3RD INTERDISCIPLINARY MEETING – PLATFORM FOR THE DIALOGUE BETWEEN SCIENTIFIC GENERATIONS

60TH MEETING OF NOBEL LAUREATES AT LINDAU
RETROSPECTS AND PROSPECTS 2010

Kuratorium für die Tagungen der Nobelpreisträger in Lindau
Council for the Lindau Nobel Laureate Meetings

MEETINGS OF NOBEL LAUREATES LINDAU ®

Stiftung Lindauer Nobelpreisträgertreffen am Bodensee
Foundation Lindau Nobelprizewinners Meetings at Lake Constance

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Crossing Borders, Celebrating Science: The 2010 Lindau Meeting of Nobel Laureates

The 60th Meeting of Nobel Laureates has once again shown the timeless value and vibrant original idea of this globally unique forum: As many as 59 Laureates have dedicated their valuable time outside laboratories and lecture halls to educate, to inspire and to connect the next generation of leading researchers. Once again, I would like to convey our gratitude to all participating Laureates and the scientific chairpersons.

Following the Lindau Meetings in 2000 and 2005, this year's meeting was once more dedicated to an interdisciplinary exchange. This kind of dialogue helps us to cope with the complex challenges of our time and to find answers to the most pressing issues in science and research. The Laureates, as well as the 675 young researchers have made a conscious effort, to provide and to seek inspiration beyond the boundaries of their own fields of specialisation.

Promoting this kind of exchange between generations of scientists as well as between disciplines is an important aspect of Lindau's 'Mission Education'. The panel discussion on the closing day at the Isle of Mainau about "Sustainability and Energy" provided not only a perfect

example of the lively Lindau Dialogue but opened the door for the public: The exhibition "Discoveries 2010: Energy", in cooperation with the Federal Ministry of Education and Research, presented an invitation to cutting-edge science and research. In their pavilions, 18 partners presented approaches to sustainable, safe and ecologically sound energy solutions. "The Future of Energy" formed a focal point of the 60th Meeting of Nobel Laureates, making it once more an inspiring "workshop of the future" for the international scientific community.

Today, the Lindau Meetings are built on a solid basis thanks to the efforts of the Foundation Lindau Nobelprizewinners Meetings at Lake Constance. Over the past 10 years, the financial foundations were secured and therefore it was possible to make considerable progress in establishing excellent standards regarding the programme, the participants, as well as the organisation of the meetings. This is mirrored in the way Lindau is perceived around the world. On behalf of the Council for the Lindau Nobel Laureate Meetings, I would therefore like to congratulate the Foundation Board on a successful first decade. On a personal note, I would like to extend my profound gratitude to the Chairman of the Foundation Board, Wolfgang Schürer, for his tremendous efforts. For 10 years now, he has been dedicating himself to the 'Mission Education'. Council and the Foundation are looking forward to continuing the pursuit of this noble purpose.

This report offers insights into the various facets of our 'Mission Education', founded on the concept of partnership. Let me thank the whole team of our Lindau office under the leadership of Nikolaus Turner and Wolfgang Huang, that has contributed a special and dedicated effort in realising this year's interdisciplinary meeting. The worldwide network of Academic Partners has nominated outstanding and highly promising Best Talents. This Lindau Meeting – the largest to date – has been realised thanks to funding provided by a number of institutions from science, the public and the private sector. Council and Foundation are grateful for the wide range of support. Our recognition and appreciation are due to all partners.

Countess Bettina Bernadotte,
President of the Council for the Lindau Nobel Laureate Meetings

MEETINGS OF NOBEL LAUREATES LINDAU ®

EDUCATE. INSPIRE. CONNECT.

Our 'Mission Education' in 2010

The 'Mission Education' encapsulates the aims of the work jointly carried out by the Council for the Lindau Nobel Laureate Meetings and the Foundation Lindau Nobelprizewinners Meetings at Lake Constance: to educate, to inspire and to connect scientific generations. It goes back to 1951 when the first Lindau Meeting brought together Nobel Laureates in Physiology or Medicine with medical doctors. Today, the 'Mission Education' reaches beyond the annual meeting and incorporates projects like the exhibition series "Discoveries" on the Isle of Mainau and the mediatheque with historical lectures, from past meetings.

Still, the Lindau Nobel Laureate Meetings form the centrepiece of all activities. They nurture the enthusiasm for natural sciences among the 675 young researchers from around the world. It is here that science and research are celebrated with fervor, the scientific issues of the day are focus of discussion, lasting friendships are made and answers to the great challenges of the future are considered.

Carefully selected projects like the exhibition series and the mediatheque broaden the objectives not only of the 'Mission Education' itself, but also of each annual Lindau Meeting and each contribution by Nobel Laureates. Not only those who were privileged to meet the Laureates personally in Lindau are able to learn about and be inspired by their work, but everybody interested in science. This is how the 'Mission Education' of the Council and the Foundation contributes to the dialogue between science and society.

60TH MEETING OF NOBEL LAUREATES

from June 27th until July 2nd, 2010

59 Nobel Laureates from the fields of physics, chemistry and physiology or medicine and 675 highly talented young researchers from 68 countries came together on the shores of Lake Constance for a week of personal encounters and an exchange of ideas. Almost 200 academic institutions from around the globe had nominated the up-and-coming scientists. Being the 3rd Interdisciplinary Meeting lectures and panel discussions covered a wide range of scientific topics like cosmology, the future of biomedicine, energy and sustainability and what it means to be a scientist.

FROM PAGE 6

BEYOND THE 2010 LINDAU MEETING

"Discoveries 2010: Energy" Exhibition on the Isle of Mainau from May 20th until August 29th, 2010

As an integral part of the annually changing "Science Year" campaign of the German Federal Ministry of Education and Research, the exhibition series "Discoveries" on the Isle of Mainau opened its doors for the broad public again. It focused on the future of energy. The objective was to draw attention to the challenges imposed by climate change and global population growth, to present the latest research methods and proposed solutions, and to promote societal dialogue about the necessary restructuring of the world's energy supply.

FROM PAGE 134

Building a bridge between the Lindau Meetings and the European Capital of Culture

The topic of energy has built bridges between Lake Constance and the European Capital of Culture 2010: While the future of energy was the focus of attention at the Lindau Nobel Laureate Meetings and at the exhibition "Discoveries 2010: Energy" on the Isle of Mainau, RWE was putting the project "EnergyCultureEurope" into practice in Essen as part of the Ruhr.2010 European Capital of Culture Year.

FROM PAGE 144

10 Years Foundation Lindau Nobelprize-winners Meetings at Lake Constance

The year 2000 marked a milestone in terms of ensuring the future and enhancing the development of the Lindau Meetings: The Foundation Lindau Nobelprizewinners Meetings at Lake Constance was set up by 50 Nobel Laureates. One of the Foundation's particular concerns is to continuously achieve the highest possible standards in terms of the content and organisation of the Lindau Meetings. A special publication with contributions from 40 representatives from the worlds of science, business and politics commemorates the 10th anniversary.

FROM PAGE 140

60 Years of Science History: The Mediatheque of the Lindau Meetings

The Nobel Laureate Meetings´ mediatheque is being further expanded. In the past few months, 50 new lectures presented by Nobel Laureates were carefully prepared and provided with a commentary before being put online, including contributions from Otto Hahn, George Whipple, Sir Chandrasekhara Raman and Richard Synge. Thanks to the funding provided by the Gerda-Henkel-Stiftung, it has now been possible to carry out this project for a second year.

FROM PAGE 146

THE 60TH MEETING OF NOBEL LAUREATES

JUNE 27TH – JULY 2ND, 2010

60TH MEETING OF NOBEL LAUREATES

Participating Nobel Laureates

Peter Agre
United States
Chemistry, 2003

Werner Arber
Switzerland
Physiology or Medicine, 1978

Françoise Barré-Sinoussi
France
Physiology or Medicine, 2008

Nicolaas Bloembergen
United States
Physics, 1981

Martin Chalfie
United States
Chemistry, 2008

Aaron Ciechanover
Israel
Chemistry, 2004

James W. Cronin
United States
Physics, 1980

Paul J. Crutzen
The Netherlands
Chemistry, 1995

Johann Deisenhofer
Germany
Chemistry, 1988

Christian de Duve
Belgium
Physiology or Medicine, 1974

Manfred Eigen
Germany
Chemistry, 1967

Richard R. Ernst
Switzerland
Chemistry, 1991

Gerhard Ertl
Germany
Chemistry, 2007

Sir Martin J. Evans
United Kingdom
Physiology or Medicine, 2007

Albert Fert
France
Physics, 2007

Edmond H. Fischer
United States
Physiology or Medicine, 1992

Ivar Giaever
United States
Physics, 1973

Roy J. Glauber
United States
Physics, 2005

David Gross
United States
Physics, 2004

Peter Grünberg
Germany
Physics, 2007

Theodor W. Hänsch
Germany
Physics, 2005

Leland H. Hartwell
United States
Physiology or Medicine, 2001

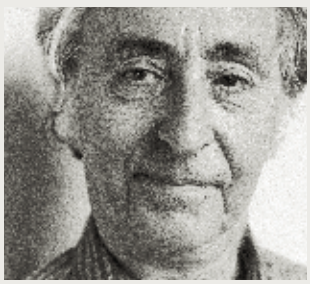
Harald zur Hausen
Germany
Physiology or Medicine, 2008

Avram Hershko
Israel
Chemistry, 2004

Robert H. Horvitz
United States
Physiology or Medicine, 2002

Robert Huber
Germany
Chemistry, 1988

Sir Tim Hunt
United Kingdom
Physiology or Medicine, 2001



Brian D. Josephson
United Kingdom
Physics, 1973

Klaus von Klitzing
Germany
Physics, 1985

Walter Kohn
United States
Chemistry, 1998

Sir Harold W. Kroto
United Kingdom
Chemistry, 1996

Robert B. Laughlin
United States
Physics, 1998

Yuan Tseh Lee
Taiwan
Chemistry, 1986

Jean-Marie Lehn
France
Chemistry, 1987

Rudolph A. Marcus
United States
Chemistry, 1992

John C. Mather
United States
Physics, 2006

Hartmut Michel
Germany
Chemistry, 1988

Luc Montagnier
France
Physiology or Medicine, 2008

Ferid Murad
United States
Physiology or Medicine, 1998

Erwin Neher
Germany
Physiology or Medicine, 1991

Ryoji Noyori
Japan
Chemistry, 2001

Christiane Nüsslein-Volhard
Germany
Physiology or Medicine, 1995

Arno A. Penzias
United States
Physics, 1978

Robert C. Richardson
United States
Physics, 1996

F. Sherwood Rowland
United States
Chemistry, 1995

Carlo Rubbia
Italy
Physics, 1984

Osamu Shimomura
Japan
Chemistry, 2008

Hamilton O. Smith
United States
Physiology or Medicine, 1978

Oliver Smithies
United States
Physiology or Medicine, 2007

George F. Smoot
United States
Physics, 2006

Jack W. Szostak
United States
Physiology or Medicine, 2009

Gerardus 't Hooft
The Netherlands
Physics, 1999

Roger Y. Tsien
United States
Chemistry, 2008

Martinus J. G. Veltman
The Netherlands
Physics, 1999

Sir John E. Walker
United Kingdom
Chemistry, 1997

Torsten N. Wiesel
Sweden
Physiology or Medicine, 1981

Robert W. Wilson
United States
Physics, 1978

Kurt Wüthrich
Switzerland
Chemistry, 2002

Ada E. Yonath
Israel
Chemistry, 2009

THE 60TH MEETING OF NOBEL LAUREATES

PARTICIPANTS

At the 60th Lindau Meeting of Nobel Laureates, 59 Nobel Laureates from the fields of physics, chemistry and physiology or medicine met 675 young scientists from 68 countries. This is by far the biggest ever gathering of Laureates for a scientific conference. Almost 200 academic institutions from around the globe had nominated the up-and-coming scientists, and far more than 20,000 young researchers had initially applied. At their 60th anniversary, the Lindau Meetings present themselves as the premiere location for a dialogue between generations of scientists – a forum where science serves as a common language, beyond gender, religion or culture.

Nobel Laureate Sir Martin J. Evans in a discussion with young researchers at the 60th Lindau Nobel Laureate Meeting.

NOBEL LAUREATES

With 59 Nobel Laureates attending, the 60th Lindau Nobel Laureate Meeting was one of the largest conventions of Nobel Laureates ever. Their diverse personal and professional backgrounds readily account for the wide variety of topics and views presented during the week. In lectures, panels and student discussions, the Nobel Laureates gave valuable insights into their latest research projects, discussed societal issues and outlined the prospects for science. Once more, the meeting showed that the issues raised here are highly relevant for the future.

Nobel Laureates who took part for the first time in a Lindau Meeting:

Françoise Barré-Sinoussi, Physiology or Medicine 2008
Sir Martin J. Evans, Physiology or Medicine 2007
Robert H. Horvitz, Physiology or Medicine 2002
John C. Mather, Physics 2006
Luc Montagnier, Physiology or Medicine 2008
Jack W. Szostak, Physiology or Medicine 2009
Harald zur Hausen, Physiology or Medicine 2008
Ada E. Yonath, Chemistry 2009

29 OUT OF 59 LAUREATES AND COUNTESS BETTINA BERNADOTTE

FIRST ROW (from left to right): **Walter Kohn, Roy J. Glauber, John C. Mather, Françoise Barré-Sinoussi, Edmond H. Fischer, Countess Bettina Bernadotte, Martin Chalfie, F. Sherwood Rowland, Harald zur Hausen, Nicolaas Bloembergen, Ryoji Noyori, Martinus J. G. Veltman,**

SECOND ROW (from left to right): **Arno A. Penzias, Hamilton O. Smith, Ivar Giaever, Avram Hershko, Jack W. Szostak, Carlo Rubbia, Werner Arber, Sir Harold W. Kroto, James W. Cronin,**

THIRD ROW (from left to right): **Sir Martin J. Evans, Robert C. Richardson, Yuan Tseh Lee, Ferid Murad, Robert B. Laughlin, George F. Smoot, Gerardus 't Hooft, Aaron Ciechanover, Peter Agre**

My personal experiences in the "Pastoral Nobel City"

This year I had my first opportunity to participate in the yearly scholar's festival that takes place in Lindau, the tranquil island situated at the beautiful Lake Constance. This unique event is a gathering of intellectuals, ranging from Nobel Prize Laureates, to highly appreciated scientists and talented young students eager to learn and top media reporters. Indeed, the reality overcame the "stories". Immediately after arrival I was soaked in immense curiosity, exceptional enthusiasm and significant boldness to inquire by everybody about everything.

As I have ample opportunities to meet my colleagues, the Laureates, I planned to use my time for discussions with the youngsters, and benefit from their fresh, still embryonic viewpoints. I grabbed every opportunity to interact with them. Surprisingly (or not) I learned that in addition to their lust to understand the "Nobel minds" and the processes of discovery, they showed immense interest in lifting the curtain on underappreciated aspects and on unexpected observations encountered on the way to the discoveries. They were glad to discover the enormous contribution of serendipity to the research pathway, and to reveal details hidden in the polished final published results. However, paradoxically, they were more eager to discuss frustrations, failures, drawbacks and intrigues associated with the everyday research as well as with the glorious moments.

I was delighted to realize that the meeting promoted the determination of these young researchers to pursue excellent science and to overcome disturbances and disappointments. I sensed that the meeting deepened their perseverance and encouraged them to undertake profound projects at the frontiers of science and I wish them great accomplishments.

Ada E. Yonath
Nobel Laureate in Chemistry, 2009

UP-AND-COMING SCIENTISTS AND ACADEMIC PARTNERS

A record total of 675 up-and-coming young scientists from 68 countries participated in the 60th Lindau Nobel Laureate Meeting. All continents were represented in Lindau with a cross-section of their best talents. Both the Nobel Laureates and the up-and-coming scientists found great inspiration in this opportunity to meet and converse with so many fellow scientists and researchers from different disciplines, nationalities and cultures.

Again, female scientists represented a large proportion: 283 young female scientists took part. Together with the worldwide network of Academic Partners, the Council and the Foundation of the Lindau Meetings promote the participation of young women in particular as science cannot afford to neglect their potential and creativity. At Lindau, they become part of international networks and share insights with Laureates on how to balance research and family life.

All the young scientists took part in an international, multi-stage selection process. The Lindau Nobel Laureate Meetings interact closely with a global network of about 200 Academic Partners to identify highly talented young scientists and to nominate them for participation in the meetings. The network includes national academies of science, ministries, research institutions, top-ranking universities, foundations and international scientific organisations. This year again, a number of Nobel Laureates nominated young scientists for participation.

Initially, young scientists submit their applications to these partners. Based on the selection criteria laid down by the Council for each meeting, the committees of the Academic Partners make preliminary evaluations and decide whether applicants are to be permitted to register in the web-based database of the Lindau Meetings. Each applicant registers here with his or her own profile and submits some essential information concerning his or her motivation, scientific publications, tutorial experience, university grades and recommendations by professors. This data forms the basis for the second stage of the selection process, when the Review Panel of the Council carefully screens and examines about 2,000 registered applicant profiles. From this pool of best talents, around 650 young researchers finally receive an invitation to attend the Lindau Nobel Laureate Meeting. Taking into account the national selection procedures, far more than 20,000 young researchers apply to attend each meeting. Members of the Review Panel this year were the Council members Professors Wolfgang Lubitz, Burkhard Fricke, Helmut Sies and Jürgen Uhlenbusch. They were assisted in their work by Nadine Gärber and Sabine Harder in the Executive Secretariat, and also by Leonore Uhlenbusch and Andreas Schmidt.

During the 60th Lindau Meeting, the Memorandum of Understanding between the Lindau Nobel Laureate Meetings and the Republic of Austria, as well as that with the Kingdom of Thailand, were extended in the presence of Austria's Federal Minister for Science and Research, Beatrix Karl, and HRH Princess Maha Chakri Sirindhorn of Thailand. The signing of these agreements expresses the common interest in ensuring the future participation of highly talented young scientists from both countries in the Lindau Nobel Laureate Meetings.

The 60th Lindau Nobel Laureate Meeting was an extremely enriching personal experience from which I returned full of motivation and new creative ideas. I have to say I feel deeply honoured for having had the opportunity of being there. The Nobel Laureates as well as the other participants were always open to discussion and their power of motivation and personality were really inspiring. I established contacts and had deep discussions with several outstanding researchers in my field, but I additionally learned a lot about other scientific topics which are out of my area of expertise. Moreover, their career advice and personal experiences have been very valuable for deciding on the next steps in my scientific career. **Rosa Castañé Selga,** Spain

FACTS & FIGURES

Representation by Country

Argentina	Finland	Liechtenstein	Saudi Arabia
Australia	France	Lithuania	Singapore
Austria	Germany	Luxembourg	Slovakia
Bangladesh	Ghana	Malaysia	Slovenia
Belarus	Greece	Mexico	South Africa
Belgium	Hong Kong	Morocco	Spain
Bosnia and Herzegovina	Hungary	The Netherlands	Sudan
Brazil	India	New Zealand	Sweden
Bulgaria	Indonesia	Nigeria	Switzerland
Cameroon	Iran	Norway	Taiwan
Canada	Ireland	Oman	Thailand
China	Israel	Pakistan	Turkey
Croatia	Italy	Philippines	Ukraine
Czech Republic	Japan	Poland	United Kingdom
Denmark	Jordan	Portugal	United States
Egypt	Korea, Republic of	Romania	Vietnam
Estonia	Latvia	Russia	Yemen

FACTS & FIGURES

Selection Criteria

For participation in the 60th meeting, 675 young researchers have been recruited worldwide among (1) undergraduate students, (2) master and doctoral students and (3) young postdoctoral scientists. The following standards and criteria have served for their selection among the applications:

All selected participants shall

- show a genuine interest in science and research,
- show a strong commitment both to their principal field of studies and to the interdisciplinary dialogue with the international academic community,
- receive an unequivocal support of their application by their academic advisor and/or by internationally renowned scientists,
- be fluent in English and an active participant in discussions,
- be familiar with societal impacts of scientific knowledge and its applications,
- not have participated in previous Lindau Meetings,
- belong to the top 10 per cent of their class, and
- deliver fully completed applications.

Moreover, it is most welcomed to have a good balance between these three groups:

(1) Undergraduate students shall
- exhibit a solid general knowledge in the natural sciences,
- have done some research work.

(2) Master and Doctoral students shall
- have excellent academic accomplishments,
- have produced outstanding research,
- have tutoring experience.

(3) Postdoctoral scientists shall
- have published results of scientific investigations in refereed journals,
- have presented research reports at international conferences,
- have acquired experience in tutoring and teaching.

Beatrix Karl, Austrian Federal Minister for Science and Research (center) with young researchers from Austria after signing a Memorandum of Understanding with the Council and the Foundation. Gabriele Dür (left) represented the International Lake Constance Conference (IBK) at the signing ceremony.

FACTS & FIGURES

Academic Partners Worldwide

International Academic Partners

Australia	Australian Academy of Sciences
Austria	Federal Ministry for Science and Research
Bangladesh	Bangladesh Academy of Sciences
Belgium	Fonds National de la Recherche Scientifique
Brazil	National Council for Scientific and Technological Development
Cameroon	Université de Yaoundé
Canada	Natural Sciences and Engineering Research Council
China	Sino-German Center for Research Promotion
Czech Republic	Academy of Sciences of the Czech Republic
Egypt	Ministry of Higher Education and Scientific Research
Estonia	Estonian Academy of Sciences
Finland	Academy of Finland
France	Académie des Sciences
Greece	Alexander S. Onassis Public Benefit Foundation
Hungary	Hungarian Academy of Sciences
India	Department of Science and Technology
Ireland	Dublin Institute for Advanced Studies
Israel	Weizmann Institute of Science
Italy	Fondazione Cariplo
Japan	Japan Society for the Promotion of Sciences
Jordan	Jordan University of Science and Technology
Latvia	University of Latvia
Liechtenstein	Hochschule Liechtenstein
Lithuania	The Lithuanian Academy of Sciences
Luxembourg	Fonds National de la Recherche
Malaysia	Academy of Sciences Malaysia
The Netherlands	Royal Netherlands Academy of Arts and Sciences
Nigeria	Ladoke Akintola University of Technology
Pakistan	Pakistan Science Foundation
Poland	Foundation for Polish Science
Portugal	Foundation for Science and Technology Foundation Calouste Gulbenkian
Russia	Russian Academy of Sciences
Saudi Arabia	King Saud University
Sweden	The Nobel Foundation
Switzerland	Swiss National Science Foundation
Singapore	Agency for Science, Technology and Research
Slovenia	Slovenian Academy of Sciences and Arts
Spain	Confederation of Spanish Scientific Societies University and Research Grant Management Agency
Taiwan	National Science Council
Thailand	National Science and Technology Development Agency
Turkey	The Scientific and Technological Research Council of Turkey
United Kingdom	Royal Society of Chemistry Medical Research Council Engineering and Physical Sciences Research Council
United States of America	Department of Energy (DOE) Oak Ridge National Laboratory (ORNL) National Science Foundation (NSF)

FACTS & FIGURES

Academic Partners Worldwide

International Organisations as Academic Partners

Association of Southeast Asian Nations (ASEAN)
Committee for Scientific and Technological Cooperation (COMSTECH)
European Commission – Marie Curie Fellowships
European Molecular Biology Laboratory (EMBL)
European Molecular Biology Organization (EMBO)
European Organization for Nuclear Research (CERN)
International Atomic Energy Agency (IAEA)
Internationale Bodensee-Hochschule (IBH)
International Human Frontier Science Program Organisation (HFSPO)
The Academy of Sciences for the Developing World (TWAS)

Nobel Laureates Nominating Participants in 2010:

Peter Agre
Zhores Alferov
Francoise Barré-Sinoussi
Martin Chalfie
Theodor W. Hänsch
Alan J. Haeger
Harald zur Hausen
Robert H. Horvitz
Robert Huber
Klaus von Klitzing
Yuan Tseh Lee
David M. Lee
Erwin Neher
Ryoji Noyori
George A. Olah
Marcus A. Rudolph

Academic Partners in Germany

Alexander von Humboldt Foundation (AvH)
Association of the Chemical Industry (VCI)
Association of Bavarian Chemical Industry (VBCI)
Association of German Engineers (VDI)
Bavarian Academy of Sciences
Deutsche Bundesstiftung Umwelt (DBU)
Deutsche Telekom Foundation
Eduard Rhein Foundation
Elite Network of Bavaria
European Students' Conference (ESC), Charité Berlin
Foundation Mercator
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung (FhG)
Fulbright Commission Germany
German Academy of Science and Engineering (acatech)
German Academic Exchange Service (DAAD)
German Research Foundation (DFG)
German Aerospace Center (DLR)
Gottlieb Daimler and Karl Benz Foundation
Helmholtz Association of German Research Centres
Hertie Foundation
Klaus Tschira Foundation gGmbH (KTS)
Konrad-Adenauer-Foundation (KAS)
Leibniz Association
Max Planck Society for the Advancement of Science (MPG)
Robert Bosch Foundation
Ernst Schering Foundation
Südwestmetall–association of metal and electrical industry in Baden-Württemberg
Volkswagen Foundation
Wilhelm Sander Foundation
XLAB Experimental Laboratory for Young People in Göttingen

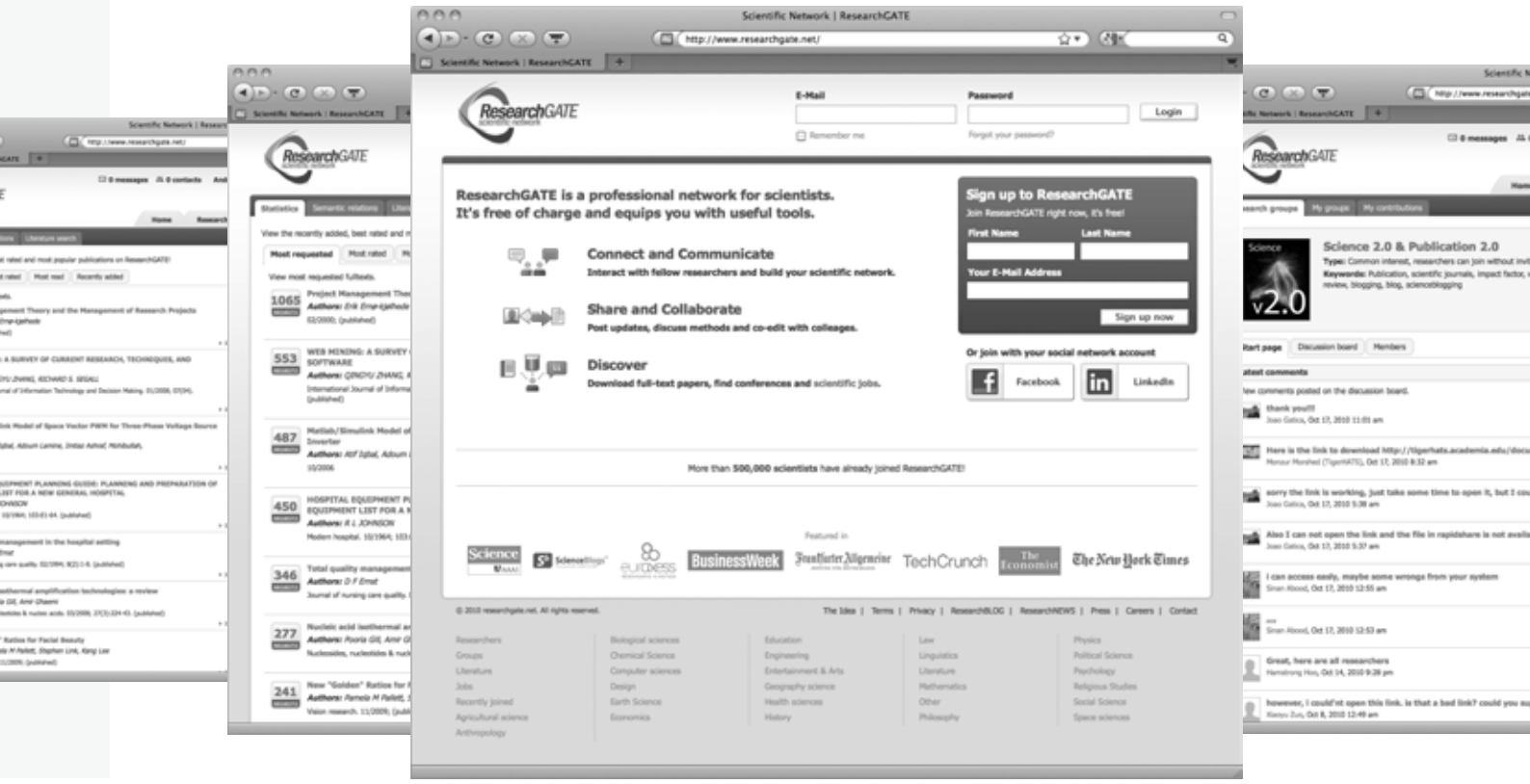
A complete list of 42 nominating German Universities can be found at www.lindau-nobel.org

THE OFFICIAL ONLINE COMMUNITY OF THE LINDAU MEETINGS AT RESEARCHGATE

In order to make even better use of the high potential of the networks forged during the Lindau Meetings, the Council and the Foundation have launched an exclusive Lindau community platform on ResearchGATE, which is the largest academic online platform for scientists. It combines services such as Facebook, Twitter, LinkedIn, and Google-Docs with scientific databases like PubMed, ArXiV, and IEEE. Currently the community has over 500,000 members worldwide. Scientists who have attended the Lindau Nobel Laureate Meetings are invited to join the Lindau Nobel sub-community to connect with their fellow alumni. Thus, the inspiring scientific discussions started during the 60th Lindau Nobel Laureate Meeting can continue in the future and be accessible to interested scientists around the world.

ResearchGATE is more than just a place to collect contacts; with its many unique features, ResearchGATE is a place for interactive collaboration. Users can work together on documents, share articles, and get advice about experimental techniques here. They can join interest based groups to trade ideas via discussion boards, share news with microblogs, and swap files, such as presentations, documents, and articles, in the file-sharing section. These groups can be made private for confidential exchanges. The “Methods Group” is especially helpful to researchers working in the lab; members trade tips about experimental techniques and methods here. Furthermore, users can store uploaded documents, such as journal articles, on their profiles, allowing others in the ResearchGATE community to access these articles as if they were published in an open access journal. Also, ResearchGATE offers interesting solutions for literature searches. With semantic searching, users can input an abstract to find articles that have similar keywords. This same search tool can also be used to identify journals that contain articles similar to users’ abstracts, which helps them find new places to publish their work.

Connecting the Lindau community online is a key strategy in the context of the ‘Mission Education’ of the Council and the Foundation.



FACTS & FIGURES

Results from the Participant Survey, Part I

The Lindau Nobel Laureate Meetings are a platform for the exchange of ideas and information between different generations of scientists. Every year the Council and the Foundation conduct a survey among the participants to evaluate their 'Mission Education'. This year a new record was set among young researchers in regard to their approval of the Lindau Meetings. Nearly 96% of the surveyed participants confirmed that the Lindau Nobel Laureate Meetings are fostering a dialogue between Nobel Laureates and young researchers. Additionally, all those polled feel highly motivated after having participated in the Lindau Meeting.

Has this year's Lindau Nobel Laureate Meeting succeeded in fostering a dialogue...

...between Nobel Laureates and young researchers?

Very much	48 %
Rather yes	48 %
Rather no	4 %
Not at all	0 %

...between young researchers from different countries?

Very much	63 %
Rather yes	22 %
Rather no	15 %
Not at all	0 %

...between young researchers from different disciplines?

Very much	62 %
Rather yes	23 %
Rather no	15 %
Not at all	0 %

...that will influence your scientific career?

Very much	34 %
Rather yes	49 %
Rather no	15 %
Not at all	2 %

...that motivates you?

Very much	79 %
Rather yes	21 %
Rather no	0 %
Not at all	0 %

A preponderant number of participants is very positive (84%) about the idea to extend the reach of the Lindau Nobel Laureate Meetings via an own online community to foster the contacts made at Lindau.

Are you interested in and would you use...

...a Lindau online community?

Very much	42 %
Rather yes	42 %
Rather no	16 %
Not at all	0 %

...an all-year Lindau blog?

Very much	29 %
Rather yes	27 %
Rather no	33 %
Not at all	11 %

...scientific online videos and multimedia?

Very much	49 %
Rather yes	36 %
Rather no	13 %
Not at all	2 %

It was a memorable experience for me being at Lindau. I think that this meeting completely achieved its three goals to educate, inspire and connect. The warm atmosphere greatly contributed to the fact that both Nobel Laureates and young researchers alike freely exchanged ideas with one another. I would like to thank everyone who contributed to this meeting and I wish this meeting a bright future since it does not only provides benefits for young researchers, but also for future frontier research.
Nithiwadee Thaicharoen, Thailand

THE 60TH MEETING OF NOBEL LAUREATES

PROGRAMME

55 lectures by Nobel Laureates from the fields of physics, physiology or medicine and chemistry in four days reflected current scientific topics and presented relevant fields of research of the future to the scientific elite of tomorrow. Four panels with their focus on biomedicine, cosmology, energy and sustainability, and on what it means to be a scientist offered insights into concepts, the generation of new ideas and the promotion of cooperation. The extensive scientific programme of the 60th Lindau Meeting of Nobel Laureates found its logical progression in a supporting programme that not only incorporated the traditional structure but also innovations.

Nobel Laureate Albert Fert during his lecture at the 2010 Lindau Meeting.

OPENING DAY

The significance of the Lindau Meetings in the 60th year of their existence, their future and their two most important groups of participants – Nobel Laureates and young scientists – were the focus of the opening ceremony of this 3rd Interdisciplinary Meeting. In a video message, young scientists at this year's meeting outlined their expectations for the coming week, thereby setting the stage for the following addresses and discussions, which were very much in the spirit of two anniversaries: the 60th Meeting of Nobel Laureates and also the 10-year existence of the Foundation Lindau Nobelprizewinners Meetings at Lake Constance. For the second time, the opening ceremony was moderated by Adam Smith, Editor-in-Chief of nobelprize.org.

