7ECM BERLIN 2016

LAUREATES

7th European Congress of Mathematics
July 18-22, 2016
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7ECM – Laureates

With this brochure, we introduce to you the **twelve laureates**, who were awarded with the Felix Klein Prize, the Otto Neugebauer Prize and the ten EMS Prizes on July 18th, 2016, during the Opening Ceremony of the 7th European Congress of Mathematics (7ECM) in Berlin.

The prizes were awarded by the President of the European Mathematical Society, Pavel Exner (Prague, Czech Republic), together with representatives of the prize committees. Each award comprises a certificate and a cash prize of 5000 €.

The **Felix Klein Prize**, endowed by the Fraunhofer Institute for Industrial Mathematics in Kaiserslautern, is awarded to a young scientist (under the age of 38) for using sophisticated methods to give an outstanding solution, which meets with the complete satisfaction of industry, to a concrete and difficult industrial problem. Chair: Mario Primicerio, University of Florence.

The **Otto Neugebauer Prize** is awarded for a highly influential article or book in the field of history of mathematics that enhances our understanding of either the development of mathematics or a particular mathematical subject in any period and in any geographical region. It is sponsored by the Springer Verlag. Chair: Jesper Lützen, University of Copenhagen.

Ten EMS Prizes are awarded to young researchers not older than 35 years, of European nationality or working in Europe, in recognition of excellent contributions in mathematics. The main supporter of the EMS Prizes is the non-commercial Foundation Composition Mathematica. Chair: Björn Engquist, Uppsala University; University of Texas, Austin.

7ECM Prize Lectures

Felix Klein Prize Lecture	Monday, 16:00 – 16:45
Chair: Marion Schulz-Reese	Audimax (main buildung)

16:00 **Patrice Hauret**, Eric Lignon, Benoît Poulot, Nicole Spillane: *Space-Time Two-Scale Methods for Computational Solid Mechanics*

Otto Neugebauer Prize Lecture	Monday, 16:00 – 16:45
Chair: Moritz Epple	H0104 (main buildung)

16:00 **Jeremy Gray**: *Living Mathematics: Poincar'e and Weyl in context*

EMS Prize Lecture I	Tuesday, 11:45 – 12:30
Chair: Laurence Halpern	H0104 (main buildung)

11:45 **Sara Zahedi**: *Cut Finite Element Methods*

EMS Prize Lecture II	Tuesday, 11:45 – 12:30
Chair: Martin Raussen	H1012 (main buildung)

11:45 **Mark Braverman**: *Information Complexity and Applications*

EMS Prize Lecture III	Tuesday, 11:45 – 12:30
Chair: Mats Gyllenberg	H1058 (main buildung)

11:45 **Vincent Calvez**: *Mesoscopic models in biology*

EMS Prize Lecture IV	Tuesday, 11:45 – 12:30
Chair: Sjoerd Verduyn Lunel	H2032 (main buildung)

11:45 **Guido De Philippis**: *On the singular part of measures constrained by linear PDEs and applications*

EMS Prize Lecture V = Plenary Lecture 2	Monday, 14:30 – 15:30
Chair: H. Esnault	H105 (main buildung)

14:30 **Peter Scholze**: *Perfectoid Spaces and their Applications*

EMS Prize Lecture VI	Wednesday, 11:45 – 12:30
Chair: N.N.	H0104 (main buildung)

11:45 **Peter Varju**: *Recent progress on Bernoulli convolutions*

EMS Prize Lecture VII	Wednesday, 11:45 – 12:30
Chair: Alice Fialowski	H1012 (main buildung)

11:45 **Thomas Willwacher**: *Graph complexes in algebra and topology*

EMS Prize Lecture VIII	Wednesday, 11:45 – 12:30
Chair: Janos Pintz	H1058 (main buildung)

11:45 **James Maynard**: *Primes with missing digits*

EMS Prize Lecture IX	Wednesday, 11:45 – 12:30
Chair: Volker Mehrmann	H2032 (main buildung)

