

This eTraining module is 45 minutes and you can find a handout and the link to the eTraining course on the webpage shown. The module is designed to provide beginners with a quick overview of the following:

- Key sources of information on Framework 7
- The Structure and Terminology used in Framework 7
- Overview of the Research Priorities
- The different grants (Funding Schemes)
- Which countries can participate?
- How proposals are evaluated
- How to start and how to proceed.

Ethics of nanotechnology or... nanoethics? [SCIENCE & SOCIETY]

Roger Maynard,
Université Joseph Fourier • Grenoble, France

Unlike biologists and physicians, physicists, when they meet in scientific conferences, are not accustomed to addressing ethical issues. Indeed the scientists of *non-living* matter are more likely to be concerned with facts rather than values. However recent progress in nanotechnologies has raised, and is bound to raise more and more, several major ethical questions about the contribution of nanotechnologies to the development of mankind and society. These questions are fundamental and concern much more macroethics than nanoethics.

A few features

The development of nanosciences is very recent. Less than ten years ago, in the USA, Mike Roco and others had grown weary to see the bulk of research funding go to genomic studies at the expense of other disciplines. So they launched an ambitious project « National Nanotechnology Initiative » (NNI) backed by big government agencies such as the National Science Foundation (NSF), the National Institutes of Health (NIH)... and even by President Clinton in his State of the Union Address in January 2000! A little later, and for the same reasons, the European officials in charge of Research also launched a programme of research in nanosciences and nanotechnologies. It must be said that the worldwide effort in public and private research in 2007 has reached a final budget of about 10 billion dollars. The public part amounts to roughly half of this budget, that is to say 5 billion dollars equally shared between the USA, Japan, Europe and the rest of the world. Yet, as expected, the industrial part is much more important in the USA and in Asian countries than it is in Europe. Economists predict that in the long term there will be a world production market of nano objects of 1000 billion dollars and a job market of 2 million. It shows the economic importance of this sector.

Today's progress in technology

The dazzling progress concerning the integration of transistors onto chips obeying

Moore's law (doubling of performances every 18 months) now provides huge capacities to treat information and to memorize. This is central to today's development of nanotechnologies with some specific features, for example the efforts in R & D are growing faster than the markets! Nanostructured materials such as the insertion of nanotubes or of nanoparticles in a matrix opens the way to many new applications. In biology and medicine, the introduction of nanoscopic instrumentation adapted to biological macro- molecules has already made new characterizations and manipulations possible. In medicine the vectorization of nanoparticles with specific physical or chemical functionalities targeting tumours paves the way to many therapeutic possibilities.

And in the future

Within the next twenty years many discoveries and inventions can be expected: the emergence of quantum calculation, combinatory biology, and interdisciplinary convergence between Nanotechnologies, Biotechnologies, Information and Cognitive Science (NBIC) such as the implantation in the brain of devices capable of repairing deficient functions or even retinal implants interfaced with the brain. Other fields of application will probably come out such as new devices of photovoltaic energetic conversion and hydrogen processing, as well as water filtration and purification in response to the problems of degradation of the environment.

Nanotechnologies and ethics

First the **danger of toxicity** has become increasingly relevant. Several factors of risk are or will be analyzed:

- The tendency to agglutinate for synthetic nanometric particles with possible effects on the environment and living organisms.
- The importance of the specific surface of nanoparticles and the strong reactivity of metallic nano-powder, which can trigger risks of explosion and inflammability.
- The capability of the nanomatter to penetrate through the barriers of protection of living systems (skin, blood, brain, lungs, intestines, placenta...).

As a result of a growing awareness of sanitary and environmental risks a bigger percentage (roughly 7%) of the total research budget is devoted to the study of these risks to abide by the principle of precaution. In most countries constraining regulations are under way.

Will nanotechnologies instigate a "big brother" world?

Here lies the **second ethical issue** which stems from significant progress occurring in new identification devices leading to tracing, traceability and chip inserting. What is today carried out on a millimetric scale through Radio Frequency Identification Devices (RFID) could be greatly improved thanks to extreme miniaturization, so that anything produced on earth could be identified. The quantity of information memorized in these devices would practically be limitless. However useful this tracing can be in cases of diseases and their treatments, it cannot be denied that the danger of a "Big Brother" use of such a device does exist, hence the need to protect people's privacy and integrity.

Human improvement?

The **third ethical issue** covers a much greater scope. What is at stake is improving mankind, which is now within our reach. Human performances could be significantly increased both in terms of physical capacities through implants to hear and see better... and in terms of cognitive capacities through the manipulation of the brain thanks to drugs or the invention of a sophisticated human/machine interface in order to increase tenfold the memory size. In the NBIC program, the project is to imitate nature, possibly to improve it, which could blur the distinction between the natural and the artificial, the very distinction which founds our moral and cultural values.

As ethics implies a reflection on values and goals let us establish a non-exhaustive list of the issues at stake:

To what extent can a human being be transformed and remain human?

- How far will individuals remain accountable and the master of their deeds?

- What is the limit to the research of perfection for the human being?
- Is society ready to let people go in that direction?
- Where does the unique character of each human being lie?
- Is extreme longevity, coveted by the transhumanists, acceptable?

Whether it is too early to ask here these questions about today's status of science and know-how remains to be seen. If scientific progress helps understand the living better, it also points to its incomparable complexity. Indeed the realization of a synthetic living object is not for tomorrow!!

The most ambitious project of nanotechnologies is NBIC convergence. According to Jean-Pierre Dupuy, this programme is based on a world (the universe, nature, the human being, the mind) modelled as an informational or "algorithmic" machine. A metaphor introduced by C Damien Broderick stigmatizes this approach: "(At the origin) genetic algorithms in huge numbers would stagger along on the surface of the earth and the deep seas (...). Eventually the entire ecology of the living world on this planet has kept stocking and today it represents in a com-

pressed and schematic form a huge quantity of information." (1) Obviously, this vision is inspired by the outstanding progress of computer science and by a conception of molecular biology seen as a vast system of genetic programming based on DNA. Even Wolfram's physics could be formulated in terms of cellular automata. However this approach is highly controversial as it gives more than its due to entropy at the expense of energy...

Where do today's physicists stand?

Scientists have been very recently questioned by citizens through various associations. They want to be informed about the objectives and impacts on society of research led in public institutions and in the corporate world. They have expressed a clear need of transparency on the aims of programs of research in nanotechnology. These opinions have been summarized in France in the "Cahiers d'acteurs" in nanotechnology at the City of Sciences and Industry in Paris (March 2007). Several citizen panels have been organized in Europe. In the United Kingdom, the Royal Society has produced a report on nanotechnologies, which takes into account

both the scientific aspects and the social impact of this development. Such a questioning calls for straightforward answers from the scientific community. It seems an opportune time for a meeting, which should be organized to encourage a dialogue between exact and social sciences. It would be both possible and enriching. Are scientists ready to face such questioning? In order to prepare and help them to do so, research contracts should include a part of "outreach" concerning the social impact of research. This is the case for the research projects funded by the European Commission, which include an ethical evaluation. Scientists' awareness must be raised: the programmes of scientific meetings (for example the meetings about Condensed Matter, organized by the EPS) should include debates about the ethical questions mentioned above. ■

About the author

Roger Maynard is Professor Emeritus at the Université Joseph Fourier in Grenoble France). He is Past-President and presently Vice-President of the French Physical Society.

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Julius Wess (1935-2007) [OBITUARY]

Julius Wess, one of the leading theoretical physicists of the last 50 years, died unexpectedly at the age of 72 years on 8 August 2007. Together with B. Zumino, he was one of the fathers of supersymmetry, a concept which has revolutionized and dominated theoretical physics for many years, linking bosons and fermions via a new type of symmetry. The importance of this work, as well as many other outstanding contributions of which Julius was part, is perhaps best reflected in the large number of results that now carry the label "Wess-Zumino" as well as the large number of experiments aimed at searching for supersymmetry. It is therefore particularly tragic that he will not see

the results of the upcoming LHC experiments, which one may hope will give first indications of the existence of supersymmetric particles in nature.

Julius's scientific role transcended his outstanding research. He played an active role in many committees which influenced the path of European Physics; he was for years an influential member of the High Energy Physics Board of the European Physics Society. He supported scientific freedom in the Soviet Union and strengthened German-Israeli scientific ties. He generously contributed of his time to offer the community text books (written in collaboration with Bagger) on SuperSymmetry and Super-

Gravity. A generation of scientists have grown up on them.

Julius Wess received several prestigious honors and distinctions, of which, amongst others, were the Dannie Heinman Prize of the APS (with B. Zumino) and the Max Planck Medal, the highest distinction of the German Physical Society.

Despite the greatness and importance of his scientific opus, he always remained admirably modest and unpretentious as a human being. We will always remember his human warmth and his Viennese charm and sense of humor. He will be greatly missed. ■

Hermann Nicolai and Eliezer Rabinovici

Forum Physics and Society I & II

Graz, April 19 - 22, 2006 & Zakopane, September 30 - October 2, 2007 [REPORT]

The EPS Council formally established Forum Physics and Society (FPS) at its 2007 London meeting. The aim of FPS is to *establish a more active EPS role in the relation of physics to society, taking seriously the challenge of maintaining a strong and critical dialogue between physicists and decision makers from policy and economics.*

The Council decision was based on the successful impact on society of the World Year of Physics in 2005 as well as the *Forum Physics and Society I* held in Graz, 2006. The Graz meeting was a major success¹ expressing consolidated views on issues such as education, research policies and funding, energy and research ethics. The resolutions and recommendations were given to the Austrian Minister of Education during the EU Educational Ministers meeting also taking place in Graz. At the end of the meeting Nobel laureate Walther Kohn of the US gave a talk outlining the history of the APS initiative on Physics and Society, an activity started in the US in 1971. This talk was, together with the Graz meeting itself a major inspiration to try to establish an EPS *Forum Physics and Society*.

The last event pointing towards a more active EPS role in the relation of physics to society was the prize EPS received from the European Economic and Social Committee (EESC) for organized civil society. This prize signals the importance of EPS being open to society and taking seriously the challenge of maintaining a strong and critical dialogue with society.

The *Forum Physics and Society* has a clear message to decision makers that innovation, competitiveness and wealth creation strongly depends on advanced

education and science. Physics, a powerful basic science activity is keenly aware of its obligation to further these aims of society. Both national and international physical societies see themselves as bodies that offer their competence to assist in answering difficult questions pertaining to the development of society.

The *Forum Physics and Society*, the EPS outreach body aims at catalyzing this development through advanced workshops and meetings gathering decision makers and physicists to put the spotlight on topics of interest to both society and to the physics community.

Forum Physics and Society II

Zakopane, September 30 - November 2, 2007

Following the FPS I meeting in Graz (2006) three topics were selected for presentation, discussion and evaluation at the Zakopane (2007) meeting

- Education and scientific literacy
- Creativity and innovation
- Science and ethics

36 participants from 15 countries participated in two days of group work. The three topics were initiated by three distinguished keynote speakers.

Katherine Richardson, Vice Dean (Outreach), Faculty of Natural Sciences, Copenhagen University was keynote speaker in the first topic, *education and scientific literacy*. She gave a sharp analysis of the physics culture based on her own experience as a marine ecologist, a research field central to outstanding problems facing society today. With this starting point Katherine Richardson stressed the increasingly more interdisciplinary character of modern science and continued with an analysis of the need for physics to better understand this shift in nature of important problems both in science itself and in society.

Pierre Léna, professor in astrophysics at University Denis-Diderot (Paris 7) and 'Délégué à l'Éducation et à la Formation' of the French 'Académie des Sciences' was the second keynote speaker on the topic of *education and scientific literacy*. He has, for the last 10 years worked with physics education within a major French initiative on primary and

secondary science teaching, *La Main à la Pâte*. With this starting point, he gave a lucid analysis of the present elementary educational practices and pointed to the need for reforms. He discussed *inquiry based learning practices* and referred to extensive progress made in France. This presentation raised, as did also the first keynote, a vivid discussion on the present dire situation of physics education in Europe.

Krishna Nathan, an astronomer turned IBM-executive was keynote speaker on the second workshop theme, that of *creativity and innovation*. Based on his extensive experience from IBM he decisively showed how innovation was developed into a direct tool for the creation of new products and services. He then projected this experience onto the academic world and showed how the concepts of creativity and innovation are universal and not restricted to specific businesses.

Vagn Lundsgaard Hansen, a mathematics professor at the Technical University of Denmark and a member of the Danish *Committee on scientific dishonesty* was keynote speaker on the third workshop topic, *science and ethics*. He gave a careful presentation of the topics to be considered in maintaining integrity and honesty in scientific work. He also stressed the need for ethics to be fully and better integrated in scientific work than is the case today.

Summary of visions & recommendations

The working groups worked within the same frame in order for the recommendations to be easily adopted by EPS as well as its national member societies and other relevant bodies.

Science education and scientific literacy

The **vision** for the work was: *Since science is a key to intellectual and economic*

¹ The Graz Forum on Physics and Society, Resolutions and Recommendations, Graz, 21 April 2006 www.wyp2005.org/impact/Forum%20Physics&Society.pdf · www.wyp2005.at/index.html

Erratum

In the article on the Società Italiana di Fisica (EPN 38/5), the caption of the first picture has been wrongly duplicated in the middle of column 2, p.13. Please disregard it. The web version has been corrected.

development we need to guarantee an appropriate science education on all levels. Three recommendations were expressed:

- Improving science education at all levels is one of the principal responsibilities of the physics community which includes teachers at all levels as well as physicists at universities, research institutions and industries.
- European funding for pilot projects in science and physics education as well as for the dissemination and adaptation of good practise examples should be increased significantly.
- A vital element in improving science education is increased public recognition of teachers and an improvement of their professional development reflected in their career.

Creativity and innovation

The **challenges and visions** for the work were, *supporting creativity, changing culture and simplifying processes*. Three recommendations were expressed:

- To resolve the EU Innovation Paradox we need to create a culture of risk taking within the science community by including entrepreneurship skills in the higher education curriculum. Appropriate support services, such as advice on financial, management and intellectual property matters, must be provided in parallel.
- Improve the environment for learning and creative thinking. This can be done, for example, by generating a positive image of science in the media, by encouraging the dialog between teachers and researchers, by using science museums as an additional resource in education, and by including architectural and art elements related to science in schools and public spaces.
- Identify the procedures to simplify the transfer of ideas and visions into reality. This will accelerate innovation and enhance the creation of economic value.