Nobel Laureates and young researchers from around the globe together with representatives from the worlds of science, business and politics attended the opening ceremony. The Council and Foundation were pleased to welcome Her Royal Highness Princess Maha Chakri Sirindhorn of Thailand, who participated for the third consecutive year; Klaus Tschütscher, Prime Minister of the Principality of Liechtenstein; German Federal Minister of Education and Research, Annette Schavan; Beatrix Karl, Federal Minister for Science and Research in Austria; Turkish Minister of EU Affairs, Egemen Bagis; Toichi Sakata, Vice-Minister for Science and Research in Japan; Tony Tan Keng Yam, Chairman of the National Research Foundation Singapore; Koji Omi, Founder and Chairman of the STS Forum; and Christof Bosch, Member of the Board of Trustees of the Robert Bosch Foundation. Furthermore, Rolf-Dieter Heuer, Director General of CERN; Henning Kagermann, President of acatech; Wilhelm Krull, Secretary General of the Volkswagen Foundation and President of the Association of German Foundations; Jürgen Großmann, President and CEO of RWE; and Ernst-Ludwig Winnacker, Secretary General of the International Human Frontier Science Program were also in attendance.

**** The video presenting the participants' statements is available online at http://tiny.cc/4ryf6.***

Countess Bettina Bernadotte, President of the Council.

Countess Bettina Bernadotte: "Today's world needs joint approaches in order to succeed"

Countess Bettina Bernadotte, the President of the Council, opened the 60th Lindau Nobel Laureate Meeting. She emphasized that the Council and Foundation are very aware of the complexity of the world and its long-term problems. Complexity is a real-life feature that has to be met with interdisciplinary efforts. The stated aim of the Lindau Meetings is to promote the 'Mission Education' by bringing together scientists from all over the world in order to advance cooperation as well as to foster science and education on an international scale.

The President of the Council expressed her sincere thanks to all institutions and individuals, who, through their support, make it possible to organise the Lindau Meetings and enable the participation of the Best Talents from around the world. She stressed that the meetings have developed "into a genuine public-private partnership, where partners from science, the public and private sectors as well as non-profit organisations join forces to enable the scientific dialogue of the 21st century". Countess Bernadotte took the opportunity to particularly thank the German Federal Ministry of Education and Research and the Federal Minister, Annette Schavan, for their long-standing support.

Countess Bernadotte also highlighted the 10th anniversary of the Foundation Lindau Nobelprizewinners Meetings at Lake Constance, which was established in the

Wolfgang Schürer, Chairman of the Foundation.

Hans Jörnvall, Secretary of the Nobel Committee and Assembly at Karolinska Institutet and Member of the Council.

year 2000 (see also pp. 140). "The Foundation has developed into a sound foundation for the Lindau Dialogue, not only providing the necessary financial backing but also playing a major role in the long-lasting internationalisation of the Lindau Meetings." For his support and advice, she thanked the former German Federal President, Roman Herzog, who is also the Honorary President of the Foundation (see also pp. 33). She extended her profound thanks to Wolfgang Schürer, Chairman of the Foundation, "who works tirelessly to further professionalize the implementation of the 'Mission Education' while staying firm on the principle of pro bono work".

Wolfgang Schürer:
"It is one of my 'noble' tasks to convince others to join"

On the occasion of the 10th anniversary of the Foundation Lindau Nobelprizewinners Meetings at Lake Constance, Adam Smith invited Wolfgang Schürer, Chairman of the Foundation, to share some insights into the ongoing development of the institution. Asked why it was necessary to create the Foundation, Wolfgang Schürer remembered the involvement of the Nobel Laureates and Germany's former Federal President, Roman Herzog, in establishing the Foundation. The initial aim of 50 Laureates and a number of other supporters was one of taking stock, but almost immediately it became clear to them that the vision of the late Count Lennart Bernadotte was immensely attractive. His idea of creating a place for an intergenerational dialogue without regard to nationality, religion or gender, where for "one week, the world can meet the world of science and become inspired by the dialogue with the Laureates and their wisdom" still holds incredible impact. When asked about the future direction of the Lindau Meetings, Wolfgang Schürer underlined that the Council and Foundation shared a unanimous determination to refrain from enlarging the meetings in order to preserve their unique atmosphere. However, they had at the same time made the decision to expand their outreach by providing live streams of lectures and panel discussions, blogs, and by the use of social media tools. As the Chairman of the Foundation, Wolfgang Schürer expressed his gratitude to all Nobel Laureates, Academic Partners, benefactors and supporters who are helping to fulfil the 'Mission Education' of the Lindau Meetings. Without their commitment and dedication, this forum would not be possible at all.

Hans Jörnvall:
"This is a sign of the trust that we feel for this meeting"

Hans Jörnvall, Secretary of the Nobel Committee and Nobel Assembly at Karolinska Institutet Stockholm and member of the Council for the Lindau Nobel Laureate Meetings, conveyed special greetings on behalf of the Nobel Foundation. He described the long-term dedication of the Nobel Foundation to the Lindau Meetings by sending students from Sweden, Russia and Norway to Lindau.

Jörnvall explained that the Nobel Foundation appreciates the Lindau Meetings´ dedication to their 'Mission Education' and shares their goal to promote science and bring it to the next level. He described a "testimony of trust" the Nobel Foundation places in the Lindau Meetings. Furthermore, Jörnvall challenged the young researchers to "absorb all the experience and wisdom you can" because "the best reward you can give to the Laureates is to take part, to discuss, even to question and to modify some of their comments".

New Members of the Honorary Senate

The Foundation Lindau Nobelprizewinners Meetings at Lake Constance honoured three outstanding personalities for their tireless efforts in fostering and promoting the dialogue between science and society: Her Royal Highness Princess Maha Chakri Sirindhorn and Christof Bosch, member of the Board of Trustees of the Robert Bosch Foundation, as well as German Federal Minister of Education and Research, Annette Schavan. All three renowned individuals were inducted into the Honorary Senate, which brings together leading personalities from science, politics as well as business, and advises the Foundation Board.

HRH Princess Maha Chakri Sirindhorn, has dedicated herself to the promotion of science and research. Her aim is to make science and research usable so that new opportunities for the future can be created, and in particular, through international networking. By inducting her into the Honorary Senate, the Foundation Board is particularly acknowledging her commitment to the next generation of researchers in Thailand – for example, through the participation of young Thai scientists in the Lindau Meetings.

Christof Bosch takes a personal interest in education and research for the benefit of the common good. He is a member of the Board of Trustees of the Robert Bosch Foundation, which, with its programmes for international understanding, provides vital momentum and sets new standards in promoting the next generation of scientists. It is a reliable partner of the Lindau Nobel Laureate Meetings, with which it shares the commitment to dialogue between science and society. Christof Bosch has always played his part in this exchange and has shown consistently great dedication to it. The Foundation Board is acknowledging this by welcoming him into the Honorary Senate.

The Federal Minister of Education and Research, Annette Schavan, sees science and research not as ends in themselves, but as a service to society. With her initiatives, she contributes to Germany's international standing as a centre of science and research. One issue that is always of great importance to her is the dialogue between the humanities and the natural sciences, as also cultivated by the Lindau Meetings. By inducting her into the Honorary Senate, the Foundation Board is paying a special tribute to her outstanding work for the further development of the Nobel Laureate Meetings. She has always supported and shown a benevolent interest in the consistent widening of the Council's and the Foundation's 'Mission Education' to embrace dialogue in the interests of sustainability as well as dialogue between the natural sciences and humanities.

NEW MEMBERS OF THE HONORARY SENATE

Her Royal Highness,
Maha Chakri Sirindhorn,
Princess of Thailand:

"Science is universal and young talents from all over the world should have the opportunity to meet and work together for the benefit of mankind. The Meetings of Nobel Laureates in Lindau have provided an excellent platform for scientists. Reaching senior scientists with the young ones, embracing young talents from all over the world in an interactive atmosphere with so many top scientists like this will surely motivate and inspire them."

Christof Bosch,
Member of the Board of Trustees of the Robert Bosch Foundation:

"A gathering of Nobel Laureates and young scientists is often stated as the time when Lindau is the smartest town in the whole world. I want to reframe that a little bit. It is also probably the most intelligent response to the questions and issues of the globalisation of the human mind. (...) The most significant value arises from the alchemy, and I dare to say alchemy, of spirit that happens when excellent people meet for a free exchange of ideas, of perspectives, of knowledge and, most importantly, of open questions, of questions that don't have an answer yet. When this exchange brings together different generations, different cultures, different sciences, its transformative power multiplies."

Annette Schavan,
German Federal Minister of Education and Research:

"In recent years, the Lindau Meetings have been characterized by a second dialogue, the dialogue between science, economics and politics. This is of significant importance because it is not enough to talk of a science-based society, because it is not enough to talk of science as the lifeblood of modern society without building bridges between science, economics and politics. (...) And therefore, I want to express my gratitude to the Foundation for establishing this dialogue. It is of central importance for international politics, for national science policies and how nation states shape their own science policies."

PANEL:

What makes the Lindau Meetings special for their participants?

With a panel designed to encourage young researchers to make the most of their participation in the anniversary meeting, the opening ceremony reached its finale. Two Nobel Laureates, Ivar Giaever and Aaron Ciechanover, gave insights into the forthcoming days and explained why they like to return to the meetings. Two Lindau alumni, Horst Grimme and Bilge Dimirkoz, also told the audience what impressions they had taken home from the Meetings back in 1963 and in 2008. The panel was moderated by Adam Smith.

Horst Grimme, now an Emeritus professor of biology, attended the Lindau Meeting as a resident of Lindau and reminisced about those days in 1954: how the Laureates all dressed so well and how it was impossible for him to avoid the temptation of gate-crashing the meetings even as a high school student. Later in 1963, Grimme attended the meeting as a student of pharmacy, and what followed changed his life: On the recommendation of Nobel Laureate Otto Warburg (Physiology or Medicine, 1931), he took up research in photosynthesis and went on to become a professor of biology.

Nobel Laureate Ivar Giaever, who has participated in 14 Lindau Meetings since 1976, remembered how the meetings were attended mainly by German students until as recently as 10 years ago and noted how international they are today. He remarked on the difficulty of being selected as a researcher to come to Lindau now and said, "Congratulations! You have to be lucky to be here. Nobel Prize winners do not admit that to win the prize, they have to be lucky as well, and hopefully you (students) haven't used up all your luck to come here."

Bilge Demirkoz, attendee at the 2008 Lindau Meeting, said that she was rewarded beyond her expectations then. She was inspired by learning from and personally talking to the Laureates. But what made her participation even more special were the connections she made with fellow researchers. As a physicist at CERN, she would hardly see scientists from other fields of physics, and it was a great experience for her to meet so many young people with different research backgrounds and interests from all over the word. She is still in touch with many of them and is proud of the connections she made.

Nobel Laureate Aaron Ciechanover stressed not only the importance of the interdisciplinary role of the meeting but also the opportunity to meet people from so many countries. He called on the young researchers not to freeze with respect when meeting a Nobel Laureate, adding that they "walk on two feet, have two hands and two eyes, speak broken English like mine and push their curiosity". Discoveries that lead to Nobel Prizes are sometimes achieved by embarrassingly simple experiments and this fact should enable the researchers present in Lindau to believe in the power of their own science.

**** Article based on text by Alexander Akshat Rathi for the official meeting blog at www.lindau.nature.com***

Nobel Laureates and Lindau Alumni discussed the question why the Lindau Meetings are so special for participants.

Foundation Dinner

The festive Foundation Dinner traditionally concludes the opening day of the Lindau Nobel Laureate Meetings. At the invitation of the Foundation Lindau Nobelprize-winners Meetings at Lake Constance, representatives from the fields of science, politics and business as well as members of the Council for the Lindau Nobel Laureate Meetings joined Nobel Laureates and the Foundation Board for the evening.

The Chairman of the Foundation Board, Wolfgang Schürer, highlighted the 10th anniversary of the Foundation in his opening remarks. He thanked all supporters as well as all members of the Board of the Foundation and of the Council for their ongoing commitment to the joint 'Mission Education'. Over the last 10 years, the Foundation had been able both to strengthen the financial basis for the Lindau Meetings and to foster their internationalization, which is "a success that would not have been possible without the dedication and commitment of all our associates, partners and the Nobel Laureates". He especially thanked the German Federal Ministry of Education and Research, represented at the dinner by Minister Annette Schavan, for the constructively critical support during the transformation of the Lindau Meetings. On the occasion of the 10th anniversary of the Foundation's inception, Wolfgang Schürer presented a commemorative publication to which ten Nobel Laureates and other renowned authors had contributed (see also pp. 142).

Turkey's Minister for EU Affairs, Egemen Bagis, attended the opening day of the meeting, including the Foundation Dinner. In his message of greetings, he highlighted the importance of international cooperation in science and research, as demonstrated by the signing of a Memorandum of Understanding between the Scientific and Technological Research Council of Turkey (TÜBITAK) and the Lindau institutions last year, which enables Turkey to send some of its best young scientists to attend the Lindau Meetings each year. In 2010, eight Turkish researchers were selected. He reminded guests that the first chapter provisionally closed by the European Union in the accession negotiations was the one on science and research (in June 2006).

The Federal Minister for Science and Research in Austria, Beatrix Karl, pointed out how important the Lindau Nobel Laureate Meetings are in promoting the Lake Constance area as a location for science and research. Before the Foundation Dinner, she renewed the Memorandum of Understanding between Austria and the Lindau Meetings (see also pp. 18).

On behalf of the Council, Vice-President Helmut Sies expressed some words of gratitude to the members of the Foundation Board for their tireless efforts in fostering the Lindau Meetings and the 'Mission Education'. He highlighted the ongoing efforts of the Foundation in establishing partnerships with academic institutions around the world to give even more young researchers the opportunity to take part in the Lindau Dialogue.
The Foundation Board was able to welcome distinguished guests to this dinner. Among them were representatives of leading scientific institutions, such as Jürgen Mlynek, President of the Helmholtz Association of German Research Centres; Ernst Rietschel, President of the Leibniz Association as well as his designated successor Karl Ulrich Mayer; Matthias Kleiner, President of the German Research Foundation (DFG) and the President of the German Academy of Sciences Leopoldina, Jörg Hacker; Tony Tan Keng Yam, Chairman of the National Research Foundation Singapore; the Director-General of CERN, Wolf-Dieter Heuer as well as Petra Herz, Chairman of the Joachim Herz Foundation; Pier Mario Vello, Secretary General of the Fondazione Cariplo; and Koji Omi, Founder and Chairman of the STS Forum. Representatives from the world of business also joined the Foundation Board for this occasion, including Jürgen Großmann, President and CEO of RWE AG; Walter Kielholz, Chairman of the Swiss Reinsurance Company; Klaus Kleinfeld, CEO of Alcoa Inc; Jürgen Kluge, Chairman of the Franz Haniel Ĳ Cie. GmbH; as well as the CTO of Merck KGaA, Thomas Geelhaar.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1 Egemen Bagis, Turkish Minister for EU Affairs during his speech at the Foundation Dinner.
2 Nobel Laureate Jack W. Szostak (left) and Klaus Kleinfeld, CEO of Alcoa Inc.
3 Impressions from the Foundation Dinner
4 Former State Secretary, Wolfgang Ischinger (left) and Ernst-Ludwig Winnacker, Secretary General of the International Human Frontier Science Program.

Lennart Bernadotte Medal for Roman Herzog

Countess Bettina Bernadotte (right) together with former Federal President of Germany, Roman Herzog (center), and his wife Alexandra von Berlichingen after the bestowal of the Lennart Bernadotte Medal on Götzenburg Castle.

During an official visit to Götzenburg Castle at Jagsthausen in September 2010, Countess Bettina Bernadotte, President of the Council for the Nobel Laureate Meetings presented the Lennart Bernadotte Medal to the former Federal President of Germany, Roman Herzog. He was honoured for his long-standing commitment and dedication in support of the Lindau Nobel Laureate Meetings. In 1995, Roman Herzog became the first Federal President to visit the Lindau Meetings. Ever since, the Council and the Foundation have come to appreciate him as both a trusted and also critical companion, who continuously encourages them to further the development of the meetings with courage and purpose. The inception of the Foundation Lindau Nobelprizewinners Meetings at Lake Constance was based on a suggestion made by Roman Herzog and has proven to be a crucial milestone in giving the Lindau Dialogue a long-term and sustainable perspective.

The Lennart Bernadotte Medal is named after the 'spiritus rector' of the Nobel Laureate Meetings, Count Lennart Bernadotte (1909–2004). Since 2002, it has been awarded to individuals who have rendered oustanding services to the Lindau Meetings. Those who have received this award include amongst others the Nobel Laureates, Ernst Otto Fischer, Willis Eugene Lamb and Werner Arber as well as the Directors of the Nobel Foundation, Baron Stig Ramel and Michael Sohlman.

NATURE HAS NEVER 'RECOGNIZED' THE ARTIFICIAL SEPARATION BETWEEN CHEMISTRY, PHYSICS, BIOLOGY, NOT EVEN MEDICINE.

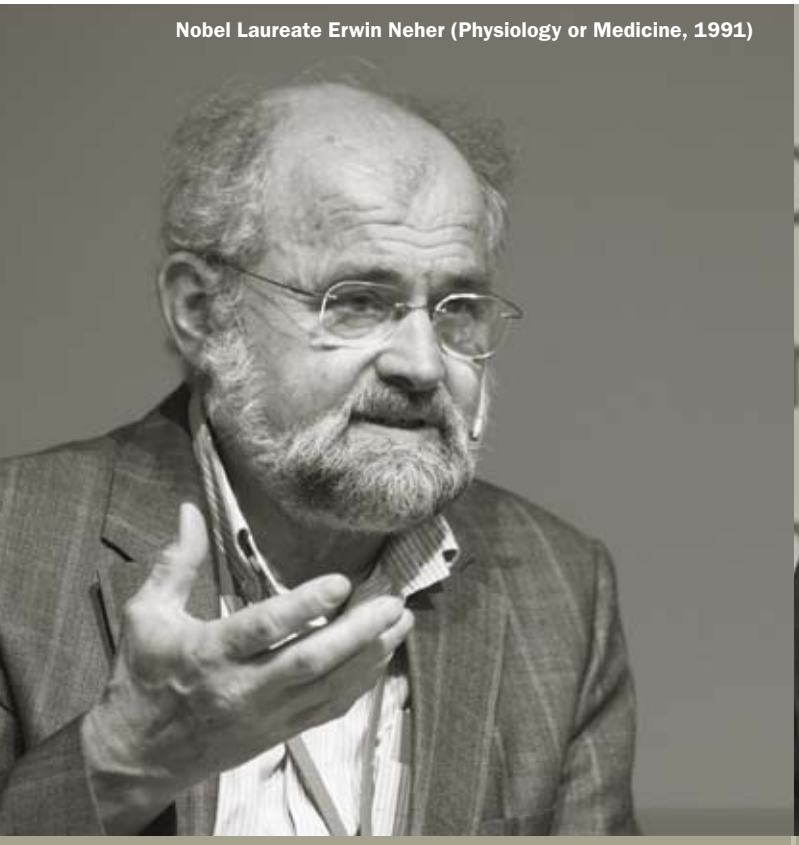
Interdisciplinary – is it a new field of research? A novel undiscovered area? No, it is a reflection of time and progress in many fields that allow us now to look at an integrated picture. Nature has never 'recognized' the artificial separation between chemistry, physics, biology, not even medicine, that were introduced by people for the convenience of teaching once universities were established in the 12th century. In living organisms – healthy as well as sick – all these 'disciplines' live under the same one roof; physical rules drive chemical reactions that occur in a biological context, that if dysregulated result in a disease. We have kept these disciplines separated as we have not been equipped with tools to look at the complex biological organism in an integrated manner. Now, with strong computational tools, and novel technologies that have exposed the genomes of many organisms and their dynamic proteomes (based on the development of novel chemical methods), and sophisticated imaging methods (developed mostly by physicists), we can start integrating the view, with the hope to be able to look at the organism as a whole, dissecting processes as they relate to the entire set of reactions occurring in the body and its response to the environment. We need to breed a new generation of scientists that will command several languages, though not necessarily in depth, as we shall still need experts in the 'narrow' classical fields. These new generations of scientists will bridge over gaps and will lead team work that will decipher the complex processes – normal as well as pathological – that are currently beyond the reach of any single expert in any discipline. The Lindau Foundation met this emerging field and challenge, assembling Nobel Laureates from the three 'classical' disciplines – physics, chemistry and physiology/medicine, thus exposing the students to the immense broadening of knowledge horizons.

Aaron Ciechanover,
Nobel Laureate in Chemistry, 2004

The 60th Nobel Laureate Meeting in Lindau has been, since my return, an inexhaustible source of inspiration and the realization one of my biggest dreams. I was astonished by the ingenuity, humility and the kindness the Nobel Laureates showed towards us young researchers and they all took time to offer satisfactory explanations to the mindboggling questions, until we understood them. During the lectures, I was amazed by the way they reasoned; how they always push hard the boundaries of human knowledge and break with conventional thinking. Also, I was impressed about how they succeeded in explaining complicated topics from different backgrounds of research to a multidisciplinary audience to understand. I realized that, it was one of the keys to been a great scientist - the ability to explain your research to someone who is not in your sphere of endeavour to comprehend. We had a unique discussion session captioned "Being a Scientist", where the Nobel Laureates shared their experiences and challenges with us, as to how to become effective and great scientists. They stressed that, to be effective, one needs to be passionate, focused, disciplined and committed to whatever research one is pursuing. They also admonished us to collaborate with other scientists in our area of interest, as well as with other non-related professionals to get their advice and input. My meeting with Prof. Oliver Smithies was one of my memorable experiences. I was taking aback to see someone at 85 years old, still researching and publishing for the advancement of the science discipline! He was a model of passion, hard work, enthusiasm. My take home message from this Lindau Meeting was from Prof. Aaron Ciechanover during the opening ceremony. Talking about his experiences as a Nobel Prize winner, he said that "It is doable"; this means that, with a passion and a lot of hard work, we could one day also, make discoveries that will change the course of science. The country of nationality does not matter. What matters is that, the passion and the love for what we are doing. Every day, I remind myself that, no matter the difficulties, the failures and the challenges that might come my way, if I am passionate and hardworking enough, one day be I will be able to make some great discoveries that will enhance the furtherance of modern science.

Alvine Kamaha,
Participant of the 2010 Lindau Meeting, Cameroon

THE COUNTRY OF NATIONALITY DOES NOT MATTER. WHAT MATTERS IS THAT, THE PASSION AND THE LOVE FOR WHAT WE ARE DOING.

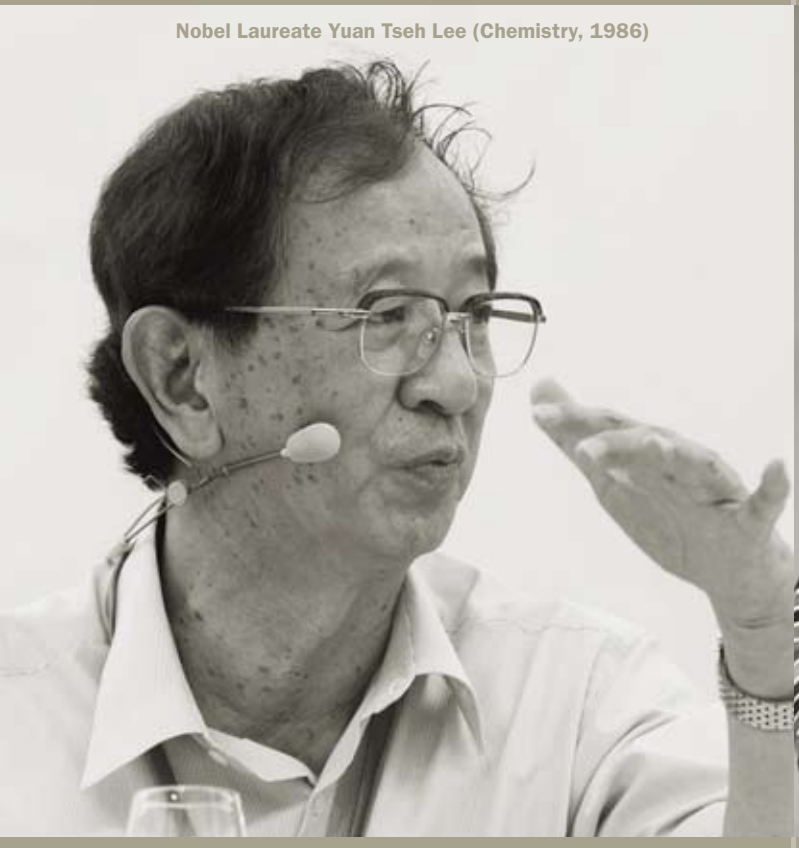


Nobel Laureate Erwin Neher (Physiology or Medicine, 1991)

PAGE 37 FOCUS:
Biomedicine and the Molecules of Life

Nobel Laureate George F. Smoot (Physics, 2006)

PAGE 40 FOCUS:
Cosmology



Nobel Laureate Yuan Tseh Lee (Chemistry, 1986)

PAGE 42 FOCUS:
Sustainability

Nobel Laureate Françoise Barré-Sinoussi (Physiology or Medicine, 2008)

PAGE 45 FOCUS:
On Being a Scientist

SCIENTIFIC PROGRAMME

In the 21st century, interdisciplinary research will play a central role in finding solutions for the imminent problems of this planet, such as climate change, the shortage of natural resources or the spread of epidemics and diseases. The 2010 Lindau Meeting contributed to the solution of these challenges by offering insights into concepts, generating new ideas and promoting cooperation between disciplines, cultures and nations. The scientific programme of this 3rd Interdisciplinary Lindau Meeting offered more than 50 plenary lectures and seminar-like discussions as well as a number of high-level panels, with a focus on cosmology, biomedicine, sustainability as well as today's challenges for the top scientists of tomorrow. Together with the open dialogue between Nobel Laureates and young researchers, this unique composition of themes made the 60th Lindau Nobel Laureate Meeting a fertile and productive "laboratory for the future", as it was described by the Frankfurter Allgemeine Zeitung (FAZ).

FOCUS:

Biomedicine and the Molecules of Life

The scientific programme of the 60th Lindau Nobel Laureate Meeting was opened by Ada E. Yonath, the fourth woman ever to be awarded a Nobel Prize in Chemistry (2009) with her lecture "The Amazing Ribosome". Her subject perfectly fitted the interdisciplinary approach of this year's meeting, as she presented a specific biological factory of medical importance whose chemical construction she elucidated with a physical method. After talking about the catalytic activities of rRNA as well as the mechanisms of antibiotic action, Ada E. Yonath finished with some more personal thoughts on being a scientist and simultaneously having a family: "You can be a scientist and a loved family member," she said, addressing female participants in particular. "Please, ladies, go into science, it's a lot of fun!"

Knowing the spatial structure of a biomolecule does not necessarily enable a scientist to directly deduce its function. Many correlations between structure and function are yet to be resolved, as Nobel Laureate Johann Deisenhofer (Chemistry, 1988) discussed in his talk on "Structural Studies on Cholesterol Transport". Nuclear magnetic resonance (NMR) spectroscopy might help for a better understanding and is gaining increasing importance in the structural elucidation of biomolecules. One of its pioneers, Nobel Laureate Kurt Wüthrich (Chemistry, 2002), talked about "Structural Genomics and the Expanding Universe of Protein Sequences".

Nobel Laureate Jack W. Szostak (Physiology or Medicine, 2009), who received his award for his contribution to the understanding of the telomerase enzyme, explored the topic of the origin of life and of designing an artificial cell by taking inspiration from places on Earth which are extremely hostile and still have life. His research centres on the question of how self-organising systems could be exploited to polymerise unnatural DNA without DNA polymerase. He showed results of such polymerisation as a chemical reaction within a 'cell' that was made out of the simple phospholipid membrane.

Nobel Laureate Harald zur Hausen during his lecture.

In 2010, all three recipients of the Nobel Prize in Physiology or Medicine in the year 2008 were present. Nobel Laureate Harald zur Hausen lectured on "Human Cancers Linked to Infections". He demonstrated how cancer can possibly be caused by infections. As such, he mentioned the papilloma virus (HPV), for whose role in cervical cancer he was jointly awarded the Nobel Prize in 2008. Zur Hausen explained that there are many more viruses

that possibly introduce oncogenes into their host cells, thereby potentially turning them into tumour cells. In some cases, even parasites can lead to cancers, such as schistosoma being associated with bladder cancer. He estimates that 21 percent of all global cancer incidents are linked to infections – and many of them are preventable. Harald zur Hausen also showed another interesting aspect that might lead to new ways of reducing the prevalence of cancers. In comparing risk factors for early-childhood leukaemia, he pointed out that infections during our childhood in general lower the risk of developing such a cancer. However, if the infections occur frequently in the first year of life, this increases the likelihood – presumably, the immune system is not able to fully develop as a result. In order to reduce such types of cancer that are triggered by infections, zur Hausen urged more research into vaccines. Together with his wife, Prof. Ethel-Michele de Villiers, he is also currently carrying out research into the TT virus – a virus that 'only' attacks the liver per se, but which is at the same time believed to be responsible for the development of brain tumours and auto-immune illnesses, such as asthma or multiple sclerosis. The fascinating relationship between infections and cancer has been a recurring theme for a number of Nobel Laureates in Physiology or Medicine in the past 50 years. In fact, this year marks the 100th anniversary of one of the first important discoveries in the field. Nobel Laureate Peyton Rous (Physiology or Medicine, 1966) in 1910 described a malignant chicken sarcoma which could be propagated by transplanting its cells, forming new tumours in other chickens. He also showed that these tumours were caused by a virus (the Rous Sarcoma Virus), but it took 15 years of discussions before the scientific community unanimously accepted this connection.

Zur Hausen's lecture was followed by Luc Montagnier, who provided an insight into his research that analyses DNA under physical as well as biological aspects. These lectures were completed by the third recipient of the Nobel Prize in Physiology or Medicine in 2008, Françoise Barré-Sinoussi, who talked about the discovery of HIV and how it was facilitated by global translational research.

**** Article based on blog entries by Michael Fenner and Jessica Riccò for the official meeting blog at www.lindau.nature.com***

PANEL DISCUSSION

Impact of Chemistry and Physics on Biomedicine: Where is the Future?

The Tuesday panel discussion gave insights into possible future interdisciplinary interconnections in science and research. As scientific knowledge has become more specialised, the need for interdisciplinarity is becoming even more pressing. Nobel Laureates Aaron Ciechanover, Ivar Giaever, Erwin Neher, Roger Y. Tsien and Harald zur Hausen participated in the panel, which was chaired by Hans Jörnvall and Helmut Sies.

How can basic physics contribute to medicine?

Starting the discussion with a historical reference to the discovery of X-rays by physicist and 1901 Nobel Laureate, Wilhelm Conrad Röntgen, and its many implications for medicine, Helmut Sies raised the question "How can basic physics contribute to medicine?" Erwin Neher noted that physics has contributed substantially to the large arsenal of imaging techniques, such as alpha microscopy, resonance microscopy, PET or CT scans that are available for diagnostic purposes in medicine today and are commonly acknowledged by medical doctors as the most important recent innovations for their discipline. Chemist Roger Y. Tsien added the example of Boron Neutron Capture Therapy (BNCT) in cancer treatment and advised physicists of the increasing demand for neutron generators in medicine. Generally, Roger Y. Tsien sees an increasing demand for the expertise of theoretical physicists in biomedicine. Many of them seem to have gone on to careers in financial engineering on Wall Street, but future graduates should reconsider this and rather help with the analysis of large biological datasets. "This is my plea to some of you out there," Roger Y. Tsien said to all young physicists in the audience.

What can physics and chemistry learn from biology?

Turning the question around, Helmut Sies then asked the panel, "What can physics and chemistry learn from biology?" Erwin Neher took up the example of brain studies and explained the links between neuroscience, statistical physics and engineering, and Roger Y. Tsien encouraged young researchers to focus on finding better non-invasive ways of studying neuronal activity.

Nobel Laureates discussing the possible future interdisciplinary interconnections in science and research.

As another example of research intersections between physics and biomedicine, Erwin Neher pointed out that stochastics play an important role in the study of decision-making and that neurotransmitters are released stochastically. Referring to research findings that cancer and pathogens operate on Darwinian selection, Roger Y. Tsien raised the question whether evolution might be used to explain biologic processes in diseases. In this regard, Harald zur Hausen showcased the evolutionary character of viral DNA integrating into the human genome.

One young scientist from Germany asked the panellists whether quantum physics provides useful input for biology and biomedicine. Roger Y. Tsien and Erwin Neher disagreed with Ivar Giaever, who argued that quantum physics was far too complicated to be embraced in biological research. Neher and Tsien countered with the examples of photoreception or photoconversion of energy to underline that understanding of quantum physics is in fact often indispensable when studying biological processes.

Despite promising examples of successful interdisciplinary research, Ivar Giaever also warned against going too far in crossing boundaries of disciplines. Interdisciplinary research projects would often fail to include specialists. Giaever pointed to the example of 10 institutes at the National Cancer Institute in the USA which are all led by physicists instead of medical doctors. "I don't think that's a particularly good idea," he said.

However, Aaron Ciechanover put this into perspective by pointing out that if specialists from different disciplines collaborate closely and keep the big picture in focus, then there are many synergy effects to be expected from interdisciplinary research.

Boundaries between physics, biology and chemistry are in fact artificial.

Ending with the statement by Harald zur Hausen that interdisciplinary cooperation and teamwork between students and young researchers is necessary and highly beneficial, the panel came to the conclusion that the integration of biology or medicine, chemistry and physics is a guiding strategy in science and research. Summing up, Aaron Ciechanover made the point that the boundaries between physics, biology and chemistry are in fact artificial: "They are concepts developed from our need to teach. […] Processes in nature like photosynthesis are not biology or chemistry or physics, but they encompass them all. And as the mode of classical research is changing, from biology to systems biology, for example, it will require us to find a new way to think, to teach, and to work in teams."

FOCUS:
Cosmology

Cosmology is a recurring theme at the Lindau Nobel Laureate Meetings. Although it is a relatively recent discipline in physics, it has already had a tremendous impact on our view of the universe. The questions regarding how our universe began and how it will develop in the future are a hotly debated topic among the scientific community. Young researchers and Noble Laureates had ample opportunity at this year's meeting to discuss recent advances in the field of particle physics and their influence on cosmology.

First-time participant Nobel Laureate John C. Mather (Physics, 2006) took the audience on a walk through "The History of the Universe, from the Beginning to the Ultimate End". First, there was the Big Bang. Then a brief period of stupendous growth occurred, known as 'inflation'. The early universe was extremely hot and contained simple particles of matter as well as antimatter; the matter and antimatter annihilated upon contact until only one part per billion of the early universe was antimatter. Within the first three minutes, the formation of helium nuclei had occurred. The universe remained in a dense fog of mostly free protons, electrons and helium nuclei until about 400,000 years after the Big Bang. At this point, the universe had cooled enough to enable electrons to be captured by the free protons and helium nuclei to form neutral atoms. The photons, which up until this point had been scattering off the free particles, suddenly found that they could effectively travel the entire distance of the universe before having another scattering. These photons cooled as they traversed the expanding universe until they encountered the detectors on the Cosmic Background Explorer (COBE). Mather also referred to the forthcoming James Webb Space Telescope, which is planned to succeed the Hubble Space Telescope in 2014. He argued that this large, infrared-optimized space telescope will, among other things, seek Earth-like planets and glean clues about their chemistry.

