europhysicsnews
THE MAGAZINE OF THE EUROPEAN PHYSICAL SOCIETY

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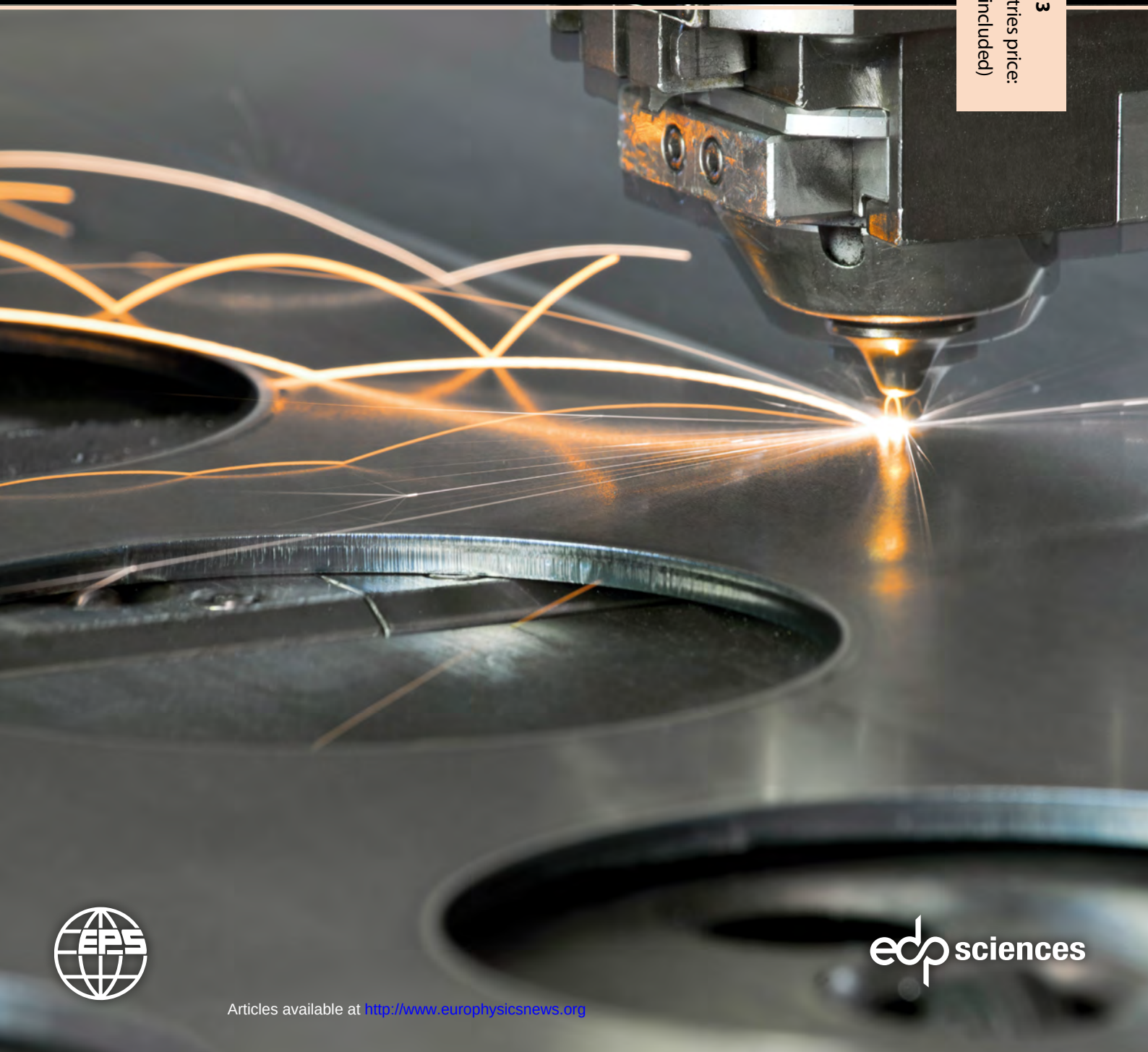
The force of a tiny synthetic machine
Making the Elements in the Universe
Royal Academy of Sciences and Arts
EPS Council (April 2013)

44/3
2013
Volume 44 • number 3
European Union countries price:
90€ per year (VAT not included)



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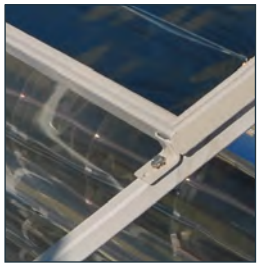
Cover picture: Laser metal-cutting manufacturing tool in operation, see the editorial by John Dudley on page 03. ©iStockPhoto



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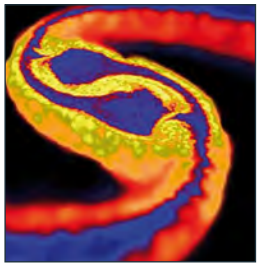

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Making the Elements in the Universe

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[EDITORIAL]

The Challenge of Communication

The coming years are full of challenges for physics and physicists. Researchers are under more and more pressure to provide value for money to governments, and funding models are evolving towards supporting specific technical goals of relevance to society and industry.

Curiosity-driven research into the fundamentals is perceived as increasingly unaffordable. The need to focus on applied research and industrial concerns is understandable to address problems in areas such as telecommunications, climate change, sustainable energy, healthcare, agriculture and so on. Ensuring that there is a critical mass of technical effort in applied research fields is of course important.

Yet it is clear from history that many of the most pervasive technologies that we now benefit from have not arisen from target-driven research at all, but have developed from curiosity-driven directions with no link to their ultimate application. Using an example from my own field of optical physics, laser pioneer Charles Townes in his wonderful book *How the Laser Happened: Adventures of a Scientist* (Oxford, 2002) illustrated this beautifully by asking: "What research planner, wanting a more intense light, would have started by studying molecules with microwaves?" The laser is a clear example of the unpredictability of technology development from fundamental science. Indeed, whilst some of the applications of lasers such as industrial machining or perhaps even surgery might have been expected as a practical use of a bright light source, who would possibly have anticipated the use of lasers as a critical component of audio products?

There are many similar success stories that show how basic research in science has led to dramatic and unexpected benefits to society. As scientists, we recognize these achievements, but we are also motivated in our research by the belief that the creation of new knowledge provides intrinsically valuable insight into the physical world. We need no further convincing.

Yet the recent pressure being placed on fundamental research support suggests that we are clearly not effectively explaining its benefits. So we must try harder to ensure that the importance of physics and its central place in education and research is clearly communicated to policymakers.

But this is not easy. Our training as scientists does not necessarily prepare us for the environment of vigorous debate that is needed to interact in a political context. We often prefer to remain in our familiar research environments rather than spend the necessary days and weeks in committees and on boards.

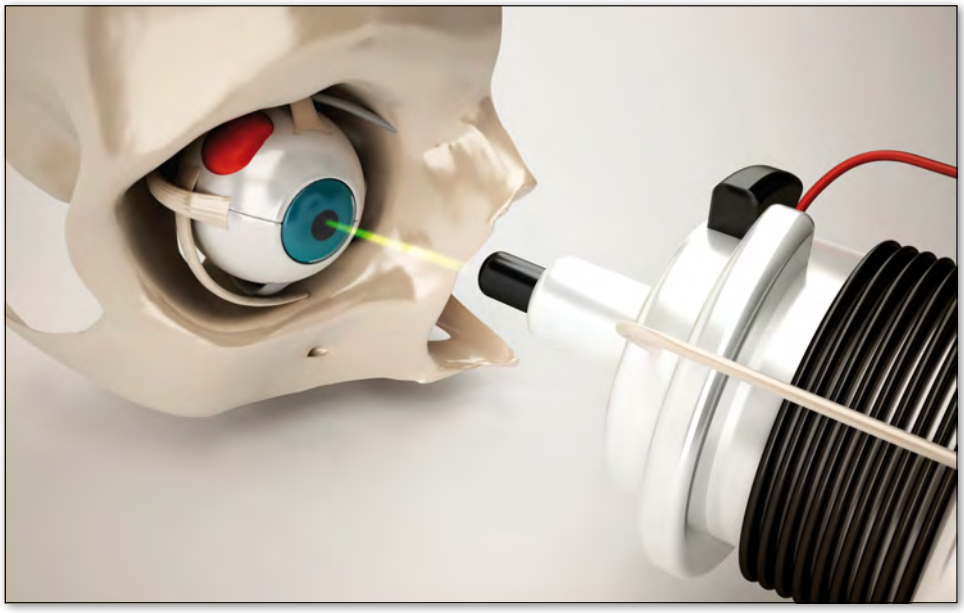
Yet it is essential that we leave the comfort of our laboratories and argue effectively for our research

Yet it is essential that we leave the comfort of our laboratories and argue effectively for our research. This aspect of communication with decision-makers now forms an essential part of our educational mission.

Pressure on basic research is strongly felt worldwide, and is not just a problem for physics, but for all of science. It is here that EPS can play a central role in coordinating efforts between different national societies, and by acting together with professional societies in different fields.

The problem is of concern for all scientists. Participating in the activities of professional and learned societies on a national and international level is more important than ever as we work together to solve it. ■

John Dudley
President of the EPS



▼ Eye surgery, an example of laser applications ©iStockPhoto

europhysicsnews
2013 · Volume 44 · number 3

Europhysics news is the magazine of the European physics community. It is owned by the European Physical Society and produced in cooperation with EDP Sciences. The staff of EDP Sciences are involved in the production of the magazine and are not responsible for editorial content. Most contributors to Europhysics news are volunteers and their work is greatly appreciated by the Editor and the Editorial Advisory Board.

Europhysics news is also available online at: **www.europhysicsnews.org**.

General instructions to authors can be found at: **www.eps.org/publications**

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Individual Members of the European Physical Society receive Europhysics news free of charge.

Members of EPS National Member Societies receive Europhysics news through their society, except members of the Institute of Physics in the United Kingdom and the German Physical Society who have access to an e-version at www.europhysicsnews.org. The following are 2012 print version subscription prices available through EDP Sciences (Prices include postal delivery cost).

European Union countries: 90 € (VAT not included, 19.6 %). **Rest of the world:** 108 €

Contact: EPN Europhysics News · BP 95 · 92244 Malakoff Cedex · **info@route66-agence.com** or visit **www.edpsciences.org**

ISSN 0531-7479 • ISSN 1432-1092 (electronic edition)

Printer: Fabrègue · Saint-Yrieix-la-Perche, France

Dépôt légal: June 2013

EPS HISTORIC SITES

The study of Bruno Pontecorvo,

Joint Institute for Nuclear Research in Dubna, Russia

On 22 February 2013 a ceremony of unveiling an EPS Historic Site plaque at the entrance of the study of Bruno Pontecorvo took place at the Dzhelepov Laboratory of Nuclear Problems, Joint Institute for Nuclear Research (Dubna, Russia). The ceremony was attended by members of the JINR Scientific Council, members of the JINR-INFN Cooperation Committee, EPS representatives and scientists of the Laboratory.

The idea of marking historic places with commemorative plaques was put forward in 2010 to stress the unity of scientists. Dubna has become the fourth EPS Historic Site. The first Historic Site plaque of the European Physical Society is in the *"Centro Fermi"* (Enrico Fermi Historical Museum of Physics and Centre for Study and Research) in Rome, formerly the Physics Institute of Enrico Fermi. The second plaque is in the *"Laboratoire des Cosmiques"* on Mont Blanc, a very high altitude laboratory of the past for studying cosmic rays. The third plaque is on the *"Hoza 69"* building, now hosting the Institute of Experimental Physics and the Institute of Theoretical Physics of the University of Warsaw. All these plaques were mounted to highlight significance of scientific cooperation and unity in Europe.

▾ The view of the Dzhelepov Laboratory of nuclear problems JINR at Dubna (Russia).

Professor Luisa Cifarelli (University of Bologna, Italy), President of the EPS, opened the unveiling ceremony saying: "I am very glad to be here in the year of the centennial of Bruno Pontecorvo. This year also marks the 45th anniversary of the European Physical Society. It was created in 1968, long before the fall of the Berlin Wall, to demonstrate determination of scientists to collaborate irrespective of political orientations. Now 41 states are members of the EPS and 35 prominent institutes, including JINR, are its associate members."

JINR Director V.A. Matveev spoke of Bruno Pontecorvo as an outstanding physicist and person, who had paramountly contributed to the JINR activities and science as a whole. Indeed, Bruno Pontecorvo always had a lot of various bold ideas. As far back as 1940, when he worked in the United States, he proposed a new effective method for oil and gas prospecting, neutron logging, which was practically used in 1943. In 1946 he proposed his famous method of detection of neutrinos using the transformation reaction of chlorine nuclei to radioactive argon nuclei. In 1947, B. Pontecorvo published the paper "Meson Capture by Nuclei and Meson Decay", where he pointed to possible equality of electron-nucleon and muon-nucleon interaction constants. Later this equality became a starting point for developing a more general idea of universal interaction by E. Fermi. In 1948, together with E.P. Hincks, he conducted muon decay experiments and showed that decay of a cosmic-ray muon did not result in emission of either a photon or a neutral meson decaying into two photons. He also found a high-enhancement mode of operation of proportional counters and went on developing that low-background proportional counter technique for experiments with solar neutrinos. In 1949, together with G. Hanna, he measured the tritium beta spectrum and obtained one of the first limits on the neutrino mass. Since 1950 B. Pontecorvo had been working in Dubna.

▲ The memorial plaque is unveiled. Left to right: A.G. Olshevskiy, D.B. Pontecorvo, L. Cifarelli, and V.A. Matveev.

The range of his works and interests was utterly wide, including investigation of neutral pion formation in collisions of neutrons with protons and nuclei at the 5-m synchrocyclotron of the Laboratory of Nuclear Problems, investigation of interactions of pions with hydrogen and nuclei, investigation of the reaction of absorption of negative muons by helium-3 nuclei, *etc.* In 1956 B. Pontecorvo came up with an idea of possible mesonless annihilation of the antiproton on the deuteron (Pontecorvo reaction) and in 1957 with an idea of neutrino oscillation. In 1959 he published the paper "Electron and Muon Neutrinos" with in-depth discussion of the problems and identity of electron and muon neutrinos and proposed an experiment that could answer the question of whether electron and muon neutrinos are identical or different particles. He proposed accelerator experiments with neutrino beams and pointed out significance of the universal Fermi interaction between electrons and neutrinos for astrophysical processes. B. Pontecorvo was the first to propose the theory of oscillation of Majorana neutrinos, indicate the importance of neutrino oscillations for interpretation of solar neutrino experiments, and develop the model of the Dirac and Majorana neutrino mixing.

Had B. Pontecorvo been alive now, he would have been awarded the Nobel Prize. It should be borne in mind that he came up with the ideas of different sorts of neutrinos and their oscillations when only one type of neutrino was known.

The unveiling ceremony was also attended by the new Bruno Pontecorvo Prize winner, professor of the University of Milan E. Fiorini, who said: *"I am proud to be awarded this prize. It a great honor to me, firstly, because it is a very prestigious award and, secondly, Bruno Pontecorvo and I were friends, though he was much older than me. We met each other at conferences in the USSR and Eastern Europe. I have learned much from him, and not I alone—many learned neutrino physics from Bruno."*

In the text on the plaque among the other words about the scientific legacy of Bruno Pontecorvo one can read: *"… In 1957 Pontecorvo introduced the original concept of oscillations between neutrinos and antineutrinos, and in 1967 between electron- and muon-neutrinos… The implications on neutrino masses and mixing opened the first window on 'physics beyond the Standard Model'."* ■

Alexander Olshevskiy
JINR, Dubna

European Physical Society Council
5-6 April 2013 Strasbourg, France

The EPS Council was held at the Institut de Science et d'Ingénierie Supramoléculaires (ISIS), in Strasbourg (FR). Over 80 delegates attended representing the 41 EPS Member Societies, Divisions, Groups, Individual Members and Associate Members.

