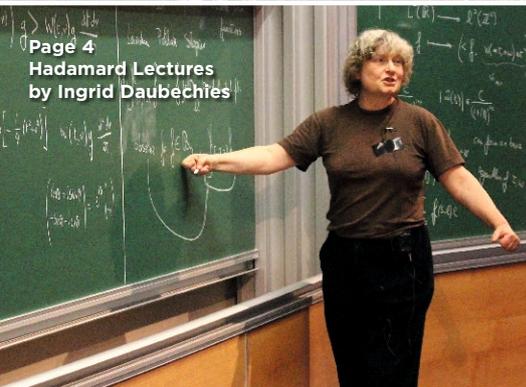
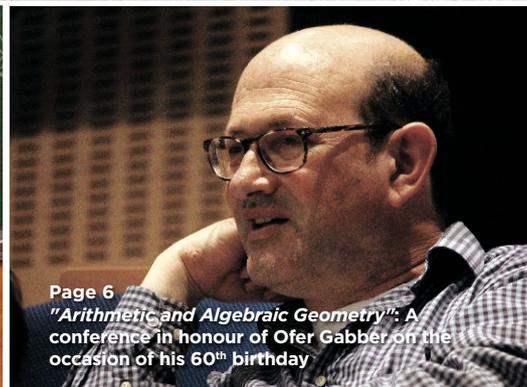


BOIS-MARIE

IHES Annual Newsletter | Issue 14 | 2018



Page 4
Hadamard Lectures
by Ingrid Daubechies



Page 6
"Arithmetic and Algebraic Geometry": A
conference in honour of Ofer Gabber on the
occasion of his 60th birthday



INSTITUT DES HAUTES ÉTUDES SCIENTIFIQUES

Le Bois-Marie, 35 route de Chartres, 91440 Bures-sur-Yvette, France
+33 1 60 92 66 00 | comdev@ihes.fr | www.ihes.fr

IHES, founding member of

université
PARIS-SACLAY

Editorial



Scientific research is not a spontaneous phenomenon (...) it is something to be worked on, that can be cultivated". This is what Léon Motchane wrote after he founded IHES early in the summer of 1958. Offering researchers the best possible environment for their work and allowing them to dedicate themselves exclusively to their research has always been IHES' mission and its strength.

Visitors to the Institute are invariably struck by the serene and studious atmosphere emanating from the site. "Bois-Marie" is an invitation to the richest of daydreams. On entering the scientific building, the intensity of exchanges in scientific events or informal conversations is equally striking. A chalkboard becomes a collective research enterprise.

The questions that both invited and permanent Professors address at IHES are deep ones; their work is an inspiring model of rigour and intransigence. In a world where speed is of the essence, the Institute gives its researchers the luxury of taking their time, the time it takes to let an idea emerge and then to develop that idea, sometimes over decades. The financial equilibrium achieved by IHES with a combination of private and institutional funds, French and international partners, endowment and operating funds offers scientists the guarantee of complete freedom.

This unique institution for fundamental research, based on excellence, freedom and exchanges continues to play a key role in the scientific community. A group like BNP Paribas uses advanced mathematics on a daily basis and we are proud that we have chosen to support the Institute by becoming a "major donor". I have agreed to become the Co-Chair of its new Campaign Committee with Philippe Camus, to convince other companies and sponsors to contribute to IHES' mission.

Since 1958, the Institute has been turning Motchane's visionary dream into reality. Join me this autumn to celebrate sixty years spent at the avant-garde of science!

Jean-Laurent Bonnafé,
Campaign Committee Co-Chair



Contents

3-4-5
Events

6-7-8-9
**60th Anniversary
programme**

10
Professor

11
Development

12
**Recollections from
Robert Penner**
Agenda

Content
IHES, M. Caillat and V. Touchant

Photo credits
IHES, M.-C. Vergne

Graphic design
www.blossom-creation.com

Translation
Hélène Wilkinson Traduction

A conference to pay tribute to Marcel Berger

IHES hosted the international conference "*Riemannian Geometry, past, present and future: an Homage to Marcel Berger*" from December 6 to 9, 2017.

Marcel Berger passed away on October 15, 2016 at the age of eighty-nine. In addition to creating a school of Riemannian geometry, he was Director of IHES from 1985 until 1993.

The idea, summarised in the title, was to present a panorama of Riemannian Geometry and its recent trends. The list of speakers reflected this general idea, and ranged from mathematicians who have known Marcel's group for a long time, to young people at an early stage of their careers, including one former student of M. Berger, D. Hulin, and two mathematical "grandsons", G. Carron and C. Guillarmou. It had always been M. Berger's wish that seminar lectures should be accessible to beginners.

Marcel's influence could be felt during the talks which were all of a very high quality, both for their scientific content and for the quality of the exposition. Deep results were described in a convivial atmosphere, including the proofs of a couple of conjectures, and we believe that the graduate students who participated in this event benefited greatly from it.

On Friday, December 8, a recollection session was organised, in the presence of Marcel's family. Participants could share their personal memories with the public. M. Gromov recounted his recollections via videoconferencing. Friends of Marcel delivered moving speeches about his habits in his professional, or in his private life.



Odile Berger, her daughters and grand-children.

The staff of IHES and the facilities provided made this conference a truly exceptional success with 102 officially registered participants and we would like to thank the Institute for their hospitality and help with the organisation.

A special issue of the *Annales de l'Institut Fourier* will be dedicated to the speakers' scientific contributions. The journal's policy is that the articles are freely accessible online as soon as they are accepted.

