

## Preface

The Sixth European Congress of Mathematics (6 ECM) was held from July 2nd till July 7th, 2012 at the Auditorium Maximum of the Jagiellonian University in Kraków. It was organized by the Polish Mathematical Society (Polskie Towarzystwo Matematyczne, PTM) in collaboration with the Jagiellonian University (UJ), under the auspices of the European Mathematical Society (EMS). Previous European Congresses of Mathematics were held in Paris (1992), Budapest (1996), Barcelona (2000), Stockholm (2004) and Amsterdam (2008).

As at all the previous EMS congresses, ten young researchers selected by the Prize Committee nominated by the EMS received the EMS prizes in recognition of outstanding research accomplishments. Twenty years after the 1 ECM in Paris (1992), these prizes are considered to be one of the most prestigious awards for young talented mathematicians. A glance at the lists of all EMS prize winners and of the Fields Medal laureates confirms that view. In addition, the Felix Klein Prize was awarded for a third time, jointly by the EMS and the Institute for Industrial Mathematics in Kaiserslautern, for a remarkable solution of an industrial problem. Finally, for the first time the Otto Neugebauer Prize was awarded for a highly original and influential piece of work in the history of mathematics.

About 1000 mathematicians attended the congress and took part in the activities that consisted of 10 plenary lectures, 33 invited lectures, 3 special lectures and 11 lectures by the prize winners, complemented by 6 panel discussions and 24 minisymposia with 94 talks. 179 posters were presented, and 11 of them were awarded prizes, funded by the publishers presenting their products during the congress. Moreover, at the nearby AGH University of Science and Technology, 15 satellite thematic sessions were held with 155 talks. In total, almost half of the participants presented their results in some form. A variety of opportunities of presentations helped to increase participation in the 6 ECM. Finally, 29 satellite conferences of the 6 ECM have been organized.

These proceedings present extended versions of most of the invited talks which were delivered during the congress, or in one case submitted to the proceedings by the plenary speaker who couldn't come. A volume such as this one is always a specific snapshot, possibly somewhat biased but still worthwhile to look at, of the current state of mathematics; it tries to capture and show the most fashionable trends, crucial achievements, emerging new research directions, and – last but not least – the research leaders who shape the field. The organizers of 6 ECM and the editors of the proceedings thank all the authors who made an effort to prepare papers for this volume; we all do know that the free time necessary to complete such a task is a rare and precious commodity that one has to provide taking into account the never-ending heap of research, teaching, administrative and personal duties.

We are grateful for all the support we have obtained. All errors in that book are ours.

On behalf of the editors

Paweł Strzelecki



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Andrzej Pelczar (1937–2010), the initiator and original organizer of the 6 ECM  
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*Photos:* Ada Pałka

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\*UW = Univeristy of Warsaw

†PTM = Polish Mathematical Society

‡UJ = Jagiellonian University in Kraków

§WAT = Military University of Technology, Warszawa

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## Opening Ceremony

The opening ceremony of the **6th European Congress of Mathematics**, presided over by Piotr Krasnowolski, was held on Monday, July 2 in the Auditorium Maximum of the Jagiellonian University in the heart of Kraków old town. After a brief welcome address by the Rector of Jagiellonian University, Professor Karol Musioł, three speeches were delivered by Professor Barbara Kudrycka, Minister of Science and Higher Education of Republic of Poland, by Professor Marta Sanz-Solé, President of the European Mathematical Society and by Professor Stefan Jackowski, President of the Polish Mathematical Society and Chair of the Executive Organizing Committee of the 6th ECM.

### Speech of Minister Barbara Kudrycka

We are meeting today in Kraków, a magical city in Poland. Magical, because it combines what is the most beautiful of Poland's historical heritage with the most modern science and technology.

We are meeting at the Jagiellonian University – one of the oldest universities in Europe with a long and distinguished scientific tradition. Today Kraków is one of the most attractive places in Europe for international investors in terms of BOP<sup>‡‡</sup> factors, thanks to high qualification of its residents.



Kraków has recently become the seat of the National Science Centre that finances fundamental research, and which, by the way, is headed by a mathematician – Professor Michał Karoński, the Chairman of the NCN Council.

Kraków is a very special place for Polish mathematics. In 1916, whilst strolling through the Planty Park, Dr. Hugo Steinhaus met Stefan Banach – at that time a young student. Steinhaus heard the young man discussing mathematics with a friend. He interrupted his conversation and gave Banach his first academic job. Today, nearly half of all com-

petitions announced by the National Science Centre are addressed to very young scientists.

Polish mathematicians of today continue Banach's great tradition. The prestigious European Mathematical Society Prize was awarded to the Polish

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<sup>‡‡</sup>BOP = balance of payments.

mathematicians: Tomasz Łuczak (in 1992) and Agata Smoktunowicz (in 2008), both of whom are present at this congress. Young university students, and even high school students, have also achieved success in this field. Last year, the Third Prize at the 23rd EU Contest for Young Scientists organized by the European Commission was awarded to Michał Miśkiewicz, a young mathematician from Warsaw. Research work carried out by individuals who were not yet even university students also qualified for the competition. Students of the Jagiellonian University turned out to be the best at the International Mathematics Competition for University Students.