Catherine Florentz, the Vice President for Research from the University of Strasbourg welcomed the participants. The University of Strasbourg has a dynamic research programme, particularly in physics. The ISIS is a multidisciplinary research institute, on the frontier of physics, chemistry and biology. ISIS welcomes researchers from around the world, providing opportunities for leading senior scientists as well as promising young scientists. ISIS has many public and private sector partnerships in fields such as supramolecular chemistry, nanostructure and quantum physics.

President's Report

In 2011, the Council adopted the EPS Strategy Plan 2010+. Over the past 2 years, the President, with the support of an enlarged and active Executive Committee has led the effort to implement the strategic orientations described in the Strategy Plan 2010+.

As a federation of European national physical societies, the EPS has assumed its role to represent the European physics community on an international level. Many events, such as the celebration of the 80th anniversary of the Chinese Physical Society gave the EPS the opportunity to present its activities to an international audience. A roundtable discussion on issues of common interest and concern was held, focusing on better cooperation in various fields. Other participants of the roundtable included the American Physical Society (APS), other major physical societies in Europe (DPG, IOP) and Asia [the Physical Society of Japan (PSJ), the Japan Society of Applied Physics (JSAP) and the Association of Asia Pacific Physical Societies (AAPPS)].

L. Cifarelli is a member-at-large of the APS Forum on International Physics (FIP) & a member of the APS Committee on International Scientific Affairs (CISA). This opened up lines of communication, through regular meetings of CISA, and has led to discussions regarding joint policy statements with APS (*e.g.* open access, education…), as well better cooperation through joint activities such as joint prizes & grants with APS (*e.g.* SESAME, Energy School, the EPS/APS Landau Spitzer Award in plasma physics…). L. Cifarelli has contributed articles to APS magazines and newsletters *e.g. 'The Bologna Process: a voluntary harmonization of the European higher education system'*, APS NEWS (2012), and an article planned in 2013 in the FIP bulletin *'The importance of physics to the economies of Europe'*. The EPS will also participate in the APS Executive Board Retreat in June 2013, to examine issues 'to support the goal of greater global engagement'.

The EPS has been particularly active in organising the third Asia Pacific Physics Summit (ASEPS), which will take place on 14-19 July 2013 in Chiba, Japan as part of the 12th Asia

▼ The participents to the EPS Council Meeting held in the University of Strasbourg, April 2013

Pacific Physics Conference [APPC]. It will bring together researchers and policy makers from Asia, Europe and the US. Four plenary lectures will present the latest most exciting developments in physics research from around the world, and four roundtables will be organised, allowing for intense exchange of ideas on topics of particular interest for Asia - Europe cooperation.

Statements and Studies

Throughout 2012, the EPS issued studies and statements relating to physics. Notably, a statement *"On the use of bibliometric indices during assessment"*, as well as a statement on *"Research and education opportunities for innovation in Horizon 2020"* were issued and widely communicated. The Executive Committee examined and approved an important statement on physics education by the EPS Physics Education Division (PED).

In 2012, the EPS commissioned a report from the Centre for Economics and Business Research (CEBR) to examine the importance of physics in the economies of EU27 countries (plus Norway and Switzerland) over the period from 2007 - 2010. The report was completed in December 2012, and was finalized at the beginning of 2013. It was first presented to the EPS Council, and other high profile events are scheduled in 2013.

The economic analysis presented in the study of *"The importance of physics to the economies of Europe"* is aimed at EPS Members, the physics community and policy makers at all levels: national, Europe and global. It highlights that physics-based industry contributes €3.8 trillion to the EU economy, and provides 15.4 million jobs. Moreover, the study provides a clear definition of physics, and defines the contours of the physics-based industry.

The EPS responded to numerous EC consultations, for instance the ERA Framework Public Consultation on 'Areas of untapped potential for the development of the European Research Area', or the consultation on the Green Paper: *'Towards a Common Strategic Framework for EU research and innovation funding'*, or the one on *'Access to and preservation of digital information'*. (all available on www.eps.org)

▲ Left to right, D. Lee, Secretary General, L. Cifarelli, outgoing President and J. Dudley, new President of the EPS

Links with learned societies outside Europe have been strengthened, in Africa, Asia and Latin America. The EPS and the American Physical Society also cooperate in the field of physics for development with the SESAME grant initiative, and are considering common statements.

As a 'learned society', the electronic bulletin 'e-EPS' was launched, and is now distributed to over 40,000 subscribers. The new EPS website has just gone online, with new structure, layout, contents, facilities, *etc.* The number of EPS Individual Members and of Associate Members has increased since 2011 and this will also be a goal in 2013.

Divisions and Groups

The conferences of EPS Divisions/Groups continue to be outstanding, and they organised over 20 events in 2011, with more than 5,000 participants. Divisions and Groups are also active in awarding prizes in all fields of physics, and they awarded 10 prizes in 2012, recognising outstanding achievements in physics, contributions to the EPS, and promising young researchers. To strengthen the role of the EPS in the field of applied physics, the Technology and Innovation Group (TIG) has been reformed, and a TIG workshop was held in Erice (IT) on the projected R&D and technological innovations in physics research and potential spin-offs to society. Energy has also been central to EPS activities, with a successful second European Energy Conference in Maastricht (NL) in 2012, and plans to hold the third E2C in Budapest, in October 2013. Moreover the Joint EPS-SIF International School on Energy has been established, with a first course successfully held in Varenna (IT) in summer 2012. The next one is scheduled for 2014, in the same venue. Finally the EPS has undertaken a series of reorganizational steps, in particular concerning its committees. The staff and Secretariat have worked hard, under the guidance of the Executive Committee, to work towards the goals established in the Strategy plan 2010+. The EPS plans to continue efforts to increase its visibility and strengthen its impact.

Highlights 2012

In the area of physics education, the EPS published a series of documents looking at university studies in physics. The EC-funded study of the Bologna Reforms in Physics Studies was finalised, with the publication of the study of the implementation of the Bologna Reforms at the Doctoral level. The EPS also published *'Specification Descriptions'* for physics studies at the bachelor, master and doctoral levels, available at www.eps.org

The EPS was also a partner in two EC financed projects in the field of education and outreach. The first is "PATHWAY" - www.pathway-project.eu - which brings together partners in the field of science education. The project aims to study and propose a model derived from best practice for inquiry-based science education. The second project, "Odysseus" is a contest for young students. Under the guidance of their teachers, students will prepare projects revolving around one of three major themes in space science: Solar System; Spaceship – global cooperation; and the Co-evolution of life. The contest and the project aim to engage

and inspire the European youth in the "New Frontier". For more information and to participate:
www.eps.org/?page=odysseus
www.odysseus-contest.eu/?page_id=196
The EPS Quantum Electronics and Optics Division, under the leadership of John Dudley, has piloted the initiative to declare 2015 as the International Year of Light. After approval of the EPS Council (2010) and the IUPAP Council (2011), the UNESCO approved a resolution proposing an International Year of Light in 2015, which was adopted during the 190th Session of the UNESCO Executive Board in October 2012. The resolution was co-signed by an impressive list of nearly 30 nations. A formal request is now being prepared for the United Nations General Assembly in 2013. Not only will the IYOL be a good opportunity to promote physics, it will strengthen links to physics communities around the world, particularly in African and Latin American countries. A prospectus describing the IYOL is available at www.eps.org/resource/resmgr/activities/eps_iyol_2.pdf

The UNESCO approved a resolution proposing an International Year of Light in 2015

Open Access Roundtable

A Roundtable was organised during Council 2013, moderated by Professor Sir John Enderby. Participants with various interests and backgrounds exchanged their views on the evolving landscape of scientific publications. Professor Enderby opened the discussions by a presentation of the different interests in scientific publications: researchers, funders, librarians and information managers, publishers, small and medium enterprises, and the general public. The recent statements by governments on the implementation of open access [OA] constitute a major change in the paradigm of scientific publication.
Almost all of the learned societies involved in the debate are also scientific publishers, and they presented the challenges to face the economic transition from a subscription-based model to an "author-pays" model. For all learned societies income from publications is a non-negligible fraction of their budget, allowing the financing of other community building services.
All participants in the roundtable agreed on the complex situation in the domain, which intimately entangles the assessment of both researchers and their research funding proposals with their publication record, and many learned societies and academies have strongly advised against the exclusive use of numerical bibliometric data for evaluation.
There was a strong consensus that learned societies must work to find common ground on this subject in order to speak with a common voice. The active involvement and input from scientists (who play a central role in the publication process as authors, readers, and as referees) is to be encouraged in order to ensure that future publication models work in the best interest of all members of the community. The publication of a common statement is envisaged.
The participants at the roundtable, in alphabetical order were John Dudley, EPS president; Martin Huber, European Astronomical Society (EAS), and former chairman of the board of EPL journal; Daniel Kulp, editorial director, American Physical Society (APS); Bernd Pulverer, head of scientific publications (EMBO); Angela Oleandri, editorial manager of EPJ journals series founded by EDP Sciences, Società Italiana di Fisica (SIF) and Springer; Ulrich Schubert, president of the European Association for Chemical and Molecular Sciences (EuCheMS); Jacques-Henri Weil, board member of the Federation of European Biochemical Societies (FEBS)

Change of Presidents

John Dudley was welcomed as the President of the EPS. His term of office began in the morning of 6 April, and will run until the Council meeting in 2015.
The EPS Council sincerely congratulated Luisa Cifarelli for her outstanding achievements over the past 2 years as EPS President. She will remain on the Executive Committee as Vice-President until Council 2014.

Decisions

Council approved the following individuals as Honorary Members of the EPS:
- Sergio Bertolucci (Italy)
- Serge Haroche (France)
- Rolf Dieter Heuer (UK)
- Stephen Myers (Germany)

(more information: www.eps.org/directory/honorary-members)

Council approved the following individuals as fellows of the EPS:
- Halina Abramowicz (Israel)
- Dimitri Batani (Italy)
- Giovanni Ciccotti (Italy)
- Wolfgang Ernst (Austria)
- Albert Hofmann (Switzerland)
- Jean-François Joanny (France)
- Frédéric Merkt (Switzerland)
- François Peeters (Belgium)
- Angiolino Stella (Italy)
- Victor R. Velasco (Spain)
- Albrecht Wagner (Germany)

Council approved the award of the Gero Thomas Memorial Medal to Christine Petit Jean Genaz (Switzerland).

Invited Speakers

Rolf Heuer, CERN Director General, and Stephen Myers, Director for Accelerators and Technology at CERN, presented the research and technology that were essential to the discovery in July 2012 of a Higgs boson. R. Heuer, S. Myers and S. Bertolucci, Director for Research and Computing at CERN, were the joint recipients of the EPS Edison Volta Prize in 2012. For more information, please see: www.eps.org/?page=distinction_prize_ed
I would like to thank Thomas Ebbesen from ISIS for hosting the EPS Council in Strasbourg, the EPS President, L. Cifarelli and the EPS staff for their hard work and dedication for making this year's Council meeting a memorable experience. ■

David Lee
Secretary General of the EPS

The 2013 QEOD Major Prizes

EPS Quantum Electronics and Optics Division

The two most prestigious prizes of the EPS in Quantum Electronics and Optics are awarded only once every two years, and recognize the very highest level of achievements in applied and fundamental research in optical physics.

The 2013 awards were presented in a special plenary ceremony on 14 May 2013 during the Conference on Lasers and Electro-Optics Europe (**CLEO®/Europe**) and the International Quantum Electronics Conference (**IQEC**), held during the World of Photonics Congress in Munich, Germany.

Prize for Applied Aspects of Quantum Electronics and Optics: Federico Capasso

The 2013 Prize for Applied Aspects of Quantum Electronics and Optics is awarded to Professor Federico Capasso, Professor at the School of Engineering and Applied Sciences, Harvard University, MA, USA. The Prize is awarded to Professor Capasso *"For seminal contributions to the invention and demonstration of the quantum cascade laser"*. F. Capasso is the Robert Wallace Professor of Applied Physics at Harvard University, which he joined in 2003 after 27 years at Bell Labs where he was Member of Technical Staff, Department Head and Vice President for Physical Research. His research has focused on nanoscale science and technology encompassing a broad range of topics including band-structure engineering of semiconductor nanostructures and quantum devices, the investigation of attractive and repulsive Casimir forces, plasmonics and flat optics based on metasurfaces. He is a member of the National Academy of Sciences, the National Academy of Engineering and a fellow of the American Academy of Arts and Sciences. His awards include the IEEE Sarnoff Award in Electronics (1991), the Materials Research Society Medal (1995), the Wetherill Medal of the Franklin Institute (1997), the Rank Prize in Optoelectronics (1998), the Optical Society Wood Prize (2001), the IEEE Edison Medal (2004), the APS Arthur Schawlow Prize in Laser Science (2004), the King Faisal Prize (2005), the Berthold Leibinger Zukunft Prize (2010), the Julius Springer Prize in Applied Physics (2010), the Jan Czochralski Award for lifetime achievements in Materials Science (2011), and the SPIE Gold Medal (2013).

Prize for Fundamental Aspects of Quantum Electronics and Optics: Maciej Lewenstein

The 2013 Prize for Fundamental Aspects of Quantum Electronics and Optics is awarded to Professor Maciej Lewenstein, ICREA Research Professor and Head of the Quantum Optics Theory Group at The Institute of Photonic Sciences (ICFO), Barcelona, Spain. It is awarded to M. Lewenstein *"For outstanding contributions to several areas of theoretical quantum optics and to the use of quantum gases for quantum information and to attosecond optics."*

M. Lewenstein obtained his PhD in physics from Universität Essen and Center for Theoretical Physics (CTP)

◂ Left to right: Luc Bergé, Federico Capasso Markus Pollnau

▸ Left to right: Luc Bergé, Maciej Lewenstein Markus Pollnau

in Warsaw. He continued research at CTP until 1984, finishing his habilitation in 1976, and obtaining the Professor title in 1993. M. Lewenstein was a research associate of Prof. R.J. Glauber at Harvard from 1986 till 1989. He was a Visiting Fellow at JILA and ITAM in 1993 and 1994. In 1995 he became faculty member at CEA-Saclay, France, and in 1998 he accepted the Professor chair at the G. W. Leibnitz Universität Hannover. He finally became ICREA Professor and Head of the Quantum Optics Theory group at ICFO, Barcelona, Spain. His research focuses on atom, molecular and optical physics, from attosecond physics to physics of ultracold matter, quantum information, as well as mathematical and statistical physics. Maciej Lewenstein is a Fellow of APS (2004), recipient of Senior Humbold Award (2007), ERC Advanced Grant 2008, Prize of the Foundation for Polish Science (2010), Hamburg Theory Prize of Hamburg University/J. Hertz Foundation, Gutenberg Prize of the Gutenberg Research College of Mainz University (2013).

Background Information on EPS-QEOD

The European Physical Society provides an international forum for physicists and acts as a federation of national physical societies. Founded in 1968, the EPS plays a leading role in both scientific and policy activities within the community of European physicists. The Quantum Electronics and Optics Division (QEOD) of the EPS acts as a focal point for European research in optics and photonics through its wide range of strategic activities, sponsorship and conference organisation. In addition to the major awards described above, it also awards Young Researcher (Fresnel) and PhD Student Prizes. These will be in http://qeod.epsdivisions.org

Immanuel Bloch and Luc Bergé,
Chairman and Secretary of Quantum Electronics and Optics Awards Committee 2013
immanuel.bloch@mpq.mpg.de and luc.berge@cea.fr

EPL: Giorgio Benedek succeeds Michael Schreiber

May 2013. After his regular three years term Michael Schreiber (Institut für Physik, Technische Universität Chemnitz, Germany) leaves EPL as the Editor in Chief. In future he will act as an Advisory Editor. Our new Editor in Chief for the next three years is Giorgio Benedek (Dipartimento di Scienza dei Materiali, Università degli Studi di Milano – Bicocca, Milano Italy).