G erard Besson, Research Director, CNRS
and *Pierre B erard*, Emeritus Professor,
universit  de Grenoble

"Combinatorics and Arithmetic for Physics" meeting

The third edition of "Combinatorics and Arithmetic for Physics" (CAP) took place on 9 and 10 November 2017, at IHES. The meeting brings together some 20 participants, mostly Russian and European.

Combinatorics and Arithmetic for Physics: special days
9-10 November 2017
Centre de conf rences Marilyn et James Simons
Bures-sur-Yvette, France

Organisers
G rard H. E. DUCHAMP
Vincel HOANG NGOC MINH
Maxim KONTSEVITCH
Gleb KOSHEVOY

Speakers
Nicolas Behr (Paris 7)
Marek Bozejko (Wroclaw)
Pierre Cartier (IHES)
G rard H.E. Duchamp (Paris 13)
Vladimir Fock (Strasbourg)
Hoang Ngoc Minh (Lille2/Paris 13)
Maxim Kontsevitch (IHES)
Dimitry Grigoryev (CNRS-Lille 1)
Gleb Koshevoy (Poncellet Lab, IHES)
Pierre Laitrez (INRIA-LIX)
Karol Penson (Paris 6)
Leila Schneps (CNRS-Paris 6)

Sponsor
GDR
« Renormalisation »
renorm.math.cnrs.fr

Web announcement
lipn.univ-paris13.fr/~ngocminh/CAP3.html

The meeting's focus is on questions of discrete mathematics and number theory with an emphasis on computability.

Problems are drawn mainly from theoretical physics (renormalisation, combinatorial physics, geometry) or related to its models. Computation, based on combinatorial structures (graphs, trees, words, automata, semirings, bases) or classic structures (operators, Hopf algebras, evolution equations, special functions, categories) are good candidates for computer-based implantation and experimentation

From the start, these meetings have been supported by GDR Renormalisation and benefited from the facilities at IHES.

The next meeting will be held at IHES on 24 and 25 October 2018.

G rard Duchamp, IHP, Professor,
Universit  Paris-Nord and
Vincel Hoang Ngoc Minh, Professor,
Universit  de Lille

Cours de l'IHES

The 2017-2018 videos are on YouTube:



Vincent Vargas

"Liouville Conformal Field Theory and the DOZZ Formula" (November 2017)



Hugo Duminil-Copin

"The Self-avoiding Walk Model" (March 2018)



Bertrand Eynard

"Topological Recursion, from Enumerative Geometry to Integrability" (March 2018)



Francis Brown

"Mixed Modular Motives and Modular Forms for $SL_2(\mathbb{Z})$ " (April 2018)



Sergiu Klainerman

"On the Mathematical Theory of Black Holes" (June 2018)

Hadamard lectures



This year, the Hadamard lectures, which are organised by the foundation of the same name, were

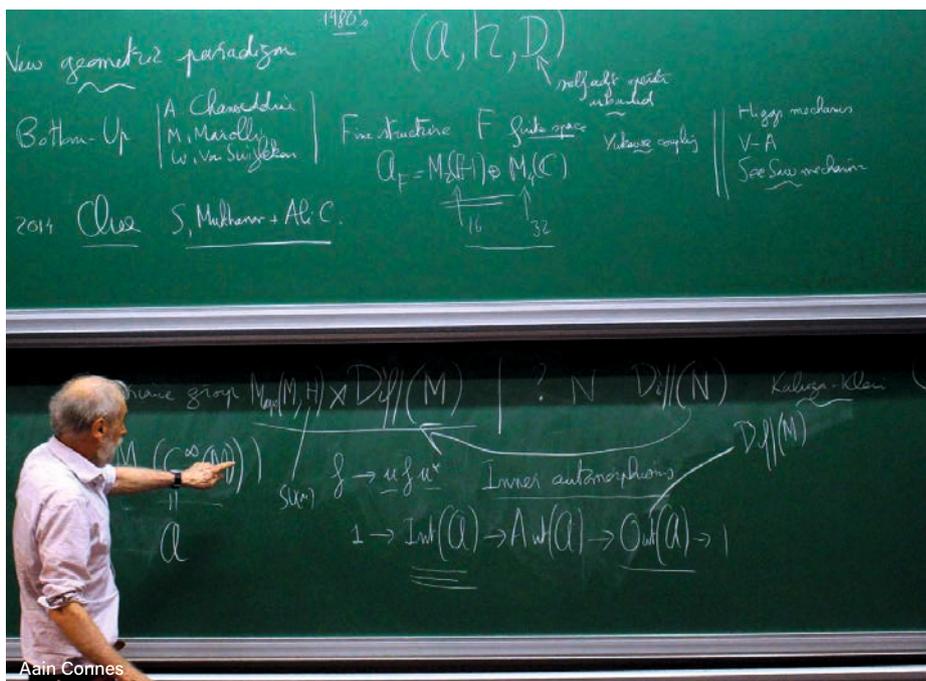
given by Ingrid Daubechies on 19 February at IHES, on the topic "Time-frequency Location and Applications".

I. Daubechies, Professor at Duke University, is a member of the National Academy of Science in the US, a foreign member of the Académie des Sciences de Paris and a former President of the International Mathematical Union.