Science and ethics

The **challenges and visions** for the work were, to *have all physicists following codes of conduct and ethical guidelines*

and the public appreciating ethical issues in physics-related topics. Four recommendations were expressed:

- EPS should prepare a code of ethical conduct covering the prohibition of fabrication, falsification and plagiarism of results *etc*, with a recommendation that this be adopted by its Member Societies.
- EPS should also consider aspects of questionable practice in research and other professional domains and provide appropriate guidelines.
- In addition EPS should produce ethical guidelines requiring physicists to consider the ethical implications of their work (particularly R&D) and to act according to their consciences. Physicists should be encouraged to bring forward for application results of fundamental research when it appears it would benefit society, but on the other hand not knowingly to overstate the expected benefits of particular lines of research.
- EPS should develop a strategy for public appreciation of ethical issues in physics-related topics, including its applications in the life sciences and environmental issues.

EPS tasks and actions

The European Physical Society (EPS) should review these recommendations and if appropriate, update its position papers on *Education*² and *Ethical conduct*³.

The European Physical Society (EPS) should review the recommendations on *Creativity and Innovation* and consider their implication on its position paper on *Brain Drain, a topic related to creativity and innovation*⁴.

Science education and scientific literacy (Group report)

1. Introduction

Science education, the key to scientific literacy, is important for the development of our society. Therefore it is one of the principal tasks of the scientific community. At present science education is widely perceived as being unsatisfactory. Specific activities directed to pupils, teachers and the general public are sug-

gested, and some recommendations for decision makers are formulated.

2. Challenges vision

Since science is a key to intellectual and economical development we need to guarantee an appropriate science education at all levels.

3. Analysis

>>> Goals

The most important target of science education is to assure that everybody is scientifically literate. Just as it is expected that everybody can read and write, it should be expected that everybody should be able to understand information about science in the mass media.

Science education also has other broader goals. Science education contributes in many ways to solving societal problems. Science education is essential to the development of the European culture and democracy by creating a scientifically literate society. Finally, since science is essential to economy growth, good science education is a strong prerequisite for development.

Physics is the most fundamental natural science. The methodology of physics in order to understand nature is of central importance to all branches of science.

>>> Problems

To reach these goals of science education, it is very important to teach science at all levels starting from primary school.

We are aware of the vicious circle: there are too few good university students in science. In consequence the number of good science teachers, physics in particular, remains low. Therefore many teachers are unable to convey science to school students in a convincing way. This leads to low esteem of physics among the school students. In ...

² Physics Education www.eps.org/about-us/position-papers/education

³ Physics and Ethics www.eps.org/about-us/position-papers/physics-and-ethics

⁴ Brain Drain www.eps.org/about-us/position-papers/brain-drain

... fact students consider science education as irrelevant and difficult, 85% of Europeans are unhappy with their science classes. This leads to low number of good university students and the vicious circle is closed.

>>> How to make teaching more attractive and effective?

Science should be presented to children in all stages of their development, starting in kindergarten and elementary school. Children at primary schools are often enthusiastic about science and technology. For them it is challenging, exciting, and appealing to their imagination. It is the challenge of their teachers to keep their attention and further stimulate their affinity with science. Skills like reasoning, designing and planning can be developed effectively through contact with science. Good practice examples already exist in various European countries, for example “La main à la pâte”, and should be further developed, evaluated and adapted to different educational systems.

In secondary schools the primary purpose should be to interest pupils in science and giving them a feeling for the process by which knowledge is obtained in science, even at the cost of restricting the range of subjects. Development in science research and application show the need for interdisciplinarity. Therefore the interdisciplinary character of science should be stressed; the need for distinct contributions of the various disciplines to increase our understanding of nature and solve the problems of society should be pointed out. In addition an interdisciplinary approach may make science more attractive for girls.

Science education in secondary schools should be directed primarily to the large majority of students that will not become professional scientists to enhance scientific literacy in society. Special programs should be developed to promote the highly talented and /or interested pupils. They should involve contact with actual research in universities and research institutions.

The physics community, with the participation of teacher representatives, should develop a system of professional development (lifelong learning) for teachers. For primary school teachers the emphasis should be on providing teaching

materials, and building up a support system. Secondary school teachers should be encouraged to stay informed about developments in science, teaching methodology and science education research.

Innovative teaching and professional development should be recognized by the science community and be reflected in their career prospects. To help recruit teachers their working conditions and social status should be improved and they should be freed from unnecessary chores.

A second possibility to break the vicious circle is to improve public understanding of science through increased outreach activities which should be directed to the general public, to decision makers, as well as to teachers and pupils. For this purpose a small percentage of research grants should be reserved for outreach activities including activities directed to schools.

In tertiary education training in communicating physics to non-specialists should be an integrative part of the curricula.

Academic teachers and researchers should receive training in outreach activities and engagement in these fields should be considered in their career profile.

4. Recommendations

- Improving science education at all levels is one of the principal responsibilities of the physics community which includes teachers at all levels as well as physicists at universities, research institutions and industries.
- European funding for pilot projects in science and physics education as well as for the dissemination and adaptation of examples of good practice should be increased significantly.
- A vital element in improving science education is increased public recognition of teachers and an improvement of their professional development reflected in their career.

Creativity and innovation

“Science is a creative team-game from which ‘cool’ innovation arises!”

1. Introduction

We propose the following definitions:

Creativity:

generation of novel ideas and concepts

beyond accepted boundaries relying on critical questioning of existing concepts. Creativity requires curiosity, imagination and risk taking.

Innovation:

intersection of invention and insight. Innovation needs creativity and is the product of inspiration, interconnections of ideas and concepts and often is a result of cross-fertilization. Good judgment and persistent action are needed to go from original ideas to their realization. Innovation is never fully predictable, but often is the outcome of a random process.

EU Innovation paradox:

EU countries invest heavily in science and higher education but create too little economic value in return. The mentality of entrepreneurship in the EU is yet to catch up with other parts of the world and facilities, such as incubators or techno parks, are still lacking.

2. Challenges and visions

>>> Supporting creativity

In order to generate innovation that delivers greater economic value we need to support creativity. Good science and education are not enough; we must facilitate the transition to entrepreneurship and create a culture of risk taking. (cf. EU paradox)

>>> Changing culture

The existing risk-averse culture can be changed by challenging the attitude of working scientists as well as by attracting more students into natural sciences. The public perceptions of science must be improved by showing that science is indeed a creative process.

>>> Simplifying processes

Scientists must be encouraged to take risks and become innovative. At the same time the processes for creating and subsidizing start-up and spin-off companies must be simplified.

3. Analysis

Innovation *should not* be a goal in itself but rather a tool to make changes towards a *better society and a better quality of life*, including a better market place. Expertise from the Humanities and Social Sciences, as well a meaningful

dialogue with wider society, is needed to guide innovation into reasonable and widely accepted directions.

Children's creativity and natural curiosity, especially for sciences, should be encouraged rather than inhibited. Students should be guided to be inspired by nature. The early subject choice (science *vs.* arts) required by most formal education systems should be replaced by a more open approach towards general education. Specialization to prepare for professional life should occur at a later stage. Teacher training must include science as part of the broader cultural context.

Dreams and imagination are *sine qua non* for creativity. 'Scientific playgrounds' are needed for both children and adults. Scientific projects which capture the imagination of the public, *e.g.* the past Apollo missions, the search for extraterrestrial life, the genome project, *etc.* are valuable and exciting sources of inspiration.

Science is not a solitary pursuit, but relies to a large extent on teamwork and collaboration. The social and emotional aspects of science should be conveyed to the wider public.

Both science and engineering are part of our culture just as the arts, literature and music are, and should be recognized as creative endeavors.

4. Recommendations

- To resolve the EU Innovation Paradox we need to create a culture of risk-taking within the scientific community by including entrepreneurship skills in the higher education curriculum. Appropriate support services, such as advice on financial, management and intellectual property matters must be provided in parallel.
- Improve the environment for learning and creative thinking. This can be done, for example, by generating a positive image of science in the media, by encouraging the dialogue between teachers and researchers, by using science museums as an additional resource in education, and by including architectural and art elements related to science in schools and public spaces.
- Identify procedures to simplify the transfer of ideas and visions into reality. This will accelerate innovation and enhance the creation of economic value.

Science and ethics

1. Introduction

Ethical problems in science include as a minimum honesty in publication of results, ethical issues in R&D and public appreciation of physics-related issues. Some problems are related to basic research, which may be easier to handle. Many more are connected to applications and these are more complex.

2. Challenge/Vision

To have all physicists following codes of conduct and ethical guidelines and the public appreciating ethical issues in physics-related topics.

3. Analysis

Research misconduct includes fabrication, falsification and plagiarism (FFP), *etc.* for which an enforceable code may be written. Related to this are issues of people appearing as authors when they have made little or no contribution to the work and multiple publication of substantially the same paper. Ethics also covers issues as to whether certain lines of research and development are to the benefit or detriment of society. For this only guidelines can be written, the most important of which is that physicists should consider the ethical aspects of the work they undertake and act in accordance with their consciences. Further aspects of ethics to be included within such guidelines are a requirement to bring forward results of fundamental research which may be applied to the benefit of society rather than keep it as knowledge for the sake of knowledge. On the other hand they should not knowingly overstate the expected benefits from a particular line of research.

Fortunately much work has already been done, including the work by IUPAP, the EU code for researchers, codes of conduct by physical societies and, of course, the EPS position paper on ethics. These should be studied carefully and ideas taken from them rather than trying to develop codes and guidelines from first principles.

It is a big challenge to inform society adequately about ethical questions in physics, to ensure that both positive and negative issues in connection with physics research and related technologies are recognized and appreciated by the public. Organizers of physics con-

ferences, in particular EPS-conferences, should encourage debates, round tables, *etc.* on ethical issues of particular applications of physics, *e.g.* in the life sciences or environment.

4. Recommendations

- EPS should prepare a code of ethical conduct covering the prohibition of fabrication, falsification and plagiarism of results *etc.*, with a recommendation that this be adopted by its Member Societies.
- EPS should also consider aspects of questionable practice in research and other professional domains and provide appropriate guidelines.
- In addition EPS should produce ethical guidelines requiring physicists to consider the ethical implications of their work (particularly R&D) and to act according to their consciences. Physicists should be encouraged to bring forward for application results of fundamental research when it appears it would benefit society, but on the other hand not knowingly to overstate the expected benefits of particular lines of research.
- EPS should develop a strategy for public appreciation of ethical issues in physics-related topics, including its applications in the life sciences and environmental issues. ■

Organizing Committee

Martial Ducloy (chair)

Peter Melville (secretary)

Maciej Kolwas (local organiser)

Martin Huber

Christophe Rossel

Max Lippitsch

Ove Poulsen

EPS Mobility Fellowships

The European Physical Society in order to promote student mobility in Europe offers four mobility fellowships of 6000 € each for academic year 2008/9. The fellowships will be offered to students as recognition of their academic excellence. For more information, please see: www.eps.org/news/eps-mobility-fellowships.

The deadline for the applications is **31 March 2008**. Applicants will be informed of the decision by 30 April 2008. ■

The EPS Executive Committee

> Anne-Marie Levy Rasmussen (1971, Horsholm, Denmark)



After completing my higher education in Physics at the University of Copenhagen, I decided to leave the university to work in a more political direction.

Along with my studies, I had looked for ways to promote and enhance the interest of high school students in science and particularly physics. This was an interesting and eye-opening experience, because so many of them didn't know how many fascinating jobs you can get with a background in science. It showed me that generating new physicists needed specific actions. I then worked mainly for that for four years in The Confederation of Danish Industries as a political advisor. I also worked to promote the interaction between researchers at universities and companies, founding, in particular, The Business Network For Young Scientists, which still exists. Upon this part of my work, I was asked by The Faculty of Science at University of Copenhagen to join them as the director for research and innovation. I am now at GlaxoSmithKline in Denmark where I am the director of cooperate affairs and a member of the management team.

My work and experience have shown me that:

- One can do many interesting things with a good education in physics
- We have to do something to increase the number of students in physics in Europe
- We have to do something to increase the science knowledge and innovation in Europe

EPS is playing a key role in all this. It should continue to focus on making a stronger and more open educational system in physics from primary school to university. EPS can continue in making the European politicians aware of the decreasing number of students in physics and help the national organizations to promote physics to young people. EPS can play a very important role in increasing the degree of innovation and partnerships between universities and companies in Europe. ■

> Françoise Masnou-Seeuws (1943, Gif sur Yvette, France)



After completing my higher education in physics (ENS, laboratoire Kastler Brossel), I entered the CNRS as Research Physicist in Paris-Meudon Observatory in 1966...

... and completed a "thèse d'Etat" in 1973. I moved to Orsay in 1976, became director of research in CNRS in 1982, and joined Laboratoire Aimé Cotton, Orsay, in 1993. I have worked on the theory of atomic collisions, first at thermal energies, and later in the ultra-cold regime. I have developed new methods for accurate calculations of interatomic potentials and for precision spectroscopy. In collaboration with the experimental team of Pierre Pillet, the first evidence for ultra-cold molecules (caesium dimers in their lowest triplet state) was found at LAC in 1997. Mechanisms for the formation of stable molecules by laser photo-association of ultra-cold atoms have next been intensively studied, and the possibility of using shaped laser pulses to control the reaction is explored. The challenge is the achievement of Bose-enhanced chemical reactions in atomic or molecular condensates.

From 2002 till 2007, I was coordinator of the European Training Network "Cold Molecules: formation, trapping and dynamics". I have been chairperson of the board of the « Molecular Physics » section in the « Atomic and Molecular Physics » division of the EPS (1996-2001), organizing two European Schools for Ph. D students and post-docs. I have been vice-chair of the « Atomic and Molecular Physics » division (2001-2004), organizing the ECAMP conference in Rennes in 2004.

On the EPS Executive committee, I want to address the problem of evaluation of European cooperative projects, to enhance cooperation in the training of young researchers, and to encourage invited talks by talented young women in EPS conferences. ■

> Viktor Urumov (1946, Skopje, Macedonia)



Born in Belgrade, I received my basic education in Skopje where I became involved in mathematics and physics competitions, obtaining first prize at the Yugoslav national...

... competition in mathematics and the silver medal at the International Mathematics Olympiad (1964). After graduation from Moscow State University, I received my M.Sc. and Ph.D. (1973) from Manchester University working on polyelectrolyte solutions theory. I work in the Institute of Physics at the Faculty of Natural Sciences in Skopje, since 1989 as a full professor, teaching mostly theoretical subjects with mathematical methods in physics as my principal course.