When we speak about mathematics we must remember that mathematics is the most fundamental of fundamental sciences. In recent years Poland has greatly increased its spending on basic research, largely as a result of the establishment of the National Science Centre, whose budget (in PLN) amounted to 471 million in 2011, while in 2012 it will reach 858 million.

The Polish business community is becoming increasingly aware of the importance of research in mathematics. Ericpol – Poland’s largest software exporter, can serve as an example, as it funds the Stefan Banach Prize for doctoral dissertations in mathematics.

Poland is very aware of the importance of science education, which of course includes mathematics. The government has provided considerable support for science studies through the “priority studies” programme, which allocates additional grants for science and technology students. As a result, last year the number of candidates applying for technical studies exceeded the number of candidates for non-technical disciplines for the first time in many decades.

The government is aware of the special role of mathematical abilities in the labour market. That is why in 2010 mathematics was reintroduced as a compulsory subject at secondary school final exams. The recently initiated process of selecting Leading National Research Centres in Poland will play an important role in the reform of science and education as a whole. The Leading Centres will attract people of the highest research and teaching ability, bringing together outstanding scientists, doctoral students and undergraduates.

This month the Leading Centre in mathematics will be selected from applying institutions, given the central role of mathematics in all sciences.

For the same reason, of the many scientific congresses that take place in Europe every year, I have no doubt that this one – the scientific congress of mathematics – is the most important. Ladies and Gentlemen, people of science are travellers. Thank you that these days you arrived in Kraków. I am sure that you will have a very good and fruitful scientific discussion here and it will be an interesting experience.

## Speech of EMS President Marta Sanz-Solé

Rector Magnificus; Minister of Science and Higher Education of the Republic of Poland; distinguished guests, Ladies and Gentlemen!

It is my privilege to welcome you all to the 6th ECM. This is one of the largest events in mathematics in the world and the most important scientific activity of the European Mathematical Society.



We express our sincere thanks to the Jagiellonian University for hosting the Congress and for its generous support. We also thank the distinguished guests. With your presence, you are showing a much appreciated interest and support to mathematics. The invitation to Kraków was made by a honourable member of this university, the former Professor and Rector, and also former Vice-President of the European Mathematical Society, Andrzej Pelczar. Let me take this opportunity to honor his memory and to pay tribute to his devoted work for the Society.

Mathematics has a strong tradition of volunteer work. Running mathematical societies, organizing scientific events, publishing journals and books, and organizing activities to attract talented young students are among the very many examples.

Poland, with its longstanding and solid mathematical tradition, and outstanding mathematicians, has been among the most generous in this respect.

Let me mention a very few but illustrative cases:

- In 1929, only ten years after its foundation, the Polish Mathematical Society organized the First Congress of Mathematicians of the Slavic countries.
- Poland was the organizer of the International Congress of Mathematicians (ICM) in August 1983. To put this event into better context, let us recall that between December 1981 and July 1983, this country was under martial law, in an attempt to crash political opposition. These were extremely difficult times for most of the citizens of this country.
- Mathematics institutions in Poland, and in particular the Banach Centre, have been instrumental in providing conditions for interaction and collaboration of mathematicians across Europe. This has been extremely valuable, specially for those coming from East European countries in a period where crossing borders was extremely difficult if not impossible.

– The last example is of special significance for the history of the EMS, since it constitutes its public debut.

Our Society was founded on the 28th October 1990, in a residence of the Polish Academy of Sciences in Maðralin (near Warsaw). Bogdan Bojarski, on behalf of the Polish Academy of Sciences, and Andrzej Pelczar, President of the Polish Mathematical Society, were the hosts of this important event.

We are just about to enjoy a great feast of mathematics in Europe. This is made possible thanks to the devoted efforts of very many people and institutions who deserve our gratitude. Let me mention them:

– the members of the Scientific Committee for their excellent work in putting together the program of lectures;

– the members of the three prize committees – the EMS Prize, the Felix Klein Prize and the Otto Neugebauer Prize – for their difficult task in selecting the awardees among a large number of remarkable nominations;

– the Organizing Committee. Thanks to its tremendous and brilliant work, we will all be able to savour an unforgettable event. This is yet another example of generous service to mathematics of the Polish mathematical community;

– the sponsors of the Congress: all the funding agencies, universities from Kraków, Warsaw and other cities, and private and public organisations;

– the sponsors of the Prizes: Foundation Compositio Mathematica, the Institute for Industrial Mathematics in Kaiserslautern and Springer Verlag.

### **Why ECM's?**

Like many other disciplines, mathematics has reached a degree of extreme specialization. Nevertheless, there remains a need for keeping its unity as a scientific discipline, for resisting fragmentation, and for maintaining and even increasing fluid communication between its domains. A holistic structure will better contribute to genuine progress of scientific knowledge.

As for other theoretical or experimental areas, scientific, social or humanistic, the most significant mathematical advances and breakthroughs involve a complex and sophisticated combination of ingredients, expertise and techniques from different fields.

By keeping our minds wide open, and nurturing the desire of exploring beyond the boundaries of one's specific research speciality, we will have a better chance to be at the forefront of the scientific advances in our discipline.

