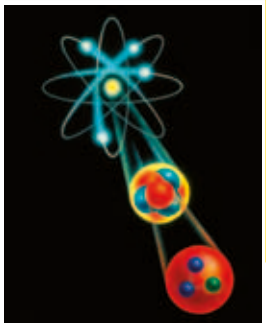
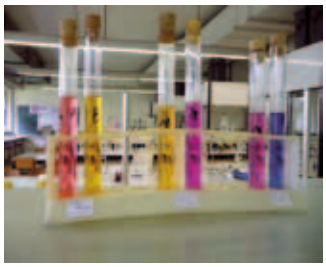
# REPORT 2012

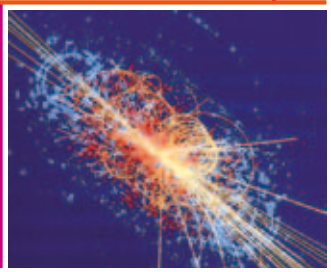
INTERNATIONAL SOLVAY INSTITUTES
BRUSSELS

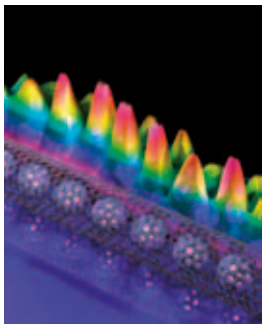
# REPORT 2012

INTERNATIONAL SOLVAY INSTITUTES
BRUSSELS





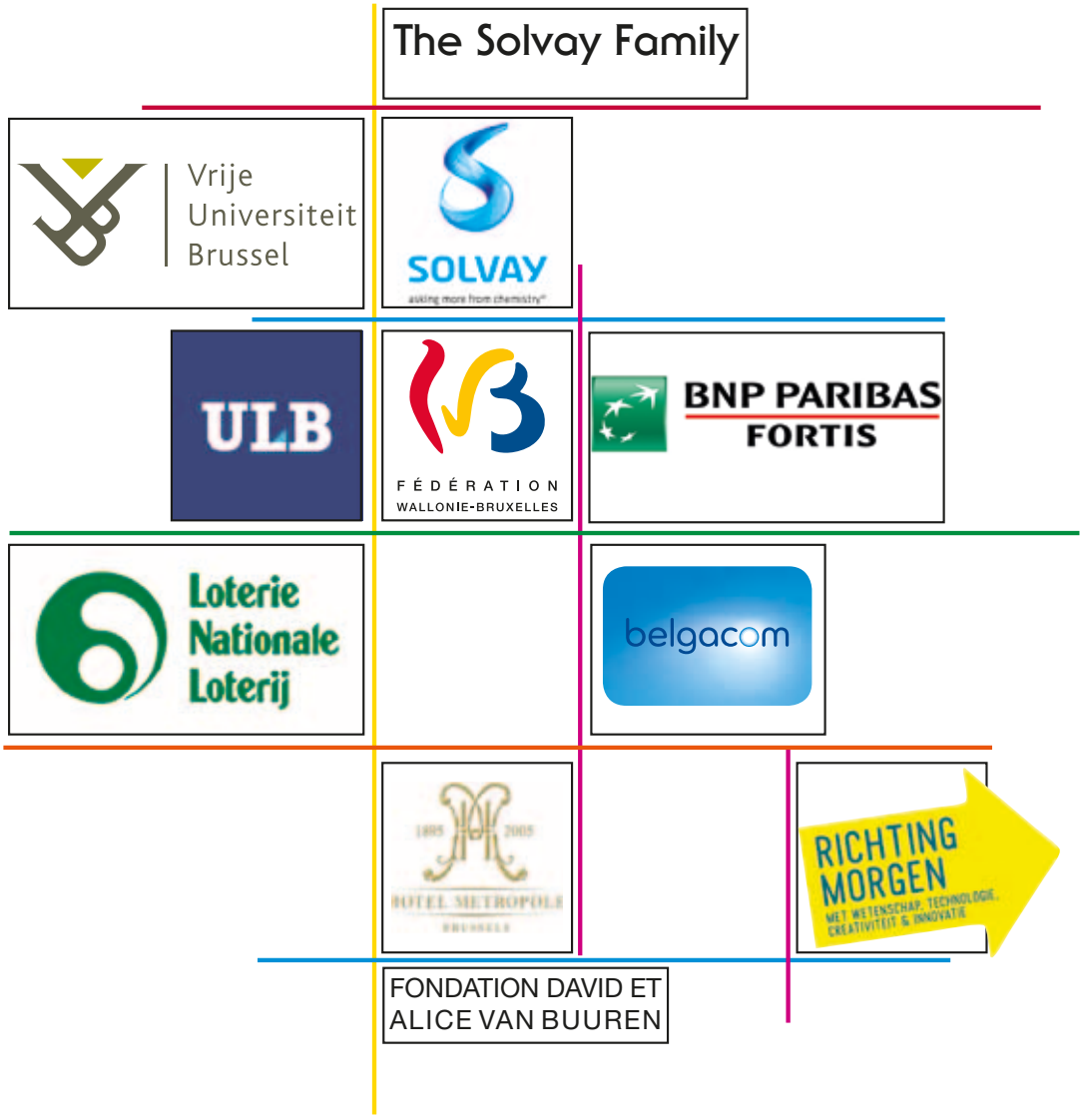




*We must not forget that when radioactivity was discovered no one knew that it would prove useful in hospitals. The work was one of pure science. And this is a proof that scientific work must not be considered from the point of view of the direct usefulness of it. It must be done for itself, for the beauty of science, and then there is always the chance that a scientific discovery may become like the radioactivity a benefit for humanity.*

*Marie Curie*

The International Institutes for Physics and Chemistry, founded by Ernest Solvay, acknowledge with gratitude the generous support of



# Contents

# A word from the President

This year, we have enjoyed the renewed visit of the International Advisory Committee comprised of outstanding scientists such as Lars Brink, Hermann Nicolai, Leticia Cugliandolo, Hirosi Ooguri, Jacques Prost and Gunnar von Heijne. They spent three days in Brussels interviewing the scientists involved with the organization of the scientific program and provided us with the precious advice and recommendations that we feel are necessary to continue on our path forward. Further, they reflected upon the future of fundamental research and the focus that should be ours in this new century.

The public events that were held in October were again of very high quality. We had presentations from Kurt Wüthrich, George Whitesides and Michael Freedman who were all fascinating. Although it is believed that science does not attract large crowds, we were pleased to see that our Solvay Public Lectures could fill a theatre on a sunny Sunday afternoon to discuss fascinating questions relating to the protein universe, the science of simplicity and quantum computers.

The Institutes are grateful for the support of the Solvay Group, of my mother, of my sisters Carole and Anne-Christine and in particular, my sister Marina for her support of individual postdoctoral scientists through her “Marina Solvay Postdoctoral Fellowship”. Her passion for science will provide a unique avenue of development to talented students.

I would like to thank Marc Henneaux, the staff of the Institutes and all the associated scientists for their skill at organizing the outstanding scientific program that is outlined in details in the following pages and that has attracted to our facilities, on a monthly basis, intellectual curiosity of the best order.

Lastly, I would like to welcome Mr. Lode Wyns, a renowned chemist, who as deputy director will assist Marc Henneaux in the organization of the activities in chemistry.

Jean-Marie Solvay
President

# A word from the Director

In 2008, the Board of Directors of the International Solvay Institutes decided to set up an International Advisory Committee. Its mission is to periodically review the scientific activities of the International Solvay Institutes, to report to the Board and to provide advice for future developments.

The Committee visited the Institutes this year for the second time. They interviewed not only the people working at the Institutes or collaborating with them, but also various scientists in charge of basic research both at the universities of Brussels (ULB and VUB) and in national research organizations. The report of their visit is enclosed at the end of this document.

The general evaluation of the activities of the Solvay Institutes made by the Advisory Committee is extremely positive. This is a great encouragement.

The report of the Committee also contains important recommendations: (i) One of them is that the "local activities" of the Institutes should be decided on a broader basis, involving scientists from all Belgian universities. In order to implement this recommendation, which is perfectly in line with the philosophy of the Institutes, the Local Scientific Committees have been renewed and enlarged. They include now scientists from the ULB, the VUB and also from the universities of Antwerp (Universiteit Antwerpen), Ghent (Universiteit Gent), Hasselt (UHasselt), Leuven (KUL), Liège (ULg), Louvain (UCL), Mons (UMons) and Namur (FUNDP). With their assistance, the local activities of the Institutes – Solvay workshops and Solvay chairs – will reach out to even bigger circles in physics and chemistry. [These workshop and chair programs complement our flagship activity, the Solvay Conferences on Physics and Chemistry, which are run by the International Scientific Committees.]

(ii) Another recommendation of the Advisory Committee is to provide more support to biochemistry and biophysics whenever possible. To fulfil this goal, Professor Lode Wyns from the VUB was appointed

deputy-director for chemistry of the Institutes. Lode is a renowned biochemist and molecular biologist who will help us in this endeavor.

Welcome to Lode and to all the new members of the local committees, and thanks for their commitment to assist us! Periodic reviews by an external eye are extremely healthy. I am very grateful for the careful work done by the International Advisory Committee and wish to thank all its members, and especially its chair Professor Lars Brink, for their evaluation and advice. I would also like to thank Professor Ben Feringa from the University of Groningen for having accepted to serve the Committee for their future reviews.

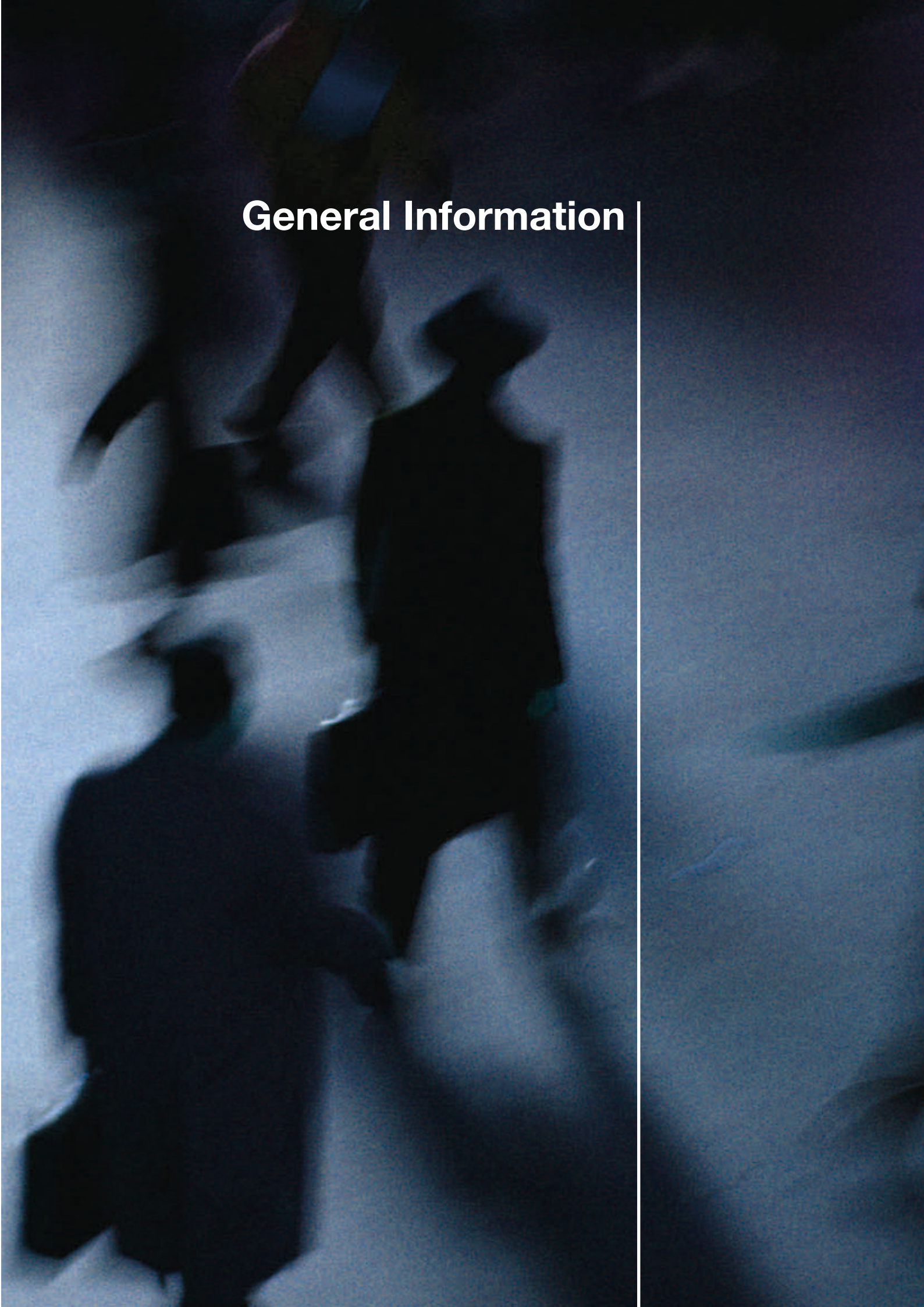
Since the very beginning, the International Solvay Institutes have been fortunate to benefit from the active and important support of the Solvay family. This constant backing of fundamental research has gone one step further in 2012 with the creation of the "Marina Solvay Postdoctoral Fellowship" to be given each year to a foreign postdoctoral researcher working in the group of the director of the Institutes. I am grateful to Marina Solvay for this initiative and to our President, Jean-Marie Solvay, who has been instrumental in its materialization.

The present report gives a survey of all the activities organized or supported by the International Solvay Institutes during the year 2012. These activities (colloquia, workshops, chairs, doctoral school, public lectures), pursued at the frontiers of knowledge, were attended by hundreds of participants from all over the world. The report describes also the advances in the research carried by the scientists affiliated with the Institutes.

These activities and this research would not have been possible without the support of the sponsors of the International Solvay Institutes, to whom I would like to express our gratitude. These are the Université Libre de Bruxelles, the Vrije Universiteit Brussel, the Solvay Group, the Belgian National Lottery, the Fédération Wallonie-Bruxelles, the Vlaamse Regering, BNP-Paribas Fortis, Belgacom, the David & Alice Van Buuren Foundation, the Hôtel Métropole and last but not least – and as recalled above –, the Solvay family: Mrs Solvay, Anne-Christine Solvay, Carole Solvay, Marina Solvay and Jean-Marie Solvay.

The extraordinary dedication and efficiency of the entire staff working at the Institutes is again gratefully acknowledged. I also thank our treasurer, Professor Bingen, for his assistance in managing the finances.

Marc Henneaux
Director



# General Information

# Members of the Board of Directors

Mr. Jean-Marie Solvay

President

Professor Franz Bingen
Emeritus - Professor VUB

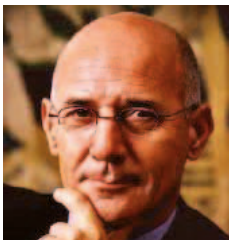
Vice-president and Treasurer

Professor Lode Wyns
Vice-Rector for Research VUB

Secretary (to May 2012)

Professor Benjamin Van Camp
Former Rector VUB
President of the Board of Directors UZ Brussel

Secretary (since May 2012)



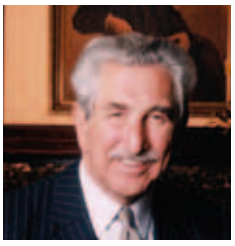
Mr. Philippe Busquin
Minister of State

Professor Eric De Keuleneer
Solvay Brussels School of
Economics & Management

Mr. Bernard de Laguiche
Chief Financial Officer Solvay Group

Mr. Alain Delchambre
President of the Administrative
Board of the ULB

Baron Daniel Janssen
Honorary Chairman of the Board
of Directors of Solvay Group



Mr. Eddy Van Gelder
President of the Administrative
Board of the VUB

# Board of Directors

## Honorary Members

Baron André Jaumotte — Honorary Director
Honorary Rector and Honorary President ULB

Mr. Jean-Marie Piret
Emeritus Attorney General of the Supreme Court of Appeal
and Honorary Principal Private Secretary to the King

Professor Jean-Louis Vanherweghem
Former President of the Administrative Board of the ULB

Professor Irina Veretennicoff
Professor VUB

## Guests

Professor Anne De Wit — Scientific Secretary of the International Committee for Chemistry
Professor ULB

Professor Hervé Hasquin
Permanent Secretary of the Royal Academy of Sciences, Letters and Fine Arts of Belgium

Professor Marc Henneaux — Director
Professor ULB

Professor Franklin Lambert
Professor VUB

Professor Alexander Sevrin — Deputy Director
Professor VUB — Scientific Secretary of the International Committee for Physics

Professor Géry van Outryve d'Ydewalle
Permanent Secretary of the Royal Flemish Academy of Belgium for Sciences and the Arts

## Management and Staff

| | |
|---|---|
| Director | Professor Marc Henneaux (ULB) |
| Deputy Director for Physics | Professor Alexander Sevrin (VUB) |
| Deputy Director for Chemistry (since December 2012) | Professor Lode Wyns (VUB) |
| Assistants to the Director | Professor Anne De Wit (ULB)<br>Professor Glenn Barnich (ULB)<br>Professor Ben Craps (VUB) |
| Office Manager | Ms Dominique Bogaerts |
| Project Coordinator | Ms Isabelle Van Geet |
| Accounting Officer | Ms Chantal Verrier |

Postal address: International Solvay Institutes, Campus Plaine ULB / CP 231, Bd du Triomphe, B-1050 Brussels, Belgium.

Delivery address: International Solvay Institutes, Campus Plaine ULB / Access 2, Bd de la Plaine, Building NO, 5th Floor, Office 2N5 105A, B-1050 Brussels, Belgium.

Tel: + 32 2 650 54 23 (Ms Van Geet) or + 32 2 650 55 42 (Ms Bogaerts)
Fax: + 32 2 650 50 28
Emails: dominique.bogaerts@ulb.ac.be, isabelle.vangeet@solvayinstitutes.be

Website: http://www.solvayinstitutes.be

## International Scientific Committee for Physics

Members are appointed for a 6-year period term, renewable once.

**Chair**

Professor David Gross, 2004 Nobel Laureate, Kavli Institute for Theoretical Physics, Santa Barbara, USA

**Members**

Professor Roger Blandford, Stanford University, USA (1 June 2010 - 31 May 2016, first term)

Professor Steven Chu, 1997 Nobel Laureate, Stanford University, USA (1 January 2008 - 31 December 2013, first term)

Professor Robbert Dijkgraaf, Institute for Advanced Study, Princeton, USA and Instituut voor Theoretische Fysica, Universeit van Amsterdam, the Netherlands (1 June 2010 - 31 May 2016, first term)

Professor Bert Halperin, Harvard University, Cambridge, USA (1 June 2010 - 31 May 2016, first term)

Professor Gerard 't Hooft, 1999 Nobel Laureate, Spinoza Instituut, Utrecht, the Netherlands (1 July 2010 - 30 June 2016, second term)

Professor Giorgio Parisi, Università La Sapienza, Roma, Italy (1 January 2008 - 31 December 2013, first term)

Professor Pierre Ramond, University of Florida, Gainesville, USA (1 July 2010 - 30 June 2016, second term)

Professor Klaus Von Klitzing, 1985 Nobel Laureate, Max-Planck-Institut, Stuttgart, Germany (1 July 2010 - 30 June 2016, second term)

Professor Peter Zoller, Institut für Theoretische Physik, Universität Innsbruck, Austria (1 June 2010 - 31 May 2016, first term)

**Scientific Secretary**

Professor Alexander Sevrin, Vrije Universiteit Brussel, Belgium

## International Scientific Committee for Chemistry

Members are appointed for a 6-year period term, renewable once.

**Chair**

Professor Dr. Kurt Wüthrich, 2002 Nobel Laureate, Institut für Molekularbiologie und Biophysik, Zürich, Switzerland

**Members**

Professor Graham Fleming, University of Berkeley, USA (1 June 2011 - 31 May 2017, second term)

Professor Robert H. Grubbs, 2005 Nobel Laureate, Caltech, Pasadena, USA (1 June 2011 - 31 May 2017, first term)

Professor Roger Kornberg, 2006 Nobel Laureate, Stanford University, USA (1 January 2010 - 31 December 2016, first term)

Professor Harold W. Kroto, 1996 Nobel Laureate, University of Sussex, Brighton, UK (1 June 2011 - 31 May 2017, second term)

Professor Henk N.W. Lekkerkerker, Utrecht Universiteit, the Netherlands (1 June 2011 - 31 May 2017, second term)

Professor K.C. Nicolaou, University of California, San Diego, USA (1 June 2011 - 31 May 2017, second term)

Professor JoAnne Stubbe, MIT, Cambridge, USA (1 June 2011 - 31 May 2017, first term)

Professor George M. Whitesides, Harvard University, Cambridge, USA (1 June 2011 - 31 May 2017, first term)

Professor Ahmed Zewail, 1999 Nobel Laureate, Caltech, Pasadena, USA (1 June 2011 - 31 May 2017, first term)

**Scientific Secretary**

Professor Anne De Wit, Université Libre de Bruxelles, Belgium

## International Advisory Committee

Members are appointed for a 6-year period term, renewable once.

**Chair**

Professor Lars Brink, Chalmers University of Technology, Göteborg, Sweden (1 June 2008 - 31 May 2014)

**Members**

Professor Leticia Cugliandolo, Université Paris 6, France (1 June 2008 - 31 May 2014)

Professor Ben Feringa, Rijksuniversiteit Groningen,the Netherlands (1 January 2013 - 31 May 2014)

Professor Hermann Nicolai, Max-Planck-Institut für Gravitations physik (Albert-Einstein-Institut), Potsdam, Germany (1 June 2008 - 31 May 2014)

Professor Jacques Prost, École Supérieure de Physique et Chimie Industrielles (ESPCI), Paris, France (1 June 2008 - 31 May 2014)

Professor Hirosi Ooguri, Caltech, Pasadena, USA and Tokyo University, Japan (1 June 2008 - 31 May 2014)

Professor Gunnar Von Heijne, Stockholm University, Sweden (1 June 2008 - 31 May 2014)

During its meeting of December 18, 2012, the Board of Directors of the International Solvay Institutes has appointed Professor Ben Feringa (University of Groningen, the Netherlands) as Member of the International Advisory Committee.

Professor Ben L. Feringa obtained his PhD degree in 1978 at the University of Groningen in the Netherlands under the guidance of Professor Hans Wynberg. After working as a research scientist at Shell in the Netherlands and the UK, he was appointed lecturer and in 1988 full professor at the University of Groningen and named the Jacobus H. van't Hoff Distinguished Professor of Molecular Sciences in 2004. He was elected Foreign Honory member of the American Academy of Arts and Sciences and member of the Royal Netherlands Academy of Sciences. In 2008 he was appointed Academy Professor and was knighted by Her Majesty the Queen of the Netherlands.

During its meeting of December 18, 2012, the Board of Directors of the International Solvay Institutes has decided to reorganize the Local Scientific Committee and to set up a Local Scientific Committee for Physics and a Local Scientific Committee for Chemistry.
Members are appointed for a 3-year period term.

## Local Scientific Committee for Physics (2013-2015)

**Chair**

Professor Marc Henneaux (ULB, Brussels)

**Members**

Professor Ben Craps (VUB, Brussels)
Professor Jan Danckaert (VUB, Brussels)
Professor Pierre Gaspard (ULB, Brussels)
Professor Jean-Marc Gérard (UCL, Louvain)
Professor Joseph Indekeu (K.U.Leuven)
Professor Philippe Lambin (FUNDP, Namur)
Professor Alexander Sevrin (VUB, Brussels)
Professor Petr Tinyakov (ULB, Brussels)
Professor Christian Van den Broeck (U.Hasselt)
Professor Sophie Van Eck (ULB, Brussels)

Participant from the Chemistry Committee (for coordination)
Professor Anne De Wit (ULB, Brussels)

## Local Scientific Committee for Chemistry (2013-2015)

**Chair**

Professor Lode Wyns (VUB, Brussels)

**Members**

Professor Annemie Bogaerts (U. Antwerp)
Professor Jean-Luc Bredas (Georgia Institute of Technology, Atlanta, USA)
Professor Pierre-François Coheur (ULB, Brussels)
Professor Pierre De Clercq (U.Ghent)
Professor Gert Desmet (VUB, Brussels)
Professor Anne De Wit (ULB, Brussels)
Professor Paul Geerlings (VUB, Brussels)
Professor Yves Geerts (ULB, Brussels)
Professor Marc Henneaux (member as director of the Solvay Institutes)
Professor Roberto Lazzaroni (UMons)
Professor André Matagne (ULg, Liège)

Participant from the Physics Committee (for coordination)
Professor Pierre Gaspard (ULB, Brussels)

## Honorary Members

| | |
|---|---|
| Professor Fortunato Tito Arecchi | Università di Firenze and INOA, Italy |
| Professor Claudio Bunster | Centro de Estudios Científicos, Valdivia, Chile |
| Professeur Claude Cohen-Tannoudji<br>1997 Nobel Laureate | Ecole Normale Supérieure, Paris, France |
| Professor Manfred Eigen<br>1967 Nobel Laureate | Max-Planck Institut, Göttingen, Germany |
| Professor François Englert | Université Libre de Bruxelles, Belgium |
| Professor Ludwig Faddeev | V.A. Steklov Mathematical Institute, St Petersburg, Russia |
| Professor Stephen Hawking | Cambridge University, UK |
| Christian Jourquin | Former CEO Solvay Group, Belgium |
| Professor I.M. Khalatnikoff | Landau Institute of Theoretical Physics, Moscow, Russia |
| Professor Jean-Marie Lehn<br>1987 Nobel Laureate | Collège de France, Paris, France |
| Professor Mario J. Molina<br>1995 Nobel Laureate | Massachusetts Institute of Technology, Cambridge, USA |
| Professor Victor P. Maslov | Moscow State University, Russia |
| Professor Stuart Rice | University of Chicago, USA |
| Professor Victor A. Sadovnichy | Moscow State University, Russia |
| Professor Roald Sagdeev | University of Maryland, College Park, USA |
| Professor E.C.G. Sudarshan | University of Texas, Austin, USA |
| Professor Chen Ning Yang<br>1957 Nobel Laureate | Chinese University Hong Kong & Tsinghua University, Beijing, China |

## Announcements

Starting July 1, 2012 Professor Dijkgraaf became the director of the Institute for Advanced Study in Princeton. Professor Dijkgraaf is a member of the International Scientific Committee for Physics of the Solvay Institutes.

In 2012, The Milner Foundation launched the Fundamental Physics Prize Foundation, a not-for-profit corporation ("Foundation") dedicated to advancing our knowledge of the Universe at the deepest level by awarding annual prizes for scientific breakthroughs, as well as communicating the excitement of fundamental physics to the public.

In its inaugural year, Milner Foundation has awarded nine Fundamental Physics Prizes and all the recipients agreed to serve on the Selection Committee of the Fundamental Physics Prizes Foundation to select recipients of future prizes.

The prizes are given annually by the Foundation for accomplishments in fundamental physics broadly defined, including advances in closely related fields with deep connections to physics.

Eight of the 2012 laureates are regular participants in the Solvay Conferences: Nima Arkani-Hamed, Alan Guth, Alexei Kitaev, Andrei Linde, Juan Maldacena, Nathan Seiberg, Ashoke Sen, Edward Witten.

Our congratulations to all of them.

# Solvay Public Event & Solvay Awards

# Solvay Public Event & Solvay Awards

## Solvay Public Lectures: background

Supporting frontier research at the highest level in physics and chemistry is the main mission of the Solvay Institutes. But this is not their only mission. It is also the responsibility of scientists to inform society on the latest developments in science. For this reason, the Institutes committed themselves in 2004 to periodically organize public events during which the best researchers would deliver popular lectures on their recent work.

Informing the general public about the current scientific developments and discoveries can also arouse enthusiasm for science and create new vocations among the young generations. It is more than ever needed that these young generations embrace scientific careers to solve the numerous challenges that our contemporary society faces. The decrease in the number of students in faculties of sciences is without doubt a great source of concern.

The Solvay Institutes organize one public lecture per year. The 2012 Public Event was the 9th one in the series. The Solvay Institutes have been fortunate each time to greet exceptional scientists who gave fascinating talks.

## The Solvay Public Lectures

### 22 June 2005

Gerard 't Hooft (Utrecht), 1999 Nobel Laureate in Physics,
"From Quarks to the Quantization of Gravitation: Challenges and Obstacles in our Search for the Fundamental Forces"

Kurt Wüthrich
(Zürich and La Jolla), 2002 Nobel Laureate in Chemistry,
"From Structural Biology to Structural Genomics: New Challenges for Physics and Chemistry in the Post-Genomic Era"

### 4 December 2005

Robbert Dijkgraaf
(Amsterdam),
"Strings, Black Holes and the End of Space and Time"

Brian Greene
(New York),
"The Fabric of the Cosmos, Space, Time and the Texture of Reality"

### 20 May 2007

Stephen Hawking
(Cambridge, UK),
"The Origin of the Universe"

Harold Kroto
(Brighton), 1996 Nobel Laureate in Chemistry,
"Architecture in Nanospace"

### 2 December 2007 "Chemistry? More than ever!"

Jean-Marie Lehn
(Paris and Strasbourg), 1987 Nobel Laureate in Chemistry,
"De la Matière à la Vie: la Chimie? La Chimie!"



### 12 October 2008 – "Images from the Quantum World"

Wolfgang Ketterle
(Cambridge, USA), 2001 Nobel Laureate in Physics,
“New Forms of Quantum Matter near Absolute Zero Temperature”

J.C. Seamus Davis
(Ithaca, USA),
“Visualizing Complex Electronic Quantum Matter at Atomic Scale”

### 4 October 2009

Françoise Barré-Sinoussi
(Paris), 2008 Nobel Laureate in Medecine,
"VIH/SIDA, une aventure scientifique et humaine en réponse à une épidémie émergente"

### 17 October 2010 – "Chemistry: at the crossroads of Physics and Biology"

Wolfgang Wiltschko
(Frankfurt am Main),
"The magnetic compass of birds and its physical basis"

Rudolph Marcus
(Pasadena), 1992 Nobel Laureate in Chemistry,
"Experimental surprises and their solutions in theory"

### 23 October 2011 – "The Future of Physics"

William Phillips
(College Park), 1997 Nobel Laureate in Physics,
"Time and Einstein in the 21st century"

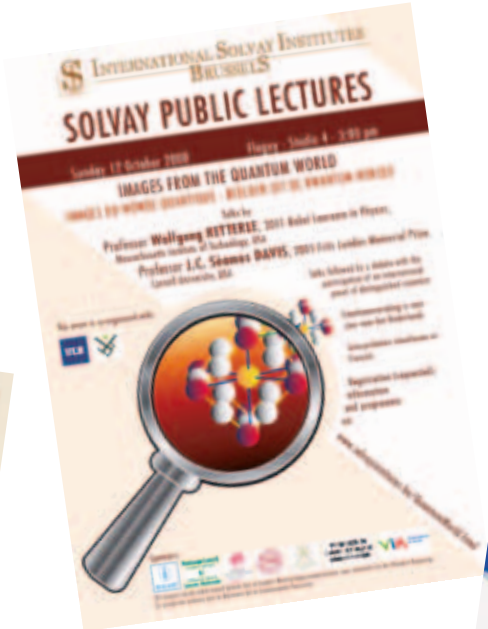
Frank Wilczek
(Cambridge, USA), 2004 Nobel Laureate in Physics, "Quantum Beauty"

### 21 October 2012

George Whitesides
(Cambridge, USA),
"The Science of Simplicity"

Michael Freedman
(Santa Barbara), 1986 Recipient of the Fields Medal,
"Will our Thinking Become Quantum-Mechanical?"

Kurt Wüthrich
(Zürich and La Jolla), 2002 Nobel Laureate in Chemistry,
"Exploring the Postgenomic Protein Universe"






**21 October 2012**

More than 800 participants listened to the popular lectures delivered by Professor George Whitesides (Harvard University), Professor Michael Freedman (Microsoft Station Q, University of California at Santa Barbara) and Professor Kurt Wüthrich, 2002 Nobel Laureate (ETH Zürich and Scripps Research Institute, La Jolla).

Mr. Steven Vanackere (Finance Minister) and Mr. Paul Magnette (Minister in charge of the Scientific Policy) were respectively represented by Mr. Dries Cools and Mr. Xavier Lepoivre.

The event closed with a drink offered to all the participants, which allowed the public to interact more closely with the lecturers.

The International Solvay Institutes warmly thank the speakers who accepted to deliver a lecture. They are very busy persons and the Institutes value very much the time that they gave them to make their 9th Public Event a great success.

In the spirit of the Solvay public lectures whose aim is to boost the interest for science, especially among the young people, a short Solvay Award ceremony took place during which brilliant young scientists who had been distinguished for their master or doctoral work in the fields of physics, chemistry or engineering at the ULB and the VUB, were rewarded by Jean-Pierre Clamadieu, CEO of the Solvay Group.


## About the speakers

### Michael Freedman

Before joining Microsoft Research and becoming director of Station Q, Michael Freedman was Charles Lee Powell Professor of Mathematics at UCSD. In an earlier career, he solved the long-standing Poincaré conjecture in four dimensions, for which he received the Fields Medal, the highest honor in mathematics. He has received numerous other awards and honors including the Veblen prize, a MacArthur Fellowship and the National Medal of Science. He is an elected member of the National Academy of Sciences and the American Academy of Arts and Sciences. His main research interest is topological states of matter and the construction of mathematical models which illuminate these.

## George M. Whitesides

George Whitesides is professor of chemistry at Harvard University. Whitesides's scientific contributions come from such diverse areas as nuclear magnetic resonance spectroscopy (NMR), materials and surface science, microfluidics and nanotechnology.

He is best known for his insights into surface chemistry and understanding how molecules arrange themselves on a surface. His discoveries laid the groundwork for advances in nanoscience that led to new technologies in electronics, pharmaceutical science and medical diagnostics. His recent research interests include energy, the origin of life, and science for developing economics. Whitesides is the recipient of numerous awards, including the prestigious National Medal of Science (1998) and the Priestley Medal (2007).

## Kurt Wüthrich

Kurt Wüthrich shares his time between the positions of Professor of Biophysics at the ETH Zürich, and Cecil H. and Ida M. Green Professor of Structural Biology at the Scripps Research Institute (TSRI) in La Jolla, CA, USA. His research interests are in molecular structural biology, protein science and structural genomics. His specialty is nuclear magnetic resonance (NMR) spectroscopy with biological macromolecules in solution, where his discoveries opened the door to prodigious developments of molecular biology revolutionizing the field. He has received numerous awards and honors including the prestigious 2002 Nobel Prize in Chemistry.

## Program

| | |
|---|---|
| 15:00 - 15:20 | Welcome by Professor Marc Henneaux and Opening by Vice Prime Minister Steven Vanackere and Minister Paul Magnette (represented by Mr. Dries Cools and Mr. Xavier Lepoivre) |
| **Moderator** | Professor Franklin Lambert |
| 15:20 - 16:00 | *The Science of Simplicity* Professor George Whitesides (Harvard University) |
| | Question session |
| 16:00 - 16:30 | Solvay Awards Ceremony with Jean-Pierre Clamadieu, CEO of the Solvay Group |
| 16:30 - 17:10 | *Will our thinking become quantum-mechanical?* Professor Michael Freedman (Microsoft Station Q, University of California at Santa Barbara) |
| | Question session |
| 17:10 - 17:50 | *Exploring the Postgenomic Protein Universe* Professor Kurt Wüthrich (ETH Zürich and Scripps Research Institute, La Jolla) |
| | Question session |
| 17:50 - 17:55 | Closing |
| 18:00 - 19:00 | Drink |

N. Boël, Mrs Solvay de la Hulpe, J-P. Clamadieu, D. Viviers, Mrs and Mr Janssen

# Solvay Public Event & Solvay Awards


## Solvay Awards Ceremony

Each year, these Awards reward a number of young graduates and young researchers who have come out of the Faculties of Science and Applied Science of the Université Libre de Bruxelles and the Vrije Universiteit Brussel.