The objective of I. Daubechies' Hadamard lectures was to present a corpus of some mathematical analysis tools developed and applied over the past thirty years. The idea is to decompose a signal, function or operator, so as to combine local data both as a time and a frequency variable. As such, these decompositions can be considered as improvements on the Fourier transform, the latter only enabling to pass from one variable to the other. In a different physical context, in which time is replaced by localisation and frequency by momentum, these decompositions are fundamental in quantum mechanics and are akin to microlocal analysis in the theory of partial differential equations.

In her lectures, I. Daubechies gradually introduced the most important of these decompositions: localised trigonometric bases, windowed Fourier transforms, Wilson bases, right up to the wavelet transforms and the more recent developments related to the use of several windows or random windows. The wide range of applications was presented extensively, including image compression, medical imaging, birdsong analysis and the detection of gravitational waves.

Patrick Gérard,
Professor, Université Paris-Sud



"Quantum Gravity: Physics and Philosophy" at IHES

A workshop held from 24 - 27 October thanks to funding from the Philosophy of Canonical Quantum Gravity ERC project was organised by T. Damour, G. Catren, E. During and F. Zalamea.

Research in quantum gravity represents a particularly suitable ground for a productive confrontation between physics and philosophy. The workshop brought together internationally renowned physicists and philosophers with the twofold objective of assessing the key conceptual problems that research in quantum gravity encounters, and explore the philosophical significance of the ideas that have emerged over the past twenty years. Talks focused on transversal questions, and more particularly on the principles and methods coming into play in different research programmes (string theory, loop quantum gravity, noncommutative geometry).

The conference's twelve lectures were organised in separate themes for each of the four days. Each lecture ended with a lengthy questions and exchanges session, making for extensive interaction among all participants. Videos of all conferences can be viewed on the conference website.

G. Veneziano (CERN), S. Carlip (University of California, Davis) and C. Rovelli (CPT) first gave an overall view of the current state of research in quantum gravity. C. Bachas (ENS) and S.

de Haro (Universiteit van Amsterdam) then explored the conceptual lessons to be learnt from holographic principles generally and from the AdS/CFT correspondence in particular, while A. Connes (IHES) discussed the reasons for coupling gravity and the standard model in light of the new geometric paradigm from noncommutative geometry. The third day focused on the status of space-time in the various quantum gravity programmes: D. Dieks (Universiteit Utrecht) and Y. Dolev (Bar-Ilan University) explored the extent to which theoretical physics can lead to an understanding of the nature of time and G. Horowitz (University of California, Santa Barbara) gave an overall view of the nature of space-time emerging from string theory. During the final day, problems arising from cosmology and black holes were covered: K. Kiefer (Universität zu Köln) presented the most recent findings in quantum cosmology, T. Jacobson (University of Maryland) challenged the current understanding of the information paradox in black holes and T. Vistarini (University of Colorado Boulder) explored how the thinking in modal realism should change to take into account the methodological specificities of string theory.

Federico Zalamea,
Postdoc, Université Paris-Diderot



International Congress of Mathematicians

The International Mathematical Union announced the names of the 2018 Fields medallists on August 1st: **Caucher Birkar, Alessio Figalli, Peter Scholze and Akshay Venkatesh**. Warmest congratulations to this group of young mathematicians on receiving the highest award in mathematics!

Peter Scholze gave a lecture on perfectoid spaces at IHES in 2011, as part of the "Cours

d'arithmétique et de géométrie algébrique." He also came to IHES last year to give a series of Hadamard lectures, "On the Local Langlands Conjectures for Reductive Groups over p -adic Fields". More recently, he was invited to an "Arithmetic and Algebraic Geometry" conference in honour of O. Gabber's 60th birthday in 2018.

Akshay Venkatesh gave a series of lectures at the IHES Summer school in 2014, on analytical number theory.

The IMU awarded the Chern Medal to **Masaki Kashiwara** who had given a *Cours de l'IHES* in 2015. A conference was also organised in his honour in 2017.

 Conferences and seminars organised at the Institute are available on the IHES YouTube Channel

"Geometry and Discrete Groups" seminar

The "Geometry and Discrete Groups" seminar is a monthly research seminar which has been taking place at IHES since September 2016. It has been funded since September 2017 by the *ERC Starting Grant DiGGeS*.

The seminar covers a broad range of topics around groups and geometry, including for instance (classical or higher) Teichmüller theory, discrete subgroups of Lie groups, various types of homogeneous geometries (hyperbolic, convex projective, affine, pseudo-Riemannian), random walks on groups, or groups of homeomorphisms or diffeomorphisms of manifolds. The seminar's focus thus lies at the intersection of geometric group theory, differential geometry, Lie theory, topology, and dynamical systems.

Each meeting consists of two lectures. These past two years we had speakers from Europe (France, Germany, Italy, Switzerland, Luxembourg) and America (United States, Canada, Uruguay). The audience includes researchers, postdocs, and graduate students from various institutions in the Paris region, invited or permanent IHES researchers, and a few colleagues from outside the Paris region.

The lectures are slightly longer (one hour and fifteen minutes) than usual, in order to leave time for speakers to motivate their topic and make it accessible to nonexperts, and then go into the details of their latest results. Ample time is devoted to questions and discussions, in view of promoting interaction between researchers of diverse origins and at different stages of their career. We hope that the seminar will attract again a varied audience this year.

Fanny Kassel, CNRS Researcher at IHES

New Associated Professor

SCHLUMBERGER CHAIR FOR MATHEMATICAL SCIENCES

Gilles Blanchard (starting October 2018), mathematician at Universität Potsdam (Germany). His research interests are statistics and machine learning and more specifically learning theory, model selection and regularisation, multiple test methods and the trade-off between statistical and computational efficiency.