11:45 **Hugo Duminil-Copin**: *The Ising model: beyond integrability*

EMS Prize Lecture X	Wednesday, 11:45 – 12:30
Chair: Gert Martin Greuel	H1028 (main buildung)

11:45 **Geordie Williamson**: *Shadows of Hodge theory in representation theory*

Patrice Hauret

* 1977 in Pau (France)

Tire Designer
Michelin

Felix Klein Prize 2016

Patrice Haurets research and teaching in the field of applied mathematics have made extremely useful contributions to industrial needs: He has advanced the modelling and simulation of tires for Michelin. And he has dealt with the interaction of solids with flows (as the air spinning of filaments), and multiscale-approaches, as required e.g. in the simulation of filters of any kind.

Research Interests

Patrice Haurets main scientific interests are in the field of computational solid mechanics, ranging from the analysis of discretization methods to multi-scale and domain decomposition. He has lead the Computational Solid Mechanics Group at Michelin Technology Center and coordinated corporate and academic cooperation in scientific computing and simulation.

Curriculum Vitae

2016	Tire Designer at Michelin
2012	Head of Computational Mechanics Group at Michelin
2011	Habilitation in Applied Mathematics, Univ. Pierre et Marie Curie
2006	Computational Mechanics Project Leader at Michelin
2004	Post-Doc at the California Institute of Technology
2004	Ph.D. Thesis in Applied Mathematics, Ecole Polytechnique
2001	Engineer's Degree
2000	Master (DEA) Numerical Analysis, Université Pierre et Marie Curie
1997	Studies of Applied Mathematics and Mechanical Engineering

Felix Klein Prize Lecture – Abstract

Space-Time Two-Scale Methods for Computational Solid Mechanics

The efficient, robust and accurate assessment of structures in large deformation simultaneously requires: i) the resolution of micro-scale states to avoid theuse of empirical material laws and assess reliability,
ii) the availability of sufficiently light models to enable optimal structure design and uncertainty quantification.

The present work contributes to the first objective by the use of variational integrators, a non-conforming space discretization in the sense of mortar methods and the design of optimal coarse grids to enhance traditional domain decomposition methods.The second issue is handled by an homogenized problem iteratively improved by accurate subgrid models in space and time. Several aspects of the method are analyzed and some examples are displayed as an illustration.

Patrice HAURET (Michelin), Eric LIGNON (Michelin), Benoît POULIOT (Université Laval), Nicole SPILLANE (Ecole Polytechnique)

Jeremy Gray

* 1947 in Newcastle upon Tyne (England)

Emeritus Professor
Open University, Milton Keynes, UK

Otto Neugebauer Prize 2016

Jeremy Gray is one of the (of not the*) leading historian of modern mathematics. His highly original, extensive and deep body of work on 19th and 20th century mathematics has greatly advanced our knowledge about this period.*

Research Interests

The history of mathematics, specifically the history of geometry and analysis, and mathematical modernism in the 19th and early 20th Centuries. The work on mathematical modernism links the history of mathematics with the history of science and issues in mathematical logic and the philosophy of mathematics.

Curriculum Vitae

2015 Honorary Professor in the Math. Dep., University of Warwick (UK)
2014 Emeritus Professor, Open University, Milton Keynes (UK)
2012 Inaugural Fellow of the American Mathematical Society
2002 Professor Open University, Milton Keynes (UK)
1998 (since) Affiliated Research Scholar, University of Cambridge (UK)
1983 Visiting Assistant Professor of Mathematics, Brandeis Univ. (USA)
1987 Senior Lecturer Open University, Milton Keynes (UK)
1978 Lecturer Open University, Milton Keynes (UK)
1970 MSc Mathematics, University of Warwick (UK)
1969 First Class Honours in Mathematics, University of Oxford (UK)

Otto Neugebauer Prize Lecture – Abstract

Living Mathematics: Poincaré and Weyl in context

Henri Poincaré and Hermann Weyl enriched both mathematics and physics. Indeed, Poincaré and Weyl lived their mathematics, physics, and philosophy, and they reflected deeply on their work in their popular essays. By looking at the popular writings we can gain an intimate sense of what animated them, the different sets of values and aspirations that they had, and the ways they saw the significance of their work.