The 2010 and 2011 winners have been selected by a jury made up of Solvay experts and representatives from the 2 universities by way of a test that consisted of two components: the public defence of their Master's or Doctoral thesis and a situation analysis of their respective fields of research, specifically highlighting the potential for innovative applications they bring, that will help build the society of tomorrow.

## 2010/2011 Solvay Awards Laureates

Renaud Bastaits (ULB)
Joost Brancart (VUB)
Matthieu Doyen (ULB)
Kevin Garnir (ULB)
Flore Keymeulen (ULB)
Jérôme Loreau (ULB)
Arnaud Mahieux (ULB)
Thibault Muselle (VUB)
Bernard Nisol (ULB)
Michel Rasquin (ULB)
André Stephan (ULB)








# International Solvay Chairs

The International Solvay Chairs enable the Institutes to invite in Brussels eminent scientists for a period of one to two months in order to give lectures on their work to researchers in the corresponding fields, not only from the ULB and the VUB, but also from other Belgian universities and abroad. The program started in 2006 for physics. In 2011 the physics chair was re-named the International "Jacques Solvay Chair in Physics" in memory of Jacques Solvay, who was president of the Institutes for more than 50 years. The chair program in chemistry was launched in 2008 thanks to a generous grant from the Solvay Company, which the Institutes gratefully acknowledge.

The 2012 International Solvay Chairs are described in separate sections.

## Jacques Solvay Chairs in Physics

2006 Professor Ludwig Faddeev (Steklov Mathematical Institute, Saint-Petersburg, Russia)

2007 Professor Sir Michael Berry (University of Bristol, United Kingdom)

2008 Professor David Gross (Kavli Institute for Theoretical Physics, Santa Barbara, USA)

2009 Professor Valery Rubakov (Institute for Nuclear Research of the Russian Academy of Sciences, Moscow, Russia)

2010 Professor Serge Haroche (Collège de France and Ecole Normale Supérieure, Paris, France)

2011 Professor Nathan Seiberg (Institute for Advanced Study, Princeton, USA)

2012 Professor Jan Zaanen (Leiden University, the Netherlands)

## Solvay Chairs in Chemistry

2008 Professor Richard J. Saykally (University of Berkeley, USA)

2009 Professor Alexander Mikhailov (Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin, Germany)

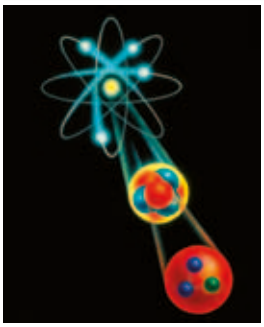
2010 Professor Weitao Yang (Duke University, USA)

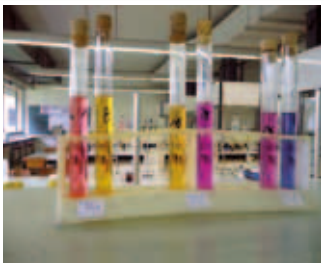
2011 Professor Jean-Luc Brédas (Georgia Institute of Technology, Atlanta, USA)

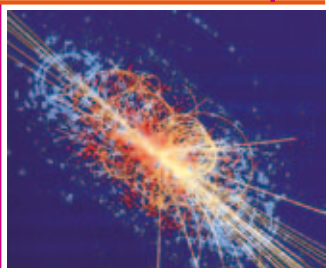
2012 Professor Viola Vogel (ETH Zürich, Switzerland)

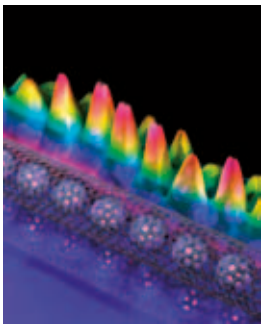
# 2011 International Solvay Chair in Chemistry

Professor **Jean-Luc Brédas**
Georgia Institute of Technology,
Atlanta, USA









# 2011 International Solvay Chair in Chemistry

The last lectures of the 2011 Solvay Chair in Chemistry, held by Professor Jean-Luc Brédas, took place in 2012. They were the continuation of the lectures given in 2011 and devoted to organic electronic materials.

Monday 16 April 2012

## Charge-Transport Processes in Organic Materials

After a short introduction to recent developments in the field of organic electronics, which will highlight the importance of charge-carrier mobility in devices such as organic field-effect transistors, we will discuss the main concepts behind charge transport in organic materials. We will describe in particular the impact of molecular packing on electronic coupling between adjacent molecules or polymer segments as well as the influence of the coupling between electrons and both intramolecular and intermolecular vibrations.

Tuesday 17 April 2012

## Hybrid Interfaces between Organic Layers and Transparent Conducting Oxides

This seminar addressed the nature of the electronic structure at the interface between (inorganic) electrodes, in particular transparent conducting oxide (TCO) electrodes, and organic overlayers. These interfaces play a critical role in determining the efficiency of electron injection or collection in a variety of organic electronic devices, including organic light-emitting diodes (OLEDs), organic field-effect transistors (OFETs), and organic photovoltaic (OPV) cells.

Tuesday 11 December 2012

## Organic nonlinear optical chromophores for all-optical signal processing applications

All-optical signal processing / switching applications require materials with large third-order nonlinearities and low nonlinear optical losses. Recently, a joint experimental / theoretical design approach was proposed, that involved enhancing the real part of the third-order polarizability ($\gamma$) of polymethine-type molecules through incorporation of heavy chalcogen atoms into terminal groups, while controlling the molecular length to obtain favorable one- and two-photon absorption resonances that lead to suitably low optical loss and to substantial dispersion enhancement of Re($\gamma$). This approach was implemented in a soluble bis(seleno-pyrylium) heptamethine dye that exhibits a real part of $\gamma$ that is exceptionally large throughout the wavelength range used for telecommunications, and an imaginary part of $\gamma$, a measure of nonlinear loss, that is two orders-of-magnitude smaller. Such a combination is critical in enabling low-power

and high-contrast optical switching.

In this presentation, we will first review the relationship between the degree of bond-length alternation and the nonlinear optical response in polymethine dyes [2]. We will then provide a quantum-chemical description of the real and imaginary nonlinear optical properties of relevant cyanine-type molecules. Finally, we will discuss the strategies that need to be followed in order to translate the properties of the isolated molecules into the solid state [3].

References
[1] J.M. Hales et al., Science 327, 1485 (2010).

[2] S.R. Marder et al., Science 265, 632 (1994).

[3] S. Mukhopadhyay et al., Chemical Science 3, 3103 (2012).

Thursday 13 December 2012

## Electronic and Optical Processes in Organic Solar Cells

In this course, we will first briefly review the current state-of-the-art in the field of organic electronics and then focus on organic solar cells, which we define as solid-state cells in which the semiconducting materials between the electrodes are organic, polymers, oligomers, or small molecules. We describe the optical and electronic processes that take place in such cells and turn our attention successively to: (i) optical absorption and exciton formation; (ii) exciton migration to the electron donor – electron acceptor interface; (iii) exciton dissociation into charge carriers, resulting in the appearance of holes in the donor component and electrons in the acceptor component; (iv) charge carrier mobility; and (v) charge collection at the electrodes [1-3].

In the second part of the presentation, we underline the complexity of the processes taking place at the nanoscale at the donor/acceptor interfaces and highlight the molecular understanding that comes from a computational approach combining electronic-structure theory calculations, molecular mechanics / molecular dynamics simulations, and Monte Carlo simulations [4-6].

References
[1] B. Kippelen and J.L. Bredas, Energy & Environmental Science 2, 251 (2009).

[2] J.L. Bredas, J. Norton, J. Cornil, and V. Coropceanu, Accounts of Chemical Research 42, 1691 (2009).

[3] Y. Zhou et al., Science 336, 327 (2012).

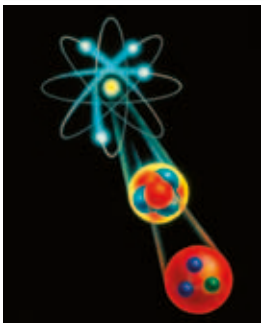
[4] N.C. Miller et al., Advanced Materials, 2012 (DOI: 10.1002/adma.201202293).

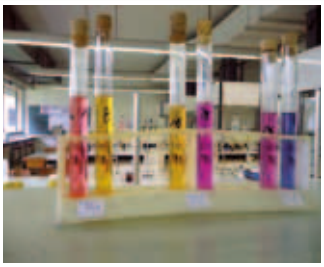
[5] N.C. Miller et al., Advanced Energy Materials, 2012 (DOI: 10.1002/aenm.20 1200392).

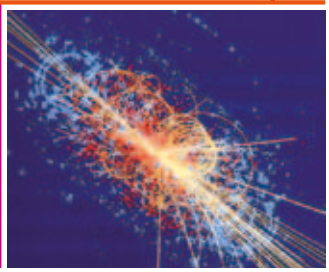
[6] Y.T. Fu, C. Risko, and J.L. Bredas, Advanced Materials, 2012 (DOI: 10.1002/adma.2012 03412).

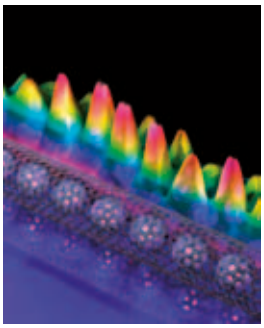
# 2012 International Solvay Chair in Chemistry

Professor **Viola Vogel**
Laboratory of Applied Mechanobiology,
Department of Health Sciences and Technology, ETH Zürich, Switzerland









# 2012 International Solvay Chair in Chemistry

The fifth international Chair in Chemistry was held by Professor Viola Vogel, from ETH-Zürich, one of the leading world's experts in bioengineering and nanoengineering. Her inaugural lecture, given on the 16th of October 2012, was devoted to the role of mechanical forces in the interactions of bacteria with their hosts. Mechanobiology is a fascinating subject at the border of biology, chemistry and physics and is a field where Professor's Vogel group has a unique expertise.

Professor Vogel gave then the first lectures of her course in November of 2012. These were incorporated in the master program in chemistry of the ULB and introduced further challenging ideas and concepts from mechanobiology (bioinspired robotics, proteins as mechano-chemical switches, how cells recognize material properties).

The rest of Professor's Vogel lectures will be given in February and March of 2013.

## Program

### Inaugural Lecture

Tuesday 16 October 2012

### Bacterial Infections: The Art of Holding On

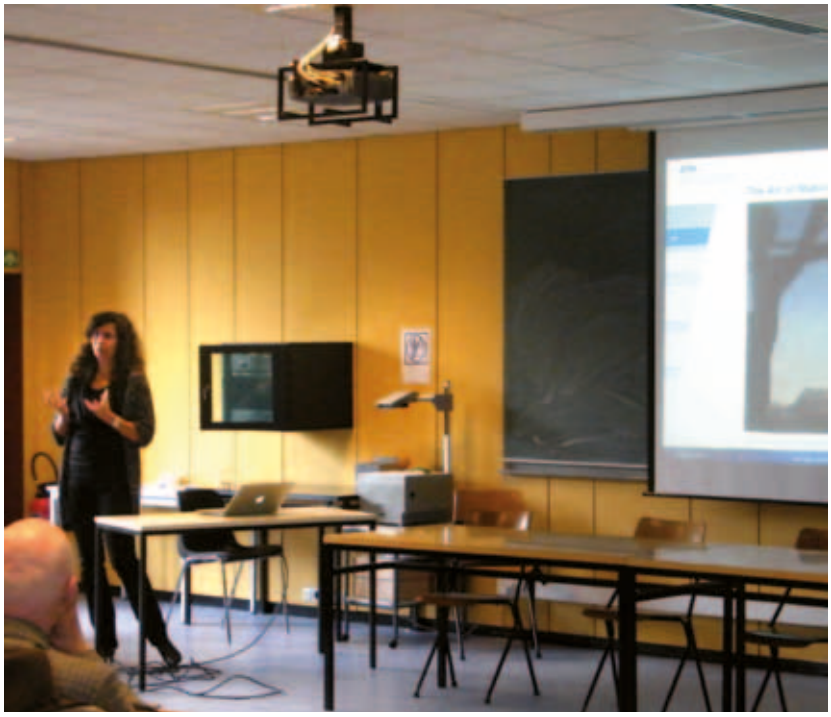
Learning how to better interfere with the adhesion and invasion of bacteria into host tissues is crucial, particularly in light of the sharply rising occurences of antibiotic resistencies. While much is known about the biochemistry by which bacteria recognize their hosts, little insights exist on how such interactions are modulated by mechanical forces. A variety of bacterial and cellular adhesion molecules have evolved superadhesins that get activated when tensile forces pull on them. Such catch bonds allow E. coli to hold on to surfaces even when they are rinsed by body fluids and subsequently cause urinary tract infections. Also S. aureus exploits a nanoscale trick to distinguish between the tension on fibers in tissues versus wound sites.

The mechanical strain of extracellular matrix has never been considered before in the description of bacterial adhesion and host invasion cycles. Deciphering how proteins can serve as mechano-chemical signalling switches is thus not

Viola Vogel is a Professor in the Department Health Sciences and Technology, heading the Laboratory of Applied Mechanobiology at the ETH Zürich. After completing her graduate research at the Max-Planck Institute for Biophysical Chemistry, she received her PhD in Physics at the Johann-Wolfgang Goethe University in Frankfurt/Main, followed by two years as a postdoctoral fellow at the University of California Berkeley where she applied nonlinear optical techniques to analyze fluid interfaces. She became an Assistant Professor in Bioengineering at the University of Washington/Seattle in 1991, with an Adjunct appointment in Physics. She launched a new program in Molecular Bioengineering, and was later promoted to Associate (1997) and Full Professor (2002). She was the Founding Director of the Center for Nanotechnology at the University of Washington (1997-2003), and moved to the ETH in 2004.

Her work has been internationally recognized by multiple awards (including Otto-Hahn Medal; NIH FIRST Award; Philip Morris Foundation Research Award; Julius Springer Prize 2006 for Applied Physics; ERC Advanced Grant (2008), major lectureships and services for International Organizations (US Representative on the Council of Scientists of the Human Frontier Science Program), as well as jury duties for the European Research Council, the British Marshall Fund, the Humboldt Foundation, the National Research Council (USA) and the German Government.

# Professor Viola Vogel



only essential to learn how bacteria and cells probe and respond to their environments, but it has also far reaching implications for developing new strategies to treat infectious diseases.

## Lectures

Thursday 22 November 2012

### Bioinspired Robotics: Harnessing Biological Motors and Cells to Power Devices

The industrial revolution was driven by man-made machines that created directed power strokes and movement, and even today most of the very same operational mechanisms are broadly used. In contrast, biological propulsion systems made from molecules and cells evolved in aqueous environments and are driven by motor proteins that hydrolyze water-soluble molecules. Here we will discuss first progress in learning how to harness biological motors and cells for technical ex-vivo applications.

Monday 26 November 2012

### Proteins as Mechano-Chemical Switches: How Nature Exploits Mechanical Forces

Proteins are the workhorses of cells and organisms, and much attention has been spent in recent decades to identify all proteins that are part of the human genome, and to characterize their structure-function relationships. Nanotechnology and computational tools revealed in recent years though that the structure-function relationship of many proteins can be switched by mechanical forces. Thus, mechanical forces can regulate various cell signaling events and thereby control physiological processes. This new field of mechanobiology is rapidly emerging.

Wednesday 28 November 2012

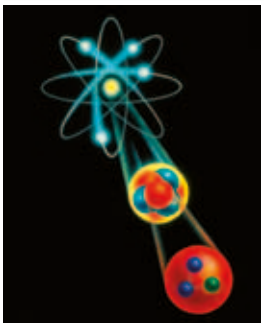
### Stretching and Breaking Bonds: How Cells Recognize Material Properties

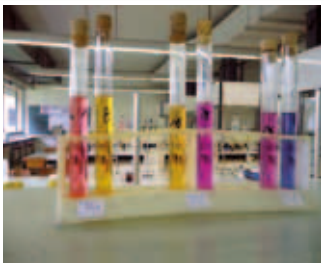
Cells can sense and respond to their environments and recent studies suggest that they can actually “feel” the properties of synthetic materials. While cells utilize mechanical forces to explore their environments, as well as to probe material properties and topographies, it remains mostly unclear how physical and mechanical cues are thereby translated into biochemical signals. Such mechanotransduction events will ultimately regulate cell functions, including the differentiation of stem cells.

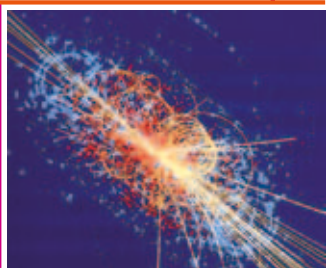
The rest of her lectures will be given in February and March 2013.

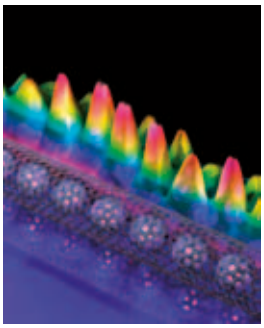
# 2012 International Jacques Solvay Chair in Physics

Professor **Jan Zaanen**
Lorentz Institute for Theoretical Physics, Leiden University, Leiden, the Netherlands









# 2012 International Jacques Solvay Chair in Physics

The seventh international Chair in Physics took place in October 2012. It was held by Professor Jan Zaanen, from the Lorentz Institute (University of Leiden). Jan Zaanen is a leading figure in theoretical condensed matter physics, where he made major contributions, in particular, to the physics of electrons in strongly correlated material and high temperature superconductivity.

Unexpected and intriguing connections between the mathematics of string theory and high temperature superconductivity have produced a lot of excitement in both the string and condensed matter communities. Jan Zaanen has played a pivotal role in these intriguing developments. His lectures were devoted to this exciting subject and were part of the program of the International Doctoral School on "Quantum Field Theory, Strings and Gravity" co-organized with the University of Amsterdam, the Ecole Normale Supérieure in Paris and the two Brussels Universities ULB and VUB.

## Inaugural Lecture

Tuesday 2 October 2012

## The Black Hole in a Grain of Copper Rust and other Surprises in the Quantum Matter Universe

The matter that we observe with our human senses is a completely understood affair. However, there is much more to it. Perhaps the most outlandish form of matter is associated with black holes. As objects made out of the fabric of space and time, these behave as material bodies emitting radiation through quantum processes: this is the discovery that made Stephen Hawking famous.

In a quite different area of physics, the experimental study of systems composed of an infinity of highly quantum mechanical, strongly interacting particles as realized in

Jan Zaanen holds a chair of theoretical condensed matter physics at the Instituut-Lorentz. His core research interests are in the subject of quantum matter.

He is best known for his contributions to the understanding of the quantum physics of the electrons in strongly correlated material, and in particular High temperature superconductivity.

In 1982, he was graduated in Chemistry from University of Groningen, Cum Laude and in 1986 he received his Doctorate in Physics from the University of Groningen.

In 2006 he received the Spinozapremie, the "Dutch Nobel prize", for his scientific accomplishments.

earthly laboratories has leaped forward in recent years. These systems need also extreme conditions: they are formed at very low temperatures from either electrons in special solids or atoms trapped by laser fields. But surprisingly similar stuff is also formed at very high temperatures, in the elementary particle fire balls created at particle accelerators.

The 'quantum matter' that is found under these circumstances is called 'quantum' because the weirdness of quantum physics has dramatic imprints on its behavior on the macroscopic scale. Although much is known experimentally, the theorists got increasingly lost in the course of time: quantum matter is littered with mysteries, the most famous example being the superconductivity occurring at unreasonably high temperatures in copper oxides.

But very recently help arrived from an unexpected side, in the form of the awesome mathematical machinery developed by string theorists in order to understand quantum gravity. This approach yields some deep insights in the quantum matter mysteries, in a setting that is mind boggling. According to string theory, the quantum matter as realized in the laboratories could be like a kind of hologram, encoding indirectly (and quite unanticipatedly!) the Hawking-like quantum physics of a zoo of new

types of black holes living in a higher dimensional universe.

## Lectures

Wednesday 17, Thursday 18, Friday 19 and Tuesday 23 October 2012

## Holography and Quantum Matter: String Theory Answers to Condensed Matter Questions

The lectures are intended as a research project by itself. The present flirtation between condensed matter physics and the AdS/CFT correspondence has a very strong and in a way mysterious appeal to the minds on both sides of this interdisciplinary pursuit. My intention is to organize a dialogue aimed at making this shared intuition more explicit. Disciplined by the proximity to experiment, condensed matter theorists like myself are in the grip of the Landau method. Physics appears as the quest to find the great mathematical principles governing emergence per se. From this perspective AdS/CFT has a particularly strong appeal that I will try to make

manifest, to find out how it resonates with the high-energy view. The program is as follows:

1. Modern condensed matter theory: quantum phase transitions, the quantum critical state including the Planckian dissipation twist. The weak-strong, local-global dualities of simple field theories, emergent gauge invariance and the idea of fractionalization as finite density deconfinement.

2. AdS/CFT as the grand unified duality: a review of the dictionary from the emergence perspective. The finite temperature CFT miracle: the gravitational encoding of the great emergence theories of thermo and hydrodynamics.

3. Quantum matter at finite density: how the empirical revolution caused an intellectual crisis. The great mystery of high Tc superconductivity, the strange metals, and the pseudo gap regime. An introduction to the fermion sign problem.

4. AdS/CFT and finite density quantum matter: the remarkable Reissner-Nordstrom non-Fermi liquids. Generalizing BCS: Holographic superconductivity and the emergent Fermi-liquids as mean field instabilities. The central question: is this about large N pathology or general emergence principle?

Wednesday 24 October 2012

### Matter at a Finite Density: the Devious Fermion Signs

When dealing with strongly interacting fermion systems at a finite density, one encounters a non-probablistic structure that severs the connection with the powerful machinery of quantum field theory, resting in turn on statistical physics. This sign problem is conventionally viewed as a technicality spoiling the progress in the use of numerical methods.

However, forced by empirical circumstances the awareness has been growing in the condensed matter community that the signs might be 'the' funda-

# Professor Jan Zaanen

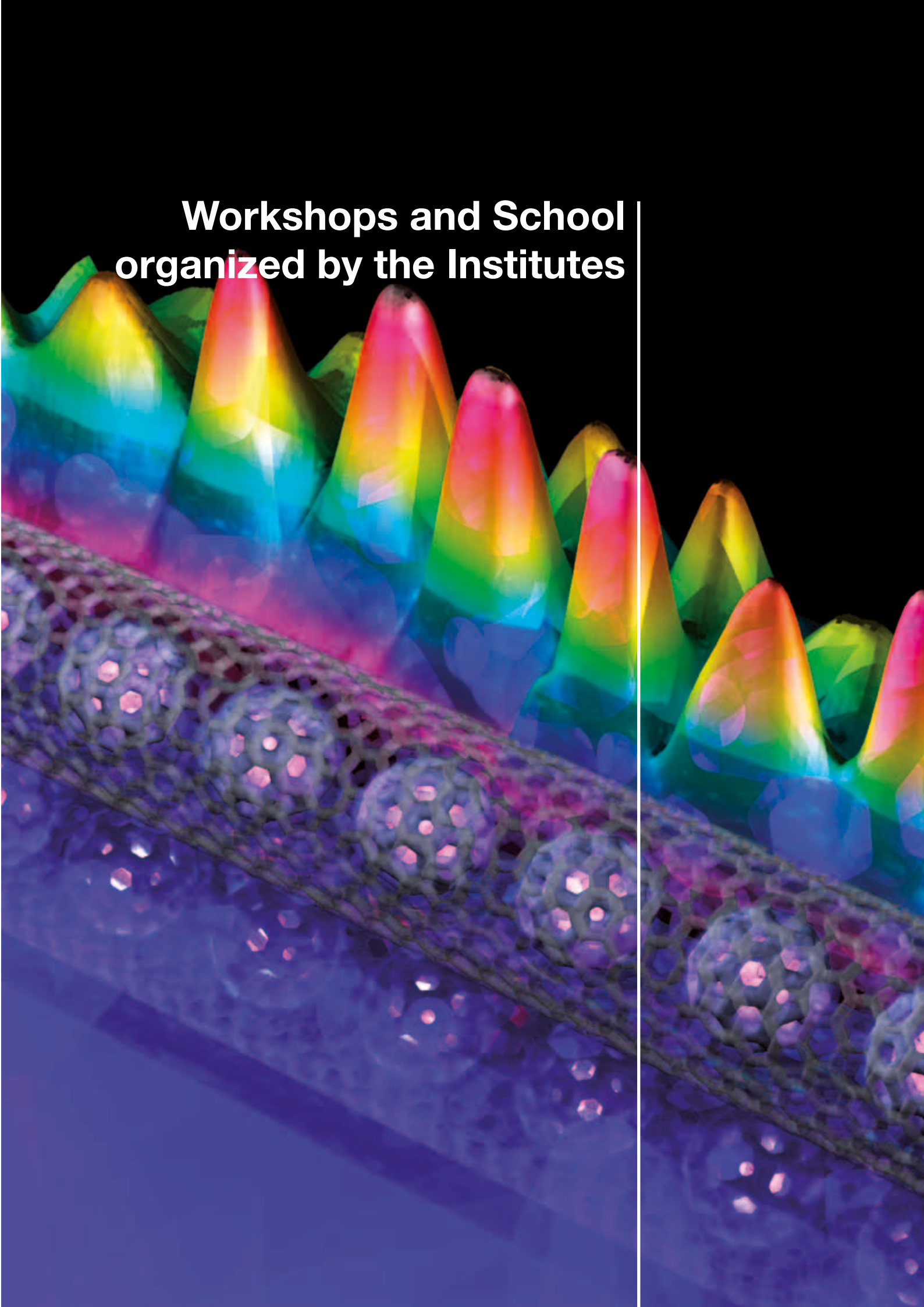

mental problem, obscuring our mathematical understanding of nature.

The bright side is that this opens up plenty of room for surprises in the form of new states of matter governed by 'signful' emergence principles. The AdS/CFT correspondence appears to be the first working 'sign processing' mathematical machine. Are the recently discovered holographic strange metals ruled by such new sign principles? As a training for the mind I will present two condensed matter stories that shed some light on the depth of the fermion sign mystery:

1. Geometrizing the signs with Ceperley's constrained path integral: the conformal state of Fermions and the fractal nodal surface.

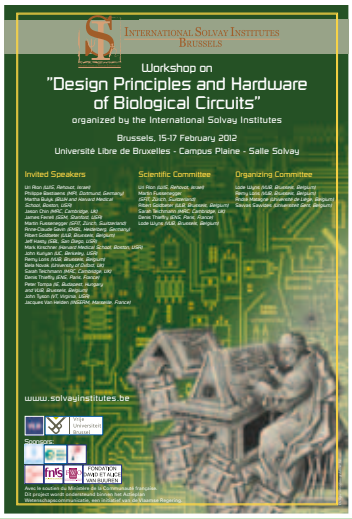
2. Mottness versus Weng statistics: the dynamical signs behind RVB superconductivity.

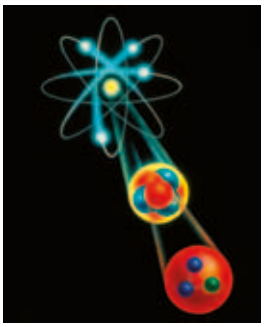
# Workshops and School organized by the Institutes

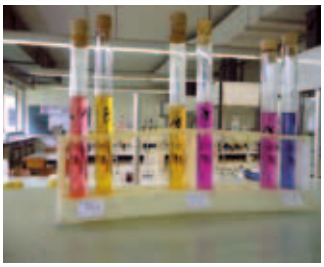


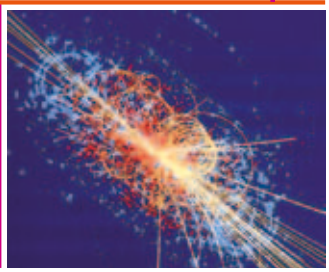
# Workshop on "Design Principles and Hardware of Biological Circuits"

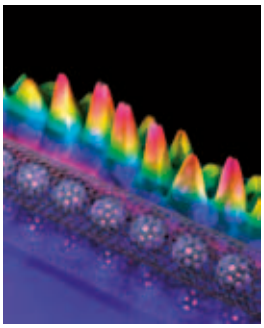
## 15 -17 February 2012









# Workshop on "Design Principles and Hardware of Biological Circuits"

In a living cell all macromolecular components form highly complex and interacting networks that operate under non-equilibrium conditions. Understanding how cells stay alive means understanding these molecular networks, and requires three levels of knowledge: (1) which macromolecules interact with each other, (2) what is the nature of the interaction and (3) what are the emerging properties.The first level encompasses the field of proteomics, which typically identifies direct physical interactions between two components, such as in a two hybrid screen. Other types of equally important but indirect interactions (e.g. different enzymes within a particular pathway) will require different tools to be detected. These approaches will also often be blind to the border conditions required for the interaction, e.g. co-localization, the presence of effector molecules. The second level of understanding is currently the area of classical biochemistry and biophysics. Here detailed information is obtained on interacting pairs of macromolecules: binding affinities, interaction mechanisms (allostery, conformational changes, cooperativity, ...).
Understanding emerging properties of networks requires the combination of experimental and theoretical approaches. Geneticists are used to interpret small networks of interactions in logical terms (if gene A is on, then gene B will be activated and protein C will ...). Even for relatively small networks, interpretation through intuition will however not suffice and a formal mathematical representation is required. Modeling of biological systems focuses on small systems for which precise parameters have to be estimated, on the basis of carefully designed experiments. However, with the advent of high-throughput biology, we are now facing huge amounts of data containing both valid information as well as significant amounts of noise that will need to be integrated into mathematical models and understood in terms of molecular mechanisms.

## Goals of the workshop

The workshop covered principles of protein function (including allostery), how they interact and communicate with each other and how they form interacting networks that regulate protein production and activities. The goals of this workshop were three-fold:

1. Bridge the gaps between experimental and theoretical biologists, as well as between high-throughput (e.g. transcriptome analysis, proteome-level interaction maps …) and model-specific approaches (e.g. detailed analysis of the Lac operon). To meet this goal, sessions were organized on a thematic rather than disciplinary basis, by inviting speakers who treat the same biological systems at different levels.

2. Address the complexity of biological systems. Complexity is too frequently mixed up with data volume. Instead, we emphasized the need to understand systems in terms of emerging properties: properties that result from a system as a whole, and cannot be explained by the sum of activities of its elements.

3. Stimulate inter-disciplinary debate, in order to identify the currents pitfalls, issues and challenges in network biology. To this purpose, speakers were invited to present not only success stories of their field, but also unanswered questions, knowledge gaps, and failures. A sufficient time was scheduled to organize interactive discussions between all participants in order to propose fresh avenues towards future solutions.