Events like the European Congresses of Mathematics provide a very suitable stage and good conditions for these practices. An ECM is a forum for sharing mathematical knowledge and experience with mathematicians interested in different subjects, including those at the crossroads of the discipline. It is also a forum for discussion of many aspects of the profession, a place for networking and for establishing bonds of solidarity, for becoming

more aware of the importance of mathematics for the world, for feeling the need of coming closer to society, explaining the usefulness of mathematics to the public.

We are in an ancient and beautiful city of Europe, located in a splendid region and full of historical monuments. Those who enjoy nature and landscape will have the possibility to navigate along the Vistula River, or to hike in the Tatra mountains. If you would prefer peace and time for meditation, you will find shelter in the omnipresent magnificent Krakovian churches. And on the streets, be surprised! You will see that mathematics is the cultural protagonist in the city throughout this week.

On behalf of the European Mathematical Society, I would like to thank all those who helped to bring the 6 ECM to fruition, and I wish you all a rewarding and enjoyable Congress.

I declare the 6 ECM open.

Thank you very much.

## **Speech of PTM President Stefan Jackowski**

Madame Minister, Rector Magnificus, Madame President of the EMS, Fellow mathematicians,

On behalf of the Polish Mathematical Society and everyone involved in the organization of the Congress, I welcome all of you to the 6th European Congress of Mathematicians! I would like to extend a particular welcome to all the members of the European Mathematical Society.



Let me remind you that the Society was founded in 1990 in Poland, near Warsaw. We are very pleased and honoured that this year the flagship meeting of the EMS is taking place in our country – welcome back!

Thanks are due to the Scientific Committee of the 6 ECM for selecting speakers and to the prize award committees for nomination of the prize winners. I welcome cordially the speakers and organisers of many congress activities. I offer a special welcome to our colleagues from countries which do not yet enjoy the privileges of free travel around Europe. They often had to overcome many bureaucratic and financial obstacles to come here.

I'd like to express our thanks to the sponsors of the congress – especially the EMS and the Polish Science Foundation whose generous grants made participation possible for many young mathematicians and for mathematicians from the economically challenged countries.

Welcome to all our friends from other continents who are with us today. Welcome to everybody!

Mathematicians are very grateful to the President of Poland who is the patron of our Congress and to the members of the Honorary Committee. The presence here of the Minister of Science and Higher Education emphasizes the place of mathematics in science, and will help to raise awareness of the role of mathematics and its prestige among the general public. Thank you very much, Professor Kudrycka for coming! We are very grateful for the hospitality of the city of Kraków and the Małopolska region, the AGH University of Science and Technology and last but not least the Jagiellonian University – co-organizer of the Congress.

I cannot speak about the Jagiellonian University without mentioning Professor Andrzej Pelczar, a former Rector of the University, a past President of the PTM and a past vicepresident of the EMS – the initiator and original organizer of the congress, who died in May 2010 at the beginning of the preparations, leaving us with the obligation to turn his dream into reality. Professor Pelczar was a great patriot of his city.

Kraków is a magical historic place for all Poles, also for mathematicians. I would like to remind you that the Polish Mathematical Society was founded here 93 years ago, and Stefan Banach, born in Kraków, was one of its founders. In the special volume of *Wiadomości Matematyczne* – journal of the Polish Mathematical Society – which participants will find in their conference bags, there is a lot of information about the history of mathematics in Poland, and in particular in Kraków. Besides the strictly scientific programme which offers a panorama of contemporary mathematics, the congress has very important social and cultural aspects. Panel discussions will touch upon social and political issues related to mathematics. Exhibitions of old mathematical books and of art related to mathematics, as well as 'maths busking' in the streets of Kraków, will help to raise public awareness of mathematics.

The tourist programme will provide an opportunity to learn more about Poland's complex history, and about its contemporary affairs, with the emphasis on its broader European context. I wish all of the participants a mathematically illuminating experience at the congress, and interesting social encounters. I wish all participants and their companions an interesting and pleasant stay in Kraków.

Thank you for your attention.



## The Prize Winners

During the Opening Ceremony, the prize winners, their work and achievements have been presented by the chairs of the respective prize committees.<sup>†</sup> Ten EMS Prizes, the Felix Klein Prize and the Otto Neugebauer Prize have been awarded.



Laureates at the Opening Ceremony

## EMS Prize Winners

**Simon Brendle**, STANFORD UNIVERSITY, USA



*Born: 1981, Germany.*

*PhD: Tübingen University.*

Simon Brendle has received the EMS Prize for his outstanding results on geometric partial differential equations and systems of elliptic, parabolic and hyperbolic types, which have led to breakthroughs in differential geometry including the differentiable sphere theorem, the general convergence of Yamabe flow, the compactness property for solutions of the Yamabe equation, and the Min-Oo conjecture.

<sup>†</sup>The editors use quotations from the prize committees statements.

**Emmanuel Breuillard**, UNIVERSITÉ DE PARIS-SUD, ORSAY, FRANCE

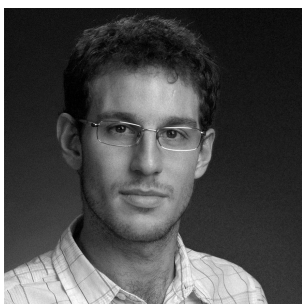


*Born: 1977, France.*

*PhD: Université Paris-Sud, joint degree from Yale University.*

Emmanuel Breuillard received the EMS Prize for his important and deep research in asymptotic group theory, in particular on the Tits alternative for linear groups and on the study of approximate subgroups, using a wealth of methods from very different areas of mathematics, which has already made a lasting impact on combinatorics, group theory, number theory and beyond.