Tradition is for the mathematician to create, change, even transcend – and surely Poincaré and Weyl transcended it – and for the historian to take apart, complicate, re-balance, even reject. But everyone is marked by their time and place.

Sara Zahedi

* 1981 in Teheran (Iran)

Assistant Professor
Royal Institute of Technology (KTH), Sweden

EMS Prize 2016

„For her outstanding research regarding the development and analysis of numerical algorithms for partial differential equations with a focus on applications to problems with dynamically changing geometry.“

Research Interests

Sara Zahedis research interests lie in the development and analysis of computational methods, in particular finite element methods, for solving partial differential equations on dynamic geometries. The main application she has in mind is multiphase flows. She is also interested in numerical methods for representing and evolving interfaces separating immiscible fluids.

Curriculum Vitae

2014 Assistant Professor in Numerical Analysis, KTH, Stockholm (Swe)
2011 Postdoctoral Position, Uppsala University (Swe)
2011 PhD in Numerical Analysis, KTH, Stockholm (Swe)
2006 Master of Science with a major in Mathematics, KTH (Swe)
2006 Teaching Assistant, Dept. of Numerical Analysis, KTH (Swe)
2003 Teaching Assistant, Stockholm University (Swe)

EMS Prize Lecture I – Abstract

Cut Finite Element Methods

Finite element methods are famous for efficiently solving Partial Differential Equations (PDEs) in complex geometries but require the mesh to conform to the geometry. When the geometry is evolving and undergoes strong deformations the required remeshing and interpolation [3] leads to significant complications, especially in three space dimensions.

We present a new computational method for solving PDEs in dynamic geometries. Such PDEs occur for example in multiphase flow problems where PDEs on interfaces sepa- rating immiscible fluids or in bulk domains having these interfaces as boundaries need to be solved. The proposed method, referred to as Cut Finite Element Methods (CutFEM), allows the dynamic geometry to be arbitrarily located with respect to a fixed background mesh. The strategy is essentially to embed the time-dependent domain where the PDE has to be solved in a fixed background mesh, equipped with a standard finite element space, and then take the restriction of the finite element functions to the time-dependent domain. Since the geometry can cut through the mesh arbitrarily there might be elements with small cuts. Such "small cut elements" may cause ill-conditioning and also prohibit the application of a whole set of well-known estimates, such as inverse inequalities. We add consistent stabilization terms [1] to the variational formulation which let us transfer the control of discrete functions on small cut elements to close-by neighbors with large intersection. These stabilization terms guarantee that the resulting system matrices have bounded condition number independently of the position of the dynamic geometry relative to the background mesh.

We have proposed stabilized CutFEM for the Stokes equations involving two immiscible incompressible fluids with different viscosities and with surface tension [4], for PDE:s on time-dependent surfaces [5], for stationary coupled bulk-surface problems [2], and for time dependent coupled bulk-surface problems [6] modeling the evolution of soluble surfactants.

References

[1] E. Burman. Ghost penalty. C. R. Acad. Sci. Paris, Ser. I 348 (21-22) (2010), 1217–1220.

[2] E. Burman, P. Hansbo, M. G. Larson, S. Zahedi. Cut finite element methods for coupled bulk-surface problems. Numer. Math. 133 (2) (2016), 203–231.

[3] S. Ganesan, L. Tobiska. Arbitrary Lagrangian–Eulerian finite-element method for computation of two-phase flows with soluble surfactants. J. Comput. Phys. 231 (9) (2012), 3685–3702.