In 2006, John C. Mather received the Nobel Prize in Physics together with George F. Smoot for their discovery of the blackbody form and anisotropy of cosmic microwave background (CMB) radiation. ▶ p. 42

SPECIAL AFTERNOON DEBATE

What will CERN teach us about the Dark Energy and Dark Matter of the Universe?

When six distinguished physicists – Nobel Laureates David Gross, John C. Mather, Carlo Rubbia, George F. Smoot, Gerardus 't Hooft and Martinus J. G. Veltman – debate on what CERN will teach us about dark energy and dark matter, you cannot guarantee the same kind of harmony that these physicists strive for in their own theories. There was a majority agreement that there are triumphs in cosmology concerning the discovery of missing mass (dark matter) and the observation of the accelerating universe (dark energy). There was also agreement that CERN will place constraints or make discoveries on dark matter; however, it is not at all clear whether CERN has any bearing on dark energy.

The debate was opened by Lars Bergström, member of the Council; and moderated by UK-based science journalist, Matthew Chalmers. It opened with short lectures on the standard cosmological model and standard particle physics model in order to place the discussion in context. George F. Smoot briefly discussed the standard cosmological model's great successes, and David Gross covered dark matter and dark energy from the perspective of particle physics. Gross pointed out that dark matter was the first form of matter to be discovered by looking at the sky. He was intrigued by the prospect of Weakly Interacting Massive Particles (WIMPs) being detected at CERN because WIMPs have a mass predicted from theoretical considerations somewhere between 100 Gev to 1 Tev, which is just right for the Large Hadron Collider (LHC).

During the entire talk, there was a video conference link to the control room at CERN, where the LHC was colliding particles at 3.5 Gev. Sergio Bertolucci, Director for Research and Scientific Computing at CERN, spoke about the enormous demand for experimental results and pointed out that the LHC was doing its part, with which the panel in Lindau agreed. Bertolucci interjected into the discussion the sense of excitement when experiments lead to the discovery of unknown unknowns.

On Tuesday afternoon Nobel Laureates discussed what scientists hope to learn from experiments at CERN using the LHC.

Dark matter may be on the road to exact experimental determination in the next decade.

The multitude of observations that support the existence of dark matter have led astrophysicists to conclude that the presence of dark matter is the most natural solution to the missing mass problem rather than modifying fundamental theories of gravity. Rubbia thinks that, given that there is such a large amount of dark matter present, it must be streaming through us and detectors, so dark matter will eventually be detected here on Earth, assuming it has some interaction other than gravity. Although, it is not obvious that dark matter will have interactions in nature besides gravity, but if it does have an electroweak interaction, there are two good possibilities. First, in supersymmetry theory, each particle in the standard model has a supersymmetric partner and the lightest supersymmetric partner particle would be stable, and this particle may be the WIMP. The second possibility is that there could be sterile neutrinos beyond the standard three known flavors (electron, muon, tauon) and current experiments on neutrino oscillations could be key in discovering discrepancies. Gross summarized the situation by stating that dark matter may be on the road to exact experimental solution in the next decade, particularly because the LHC is at just the right energy.

There is more to learn about physics and cosmology from the LHC.

Gross opened the discussion about dark energy by expressing his opinion that dark energy is exceptionally poorly named. It is not energy but negative pressure that is acting on our universe to cause accelerated expansion, so if anything, we should call it dark pressure. Dark energy is actually a triumph of Einstein's theory, not his biggest blunder, Gross explained as the rest of the panel murmured protests regarding the historical accuracy of this story. The discussion turned at one point to the best evidence we have to date for dark energy, which is type Ia supernovae used as standard candles. Rubbia insisted we must determine whether we fully understand these supernovae and we need to gather more data and statistics on them. Mather was careful to inform the audience that we have several other methods for measuring dark energy, including microwave background radiation, baryonic acoustic oscillations and the growth of structure. 't Hooft pushed the theoretical frontier when he stated that we need to quantize gravity, a problem that has daunted physicists, for close to a century.
The panellists agreed that there is more to be said and more to learn about particle physics and cosmology from the LHC. The LHC is set to confirm or throw into doubt all of physics and the standard model when it begins to gather data to confirm the existence of the Higgs Boson (which is the mechanism that imparts mass to all particles), and the LHC may also shine a light on dark matter and energy.

**** Shortened version of article written by Alexander Bastidas Fry for the official meeting blog at www.lindau.nature.com***

In his lecture "Mapping the Universe and Its History", George F. Smoot further elaborated on this issue. A precision inspection and investigation of CMB radiation and other observations, along with careful analysis, discussion and computer modelling, have allowed us to determine what happened over billions of years with amazing certainty and accuracy. He took the opportunity to tell young scientists a few more details about CMB radiation and its ramifications. The minor variations in CMB radiation are quantum fluctuations that were supersized during the period of inflation. Smoot said that our own galaxy was a quantum fluctuation at one time. Through analysis of the CMB using the technique of spherical harmonics, Smoot argues that the early universe is extremely linear and that deviations from the known amount of dark matter, dark energy or age of the universe create significant inconsistencies with the data and the theory.

Since physicists have realized that only 4 percent of the universe consists of known ingredients, while 96 percent is made up of dark matter and dark energy, the basic construction of this fabric is more mysterious than ever before. For Carlo Rubbia (Physics, 1984), "the nature of dark matter in the universe is one of the major unsolved mysteries in cosmology". Now, the huge particle accelerator, the Large Hadron Collider (LHC) at the European Nuclear Research Centre (CERN) in Geneva, Switzerland, offers the opportunity to shed light on this darkness.

FOCUS:

Sustainability

Sustainability was again a core theme of this year's meeting with a wide range of lectures and discussions focusing on sustainability. For example, Nobel Laureate Richard R. Ernst (Chemistry, 1991) invited young researchers to "Develop concepts for a beneficial global future". In his lecture, he directly addressed his audience since they will potentially assume leading positions in tomorrow's society and are expected to contribute to a beneficial future. He stressed the importance of developing this issue solutions for today's economic and ecological problems, because otherwise future generations will be severely limited in their scope of actions. As an example of these limitations, he named the depletion of natural resources. Ernst picked up on one of the major themes of the Lindau Meetings of building bridges between science, politics and the economy because only joint efforts will have a chance of success, since "all the major problems to be solved are of global relevance and require for their solution strong international institutions".

Robert C. Richardson, who was awarded the Nobel Prize in Physics in 1996, argued in his lecture "The Looming World Shortage of Helium" that we can already expect the first critical shortages of important resources in the near future. Helium molecules, produced by the sun's energy, naturally make up only about five parts per million of the Earth's atmosphere. Helium is used in a wide range of medical and scientific fields and is very important to many industrial processes. Based on a survey done in 2007, 28 percent of helium was used for cryogenics, for MRI and nuclear magnetic resonance machines for medical purposes. Some 26 percent of helium is used in pressurizing and purging of rockets, another 20 percent for welding, and 13 percent provides inert atmospheres in the production of fibre optics, LCD displays and food. Helium is currently used quite carelessly. Since the United States of America, which hold a majority of the world helium stocks, decided to sell of these helium reserves, the prices on the world market have been falling continuously. Mostly, helium is not recycled and is instead simply vented. "Once helium is released into the atmosphere in the form of party balloons or boiling helium, it is lost to the Earth forever," Richardson points out. He explained that this development is very problematic because it is currently cheaper to buy helium instead of recycling it, thereby rapidly depleting the globally available supplies. His lecture was concluded with the sentence "That which God has taken 4.7 billion years to create will be dissipated in a little more than 100 years".

Nobel Laureate Robert B. Laughlin (Physics, 1998) took a look into the future. During his lecture "When coal is gone", he discussed the scenario when there is no more oil or coal available for usage as fuel. Elaborating on the energy density of carbon-based fuels and their relations to gross domestic product (GDP), he explained how essential energy is to economic growth. ▶ p. 45

PANEL DISCUSSION

"Energy and Sustainability"

The panel discussion on Friday on the Isle of Mainau centred on one of the currently most demanding topics of mankind. The panellists Nobel Laureates Yuan Tseh Lee and Carlo Rubbia, Hans J. Schellnhuber (Director of the Potsdam Institute for Climate Impact Research) and Georg Schütte (State Secretary of the German Federal Ministry of Education and Research) discussed how to sustain our energy supply, how to sustain the economy that keeps us prosperous and how to sustain the biosphere that keeps us alive. The panel was moderated by Geoffrey Carr (science editor of The Economist).

Sustainability is a technological, economic and cultural issue.

In the course of the discussion, it became evident that multidimensional approaches are needed to tackle the challenge of sustainability. In view of the enormous growth in population and the resulting growing demand for energy supply, Yuan Tseh Lee sees no other option to evade the menace of energy shortage than to rethink the constant development of our societies. "Humanity is simply living beyond its means," he said.

Taking into account the constant growth of population, he sees no further potential for development and postulates an immediate turning back to a sustainable life in tune with nature and its finite resources. Hans J. Schellnhuber provided a system analysis of the challenges of climate change. Defining sustainable development in general as "perpetual progress within boundaries", he identified three approaches to the problem: First, "pushing the boundaries", meaning the quest for new energy resources; secondly, "accept and accommodate the boundaries", which means allocating and distributing the existing resources more effectively and justly within these boundaries. The third approach is the focus on development in fields where there are no boundaries at all. Referring to estimations that the world population will grow to 9 billion by the year 2050, Schellnhuber pointed out that mankind is left with "40 years for probably the biggest transition in the history of humanity", namely transforming the energy system by decarbonising and going completely renewable or nuclear. Speakers from the audience recollected notions of recycling efforts, cradle-to-cradle initiatives and preservation of biodiversity as apparently trivial means of sustaining the biosphere.

The Isle of Mainau was not only the location of the exhibition "Discoveries 2010" which focused on the topic of energy but also hosted this year's panel discussion about "Energy and Sustainability".

In fact, they are indications of the change or shift of perspective in society demanded by Georg Schütte. "People should learn to value a healthy environment as being equally important as prosperity and safety," he said. With numerous societies around the world in different states of political, economic and cultural development, negotiating a global sustainability programme is a difficult process which is likely to produce multiple answers to the questions of climate change and the future of energy. Nevertheless, Schütte called for action now and proposed the implementation of research policies, initially on national levels, which leave no options for energy research untouched.

Limit emissions and go renewable!

Asked about the key technologies in a sustainable energy economy of the future, the panel consented to the notion that limiting emissions is only possible by replacing fossil energy resources with renewables. Carlo Rubbia was optimistic that innovations of science and research in the fields of solar and nuclear energy will compensate for the loss of fossil energy resources, such as gas, oil and coal, and put an end to the "fossil age" we are living in at present. "Science can once again solve the problem," he said. "But how, for instance, will we be able to fly when oil is gone?" a young scientist asked. Carlo Rubbia agreed that not all forms of energy are equivalent and that the problem of transportation was not yet solved. But he and Georg Schütte hinted at recent improvements in the fields of synthetic fuels and electro-mobility to tackle this problem. With regard to carbon capture and storage (CCS) and geo-engineering, the discussion was predominated by scepticism over their applicability and effectiveness.

Getting society aboard

The observed lack of consciousness about sustainability among larger parts of society was detected as a serious matter. A young American scientist from the audience brought the example that sudden snowfall in Houston, Texas, was publicly regarded as counter evidence against global warming and asked the panellists to suggest a communication strategy for this issue. Yuan Tseh Lee complained that the general public does not get the significance of global mean temperatures. With the daily temperature ranging between 20° C, a possible 2° C shift in the global temperature does not sound threatening enough to non-scientists.

Nobel Laureates, young researchers and representatives from science and politics engaged in a lively debate about "Energy and Sustainability".

Hans J. Schellnhuber introduced a metaphor that might clarify the danger of global warming: "A rise in human body temperature of around 2° C might only cause fever, whereas a rise of around just three degrees Celsius for a significant length of time could lead to death.". Generally, the reluctance to communicate with the public was seen as a general problem within the scientific community because intensive communication work is often rather unrewarding in a scientific career. Another problem concerns public confusion, scepticism and even disbelief regarding scientific findings on climate change, such as the assigning of recent temperature rises to anthropogenic CO_2. Taking recourse to paleoclimatology, Hans J. Schellnhuber stressed that greenhouse warming is on a strong scientific footing. There was consensus among the panellists that improved scientific models could help to generate a broad consciousness of climate change, but considering the large costs in terms of computing power, they all agreed to rather spend these means on counteractions against common effects of climate change. Bringing the debate to a conclusion, Yuan Tseh Lee positioned himself clearly by saying, "Do we need to spend these enormous heaps of our natural resources to make us happy? I say: No. We don't have to go that way."

And this demand will steadily increase in the future. Laughlin concluded that finding a reliable and readily available energy source will be paramount for our future since the need for energy will also dictate the future of the global geopolitical system.

FOCUS:

On Being a Scientist

The Lindau Nobel Laureate Meetings are not only about science. They are also about promoting the exchange of ideas and knowledge through personal interaction. The value of personal interactions is highly regarded by Nobel Laureates and young researchers alike. One question which is always intensely debated among participants at the Lindau Meetings is what it means to be a scientist. As a first-time attendee, Nobel Laureate Oliver Smithies (Physiology or Medicine, 2007) used the 60th Lindau Meeting as an opportunity to talk about "Chance, Opportunities and Planning in Science". By using his lab notebook as a guide, he took the audience on a tour through his scientific career, from its beginnings to the present day. Smithies started by describing his chance invention of molecular sieving lectrophoresis by using starch instead of filter paper. Using blood samples of friends and colleagues, he discovered complicated genetic differences between the plasma proteins of different people and seized the opportunity to investigate these complex new findings. The ability of planning had the most important consequences for his work. By doing so, he was able to devise a plan to alter genes in living cells by homologous recombination, which has been hugely successful. Smithies told the audience that he highly values cooperation between scientists and advised young researchers to "never hesitate to ask for help from other scientists. Most of the time you will get it, so 9 times out of 10, you will get joy." By showing not only his successes but also his failures, Smithies was an immensely inspirational example in answer to the question of what it means to be a scientist. In response to questions from the audience about whether he enjoys being a scientist, his message to all the young researchers present was: "When you are still doing experiments on a Saturday when you are 85, you are enjoying life as scientist".

Nobel Laureate Martin Chalfie (Chemistry, 2008) held a lecture about his "Adventures in Nontranslational Research", meaning research that does not directly translate findings in the laboratory into new treatments for medical conditions. He used examples from his own research in developing the green fluorescent protein (GFP) as a biological marker to highlight the importance of basic research. Chalfie told the audience that science can be fun despite some of the politics involved when publishing data, and shared the story about the title of his key science paper, where he was told to omit the word "new" because "everything in science is new". Chalfie ended his talk by highlighting five points which young researchers should always keep in mind:
1) Success may come via many routes. 2) Scientific progress is cumulative. 3) Students and post-docs are the lab innovators. 4) Basic research is essential. 5) All life should be studied, not just model organisms.

Although the theme of his lecture was "Designing molecules and nanoparticles to help see and treat disease", Nobel Laureate Roger Y. Tsien (Chemistry, 2008) punctuated his talk with references to how and why he had made certain decisions in his scientific career. From admitting to liking "pretty colours" since he was a child, as well as being from a family of engineers, to describing an affinity with Feynman's famous quote "What I cannot create, I do not understand", his explanations were lucid, often personal and derived from basic principles. Even his decision to move into more clinical applications of fluorescent imaging techniques has been prompted by the deaths of his father, nephew and PhD supervisor due to cancer.
Tsien showed a good sense of humour in his awareness of the pressures and politics in science with statements such as "that was all well and good and it got me tenure, but I needed to do something that was more acceptable". He also joked about naming the rainbow of fluorescent markers that his lab developed by using the colour scheme on the Crayola website. Tsien advised the young researchers that it is important to be persistent in what they do and that prizes are ultimately a matter of luck, so they should avoid being motivated or impressed by them.

Nobel Laureate Oliver Smithies during his lecture at the 60th Lindau Nobel Laureate Meeting.

PANEL DISCUSSION

Being a Scientist

On Thursday, Nobel Laureates Françoise Barré-Sinoussi, Sir Harold W. Kroto, John C. Mather and Oliver Smithies gathered for an interactive brainstorming session on the topic of what it takes to be a scientist, moderated by Adam Smith, Editor-in-Chief of nobelprize.org. With their diverse scientific and personal backgrounds, representing the interdisciplinary composition of the audience and the diversity of subjects discussed at the 60th Lindau Nobel Laureate Meeting, the panellists gave an account of their approaches to science.

Work hard? Play hard!

At the beginning of the discussion, Oliver Smithies emphasized that a scientist should enjoy what he is doing. Therefore, his advice to young researchers was not "work hard" but rather "play hard". Similarly, John C. Mather recounted that his scientific career had always been based on the pleasure of devoting himself to a field of research that had fascinated him since his childhood. Sir Harold W. Kroto pointed out that a scientist should commit himself entirely to his work, but to him, this meant not only having fun but also continuously striving to achieve the best results. Consequently, his advice was never to resign oneself to second-rate work, but to focus on subjects that match one's interests and abilities.

Explain and advocate your work.

Asked by Adam Smith about the most important abilities of a scientist, the panellists all agreed on communication skills, but with different approaches. Besides the ability of logical reasoning, a successful scientist should have strong communication skills in order to explain and advocate his work and thus get support from others, said John C. Mather. In physics in particular, scientists would face major challenges trying to explain highly complex matters such as cosmology or the "big bang" to a non-physicist audience. Using simple language with metaphors and similes might help in some cases because a small story told well is often more persuasive than a long talk full of scientific details held poorly. Generally, Sir Harold W. Kroto added, improving one's presentation skills to the fullest is part of every scientist's job. He advocated the advantages of presentation programs, such as incorporating images and multimedia applications, and argued that it was a highly effective presentation tool if applied skilfully. However, Oliver Smithies warned that the over-reliance on presentation programs for presentations might result either in misleading complexity or over-simplification. Consequently, his advice to young researchers was also to practise non-technical presentation skills. According to Françoise Barré-Sinoussi, beyond being able to provide information for a scientific audience and educate fellow researchers, scientists should also be capable of communicating their work to any member of the civil society, regardless of their educational background, by translating scientific language into common language.

Balance your career and family.

The first question from the audience, raised by a young Austrian scientist currently working in Japan, tackled the important issue of whether scientists are able to handle both their time-consuming professional career and a family or partnership. "Especially in science," he said, "we are vitally dependent on our partners to support us." Oliver Smithies answered that family life was not only compatible with a scientific career, more than that, it was an essential part of it. Without strong support from their families, partners or friends, scientists would not be able to commit themselves intensively to their research. Therefore, he argued, it is absolutely necessary to balance family life and a professional career in a way that neither the partners or family members are neglected nor the research work loses out. However, Françoise Barré-Sinoussi thought that it was a very personal and individual decision about how to deal with this issue. For instance, she recounted humorously that she had spent the day of her wedding in the lab. Nevertheless, she emphasized that the rather erratic lives of scientists call for relationships with partners who show full understanding and are able to adapt to the unsteady rhythm of life of their spouses.

Convince the general public of scientific evidence.

Another issue raised by the audience concerned the difficulty of science explaining itself to the general public,

Nobel Laureates discussing the challenges scientists are facing.

and thus, being legitimated as an important system within society. The examples of Copernicus or Charles Darwin have shown that scientists often face rejection and mistrust when they propose major changes in matters of common knowledge. Sir Harold W. Kroto argued that it is in fact the mission and duty of scientists to transfer uncommon sense into common sense by providing evidence for their findings. However, as evidence is often not easy to find, science is continuously challenged to explain itself. The current debate on climate change is a vivid example of our timeof science being confronted with scepticism and disbelief by parts of society. Even when evidence is provided and explained fully, patience is often an essential characteristic and rule of conduct for scientists, John C. Mather added.

Build a network.

The role of a leading scientist requires the ability to listen to people and rely on them. In this context, Françoise Barré-Sinoussi explained that she does a lot of networking to identify key individuals with complementary competencies whom she can trust and rely on as collaborators. To her, it is essential to be in close connection with her colleagues and cooperation partners at all times. Although this is facilitated by new communication and information technologies, she underlined the importance of personal encounters and direct dialogue with partners, employers and employees as a source of mutual inspiration and motivation. Productive collaboration in general, Oliver Smithies added, always includes anticipating and also working for the beneficial outcome for your collaborator. Thus, one can build up a large network of scientific friends. In addition, John C. Mather's job as senior project scientist at NASA requires a significant amount of management ability and organisational skills. Conceiving ideas is one thing, but instructing staff teams of hundreds of people and passing multi-step production processes in order to put the original idea into practice, is another essential responsibility of scientists working on large-scale projects like the launching of satellites.

When to stop if a research project produces no rewarding results?

"Once you get bored" was Oliver Smithies' direct answer to this question asked by a young scientist from Nigeria, putting into perspective that terminating an unrewarding project is different from giving up when there is still work that can in fact be done. Sir Harold W. Kroto argued

Young researchers were actively involved in the discussion on “Being a Scientist”.

that putting an end to a long-time research project might be a momentous decision because one never knows if a possible breakthrough is just ahead. Encountering problems and obstacles is common in almost every scientific career, and despite strong determination to bring a project to an end, it might sometimes be useful to find the right moment to stop, he said. One can possibly resume an abandoned project at some later point in time and then overcome obstacles which earlier appeared to be brick walls, as John C. Mather had himself experienced with cosmic microwave background radiation. With her experience in the difficult field of HIV vaccine research, Françoise Barré-Sinoussi gave the advice that an abandoned project should be kept in mind while trying new approaches or focusing on new fields of research, hoping for new ideas to come or new technological solutions to be invented in the meantime.

Take risks!

“Did your ideas get even better after winning the Nobel Prize?” asked a young Pakistani scientist. “What is a good idea?” Sir Harold countered. The panellists all agreed that ground-breaking discoveries in science seldom arise from conventional ideas. Taking risks and pursuing special or uncommon ideas is more likely to lead to unexpected success. The really good ideas might in fact sound ‘crazy’ in the first instance, Sir Harold W. Kroto confessed, but these ideas make for a great deal of what it takes to be an exceptional scientist.

PROGRAMME CHAIRS OF THE 60TH MEETING OF NOBEL LAUREATES

Lars Bergström is Professor in Theoretical Physics of the Physics Department on Cosmology, Particle Astrophysics and String Theory at Stockholm University, and leads the Oskar Klein Centre for Cosmoparticle Physics. Professor Bergström spent two years at CERN, Geneva, working further on theory of elementary particles. He was elected Secretary of the Nobel Committee for Physics at the Royal Swedish Academy from 2004. He has also been a corresponding member of the Council for the Lindau Nobel Laureate Meetings since 2004, and took part in organizing the scientific part of the meeting of Physics Laureates in Lindau in 2004 and 2008, as well as the meeting in 2010.

Burkhard Fricke is Professor in Theoretical Physics at the University of Kassel, where he was the university's Vice-President from 1990 to 1994, and where he has been the Dean of the newly founded Faculty of Natural Sciences since 2003. His most important activities outside the university were Board Member of the Deutsche Physikalische Gesellschaft (DPG) and Senior Referee of Physics at the Deutsche Forschungsgemeinschaft (DFG). From 2003 to 2004 he was a guest scientist at the University of Auckland, New Zealand.

Astrid Gräslund received her Ph.D. in Biophysics at Stockholm University in 1974. She has been Chair of the Department of Biochemistry and Biophysics at Stockholm University since 2001. She has published more than 300 scientific papers in the fields of molecular biophysics and biochemistry. Professor Gräslund has been Secretary of the Nobel Committee for Chemistry since 1996 and Deputy Member of the Board of Directors of the Nobel Foundation since 2006. She has been a member of the Council for the Lindau Nobel Laureate Meetings since 2002.

Hans Jörnvall is Professor in Physiological Chemistry at Karolinska Institutet, where he was Chairman of the Department of Medical Biochemistry and Biophysics from 1993 to 1999. Since 2000, he has been Secretary of the Nobel Assembly at Karolinska Institutet. Professor Jörnvall has been a member of the Council for the Lindau Nobel Laureate Meetings since 1999.

Wolfgang Lubitz is a scientific member of the Max Planck Society and Director at the Max Planck Institute for Bioinorganic Chemistry in Mülheim an der Ruhr (since 2000). His research work is focused on the investigation of catalytic metal centres in metalloproteins, the primary processes of photosynthesis and structure determinations using spectroscopic methods and quantum chemical calculations. He is a Fellow of the Royal Society of Chemistry (UK) and member of the Council for the Lindau Nobel Laureate Meetings (since 2004).

Helmut Sies has been Chairman of the Institute for Biochemistry and Molecular Biology I at Heinrich Heine University Düsseldorf since 1979. Professor Sies was the President of the North Rhine-Westphalian Academy of Sciences (2002–2005). He has been a member of the Council for the Lindau Nobel Laureate Meetings since 2005 and Vice-President since 2009. As a student, he took part in the Meeting of Nobel Laureates in 1963.

I attended the 60th Lindau Nobel Laureate Meeting with support of the Hertie Foundation and the German Cancer Research Center. I would like to express my sincere thanks to the supporters for providing the exceptional experience. The meeting was full of discussions with the world leading scholars as well as brilliant young scientists which was an inspiring experience. These interactions were not limited to specific scientific questions, but also about motivations and dedications to science and society. Communication between different disciplines allowed us to build constructive views among scientist as a community. This experience helped me to get a new look on my field or research as well as to train myself in pursuing my long standing interest. The Lindau Meeting had a profound impact on me and therefore I am truly grateful to everyone who made my participation possible.
Yoon Jung Park, Republic of Korea

FACTS & FIGURES

Scientific Programme

MONDAY, JUNE 28TH

09:00 PLENARY LECTURE

Ada E. Yonath: The Amazing Ribosome

09:30 PLENARY LECTURE

Jack W. Szostak: Learning about the Origin of Life from Efforts to Design an Artificial Cell

10:00 PLENARY LECTURE

John C. Mather: The History of the Universe, from the Beginning to the Ultimate End

10:30 COFFEE BREAK

11:00 PLENARY LECTURE

Harald zur Hausen: Human Cancers Linked to Infections

11:30 PLENARY LECTURE

Luc Montagnier: DNA between Physics and Biology

12:00 PLENARY LECTURE

Françoise Barré-Sinoussi: HIV, a Discovery Highlighting the Global Benefit of Translational Research

12:30 LUNCH BREAK

14:30 PARALLEL LECTURE AND DISCUSSION SESSIONS

Paul Crutzen: Atmospheric Chemistry and Climate in the Anthropocene
Roy J. Glauber: What is Quantum Optics?
Robert B. Laughlin: When Coal is Gone
Christine Nüsslein-Volhard: On the Genetic Basis of Morphological Evolution
F. Sherwood Rowland: Greenhouse Effect and Climate Change

14:30 PARALLEL DISCUSSION SESSIONS

Harald zur Hausen, John C. Mather, Luc Montagnier, Jack W. Szostak, Ada E. Yonath

15:45 COFFEE BREAK

16:15 PARALLEL LECTURE AND DISCUSSION SESSIONS

Nicolaas Bloembergen: 50 Years of Lasers
Johann Deisenhofer: Structural Studies on Cholesterol Transport
Carlo Rubbia: The Underground Physics: Neutrino and Dark Matter
Hamilton O. Smith: Building a Synthetic Bacterial Cell
George F. Smoot: Mapping the Universe and Its History
Robert W. Wilson: The Discovery of Cosmic Microwave Background Radiation and its Role in Cosmology
Arno A. Penzias: Energy Advances – What's New; What's Next; What's Missing

16:15 PARALLEL DISCUSSION SESSIONS

Françoise Barré-Sinoussi, Torsten Niels Wiesel

TUESDAY, JUNE 29TH

09:00 PLENARY LECTURE

Roger Y. Tsien: Designing Molecules and Nanoparticles to Help See and Treat Diseases

09:30 PLENARY LECTURE

Theodor W. Hänsch: The Heartbeat of Light

10:00 PLENARY LECTURE

Robert H. Horvitz: Programmed Cell Death in Development and Disease

10:30 PLENARY LECTURE

Martin Chalfie: Adventures in Nontranslational Research

11:00 COFFEE BREAK

11:30 PANEL DISCUSSION (see page 38)

»Impact of Chemistry and Physics to Biomedicine: Where is the Future?«
Aaron Ciechanover, Ivar Giaever, Harald zur Hausen, Erwin Neher, Roger Y. Tsien
CHAIRPERSON: Hans Jörnvall, Helmut Sies

12:30 LUNCH BREAK

14:30 SPECIAL AFTERNOON DEBATE (see page 40)

»What Will CERN Teach us About the Dark Energy and Dark Matter of the Universe?«
David Gross, John C. Mather, Gerardus 't Hooft, Carlo Rubbia, George F. Smoot, Martinus J. G. Veltman
CHAIRPERSON: Lars Bergström, Matthew Chalmers

14:30 PARALLEL LECTURE AND DISCUSSION SESSIONS

Werner Arber: Genetic and Cultural Impacts on the Course of Biological Evolution
Robert Huber: Basic Science and Co-entrepreneurship, my Experience
Brian D. Josephson: Life, Extended Mind, and Fundamental Physics
Walter Kohn: Can Math and Optical Physics Help People with Macular Degeneration of the Eye?
Sir Harold W. Kroto: The Revolutionary Impact of the GooYouWiki World (GYWW) on Education and Student Success
Leland H. Hartwell: Your Grand Challenge: Developing a Sustainable World

14:30 PARALLEL DISCUSSION SESSIONS

Martin Chalfie, Robert H. Horvitz

15:45 COFFEE BREAK

16:15 PARALLEL LECTURE AND DISCUSSION SESSIONS

Edmond H. Fischer: The Origin of Reversible Protein Phosphorylation
Avram Hershko: Roles of Protein Degradation in Health and Disease
Tim Hunt: Getting In and Out of Mitosis
Erwin Neher: Biophysics of Short-term Synaptic Pasticity
Ryoji Noyori: Molecular Catalysis for Green Chemistry

16:15 PARALLEL DISCUSSION SESSIONS

Theodor W. Hänsch, Roger Y. Tsien

FACTS & FIGURES

Scientific Programme

WEDNESDAY, JUNE 30TH

09:00 PLENARY LECTURE

Aaron Ciechanover: Why Our Proteins Have to Die so We Shall Live

09:30 PLENARY LECTURE

Gerardus 't Hooft: The Big Challenges

10:00 PLENARY LECTURE

Sir Martin J. Evans: Mice, Men and Medicine

10:30 COFFEE BREAK

11:00 PLENARY LECTURE

Oliver Smithies: Chance, Opportunity and Planning in Science

11:30 PLENARY LECTURE

David Gross: Frontiers of Physics

12:00 PLENARY LECTURE

Kurt Wüthrich: Structural Genomics and the Expanding Universe of Protein Sequences

12:30 LUNCH BREAK

14:30 PARALLEL LECTURE AND DISCUSSION SESSIONS

Richard R. Ernst: Let Us Develop Concepts for a Beneficial Global Future!
Ivar Giaever: From Biology to Physics
Ferid Murad: Discovery of Nitric Oxide and Cyclic GMP and Application to Drug Development
Robert C. Richardson: The Looming World Shortage of Helium

14:30 PARALLEL DISCUSSION SESSIONS

Aaron Ciechanover, Sir Martin J. Evans, Gerardus 't Hooft, Kurt Wüthrich

15:45 COFFEE BREAK

16:15 PARALLEL LECTURE AND DISCUSSION SESSIONS

Gerhard Ertl: From Disorder to Order
Peter Grünberg: The Physical Foundations of Harmony in Music including live demonstrations by Peter Grünberg together with soprano Keiko Hibi
Yuan Tseh Lee: Dynamics of Chemical Reactions and Photochemical Processes
Rudolph A. Marcus: Experimental Surprises and Their Solution in Theory
Hartmut Michel: Oxygen Reduction and Water Formation in Biology – Enzymes, Structures, Mechanisms
Martinus J. G. Veltman: The Development of Particle Physics

16:15 PARALLEL DISCUSSION SESSIONS

David Gross, Oliver Smithies

THURSDAY, JULY 1ST

09:00 PLENARY LECTURE

Jean-Marie Lehn: Perspectives in Chemistry: Towards Adaptive Chemistry

09:30 PLENARY LECTURE

James W. Cronin: Cosmic Rays: the Most Energetic Particles in the Universe

10:00 PLENARY LECTURE

Sir John E. Walker: How Energy is Converted in Biology

10:30 PLENARY LECTURE

Albert Fert: The World of Spintronics: Electrons, Spin, Computers and Telephones

11:00 COFFEE BREAK

11:30 PANEL DISCUSSION **(see page 47)**

»Being a Scientist«

Françoise Barré-Sinoussi, Sir Harold W. Kroto, John C. Mather, Oliver Smithies

CHAIRPERSON: Adam Smith

12:30 LUNCH BREAK

14:30 PARALLEL LECTURE AND DISCUSSION SESSIONS

Peter Agre: Aquaporin Water Channels

Christian de Duve: Natural Selection and the Future of Life

14:30 PARALLEL DISCUSSION SESSIONS

James W. Cronin, Albert Fert, Klaus von Klitzing, Jean-Marie Lehn, Osamu Shimomura, Sir John E. Walker

FRIDAY, JULY 2ND

08:00 BOAT-TRIP TO THE ISLE OF MAINAU

11:00 PANEL DISCUSSION **(see page 43)**

»Energy and Sustainability«

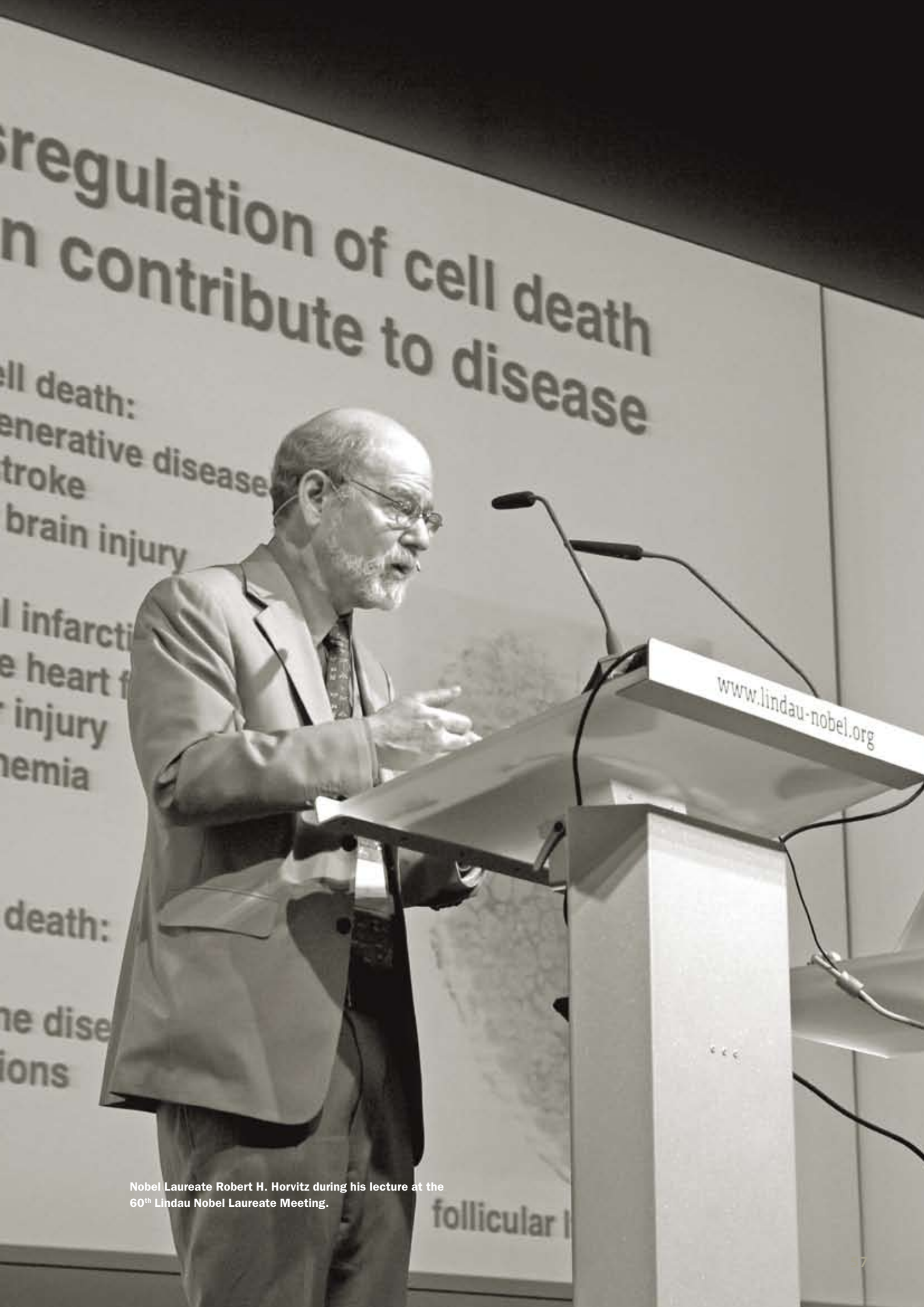
Yuan Tseh Lee, Carlo Rubbia, Hans J. Schellnhuber (Director, Potsdam Institute for Climate Impact Research), Georg Schütte (State Secretary, Federal Ministry of Education and Research/Germany)

CHAIRPERSON: Geoffrey Carr

13:15 GUIDED TOUR EXHIBITION "DISCOVERIES 2010: ENERGY"

THE 60TH MEETING OF NOBEL LAUREATES

ABSTRACTS FROM THE LECTURES



Nobel Laureate Robert H. Horvitz during his lecture at the 60th Lindau Nobel Laureate Meeting.