**Alessio Figalli**, UNIVERSITY OF TEXAS, AUSTIN, USA



*Born: 1984, Italy.*

*PhD: Scuola Normale Superiore, Pisa, and École Normale Supérieure, Lyon.*

Alessio Figalli received the EMS Prize for his outstanding contributions to the regularity theory of optimal transport maps, to quantitative geometric and functional inequalities and to partial solutions of the Mather and Mañé conjectures in the theory of dynamical systems.

**Adrian Ioana**, UNIVERSITY OF CALIFORNIA AT SAN DIEGO, USA



*Born: 1981, Romania.*

*PhD: University of California, Los Angeles.*

Adrian Ioana received the EMS Prize for his impressive and deep work in the field of operator algebras and their connections to ergodic theory and group theory, and in particular for solving several important open problems in deformation and rigidity theory, among them a long standing conjecture of Connes concerning von Neumann algebras with no outer automorphisms.

**Mathieu Lewin**, CNRS & UNIVERSITÉ CERGY-PONTOISE, FRANCE

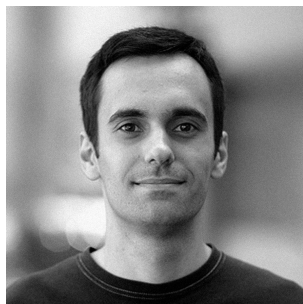


*Born: 1977, France.*

*PhD: Université Paris-Dauphine.*

Mathieu Lewin received the EMS Prize for his ground breaking work in rigorous aspects of quantum chemistry, mean field approximations to relativistic quantum field theory and statistical mechanics. His research focuses on applications of variational and spectral methods to models from quantum mechanics.

**Ciprian Manolescu**, UNIVERSITY OF CALIFORNIA, LOS ANGELES, USA



*Born: 1978, Romania.*

*PhD: Harvard University.*

Ciprian Manolescu received the EMS Prize for his deep and highly influential work on Floer theory, successfully combining techniques from gauge theory, symplectic geometry, algebraic topology, dynamical systems and algebraic geometry to study low-dimensional manifolds, and in particular for his key role in the development of combinatorial Floer theory.

**Grégory Miermont**, UNIVERSITÉ DE PARIS-SUD, ORSAY, FRANCE



*Born: 1979, France.*

*Phd: École Normale Supérieure, Paris.*

Grégory Miermont received the EMS Prize for his outstanding work on scaling limits of random structures such as trees and random planar maps, and his highly innovative insight in the treatment of random metrics.

**Sophie Morel**, HARVARD UNIVERSITY, USA

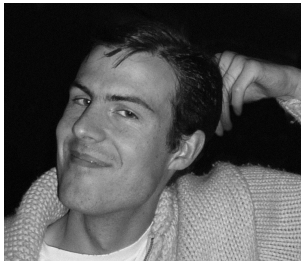


*Born: 1979, France.*

*PhD: Université de Paris-Sud, Orsay.*

Sophie Morel's research focuses on number theory, algebraic geometry, and group representation theory. She has obtained the EMS Prize for her deep and original work in arithmetic geometry and automorphic forms, in particular for her study of Shimura varieties, bringing new and unexpected ideas to this field. (Sophie Morel did not attend the 6 ECM).

**Tom Sanders**, UNIVERISTY OF OXFORD, UNITED KINGDOM



*Born: 1981, UK.*

*PhD: Cambridge Univeristy.*

Tom Sanders received the EMS Prize for his fundamental results in additive combinatorics and harmonic analysis, which combine in a masterful way deep known techniques with the invention of new methods to achieve spectacular applications.

**Corinna Ulcigrai**, UNIVERSITY OF BRISTOL, UNITED KINGDOM



*Born: 1980, Italy.*

*PhD: Princeton University.*

Corinna Ulcigrai has received the EMS Prize for advancing our understanding of dynamical systems and the mathematical characterisations of chaos, and especially for solving a long-standing fundamental question on the mixing property for locally Hamiltonian surface flows.

## Otto Neugebauer Prize

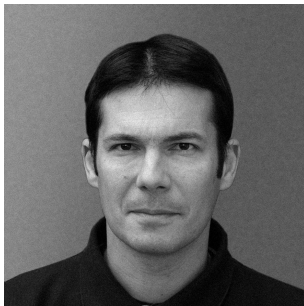
**Jan P. Hogendijk**, UTRECHT UNIVERSITY, THE NETHERLANDS



Professor Jan Hogendijk has illuminated how Greek mathematics was absorbed in the medieval Arabic world, how mathematics developed in medieval Islam, and how it was eventually transmitted to Europe. His analysis also embraces the scientific traditions of the Babylonian, Greek, Indian, Persian, Eastern and Western Arabic, and Latin civilizations. His work is based on previously unexplored manuscripts and primary sources, and the highly specialized contents of his writings are balanced by his precise yet friendly style. For all of these reasons the jury is unanimous in recommending that Prof. Hogendijk receive the Neugebauer Prize.