EPL is the broadband letters journal exploring the frontiers of physics. Its authors and their topics cover all fields of physics (all categories of the *Physics and Astronomy Classification Scheme*, PACS)[1]. EPL is published under the scientific policy and control of the European Physical Society (EPS) by Edition Diffusion Presse Sciences (EDP Sciences), the Institute of Physics Publishing (IOPP) and by the Società Italiana di Fisica (SIF) for the Europhysics Letters Association (EPLA) – a partnership of 17 European Physical Societies.

Beside the Editor in Chief, and the Executive Editor Graeme Watt (IOPP), the Staff Editor Frédéric Burr, and the Business Manager David Lee (both EPS) the most important personalities for the high quality peer review and publication process are the **Co-Editors.** Presently EPL has 51 Co-Editors. All of them are active physicists of high standing. They are carefully selected by the Editor in Chief from research institutions in European countries as well as in countries beyond Europe (presently: Brazil, China, India, Israel, Japan, Russia, Singapore and USA). A Co-Editor selects both the number and the names of the **Referees** for a manuscript which has been submitted to EPL, and finally decides whether a manuscript is accepted for publication or rejected. Co-Editors can moreover recommend that excellent letters receive the mark 'Editors Choice', and the Editor in Chief has the option to offer free 'Open Access' privileges to authors of truly outstanding articles.

▲ Left: Giorgio Benedek Right: Michael Schreiber

The total number of submissions for 2012 was 2,130. They arrived from 47 countries with a geographical distribution (by corresponding author) of Asia: 53%; Europe: 33 %; North America: 7%; rest: 7%. The 977 published articles have a different focus of Europe: 47%; Asia: 36%; North America: 10%; rest: 7%.

NOTE

[1] PACS:

00	General
10	The Physics of Elementary Particles and Fields
20	Nuclear Physics
30	Atomic and Molecular Physics
40	Electromagnetism, Optics, Acoustics, Heat Transfer, Classical Mechanics, and Fluid Dynamics
50	Physics of Gases, Plasmas, and Electric Discharges

The medians submission-to-accept time were 67 days and accept-to-online time 33 days. For the fast tracking of 83 exceptional articles published in 2012 the submission-to-online time was 38 days. The total sales order represents to over 2,620 institutions. The average number of downloads per article published increased from 135 in 2011 to 153 in 2012. The total number of downloads in 2012 reached 647,228 and were sought from over 100 countries; among them 18% from North America and 16% from China.

On behalf of the Board of Directors of the Europhysics Letters Association I thank Michael Schreiber and the Co-Editors, and also Graeme Watt, Frédéric Burr and David Lee for their successful work to improve both prestige and quality of EPL in the past three years.

Also on behalf of the Board of Directors I welcome Giorgio Benedek as our new Editor in Chief. He is a Full Professor of Structure of Matter since 1986 and a very successful condensed matter physicist. His research areas cover the Physics of low dimensional physics: surface dynamics and spectroscopy, cluster materials and supersonic jets as well as physics of quantum solids. His list of publications comprises more than 350 articles in peer reviewed journals, books, book-chapters and international school proceedings. Since more than 30 years Professor Benedek cultivates permanent and fruitful collaborations with foreign colleagues. He received several high rank and international Honors and Awards, and he has broad experiences in physics publishing processes of several well-known physics journals, for example as Co-Editor (1995 – 2002) and Advisory Editor (2002 – 2005) of EPL.

I personally wish our new Editor in Chief to be successful in further improving both the quality and the prestige of EPL. To him and to the Co-Editors I recommend raising the rejection rate in order to select and publish more and more only those physics letters in EPL, which have a good chance to be read and cited by colleagues exploring the frontiers of physics, worldwide. I also wish Giorgio and the Co-Editors good luck in spying out new fields in physics research, which have the potential of growth. And personally I recommend trying to raise the fraction of articles from experimental physics in order to balance theory and experiment.

The 17 Physical Societies of the Europhysics Letters Association should be proud to own EPL as the broad band, peer reviewed physics letters journal, the quality of which is equal to the very few top physics letters journals worldwide. Physicists from all over the world are invited to publish their top results in EPL.

The total number of downloads in 2012 reached 647,228 from over 100 countries

Good luck and success, Giorgio! ■

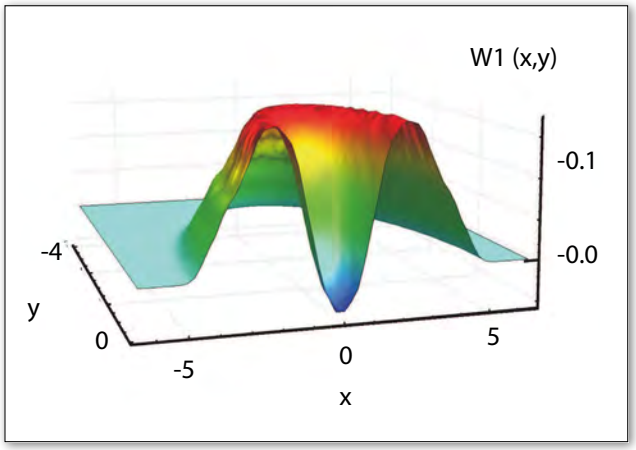
Prof. Markus Schwoerer,
Chairman of the Board of Directors of the Europhysics Letters Association (EPLA), Universität Bayreuth, D-95440 Bayreuth (DE)

Highlights from European journals

QUANTUM PHYSICS

High-fidelity single photons

Many quantum technologies—such as cryptography, quantum computing and quantum networks—hinge on the use of single photons. In the present paper, the authors have identified the extent to which photon detector characteristics shape the preparation of a photon source designed to reliably generate single photons. They determined the value of key source parameters that are necessary to generate high-fidelity single photons.



▲ High fidelity single photons are crucial for quantum technologies

The problem with photon detectors is that they can be noisy or have a limited ability to detect single photons. Some cannot identify the number of photons; they can only detect their presence. Given the influence of these factors, improving the fidelity of single-photon generation is very challenging.

Single photons are typically generated using two laser beams that are correlated at the quantum level. This means that the detection of a single photon in the first beam heralds the generation of a single photon in the second one.

The authors simulated which photons would be obtained from different initial sources. This led to outline the conditions under which the heralding detector can deliver good resolution of the number of photons, as a means of improving the reliability in obtaining single photons. Using two experimental detectors checked these findings. ■

■ **V. D'Auria**, **O. Morin**, **C. Fabre** and **J. Laurat**, 'Effect of the heralding detector properties on the conditional generation of single-photon states', *Eur. Phys. J. D* **66**, 249 (2012)

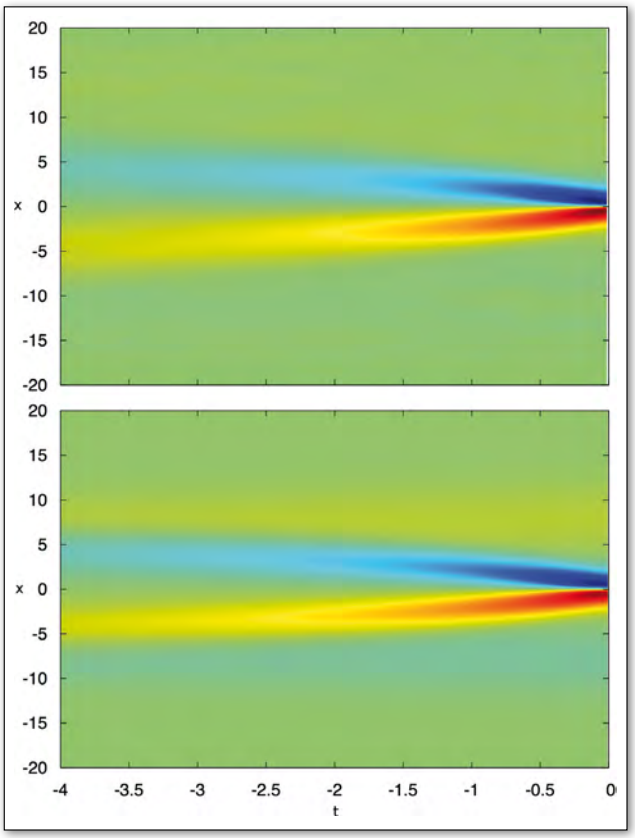
STATISTICAL PHYSICS

Instanton filtering for **the stochastic Burgers equation**

Extreme events in stochastic nonlinear systems play an essential role in nature. Characterizing their likelihood is a fundamental albeit challenging problem since the tails of the underlying probability distributions are usually non-Gaussian and governed by saddlepoints of the corresponding path integrals, so-called "instantons".

Understanding intermittency in turbulent systems is still one of the open problems in classical physics. Since intermittency is governed by the non-Gaussianity of rare fluctuations, instantons might offer a way to better understand the behaviour of turbulent systems. In the present work we concentrate on rare fluctuations in Burgers turbulence and we address the question whether one can identify instantons in direct numerical simulations of the stochastically driven Burgers equation. This is of special importance since this demonstrates that instantons indeed form the skeleton of rare turbulent fluctuations. For this purpose, we first solve the instanton equations

▼ Comparison of the filtered velocity field (new direct method, top) and the instanton field (Chernykh-Stepanov method, bottom) as a space-time contour plot



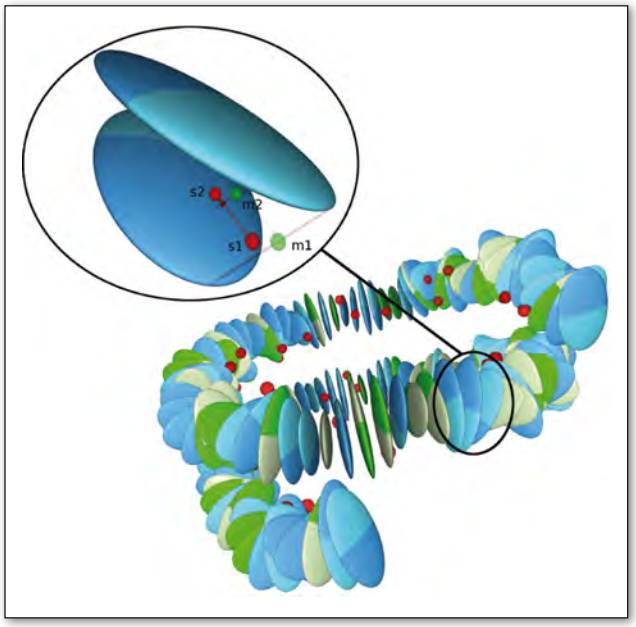
using the Chernykh-Stepanov method [*Phys. Rev. E* **64**, 026306 (2001)]. These results are then compared to direct numerical simulations by introducing a filtering technique to extract prescribed rare events from massive data sets of realizations. Using this approach we can extract the entire time history of the instanton evolution, which allows us to identify the different phases predicted by the direct method of Chernykh and Stepanov with remarkable agreement. ■

▮ **T. Grafke**, **R. Grauer** and **T. Schäfer**, 'Instanton filtering for the stochastic Burgers equation', *J.Phys.A: Math. Theor.* **46**, 062002 (2013)

BIOPHYSICS

How proteins read **meta DNA code**

T-Scientists have for the first time accurately calculated the sliding mechanism for deciphering the second genetic code written within the DNA base pair sequence.



▲ Schematic representation of the model

Three quarters of the DNA in evolved organisms is wrapped around proteins, forming the basic unit of DNA packaging called nucleosomes, like a thread around a spool. The problem lies in understanding how DNA can then be read by such proteins. In the present paper, the authors have created a model showing how proteins move along DNA.

A basic computer model of the nucleosome is developed, in which DNA is described by a sequence of rigid blocks representing the base pairs. The idea is that a small defect in the form of a missing or extra base pair enters the DNA section wrapped around a nucleosome. This defect can then diffuse through the wrapped DNA and once it leaves the other end of the wrapped section, the nucleosome moves by the extra or missing length that the defect carried with it.

This model supports the idea of a second genetic code, consisting of a mechanical code written down within the base pair sequence and multiplexed with the traditional genetic code. ■

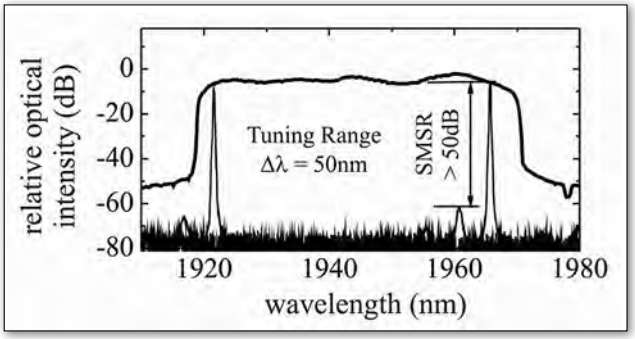
▮ **A. Fathizadeh**, **A. Berdy Besya**, **Mo. Reza Ejtehadi** and **H. Schiessel**, 'Rigid body molecular dynamics of DNA inside a nucleosome', *Eur. Phys. J. E* **36**, 21 (2013)

APPLIED PHYSICS

Laser detectors of possibly toxic gases

It is the increasing demand of safety at work and also at home, which acts as the driving force for new developments in nanotechnology and laser physics. Hazardous and toxic gases are representing maybe the most severe risk as being invisible, fast, deleterious and partially lethal in its effect. Handheld systems, which can be used for the on-site detection of these gases, are of huge interest these days. With the present Surface Micro Machined (SMM) Micro-Electro-Mechanical-System Vertical-Cavity-Surface-Emitting-Lasers (MEMS VCSEL) devices, the key technology for these systems has been realized. VCSELs are vertically emitting laser devices with extremely low thresholds but sufficiently high optical output power for gas sensing applications. A monolithically integrated membrane as top reflector on every single VCSEL device (described by the acronym MEMS) serves as deflectable element, which can be actuated both electro-thermally and electro-statically. The generated air-gap underneath can be continuously changed by this technique and hence the emission wavelength. This enables continuous scanning over specific gas absorption lines. The present lasers are the first widely tunable ones in this wavelength range. Devices with 50 nm of continuous tuning, 50 dB of side mode suppression ratio (30 dB would already be sufficient for sensing

▼ Envelope function and two spectra illustrating the continuous tuning range of the realized single mode SMM VCSEL structures.



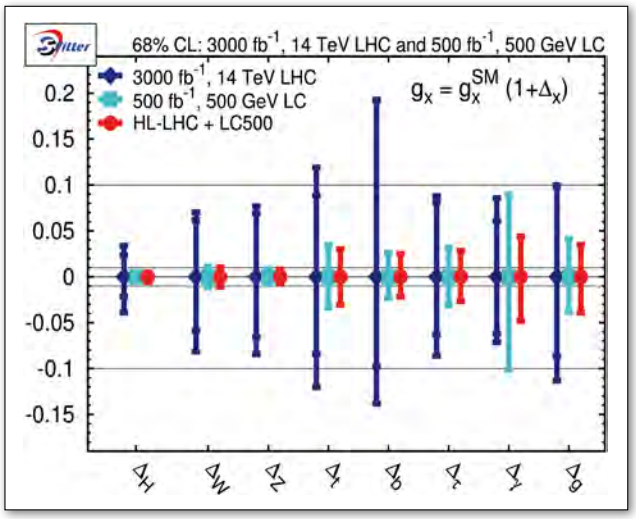
applications), peak optical powers of 1 to 2 mW and extremely low threshold current densities of 2.2 kA/cm^2 are perfect for this application. ■

▮ **T. Gruendl** and **10 co-authors**, '50 nm continuously tunable MEMS VCSEL devices with surface micromachining operating at 1.95 µm emission wavelength', *Semicond. Sci. Technol.* **28**, 012001 (2013)

PARTICLE PHYSICS

Measuring Higgs couplings at a linear collider

In 2012 the experiments ATLAS and CMS discovered a new particle in proton-proton collisions at CERN's Large Hadron Collider (LHC). The measurements show that the properties of the particle are compatible with those predicted for the Higgs boson of the Standard Model.



▲ Expected precision for Higgs coupling measurements for the HL-LHC, ILC and the combination of the HL-LHC and the ILC.