# "Design Principles and Hardware of Biological Circuits"

## Organizing Committee

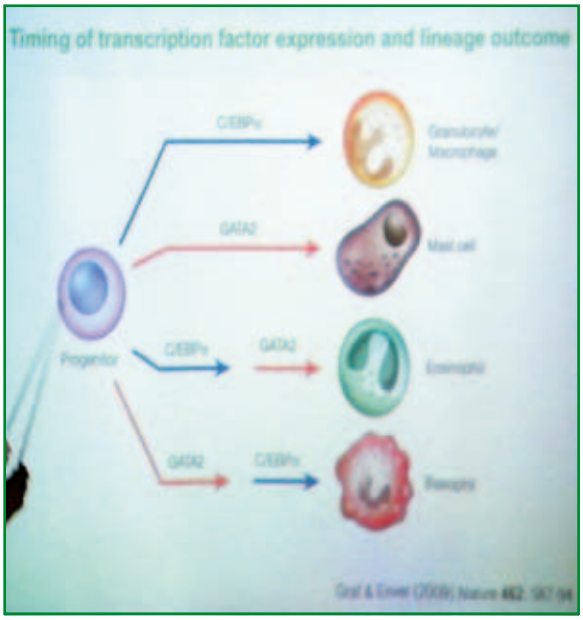
L. Wyns (VUB, Belgium)
R. Loris (VUB, Belgium))
S. Sawides (UGent, Belgium)

## Scientific Committee

U. Alon (WIS, Israel)
M. Fussenegger (SFIT, Switzerland)
A. Goldbeter (ULB, Belgium))
S. Teichmann (MRC, UK)
D. Thieffry (ENS, France)
L. Wyns (VUB, Belgium)

## Speakers

U. Alon (WIS, Israel)
P. Bastiaens (MPI, Germany)
M. Bulyk (BWH & Harvard, USA)
J. Chin (MRC, UK)
J. Ferrell (SSM, USA)
M. Fussenegger (SFIT, Switzerland)
A. Gavin (EMBL, Germany)
A. Goldbeter (ULB, Belgium)
J. Hasty (SBL, USA)
M. Kirschner (Harvard, USA)
J. Kuriyan (UC, USA)
R. Loris (VUB, Belgium)
B. Novak (Oxford, UK)
S. Teichmann (MRC, UK)
D. Thieffry (ENS, France)
P. Tompa (IE, Hungary & VUB, Belgium)
J. Tyson (VT, USA)
J. van Helden (Aix-Marseille Université, France)




## Program

*Wednesday 15 February 2012*

**Session 1: Hardware/Software Connection**

**Chair:** L. Wyns

Welcome by M. Henneaux, Director of the Solvay Institutes and Lode Wyns

| | |
|---|---|
| R. Loris | *Allostery and dynamics: toxin-antitoxin modules as model systems* |
| P. Tompa | *Promiscuity in protein-protein interactions by intrinsically disordered proteins* |
| J. Kuriyan | *Allosteric interactions in the control of protein kinases* |

**Session 2: Cell Cycle**

**Chair:** U. Alon

| | |
|---|---|
| A. Goldbeter | *Temporal self-organization of the Cdk network driving the mammalian cell cycle* |
| B. Novak | *System-level feedbacks in cell cycle control* |
| J. Tyson | *Control of cell growth, division and death* |

*Thursday 16 February 2012*

**Session 3: Network Motifs**

**Chair:** A. Goldbeter

| | |
|---|---|
| U. Alon | *Design principles of biological circuits* |
| J. Ferrell | *Dissecting the mitotic oscillator* |
| M. Kirschner | *Principles of growth control in mammalian cells* |

**Session 4: Synthetic Biology**

**Chair:** S. Teichmann

| | |
|---|---|
| M. Fussenegger | *Mammalian synthetic biology – from tools to therapies* |
| J. Chin | *Reprogramming the genetic code* |
| J. Hasty | *Sensing array of radically coupled genetic biopixels* |

*Friday 17 February 2012*

**Session 5: Relations between Network Structure and Function**

**Chair:** D. Thieffry

| | |
|---|---|
| M. Bulyk | *Transcription factors and DNA regulatory elements* |
| J. van Helden | *Deciphering genetic and epigenetic regulation in the era of massively parallel sequencing* |
| S. Teichmann | *A quantitative view of gene expression* |

**Session 6: Transcriptional Networks**

**Chair:** J. van Helden

| | |
|---|---|
| D. Thieffry | *Logical modeling of cell fate specification* |
| A. Gavin | *Biochemical approaches to bio-molecular networks* |

**Session 7: Spatial Context of Signaling Dynamics**

**Chair:** L. Wyns

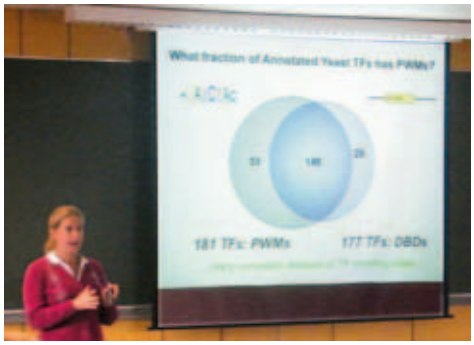
| | |
|---|---|
| P. Bastiaens | *Spatial organization of intracellular communication* |
| L.Wyns | *Concluding remarks* |

## Participants

| | |
|---|---|
| Ariane Bigre | ULB, Belgium |
| Yehudi Bloch | Ghent University, Belgium |
| Sabrina Bousbata | ULB, Belgium |
| Eric Bullinger | Université de Liège, Belgium |
| Maria de los Angeles Ceregido-Pérez | University of Granada, Spain |
| Samuel Chaffron | VUB, Belgium |
| Danny Charlier | VUB, Belgium |
| Benoît Charloteaux | Université de Liège, Belgium |
| Fen Chen | Cell Press, UK |
| Jean-Francois Collet | UCL, Belgium |
| Stefan Constantinescu | UCL, Belgium |
| Frederik Coppens | Ghent University, Belgium |
| Jan Danckaert | VUB, Belgium |
| Youssef Darzi | VUB, Belgium |
| Stefanie De Bodt | Ghent University, Belgium |
| Henri De Greve | VUB, Belgium |
| Dries De Maeyer | KUL, Belgium |
| Laurane De Mot | ULB, Belgium |
| Andrew Deonarine | Cambridge University, UK |
| Stijn Dhondt | Ghent University, Belgium |
| Geneviève Dupont | ULB, Belgium |
| Alexandra Dusa | IMEC, Belgium |
| Jonathan Elegheert | Ghent University, Belgium |
| Yves Engelborghs | KUL, Belgium |
| Karoline Faust | VUB, Belgium |
| Jan Felix | Ghent University, Belgium |
| Philippe Gabant | Delphi Genetics, Belgium |
| Moreno Galleni | Université de Liège, Belgium |
| Roberto Garcia | VUB, Belgium |
| Abel Garcia Pino | VUB, Belgium |
| Marc Garcia-Garcera | VUB, Belgium |
| Lendert Gelens | VUB, Belgium |
| Claude Gérard | ULB, Belgium |
| Didier Gonze | ULB, Belgium |
| Jayson Guttierez | Ghent University, Belgium |
| San Hadzi | University of Ljubljana, Slovenia |
| Maarten Hertog | KUL, Belgium |
| Valerie Hertveldt | ULB, Belgium |
| Fabien Heuze | Université de Liège, Belgium |
| Falk Hildebrand | VUB, Belgium |
| Lydia Hill | VUB, Belgium |
| Radu Huculeci | VUB, Belgium |
| Seyung Hyun | UCL, Belgium |
| Marceline Kaufman | ULB, Belgium |
| Jurij Lah | University of Ljubljana, Slovenia |

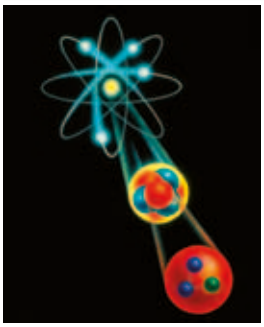
# "Design Principles and Hardware of Biological Circuits"

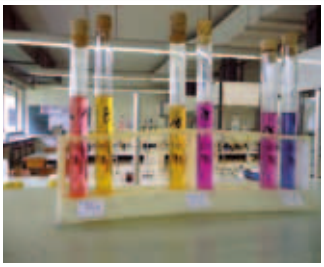
| | |
|---|---|
| Jean-Christophe Leloup | ULB, Belgium |
| Tom Lenaerts | ULB, Belgium |
| Luc Leyns | VUB, Belgium |
| Gipsita Lima-Mendez | VUB, Belgium |
| Steven Maere | Ghent University, Belgium |
| Giovanni Maglia | KUL, Belgium |
| Arnaud Marchant | ULB, Belgium |
| Joris Messens | VUB, Belgium |
| Kedar Moharana | Ghent University, Belgium |
| Michel Moutschen | Université de Liège, Belgium |
| Bernard Peers | Université de Liège, Belgium |
| Evely Peeters | VUB, Belgium |
| Jeroen Raes | VUB, Belgium |
| Han Remaut | VUB, Belgium |
| Yvan Saeys | Ghent University, Belgium |
| Bram Slabbinck | Ghent University, Belgium |
| Patrice Soumillion | UCL, Belgium |
| Yann Sterckx | VUB, Belgium |
| René Thomas | ULB, Belgium |
| Laurence Van Melderen | ULB, Belgium |
| Nico van Nuland | VUB, Belgium |
| Ruben Vandermeeren | Ghent University, Belgium |
| Alexandra Vandervelde | VUB, Belgium |
| Bjorn Vergauwen | Ghent University, Belgium |
| Vanessa Vermeirssen | Ghent University, Belgium |
| Wim Versées | VUB, Belgium |
| Kenneth Verstraete | Ghent University, Belgium |
| Sara Vieira-Silva | VUB, Belgium |
| Palakkad Vinod | Oxford University, UK |
| Krzysztof Wabnik | Ghent University, Belgium |
| Ronnie Willaert | VUB, Belgium |
| Alexandre Wohlkonig | VUB, Belgium |
| Catherine Yourassowsky | ULB, Belgium |
| Tongli Zhang | Oxford University, UK |

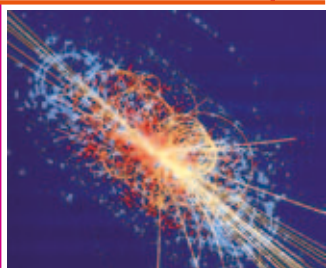


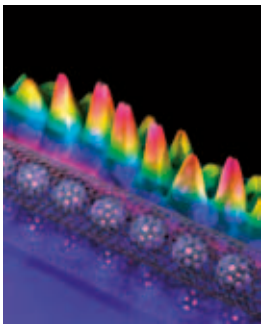

# Workshop on "Femto-, Astro-, Spectro-Ethyne (FASE)"

## 2 - 5 May 2012







# Workshop on "Femto-, Astro-, Spectro-Ethyne (FASE)"

The International Solvay Institutes organized a workshop devoted to a species exhibiting prototypical properties in chemical-physics, at the microscopic level of investigation: Ethyne, also named acetylene (C2H2). This topic was central to the activities of the “Laboratoire de chimie quantique et photophysique de l’ULB” which organized the workshop.

Ethyne, also named acetylene (C2H2), has attracted over the years and currently concentrates research efforts among a significant group of scientists investigating fundamental topics in chemical physics. The workshop addressed these topics, including rovibrational spectroscopy, intramolecular dynamics, excited electronic states, aggregates, reactivity, astrochemistry and astrophysics. The mechanisms around acetylene were put into perspective by dedicated speakers.

## National Organizing Committee

E. Biémont (UMH & Ulg, Belgium)
K. Didriche (ULB, Belgium)
P. Geerlings (VUB, Belgium)
M. Herman (ULB, Belgium)
I. Juif (Solvay Institutes, Belgium)
M. Lepère (FUNDP, Belgium)
J. Liévin (ULB, Belgium)
X. Urbain (UCL, Belgium)
J. Vander Auwera (ULB, Belgium)
I. Van Geet (Solvay Institutes, Belgium)

## International Scientific Committee

G. Di Lonardo (U. Bologna, Italy)
R.W. Field (MIT, Boston, USA)
E. Herbst (UVa, Charlottesville, USA)
M. Herman (ULB, Belgium)
D.S. Perry (UA, Akron, USA)
R.J. Saykally (Berkeley, USA)
J. Tennyson (UC, London, UK)
R. Thissen (UJF, Grenoble, Switzerland)
J.K.G. Watson (NRCC, Ottawa, Canada)

# "Femto-, Astro-, Spectro-Ethyne (FASE)"

## Speakers

P. Casavecchia (U. Perugia, Italy)
L.H. Coudert (U. Paris 12 and Paris 7, France)
F.F. Crim (UW, Madison, USA)
K. Didriche (ULB, Belgium)
G. Di Lonardo (U. Bologna, Italy)
M. Fárnik (Heyrovsky Inst., Prague, Czech Republic)
R.W. Field (MIT, Boston, USA)
J.-C. Guillemin (U. Rennes, France)
E. Herbst (UVa, Charlottesville, USA)
M. Herman (ULB, Belgium)
J.T. Hougen (NIST, Gaithersburg, USA)
M.E. Kellman (U.Oregon, Eugene, USA)
W. Klemperer (Harvard, USA)
C. Leforestier (U. Montpellier II, France)
K.K. Lehmann (UVa, Charlottesville, USA)
M. Lepère (FUNDP, Namur, Belgium)
J. Liévin (ULB, Belgium)
A.R.W. McKellar (NRCC, Ottawa, Canada)
A.J. Merer (UBC, Vancouver, Canada)
V.I. Perevalov (RAS, Tomsk, Russia)
D.S. Perry (UA, Akron, USA)
E.L. Sibert (UW, Madison, USA)
R. Signorell (U. British Columbia, Canada)
J. Tennyson (UC, London, UK)
R. Thissen (UJF, Grenoble, Switzerland)
E.F. van Dishoeck (U. Leiden, the Netherlands)
J.K.G. Watson (NRCC, Ottawa, Canada)

## Program

*Wednesday 2 May 2012*

**Session 1: Rovibrational Spectroscopy**

**Chair:** G. Di Lonardo

| | |
|---|---|
| M. Herman | *Acetylene* |
| V.I. Perevalov | *Calculation of the line intensities of linear molecules within the framework of the method of effective operators: application to the acetylene molecule* |
| M. Lepère | *High resolution spectroscopy: line profile and parameters of hydrocarbons* |

Welcome speech by Alexandre Sevrin (Deputy Director of the Solvay Institutes)

**Chair:** J. Vander Auwera

| | |
|---|---|
| J. Tennyson | *Calculated line lists for spectra of hot molecules* |
| K.K. Lehmann | *Spectroscopy and Dynamics in helium superfluid nanodroplets* |

*Thursday 3 May 2012*

**Session 2: Dynamics**

**Chair:** D. Bermejo

| | |
|---|---|
| R.W. Field | *The Road Toward $S_0$ Vinylidene* |
| D.S. Perry | *Systematic behaviors in the intramolecular dynamics of acetylene for vibrational excitations of 5,000 to 13,000 $cm^{-1}$* |

**Chair:** L. Fusina

| | |
|---|---|
| M.E. Kellman | *New vibrational motions in highly excited acetylene* |
| E. Sibert | *Insights into Vibrational Dynamics via Spectroscopic Hamiltonians* |

**Session 3: Astrochemistry and astrophysics**

**Chair:** B. Plez

| | |
|---|---|
| J-C. Guillemin | *Chemistry and photochemistry with ethynefor space sciences* |
| E. Herbst | *The Astrochemistry of Ethyne from cold to hot regions* |

**Chair:** N. Moazzen-Ahmadi

| | |
|---|---|
| E. van Dishoeck | *Observations of $C_2H_2$ and related molecules in hot cores and protoplanetary disks* |
| B. Klemperer | *Molecule formation in Molecular Clouds. Speculation on polymer growth in GMC* |

Dining poster session

*Friday 4 May 2012*

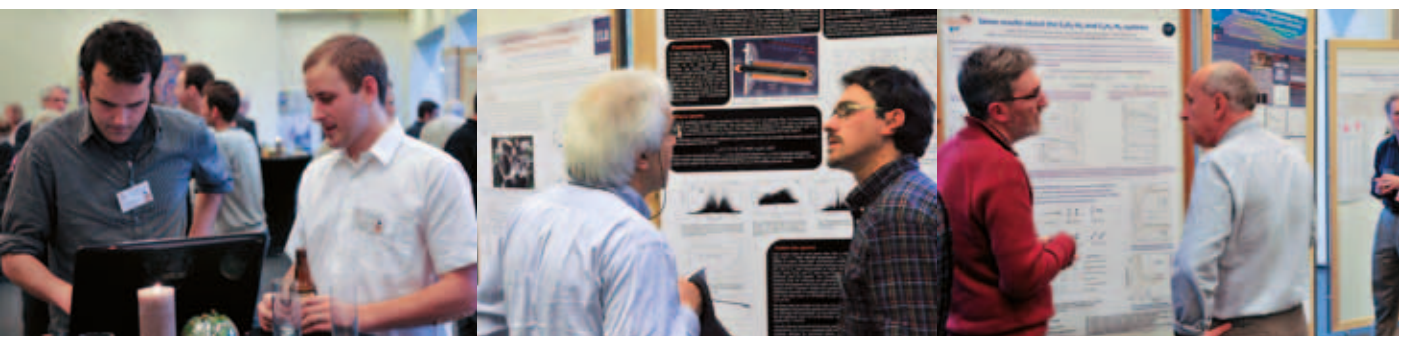
**Session 4: Reactivity**

**Chair:** X. Urbain

| | |
|---|---|
| P. Casavecchia | *Reaction dynamics of ethyne with atomic (C, N, O, S) and molecular (CN, $C_2$) radicals* |
| M. Fárník | *Photodissociation of acetylene in clusters* |

**Chair:** P. Cacciani

| | |
|---|---|
| R. Signorell | *Properties of pure and mixed solid acetylene particles from infrared spectra* |
| R. Thissen | *$C_2H_2$ on Titan, origin and fate* |



**Session 5: Aggregates**

**Chair:** R. Georges

| | |
|---|---|
| K. Didriche | *Experimental investigation of acetylene complexes in the overtone range* |
| L. Coudert | *The potential energy surface of Rg-acetylene complexes and related species as obtained from their high-resolution spectroscopic data* |

**Chair:** C. Lauzin

| | |
|---|---|
| C. Leforestier | *Effective potential energy surfaces for the acetylene dimer* |
| A.R.W. McKellar | *Spectroscopy of acetylene dimers and trimers* |

Banquet

*Saturday 5 May 2012*

**Session 6: Excited electronic states**

**Chair:** J.K.G. Watson

| | |
|---|---|
| A. Merer | *Cis-trans isomerization in the $S_1$ electronic state of acetylene revealed by anomalies in its vibrational structure* |
| J.T. Hougen | *The use of extended permutation-inversion groups in a unified symmetry treatment of trans-bent acetylene, cis-bent acetylene, and vinylidene* |

**Chair:** S. Rosenwaks

| | |
|---|---|
| J. Liévin | *Ab intio study of acetylene/vinylidene isomerization in Rydberg states* |
| F.F. Crim | *Isomerization and Conical Intersections: Beyond Acetylene and Beyond Isolated Molecules* |

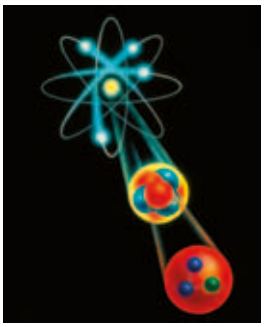
Final comments

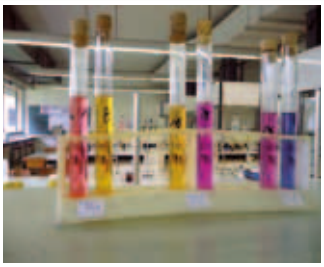
## Participants

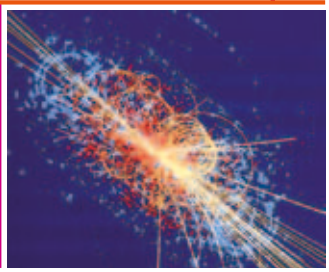
| | |
|---|---|
| Badr Amyya | Université de Rennes 1, France |
| Dionisio Bermejo | CSIC, Spain |
| Emile Biemont | Liège and Mons, Belgium |
| Severine Boye-Peronne | Université Paris-Sud, France |
| Patrice Cacciani | Université de Lille, France |
| Réginald Colin | Université de Lille, France |
| Jean Cosléou | Université de Lille, France |
| Xavier de Ghellinck | ULB, Belgium |
| Tomas Foldes | ULB, Belgium |
| Luciano Fusina | ULB, Belgium |
| Aline Gardez | ULB, Belgium |
| Pierre Gaspard | ULB, Belgium |
| Robert Georges | Université de Rennes 1, France |
| Dariusz Golebiowski | ULB, Belgium |
| Jean Jeener | ULB, Belgium |
| Clément Lauzin | ULB, Belgium |
| Christof Maul | TU Braunschweig, Germany |
| Georg Mellau | Justus-Liebig-University Giessen, Germany |
| Nasser Moazzen-Ahmadi | University of Calgary, Canada |
| Roman Motiyenko | Université de Lille, France |
| Bertrand Plez | Université Montpellier 2, France |
| Atina Rizopoulos | ULB, Belgium |
| Severine Robert | Belgian Institute for Space Aeronomy, Belgium |
| Salman Rosenwaks | Ben-Gurion University of the Negev, Israel |
| Brian Sutcliffe | ULB, Belgium |
| Filippo Tamassia | University of Bologna, Italy |
| Franck Thibault | Université de Rennes 1, France |
| Marcela Tudorie | ULB, Belgium |
| Xavier Urbain | Université catholique de Louvain, Belgium |
| Nathalie Vaeck | ULB, Belgium |
| Patrick Van Poucke | ULB, Belgium |
| Jean Vander Auwera | ULB, Belgium |
| Thomas Vanfleteren | ULB, Belgium |
| Mattia Villa | University of Bologna, Italy |
| Stephane Vranckxz | ULB, Belgium |

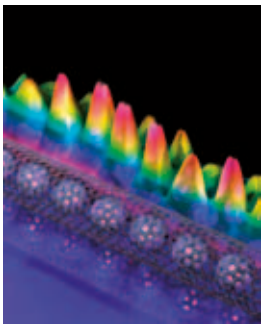
# Workshop on "Cosmological Frontiers in Fundamental Physics"

## 29 May - 1 June 2012







# Workshop on "Cosmological Frontiers in Fundamental Physics"

The workshop was part of a series organized jointly by the International Solvay Institutes, APC (Université Paris VII, Paris) and the Perimeter Institute (Waterloo, Canada). The series aimed to discuss, in an informal setting, recent developments at the interface of cosmology and fundamental physics. The previous edition was held at APC in June 2011. The main emphasis of the 2012 edition was on holographic/string cosmology and related topics.

## Scientific Committee

L. Boyle (PI, Waterloo, Canada)
B. Craps (VUB & Solvay Institutes, Brussels, Belgium)
T. Hertog (K.U.Leuven, Belgium)
G. Horowitz (UCSB, Santa Barbara, USA)
E. Kiritsis (APC, Paris & University of Crete, Greece)
D. Langlois (APC, Paris, France)
E. Silverstein (Stanford University, USA)
A. Strominger (Harvard, Cambridge, USA)

## Organizing Committee

B. Craps (VUB & Solvay Institutes, Brussels, Belgium)
M. Henneaux (ULB & Solvay Institutes, Brussels, Belgium)
T. Hertog (K.U.Leuven, Belgium)
I. Van Geet (Solvay Institutes, Brussels, Belgium)

## Speakers

D. Anninos (Stanford University, USA)
T. Banks (Rutgers University & UCSC, USA)
J. Barbon (IFT UAM/CSIC, Madrid, Spain)
R. Bousso (UC Berkeley, USA)
C. Deffayet (APC, Paris, France)
F. Denef (K.U.Leuven, Belgium)
B. Freivogel (UvA, Amsterdam, the Netherlands)
D. Green (IAS, Princeton, USA)
D. Harlow (Stanford University, USA)
J. Hartle (UCSB, Santa Barbara, USA)
T. Hartman (IAS, Princeton, USA)
D. Marolf (UCSB, Santa Barbara, USA)
S. Shenker (Stanford University, USA)
E. Silverstein (Stanford University, USA)
K. Skenderis (UvA, Amsterdam, the Netherlands)
A. Strominger (Harvard, Cambridge, USA)
L. Susskind (Stanford University, USA)
N. Turok (PI, Waterloo, Canada)
E. Verlinde (UvA, Amsterdam, the Netherlands)
M. Zaldarriaga (IAS, Princeton, USA)

## Program

*Tuesday 29 May 2012*

Welcome by Marc Henneaux, Director of the Solvay Institutes

| | |
|---|---|
| Stephen Shenker | *Aspects of Vectorlike Holography* |
| Daniel Green | *Detecting Particles during Inflation* |
| Dionysis Anninos | *A tale of two observers* |
| James Hartle | *From dS to AdS with the No-Boundary Quantum State* |
| Leonard Susskind (Colloquium) | *The Universe May Be Much Bigger Than You Think* |

*Wednesday 30 May 2012*

| | |
|---|---|
| Thomas Banks | *Holographic Space-time* |
| Daniel Harlow | *A Solveable Limit of Eternal Inflation* |
| José Barbon | *Modeling de Sitter-fast-scramblers* |
| Neil Turok | *Holographic Cosmology in the Stringy Regime* |
| Eva Silverstein | *Unitarity bounds and RG in uplifted gauge/gravity duality* |

*Thursday 31 May 2012*

| | |
|---|---|
| Matias Zaldarriaga | *Loop corrections to inflationary correlations* |
| Don Marolf | *The dS Optical Thm: implications for dS/CFT* |
| Raphael Bousso | *The Measure Problem in Eternal Inflation* |
| Leonard Susskind | *Fractal Flow, and the Dominant Eigenvector* |
| Andrew Strominger | *Progress in dS/CFT* |

*Banquet*

*Friday 1 June 2012*

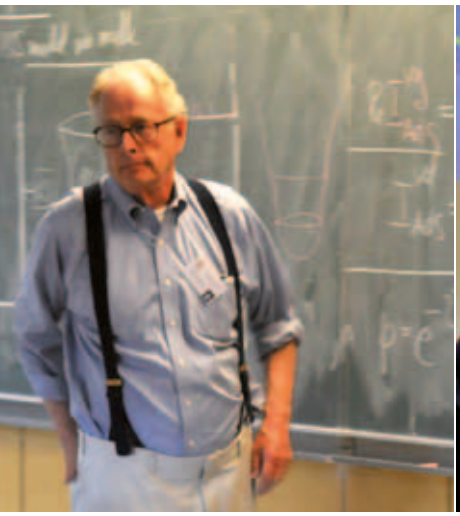
| | |
|---|---|
| Thomas Hartman | *de Sitter Holography with the Sp(N) Model* |
| Kostas Skenderis | *Holographic slow-roll inflation* |
| Ben Freivogel | *TBA* |
| Frederik Denef | *TBA* |
| Cédric Deffayet | *Some recent results about massive gravity* |

## Participants

| | |
|---|---|
| Riccardo Argurio | Université Libre de Bruxelles, Belgium |
| Valentin Assassi | University of Cambridge, UK |
| Glenn Barnich | Université Libre de Bruxelles, Belgium |
| Daniel Baumann | University of Cambridge, UK |
| Raphael Benichou | Vrije Universiteit Brussel, Belgium |
| Alice Bernamonti | Vrije Universiteit Brussel, Belgium |
| Benjamin Bollen | Ghent University, Belgium |
| Adam Brown | Princeton University, USA |
| Fabio Capela | Université Libre de Bruxelles, Belgium |
| Diego Chialva | Université de Mons, Belgium |
| Sebastien Clesse | University of Cambridge, UK |
| Cyril Closset | Weizmann Institute, Israel |
| Frederik Coomans | K.U.Leuven, Belgium |
| Sophie de Buyl | ULB, Belgium & Harvard University, USA |
| Vittoria Demozzi | K.U.Leuven, Belgium |
| Stephane Detournay | Harvard University, USA |
| Jean-Francois Dufaux | APC, Université Paris VII, France |
| François Englert | Université Libre de Bruxelles, Belgium |
| John Estes | K.U.Leuven, Belgium |
| Davide Forcella | Université Libre de Bruxelles, Belgium |
| Federico Galli | Vrije Universiteit Brussel, Belgium |
| Xian Gao | Université Paris Diderot - Paris 7, France |
| Stephen Hawking | University of Cambridge, UK |
| Sergio Hortner | Université Libre de Bruxelles, Belgium |
| Mark Jackson | APC, Université Paris VII, France |
| Bert Janssen | Universidad de Granada, Spain |
| Paul Koerber | K.U.Leuven, Belgium |
| Alexey Koshelev | Vrije Universiteit Brussel, Belgium |
| Manuel Krämer | University of Cologne, Germany |
| Darya Krym | K.U.Leuven, Belgium |
| Manuela Kulaxizi | Vrije Universiteit Brussel, Belgium |
| Pierre-Henry Lambert | Université Libre de Bruxelles, Belgium |
| Gustavo Lucena Gómez | Université Libre de Bruxelles, Belgium |

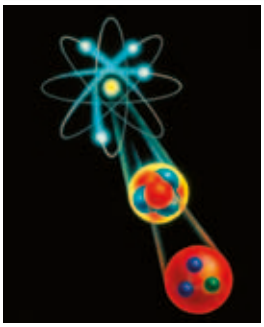
# "Cosmological Frontiers in Fundamental Physics"

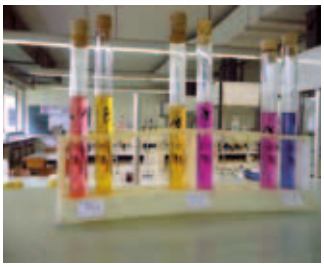
| | |
|---|---|
| Javier Martínez | Universidad Autónoma de Madrdi, Spain |
| Kentarou Mawatari | Vrije Universiteit Brussel, Belgium |
| Paul McFadden | Perimeter Institute, Waterloo, Canada |
| Laura Mersini-Houghton | University of North Carolina, USA |
| Shuntaro Mizuno | APC, Université Paris VII, France |
| Ian Morrison | University of Cambridge, UK |
| Micha Moskovic | Université Libre de Bruxelles, Belgium |
| Marcello Musso | K.U.Leuven, Belgium |
| Jakob Palmkvist | Université Libre de Bruxelles, Belgium |
| Laurence Perreault Levasseur | University of Cambridge, UK |
| Rakibur Rahman | Université Libre de Bruxelles, Belgium |
| Diego Redigolo | Université Libre de Bruxelles, Belgium |
| Massimiliano Rinaldi | FUNDP, Namur, Belgium |
| Diederik Roest | University of Groningen, the Netherlands |
| Antonin Rovai | Université Libre de Bruxelles, Belgium |
| Jeremy Sakstein | University of Cambridge, UK |
| Tiziana Scarna | Université Libre de Bruxelles, Belgium |
| Alexander Sevrin | Vrije Universiteit Brussel, Belgium |
| Dimitri Skliros | University of Nottingham, UK |
| Adam Solomon | Sidney Sussex College, University of Cambridge, UK |
| Philippe Spindel | Université de Mons, Belgium |
| Piotr Surowka | Vrije Universiteit Brussel, Belgium |
| Dirk Teerlinck | Ghent University, Belgium |
| Daniel Thompson | Vrije Universiteit Brussel, Belgium |
| Yuko Urakawa | University of Barcelona, Spain |
| Jan Willem van Holten | NIKHEF, the Netherlands |
| Bert Van Pol | K.U.Leuven, Belgium |
| Antoine Van Proeyen | K.U.Leuven, Belgium |
| Thomas Van Riet | IPhT, CEA-Saclay, France |
| Joris Vanhoof | Vrije Universiteit Brussel, Belgium |
| Erick Weinberg | Columbia University, USA |

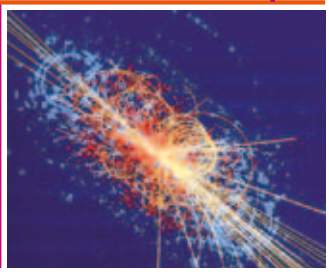


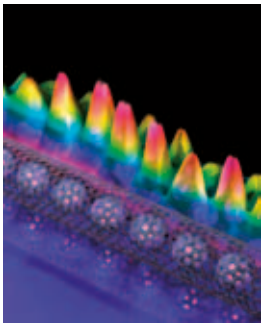
# Workshop on
# "The Quantum Quest: a Fascinating Journey"
# To Celebrate François Englert's 80th Birthday

## 5 - 7 November 2012







# Workshop on "The Quantum Quest: a Fascinating Journey"

## To Celebrate François Englert's 80th Birthday

On the occasion of the 80th birthday of François Englert, the International Solvay Institutes organized a scientific celebration of his work in the form of a workshop devoted to "The Quantum Quest: A fascinating Journey". More than 80 physicists from all over the world attended the event and gave lectures on topics investigated by François Englert during his career, showing the immense contribution that this exceptionally creative figure brought - and continues bringing! - to the development of physics. A special session was held in memory of Laurent Houart, collaborator of François who passed away much too early.

A banquet was given by the ULB, during which the Rector of the university greeted the participants.

François Englert is Honorary Member of the International Solvay Institutes.

## Scientific Committee

R. Argurio (ULB, Belgium)
L. Brink (Chalmers, Sweden)
J-M. Frère (ULB, Belgium)
M. Henneaux (ULB & Solvay Institutes, Belgium)
A. Kleinschmidt (Max-Planck-Institut, Germany)
H. Nicolai (Max-Planck-Institut, Germany)
P. Ramond (UF, USA)
A. Sevrin (VUB & Solvay Institutes, Belgium)
P. Spindel (UMons, Belgium)
M. Tytgat (ULB, Belgium)
A. Van Proeyen (K.U.Leuven, Belgium)

## Organizing Committee

R. Argurio (ULB, Belgium)
J-M. Frère (ULB, Belgium)
M. Henneaux (ULB & Solvay Institutes, Belgium)
A. Kleinschmidt (Max-Planck-Institut, Germany)
A. Sevrin (VUB & Solvay Institutes, Belgium)
P. Spindel (UMons, Belgium)
M. Tytgat (ULB, Belgium)
I. Van Geet (Solvay Institutes, Belgium)
A. Van Proeyen (K.U.Leuven, Belgium)

# "The Quantum Quest: a Fascinating Journey"

A special workshop was held on Monday afternoon:

**"Branes and Symmetries"** a Scientific Commemoration of Laurent Houart.

## Organizing Committee

R. Argurio (ULB, Belgium)
J-M. Frère (ULB, Belgium)
M. Henneaux (ULB & Solvay Institutes, Belgium)
A. Kleinschmidt (Max-Planck-Institut, Germany)
A. Sevrin (VUB & Solvay Institutes, Belgium)
P. Spindel (UMons, Belgium)
M. Tytgat (ULB, Belgium)
A. Van Proeyen (K.U.Leuven, Belgium)

## Speakers

C. Bunster (CECs, Chile)
F. Englert (ULB, Belgium)
A. Gomberoff (UAB, Chile)
Y. Lozano (UNIOVI, Spain)
A. Sagnotti (SNS, Italy)
K. Stelle (Imperial College, UK)







## Invited Participants

D. Amati (ICTP, Italy)
I. Antoniadis (CERN, Switzerland)
C. Bachas (LPTENS, France)
M. Bañados (U de Santiago, Chile)
A. Belavin (Landau Institute, Russia)
F. Bigazzi (Firenze U, Italy)
G. Bonelli (SISSA, Italy)
C. Bunster (CECs, Chile)
A. Casher (TAU, Israel)
M. Chaichian (HIP, Finland)
B. Clerbaux (ULB, Belgium)
P. Cook (King's College London, UK)
T. Curtright (UM, USA)
B. De Wit (ITP, the Netherlands)
N. Deruelle (IHES, France)
J. Edelstein (CECs, Chile)
D. Fairlie (Durham U, UK)
L. Fayard (Orsay U, France)
P. Fayet (LPTENS, France)
W. Fischler (Texas U, USA)
P. Freund (Chicago U, USA)
B. Gavela (UAM, Spain)
F. Gianotti (CERN, Switzerland)
N. Glover (Durham U, UK)
M. Green (Cambridge U, UK)
G. 't Hooft (Utrecht, the Netherlands)
D. Horn (TAU, Israel)
L. I-Fayard (Orsay U, France)
J. Iliopoulos (LPTENS, France)
J. Incandela (UCSB, USA)
J. Katz (HUJI, Israel)
C. Kounnas (LPTENS, France)
M. Krawczyk (Warsaw U, Poland)
C. Martinez (CECs, Chile)
V. Mukhanov (LMU, Germany)
J. Moreno (CSIC, Spain)
S. Nussinov (TAU, Israel)
J. Nuyts (UMons, Belgium)
J. Orloff (LPC, France)
R. Parentani (CNRS, France)
G. Parisi (Sapienza U, Italy)
M. Petrini (LRTHE, France)
T. Piran (HUJI, Israel)
S. Pokorski (Warsaw U, Poland)
S. Popescu (Bristol U, UK)
E. Rabinovici (HUJI, Israel)
M. Rooman (ULB, Belgium)
A. Sagnotti (SNS, Italy)
P. Sikivie (UF, USA)
K. Stelle (Imperial College, UK)
H. Stern (ULB, Belgium)
L. Susskind (Stanford U, USA)
A. Taormina (Durham U, UK)
C. Thorn (UF, USA)
G. Tonelli (CERN, Switzerland)
J. Tran Thanh Van (Orsay U, France)
R. Troncoso (CECs, Chile)
A. Tureanu (HIP, Finland)
P. West (King's College, UK)
P. Windey (LPTHE, France)
J. Zanelli (CECs, Chile)



## Program

### Monday 5 November 2012

| | |
|---|---|
| Jean Iliopoulos | *Gauge Theories and non-Commutative Geometry* |
| Stefan Pokorski | *The 125 GeV Scalar - End of a certain Story* |
| Aharon Casher | *Breakdown of Supersymmetry in Perturbative SuperYangMills* |
| Gerard 't Hooft | *Superstrings and Determinism* |

### Session in Memory of Laurent Houart

| | |
|---|---|
| François Englert & Claudio Bunster | *Introduction* |
| Augusto Sagnotti | *String Theory, Climbing Scalars and the CMB* |
| Yolanda Lozano | *Non-Singlet Baryons in Gauge/Gravity Duality* |
| Kelly Stelle | *Supergravity Infinities and Counterterm Structures* |
| Andres Gomberoff | *Phase Transitions in Lovelock Gravity* |

### Tuesday 6 November 2012

| | |
|---|---|
| Claudio Bunster | *General Relativity as an Already-Born-Infeld Theory* |
| Sandu Popescu | |
| Anne Taormina | *Mathieu 24 Moonshine* |
| Alexander Belavin | *On the Reason of AGT Correspondence and the New Use of Instantons* |
| Michael Green | *Supersymmetry, Duality and String Scattering Amplitudes* |
| Pierre Fayet | *U Bosons, Dark Photons and New Forces* |
| Ignatios Antoniadis | *Mass Hierarchies in String Theory and Electroweak Symmetry Breaking* |
| Bernard de Wit | *The Ultimate Vacuum* |
| Peter West | |
| Joseph Katz | *Dark Energy and Dark Matter* |

**Wednesday 7 November 2012**

**Special Session: Scalar Bosons - Present and Future at LHC**

| | |
|---|---|
| François Englert | *Introduction* |
| Fabiola Gianotti | *Current Status and Expectations (current LHC run - ATLAS)* |
| Joe Incandela | *Current Status and Expectations (current LHC run - CMS)* |

**Round table "What Next?"**

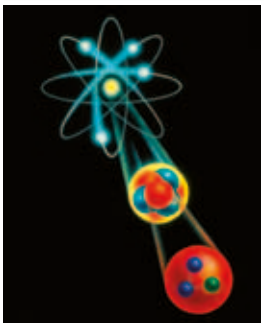
Introduced by Jean Orloff (*Theory outlook*), Guido Tonelli and Louis Fayard (*The Scalar Sector: How far can we reach with LHC*)

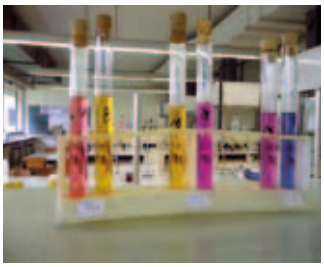
General discussion

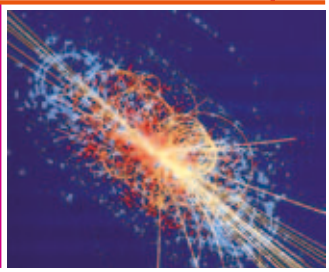
| | |
|---|---|
| Viatcheslav Mukhanov | *From Quantum Fluctuations to the Large Scale Structure of the Universe* |
| Tsvi Piran | |
| Gerard 't Hooft | *Closing Remarks* |

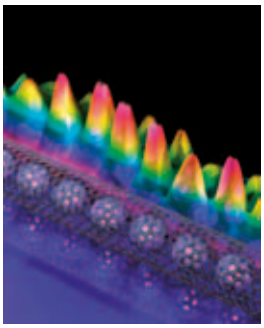
# Modave Summer School in Mathematical Physics

## 26 August - 1 September









# Modave Summer School in Mathematical Physics


## Foreword

The eighth edition of the Modave Summer School in Mathematical Physics took place from the 26th of August to the 1st of September 2012. This school is organized by enthusiastic PhD students from Belgian universities (ULB, VUB, KUL) for other young PhD students or post-docs from all around Europe. The main goal is to present introductory and pedagogical lectures on topics that are usually considered as known in recent papers, reviews or books. The informal setting and relaxed atmosphere of the school is meant to trigger discussions among the participants.