## Felix Klein Prize

**Emmanuel Trelat**, UNIVERSITÉ PIERRE ET MARIE CURIE, PARIS, FRANCE



Emmanuel Trélat combines truly impressive and beautiful contributions in fine fundamental mathematics to understand and solve new problems in control of PDE's and ODE's (continuous, discrete and mixed problems), and above all for his studies on singular trajectories, with remarkable numerical methods and algorithms able to provide solutions to many industrial problems in real time, with substantial impact especially in the area of astronautics. He is certainly an example of a successful researcher in the field of mathematics for industry, illustrating that it is possible to be highly recognized in mathematics and working on real problems, with end-product in the form of software that is really useful in industry.

## Collector coins commemorating Stefan Banach



On the occasion of the 6 ECM, National Bank of Poland issued collector coins designed by Robert Kotowicz: bronze 2 PLN, silver 10 PLN, and gold 200 PLN, to commemorate Stefan Banach (1892–1945). On the reverse of all three coins Banach is portrayed; each obverse depicts a notion or result of functional analysis. At the opening ceremony a Member of the Board of the National Bank of Poland, Professor Eugeniusz Gatnar, handled silver coins to prize winners. (All 6 ECM participants received bronze coins.)

## List of events

### PLENARY LECTURES

- Adrian Constantin*, Some mathematical aspects of water waves  
*Camillo De Lellis*, Dissipative solutions of the Euler equations  
*Herbert Edelsbrunner*, Persistent homology and applications  
*Mikhail Gromov*, In a search for a structure<sup>‡</sup>  
*Christopher Hacon*, Classification of algebraic varieties  
*David Kazhdan*, Representations of affine Kac–Moody groups over local and global fields  
*Tomasz Łuczak*, Threshold behaviour of random discrete structures  
*Sylvia Serfaty*, Renormalized energy, Abrikosov lattice, and log gases  
*Saharon Shelah*, Classifying classes of structures in model theory  
*Michel Talagrand*, Geometry of stochastic processes

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<sup>‡</sup>The plenary lecture of Misha Gromov has been cancelled due to his illness; however, the reader will find his text on p. 51 in the present volume.

## INVITED LECTURES

- Anton Alekseev*, Bernoulli numbers, Drinfeld associators and the Kashiwara–Vergne problem
- Kari Astala*, Holomorphic deformations, quasiconformal mappings and vector valued calculus of variations
- Jean Bertoin*, Coagulation with limited aggregations
- Serge Cantat*, The Cremona group
- Vicent Caselles*, Exemplar-based image inpainting and applications
- Alessandra Celletti*, KAM theory: a journey from conservative to dissipative systems
- Pierre Colmez*, The  $p$ -adic Langlands program
- Alessio Corti*, Mirror symmetry and Fano manifolds
- Amadeu Delshams*, Irregular motion and global instability in Hamiltonian systems
- Hélène Esnault*, On flat bundles in characteristic 0 and  $p > 0$
- Alexander A. Gaifullin*, Combinatorial realisation of cycles and small covers
- Isabelle Gallagher*, Remarks on global regularity for solutions to the incompressible Navier–Stokes equations
- Olle Häggström*, Why the empirical sciences need statistics so desperately?
- Martin Hairer*, Solving the KPZ equation
- Nicholas J. Higham*, The matrix logarithm: from theory to computation
- Arieh Iserles*, Computing the Schrödinger equation with no fear of commutators
- Alexander S. Kechris*, Dynamics of non-archimedean Polish groups
- Bernhard Keller*, Cluster algebras and cluster monomials
- Sławomir Kołodziej*, Weak solutions to the complex Monge–Ampère equation
- Gady Kozma*, Phase transitions in self-interacting random walks
- Frank Merle*, On blow-up curves for semilinear wave equations
- Andrey Mironov*, Commuting higher rank ordinary differential operators
- David Nualart*, Stochastic calculus with respect to the fractional Brownian motion
- Alexander Olevskii*, Sampling, interpolation, translates
- Leonid Parnowski*, Multidimensional periodic and almost-periodic spectral problems: Bethe–Sommerfeld Conjecture and integrated density of states
- Florian Pop*, About covering spaces and numbers
- Igor Rodnianski*, Evolution problem in General Relativity
- Zeév Rudnick*, Quantum chaos and number theory
- Benjamin Schlein*, Effective equations for quantum dynamics
- Piotr Śniady*, Combinatorics of asymptotic representation theory
- Andrew Stuart*, Probing probability measures in high dimensions

*Vladimír Sveřák*, On scale-invariant solutions of the Navier–Stokes equations

*Stevo Todorčević*, Ramsey-theoretic analysis of the conditional structure of weakly-null sequences

#### SPECIAL LECTURES AND EVENTS

*José Francisco Rodrigues*, Mathematics for the Planet Earth. A Challenge and an Opportunity to Mathematicians

*Maciej P. Wojtkowski*, Tilings and Markov Partitions. PTM Andrzej Pelczar Memorial Lecture

*Philip Welch*, Mechanising the Mind: Turing and the Computable. A Centenary Lecture