In the article we estimate the precision with which some of the fundamental properties of the particle, its couplings to other particles, can be measured including theoretical errors, at a high-luminosity LHC (HL-LHC), a linear electron-positron collider and the combination of the two. The uncertainties are expected to be better than 1% for a single parameter modifying all Higgs couplings simultaneously, and at the percent level if all relevant couplings are left free and independent of each other. The combination of the measurements at the two machines improves on the uncertainty of each one of these. Thus a HL-LHC and a linear collider form a dream team to study the properties of the Higgs boson with high precision. ■

▮ **M. Klute**, **R. Lafaye**, **T. Plehn**, **M. Rauch** and **D. Zerwas**, 'Measuring Higgs couplings at a linear collider', *EPL* **101**, 51001 (2013)

CONDENSED MATTER

Gauge theory of topological phases of matter

Topologically protected states of matter are the focus of recent intensive research efforts. Such states may play an important role in future concrete implementations of devices for topological quantum computing. Prominent examples are incompressible 2D electron gases exhibiting the Quantum Hall effect or the spin Hall effect, 3D topological insulators and superconductors, *etc.* From a conceptual point of view it is important to note that the low-energy effective theories describing all these states can be derived, using only very general principles, from a unified theoretical framework which we have called *"gauge theory of states of matter"*.

A key idea underlying our framework is to promote fundamental or emergent global symmetries of idealized systems to local gauge symmetries of realistic systems, and to then study the response of such systems under variations of the corresponding gauge fields. For systems with a bulk energy gap, our theory predicts the general form of the response laws, transport equations, and the structure of gapless surface modes. It also elucidates how the structure of the ionic background, electromagnetic fields, velocity fields and curvature influence the properties of such systems. ■

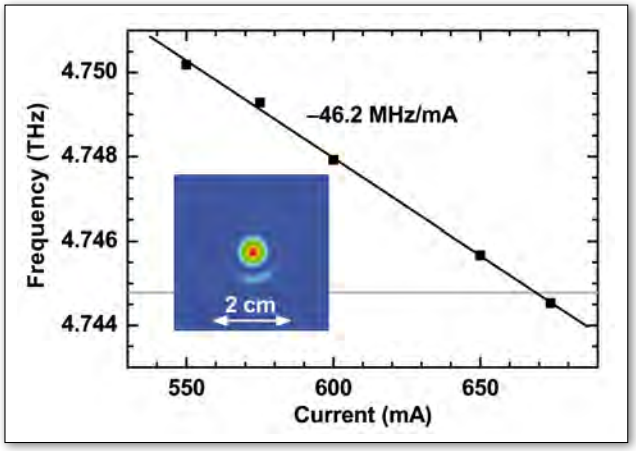
▮ **J. Fröhlich** and **P. Werner**, 'Gauge theory of topological phases of matter', *EPL* **101**, 47007 (2013)

APPLIED PHYSICS

A customized THz quantum-cascade laser

Quantum-cascade lasers for the terahertz spectral region are promising light sources for several spectroscopic applications, despite currently only operating at cryogenic temperatures. The authors developed a local oscillator to be used in an airborne heterodyne receiver for the investigation of interstellar atomic oxygen. The challenge for the design consists in the simultaneous fulfilment of demanding specifications for a set of operating parameters.

The developed laser emits a single mode with an optical power of about 0.5 mW and an almost Gaussian beam shape. The laser mode can be tuned using the applied current to cover about 5 GHz in the vicinity of 4.745 THz. The local oscillator, which is based on a distributed-feedback laser combining a quantum-cascade laser with a single-plasmon waveguide and a lateral first-order grating, can be operated in a cryogen-free cooler in continuous-wave mode. The developed quantum-cascade laser exhibits large



▲ Frequency tuning using the applied current and beam profile of the local oscillator. The gray horizontal solid line indicates the frequency of the oxygen line.

wall-plug efficiency over a wide range of current densities with a negligible spectral shift of the gain maximum in order to achieve the required tuning range. ■

▮ **L. Schrottke**, **M. Wienold**, **R. Sharma**, **X. Lü**, **K. Biermann**, **R. Hey**, **A. Tahraoui**, **H. Richter**, **H.-W. Hübers**, and **H. T. Grahn**, 'Quantum-cascade lasers as local oscillators for heterodyne spectrometers in the spectral range around 4.745 THz', *Semicond. Sci. Technol.* **28**, 035011 (2013)

MATERIAL SCIENCE

Unlocking **fuel cell conductivity**

Yttria stabilized zirconia, also known as YSZ, is a material of great interest because of its relatively high oxygen-ion based conductivity. In particular, it finds applications in electrochemical devices, such as solid oxide fuel cells and oxygen sensors. The present work developes a model of the oxygen-ion dynamics contributing to the conductivity of YSZ.

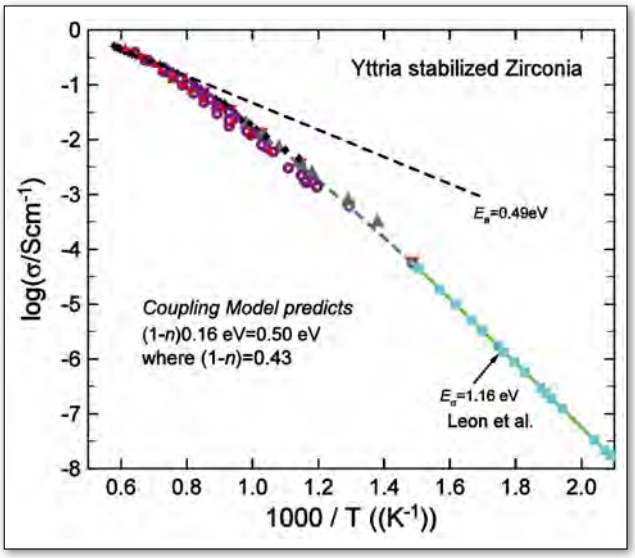
The problem is that fuel cells currently operate above 700 °C, which strongly limits their use. Understanding oxygen-ion diffusion is key in helping lower operating temperature towards ambient. Previous attempts to do so were done with the so-called coupling model (CM), describing simple physical concepts related to ion-ion interaction. This helped uncover the importance of ion-ion correlation in limiting long-range ion mobility, and thus conductivity.

The trouble is that experiments show that ionic conductivity in YSZ requires an activation energy that is much higher than that supplied by computer simulations describing independent ion hopping. Relying on the CM model, the authors first established a quantitative description of the ion dynamics in YSZ. Then they compared the predictions of the CM with experimental results and with simulations, particularly those of nanometric-scale thin films, published in the last ten years.

Thus, the present model establishes the connection between the level of the energy barrier for independent ion-hopping simulations and the level of activation energy of long-range oxygen ions measured experimentally. This model could also be used to study the conductivity relaxation of so-called molten, glassy and crystalline ionic conductors and ambient temperature ionic liquids. ■

▮ **K.L. Ngai**, **J. Santamaria** and **C. Leon**, Dynamics of interacting oxygen ions in yttria stabilized zirconia: bulk material and nanometer thin films', *Eur. Phys. J. B* **86**, 7 (2013)

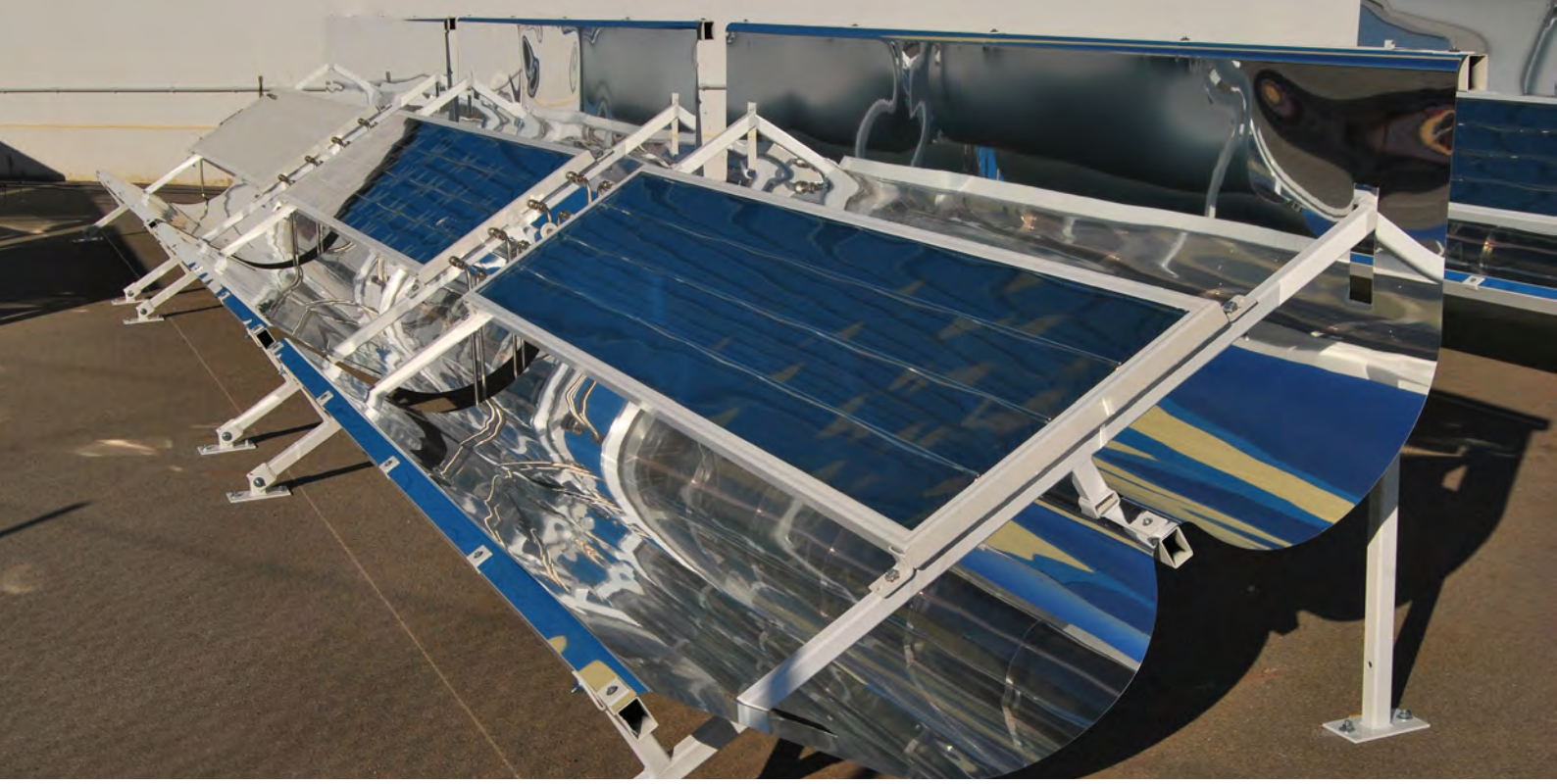
▼ Temperature dependence of conductivity data of bulk YSZ.



EPS VOLTA PRIZE LAUREATES

The detailed presentation of the Volta prize and of its first laureates will be published in the next issue of Europhysics News.

The laureates are:
Steve Myers, *CERN Director for Accelerators and Technology,*
Rolf Heuer, *CERN Director General,*
Sergio Bertolucci, *CERN Director for Research and Computing.* ■



THE SRB SOLAR THERMAL PANEL

C. Benvenuti – SRB Energy, c/o CERN – 1211 Genève 23, Switzerland – DOI: 10.1051/epn/2013301

Can one build a solar thermal collector which reaches 400 °C even without using focusing mirrors? Yes we can, says SRB Energy, a company aiming at industrially producing a flat panel solar collector patented at CERN in 2003. The distinctive feature of this collector is the high efficiency achieved thanks to the vacuum maintained by a getter pump powered by the sun.

▲ View of the SRB solar thermal panel with cylindrical mirrors

The mechanical design of the panel [1] is shown schematically in Fig. 1. It consists of a metal frame sealed on both sides by glass windows, allowing solar radiation to enter at either side. The resulting box contains blackened copper heat absorbers which capture the solar energy. The absorbers are laser welded to stainless steel pipes which allow the heat to be extracted by circulating a fluid. These features are common to any flat solar thermal panel. The distinctive feature of the SRB panel is that it is under vacuum.

Evacuated flat-plate panels were not produced so far because a vacuum-tight connection between large glass windows and the metal structure of the panel presents an (almost) insurmountable difficulty. The SRB solution to this problem consists of a plasma-sprayed metal coating on the glass perimeter, on which a metal joint may then be fixed by soft soldering.

When the panel is under vacuum, the atmospheric pressure applies a force of 10 N/cm^{-2} on the panel windows, resulting in a weight of many tons for a medium-size panel. This force would lead to implosion of the panel if not properly supported. The spacing between the supports depends on the glass type and thickness. The SRB panel makes use of tempered glass 5 mm thick and longitudinal supports spaced by 14 cm, resulting in an implosion pressure of 2.5 bar.

The absorbers are coated with a selective coating, to efficiently absorb the incident sunlight while providing low emission in the infrared range (*see optical characteristics*). High vacuum is maintained throughout the panel life of 30 years by a getter pump driven by solar energy (*see vacuum considerations*).

Optical characteristics

Both the pump and the absorbers are blackened electrolytically with a layer of Cr oxide which provides an absorption coefficient of about 0.9 and an infrared emissivity at 300°C below 0.07. This coating is stable when

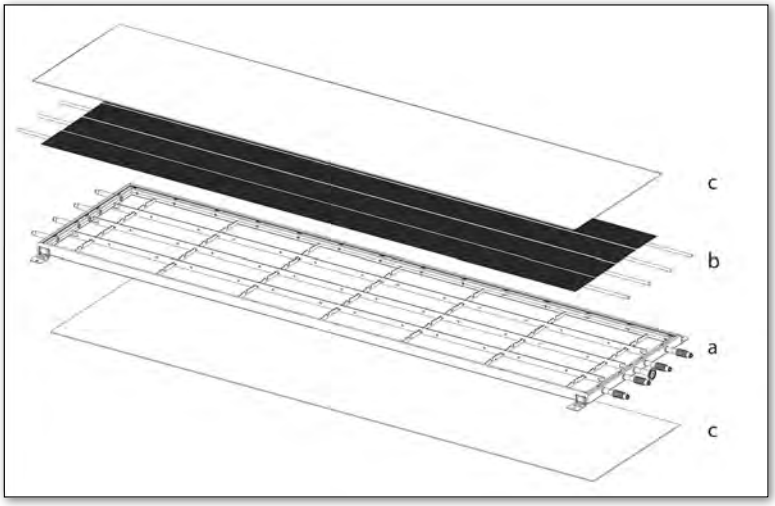
heated under vacuum at 450°C for months or in case of an accidental air inlet during operation.
Although mirrors are not needed to reach high temperatures, the SRB panel can be equipped with cylindrical mirrors which reflect diffuse and direct light equally well onto the back of the panel, and do not require sun tracking. Parabolic mirrors – which do need sun tracking – are not suitable for diffuse light, which may exceed 50% of the total in regions like Central Europe. Use of the cylindrical mirror almost doubles the absorbed power, while the panel cost is only marginally increased.