## Organizing Committee

Antonin Rovai (ULB, main organizer), Pierre-Henry Lambert (ULB), Frederik Coomans (KUL), Federico Galli (VUB), Gustavo Lucena Gómez (ULB), Micha Moskovic (ULB), Diego Redigolo (ULB), Bert Van Pol (KUL).

## Participants

| | |
|---|---|
| Antonin Rovai | (ULB) |
| Pierre-Henry Lambert | (ULB) |
| Diego Redigolo | (ULB) |
| Micha Moskovic | (ULB) |
| Gustavo Lucena Gómez | (ULB) |
| Frederik Coomans | (KUL) |
| Bert Van Pol | (KUL) |
| Lihui Liu | (École Polytechnique) |
| Dan Thompson | (VUB) |
| Rakibur Rahman | (ULB) |
| Alessandro Sfondrini | (ITF Utrecht) |
| Michael Warschawski | (Swansea University) |
| Hampus Linander | (Chalmers University) |
| Sergio Hortner | (ULB) |
| Laura Donnay | (ULB) |
| Joris Vanhoof | (VUB) |
| Mikhail Goykhman | (Lorentz Institute, Leiden) |
| Stepan Sidorov | (Joint Institute for Nuclear Research, Dubna) |
| Thomas Mertens | (Ghent University) |
| Michael Fleming | (King's College London) |
| Paul Dempster | (University of Liverpool) |
| Hamid Afshar | (Vienna University of Technology) |
| Benjamen Bollen | (Ghent University) |
| Maria-Ioanna Stylianidi Christodoulou | (University of Amsterdam) |
| Ali Zahabi | (University of Helsinki) |
| Kristof Moors | (KUL) |
| Ruben Monten | (KUL) |

# Modave Summer School in Mathematical Physics


## Lectures

### 1. Thermodynamics of string gas (Lihui Liu)

In these lectures, Lihui presented in detail some basic computations made in the field of string gases at finite temperature. He started to recall how typical computations in quantum theory at finite temperature were done by considering the analytic continuation to periodic Euclidean time of the path integral. He then applied this trick to string gases and computed the partition function of some simple models.

### 2. Higher Spin Theory (Gustavo Lucena Gómez and Rakibur Rahman)

In the first part of these lectures, Rakibur introduced the basics of higher spin theory. He started with some motivations and presented the interplay between higher spins and gauge symmetries. No-go theorems were then considered, as well as their loopholes.

In the second part, Gustavo discussed higher spin theory in three dimensions. He started to recall the driebein and Chern-Simons formulations of gravity in three dimensions. He then moved to the higher spin generalization of these formalisms before closing with some remarks on more advanced topics.

### 3. c- and a- theorems (Diego Redigolo and Micha Moskovic)

Diego started these lectures by introducing general ideas about the Renormalization Group (RG) flows between quantum field theories. He set up the Wilsonian picture and presented the Zamolodchikov proof for the c-theorem in two dimensions. Then Micha presented new approach to RG flow studies. He presented a revisited proof of the c-theorem in two-dimensions and then exposed the recent proof of the analog of the c-theorem in four dimensions, known as the a-theorem.

### 4. Introduction to universality and renormalization group techniques (Alessandro Sfondrini)

Alessandro introduced the notion of theory space, in which RG flows may be analyzed using the natural framework of dynamical systems. He discussed various possibilities for the asymptotic behaviors like fixed points and bifurcations of the flows. He then discussed the Wetterich's functional renormalization group equations, and worked out in details the case of the Wilson-Fisher fixed point.

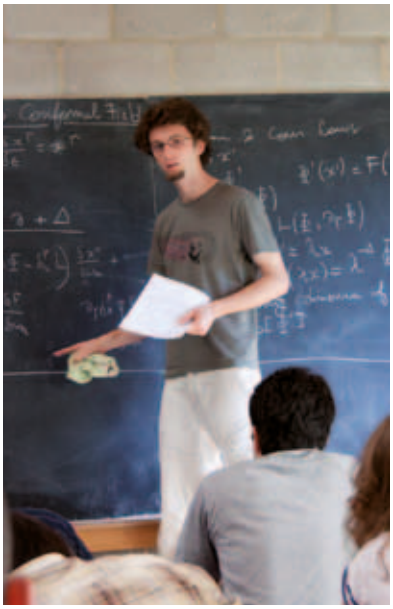
### 5. Duality Symmetric Approaches to String and M-theory (Dan Thompson)

Dan started his lectures with a review of T-duality at the level of the fundamental string mass spectrum, refreshing our minds with string quantisation basics. He also presented step-by-step how T-duality may be seen at the worldsheet level. Next, the notion of doubled space-time (Double Field Theory) was introduced and discussed. The lectures ended on a discussion of duality invariances in M-theory, working out for us a simple example with SL(5) as the T-duality group.

Website
http://www.ulb.ac.be/sciences/ptm/pmif/Rencontres/ModaveVIII/index.html

### 6. Introduction to Conformal Field Theories (Antonin Rovai)

For these lectures, it was decided to keep a very introductory level so that everybody could follow without difficulty. This was particularly important as other lectures were actually relying on basics of conformal field theories. A recall of the fundamental relation between symmetries and conservation laws was presented. Then basic definitions and consequences of conformal invariance were thus discussed in various dimensions. Specializing to two dimensions, consequences of the Ward identities on the holomorphicity properties of the energy-momentum tensor were derived. To end with, the trace anomaly formula was discussed.




Gong show!
Ariana
Gong show!
DETROIT
LOW
FILATON

# The International Doctoral School

# The International Doctoral School

## 8 - 26 October 2012

This school on "Quantum Field Theory, Strings and Gravity" was organized for the sixth consecutive year in the fall of 2012 by the International Solvay Institutes and the Service de Physique Théorique et Mathématique at U.L.B., the Theoretical Particle Physics group at V.U.B, the Laboratoire de Physique Théorique at École Normale Supérieure in Paris and the Institute for Theoretical Physics in Amsterdam. Each of the organizing sites (Brussels, Paris and Amsterdam) welcomed the students for intense three-week sessions separated by one-week breaks.

The participants were all beginning graduate students, from the organizing nodes and also from various other institutions in France, the Netherlands and Belgium. All the students followed more than 250 hours of lectures organized in various courses. The main goals were to strengthen their training in quantum field theory and string theory and to introduce them to cutting-edge research problems in the field. In Brussels, Prof. Adel Bilal and Alberto Lerda taught the Advanced Quantum Field Theory (30 h) and Introduction to String Theory (24 h) courses respectively, carrying on their much appreciated contribution to the school. Prof. Nathalie Deruelle, from the Astro Particule Cosmologie laboratory in Paris VII University, was in charge of lectures on General Relativity, Cosmology and Black holes (24 h). Finally, Prof. Jan Zaanen, holder of the Jacques Solvay Chair in Physics, presented a series of lectures on the application of holographic techniques in string theory to the condensed matter theory of strongly interacting fermions, which has led to important breakthroughs in this field in recent years.

This programme is unique in Europe. It provides a great opportunity for the students to be introduced, at an unusually early stage in their training, to the “Big Picture” of a highly technical field that covers large areas of Physics and Mathematics. The possibility to meet leading experts in an informal setting and to share research interests and insights with fellow graduate students from other countries, which may become long-term collaborators after their PhD study, is also a great asset of the School.

In Brussels, the School greatly benefits from the assistance of the International Solvay Institutes, both through financial and organizational supports.

The School has now reached maturity, with an excellent organization, thoroughly chosen topics and a smooth transition between the trainings offered at the different nodes. All the participants seem extremely enthusiastic about this programme and we are looking forward to welcoming the students next year.

Frank Ferrari,
Professor ULB

**Opinion of a student** (Laura DONNAY, ULB)

Participating to this doctoral school was a rewarding experience. In my opinion, the aim of this school, which is to allow students to complete their formation in the very beginning of their PhD, is completely fulfilled. Some courses of the first part of the school such as Advanced Quantum Field Theory or Introduction to Supersymmetry had some overlaps with our Master's studies, which helped us to refresh our memory before starting the most advanced topics. It also gave the opportunity for students who had never had these courses to start on firm ground. The more time passed, the more advanced were the lectures: for instance, those on Supergravity and AdS/CFT were completely new for me. Fortunately, lecturers managed to give us a good insight of theses stimulating topics; for a deep understanding, an additional work after classes was sometimes required.

Globally speaking, the teaching quality was very good: lecturers were always open to discussion and answering questions. I have especially appreciated Alberto Lerda's lectures on String Theory, which were extremely clear and pedagogical (and I think a lot of students share this opinion).

During the school, we could also train ourselves thanks to exercise sessions organized by the lecturers, which were really useful for a better understanding of the technical features. Moreover, it seems to me that the fact that the school is organized in collaboration with different institutes broadened our mind since we were confronted with different points of view, different ways to teach and different research areas as well.

Beyond theses aspects, this school gave me the opportunity to meet PhD students coming from all around Europe. I was glad to share with them this experience and to learn about their thesis project; there is no doubt that we will meet again and probably work together in the future.

## The Brussels Organizing Committee

Riccardo Argurio (ULB)
Ben Craps (VUB)
Frank Ferrari (ULB)

## Participating Institutions

Institute for theoretical physics, Universiteit van Amsterdam, the Netherlands

Laboratoire de physique théorique, Ecole Normale Supérieure (Paris), France

Physique théorique et mathématique, ULB / Theoretical particle physics, VUB, Brussels, Belgium

## Program Brussels 2012

*String Theory*
Alberto Lerda (Universitá del Piemonte Orientale, Alessandria, Italy)

*Advanced Quantum Field Theory*
Adel Bilal (ENS, Paris, France)

*General Relativity, Cosmology and Black Holes*
Nathalie Deruelle (AstroParticule Cosmologie, Paris VII, France)

*Holography and Quantum Matter: String Theory Answers to Condensed Matter Questions*
Jan Zaanen (Leiden University, the Netherlands)

### Program Paris

5 - 23 November 2012

*Introduction to supersymmetry*
Ulrich Ellwanger (Paris 11)

*Seiberg-Witten theory*
Nikita Nekrasov (IHES Paris and Simon Center Stony Brook)

*Introduction to supergravity*
Antoine van Proeyen (Leuven)

*Non-perturbative string theory*
Costas Bachas (ENS Paris)

*Beyond the standard model*
Emilian Dudas (Ecole Polytechnique)

### Program Amsterdam

3 - 21 December 2012

*Introduction to AdS/CFT*
Kyriakos Papadodimas

*Quantum Field Theory in Curved Space Time*
Borun Chowdhury

*Chern-Simons theory and knot invariants*
Satoshi Nawata

*Applications of AdS/CFT* - JHL

*Dualities in String Theory* - Niels Obers

## Participants

| | |
|---|---|
| Nicolas Babinet | ENS, Paris, France |
| Tresa Bautista | University of Amsterdam, the Netherlands |
| Adolfo Cisterna | Pontificia Universidad Católica de Chile, Chile |
| Gabriele Conti | K.U.Leuven, Belgium |
| Laura Donnay | Université Libre de Bruxelles, Belgium |
| Harold Erbin | UPMC, Paris, France |
| Marco Fazzi | Université Libre de Bruxelles, Belgium |
| Lucien Heurtier | CPHT, Paris, France |
| Yunfeng Jiang | Ecole Normale Supérieure, Paris, France |
| Jules Lamers | Utrecht University, Utrecht, the Netherlands |
| Laetitia Leduc | Sorbonne Université, Paris, France |
| Wenliang Li | Université Paris 7, France |
| Hampus Linander | Chalmers University of Technology, Sweden |
| Pujian Mao | Université Libre de Bruxelles, Belgium |
| Javier Matulich | CECs, Chile |
| Tom Mertens | University of Antwerp, Belgium |
| Balázs Meszéna | University of Leiden, the Netherlands |
| Ruben Monten | K.U.Leuven, Belgium |
| Blagoje Oblak | Université Libre de Bruxelles, Belgium |
| Valentin Reys | Nikhef, the Netherlands |
| Matteo Rosso | Eidgenössische Technische Hochschule (ETH), Zürich, Switzerland |
| Marco Scalisi | University of Groningen, the Netherlands |
| Ellenvan der Woerd | K.U.Leuven, Belgium |
| Valentin Verschinin | CPHT, Paris, France |

# Colloquia


Solvay Colloquium
Professor Conny Aerts
Hasselt University, Belgium
University of Leuven, Belgium
Radboud University Nijmegen, the Netherlands
Probing Stellar Physics and Testing Stellar Evolution through Asteroseismology
Abstract: After a brief general introduction in the research area of asteroseismology, we illustrate how the CoRoT and Kepler space missions currently revolutionise our view on stellar interiors. The immense advantage of having long-term uninterrupted data from space with two orders of magnitude better precision compared to data from ground-based telescopes implies good progress in the probing of stellar physics. We discuss case studies for which gravity-mode oscillations were detected in addition to acoustic modes and show how this allowed tuning of the near-core regions in various types of stars. The transition from asteroseismology of single stars to the one of large ensembles of stars is also discussed. We end by highlighting future prospects based on the continuing data gathering by ongoing space missions complemented by ground-based data.
Tuesday 4 December 2012 at 4.00 P.M.
COFFEE AND TEA WILL BE SERVED AT 3.45 P.M. IN FRONT OF THE SOLVAY ROOM
SOLVAY ROOM
UNIVERSITÉ LIBRE DE BRUXELLES
CAMPUS PLAINE - BUILDING N.O. - 5TH FLOOR
BOULEVARD DU TRIOMPHE - ACCESS 2
1050 BRUSSELS
ULB
belgacom
Vrije Universiteit Brussel

# Neutrino Physics: What is Next?

**Professor Alexei SMIRNOV**
*ICTP, Trieste, Italy & INR, Moscow, Russia*

6 March 2012


Abstract

During the last decade enormous progress in neutrino physics and astrophysics was related to the discoveries of neutrino oscillations and flavor conversion in matter. These discoveries allowed to partially reconstruct the neutrino mixing pattern and mass spectrum. I will present three stories about three recent developments which will drive further advances in the field:

1. **Huge impact of the smal lest mixing** - about the determination of the 1-3 mixing and its implications for theory and phenomenology;

2. **Searches for sterile in ice** - about motivations for existence and searches for new neutrino states, sterile neutrinos;

3. **Behind neutrino mass** - about some attempts to uncover the nature and origins of the neutrino masses.

# Ultra-cold molecules for ultra-cool chemistry

**Professor Tim SOFTLEY**
*University of Oxford, UK*

20 March 2012

Abstract

Modern techniques of physics have enabled the production of samples of gas-phase atoms and molecules at temperatures very close to absolute zero (from milliKelvins down to nanoKelvins). These samples can only exist in the gas-phase at such temperatures because the density is very low. This work has led to the award of two sets of Nobel prizes in Physics in 1997 for laser cooling and 2001 for Bose Einstein Condensation. But what does this mean for Chemistry and what new opportunities does it provide to understand and control the outcome of chemical processes? Why should there be any chemistry at all at such low temperatures given that reactions generally have activation energy barriers? The sub-Kelvin temperature range is not a natural one - there is no place in the universe where the temperature is so low and we enter a mysterious world where the wave nature of matter is expected to dominate over its particle- like behaviour. Under conditions of the lowest temperatures gas-phase matter can develop condensed phase properties while still at very low densities. What implications does all this have for the way that chemical processes occur? Will this have any impact in the 'real world'? Many of these questions remain open and to be explored. In this lecture I shall review some of the latest developments in this rapidly moving field and describe our own experiments in which we study reaction of ionic species under conditions where we can observe reactions of single trapped occurring at very low temperatures using fluorescence microscopy.

# Hybrid Interfaces between Organic Layers and Transparent Conducting Oxides

**Professor Jean-Luc BREDAS**
*Georgia Institute of Technology, Atlanta, USA*

17 April 2012

Abstract

This seminar will address the nature of the electronic structure at the interface between (inorganic) electrodes, in particular transparent conducting oxide (TCO) electrodes, and organic overlayers. These interfaces play a critical role in determining the efficiency of electron injection or collection in a variety of organic electronic devices, including organic light-emitting diodes (OLEDs), organic field-effect transistors (OFETs), and organic photovoltaic (OPV) cells.

# From Ultracold Fermi Gases to Neutron Stars

**Professor Christophe SALOMON**
*ENS, Paris, France*

24 April 2012

Abstract

The year 2011 witnessed the hundredth anniversary of the discovery by Kammerlingh Onnes of electron superconductivity in a mercury wire cooled to a temperature of about 4 kelvins. This discovery was the first observation of a modification of macroscopic properties of a system induced by collective quantum effects. With the discovery of superfluid liquid helium, it opened the way to a very active research domain and to a great variety of applications. In this vast family of quantum solids or fluids, ultracold gases and polaritons are the last born. Thanks to the great flexibility of laser cooling and trapping methods, ultracold gases offer to study these quantum correlated systems with a new twist. It is possible for instance to tune the strength and sign of the interaction between atoms. Optical lattices, realized by interfering laser beams, create periodic optical potentials that mimic the crystalline potential seen by electrons in solids. Controlled disorder can be introduced to study the localization of matter-waves predicted by P.W. Anderson more than 50 years ago. Dilute atomic gases can thus be considered as model systems to address some pending problem in many-body physics that occur in condensed matter systems, nuclear physics, and astrophysics.
In this talk, we will describe the seemingly simplest case of attractive spin 1/2 fermions with tunable interaction. We will show that the gas properties can continuously change from those of weakly interacting Cooper pairs described by Bardeen-Cooper-Schrieffer theory to those of strongly bound molecules undergoing Bose-Einstein condensation. A new imaging method enable us to probe with high precision the thermodynamics of locally homogeneous ultracold gases and to perform stringent tests of recent many-body theories. The equation of state of fermions has been measured as a function of interaction strength and temperature. Despite orders of magnitude difference in density and temperature, our equation of state can be used to describe low density neutron matter such as the outer shell of neutron stars.

# Laser Light Can Crystallize Amino Acids and Proteins in Solution

**Professor Hiroshi MASUHARA**
*National Chiao Tung University, Taiwan*

8 May 2012

Abstract

Laser has been contributing to the developments of various fields of science and technology since its invention in 1960 and one of its outstanding outcomes is to provide new concepts and methodologies for the next generation in science and technology. Indeed laser is very useful to explore novel light-induced phenomena, to analyze their dynamics and mechanism, and to develop new fabrication methods. Utilizing lasers and microscopes, we have devoted our efforts to advance molecular nanoscience and nanotechnology; (a) nano spectroscopy and photochemistry, (b) nano trapping and manipulation, and (c) nano ablation. Recently we have succeeded in demonstrating laser-induced crystallization and crystal growth of molecules in solution, which is reported and discussed in this Colloquium: (1) Crystallization and micro-seeding by femtosecond pulsed laser irradiation. Femtosecond laser excitation of aqueous solutions leads to its ablation at the focal point, inducing local microbubble formation, shockwave propagation, and convection flow. This laser bubbling phenomenon achieves crystallization of various molecules and proteins from their supersaturated solutions. Femtosecond laser ablation of single crystals in saturated solution forms their daughter crystals. The growth process was directly monitored for urea, while application to micro-seeding is developed for protein. (2) Crystallization by local heating due to steady state laser irradiation. Irradiation of gold thin film in saturated amino acid solution results in bubbling on which surface a dense liquid droplet was formed and followed by single crystal formation. (3) Crystallization and crystal polymorph control by laser trapping. Laser trapping of amino acid clusters at the air/solution interface evolves to its crystallization. Always one single crystal is prepared in a spatio-temporally controlled manner, and its crystal polymorph can be controlled by laser polarization and power. Upon irradiation at the glass/solution interface, a mm-sized dense liquid droplet is formed. This liquid-liquid phase transition is a precursory process before crystallization.

# The Universe May Be Much Bigger Than You Think

**Professor Leonard SUSSKIND**
*Stanford University, USA*

29 May 2012

Abstract

I will explain how cosmology and string theory are conspiring to push us to a very radical view of the universe - a view in which gigantic numbers like ten-to-the-ten-to-ten-to-the-ten years, and even exponentially bigger distances are becoming common subjects of discussion. According to this viewpoint our tiny corner of the universe may represent an extraordinarily rare fluctuation in which the local laws of physics allow our own existence.

# The Black Hole in a Grain of Copper Rust and other Surprises in the Quantum Matter Universe

**Professor Jan ZAANEN**
*Lorentz Institute for Theoretical Physics, Leiden University, Leiden, the Netherlands*

2 October 2012

Abstract

The matter that we observe with our human senses is a completely understood affair. However, there is much more to it. Perhaps the most outlandish form of matter is associated with black holes. As objects made out of the fabric of space and time, these behave as material bodies emitting radiation through quantum processes: this is the discovery that made Stephen Hawking famous.
In a quite different area of physics, the experimental study of systems composed of an infinity of highly quantum mechanical, strongly interacting particles as realized in earthly laboratories has leaped forward in recent years. These systems need also extreme conditions: they are formed at very low temperatures from either electrons in special solids or atoms trapped by laser fields. But surprisingly similar stuff is also formed at very high temperatures, in the elementary particle fire balls created at particle accelerators.

The 'quantum matter' that is found under these circumstances is called 'quantum' because the weirdness of quantum physics has dramatic imprints on its behavior on the macroscopic scale. Although much is known experimentally, the theorists got increasingly lost in the course of time: quantum matter is littered with mysteries, the most famous example being the superconductivity occurring at unreasonably high temperatures in copper oxides.
But very recently help arrived from an unexpected side, in the form of the awesome mathematical machinery developed by string theorists in order to understand quantum gravity. This approach yields some deep insights in the quantum matter mysteries, in a setting that is mind boggling. According to string theory, the quantum matter as realized in the laboratories could be like a kind of hologram, encoding indirectly (and quite unanticipatedly!) the Hawking-like quantum physics of a zoo of new types of black holes living in a higher dimensional universe.

# Bacterial Infections: The Art of Holding On

## Professor Viola VOGEL

*Laboratory of Applied Mechanobiology, Department of Health Sciences and Technology, ETH Zürich, Switzerland*

16 October 2012

Abstract

Learning how to better interfere with the adhesion and invasion of bacteria into host tissues is crucial, particularly in light of the sharply rising occurences of antibiotic resistencies. While much is known about the biochemistry by which bacteria recognize their hosts, little insights exist on how such interactions are modulated by mechanical forces. A variety of bacterial and cellular adhesion molecules have evolved superadhesins that get activated when tensile forces pull on them. Such catch bonds allow E. coli to hold on to surfaces even when they are rinsed by body fluids and subsequently cause urinary tract infections. Also S. aureus exploits a nanoscale trick to distinguish between the tension on fibers in tissues versus wound sites.
The mechanical strain of extracellular matrix has never been considered before in the description of bacterial adhesion and host invasion cycles. Deciphering how proteins can serve as mechano-chemical signalling switches is thus not only essential to learn how bacteria and cells probe and respond to their environments, but it has also far reaching implications for developing new strategies to treat infectious diseases.

# Soft Robotics

**Professor George M. WHITESIDES**
*Department of Chemistry and Chemical Biology, Harvard University, Cambridge MA, USA*

22 October 2012


Abstract

Robotics is a field with broad interest: it combines mechanical engineering, information science, and animal physiology with manufacturing, workforce development, economics, and other areas. The most highly developed classes of robots have been build based on conceptual models provided by the body-plans of animals with skeletons (humans, horses), and have made it possible to carry out tasks that humans and animals could not (for a variety of reasons). We are interested in robots based on a different, simpler class of organisms (invertebrates: starfish, worms, octopi).

Because these organisms, and the robots having designs stimulated by them, have no skeletons, they provide enormous opportunities in materials and polymer science, rather than primarily in mechanical engineering. This seminar will outline one approach to soft robots, and suggest problems and opportunities in this new field.

For leading references, see: *Camouflage and Display for Soft Machines,* Morin, S.A., Shepherd, R.F., Kwok, S. W., Stokes, A.A., Nemiroski, A. and Whitesides, G.M., Science, 2012, 337, 828-832.

# Georges Lemaître

## Life and Scientific Works of the Big Bang's father

**Professor Dominique LAMBERT**
*FUNDP, Namur, Belgium*

25 October 2012

Abstract

The aim of the talk is to give a concise survey of the main scientific contributions of Georges Lemaître with a special emphasis on the history of his "Primeval Atom Hypothesis" which paves the way for Big Bang cosmology. We will shed also some light on his less-known contributions: computing science, spinor theory, regularization of three-bodies problem,... Proceeding chronologically, the talk will be illustrated with documents coming from the personal archives of Georges Lemaître.

# Probing Stellar Physics and Testing Stellar Evolution through Asteroseismology

**Professor Conny AERTS**
*Hasselt University, Belgium, University of Leuven, Belgium, Radboud University, Nijmegen, the Netherlands*

4 December 2012

Abstract

After a brief general introduction in the research area of asteroseismology, we illustrate how the CoRoT and Kepler space missions currently revolutionise our view on stellar interiors. The immense advantage of having long-term uninterrupted data from space with two orders of magnitude better precision compared to data from ground-based telescopes implies good progress in the probing of stellar physics. We discuss case studies for which gravity-mode oscillations were detected in addition to acoustic modes and show how this allowed tuning of the near-core regions in various types of stars. The transition from asteroseismology of single stars to the one of large ensembles of stars is also discussed. We end by highlighting future prospects based on the continuing data gathering by ongoing space missions complemented by ground-based data.

# Workshops sponsored by the Institutes

© Cern

## Workshop on "Quantum Mechanics of Fundamental Systems VIII"


**Co-organized with the Centro de Estudios Científicos (Valdivia, Chile)**

**12 – 18 January 2012**

In 2004, the Centro de Estudios Científicos (CECs) in Valdivia (Chile) and the International Solvay Institutes signed a scientific cooperation agreement. In that context, the two institutions jointly organized in January of 2012 the meeting "Quantum Mechanics of Fundamental Systems VIII".
This was the 8th edition of a series of international conferences on theoretical physics initiated by CECs in the 80s.
The meeting took place in Valdivia and brought scientists from all over the world. Distinguished lecturers included Professors Bachas (Paris), Brink (Göteborg), Hull (Cambridge), Julia (Paris), Mukhanov (Munich), Oz (Tel-Aviv), Ramond (Gainesville), Shifman (Minneapolis), Theisen (Potsdam) as well as researchers from Valdivia and Brussels.

## General Scientific Meeting 2012

**A conference organized by the Belgian Physical Society and the Vrije Universiteit Brussel**

**30 May 2012**

### Organizing Committee

- Freya Blekman (VUB)
- Ben Craps (VUB)
- Jan Danckaert (VUB)
- Catherine De Clercq (VUB)
- Gilles de Lentdecker (President BPS, ULB)
- Jorgen d'Hondt (VUB)
- Alexander Sevrin (VUB)

### Plenary Lectures

"Supernovae and the Accelerating Universe: the 2011 Nobel Prize in Physics"
Ariel Goobar
(University of Stockholm)

"MYRRHA: building a high power proton accelerator driven system for nuclear research and technology applications"
Paul Schuurmans
(SCK-CEN, R&D Scientific advisor of the MYRRHA project)

### Parallel sessions Topics

- Condensed Matter and Nanophysics
- Biophysics and Medical Physics
- Nuclear and Particle Physics
- Atoms, Molecules and Optics
- Astro-, Geo- and Plasma physics
- Physics and Education
- Statistical and Mathematical Physics

## Oscillations, Thresholds and Bistability in Cellular Regulatory Networks

### A symposium in the honor of Albert Goldbeter

### 27 – 29 September 2012

The symposium "Oscillations, Thresholds and Bistability in Cellular Regulatory Networks" took place on the 27-29th of September 2012 at the University Foundation (Brussels), and was organized by G. Dupont, J.-C. Leloup and D. Gonze (Unit of Theoretical Chronobiology, ULB), T. Erneux (Theoretical Nonlinear Optics, ULB) and E. Bullinger (Systems and Modeling, ULg).

The aim of this meeting was to gather world experts in the field of systems biology and focus on modelling approaches of dynamical behaviours observed at the cellular level in which oscillations, thresholds or bistability play a primary role. Besides the scientific interest, the organisers of the symposium also wished to celebrate Albert Goldbeter ("Prix Quinquennal du FNRS 2006-2010") on the occasion of his official retirement. There were 60 participants originating from 11 different countries.

The scientific program was divided into several sessions and more than 20 talks were given. For most themes, there were two conferences, one from an experimentalist and one from a modeller.

The topics that were covered during this symposium are:

- Cell cycle
- Chemical and Biochemical oscillations
- Circadian clocks
- Non-circadian cellular rhythms
- Thresholds, oscillations and bistability in signalling cascades
- Segmentation clock
- Signalling in Dictyostelium amoeba
- Temporal disorder in physiological systems

## International Colloquium Henri Poincaré

### November 2012 (Paris)

Henri Poincaré, exceptional mathematician and physicist, is one of the dominating figures of the first Solvay Conference on Physics.

It was therefore very natural that the Institutes were associated with the scientific celebrations held in Paris to commemorate his memory on the occasion of the hundredth anniversary of his death (1912).

# Science Day

# Science Day

## 25 November 2012

Every year the Research Ministry of the Flemish Community organizes a science week for secondary school pupils culminating in a one day science festival. Offered by the Flemish Universities and related scientific institutions, it adresses a broad public, including young adolescents.

So on 25 November 2012 the Vrije Universiteit Brussel invited the scientifically minded people to such an event in a particularly suited venue, one of the spheres of the Brussels Atomium. The Solvay Institutes contributed with three activities.

One was meant for youngsters with enough geometric imagination and dexterity in their fingers: constructing with the "Zometool" system a geometrical model of a buckyball; it represents the regular C60 molecule of Carbon, the first molecule to be found with the same symmetry group as a regular dodecahedron.

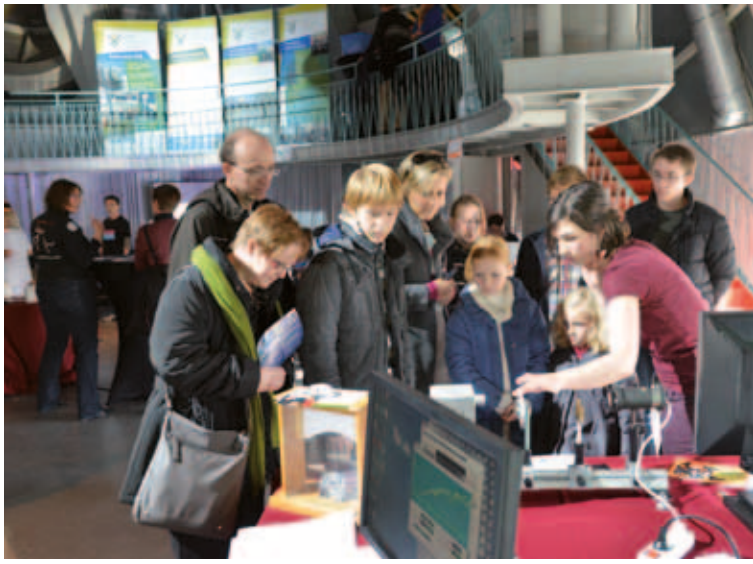
The other two went deeper into physics.

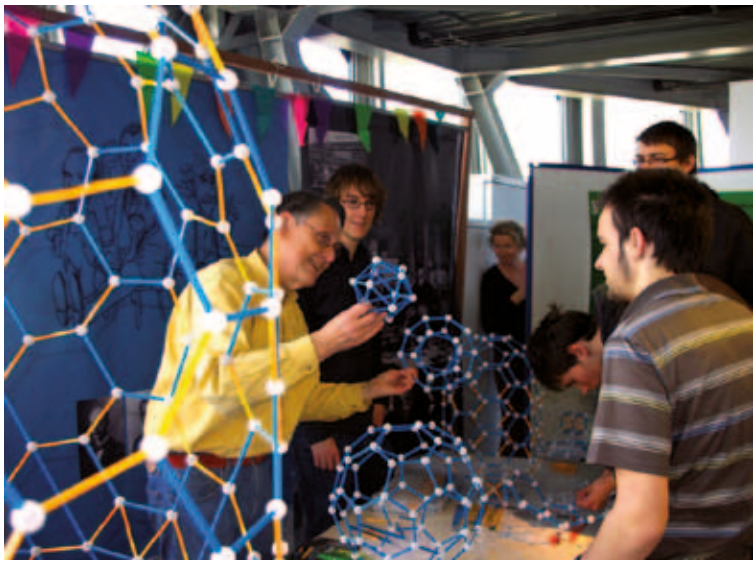
One was related to the photoelectric effect: when light falls on a metal, then under suitable circumstances an electric current is produced (this effect is used in photoelectric cells). The visitors could observe the existence of a limit frequency for the effect: if the frequency of the light is to small, no current is produced. This limit frequency was explained by Albert Einstein in 1905, giving at the same time a confirmation of the quantum hypothesis of Max Planck (both where active participants of the first Solvay conference in physics in 1911). Using different materials one could also observe that this limit frequency depends on the material used in the experiment.