EMS Friedrich Hirzebruch Memorial Session

#### MINI-SYMPOSIA

25 Years of Quantum Groups: From Definition to Classification (Alexander Stolin)

Absolute Arithmetic and  $\mathbb{F}_1$ -geometry (Koen Thas)

Applied and Computational Algebraic Topology (Martin Raussen)

Arithmetic Geometry (Wojciech Gajda, Samir Siksek)

Bachelier Finance Society: Mathematical Finance (Peter K. Friz)

Braids and Configuration Spaces (Mario Salvetti)

Computational Dynamics and Computer Assisted Proofs (Warwick Tucker, Piotr Zgliczyński)

Continuous Real Rational Functions and Related Topics (Krzysztof Kurdyka)

Differential Algebra and Galois Theory (Zbigniew Hajto)

Discrete Structures in Algebra, Geometry, Topology, and Computer Science (Eva-Maria Feichtner, Dmitry Feichtner-Kozlov)

Fluid Dynamics (Piotr B. Mucha, Agnieszka Świerczewska-Gwiazda)

Geometric and Quantitative Rigidity (Marta Lewicka)

How Mathematics Illuminates Biology (Marta Tyran-Kamińska, Michael C. Mackey)

Hyperbolic Conservation Laws (Piotr Gwiazda, Agnieszka Świerczewska-Gwiazda)

Implicitly Constituted Material Models: Modeling and Analysis (Josef Malek, Endre Süli)

Infinite-dimensional Dynamical Systems with Time Delays (Tibor Krisztin, Hans-Otto Walther)

Knot Theory and its Ramification (Józef H. Przytycki)

Matchbox Dynamics (Krystyna Kuperberg)

On Solutions to the Euler Equations of Incompressible Fluids (Xinyu He)

Optimal Stopping and Applications (F. Thomas Bruss, Krzysztof Szajowski)

Probabilistic Methods for Partial Differential Equations (Dan Crisan)



Progress in ‘Chemical Reaction Network Theory’ (Carsten Wiuf, Elisenda Feliu)  
Semigroups of Operators: Theory and Applications (Adam Bobrowski, Yuri Tomilov, Ralph Chill)  
Stochastic Models in Biosciences and Climatology (Samy Tindel)

#### SATELLITE THEMATIC SESSIONS

Algebraic and Geometric Methods in Nonlinear PDEs, Mechanics and Field Theory (Vyacheslav S. Kalnitsky, Alexandre M. Vinogradov)  
Anisotropic Parabolic Problems and their Applications (Piotr B. Mucha, Piotr Rybka)  
Combinatorics (Jarosław Grytczuk, Michał Karoński, Mariusz Woźniak)  
Delay Equations in Biomedical Applications (Urszula Forys)  
Geometric Methods in Calculus of Variations (Marcella Palese)  
Geometric Topology (Jerzy Dydak, Danuta Kołodziejczyk, Stanisław Spież)  
Geometry in Dynamics (Alex Clark, Krystyna Kuperberg)  
Homotopy Theory (David Blanc, Marek Golasieński)  
Infinite Dimensional Dynamical Systems with Time Delays (Tibor Krisztin, Hans-Otto Walther)  
Integrable Systems (Maciej Błaszak)  
Knot Theory and its Ramification (Józef H. Przytycki, Bronisław Wajnryb, Paweł Traczyk)  
Mathematical Physics and Developments in Algebra (Alexander Stolin, Konstantin Zarembo)  
Optimal Stopping and Applications (Łukasz Balbus, F. Thomas Bruss, Krzysztof Szajowski)  
Quasiconformal Mappings and Complex Dynamical Systems (Mark Elin, Anatoly Golberg, Stanisława Kanas, Toshiyuki Sugawa)  
Special Classes of Hilbert Space Operators (Marek Ptak)

#### PANEL DISCUSSIONS

EuDML: Accessing Europe’s Mathematical Treasures (moderator: Jiří Rákosník), speakers: Laurent Guillopé, Marek Niezgódka, Olaf Teschke  
Financing of Mathematical Research (moderator: Pavel Exner), speakers: Mats Gyllenberg, Michał Karoński, Sastry G. Pantula, Lex Zandee  
Redressing the Gender Imbalance in Mathematics: Strategies and Outcomes (moderator: Caroline Series), speakers: Penelope Bidgood, Kari Hag, Marja Makarow, Christie Marr, Marie-Francoise Roy  
The Role of Mathematics in the Emerging Economies (moderator: Andreas Griewank, Tsou Sheung Tsun), speakers: Neela Nataraj, Alexander Shananin, YuanJin Yun, Gareth Witten

‘Solid Findings’ in Mathematics Education; Proposals and Discussion, speakers: Guenter Toerner, Tommy Dreyfus, Despina Potari

What Is Expected From European Learned Societies? (moderator: Marta Sanz-Solé), speakers: Ehrhard Behrends, Wolfgang Eppenschwandter, Maria J. Esteban, Gert-Martin Greuel, Ari Laptev