Mark Braverman

* 1984 in Perm (Russia)

Professor at Department of Computer Science
Princeton University, NJ (USA)

EMS Prize 2016

“For his important contributions to several fields at the interface of mathematics and computer science with answers to many basic questions on the computability of objects that arise in dynamical systems, on computing of Riemann mappings and a remarkable solution of the Linial-Nisan conjecture.“

Research Interests

Braverman focuses on Theoretical Computer Science and its connections to other disciplines. Specific areas include: Computational complexity theory and algorithms, with connections to analysis and geometry. Information theory and its applications to computational complexity theory through the new area of information complexity, which he helped develop. Computability and complexity in analysis and dynamics. Mechanism design theory, particularly developing algorithmic approaches to mechanism design.

Curriculum Vitae

2015 Professor, Dept. of Computer Science, Princeton University (USA)
2011 Assistant Professor, Computer Science, Princeton University (USA)
2010 Assistant Professor, Comp. Science, University of Toronto (Ca)
2008 Postdoc Microsoft Research New England, Cambridge (USA)
2008 PhD in Computer Science, University of Toronto (Canada)
2004 MSc in Computer Science, University of Toronto (Canada)
2002 MSc in Mathematics, University of Toronto (Canada)
2001 BA in Mathematics with Comp. Sci., Technion, Haifa (Israel)

EMS Prize Lecture II – Abstract

Information Complexity and Applications

Over the past two decades, information theory has reemerged within computational complexity theory as a mathematical tool for obtaining unconditional lower bounds in a number of models, including streaming algorithms, data structures, and communication complexity. Many of these applications can be systematized and extended via the study of information complexity — which treats information revealed or transmitted as the resource to be conserved.

In this talk we will discuss the two-party information complexity and its properties — and the interactive analogues of classical source coding theorems. We will then discuss applications to exact communication complexity bounds, hardness amplification, and quantum communication complexity.

Vincent Calvez

* 1981 in Saint-Malo (France)

CNRS Young Researcher
Ecole Normale Supérieure de Lyon (France)

EMS Prize 2016

„For his pioneering work at the intersection between mathematics and biology with fundamental contributions to mathematical analysis and development of new mathematical models with applications in biology and biophysics.“

Research Interests

Vincent Calvez is working in mathematical biology. He has been studying collective migration of bacteria within a large concentration wave, inside a micro-channel. Thus, he could compute the speed of propagation, by taking into account individual movements of bacteria within the large wave. This enhances knowledge about bacteria interactions, and raises new mathematical questions. More recently, he moved to theoretical evolutionary biology, e.g. dispersal evolution, invasive species, and ageing.

Curriculum Vitae

2015 Habilitation à Diriger des Recherches (HDR), ENS Lyon
2009 Member of the project team Inria NUMED at ENS Lyon
2008 CNRS Young Researcher at UMPA, ENS de Lyon (France)
2007 PhD in Mathematics, Univ. of Paris 6 and ENS de Paris (France)
2005 Agrégation de mathématique with rank 6
2004 MSc in PDE and Numerical Analysis, Univ. of Paris 6 (France)
2001 Interdisciplinary programme in math and biology, Ecole Normale Supérieure (ENS), Paris (France)

EMS Prize Lecture III – Abstract

Mesoscopic models in biology

I will discuss the problem of concentration waves of swimming bacteria. I will present both the biological content, and some mathematical challenges that arise from this study. Concentration waves of bacteria Escherichia coli were described in the seminal paper by Adler (Science 1966). This is one of the most salient effects of chemotaxis – the way how bacteria respond to chemical stimuli in their environment. These experiments gave rise to intensive mathematical modelling and analysis, after the original work by Keller and Segel (J. Theor. Biol. 1971), and the contributions of Alt and co-authors in the 80s (J. Math. Biol. 1980).

We have revisited this old problem in collaboration with a group of biophysicists (Silberzan's Lab, Institut Curie, Paris). Based on massive tracking experiments, we could validate a kinetic model analogous to the Boltzmann equation, the so-called run-and- tumble equation. This equation expresses the fact that bacteria spends more time in favourable directions (here, favourable means that the chemical concentration of some nutrient is increasing). When coupled with suitable reaction-diffusion equations for the chemical signals in the environment, this model agrees very well with the experiments [2].