As a visitor I have taught in the universities in Gainesville (Florida), and in Sidi-bel-Abbès and Oran (Algeria). My main research publications deal with some exactly solvable Ising models and with universal metric properties of one-dimensional maps. I have published several textbooks and many physics popularization articles. For several years I was Head of the Institute of Physics in Skopje.

I have been President of the Society of Physicists of Macedonia and leader of the Macedonian team at the International Physics Olympiads. I have served in the East-West Task Force of EPS and on the Executive Committee of the Balkan Physics Union. My aim is to bring the Balkan area closer to EPS, to internationalize the continuing education of physics teachers and to bring exciting international lecturers to schools. ■

> Victor R. Velasco (1952, Madrid, Spain)



After higher education in Physics at the "Universidad Autónoma de Madrid" (UAM), ended by a Ph.D in 1979, and Post-Doctoral stays at Università degli Studi di Milano (Italy)...

... and at Institut Supérieur d'Electronique du Nord, Lille (France), I became Junior Research Officer at Consejo Superior de Investigaciones Científicas (CSIC) in 1981, then Senior Research Officer in 1986 and now Research Professor at CSIC, in Madrid since 1989.

In the mean time, I have been visiting scientist in several places in various countries (Italy, France, UK, Mexico, Cuba, Brazil and Morocco). I have been awarded the Honor Diploma Facultad de Física (Universidad de La Habana) and the Medal of the Real Sociedad Española de Física

My scientific interests concern the vibrational and electronic properties of surfaces, interfaces and multilayer systems, the physical properties of aperiodic systems and the mechanical and vibrational properties of carbon nanotubes.

Physics, and Science in general, must confront in these times important

problems in education, research (academic and industrial) and society. After the big effort and visibility of the World Year of Physics 2005, some things were improved, but the problems are not solved and much remains to be done. It is necessary to improve the teaching of Physics at all levels of education, making it more attractive. This would be rewarding for the next generation of physicists, but also for society in general and for the policy and decision makers of the future. The EPS has a very important role to play in these areas with the cooperation of the National Societies. ■

The 34th annual conference of the EPS Plasma Physics Division was recently held in the Palace of Culture and Science in Warsaw (2-6 July 2007). The host was the Institute for Plasma Physics and Laser Microfusion, Warsaw, under the chairmanship of Professor Zygmunt Skladanowski, Director of the IPPLM. The wide scope of Plasma Physics was represented in plenary and parallel oral presentations, as well as in poster sessions, under the scientific Programme chairmanship of Prof. Sibylle Günter, IPP Garching, Germany. The conference was very well attended by 655 delegates from 37 countries, including a relatively large number of delegates from the Russian Federation.

The long term integration of magnetic confinement fusion and the strong beam-plasma community has now reached a durable equilibrium. The divisional conference now represents a major event on the calendar for both communities. The astrophysical plasma community and the dusty and low temperature community are still rather weakly represented, except in areas in which there are more direct implications in the two larger communities. Nonetheless, the number of participants from these two communities attending the conference increases with the years. The Divisional board maintains its strategy of providing a global view of Plasma Physics to all the delegates from these four communities.

A well-attended evening session was devoted to the ongoing review process inside the ITER project, coordinated externally by Günther Janeschitz (Forschungszentrum Karlsruhe). Dr Janeschitz presented the current state of this process and a long technical debate ensued. Another session outside the conference scientific programme was dedicated to the challenges facing women who (wisely) choose a career in physics. This will be reported separately in EPN and is the latest in a line of such debates during our annual conferences.

Our hosts laid on a complete social programme for accompanying persons to visit Warsaw, and arranged a traditional country evening outside the city

for everyone. Professor Malcolm Haines once again presented the delegates with a moment of serenity in a wide-ranging organ recital in the Evangelical-Augsburg Church of the Holy Trinity.

Hannes Alfvén prize

The 2007 divisional Hannes Alfvén Prize was awarded during the opening ceremony to Professor **Friedrich Wagner** (IPP Greifswald), who is the present chairman of the European Physical Society, and a member of the Max-Planck society. The laudation for this academic distinction reads as follows:



▲ "Professor Friedrich Wagner is awarded the Hannes Alfvén prize for his continuing outstanding contributions to research into fusion by magnetic confinement."

"His discovery of the High Confinement mode (H-mode) in the ASDEX tokamak and subsequent work on transport barriers brought on a new era in nuclear fusion research, with consequences for ITER and future fusion reactors. Historically, study of the High Confinement mode led to the discovery of the stabilizing effect of sheared flows on plasma turbulence, implying a revolutionary step forward in the understanding and control of plasma turbulence and transport. The best fusion performance to date has been obtained in plasma conditions involving transport barriers and the concomitant turbulent transport reduction.

The successes achieved by the Wendelstein 7-AS experiment have re-vitalised

the stellarator as a viable alternative confinement concept. Thus, although the next major magnetic confinement device ITER is a tokamak, it has become clear that other magnetic confinement concepts offer significant potential advantages, while a single machine concept may not provide a comprehensive solution for all possible applications of fusion energy. Contributions from the Max Planck Institute stellarator team lead by Professor Wagner have shown that the performance and physics of confinement in stellarator devices are of general interest to the fusion community.

Professor Wagner plays a leading role in both tokamak and stellarator communities and stands out by his ability to summarize the essence of seemingly complex plasma phenomena. His open-minded approach to promoting the development of plasma physics has stimulated the creation of multi-disciplinary links between different scientific communities."

PhD Research Award

The Plasma Physics Division PhD Research Award was judged by a committee comprising Prof. Fussmann (Humboldt University, Berlin), Prof. Treumann (currently at the ISSI, Bern) and Prof. Benkadda (Université de Marseille). The 2007 recipients were:

- **Dr Oliver Arp** (Christian-Albrechts-Universität, Kiel) for his thesis "*Coulomb balls – structure and confinement of spherical dust crystals in a plasma*"
- **Dr Yannick Glinec** (Ecole Polytechnique, Palaiseau) for his thesis entitled "*Propagation of an ultra-intense laser pulse in an under-dense plasma: Production of quasi mono-energetic electron beams and development of applications*"
- **Dr Navid Mahdizadeh** (Universität Stuttgart) for his thesis "*Investigation of three-dimensional turbulent structures in the torsatron TJ-K*"
- **Dr Alexander Thomas** (Imperial College, London) for his thesis entitled "*Studies of Laser Propagation and Mono-Energetic Electron Beam Injection in Laser-Wakefield Accelerators*"

As well as receiving a modest financial reward, the recipients were given the opportunity to make a 20 minute oral presentation to the conference.

Itoh turbulence prize

Professor Sanae Itoh from Kyushu University once again generously sponsored her "Itoh Project Prize in Plasma Turbulence". The 2007 prize was awarded to **Dr. Peter Manz** for his

thesis entitled "*Experimental estimation of nonlinear energy transfer in two-dimensional plasma turbulence*", awarded by the University of Stuttgart, Germany. This award will allow Peter Manz to briefly visit research groups at Kyushu, Japan. Dr Robert Wicks (University of Warwick) and Dr Andreas Schmid (IPP Garching) were highly commended by the jury, composed of Professors Itoh, Fukuyama, Ryotov and Wagner.

PhD student poster awards

The Institute of Physics traditionally encourages young physicists with the IOP Poster Prize, which was awarded this year to 4 candidates: **Eva Belonohy** (KFKI, Budapest), **Frederico Fiuza** (IST, Lisbon), **Imke Goertz** (University of Kiel) and **Francesca Turco** (CEA Cadarache). ■

Jo Lister (CRPP-EPFL),
Chairman of the Plasma Physics Division

Astronomers get their hands dirty

as they lift the veil on galactic dust [CONFERENCE REPORT]

There is more to a grain of dust than meets the eye, at least for astronomers as they attempt to probe deeper into distant galaxies. Until now dust has been a nuisance because it has obscured galaxies, and the stars within them, by absorbing the radiation they emit. But more recently dust has started to present opportunities because it emits radiation itself as a consequence of being heated up by nearby stars. Aided by new observing instruments and sophisticated computer software, this radiation enables astronomers to reconstruct what lies behind the dust. Furthermore the dust itself plays a vital role in star formation within galaxies.

The stage was set for dramatic advances in the study of galactic dust in a recent workshop funded by the European Science Foundation (ESF)'s Exploratory Workshop. The big breakthrough is the ability to detect the dust at much higher resolution from its infrared radiation, according to Simone Bianchi, co-convenor of the ESF workshop. "It has been possible to do this since the eighties, but the new instruments have a higher sensitivity," said Bianchi.

At the same time new computer models are making it possible to work out the structure of the galaxy lying behind the dust, even though it cannot be observed directly at any wavelength. The key here is

that the dust is acting as a relay for radiation emitted by the stars behind it. The dust absorbs high energy radiation from the stars and then heats up as a result. It then re-emits in the infrared waveband, which can now be detected with sensitive new instruments.

Plans were made at the workshop to use the European Space Agency's new infrared space telescope called Herschel, which will be launched in 2008 and be capable of detecting infrared radiation emitted by distant galactic dust. "The new instruments will allow us to detect dust associated with less dense regions of the interstellar medium," said Bianchi.

Astronomers also hope to learn more about the role played by dust in star formation. As Bianchi pointed out, there is a well established connection between the dust and the gas from which stars are formed. But the detailed relationship is unknown, and will require knowledge about the dust itself, in particular its molecular structure and lifecycle.

The ESF workshop focused mainly on spiral galaxies, because these are heavily obscured by dust. Galaxies are split into three categories by their structure, spiral, elliptical, and irregular. There is less dust in elliptical galaxies, while irregular galaxies are more difficult to model because they lack any orderly structure. "Spiral galaxies can be modelled in a more direct

way because of their relatively simple geometry," said Bianchi. "However, recent comparison with observations of dust emission has shown that models may need a higher degree of complexity. This can be achieved now with the advances in computational facilities."

The ESF workshop was well timed to help Europe exploit the full potential of the data that will be obtained from the new instruments. It has already brought together the relevant European groups specialising in spiral galaxies and modelling dust, providing the platform for major advances in the field.

The workshop, held in Ghent, Belgium in May 2007, brought together 29 researchers from 10 different countries.

Each year, ESF supports approximately 50 Exploratory Workshops across all scientific domains. These small, interactive group sessions are aimed at opening up new directions in research to explore new fields with a potential impact on developments in science. ■

For further information about the workshop please go to:

www.arcetri.astro.it/radtran

For more information about the ESF Exploratory Workshops please go to:

www.esf.org/activities/exploratory-workshops.html

IUPAP Young Scientist Prize

in Computational Physics: Rules 2008 [CALL FOR NOMINATIONS]

Frequency/Venue:

Triennially, up to three International Union of Pure and Applied Physics [IUPAP] Young Scientist Prizes in Computational Physics will be awarded.

They will be announced and presented at the annual Conference on Computational Physics [CCP].

It is intended that one award be made each year. However, in any given year, the selection committee may, at its discretion, decide not to make an award. If so, multiple awards may be made in the following year.

It is intended that the 2008 award be made at CCP2008 in Ouro Preto, Brazil in August 2008.

Criteria for selection:

The recipients in a given year should on January 1 of that year have a maximum of 8 years research experience

(excluding career interruptions) following the PhD.

The recipient should be the principal performer of original work of outstanding scientific quality in Computational Physics.

A previous recipient will not be eligible for another award.

Nomination procedure

The awards will be advertised electronically by the C20 Commission on its web page [see www.iupap.org or <http://c20.iupap.org/prizes.htm>] and elsewhere.

The deadline for nominations is 1st March.

Self-nominations will not be considered.

Nominations shall be made to the Chairman of the C20 Commission by email (p.h.borcherds@bham.ac.uk) and should include the following:

- A letter of not more than 1,000 words

evaluating the nominee's achievements and identifying the specific work to be recognised.

- A Curriculum Vitae including all publications.
- A brief biographical sketch.

The selection committee

The selection committee consists of the Members and Associate Members of the C20 Commission. The selection committee may consult with appropriate external assessors.

Type of Awards

The Awards will be US\$1000 each, plus a medal and certificate to be provided by IUPAP.

The award money will normally be given as a contribution towards the expenses for attending the CCP.

The winner will be invited to present a paper at the CCP. ■

Conference Announcements

ESCAMPIG-2008

Granada, Spain, will host the 19th Europhysics Conference on the Atomic and Molecular Physics of Ionized Gases (ESCAMPIG), July 15-19, 2008. The conference will bring together experienced and young researchers working in atomic and molecular processes in plasmas, plasma diagnostics, low and high plasma sources, plasma and discharges theory and simulation, physical basis of plasma chemistry, laser produced plasmas and, among other topics, plasmas and gas flows.

> Website:

www.escampig2008.csic.es

Collective effects in cell biophysics

The workshop on "Collective effects in cell biophysics" will be held in Les Houches (France), April 6-11, 2008. The objective of the meeting is to gather physicists and biologists, PhD, post-docs and confirmed researchers, to discuss collective effects and dynamic

phase transitions in various aspects of cell biology going from molecular motors to tissues and interacting neurones.

> Website:

www.houches2008.curie.fr

7th ESPS-NIS

The 7th ESPS-NIS International Workshop "Epitaxial Semiconductors on Patterned Substrates and Novel Index Surfaces" will primarily focus on the topics currently of strong interest in the fields of semiconductor nanostructures, high index surfaces and nano-patterned substrates. It will be held in "Les Arcenaux" Marseilles (France), 21-24 April 2008.

> Website:

www.l2mp.fr/ESPS-NIS/index.html

X 2008

The 21st International Conference on X-Ray and Inner-shell Processes will be held in Paris, 22-27 June 2008. This conference coincides with the start of the new, third generation synchrotron

SOLEIL in Saclay, near Paris. The programme will cover all aspects of X-ray and inner shell physics, as well as new instrumental developments from detectors to X-FEL, from heavy ion storage rings to laser generated plasmas.

> Website:

<http://x08.spectro.jussieu.fr>

Actinide XAS 2008

Ten years after the inaugural conference, we are pleased to inform you that Actinide XAS 2008, the 5th Workshop on Speciation, Techniques, and Facilities for Radioactive Materials at Synchrotron Light Sources, will be held at the Synchrotron SOLEIL, near Paris (France), 15-17 July 2008. Actinide XAS is a series of workshops providing a unique opportunity for presentations and discussions on the applications and results from synchrotron-based techniques in radionuclide/actinide sciences.