Scientific Awards

CNRS felt it important to reward the French contributions to the first observation of gravitational waves emitted by the coalescence of a binary black hole system. Exceptionally, it awarded two gold medals in December 2017: one to **Thibault Damour** for his "theoretical work (...) that has been instrumental in the data analysis of gravitational waves"; the other to **Alain Brillet** "a visionary in the development of gravitation wave detection, [and] one of the fathers of the European Virgo instrument".



Not only does this prize recognise T. Damour's extraordinary contribution to contemporary physics, it also underlines the critical importance of theoretical research in major scientific breakthroughs.



Frank Merle, Cergy-Pontoise-IHES Analysis Chair holder, received the Electricité de France Ampère Prize, awarded

by the Académie des Sciences, which recognises outstanding research in the fields mathematics of physics, fundamental or applied. F. Merle works especially on universality questions related to time asymptotic behaviors of solutions of nonlinear dispersive and hyperbolic partial differential equations.

Léon Motchane founded IHES on 27 June 1958. 60 years later, the Institute's values of excellence, freedom and exchanges remain essential to its continued service to the scientific community. IHES has chosen to schedule a number of events to celebrate this anniversary. 2018 will see four major conferences taking place: the theoretical biology conference (5-9 March), the algebraic geometry conference in honour of Ofer Gabber (11-15 June), the physics summer school (16-27 July), and the theoretical computer science conference, the first of its kind at IHES (15-18 October 2018).

The 60th anniversary celebrations also represent an opportunity to reach a wider community and share enthusiasm for research. The publication of the Institute's history is being planned and IHES is also preparing a public event on 16 October, "*Savant Mélange, la soirée de la recherche scientifique*".

Ofer Gabber's 60th birthday



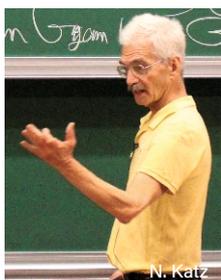
T. Saito



P. Scholze



G. Faltings



N. Katz

On the occasion of Ofer Gabber's 60th birthday, a conference in his honour titled "Arithmetic and Algebraic Geometry" has been held at IHES on June 11-15, 2018.

Ofer Gabber has done crucial mathematical research and has done it with bold constancy over the past four decades. He represents the highest levels of precision in mathematical thought and in writing. His desire to express that thought in the most suitable and general foundations has been an inspiration for generations of mathematicians. Indeed, Ofer has been a grand 'presence' in the international mathematical community even though he rarely parts from his beloved IHES where he has been doing his marvelous work since 1980. Given the ease—and gracefulness—of the way Ofer thinks about and communicates his

mathematics, he stands out, as someone once said, as one of the rare "native speakers of the mathematical language."

And his interests are wider than can be encompassed by the radius of his specific field of focus: Arithmetic and Algebraic Geometry—wide though that field is! His outstanding contributions include a proof of the purity of the intermediate extension (the most crucial result in his fundamental work with Beilinson, Bernstein, and Deligne "*Faisceaux pervers*", *Astérisque* 100, of which a second edition has just appeared), a proof of Grothendieck's absolute cohomological purity conjecture, and deep theorems on étale cohomology of quasi-excellent schemes, based on a striking, new local uniformisation theorem ("*Travaux de Gabber*", *Astérisque* 363-364).

Ofer has written two books, both fundamental foundational works: "Almost Ring Theory" (2003) with L. Ramero, "Pseudo-Reductive Groups" (2010) with B. Conrad and G. Prasad.

He has received two prizes for his research: the Erdős Prize (1981) from the Israel Mathematical Union; and the Prix Thérèse Gautier (2011) from the French Academy of Sciences.

Ofer arrived on the mathematical scene (at least from my perspective) when he came from Israel to enter the graduate program at Harvard University at the age of sixteen. My

wife Gretchen and I were asked to orient him, to the extent that was necessary, to living in the United States, and to take care of—and lodge—him for his first semester. I recall vividly my first encounter with Ofer as I drove him from the airport in Boston to our house in Cambridge. "*Professor Mazur*," Ofer said. "*I have a question.*" "*Great*," I said, steering onto Massachusetts Avenue. What followed was an ingenious question about possible generalisations of the classical Schoenflies Problem (this was what I had written my PhD thesis about, and had never thought to ask Ofer's question). "*Great question*," I said. "*I don't know the answer.*" This began a routine, where almost every day I would field yet another brilliant question from sixteen-year-old Ofer by... having to say "*I don't know.*"

"[Gabber] stands out as one of the rare native speakers of the mathematical language!"

Ofer Gabber has been—from then on, and surely will continue to be—wonderful for our mathematical community!

Barry Mazur, Gerhard Gade University Professor, Harvard University

EXCLUSIVE
Watch interviews with N. Katz, L. Illusie and O. Gabber on the IHES YouTube channel



Luc Illusie, Ofer Gabber

Successful biology conferences

For almost twenty years now, the Institute has been creating and developing the research field at the interface of mathematics and biology. As an important part of this activity, Professor Misha Gromov and his math-bio group has been organising a set of interdisciplinary international workshops and conferences which have been successful in creating the conditions for effective communication among researchers from different fields.

The last event in this series was the conference "From Molecules to Cells and Human Health" which took place at IHES in March 2018, organised by M. Gromov (IHES), A. Harel-Bellan, N. Morozova (CNRS, CEA, IHES) and N. Segev (University of Illinois at Chicago).