When reduced to a macroscopic equation at a larger scale, exact travelling wave solutions can be computed explicitly [1]. However, mathematical difficulties arise at the mesoscopic scale. I will present a recent result about existence of travelling waves for the coupled kinetic/reaction-diffusion system for chemotactic bacteria [3].

I will finally discuss two other problems that emerged from this case study: evolution of dispersal at some species' invasion front, and maladaptation in age structured population. These problems share similar features: propagation phenomena, and multivariate structure of the equation. As for position × velocity in the kinetic model for bacteria, the model for dispersal evolution involves position × dispersal ability, whereas the model for evolutionary ageing involves age × phenotype. I will build on this analogy to discuss applications of mathematical analysis in biology. In particular, original Hamilton-Jacobi equations emerge from the quantitative analysis of such propagation phenomena.

References

[1] J. Saragosti, V. Calvez, N. Bournaveas, A. Buguin, P. Silberzan, and B. Perthame. Mathematical description of bacterial travelling pulses. PLoS Comput. Biol. (2010).

[2] J. Saragosti, V. Calvez, N. Bournaveas, B. Perthame, A. Buguin, and P. Silberzan. Directional persistence of chemotactic bacteria in a travelling concentration wave. Proc. Natl. Acad. Sci. U.S.A. (2011).

[3] V. Calvez. Chemotactic waves of bacteria at the mesoscale. Preprint arXiv:1607.00429 (2016).

Guido De Philippis

* 1985 in Fiesole (Italy)

Associate Professor
SISSA Trieste (Italy)

EMS Prize 2016

„For his outstanding contributions to the regularity of solutions of Monge-Ampére equation and optimal maps and for his deep work on quantitative stability inequalities for the first eigenvalue of the Laplacian and rigidity in some isoperimetric type inequalities.“

Research Interests

Guido De Philippis is working in the area of Calculus of Variations, Geometric Measure Theory and Partial Differential Equations (PDE). In particular he is interested in the study of regularity and singularity issues in geometric variational problems (minimal surfaces, shape optimisation problems, capillarity problems) and non linear elliptic PDE. He is also interested in the study of qualitative of solutions and in quantitative geometric and functional inequalities.

Curriculum Vitae

2016 Associate Professor, SISSA Trieste (Italy)
2015 Chargé de Recherche CNRS, ENS Lyon (France)
2014 National Italian Habilitation as Associate Prof. in Math. Analysis
2014 Post Doc, University of Zurich, Zurich (CH)
2013 HCM Post Doc, Hausdorff Center for Mathematics, Bonn (D)
2012 PhD in Mathematics, Scuola Normale Superiore Pisa (Italy)
2004 MSc in Mathematics, University of Florence (Italy)
2007 BSc in Mathematics, University of Florence (Italy)

EMS Prize Lecture IV – Abstract

On the singular part of measures constrained by linear PDEs and applications

The aim of the talk is to present some recent results on the structure of the singular part of measures satisfying a PDE constraint, and to describe some applications.

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Peter Scholze

* 1987 in Dresden (Germany)

Hausdorff Chair
University of Bonn (Germany)

EMS Prize 2016

„For his original and groundbreaking contributions at the interface of Arithmetic Algebraic Geometry and the theory of automorphic forms, for example, with his is new proof of the local Langlands conjecture for p-adic local fields and his theory of perfectoid spaces.“

Research Interests

Peter Scholze works in arithmetic geometry. Much of his work is based on the theory of perfectoid spaces, which are certain fractal-like objects in p-adic geometry. He has applied this theory to various problems including the weight-monodromy conjecture, p-adic Hodge theory, the existence of Galois representations and the theory of local Shimura varieties.