The other activity estimated the surface temperature of a star. For this the spectrum of a star – in the first place our sun – was downloaded from an internet data bank. The intensity of the light depends on its frequency. For a star it is fairly comparable to that of a "black body". Max Planck had calculated this dependency in function of the temperature ( it is for this calculation that he introduced the quanta of light). The apparatus made it possible to adjust the temperature of the black body to the spectrum of the star, measuring in this way its surface temperature.

The three activities were very successful with the first one getting the most enthusiastic public.

# Science Day





# Seminars

The list below gives the joint inter-university weekly seminars co-organized by the International Solvay Institutes and the research groups in theoretical and mathematical physics of the ULB, the VUB, the KUL and the UMons-Hainaut. It also gives the group seminars of the research team of the Director.

*Constraining theories with higher spin symmetry*
Juan Maldacena (IAS)
January 17, 2012.

*Equidistribution of zeros of holomorphic sections of high tensor powers of line bundles*
George Marinescu
(Universität zu Köln)
January 20, 2012.

*Black hole instabilities and local Penrose inequalities*
Harvey Reall (Cambridge)
February 1, 2012.

*AdS black holes in supergravity*
David Chow (ULB)
February 1, 2012.

*Anisotropic Lattice Gauge Theories with Extra Dimensions*
Stam Nicolis (LMPT, Univ.Tours)
February 15, 2012.

*Transverse invariant Lagrangians for higher spins*
Andrea Campoleoni (MPI Golm)
February 15, 2012.

*Borcherds algebras from superspace*
Jesper Greitz (Nordita)
February 21, 2012.

*Holography of the tachyon*
Andrei Parnachev (Leiden)
February 22, 2012.

*Higher-Spin Interactions: on four-point functions and beyond*
Massimo Taronna (Pisa)
February 22, 2012.

*Instantons and 2d Coset CFT*
Alexander Belavin
(Landau Institute for Theoretical Physics)
February 24, 2012.

*Conical spaces in higher spin gravity*
Joris Raeymaekers
(ASCR, Czech Republic)
February 29, 2012.

*Dynamical Completions of Generalized O'Raifeartaigh Models*
Lorenzo Di Pietro (ETH Zurich)
February 29, 2012.

*RR Photons*
Fernando Marchesano
(Madrid, IFT)
March 7, 2012.

*Anomalous Transport form Kubo Formulas*
Karl Landsteiner (Madrid, IFT)
March 7, 2012.

# Seminars

*Three-sphere partition function, counterterms and supergravity*
Cyril Closset (Weizmann Inst.)
March 14, 2012.

*Unitarity Constraints in Holography and Field theory*
Manuela Kulaxizi (ULB)
March 14, 2012.

*Holographic thermalization of entanglement entropy, mutual and tripartite information in 2d CFTs*
Federico Galli (VUB)
March 21, 2012.

*The Resurgent Bootstrap and the 3D Ising Model*
Sheer El-Showk (Saclay, Paris)
March 21, 2012.

*Gauged supergravity and Borcherds algebras*
Jakob Palmkvist (ULB)
March 28, 2012.

*Holographic Wilson loops and topological insulators*
Andy O'Bannon (Cambridge)
March 28, 2012.

*Banishing AdS ghosts with a UV cutoff*
Tomás Andrade
(UCSB, Santa Barbara)
April 18, 2012.

*On the perturbative structure of scattering amplitudes of massless particles and the space of interacting theories*
Paolo Benincasa
(Santiago de Compostela)
April 18, 2012.

*Kähler-Einstein metrics emerging from free fermions and statistical mechanics*
Robert Berman
April 24, 2012.

*Regularized action for higher spin gravity in 3D: black holes, global charges and thermodynamics*
Alfredo Perez (Valdivia)
April 24, 2012.

*Non-standard Higgs decays and LHC signatures from low scale supersymmetry breaking*
Christoffer Petersson
(IFT, Madrid)
April 25, 2012.

*Gravity duals of supersymmetric gauge theories on curved manifolds*
James Sparks
(Oxford University)
April 25, 2012.

*Emergent Space Model Building and the Example of Ads_5XS^5*
Frank Ferrari (ULB)
May 2, 2012.

*Non-linear Realizations, Goldstone bosons of broken Lorentz rotations and effective actions for p-branes*
Joaquim Gomis (Barcelona)
May 2, 2012.

*Uplifting AdS/CFT to cosmology*
Gonzalo Torroba (Stanford)
May 7, 2012.

*Higher Spins, Strings and Holography*
Massimo Bianchi (Rome)
May 9, 2012.

Ruben Minasian
(Saclay, Paris)
May 9, 2012.

*Scaling BPS solutions and pure-Higgs states*
Dieter Van den Bleeken
May 16, 2012.

*Lovelock theory, black holes and holography*
José Edelstein
(Santiago de Compostela)
May 16, 2012.

*Tree level of theories of massless particles from an S-matrix perspective*
Eduardo Conde
(Universidade de Santiago de Compostela)
May 16, 2012.

*Some Applications of Gauge Strings Duality*
Carlos Núñez (Swansea)
May 23, 2012.

*OPE convergence in Conformal Field Theories*
Slava Rychkov
(ENS, Paris)
May 23, 2012.

*Making predictions in the multiverse*
Ben Freivogel (UvA)
May 24 and 25, 2012.

*Superconformal field theories in 6D with non-abelian tensor-Yang-Mills couplings*
Ergin Sezgin (Texas A&M)
June 6, 2012.

*Quantum Geometry*
Jan Ambjørn
(NBI, Copenhagen)
June 6, 2012.

*Cubic interactions of higher spins in (A)dS*
Euihun Joung (Pisa SNS)
June 21, 2012.

*Anti-brane singularities as an indication of instabilities*
Thomas Van Riet
(Saclay and K.U.Leuven)
October 3, 2012.

*Massive higher-derivative gravity: beyond spin-2 and beyond 3D*
Yihao Yin
(University of Groningen)
October 3, 2012.

*Non-Abelian T-duality in type--II Supergravity*
Kostas Sfetsos (Surrey)
October 10, 2012.

# Seminars

*Strange Metals in One Spatial Dimension*
Kareljan Schoutens (UvA)
October 10, 2012.

*Hilbert Series and Supersymmetric Gauge Theories*
Rak-Kyeong Seong
(Imperial College London)
October 17, 2012.

*Matter at a Finite Density: the Devious Fermion Signs*
Jan Zaanen (Leiden)
October 24, 2012.

*Higher spin black hole entropy in 3D*
Ricardo Troncoso (CECs Chile)
October 31, 2012.

*New SCFTs From Wrapped Branes*
Brian Wecht (Queen Mary)
October 31, 2012.

*The back-reaction of anti-branes in warped fluxes compactification*
Stanislav Kuperstein
(Perimeter Institute)
November 14, 2012.

*Gauged N=4 supergravity from Calabi Yau threefolds*
Hagen Triendl (Saclay)
November 14, 2012.

*Dark radiation in the LARGE volume scenario*
Joe Conlon (Oxford)
November 21, 2012.

*On the applicability of linearized gravity in the description of homogeneous processes of holographic thermalization*
Michal Heller
(University of Amsterdam)
November 21, 2012.

*Supersymmetry on Curved Spaces and Holography*
Claudius Klare (Milan)
November 28, 2012.

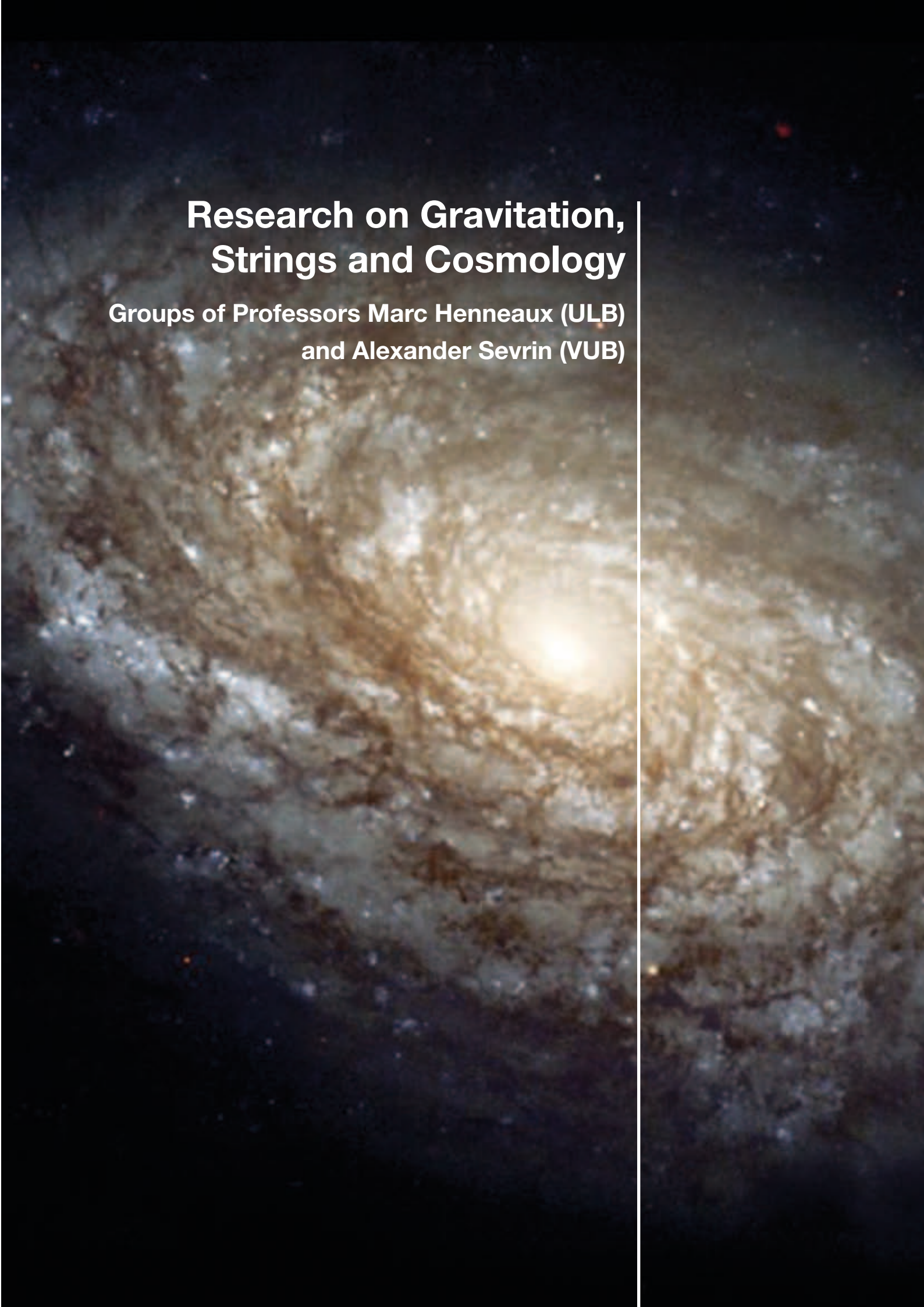
*Partition functions of N=4 Yang-Mills and applications*
Jan Manschot (Bonn)
November 28, 2012.

*Brane instantons and fluxes in F-theory*
Luca Martucci (Munich)
December 5, 2012.

*An infalling observer in AdS/CFT*
Kyriakos Papadodimas
(Groningen)
December 5, 2012.

*Universal features of the Quark-gluon Plasma and 5D Holography*
Umut Gursoy (Utrecht)
December 12, 2012.

*Diffeomorphism Invariance and Non-relativistic Holography*
Andreas Karch
(University of Washington)
December 12, 2012.



# Research on Gravitation, Strings and Cosmology

Groups of Professors Marc Henneaux (ULB)
and Alexander Sevrin (VUB)

## Researchers

### Permanent Members

Riccardo Argurio (ULB)
Glenn Barnich (ULB)
Andrès Collinucci (ULB)
Geoffrey Compère (ULB)
Ben Craps (VUB)
Frank Ferrari (ULB)
Marc Henneaux (ULB)
Thomas Hertog (KUL)
Axel Kleinschmidt (Max-Planck-Institute, Potsdam)
Alexander Sevrin (VUB)

### Postdoctoral Members

Raphael Benichou (VUB)
Andrea Campoleoni (ULB)
David Chow (ULB)
Eduardo Conde Pena (ULB)
Neil Copland (VUB)
Ignacio Cortese Mombelli (ULB)
Priscila de Aquino (VUB)
Sophie De Buyl (ULB)
Davide Forcella (ULB)
Phillip Grajek (VUB)
Semyon Klevtsov (ULB)
Alexey Koshelev (VUB)
Manuela Kulaxizi (ULB)
Laura Lopez Honorez (VUB)
Alberto Mariotti (VUB)
Kentarou Mawatari (VUB)
Daniele Musso (ULB)
Jakob Palmkvist (ULB)
Christoffer Petersson (ULB)
Rakibur Rahman (ULB)
Waldemar Schulgin (ULB)
Piotr Surowka (VUB)
Anastasios Taliotis (VUB)
Daniel Thompson (VUB)

### Doctoral Students

Alice Bernamonti (VUB)
Karen De Causemaecker (VUB)
Laura Donnay (ULB)
Marco Fazzi (ULB)
Federico Galli (VUB)
Sergio Hörtner (ULB)
Pierre-Henry Lambert (ULB)
Gustavo Lucena Gómez (ULB)
Pujian Mao (ULB)
Javier Matulich (ULB)
Micha Moskovic (ULB)
Blagoje Oblak (ULB)
Bettina Oexl (VUB)
Diego Redigolo (ULB)
Antonin Rovai (ULB)
Dimitri Terryn (VUB)
Joris Vanhoof (VUB)

### Master Students

Laure-Anne Douxchamps (ULB)
Amaury Leonard (ULB)

## Research Summary

Of all the fundamental forces (electromagnetism, gravitation, weak and strong nuclear forces), gravity remains the most mysterious. In spite of its remarkable successes, Einstein's general theory of relativity, which has led to an unprecedented geometrization of physics, is an unfinished revolution. Fully unravelling the mysteries of the gravitational force is a long-term research goal.

The group has a long-standing interest and a demonstrated expertise in quantum gravity, quantum field theory, string theory and M-theory, black holes, cosmology, the cosmological constant problem ("dark energy") and the novel mathematical structures underlying these questions. These challenging areas raise many of the most profound issues in theoretical physics.

A central thread in the study of gravity and the fundamental interactions is the concept of symmetry (global and local). Some of the general background is given below.

## General Framework

The standard model of particle physics is based on quantum field theory, a framework that reconciles Poincaré invariance with quantum mechanics and allows one to understand the electromagnetic and the two types of nuclear interactions. The fourth fundamental interaction, gravitation, is described by Einstein's theory of general relativity. Experiments as well as theoretical arguments indicate that neither the standard model, nor general relativity can be complete.

Purely theoretical attempts at generalizations are constrained, of course, by mathematical consistency and the need to incorporate the previous theories in the domains where they have been successful. Additional guiding principles are needed, though. Symmetry is such a principle and pervades most of the research carried out in theoretical high energy physics.

The Yang-Mills type theories for the three microscopic forces of elementary particle physics are invariant under Poincaré symmetries, the symmetry group of flat space-time.

These theories admit in addition certain internal symmetries known as gauge symmetries. In general relativity, gravitation arises when going from a flat to a curved spacetime, and Poincaré symmetries become part of the gauge group of diffeomorphisms.

In models that go beyond the existing theories, other symmetries come to the front.

### (i) Supersymmetry

Supersymmetry is a natural extension of Poincaré symmetry in the presence of fermionic matter fields. Supersymmetric extensions of the standard model will be tested at the experiments planned in the Large Hadron Collider at CERN in Geneva.

Supersymmetry is also an important ingredient of string theory, a model for unification of the four fundamental interactions and for a microscopic formulation of gravity. At low energy, higher dimensional theories of gravitation emerge that include supersymmetry as part of their gauge group together with supersymmetric extensions of Yang-Mills gauge theories.

## Research Summary

### (ii) Dualities

One of the first theoretical extensions of Maxwell's theory of electromagnetism has been the inclusion of magnetic sources. The introduction of such sources is motivated by the desire to preserve invariance under duality rotations, a symmetry of the source-free equations. The solution that is dual to the Coulomb solution describing a static point-particle electron is a magnetic monopole. In some sense, black hole solutions in gravitational theories are the analog of the Coulomb solution to Maxwell's theory.

In nonlinear theories like Yang-Mills theories, dualities relate a strongly coupled regime to one at weak coupling, where standard perturbative computations may be performed. In supersymmetric situations, these dualities become tractable. Finally, dualities between different string theories as well as holographic duality between gauge and gravity theories feature prominently in most of the recent developments in string theory.

### (iii) Hidden symmetries

Hidden symmetries in gravity and string theory arise in compactifications of supergravity theories and among the string duality groups. The algebraic structure of these symmetries isrelated to infinite-dimensional Lorentzian Kac-Moody algebras, in particular those of $E_{10}$ and $E_{11}$.

## Research carried out in 2012

We have continued our research along the general directions outlined above. This has led to 65 published papers and preprints submitted for publication. These are listed on pages 148-151. Specific achievements by some researchers from the group are also described in the subsequent pages.

As in previous years, the group has benefited from the support of the Solvay family, which is gratefully acknowledged. This support was precious to cover international collaborations, grants to researchers and the organization of the Solvay workshops in theoretical physics.

The year 2012 has seen the launch of the Marina Solvay Postdoctoral Fellowship. The first holder is Dr. Waldemar Schulgin. His research work is covered on pages 127-129.

# Marina Solvay Postdoctoral Fellowship

Thanks to a special gift of Mrs. Marina Solvay, the "Marina Solvay Postdoctoral Fellowship" was created in 2012. The fellowship enables a brilliant young researcher to pursue his career as a post-doctoral fellow in the group of "physique théorique et mathématique" of the ULB.

Dr. Waldemar Schulgin is the first holder of the Marina Solvay Postdoctoral Fellowship (2012-2014). He obtained his PhD degree in 2007 from the Ludwig Maximilian University in Munich (Germany). After a postdoctoral stay at the Ecole Normale Supérieure in Paris (France) from September 2007 through August 2009, he held a second postdoctoral position in the "Mitchell Institute for Fundamental Physics and Astronomy" (Texas A&M University, USA) from September 2009 through August 2012. He joined the ULB group in September 2012.

## Scientific Report

### Dr. Waldemar Schulgin

In 2012 I worked mainly on the following two topics: Kerr/CFT correspondence and Integrability in N=4 Super Yang-Mills Theory.

### Kerr/CFT correspondence

Dualities appear to play a crucial role in our understanding of physical theories. One of such dualities, the AdS/CFT correspondence, which was conjectured by Maldacena in 1997, played a major role in the recent development of theoretical physics.

It maps into each other two seemingly unrelated theories. One is a theory in five dimensions, which includes gravitational interactions, and the other one is a theory in one dimension less with no gravitational interactions. AdS/CFT correspondence states that even though the physical content of both theories is different, their particular observables are related to each other. This means that in some cases we can find a solution of one theory by finding the solution of the other one.

The Kerr/CFT correspondence was conjectured by Guica, Hartman, Song and Strominger in 2008. Its construction has some similarities to the AdS/CFT correspondence, namely relating two theories, one with gravitational interactions and the other one without. In the original construction by Guica et al., the gravitational theory lives in four dimensions and the dual one in two. Later, higher dimensional analogs of this duality were also constructed.

What are these theories that are supposed to have a relation? In the first case, one is considering matter fields, like scalars, fermions, vectors, etc. in the vicinity of the event horizon of a Kerr black hole. A Kerr solution is a solution of general relativity which describes the form of the space time as a result of the presence of a rotating black hole. Black holes observed in nature are expected to be exactly of this type, making the complicated Kerr solution more than just a pure abstraction. An example of the presence of matter fields would be an infalling electromagnetic wave into the black hole. As observed by Strominger and his collaborators, the absorption probability of the wave is related to particular observables of a completely independent two-dimensional theory with conformal symmetry, the so-called two-point correlation functions.

The spectrum of excitations and the interactions of the dual two-dimensional conformal theory is not known. Still, one can relate particular observables on both sides of the duality in a very neat way. Such pairs of observables, among others, are the entropy of the black hole versus the entropy of the conformal field theory, and as mentioned before, the absorption probability versus two-point functions of the dual CFT.

Together with Melanie Becker (Texas A&M University), I was interested in additional tests of this duality with the goal of obtaining a clear dictionary similar to the one of AdS/CFT correspondence. One way to test this duality is to assume an analogous dictionary to AdS/CFT and compute, for example, known observables on the side of the conformal field theory using only the information of the theory in the Kerr background. We did such computation in the case of the two-point functions for the fermionic fields and found the same result as expected by the duality. Even if such computations look very similar to the ones executed in AdS/CFT, such duality tests give additional insights into the differences and also subtitles which are not present in the standard AdS/CFT dictionary.

## Intergrability in N=4 Super Yang-Mills theory

As mentioned before, AdS/CFT opened an approach of solving particular physical theories by looking at their dual pendants. An example where AdS/CFT duality was studied the most is the map between supersymmetric string theory living on the space-time of negative curvature and a four dimensional field theory with maximal supersymmetry. The nomenclature "maximal supersymmetry" means that there is a relation between fermionic and bosonic excitations, such that the number of such relations is maximally possible for a theory without gravitational interactions.

Confirmed theories describing elementary particle physics are non-supersymmetric Yang-Mills theories. In the near future the experiments, like those at the Large Hadron Collidor (LHC), may show that these theories are actually supersymmetric, where the symmetry between fermions and bosons is broken at the energies we observe at the moment. If so, and the Standard Model of elementary particles obtains a supersymmetric extension, one would still expect not a maximally supersymmetric, but a theory with the minimal amount of symmetry relations between bosons and fermions, so called N=1 supersymmetric theory.

That is why it may seem that N=4 theory is just a toy model, but as it is very often in physics, the toy models often allow us to illustrate the relevant problems without considering unnecessary details. Considering N=4 SYM theory may help us to obtain a global picture how AdS/CFT works in details and whether it is possible to extend it to other more realistic theories. Also, if we better understand N=4 SYM by means of the AdS/CFT dictionary, it will improve our understanding of the string theory on the backgrounds with negative curvature.

Maximal supersymmery constrains the form of the theory, like the number of fields and also their interactions. On top of it, because of its highly symmetric nature, it appears

to possess a large amount of additional symmetries (actually, infinitely many), which fits under the name of integrable model.

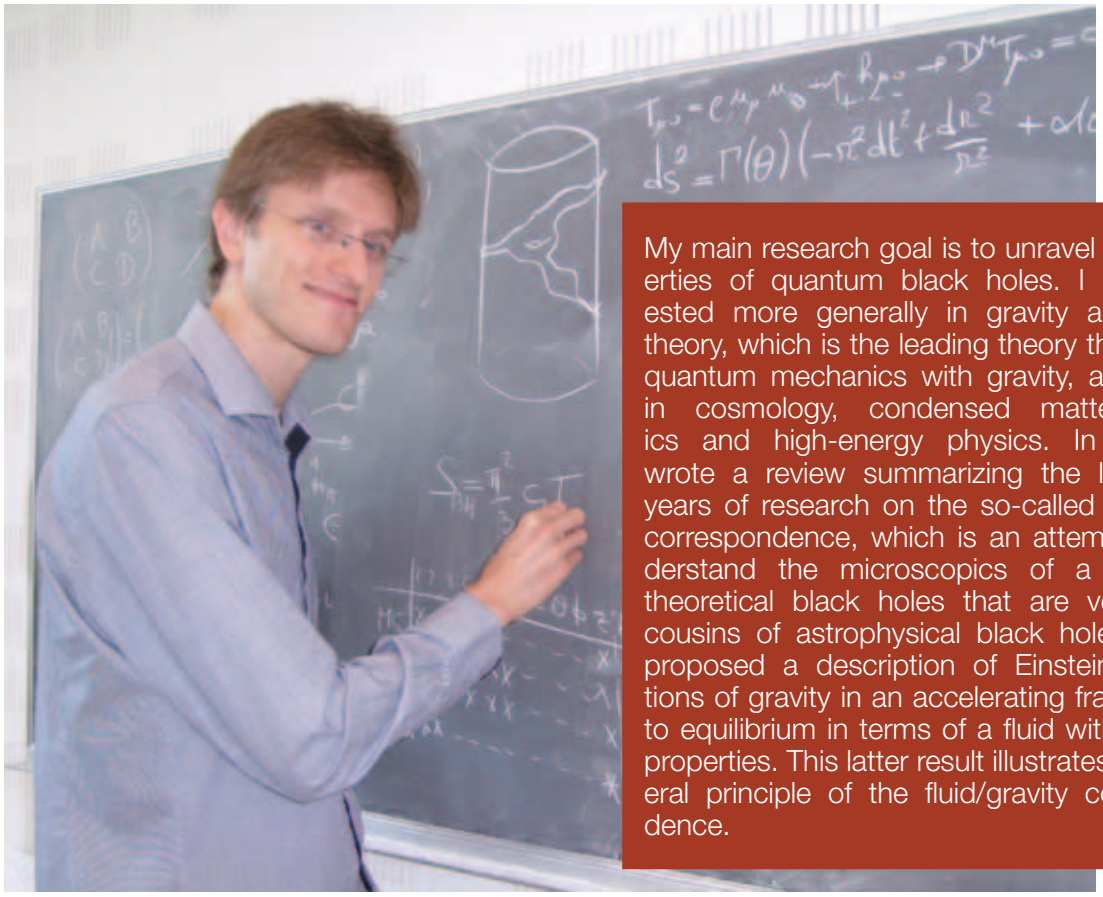
In the case of a perturbative quantum field theory, solving a theory means computing all the scattering amplitudes or equivalently so called "n-point correlation functions" between all the observables. For theories with conformal symmetry it appears that the whole information is captured by only two- and three-point correlators. Computing them will be equivalent to solving the conformal field theory. Their computation by the standard methods of perturbative quantum field theory is a very tedious task, which usually becomes too complicated after few terms in the perturbative expansion.

Integrable theories appear in different subfields of physics and were studied a lot in the past. Different techniques and tools were developed to understand them and they can be applied to the study of N=4 SYM theory. In the recent years there was a lot of effort in computing two-point correlators and in principle this problem appears now to be solved (at least numerically). To come closer to the goal of solving the N=4 Super Yang Mills (in the perturbative regime and planar limit), in 2010, Escobedo, Gromov, Sever and Vieira came up with a proposal how the integrability symmetry could simplify and shorten the tedious computation of the three-point functions. They proposed a technique that is simpler than the brute force computation by the standard methods of quantum field, but one that is still quite involved. At first glance it is not obvious whether this proposal will give the correct result.

Together with Andrei Zayakin (University of Santiago de Compostela) we are using this proposal to compute three-point functions for a class of particular operators and test it against known results or against results which we can compute by other methods (e.g. by using string field theory). Getting a good handle on techniques which use integrability appears to be very promising in the goal of completely solving N=4 SYM Theory.

# Geoffrey Compère

**Permanent Member (ULB)**



My main research goal is to unravel the properties of quantum black holes. I am interested more generally in gravity and string theory, which is the leading theory that unifies quantum mechanics with gravity, as well as in cosmology, condensed matter physics and high-energy physics. In 2012, I wrote a review summarizing the last three years of research on the so-called Kerr/CFT correspondence, which is an attempt to understand the microscopics of a class of theoretical black holes that are very close cousins of astrophysical black holes. I also proposed a description of Einstein's equations of gravity in an accelerating frame close to equilibrium in terms of a fluid with specific properties. This latter result illustrates the general principle of the fluid/gravity correspondence.

## Holography as a new tool

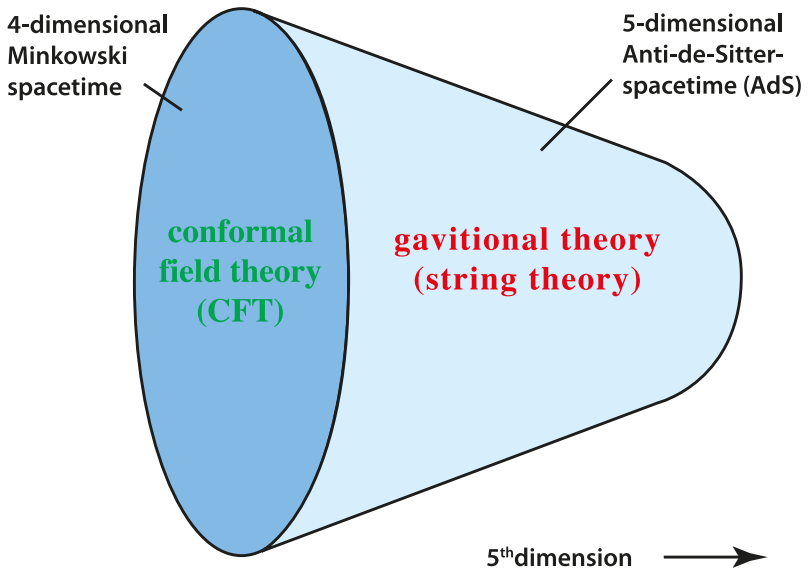
One of the most surprising and revolutionary development that emerged from research in quantum gravity over the last fifteen years is the so-called gauge/gravity, AdS/CFT or holographic correspondence. It states that some quantum field theories (closely related to the one describing the fundamental matter) are described equivalently by a theory of quantum gravity with one additional spatial dimension. This correspondence has already several implications for our understanding of strongly coupled quark/gluon plasmas that are studied in the Relativistic Heavy Ion Collider. More importantly, it is a new theoretical tool that has the potential to lead to dramatic new perspectives on black hole physics, condensed matter physics and cosmology. One aspect of holography close to equilibrium is the correspondence between black holes in so-called anti-de Sitter spaces (AdS) and an equivalent dual fluid in the dual conformal field theory (CFT). This correspondence allows to map the properties of the quark/gluon plasma, which is in a first approximation a fluid in a CFT, to the properties of black holes in the dual holographic theory. This is in essence how the duality works: the holographic correspondence is an incredible mapping between seemingly very distinct systems which however share the same dynamics. Moreover, when one system is intractable because of strong interactions, the other systems is weakly interacting and therefore tractable. This is why the holographic correspondence is useful.

## Extremal black holes and warped field theories

Recent astrophysical evidence indicates that some black holes rotate extremely fast, as close as 98% to the extremality bound. The Kerr/CFT correspondence is a proposal made by the Harvard group lead by Strominger to describe this class of black holes using a holographically dual conformal field theory. The challenge consists in describing the microstates of the black holes and the vicinity of its horizon using a theory that does not contain gravity: a quantum field theory with conformal invariance. Partial matching between the two systems has been achieved in the last years but several insurmontable obstacles prevent a mapping between the two classes of theories. I summarized the initial proposal and the subsequent developments in a Living Review in Relativity. After further investigations, it turned out that the proposal can be refined and the holographically dual theory cannot be a conformal field theory, but may be a close cousin thereof, a so-called warped CFT. Such theories have not yet been constructed from first principles but research is currently outgoing to build them.

## A fluid describing the nearly vacuum spacetime

An important regime of the holographic correspondence is when both the initial and dual systems are close to equilibrium. In the long range and low energy approximation, such systems are described by fluids. Even thought the correspondence has been mainly developed for spacetimes with a negative cosmological constant (AdS spacetimes) because such correspondences are describable in string theory, it is possible to study it in the fluid approximation in more general contexts, even without a string theory description. Following earlier work describing fluids around black holes by Damour in the 70s, I looked with collaborators in the University of Amsterdam on the fluid description of Einstein gravity in vacuum spacetimes, without a cosmological constant. It turns out that such a fluid description exists for accelerating "Rindler" observers. The fluid has very unusual properties: it has a positive pressure at rest but a zero energy. A normal fluid like water has an energy at rest which has to be larger than its pressure, but the holographic fluid has a different nature: it describes the spacetime itself and can have unusual properties. The fluid still obeys the standard second law of thermodynamics: it has an entropy that grows with time, which would otherwise be inconsistent with the laws of physics! We built one model for such a fluid: a scalar field which obeys some non-local variational principle. It is still a challenge to use that information to obtain an effective description of quantum gravity in flat spacetimes.



# Rakibur Rahman

**Postdoctoral Member (ULB)**

Presently a postdoctoral researcher at Physique Théorique et Mathématique, Université Libre de Bruxelles & International Solvay Institutes, I focused my attention in the previous year primarily on interactions of higher spin fermionic gauge fields. Besides, I was interested in whether holography could constraint the electromagnetic and gravitational couplings of an elementary particle. What follows is a brief summary of my research interests.

## Electromagnetic and gravitational interactions of massless higher spin fermions

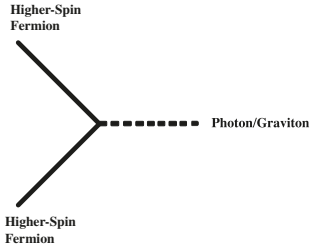
Every elementary particle in nature possesses the intrinsic properties of mass and spin. Mass is the amount of "stuff" a particle contains, while spin is its intrinsic angular momentum. Naively, one might picture a particle as a spinning top, whose spin measures the momentum associated with its rotational motion. It turns out that the spin of a particle, in some natural units, may only take integer values like 0, 1, 2, ... or half-integer values like 1/2, 3/2, 5/2, ... . A particle carrying an integer spin is called a boson, whereas one with a half-integral spin is a fermion. In nature all force-mediating particles are bosons, e.g. those of electromagnetism and gravity. Fermions, on the other hand, constitute all matter particles.

Of course, one would like to formulate a theory in which different particles interact and they do so in a consistent manner. The job becomes particularly difficult for higher spin particles because the interacting theory exhibits various pathological features. Of particular interest is the case of massless particles, a.k.a. gauge fields, since it is generally believed that consistent interactions of massive particles should come from an underlying massless theory. One of the key ingredients of particle physics is special relativity, and it is very convenient to keep the associated symmetry (Lorentz invariance) manifest in a theory. Then the description of massless particles incorporates some redundancies, called gauge symmetry.

Although mere redundancy in description, this gauge invariance is extremely useful in that it helps one to write down possible consistent interactions of massless particles.
With Marc Henneaux and Gustavo Lucena Gómez, I have been studying the electromagnetic and gravitational interactions of higher spin fermionic gauge fields. When there are no interactions, the spin-1 electromagnetic field (photon), the spin-2 gravitational field (graviton) and the massless higher spin fermion each comes with its own gauge invariance. In other words, the free theory enjoys gauge symmetry. An arbitrary interaction term will generically ruin this gauge invariance, which is a sign of inconsistency. This is because gauge invariance is a mere re-

dundancy that one has chosen to keep along, and at any point one should be able to use it to remove the redundant degrees of freedom in the system. Therefore, gauge invariance cannot be lost by consistent interaction terms. However, not all terms that respect gauge symmetry is a non-trivial interaction; often such terms turn out to be just redefinition of the associated fields, in which case it is not a true interaction.

The program then is to write down gauge-invariant interactions that cannot be removed by field redefinitions. To achieve this feat one may employ the so-called BRST-antifield formalism, which is a very systematic approach for any system of gauge fields. The first thing is to write down cubic terms, i.e. interactions with three particles. In our case, we have two higher spin fermions and a photon or graviton in the cubic interaction. It follows that any massless fermion with spin 3/2 or higher cannot have an electric charge in flat space-time. The number of derivatives in an allowed non-minimal cubic electromagnetic interaction is restricted. One can explicitly work out the cubic vertices to show that some of them do not exist in 4 space-time dimensions.