The purpose of the conference was to bring together researchers from different areas of biology to discuss together with mathematicians the most important hot problems of current biology. Most of these problems cannot be solved by biological methods only, and thus need mathematical formalisation and vision in order to be solved.

Examples of the topics which were very heavily discussed are: regulation of cell fate decisions, intra-and extra-cellular coordination and communication, molecular pathway analysis, manipulation of genome expression, problems of ageing and cancer progression.



Mikhail Gromov discussing with participants

Together with a large portion of time devoted to different types of discussions of these topics, a set of Workshops was held for exploring ideas in theoretical biology, which gave mathematicians and physicists the opportunity to have brainstorms on possible formalisation and analysis of concrete problems.

Among the speakers there were many world-wide famous researchers such as T. Kirchhausen (Harvard University, USA), D. Drubin (University of California, Berkeley, USA), K. Mostov

(University of California, San Francisco, USA), Y. Barral (ETH Zürich, Switzerland), J.-P. Vert (Institut Curie, France), N. Sonenberg (McGill University, Canada), and the audience included a strong group of mathematicians and physicists interested in biology, from many countries.

The fruitful discussions of the problems presented to the audience of scientists from different fields (mathematicians, physicists, biologists, computer scientists, etc.) have actively promoted the emergence of new ideas.

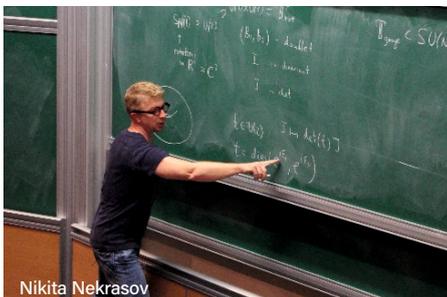
Another important part of interdisciplinary activity by M. Gromov and the IHES math-bio group in 2017 was the organisation of a series of molecular biology seminars "Fundamental Questions and Amazing Logic of Molecular Biology", which were held at the Institut Henri Poincaré, Paris. The talks with an audience, which included mathematicians, physicists and biologists, were followed by an interdisciplinary discussion.

Nadya Morozova, CNRS, CEA, IHES and Jérémie Kropp, Postdoc, IHES

Summer school in physics

This year, for the first time since Summer schools were created 10 years ago, the theme was a physics topic.

The "Supersymmetric Localization and Exact Results" Summer school took place from July 16 to 27, 2018 at IHES. Supersymmetric localization allows the computation of some (infinite-dimensional) path integrals that appear when studying supersymmetric quantum field theories. It has numerous applications: integrable systems, special functions, Gromov-Witten invariants, infrared dualities, renormalisation group flows,



Nikita Nekrasov

AdS/CFT correspondence, etc. The goal of this school was to familiarise PhD students and postdocs with the various uses of this technique developed in the decade since the work of Vasily Pestun (IHES).

On the one hand, students learned supersymmetric localization (F. Benini, SISSA), its mathematical aspects including the use of index theorems (M. Zabzine, Uppsala) and the construction of supersymmetric theories on curved spaces (G. Festuccia, Uppsala). On the other hand, students learned of applications to gluino condensation in four dimensions (S. Terashima, Kyoto), to non-local operators such as Wilson and 't Hooft loops (T. Okuda, Tokyo), and to Seiberg-Witten theories in four dimensions: their sphere partition function (W. Peelaers, Rutgers), instantons (N. Nekrasov, Stony Brook), conformal manifold and some correlators (Z. Komargodski, Stony Brook)



and chiral algebra (B. van Rees, Durham). We made 130 pages of notes taken during lectures available online and we will edit some of them to make them more widely useful.

Each week included long courses, more advanced talks and exercise sessions. Students seemed to like the latter because they led to very interesting discussions with professors. Outdoors blackboards were very successful. It is a honour to have been able to organise this event at IHES and we thank all those who contributed to its success.

Bruno Le Floch, Postdoc, Princeton university, Elli Pomoni, Professor, universität Hamburg and Masahito Yamazaki, Associated Professor, Kavli IPMU

GOMAX



Organisers	Andras BENCZUR (MTA SZTAKI Budapest) Dima SHEPELYANSKY (CNRS-Univ. Paul Sabatier, Toulouse) Emmanuel ULLMO (IHES)
Scientific Advisory Board	Andras BENCZUR, Misha GROMOV (IHES) Maxim KONTSEVICH (IHES), Dima SHEPELYANSKY
Confirmed SPEAKER	Paolo BOLDI (Universita di Milano, IT) Jean-Philippe BOUCHAUD (CFM, Paris, FR) Sergey DOROGOVTEV (University of Aveiro, PT) Leonardo ERMANN (Comisión Nacional de Energía Atómica, AR) Klaus FRAHM (Université de Toulouse, FR) Katia JAFFRES-RUNSER (IRIT, INPT-ENSEEIH, Toulouse, FR) Ravi KUMAR (Google CA, USA) Jose LAGES (Institut UTINAM, Besançon, FR) Yann LEGUN (Facebook AI Research, US) Matteo MARSILI (ICTP Trieste, IT) Stéphane NONNENMACHER (CEA/DSM/IPHT, CEA/Saclay, FR) Robert PALOVICS (MTA SZTAKI Hungarian Academy of Sciences, HU) Lior ROKACH (Ben-Gurion University of the Negev, IL) Jean-Jacques SLOTINE (MIT, US) Misako TAKAYASU (Tokyo Institute of Technology, JP) Andrew TOMKINS (Google CA, USA) Piet VAN MIEGHEM (Delft Univ., NL) Andrey ZINOVYEV (Institut Curie, FR)
With the support of	Google, CNRS, SOCIÉTÉ GÉNÉRALE, FMJH
Information and registration: www.ihes.fr	

With communication becoming globalised, mathematical concepts play an increasingly important role. Specifically, the mathematical concept known as Markov chains, introduced in 1906, has found a modern application in information search and the analysis of data flows that are at the very heart of search engines and the largest Internet companies. With the "Google Matrix, fundamentals, applications and beyond" conference, GOMAX, IHES aims to create new contact points between mathematics, physics, computer science and the world of high-tech companies.