Curriculum Vitae

2012 Professor at the Haussdorff Center for Mathematics Bonn (Hausdorff Chair)
2012 PhD in Mathematics, University of Bonn (D)
2010 MA University of Bonn (D)
2009 BA University of Bonn (D)

EMS Prize Lecture V – Abstract

Perfectoid Spaces and their Applications

Péter Varjú

* 1982 in Szeged (Hungary)

Royal Society University Research Fellow
University of Cambridge (UK)

EMS Prize 2016

„For his deep work on arithmetic combinatorics and its applications to spectral gap estimates and equidistribution, including a solution to a long-standing problem regarding equidistribution of random walks on the isometry group of Euclidean spaces, his contribution to the study of spectral gap on quotients of arithmetic groups, self similar sets and measures."

Research Interests

Péter Vardú studies random walks in groups. More specifically, he works on estimates for the spectral gap and the diameter. He is also interested in additive combinatorics and uses it in the context of random walks. Recently, he started to investigate self-similar measures and Bernoulli convolutions, in particular.

Curriculum Vitae

2015 Royal Society University Research Fellow, Univ. of Cambridge (UK)
2012 Junior Research Fellow, Trinity College Cambridge (UK)
2011 (till 2015) Simons Postdoctoral Fellow, Univ. of Cambridge (UK)
2011 Visiting Researcher at The Hebrew University, Jerusalem (Israel)
2011 PhD in Mathematics, Princeton University (USA)
2007 Graduate Studies of Mathematics, Princeton University (USA)
2001 Undergraduate Studies of Mathematics, University of Szeged (HU)

EMS Prize Lecture VI – Abstract

Recent progress on Bernoulli convolutions

The Bernoulli convolution with parameter $\lambda \in (0, 1)$ is the measure ν_λ on **R** that is the distribution of the random power series $\Sigma \pm \lambda^n$, where ± are independent fair coin tosses. These measures are natural objects from several points of view including fractal geometry, dynamics and number theory. The main question of interest is to determine the set of parameters for which the measure is absolutely continuous with respect to the Lebesgue measure, a problem that goes back to the 1930's.

If $\lambda < 1/2$, then ν_λ is always singular being supported on a Cantor set. In the range $\lambda \in [1/2,1)$, there are examples for both type, ν_λ may be absolutely continuous or singular. Which parameters exhibit which behaviour is still not fully understood. In the last few years our knowledge dramatically improved thanks to the work of several authors and a new method based on the growth of entropy of measures under convolution. I will survey this recent progress.

Thomas Willwacher

* 1983 in Freiburg i. Brsg. (Germany)

Associate Professor for Mathematics
ETH Zurich (CH)

EMS Prize 2016

„For his striking and important research in a variety of mathematical fields: homotopical algebra, geometry, topology and mathematical physics, including deep results related to Kontsevich's formality theorem and the relation between Kontsevich's graph complex and the Grothendieck-Teichmüller Lie algebra.“

Research Interests

Thomas Willwacher is a mathematical physicist, working at the interface between algebra, topology and physics. He started his career in the field of deformation quantization, studying the transition from classical to quantum physics from an algebraic viewpoint. Currently, he is interested in algebraic structures arising from configuration spaces of points and their relation to topological field theories. Furthermore, he is working on graph complexes, trying to connect several areas in homological algebra and algebraic topology.

Curriculum Vitae

2015 Associate Professor at ETH Zurich (CH)
2013 Assistant Professor in pure Mathematics at University of Zurich (CH)
2012 Postdoc at ETH Zurich (CH)
2010 Junior Fellow of the Society of Fellows, Harvard University (USA)
2009 PhD in Mathematics, ETH Zurich (CH)
2007 Diploma in Physics, ETH Zurich

EMS Prize Lecture VII – Abstract

Graph complexes in algebra and topology

Many hard problems in algebraic topology and homological algebra can be restated as computations in homological complexes of diagrams. These graph complexes are themselves hard to understand, and thus it is not always clear what is won by such a reformulation. We will give an overview of recent progress in understanding the algebraic structures on and connections between several types of graph complexes, and show how graphical methods can be used to elucidate problems in algebraic topology.