> Website:

www.synchrotron-soleil.fr/workshops/2008/ActinideXAS

Highlights from european journals

Colossal Seebeck coefficient in semiconducting FeSb₂

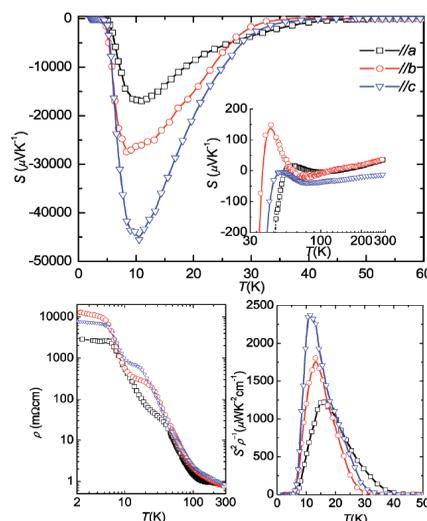
Rare-earth, actinide or transition-metal containing correlated semiconductors are characterised by a small hybridisation gap at the Fermi level from mixing of a broad conduction band with a narrow *d*- or *f*-band. Such materials are expected to have large absolute values of the Seebeck coefficient, $S=V/DT$, where V is the voltage difference due to charge carrier diffusion from a hot to a cold region of a material with a temperature difference T .

The figure shows the electrical resistivity (ρ) of single crystalline FeSb₂. $\rho(T)$ is semi-conducting and decreases with increasing temperature with a 'shoulder' in the temperature range from 10 K to 30 K. The Seebeck coefficient (S) drops to a sample dependent local minimum which in one sample reaches the record low value of -45000 mVK^{-1} . A plausible interpretation of these properties involves excitations of charge carriers across a very narrow band-gap formed by Fe *3d* states weakly hybridised with

Sb *5p* states whose coherence starts to deteriorate when the temperature increases above 10 K. The thermoelectric conversion efficiency increases monotonically with $ZT=(S^2 \cdot r - \rho^{-1}/\kappa) \cdot T$, κ being the thermal conductivity. Materials with $ZT > 1$ are considered useful for thermoelectric cooling or power applications. The thermoelectric power factor $PF=S^2 \cdot r - \rho^{-1}$, an important part of ZT , is also shown in the figure. At 12 K the power factor reaches a record high value of $\sim 2300 \text{ mWK}^{-2}\text{cm}^{-1}$, however a large κ reduces ZT to 0.005. Nonetheless, if κ is reduced to $\sim 3 \text{ Wm}^{-1}\text{K}^{-1}$, as observed in *e.g.* thin films, $ZT \sim 1$ can be obtained thus underlining the potential of FeSb₂ as a future solid-state thermoelectric cooling device. ■

Anders Bentien, Simon Johnsen, Georg Kent Hellerup Madsen, Bo Brummersted Iversen and Frank Steglich,
"Colossal Seebeck coefficient in strongly

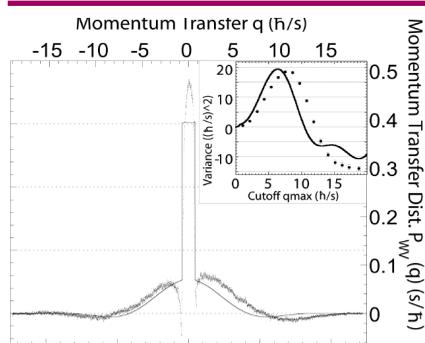
correlated semiconductor FeSb₂", *Eur. Phys. Lett.* **80**, 17008 (2007)



▲ Electrical transport properties as function of temperature along different crystallographic directions on different single crystalline FeSb₂ samples.

Back to the complementarity-uncertainty debate

This paper addresses the long-standing debate over how measurement may



▲ The weak-valued distribution for the momentum transfer $P(q)$. The dots are experimental data and the thin solid line is theory. It is clear that the distribution has a width greater than \hbar/s , where s is the slit separation, as expected from the uncertainty principle. The inset is the variance integral (experiment as dots, theory as curve) over the range $(-q, q)$ as a function of q . The fact that this oscillates around zero is characteristic of the fact that the mean squared momentum transfer is zero. This is possible only because of the (very slightly) negative values of $P(q)$ evident in the main plot.

destroy interference, which dates back to Bohr and Einstein in the 1920s. It is known that any "which-way" measurement destroys interference, but it has remained controversial what mechanism enforces this "complementarity." In particular, this was debated in the pages of Nature through the 1990s. One camp (Storey *et al*) claimed to show that the mechanism is always momentum disturbance, in accordance with Heisenberg's uncertainty principle, as Bohr had argued. The other camp (Scully *et al*) argued that no such disturbance is necessary, so that complementarity is not enforced by the uncertainty principle. In this paper we present the first measurement of the momentum transfer caused by a "which-path" measurement. Using a simple method that would make sense to a classical physicist, we measure the probability distribution $P(q)$ of momentum transfers q , but find that this distribution is negative for some values of q because of the quantum nature of the

momentum transfer. This allows the distribution we measure (a weak-valued distribution) to satisfy theoretical claims made by both sides of the debate: its width is of order that expected by the uncertainty principle, but its variance is consistent with zero (see figure). Thus our experiment has the potential to reconcile the two camps by fully demonstrating the connections between three of the most fundamental issues in quantum mechanics: complementarity, measurement, and the uncertainty principle. Moreover, this was done using the archetype of quantum mechanics experiments - Young's double-slit - familiar to all physicists. [References in the article]. ■

R. Mir, J.S. Lundeen, M.W. Mitchell, A.M. Steinberg, J.L. Garretson and H.M. Wiseman,
"A double-slit 'which-way' experiment on the complementarity-uncertainty debate", *New Journal of Physics*, **9**, 287 (2007)

Influence of gold dots on the decay rate of Eu-chelate dye

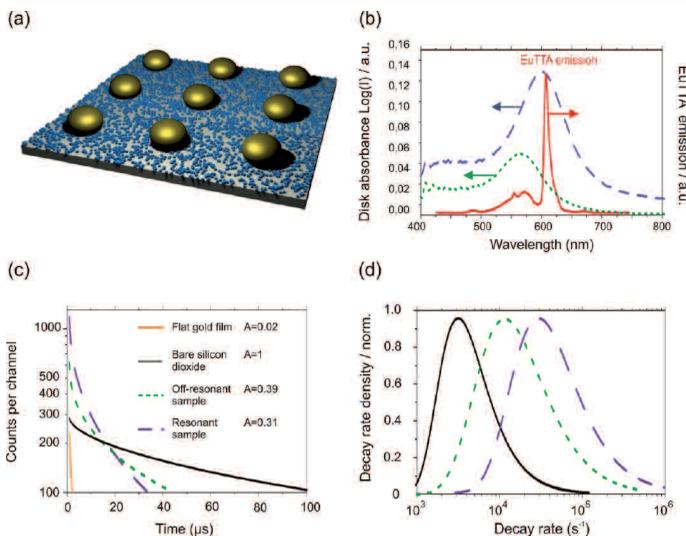
Nanometre-sized metal structures support localized surface plasmons associated with collective oscillations of conduction band electrons in the light frequency regime. While some plasmonic phenomena, such as the strong selective optical absorption of gold colloids in red church window glass, have been known for centuries, surface plasmons have only recently become

the basis for numerous technological applications.

In connection with their special scattering and absorption characteristics, metallic nanoparticles can strongly couple to fluorophores. As a consequence, the fluorescence properties of such molecules become substantially modified. In particular, their (de-)excitation rates can increase by orders of magnitude with

respect to the free-space case, depending on a number of factors.

In this paper, we investigate the modifications of the de-excitation processes in a Eu^{3+} -chelate fluorophore (EuTTA) on top of arrays comprised of nanoparticles of various sizes and shapes, as illustrated in Fig. 1 (a). The absorption spectra of two selected arrays are plotted in (b); the “resonant” (dashed line) peaks at the main EuTTA emission wavelength; the “off-resonant” (dotted line) is off by about 50nm. When the peaks of plasmon resonance and fluorescence emission overlap well, the molecules show a dramatically shortened fluorescence lifetime and an enhanced initial signal amplitude, see (c) and (d). This is a valuable mechanism for new labelling techniques in biosciences and for modifications of OLED emission properties. ■



◀ (a) Schematic drawing of a nano-oscopic array of gold disks or rods employed in our experiment. (b) Absorbance of two types of disk arrays compared to the EuTTA emission line. (c) Luminescence intensity of EuTTA fluorophore on top of the disks in (b), a smooth gold film and SiO_2 . (d) Corresponding decay rate distributions.

Frank Reil, Sebastian Gerber, Joachim R. Krenn and Alfred Leitner, “Comparing the influence of gold nanorods and -discs on the spontaneous decay rate of Eu-chelate dye”, *J. Opt. A: Pure Appl. Opt.* **9**, S437 (2007)

Brownian motion in a modulated optical trap

Optical traps are now a quantitative tool for single-molecule biophysics experiments. Many experiments use several traps, with focussed light beams each holding a micron-sized bead tethered to a molecule of interest. An enormous variety of experiments is possible, including stalling molecular motors, knotting DNA, unfolding proteins, applying specific stresses to biological materials.

Multiple traps can be created by rapidly modulating a single laser beam, “time-sharing” its power among several positions. Intuitively, if this is done fast enough, a particle responds only to the average power delivered to its trap. But how fast is fast enough? This question has been addressed by Yi Deng *et al.* by examining the effect of temporal modulation of an optical trap on the dynamics of a trapped particle. At a given power, a bead fluctuates in a trap with a characteristic “corner” frequency. The authors show that if the trap power is modulated

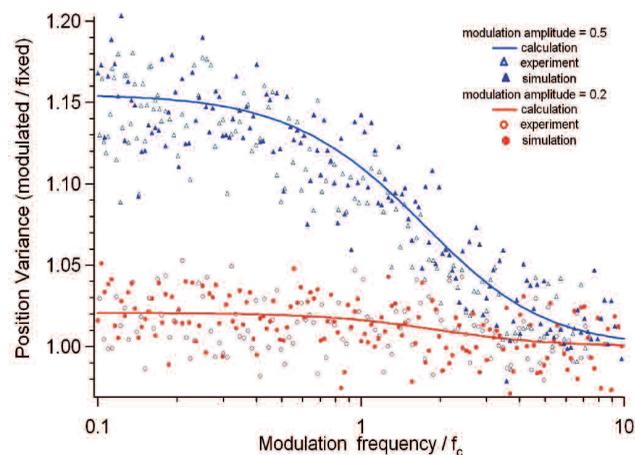
at much higher frequencies, the trapped particle experiences an effectively constant potential and its position variance approaches that of an unmodulated trap. At much lower frequencies, the particle adiabatically tracks the modulation, displaying a larger variance.

Thus, in time-sharing optical tweezers, the trap power must be modulated faster than the corner frequency for the

trapping potential to be well approximated by its average value. There are subtleties: beads tethered to a material relax faster than when isolated in solution, and one must scan among traps correspondingly faster. This work allows a straightforward interpretation of the forces measured in optical trapping. ■

Yi Deng, John Bechhoefer and Nancy R. Forde,

“Brownian motion in a modulated optical trap”, *J. Opt. A: Pure Appl. Opt.* **9**, S256 (2007)

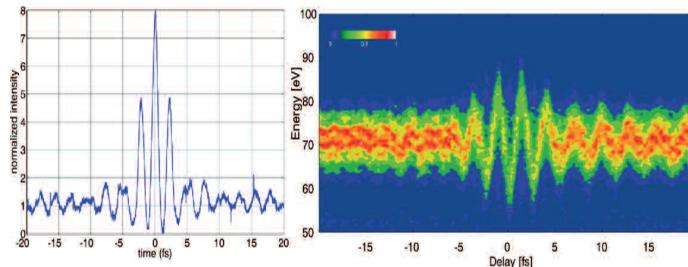


◀ Only at modulation frequencies well above the corner frequency f_c does the trapped particle’s position variance approach that of a particle in an unmodulated trap.

Advancing attosecond technology

Beneath the surface, electron dynamics are responsible for the making and breaking of chemical and molecular bonds, and underlie virtually all modern technologies. The characteristic timescale for these motions is attoseconds, where one attosecond is a billionth of a billionth of a second. To freeze this hyperfast action for study, corresponding isolated attosecond flashes of light are required. Shorter attosecond pulses capture faster processes.

Isolated attosecond pulses are generated in two steps. First, to produce the bandwidth required to support such a pulse, an infrared laser pulse is focused onto a gas target. The laser field pulls an electron from an atom, accelerates it away from the nucleus, turns it around, and finally recollides it with the nucleus, in a process which emits XUV radiation. This occurs during each half-cycle of the driving laser field. But, if the laser pulse is comprised of less than two cycles, the field strength varies strongly between adjacent half-cycles, as does the corresponding energy of XUV emission.



◀ Left: Interferometric autocorrelation of a ~1.25-cycle laser pulse. Right: Atomic transient recorder trace of a 170-as XUV pulse.

In the second step the highest-energy XUV radiation, generated only once and by the strongest half-cycle, is filtered out, resulting in an isolated attosecond pulse.

Recent developments in this field are reported in a pair of papers published in the *New Journal of Physics*. New XUV multilayer filtering technology has resulted in attosecond pulses measured to be as short as 170 attoseconds, with high enough photon energy to provide access to ultrafast inner-shell dynamics. In a further development, by shortening the drive laser pulse to ~1.25 wave cycles, useful XUV bandwidth has been significantly increased. Both advances open the door to attosecond pulses in the sub 100-as regime. ■

M. Schultze, E. Goulielmakis, M. Uiberacker, M. Hofstetter, J. Kim, D. Kim, F. Krausz, and U. Kleineberg,

“Powerful 170-attosecond XUV pulses generated with few-cycle laser pulses and broadband multilayer optics”, *New Journal of Physics* **9**, 243 (2007)

A.L. Cavalieri, E. Goulielmakis, B. Horvath, W. Helml, M. Schultze, M. Fießl, V. Pervak, L. Veisz, V.S. Yakovlev, M. Uiberacker, A. Apolonski, F. Krausz and R. Kienberger,

“Intense 1.5-cycle near infrared laser waveforms and their use for the generation of ultra-broadband soft-X-ray harmonic continua”, *New Journal of Physics* **9**, 242 (2007)

Nonlocal energetic electrons control plasma properties

In a plasma, electrons exchange energy with atoms and molecules. This exchange can be described by an energy relaxation length, λ_e , which is a measure of the distance an electron travels before it equilibrates with the energy of the bulk electrons. Consequently, the energy of this electron depends not only on conditions at one point, but on conditions within a volume. The behavior of these electrons can be described as “nonlocal”. The non-

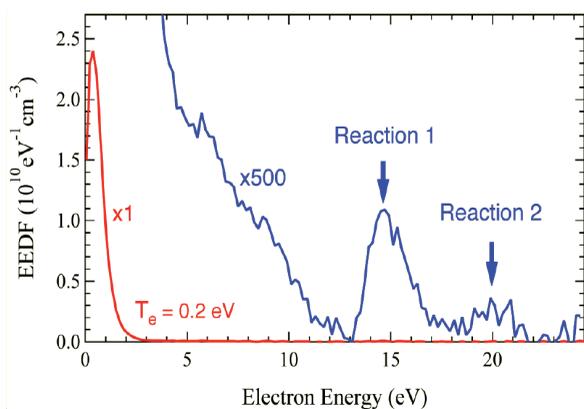
local nature of the electron behavior is important in low-pressure plasmas, and in atmospheric-pressure microdischarges.