The story is similar, albeit more complicated, for gravitational interactions, where the issues start from spin 5/2. As expected, the higher spin fields cannot have minimal gravitational coupling, and the non-minimal interactions have number of derivatives in a given range. All this is in complete accordance with what is known so far about such cubic interactions.

## Holographic constraints on elementary particles

In another project with Manuela Kulaxizi, I have investigated the electromagnetic and gravitational couplings of a massive spin-1 particle (vector boson) in the context of holography. Holography or gauge/gravity duality is the conjecture that certain gravitational theory in d+1 space-time dimensions is dual to some non-gravitational field theory living in the d-dimensional boundary manifold. The (d+1)-dimensional bulk has an "asymptotically Anti-de Sitter" geometry, and the boundary hosts a theory with conformal symmetry. Such dualities can be useful in determining the consistency of a theory as some pathological features are made more manifest in one side of the duality or the other.

What are the allowed electromagnetic and gravitational couplings of a massive vector boson? It may possess an electric charge, a magnetic dipole moment and an electric quadrupole moment. The third one is completely determined by the first two. The magnetic dipole moment is quantified by the g-factor, which is a free parameter unless quantum physics is considered. Similarly, apart from the gravitational charge (mass) there is the gravitational quadrupole moment, quantified by another free parameter – the h-factor. One would like to know if holography could constrain these parameters.

To this end, we analyze the equations of motion of spin-1 fluctuations in a gravitational background – the Anti-de Sitter charged black hole background. The dual boundary theory has a finite chemical potential and contains a spin-1 operator. Coupled to this operator, there are some boundary modes obeying certain dispersion relations – relations between their frequencies and momenta. In a suitable limit of large frequency, large momentum and large chemical potential, the spin-1 equations simplify considerably, so that they can be solved by the well-known WKB approximation method. This allows one to analytically determine the group velocity of the boundary modes. Requiring that these modes do not propagate signals faster than light constrains the g- and h-factors of the bulk theory.

For a particle of any spin one should be able to do similar analyses to constrain its EM and gravitational couplings. It would be interesting to consider the next simple case of a spin-2 field.

# Karen De Causmaecker

**Doctoral Student (VUB)**

In 2010, the Large Hadron Collider (LHC) at the CERN laboratory in Geneva started colliding protons. With this milestone, we entered a very exciting period for high-energy particle physics and I decided to dedicate my PhD to collider physics phenomenology.
Phenomenology essentially boils down to building bridges in between people working in theoretical physics and people performing real experiments.

My phenomenological research is mainly concentrated on supersymmetric theories and their experimental signatures at the LHC. In 2012, I worked on two projects: I studied the collider signatures of goldstini in gauge mediation and started the development of a general framework for supersymmetric mass spectrum generation.

## Supersymmetry and its experimental signatures at the LHC

### Supersymmetry

The Standard Model (SM) of particle physics is a very successful theory describing the fundamental particles and their interactions. This model provides us with an excellent description of reality as it fits the current experimental data extremely well. Nevertheless, the SM remains unsatisfactory. Although it nicely describes the strong and electroweak interactions, gravity is not included. Moreover, there are many free parameters and some important questions such as the hierarchy problem and the origin of dark matter remain unanswered.

An elegant solution to many of these problems is offered by the introduction of supersymmetry (SUSY), a symmetry relating bosons and fermions. Due to this symmetry all the particles of the SM have a SUSY partner. If SUSY were an exact symmetry of nature, the SM particles and their partners should have the same masses. As we did not observe any of the SUSY partners yet, this is clearly not the case and we know that SUSY must be broken. There are several SUSY breaking schemes available and, therefore, many candidate SUSY theories exist. Each with its own signatures to be observed at the LHC.

### The Large Hadron Collider (LHC)

The LHC, built at CERN (European Organisation for Nuclear Research), is the world's largest and most powerful particle accelerator. The accelerator consists of an underground tunnel (Fig. 1) with a circumference of 27 km located on the border between Switzerland and France and is mainly designed to perform proton-proton collisions at a centre of mass energy of 7 - 14 TeV.

*Fig. 1: The Large Hadron Collider, inside the tunnel. ©CERN 2012*

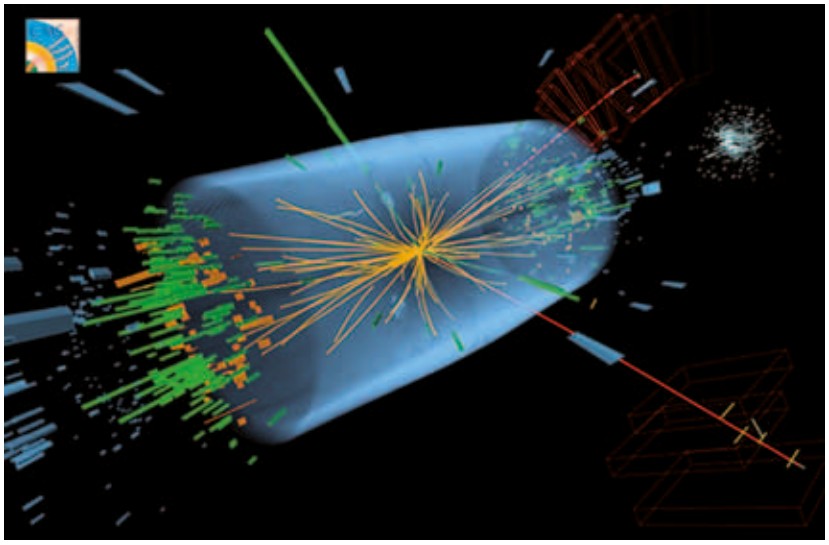


*Fig. 2: Event recorded with the CMS detector in May 2012 at a proton-proton centre of mass energy of 8 TeV. The event shows characteristics expected from the decay of the Brout-Englert-Higgs boson to a pair of Z bosons, one of which subsequently decays to a pair of electrons (green lines and green towers) and the other Z decays to a pair of muons (red lines). The event could also be due to known standard model background processes. © 2012 CERN, for the benefit of the CMS Collaboration.*

The main aim of the LHC is to test the predictions of the Standard Model and to gain insight in the nature of physics beyond the Standard Model. On the 4th of July 2012, the discovery of a new particle was announced. This particle might be related to the Brout-Englert-Higgs boson (Fig. 2). If this is the case, the last missing brick of the Standard Model would be found and we can focus on the search for physics beyond the Standard Model, like super-symmetry.

Looking for new-physics events in proton-proton collisions is much like searching for a needle in a haystack. The aim of my research is to guide the experimentalists in their search and to interpret the obtained data in the framework of supersymmetric theories.

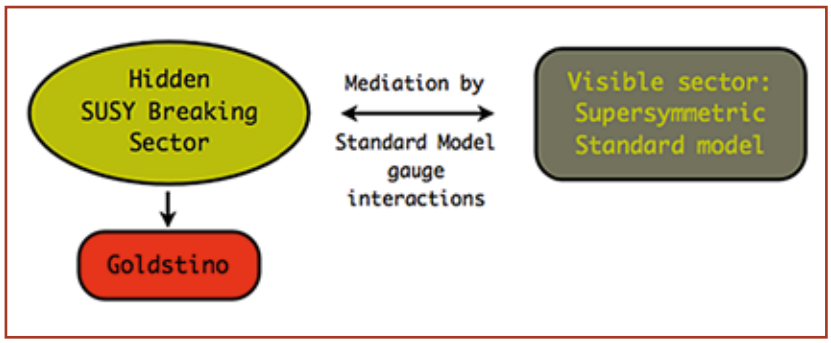



*Fig. 3: Gauge mediated supersymmetry breaking with one SUSY breaking sector.*

## Collider signatures of goldstini in gauge mediation

In collaboration with Riccardo Argurio, Gabriele Ferretti, Alberto Mariotti, Kentarou Mawatari and Yoshitaro Takaesu, I studied the collider signatures of goldstini in gauge mediation. In Gauge Mediated Supersymmetry Breaking (GMSB), supersymmetry is broken in a hidden sector and mediated to the visible sector by the SM gauge interactions (Fig. 3). We generalised this breaking scenario and considered two instead of one SUSY breaking sector. In this scenario there are two goldstini, the true goldstino and the pseudo-goldstino, one for each breaking sector.

We studied the collider signatures at the LHC and at a future linear electron-positron collider. At the LHC, we expect – compared to the one goldstino case – less energetic photons in our two goldstini scenario. This makes SUSY harder to detect and weakens the current experimental constraints on GMSB. On the other hand, we found that a future linear electron-positron collider can reveal the mass of the pseudo-goldstino and the neutralino.

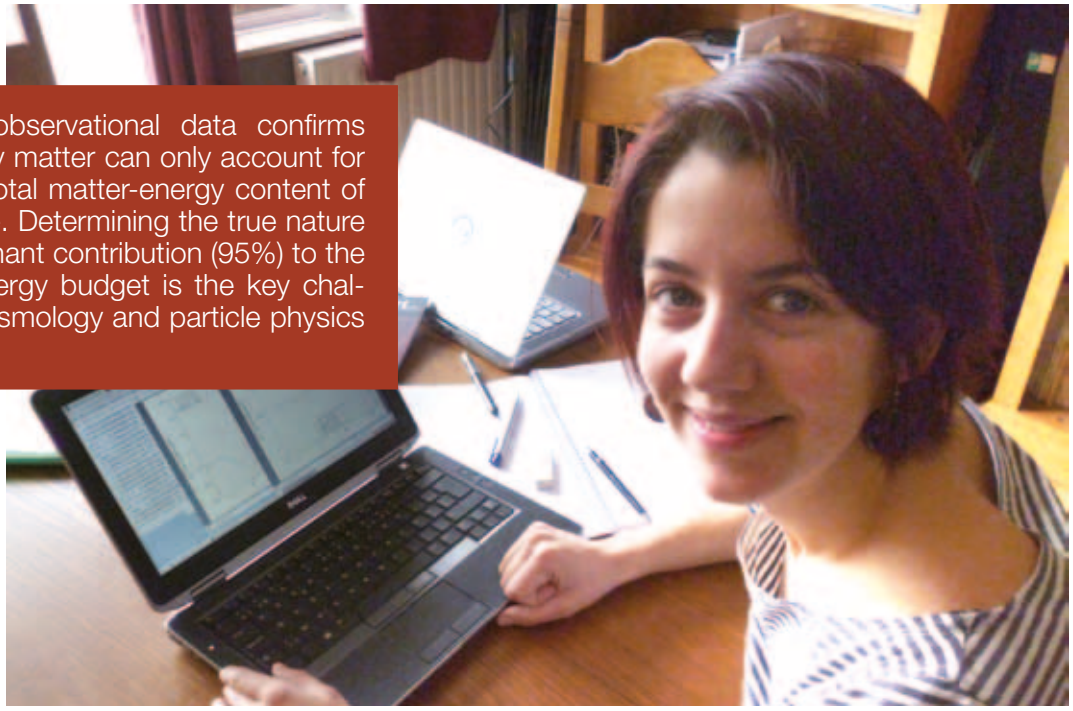
## Supersymmetric mass spectrum generation

To study the experimental signatures of a supersymmetric theory, the masses of the SUSY particles are crucial. The heavier the particles are, the more energy will be needed to produce them at the LHC and the less probable their production will be. Apart from the numerical values of the masses, also the mass hierarchy is important as this will determine which other particles a certain SUSY particle can decay to.

The masses of the SUSY particles are determined by the SUSY breaking mechanism and can often be calculated starting from a small number of parameters. This calculation involves several steps which, for practical use, are automatised in dedicated tools. These tools are usually rather model dependent. In a project in collaboration with Adam Alloul and Benjamin Fuks, we aim at developing a model independent framework for supersymmetric mass spectrum generation. The project is still in progress, but one building block is already put in place. In collaboration with Adam Alloul, Jorgen D'Hondt, Benjamin Fuks and Michel Rausch de Traubenberg, we automated the rotation between gauge and mass eigenstates in a Lagrangian. This is a first step in what will become a very flexible and user-friendly tool to study the collider phenomenology of supersymmetric theories. Hopefully, in the exciting years coming, this will help us in our quest for new-physics phenomena.

# Laura Lopez Honorez

**Postdoctoral Member (VUB)**



Compiling observational data confirms that ordinary matter can only account for 5% of the total matter-energy content of our universe. Determining the true nature of the dominant contribution (95%) to the universe energy budget is the key challenge for cosmology and particle physics today.

The first hint of the presence of dark matter, dates back to the 1930s when it was suggested that a large amount of "missing mass" was necessary in order to account for the motion of galaxies in clusters of galaxies. Since then, several analysis of Large Scale Structures (LSS) have revealed the presence of some new invisible and collisionless component, the dark matter. Since 1998, Supernovae Ia (SN Ia) have provided evidence for a currently accelerating universe. This requires the existence of an extra component with negative pressure, the dark energy. The simplest candidate for dark energy is a cosmological constant which associated to cold dark matter constitutes the "LambdaCDM" model. Within that framework, the joint analysis of SN Ia, Cosmic Microwave Background (CMB) data and baryon acoustic oscillations now suggest that about 73% of the energy budget of the universe is made of dark energy and 22% is made of dark matter.

In 2012, the particle physics community likely unveiled the properties of the last missing building block of the Standard Model (SM). Two experiments at the Large Hadron Collider (LHC situated at CERN, Geneva, Switzerland), obtained the first hints of signals that could be associated to the Brout-Englert-Higgs (BEH) particle. If definitively confirmed, the LHC experiments have now provided the mass of BEH particle that plays a key role in the SM and beyond. It is worth emphasize that, despite its great successes, the SM model fails in providing a satisfactory dark matter candidate. In order to characterize the properties of the dark matter, we are thus forced to explore particle physics models beyond the SM.

Given the new results from the LHC, we have been particularly interested to study the impact of the BEH particle properties on the so-called "Brout-Englert-Higgs-portal" dark matter models. In these simple - yet very rich and predictive-

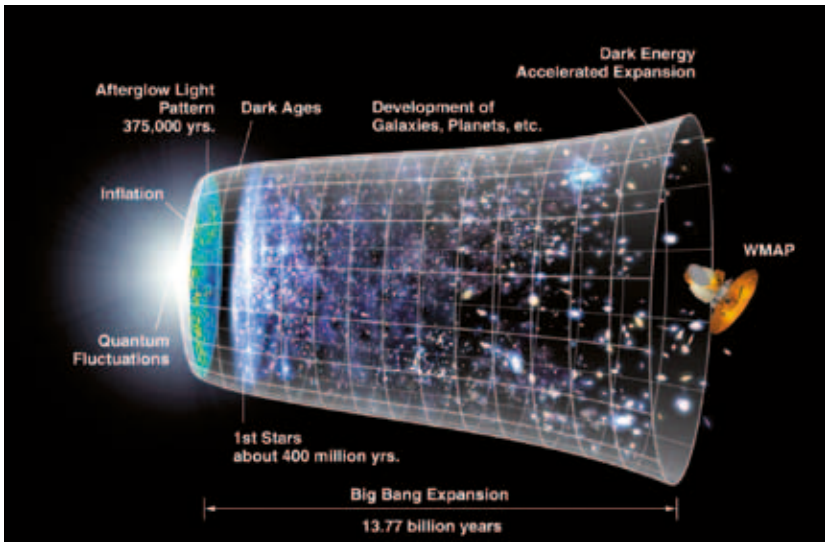



*Figure 1: Timeline of the Universe*

*Representation of the evolution of the universe over 13.77 billion years. The afterglow light (the CMB) seen by WMAP was emitted about 375,000 years after inflation and has traversed the universe largely unimpeded since then. It help us to probe its composition.*

*Credit: NASA / WMAP Science Team*

extensions of the SM model, the link between the ordinary matter (the SM particles) and the dark matter is provided by the BEH particle itself. We have analyzed the interplay between the possible detection of dark matter in colliders through dark matter production in high energy collisions, direct detection through dark matter collision with heavy nuclei in underground laboratories and indirect detection of gamma rays resulting from dark matter annihilation. Among the latter experiments, direct and indirect detection searches in combination with BEH collider searches are already strongly threatening the viable parameter space of the BEH-portal models. We demonstrated though that such bounds could still be evaded if the dark matter sector is made of several species or if e.g. the dark matter particle is interacting with the BEH particle through so called "pseudo-scalar" interactions.

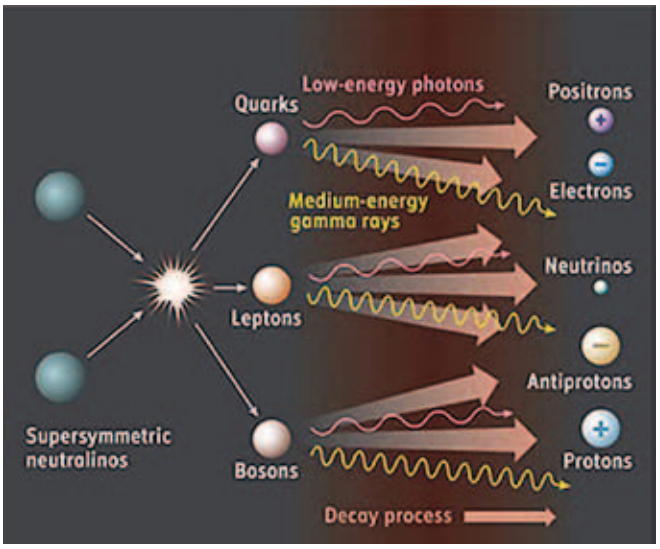



*Figure 2: Channels for indirect detection of dark matter*

*This figure illustrates the possible products of annihilation of dark matter particles.*

*Credit: adapted from http://theastronomist.fieldofscience.com*

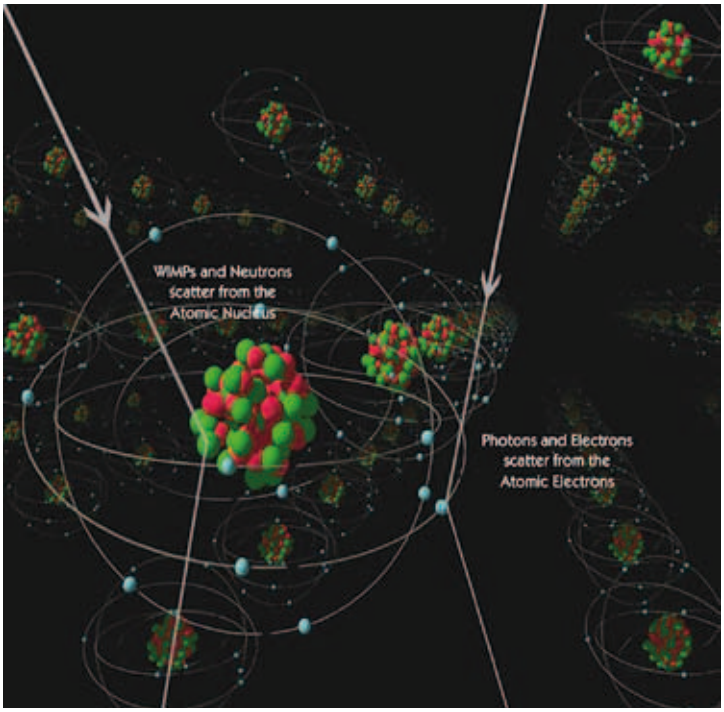



*Figure 3: Direct detection of dark matter*

*This figure illustrates a collision of a Weakly Interacting Massive Particle (WIMP), a typical dark matter candidate, on a nucleus in underground detectors.*

*Credit: cdms.berkeley.edu*

In 2012, we have also studied the potential of a next generation of cosmological probe providing the measurements of the 21-cm brightness temperature fluctuations from the neutral hydrogen to constrain the LambdaCDM model. The motivation is that the information contained in the 3-dimensional 21-cm signal could eventually help us to probe our cosmological model in particularly dark epochs of the history of the universe (the dark ages, also illustrated in Fig. 1) from which up to now, we still have no information.

## Cooperation with Chile

The international collaboration with the Centro de Estudios Científicos (Valdivia, Chile), based on a collaboration agreement between the Institutes and the Center in Chile, was active in 2012.


Visits of Chilean Scientists to Belgium

Dr. Alfredo Perez
21 - 28 April 2012

Dr. David Tempo
20 April - 4 May 2012

Prof. Cristián Martínez
25 October - 8 November 2012

Prof. Ricardo Troncoso
25 October - 8 November 2012

Prof. Andrés Gomberoff
27 October - 8 November 2012

Prof. Claudio Bunster
4 - 8 November 2012

Prof. Jorge Zanelli
4 - 8 November 2012

Visits of Belgian Scientists to Chile

Prof. Riccardo Argurio
10 - 19 January 2012

Prof. Glenn Barnich
10 - 19 January 2012

Prof. Marc Henneaux
9 - 22 January 2012
7 - 18 June 2012
13 - 25 November 2012

Sergio Hörtner
10 - 20 January 2012

Pierre-Henri Lambert
10 - 20 January 2012

Gustavo Lucena Gómez
10 - 20 January 2012

## Joint Publications and Preprints

G. Barnich, A. Gomberoff , H. A. Gonzalez, "The Flat limit of three dimensional asymptotically anti-de Sitter spacetimes", Phys. Rev. D 86 (2012) 024020.

C. Bunster, M. Henneaux, "Duality invariance implies Poincare invariance", Phys. Rev. Lett. 110 (2013) 011603.

C. Bunster, M. Henneaux, "Supersymmetric electric-magnetic duality as a manifest symmetry of the action for super-Maxwell theory and linearized supergravity", Phys. Rev. D 86 (2012) 065018.

G. Barnich, A. Gomberoff, H. A. Gonzalez BMS3 invariant two dimensional field theories as flat limit of Liouville, e-Print: arXiv:1210.0731 [hep-th].

C. Bunster, M. Henneaux, S. Hörtner, Gravitational Electric-Magnetic Duality, Gauge Invariance and Twisted Self-Duality, e-Print: arXiv:1207.1840 [hep-th].

## Joint Workshop

"Quantum Mechanics of Fundamental Systems VII", Valdivia, Chile

12 - 18 January 2012

## Appraisals & Prizes

• Dr. Geoffrey Compère successfully applied for a prestigious permanent FNRS research position (« Chercheur qualifié ») and joined the ULB group.

• The PhD thesis of Dr. Priscila de Aquino was nominated as "outstanding PhD thesis" by the Catholic University Leuven and will be published by Springer in the series "Springer Theses".

• Dr. Laura Lopez Honorez applied for a prestigious FWO postdoctoral fellowship and was ranked second among all scientists (coming from all Flemish universities) applying in the physics commission.

• Prof. Dr. Alexander Sevrin was elected as member of the Royal Flemish Academy of Belgium for Science and the Arts (Class of Natural Sciences).

• Dr. Piotr Surówka successfully applied for a prestigious FWO postdoctoral fellowship and was ranked fourth among all scientists (coming from all Flemish universities) applying in the physics commission.

## Theses

Alice Bernamonti obtained her PhD titled: "Applications of the AdS/CFT correspondence to strongly coupled dynamics" on May 22, 2012. Promoters were Prof. Dr. Ben Craps (VUB) and Prof. Dr. Alexander Sevrin (VUB)

## Talks

January 05, 2012: Semyon Klevtsov - *2D gravity, matrix models and random Kahler metrics* - Institut Henri Poincaré - Paris, France.

January 06, 2012: Semyon Klevtsov - *2D gravity, matrix models and random Kahler metrics* - Institut de Physique Theorique - Saclay, France.

January 12, 2012: Glenn Barnich - *Asymptotically flat general relativity as an extended conformal field theory* - Centro de Estudios Científicos - Valdivia, Chile.

January 14, 2012: Riccardo Argurio - *SUSY breaking and its mediation, with a particular regard to (pseudo)-goldstini* - Centro de Estudios Cientificos - Valdivia, Chile.

January 18, 2012: Marc Henneaux - Higher Spins AdS Supergravity in 2+1 dimensions - CECs - Valdivia, Chile.

January 25, 2012: Raphael Benichou - *Open strings on backreacting D-branes* - KIAS- Seoul, Korea.

January 26, 2012: Raphael Benichou - *Open strings on backreacting D-branes* - Seoul National University - Korea.

January 30, 2012: Glenn Barnich - *Classical and quantum aspects of the extended BV formalism* - Univ. Paris 6 - Paris, France.

February 01, 2012: Raphael Benichou - *Open strings on backreacting D-branes* - CQuest - Seoul, Korea.

January 18, 2012: Marc Henneaux - Higher Spins AdS Supergravity in 2+1 dimensions - CECs - Valdivia, Chile.

February 02, 2012: Raphael Benichou - *The exact spectrum of planar N=4 SYM from quantum integrability* - KIAS - Seoul, Korea.

February 17, 2012: Raphael Benichou - *Open strings on backreacting D-branes* - IPhT - Saclay, France.

February 23, 2012: Marc Henneaux - Higher Spins AdS Supergravity in 2+1 dimensions - University of Amsterdam - Amsterdam, the Netherlands.

March 03, 2012: Karen De Causmaecker - *Gauge-mediated supersymmetry breaking and goldstini phenomenology* - FeynRules 2012 workshop - Ottrott, France.

March 13, 2012: Glenn Barnich - *Topics in asymptotically flat gravity in 3 and 4 dimensions* - Erwin Schroedinger International Institute for Mathematical Physics - Vienna, Austria.

March 15, 2012: Riccardo Argurio - *Pseudo-Goldstini and Gauge Mediation* - Torino University - Torino, Italy.

March 15, 2012: Alexey Koshelev - *Modified non-local gravity: exact solutions and applications* - Moriond 2012, Cosmology - La Thuile, Italy.

March 15, 2012: Alberto Mariotti - *Collider Signature of Pseudo-Goldstini in Gauge Mediation* - Montpellier University - Montpellier, France.

March 22, 2012: Riccardo Argurio - *Pseudo-Goldstini and Gauge Mediation* - Institut Henri Poincaré - Paris, France.

March 22, 2012: Piotr Surówka - *Anomalies and transport in finite temperature QFT* - University of Johannesburg - Johannesburg, RSA.

March 27, 2012: Piotr Surówka - *Anomalies and transport in QFTs at Finite temperature* - University of Witwatersrand - Johannesburg, RSA.

March 28, 2012: Marc Henneaux - *Super-W(infinity) Asymptotic Symmetry of Higher-Spin AdS(3) Supergravity* - Institute for Advanced Study - Princeton, USA.

March 28, 2012: Rakibur Rahman - *Higher-Spin Fermionic Gauge Fields & Their Electromagnetic Coupling* - CQUeST, Sogang University - Seoul, Korea.

March 30, 2012: Alberto Mariotti - *Gauge Mediation: Review and Updates* - Problemi Attuali di Fisica Teorica - Vietri, Italy.

April 14, 2012: Piotr Surówka - *Anomalies in QFT at finite temperature – accomplishments and goals* - University of Wrocław - Wrocław, Poland.

April 16, 2012: Marc Henneaux - *Three-dimensional gravity : a superb theoretical laboratory* - Technische Universität Wien - Wien, Austria.

April 17, 2012: Riccardo Argurio - *Holographic correlators and SUSY breaking* - Swansea University - Swansea, United Kingdom.

April 18, 2012: Rakibur Rahman - *Higher-Spin Fermionic Gauge Fields & Their Electromagnetic Coupling* - Erwin Schrödinger Institute - Vienna, Austria.

April 20, 2012: Marc Henneaux - *Higher Spin AdS Supergravity in 2+1 Dimensions and Super W(Infinity)-Algebras* - International Schrödinger Institute - Vienna, Austria.

April 25, 2012: Jakob Palmkvist - *Gauged supergravity and Borcherds algebras* - Albert Einstein Institute - Golm, Germany.

April 25, 2012: Alexander Sevrin - *The Ouroboros of Physics* - The Royal Academy of Belgium for Science and the Arts - Brussels, Belgium.

April 25, 2012: Raphael Benichou - *Quantum Integrability in 2D sigma-models on supergroups and supercosets* - Heriot Watt University - Edinburgh, Scotland.

May 02, 2012: Raphael Benichou - *Gravity on stringy brane-worlds* - Uppsala University- Uppsala, Sweden.

May 05, 2012: Bettina Oexl - *Jets plus missing energy in light gravitino productions at the LHC* - Belgian Physics Society meeting - Brussels, Belgium.

May 08, 2012: Kentarou Mawatari - *Collider signatures of goldstini in gauge mediation* - University of Pittsburgh , USA.

May 13, 2012: Marc Henneaux - *Gravitational Duality* - Universidade Federal do Rio Grande do Norte - Natal, Brazil.

May 14, 2012: Marc Henneaux - *Higher Spin AdS Supergravity in 2+1 Dimensions* - Universidade Federal do Rio Grande do Norte - Natal, Brazil.

May 16, 2012: Davide Forcella *Negative Refraction and Hydrodynamics* - Eötvös University - Budapest, Hungary.

May 17, 2012: Alberto Mariotti *Collider Signature of Pseudo-Goldstini in Gauge Mediation* Institute for Particle Physics Phenomenology - Durham, UK.

May 17, 2012: Piotr Surówka *Anomalies and transport in QFTs at finite temperature* - University of Oxford - UK.

May 25, 2012: Karen De Causmaecker - *Generating Susy Mass Spectrum Generators* - Vrije Universiteit Brussel (VUB) Brussels, Belgium.

May 29, 2012: Marc Henneaux *What Can We Learn From Three-Dimensional Gravity ?* Humboldt University - Berlin, Germany.

May 30, 2012: Karen De Causmaecker - *Gauge-mediated supersymmetry breaking and goldstini phenomenology* - VUB - Brussels, Belgium.

June 05, 2012: Alexey Koshelev - *Non-singular bounce in nonlocal gravitational models* - QUARKS 2012 Yaroslavl, Russia.

June 08, 2012: Daniel Thompson - *Duality Invariance in M-theory* - University of Surrey - Guildford, UK.

June 08, 2012: Karen De Causmaecker - *Gauge-mediated supersymmetry breaking and goldstini phenomenology* - Theory @ the sea - Oostduinkerke, Belgium.

June 09, 2012: Bettina Oexl *Jets plus missing energy in light gravitino productions at the LHC* - Theory at the Sea - Ostende, Belgium.

# Talks

June 09, 2012: Kentarou Mawatari - *Particle physics life in the LHC era* - Oostduinkerke, Belgium.

June 11, 2012: Marc Henneaux *3+1 Lectures on Lie Algebras* CECs - Valdivia, Chile.

June 26, 2012: Piotr Surówka - T*owards kinetic theory with anomalies* - Brookhaven National Laboratory - Upton, USA.

July 02, 2012: Frank Ferrari - *Introduction to quantum gravity (in two dimensions)* - Université de Montréal - Montreal, Canada.

July 04, 2012: Semyon Klevtsov - *Integration over the space of Bergman metrics* Centre de recherches mathématiques - Montreal, Canada.

July 05, 2012: Jakob Palmkvist - *Gauged supergravity and Borcherds algebras* - 13th Marcel Grossmann meeting - Stockholm, Sweden.

July 05, 2012: Frank Ferrari - *Emergent Space and the Example of AdS_5XS^5* - Mc Gill University - Montreal, Canada.

July 05, 2012: Frank Ferrari - *New perspectives in 2D quantum gravity* - Université de Montréal - Montreal, Canada.

July 10, 2012: Riccardo Argurio - *Holographic Correlators for General Gauge Mediation* - Universidade de Santiago de Compostela - Santiago de Compostela, Spain.

August 01, 2012: Glenn Barnich *Topics in asymptotically flat gravity in 3 and 4 dimensions* Tomsk State Pedagogical University - Tomsk, Russia.

August 15, 2012: Alexey Koshelev - *From non-locality to holography* - Steklov Math. Institute - Moscow, Russia.

August 23, 2012: Karen De Causmaecker - *Generating Susy Mass Spectrum Generators* - Institut d'Etudes Scientifiques de Cargese - Cargese, France.

August 24, 2012: Frank Ferrari - *Emergent Space and the Example of AdS_5XS^5* - ENS - Paris, France.

August 27, 2012: Glenn Barnich - *Classical and gravitational aspects of the AdS3/CFT2 correspondence* University of Tromso - Tromso, Norway.

August 28, 2012: Bettina Oexl *Light gravitino production in association with gluinos at the LHC* - Cargese Summer School - Cargese, France.

September 04, 2012: Glenn Barnich - *A note on the Newman-Unti group and the BMS charge algebra in terms of Newman-Penrose coefficients* - International Conference on Mathematical Modeling in Physical Sciences. Session: Gravity, Quantum, and Black Holes - Budapest, Hungary.

September 07, 2012: Kentarou Mawatari - *Top window for dark matter* Kobe University Brussels European Centre - Brussels, Belgium.

September 08, 2012: Bettina Oexl - *Light gravitino production in association with gluinos at the LHC* - Workshop on LHC Physics, VUB+Kobe+Glasgow University - Brussels, Belgium.

September 08, 2012: Kentarou Mawatari - *Collider signatures of goldstini in gauge mediation* - VUB - Brussels, Belgium.

September 11 and 13, 2012: Alexey Koshelev - *Non-local gravity: exact solutions and their signatures in the observational data* - 7th Mathematical Physics meeting - Belgrade, Serbia.

September 14, 2012: Piotr Surówka - *Heavy-ion collisions and AdS/CFT correspondence* - Wigner Research Centre for Physics - Budapest, Hungary.

September 20, 2012: Marc Henneaux - *Gravitational Electric-Magnetic Duality* - University of Craiova - Craiova, Romania.

September 21, 2012: Glenn Barnich - *Topics in asymptotically flat gravity in 3 dimensions* - University of Craoiva - Craiova, Romania.

September 21, 2012: Daniele Musso - *Unbalanced Holographic Superconductor & Spintronic* - Corfu Summer Institute - Corfu, Greece.

September 21, 2012: Alexander Sevrin - *Some Aspects of N = (2; 2) Non-Linear sigma-Models* - 18th European Workshop on String Theory - Corfu, Greece.

September 25, 2012: Federico Galli - *Holographic thermalization of mutual and tripartite information in 2d CFTs* - XVIII European Workshop on String Theory - Corfu Summer Institute - Corfu, Greece.

September 25, 2012: Joris Vanhoof - *The spectral function in a strongly coupled, thermalising CFT* XVIII European Workshop on String Theory Kerkira, Greece (Corfu).

October 07, 2012: Karen De Causmaecker - *Mass Diagonalisation* - Madgraph meeting 2012 - Natal, Brazil.

October 07, 2012: Kentarou Mawatari - *TauDecay* - Natal, Brazil.

October 08, 2012: Davide Forcella - *Toric Geometry: an Introduction* - ULB - Bruxelles, Belgium.

October 09, 2012: Davide Forcella - *Toric Geometry: the Dual Cone* - ULB - Bruxelles, Belgium.

October 10, 2012: Marc Henneaux - *Gravitational Duality* - University of Santiago de Compostela - Santiago de Compostela, Spain.

October 10, 2012: Priscila de Aquino - *From gravitons to gravitinos: MET Signatures at the LHC* - Invited seminar at Universidade Estadual de Campinas - Campinas, Brazil.

October 11, 2012: Davide Forcella - *Toric Geometry: Polytopes and Toric Fibration* - ULB - Bruxelles, Belgium.