James Maynard

* 1987 in Chelmsford (UK)

Fellow
Magdalen College Oxford (UK)

EMS Prize 2016

„For his remarkable and deep results in number theory, mainly dealing with non-trivial aspects of the theory of primes and in particular his original and new proof and improved estimate of the famous, so called, "small gaps between primes theorem".“

Research Interests

James Maynard is primarily interested in classical number theory, especially the distribution of prime numbers. His research focuses on using tools from analytic number theory, particularly sieve methods, to study the primes. His main research has been on the gaps between prime numbers, showing that they can occasionally be unusually small or unusually large.

Curriculum Vitae

2017 Member of the Institute for Advanced Study, Princeton (USA)
2017 Research Member MSRI
2015 Clay Research Fellowship
2013 Fellow by Examination, Magdalen College Oxford (UK)
2013 CRM-ISM Postdoctoral Fellow, University of Montreal (Canada)
2013 PhD in Mathematics, Balliol College Oxford (UK)
2009 Certificate of Advanced Study in Mathematics, Queens' College, Cambridge (UK)
2008 BA Mathematics, Queens' College, Cambridge (UK)

EMS Prize Lecture VIII – Abstract

Primes with missing digits

Several long-standing problems in prime number theory are examples of asking whether there are infinitely many primes in some set which contains only $O(x^{1-\varepsilon})$ integers less than x. The sparsity of such sets presents several difficulties, and typically we only succeed if the set has ‘linear’ or ‘multiplicative’ structure.

We will talk about some recent results showing the existence of infinitely many primes with no 7 in their decimal expansion. This is a thin set of integers, but has ‘combinatorial’ rather than ‘linear’ or ‘multiplicative’ structure.

Hugo Duminil-Copin

* 1985 in Chatenay-Malabry (France)

Permanent Professor
Institut des Hautes Études Scientifiques (France)

EMS Prize 2016

„For his outstanding research in statistical physics, in particular on critical phenomena for models in dimensions below the critical one, including Fortuin-Kasteleyn percolation, Ising and Potts models, self-avoiding walks and to harmonic analysis in disordered media.“

Research Interests

The research interests of Hugo Duminil-Copin lie at the interface between Combinatorics, Mathematical Physics and Probability. He is interested in the large scale behavior and the phase transition of probabilistic models coming from statistical physics. In particular, he is studying percolation models emerging as graphical representations of lattice spin models (for instance the Ising model of magnetism).

Curriculum Vitae

2016 Permanent Professor Institut des Hautes Études Scientifiques (F)
2014 Professor (part-time since 2016), Université de Genève (CH)
2013 Assistant Professor, Université de Genève (CH)
2012 Postdoc, Université de Genève (CH)
2011 PhD, Université de Genève (CH)
2008 Agrégation de mathématiques, École Normale Supérieure de Paris
2007 Master, Université de Paris XI, Paris (France)
2005 MPSI and MP (preparatories classes), Lycée Louis-Le-Grand, Paris

EMS Prize Lecture IX – Abstract

The Ising model: beyond integrability

In the Ising model, a magnetic material is described as a collection of small magnetic moments placed regularly on a lattice. Since its introduction by Lenz in the beginning of the twentieth century, the model has provided the testing ground for a large variety of techniques, both physical and mathematical, and it is fair to say that the model is one of the most studied model of statistical physics.

In 2D, the Ising model is the archetypical example of an integrable model. The free energy was computed exactly by Onsager, and since then many other properties of its phase transition have been rigorously understood. Unfortunately, the model does not seem to be integrable in higher dimension. The aim of this talk is to describe graphical representations of the Ising model and their connections to other models of probability such as percolation and random-walk models. Of particular interest will be the fact that these representations are not limited to the planar model. We will thus also illustrate how they can be used to understand the phase transition in higher dimensions, in particular in the special case of the 3D model.