Nonlocal effects are pronounced when an energetic electron component exists with energy much greater than that of the bulk electron population. It was demonstrated that the presence even a small fraction (say, 0.001%) of these energetic electrons could lead to their self-trapping in the volume and a significant change in

plasma properties. The exploitation of these effects can lead to methods for controlling the plasma properties, which is a major goal of modern plasma engineering.

In this work, nonlocal, energetic electrons are created, and their effects observed, following power switch-off in a radio-frequency generated plasma that contains long-lived excited atoms. These “metastable” atoms react to produce the energetic electrons.

Shown in the figure is an example of the measurement of the electron energy distribution function (EEDF) in helium illustrating two groups of energetic electrons, one at ~15 eV and one at ~20 eV generated by two types of metastable reactions. ■



◀ Measured EEDF in the afterglow of a 100% power-modulated radio-frequency helium plasma. The red curve shows the cold (bulk) electrons and the blue curve is multiplied by 500 to show the high-energy (fast) peaks in the distribution. The arrows mark electrons produced primarily by two gas-phase reactions:

- 1) $He^* + He^* \rightarrow He^+ + He + e_{fast}$
- and 2) $He^* + e_{bulk} \rightarrow He^+ + e_{fast}$.

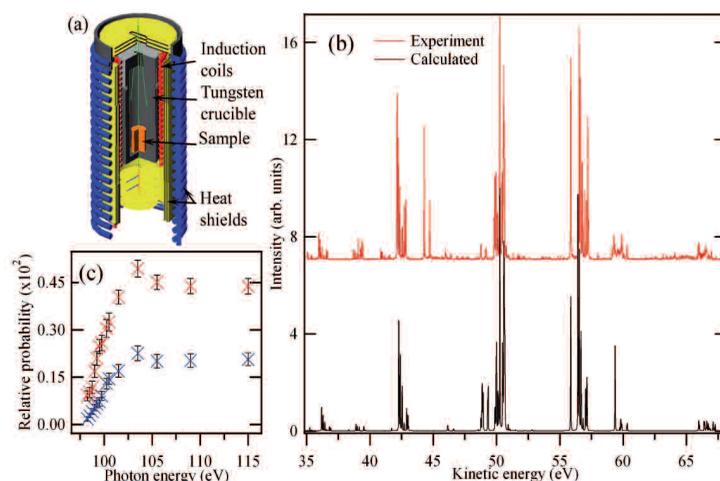
C.A. DeJoseph, Jr., V.I. Demidov, J. Blessington, and M.E. Koepke, ‘Investigation of a radio-frequency inductive-couple-plasma discharge afterglow in noble gases’, *J. Phys. B: At. Mol. Opt. Phys* **40**, 3823 (2007)

Probing many-electron effects in atoms

Electron spectroscopy is a well-established tool to study the structure and dynamics of atoms. Present improvements in the electron energy analyzers and synchrotron radiation sources have allowed sophisticated fine-structure resolved photo-ionization and Auger decay studies *i.e.* of vapour phase metal atoms.

Electron-electron interaction is one of the key points for understanding the properties of materials. Describing these many-body effects has proven to be an extremely demanding task even for single atoms. In a recent paper, an experimental and theoretical study of many-electron processes in 2p photo-ionization and Auger decay of atomic Al was presented. Small lifetime broadening of the 2p ionized states and three electrons in $3s^2 3p^1$ shells above the ionized orbital provided an ideal case for studying phenomena arising from electron correlation in an open shell atom. Difficulties on handling the high temperatures and highly reactive liquid Al were overcome by heating the sample inductively. Extensive *ab initio* multi-configuration calculations were performed to interpret the experimental results.

The main 2p photoelectron spectrum is well predicted by a low-correlation ap-



◀ (a) Layout of the induction oven. (b) Experimental and simulated 2p Auger electron spectrum of atomic Al. (c) Relative $2p^{-1}3p^{-1}$ double ionization probabilities to two different final states.

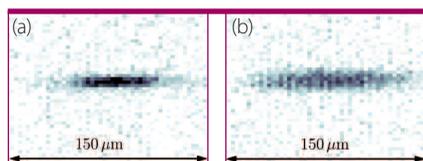
proximation. In contrast, complete breakdown of this model was observed in Auger decay. This shows striking insensitivity of the photo-ionization to probe the electron correlation in the final state of photo-ionization. Clearly isolated Auger final states allowed studies of the effects of parity and total angular momentum of the final states on the Auger rates. The parity of the considered final state (and continuum) mainly defines the shapes of the Auger decay patterns. However, electron correlation was found to play a very significant role on the total intensities of Auger

branches and to cause sudden suppressions of spectral lines. The relative double ionization probabilities on 2p ionization of Al were determined as a function of photon energy from the Auger electron spectrum without a complex coincidence setup. ■

K. Jänkälä, S. Fritzsche, M. Huttula, J. Schulz, S. Urpelainen, S. Heinämäki, S. Aksela and H. Aksela, "Many-electron effects in 2p photoionization and Auger decay of atomic aluminium", *J. Phys. B: At. Mol. Opt. Phys.* **40**, 3435 (2007)

More on molecular Bose-Einstein condensation

Laser and evaporative cooling of neutral atoms has opened the way to studies of quantum degenerate bosonic and fermionic systems. Recently, it has become possible to produce Bose-Einstein Condensates (BEC) of molecules, comprised of pairs of fermionic atoms, with long lifetimes [Ref. in the article]. These systems are now the subject of intense in-



▲ In situ absorption images of a trapped molecular Bose-Einstein condensate and degenerate Fermi gas, in identical crossed dipole traps following evaporation and imaging (a) on the BEC side or (b) on the BCS side of the Feshbach resonance. The difference is clearly evident in the density and size of the clouds.

vestigation as they may help further our understanding of other degenerate Fermi systems such as neutron stars and high temperature superconductors. We have produced Bose-Einstein condensates of ${}^6\text{Li}_2$ molecules in a low power, variable geometry optical dipole trap. Our system contains a number of simplifications over previous experimental setups and allows us to easily tune the trap geometry from near spherically symmetric to highly elongated cigar shaped. In our experiment, fermionic ${}^6\text{Li}$ atoms are collected in a magneto-optical trap from a Zeeman slowed atomic beam, then loaded into the optical dipole trap. Evaporative cooling is achieved by reducing the dipole trap laser power near a broad collisional Feshbach resonance centred at 834 G. When the magnetic field is tuned just

below the resonance a weakly bound molecular state exists. This state can then be populated through three-body recombination at sufficiently low temperatures. Further temperature reduction leads to the creation of a BEC of ${}^6\text{Li}_2$ molecules. After reducing the laser power by a factor of approximately 1000 we have observed condensates of up to 9,000 molecules. By evaporating above the Feshbach resonance we have also produced a highly degenerate Fermi gas, as evidenced by the emergence of the Fermi pressure (see figure). ■

J. Fuchs, G. J. Duffy, G. Veeravalli, P. Dyke, M. Bartenstein, C. J. Vale, P. Hannaford and W. J. Rowlands, "Molecular Bose-Einstein condensation in a versatile low power crossed dipole trap", *J. Phys. B: At. Mol. Opt. Phys.* **40** (2007) 4109

Mapping of wave functions of cold colliding atoms

Interacting cold and ultracold atoms are the key players in the lively field of quantum optics. Atomic interactions determine characteristics of Bose-Einstein condensates, their stability and their behaviour in external

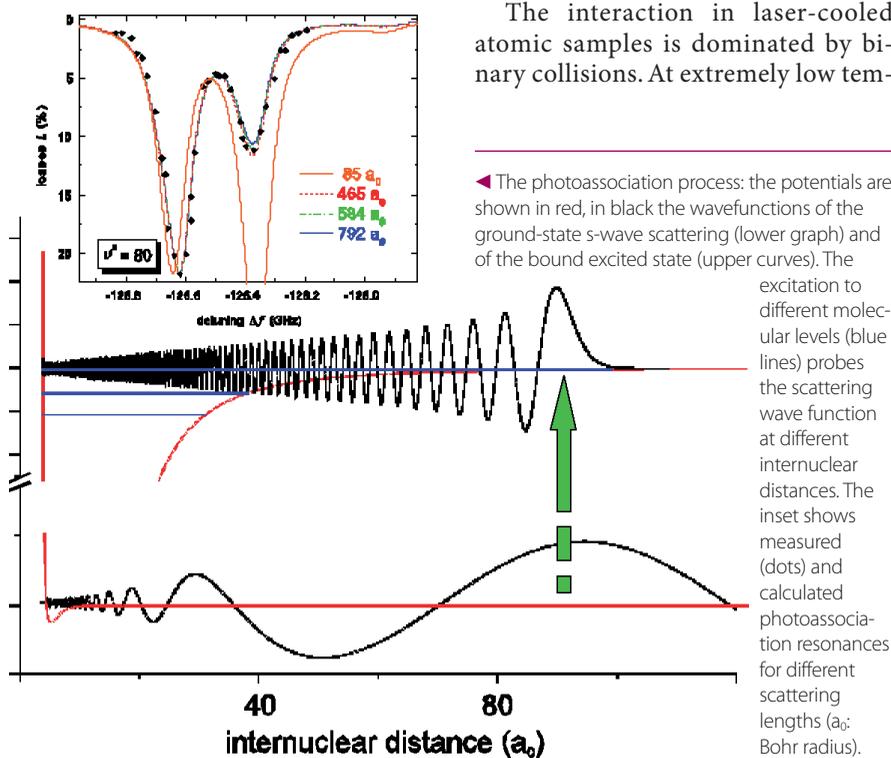
fields. Since cold atomic gases are applied for the most precise clocks and for the realization of the second as the unit of time, the description of cold collisions is essential for the evaluation of the uncertainty of these standards.

The interaction in laser-cooled atomic samples is dominated by binary collisions. At extremely low tem-

peratures they are described by only a few partial waves, where the lowest one (s-wave) can be well parameterized by the scattering length.

The experiment made use of photoassociation, a process in which two colliding atoms are resonantly excited to a bound long-range molecular level. The excitation became visible as additional loss of calcium atoms from the magneto-optical trap. The relative intensities of resonances stemming from different rotational and vibrational molecular levels reflect (according to the Franck-Condon principle) the amplitude of the scattering wave function at various internuclear distances. The comparison of the observed profiles with detailed simulations of the photoassociation process allowed the ^{40}Ca ground state scattering length to be determined with high precision and gave a stringent test of modelling the photoassociation spectra of cold atoms. ■

F. Vogt, Ch. Grain, T. Nazarova, U. Sterr, F. Riehle, Ch. Lisdat and E. Tiemann, "Determination of the calcium ground state scattering length by photoassociation spectroscopy at large detunings", *Eur. Phys. J. D* 44, 73 (2007)



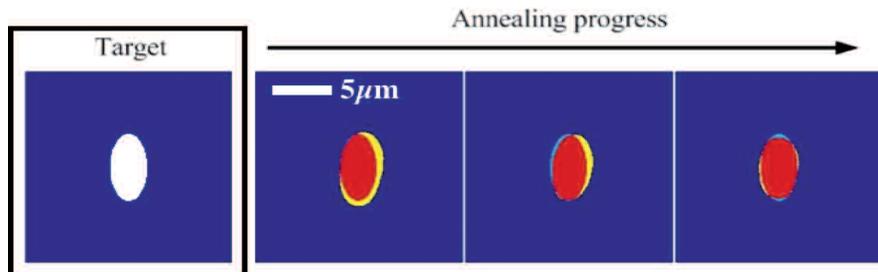
Optimization of femtosecond laser ablation

The well-defined value of the machining threshold in femtosecond laser machining means that adaptive optic beam shaping can be used effectively to tailor the size and shape of the holes created by this process. In this paper we have demonstrated that precision holes with diameters of only a few microns can be created and shaped using adaptive optics. The unique aspect of our work, and what makes it distinct from previous research, is that we have used a computer-controlled feedback algorithm to monitor the machined hole and then to modify the adaptive optics so that its size and shape precisely matches that of a pre-defined target hole. The figure shows a target which corresponds to a $3\mu\text{m} \times 6\mu\text{m}$ hole, and samples of actual holes machined as the optimization algorithm progressed. Red shading denotes the overlap between

the target and the machined hole. Beyond mechanical machining, femtosecond laser material processing is also well known as a technique for inscribing optical waveguides into glasses and crystalline materials. In this context our technique could also be applied to improve the mode symmetry of waveguides created using femtosecond lasers and to compensate for

spherical aberrations at the air-dielectric interface that vary as waveguides are written at different depths in a sample. ■

S. Campbell, S.M.F. Triphan, R. El-Agmy, A.H. Greenaway and D.T. Reid, "Direct optimization of femtosecond laser ablation using adaptive wavefront shaping" *J. Opt. A: Pure Appl. Opt.* 9 (2007) 1100



▲ Progress of the adaptive optimisation algorithm showing the target shape (left box) and the holes machined in a chromium on glass film as the algorithm converged.

"On the way we conference" [OPINION]

Wiebke Drenckhan,
LPS, Université Paris-Sud, Orsay (France)

You are at (yet) another one of these big conferences where - unless you paid the 75 Euro for the conference dinner - you spend your night leafing through a book of abstracts of a size which poses a serious threat to the weight limit on the flight back.