From 15 to 18 October 2018, the conference will focus on the key characteristics that determine information flow effectiveness and control on directed networks and information retrieval. It will also discuss some of the fundamental properties of the Google matrix, such as the fractal Weyl law and the Anderson localisation for the Google matrix's own vectors. The milestones and future outlook in this field of research will be analysed 20 years after Brin and Page's seminal publication in 1998, with 18 high-calibre speakers.

A book for the 60th Anniversary

Since its creation in 1958, IHES has been a place for meetings and the sharing of knowledge, for the entire scientific community. Designed as it was from the start to become an international centre, the Institute has welcomed and continues to welcome leading figures of science. David Aubin's work, "A Cultural History of Catastrophes and Chaos Around the IHES", dealt with the 1958-1980 period but to date there has been no publication providing a history of the Institute.

Oppenheimer pushed for the creation of a physics department, Grothendieck reshaped the mathematics of the 1960s with his algebraic geometry seminar, Misha Gromov revolutionised geometry before addressing himself to biology, Thibault Damour developed computations that enabled gravitational waves to be detected... those are just some of the crucial stages in the history of science that took place at IHES.

The book aims to review the key moments in the history of the Institute and to show how it has evolved over time to become "a collective place for mathematics" in the words of historian Anne-Sandrine Paumier.

The book, which is being written, has received patronage from UNESCO.



Nicolaas Kuiper, Léon Motchane, Marcel Berger

MÉL SAVANT GE

la soirée
de la recherche
scientifique

An event designed by IHES to celebrate its 60th anniversary with science enthusiasts:
researchers, artists and also general public

Mathieu Vidard
Journalist

Cédric Villani
Mathematician and deputy

Claire Voisin
Mathematician, Professor at Collège de France

Olivier Peyon
Director

Thibault Damour
Physicist, Professor at IHES

Malek Bourkerchi
Philosopher and storyteller

Hugo Duminil-Copin
Mathematician, Professor at IHES

Laure Saint-Raymond
Mathematician, Professor at ENS de Lyon

Bruce Benamran
Creator and host of the "e-penser" YouTube Channel

Tuesday 16 October 2018 - 8.00 pm to 10.30 pm
Grand Amphitheatre at the Sorbonne

Free event (in French) but registration is required
www.savant-melange.ihes.fr





Slava Rychkov, new Permanent Professor

Born in Samara, Russia in 1975, I was introduced to mathematics and physics by my father, an aircraft engineer.

I attended a specialised physics-math high school in Samara and participated in mathematics olympiads. I went to study at the Moscow Institute of Physics and Technology, graduating in 1996. I published my first research article aged 19, and wrote a master thesis in pure mathematics (function spaces) under the guidance of O. Besov. I then started PhD studies in function spaces in Jena, Germany, with H. Triebel, subsequently transferring to the Mathematics Department of Princeton University (USA), where I got my PhD in 2002 with a thesis in harmonic analysis supervised by E. Stein.

My research focus shifted radically while at Princeton under the influence of Alexander Polyakov, who introduced me to modern theoretical physics and string theory. After

postdoctoral positions in Amsterdam (where I worked on the possibility of mini-black hole production in elementary particle collisions) and in Pisa (where I got interested in the Higgs boson physics and the scenarios of electroweak symmetry breaking beyond the Standard Model, collaborating with R. Barbieri), I became a professor of physics at the University Pierre and Marie Curie in 2009. In 2012-2017 I held a research staff position at the Theoretical Physics department at CERN, Geneva. Since October 2017, I have been a permanent professor at IHES. I also hold a part-time Mitsubishi professorship of high energy physics at the Ecole Normale Supérieure (rue d'Ulm).

While some of the pure math theorems that I proved 20 years ago are still in use, overall I find that the mindset of theoretical physics fits better my natural inclinations. In physics, I am able to find better balance between formal and conceptual beauty as well as applications to real-world systems, and I also value highly the

practical aspect of the physicist's job - to make predictions and explain the experiments. It is in physics that I was able to produce my most satisfying result so far - demonstrating the practical feasibility of an algebraic approach to the physics of second-order phase transition known as the conformal bootstrap (see below). For this work I was awarded the 2014 New Horizons in Physics Prize by the Breakthrough Foundation.

A high energy physicist by training, I also have great interest in neighboring fields such as statistical physics and condensed matter physics, which pose conceptually similar problems - dealing with systems consisting of infinitely many particles or infinitely many fluctuating entities. The IHES environment fosters close interaction between physicists and mathematicians. For me this is precious, as some physics problems I am currently interested in could benefit from a mathematically rigorous perspective.