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Geordie Williamson

* 1981 in Bowral (Australia)

Advanced Researcher
Max Planck Institute for Mathematics Bonn (D)

EMS Prize 2016

„For his fundamental contributions to representation theory of Lie algebras and algebraic groups, for example, with the elegant proof of Soergel's conjecture on bimodules associated to Coxeter groups and the counter-examples to expected bounds in Lusztig's conjectured character for rational representations of algebraic groups."

Research Interests

Geordie Williamson is working in the field of representation theory of Lie algebras and algebraic groups. As a slogan for that he claims: „Don't underestimate symmetry." His results include proofs and re-proofs of some long-standing conjectures, as well as spectacular counterexamples to the expected bounds in others.

Curriculum Vitae

2011	Advanced Researcher (W2 Research Professor), Max Planck Institute for Mathematics Bonn (D)
2008	EPSRC Postdoctoral Research Fellow, University of Oxford (UK)
2008	Junior Research Fellow, St Peter's College, Univ. of Oxford (UK)
2008	PhD in Pure Mathematics, Albert Ludwigs University Freiburg (D)
2003	Honours in Pure Mathematics, University of Sydney (Australia)
2002	BA University of Sydney (Australia)

EMS Prize Lecture X – Abstract

Shadows of Hodge theory in representation theory

The Kazhdan-Lusztig conjecture is a remarkable 1979 conjecture on the characters of simple highest weight modules over a complex semi-simple Lie algebra. It was proved in 1981 by Beilinson and Bernstein [1] and Brylinski and Kashiwara [2]. The basic paradigm established by the Kazhdan-Lusztig conjecture has proven extremely useful throughout representation theory [5].Traditional proofs of the Kazhdan-Lusztig conjecture and its generalizations rely on deep geometric tools (Deligne's theory of weights or Saito's mixed Hodge modules). Recently Elias and the author gave an algebraic proof of the Kazhdan- Lusztig conjecture [4]. The idea is to establish the existence of certain "pure Hodge structures" in an algebraic manner. The proof relies on an the theory of Soergel bimodules [6] as well as some beautiful geometric ideas of de Cataldo and Migliorini [3]. Remarkably, the methods apply to more general objects than those handled by the classical theory, thus establishing Hodge structures on objects with no obvious geometric heritage.We will present a survey of the techniques and applications of "algebraic Hodge theory" in representation theory, including applications to Kazhdan-Lusztig conjectures, Janzten conjectures and positivity conjectures. Parallels and differences to the classical geometric theory will be discussed, as well as related work (toric geometry, combinatorial geometry) and other objects in representation theory where similar approaches might be fruitful (KLR algebras, . . .).

References

[1] A. Beilinson, J. Bernstein, Localisation de g-modules, C. R. Acad. Sci. Paris Sér. I Math. 292 (1981), no. 1, 15–18.

[2] J.-L. Brylinski, M. Kashiwara, Kazhdan-Lusztig conjecture and holonomic systems, Invent. Math. 64 (1981), no. 3, 387–410.

[3] M.-A. de Cataldo, L.-Migliorini, Luca, The hard Lefschetz theorem and the topology of semi-small maps. Ann. Sci. École Norm. Sup. (4) 35 (2002), no. 5, 759–772.

[4] B. Elias, G. Williamson, The Hodge theory of Soergel bimodules, Annals of Mathe- matics, (2) 180 (2014), no. 3, 1089–1136.

[5] G. Lusztig, Intersection cohomology methods in representation theory. Proceedings of the Interational Congress of Mathematicians, Vol. I, II (Kyoto, 1990), 155–174, Math. Soc. Japan, Tokyo, 1991.

[6] W.Soergel,Kazhdan-Lusztig-Polynome und unzerlegbare Bimoduln über Polynomrin- gen, J. Inst. Math. Jussieu 6 (2007), no. 3, 501–525.

Composition:

Dr. Uta Deffke

Research Center Matheon
ECMath
Public Relations
TU Berlin

Information and Photos:
Sent by the Scientists and the Prize Committees

Berlin, July 12th, 2016