Aquaporin Water Channels

Peter Agre

Genetic and Cultural Impacts on the Course of Biological Evolution

Werner Arber

HIV, a discovery highlighting the global benefit of translational research

Françoise Barré-Sinoussi

50 Years of Lasers

Nicolaas Bloembergen

Peter Agre:
Aquaporin Water Channels

The aquaporin water channel proteins confer high water permeability to biological membranes. AQP1 has been thoroughly characterized biophysically, and the atomic structure of AQP1 has been elucidated. Twelve homologous proteins have been identified in humans. These are selectively permeated by water (aquaporins) or water plus glycerol (aquaglyceroporins). The sites of expression predict the clinical phenotypes. When deprived of water, AQP1-null individuals exhibit a defect in urine concentration and a marked reduction in fluid exchange from lung capillaries. AQP1 is expressed in multiple tissues where physiologically important fluid secretion is known to occur including cerebrospinal fluid in brain and aqueous humor in eye. AQP2 is expressed in renal collecting duct principal cells where membrane trafficking is regulated by vasopressin. Too little AQP2 expression is found in clinical disorders of urinary concentration, such as bed wetting. Too much AQP2 expression is found in disorders of fluid retention, such as congestive heart failure. AQP0 is expressed in lens fiber cells and mutations result in familial cataracts. AQP5 is expressed in the apical membranes of salivary and lacrimal glands and sweat glands. Aquaporins have been implicated in other human clinical disorders such as brain edema, epilepsy, neuromyelitis optica (AQP4), anhidrosis (AQP5) renal tubular acidosis (AQP6). Aquaglyceroporins have been implicated in malaria, skin hydration (AQP3), glucose homeostasis during starvation and protection against arsenic poisoning (AQP7 and AQP9). Aquaporins are known to protect micro-organisms from freezing and osmotic shock. Plant aquaporins are involved in numerous processes including the uptake of water by rootlets and carbon dioxide by leaves.

Werner Arber:
Genetic and Cultural Impacts on the Course of Biological Evolution

According to the Neo-Darwinian theory, biological evolution is driven by the availability of genetic variants in large populations. Natural selection, together with the at any time available genetic variants, directs the evolution while geographic and reproductive isolations modulate the process. With molecular genetic and bioinformatic research strategies it has become possible to gain

knowledge on molecular mechanisms that spontaneously generate at low rates genetic variants. Several specific molecular mechanisms contribute to genetic variation. Products of so-called evolution genes act thereby as variation generators and as modulators of the rates of genetic variation, in cooperation with non-genetic elements such as intrinsic properties of matter, chemical and physical mutagens and random encounter. The identified molecular mechanisms of genetic variation can be classified into three natural strategies to generate genetic variants: local changes in the sequences of nucleotides, intragenomic rearrangements of DNA segments, and the acquisition of a foreign DNA segment by horizontal gene transfer.

After a short introductory lecture into molecular Darwinism much time shall be devoted to a broad discussion. This debate can deepen insights into some specific mechanisms of spontaneous generation of genetic variants. This can then lead to reflect on possible impacts that human activities might have on the course of biological evolution. What are possible impacts of genetic engineering on the evolutionary process? What are impacts of classical plant and animal breeding methods, sometimes including the use of mutagens? What are impacts of modern agricultural practices altogether? What are impacts of disrespecting geographic isolation? How does nature react to disrespect of reproductive isolation? Which impact on habitats and on biodiversity can we expect from climate change by affecting natural selection? Any other relevant question will be welcome and can further stimulate the open discussion.

Françoise Barré-Sinoussi:
HIV, a discovery highlighting the global benefit of translational research

The fantastic progress made in medicine led the scientific community to hope about the complete eradication of infectious diseases in the middle of the 20th century. The sudden emergence of AIDS in the early 80's cruelly reminded us that this dream was far from being true.

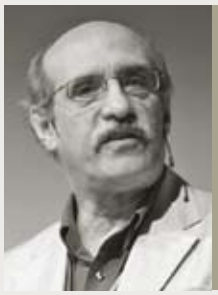
In June 1981, clinicians in the United States first reported few cases of Pneumocystis carinii in homosexual men presenting all a severe immune deficiency. Soon after, similar observations were made in France. Realizing the urgency, some French clinicians started a working group and contacted, in December 1982, retrovirologists at the Institut Pasteur. The discovery of HIV few months later originated from this collective adventure, which mobilized clinicians, researchers and patients altogether. This collaboration later proved crucial to rapidly expand our knowledge of the virus and developing the first diagnostic tests and antiretroviral therapy (ART).

Since then, the continuous mobilization of the scientific, clinical and patient communities, supported by local authorities and international organizations, enabled substantial progress in the worldwide fight against AIDS, especially in the field of access to ART in resource-limited settings. But beyond HIV/AIDS, these efforts prompted a global improvement of health care systems for the benefit of all patients independently of the infection they are suffering from.

More than 25 years after the discovery of the etiological agent responsible for AIDS, research priorities still remain care, treatment and prevention with the major objective of developing a preventive vaccine. This objective remains distant today and in order to reach it, we must pursue our work following Pasteur's vision of scientific commitment: a multidisciplinary and translational research for the global benefit of humanity.

Nicolaas Bloembergen:
50 Years of Lasers

Theodore Maiman demonstrated the operation of a ruby laser in 1960. Soon many different types were invented, including the heium-neon laser, the neodumium-glass laser, GaAS semiconductor lasers, CO_2 lasersand dye-lasers. In those early years lasers were sometimes described as a solution looking for a problem, but now applications are ubiquitous. They play an essential role in world-wide internet communications, in surgery, in medicine, as research tool in chemistry, biology astronomy, geology, materials science, etc. More mundane applications occur in the construction industry, the automotive and shipbuilding industry, barcode readers in supermarkets, holographic displays, analysis of artworks, etc. While originally military considerations provided much of the financial support for laser research, now the peaceful uses far outweigh the military applications.

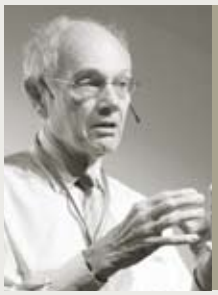


Adventures in Nontranslational Research

Martin Chalfie

Why Our Proteins Have to Die so We Shall Live

Aaron Ciechanover

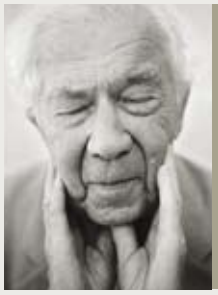


Cosmic Rays: The Most Energetic Particles in the Universe

James W. Cronin

Atmospheric Chemistry and Climate in the Anthropocene

Paul J. Crutzen



Natural Selection and the Future of Life

Christian de Duve

Martin Chalfie: *Adventures in Nontranslational Research*

For at least the last ten years university administrators, governmental officials, and clinical researchers have increasingly called for a greater emphasis on "translational research" (research that translates findings in the laboratory into new treatments for medical conditions) over basic research in the biological sciences. Although the application of biological research to human disease (as well as toward improvements in agriculture and industry) is important, I feel that an increased emphasis is not needed and is actually detrimental. Ultimately, this emphasis is self-defeating because one needs the fruits of basic research to fuel these applications.
I will give examples from my own research developing green fluorescent protein (GFP) as a biological marker and uncovering the molecular basis of the sense of touch to argue that basic research into fundamental problems in biology is important for its own sake and, not surprisingly, for the development of various applications.

Aaron Ciechanover: *Why Our Proteins Have to Die so We Shall Live*

Between the 50s and 80s, most studies in biomedicine focused on the central dogma - the translation of the information coded by DNA to RNA and proteins. Protein degradation was a neglected area, considered to be a non-specific, dead-end process. While it was known that proteins do turn over, the high specificity of the process - where distinct proteins are degraded only at certain time points, or when they are not needed any more, or following denaturation/misfolding when their normal and active counterparts are spared - was not appreciated. The discovery of the lysosome by Christian de Duve did not significantly change this view, as it was clear that this organelle is involved mostly in the degradation of extracellular proteins, and their proteases cannot be substrate-specific. The discovery of the complex cascade of the ubiquitin solved the enigma. It is clear now that degradation of cellular proteins is a highly complex, temporally controlled, and tightly regulated process that plays major roles in a variety of basic cellular processes such as cell cycle and differentiation, communication of the cell with the extracellular environment and maintenance of the cellular quality control. With the

multitude of substrates targeted and the myriad processes involved, it is not surprising that aberrations in the pathway have been implicated in the pathogenesis of many diseases, certain malignancies and neurodegeneration among them, and that the system has become a major platform for drug targeting.

James W. Cronin
Cosmic Rays: The Most Energetic Particles in the Universe

Astrophysical objects are able to accelerate atomic nuclei to energies 10^7 times more than man made accelerators such as LHC.
Particles arrive at Earth from space with energies as great as 50 joules, a macroscopic energy in a microscopic particle. It is not understood how nature can accelerate particles to such energies. Such remarkable events occur rarely, about one per kilometer squared per century. Recently a cosmic ray observatory has been built in Argentina that covers an area of 3000 square kilometers.
This Pierre Auger Observatory is a collaboration of 16 countries. Excellent data has been collected since January 2004. The details of the observatory will be described. The most significant results will be reported.

Paul J. Crutzen:
Atmospheric Chemistry and Climate in the Anthropocene

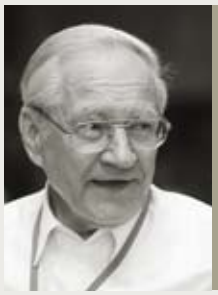
Despite their relatively small mass, 10^{-5} of the earth biosphere as a whole, generations of ambitious 'homo sapiens' have already played a major and increasing role in changing basic properties of the atmosphere and the Earth's surface. Human activities accelerated in particular over the past few hundred years, creating a new geological era, the 'Anthropocene', as already foreseen by Vernadsky in 1928: "…the direction in which the processes of evolution must proceed, namely towards increasing consciousness and thought, and forms having greater influence on their surroundings."
Vernadsky's predictions are more than fulfilled. Human activities are affecting, and in many cases out-competing, natural processes, for instance causing the 'ozone hole', the rise of greenhouse gases with their impact on climate, urban and regional air pollution, 'acid rain', species extinction, with all their consequences for human and ecosystem health.

Christian de Duve:
Natural Selection and the Future of Life

Life appeared on Earth more than 3.6 billion years ago and progressively evolved into microbes, plants, fungi, and animals of increasing complexity, with as latest significant event the emergence of our species, Homo sapiens sapiens, a mere 200.000 years ago. Denied by creationists, the occurrence of this process has been established beyond reasonable doubt.
It is generally accepted, except by the defenders of "intelligent design", that biological evolution has been largely governed by natural selection, a process dependent on accidental genetic modifications (mutations), leading to competition among the resulting variants for available resources, with as outcome the necessary emergence of those forms best able to survive and reproduce under the prevailing physical-chemical conditions. A critical feature of natural selection is that it is dependent only on immediate benefits, whatever the nature, good or bad, of its later consequences.
Human beings have come out as the uncontested winners in this evolutionary process, having succeeded, in invading every part of our planet, accaparating for their own benefit a major part of its resources, and multiplying at an ever increasing rate. This success, achieved thanks to a number of traits favored by the blind process of natural selection, has reached a point where the very future of humanity is seriously threatened. Our only hope to escape extreme hardships, if not extinction, is to take advantage of our ability, unique in the entire living world, to act against natural selection, displaying foresight, determination, and, especially, wisdom. Such is the challenge for future generations.

Structural Studies on Cholesterol Transport

Johann Deisenhofer



Let Us Develop Concepts for a Beneficial Global Future

Richard R. Ernst

From Disorder to Order

Gerhard Ertl

Mice, Men and Medicine

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The World of Spintronics: Electrons, Spins, Computers and Telephones

Albert Fert

Johann Deisenhofer

Structural Studies on Cholesterol Transport

Cholesterol is essential for mammals; it is produced internally or taken up with the diet and transported in the blood stream in the form of lipoproteins, with low density lipoprotein (LDL) being most abundant. LDL is bound at cell surfaces by receptors and internalized. Inside cells, LDL particles are released from the receptors, degraded in lysosomes, and cholesterol is transported by specific binding proteins to its destinations. I will describe four studies on structural aspects of cholesterol transport:
Electron microscopy of low density lipoprotein (LDL) with and without bound LDL receptor protein shows size, shape and internal structure of typical LDL particles [1]. The crystal structure of the extracellular portion of human LDL receptor [2] at pH 5.3 illustrates the domain organization of the receptor, and suggests possible mechanisms for LDL release at low pH. The recently discovered protein PCSK9 binds to the LDL receptor and appears to regulate the degradation of the receptors. A crystal structure of the complex of PCSK9 with a fragment of the LDL receptor [3] defines the binding interface and could lead to the development of new cholesterol-lowering drugs. Mutations in the proteins NPC1 and NPC2 can cause Niemann-Pick disease by slowing down or preventing the transport of cholesterol out of lysosomes. The crystal structure of the N-terminal domain of NPC1 with and without bound cholesterol [4] sheds light on the intra-lysosomal cholesterol transport pathway.

[1] Ren, G., Rudenko, G., Ludtke, S.J., Deisenhofer, J., Chiu, W., Pownall, H.J. (2010). PNAS 107, 1059-1064.
[2] Rudenko, G., Henry, L., Henderson, K., Ichtchenko, K., Brown, M.S., Goldstein, J.L., Deisenhofer, J. (2002). Science 298, 2353-2358.
[3] Kwon, H.J., Lagace, T.A., McNutt, M.C., Horton, J.D., and Deisenhofer, J. (2008). PNAS 105, 1820-1825.
[4] Kwon, H.J., Abi-Mosleh, L., Wang, M.L., Deisenhofer, J., Goldstein, J.L., Brown, M.S., and Infante, R.E. (2009). Cell 137, 1213-1224.

Richard R. Ernst

Let Us Develop Concepts for a Beneficial Global Future

What is more important for young people than to reflect about their own precious future? Many of the participants at Lindau will assume leading positions in tomor-

row's society and are expected to contribute towards a beneficial future. A brief analysis of the present situation and an attempt to extrapolate today's behavior into the future easily reveals our being on a non-sustainable track and the questionable nature of our short-term goals. The discussion leader will not present recipes but he will try to stimulate reflections of the participants. He will try to emphasize the responsibility of global citizens, but particularly of prospective academics, politicians, and business leaders, for implementing the required changes in our personal and collective endeavors.

Much of today's shortcomings, much of today's economical problems are caused by our egoistic goal setting. Erroneously, we are encouraged to behave selfishly and to thrive and prosper towards personal wealth. We are given the wrong impression that our personal "value" is measured universally in monetary units. - In this situation, we have to establish a new value system where moral and ethical concerns are more prominent and where competition is superseded by collaboration, foresight, and compassion. Sustainability shall be our goal. We should avoid to limit the liberties of action of future generations by our short-sighted exhausting of natural resources. We can achieve this far reaching goal only by close international collaboration. Independent Nation States alone are no longer in a position to act responsibly. All the major problems to be solved are of global relevance and require for their solution strong international institutions supported by international law enforcement.

Gerhard Ertl

From Disorder to Order

Our experience suggests that a system will usually show the tendency to undergo spontaneously a transition from the state of order into disorder. Quite in contrast, our world developed from an initial state of great disorder into another one where even the highest degree of order is observed in living organisms. The basic mechanisms governing these unexpected transformations are phase transitions (self assembly) in closed systems attempting to attain thermal equilibrium and self-organization in open systems far from equilibrium. Chemical processes occurring at solid surfaces will serve as examples to illustrate the underlying principles.

Sir Martin J. Evans

Mice, Men and Medicine

The humble house mouse has provided the most important basis for understanding human biology because it has been possible to alter the genetics in mice to order. Mice and men are sufficiently similar for studies with the mice to be able to be related directly to man; thus the laboratory mouse provides the experimental arm for the human genome project. This has become possible through the use of mouse embryonic stem cells. The advent of human embryonic stem cells has opened up ideas for using them as an universal source of therapeutic cells for regenerative medicine.

Albert Fert

The World of Spintronics: Electrons, Spins, Computers and Telephones

Spintronics [1] is a new field of research which exploits the influence of the electron spin on electronic transport. It is well known for the giant magnetoresistance of the magnetic multilayers and its application to increase the capacity of the hard discs, but it has also revealed many other interesting effects. In my talk I will review some of the most promising directions of today, which will includes the study of the spin transfer phenomena, spintronics with semiconductors and molecular spintronics. In a spin transfer experiment, for example, one manipulates the orientation of a nanomagnet by transfusing spin angular momentum into it from a spin-polarized electronic current. This electronic spin transfusion can be used to switch the magnetization (with near applications to the writing of magnetic memories) or to generates oscillations in the radio-wave frequency range (with promising applications in telecommunications). Spintronics with semiconductors aims to some fusion between conventional electronics and spintronics, while molecular spintronics turns out to be a possible way to go "beyond CMOS", that is beyond the silicon electronics of today.

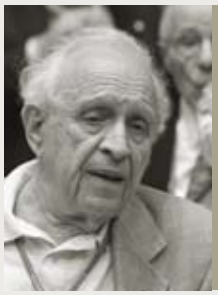
[1] C. Chappert, A. Fert, F. Nguyen Van Dau, The emergence of spintronics in data storage, Nature. Mat. 6, 813 (2007)

The Origin of Reversible Protein Phosphorylation

Edmond H. Fischer

From Biology to Physics

Ivar Giaever



What Is Quantum Optics?

Roy J. Glauber

Frontiers of Physics

David Gross

The Physical Foundations of Harmony in Music

Peter Grünberg

The Heartbeat of Light

Theodor W. Hänsch

Edmond H. Fischer

The Origin of Reversible Protein Phosphorylation

A historical account of the discovery of reversible protein phosphoryltion will be presented. It occurred fifty five years ago during a study undertaken with Ed Krebs to elucidate the complex hormonal regulation of glycogen phosphorylase. While it is extremely simple, it came nevertheless as a complete surprise because essentially nothing was known at that time about the mechanism of enzyme regulation or the structure and function of phosphoproteins. We know today that the process represents one of the most prevalent mechanism by which eukaryotic cellular events are regulated. The study led to the establishment of the first hormonal cascade of enzymes acting on enzymes initiated by cAMP discovered by Earl Sutherland. It also showed how two different physiological processes (carbohydrate metabolism and muscle contraction) could be regulated in concert by the release of calcium ions.

Ivar Giaever

From Biology to Physics

Biology used to be a very descriptive field void of mathematics, but the discovery of DNA changed all that. Molecular biology today attracts the most fertile young minds, and many older physicists like myself, also feel intrigued. In this talk I will describe why and how I entered the field. “Why” is easy, contrary to present day physics, it is easy to identify real unsolved problems, for example: How does memory work? “How” is more problematic, but the easiest is probably to start eating lunch with biologists. I started in the field of immunology and have ended up in tissue culture. I will describe the journey in hopefully simple terms.

Roy J. Glauber
What Is Quantum Optics?

The image of lightwaves as oscillating electromagnetic fields explains virtually all the phenomena of traditional optics. An awareness that these waves are somehow subdivided into quanta has however been with us since the early 20th century. The naive effort to view light quanta as ordinary particles led quickly to a succession of contradictions and paradoxes that could only be resolved by the development of the broader theory of the wave-mechanical behavior of all varieties of particles.
The application of the same principles to electromagnetic theory led to the development of the subject now called quantum electrodynamics. It is an enormously versatile theory which comprehends a vast range of Interesting and occasionally strange ways in which light quanta can behave. We shall discuss some of these behaviors, noting that they are now seen as common to fields oscillating at all frequencies – from radio waves to gamma rays. A recent development has been the use of standing-wave beams of light to bind atoms in loose lattice structures that resemble crystals but are remarkably adjustable in their properties.A more richly detailed science of optics is now emerging from the more explicit study of quanta and their behavior.

David Gross
Frontiers of Physics

I will discuss a few of the questions facing fundamental physics that might be answered before the 100th Lindau meeting.

Peter Grünberg
The Physical Foundations of Harmony in Music

When a tone – say „g“ is played on some musical instrument, it is not only „g“ which sounds but in general also a whole series of „partials“ or higher harmonics. Already the ancient Greeks as described by Pythagoras knew about this. The origin of the partials is particularly transparent in the case string instruments like guitars or violins and can be explained by the formation of standing wave oscillations with different numbers of nodes. The frequencies are given by the corresponding components of a Fourier analysis where the fundamental and the first harmonic in the present example correspond to “g”. Surprisingly the listener still has the mental sensation “g” even if fundamental and first harmonic are cut off by an acoustic high pass filter.
In the 19th Century the German Physicist, H. v. Helmholtz found the relation between the harmonic character of an interval or a chord and the associated partials. This will be demonstrated for prominent intervals like octaves, quarts, and terces. The results of these considerations will be supported by live demonstrations with alpine folklore music German songs from the renaissance and Japanese traditional folk songs.

Theodor W. Hänsch
The Heartbeat of Light

Laser frequency combs have revolutionized the art of measuring the frequency of light. They have become the indispensible tools for precise laser spectroscopy from the THz region to the extreme ultraviolet. Their invention has been motivated by the long quest to study the spectrum of the simple hydrogen atom with the highest possible precision, in order to measure fundamental constants and to stringently test the fundamental laws of quantum physics.
Today, laser combs are serving as clockworks for optical atomic clocks, with applications from fundamental research to telecommunications and satellite navigation. By offering control of the electric field of extremely short light pulses, laser combs have become key tools for the emerging field of attosecond science. The calibration of astronomical spectrographs with laser combs will enable new searches for Earth-like planets in distant solar systems, and may reveal the continuing expansion of space in the universe. Laser combs are revolutionizing molecular spectroscopy by dramatically extending the resolution and recording speed of Fourier spectrometers.
High harmonic generation promises to extend frequency comb techniques and precise spectroscopy into the extreme ultraviolet and soft X-ray regime.

Your Grand Challenge: Developing a Sustainable World

Leland H. Hartwell

Human Cancers Linked to Infections

Harald zur Hausen

Roles of Protein Degradation in Health and Disease

Avram Hershko

The World of Spintronics: Electrons, Spins, Computers and Telephones

Robert H. Horvitz

Leland H. Hartwell

Your Grand Challenge: Developing a Sustainable World

There is great concern that 6.5 billion people are depleting the Earth's resources so that future generations will find it much less habitable. Finding sustainable solutions for human well-being is the great challenge of your generation. Are there principles that you can use to achieve sustainability?

Harald zur Hausen

Human Cancers Linked to Infections

Advances during the past 2-3 decades permitted the isolation and identification of a number of infectious agents causing specific wide-spread human cancers. During this period of time approximately 21% of the global cancer incidence has been linked to infectious events. Besides a bacterial infection, Helicobacter pylori, causing the majority of gastric cancers, two types of viral infections with Hepatitis B virus (HBV) and high risk human papillomaviruses (HPV) (mainly types 16 and 18) have been identified. The former virus causing a substantial percentage of liver cancers, the latter being the predominant causes of cancer of the cervix, the second most frequent cancer in females on the global scale. Again in particular methods of genetic engineering permitted the development of vaccines against HBV and HPV infections. These vaccines can be considered as the first preventive cancer vaccines, obviously providing long-time protection against the respective forms of cancer. Applied globally in the respective age groups, jointly both vaccines have the potential to reduce the cancer burden in females by 12-15%, in males by 4-5%.
The novel mode of cancer prevention by vaccination encourages further research on a potential involvement of still other infections in cancers, not yet linked to exogenous agents. We are presently studying the putative role of novel viruses in cancers of the hematopoietic system and in gastrointestinal malignancies. Data from these studies will be presented as well as considerations how such infections could be prevented.

Avram Hershko

Roles of Protein Degradation in Health and Disease

The selective degradation of many short–lived proteins in eukaryotic cells is carried out by the ubiquitin-mediated proteolytic system. In this pathway, proteins are targeted for degradation by covalent ligation to ubiquitin, a highly conserved small protein. The ligation of ubiquitin to protein involves the successive action of three types of enzymes: the ubiquitin-activating enzyme E1, a ubiquitin-carrier protein E2 and a ubiquitin-protein ligase, E3. The selectivity and the regulation of the degradation of a specific protein are usually determined by the properties of its specific ubiquitin ligase (E3) enzyme. We have been studying two ubiquitin ligase complexes that have important roles in different aspects of cell cycle regulation. One is the cyclosome, or Anaphase-Promoting Complex (APC/C), which acts on mitotic cyclins and some other cell cycle regulators in exit from mitosis. The APC/C is activated at the end of mitosis by phosphorylation, a process that allows its further activation by the ancillary protein Fizzy/Cdc20. A different complex, which belongs to the SCF (Skp1-Cullin-F-box protein) family of ubiquitin ligases, is involved in the degradation of p27, a mammalian G1 Cdk inhibitor, following mitogenic stimulation. Its action is triggered by Cdk2-dependent phosphorylation of p27, as well as by the increase in levels of a specific F-box protein, Skp2, that takes place in the G1 to S-phase transition.

Work from other laboratories has shown that ubiquitin-mediated degradation of regulatory proteins is involved in a large variety of basic biological processes including the control of cell proliferation, inflammation and immunity, embryonic development, signal transduction and gene expression. Abnormalities in protein degradation are involved in diseases such as some types of cancer and neurodegenerative disorders. The mode of the involvement of the ubiquitin system in cancer will be discussed in some detail.

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Robert H. Horvitz

Programmed Cell Death in Development and Disease

Programmed cell death (often referred to as apoptosis) is a normal feature of animal development and tissue homeostasis. The misregulation of cell death has been implicated in a diversity of human disorders, including cancer, autoimmune diseases, heart attacks, stroke and neurodegenerative diseases. Our laboratory has analyzed the mechanisms responsible for programmed cell death by studying the nematode Caenorhabditis elegans. During the development of C. elegans, 131 of the 1,090 cells generated undergo programmed cell death. We have characterized developmentally, genetically and molecularly the roles of many genes that function in C. elegans programmed cell deaths. We have analyzed genes that control the death process, genes that act in the phagocytosis of dying cells by their neighbors, and genes that function in the digestion of the DNA of cell corpses. We have studied in some detail genes that specify which cells will or will not express this cell-death program. Most but not all of these genes involved in cell-type-specific programmed cell death encode transcription factors that specify whether or not the first gene in the core killing pathway, egl-1 (which encodes a BH3-only member of the BCL-2 protein superfamily), is transcribed. Many of the C. elegans genes involved in programmed cell death show structural and functional similarities to genes that act in mammalian apoptosis, indicating that the major mechanisms of programmed cell death are conserved among organisms as distinct as nematodes and humans. A number of the human counterparts have been implicated in human disorders, including deafness and cancer. We recently have been analyzing a few cell deaths that occur in the absence of the activity any of the components of the core killing pathway. These deaths occur even in mutants defective in all four C. elegans caspase genes (caspases drive apoptosis in worms and other organisms) and involve cells that normally are killed rapidly by the core killing pathway but in the absence of this pathway still die but do so more slowly. Thus, there is a second as yet uncharacterized pathway for programmed cell death in C. elegans, and for at least some of the cells that die by programmed cell death during C. elegans development two distinct mechanisms of cell killing act to ensure that the cells that should die do so.

Basic Science and Co-entrepreneurship, my Experience

Robert Huber

Getting In and Out of Mitosis

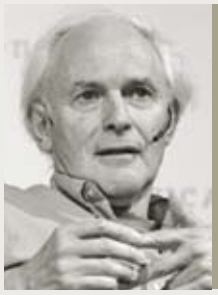
Tim Hunt

Life, Extended Mind, and Fundamental Physics

Brian D. Josephson

Can Math and Optical Physics Help People with Macular Degeneration of the Eye?

Walter Kohn



The Revolutionary Impact of the GooYou-Wiki World (GYWW) on Education and Student Success

Sir Harold W. Kroto

Robert Huber

Basic Science and Co-entrepreneurship, my Experience

The design and development of inhibiting (or occasionally activating) ligands of target proteins in medicine and crop protection guided by molecular structures and functions has become an established technology in academia and industry recently.

In my lecture I will present examples from the protein groups of proteolytic enzymes and antibodies describing research background gathered in academia (www.biochem.mpg.de/eg/huber/publications) and translation into industry, a process which I attended as co-founder and scientific advisor with the companies Proteros (www.proteros.de) and Suppremol (www.suppremol.com).

Tim Hunt

Getting In and Out of Mitosis

The process of mitosis involves a comprehensive reorganisation of the cell: chromosomes condense, the nuclear envelope breaks down, the mitotic spindle is assembled, cells round up and release their ties to the substrate and so on and so forth. This reorganisation is triggered by the activation of a protein kinase called Cyclin-Dependent Kinase 1 (CDK1). The end of mitosis is marked by the proteolysis of the cyclin subunit of CDK1, which terminates kinase activity. At this point, the phosphate moeities that altered the properties of hundreds of proteins to bring about the cellular reorganisation are removed by protein phosphatases.

We recently began to pay attention to the control of these protein phosphatases, conscious that it was quite likely that they were shut off as cells enter mitosis, and reactivated when mitosis is complete, allowing return to interphase. It is difficult to see how proteins could be fully phosphorylated if both kinases and phosphatases were simultaneously active (much as a wash basin requires not only turning on the water taps, but also putting in the plug, if it is to be filled).

It emerged that at least one important protein phosphatase in the PP2A family was completely shut off in mitosis. Depletion of this particular phosphatase accelerated entry into mitosis, and blocked exit from mitosis. We have discovered how this phosphatase is regulated. It entails binding a small inhibitor protein that is phosphorylated by a protein kinase called greatwall, itself a

substrate of CDK1. I will explain how we found this out, and discuss the role of this particular control mechanism in the control of mitosis.

Brian D. Josephson

Life, Extended Mind, and Fundamental Physics

The problem of how life came into existence is a major challenge for biology. I shall argue for an explanation involving the idea that a more elementary form of life, not dependent on matter, existed prior to the big bang, and evolved at the level of ideas in the same way that human societies evolve at the level of ideas. Just as human society discovered how to use matter in a range of technological applications, the hypothesised life before the big bang discovered how to organise energy to make physical universes, and to make fruitful use of the matter available in such universes. In addition, our various creative abilities are in part expressions of aspects of this original life.

Walter Kohn

Can Math and Optical Physics Help People with Macular Degeneration of the Eye?

Macular degeneration (MD) is a partial or total physical breakdown of the macula, a small spot at the back of the retina. The macula, with an area of about 2.5mm^2, absorbs that part of the incident light which is responsible for our most acute vision, the so-called central vision.
MD affects primarily older people, 50% of those over 80, and is the leading cause of legal blindness of people over 55. Because of lengthening average life-expectancy, MD is becoming increasingly important.
I shall report and demonstrate the status of a project aimed at improving the vision of patients with moderate MD, conducted with the help of engineer Jim Klingshirn, using "higher" mathematics, unconventional optics, and interactive participation of patients.