Vacuum considerations

Vacuum is the best thermal insulator provided by nature. In a traditional thermal solar panel, conduction and convection through the ambient air results in large thermal losses, which limits the panel temperature and the range of applications. By evacuating the panel, thermal losses are reduced dramatically, thus increasing the panel efficiency. When an SRB panel is exposed to sun light while being in vacuum, its temperature is limited only by emission losses through infrared radiation. If the pressure is progressively increased, the temperature does not change until about 10^{-4} mbar, and then it drops quickly due to molecular conduction and becomes constant after reaching 10^{-1} mbar. Therefore, the pressure inside the solar panel must be kept below about 10^{-4} mbar during the lifetime of the panel to keep the molecular conduction losses negligible with respect to the radiation losses.
In any sealed device, after initial evacuation of the atmospheric air, vacuum must be maintained by pumping the gases desorbing from the device components. Since about a century this is done by getters, which are materials able to chemically adsorb reactive molecules in the form of stable compounds. In this process the gas molecules are removed from the vacuum chamber, and the getter surface is progressively covered until its pumping capacity vanishes. The attractive property of Non Evaporable Getters (NEG) is the possibility of restoring the lost pumping capacity by heating. Heating provides the energy required for the gases adsorbed on the surface to diffuse into the getter bulk. The surface is then available for further pumping. However, when most of the NEG atoms have reacted with gas molecules, the pumping action gets finally lost. For this reason the quantity of NEG inserted in the solar panel must be tailored to the total quantity of gas to be pumped during the panel life (30 years). This requires the panel to be constructed with the usual precautions for ultrahigh vacuum (UHV) applications, although the vacuum required does not need to meet UHV standards. Outgassing rates of materials may vary by more than 10 orders of magnitude, but the pumping capacity cannot be increased in the same proportion. Therefore, organic materials cannot be used, and the surfaces of the vacuum system components must be carefully cleaned.
As a by-product of the constraint of maintaining the required vacuum over the panel life, the pressure is initially lower than strictly needed (*see Panel performance*).
Apparently these considerations are not always taken into account sufficiently by the manufacturers of cylindrical evacuated solar panels, whose performance is often spoiled by vacuum deterioration [2].
NEGs were used for the first time to provide the large and linear pumping required for accelerators in the Large Electron Positron collider at CERN [3]. To cope with the requirements of the subsequent CERN accelerator (the Large Hadron Collider), NEG thin film coatings were developed [4], a technology covered by CERN patents and widely used in other projects since.
The getter used for the panel consists of a thin film deposited on both sides of an aluminium foil by means of a dedicated sputtering system, which may produce about 150 m^2 of coated foil per week. The coated foil is inserted in a box coated by the same chromium black used for the panel absorbers. The absorbed sun light provides the heating of the box needed to regenerate the NEG.
Vacuum leaks were not mentioned so far. Leaks are an intrinsic danger for any vacuum system, and a correct design may at best reduce this risk to an acceptable level. Since the size of a leak cannot be predicted, the risk of leaks cannot be taken into account when dimensioning the pumps. However, an upper limit of the tolerable leak size may be obtained by comparing the quantity of gas entering from a leak with that resulting from degassing. In the present case a leak of the order of 10^{-8} mbar.l.s^{-1} would not appreciably affect the panel performance during 30 years.

Panel performance

The thermal efficiencies of the bare panel and of the panel equipped with cylindrical mirrors are shown in Figs. 2 and 3. The low-temperature performance of the bare panels is slightly higher than those equipped with mirrors, due to the non-ideal mirror reflectivity. At high temperatures, however, the mirrors provide higher efficiencies thanks to the increased power absorbed.



▼ **FIG. 1:** Schematic view of the SRB solar panel. a: frame with spacers; b: absorbers with cooling pipes; c: glass windows. The panel is 3 m long and 70 cm wide. The panel thickness is 45 mm.

When mirrors are used, an efficiency of about 45% is reached at 200°C for maximum solar power, and over 40% at 100°C for a solar power of only 200 W/m^2.

The pressure inside the panel is in the 10^{-7} mbar range just after panel sealing, and is later strongly dependent on the temperature of the absorbers. The higher this temperature, the larger the degassing and the pressure. At 350°C the pressure reaches the 10^{-6} mbar range, while during cold winter nights it may even go down below 10^{-9} mbar. These vacuum conditions did not change in some panels during the 3 years following their production.

"Cylindrical mirrors reflect diffuse and direct light equally well onto the back of the panel"

Applications

The SRB panel is very versatile: it may be used to produce heat at temperatures up to 250°C, and the heat may be used also for refrigeration by means of a cooling-cycle machine. Obviously, in sunny, hot countries also less sophisticated solar panels could be used for low-temperature applications. In cold countries, however, the SRB panel provides much higher efficiencies, plus the important benefit of being insensitive to the external temperature, thanks to its vacuum barrier.

More generally, the SRB panel represents the best choice to produce heat for industrial processes up to 250°C (particularly in countries characterized by an important percentage of diffuse light), or to drive a cooling-cycle machine in hot countries.

These panels were already used, for instance: by a pharmaceutical industry in Spain for production cooling; to keep bitumen at 180°C in the Geneva area; to provide heating and air conditioning for the Geneva Airport. This last project, with a solar field covering an area of about 1200 m^2, is described in detail on the WEB [5].

When equipped with Fresnel mirrors, the panel could also produce electricity. This application, however, faces competition of the photovoltaic technology, the cost of which is steadily decreasing. ■

▼ **FIG. 2:** Bare-panel efficiency as a function of operating temperature for different incident solar powers. In this case the panel absorbers are blackened only on the side exposed to sun.

▶ **FIG. 3:** Same as for Fig. 2, now for panels equipped with cylindrical mirrors. These mirrors are equally efficient for the direct and diffuse sun light reflected onto the back side of the panel. The absorbers are blackened on both sides in this case.

Acknowledgments

SRB Energy belongs to the Grupo Segura, a Spanish company active in the automotive sector and employing about 500 people, with production factories in Spain and Hungary. The SRB panels are produced at Almussafes, close to Valencia (Spain) while the development laboratories are located on the CERN site close to Geneva (Switzerland). The SRB panel is an industrial reality thanks to the competence and the commitment of the Geneva and Valencia SRB staff.

About the author

Cristoforo Benvenuti was born in Milano in 1940. After graduating in physics in 1963 and a fellowship at the Ispra Research Center, he joined CERN in 1966, to work initially in Vacuum technology, later in Materials technology and finally as head of the Accelerators Engineering Service.

He received various awards for technological achievements: the 1998 European Prize for Achievement and Innovation in the Accelerator field, and the 2002 Gaede Langmuir Award of the American Vacuum Society.

After retiring from CERN in 2005 he created SRB Energy with private investors. SRB is a company aimed at producing and commercializing an evacuated thermal solar panel which he had patented while being at CERN in 2003.

References

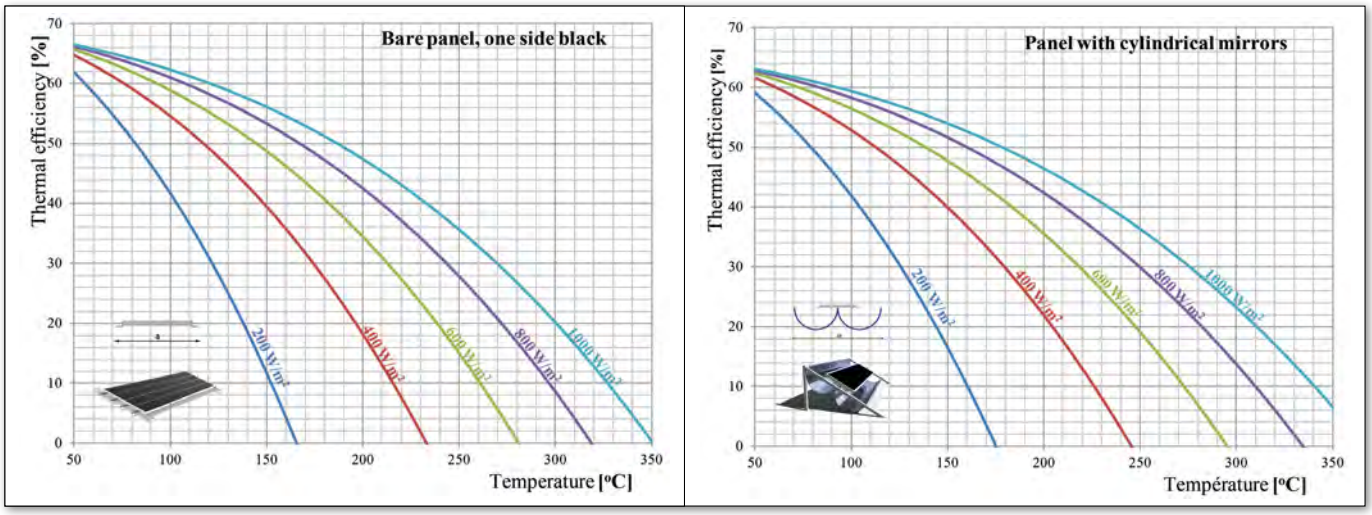
[1] C. Benvenuti and V. Ruzinov, *Proc. ECOS* 2010, June 14-17, Lausanne, Switzerland 2010, 2, p. 429

[2] A.W. Badar, R. Buchholz, F. Ziegler, *Solar Energy* **85**, 1447 (2011)

[3] C. Benvenuti, *Nuclear Instruments and Methods* **205**, 391 (1983)

[4] C. Benvenuti et al, *Vacuum* **60**, 57 (2001)

[5] www.youtube.com/watch?v=qyFZv1gWh4c&feature=youtu.be



by Jacques Roturier - Bordeaux, France - jacquesroturier@orange.fr - DOI: 10.1051/epn/2013302

Unlearned lessons from a forgotten crisis

Through this letter I like to give the readers of Europhysics News a brief flashback to October 1973, now 40 years ago. I am referring to the OPEC oil embargo, also known as the first oil crisis. Up to then, energy resources seemed unlimited and so cheap that the annual growth in Gross Domestic Product (GDP) and energy demand were nearly identical: about 5 % a year, *i.e.*, doubling every 15 years. That embargo had an immediate and negative impact on the world economy. Its message – underlined a few years later by the Iran revolution – was this: energy will no longer be supplied at a non-negligible price. In fact, that price increased by an order of magnitude during the 1973-1983 decade.

As a result, a new paradigm in energy policy was born: "Energy Conservation". Commonly known as one of the most fundamental laws of physics, the term now specified the OECD countries' new Energy Policy, aimed at reducing energy vulnerability. It focused mainly on the Supply-Side (save the oil reserves), while the Demand-Side (save energy) got much less attention in general. However, in two OECD countries, Sweden and Switzerland, the energy policy has been mandatorily driven by Demand-Side technology and legislation. Various measures concerning energy efficiency and energy savings were successfully implemented. As a result, the GDPs and the energy demand were no longer similar: the former grew by 20% while the latter remained unchanged over the decade.

Many concerned physicists worldwide decided to meet the challenge, either by redirecting their own activity or by creating new labs. Many became Supply-Side (nuclear or renewable) experts. However, the Demand-Side part of energy conservation got little attention, also among physicists. From my own analysis during the last three decades, most workshops and schools on energy issues[1] focus on the Supply Side, while the Demand Side remains underexposed. Yet, several experts in the field of energy conservation do exist, and in particular I wish to acknowledge our colleague, Professor Arthur H. Rosenfeld from the Lawrence Berkeley National Laboratory (LBL), widely recognised as the Godfather[2] of the field. In October 1973 he moved, in one night, from Particle Physics to create LBL's 'Center for Building Science' (now EETD - Environmental Energy Technologies Division). Being the first Energy Conservation lab worldwide, EETD was rapidly regarded as an important player, both within the US and by the International Energy Agency. During 1980's and 1990's, many European physicists had the privilege to establish Energy-Efficiency R-D collaborations with Rosenfeld, not to forget the Ecocampus initiatives.

Today, each new technology is expected to be more energy-efficient than the previous one. For the general public – which has only limited knowledge of underlying technology – advertisements and labels are often the only source of information, which is quite annoying from a physicist's point of view. Could our community be of any help? May I then call for a first step: more related papers in Europhysics News? Moreover, some energy systems and materials claim to decrease the user's energy or environmental footprint. May I naïvely ask a second question: when in use, is their energy balance always positive? Of course, Life-Cycle Assessment methods yield a cost/benefit energy analysis of a single piece of equipment. For complex systems however (*e.g.*, 'zero-energy buildings', 'green cars'), this is much more difficult and less accurate. In such situations, I guess that the physicist's know-how could be more systematically called upon.

In addition, our community could demonstrate to students the energy-efficient and environmentally safe policies of their workplace. Actually, following the 1990's very modest Ecocampus initiatives, a growing list of Green Campuses is now resulting from the increasing awareness and concern. The University of Copenhagen[3], where the 'demand from students in a University strategy process taking place' was one of the reasons for such an involvement, is a perfect example.

Finally: the Energy Conservation paradigm, being however nothing but a "cost-of-oil-barrel" fluctuating policy, was quite appropriate 30-40 years ago. Bearing in mind all 21st century energy challenges (climate change, sustainability, nuclear accidents, geopolitical issues), can we keep it that way? I do not think so! Mainly relying on Demand-Side policies, Energy Sustainability is unavoidably expected to be the new paradigm. And, as an example, in such framework, future generations would gratefully acknowledge any today's decision aiming to sanctuarise the shale oil and gas reserves. ■

For more information I suggest the following key websites:
ACEEE and ECEEE (respectively American and European Council for an Energy-Efficient Economy, which are NGOs sisters); Energy Efficiency Journal; International Journal of Sustainability in Higher Education

NOTES

[1] For example, the Varenna EPS-SIF International School on Energy 2012
[2] See EETD's Art Rosenfeld to Receive National Medal of Technology and Innovation in 2012
[3] http://climate.ku.dk/green_campus/green_results_and_indicators_/UCPH_Green_Accounts_2011_short.pdf/ contact person Tomas Refslund Poulsen, Teamleader)

THE FORCE OF A TINY SYNTHETIC MACHINE

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In order to function, living organisms use an amazing number of molecular machines. These machines are essential in controlling and performing numerous biological functions, like muscle contraction or intracellular transport. They are able to rectify random thermal motion to generate force and carry out macroscopic tasks. This ability has inspired attempts to create synthetic machines exhibiting control over motion to perform work.

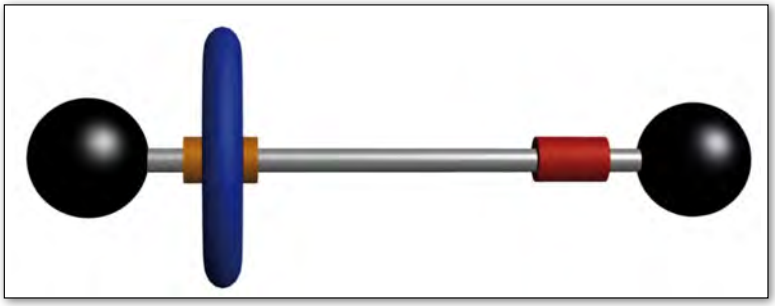
Molecular biological machines have inspired chemists who, for some years now, have been synthesising systems capable of mimicking the natural world [1-3] by producing mechanical work that can manifest itself at the microscopic or macroscopic scale. Examples include the transport of a droplet up an inclined surface against gravity [4], the rotation of submillimetre objects on a substrate [5], or the deflection of a microcantilever [6]. A molecular machine is a molecular complex composed of two parts which can move with respect to one another in response to a stimulus (light, electrons, a concentration gradient,…), the net result being mechanical work. This intramolecular motion is capable of generating a considerable directional force. Despite remarkable advances in recent years, there is still a lack of a deep understanding of how to harness sub-molecular motion to generate a useful response to perform physical tasks.

Rotaxanes are prototypical synthetic molecular machine systems. They are made of a molecular ring threaded onto a molecular axle [3]. (Fig. 1). The thread bears one or more recognition sites called stations, onto which the ring can bind through intra-molecular bonds according to its affinities. The chemical environment also forces the ring to preferentially remain on one of the stations (where it can make the strongest bonds, this site being thermodynamically favoured). Rotaxanes can behave as molecular shuttles: the ring can be translocated from one binding site on the thread to the other one through biased Brownian motion in response to an external trigger [3]. The collective dynamics of such systems have been studied with increasing structural sensitivity and temporal precision [7]. In contrast, much of the exquisite and detailed

information about how biomolecular machines operate has been gleaned from direct measurements made on single molecules with manipulation techniques like optical tweezers or force-clamp atomic force microscopy (AFM). Such measurements have shown that single biological machines are able to generate forces against loads of 5-60 pN, and have highlighted many details about their mechanical properties [8]. AFM-based single molecule force spectroscopy is a tool able to monitor mechanical forces with sub-nanometer resolution and has been widely used to investigate molecular-level processes [9, 10].