Slava Rychkov, Permanent Professor, IHES

A few words about the conformal bootstrap

A key to understanding a physics problem is often an idealisation which captures the essential details and removes the unnecessary ones. Take for example a magnetic material. Its often-used idealised formulation is the Ising model, which replaces a real magnet by a system of microscopic magnetic moments (supposed to represent electron spins) which are restricted to live on a cubic lattice and can only take values ± 1 ("up" and "down"). In addition, one assumes that only nearest-neighbor spins interact. This idealisation is useful - it allows to understand that microscopic spins will align, giving rise to magnetic behavior, at sufficiently low temperatures, while at temperatures above a certain critical temperature T_c , the individual spin directions will randomise and magnetism will be lost. (Try to heat your fridge magnet with a lighter and you will see).

It often happens that an idealised description works well in one regime but will become less powerful in another. In the above situation, while the Ising model was useful to predict the existence of the critical temperature, it is

nontrivial to use it to say what happens exactly at this critical point. While for 2D magnets this has been accomplished, in the case of 3D magnets it is still unknown if and how this can be done.

Fortunately, there is another way to think about the critical point. Instead of individual spins, one thinks in terms of their collective behavior. Like vibrations of a string can be decomposed into harmonics, each characterised by its frequency, fluctuations of spins in a magnet at the critical temperature can be decomposed into independent components, each characterised by a real number called scaling dimension. There are infinitely many fluctuation types, with larger and larger scaling dimensions, which means that they decay faster and faster with distance. Scaling dimensions are experimentally measurable and interesting quantities, but to determine them theoretically is a nontrivial task. Until recently, this could only be done approximately by the renormalisation group method (K. Wilson, Nobel prize 1982). The conformal bootstrap provided a new (and in some cases more precise) solution. "Conformal" refers to the key role played in

this solution by the conformal transformations - transformations which deform the space in a way which preserves the angles. That such transformations should have something to do with magnets at the critical temperature, was first hypothesised in 1970 by my Princeton advisor A. Polyakov, whose prophetic work laid foundations for the more recent developments. "Bootstrap" refers to the magic - to a non-initiated, it may look like one gets the answer seemingly out of nothing, "pulling oneself up by the bootstraps". More precisely, the conformal bootstrap identifies several key properties that the scaling dimensions have to satisfy, writing down a system of consistency conditions, and showing that it has a unique solution. This kind of reasoning is somewhat unusual in physics (although it is used more often in mathematics). The precise reason why this works is not yet fully understood and one expects more exciting developments in the years to come. Simons Collaboration on the Non-perturbative bootstrap (<http://bootstrapcollaboration.com>) was founded in 2016 and unites researchers worldwide interested in this topic.



Yann LeCun, Jennifer Chayes

Record success for 2017 gala

Friends of IHES, the foundation which supports IHES in the US, organised an unforgettable evening for its fifth New York gala.

Guests of honour Yann LeCun, Director of Artificial Intelligence Facebook and Jennifer Chayes, Director of Microsoft Research New England, New York City and Montreal, enthralled the 180 guests with their talks on artificial intelligence, the theme of the gala.

Michael R. Douglas, President and Executive Director of Friends of IHES thanks the sponsors and participants who between them raised over \$500,000, a record for this event!

All the photos and a video of the evening are on www.ihesgala.org

Support from Crédit Agricole d'Ile-de-France Mécénat

Since 2007, the Institute has been pursuing an ambitious project to digitise its archives, which represent important scientific and historic heritage that needs to be preserved and made available to the public.

The generosity of Crédit Agricole d'Ile-de-France Mécénat made it possible for IHES to recruit a young archivist and historian to continue this project and extend its scope. He spent the few months he was at the Institute exploring fascinating documents, showing the links between IHES and a number of key figures who left their mark on the history of science.

François Imbault, President of Crédit Agricole Ile-de-France, came to the Institute with a delegation on 4 April. By meeting the teams and exploring the archives, the delegation was able to see the impact of their support. The visit ended with a ceremony celebrating the official signature of the partnership.



François Imbault, Emmanuel Ullmo

The Institute is now on Twitter, follow [Institut_IHES](https://twitter.com/Institut_IHES), for all our latest news!



Generous donors for the 60 years of IHES

The Institute's major sponsors, as well as prestigious institutions have chosen to support the IHES 60th Anniversary. Scientific events and activities for the public have received funding and patronage, the practical consequence of which is that the Institute is able to implement an ambitious program of celebrations.

Emmanuel Ullmo, IHES Director and Marwan Lahoud, Chairman of the Board of Directors, would like to thank all the Institute's partners:

- UNESCO and French Commission for UNESCO
- Mairie de Paris
- BNP Paribas
- Société Générale
- Google
- Schlumberger
- CNRS
- Génopole
- Institut Curie
- CARMIN
- Clay Mathematical Institute
- Fondation mathématique Jacques Hadamard

Fundraising

A supporter of the Institute for several years, Jean-Laurent Bonnafé, Director and Chief Executive Officer of BNP Paribas, has agreed to co-chair, together with Philippe Camus, the "IHES, *avant-garde de la science*" campaign.

This third fundraising campaign will be launched officially on 16 November 2018 at an event in the presence of the French Minister for Higher Education, Research and Innovation, Frédérique Vidal.



recollections from...

Robert Penner

Robert Penner's early research was in the fields of topology and dynamical systems, his interest then turned to geometry and its interfaces with physics. A frequent Visiting Professor at IHES for decades, he has been holding the newly created René Thom Chair since 2014 and works in theoretical biology.