October 12, 2012: Diego Redigolo - *Tame D-Tadpoles in Gauge Mediation* - SISSA - Trieste, Italy.

October 12, 2012: Davide Forcella - *Toric Geometry: Symplectic Quotient* - ULB - Bruxelles, Belgium.

October 16, 2012: Frank Ferrari - *Emergent Space and the Example of AdS_5XS^5* Vienna University - Vienna, Austria.

October 17, 2012: Diego Redigolo - *Holographic Correlators for General Gauge Mediation* CP3-Université Catholique de Louvain - Louvain-la-Neuve, Belgium.

October 17, 2012: Daniel Thompson - *Non-abelian T-duality and AdS/CFT* - Queen Mary University - London, UK.

October 17, 2012: Priscila de Aquino - *Light gravitino production at the LHC* - Informal pheno meeting at Universidade de São Paulo - São Paulo, Brazil.

October 22, 2012: Davide Forcella - *Toric Geometry: CY, Resolutions and Deformations* ULB - Bruxelles, Belgium.

October 22, 2012: Manuela Kulaxizi - *Unitarity Constraints along the Renormalization Group Flow* - Nordita - Stockholm University - Stockholm, Sweden.

October 23, 2012: Davide Forcella - *Toric Geometry: Well-known Examples* - ULB - Bruxelles, Belgium.

November 01, 2012: Riccardo Argurio - *Holographic Correlators for General Gauge Mediation* - Chalmers University Gothenburg, Sweden.

November 01, 2012: Alexey Koshelev - *SFT and p-adic String Based Cosmological Models* - SFT 2012 - Jerusalem, Israel.

November 07, 2012: Alberto Mariotti - *Gauge Mediation: Review and Updates* - GDR Terascale - Paris, France.

November 09, 2012: Frank Ferrari - *Emergent Space and the Example of AdS_5XS^5* Swansea University - Swansea, United Kingdom.

November 11, 2012: Diego Redigolo - *Lectures on a and c Theorems* - Università di Firenze - Firenze, Italy.

November 12-16, 2012: Ben Craps - *Holographic Thermalization in Field Theories* - Niels Bohr Institute (PhD School) - Copenhagen, Denmark.

November 14, 2012: Diego Redigolo - *Holographic Correlators for General Gauge Mediation* - Università di Firenze - Firenze, Italy.

November 27, 2012: Frank Ferrari - *Emergent Space and the Example of AdS_5XS^5* - University of Turin - Turin, Italy.

November 30, 2012: Andrea Campoleoni - *Higher-spin gravity* - University of Vienna - Vienna, Austria.

December 06, 2012: Andrea Campoleoni - *Metric-like higher-spin gauge theories in three dimensions* - Czech Academy of Sciences - Prague, Czech Republic.

December 07, 2012: Laura Lopez-Honorez - *Fermionic DM via sms portal* - Vrije Universiteit Brussel - Brussels, Belgium.

December 12, 2012: Priscila de Aquino - *Summary on Higgs characterization with MadGraph5 and aMC@NLO* ATLAS meeting at CERN (presented from Brussels via EVO) - Geneva, Switzerland.

December 15, 2012: Alexey Koshelev - *Bounce, Galileons, non-locality and all of that* - ITEP - Moscow, Russia.

December 17, 2012: Piotr Surówka - *Gauge and Gravitational anomalies in hydrodynamics – kinetic theory approach* - Institut of Nuclear Physics, Polish Academy of Sciences - Kraków, Poland.

December 19, 2012: Andrea Campoleoni - *Higher spins and dualities in various dimensions* - Scuola Normale Superiore - Pisa, Italy.

December 20, 2012: Kentarou Mawatari - *X>tautau for spin/parity determination* - Brussels, Belgium.

December 20, 2012: Daniel Thompson - *Duality and Geometry in String Theory* - IAP meeting - Brussels, Belgium.

1- Amariti, D. Forcella and A. Mariotti, “Integrability on the Master Space,” JHEP 1206, 053 (2012) [arXiv:1203.1616 [hep-th]].

2- Amariti, D. Forcella and A. Mariotti, “Negative Refractive Index in Hydrodynamical Systems,” JHEP 1301 (2013) 105 [arXiv:1107.1240 [hep-th]].

3- R. Argurio, K. De Causmaecker, G. Ferretti, A. Mariotti, K. Mawatari and Y. Takaesu, “Collider signatures of goldstini in gauge mediation,” JHEP 1206, 096 (2012) [arXiv:1112.5058 [hep-ph]].

4- R. Argurio, M. Bertolini, L. Di Pietro, F. Porri and D. Redigolo, “Holographic Correlators for General Gauge Mediation,” JHEP 1208, 086 (2012) [arXiv:1205.4709 [hep-th]].

5- R. Argurio, M. Bertolini, L. Di Pietro, F. Porri and D. Redigolo, “Exploring Holographic General Gauge Mediation,” JHEP 1210, 179 (2012) [arXiv:1208.3615 [hep-th]].

6- G. Barnich, A. Gomberoff and H. A. Gonzalez, “The Flat limit of three dimensional asymptotically anti-de Sitter spacetimes,” Phys. Rev. D 86, 024020 (2012) [arXiv:1204.3288 [gr-qc]].

7- G. Barnich and P. -H. Lambert, “A note on the Newman-Unti group,” Adv. Math. Phys. 2012, 197385 (2012) [arXiv:1102.0589 [gr-qc]].

8- G. Barnich, “Entropy of three-dimensional asymptotically flat cosmological solutions,” JHEP 1210, 095 (2012) [arXiv:1208.4371 [hep-th]].

9- R. Benichou, “The Hirota equation for string theory in AdS5xS5 from the fusion of line operators,” Fortsch. Phys. 60 (2012) 896 [arXiv:1202.0084 [hep- th]].

10- R. Benichou and J. Estes, “Geometry of Open Strings Ending on Backreacting D3-Branes,” JHEP 1203 (2012) 025 [arXiv:1112.3035 [hep-th]].

11- R. Benichou and J. Estes, “The Fate of Newton’s Law in Brane-World Scenarios,” Phys. Lett. B 712 (2012) 456 [arXiv:1112.0565 [hep-th]].

12- E. A. Bergshoeff, A. Kleinschmidt and F. Riccioni, “Supersymmetric Domain Walls,” Phys. Rev. D 86, 085043 (2012) [arXiv:1206.5697 [hep-th]].

13- D. S. Berman, E. T. Musaev, D. C. Thompson and D. C. Thompson, “Duality Invariant M-theory: Gauged supergravities and Scherk-Schwarz reductions,” JHEP 1210 (2012) 174 [arXiv:1208.0020 [hep-th]].

14- M. Bianchi, A. Collinucci and L. Martucci, “Freezing E3-brane instantons with fluxes,” Fortsch. Phys. 60, 914 (2012) [arXiv:1202.5045 [hep-th]].

15- T. Biswas, A. S. Koshelev, A. Mazumdar and S. Y. Vernov, “Stable bounce and inflation in non-local higher derivative cosmology,” JCAP 1208 (2012) 024 [arXiv:1206.6374 [astro-ph.CO]].

16- P. Braun, A. Collinucci and R. Valandro, “Algebraic description of G-flux in F-theory: new techniques for F-theory phenomenology,” Fortsch. Phys. 60, 934 (2012) [arXiv:1202.5029 [hep-th]].

17- C. Bunster and M. Henneaux, “Supersymmetric electric-magnetic duality as a manifest symmetry of the action for super-Maxwell theory and linearized supergravity,” Phys. Rev. D 86, 065018 (2012) [arXiv:1207.1761 [hep-th]].

18- A. Collinucci and R. Savelli, “On Flux Quantization in F-Theory II: Unitary and Symplectic Gauge Groups,” JHEP 1208, 094 (2012) [arXiv:1203.4542 [hep-th]].

19- B. Craps, C. Hoyos, P. Surowka and P. Taels, “Chern-Simons diffusion rate in a holographic Yang-Mills theory,” JHEP 1211 (2012) 109 [Erratum-ibid. 1302 (2013) 087] [arXiv:1209.2532 [hep-th]].

20- P. de Aquino, F. Maltoni, K. Mawatari and B. Oexl, “Light Gravitino Production in Association with Gluinos at the LHC,” JHEP 1210 (2012) 008 [arXiv:1206.7098 [hep-ph]].

# List of publications


21- S. Detournay, J. M. Lapan and M. Romo, “SUSY Enhancements in (0,4) Deformations of $AdS_3$ /$CFT_2$ ,” JHEP 1201, 006 (2012) [arXiv:1109.4186 [hep-th]].

22- F. Englert, D. Goncalves-Netto, K. Mawatari and T. Plehn, “Higgs Quantum Numbers in Weak Boson Fusion,” JHEP 1301 (2013) 148 [arXiv:1212.0843 [hep-ph]].

23- F. Ferrari, S. Klevtsov and S. Zelditch, “Simple Matrix Models for Random Bergman Metrics,” J. Stat. Mech. 2012, P04012 (2012) [arXiv:1112.4382 [hep-th]].

24- F. Ferrari, S. Klevtsov and S. Zelditch, “Gravitational Actions in Two Dimensions and the Mabuchi Functional,” Nucl. Phys. B 859, 341 (2012) [arXiv:1112.1352 [hep-th]].

25- P. Fleig and A. Kleinschmidt, “Eisenstein series for infinite-dimensional U-duality groups,” JHEP 1206, 054 (2012) [arXiv:1204.3043 [hep-th]].

26- F. Galli and A. Mariotti, “Soft Spectrum in Yukawa-Gauge Mediation,” JHEP 1206 (2012) 055 [arXiv:1201.4893 [hep-ph]].

27- D. Goncalves-Netto, D. Lopez-Val, K. Mawatari, T. Plehn and I. Wigmore, “Automated Squark and Gluino Production to Next-to-Leading Order,” Phys. Rev. D 87 (2013) 014002 [arXiv:1211.0286 [hep-ph]].

28- D. Goncalves-Netto, D. Lopez-Val, K. Mawatari, T. Plehn and I. Wigmore, “Sgluon Pair Production to Next-to-Leading Order,” Phys. Rev. D 85 (2012) 114024 [arXiv:1203.6358 [hep-ph]].

29- J. Hartle and T. Hertog, “Arrows of Time in the Bouncing Universes of the No-boundary Quantum State,” Phys. Rev. D 85, 103524 (2012) [arXiv:1104.1733 [hep-th]].

30- M. Henneaux, A. Kleinschmidt and H. Nicolai, “Real forms of extended Kac-Moody symmetries and higher spin gauge theories,” Gen. Rel. Grav. 44, 1787 (2012) [arXiv:1110.4460 [hep-th]].

31- M. Henneaux, G. Lucena Gómez, J. Park and S. -J. Rey, “Super- W(infinity) Asymptotic Symmetry of Higher-Spin $AdS_3$ Supergravity,” JHEP 1206, 037 (2012) [arXiv:1203.5152 [hep-th]].

32- M. Henneaux, G. Lucena Gómez and R. Rahman, “Higher-Spin Fermionic Gauge Fields and Their Electromagnetic Coupling,” JHEP 1208, 093 (2012) [arXiv:1206.1048 [hep-th]].

33- S. Koshelev and S. Y. Vernov, “On bouncing solutions in non-local grav- ity,” Phys. Part. Nucl. 43 (2012) 666 [arXiv:1202.1289 [hep-th]].

34- S. Koshelev, “Modified non-local gravity,” Rom. J. Phys. 57 (2012) 894 [arXiv:1112.6410 [hep-th]].

35- S. Koshelev and S. Y. Vernov, “Cosmological perturbations in SFT inspired non-local scalar field models,” Eur. Phys. J. C 72 (2012) 2198 [arXiv:0903.5176 [hep-th]].

36- M. Kulaxizi, A. Parnachev and K. Schalm, “On Holographic Entanglement Entropy of Charged Matter,” JHEP 1210, 098 (2012) [arXiv:1208.2937 [hep- th]].

37- R. Loganayagam and P. Surowka, “Anomaly/ Transport in an Ideal Weyl gas,” JHEP 1204 (2012) 097 [arXiv:1201.2812 [hep-th]].

38- J. Palmkvist, “Tensor hierarchies, Borcherds algebras and E11,” JHEP 1202, 066 (2012) [arXiv:1110.4892 [hep-th]].

39- J. Palmkvist, “Borcherds and Kac-Moody extensions of simple finite-dimensional Lie algebras,” JHEP 1206, 003 (2012) [arXiv:1203.5107 [hep-th]].

40- D. Redigolo, “On Lorentz-Violating Supersymmetric Quantum Field Theories,” Phys. Rev. D 85, 085009 (2012) [arXiv:1106.2035 [hep-th]].

## Preprints

41- R. Argurio and D. Redigolo, "Tame D-tadpoles in gauge mediation," arXiv:1206.7037 [hep-ph].

42- R. Argurio, D. Forcella, A. Mariotti, D. Musso and C. Petersson, "Field Theory Interpretation of N=2 Stringy Instantons," arXiv:1211.1884 [hep- th].

43- V. Balasubramanian, A. Bernamonti, B. Craps, V. Keranen, E. Keski-Vakkuri, B. Muller, L. Thorlacius and J. Vanhoof, "Thermalization of the spectral function in strongly coupled two dimensional conformal field theories," arXiv:1212.6066 [hep-th].

44- G. Barnich, A. Gomberoff and H. A. Gonzalez, "$BMS_3$ invariant two dimensional field theories as flat limit of Liouville," arXiv:1210.0731 [hep-th].

45- M. Berg, I. Buchberger, D. M. Ghilencea and C. Petersson, "Higgs diphoton rate enhancement from supersymmetric physics beyond the MSSM," arXiv:1212.5009 [hep-ph].

46- S. Berman, M. Cederwall, A. Kleinschmidt and D. C. Thompson, "The gauge structure of generalised diffeomorphisms," arXiv:1208.5884 [hep-th].

47- Bernamonti, N. Copland, B. Craps and F. Galli, "Holographic thermalization of mutual and tripartite information in 2d CFTs," arXiv:1212.0848 [hep-th].

48- C. Bunster, M. Henneaux and S. Hörtner, "Gravitational Electric-Magnetic Duality, Gauge Invariance and Twisted Self-Duality," arXiv:1207.1840 [hep- th].

49- C. Bunster and M. Henneaux, "Duality invariance implies Poincaré invariance," arXiv:1208.6302 [hep-th].

50- E. Dudas, C. Petersson and P. Tziveloglou, "Low Scale Supersymmetry Breaking and its LHC Signatures," arXiv:1211.5609 [hep-ph].

51- F. Ferrari, "Emergent Space and the Example of $AdS_5 \times S^5$," arXiv:1207.0886 [hep-th].

52- D. Goncalves-Netto, D. Lopez-Val, K. Mawatari, I. Wigmore and T. Plehn, "Looking for leptogluons," arXiv:1303.0845 [hep-ph].

53- K. Hagiwara, T. Li, K. Mawatari and J. Nakamura, "TauDecay: a library to simulate polarized tau decays via FeynRules and MadGraph5," arXiv:1212.6247 [hep-ph].

# List of publications


54- J. B. Hartle, S. W. Hawking and T. Hertog, “Inflation with Negative Λ,” arXiv:1207.6653 [hep-th].

55- J. B. Hartle, S. W. Hawking and T. Hertog, “Accelerated Expansion from Negative Λ,” arXiv:1205.3807 [hep-th].

56- G. Itsios, C. Nunez, K. Sfetsos and D. Thompson, “Non-Abelian T-duality and the AdS/CFT correspondence:new N=1 backgrounds,” arXiv: 1301.6755 [hep-th].

57- G. Itsios, C. Nunez, K. Sfetsos and D. C. Thompson, “On Non-Abelian T-Duality and new N=1 backgrounds,” arXiv:1212.4840 [hep-th].

58- D. Katsimpouri, A. Kleinschmidt and A. Virmani, “Inverse Scattering and the Geroch Group,” arXiv:1211.3044 [hep-th].

59- A. Kleinschmidt, T. Nutma and A. Virmani, “On unitary subsectors of polycritical gravities,” arXiv:1206.7095 [hep-th].

60- S. Koshelev, “Stable analytic bounce in non-local Einstein-Gauss-Bonnet cosmology,” arXiv:1302.2140 [astro-ph.CO].

61- M. Kulaxizi and R. Rahman, “Holographic Constraints on a Vector Boson,” arXiv:1212.6265 [hep-th].

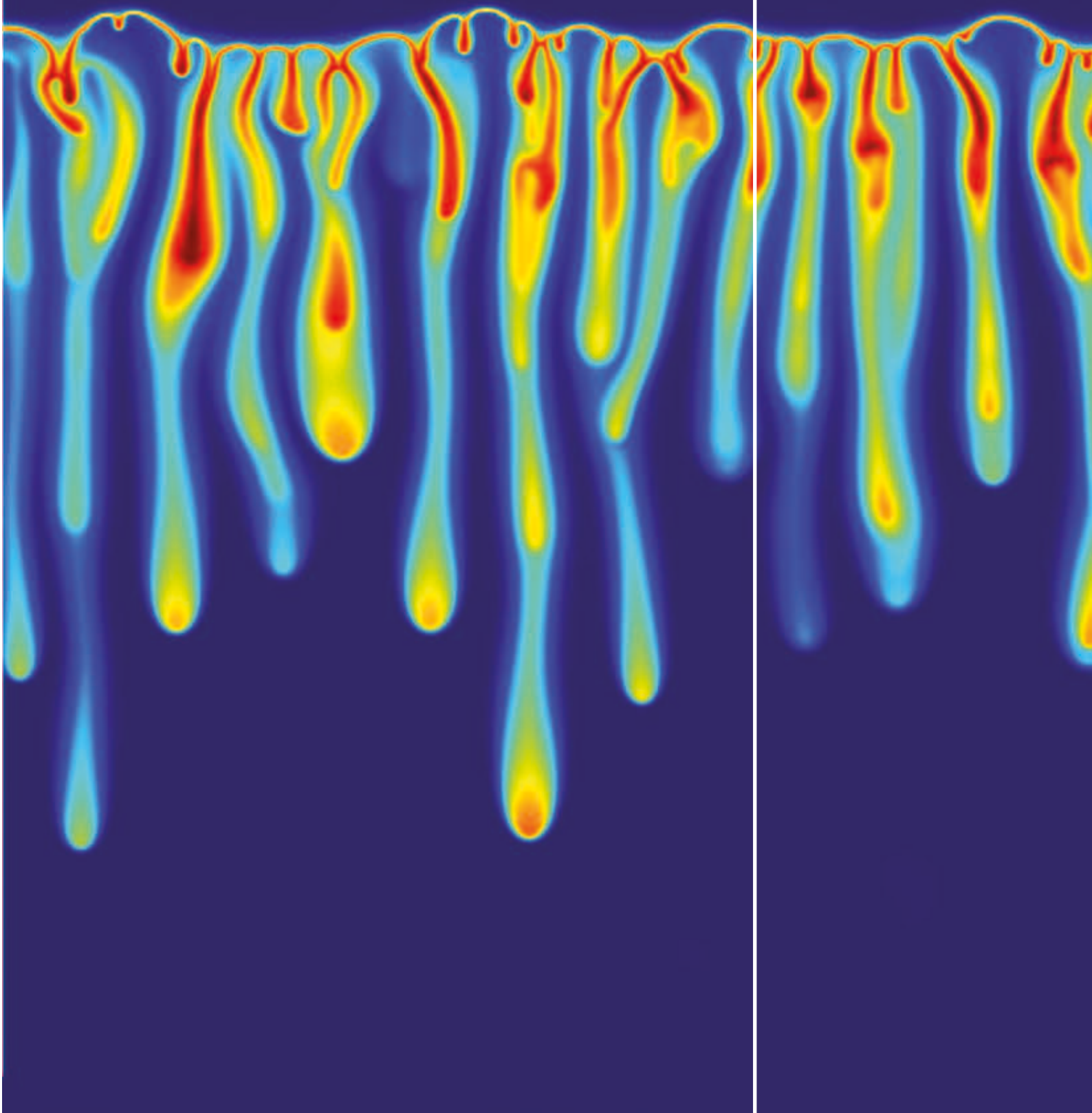
62- D. Lopez-Val, D. Goncalves-Netto, K. Mawatari, T. Plehn and I. Wigmore, “MadGolem: automating NLO calculations for New Physics,” arXiv:1209.2797 [hep-ph].

63- K. Mawatari, “Associated production of light gravitinos at future linear colliders,” arXiv:1202.0507 [hep-ph].

64- C. Petersson, A. Romagnoni and R. Torre, “Liberating Higgs couplings in supersymmetry,” arXiv:1211.2114 [hep-ph].

65- A. Taliotis, “Extra dimensions, black holes and fireballs at the LHC,” arXiv:1212.0528 [hep-th].

# Research in Chemistry carried out in the group of Professor Anne De Wit (ULB)



## Researchers

### Permanent Member

De Wit, Anne

### Postdoctoral Members

Budroni, Marcello
Haudin, Florence
Rongy, Laurence

### Graduate Students

Elyahyioui, Jihane
(co-direction B. Knaepen)
Lemaigre, Lorena
Loodts, Vanessa
Riolfo, Luis

### Master Student

Thomas, Carelle

## Research Summary

Chemo-hydrodynamic patterns and instabilities appear in out of equilibrium systems when chemical reactions and diffusion interplay with advection or convection processes. Complex spatio-temporal evolution of concentrations can then set in due to the highly nonlinear character of the underlying dynamics.

Our research aims at investigating by combined experimental and theoretical approaches new patterns and dynamics resulting from such a coupling between chemical reactions and hydrodynamic instabilities. Various systems are investigated to tackle different possible sources of flows.

For buoyancy-driven flows, we have demonstrated that chemical reactions are able to break the symmetry of the chemo-hydrodynamic patterns triggered by density gradients in the gravity field. In absence of chemical reactions, a so-called Rayleigh-Taylor instability develops when a denser solution is put on top of a less dense one, giving rising and sinking fingers developing symmetrically around the initial contact line (Fig.1a). If the solutions at hand contain chemicals, reactions change the composition, which may impact the density profile and hence modify the pattern. In some cases (Fig.1b), the reactions can break the symmetry of the spatial structure, which shows the importance of

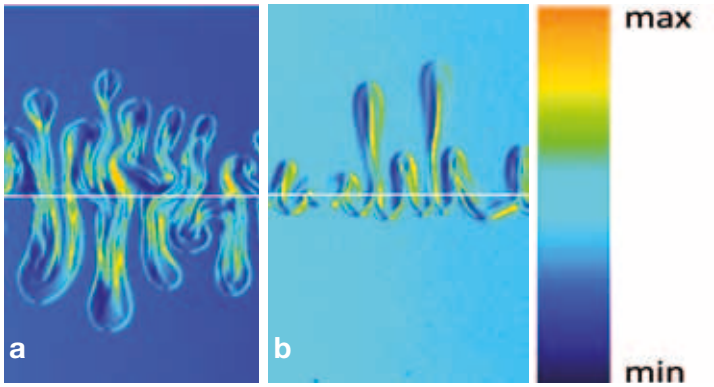



*Fig.1: Comparison between non-reactive (a) and reactive (b) Rayleigh-Taylor instability developing in a vertical two-dimensional set-up when a denser upper solution is put on top of a less dense one in the gravity field. The reaction breaks the symmetry of the resulting fingers with regard to the initial horizontal contact line shown in white.*

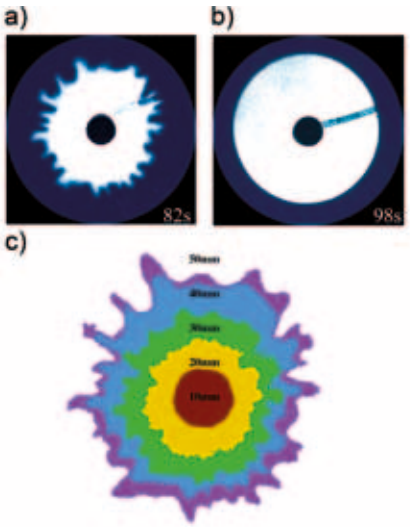
taking reactions into account in the modeling and predictions of new hydrodynamic patterns in reactive systems.

In parallel, we investigate by combined experimental and theoretical approaches how such buoyancy-driven hydrodynamic instabilities impact $CO_2$ sequestration in salted water. We have shown by linear stability analysis that a simple A+B-->C reaction can accelerate the convective dissolution of $CO_2$ in a saline aquifer and have started to conduct related laboratory-scale experiments.

For Marangoni flows triggered by surface-tension gradients, we have compared numerically how Marangoni or buoyancy-driven convection triggered by compositional or thermal gradients across autocatalytic or simple A+B-->C fronts can deform and accelerate these fronts. These numerical predictions enlighten dynamic differences observed between convective flows experiments performed either on earth or in microgravity within the European Space Agency topical group on "Chemo-hydrodynamic patterns and instabilities".

Eventually, we have demonstrated both experimentally and theoretically that a chemical reaction is able to trigger viscous fingering instabilities due to unfavorable viscosity gradients. In particular, when a polymer solution displaces water in a porous medium or between two glass plates like in Fig.2b, the situation is viscously stable. However, if the water contains some given chemicals able to react with the polymer and change its viscosity in-situ in the miscible reaction zone, a viscous fingering instability (Fig.2a,c) can be triggered by the reaction.

*Fig.2: Chemically-driven viscous fingering instability obtained when a pH-sensitive polymer displaces radially an acid dyed aqueous solution between two transparent horizontal glass plates (a). If the displaced fluid is only dyed water i.e. in absence of reaction, the displacement is stable (b). The development of the reactive unstable pattern is better seen when superposing images shown in false colors and taken at successive times (c).*




## Acknowledgements

This research benefits from financial support from
- FRS-FNRS
- Prodex
- the European Space Agency
- the Action de Recherches Concertées programme CONVINCE "Convective instabilities in porous media and sea ice"

# Florence Haudin

**Postdoctoral researcher, PRODEX contract**

In porous media, the hydrodynamic viscous fingering instability develops when a given fluid is injected into a more viscous one, for instance in the context of oil recovery, polymer displacements or in some chromatography applications. In the laboratory, this instability is conveniently studied by conducting displacement experiments in quasi-bidimensional systems, typically in Hele-Shaw cells made of two transparent glass or plexyglass plates separated by a small gap.

In such Hele-Shaw cells, we have investigated reverse situations where a more viscous and denser fluid is injected radially into a dyed less dense and less viscous miscible fluid, in a horizontal set-up. No fingering should appear since this situation is expected to be stable from a viscous point of view. Nevertheless, in the region where the two miscible fluids are mixing, a pattern consisting in very thin stripes is forming (Figure 1). Beyond a given distance from the injection point, such stripes sometimes split, giving rise to a smaller wavelength close to the outer rim of the mixing zone. This instability is prone to be observed in every horizontal miscible displacement and needs to be characterized in order to control its possible effect on the flow and the mixing.

As a first step, we have proposed an explanation of the instability mechanism based on buoyancy: as the two fluids are different, there generally exists a density difference across the miscible interface between them. In the small gap of the cell, this density difference can locally lead to an unstable stratification of a denser fluid on top on a less dense one within the concentration profile stretched by the flow in the gap.

Such a situation is known to be buoyantly unstable and to lead to a so-called Rayleigh-Taylor instability. As a consequence, even if the thickness of the cell is very small (less than a millimeter), it is sufficient for convection rolls to develop. In a view from above, these rolls are seen as stripes parallel to the direction of the fluid motion appearing close to the miscible interface between the two fluids, as displayed on Figure 1.

In our experiments, the influence of the relative properties of the two fluids, of the gap width and of the injection flow rate on the onset time and wavelength of the instability have been studied.

*Figure 1 : Experimental snapshot showing the striped pattern developing when a diluted solution of glycerol (20 % in mass) is injected in dyed water in a horizontal Hele-Shaw cell. The field of view is 2.6 × 4.9 cm.*

# Marcello A. Budroni

## Postdoctoral researcher, PRODEX contract

My research objective is to analyze complex dynamics resulting from the nonlinear feedback between chemical reactions and transport phenomena. Such a feedback occurs because reactive processes coupled to diffusion can induce concentration and thermal gradients, which may trigger the onset of convective motions that, in turn, affect the chemical dynamics of the system.

To understand how interfacial chemical processes can be affected by hydrodynamic instabilities and vice-versa, my research has focused on studying numerically chemo-hydrodynamic convective flows around autocatalytic fronts (which can be figured out as the chemical analog of propagating forest fires), which are prominent examples of reactive interfaces in the realm of miscible systems. Such traveling fronts, that separate the reacted fluid from the fresh reactants, can be deformed and accelerated by the combined contribution of buoyancy and Marangoni-driven flows. I have also studied theoretically to what extent a simple A + B --> C chemical reaction can break the symmetry of convective patterns (Figure 1).

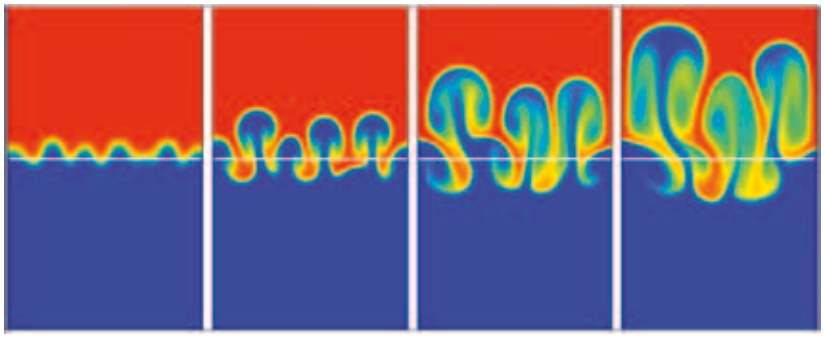
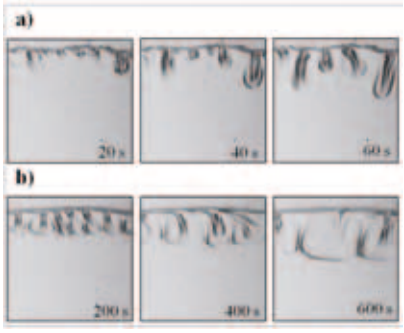


*Figure 1. Numerical simulation of a Rayleigh-Taylor instability developing at the reactive interface between two miscible solutions A (denser, top layer) and B (bottom layer). The reactive process at the interface breaks the symmetry of the pattern with respect to the initial contact line (white line).*

More recently, I have also started investigating chemo-hydrodynamic interfacial instabilities in partially miscible systems, as they are ubiquitous in many important applications such as $CO_2$ sequestration for instance. Partially miscible interfaces separate two fluids with a limited tendency to solubilize one into each other. When the transfer of mass between the two phases is associated with a reaction, the chemo-physical properties of the medium can dynamically change, affecting the hydrodynamic stability of the contact region between the two layers.

In this context, my goal is to show by means of combined experimental and numerical approaches the influence of the intrinsic miscibility and solubilization kinetics as well as the influence of chemical reactions on the emergence of hydrodynamic convective patterns (Figure 2).

*Figure 2. a) Solubilization-driven Rayleigh-Taylor instability at the non reactive interface between two partially miscible liquids: methyl-formate (upper layer) and water (lower layer). b) Chemically-controlled finger growth due to the formation of a less dense salt at the interface when a given chemical is added in the water.*



## Appraisals and Prizes

A. De Wit: Agathon de Potter Prize in Chemistry from the Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique.

A. De Wit has obtained an ARC grant for the project "CONVINCE: Convective instabilities in porous media and sea ice" (2012-2017, copromotors: B. Knaepen and J-L. Tison).

L. Lemaigre has obtained a FRIA PhD fellowship.

V. Loodts has obtained a FNRS "aspirant" PhD fellowship.

L. Rongy: Frédéric Swarts Prize from the Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique.

## Talks

January, 2012 - Anne De Wit - Research on Fluid Dynamics in the ELIPS programme - ESA - Noordwijk, the Netherlands.

February 4, 2012 - Anne De Wit - Le "mixer chimique" ou comment brasser des fluides avec des réactions chimiques - Académie royale des Beaux-Arts, des Lettres et des Sciences - Brussels, Belgium.

May, 2012 - Anne De Wit - Hydrodynamic fingering instability induced by a precipitation reaction - Lorentz Center - Leiden, the Netherlands.

May 12-17, 2012 - Luis A. Riolfo - Chemical control of miscible viscous fingering - University of Thessaly - Volos, Greece.

June 12, 2012 - Lorena Lemaigre - Dynamiques convectives autour d'un front acide-base : étude expérimentale - Summer school "Aux rencontres de Peyresq : Dynamique, non linéarités et complexité dans les phénomènes naturels terrestres" - Peyresq, France.

July 18, 2012 - Anne De Wit - Instabilities at dissipative interfaces - Session Chair: Gordon Research Conference on Oscillations and Dynamic Instabilities in Chemical Systems - Waterville, USA.

July 18, 2012 - Laurence Rongy - A + B -> C reaction fronts propagating in Hele-Shaw cells under modulated gravitational acceleration - Gordon Research Conference on Oscillations and Dynamic Instabilities in Chemical Systems - Waterville, USA.

August 19-24, 2012 - Luis A. Riolfo - How can a chemical reaction destabilize otherwise stable displacements? - IUTAM - 23rd International Conference of Theoretical and Applied Mechanics - Beijing, China.

August 28, 2012 - Anne De Wit - Asymmetric double-diffusive patterns in reactive systems - University of California Santa Cruz : Double Diffusive Systems Workshop - Santa Cruz, USA.

August 28, 2012 - Laurence Rongy - Double-diffusive Marangoni convection around exothermic chemical fronts in free-surface solution layers - University of California Santa Cruz: Double Diffusive Systems Workshop - Santa Cruz, USA.

September 02, 2012 - Lorena Lemaigre - Experimental study of buoyancy-driven instabilities around acid-base reaction fronts - European Conference on Complex Systems 2012: Young Researchers Network Meeting - Brussels, Belgium.

September 3, 2012 - Laurence Rongy - A + B -> C reaction fronts propagating in Hele-Shaw cells under modulated gravitational acceleration - Université Libre de Bruxelles - European Conference on Complex Systems - Brussels, Belgium.

September 3-7, 2012 - Luis A. Riolfo - Chemically induced viscous fingering - European Conference on Complex Systems 2012: Young Researchers Network Meeting - Brussels, Belgium.

November 18, 2012 - Laurence Rongy - Double-diffusive Marangoni convection around exothermic chemical fronts - 65th Annual meeting of the American Physical Society Division of Fluid Dynamics - San Diego, USA.

November 19, 2012 - Florence Haudin - Buoyancy-driven instability of a miscible horizontal displacement in a Hele-Shaw cell - 65th Annual meeting of the American Physical Society Division of Fluid Dynamics - San Diego, USA.

November 20, 2012 - Lorena Lemaigre - Asymmetric character of Rayleigh-Taylor and double-diffusive fingers in reactive systems - 65th Annual meeting of the American Physical Society Division of Fluid Dynamics - San Diego, USA.

November 27, 2012 - Anne De Wit - Chemically-driven hydrodynamic instabilities - Université de Mons - Mons, Belgium.

December 13, 2012 - Anne De Wit - Organisation de la recherche en Belgique - INSIS - CNRS - Paris, France.

## Journal special issue

A. De Wit, K. Eckert and S. Kalliadasis, Editors, Focus Issue of the journal CHAOS on "Chemo-hydrodynamic patterns and instabilities" (Volume 22, 2012).