Sir Harold W. Kroto

The Revolutionary Impact of the GooYouWiki World (GYWW) on Education and Student Success

It might be argued that the benefits to society of Science Engineering and Technology (SET) have generally outweighed the bad contributions, as the quality of life as well as the health of people, have improved enormously – at least in the developed world. However a massive improvement in the Political and Public Understanding of Science and Engineering etc (PPAUSE) will be necessary to realize both the future humanitarian promise of SET and/or ensure the imposition of the limitations that will safely constrain the dangers of our powerful technologies. The interference by politicians in science teaching in schools should be recognised as presenting a serious threat to our general well-being in general and the future of the Enlightenment in particular. In many countries education is superb - in the irrational - and abysmal in critical thinking; indeed in these countries the level of ignorance of SET is sure recipe for disaster in the future.
To combat such problems I set up The Vega Science Trust as a platform for expert scientists and engineers to communicate directly on issues that interest and/or concern them. Vega (www.vega.org.uk) is streaming science lectures, interviews, discussions, workshops as well as careers programs – all now freely available on the Internet. 75 of the 250 programmes were broadcast by the BBC. In addition a new, sister initiative, Global Educational Outreach for Science, Engineering and Technology (GEOSET) - has been initiated at Florida State University (US), Sheffield University (UK) and Toyo University (Japan). It is a program that recognises the fantastic potential for shifting the paradigm of the educational process that the GooYouWiki-World (GYWW), born at the start of the 21st Century, has created. Geoset uses a dual window format consisting of video coupled with synchronised, downloadable, supplementary data (eg powerpoint images etc). The primary focus is the empowerment of teachers worldwide by giving them access to the very best teaching materials, packaged for their direct use in the classroom. An unexpectedly exciting aspect has been the involvement of young students in the educational process. Furthermore a major bonus has been the creation of a highly effective new component of student CVs which is already yielding successful results in academic awards as well as job applications. The searchable gateway site is at www.geoset.info and the local site at www.geoset.fsu.edu.

"Although good decision-making cannot guaranteed by knowledge, common sense suggests that wisdom is an unlikely consequence of ignorance".

Nobel Laureate Roger Y. Tsien in a discussion with young researchers at the 2010 Lindau Meeting.

When Coal Is Gone

Robert B. Laughlin

Dynamics of Chemical Reactions and Photochemical Processes

Yuan Tseh Lee

Perspectives in Chemistry: Towards Adaptive Chemistry

Jean-Marie Lehn

Experimental Surprises and Their Solution in Theory

Rudolph A. Marcus

Robert B. Laughlin
When Coal Is Gone

A great deal of the modern-day concern about fossil fuel burning can be swept away by imagining a time, roughly six generations from now, when nobody burns carbon out of the ground any more, either because people outlawed the practice or because it's gone. You ask "What happened?" The premise is science fiction, but it's also a way to separate the technical matters from political ones, which is critically important in this subject. Elementary engineering, physical law and economics so constrain what can happen that you can make reasonable guesses about some things. For example, battery-powered airplanes are probably not in the cards because elementary principles limit a battery's energy-to-weight ratio. That being the case, either there will be no airplanes or people will find a way to make the fuel airplanes need. I will discuss a few similar constraints and their implication for the future.

Yuan Tseh Lee
Dynamics of Chemical Reactions and Photochemical Processes

Every macroscopic chemical transformation, whether it is atmospheric ozone depletion or the burning of a candle, consists of millions of microscopic chemical events which involve collisions between molecules. It has been the dream of scientists for a long time to observe and understand the details of molecular collisional processes which transform reactant molecules into product molecules with our naked eyes. During the last several decades, because of the advances in crossed molecular beams method and laser technology, especially, from the measurements of product angular and velocity distributions, it has become possible to "visualize" exact details of how chemical reactions take place through molecular collisions or through photochemical processes.
In this lecture, in addition to illustrate experimental details of crossed molecular beams method, examples will be given to demonstrate how detail information on the dynamics of chemical reactions and photochemical processes can be obtained using various molecular beam approaches. Recent investigations on controversy of photochemical processes involved in the formation of ozone hole and the new understanding of basic mechanism involved in the matrix assisted laser desorption

ionization method for the analysis of biological molecules will be presented.

Jean-Marie Lehn

Perspectives in Chemistry: Towards Adaptive Chemistry

Supramolecular chemistry explores the design of systems undergoing self-organization, i.e. systems capable of generating well-defined functional supramolecular architectures by self-assembly from their components, thus behaving as programmed chemical systems. Chemistry may therefore be considered as an information science, the science of informed matter.
The design of molecular information-controlled functional self-organizing systems also provides an original approach to nanoscience and nanotechnology
Supramolecular chemistry is intrinsically a dynamic chemistry in view of the lability of the interactions connecting the molecular components of a supramolecular entity and the resulting ability of supramolecular species to exchange their constituents. The same holds for molecular chemistry when the molecular entity contains covalent bonds that may form and break reversibility, so as to allow a continuous change in constitution by reorganization and exchange of building blocks. These features define a Constitutional Dynamic Chemistry (CDC) on both the molecular and supramolecular levels.
CDC takes advantage of dynamic constitutional diversity to allow variation and selection in response to either internal or external factors to achieve adaptation.
The merging of the features: - information and programmability, - dynamics and reversibility, - constitution and structural diversity, points towards the emergence of adaptive and evolutive chemistry.

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Rudolph A. Marcus

Experimental Surprises and Their Solution in Theory

From time to time phenomena are uncovered that are highly puzzling and are a rich source for theoretical study. Several examples drawn from my own experience are described together the theories to which they led. (i) In the field of electron transfer reactions, in its early stage, many isotopic exchange reactions mostly in water were studied in which the process was an electron transfer between two ions in different valence states, e.g., $Fe^{2+} + Fe^{3+}$. Some reactions were fast and others were slow and none of the existing theories were correct. In turn, a detailed theory (1) based on the Franck-Condon principle and the law of conservation of energy explained these differences in rates and led to specific predictions that were later confirmed experimentally. (ii) A more recent example is an unusual isotope effect in ozone formation in the stratosphere and the laboratory, the "mass-independent fractionation" of isotopes. Standard theory needed a modification, such as a non-statistical ("non-RRKM") addition. It led to the interpretation of the effects of pressure and temperature on the isotopic fractionation.(2) (iii) Another example is "on-water" catalysis. Shaking two organic reactants with excess water led surprisingly to a large reaction rate increase in some cases and none in others. The explanation is based upon surface OH-groups that are not hydrogen-bonded.(3) A similar catalysis was found with metal oxide nanoparticles enriched in surface OH-groups. (iv) The list of novel phenomena includes also the intermittency of fluorescence ("blinking") observed in single particles of semiconductors (3), dye-coated semiconductors and some fluorescent proteins. Apart from the fundamental scientific interest in these systems, they may be applied in solar energy conversion and biosensing. However, it is clear that any optimization of technical devices rests on a profound understanding of the underlying phenomena and, if possible, on their description in simplified analytical terms.

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The History of the Universe, from the Beginning to the Ultimate End

John C. Mather

Oxygen Reduction and Water Formation in Biology – Enzymes, Structures, Mechanisms

Hartmut Michel

DNA between Physics and Biology

Luc Montagnier

John C. Mather

The History of the Universe, from the Beginning to the Ultimate End

I will summarize the history of the universe, from the Big Bang through the formation of galaxies and the Solar System, and the history of the Earth and some of the special factors enabling the formation of life. Our future will be hot as the Sun gets brighter, and then dark as the Sun and all the other stars burn out and the universe continues to expand. Nobel-winning discoveries are key parts of the story, and more are yet to come, as the nature of the cosmic dark matter and dark energy are determined, and the details of the Big Bang are elucidated through further microwave studies. I will show some of the ambitious projects currently being built or planned to extend our knowledge of astronomy, including the James Webb Space Telescope.

Hartmut Michel

Oxygen Reduction and Water Formation in Biology – Enzymes, Structures, Mechanisms

Life on Earth started more than 3.8 billion years ago. The atmosphere and the oceans were under reducing conditions, molecular oxygen was absent. Photosynthesis was invented already about 3.5 billion years ago. It was anoxygenic meaning that molecular oxygen was not produced, hydrogen and hydrogen sulphide were the likely electron donors for photosynthetic electron flow and fixation of carbon dioxide. Then the ancestors of the present day cyanobacteria started to use water as a source for electrons resulting in the release of molecular oxygen into the atmosphere at least 2.8 billion years ago. A significant increase in the atmosphere's oxygen concentration was only observed about 500 million years later. The appearance of molecular oxygen was the biggest ecological catastrophe which ever happened on Earth. Oxygen, in particular in the presence of light and coloured substances, is extremely toxic, and the existing organisms had to invent ways to detoxify oxygen in order to survive. One strategy is to remove molecular oxygen by reducing it to water. There are several soluble enzymes known performing this reaction, e.g. flavohemoproteins in bacteria and yeasts and di-iron flavoproteins in archaea. They are located in the cytoplasm. More important, however, are membrane integrated enzymes, called terminal oxidases, which receive

electrons from one side of the membrane, and use protons from the opposite side in order to reduce molecular oxygen to water. As a result of the topologically opposite origin of the charged substrates (electrons and protons) an electric voltage and a pH difference is created across the membrane. This voltage is used e.g. to drive the uptake of nutrients and the formation of the universal biological energy carrier ATP from ADP and inorganic phosphate. Therefore the necessary removal of the waste product oxygen could be converted into an energy supplying reaction. Some terminal oxidases even enhance the energy conversion by "pumping" additional protons across the membrane. The most prominent representatives of the terminal oxidases are the heme-copper oxidases which are found in mitochondria of higher cells and in manybacteria and archaea. The structures of two divergent terminal oxidases, a so-called aa3-type oxidase from an aerobic bacterium, and a cbb3-type from a microaerophilic bacterium will be presented and discussed, in particular in relation to their function as proton pumps.

Luc Montagnier

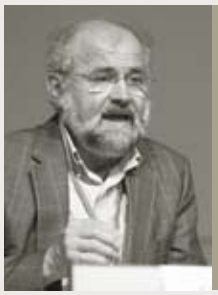
DNA between Physics and Biology

The association of DNA with water is known since the deciphering of its double helical structure by X-Ray diffraction in 1953 (Watson, Crick, Wilkins and Franklin). However the power of DNA for organizing water seems to go far beyond the direct filling of water molecules within the grooves of the double helix. Indeed, we have recently discovered that some DNA sequences – so far belonging to pathogenic bacteria and viruses – are able to induce specific structures of nanometric size in water.
When sufficiently diluted in water, these structures are emitting a spectrum of electromagnetic waves of low frequencies (ranging from 1,000 to 3,000Hz).

This is a resonance phenomenon which is dependent on excitation by very low frequency electromagnetic waves, usually provided by the ambient background. According to the theory of diphasic water, water dipoles can organize themselves, upon low energy input, into quantum coherent domains able to receive and keep biological information. In agreement with this model, we have recently obtained evidence that some specific DNA sequences can be transmitted through waves in water. This raises the interesting possibility that living structures are able to communicate through waves, like we, human beings, have recently started to do so for social purposes.
Besides these theorical considerations, there are already medical applications of the phenomenon: In the blood of patients suffering of chronic diseases, we can detect electromagnetic signatures of DNA from infectious microorganisms remaining in a latent state. In the case of HIV/AIDS, the DNA signature appears after antiretroviral therapy, revealing a niche of the virus resistant to this treatment.

Discovery of Nitric Oxide and Cyclic GMP and Application to Drug Development

Ferid Murad



Biophysics of Short-term Synaptic Plasticity

Erwin Neher

Molecular Catalysis for Green Chemistry

Ryoji Noyori

Ferid Murad

Discovery of Nitric Oxide and Cyclic GMP and Application to Drug Development

The role of nitric oxide in cellular signaling in the past three decades has become one of the most rapidly growing areas in biology. Nitric oxide is a gas and a free radical with an unshared electron that can regulate an ever-growing list of biological processes. Nitric oxide is formed from L-arginine by a family of enzymes called nitric oxide synthases. These enzymes have a complex requirement for a number of cofactors and regulators including NADPH, tetrahydrobioterin, flavins, calmodulin and heme. The enzymes are present in most cells and tissues. In many instances, nitric oxide mediates its biological effects by activating the soluble isoform of guanylyl cyclase and increasing cyclic GMP synthesis from GTP. Cyclic GMP, in turn, can activate cyclic GMP-dependent protein kinase (PKG) and can cause smooth muscles and blood vessels to relax, decrease platelet aggregation, alter neuron function, etc. These effects can decrease blood pressure, increase blood flow to tissues, alter memory and behavior, decrease blood clotting, etc. The list of effects of nitric oxide that are independent of cyclic GMP formation is also growing at a rapid rate. For example, nitric oxide can interact with transition metals such as iron, thiol groups, other free radicals, oxygen, superoxide anion, unsaturated fatty acids, and other molecules. Some of these reactions result in the oxidation of nitric oxide to nitrite and nitrate to terminate the effect, while other reactions can lead to altered protein structure function and/or catalytic capacity. These effects probably regulate bacterial infections, inflammation of tissues, tumor growth, and other disorders. These diverse effects of nitric oxide that are cyclic GMP dependent or independent can alter and regulate numerous important physiological events in cell regulation and function. Nitric oxide can function as an intracellular messenger, an antacoid, a paracrine substance, a neurotransmitter, or as a hormone that can be carried to distant sites for effects. Thus, it is a unique molecule with an array of signaling functions. However, with any messenger molecule, there can be too little or too much of the substance, resulting in pathological events. Some of the methods to regulate either nitric oxide formation, metabolism, or function have been in clinical use for more than a century, as with the use of organic nitrates and nitroglycerin in angina pectoris that was initiated

in the 1870s. Inhalation of low concentrations of nitric oxide can be beneficial in premature infants with pulmonary hypertension and increase survival rates. Ongoing clinical trials with nitric oxide synthase inhibitors and nitric oxide scavengers are examining the effects of these agents in septic shock, hypotension with dialysis, inflammatory disorders, cancer therapy, etc. Recognition of additional molecular targets in the areas of nitric oxide and cyclic GMP research will continue to promote drug discovery and development programs in this field. Current and future research will undoubtedly expand the clinician's therapeutic armamentarium to manage a number of important diseases by perturbing nitric oxide formation and metabolism. Such promise and expectations have obviously fueled the interests in nitric oxide research for a growing list of potential therapeutic applications. There have been and will continue to be many opportunities from nitric oxide and cyclic GMP research to develop novel and important therapeutic agents. There are presently more than 110,000 publications in the area of nitric oxide research. The lecture will discuss our discovery of the first biological effects of nitric oxide and how the field has evolved since our original reports in 1977. The possible utility of this signaling pathway to facilitate novel drug development and the creation of numerous projects in the Pharmaceutical and biotechnology industrials will also be discussed.

Erwin Neher

Biophysics of Short-term Synaptic Plasticity

The term 'synaptic plasticity' describes the fact that connection strengths between the neurons of our brain change constantly in a use-dependent manner. These changes occur on many time scales and underly many of the computational capabilities of our brain. Molecular mechanisms for the fast forms, so-called 'short-term plasticity' are still a matter of debate.

The 'Calyx of Held', a glutamatergic presynaptic terminal in the auditory pathway is large enough that quantitative biophysical techniques, such as voltage clamp, Ca^{++} fluorimetry and Ca^{++} uncaging can be applied. Using these experimental tools, we have studied the role of Ca^{++} and other second messengers in neurotransmitter release and short-term synaptic plasticity (see E. Neher and T. Sakaba, 2008, Neuron 59, 861-872 for review). We found that the concentration of free calcium ($[Ca^{++}]i$) has at least three roles i) it triggers neurotransmitter release in a highly cooperative fashion ii) it accelerates linearly the recruitment of new releasable synaptic vesicles during ongoing stimulation and iii) it mediates short-term facilitation. Recruitment of vesicles is rate-limiting for neurotransmitter release during sustained high-frequency activity. Therefore, the acceleration of this process by Ca^{++} has a very important modulatory role. Surprisingly we found that this process is not limited by the availability of vesicles or the assembly of a molecular release machinery. Rather, new vesicles rapidly enter a state in which they can be released by caged Ca^{++}. Another slower step is required to bring them near Ca^{++}-channels, such that they may also be released by short action potentials.

Ryoji Noyori

Molecular Catalysis for Green Chemistry

Science is inevitably intertwined with society. The state of the art of science, coupled with industrial endeavors, has determined our quality of life. Chemists are proud of their ability to generate high value from almost nothing by using accumulated scientific knowledge. Certainly, the sustainable development of our global society in this century requires truly practical chemical processes. Catalysis has been, and will remain, one of the most important research subjects, because it is the only rational means of producing useful compounds in an economical and environmentally benign way. We must develop catalytic systems effecting "perfect chemical reactions" that give only the desired products with 100% selectivity and 100% yield without unwanted wastes. Every reaction of multi-step synthesis should proceed with a high atom-efficiency, and the overall synthesis needs to be accomplished with a low E-factor. Researchers must spur public opinion and stimulate governmental policies for the promotion of Green Chemistry.

On the Genetic Basis of Morphological Evolution

Christiane Nüsslein-Volhard

Energy Advances — What's New; What's Next; What's Missing

Arno A. Penzias

The Looming World Shortage of Helium

Robert C. Richardson

Greenhouse Effect and Climate Change

F. Sherwood Rowland

The Underground Physics: Neutrino and Dark Matter

Carlo Rubbia

Christiane Nüsslein-Volhard

On the Genetic Basis of Morphological Evolution

Darwins theory of evolution states that variation of the shape and pattern of the adults rather than the embryos are the basis for natural selection. In order to understand how morphological variation arises, it is important to identify the genes that control the development of adult shape and form and their role in the formation of body patterns of animals. The zebrafish is a vertebrate model organism in which many aspects of development can be analysed by genetics. We are investigating the formation of the adult structures that arise during juvenile development with the aim to understand the genetic basis of morphological variation in evolution. We are focusing on the striped pigmentation pattern of the adult zebrafish, this pattern is distinguishing even closely related fish species. Many genes have been identified by mutations that affect the adult body pigmentation pattern in various ways. All pigment cells are derived from the neural crest, an embryonic population of pluripotent cells that migrate out from the nervous system early in development to give rise to many different structures of the fish including peripheral nervous system, and Schwann cells covering nerves. We are searching for the stem cells from which the adult pigment cells are originating. The stripes decorating the adult zebrafishes are composed of three different pigment cell types: black melanophores, yellow xanthophores and silvery iridophores. Stripe formation depends on an interaction between the three pigment cell types. We investigate mutants in which this pattern is disturbed in order to understand the molecular basis of the interaction of the different pigment cell types in the formation of a striped pattern. Our work may help to gain an understanding of the evolution of beauty in nature.

Arno A. Penzias

Energy Advances — What's New; What's Next; What's Missing

Continuing progress in emerging energy technologies underlie a promising start on a challanging journey: first reducing, then stropping, and finally reversing, our civilization's negative impact upon our natural environment. The topics to be discussed include: advances in energy use and distribution, photovoltaics, solar thermal; wind power, and energy strorage--as well as a more-practical alternative to the much-discusses "hydrogen economy" concept.

Robert C. Richardson

The Looming World Shortage of Helium

The world's supply of Helium gas comes primarily from alpha decay in rocks. The most abundant supply is in the American Southwest where it is trapped with methane is natural gas wells. That supply is estimated to last a mere 25 years. It took 4.7 billion years for the Earth to manufacture the helium. It will be squandered in 150 years since its discovery.

F. Sherwood Rowland

Greenhouse Effect and Climate Change

The "greenhouse gases" intercept a fraction of outgoing terrestrial infrared radiation, creating the natural greenhouse effect which warmed the atmosphere by approximately 32 *f* Celsius at the beginning of the 20th Century. The activities of mankind have caused several of these gases to increase in atmospheric concentration during the past century, raising the atmospheric temperature by another 0.7 *f* Celsius. Carbon dioxide, the most prominent GHG, is formed primarily by the burning of the "fossil" fuels coal, oil and natural gas, and has increased from 315 ppmv (parts per million by volume) in 1958 to 392 ppmv in 2010. Methane global concentrations increased about 1% per year from 1.52 ppmv in 1980 but slowed down in the 1990s to a nearly constant 1.78 ppmv from 2000 to 2008, and is growing slowly now. Nitrous oxide is also steadily increasing in atmospheric concentration.

The chlorofluorocarbons (CCl_2F2, CCl_3F, etc.) are not only GHG contributors but also are suppliers of atomic chlorine in the stratosphere, leading to substantial loss of ozone. Every September since the mid-1980s a rapid loss of ozone occurs in a few weeks over the south polar area, resulting in the formation of the well-known Antarctic Ozone Hole, which fades away in mid-spring. These losses in stratospheric ozone led in 1987 to the international adoption of the Montreal Protocol which banned the further manufacture and release of the chorofluorocarbon gases. This Protocol has now been in effect for 23 years, and has been very successful. Nevertheless, the Antarctic ozone loss will occur throughout the 21st century because of the long survival lifetimes of the CFCs. The increase in GHGs will warm the Earth much more in the 21st century unless controls for these GHG gases are rapidly put in place.

Carlo Rubbia

The Underground Physics: Neutrino and Dark Matter

As well known, only seven or eight percent of the Universe is composed of what we term "regular" matter. About 70 percent is dark energy, and around 22 percent of the universe is made up of dark matter. The nature of the dark matter in the Universe is one of the major unsolved mysteries in cosmology.

Dark matter so far has been detected cosmologically through its gravitational effects. The main key question is the existence of an additional electroweak coupling to ordinary matter as a necessary prerequisite to its experimental detection in the laboratory.

There is no shortage of ideas as to what the dark matter could be. A converging paradigm to naturally explain this unseen component of matter is that it may be a weakly interacting massive particle (WIMP), with mass scale ranging from tens of GeV to few TeV, presumably related to the existence of hypothetical SUSY particles. Another alternative puts forth the so-called Axion as the most promising dark matter candidate. Finally, additional sterile neutrinos may also make good candidates.

We will review in detail some of the major experimental programmes underground and on surface and the innovative technologies that are on the way to attempt the direct observation of such elusive dark matter signal in the laboratory.

Building a Synthetic Bacterial Cell

Hamilton O. Smith

Chance, Opportunity and Planning in Science

Oliver Smithies

Mapping the Universe and Its History

George F. Smoot

Learning about the Origin of Life from Efforts to Design an Artificial Cell

Jack W. Szostak

The Big Challenges

Gerardus 't Hooft

Hamilton O. Smith

Building a Synthetic Bacterial Cell

The 1.1 Mb Mycoplasma mycoides subspecies capri strain GM12 genome sequence can be found in GenBank (accession CP001668). Starting with this sequence, we made a number of design changes. We disrupted or deleted 12 genes and we introduced four watermark sequences that contained coded information uniquely identifying it as our designed sequence. The sequence was partitioned into 1078 cassettes 1,080 bp in length with 80 bp overlaps. These were chemically synthesized and obtained from a commercial source. The genome was assembled in 3 stages by transformation and homologous recombination in yeast. In the first stage, the 1,080 bp cassettes were taken 10-at-a-time to produce 10 kb assembly intermediates. The 10 kb assemblies were grown in E. coli to obtain sufficient DNA for the next stage. In the second stage, the 10 kb intermediates were taken 10-at-a-time to produce eleven ~100 kb assembly intermediates. In the final stage, all 11 DNA fragments were assembled into the complete synthetic genome and propagated in yeast as centromeric plasmid.

The circular synthetic M. mycoides genome DNA was extracted out of yeast using an agarose plug method to avoid breakage. The free DNA was then transformed into a recipient M. capricolum host cell whose genome differed substantially in sequence from our synthetic genome. Following entry of the synthetic genome into the recipient cell, the M capricolum chromosome was replaced by the synthetic genome under selection for a tetracycline resistance marker carried by the synthetic genome. This "transplantation" process resulted in colonies that appeared similar to those of native M. mycoides. Sequencing showed that the new cells contained only the DNA that we had designed with the exception of 8 new single nucleotide polymorphisms, an E. coli transposon insertion, and an 85-bp duplication in non-essential genes that occurred during the assembly process. We estimate that after about thirty generations of growth the new synthetic cells no longer contain any proteins or structural components from the original M capricolum recipient cells.

This work is helping to launch and define the new field of synthetic genomics. We expect many applications of the new technology. We now have the means to design and build a minimal cell that will define the minimal set of instructions necessary for life.

Oliver Smithies

Chance, Opportunity and Planning in Science

In thinking ahead towards the future, it is often useful to look back to find what factors have allowed us to reach our present state of knowledge. In my life as a scientist, three factors have been important. One of these factors has been CHANCE, and I will illustrate its influence on my development of a new way of separating proteins by sharing with you my laboratory notebook entries from over 50 years ago. Curiosity is also a prime mover in science. And so, out of curiosity, I tested my new protein separation method with blood plasma. The tests in due course led to the discovery of complicated genetic differences between the plasma proteins of different persons. At this stage, the second factor came into play. There was now an OPPORTUNITY to disentangle these complex new findings. The solution to this genetic problem pointed to the frequent occurrence of homologous recombination in biology. The third factor, PLANNING, had the most important consequences – I was able to devise a plan to alter genes in living cells by homologous recombination (gene targeting). The subsequent extension of this idea to altering genes in animals has been hugely successful. The message for the future that comes from this backwards look is that we must make sure that your generation of scientists will also have the freedom to take advantage of scientific chances. We must also make sure that you have the opportunity to develop your findings in ways that improve human welfare. But, above all, you must enjoy doing what you do. For without that you will never be able to look back, as I can, at 60 years of enjoyable science.

George F. Smoot

Mapping the Universe and Its History

Using our most advanced techniques and instruments we sift through study the cosmic microwave background as a relic of the early universe to understand the events surrounding the birth and subsequent development of the Universe. A precision inspection and investigation of the CMB and other observations along with careful analysis, discussion, and computer modeling have allowed us determine what happened over billions of years with amazing certainty and accuracy. Some of the findings are surprising. A continuing mapping of the large scale structure allows us to check this in detail and gives us the concepts for even more ways to map the history of the Universe. While things are so far consistent, there remain even more mysteries to be solved. In spite of that we can tell the tale of the creation and history of the Universe and show key supporting evidence some of it from very early times including using the cosmic background light to provide a direct image of the embryo universe. This talk will be a review of the current state of cosmological observations based on observations and the challenging issues still to be confronted.

Jack W. Szostak

Learning about the Origin of Life from Efforts to Design an Artificial Cell

The complexity of modern biological life has long made it difficult to understand how life could emerge spontaneously from the chemistry of the Early earth. The key to resolving this mystery lies in the simplicity of the earliest living cells. Through our efforts to synthesize extremely simple artificial cells, we hope to discover plausible pathways for the transition from chemical evolution to Darwinian evolution. We view the two key components of a primitive cell as a self-replicating nucleic acid genome, and a self-replicating boundary structure. I will describe our recent finding of a simple and robust pathway for the coupled growth and division of a model primitive cell membrane. I will also discuss recent experimental progress towards the synthesis of self-replicating nucleic acids, and the implications of these experiments for our understanding of the origin of life.

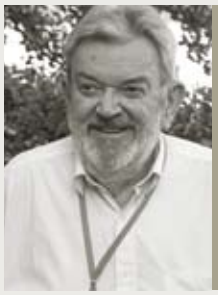
Gerardus 't Hooft

The Big Challenges

During the entire 20th century, physical sciences have advanced to such a degree that we can extrapolate how they can be applied, even in a fairly distant future. Even if we leave open the (likely) possibility of spectacular new discoveries and inventions in the future, we can already say which physical laws they will have to obey, and with that, we can foresee what kinds of advances are still possible, and which of the many ideas that have been launched in Science Fiction novels will remain Science Fiction forever. Thus, fostering dreams that allow for fantastic possibilities in the future, without violat-

Designing Molecules and Nanoparticles to Help See and Treat Disease

Roger Y. Tsien



The Development of Particle Physics

Martinus J. G. Veltman

ing the laws of physics as we know them today, is an interesting exercise. One finds that, from a purely technological point of view, planet Earth can comfortably house a substantially bigger human population than today, human colonization of the many of the moons and planets in the Solar System is possible, and both nanoscience and information technology will continue to transform our society. The most frightening development that might take place in the not-so-distant future is the construction of computers that will show genuine, manlike intelligence. The consequences of that are difficult to foresee.

Roger Y. Tsien
Designing Molecules and Nanoparticles to Help See and Treat Disease

Molecules to observe and manipulate biological systems can be devised by a variety of strategies, ranging from pure chemical design and total synthesis to genome mining and high-throughput directed evolution. Examples of both successes and failures will be chosen mainly from my own experience. The key challenge is to match one's own neuroses and pleasures with research challenges that will have the widest possible impact.

Martinus J. G. Veltman
The Development of Particle Physics

Particle physics mainly developed after World War II. It has its roots in the first half of the previous century, when it became clear that all matter is made up from atoms, and the atoms in turn were found to contain a nucleussurrounded by electrons. The nuclei were found to be bound states of neutrons and protons, and together with the idea of the photon (introduced by Einstein in 1905) all could be understood in terms of a few particles, namely neutrons, protons, electrons and photons. That was the situation just before WW II.
During WW II and directly thereafter information on the particle structure of the Universe came mainly through the investigation of Cosmic rays. These Cosmic rays were discovered by Wulf (1909) through measurements on the top of the Eiffel tower and Hess (1911) through balloon flights. It took a long time before the nature of these cosmic rays became clear; just after WW II a new particle was discovered by Conversi, Piccioni and Pancini. This particle had a mass of 105.65 MeV (compare

the mass of the electron, 0.511 MeV and the mass of the proton, 938.272 MeV). The development of photographic emulsions led in 1947 to the discovery of another particle, the charged pion (mass 139.57 MeV), by Perkins. In subsequent years yet more particles were discovered, notably the K-mesons and the "strange baryons" such as the Lambda (mass 1115,683 MeV). Gradually the phenomenology of all these particles developed, new quantum numbers were invented and classification schemes developed. At the same time, the development of new devices and methods greatly furthered the knowledge of elementary particles. The most important of these are the particle accelerators, the cyclotron and developments thereoff, and the detection instruments such as bubble chamber and spark chamber.

In the beginning sixties Gell-Mann and Zweig came up with the idea of elementary constituents called quarks. These quarks did have unusual properties, the main one being that they did have non-integer charge, in contrast to all particles known at the time that did have integer charge (such as the electron and muon with a charge of -1). For this reason the quarks were not immediately accepted by the community. In addition, as we know now, they can only occur in certain bound states such that the charge of these bound states is integer. Thus the quarks by themselves are confined to bound states. The reason for this confinement became clear much later, around 1972.

The theory of the forces seen to be active between these particles is quantum field theory (QFT), a theory of such complexity that its development stretched over many years. Around 1930 Dirac, Heisenberg and Pauli formulated the foundations of QFT, but it was soon discovered that the theory as known then was very defective, giving rise to infinite answers to well defined physical processes. Fermi was the first to apply QFT to weak interactions, notably neutron decay. The theory developed by Fermi was a perturbation theory, with answers given in terms of a power series development with respect to some small constant, the coupling constant. The lowest order approximation of Fermi's theory was quite successful, but any attempt to go beyond the lowest order met with failure. In any case, Fermi's theory involving the then hypothetical neutrino postuled by Pauli, was successful enough to cement acceptance of that particle.

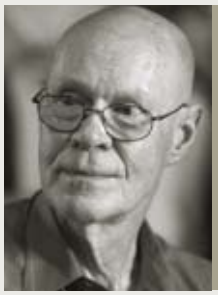
A breakthrough was due to Kramers, who already before WW II discovered that QFT implied certain corrections to the atomic spectra. Experiments by Lamb actually measured such corrections (Lamb shift), and Kramers ideas found acceptance by the community. In addition, Kramers introduced the idea of renormalization, a procedure whereby the infinities of QFT were localized, and where outside these isolated parts perfectly precise calculations could be done. Feynman, Schwinger and others took up these ideas and developed the QFT of electromagnetic interactions, allowing very precise calculations of the Lamb shift and other corrections, commonly called today radiative corrections. These developments, including very successful experimental confirmations, took place around 1948.

The development of QFT of the weak interactions was very difficult and lasted till about 1971. A new idea, the interplay of forces arranged in a very careful manner such as to avoid the occurrence of infinities, was developed. This is known under the name of gauge theories. In such a theory there is a multitude of forces and particles such that all irreparable bad features cancel out. Thus the theory thereby predicted the existence of certain new particles, necessary to complete the complex structure of balancing infinities. The actual discovery of these particles, notably the Zo and the charmed quark, topped by the discovery of the top quark in 1995, has firmly established the gauge theory of weak interactions.

The strong interactions, the forces responsible for the interactions between quarks and notably supposedly responsible for quark confinement, profited from the development of gauge theories. In the wake of the gauge theory of weak interactions also a gauge theory of strong interactions was formulated and investigated. An important step was taken with the establishment of asymptotic freedom for the gauge theory of strong interactions. By 1980 the Standard Model of Weak, em and strong interactions was settled; the Higgs sector of that model remains still to be tested, which hopefully will be done at least partially using the new machine L(arge) H(adron) C(ollider) at CERN, now running.

How Energy is Converted in Biology

Sir John E. Walker



Discovery of Cosmic Microwave Background Radiation and its Role in Cosmology

Robert W. Wilson

Structural Genomics and the Expanding Universe of Protein Sequences

Kurt Wüthrich

The Amazing Ribosome

Ada E. Yonath

Sir John E. Walker

How Energy is Converted in Biology

Oxygen evolving life may have begun on Earth about 3,400 billion years ago. The interpretation of geochemical evidence, for example in the Buck Reef Chert, is disputed, but evidence from fossilised stromatolites in Australia is perhaps more convincing. Modern oxygen evolving photosynthesis requires more than 1000 proteins, many of them organised in complex membrane bound structures. Light energy from the sun is trapped in carbohydrates and fats, providing our food with its calorific value. We release the energy by respiration, consuming in the process most of the oxygen that we have breathed in. More than 1000 proteins are involved in cellular respiration, and about 100 of them are organised in the inner membranes of mitochondria as the respiratory enzyme complexes that function as molecule machines to convert the redox energy derived from energy in food-stuffs into adenosine triphosphate (ATP), the energy currency of biology. The final synthetic step is achieved by a remarkable molecular machine with a mechanical rotary action. Its closest man-made analogue is the Wankel rotary engine. The rotor of the biological machine is driven at about 100-200 rpm by a transmembrane proton-motive force (analogous to the electron-motive force in electricity). The mechanical action of the rotor drives the chemistry of the formation of ATP from ADP and phosphate in the three catalytic sites of the enzyme. How this biological machine works, the medical consequences of dysfunctional energy conversion, and the possible evolutionary origins of the rotary machine will be discussed in the lecture.