Although single macromolecules, such as proteins and synthetic polymers, have been widely manipulated and studied by single-molecule force spectroscopy, implementing this technique on smaller molecules remains a major challenge. We have designed a hydrogen-bonded rotaxane-based molecular shuttle with a tether attached to the ring to track its motion by an AFM cantilever. The [2]rotaxane consists of a ring mechanically locked onto a thread by two bulky groups situated at either end of the axle (Fig. 2). The thread bears two sites, each of which can bind to the ring through up to four hydrogen bonds [11]. The ring predominantly resides over one of the two sites, the occupancy ratio being higher than 95:5. A polymeric chain, suitable for binding to an AFM tip, was attached to the ring. Specific groups were introduced to enable the grafting of the rotaxane onto a gold surface. The rotaxane–tether molecules were grafted onto substrates in a dilute distribution (isolated molecules).

We used the cantilever of an AFM microscope to catch the tether, then apply a mechanical load to the ring of the rotaxane and follow its motion [12]. The caught molecules were stretched in a controlled manner by moving the tip away from the substrate at a fixed pulling rate, and the force–extension profiles were measured (Fig. 3). This is very random, just like fishing: often we don't catch anything



▲ **FIG. 1:** Illustration of a [2]rotaxane with one thread (grey) and two stations (orange and red), one ring (blue) and two bulky end-stoppers at either end to prevent the ring from dethreading.

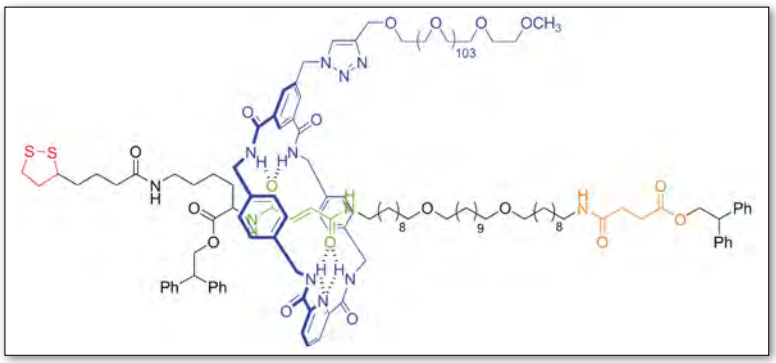
but sometimes we catch the tether of a rotaxane, and pull it up. If the force exerted on the tether is stronger than the hydrogen bonds that bind the ring to its preferred site, the ring detaches from its station. It is then pulled along the axle, away from its most stable binding site. We noticed that the ring of the rotaxane was capable of travelling back to this site, in the direction opposite to the force exerted on it by the cantilever, against a mechanical load of 30 pN, thus delivering mechanical work. If we trap the ring and then slightly decrease the force on the tether while maintaining the pulling, the ring is capable of pulling more strongly to recover its preferred position [12].

This exploit is the result of eight long years of research and collaboration with Professor D.A. Leigh's team (University of Edinburgh, currently at the University of Manchester) who has synthesised the rotaxane, and Professor C.-A. Fustin's team (Université catholique de Louvain) who connected the polymeric tether.

For the first time, a quantitative measurement of the work done by a single synthetic molecule less than 5 nm long has been achieved. It shows that the biased Brownian motions caused by thermal energy can be harnessed within a single synthetic small molecule, to generate significant directional forces similar in magnitude to those generated by natural molecular machines, which are a lot bigger. The results also show that in certain conditions (loading rate, solvent, *etc.*), this synthetic nanomachine is capable of using and converting 100% of the energy available in the molecule in the form of binding energy to perform mechanical work.

The study of systems at the single molecule level has considerable importance on a fundamental level. Indeed, the laws of physics and chemistry which govern the macroscopic world are no longer necessarily valid at the molecular level. The principles of thermodynamics describe processes of energy exchange (work and heat) of macroscopic systems with their environment. In a general way, in macroscopic systems, the average behaviour is reproducible and the fluctuations are of little importance. When the dimensions of the system become nanoscopic, the fluctuations can give rise to significant deviations with regard to the average behaviour. An individual molecule can, for example, extract energy (which comes from thermal energy) from its environment to perform a mechanical work higher than the energy available in the molecule. This is inconceivable

◂ A simplistic representation of the molecular machine experiment. A woman holds a dog on a leash and exerts a pulling force on the leash to hold the dog back, but the dog decides to run, carrying the woman along, even if the latter continues to pull on the leash. The dog therefore exerts a higher force against the mechanical load that the woman represents and which continues to pull in the opposite direction. ©istockphoto



◂ **FIG. 2.** Chemical structure of the rotaxane molecule, synthesised by the group of D.A. Leigh, UK. The rotaxane consists of a benzylic amide molecular ring (in blue) mechanically locked onto an axle by bulky diphenylethyl ester groups situated at either end. The axle bears a fumaramide group (in green) and a succinic amide-ester group (in orange), either of which can act as a binding site for the ring through up to four intercomponent hydrogen bonds. The affinity of the ring for the fumaramide site is much higher than for the succinic amide-ester site, so that the fumaramide:succinic amide-ester occupancy ratio is higher than 95:5. Next to the fumaramide binding site, a disulfide group (in red) was introduced to enable the grafting of the molecule onto gold substrates. A 4600 M_n PEO tether (in blue) is attached to the ring in order to link the molecule to the AFM probe and track the motion of the ring along the axle.

for a set of billions of molecules because they all have to do it at the same time, which is statistically impossible. Thus, well-known concepts of physics and chemistry must be redefined or improved in order to reconcile the nanoscopic and macroscopic worlds. It is from this perspective that for several years, theoretical physicists have established fluctuation theorems. These theorems reconcile what we observe on a large scale and for a large number of molecules in equilibrium with the data obtained for a single molecule (or a small number of molecules) in non-equilibrium conditions. For the first time, we have shown that it is possible to apply modern theories of non-equilibrium statistical mechanics to AFM force measurements.

Studying the movements in a single molecule of less than 5 nanometres long and measuring the work it can perform is a real breakthrough. If manipulations at the molecular level have been known for fifteen years, so far it was a matter of measuring the movements within biological molecules which are a thousand times bigger than a rotaxane molecule. ■

About the Authors

Tiziana Svaldo-Lanero studied Physics at the University of Genoa, Italy, where she also obtained her PhD in Biotechnology in 2008. In 2008-2009, she was Post-doc at Duke University, Durham, USA. Since 2009 she is Post-doc in the group of Professor A.-S. Duwez at the University of Liège, Belgium.

Anne-Sophie Duwez received her PhD in Chemistry from the University of Namur, Belgium. After a post-doc at the Max-Planck Institute in Mainz, Germany and a senior scientist position at the Université catholique de Louvain, she took up the Chair of Chemistry at Surfaces at the University of Liège in 2006 and set up a new lab. She is currently professor of surface chemistry and nanotechnology. Her research interests focus on the development of AFM-based techniques to manipulate single molecules. They include the investigation of mechanochemical processes in bio- and synthetic systems and the design of single molecule devices.

References

[1] M. Schliwa (ed.), *Molecular Motors* (Wiley-VCH, Weinheim, 2003).

[2] K. Kinbara & T. Aida, *Chem. Rev.* **105**, 1377 (2005).

[3] E.R. Kay, D. A. Leigh & F. Zerbetto, *Angew. Chem. Int. Ed.* **46**, 72 (2007).

[4] J. Berná, D.A. Leigh, M. Lubomska, S.M. Mendoza, E.M. Perez, P. Rudolf, G. Teobaldi, & F. Zerbetto, *Nature Mater.* **4**, 704 (2005).

[5] R. Eelkema, M.M. Pollard, J. Vicario, N. Katsonis, B.S. Ramon, C.W.M. Bastiaansen, D.J. Broer & B.L. Feringa, *Nature* **440**, 163 (2006).

[6] Y. Liu, A.H. Flood, P.A. Bonvallet, S.A. Vignon, B.H. Northrop, H.R. Tseng, J.O. Jeppesen, T.J. Huang, B. Brough, M. Baller, S. Magonov, S.D. Solares, W.A. Goddard, C.-M. Ho & J.F. Stoddart, *J. Am. Chem. Soc.* **127**, 9745 (2005).

[7] M.R. Panman, P. Bodis, D.J. Shaw, B.H. Bakker, A.C. Newton, E.R. Kay, A.M. Brouwer, W.J. Buma, D.A. Leigh & S. Woutersen, *Science* **328**, 1255 (2010).

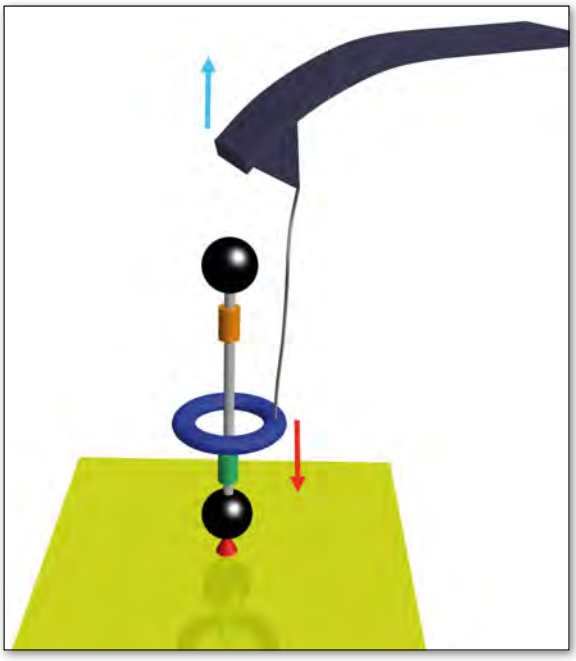
[8] Single-molecule theme, Special issue, *Annu. Rev. Biochem.* **77**, 45-228 (2008).

[9] E. Evans, *Annu. Rev. Biophys. Biomol. Struct.* **30**, 105 (2001).

[10] J. Liang & J.M. Fernández, *ACS Nano* **3**, 1628 (2009).

[11] A. Altieri, G. Bottari, F. Dehez, D.A. Leigh, J.K.Y. Wong & F. Zerbetto, *Angew. Chem. Int. Ed.* **42**, 2296 (2003).

[12] P. Lussis, T. Svaldo-Lanero, A. Bertocco, C.-A. Fustin, D.A. Leigh & A.-S. Duwez, *Nature Nanotech.* **6**, 553 (2011).



▸ **FIG. 3:** Pulling experiment on the ring of a rotaxane with the help of the cantilever of an atomic force microscope (AFM). The molecule is made up of a ring threaded onto an axle. A polymer tether (grey string) connects the ring to the AFM tip. The tip pulls the tether upwards (blue arrow), but the ring moves in the opposite direction to the pulling force (red arrow), generating a force against the mechanical load, thus performing work. From *Nature Nanotech.* **6**, 553-557 (2011).

MAKING THE ELEMENTS IN THE UNIVERSE

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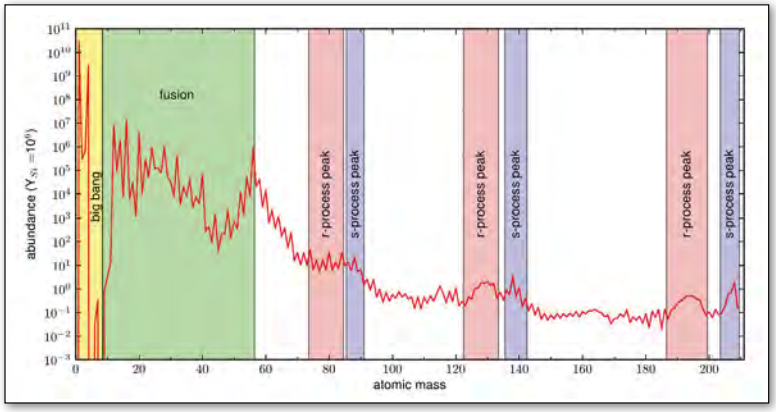
Nuclear Astrophysics combines astronomy/astrophysics with nuclear physics and aims at unveiling the origin of the chemical elements and the astrophysical sites where they are formed. Recent years have witnessed tremendous advances in powerful observatories, laboratory reaction measurements, radioactive ion-beam facilities providing highly unstable nuclei, and progress in astrophysical and nuclear modeling.

Nuclear Astrophysics has a long tradition, going back to the early days of nuclear physics, when nuclear reactions started to be considered as the source of energy generation in the stars. Later on, primordial nucleosynthesis during the Big Bang was understood to only have produced light nuclides (mainly ^{1}H and ^{4}He). Because Big Bang densities at the relevant temperatures were too small to bridge the nuclear mass gaps at A=5 and 8 (for which no stable and only extremely short-lived nuclei exist), stars have been identified as the main cauldrons for the elements in the Universe. Already more than half a century ago, J. and M. Burbidge, W.A. Fowler, and F. Hoyle, as well as independently A. Cameron laid down the ground work to understand the origin of the abundance pattern of the elements, as we observe it today [1]. They postulated that stars go through various burning stages. The first stellar energy source is hydrogen fusion into helium, followed by further nuclear fusion processes, which involve the ashes of the previous stages up to nuclei around Fe, possessing the highest binding energies. The origin of the heavier nuclei up to Pb and Bi or even Th, U, Pu and beyond is due to sequences of neutron captures and beta-decays.

Stellar Evolution

After enormous efforts in experimental and theoretical reaction investigations, required for nucleosynthesis studies (with initially assumed or approximated environment conditions), step by step a transition occurred to realistic astrophysical models. Such detailed stellar evolution models include all relevant nuclear physics as well as dynamics, radiation transport, mixing via convective instabilities or induced by rotation, and mass loss via stellar winds (for present models see *e.g.*, [3]).

Stars with an original mass of less than $8M_{\odot}$ ($M_{\odot}$ denotes the mass of the Sun) end their stellar evolution as white dwarfs (after having finished hydrogen and helium burning and losing significant amounts of mass in stellar winds which are observable as planetary nebulae). A white dwarf is the remaining central C/O-core of the star, which has typically the size of the Earth. It is very dense and stabilized by the pressure of the low-temperature degenerate Fermi gas of electrons, which prevents further contraction and burning stages. More massive stars pass through all nuclear burning stages, also encountering C, Ne, O, and Si-burning and end with a central Fe-core. Consisting of matter with the highest binding energy per nucleon, no further nuclear burning can prevent this core to collapse up to nuclear densities. The collapse results in a central ultra-dense neutron star, and triggers the explosive ejection of the outer layers in an extremely bright event called a core collapse supernova (*e.g.*, [4]).



▼ **FIG. 1:** Solar abundances from H to Bi isotopes as a function of mass number A, spanning over 12 orders of magnitude [2]. For historical reasons Si is normalized to 10^6. Only H, He, an Li were formed in the Big Bang, all heavier elements are due to stellar evolution and stellar explosions. Up to the Fe-peak these are fusion reactions. The heavier elements are formed by neutron captures with peaks (red/blue shades) related to the closed neutron shells 50, 82, and 126. The separation between the peaks of the r(apid)-and the s(low) process is due to the fact that the reaction paths encounter these shell closures for different proton numbers Z (among stable or short-lived neutron-rich unstable nuclei, see also Fig.3).