Over the years you have developed a sophisticated point system to help you decide efficiently which of the densely packed parallel sessions to go to, and especially which ones to skip, in order to have some time to discuss with colleagues (who will have to be convinced first to skip the same talks). You also have a map of the conference venue ready in which you have drawn in multiple colours the connections between rooms which minimise the time it takes you to run between them. Now that you are here you might as well make the most of it!

You have come because you have been invited to give a talk (and you are proud of it). You have come because you have always gone. You have come because your colleagues always do, because it is necessary to add another bullet point in your CV proving your research activity, because you were afraid to miss out on something, because you hoped that this one would prove more useful than the previous one, ... You have come because it is in a nice location and you will stay on with your family for two more days for that long overdue holiday that you had promised them when you did not have time to come home for dinner because you were preparing for conferences.

We have many reasons to go to conferences! But do we go for the right ones?

Conferences have been around for hundreds of years and for very good reasons. They are intended to allow easy **communication**, *i.e.* the exchange of ideas and the formation of collaborations so essential to progress in science. As such they are vital in developing a sense of the community in which we need to navigate comfortably. Conferences are also meant as means of **inspiration**, and they aim to provide opportunities for ideas to crash into one another to pave the way for those which prove the most appropriate in describing (and manipulating) the natural world.

But are our conferences really living up to this?

With the availability of the phone at ever dropping rates and the explosion of the internet and its capacity - which not only brought along email and video conferences, but also very rapid publishing - conferences have become just **one of many** means of communication in science.

Nowadays, when a colleague at the other end of the world makes an exciting discovery, we can know of it within a few hours, can discuss it via a video conference and have a paper written and submitted within a few days. Within a few weeks it can be published (provided that Nature or Science agree that it is exciting), or otherwise within a few months (provided the referees agree). Or, we simply put it on the web. Those with a dislike of digital communication can spend money from one of the several travel grants they have and benefit from

the boom of low-cost airlines to go and see those colleagues personally.

As a consequence, we generally know rather well what is going on in our field. And we can also routinely keep ourselves up to date about the current affairs in any other field thanks to the vast amount of electronic search engines and journals (possibly even with "free" access to articles, if recent developments continue).

What a change compared to even 50 years ago, when scientists were communicating with their colleagues abroad via snail mail in elegant handwriting, one at a time!

What has changed very little, however, is the way we "conference" in this new ICT era and the way we spend summers and research money touring conference hotels and parallel sessions, just to get lost in the hundreds of overspecialised PowerPoint presentations that run non-stop throughout the whole day; and trying to toss back the terrible coffee, whilst flying through hundreds of posters in the few hours available before the next lot is put up...

Conferences are absolutely essential for exactly the reasons I have mentioned before. But I feel that we have got stuck in an old-fashioned routine in the way we run them. I would therefore like to suggest that we pause for a moment, step back and rethink what role conferences could and should play in present-day science communities and how they can really fill the gaps which modern means of communication and travel cannot provide. In my opinion, the key gap to be filled is that of human contact and interaction!

In this spirit I believe that whatever shape conferences take, it is absolutely essential to **avoid parallel sessions** and to provide **sufficient time for participants to meet and to discuss**. (The currently available two minutes for questions after each talk mostly serve the purpose of profiling individuals in the audience or simply of running between parallel sessions.)

Beyond this, I see two particularly important functions that conferences should fulfil. And they should be clearly dedicated to one or the other without overlap.

Depth and detail

We certainly need small conferences with a focus on a narrow theme where plenary-type overview lectures of current progress and specific talks/posters/etc. are regularly followed by discussions on a larger scale and between individuals. (Which is basically what conferences used to be like, did they not?)

Across boundaries

Generally, scientists apply similar fundamental principles to the description of different fields, which leads to the not-so-surprising fact that similar methods are commonly developed independently and simultaneously in different fields. Hence, thematically wider-scale conferences with only plenary-type presentations by experts can not only ensure transfer of

knowledge and technologies across boundaries, but can also provide the inspiration that is often triggered by interdisciplinary contacts and collaborations.

In all cases it is absolutely essential that speakers are (made) aware of their target audience and that they adjust their presentation accordingly. I find it less embarrassing to bore 50% of the audience than to lose the same number after the first few minutes.

In general, scientists should be intrinsically interested in attending and enjoying conferences even without presenting their own research work. The current trend, namely that speakers appear only for the day of their presentation, speaks for itself and is completely beside the point of such meetings.

Such trends are amplified by the fact that the number of conferences each of us could attend every year seems to increase exponentially, with new conferences being announced continuously, whilst “old ones” rarely disappear. (Unfortunately, Darwin’s law does not seem to apply to conferences.) As a result, scientific excellence at conferences is increasingly rare and far between, a trend we should re-consider **valuing scientific quality over quantity**.

I do not believe that such considerations can (nor must) lead to the “optimal answer” or to the “ideal recipe” regarding the way we conference. The “recipe” will and should always depend on the specific aim and communities concerned, and

it also needs to find its place between other scientific meetings, such as workshops or schools. What is more important is that conference organisers develop the habit of critically questioning and consequently adjusting the way things are done to integrate them naturally and fruitfully into the progress and overall “well-being” of our community.

Why not be braver and experiment a little more with conferences? People might argue (rightly, I believe) that it is important to know what they are getting themselves into before signing up for a conference. But instead of providing such transparency by making all conferences alike, we should use the power of digital communication in advance of the conference, *i.e.* by expressing the conference targets and procedures clearly on the web.

Hanging on to the traditional format of conferences, without finding very good reasons to do so, is – according to my opinion – a waste of taxpayers’ money and researchers’ time. As it is, too many conferences serve mostly the tourism industry (which gets to feed, sleep and transport all those hundreds of scientists and their spouses) and the CVs and egos of the conference organisers. And not to forget about those politicians who arrive for every opening session to announce the conference location as internationally leading in terms of scientific output, technological innovation and, of course, natural beauty. ■



▲ Conference stress

Global mapping of greenhouse gases and air pollutants [DOI: 10.1051/epn:2007024]

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Man must rise above the earth, to the top of the clouds and beyond, for only thus will he fully understand the world in which he lives, Socrates (470-399 B.C.) observed. Two and a half millennia later satellites orbiting the earth duly obliged, taking images spectrally resolved of the earth atmosphere in order to gain a better understanding of ozone chemistry, air pollution and of climate change.

SCIAMACHY (Scanning Imaging Absorption spectroM-eter for Atmospheric CHartographY) fighting light and shadow in Greek mythology, is an optical spectrometer [1,2,3 and see Box 1] developed by German, Dutch and Belgian scientists and industry as a contribution in kind to ENVISAT, Europe's biggest satellite (see Box 2). Launched on March 1st 2002 by a European Ariane-5 rocket, it has since completed nearly 30.000 orbits around the earth, producing more than 35 million measurement scenes. Its projected 5 year lifetime has now passed. Time to take stock.

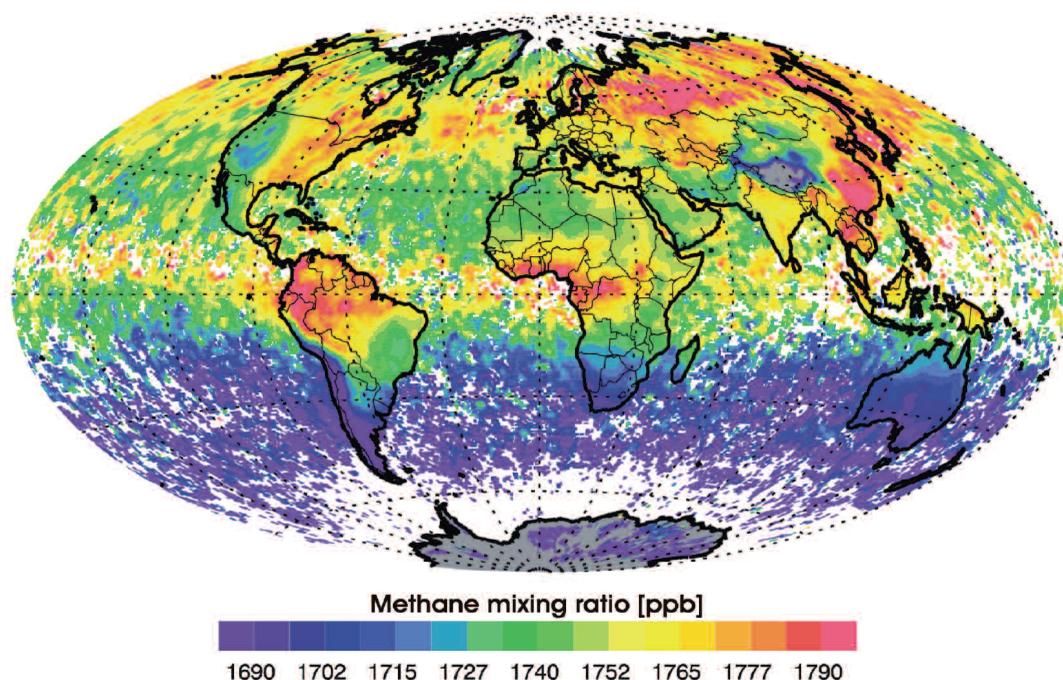
Climate change

A useful concept in climate research is radiative forcing, the change in net irradiance (W/m^2) at tropopause height (between 8 and 18 km) exerted by a change in greenhouse gas concentration. For small changes this provides a measure for the change in temperature at the earth surface. The human induced effect is of the order of a few W/m^2 ($CO_2 \sim 1.5 W/m^2$, $CH_4 \sim 0.7 W/m^2$, $O_3 \sim 0.35 W/m^2$), compared with a globally av-

eraged solar irradiation of $340 W/m^2$ [4]. Greenhouse gas radiative forcing can be calculated from measurement of the concentration distribution and is most sensitive in the upper part of the troposphere.

The underlying parameter for greenhouse gas concentrations are the sources and sinks of the greenhouse gases. Emissions may be estimated from measured emission factors in combination with statistical data, the so-called bottom-up approach used by countries reporting under the United Framework Convention on Climate Change and the Kyoto Protocol. Emissions can also be derived from measurement of the concentration distribution and inverse modelling, the so-called top-down approach. Discrepancies exist between the two approaches whilst uncertainties are considerable [4]. This limits our understanding of climate change and adversely affects verification of greenhouse gas emission inventories.

Inverse modelling has been carried out from ground based observations, but results are limited by their scarce and unbalanced distribution over the earth surface [5]. From their vantage point in space satellite measurements have the benefit of global coverage, but measurement accuracy in the lowest layers of the atmosphere is a challenge. This challenge was met by EVERGREEN (EnVisat for Environmental Regulation of GREENhouse gases), a European Commission RTD project carried out by a consortium of 12 European organisations [6].



◀ **Fig. 1:** The global distribution of atmospheric methane (column-averaged dry air mixing ratio) retrieved from SCIAMACHY near-infrared nadir spectra over the year 2003. Most methane sources reside in the Northern Hemisphere (wetland, rice paddies, ruminants), which shows up as a North-South hemisphere gradient. Major source regions are clearly visible such as wetlands in Russia, rice paddies and wetlands in China and broad leaved forest areas in South America and wetlands in Central Africa (Schneising *et al.*, 2007, ref. 8)

Box 1: SCIAMACHY

This spectrometer combines a large spectral range (240 nm to 2400 nm) with a medium spectral resolution (~ 0.2 nm) accomplished in two stages. First the light is pre-dispersed by a prism. Subsequently, the spectrum formed is peeled off and directed into eight separate channels in which final dispersion is obtained by a grating. Thus, high and low signal regimes are separated to suppress stray light and to avoid overlapping spectral orders.

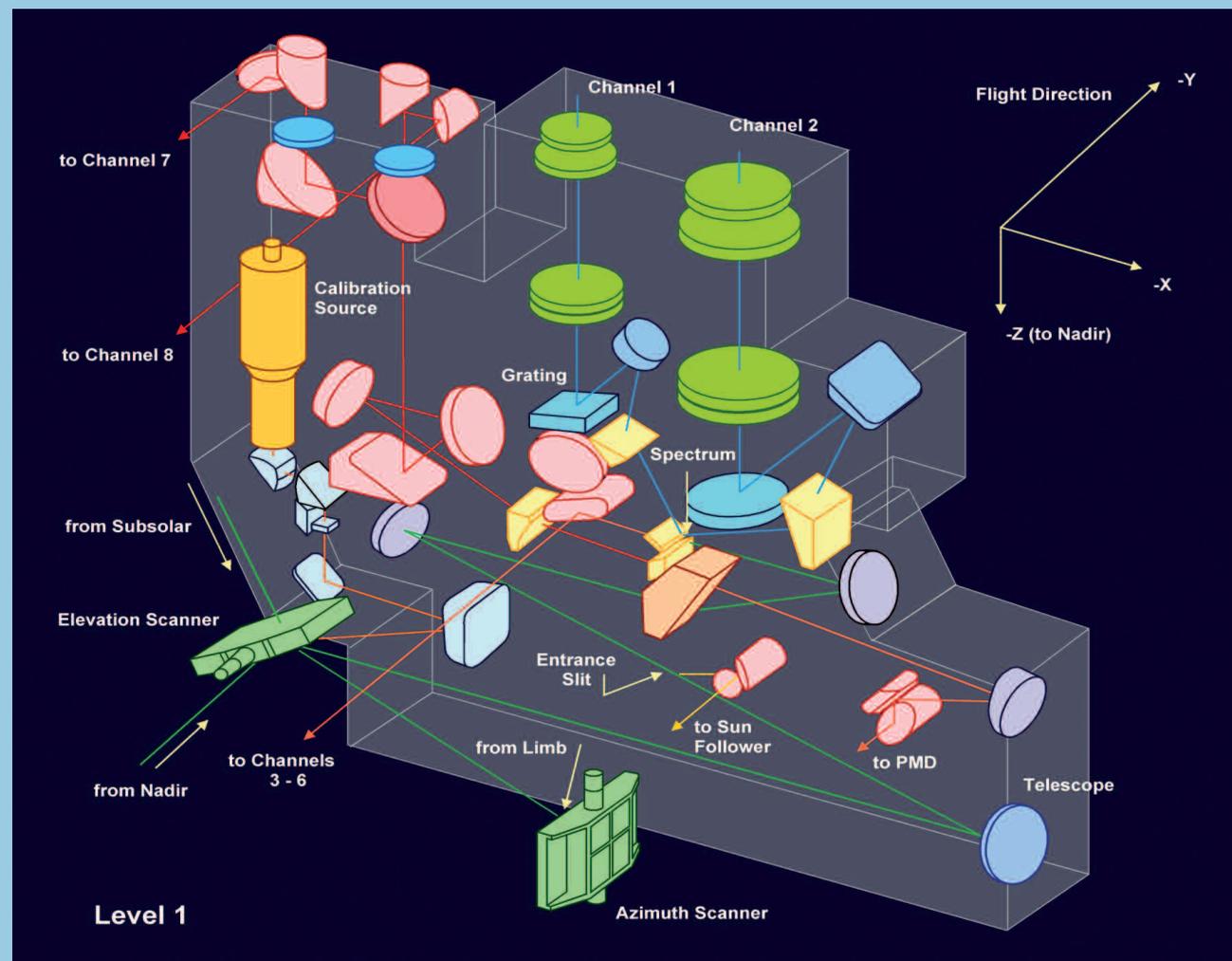
The approach was made possible by the development of solid-state linear array (1024) detectors which measure the entire spectrum in one go, rather than scanning the spectrum over a photo multiplier tube, the common technology at the time (1988). The near infrared (1000-2400 nm) InGaAs detectors were developed and space qualified by the project. The measurements presented in this paper originate with these unique detectors.