Robert W. Wilson

Discovery of Cosmic Microwave Background Radiation and its Role in Cosmology

Prior to the 20th Century, cosmology was the study of objects in the universe, not the physics of the universe as a whole. In this talk I will briefly review the development of cosmology in the first half of the 20th Century. I will then discuss the discovery of the Cosmic Microwave Background Radiation by Arno and me at Bell Labs and several near misses which preceded us. I will close with an overview of the current understanding of our universe.

Kurt Wüthrich

Structural Genomics and the Expanding Universe of Protein Sequences

With the availability of the complete DNA sequences of a wide range of organisms, structural biologists are faced with new opportunities and challenges in "structural genomics". Research in structural genomics is focused on gene products with unknown structures, unknown functions, and minimal similarity to previously studied proteins. A precisely formulated initial goal of structural genomics was to investigate representatives of all protein families, and thus to cover a large part of the protein universe with three-dimensional structures. My research group is specialized in the use of nuclear magnetic resonance (NMR) spectroscopy for studies of proteins and represents this technique in the California-based Joint Center for Structural Genomics (JCSG: www.jcsg.org), which is one of four large-scale consortia in the NIH-funded Protein Structure Initiative (PSI: www.nigms.nih.gov/Initiatives/PSI/). When compared to structure determination by X-ray crystallography, which is the principal technique used by the JCSG, the NMR method is complementary by the fact that atomic resolution structures and other function-related data can be obtained under solution conditions close to the physiological milieu in body fluids. By generating data on protein structure, stability, dynamics and intermolecular interactions in solution, NMR thus has an exciting role in the longer-term challenge leading from the expanding protein structure universe to new insights into protein functions and chemical biology.

Ada E. Yonath

The Amazing Ribosome

Ribosomes are the universal cellular machines that act as polymerases that translate the genetic code into proteins. They posses spectacular architecture accompanied by inherent mobility that facilitate their smooth performance in decoding, peptide bond formation and nascent protein elongation. These huge particles are composed of proteins and RNA, among which the RNA moieties perform both tasks: decoding and peptide bond formation. The site for peptide bond formation (PTC) is located within a universal symmetrical region, an outstanding feature within the otherwise asymmetric ribosome, which seems to be the remnant of a prebiotic RNA machine. Owing to its stunning design, the symmetrical region is capable of positioning both the amino acylated- and Peptidyl-tRNA substrates in stereochemistry required for peptide bond formation, for substrate-mediated catalysis, and for tRNA translocation, thus enabling the repetition of peptide bond formation. In the contemporary ribosomes this region connects all of the remote ribosomal features involved in its functions, hence may transmit signal between them. The elongated tunnel along which nascent chains progress until they emerge out of the ribosome is situated adjacent to the PTC. This tunnel provides hosts a major family of antibiotics and may be involved in chaperoning and provides the binding site of the first cellular chaperone that encounters the emerging nascent chain.

Petra Meier to Bernd-Seidl, Mayor of the City of Lindau (left) and Countess Bettina Bernadotte welcoming citizens of Lindau and participants of the 2010 Lindau Meeting to the "Grill & Chill" Barbeque.

SOCIAL PROGRAMME

The Lindau Nobel Laureate Meetings offer a high-class scientific programme but they also take a unique approach to combining cutting-edge research topics in lectures and panel discussions with personal interactions between Nobel Laureates and young researchers during the events of the social programme. True to the 'Mission Education', this is an integral part of each Lindau Meeting. The goal is to foster an atmosphere which aims to educate, inspire and connect generations of scientists.

This year's traditional Get-Together Evening was hosted by the European Commission's Directorate-General for Research. It heralded the beginning of the social programme by showcasing the diversity of the European Union in terms of scientific competence as well as culinary delicacies (see special section on p. 100).

Welcome Parties

On Sunday evening, young researchers had their first opportunity to become acquainted with colleagues from all over the world. Three welcome parties at three different locations around the Isle of Lindau offered a variety of opportunities to discuss ideas and projects. The events were held at the invitation of the Spielbank Lindau, the U.S. Department of Energy (DOE), the National Science Foundation's Mathematical and Physical Science Directorate, the National Institute of General Medical Sciences, the Oak Ridge Associated Universities (ORAU), Mars, Incorporated and the Foundation Lindau Nobelprizewinners Meetings at Lake Constance.

Academic Partners' Dinners

On Tuesday evening, a number of institutions invited Nobel Laureates and young researchers to small group dinners. In an informal atmosphere, all participants gathered at restaurants all over Lindau to exchange ideas and opinions and also get to know each other. Lou Woodley was part of the official blogging team for the conference blog on www.lindau.nature.com. She attended one of the dinners, stating that they "really brought the Laureates to life as personalities that extended beyond their scientific achievements".

Grill & Chill: Connecting Cultures

The newest addition to the social programme was a barbeque called "Grill & Chill", which brought together participants of the meeting and citizens of Lindau. At the invitation of the City of Lindau and the Council, more than 480 young researchers and nearly 400 citizens of Lindau came together at a park on the shores of Lake Constance. Petra Meier to Bernd-Seidl, Mayor of the City of Lindau, and Countess Bettina Bernadotte welcomed all the guests. Taking the motto of the Grill & Chill "Connecting Cultures" seriously, young researchers and citizens of Lindau alike enjoyed a warm summer evening with ample opportunities to engage in conversations that gave insights into everyday life in Lindau and the diversified cultural background of the participants at the 60th Lindau Nobel Laureate Meeting.

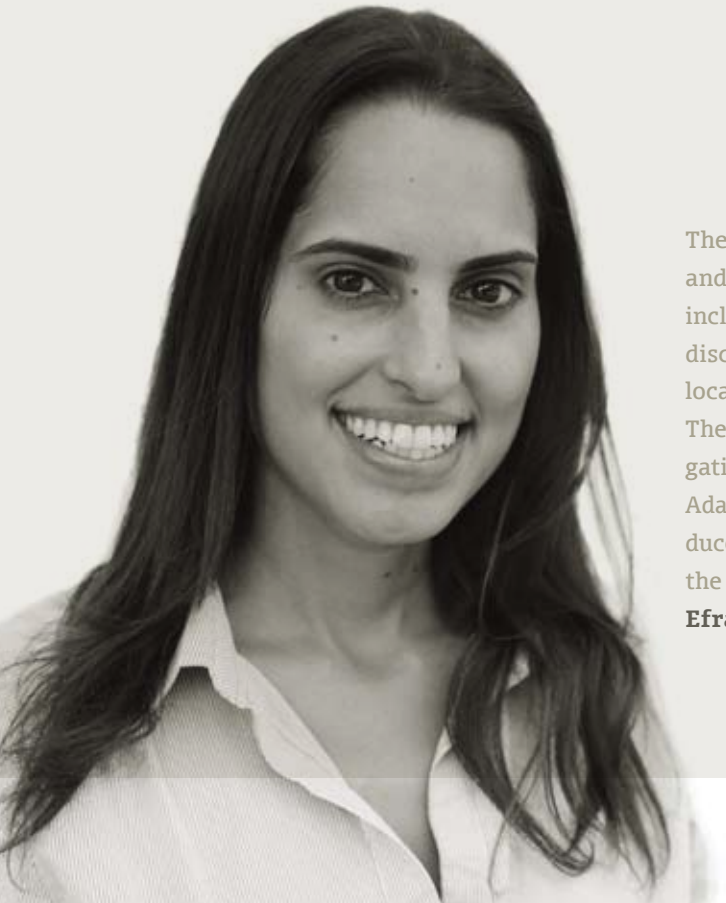
With the help of regional sponsors and thanks to services provided by the city of Lindau on a pro bono basis, organizers were able to invite everybody to the Grill & Chill as their guest. Lindau citizens were asked to donate money for kindergartens taking part in the "Tiny Tots Science Corners" initiative (Haus der kleinen Forscher).

"Grill & Chill" Barbeque at the Toscana Park took place next to the Lindau municipal administration.

Concert by the Verbier Festival Chamber Orchestra

On Wednesday evening, all participants of the 60th Lindau Nobel Laureate Meeting were invited to attend a concert by the Verbier Festival Chamber Orchestra. Sharing the common goal of promoting young talents from all over the world, the Council and Foundation of the Lindau Meetings were pleased that the orchestra was once more able to perform at this year's meeting thanks to the personal support of Martin Engstroem, 'spiritus rector' of the Verbier Festival. The Verbier Festival Orchestra and the Verbier Festival Chamber Orchestra have set a world standard in orchestral training. Made up of approximately one hundred young musicians from around the world aged 17 to 29, the orchestra offers a unique opportunity for talented young musicians to network and develop within a professional environment. This orchestra has been widely recognised for its dynamic and passionate performances.

The international ensemble of the Verbier Festival Chamber Orchestra delivered a passionate and dynamic performance during the 2010 Lindau Meeting.



The 60th Lindau Nobel Laureate Meeting was great, both on a personal and a scientific level. I really enjoyed the format of the meeting, which included the lectures by laureates in the morning and the more intimate discussions during the afternoon. The organization was superb, and the location in the beautiful Lindau greatly contributed to the atmosphere. The most memorable experience for me was a lunch for the Israeli delegation with 4 Laureates, spontaneously organised by the Nobel Laureate Ada E. Yonath. I also greatly enjoyed the Grill and Chill party, which introduced us to the locals. I made great contacts with students from all over the world, which I believe will contribute significantly to my work.
Efrat Shema, Israel

The Bavarian Evening uniquely presented culture and science.

Rosa Costañé-Selga and Franz Hagn were two of three fellows from the Elite Network of Bavaria who presented their scientific work during the Bavarian Evening.

Nobel Laureate Johann Deisenhofer (left) and Wolfgang Heubisch, Bavarian Minister of State for Science, Research and the Arts.

Bavarian Evening

Becoming a tradition in itself, this year's meeting was again enriched by the Bavarian Evening. The Free State of Bavaria and the Elite Network of Bavaria extended an invitation to all participants of the 60th Lindau Nobel Laureate Meeting to an evening that uniquely fuses Bavarian customs with current science and research topics. Following the welcome address by the Bavarian Minister of State for Science, Research and the Arts, Wolfgang Heubisch, the native Bavarian and Nobel Laureate, Johann Deisenhofer, took to the stage. He introduced the three members of the Elite Network of Bavaria, who presented their research projects to the audience. Musicians from Hintersberg and performers from Nußdorf in their traditional costumes heralded the beginning of the informal part of the evening with traditional Bavarian food and beverages.

Minister Heubisch emphasized in his speech the importance of cooperation: "In science, the path to knowledge has always been travelled best in company, and today, in a globalised world, international cooperation is the key to scientific excellence." The Lindau Meetings contribute to such joint efforts by providing a "forum for Laureates to connect and share their knowledge with other scientists". He firmly believes that young researchers will one day come up with innovations and solutions for global problems and will therefore help to shape the future. Some of them might make major discoveries and innovations in Bavaria, so Heubisch extended an invitation to all participants to learn more about the state of Bavaria as a hotspot of science and research over the course of this evening.

Nobel Laureate Johann Deisenhofer guided the audience through the evening. He drew parallels between the Free State and his new home in Texas by pointing out that they both share the same spirit and sense of independence. But besides the fact that Bavarian beer is almost non-existent in Texas, he highlighted the Elite Network of Bavaria as a decisive difference. This institution provides great benefits to young researchers involved there, and most importantly, the "feeling of belonging to some large group that enables them to exchange experiences and discuss career opportunities with peers".

14 members of the Elite Network took part in the 60th Lindau Nobel Laureate Meeting. Three of them presented their research projects during the Bavarian Evening.

3 Presentations Were Held by Members of the Elite Network of Bavaria:

Franz Hagn: Structure, Stability and Assembly Mechanism of Spider Silk Proteins
Rosa Castañé-Selga: Stability Preservation in Model Order Reduction of Large-Scale Systems
Anne-Kathrin Pröbstel: Autoantibodies in Childhood Demyelinating Diseases

FACTS & FIGURES

Results from the Participant Survey, Part II

In order to meet the high standards of the Lindau Meetings, both in terms of content as well as organisation, the participants' feedback is taken into account when compiling the programme. Being the 3rd Interdisciplinary Meeting held at Lindau, the Council and the Foundation were keenly interested in the opinion of all participants whether the balance between all scientific fields in the programme was accomplished. Of all surveyed young researchers 63% rated the interdisciplinarity of this year's meeting as excellent and therefore confirmed that the offered scientific events were able to attract the interest of a large number of participants from different fields of science. In addition to this, the scientific programme of the 60th Lindau Nobel Laureate Meetings as a whole was received very well by all participants and was even rated more highly than in the previous years.

How do you rate the quality, structure and concept of the meeting?

Interdisciplinarity

Too much	7 %
Excellent	63 %
Appropriate	27 %
Too focused	3 %

Young Researchers Involvement

Too specific	0 %
Excellent	61 %
Appropriate	36 %
Too little	3 %

Participant Interaction

Too much	2 %
Excellent	59 %
Appropriate	35 %
Too little	4 %

My expectations were...

Exceeded	43 %
Excellent	29 %
Met	28 %
Not met	0 %

Please assess the following parts of the programme:

Plenary Lectures (mornings)

Excellent	45 %
Good	55 %
Fair	0 %
Poor	0 %

Student Discussions (afternoons)

Excellent	46 %
Good	40 %
Fair	12 %
Poor	2 %

Lectures & Discussions (afternoons)

Excellent	41 %
Good	45 %
Fair	14 %
Poor	0 %

Interdisciplinary Panel Discussion (Tuesday)

Excellent	24 %
Good	54 %
Fair	10 %
Poor	12 %

Afternoon Discussion "CERN" (Tuesday)

Excellent	31 %
Good	28 %
Fair	6 %
Poor	35 %

Discussion / Brainstoming "Being a Scientist" (Thursday)

Excellent	49 %
Good	45 %
Fair	6 %
Poor	0 %

Panel Discussion on the Isle of Mainau (Friday)

Excellent	35 %
Good	27 %
Fair	27 %
Poor	11 %

FACTS & FIGURES

Results from the Participant Survey, Part II

The overall organisation of this year's Meeting of Nobel Laureates has set new standards in terms of professionalism as well as convenience for the most talented international young researchers. 84% of all surveyed participants agreed that the organisation of the 60th Lindau Nobel Laureate Meeting was excellent.

Additionally, the continuing improvements of the opening ceremony, which were started in 2009 are evidently successful since 46% of all young researchers (up from 40% in 2009) rated the ceremony as being excellent. The efforts to regularly introduce new formats received widespread acceptance. The "Grill & Chill" Barbeque where citizens of Lindau were able to meet the participants of this year's meeting received very positive feedback from the young researchers.

Please rate the following aspects:

Overall Organisation

Excellent	84 %
Good	16 %
Fair	0 %
Poor	0 %

Information provided before the Meeting

Excellent	43 %
Good	45 %
Fair	12 %
Poor	0 %

Young Researchers Registration Desk

Excellent	70 %
Good	30 %
Fair	0 %
Poor	0 %

Internet Access at Meeting Venue

Excellent	40 %
Good	45 %
Fair	11 %
Poor	4 %

Please rate the following social events:

Opening Ceremony

Excellent	46 %
Good	35 %
Fair	19 %
Poor	0 %

International Day/Get-Together Evening

Excellent	53 %
Good	28 %
Fair	14 %
Poor	5 %

Academic Dinner

Excellent	50 %
Good	29 %
Fair	18 %
Poor	3 %

Grill & Chill

Excellent	45 %
Good	42 %
Fair	13 %
Poor	0 %

Concert Evening

Excellent	65 %
Good	31 %
Fair	2 %
Poor	2 %

Bavarian Evening

Excellent	44 %
Good	35 %
Fair	16 %
Poor	5 %

Boat Trip and Afternoon on the Isle of Mainau

Excellent	57 %
Good	43 %
Fair	0 %
Poor	0 %

Nobel Laureate Arno A. Penzias explaining the "science of chess" to young researchers during the boat trip to the Isle of Mainau.

CLOSING DAY ON THE ISLE OF MAINAU

The closing day of the Lindau Nobel Laureate Meetings is traditionally held on the Isle of Mainau. For the third consecutive year, the State of Baden-Württemberg and the Bernadotte Family together were hosts for this full day of events. It began early on board the "MS Sonnenkönigin", which took all participants to the Isle of Mainau. On the boat, the Science Minister of Baden-Württemberg, Peter Frankenberg, presented the federal state to young researchers as a hotspot for research and innovation. The boat trip offered plenty of opportunities to talk to representatives from science and industry based in Baden-Württemberg. Seven universities and a number of research institutes, such as the German Cancer Research Centre or the Max Planck Society, showcased their projects and facilities. Technology-driven companies, such as Robert Bosch GmbH, were also present, among many others.

On the Isle of Mainau, the scientific programme of the 60th Lindau Nobel Laureate Meeting came to its conclusion with an interdisciplinary panel discussion on "Energy and Sustainability". Nobel Laureates Yuan Tseh Lee (Chemistry, 1986) and Carlo Rubbia (Physics, 1984) as well as Hans J. Schellnhuber, Director of the Potsdam Institute for Climate Impact Research in Germany, and Georg Schütte, State Secretary of the Federal Ministry of Education and Research in Germany, engaged in a lively discussion (see page 43). In addition to this panel discussion, all participants were invited to learn more about the future of energy in the exhibition "Discoveries 2010: Energy" on Mainau. This outreach project within the 'Mission Education' of the Foundation Lindau Nobelprizewinners Meetings at Lake Constance is part of the "Science Year 2010 – The Future of Energy" of the Federal Ministry of Education and Research of Germany.

The Minister President of Baden-Württemberg, Stefan Mappus, joined participants and organizers on the Isle of Mainau for the official farewell. "Communication in science as it is practised here – between established and young researchers, across disciplines and national borders – will be of increasing importance in the future," he said. On behalf of all young researchers present, Eva Elisabeth Deinum from the Netherlands thanked not only the Nobel Laureates for their openness and will-

ingness to share their experiences, but also the Council and Foundation for the opportunity to take part. She concluded with an appeal to all participants to continue the dialogue which started at this anniversary Lindau Meeting: "What we have is the seed of contact, so make the effort to let these seeds grow, cherish them and take your responsibility to make the aims of the meetings come true."

On behalf of the Nobel Laureates, Jack W. Szostak thanked the Bernadotte Family for their hospitality and congratulated the Council and the Federation for organising the meeting. As a first-time attendee of the Lindau Meetings, he was clearly impressed by the curiosity of the young researchers and wished them all the best for their future scientific careers.

Countess Bettina Bernadotte also bade farewell to all participants. She called upon the young scientists to further foster the friendships and contacts made during this past week and to play their part in solving the challenges of the future: "Take your participation in the Lindau Meeting as a starting point", Countess Bernadotte suggested.

Nobel Laureate Jack W. Szostak congratulated the organisers to a successful meeting.

Eva E. Deinum thanked on behalf of all young researchers for an unforgettable week.

This was the first Lindau Meeting that I have been privileged to attend. Both I and my wife thoroughly enjoyed it. I greatly appreciated both the opportunity to talk with the participating 'students' and in particular the opportunity to meet many Nobel Laureates whom I did not previously know. I particularly appreciated this multidisciplinary meeting and was fascinated to hear the presentations from cosmologists, physicists and chemists as well as from my biological colleagues. It was a very worthwhile and rewarding experience and I look forward to attending as many more as I can.

Sir Martin J. Evans,
Nobel Laureate in Physiology or Medicine, 2007

Nobel Laureates Theodore Hänsch (from left) and Klaus von Klitzing as well as Stefan Mappus, Minister President of Baden-Württemberg and Peter Frankenberg, Science Minister of Baden-Württemberg, together with participants of the "Jugend Forscht" science competition.

THE 60TH MEETING OF NOBEL LAUREATES

THE EUROPEAN COMMISSION AS PARTNER OF THE INTERNATIONAL DAY

As announced last year by the President of the European Commission, José Manuel Barroso, this year's "International Day" (Monday) was supported by the European Commission. Its Directorate-General for Research put a special focus on presenting career opportunities in Europe for top scientists from around the world. The special day ended with the traditional Get-Together Evening, when young researchers and Nobel Laureates gathered at the Inselhalle. Taking place since the very first Lindau Meeting back in 1951, this event offers Laureates and young scientists alike the opportunity to converse in an open and informal atmosphere.

Michel Claessens, Angélica Cuapio Gómez, Tim Radford and Nobel Laureate Peter Agre discussed the importance of communicating science to the public.

Wolfgang Burtscher, Deputy Director-General of the European Commission's Directorate-General for Research, opened the evening. "Our research programmes are open to the world – to you," he emphasized. As a beacon for cutting-edge science and research, Europe hopes that many of the participants will consider spending part of their research time in Europe. "Lindau is a taste of what Europe has to offer," he said. "It is our hope that the students here can learn from one another and make lifelong connections, and that the Nobel Laureates will be inspired by these students," Burtscher added.

Wolfgang Burtscher, Deputy Director-General of the Directorate-General for Research of the EU Commission.

The outreach to the public as a responsibility of scientists and researchers was the focus of a roundtable discussion. Nobel Laureate Peter Agre, young researcher Angélica Cuapio Gómez and science journalist Tim Radford attended the discussion, which was moderated by Michel Claessens, Deputy Head of Communications at the European Commission's Directorate-General for Research. "While a recent study showed that 80 percent of Europeans said they are interested in science and technology, only 10 percent of those polled felt that they were actually well-informed about scientific issues," Claessens said. Peter Agre quoted Albert Einstein in explaining how to make science understandable to the broad public: "Make it as simple as possible, but no simpler." "There are at least two reasons why the public needs to understand science better," Agre said. "First, they – the tax payers – are paying for what we do. We owe it to them to explain what we are doing." Second, "we have political leaders who are capitalizing on misconceptions about science." For all scientists, communicating clearly about research discoveries is essential. Scientists are doubly obliged to explain what they do, explained Tim Radford. "But here's the catch: in a democracy, the public is not obliged to listen," he continued. "People will be interested in science only if we can make them interested. And as scientists and science journalists, we are not doing a very good job at educating the public," said Radford and emphasised "but we are trying because it's our job to be translators of science for the public".

Nobel Laureate Sir Harold W. Kroto and young researchers at the traditional Get-Together Evening as part of the International Day.

Participating for the first time in the Lindau Meeting was a fantastic experience. The very nice and fruitful exchanges I had with young scientists from all around the world, their perception of research careers, motivations and expectations truly enriched my own vision on the actual evolution of science in the context of a globalized world.

Françoise Barré-Sinoussi,
Nobel Laureate in Physiology or Medicine, 2008

Nobel Laureate Peter Grünberg in a discussion with a young researcher at the 2010 Lindau Meeting.

THE 60TH MEETING OF NOBEL LAUREATES

ASSOCIATED PROGRAMMES

The Lindau Nobel Laureate Meetings have evolved during the past 60 years into an international forum of science and research. The Council and Foundation are constantly looking for new partners who share the same goals and values. A steady dialogue between these partners generates ideas for new and innovative formats. Firmly believing in the importance of building bridges between science, politics and business, the Council and Foundation welcome formats that help to foster such a dialogue.

More than 60 young researchers followed Minister Schavan´s invitation for a boat trip on the "MS Lindau" on the day before the opening of the 60th Lindau Meeting.

Nobel Laureate Gerardus 't Hooft and Dieter Jahn, Senior Vice President of BASF SE on their way to the CTO Briefing.

CTO BRIEFING

On the Saturday before the 2010 Lindau Meeting started, Nobel Laureates and Chief Technology Officers (CTO) of international corporations met to discuss future challenges for both science and business. This first CTO Briefing goes back to an initiative by Nobel Laureate Martin Chalfie, and added a new aspect to the Lindau Dialogue. Eleven Nobel Laureates and 33 CTOs convened in the Festspielhaus in Bregenz (Austria) for an afternoon. After a welcome speech and introduction held by Nobel Laureate Aaron Ciechanover, participants joined specific discussion groups which focused on topics ranging from "Educating and Tutoring Best Talents" to "Innovation Opportunities". Bringing together exceptional scientists and representatives of business in an informal and open atmosphere proved to be extremely fruitful for both sides. "It is always important to have a fresh look at certain issues and it is immensely helpful to understand how someone judges a situation from a different perspective," said Wolfgang Schürer, Chairman of the Board of the Foundation Lindau Nobelprizewinners Meetings at Lake Constance.

Nobel Laureate Jack W. Szostak (from left), Ernst-Ludwig Winnacker, Secretary General of the Human Frontier Science Program and Koji Omi, Founder and Chairman of the STS Forum attended the CTO Briefing.

SATURDAY BOAT TRIP

Following last year's successful introduction, the Federal Ministry of Education and Research again organised a special boat trip. Federal Minister Annette Schavan invited attendees of the 60th Lindau Nobel Laureate Meeting to join her and representatives from the fields of science and politics on the "MS Lindau". More than 60 participants enjoyed a panoramic boat trip on the day before the official opening ceremony. They exchanged ideas and spoke of their expectations for the forthcoming week. Federal Minister Annette Schavan pointed out how important this dialogue is in order to build bridges between science, politics and business. Only joint efforts will lead to sustainable solutions for the challenges of the 21st century.

Howard Shapiro, Director Plant Science and External Research, Mars, Incorporated (from left), Nobel Laureate Françoise Barré-Sinoussi and young researcher Tanya Pedrossian.

A large number of participants followed the invitation to the science breakfast onboard the "MS Lindau".

SCIENCE BREAKFAST

Although it started early in the morning at 7.15 am, the science breakfast hosted by Mars, Incorporated on board the 'MS Lindau' attracted a large number of young researchers to the harbour. The continental selection of delights was much appreciated by the young researchers, but the real highlight came with the subsequent discussion session on "How can science serve society?"

Proficiently chaired by Adam Smith, the panel consisted of Howard Shapiro, who heads up Mars's plant science research activities, Françoise Barré-Sinoussi, 2008 Nobel Laureate for Medicine, and Tanya Pedrossian, a young researcher from UCLA. Proceedings kicked off with an interesting contribution from Shapiro which focused on his team's collaboration with the US Department of Agriculture and IBM (among others) to sequence the cocoa tree genome and the implications such work could have for society, and in particular, for the millions of rural workers in tropical nations around the world who rely on this tree for their livelihood.

The subsequent panel discussion ranged widely. Françoise Barré-Sinoussi picked up on many of the themes from her excellent address on the opening day of the meeting, exploring the societal implications of her Nobel Prize-winning work identifying HIV and subsequent efforts to deal with the viral menace across the globe. Tanya Pedrossian's contributions kicked off some of the most interesting discussions among the panel. Of particular interest here were observations about what makes a good scientific collaboration (complementarity, communication and trust), whether scientists should be evaluated by criteria that move beyond their publications, and how young scientists should balance the pressure to put their research data in the public domain as soon as possible with the understandable inclination not to do so before they have analyzed and written up this data to ensure that they get full credit for their work. Only a few questions were possible in the time available, but the passion and enthusiasm on display made up for this.

based on a blog entry by Nick Campbell for the official meeting blog at www.lindau.nature.com

THE 60TH MEETING OF NOBEL LAUREATES

POST-CONFERENCE ACTIVITIES

As in previous years, partners of the Lindau Nobel Laureate Meetings offered post-conference activities. Here, international Best Talents had the opportunity to find out more about Europe's science and education landscape. The success of such programmes following the Nobel Laureate Meeting is demonstrated by, amongst other things, the number of individuals who later actually return to institutes and other scientific institutions. The Sino-German Center for Research Promotion, for example, can look back on an impressive outcome of its post-conference programme: "Since 2000, nearly 200 young researchers from China have participated in the Lindau Meetings. 15 percent of them came back to Germany with a scholarship at a German scientific institution," said Zhao Miaogen, Vice Director of the Center.

50 young researchers participated in the "Lindau fellows go ESOF!" programme of the Robert Bosch Foundation and travelled to Turin after attending the 2010 Lindau Meeting.

SINO-GERMAN CENTER

The Sino-German Center for Research Promotion (CDZ) is this year celebrating its 10th anniversary. Being a co-operation between the German Research Foundation (DFG) and its Chinese partner organisation, the National Natural Science Foundation of China (NSFC), the institution offered a one-week post-conference programme to Chinese participants of the 60th Lindau Meeting. Young researchers had a chance to visit German universities and laboratories in Munich, Dresden, Berlin and Bonn, as well as the Center for NanoTechnology (CeNTech) in Münster, which aims at improving the utilization of the vast potential and multifaceted prospects of nanotechnological research.

DFG AND DST

At the invitation of the Department of Science & Technology in India and the German Research Foundation (DFG), 20 Indian scientists participated in a week-long post-conference programme. The delegation visited a number of premier German science institutions, such as the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig or the Technical University of Dresden. In addition, the young researchers were able to get to know research institutions in Jena and Bonn, and also to participate in information sessions on funding opportunities for studying in Germany, which were organised by the Alexander von Humboldt-Foundation (AvH) and the German Research Foundation (DFG).

BADEN-WÜRTTEMBERG

Baden-Württemberg's Ministry of Science, Research and the Arts invited 20 international young researchers to a four-day tour following the 2010 Lindau Meeting. The itinerary included visits to the Kepler Center for Astro and Particle Physics in Tübingen as well as universities and research institutes in Freiburg and Heidelberg.

LINDAU FELLOWS GO ESOF

The Robert Bosch Foundation organised a post-conference trip to the EuroScience Open Forum (ESOF) 2010 in Turin for international participants of the 60th Lindau Nobel Laureate Meeting. 50 young researchers – most of them from outside Europe – were selected by the foundation to participate in this biennial pan-European meeting, which showcases European and international achievements across the scientific spectrum and serves as an open forum for debates on science-related issues. The programme "Lindau fellows go ESOF!" helped these Best Talents to get an overview of European Research and its stakeholders. In Turin, they met Europe's top scientists, science policy-makers and science communicators, and had the opportunity to further enhance their expert network for future research.

FALLING WALLS

Alumni of the Lindau Meetings had the opportunity to participate in the prestigious Falling Walls Conference in Berlin (November 2010) as part of the "Young Scholar Einstein Berlin Programme". First held in 2009 on the 20th anniversary of the fall of the Berlin Wall, this scientific conference aims to showcase groundbreaking work being done by respected international scientists from a wide range of disciplines.

Young researchers from China were invited by the Sino-German Center for Research Promotion (CDZ) to participate in the 2010 Lindau Meeting. Present were also (from left to right) Chen Lesheng, Vice Director of the CDZ; Matthias Kleiner, President of the DFG; Armin Krawisch, Director of the CDZ as well the Vice Director, Zhao Miaogen.

Young Scholar Einstein Berlin Programme: 27 Lindau Alumni participated in the Falling Walls Conference 2010 in Berlin.

THE 60TH MEETING OF NOBEL LAUREATES

ENABLING THE 'MISSION EDUCATION'

The Foundation Lindau Nobelprizewinners Meetings at Lake Constance is committed to the public-private partnership model. With its donors and sponsors, it has established a unique cooperation that has enabled the Foundation to set up a substantial endowment within a relatively short period of time.
The Board of the Foundation hopes to further enhance this capital stock within 10 years to generate sufficient yields to cover half of the meeting costs. Meanwhile, project-related support and donations in kind played a pivotal role this year in securing the high standards of the 60th Lindau Meeting and will continue to do so in the future. In its 10th year, the Foundation has put enormous efforts into securing once again the organisation of a high-profile meeting for the international elite of young scientists – even in a difficult economic environment.

675 highly talented young researchers from 68 countries came together on the shores of Lake Constance for a week of personal encounters and an exchange of ideas.

ENDOWMENT OF THE FOUNDATION

Even in the currently difficult economic environment, the Board of the Foundation Lindau Nobelprizewinners Meetings at Lake Constance under the chairmanship of Wolfgang Schürer has succeeded in acquiring new partners for the Lindau Dialogue. Support for the scientific dialogue is increasing at home and abroad, and the paid up endowment of the Foundation currently stands at €21.5 million.

With the Lockheed Martin Corporation, another American company is actively committing itself to the Lindau Dialogue as a Maecenate. In previous years, it has been possible to welcome organisations such as Mars, Incorporated and the Microsoft Corporation into this circle as endowment contributors. The Jacobs Foundation from Switzerland has become a new endowment contributor as a principal donor, and Bayer AG, Holcim Ltd., Lonza AG, Mars, Incorporated and the Volkswagen Group are among the group of partners who have increased their contributions to the Foundation's capital.
Following a close review of the 60th meeting, Fondazione Cariplo decided to join the Foundations partners as a Principal Donor as well as acting as an official Academic Partner for participants from Italy as of 2011.
In view of the low interest rates currently available in financial markets, the Foundation continues to face considerable challenges. Although the Foundation's capital has increased from €16 million in 2008 to the current level of €21.5 million, the increase in capital currently does not offset the loss in earnings as a result of the low interest rates. The Foundation Board's strategy of raising project-related funds in addition to the Foundation's endowment therefore remains absolutely essential for the foreseeable future. This ensures that the further development of the Lindau Meetings can be continued in the current difficult economic environment while at the same time securing their long-term future.

PROJECT-RELATED SUPPORT

Never before has one Meeting of Nobel Laureates been as large as it was on the occasion of the 60th meeting. The Council and Foundation were able to welcome 59 Nobel

Laureates and 675 young scientists from 68 countries. In view of this number of participants, a special effort was made this year to create an atmosphere that would encourage open dialogue. The extra work on infrastructure and technology, as well as the additional expenditure on accommodation, travel costs and catering, could only be covered thanks to the generous support of the benefactors of the 60th Meeting of Nobel Laureates. They made it possible for young researchers from around the world to take part solely on the grounds of their scientific achievements, thereby transforming Lindau for a week into the international hotspot of science.

The biggest single donor to the Lindau Dialogue in 2010 was once again the German Federal Ministry of Education and Research. Through its support, the Council and Foundation were able to forge ahead with their efforts to give the meeting a more international and professional touch. As part of the "Year of Science 2010 – The Future of Energy", the Federal Ministry also supported the "Discoveries 2010: Energy" exhibition on the Isle of Mainau (see page 134).

The participation of up-and-coming German researchers was supported by a variety of foundations. Young scientists from the field of physics were sponsored by the Wilhelm and Else Heraeus Foundation (as they had also

A large number of benefactors made it possible to create an atmosphere that encouraged an open dialogue between all participants of the 60th Lindau Nobel Laureate Meetings.

been at the Physics Meeting in 2008). Together with the Hertie Foundation, the Boehringer Ingelheim Foundation supported the participation of young researchers from the fields of physiology and medicine. As in 2009, the Chemical Industry Fund within the German Chemical Industry Association (VCI) enabled young chemists to take part.