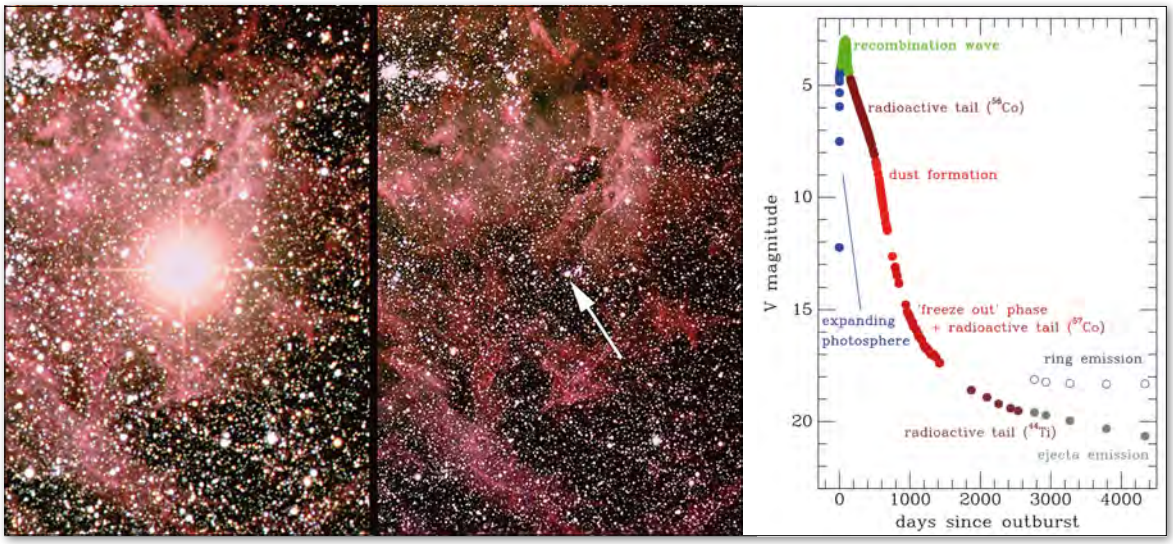
Supernovae

Supernovae belong to the most powerful explosions in the Universe. They are also the dominant sources of intermediate and heavy elements [6,7] and come spectroscopically in two varieties (type I and II, *i.e.*, with or without hydrogen lines in their spectra), both similar in their output of kinetic energy close to 10^{44} J.

Type Ia supernovae are related to the explosion of a white dwarf star, exceeding its maximum stable mass (the Chandrasekhar mass, $1.4M_{\odot}$) due to mass transfer from an orbiting companion star. This causes contraction and ignition of nuclear burning of C and O (mainly to intermediate mass nuclei up to the Fe/Ni region) in an explosive manner. The nuclear burning front disrupts the whole star, leading to the ejection of about $0.6M_{\odot}$ of Ni/Fe, smaller amounts of intermediate mass elements from Si through Ca, and some unburned C and O into the interstellar medium (*e.g.*, [8]). As type Ia supernovae start from very similar initial conditions (a $1.4M_{\odot}$ white dwarf), they lead to similar light outbursts and can be utilized as standardizable light candles, thus also serving as distance indicators in the Universe. This property has led to the 2011 Nobel Prize discovery of the accelerating expansion of the Universe.

Core-collapse supernovae (spectroscopically Type II or Ib/c, the latter having lost their hydrogen envelope) are related to the collapse of massive stars forming a neutron star, stabilized by the degeneracy pressure of nuclear matter. The gravitational binding energy of the stellar core, about 10^{46} J, is released in form of neutrinos of all types, of which about 10^{44} J are converted into local thermal energy via neutrino and antineutrino captures on free neutrons and protons. This triggers, possibly together with the energy drawn from the winding of magnetic fields due to rotation and supplemented by hydrodynamic/convective instabilities, the ejection of the outer layers of the star with a total kinetic energy of about 10^{44} J, similar to the one of type Ia supernovae [4]. The observation of 19 neutrinos from supernova SN1987A by the Kamiokande-II and the Irvine-Michigan-Brookhaven (IMB) water-Cerenkov detectors have proven that our basic understanding of core-collapse supernovae is correct. In spiral galaxies similar to the Milky Way they occur typically 2 to 3 times more often than type Ia supernovae.

This very brief and simplified description of the two types of supernova explosion mechanisms depends highly on the nuclear physics entering the understanding of such hot,



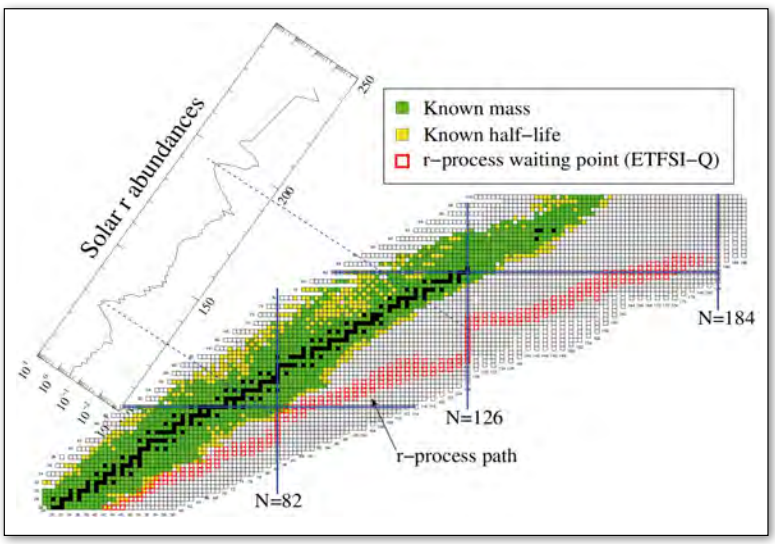
◂ **FIG. 2:** **(Left)** Supernova 1987A; **(Middle)** the identified progenitor star (*Sanduleak −69° 202*) in the Large Magellanic Cloud, a 20$M_\odot$ star ©anglo Australian Observatory; **(Right)** the observed lightcurve (evolution of the brightness of the event with time), exhibiting the decay-heat of unstable ^{56}Co, ^{57}Co, and ^{44}Ti [5].

high-density plasmas. While nuclear burning through fusion is one important ingredient, reactions mediated via the weak interaction are essential for the dynamics of the collapsing core, the explosion and the associated explosive nucleosynthesis. Of particular importance during central burning of type Ia supernovae as well as in core-collapse supernovae are electron captures on protons (free and in nuclei), which are changed into neutrons. This process changes the overall proton/neutron ratio and reduces the electron degeneracy pressure and the core temperature, as the neutrinos produced by the capture can initially leave the star unhindered. The latter two effects accelerate the collapse of massive stars. There has been significant progress in recent years in describing electron captures under stellar conditions based on modern nuclear many-body models [9], which have been confirmed by recent measurements on selected nuclei [10]. The nuclear equation of state at and beyond nuclear densities enters the simulation of core collapse supernovae, the maximum neutron star mass, and the possible transition to black holes, combined with a transition from supernovae to hypernovae and Gamma-Ray Bursts [11].

Properties of Nuclei far from Stability and Explosive Nucleosynthesis

One of the great mysteries in nuclear astrophysics is the site of the so-called rapid neutron capture process (r-process), which is responsible for the production of the heaviest elements up to Th, U and Pu [13]. It requires an astrophysical environment with an extremely high neutron density, making neutron captures much faster than beta-decays. As a consequence the r-process runs through nuclei with such an extreme neutron excess that most of them have never been produced in the laboratory yet. Hence, r-process simulations rely on our theoretical understanding of nuclear structure far from stability. Of particular importance are nuclear masses and beta-decay half-lives, which determine the r-process path and duration, complemented by neutron capture cross sections, fission rates and yield distributions, and possibly neutrino-induced reaction cross sections [9]. The astrophysical site(s) of the r-process is/are not yet clearly identified. The current favorites are the neutrino-driven wind in core-collapse supernovae, and ejecta from neutron star mergers or supernovae arising from progenitor stars with fast rotation and strong magnetic fields.

Another topic is the synthesis of stable proton-rich isotopes, which cannot result from neutron capture processes. These can occur in a hot bath of photons during supernova explosions, where photodisintegrations combined with beta-decays can populate stable proton-rich isotopes (p-process). Another option is explosive hydrogen burning in binary stellar systems on the surface of white dwarfs (novae) or neutron stars (X-ray bursts, and also so-called superbursts), causing a rapid proton-capture process (rp-process). In both cases the properties of proton-rich unstable nuclei and their reaction cross sections are required (*e.g.*, [15]), also addressed by experiments in radioactive ion beam (RIB) facilities and studies of proton and alpha-potentials in the related reactions.



▾ **FIG. 3:** The nuclear chart (N,Z) with stable isotopes (black), unstable isotopes with known masses (green), or known half-lives (yellow). In order to produce the solar r-process component (rapid neutron capture) a very neutron-rich reaction path has to be encountered, which passes the relevant neutron shell closures at specific charge numbers Z (closest to stability with the longest beta-decay half-lives), in order to reproduce the peaks at A=130 and 195 [12] (with courtesy from H. Schatz).

Future Challenges

Thanks to the collaborative effort of many researchers we have witnessed a significant progress in our quest to understand the origin of the elements in the Universe. Although we identified stars and their ultimate supernova explosions as the main element factories, several open questions still remain, defining the current major frontiers in nuclear astrophysics:

- the need of measurements of minute cross sections at the lowest possible energies, in particular by exploiting the unique possibility of cosmic-ray shielded underground laboratories like LUNA;
- the understanding of nuclear structure far from stability;
- the understanding of reactions mediated by the weak interaction;
- the nuclear equation of state below and beyond nuclear densities, the maximum mass of neutron stars, and the formation of black holes in stellar collapse.

A new era in nuclear astrophysics will open once the next-generation radioactive ion beam (RIB) facilities in Asia, Europe and North America will be operational, removing much of the current nuclear uncertainties in astrophysical simulations, in particular for r-process nucleosynthesis. The flagship of the new facilities will be FAIR – the Facility of Antiproton and Ion Research – which will serve as a next-generation RIB facility utilized within the NUSTAR collaboration. Moreover the CBM, PANDA and SPARC collaborations will shed new light on the phase diagram of nuclear matter and the nuclear Equation of State and determine important properties to model neutron stars and their surface. The construction of FAIR as an international facility has started and first beams are expected for 2018. ■

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Karlheinz Langanke received his PhD at the University of Münster. He has been faculty member at the California Institute of Technology and the University of Aarhus. Currently he is professor at the TU Darmstadt and research director at the GSI Helmholtz Center for Heavy Ion Research, also Senior Fellow at the Frankfurt Institute for Advanced Studies.

Friedrich-Karl Thielemann: PhD at TU Darmstadt / Max Planck Institute for Astrophysics, professorship at Harvard University 1986-1994, professor at the University of Basel since 1994, received the Hans A. Bethe Prize (APS) in 2008 and a Humboldt Research Award (spent at GSI) in 2009.

Langanke and Thielemann both served as Distinguished Visiting Scientists at Oak Ridge National Laboratory and were jointly awarded the Lise Meitner Prize 2012 of the EPS.

References

[1] E.M. Burbidge, G.R. Burbidge, W.A. Fowler, F. Hoyle, *Rev. Mod. Phys.* **29**, 547 (1957); A.G.W. Cameron, *Publ. Astron. Soc. Pac.* **69**, *201; Astron. J.* **62**, 9 (1957)

[2] M. Asplund, *Ann. Rev. Astron. Astrophys.* **43**, 481 (2005)

[3] A. Heger, C.L. Fryer, S.E. Woosley, N. Langer, D.H. Hartmann, *Astrophys. J.* **591**, 288 (2003)

[4] H.-T. Janka, *Ann. Rev. Nucl. Part. Sci.* **62**, 407 (2012)

[5] B. Leibundgut, N.B. Suntzeff, *Lecture Notes in Physics* **598**, 77 (2003)

[6] F.-K. Thielemann, K. Nomoto, M.-A. Hashimoto, *Astrophys. J.* **460**, 408 (1996)

[7] F.-K. Thielemann, F. Brachwitz, P. Höflich, G. Martinez-Pinedo, K. Nomoto, *New Astron. Rev.* **48**, 605 (2004)

[8] F.K. Röpke, M. Kromer, I.R. Seitenzahl *et al.*, *Astrophys. J.* **750**, L19 (2012)

[9] K. Langanke, G. Martinez-Pinedo, *Rev. Mod. Phys.* **75**, 81 (2003)

[10] A.L. Cole, T.S. Anderson, R.G.T. Zegers *et al.*, *Phys. Rev. C* **86**, 015809 (2012)

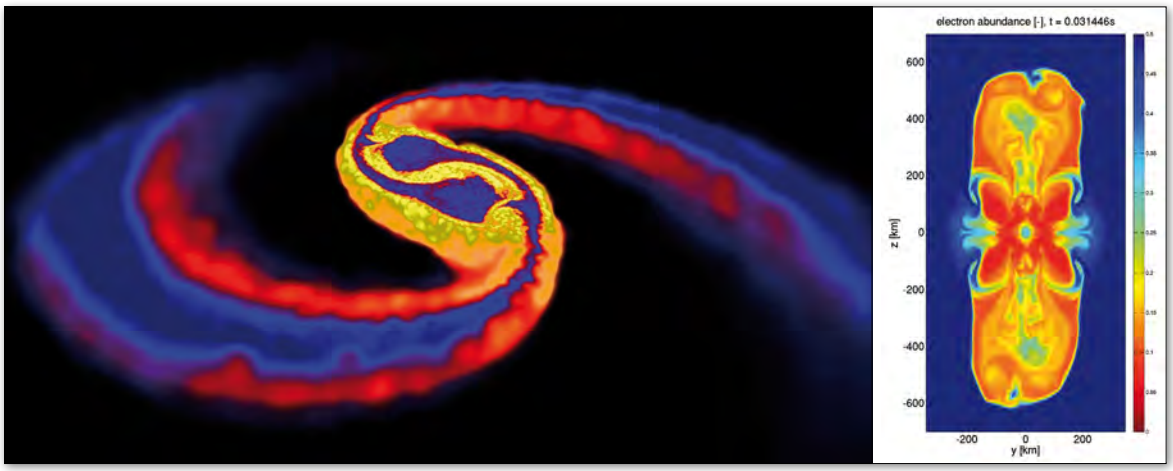
[11] J.M. Lattimer, *Ann. Rev. Nucl. Part. Sci.* **62**, 485 (2012)

[12] H. Grawe, K. Langanke, G. Martinez-Pinedo, *Rep. Progr. Phys.* **70**, 1525 (2007)

[13] C. Winteler, R. Käppeli, A. Perego *et al.*, *Astrophys. J* **750**, L22 (2012)

[14] D.J. Price, S. Rosswog, *Science* **312**, 719 (2006)

[15] G. Gyürky, P. Mohr, Z. Fülöp *et al.*, *Phys. Rev. C* **86**, 041601 (2012)



▸ FIG. 4: (Left) a color contour plot of the magnetic field strength after the merger of two neutron stars in a binary stellar system [14], which merge due to energy loss via gravitational wave radiation. The ejecta of the spiral arms are highly neutron-rich and cause a strong r-process during the expansion. (Right) color contour plot of the proton/nucleon ratio (indicating the neutron-richness of matter) from a fast rotating core collapse supernova with strong magnetic fields (magnetar), which leads to similar r-process conditions in matter ejected along the rotation (z-)axis [13].

ROYAL ACADEMY OF SCIENCES AND ARTS OF BARCELONA

In 1764 (almost 250 years ago), a group of educated citizen of Barcelona decided to organize a "Physico-Mathematical Conference" to follow the progress of science and technology. Several years earlier, in 1717, and as a consequence of the Catalonia's stance against King Philip V at the beginning of the 18th century, the Catalan universities (including the University of Barcelona) were moved to Cervera, a town in the interior of Catalonia, where they remained until 1842.

◂ P. 27: Façade of the Royal Academy of Sciences and Arts at the Rambles, Barcelona

Then, some institutions were created in order to substitute the academic, scientific and technical role of the University of Barcelona. A few years later, the "Conference" was recognized as an Academy by King Charles III, with a name very similar to the present one. Thus, the Royal Academy of Sciences and Arts of Barcelona (RACAB, www.racab.es) is one of the oldest academies in Spain.

The present site of the Academy is on Barcelona's popular central avenue, the Rambles, and was built between 1883 and 1894. It is a pre-modernistic building designed by the architect and academician Josep Domènech i Estapà and is crowned with two domed towers. The paintings in the main hall, representing allegories of the scientific sections of the Academy, are works of the well known painter Fèlix Mestres. In the entrance hall, called the Hall of Clocks, there is an exceptional collection of clocks. Apart from those associated with the normal Hourly Service, there is a monumental astronomical clock built by Billeter (1869) that displays the relative positions of the Sun, the Earth, the Moon – as well as the planets – together with the sunrise and sunset times. It also has local time dials for 24 cities around the world and a perpetual calendar.