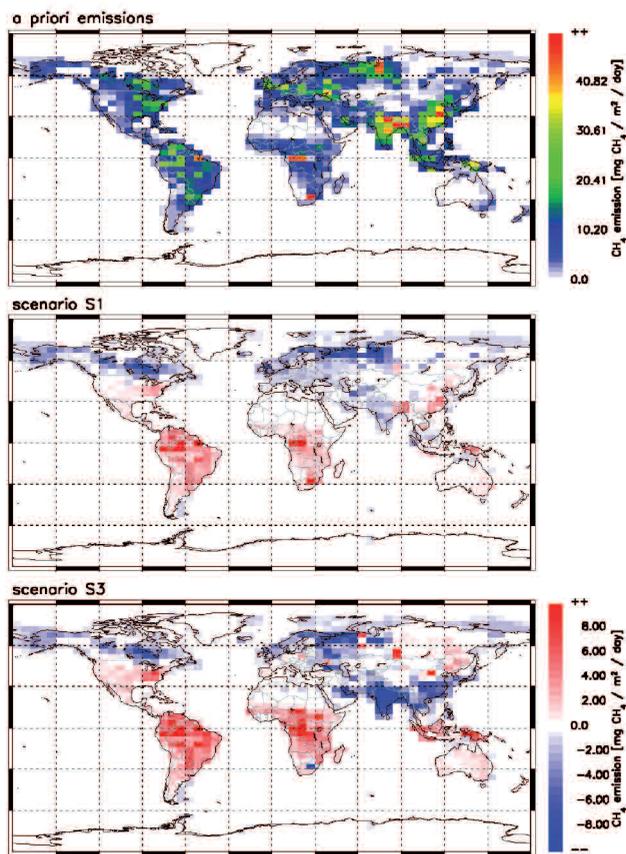
The InGaAs photo-sensitive material is epitaxially grown in thin layers of increasing In content such as to reduce the band gap energy and increase the cut-off wavelength to match the channel wavelength range. The lattice mismatch results in dislocations which produce noise. To suppress noise the detectors are passively cooled to 150 K by a 2-stage

radiator directed into deep space and connected by cryogenic heat pipes to the detectors.

The atmosphere is sampled by a mirror system in front of a telescope collecting the incoming light. A nadir scan provides a 1000 km wide swath at a horizontal resolution of approx 30 km (N-S) by 60 km (E-W). A limb scanning mirror yields vertical information at a resolution of approximately 3 km. Resolution is specific to the trace gas investigated and depends on entrance slit width, detector pixel size, signal to noise performance and data rate. After six days the entire surface of the Earth is sampled, which determines the temporal resolution of the measurements.

The Picture shows one level of the optical instrument, housing the spectral channels 1 and 2, the scan mirrors, the telescope and the calibration unit. The pentagonal element in the centre is the pre-dispersing prism, the lynch pin of the instrument which forms an intermediate spectrum, which subsequently is peeled off and relayed to individual channels. Not shown is the second level of the instrument housing the spectral channels 3 to 8. Also not shown are the electronic control and data processing units, the thermal control unit and the cooling system.





▲ **Fig. 2:** Methane source strength (top) is improved by inverse modelling, in scenario S1 with ground based measurements only and in scenario S3 with SCIAMACHY measurements added. Northern Hemispheric sources need to be adjusted downward. Tropical Southern Hemispheric sources need upward adjustment. Unknown sources in the Amazon area and West Africa have been discovered by SCIAMACHY (Bergamaschi *et al.*, 2006, ref 5). Copyright 2007 American Geophysical Union. Reproduced by permission of AGU.

The approach adopted was to use relative measurements (see Box 3). Relative measurements are less prone to errors in instrument calibration and radiation transport calculation. For example, radiation transport can be computed as accurately as one likes, including multiple scattering and polarization; if however the aerosol, haze or (cirrus) cloud distribution is not accurately known, neither will be the scattering path travelled by the photon. One way to overcome this problem is to consider the scattering of a well mixed gas as a proxy for the correction of light path. Using oxygen for the purpose improves precision to a certain extent, but is limited by the fact that the energy of an oxygen photon absorbed at the O₂ A-band (780 nm) has more than twice the energy of a photon absorbed by methane (1631-1670 nm) or carbon dioxide (1563-1585 nm). Scattering properties of the reference photons are thus different and the correction of the light path not perfect.

For methane this limitation could be avoided by normalizing the measurements on carbon dioxide. The SCIAMACHY results over the period August to November 2003 demonstrate for the first time that methane sources can be

detected from space [7]. Compared with theoretical models higher methane abundances are found over tropical areas of South America, Africa and Asia suggesting unknown emissions. Figure 1 shows the global distribution of atmospheric methane for the year 2003 [8].

Methane emissions can be derived from the measured abundances through inverse modelling. Figure 2 shows the first results for the year 2003 based on both ground and satellite data [5]. These results suggest significantly greater tropical emissions compared with bottom-up estimates and compared with inversion based on surface measurements alone. They are attributed to a larger emission from tropical wetlands and termites and a decrease in the soil sink. Global methane emission inventory of 550 ± 50 Tg/yr changes little.

Naturally, attention is focused on CO₂, the most important anthropogenic greenhouse gas responsible of more than half the anthropogenic radiative forcing. The atmospheric lifetime of CO₂ is an order of magnitude larger than that of methane (100 vs. 10 years). The disturbance in total column height due to emissions is correspondingly smaller and measurement accuracy will have to be higher. Figure 3 shows the first global CO₂ measurements by SCIAMACHY for the years 2003-2005 [9]. These are relative measurements normalized to oxygen, not ideal as explained before. Like methane, comparison with models shows good overall agreement, but also interesting differences. The yearly increase of CO₂ is well captured as demonstrated by the 2 in 380 ppm precision. The CO₂ sequestration during the growing season and its release during autumn and winter qualitatively agree with ground based measurements and models. Quantitatively however, measurement shows a larger amplitude than modelled. This may be explained by measurement error. It could also point to higher CO₂ fluxes on the Northern Hemisphere than hitherto known. This interesting result warrants further investigation.

In order to retrieve emissions from concentration distributions, data assimilation is the appropriate technique. Data assimilation is capable of optimizing a large number of model parameters simultaneously and handling large amounts of measured data. Data assimilation is based on the theorem of Bayes (1763), a Presbyterian priest who mathematically showed how to change religion in the face of new facts. In other words, it is a statistical method that incorporates measurements into a theoretical model to improve its representation of reality. The method is used in meteorology for weather prediction.

Data assimilation allows quantification of information content when adding new measurements to a theoretical model. A sensitivity analysis carried out for methane [10], shows that monthly averaged methane data from SCIAMACHY significantly improve emission data on a sub-continental scale (~500km). A necessary condition is to include clouded pixels in order to sufficiently constrain the inversion. This is made possible by the relative measurement approach, where the normalization of methane by carbon dioxide allows clouded pixels to be taken into account. Clouded pixels provide for high reflectivity over the ocean, which is needed for sufficient signal strength of the reflected radiation measured by SCIAMACHY. So far, data assimilation has not been applied to quantify CO₂ emissions, being

limited by measurement error in relation to error in vertical transport modelled.

Air quality

In the seventies the notion arose that air pollution is not merely a local problem but affects air quality on an (inter)continental scale. Meteorological condition lifts up the polluted air to the free troposphere where long-range transport sets in to subsequently precipitate and raise local air pollution levels more than 1000 km away. This poses problems to local authorities trying to meet air quality targets. In order to follow and predict air pollution transport the traditional method of air samples taken locally at the ground is not sufficient. Space based instruments add the global dimension. More recently the link to climate change has been established, a warmer climate speeding up chemical reactions and enhancing emissions.

Carbon monoxide (CO) is a toxic air pollutant which plays a role in greenhouse gas chemistry, through the production of troposphere ozone and the destruction of the hydroxyl radical which is a sink for methane. The lifetime of CO ranges from several weeks to months and therefore CO is an excellent tracer for atmospheric transport. A large, but poorly known source of CO is biomass burning, highly variable in space and time. SCIAMACHY retrieves CO from some weak overtones in the vibration-rotation spectrum at 2.31 to 2.38 μm . Again, the relative measurement procedure has been applied, now taking methane as the normalization agent. The first results show unprecedented detail in elevated levels of CO, capturing CO emission of individual cities, see Figure 4 [11]. Inverse modelling of CO sources will be the next step, see [6].

Stratospheric ozone

Satellite measurements of stratospheric ozone form the most mature part of research. Although reasonably well understood, the difficulty in predicting the trend to recovery and the interaction with climate change have the consequence that continuous monitoring of stratospheric ozone remains mandatory. Ozone also influences the radiation balance and consequently the weather. SCIAMACHY delivers total ozone column data near real time to the European weather centre ECMWF for assimilation in the medium-range weather model.

Validation and application

The validity of the SCIAMACHY methane and CO measurements has been verified by ground based Infrared Fourier Transform Spectrometry [12]. The accuracy of methane measurements is 1-2% and of CO is 10-20%. The accuracy of the CO₂ measurements is currently being assessed but is expected to be similar to methane.

The GMES project PROMOTE (PROtocol MONitoring for The Environment) employs SCIAMACHY data to deliver an operational air quality, ozone and climate service [13]. GMES, Global Monitoring for Environment and Security, is a joint programme of the European Commission and ESA and is the European contribution to the international GEO programme for a global earth observation system addressing a wide range of social and economic applications, such as health, climate and energy.

Conclusion and outlook

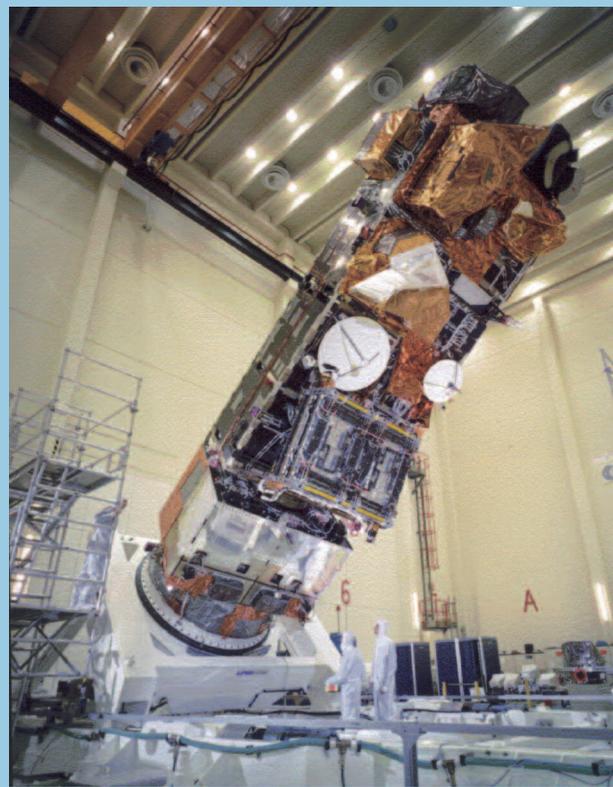
SCIAMACHY has fulfilled its original mission objective to detect greenhouse gasses and air pollutants from space and to improve ozone observations. Over one hundred papers have been published to date in peer reviewed journals including ...

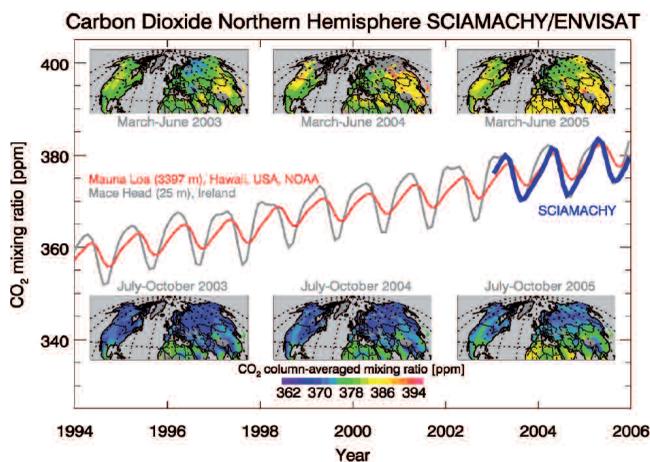
Box 2: Envisat

The SCIAMACHY instrument is mounted on the top right corner of the satellite, here shown before launch in the ESA clean room (see Picture). In orbit, the satellite moves sideways through space. Dimensions are 26x10x7m, total mass is 8140 kg and electrical power is 6.6 kW. Payload mass 2050 kg comprises 10 instruments. Total cost of the satellite is approximately 2.5 BEuro.

The satellite circles the earth in polar orbit at 800 km altitude going from North Pole to South Pole and back in approximately 100 minutes. The orbit is synchronised with the position of the sun such as to probe the earth at constant (10 am) local time or constant solar zenith angle. In contrast, a geostationary orbit at 36.000 km altitude is synchronised with the rotation of the earth sampling a fixed area on earth at changing solar zenith angle.