A number of institutions are also becoming actively involved in facilitating the participation of young international scientists. These include, amongst others, Bayer AG, the German Research Foundation (DFG), the European Commission's Marie Curie Actions programme, the Fritz Thyssen Foundation, Lockheed Martin Incorporated, Mars, Incorporated, Microsoft, the Robert Bosch Foundation, Stiftung Mercator, the Volkswagen Foundation and also the OPEC Fund for International Development.

Funding by these institutions puts the Council and Foundation in a position of being able to select the participants exclusively on the basis of scientific criteria, as all young scientists being sponsored in this way go through the multi-stage international selection process (see page 18).

The International Lake Constance Conference (IBK) has been supporting the Nobel Laureate Meetings since 2003. This support provided by the states surrounding Lake Constance serves a specific purpose and is primarily in aid of the web presence and of broadcasting the meetings over the internet. Thanks to the support of the International Lake Constance Conference and the Free State of Bavaria, it was possible to broadcast most of the lectures and all four podium discussions at the 60th Meeting of Nobel Laureates as live streams at www.lindau-nobel.org. These are now available in the Lindau Mediatheque.

The Joachim Herz Foundation supported the Lindau Dialogue for the first time this year. It covered the travel expenses of some of the Nobel Laureates and lent its support to the production of educational videos, such as the film "Turning the Tables" (see page 125). For several years now, the Klaus Tschira Foundation has been supporting the Lindau Meetings as well as the Foundation's "Nobel Portraits" photo project with Peter Badge and it has also generously supported the anniversary meeting.

Other project-related funds for organising and carrying out the meetings were made available by, amongst others, BASF AG, EnBW Energie Baden-Württemberg AG, the Free State of Bavaria, the Deutsche Telekom Foundation, the Jacobs Foundation, Mars, Incorporated, RWE AG and the State of Baden-Württemberg. A complete list can be found on page 157.

DONATIONS IN KIND

The Foundation's capital, the project-related sponsorship and donations in kind form the basis of the Lindau Dialogue's long-term financing – both in terms of the requirements for the year in question as well as its medium and long-term security. Only the interplay of project-related sponsorship (see page 116) and donations in kind makes it possible to organise the Nobel Laureate Meetings to a high standard.

The limousine service for the Nobel Laureates was provided by the Volkswagen Group.

Deutsche Telekom assumed responsibility for providing all participants with internet access: throughout the entire meeting, the premises had a high-performance wireless network and also an individually set up communication café. There, for the first time, Telekom Laboratories provided SPREE, an internet-based expert search engine. Sennheiser electronic GmbH & Co. KG ensured the excellent acoustics at the anniversary meeting by providing high-quality microphone systems for all event locations.

Volkswagen Group provided the limousine service for the Nobel Laureates. The fleet was doubled in size compared to the previous year. The MAN Commercial Vehicles Group also provided two buses for the event. And as in the past few years, Lufthansa AG provided a ticket allocation for the Laureates' intercontinental flights.

This year, for the first time, JURA Elektroapparate AG supplied the Lindau Nobel Laureate Meetings with coffee-making facilities for all participants. Bottled water was provided by EnBW Energie Baden-Württemberg AG. Since last year, Mondi Europe & International has provided high-quality paper for selected printed matter produced by the Council and Foundation. Hewlett-Packard supported the Nobel Laureate Meetings and contributed to the modernisation of the IT infrastructure in the executive secretariat office. PricewaterhouseCoopers (PwC) is drawing up the annual auditing report for the Foundation Lindau Nobelprizewinners at Lake Constance as a donation in kind.

Responsibility for assembling the multifarious endowment contributions, project-related funding and donations in kind is in the hands of the Board of the Foundation Lindau Nobelprizewinners at Lake Constance under the chairmanship of Wolfgang Schürer. Working in an honorary capacity, the Board also decides on the investment strategy for the Foundation's capital and develops the Nobel Laureate Meetings' relationships with decision-makers in the fields of science, business and politics. In preparation for the 60th Meeting of Nobel Laureates, a total of 190 working days were invested by the Board in these activities.

The Telekom AG provided all participants of the 60th Lindau Meeting with free internet access.

It was an honour to be invited to take part in such a prestigious meeting. I thoroughly enjoyed meeting other young talented researchers from around the world. Participating in discussions with Nobel Laureates was a great and motivating experience, with the multi–disciplinary format of this year's meeting being especially challenging. The varied programme of lectures, discussions, and social events together with a fantastic location and weather ensured that my interest never waned. No doubt such a meeting would not be possible without the support of organisations and I would like to express my gratitude to these benefactors.

Justin Hay, The Netherlands

THE 60TH MEETING OF NOBEL LAUREATES

COMMUNICATIONS

Interest in the Lindau Dialogue in Germany and abroad has never been greater: 150 journalists from 40 countries reported on the 60th Nobel Laureate Meeting. The partnership with the Nature Publishing Group was further expanded, with a special supplement appearing in *Nature* to mark the anniversary. The official meeting blog has attracted more readers than ever before. For the first time, TV crews from Portugal and Ireland reported from Lindau. Through media partnerships with Deutschlandfunk radio station, Frankfurter Allgemeine Zeitung newspaper, Zeit Online web portal and Deutsche Welle TV, there was extensive coverage of the meeting in Germany as well.

150 journalists from 40 countries covered the 2010 Lindau Meeting.

INTEGRATING COMMUNICATIONS

Communications for the 60th Meeting of Nobel Laureates were characterised by an integrated approach on a number of levels: in terms of content, scheduling and between the various communication channels. As a result of this networking, the Council and Foundation's projects – in addition to the Nobel Laureate Meeting, this includes in particular the "Discoveries 2010: Energy" exhibition on the Isle of Mainau and the mediatheque – have been able to benefit from the increased media interest generated by the anniversary nature of the meeting.

Whether through classic media, such as newspapers, radio and television, or via online channels and social media activities, science enthusiasts around the world have been able not only to obtain information about the meeting for themselves but also to get involved online and ask their own questions. For all these activities, the meeting provided both the starting point and also the destination. With the large number of Laureates at the Lindau Meeting, this involved an extremely wide range of topics, which were followed by a large audience through the various channels.

Partnership with *Nature:* "Outlook" Supplement, Blogs and Educational Videos

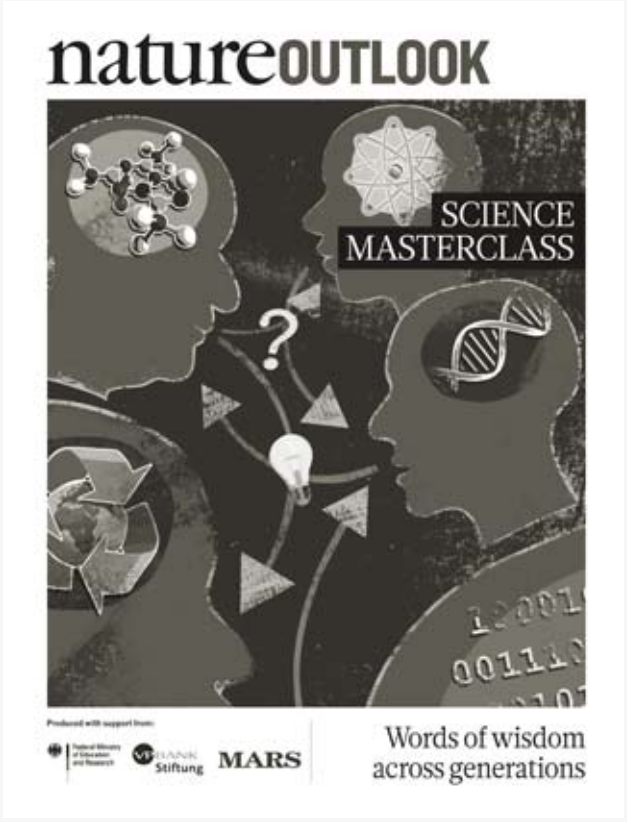
The partnership with the Nature Publishing Group has been in existence since the 58th Meeting of Nobel Laureates in 2008, and on the occasion of the anniversary meeting in 2010 it took on a new quality. The joint projects in the fields of social media, blogs and video production provide an international flavour – not least by way of their integration into the "*Nature* Outlook" supplement that appeared on the 14th of October with a run of 50,000 copies in the magazine *Nature*.

For the first time, the Nobel Laureate Meetings entered into a partnership with the Nature Publishing Group in the field of blogs and social media. Led by science journalist Beatrice Lugger, the team of bloggers reported in German and English on the official meeting blog at www.lindau.nature.com. Alexander Bastidas Fry, Martin Fenner, Bastian Greshake, Lars Fischer, Ashutosh Jogalekar, Markus Pössel, Akshat Rathi, Jessica Riccò and Lou Woodley conducted interviews with young scientists and Nobel Laureates, wrote extensively and knowledgeably about the lectures and podium discussions, and enabled the reader to also take part in the social events. Far in excess of 200 blog posts provide fascinating insights into the week of the meeting. The blog was followed in blog communities both in Germany as well as abroad, and it was possible to follow more than 90,000 page impressions about the meeting during the week alone.

But the webpage www.lindau.nature.com offered more than just blogs. For the meeting, it served as a central point of contact for the various services in the social media. Facebook, YouTube, Twitter – all contents converged on the website and were thus able to benefit from one another. Never before have the Nobel Laureate Meetings been so active in the social media realm and profited from increasing numbers in their usage. This dedication is now also being intensively continued in the aftermath of the meeting.

With a special online initiative, the page www.lindau.nature.com has opened up the Lindau Dialogue to the online community for the first time. And the response was impressive: 150 questions were asked by the web users, some of them receiving several hundred votes. A number of these questions were answered by Laureates during the meeting, and others in the special supplement "*Nature* Outlook".
There has also been a further development of the joint video project with Nature Videos. Led by Martin Freeth and Charlotte Stoddart, the team presented the interaction between Laureates and young scientists in several 10-minute films (see box for more information). To mark the 60th Lindau Meeting, two special films were produced: "The Spirit of Lindau" sheds light on the story of how the Lindau Meetings came about and familiarises the viewer with the often cited "special atmosphere" of them. Organisers, Nobel Laureates and young scientists have their say and describe what makes the Lindau Meetings so special. Mars, Incorporated made the production of this series of films possible, which, together with the educational videos of the 2008 and 2009 Meetings, can be watched at www.nature.com/lindau.

The offical meeting blog provided readers worldwide with fascinating insights into the 2010 Lindau Meetings.



Nature **published a special supplement to celebrate the 60th Lindau Nobel Laureate Meeting.**

The blogging team met daily to discuss stories and wrote more than 200 blog posts during the 2010 Lindau Meeting.

2010 *NATURE* VIDEO PROJECT

Meeting the 'systems' sceptic with Tim Hunt

Young scientist Roland Pache is trying to understand complex biological interactions using computer algorithms to hunt for patterns in vast swathes of data. Undergraduate Sophia Hsing-Jung Li is excited by this new field of 'systems biology'. In this film they meet Tim Hunt, whose prize-winning work on the cell cycle and current research on cancer centres on the behaviour of individual molecules. Will he share the students' enthusiasm for systems biology?

The handedness of life with Jack W. Szostak

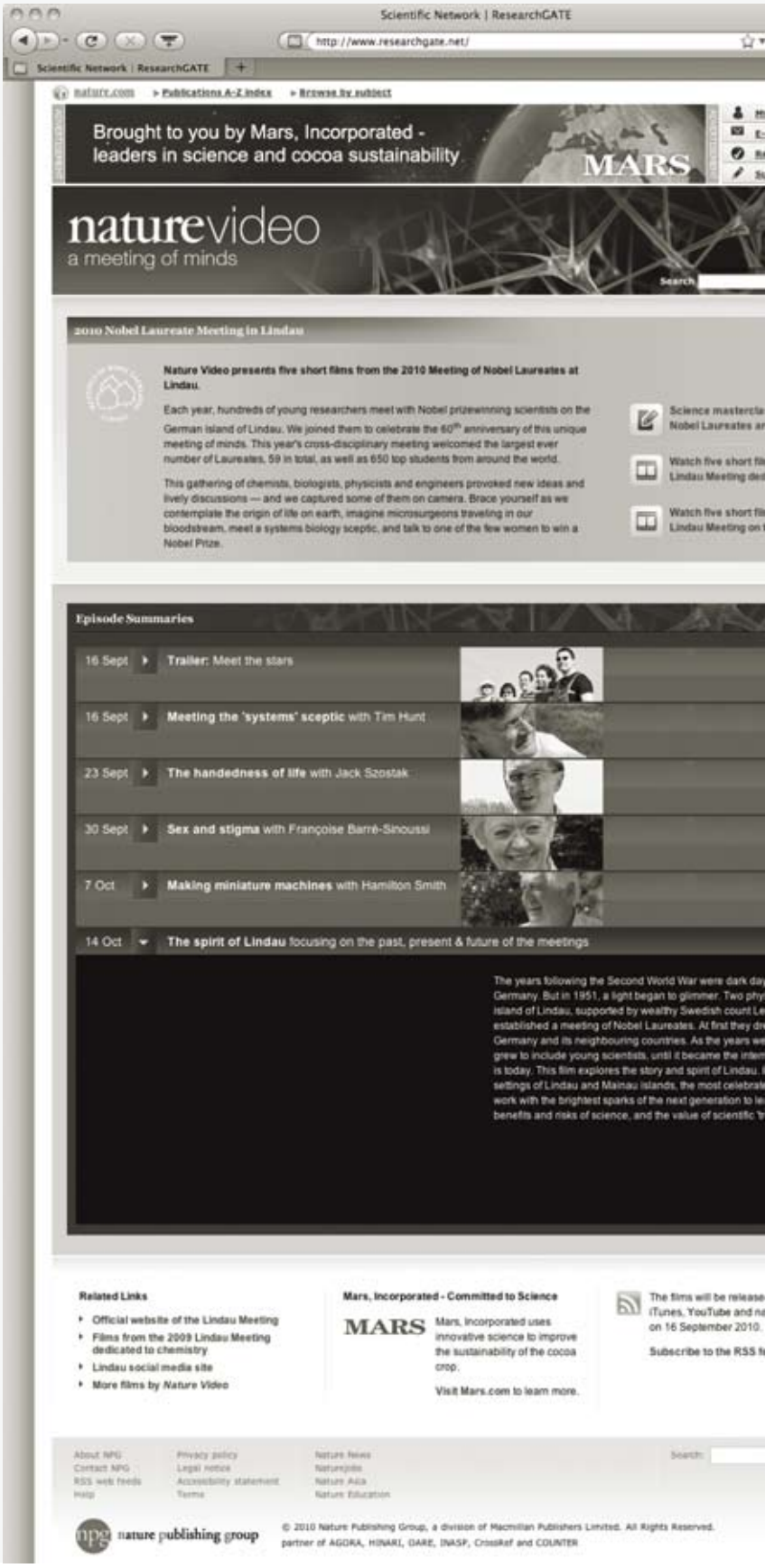
Many molecules are chiral, which means they have two possible forms that are non-superimposable mirror images of each other, just like your left and right hands. But in the amino acids and sugars that make up living things, we find only one of these forms – and young chemist Abigail Hubbard wants to know why. She is keen to pick Jack W. Szostak's brain on the source of this 'homochirality', a subject close to his own research into the origin of life on Earth.

Sex and stigma with Françoise Barré-Sinoussi

Françoise Barré-Sinoussi won her Nobel Prize for identifying HIV as the cause of AIDS. The virus is made more dangerous by the social stigmas that surround infection. Young physicist Markita Landry explores social and educational issues in HIV research with her. The pair also share their experiences of life as women working in science.

Making miniature machines with Hamilton Smith

Noy Bassik draws inspiration from origami to engineer miniature tools that he envisages as the surgeons of the future. Hamilton Smith is also in the business of creating things. Working with Craig Venter, he recently created a bacterial cell controlled by a synthetic genome. In their talk, they offer insights into the overlapping worlds of biology and engineering.

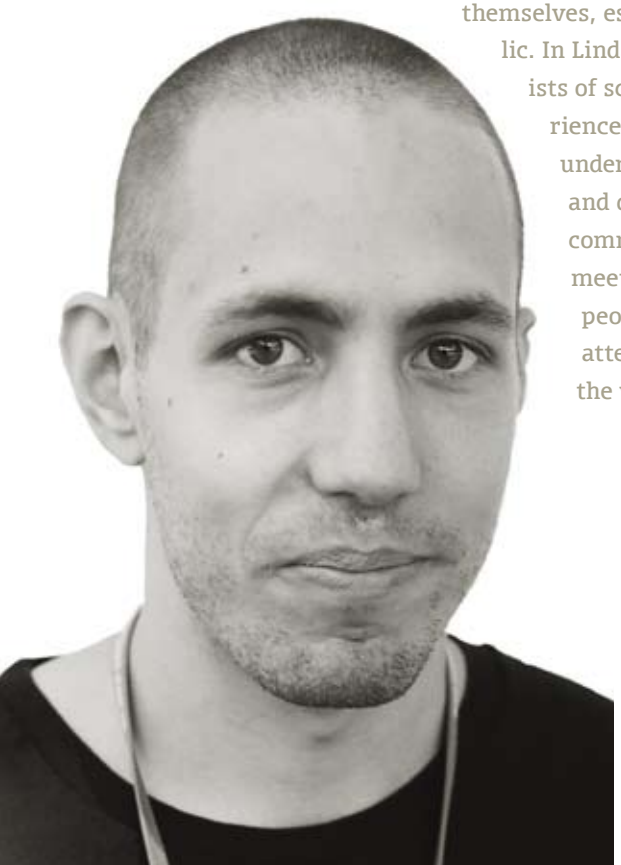


The film "Turning the Tables" documents a fascinating experiment: for the first time at a Lindau Meeting, it was not the young scientists who were asking the questions, but the Laureates. The discussion was moderated by Adam Rutherford (*Nature)*. The "journalists" – in other words, those who were asking the questions – were the Nobel Laureates Aaron Ciechanover, Ivar Giaever, Sir Harald W. Kroto, John C. Mather and George F. Smoot. The "experts" were the young scientists Carlo Alberto Ratti (Italy), Evans Boney (USA), Benyam Kinde (USA), Baybars Kuelebi (Turkey), Inna Pertsovskaya (Russia) and Paul Rupar (Canada). The discussion forms part of the "*Nature* Outlook" supplement and the film can be seen on the website accompanying the supplement. This special film was made possible thanks to the support of the Joachim Herz Foundation. The Foundation also gave its support to the presentation of the film "Spirit of Lindau".

5 Фестиваль Науки
Ежегодный Московский

The first screening of the 2010 *Nature* videos took place at the **5th Russian Science Festival** in Moscow (October 8th–October 10th, 2010).

I was able to interact with a large number of Nobel Laureates both scientifically and personally. Talking to George F. Smoot on a sustainable future, sharing a lunch table with Peter Agre, and listening to Smithies' enthusiasm on lab work such that would cause him to reject three chairs, were certainly invaluable and unforgettable moments for me from the Lindau Meeting. Being immersed into an able and vibrant scientific community and intermingling with peers was certainly the most dominant theme in Lindau. However the scientists were not the sole participants of this meeting. One aspect of the realization that I mentioned, is the acknowledgment of the other actors of the science industry. The peripheral actors of science are almost as important as the scientists themselves, especially when it comes to the translation of our specialized work to the public. In Lindau, another one of the pleasures I was able to enjoy was meeting the journalists of science. Listening to their interest, sometimes awe, and most importantly experience with scientific issues were certainly a paradigm shift. One also should not underestimate their direct contribution to the meeting, not only by writing articles and documenting the meeting, but also taking initiatives in creating platforms for communication between young researchers and Nobel Laureates. I wish that these meetings go on and continue to inspire young researchers. I only hope that more people would be able to share this experience, and not necessarily just simply by attendance but through an openness of content for both young researchers over the world and the public. **Baybars Külebi,** Turkey



MEDIA PARTNERSHIPS

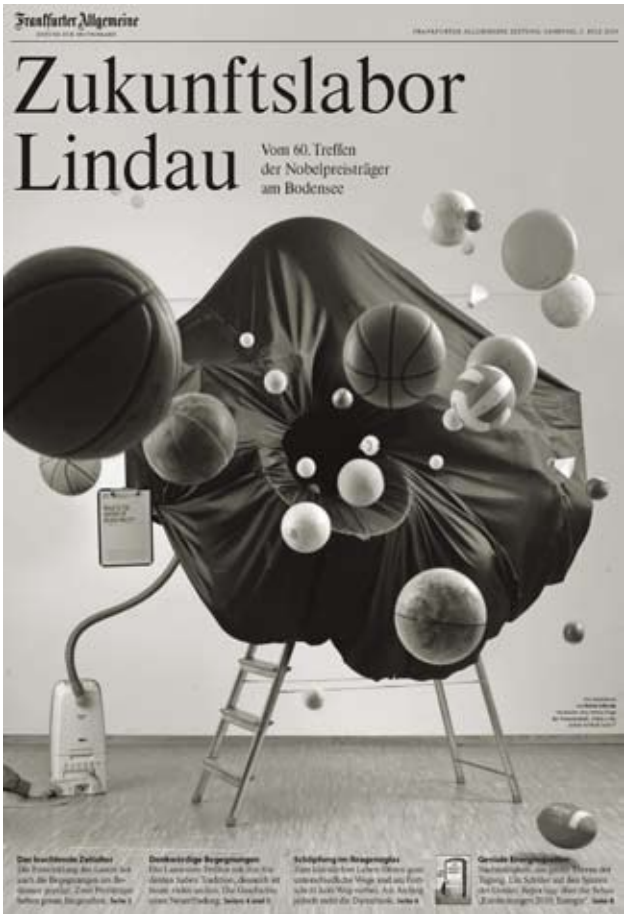
The 2010 Nobel Laureate Meeting was the largest interaction of Nobel Laureates and young scientists ever. Almost 60 lectures, panels and student discussions provided topics for media reports, Laureates and young scientists were invited to take part as dialogue partners, and with a range of media, the anniversary provided the setting in which partnerships were forged.

Every Thursday, DRadio Wissen broadcasts a lecture from the Lindau Mediatheque.

For the first time, Deutschlandfunk, the national information radio station of Deutschlandradio, accompanied the 60th Meeting of Nobel Laureates as part of an extensive collaboration. From 27 June until 3 July, the programmes "Campus & Karriere", "Forschung Aktuell", "Lebenszeit" and "PISAplus" reported from Lindau, providing on-air reports, discussions and features. Even after the meeting week, a specially set up page on Deutschlandfunk's website offers a wide range of educational audio and video features: http://nobelpreis.dradio.de. The reporting on the meeting concluded with the discussion "Noble minds, young talents – How can excellence be passed on?" It was broadcast live from the Isle of Mainau and moderated by Christian Floto (Head of the Science and Education department at Deutschlandfunk) and Martin Winkelheide. Participating in the discussion were the Nobel Laureate Johann Deisenhofer, two of the participants at the Nobel Laureate Meetings, Tobias Frauenrath and Georg Gasteiger, and also the participants at the European Talent Academy in Lindau, the students Andreas Scholten and Veronika Kinzner, as well as Eva-Maria Neher, the head of the international experimental laboratory Xlab in Göttingen.

DRadio Wissen is Deutschlandradio's third full-service station. The station is exclusively digitally broadcast via cable, satellite and on the internet and is aimed particularly at younger listeners. This station marks the beginning of a collaboration as part of the anniversary meeting, in which lectures from the archive of the Lindau Nobel Laureate Meetings as well as from the 60th Lindau Meeting were broadcast in full. Lectures given by, amongst others, Dorothy Crowfoot Hodgkin, Werner Forssmann, Friedrich von Hayek and Paul A.M. Dirac, represented the start of the week leading up to the anniversary meeting. At present, lectures from this year's meeting can be heard each Thursday, before the Laureates have their say once more about the beginnings of the Lindau Meeting in a programme which should be broadcast towards the end of the year.

In a separate supplement produced by its science department, the leading German quality paper "Frankfurter Allgemeine Zeitung" (FAZ) reported on the Saturday following the meeting about the many facets of this year's Nobel Laureate Meeting. Background reports about the meeting and its history, as well as about individual lectures provided a comprehensive overview. The


Frankfurter Allgemeine

Zukunftslabor Lindau

Vom 60. Treffen der Nobelpreisträger am Bodensee

A comprehensive supplement about the 2010 Lindau Meeting was published by the FAZ.

supplement gave an extensive report, including the lectures given by the Nobel Laureates, Nicolaas Bloembergen and Theodor Hänsch, in the context of 50 years of lasers, the history of the universe (John C. Mather) or the clarification of the structure of ribosomes, using the lectures given by Nobel Laureates as they can be seen in the mediatheque. The supplement also included the diary of one participant, Sibylle Anderl, and a report by a student, Jakob Dettmer, about the "Discoveries 2010: Energy" exhibition on the Isle of Mainau.

DEUTSCHE WELLE DW

This year, Deutsche Welle TV, Germany's international broadcaster, reported extensively from Lake Constance. In the programme "Das Interview", Manuela Kasper-Claridge spoke with Nobel Laureate Theodor Hänsch about what makes science so fascinating and how the Lindau Nobel Laureate Meetings motivate young researchers. An entire edition of the science programme "Projekt Zukunft/Tomorrow Today" was dedicated to the 60th Meeting of Nobel Laureates. It reported, amongst other things, on participants, the photographic project by Peter Badge and interviewed the Nobel Laureate and member of the Council Werner Arber.

ZEIT ONLINE

Another collaboration was established with the website of the German quality weekly "Die Zeit". A video team interviewed a range of Nobel Laureates on the topics of climate change and careers in science. The interviews can be seen from October at www.zeit.de.

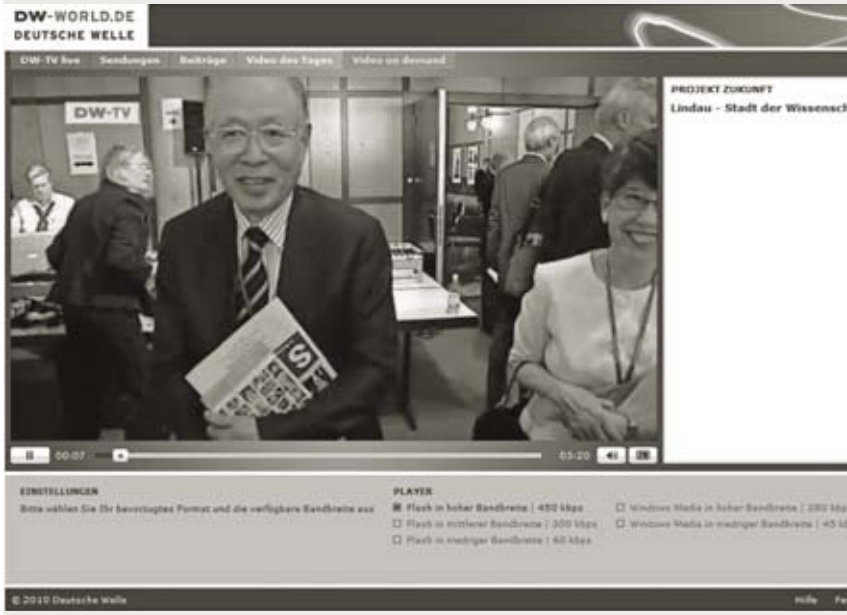
Lindauer Zeitung

For decades, the daily Lindauer Zeitung – an edition of the Schwäbische Zeitung for the Lindau district – has been reporting about the Nobel Laureate Meetings. To mark the 60th anniversary, the editorial team produced a special supplement in German and English that covers the history, the organisation and what the meeting means for the town.

TV COVERAGE

The collaboration with Deutsche Welle TV, as described above, provided broad international coverage thanks to the station's extensive transmission range. With external support, a number of international TV stations were also approached, and as a result, RTP Portugal, the country's public broadcaster, sent a team of its own to the meeting, which provided reports in a number of features. The public broadcasters from Ireland (RTÉ) and Estonia (ERR) were also represented with their own teams, and via the European Broadcasting Union (EBU), the Indian broadcaster NDTV was provided with material and interviews with Indian participants and was therefore also able to report on the meeting. Television broadcasters from Malaysia and Thailand as well as the German stations Bayerischer Rundfunk and SWR also closely followed the meeting.

Once again, the EBU broadcast lectures and podium discussions live from Lindau and also produced the high-quality live stream on www.lindau-nobel.org. Following the meeting, the lectures were incorporated into the mediatheque, where, together with lectures from previous meetings, they represent a unique archive of science history. (For more about this, see also the article about the historic lectures from page 146.)



Deutsche Welle TV, Germany's international broadcaster, reported extensively from the 60th Meeting of Nobel Laureates at Lindau.

International TV stations like RTP from Portugal and RTÉ from Ireland covered the 2010 Lindau Nobel Laureate Meeting.

ONLINE BROADCAST OF LECTURES AND DISCUSSIONS

As has been the case since 2007, most of the lectures and all four podium discussions at the 60th Meeting of Nobel Laureates can be watched as a live stream at www.lindau-nobel.org. Thanks to the support of the International Conference of Lake Constance and of the Free State of Bavaria, it was possible to watch almost 40 lectures given by Nobel Laureates – many of them live. Following the live broadcasts, the lectures can now be accessed at any time on the web page.

The conference newspaper "the week" was heavily sought-after by all participants.

"THE WEEK" MEETING NEWSPAPER

For the first time, a newspaper was produced for the week of the meeting, which was distributed to all participants and honorary guests on the closing day on the Isle of Mainau. In the style of a daily newspaper, it introduced some of the young scientists in greater detail, provided interviews with the organisers and reported about individual events at the preceding meeting. Much of the project was implemented by Melissae Fellet, a participant at the 2009 Lindau Nobel Laureate Meeting, who prepared the articles, tracked down interviewees and researched topics during her period of training in the executive secretariat office.

COLLABORATIONS WITH SCIENCE JOURNALISTS' ASSOCIATIONS

Established in 2007, the collaborations with the science journalist organisations in Europe, the Arab world, Latin America and the USA have been continued for the 60th Meeting of Nobel Laureates. In the past few years, these have resulted in close contacts with science journalists around the world. Consequently, the internationalisation of reporting about the Lindau Meetings has been brought a crucial step further forward.

MEDIA APPOINTMENTS IN THE RUN-UP TO THE MEETING

For the first time, a media briefing for the British press in London took place. This was organised with the support of CNC Communications on behalf of Mars, Incorporated in partnership with the Lindau Nobel Laureate Meetings. Wolfgang Schürer, Chairman of the Board of the Foundation Lindau Nobelprizewinners Meetings at Lake Constance, and Harold Schmitz, Chief Science

Wolfgang Schürer (left) and Christian Rapp, together with Gabriela Dür, Chair of the Commission for Education, Science and Research of the IBK and Klaus Näscher, Vice-Chairman of the IBH after a press conference.

Ijad Madisch, co-founder and CEO of ResearchGATE (from left), at a press conference with Thomas Ellerbeck, Spokesman and Member of Council, Countess Bettina Bernadotte and Wolfgang Schürer announcing the new online community.

Officer of Mars, Incorporated, informed the briefing participants about the forthcoming anniversary, the scientific programme and presented Mars as a supporter of the meeting.

A press conference about the education and research landscape at Lake Constance also took place in the run-up to the 60th Meeting of Nobel Laureates in Lindau on 15 June 2010. On this occasion, Gabriela Dür (Chair of the Commission for Education, Science and Research of the International Conference of Lake Constance (IBK)), Klaus Näscher (Vice-Chairman of the Internationale Bodensee-Hochschule (IBH) and Rector of the Liechtenstein University) and Wolfgang Schürer, representing the Lindau institutions provided information about the strengths of the region.

Thomas Ellerbeck is spokesman and member of the Council and a member of the Foundation Board. In this honorary role, he is responsible for the communication activities of the Nobel Laureate Meetings. In the Lindau office, Christian Rapp is head of the communications department, in which the orientation, planning and implementation of the Council and Foundation communication projects take place. Since May 2010, this team now also includes communication officer Jan Keese, and trainee Christian Schumacher. Melissae Fellet, participant of the 2009 Lindau Meeting and science journalist, was a member of the communications team from April until July. During the meeting, the team was supported by Maria Regele and Lisa Suckert.
Once again, the two freelance journalists Beatrice Lugger and Joachim Pietzsch carried out research work regarding topics at this year's meeting and prepared these for the media. The texts combined the topics at the anniversary meeting with lectures from the archive of meetings, and as a result, put them into a scientific and historical context.

INTERNATIONAL PRESS COVERAGE

AUSTRALIA

INDIA

SINGAPORE

CHILE

POLAND

YEMEN

BEYOND THE LINDAU MEETING

134 **"DISCOVERIES 2010: ENERGY" EXHIBITION**

144 **BUILDING A BRIDGE BETWEEN THE LINDAU MEETING AND THE EUROPEAN CAPITAL OF CULTURE**

This year's "Discoveries" exhibition showcased how science, research, politics and the economy are contributing to a safe, affordable and, above all else, sustainable energy supply for the coming decades.

"DISCOVERIES 2010: ENERGY" EXHIBITION

Sustainability has been a central issue on the agenda of the Lindau Nobel Laureate Meetings ever since their beginnings. The co-founder and spiritus rector of the meetings, Count Lennart Bernadotte, was passionately engaged in environmental and nature conservation issues as early as in the 1950s and 60s. A milestone of his work was the "Green Charter of Mainau", a declaration and a demand for active protection of nature and the environment. On Count Lennart Bernadotte's initiative, the charter was formally adopted on 20th April 1961 by representatives of politics, business and culture. The exhibition series "Discoveries" further advances Count Lennart Bernadotte's concern to raise public awareness of the important issue of sustainability.

As an integral part of the respective "Science Year" campaign of the German Federal Ministry of Education and Research, the exhibition series "Discoveries" started successfully in 2009, focussing on our planet's most important resource: water. At this year's exhibition on the future of energy, the objective was to draw attention to the challenges imposed by climate change and global population growth, to present the latest research methods and proposed solutions, and to promote continued social dialogue about the necessary restructuring of the world's energy supply.

On May 22nd 2010, the exhibition was opened by its patron, Federal Minister Annette Schavan, and Countess Bettina Bernadotte, President of the Council for the Lindau Nobel Laureate Meetings, together with Wolfgang Schürer, Chairman of the Foundation Board. During their visit of the 18 pavilions, the numerous guests from science, research, politics, and business got an idea of the future of energy.

Funded mainly by the German Federal Ministry of Education and Research, the "Discoveries" series is hosted by the Foundation Lindau Nobelprizewinners Meetings at Lake Constance. Supported by Mainau GmbH, the organisational tasks were managed by the staff of the Executive Secretariat of the Lindau Meetings.