## Closing Ceremony

The closing ceremony of the 6 ECM began with a presentation of the statistics concerning participation and the programme of the 6 ECM, by the Chair of the Executive Organizing Committee. The diagrams he showed are collected in the next section. Next, the prizes for posters were announced by Prof. Robert Wolak, the Chair of the poster prize committee. The diplomas were presented to the winners by the President of the EMS. The following mathematicians received the prizes:

Elena Yu. Bunkova (*Steklov Mathematical Institute RAS, RU*), Elliptic and Krichever formal group laws

Francesco Cellarosi (*Mathematical Sciences Research Institute, Berkeley, USA*), Ergodic properties of square-free numbers (with Ilya Vinogradov)

Andrzej Czarnecki (*Jagiellonian University, Kraków, PL*), Topological characterization of trivial cohomology with some applications

Pablo González Sequeiros (*University of Santiago de Compostela, ES*), Robinson inflation for repetitive planar tilings (with Fernando Alcalde Cuesta, Álvaro Lozano Rojo)

Maria Infusino (*University of Reading, UK*), On the discrepancy of some generalized Kakutani’s sequences of partitions (with Michael Drmota)

Andrii Khrabustovskiy (*National Academy of Sciences, UA*), Periodic Laplace–Beltrami operator with preassigned spectral gaps

Diána H. Knípl (*University of Szeged, HU*), Modelling the spread of influenza on long distance travel networks with real air traffic data

Marian Ioan Munteanu (*University of Iași, RO*), The classification of Killing magnetic curves in  $M^2(c) \times \mathbb{R}$

Ana Nistor (*KU Leuven, BE*), Constant angle surfaces in 3-manifolds

Weronika Siwek (*University of Silesia, Katowice, PL*), Stochastic bursting production in gene expression

Loredana Smaranda (*University of Pitești, RO*), Convergence of the Lagrange–Galerkin method for a fluid-rigid system with discontinuous density



Authors of Prized Posters with Professors Sanz-Solé, Jackowski, and Wolak

The winners received books and other publication prizes, provided by the publishers presenting their products during the congress. After passing the prizes to the winners the President of the German Mathematical Society (DMV) Prof. Christian Bäer came to the podium and invited everybody to the 7 ECM which will be held in Berlin in 2016.

Finally, the chair of the Executive Organizing Committee expressed his thanks to everybody involved in the organization of the 6 ECM, and invited them to the podium. Tens persons – faculty, staff and students appeared and they were gratefully applauded by the audience.

## Participants, lectures and speakers

There were total 980 registered participants of the 6 ECM; among them 76% men and 24% women. They were joined by 126 accompanying persons. In order to ensure broad participation in the 6 ECM and reduce economic barriers, grants were offered by the Foundation for Polish Science, the European Mathematical Society and by the European Women in Mathematics. Grants were awarded to 164 participants, 34 of them with Polish affiliation. Among the participants 139 were members of EMS and 129 of PTM (9 of the both societies). Below, we gather a few diagrams presenting the statistics of affiliations of the participants (Figure 1), their declared primary interests according to AMS MSC (Figure 2), and comparing the participation in the 6 ECM with the previous Congresses (Figure 3).

The scientific programme of the 6 ECM consisted of:

- 9 plenary lectures (60 minutes)
- 33 invited lectures (45 minutes in parallel sessions)
- 11 lectures of the Prize Winners (45 minutes in parallel sessions)
- 24 Mini-symposia (2 hours, in parallel sessions) at which 94 talks were given by the speakers invited by the organizers of minisymposium
- 3 special lectures, 1 special session and 6 panel discussions