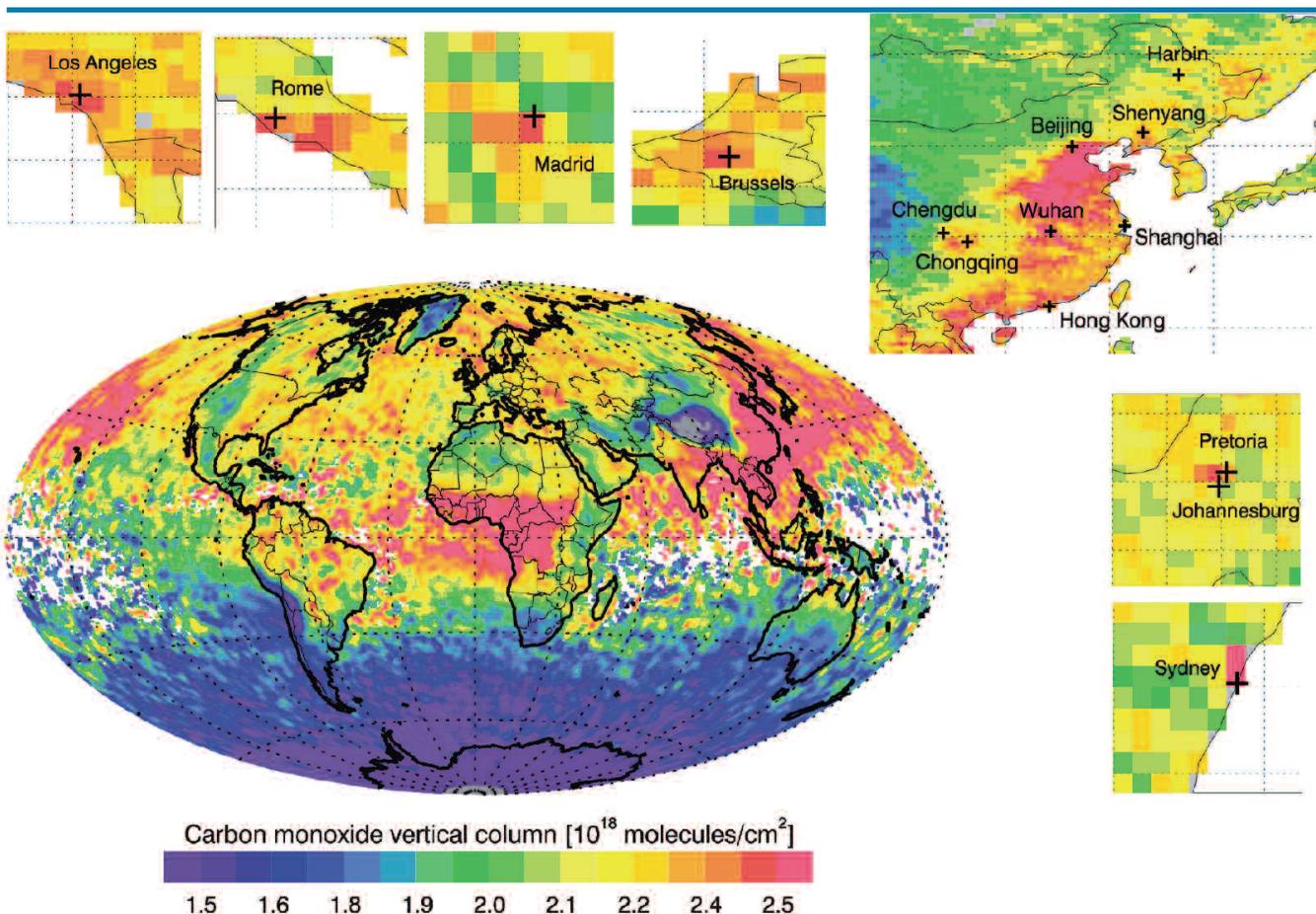
Data are transmitted at a rate of 100Mb/s to European ground stations via the Artemis data relay satellite using the Ka band. Data are also down linked via X-band to the Kiruna ground station at every Arctic overpass. Data collected are stored over one orbit using two 70 Gb solid state memories and one 30 Gb tape recorder. Raw data are being processed on ground to calibrated spectra which are subsequently processed to trace gas concentration distributions, see box 3. control unit and the cooling system.





▲ **Fig. 3:** Column-averaged mixing ratio of carbon dioxide (CO₂) during 2003-2005 over the Northern Hemisphere retrieved from SCIAMACHY data. The thin lines indicate local CO₂ surface measurements based on weekly flask sampling at Mauna Loa, Hawaii (red line) and Mace Head, Ireland (grey line) by courtesy of T. Conway and colleagues at NOAA, Boulder. The thick blue line shows the SCIAMACHY data averaged over the Northern Hemisphere, displaying our breathing planet, resulting mainly from CO₂ uptake and release by growing and decaying vegetation. The annual CO₂ increase results mainly from the burning of fossil fuels (Buchwitz *et al.*, 2007, ref. 9).

▼ **Fig. 4:** Global distribution of carbon monoxide (CO) during 2004 retrieved from SCIAMACHY measurements. Major CO source regions show up including those in Central Africa (CO from biomass burning during the dry season) and in China (CO from fossil fuel burning). Zooming in reveals elevated CO at or near major cities (Buchwitz *et al.*, 2007, ref. 11).



... Science and Nature. SCIAMACHY data have found application in the European operational atmosphere service GMES. It has given Europe the lead in atmospheric composition research with improved knowledge of the physics and chemistry of the atmosphere as a result.

The SCIAMACHY mission design lifetime of 5 years has now passed. Extension to 2010 offers some years of grace, but degradation of the instrument has irrevocably set in. The UV channel suffers from cataract whilst the infrared channels lose pixels at an alarming rate, hammered by cosmic rays. In 2010 only 30% of the pixels will still be alive.

Climate and environmental research needs long term measurement series. The European operational Earth Observation satellite MetOp will extend the SCIAMACHY measurements until 2020 with the instruments GOME-2 and IASI on board. But for innovative scientific satellites no launch opportunity appears to exist before 2018. This is not because of lack of ideas. For example, photo-chemically active climate and environment gases require diurnal time resolution, not days as is currently the case. GeoTropo, a SCIAMACHY derivative in geostationary orbit will provide half hourly synoptic air quality and climate charts over Europe, North Africa, Siberia and part of the Atlantic Ocean.

With climate high on the political agenda and energy the topic of EPS, it is appropriate to see what space based measurements of greenhouse gases can offer in understanding

climate change. The EPS will conduct a workshop in collaboration with the German Physical Society on 13 March 2008 in Darmstadt to define the way forward in measuring and modelling the environmental effects of energy production. A series of parallel EPS workshops on novel energy production and conversion physics will culminate in a final workshop organized in collaboration with the French Physical Society later that year. Be alert! ■

About the authors

Adelbert Goede initiated atmospheric space research in the Netherlands in 1988 and was SCIAMACHY Co-Principal Investigator until recently. Presently he works at FOM Rijnhuizen (NL) and is Executive Committee member of the European Joint Undertaking for ITER, Barcelona. He is chair of the EPS Environmental Physics Division

John P. Burrows is the Principal Investigator of SCIAMACHY. He is professor of Atmospheric Chemistry and Physics at the University of Bremen and leads there the Institute for Environmental Physics. In 2006 he received the prestigious William Nordberg Medal from the international space research organization COSPAR. He is member of the EPS Environmental Physics Division

Michael Buchwitz is senior scientist at the Institute of Environmental Physics of the University of Bremen. He and his group (including Oliver Schneising, Iryna Khlystova, and Maximilian Reuter) have produced the SCIAMACHY green-

house gas and carbon monoxide measurements presented in this paper.

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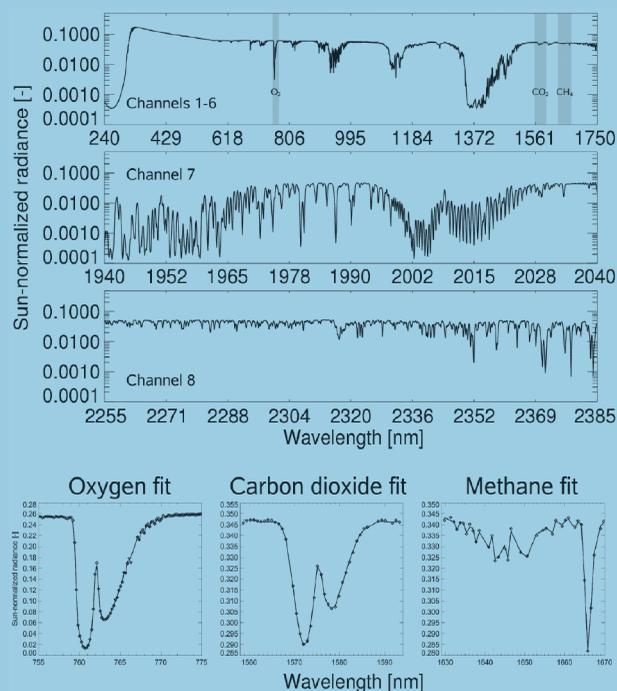
Box 3: Data retrieval

SCIAMACHY employs absorption spectroscopy in the near infrared (1000 to 2400nm) to retrieve column abundances of the gases CO₂, CO, CH₄ and N₂O, utilising the sun as the photon source. In contrast, emission spectroscopy in the mid infrared (5 to 15 μm) is based on black body radiation. The advantage of near infrared absorption spectroscopy is in the sensitivity to gasses residing in the boundary layer, where thermal infrared spectroscopy lacks contrast with the background black body radiation emitted from the earth surface.

Differential Optical Absorption Spectroscopy (DOAS) exploits the power of relative measurements to gain precision. A known molecular absorption spectrum is matched to a measured spectrum, whilst the adjacent spectral regions yield information on the photon scattering path through the atmosphere. The total column of air mass sampled is converted into vertical columns by a radiation transport calculation. Weighting Function Modified WFM-DOAS takes the height sensitivity of absorbed radiation into account [14]. In a second step, the ratio between the retrieved column and a known gas column (CO₂/O₂, CH₄/CO₂ or CO/CH₄) further improves precision as residual errors resulting from aerosol and cloud scattering are divided out.

The Figure shows SCIAMACHY sun-normalized radiance spectra measured in nadir geometry. The top panel displays the radiance from channels 1 to 6 covering 240 nm (ultraviolet) to 1750 nm (near-infrared). Shaded regions indicate the O₂, CO₂, and CH₄ column retrieval windows. The middle panels

show channels 7 and 8 spectra, the latter being employed for CO retrieval. The bottom row shows spectral fits, the dots representing the SCIAMACHY measurements and the line representing the fitted radiative transfer calculation..



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The sauna – revisited [DOI: 10.1051/epn:2007025]

L.F.J (Jo) Hermans and Timo Vesala

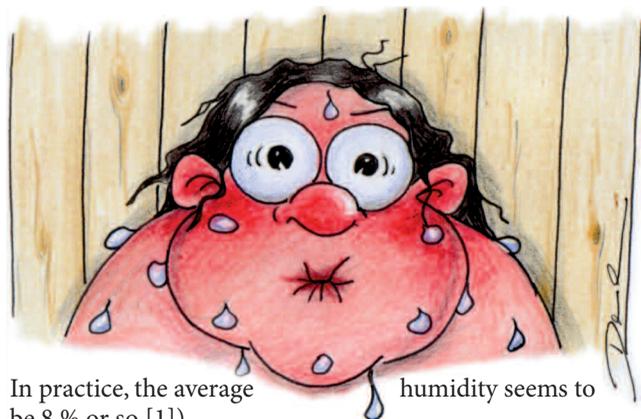
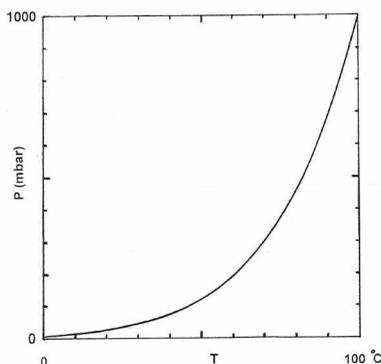
In Europhysics News 37/6 (2006) we addressed several aspects of the funny situation in which we find ourselves when visiting the sauna. One question remained a bit open: What exactly causes the temporary heat pulse that we feel when we throw some water on the hot stones, thereby temporarily elevating the air humidity? All we could produce at the time was the 'educated guess' that at least four different contributions could play a role. But that did not really solve the question satisfactorily. Fortunately, Timo Vesala, professor of Meteorology at the University of Helsinki, came to the rescue. Having done qualitative observations during a few years in his own sauna twice a week, he solved this non-trivial problem and published a paper on the issue [1]).

Here is the surprise: The latent heat released in the condensation of water vapour onto the skin is an important mechanism - perhaps the most important one. The reason is that our skin is most probably the coldest place in the sauna, and the humidity can easily become 100 % near the skin.

That's beautiful! We are used to think in terms of evaporation from our skin, not condensation. But the sauna is something special, and we should think beyond the conservative.

To check the validity of the argument, let us assume the sauna temperature to be 100°C, (real Finnish saunas are somewhere between 80 and 110°C). This eases the analysis since 100 % humidity nicely corresponds to 1000 mbar. What happens can now be easily seen from the vapour pressure curve,

reproduced here for convenience. As pointed out in the previous sauna item (and readily checked from the curve), the humidity will automatically be 3 % at most if the outside air is heated to sauna temperature. This will go up if extra H₂O is released, for example by perspiration.



In practice, the average humidity seems to be 8 % or so [1]).

From the water vapour pressure curve we see that 8 % humidity (i.e., 80 mbar in this case) will lead to saturation at about 40°C. This is almost exactly the sauna-warmed temperature of our skin: 43°C [1]), as confirmed by infrared skin-temperature observations of female students during the field course on micrometeorology at Hyytiälä Forestry Field Station (unpublished data). In other words: if the humidity is raised a bit, to 10 % for example, condensation onto our skin will be inevitable. And this is precisely what happens when we throw water on the hot stones.

One of us (T.V.) has also done a quantitative analysis to assess the extent to which condensation contributes to the heat pulse. He finds that this latent heat flux is around 4 kW. This is on the same order of magnitude as the ordinary heat flux, which is already enhanced during the heat pulse by the extra convection (the analysis does not include heat exchange by radiation between the body and the hot oven).

So: next time you're in the sauna, you may want to check the perspiration experiment.

But if you prefer to just sit and relax: no sweat. ■

References

- [1] T. Vesala: Phase transitions in Finnish sauna. In: Nucleation and Atmospheric Aerosols. Proceedings of the Fourteenth International Conference on Nucleation and Atmospheric Aerosols, Eds. M. Kulmala and P.E. Wagner, 403-406. Pergamon, 1996.