## Publications

M.P.M.A. Baroni, E. Guéron and A. De Wit, Spatiotemporal chaos in the dynamics of buoyantly diffusively unstable chemical fronts, Chaos 22, 013134 (2012).

M.A. Budroni, L. Rongy and A. De Wit, Dynamics due to combined buoyancy- and Marangoni-driven convective flows around autocatalytic fronts, Phys. Chem. Chem. Phys. 14, 14619-14629 (2012).

A. De Wit, K. Eckert and S. Kalliadasis, Introduction to the Focus Issue: Chemo-Hydrodynamic Patterns and Instabilities, Chaos 22, 037101 (2012).

K. Eckert, L. Rongy and A. De Wit, A + B —> C reaction fronts in Hele-Shaw cells under modulated gravitational acceleration, Phys. Chem. Chem. Phys. 14, 7337-7345 (2012).

# List of Publications

T. Gérard, T. Tóth, P. Grosfils, D. Horváth, A. De Wit and A. Tóth, Hot spots in density fingering of exothermic autocatalytic chemical fronts, Phys. Rev. E 86, 016322 (2012).

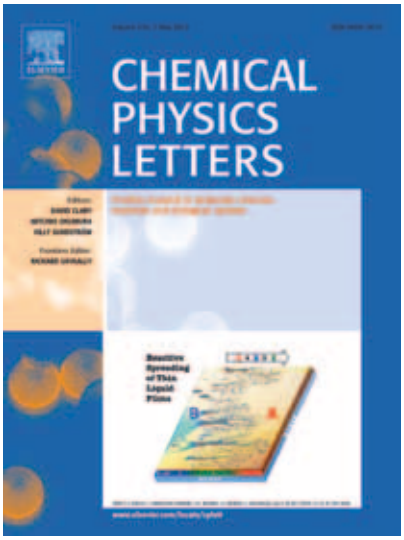
M. Mishra, A. Thess and A. De Wit, Influence of a simple magnetic bar on buoyancy-driven fingering of traveling autocatalytic reaction fronts, Phys. Fluids 24, 124101 (2012).

M. Mishra, A. De Wit and K.C. Sahu, Double diffusive effects on pressure-driven miscible displacement flows in a channel, J. Fluid Mech. 712, 579-597 (2012).

L.A. Riolfo, Y. Nagatsu, S. Iwata, R. Maes, P.M.J. Trevelyan and A. De Wit, Experimental evidence of reaction-driven miscible viscous fingering, Phys. Rev. E 85, 015304(R) (2012).

L. Rongy, P. Assemat and A. De Wit, Marangoni-driven convection around exothermic autocatalytic chemical fronts in free-surface solution layers, Chaos 22, 037106 (2012).

L.A. Riolfo, J. Carballido-Landeira, C.O. Bounds, J.A. Pojman, S. Kalliadasis and A. De Wit, Experimental reaction-driven liquid film fingering instability, Chem. Phys. Lett. 534, 13-18 (2012).




*Chem. Phys. Lett. Volume 534 front cover*

# Report from the International Advisory Committee of the Solvay Institutes

## Executive Summary

The committee wants to restate the conclusions from the last report namely that

- The Solvay Institutes are run in a most impressive and competent way.

- Within the existing organization there is not much room for a large extension of the activities.

- The Solvay Conferences are the pearls in the activities and the Centennial Conference in 2011 was a landmark in physics. Every effort should be spent to uphold this level.

- The Solvay Workshops are held at a very high scientific level with excellent speakers and participants.

- The Solvay Chairs and the Solvay Colloquia play very important roles for the universities in Brussels to get exposed to world-class scientists.

- The Solvay Public Lectures are of utmost importance to foster interest in the most modern science within the public mind.

- The Solvay Institutes and the Solvay family play an important role by providing means for postdoctoral and graduate student fellowships.

- The Solvay Institutes build an important bridge between the two language groups in Belgium.

We would further like to emphasize that we see good progress in the attempts to even out the differences between physics and chemistry and also to engage scientists from outside the Brussels area.

## The committee has the following recommendations

- The Solvay Institutes should continue to strive to broaden the funding base in order to reach an endowment large enough to ensure long-time planning stability.

- The Solvay Institutes should continue to take an active role in promoting new subjects to facilitate the universities to go into new modern areas.

- If new initiatives are taken they must carry the same excellence stamp as the other programmes.

- The Institutes should try to engage more the successful activities in bio-physics/bio-physical chemistry. A possibility would be to associate more in the chairs and the workshops the groups that are active in these areas, including those which are present in other departments than physics and chemistry. Issues in life science will most certainly be driving much of science this century.

## Introduction

The Committee that consisted of Profs Lars Brink (Göteborg), chair, Leticia Cugliandolo (Paris), Gunnar von Heijne (Stockholm) (via Skype for part of the discussions), Hermann Nicolai (Potsdam) and Jacques Prost (Paris) met in Brussels on October 23 - 25, 2012. Unfortunately Prof. Hirosi Ooguri (Pasadena) could not make it to the meeting since his flight from Tokyo to Brussels was cancelled in the last minute. In order to prepare ourselves we had obtained the annual report for 2011 and also the budget for 2011. We have also had the report from 2009 as a reference for the work.

On October 23 the Committee met with the Director and the Deputy Director Marc Henneaux and Alexander Sevrin together with the President of the Board of Directors Jean-Marie Solvay for an informal dinner. On October 24 the committee had extensive interviews with Profs Henneaux and Sevrin and with various representatives from the local faculties, Profs Barnich, Craps, Marage, De Wit, Gaspard, Geerlings, Goldbeter, De Baetselier and Wyns. The committee also had a lunch meeting with Prof. Véronique Halloin, the general secretary of FNRS and a meeting with Baron Daniel Janssen. The committee furthermore interviewed the two secretaries of the staff. Between and after the interviews and at the din-

ners and finally in the morning of October 25 the committee had its deliberations.

The committee found that all interviewees were very enthusiastic about the Solvay Institutes like last time. They are all committed to the cause to run the various activities and to uphold the excellence stamp that the name Solvay carries. Apart from the secretariat, the work behind the activities is performed on a voluntary basis within the academic positions. This puts a limit as to how much work the staff can do for the Solvay Institutes. We will comment more on this fact later.

Let us first state that the Centennial Conference in 2011 was a very heavy workload for the involved people in the last three years, but it was also a huge success for the Institutes. Even though the burden has been so big, the Director and the Board have followed our recommendations on most points in our previous report from 2009 which we find very impressive. We see very active attempts to find the right balance between physics and chemistry as well as between Brussels and the rest of the country.

## Scientific Activities

The Committee is very pleased to see how well all activities are working. The Centennial Conference was as noted above a huge success. Some 70 world leading scientists from a broad spectrum of fields in basic physics participated and the programme with longer overviews and shorter contributions led to intensive discussions among the participants. The Conference will certainly be remembered long in the future. The Proceedings which account for all the reports and the ensuing discussions will be a reference for the status of basic physics for years to come.

Even though a lot of work was committed to the organisation of the Conference, the Institutes have continued to have a full programme of Solvay workshops, Solvay colloquia, Solvay chairs as well as Solvay public lectures. On top of this the institutes have contributed to a European graduate school. We find that these programmes have been excellent as in the past. Hence there is no reason for us to discuss the individual activities. A question that was discussed now and in the previous report was if the institutes should try to accomodate more workshops. The Committee finds that the Institutes should be careful if they want to extend. The important thing is to keep the excellence of the meetings. Neither programme should be extended at the price of being diluted. We understood that it could be diffcult to get someone for a Solvay chair and be present in Brussels for the whole month. This is what should be preferred but if it cannot be achieved, a recipient of such a chair could divide up the time. As in all such questions it is up to the Director and the board to be flexible.

## The balance between physics and chemistry

The committee is pleased to see that there has been some progress in the last years to get the activities in chemistry up to a more even level with physics. There are still things to be done, but the interviewed chemists were all pleased with the work of the Director to implement this. The setting up of two separate local committees, one for physics and one for chemistry with broad participation in fields as well as in geographic spreading is a very promising step. It will be very important that these committees meet regularly and be active to propose new activities within the various programmes, and it will be the responsibility of the secretaries and the chairs of the two committees to oversee this. There was a slight complaint that there is not yet an equal number of assistants to the director from the two fields in the managerial committee. Since the work with the conferences and the publishing of the Proceedings of those are so time consuming there must be other persons involved in the other activities. There is still room for more

chemists to help in these endeavours. We encourage the Director to find and appoint one more chemist to the managerial committee to help with workshops, colloquia and chairs.

A deputy director for the chemistry activities would also help. The proposal to appoint a former vice-rector would be a splendid solution. There were some complaints that the faculty in chemistry is not taking such an active part as the one in physics. One solution to this would be the appointment of a deputy director from chemistry with apart from other missions one to engage the chemistry faculty. Another one is to more involve the activities in chemistry outside the conventional chemistry departments, such as the one in biochemistry. The committee was very pleased to see the recent success in biochemistry where one member of the faculty at VUB is an important collaborator in the work that led up to this year's Nobel Prize in chemistry. We would urge the Institutes to follow up on this success in the form of future activities.

The institutes should also use their position to introduce new important fields in physics and chemistry to the universities. It was said by a representative from ULB that there is no room for such extensions but a university must always have an eye on introducing new activities often at the expense of older activities. In the end it is the departments and the universities that decide about future directions, but the activities of the Solvay Institutes should help them in these decisions. This is another important role for the Solvay Institutes within the Belgian scientific endeavours.

Finally the Committee finds that we need one more chemist in the committee. We urge the Board to appoint one more member to help the Committee to better advise in chemistry.

## Broadening of the activities outside Brussels

The new committees with a strong participation of scientists from the rest of Belgium is a very promising attempt to engage the faculties outside the Brussels area in the activities. These people bring in new expertize in subjects not strongly represented in the Brussels area. This should lead to more proposals for the various programmes and hopefully also participation in the activities. The Committee would encourage the Director to oversee that the Solvay chairs are present not only in the Brussels area.

Already at the last meeting and again this time the committee became well aware during the discussions with the staff and the Director of the important bridge that the Solvay Institutes build between the two language groups in Belgium. The commitment to this cause is very strong and we heard appreciations for it from many corners. Also for this very difficult issue the Solvay Institutes have an important role to play.

## Postdoctoral and Graduate Student Fellowships

The committee has noticed already last time the great voluntary work that many people on the faculty perform for the Institutes. It was then suggested that a good way of rewarding this work could be to finance either a graduate student or a postdoctoral fellow for those persons. Apparently, within the Belgian system of financing graduate students it is difficult to find funding for foreign students in their first years in Belgium. A grant from the Solvay Institutes could be a handy way to overcome this problem. We notice that the Director is given a grant from the Solvay family for his activities and if the economy allows there could be room for further grants from the Institutes.

If the Solvay Institutes funding is used for such positions it is mandatory to ensure that the excellence of the students match the status that the name implies. The postdoctoral fellow or the graduate student could be called "Solvay fellow" and "Solvay graduate student" resp. to increase the attraction of such positions.

Another scheme for fostering excellence in Belgian science proposed last time was a suggestion that the Institutes might advertise two "Solvay Postdoctoral Fellowships" one in physics and one in chemistry, each year. The winners of the competition should then get a position for five years where it is mandatory that the first two or three years be spent abroad and the remaining years at an institution in Belgium. This would give exceptionally gifted Belgian students a chance to get postdoctoral training in the best universities in the world for a longer period and then be given enough time back home to get established in the Belgian system. We understand that the Board has discussed this issue and not given it a high priority. We agree with that, but will still leave it open as a possibility. This would be somewhat costly and cannot be done within the present budget, but if most of the burden could be carried by say a research council or some other organisation it could be an option.

## Staff and Support for the Director

Like last time the Committee has understood that the success of the Solvay Institutes rests heavily on the tireless and excellent work that the Director and the secretaries perform. Also the enthusiasm of the other persons involved is necessary for the success. We realize that within the present set- up one is close to the limit for what can be achieved. We are pleased to see that the secretarial staff now consists of two full-time positions and by all accounts we understand that the secretaries perform a remarkable job. With this highly skilled and motivated staff there might be room for a modest increase in the number of workshops but any new activities have to be balanced against the administrative load and the need to keep up the excellence of the activities. The Committee is not urging the Management to increase the number. It is up to them to gauge the situation and decide the appropriate number of the various activities.

Last time the Committee found the workload of the Director to be extremely heavy. Not only did he have to actively work for the funding of the Institutes and to oversee all the activities but also to take a very active role in the daily running of the Institutes. The last three years have been if possible even more strenuous for him with the Centennial Conference being planned and organized at the same time as directing all other activities. For the future his situation must be improved.
The appointment of a deputy director for the chemistry activities should ease the burden. Another heavy burden of the Director is to search for external funding to the activities. We appreciate the efforts from the Board and hope that they can take a big responsibility for this difficult affair also for the future, perhaps by appointing a person dedicated to that task. At last it is up to the Director to find a way of working which allows him to fullfill also his other activities within the university. We note that he has a very prestigious ERC grant and it is important that he also has ample time for his research.

It was remarked last time that a very important aspect of all the activities is the documentation on internet. We notice that the normal running of the web pages is performed very expertly by the staff. It is suggested in order to promote the activities and to lighten the burden for the secretariat that efficient databases and systems for organizing the list of activities within the website, as well as for communication with lecturers and participants in meetings and workshops should be introduced. Some external professional help is probably necessary to implement such systems. The director should check if there is further rationalizations that could be made to facilitate the work. The ultimate question is to check if there is funding to be saved in the long run here.

We also noted last time that the Solvay archives contain material of utmost importance for the history of science. In some respects they are unique in the world containing correspondences between some of the most important figures in the history of science. We understand that the Director has a long term plan to implement such a programme. It should be financed outside the normal budget and there should be one person with good knowledge about the Institutes and their history responsible for it. Perhaps some historian of physics could be recruted. Also the lectures and discussions at the Solvay meetings should be made available. One can here compare with the Nobel archives, which are increasingly made available on internet (apart from the ones which are still confidential.)

Already last time the Committee noted one experience from recent Solvay Conferences and Workshops that physicists want to have all the talks directly available on the internet, while chemists often want to have meetings between closed doors, being worried that intellectual property rights might otherwise become compromised or that important new ideas might be exploited by competing groups. The Institutes have to keep this in mind when making information available. If there is a possibility to show the films from the recent Conferences on the internet site, it would be very advantageous for all parties.

## Economy

The committee is very pleased to see that the economic situation for the institutes has been further strengthened. We note that there are no debts left. The budget is balanced and has even generated a surplus which has been used to pay off the old debts. This means that the Institutes are better off for the coming years than it has been in the past. We propose that the Director continues this careful handling of the budget, and further surpluses should be used to further increase the endowment unless the working committees decide to increase a certain programme. The endowment has been increased since last time but it would be preferable if it could be further enlarged. A solid endowment gives the Institutes a strong base for their independence from the universities and the common funding agencies and allows for long-term planning. We appreciate all the efforts that the Director and the Board have undertaken and encourage them to continue in this difficult endeavour.

With the prestigeous Solvay name for the various activites there should be good opportunities to attract funding from outside sources to finance many of the activities. This could help to ease the burden on the endowment and help build up the endowment. This has to be balanced though against the workload.

The Institutes pay the travel expenses for participants to the various workshops. Many scientists have quite good resources for traveling and we would encourage the institutes to gently ask the participants if they could cover the travel expenses from their own resources. This could give a surplus from the workshops that could be used elsewhere.

## Conclusions

The Committee is very pleased to see that the excellent quality of all the programmes has been upheld during the last three years and notes the great success of the Centennial Conference. The task for the Director, Board and the Management is to continue along the same lines as in recent years.

The Committee was somewhat concerned last time about the imbalance between physics and chemistry and also about the weak participation of Belgian scientists and institutions outside the Brussels area. Some important steps have been taken to even out this imbalance both

in action by the Director and the Management and by the appointment of two new committees, one for physics and one for chemistry with broad participations, and the Committee is pleased to see all that progress and believes that this is the correct way to go.

The overall impression that the committee has obtained is that the Solvay Institutes are run in a most impressive and competent way. It is remarkable that the Director and his staff have re-established the Institutes as world-leading institutions so swiftly, and the committee can only congratulate Belgium and the scientific communities in physics and chemistry to have these activities.

Göteborg Paris Stockholm Potsdam

Lars Brink Leticia Cugliandolo Gunnar von Heijne Hermann Nicolai Jacques Prost

*Lars Brink, Professor at the University of Göteborg (Sweden), Member of the Physics Nobel Committee since 2008 (chair of that committee since 2012).*

*Leticia Cugliandolo, Professor at the "Université Pierre-et-Marie-Curie" Paris VI (France).*

*Gunnar von Heijne, Professor at the University of Stockholm and at the Karolinska Institute (Sweden), Member of the Chemistry Nobel Committee from 2001 to 2009 (chair of that committee from 2007 to 2009).*

*Hermann Nicolai, Director at the Max Planck Institute (Albert Einstein Institute), Potsdam (Germany).*

*Jacques Prost, Director of the "Ecole Supérieure de Physique et de Chimie Industrielles de la Ville de Paris" (France).*

# Appendix


Le Soir
LE SOIR
lesoir.be
Le cri d'alarme de la justice francophone
CERN
High luminosity:
Remue-méninges à Bruxelles
100 ANS DE CONSEILS DE PHYSIQUE SOLVAY
Au pays de la physique quantique comme si vous y étiez né !
CATALOGUE DE L'EXPO

## Solvay Public Lectures 21 October 2012

La Libre Belgique
2 October 2012

Sciences | Conférence

# La grande science expliquée

**Trois scientifiques d'exception à Flagey, invités par les Instituts Solvay.**

Le dimanche 21 octobre après-midi, à Flagey, sera organisée la traditionnelle demi-journée publique des Instituts Solvay où trois orateurs d'exception donneront des exposés de vulgarisation sur des thèmes variés et passionnants (les années précédentes, de nombreux Prix Nobel ou célébrités comme Stephen Hawking furent invités à cette tribune) : *"The Science of Simplicity"*, *"Will our Thinking Become Quantum-Mechanical ?"*, *"Exploring the Postgenomic Protein Universe"*. Les exposés seront donnés en anglais, mais comme d'habitude, des traductions simultanées en français et en néerlandais seront assurées.

Les trois orateurs sont tout à fait exceptionnels.

George Whitesides, professeur à l'Université de Harvard, est mondialement connu pour ses travaux de pionnier dans des domaines très variés de la chimie. Lauréat de nombreux prix internationaux prestigieux, il est Docteur Honoris Causa de l'ULB. Son exposé, *"The Science of Simplicity"*, sera consacré à l'importance et au rôle de la simplicité en science et en technologie. Il sera illustré par de nombreux exemples particulièrement éloquents.

Après avoir consacré la première partie de sa carrière aux mathématiques pures où ses contributions lui ont valu la plus haute distinction (Médaille Fields 1986), Michael Freedman a tourné ses recherches vers les domaines de la physique et des mathématiques à la base des ordinateurs quantiques. Ceux-ci pourraient bouleverser l'informatique du futur. Son exposé, *"Will Our Thinking Become Quantum-Mechanical ?"* traitera de ce sujet.

Kurt Wüthrich a obtenu le Prix Nobel de Chimie en 2002 pour le développement de techniques révolutionnaires permettant l'analyse de la structure des macromolécules biologiques (protéines, acides nucléiques ADN et ARN). Ces techniques ont conduit à une explosion de la biologie moléculaire moderne. Son exposé, *"Exploring the Postgenomic Protein Universe"* sera consacré à ces techniques et à leur impact dans l'étude du génome.

A cette occasion, Jean-Pierre Clamadieu, CEO de Solvay S.A., remettra les Solvay Awards. Ces Awards récompensent de jeunes chercheurs brillants de l'ULB et de la VUB.

→ *Instituts Internationaux de Physique et de Chimie Solvay, exposés publics Solvay 2012, Espace Flagey, Studio 4. Dimanche 21 octobre 2012 à 15h. Evénement gratuit, mais inscription obligatoire sur le site de la conférence : http://www.solvayinstitutes.be/events/public2012/public2012.html. Interprétations simultanées en français et en néerlandais.*

# Newspapers

## Intra lettre ULB n° 182 – 10 October 2012

[Intra]lettre

[ Cité - Université ]

**Solvay Public Lectures**

Depuis 2005, les Instituts Solvay organisent chaque année un événement "grand public". A cette occasion, les plus grands chercheurs mondiaux viennent donner des exposés de vulgarisation sur des thèmes scientifiques variés afin de sensibiliser le public et plus particulièrement les jeunes aux grandes questions scientifiques actuelles.

Cette année, l'événement accueillera trois orateurs de premier plan:

**> George Whitesides.**
Professeur à l'Université de Harvard, il est mondialement connu pour ses travaux de pionnier dans des domaines très variés de la chimie. Lauréat de nombreux prix internationaux prestigieux, il est Docteur Honoris Causa de l'ULB. Son exposé, "The Science of Simplicity" sera consacré à l'importance et au rôle de la simplicité en science et en technologie.

**> Michael Freedman**
Après avoir consacré la première partie de sa carrière aux mathématiques pures où ses contributions lui ont valu la plus haute distinction (Médaille Fields 1986), il a tourné ses recherches vers les domaines de la physique et des mathématiques à la base des ordinateurs quantiques. Ceux-ci pourraient bouleverser l'informatique du futur. Son exposé, "Will Our Thinking Become Quantum-Mechanical ?" traitera de ce sujet.

**> Kurt Wüthrich**
Il a obtenu le Prix Nobel de Chimie en 2002 pour le développement de techniques révolutionnaires permettant l'analyse de la structure des macromolécules biologiques (protéines, acides nucléiques ADN et ARN). Ces techniques ont conduit à une explosion de la biologie moléculaire moderne. Son exposé "Exploring the Postgenomic Protein Universe" sera consacré à ces techniques et à leur impact dans l'étude du génome.

**En pratique:**
Le dimanche 21 octobre à 15h
Flagey Studio 4 - Place Ste Croix à 1050 Bruxelles

Inscription: **la conférence est gratuite mais l'inscription est obligatoire** sur le site www.solveyinstitutes.be.
Les tickets d'entrée sont envoyés par la poste
Exposés en anglais avec traduction simultanée vers le français et le néerlandais.

Contact: Dominique Bogaerts

**L'ULB organise le colloque "Ouvrir l'Université" le 25 octobre**

Afin de favoriser l'émergence d'une université vecteur d'émancipation

## Athena 284 – October 2012

AGENDA

À vos AGENDAS !

Solvay public lectures

21 octobre 2012

À Bruxelles...

## Metro – 4 October 2012

Passionné par les grandes découvertes scientifiques et leurs enjeux ? Venez assister à une conférence gratuite organisée par les Instituts Solvay !

Inscription obligatoire sur www.solvayinstitutes.be

SOLVAY PUBLIC LECTURES

SOLVAY PUBLIC LECTURES

# Solvay Public Lectures 21 October 2012

Wetenschapsinformatienetwerk


Magazine InforSciences (ULB)

## Visit to the CERN

Le Soir – 21 February 2012

Recherche / La fameuse particule élémentaire de Brout, Englert et Higgs est au menu du Cern cette année

# L'accélérateur de hadrons est « boosté »

GENÈVE

Un ministre (Jean-Marc Nollet, Ecolo), un prix Francqui (Marc Hallenaert), huit recteurs et vice-recteurs des universités francophones belges et la secrétaire générale du FNRS : le gratin de la recherche scientifique en Belgique francophone est descendu en force, lundi, sur le Cern, l'Organisation européenne pour la recherche nucléaire, située à Genève. C'est que l'année 2012 s'annonce exceptionnelle pour les physiciens belges.

« J'ai toujours voulu découvrir le LHC, ce grand accélérateur de hadrons qui permet aux physiciens de remonter aux origines de l'Univers, ou presque », explique Jean-Marc Nollet (1).

Lundi, à la frontière entre la France et la Suisse, le ministre de la Recherche de la Fédération Wallonie-Bruxelles a pu plonger vers cinéma sous la frontière franco-suisse pour découvrir ce gigantesque instrument.

Ici, en faisant se percuter à la vitesse de la lumière des protons circulant en sens inverse dans un anneau de 27 kilomètres de circonférence, on pousse la matière dans ses derniers retranchements.

Quand une collision se produit, une gerbe de particules élémentaires (comme celles qui auraient été à l'origine de l'Univers) jaillit. Et l'une d'elles, le fameux boson de Brout, Englert et Higgs (2), mobilise toutes les énergies. « Cette année, les chercheurs nous disent qu'ils auront certitude cette fameuse particule qui confère sa masse à toutes les autres », précise Nollet. Si tel est le cas, le boson n'est pas loin.

Les enfants acquièrent représentants des

25 physiciens belges impliqués dans cette aventure aussi et ils retiennent leur souffle. D'ici mars-avril, le LHC va même tourner à la vitesse supérieure : 8 TeV au lieu de 7 l'an dernier. L'objectif étant de récolter trois fois plus de données en 2012 que l'année dernière et d'aller, enfin voir ou « exclure » la fameuse particule. Le compte à rebours est lancé ! ●

CHRISTIAN DU BRULLE

## Workshop on Cosmology

Le Soir – 31 May 2012

Cosmologie / Les cordes en débat

# Stephen Hawking à Bruxelles

de Stanford, ici avec le Pr Hawking, est un des principaux chercheurs à la pointe dans la théorie des cordes. © KAN KITTANEVILLE

Le physicien britannique Stephen Hawking, professeur émérite de la chaire lucasienne de mathématiques à l'Université de Cambridge (occupée jadis par... Isaac Newton), est depuis trois jours à Bruxelles pour y suivre les travaux de l'atelier de cosmologie organisé par les Instituts Solvay et la KUL.

Les principaux physiciens de la planète spécialisés dans la théorie des cordes y discutent des problèmes-clés situés à la limite de cette théorie et de la cosmologie.

*« Etudier la théorie des cordes permet d'enrichir notre compréhension de la nature de notre univers au niveau le plus fondamental »*, a estimé Stephen Hawking. ●

C.D.B.

## Nobel Prize in Physics

Le Soir – 10 October 2012

# L'ordi quantique en ligne de mire

NOBEL Deux physiciens récompensés

- Mardi à Stockholm, le jury du prix Nobel de physique a choisi de récompenser les travaux de deux spécialistes du monde quantique.
- Serge Haroche et David Wineland étaient récemment les invités des Instituts Solvay.

En physique, quand on s'intéresse au monde microscopique, lorsqu'on étudie le comportement des plus petits composants de la matière, les lois de la physique classique ne s'appliquent plus. Ce sont celles de la physique quantique qui prévalent et qui ouvrent le champ à d'étranges propriétés.

Bien sûr, ces minuscules particules ne sont guère faciles à isoler. Pas à cause de leur taille, mais bien parce que dès qu'elles entrent en relation avec leur environnement, elles perdent leurs mystérieuses propriétés quantiques, ce qui rend leur étude particulièrement compliquée.

C'est dans ce contexte que se situent les travaux du Français Serge Haroche et de l'Américain David Wineland, tous les deux âgés de 68 ans et récompensés mardi par le prix Nobel de physique.

Les deux hommes ont chacun à leur manière mis au point des « pièges » à particules qui ne détruisent pas leur comportement quantique. Wineland attrape des atomes chargés (des ions) dans des pièges électriques. Il les contrôle et les mesure au moyen de la lumière (des photons). Serge Haroche a privilégié l'approche inverse. Il contrôle et effectue diverses mesures sur des photons en utilisant des atomes. Des données qui permettront sans doute un jour de fabriquer des ordinateurs quantiques, soit des machines bien plus puissantes que les plus puissants ordinateurs actuels.

Serge Haroche a été Maître de Conférences à l'École Polytechnique et professeur à l'Université Paris VI ainsi qu'à l'Université de Yale, aux États-Unis. Né en 1944, il est professeur au Collège de France dans la chaire de Physique quantique. Serge Haroche dirige le groupe d'électrodynamique des systèmes simples au sein du laboratoire Kastler Brossel du Département de Physique de l'ENS.

**Les deux hommes ont mis au point des « pièges » à particules quantiques**

David Wineland a participé à divers développements techniques comme l'utilisation de lasers pour refroidir les ions près du zéro absolu (-273,15 °C), une expérience réalisée pour la première fois en 1978, dans le cadre de tests en laboratoire sur les théories quantiques. Il travaille depuis 1975 au *National Institute of Standards and Technology*, du gouvernement américain, où il y dirige les études du groupe de stockage de l'ion depuis 1979.

Hier, les Instituts Internationaux de Physique et de Chimie Solvay, à Bruxelles, ont été parmi les premiers à féliciter les deux lauréats. Les deux hommes y sont bien connus. Serge Haroche y a détenu la chaire de physique en 2010 tandis que David Wineland était un des participants du 25e Conseil de Physique Solvay organisé à Bruxelles en 2013. Ce 25e Conseil marquait le centenaire de ce genre de réunions dont les premières, organisées à l'initiative de l'industriel Ernest Solvay, avaient rassemblé notamment Lorentz, Poincaré, Planck ou encore Einstein, et avaient jeté les bases de la physique quantique !

« On a beaucoup évoqué le nom d'un chercheur belge, ces dernières semaines, pour le Prix Nobel de Physique de cette année. Mais le Pr François Englert (ULB) devra patienter. La découverte annoncée cet été au Cern, à Genève, de « son » boson (imaginé avec son collègue Robert Brout, aujourd'hui décédé) et l'Ecossais Peter Higgs est sans doute trop récente. Or, comme le dit l'ULB, « *la nature de ce boson, découvert cet été, ne sera précisée que d'ici le printemps 2013* ». ●

CHRISTIAN DU BRULLE

Le Français Serge Haroche et l'Américain David Wineland sont les lauréats du prix Nobel 2012 de physique. Ils ont travaillé sur les pièges quantiques, ce qui pourrait révolutionner l'informatique. ● REUTERS

# Centenary of the First Solvay Council of Physics

Solvay live Magazine – February 2012

BETWEEN OURSELVES >>>

COUNCILS OF PHYSICS


The 1911 Solvay Council of Physics.

## of Solvay Councils
## Einstein sat here

100 years ago, the first Solvay Council of Physics took place in Brussels. A unique gathering of some of the most brilliant scientific minds in the world, the event was organized and funded by Belgian chemist, industrialist and philanthropist Ernest Solvay himself.

That first meeting, chaired by the Dutch Nobel Prize winner Hendrik A. Lorentz, included scientific luminaries no less great than Marie Curie, Albert Einstein, Max Planck, Ernest Rutherford, Henri Poincaré and Maurice de Broglie. To celebrate its 100th anniversary, the 25th Solvay Council of Physics was organized in Brussels on October 2011. With The Theory of the Quantum World as the focus of discussion, it was attended by 70 distinguished physicists, including 10 Nobel Prize winners. Among scientific circles, an invitation to a Solvay Council is an honor that simply cannot be refused. What is exceptional about the Council is the format, *"which amazingly enough is the same as it was during the 1911 conference. It's a format that favors discussions, questions and the sharing of opinions."* explains Professor Marc Henneaux, Director

Professor William Philips, Nobel Prize in Physics, 1997.

of the International Solvay Institutes for Physics and Chemistry. *"For example, there are many different views on cosmology, where quantum mechanics is relevant for understanding the early moments of the universe. One question that was very much debated this year is 'why is the universe the way it is?' If there had been different initial conditions, would then the universe be different? Is there a physical principle that implies that the universe is the way it is because there's no alternative, mathematically consistent possibility? Or are there other mathematically consistent possibilities and our universe is just one of them? And then the question is, 'why are we living in this one?' It seems a bit philosophical but there are precise scientific ways to investigate such questions."* Quantum mechanics, which provides the physical description for the interaction of matter and radiation, is intimately connected with the Solvay Councils. At the first meeting in 1911, the theory of quantum mechanics had not yet been formulated, but participants left the conference with an understanding that existing classical theories of physics could not account for phenomena observed at a microscopic level. At the fifth Solvay Council in 1927, participants discussed and completed the newly established quantum theory, as we now use it in research. In 1958, important questions of physics were debated, including gravitation. It was also the first time that black holes, though not called that at the time, were discussed. The Council of Physics has been held since 1911, and a century on, no other scientific conference has come close to having the same legendary status. ●

Solvay live · FEBRUARY 2012 29

# Newspapers

Les Cahiers (journal interne du Centre CEA de Saclay) – n° 53 – 1er trimestre 2012



## Exhibition "Brainstorming sessions in Brussels – One-hundred years of Solvay Physics Conferences"

In 2012, the exhibition started travelling through the country.





*The catalog is now available.*

## Members of the Association

Antoniou Ioannis
Barnich Glenn
Bingen Franz
Busquin Philippe
Craps Ben
De Keuleneer Eric
De Knop Paul
Delchambre Alain
Deneubourg Jean-Louis
De Wit Anne
Dewit Pascal
Gaspard Pierre
Geerlings Paul
George Claude
Goldbeter Albert
Gunzig Edgar
Halloin Véronique
Hasquin Hervé
Henneaux Marc
Janssen Daniel
Jaumotte André
de Laguiche Bernard
Lambert Franklin
Lefever René
Mandel Paul
de Maret Pierre
Monard Elisabeth
Musette-Evrard Micheline
Nicolis Grégoire
Philippot Jean
Piret Jean-Marie
Reignier Jean
Reisse Jacques
Sanglier Michèle
Schamp Niceas
Sevrin Alexander
Madame Solvay de La Hulpe
Solvay Anne-Christine
Solvay Carole
Solvay Jean-Marie
Solvay Marina
Stengers Isabelle
Thys-Clément Françoise
Van Binst Georges
Van Camp Benjamin
Van Den Broeck Christian
Van Gelder Eddy
Vanherweghem Jean-Louis
van Outryve d'Ydewalle Géry
Veretennicoff Irina
Viviers Didier
Wyns Lode
Wielemans Patrick
Willox Ralph

# Notes

# Notes

# Notes

# Colophon

Editorial Director: Professor Marc Henneaux
Editorial account: Dominique Bogaerts
Design: Marc Barbay, info@imagedemarc.be
Prepress: IMAGE de MARC, Brussels
Printing in Belgium


## Photo Credit

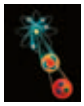
Marc BARBAY
pages 11, 12
Jean JOTTARD
pages 27, 30-35, 37, 48-51, 57, 64, 67, 78-81, 97,113-115
Antonin ROVAI
pages 86-89

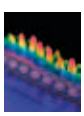
© Cern: pages 109, 135


© Cern




© Experimentarium
Chimie ULB


© Michael Gilbert
Science Photo Library/Imageglobe


© Drs A. Yazdani & D.J. Hornbaker
Science Photo Library/Imageglobe

## Postal address

International Solvay Institutes
Campus Plaine ULB / CP 231
Bd du Triomphe
B-1050 Brussels
Belgium

## Delivery address

International Solvay Institutes
Campus Plaine ULB / Access 2
Bd de la Plaine
Building NO, 5th Floor, Office 2N5 105A
B-1050 Brussels
Belgium

Tel: + 32 2 650 54 23 (Ms Van Geet)
or + 32 2 650 55 42 (Ms Bogaerts)
Fax: + 32 2 650 50 28
Emails: dominique.bogaerts@ulb.ac.be
isabelle.vangeet@solvayinstitutes.be

Website: http://www.solvayinstitutes.be