66

It is sobering to note that I am one year younger than Disneyland and one year older than IHES, which I first visited over 25 years ago. I would come regularly to see D. Sullivan, whom I had met as I got my PhD, and we quickly became friends as he hosted to dinner any of us from W. Thurston's gang in Princeton if we would attend his Gelfand-style often absurdly long seminars in NYC. In Paris, at that time I had no serious scientific contact but quite cordial casual relations with R. Thom and M. Gromov and no clue that my passions would later turn towards biology as had theirs already. I had by then almost accidentally written my first paper on RNA. There was a boiling community of topologists, physicists and dynamical systems folks around Dennis, D. Ruelle, A. Connes and T. Damour including J.-C. Yoccoz, K. Gawedzki and E. Ghys. I remember fondly O. Gabber, frankly mostly unchanged until today, and C. Soulé as well, a young number theory rock star now also working in biology, P. Cartier and A. Douady too as regulars, and J. Fröhlich also a frequent visitor. And of course, P. Gourdon dishing up gorgeous lunches binding us together in body and mind five times a week as he still does. All this under the gentle and visionary stewardship first of N. Kuiper and then J.-P. Bourguignon. And my dear friend C. Itzykson, as I understood en route to the directorship, abruptly taken from it and from us all by cancer.

Despite nearly doubling in size, Ormaille remains in many ways much the same with children everywhere after shuttling back from school during the week. I remember my own kids happily playing in gaggles with or without

common language, my son stuck in a tree he had climbed with D. Vershik unable to descend calling for help in Russian/English and his running off one morning with D. Hubbard to the boulangerie secretly "to get married" and share a pastry. Or my tiny daughter first meeting Dennis looking him up and down and saying to his amazement "so you're Sullivan, I've heard a lot about you." Ormaille used to be rather more communal with spontaneous get-togethers, and I gather it was even more so before my time, casually crawling through a window to join one or another ongoing party, Douady periodically hosting mechoui. Though a dark recollection, perhaps it is important to remember that the decorative cherry tree next to the gardien's office was planted to commemorate C. Osgood who died at Ormaille of AIDS at age two shutting the entire institute in grief and shock for days.

I have known M. Kontsevich since he was in his mid-twenties, and I recall him described then as a bunny rabbit gleefully hopping through the fields of mathematics. I remember as he contemplated coming to IHES to take over the professorship vacated by Sullivan, which in turn had been relinquished by Grothendieck. Maxim's move to IHES has changed the character of the institute, but what has not changed is his playful joy for science, his unblinking humility and spectacular intellect. Several times after months of study and work I have mentioned to him my progress on some project or other, and the first words out of his

mouth summarised what had taken me months to uncover. Humbling at best. He has brought with him not only to the institute a cadre of top Russian and other visitors across mathematics and physics but also permanence to volleyball at Ormaille. There once were only French- and English-speaking tables at lunch but now often the largest by far is Russian, the volleyball net once supported by cement-filled tires...

IHES remains the vibrant, hospitable and exciting community it has always been, and I feel lucky to be here. I have said that it

"IHES remains the vibrant, hospitable and exciting community it has always been."

compares only to IAS in Princeton, after which it was roughly modeled by founder Leon Motchane, and to the Newton Center in Cambridge, though it is about a factor of 5 and 15 smaller respectively. For

only at these institutes is there such a dynamic mix of first-rate mathematicians, physicists and biologists so thoroughly mingled. At all three there is a community working and lunching together though the comparative intimacy of IHES is critical to its cohesion and family atmosphere. I realise that as an older guy myself I have emphasised here other older guys. The appointments of L. Lafforgue, also nearly an older guy, and V. Pestun, H. Duminil-Copin and S. Rychkov, the latter several under the current astute directorship of E. Ullmo, as well as the talented CNRS-attached professors, point towards the continuing eminence of IHES for decades to come.

Joyeux 60^e anniversaire!

”

2018/2019 events

From 5 to 7 September 2018, IHES - **Freshers' welcome** for the FMJH Master program.

11 October 2018, IHES **Freshers' welcome** for the Hadamard PhD School of Mathematics.

From 15 to 18 October 2018, IHES - "**Google matrix: fundamentals, applications and beyond**" - Workshop organised by A. Benczur, D. Shepelyansky et E. Ullmo.

16 October 2018, Grand Amphitheatre at the Sorbonne "**Savant Mélange, la soirée de la recherche scientifique**".

From 24 to 25 October 2018, IHES - "**Combinatorics and Arithmetics for Physics: Special days**" organised by G.H.E Duchamp, M. Kontsevich, G. Koshevoy and V. Hoang Ngoc Minh.

22 November 2018, IHES, "**Le désordre est presque sûr**" by L. Saint-Raymond - Conference organised by *Les Amis de l'IHES*.

From 17 to 18 December 2018, IHES - **Colloquium in honour of Alain Valette for his 60th birthday**, organised by I. Chatterjee, Y. Cornulier, S. Moon, Y. Stalder and R. Tessera.

From 14 to 18 January 2019, IHES, "**IHES, Higher Structures in Holomorphic and Topological Field Theory**" - QUASIFT conference organised by C. Elliott and V. Pestun.

From 11 to 14 June 2019, IHES, "**Resurgence in mathematics and physics**" - Workshop organised by Y. Soibelman.

From 8 to 19 July 2019, IHES "**Topics in Geometry and Group Theory**" Summer school - organised by R. Canary, I. Chatterji and F. Kassel.

Cours de l'IHES start again in October 2018.
Full details on the IHES website.