Exhibitors and Themes

In close coordination with the Scientific Advisory Board and its Chairman, Bernhard Graf, Director of the Institute for Museum Research in Berlin, the organisers implemented a partnership concept to collaborate with distinguished exhibition partners like the Fraunhofer-Gesellschaft, Karlsruhe Institute of Technology (KIT), Max Planck Society and the United States' Department of Energy (see p. 139 for a list of all exhibitors).

With its 18 different pavilions, the "Discoveries 2010: Energy" exhibition showcased how science, research, politics and the economy are contributing to a safe, affordable and, above all else, sustainable energy supply for the coming decades. The exhibitors presented new techniques and methods of producing, storing and transporting energy. For instance, Fraunhofer-Gesellschaft revealed the many obstacles for scientists working for the future of electric vehicles on our roads. Other partners like the Karlsruhe Institute for Technology (KIT) or RWE AG focussed on innovative fuels of the future or highlighted the potential of renewable energy resources such as sunlight, wind, water and biomass. Adults and children were given the opportunity to playfully delve into natural science phenomena at the hands-on experimental station of Dynamikum Science Center Pirmasens: With its pavilion themed "Drawing the Sun Fire Down to Earth", the Max Planck Institute for Plasma Physics proposed nuclear fusion as a method of sustainably securing our energy supply in the future:

18 different pavilions offered insights into the future of energy.

Energy Rallye

All children who wanted to explore the future of energy together with their parents or on their own were invited to go on a specially designed "Energy Rallye". Equipped with a free rallye guide, almost 20,000 children aged eight to twelve years went on a quest for the right answers to thirteen questions and attained a lot of useful knowledge and interesting information on the topic of energy along the way. With correct answers to all of the questions, the children were entered into a draw with some thrilling prizes. Additionally, the rallye guide contained a whole host of ideas and instructions for easy experiments to do at home. The rallye was supported by Microsoft Germany.

Long Night of Science

The Long Night of Science in Constance on 17 July 2010 was staged at the initiative of the Foundation Lindau Nobelprizewinners Meetings at Lake Constance and has taken place for the very first time. At five locations – on the Isle of Mainau, on the City of Constance's "ferry of learning", at the Constance municipal utility companies, the Constance University of Applied Sciences and the University of Constance – the organisers invited visitors to participate in scientific lectures and discussions with highly respected experts, eventful guided tours, as well as a variety of impressive experiments and exhibits. The patroness was Annette Schavan, Federal Minister of Education and Research. The "Discoveries 2010: Energy" exhibition and the concluding festivities on the Isle of Mainau were just two of the evening's highlights. Almost 10,000 visitors used the Long Night of Science as an opportunity to take a glimpse into the future of energy. The Long Night was mainly funded by the Federal Ministry of Education and Research.

The exhibition was opened by Countess Bettina Bernadotte (left), German Minister of Education and Research, Annette Schavan and Wolfgang Schürer.

Children exploring the future of energy during the "Energy Rallye".

Impressions from the Long Night of Science.

Special Offers for Schools

School classes had free admission to the exhibition on prior notification. The range of offers for school classes provided by the Green School Mainau included special guided tours and projects on the topics of energy consumption, forms of energy, sustainability and energy production. Complementary tutorial material for in-advance preparation was provided free of charge on the internet homepage www.lehrer-online.de. These specially developed didactic materials were designed for four teaching units on wind energy, biofuels, geothermal energy and solar energy. Additionally, Microsoft Germany offered innovative tutorial material on the topic of energy free of charge on its online platform www.innovative-teachers.de.

Action Days

Every first Saturday in June, July and August was themed "Action Day" at the exhibition. The exhibitors and partners set up special programmes with various exciting activities to take part in. The "Little Scientist's House", for instance, invited pre-school children to playfully explore the world of energy. Children of primary school age had the opportunity to watch researchers experiment or do simple experiments themselves at workshops. Furthermore, many visitors gathered to see the winners of the "Jugend Forscht" competition introduce and explain their innovative ideas.

Communications

"Discoveries 2010: Energy" attracted many visitors from the multinational Lake Constance region and Germany, as well as tourists and travellers from around the world. The integrated communications approach including media cooperations, regional PR, radio PR and the systematic communication with schools played an important part in achieving publicity. The exhibition was covered in great detail by its media partner SÜDKURIER, many regional newspapers and radio stations, and important national papers such as Frankfurter Allgemeine Zeitung. Scientific American magazine introduced the exhibition to its website readers with a slide show.

The exhibition catalogue is available online at www.mainau-entdeckungen.de.

Children were invited to explore the exhibits for themselves.

On the 'Day of Energy' on September 25th 2010, 500 research institutions, universities and companies throughout Germany opened their doors to the general public. Six pavilions of the exhibition series "Discoveries" were shown in Berlin where the main event took place. State Secretary Georg Schütte opened the 'Day of Energy' against the backdrop of the pavilions.

"Discoveries 2010" on the Isle of Mainau

EXHIBITORS

BASF – The Chemical Company

Deutsche Telekom AG

Deutsches Museum and Rachel Carson Center

Dynamikum Science Center Pirmasens

EnBW Energie Baden-Württemberg AG

Foundation Lindau Nobelprizewinners Meetings at Lake Constance

Fraunhofer-Gesellschaft

German Federal Ministry of Education and Research

Green School Mainau

Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences

Karlsruhe Institute of Technology (KIT)

Max Planck Institute for Plasma Physics

Max Planck Society for the Advancement of Science

RWE AG

solarcomplex AG

Stadtwerke Konstanz and Hochschule Konstanz, University of Applied Sciences

University of Constance, Photovoltaic Division

U.S. Department of Energy

MAIN SUPPORTER

German Federal Ministry of Education and Research

SCIENTIFIC ADVISORY COUNCIL

Prof. Bernhard Graf (Board Representative)
Director of the Institute for Museum Research
Prussian Cultural Heritage Foundation

Dr. Wolfgang Breh
Head of Coordination Office, KIT Energy Center

Prof. Dr.-Ing. Holger Hanselka
Director of the Fraunhofer Institute for Structural Durability

Prof. Dr. Regina Palkovits
Robert Bosch Junior Professor
Max Planck Institute for Coal Research and
RWTH Aachen University

Prof. Dr. Helmuth Trischler
Museum Director, Research Department,
Deutsches Museum

ENTDECKUNGEN /DISCOVERIES ENERGIE /ENERGY 2010

 More than 230 Nobel Laureates are now members of the Founders' Assembly.

10 YEARS FOUNDATION LINDAU NOBELPRIZE-WINNERS MEETINGS AT LAKE CONSTANCE

The year 2000 marked a milestone in terms of safeguarding the future and enhancing the development of the meetings: The Foundation Lindau Nobelprizewinners Meetings at Lake Constance was set up by 50 Nobel Laureates with the aim of rediscovering the core of the Lindau idea and setting new standards.

Initially, the aspiration was to enable the most promising young scientists from around the world to take part in the Nobel Laureate Meetings in Lindau. Over the past 10 years, a global network of Academic Partners has been set up for this purpose, comprising science academies, research institutes and those foundations that are committed to the promotion of science. This way, the Foundation was able to count on the enthusiasm, critique and, above all else, the unwavering dedication of the Laureates, whose continuous support represents both a challenge and a source of inspiration. All Foundation activities follow this shining example and are aimed at passing the inspiration on to the young scientists. The scientific chairpersons and members of the Council for the Lindau Nobel Laureate Meetings ensure that the highest scientific standards the Laureates embody are lived up to.

Basic research and education are public domains. Recently, however, there have also been pioneering joint ventures in the public and private sectors. The Foundation is also committed to this model. With donors and sponsors, it has established a unique public-private partnership that has enabled the Foundation Board to set up a capital stock within a relatively short period of time. At the same time, it has continuously supported the annual Lindau Meetings by raising additional funds.
Besides safeguarding the Lindau Meetings as a beacon of Germany and Europe as centres of science, one of the Foundation's particular concerns is to continuously achieve the highest possible standards in terms of the content and also organisation of the Lindau Meetings. Setting a particular focus on the relationship between science and society goes along with the organisation's

rising standards of professionalism. Taking up Count Lennart Bernadotte's legacy, questions were raised about sustainability, exemplified by the newly introduced panel on the closing day on the Isle of Mainau and the "Discoveries" series of exhibitions there. In order to balance the exclusive nature of participation that is based on the pursuit of excellence, the Foundation strives to enable virtual participation in the Lindau Meetings anywhere in the world by making content available online.

PUBLICATION ON OCCASION OF THE ANNIVERSARY OF THE FOUNDATION

40 representatives from the fields of science, research, politics and business contributed to the publication, among them ten Nobel Laureates, the President of the European Commission, José Manuel Barroso, and the Chancellor of the Federal Republic of Germany, Angela Merkel. The following statements are taken from contributions.

Global Impulses for the 21st Century – A Dialogue of Talents in the Dialogue of Cultures

"The Lindau Nobel Laureate Meetings are not a German event, but an international conference which takes place on German soil in the heart of Europe and which has developed continually during the 60 years of its existence. The Foundation Nobelprizewinners Meetings at Lake Constance has during the ten years of its existence made key contributions."

Roman Herzog
Former President of the Federal Republic of Germany (1994–1999) and Honorary President of the Foundation Lindau Nobelprizewinners Meetings at Lake Constance

Fond Souvenirs of Lindau by a Foundation Co-Founder

"Scientific exchanges, collaborations among colleagues in an institute, among different institutes or different countries or continents, are absolutely indispensable if one wants science to progress and move forward. It was precisely to promote this progress that the Foundation Lindau Nobelprizewinners Meetings at Lake Contance was established. Considering how well it has performed, it is clear that it has amply fulfilled its mission."

Edmond Fischer
Nobel Laureate in Physiology or Medicine, 1992

Looking back on Lindau – One Year on

"The value of the connections I made in Lindau goes beyond simply having made many new friends. I have recognized that I am becoming a part of something larger than myself, larger than my research and larger than my discipline of chemistry – namely, the scientific community itself. My feelings of connectedness to that community are a result of recognizing author names on journal articles, of seeing the fruits of my peers' labors, and of engaging in scientific discussions with colleagues who I never would have known had it not been for our shared experiences in Lindau."

Jeffrey R. Lancaster
Graduate Student at Columbia University and Participant of the 2009 Lindau Meeting

International Cooperation for the Best Talent in Economics

"I am proud that the BIS, an institution dedicated to international cooperation and objectivity in economic analysis, has cooperated with the Foundation Lindau Nobelprizewinners Meetings at Lake Constance in a way that will contribute over time to a deepening of scientific inquiry and international dialogue in economics. The close working relationship between the BIS and major national central banks around the world has proven to be highly valuable in the nomination process, and has helped to ensure an ever closer relationship between the best young economists, most promising researchers, and Nobel Laureates in economics throughout the world."

Malcolm D. Knight
Vice Chairman of Deutsche Bank and former General Manager of the Bank for International Settlements (2003-2008), Member of the Honorary Senate of the Foundation Lindau Nobelprizewinners Meetings at Lake Constance

VIDA PAPER
Design AWARD
2 0 1 0

For the design of the publication "10 Years Foundation Lindau Nobelprizewinners Meetings at Lake Constance", the "unimak" agency (Hamburg) received the Vida Paper Design Award 2010. From the jury's reasoning: "In terms of its concept, the book shows exactly what constitutes Nobel Laureates. They work with dedication and for all that is good, whilst they themselves take a back seat. And this is exactly what the book's layout does."

FOCUS ON THE FUTURE OF ENERGY

Building a bridge between the Lindau Nobel Laureate Meetings and the European Capital of Culture

The topic of energy has built bridges between Lake Constance and the European Capital of Culture 2010: While the future of energy was the focus of attention at the Lindau Meeting and at the exhibition "Discoveries 2010: Energy" on the Isle of Mainau, RWE was putting the project "EnergyCultureEurope" into practice in Essen as part of the Ruhr.2010 European Capital of Culture Year. RWE is supporting the Lindau Meetings as a maecenate of the Foundation and was represented at the "Discoveries" exhibition with a pavilion of its own (see p. 134).

The interdisciplinary and international project "EnergyCultureRuhr" dealt with the question of how a scarcity of resources and climate change together with the simultaneously increasing global energy requirements will alter our culture and society by the year 2050. Since October 2009, RWE had been carrying out an online Delphi survey among international experts from a variety of disciplines as part of this project. They discussed a potential cultural and social transformation brought about by a change in energy supplies. The results of the survey then formed the basis of a podium discussion at the Zeche Zollverein world heritage site, which took place during the Lindau Meeting week. The Nobel Laureate Robert B. Laughlin travelled from the meeting in Lindau to Essen for this in order to deliver his key note speech entitled "When Coal is Gone". He was accompanied by Bilge Demirkoz, who had taken part in the 2008 Lindau Meeting as a young scientist and joined in the discussions at the Zeche Zollverein as an expert in this field.

Leonhard Birnbaum, RWE Board Member outlined the idea behind the project. "Based on certain assumptions, we can anticipate the form of the energy mix in 2030 or 2050. However, we also asked ourselves what might be the consequences of changes to the energy mix and of changes to the use of energy: for society, for the individual, for the culture our society and of course also for our quality of life."

Moderator Gerd Scobel (from left), Nobel Laureate Robert B. Laughlin, RWE Board Member Leonhard Birnbaum and Fritz Pleitgen, Chief Director of Ruhr.2010.

Lindau alumna Bilge Demirkoz (3rd from left) took part in a panel discussion on the "EnergyCultureEurope" project.

More than 40 portraits of Nobel Laureates were shown in an exhibition at the RWE tower in Essen. They all belong to the Lindau Foundation´s "Nobel Faces" project which is supported by the Klaus Tschira Foundation. Photographer Peter Badge not only portrayed almost all Nobel Laureates alive, he also photographed the next generation of top scientists: the portraits of young researchers with statements in this report were taken by him as well.

Funded by Gerda-Henkel-Stiftung, the Lindau Mediatheque offers lectures by Nobel Laureates covering 60 years of science history.

60 YEARS OF SCIENCE HISTORY: THE MEDIATHEQUE OF THE LINDAU MEETINGS

The Nobel Laureate Meetings´ mediatheque is being further expanded. In the past few months, 50 new lectures presented by Nobel Laureates were put online, including contributions from Otto Hahn, George Whipple, Sir Chandrasekhara Raman and Richard Synge. Consequently, since the 60th Meeting of Nobel Laureates this summer, 60 lectures from the archive have been put online. Thanks to the funding provided by the Gerda-Henkel-Stiftung, it has now been possible to carry out this project for a second year.

The inventory and digitalisation of the entire archive material from the years 1951 to 1985 has now been concluded. 460 lectures were held during this period, and the inventory has concluded that of these, 406 lectures are secured. So far, the missing material has included entire contributions from the Lindau Meetings in 1957 (Physiology or Medicine) and 1967 (Chemistry). The 406 now digitalised lectures originated from 162 Nobel Laureates, and it has not yet been possible to assign 50 of the lectures to individual Laureates. For this, it will be necessary to carry out further research work. Unfortunately, no audio recordings have (yet) been found from the first meeting in 1951. Therefore, the online mediatheque begins with two lectures from the 1952 Lindau Meeting: Otto Hahn (Nobel Prize for Chemistry in 1944) giving his lecture on “Radiochemistry and the Fission of Uranium”, and Frederick Soddy (Nobel Prize for Chemistry in 1922) with his lecture on “Isotopes”.

Anders Bárány, the former Vice-Director of the Nobel Museum, is continuing to process every lecture that is put online. He selects the audio documents to be published and ensures in particular that the audio recordings can also be easily understood without being able to see the speakers or their illustrations on a blackboard or slide projector. Each lecture in the mediatheque is accompanied by a commentary provided by Anders Bárány.

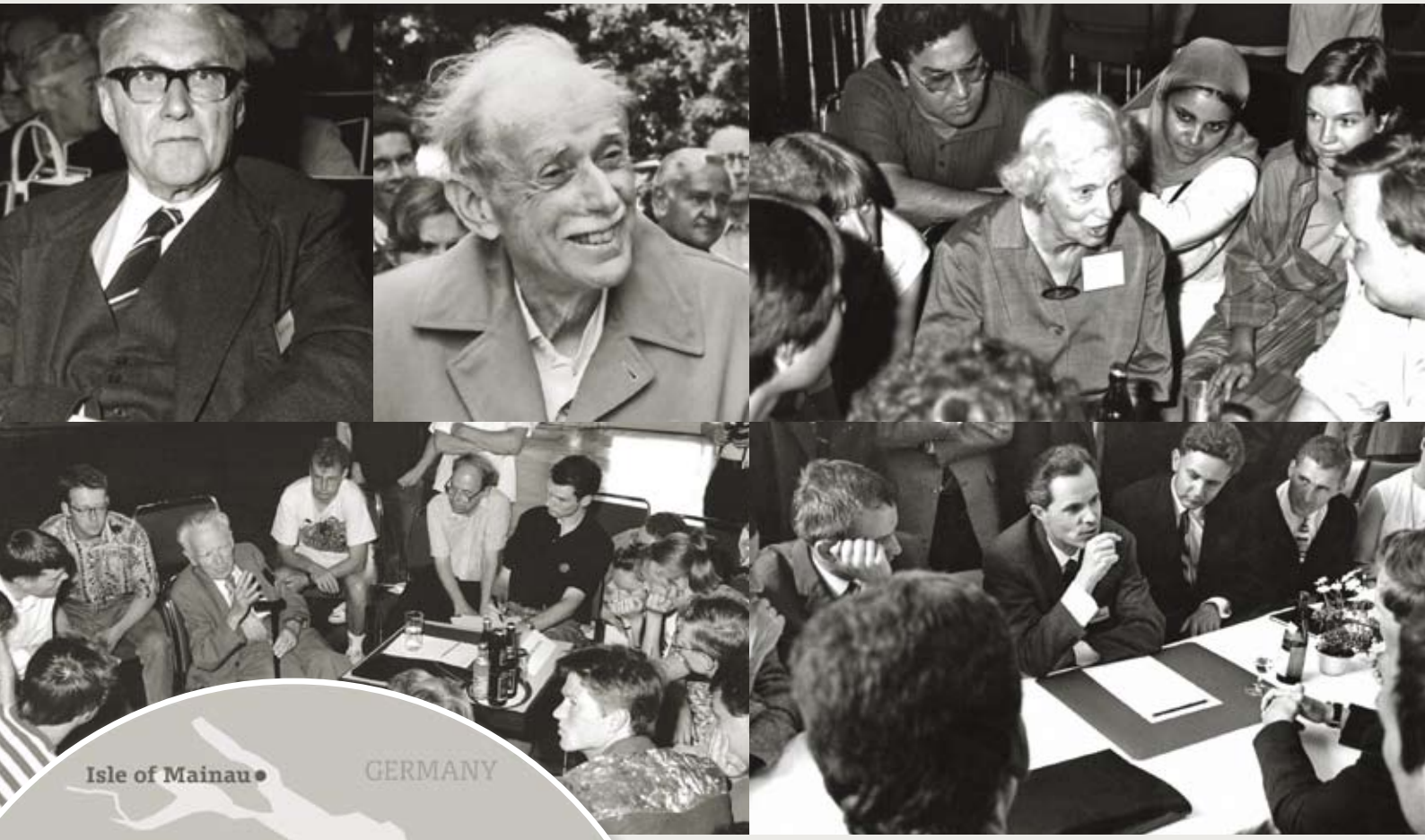
Since October 2010, Anders Bárány has been working together with Adam Smith, the Editor-in-Chief of nobelprize.org, on processing the lectures so that the mediatheque will begin to develop more rapidly in the following months. Far in excess of 100 lectures from the archive are even to be made accessible in time for the 61st Nobel Laureate Meeting.

Last year the Foundation Lindau Nobelprizewinners Meetings at Lake Constance purchased the image archive of the Bregenz photographer, Oskar Spang, that related to the Lindau Meetings. This encompasses more than 2,000 pictures and it documents the meetings from the years 1952 to 1997. The pictures were digitalised and will be accessible in the mediatheque. The funding provided by the Gerda-Henkel-Stiftung is enabling the image archive to be scientifically indexed as part of a post-doctoral project by Johanna Scherb, who is editing the archives' images from an historical aspect and examining the changes that have taken place in the imagery used.

DRadio Wissen – the third national radio station besides Deutschlandradio Kultur and Deutschlandfunk – is currently involved in a joint venture with the Lindau Nobel Laureate Meetings. For one week in the run-up to this year's meeting, DRadio Wissen broadcast one lecture each day from the mediatheque. Since then, a Lindau lecture can be heard in its entirety each Thursday at 8.05 pm.

The 'Mission Education': To learn from History

On the occasion of the 60th anniversary of the Lindau Nobel Laureate Meetings, the Council and the Foundation are proud to present the second DVD with selected historical lectures from the mediathque. This selection was compiled by Anders Bárány, scientific advisor of this project. The first DVD was released in 2009 to celebrate the introduction of the Lindau Mediatheque and to commemorate the 100th birthday of Count Lennart Bernadotte (1909–2004).




Isle of Mainau
GERMANY
SWITZERLAND
Lindau
AUSTR
LIECHTENS
dau-nobel.org
DVD for MAC/PC
Format: Quicktime
Watch more lectures at www.lindau-nobel.org
II.
EDUCATE.
A Selection of Lectures by Nobel Laureates
INSPIRE.
held at past Meetings of Nobel Laureates.
CONNECT.


EDUCATE.
INSPIRE.
CONNECT.
A Selection of Lectures by Nobel Laureates
held at past Meetings of Nobel Laureates.
EDUCATE. II.
INSPIRE.
CONNECT.
A Selection of Lectures by Nobel Laureates
held at past Meetings of Nobel Laureates.

ORGANISATION

Nobel Laureate Walter Kohn (right) together with Susanne Wieczorek (left),
Deputy-Director of the Executive Secretariat and Head of Conference Management.

Council for the Lindau Nobel Laureate Meetings

Honorary President

Count Lennart Bernadotte (†)

President

Countess Bettina Bernadotte

Vice-Presidents

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The advancement of the 'Mission Education' is a continuous process which reached a whole new level in 2010. This would not have been possible without the professionalism, great commitment and personal dedication of the staff at the Executive Secretariat in Lindau and the office of the Chairman of the Foundation in St. Gallen.

They all worked for a full year in order to plan and organise the 2010 Lindau Meeting, from the international nomination and selection process over the organisation of the meeting itself to compiling this report. Paying attention to details and managing a multitude of tasks made it possible to successfully organise and realise this year's anniversary meeting on a level which not only meets but exceeds international standards. Besides this enormous effort, the staff in Lindau and St. Gallen took great effort to organize the second part of the exhibition series "Discoveries" on the Isle of Mainau and further develop the mediatheque.

Project Staff for 2010 includes:
Andreas Gundelwein and Elisa Mussack (Exhibition "Discoveries"), Anke Burzler (Mediatheque), Alexandra Wimbauer (Young Researchers' Support), Melachrini Georgas (Nobel Portraits), and Melissae Fellet (Communications).

Last but not least, Andreas Böhm contribute tremendously to the realisation of the 'Mission Education' from St. Gallen.

The Council and Foundation Board would like to thank very much all team members for their outstanding work.

Founders´ Assembly of the Foundation with 237 Nobel Laureates

The Founders' Assembly of the Foundation Lindau Nobelprizewinners Meetings at Lake Constance currently has 237 Nobel Laureates among its members (as of November 2010). They all support the objective of the meetings: to educate, to inspire and to connect scientific generations. During the 2010 Lindau Meeting, Jack W. Szostak became member. More Laureates, who similarly dedicate themselves to the aims of the Lindau Meetings, have joined the Assembly in the past few months: Françoise Barré-Sinoussi, Yves Chauvin, Andre Geim, Richard Heck, Charles K. Kao, Makato Kobayashi, Luc Montagnier, Konstantin Novoselov and Ada E. Yonath.

A

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G

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H

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Harald zur Hausen
Richard Heck
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Avram Hershko
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J

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Nobel Laureate Robert B. Laughlin and young researchers at the 60th Lindau Nobel Laureate Meeting.

FACTS & FIGURES

Preliminary Account for the 60th Meeting of Nobel Laureates 2010

(as of October 31st, 2010)

REVENUES

Donations and funds from the public sector (Bayerisches Staatsministerium für Wissenschaft, Forschung und Kunst, Bundesministerium für Bildung und Forschung (BMBF), European Commission, Internationale Bodenseekonferenz IBK, The OPEC Fund for International Development (OFID), Stadt Lindau, UNESCO, U.S. Department of Energy), **from institutions aiding the advancement of science** (Deutsche Forschungsgemeinschaft (DFG), Stiftung Jugend forscht e.V., Stifterverband für die Deutsche Wissenschaft e. V., Wissenschaftsgemeinschaft Gottfried Wilhelm Leibnitz), **from industry** (BASF SE, Bayer AG, Deutsche Bank AG, Deutsche Telekom AG, Deutsche Telekom Laboratories, EnBW Energie Baden-Württemberg, ETO Magnetic KG, Henkel AG & Co.KGaA, Lockheed Martin Incorporated, Mars, Incorporated, Microsoft Corporation, MS Management Service AG, ProLindau Marketing GmbH & Co. KG, Qiagen GmbH, RWE AG, Sparkasse Lindau-Memmingen-Mindelheim, Bayerische Lotterieverwaltung/Spielbank Lindau, Südkurier GmbH, Verband der Chemischen Industrie (VCI)), Volkswagen Group and **charitable or non-profit organisations** (Boehringer Ingelheim Stiftung, Christa und Hermann Laur-Stiftung, Deutsche Telekom Stiftung, Deutsche Bank Stiftung, Ecoscientia Stiftung, gemeinnützige Hertie-Stiftung, Eduard Rhein Stiftung, Fritz Thyssen Stiftung, Fonds der Chemischen Industrie, Gerda-Henkel-Stiftung, Jacobs Foundation, Joachim Herz Stiftung, Klaus Tschira Stiftung gGmbH, Dr. Meyer-Struckmann-Stiftung, Peter-Dornier-Stiftung, Robert Bosch Stiftung GmbH, RWE Stiftung, Stiftung Mercator gGmbH, Stiftung van Meeteren, Wilhelm Sander-Stiftung, VolkswagenStiftung, Wilhelm-und-Else-Heraeus-Stiftung, ZEIT-Stiftung Ebelin und Gerd Bucerius and the Foundation Lindau Nobelprizewinners Meetings at Lake Constance with its **Maecenates** (Audi AG, Bayer AG, Deutsche Bank AG, Ecoscientia Stiftung, EnBW Energie Baden-Württemberg AG, Freistaat Bayern, Mars, Incorporated, Microsoft Corporation, Dr. Ing. h.c. F. Porsche AG, RWE AG, SAP AG, Verband der Bayerischen Metall- u. Elektroindustrie), **Principal Patrons** (Bertarelli Foundation, Lonza AG, NOVARTIS International AG, Principality of Liechtenstein, Siemens AG, Südwestmetall Verband der Metall- und Elektroindustrie Baden-Württemberg e.V., Verein der Bayerischen Chemischen Industrie e.V., Volkswagen AG), **Patrons** (Deutsche Telekom Stiftung, Robert Bosch GmbH, Holcim Ltd., Klaus Tschira Stiftung gGmbH, Verein Deutscher Ingenieure e.V. VDI), **Principal Donors** (Jacobs Foundation, Jungbunzlauer AG, LGT Group Foundation, Monika and Wolfgang Schürer, Synthes-Stratec Inc., Tchibo Holding AG (maxingvest ag), Verband der Chemischen Industrie e.V., Hansjörg Wyss Medical Foundation), **Donors and Friends.**

	AMOUNT	1.836.913,00 EUR

Participant fees for young scientists taken over by benefactors and subsidies or reimbursements of lodging and travel expenses of young researchers: Academy of Sciences (Malaysia), Academy of Sciences (France), Agència de Gestió d'Ajuts Universitaris i de Recerca Catalonia, Alexander S. Onassis Public Benefit Foundation, Alexander von Humboldt Foundation, A-Star University (Singapore), Audi AG, Austrian Federal Ministry of Science and Research, Bayer Science & Education Foundation, Biologie-Olympiade Baden-Württemberg, Boehringer Ingelheim Stiftung, Carl Zeiss AG, CERN, Chemieolympiade e.V, CoSCE – Confederación de Sociedades Científicas de España, Department of Energy (USA), Department of Science and Technology in India (DST), Deutsche Bundesstiftung Umwelt, Deutsche Luft und Raumfahrt (DLR), Deutsche Telekom Stiftung, Dr. Meyer-Struckmann-Stiftung, Dublin Institute for Advanced Studies (DIAS), Elite Network of Bavaria, EPSRC, European Commission, European Molecular Biology Organization (EMBO), Federal Ministry of Education and Research (Germany), Fondazione Cariplo, Fonds National de la Recherche Luxembourg, Fonds National de la Recherche Scientifique (FNRS) Belgium, Foundation for Polish Science, Foundation for Science and Technology (Portugal), Fraunhofer-Gesellschaft, Fulbright Commission, Fundaçao Gulbenkian, German Academic Exchange Service (DAAD), German Academy of Science and Engineering, Helmholtz Association of German Research Centres, Gemeinnützige Hertie-Stiftung, Hochschule Liechtenstein, Human Frontier Science Program (HFSP), Hungarian Academy of Sciences, Industrie-Club e. V., Industriellenvereinigung Wien, Internationale Bodensee-Hochschule (IBH), Japan Society for the Promotion of Sciences (JSPS), Joachim Herz Stiftung, Klaus Tschira Foundation gGmbH, Konrad-Adenauer-Foundation, Leibniz Association, Lockheed Martin Cooperation, Mars Incorporated, Max-Planck-Society, Medical Research Council of Great Britain, Microsoft Corporation, Ministry of Higher Education and Scientific Research (Egypt), National Council for Scientific and Technological Development (CNPq/Brazil), National Science and Technology Development Agency (Thailand), National Science Foundation (USA), National Science Council (Taiwan), Oak Ridge National Laboratory, The OPEC Fund for International Development (OFID), Pakistan Science Foundation, Professor-Rhein-Stiftung, Qiagen GmbH, Robert Bosch Stiftung, Royal Netherlands Academy of Arts & Sciences (KNAW), RWE AG, Siemens AG, Sino-German Center for Research Promotion (China), Slovenian Academy of Sciences and Arts, Stiftung Mercator, Südwestmetall, Swiss National Science Foundation (SNSF), The European Molecular Biology Laboratory (EMBL), The Lithuanian Academy of Sciences, The Royal Society of Chemistry (RSC), TÜBITAK (Turkey), Vacheron Constantin, VDI – The Association of German Engineers, Verein der Bayerischen Chemischen Industrie e.V., Verband der Chemischen Industrie (VCI), Volkswagen Foundation, Weizmann Institute of Science (Israel), Wilhelm und Else Heraeus-Stiftung.

	AMOUNT	477.850,60 EUR

TOTAL SUM OF REVENUES	**AMOUNT**	**2.314.763,60 EUR**

Any deficit that may arise upon presentation of all costs as of December 31st, 2010, will be balanced by an existing letter of indemnity provided by the Foundation Lindau Nobelprizewinners Meetings at Lake Constance.

EXPENDITURES

Travel		
Nobel Laureates	185.213,91	EUR
Young Researchers	13.000,00	EUR
Scientific Chairpersons & Council Members	9.000,00	EUR
Other	45.184,05	EUR
Lodging		
Nobel Laureates	81.824,20	EUR
Young Researchers	210.046,02	EUR
Scientific Chairpersons & Council Members	16.451,00	EUR
Other	97.825,00	EUR
Boarding		
Nobel Laureates	43.401,37	EUR
Young Researchers	94.076,11	EUR
Scientific Chairpersons & Council Members	4.000,00	EUR
Other	15.000,00	EUR
Scientific Programme	12.350,32	EUR
Venues & Equipment		
Rental Fees Locations incl. Tents	105.044,85	EUR
Technical Equipment	183.248,60	EUR
Utilities & Services	5.542,76	EUR
Onsite Staff	46.499,76	EUR
Transfers	11.590,00	EUR
Other Equipment	24.133,60	EUR
Supporting Programme	49.106,35	EUR
Printed Matters	159.815,45	EUR
AV Productions/Outreach		
AV Productions	95.303,59	EUR
Online Communication	30.000,00	EUR
Historical Lectures	30.628,90	EUR
Mediatheque	25.000,00	EUR
Laureates Gallery	16.000,00	EUR
Other Services	5.365,61	EUR
Press & Media		
Consulting & Production	60.332,89	EUR
Photography & CDs/DVDs	21.118,05	EUR
Distribution & Monitoring	4.744,32	EUR
Executive Secretariat		
Staffing, Wages and Salaries	363.976,62	EUR
Operating Costs (Rent, Utilities, etc.)	32.506,01	EUR
Communications	12.611,63	EUR
Accounting, Legal Advice	15.506,87	EUR
Office Supplies	4.173,42	EUR
Office Equipment (incl. Hard- and Software)	14.788,87	EUR
IT Services	37.701,37	EUR
Other Secretariat-Related Costs	24.134,68	EUR
Other External Costs	26.633,88	EUR
Expenditures until October 31st, 2010	**2.232.880,06**	**EUR**
Expected additional expenditures until December 31st, 2010	85.754,91	EUR
TOTAL EXPENDITURES	**2.318.634,97**	**EUR**

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UPCOMING LINDAU MEETINGS

61ST MEETING OF NOBEL LAUREATES
(dedicated to Physiology or Medicine) from June 26th – July 1st, 2011

4TH MEETING IN ECONOMIC SCIENCES
from August 23rd – August 27th, 2011

62ND MEETING OF NOBEL LAUREATES
(dedicated to Physics) from July 1st – July 6th, 2012

63RD MEETING OF NOBEL LAUREATES
(dedicated to Chemistry) from June 30th – July 5th, 2013

64TH MEETING OF NOBEL LAUREATES
(dedicated to Physiology or Medicine) from June 29th – July 4th, 2014

5TH MEETING IN ECONOMIC SCIENCES
from August 19th – August 23rd, 2014

65TH MEETING OF NOBEL LAUREATES
(4th Interdisciplinary Meeting with Nobel Laureates from the fields of Physics, Physiology or Medicine and Chemistry) from June 28th – July 3rd, 2015

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MEETING OF NOBEL LAUREATES AT LINDAU (2010)
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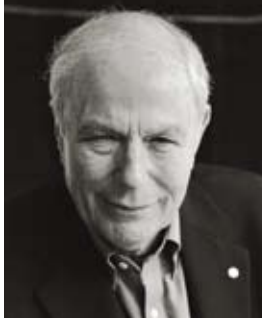

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