Throughout its life, the Academy has gathered an exceptional selection of ancient instruments. Among the collection of astrolabes, the most interesting is the Azarquiel (Ibn al-Zarqalluh) assafea (11th century). Other instruments included a Daguerre camera (1839) constructed by Alphonse Giroud (father in law of Daguerre), a dilatometer (ca.1768), some microscopes from the 18th century; and some ancient telescopes.

The Archive and the Library of the Academy have a documentary collection spanning nearly three centuries which is of great historical value. The Library, with more than a hundred thousand documents, is one of the most important in Spain concerning the second half of the 19th century. Access is especially organized for those involved in studying the History of Science and Technology. The catalogue is accessible on the Academy's web site.

At present the Academy has a maximum of 75 co-opted members distributed in seven sections: Mathematics and Astronomy; Physics; Chemistry; Science of the Earth; Biology; Technology; and Applied Arts. In addition it has some 30 Spanish and 30 foreigner corresponding members.

The Academy plays a crucial role in the study and spreading of science and its application to technology and applied arts. It is particularly active with issues that are vital to scientific progress and is taking an increasingly prominent position in furthering the role of science, engineering and technology in society. An example is the conference held in the Academy auditorium by Albert Einstein en 1923. Einstein was elected a corresponding member, as were Nobel Price winners Santiago Ramón y Cajal and Severo Ochoa. The Academy is committed to collaborate with other institutions and agents involved in policy-making on science related issues.

The Academy hosts scientific sessions on a regular basis in which its members present and discuss their research and their work. It also produces authoritative statements and reports that provide insightful advice to governments, institutions and corporations on key scientific

▾ FIG. 1: Overview of Barcelona with the Fabra Observatory

and technological issues. It organizes series of lectures and exhibits that are aimed at both specialists and non-specialists. Sessions and lectures are usually published in the Proceedings [*Memòries*] of the Academy.

From its early years, the Academy has been especially active in Astronomy. One of the promoters of the Academy, the Jesuit Tomas Cerdà was the first person lecturing on the new Newtonian theories in Catalonia and Spain. At the end of the 19th century, activity in Meteorology and Astronomy induced the creation of an astronomical observatory in order to follow the activity that its first Director Josep Comas i Solà, had developed with a telescope installed at home.

In 1886, in order to standardize the local time and disseminate it throughout the city of Barcelona, the Academy accepted the mission to define the time in Barcelona and in 1891 that time was declared the *official time* for the City. In 1895, the City Council declared the Academy also responsible of the accuracy of the clocks of the Cathedral and the City Hall and, later on, other clocks around the city. The time was set by means of astronomical observations until 1926 from a meridian telescope installed in one of the domes of the Academy at the Rambles.

In order to improve the astronomical activity of the Academy in 1902 and thanks to a donation from Camil Fabra i Fontanills - the first Marquis of Alella - the Academy decided to construct the Fabra Observatory. It was finished in 1904 and inaugurated by King Alfonso XIII. The building is also a pre-modernistic building designed by Josep Domènech i Estapà and an intrinsic part of the skyline of Barcelona. The equipment was a donation from the Barcelona City Council and the *"Diputació"* of Barcelona. The Fabra Observatory has run without interruption since its inauguration. The observation of the new meridian telescope replaced the role of the one at the Rambles until the official time was established by means of broadcast signals.

One of the important achievements of the Fabra Observatory has been the discovery by its first Director of small celestial bodies. Comas discovered eleven small planets, which were given names such as Barcelona, Gothlandia (allegorical for Catalonia), Hispania… and two comets, one of which, the Comas Solà, is periodical. One crater on the Moon and another on Mars are named by Comas also. Furthermore, Comas was the first person to observe and describe the presence of an atmosphere on Titan, the largest satellite of Saturn, on the night of August 13th 1907. The result was published in *Astronomische Nachrichten* and it took forty years to be confirmed by spectroscopic methods.

The Observatory has three sections. The Astronomical Section, which is devoted to astrometry – position setting – of small planets and comets. The Meteorological Section which collaborates with the Catalan Meteorological Service and the Spanish Meteorological Institute. Its observational series, taken at the same place which has suffered little changes in the surroundings, are particularly important because it spans a period of 100 years without interruptions. The Seismological Section, devoted to regional seismology, can record the largest earthquakes around the world. It also collaborates with the Catalan Institute of Cartography and has a second station at some 60 kilometres from Barcelona with a third site planned in order to improve the observations.

Recently, in order to avoid the luminosity of the city of Barcelona the Academy has installed a new robotic telescope in the Pre-Pyrenees. It is in cooperation with the Royal Observatory of the Spanish Army (ROA) in San Fernando (Cádiz). The Telescope Fabra Roa at Montsec (TFRM) is a refurbished NASA Baker-Nunn camera which is an excellent instrument for many different kinds of observations. ■

▲ **FIG. 2:** Entrance to the Fabra Observatory

Ramon Pascual,
- **Professor of Theoretical Physics at Universitat Autonoma de Barcelona**
- **Chairman of the EC of ALBA-CELLS Synchrotron**
- **President of the RACAB (Reial Acadèmia de Ciències i Arts e Barcelona)**
- **DOI: 10.1051/epn/2013305**

The Royal Academy of Sciences and Arts of Barcelona (SP) has kindly welcomed the EPS Executive Committee meeting early this year in its somptuous house. Its long and brilliant history through many centuries deserves to be known and Europhysics News is grateful to its President for his contribution.

Opinion:
The pitfalls of time derivatives

Fritz Wagner *is a fusion scientist. He served as EPS president from 2007-2008. Till March this year he was chairman of the EPS Energy Group*

When you read *"the distance from Berlin to Munich is about 500 km/h"* and *"last weekend, I went from Munich to Berlin with an average speed of 130 km (mostly German autobahn)"* you may want to stop now and turn the page. Please don't. A leading German daily journal reported in its economic section: *"The Dutch nuclear power station Borssele has a powerstrength of 450 Megawatt (MW) per hour. In our recent article from July 8th we erroneously quoted an annual power of 450 MW (Name of the journal)"*. I omit the name but maybe I should have stopped paying my subscription. Another leading German daily with somewhat political orientation wrote recently on the development of renewable energies in Germany: *"It is estimated that last year plants have been built which can produce electricity between 7000 and 8000 Megawatts. This corresponds to the capacity of 10 large power stations"*. This statement also confuses power and energy, or hides the difference between peak power of intermittently operating energy sources and continuous power of steady-state operating plants. A member of one of the political parties represented in the German Parliament wrote: *"With cheap electricity from Norwegian hydro power stations Germany could completely do without coal- and atomic energy"*. Strangely, Norway with 5 Million inhabitants is expected to provide the infrastructure for the needs of 80 Million people. One of the leaders of the Green party in Germany expected that the feed-in-tariff system to support the introduction of renewable energies *"will cost a typical household in Germany not more than a scoop of ice cream per month"*. Last year the subsidy amounted to € 20 Billion (minus € 3 Billion, the market value of the produced electricity); the federal science and education budget, to compare with, corresponds to € 13.7 Billion a year. Men and women play a balanced role in the Green party. I do not want to violate this (good) principle and therefore, I also quote a female leader of this party. March 11th this year she facebooked: *"Today, two years ago, there happened the disastrous atomic catastrophe of Fukushima… In total 16000 people were killed by this catastrophe…"*.

It is in the interest of everybody to abandon fossil fuels and replace them by new sustainable energy forms. But the transition has to be done in a prudent way.

These examples characterise the scenery of one of the biggest technical and societal transformations in Europe – the "Energiewende". Why should the lack of understanding, knowledge and truthfulness in the energy field bother the Europeans? It is in the interest of everybody to abandon fossil fuels and replace them by new sustainable energy forms. But the transition has to be done in a prudent way. Energy is a field governed by the laws of nature and those of economy. Unfortunately, this field was also discovered by parties as a topic to generate votes. Embracing politics too closely may lead energy research astray. The writing is already on the wall. The public denigration of one energy research field by the proponents of another one is a new behaviouristic feature. It could easily happen that under the political and societal pressure basic research loses terrain in the thrust to arrive at enforced solutions in politically accepted technologies. At this stage it is a mistake to place all eggs into one basket and to eliminate viable options. In case of renewable energies, storage is needed most probably on a chemical basis, which is not yet available at the large scales necessary. Fusion is not ready; new fast fission reactors as well as nuclear waste processing need further development. Those really concerned with the present energy situation have the environmental threats on their minds. We may not forget that the electricity production of Norway, Sweden and France is basically CO_2-free. These European countries are already where others want to be in 2050. ■

COMING EPS EVENT

- **40th EPS Conference on Plasma Physics**, *01-05 July 2013,* Espoo, Finland http://eps2013.aalto.fi/
- **ECAMP11**, 11th European Conference on Atoms and Photons 2013 *24-28 July 2013,* Aarhus, Denmark http://ecamp11.au.dk/
- **MORE ON:** www.eps.org

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EPJ is a merger and continuation of Acta Physica Hungarica, Anales de Fisica, Czechoslovak Journal of Physics, Fizika A, Il Nuovo Cimento, Journal de Physique, Portugaliae Physica and Zeitschrift für Physik. 21 European Physical Societies are represented in EPJ through the Scientific Advisory Committee, a board that advises the publishers and Editors on editorial and policy matters. The publishers of EPJ are EDP Sciences (the publishing branch of the Société Française de Physique), the Società Italiana di Fisica and Springer.

EPJ H: Introducing a rising star / Cooperation with EPS

EPJ H - Historical Perspectives on Contemporary Physics is the only journal to address the history of physics primarily from a physics and physicist's perspective. It promotes and spreads awareness and understanding of the historical development of ideas in contemporary physics, and more generally, ideas about "how nature works." As an integral part of a core physics publishing platform, it supports physicists in their efforts to reflect, understand, and improve on the culture of their own discipline. Launched in 2010 as the successor to *Annales de Physique*, it was already ISI-listed (with an impressive IF of 1.18) by 2011 and fills an essential gap in the scientific journal literature.

Alongside *EPL* and *European Journal of Physics*, it is now one of the journals that are freely available to all EPS members as part of the recent Alliance for Physics Publishing initiative (link).

Fig 1. The new portal, www.epj.org.

Happy birthday EPJ!

Celebrations

are in order this year for the European Physical Journal as this European publishing partnership for physics turns 15. It was only five years ago that *Europhysics News* published a short piece for the 10th anniversary of the launch of *The European Physical Journal*. It is gratifying to see how the teenager has in the meantime left behind its growing pains and now feels ready to tackle the world! Such confidence is indeed required in an environment that has quickly become less than transparent for scientists and publishers alike.

How will quality in science be assessed in the future, what role will peer-reviewed journals play, and how will they be financed? Social media is entering the realms of research evaluation metrics and the measure of the 'success' or 'impact' of scientific papers is a rapidly evolving concept. The simultaneous arrival of social media and the Open Access movement has shaken up the status quo and will greatly affect scientists and the way they will think about publications in the future.

Coincidentally, the drive toward Open Access comes at the same time as the imminent breakdown of classic disciplinary boundaries. This combination has triggered a great deal of experimentation in new types of journals using different business models. As the models proposed are likely to vary widely in terms of measure and speed of uptake across the various scientific communities, diversification seems to be a good strategy.

One possible route, namely that of converting existing journals to Open Access journals, is the preferred solution for high-energy physics. EPJ is pleased to see *EPJ C – Particles and Fields* lined up for conversion into a fully open access journal under SCOAP3 [http://scoap3.org/]

EPJ has also taken the opportunity to launch new Open Access titles, either in response to the emergence of new research fields at the interface between more established subjects, or to fill obvious gaps in the EPJ catalogue. After the early launches of *EPJ Web of Conferences* (the open access proceedings repository) in 2009 and *EPJ Photovoltaics* in 2010, 2012 witnessed the launch of *EPJ Data Science*. This year, three new journals are about to join them: *EPJ Nonlinear Biomedical Physics*, *EPJ Techniques and Instrumentation* and *EPJ Quantum Technology*.

In addition to these journals and in keeping with its commitment to raising the profile and impact of research in new emerging fields, EPJ has accurately identified and addressed other specific needs in the scientific community. The first example is *EPJ Special Topics*, launched in 2007 as the successor to *Journal de Physique IV*. The journal publishes only complete special issues and has rapidly reached an Impact Factor of 1.56. It is designed to address highly interdisciplinary topics, technical summary reports from research networks, and selected review-style theses of outstanding quality. A further example of a successful renewal is *EPJ Plus*, which serves as EPJ's general physics journal and moreover seeks to provide further insights into previously published work through the detailed documentation, verification and critical assessment of data and results.

The full breadth of EPJ can easily be glimpsed by browsing its newly designed web portal (see Fig.1). Serving as the central EPJ resource, epj.org also carries the *EPJ Highlights*, promoting selected papers which will be of interest to the wider scientific community.

In summary, the overall strategy of EPJ is to use its solid basis in the physics publishing landscape, i.e., its established sections *EPJ A-E*, to further develop the EPJ brand as a framework for the participating partners to launch new (Open Access) journals.

EPJ Steering Committee
Jean Daillant, Agnès Henri (SFP/EDP Sciences), Enzo De Sanctis, Angela Oleandri (SIF), Maria Bellantone, Christian Caron (Springer)

Attendees of the Meeting of the Scientific Advisory Committee & Steering Committee of EPJ, Amsterdam, 12 April 2013:

Jose Adolfo de Azcarraga, Ian Bearden, Maria Bellantone, Giorgio Benedek, Alessandro Bettini, Christian Caron, Joakim Cederkall, Jean Daillant, Solange Guéhot, Agnès Henri, Robert Klanner, Colin Latimer, Sabine Lehr, Piet Mulders, Angela Oleandri, Jozef Ongena, Per Osland, José A. Paixão, Andras Patkós, Karel Rohlena, Enzo De Sanctis, Tom Spicer, Bart van Tiggelen, Silvia Tomic, Jerzy Warczewski

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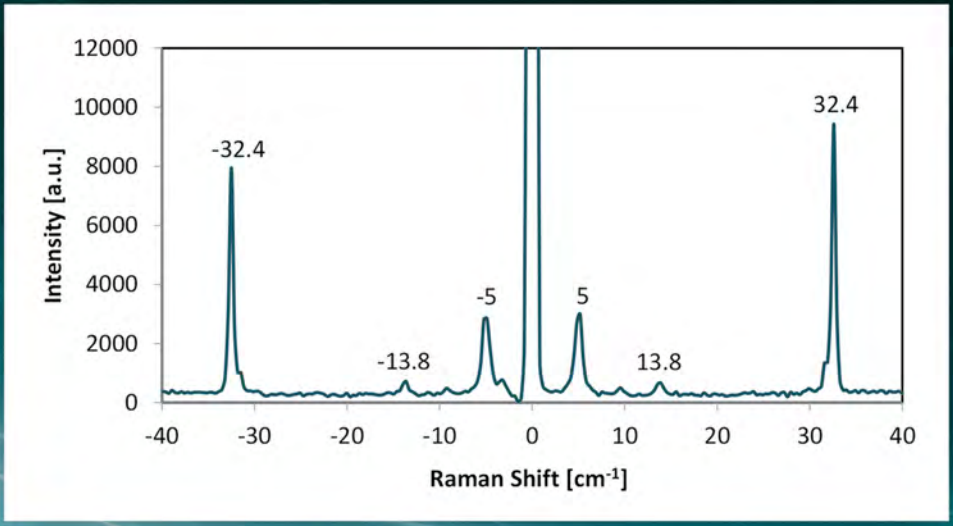

Raman spectrum of MoS_2 flakes measured at 633 nm with BragGrate™ Notch filters and single stage spectrometer

(data courtesy of : P. H. Tan, State Key Laboratory of SL and Microstr., Institute of Semiconductors, CAS, Beijing, P. R. China)

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