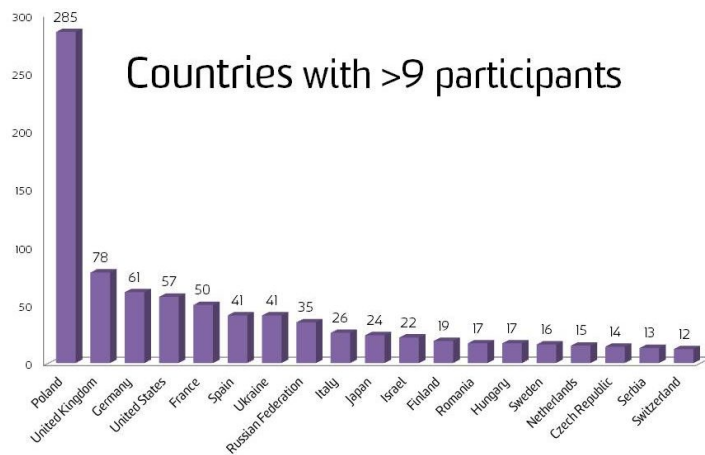


Figure 1: Affiliations of 6 ECM participants

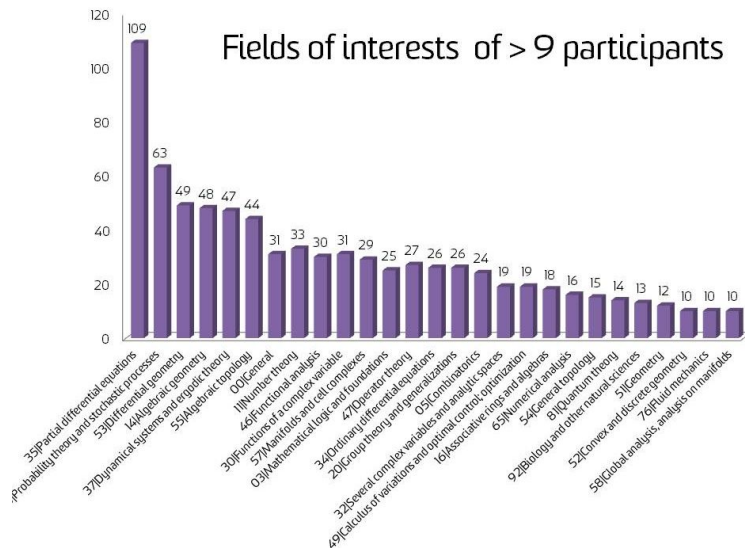


Figure 2: Declared primary interest according to AMS MSC

Distribution of the speakers by country of affiliation, in comparison to the distribution of all participants, and the proportion of number of lectures in the selected fields compared to the distribution of the interests of all participants (clearly showing some differences, and the fact that some participants had their primary interest, defined via AMS MSC, different from the primary interests of all the speakers), is presented in two diagrams that comprise Figure 4.

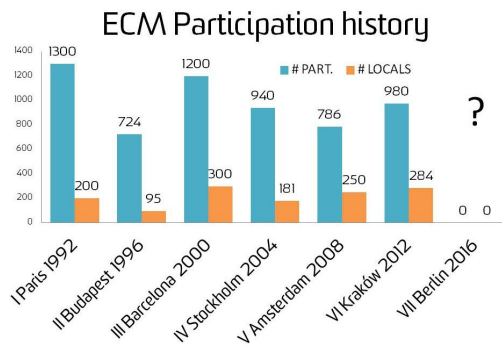


Figure 3: Numbers of ECM participants since 1992

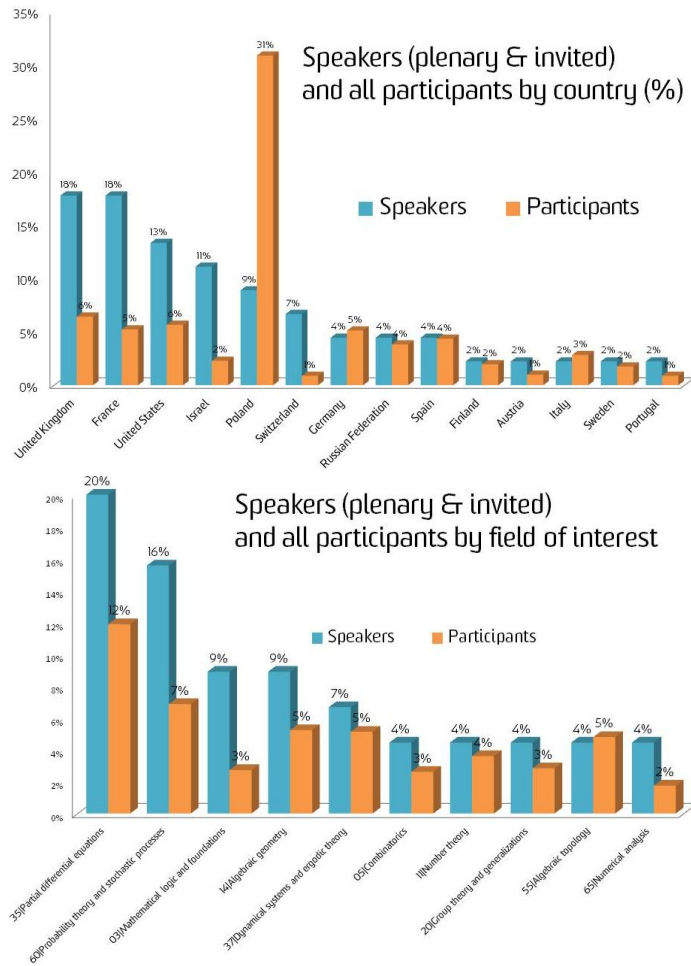


Figure 4: Participants and speakers

In order to ensure broad participation in the 6 ECM the organizers offered to the participants to organize the Satellite Thematic Sessions. There were 15, in some cases continuation of the minisymposia, at which 155 talks were delivered. Thematic distribution of all the lectures and mini-symposia is presented in the following table:

| Sections   | AMS Subjects                                   | Plenary&Invited Lectures | Posters | Mini-symposia |       | STS      |       |
|--|--|--------------------------|---------|---------------|-------|----------|-------|
|  |  |                          |         | Sessions      | Talks | Sessions | Talks |
| 1. Logic, Foundations  | 03   | 3                        | 3       |               |       |          |       |
| 2. Algebra, Number Theory, Algebraic Geometry                                    | 11, 14, 15, 16, 17, 20                         | 10                       | 25      | 4             | 16    | 1        | 9     |
| 3. Geometry, Topology, Global Analysis   | 22, 51, 52, 53, 54, 55, 57, 58                 | 3                        | 34      | 3             | 12    | 5        | 60    |
| 4. Analysis, Functional Analysis & Applications, Control Theory                  | 26, 28, 30, 32, 33, 41, 42, 46, 47, 49, 90, 93 | 3                        | 38      | 1             | 4     | 2        | 21    |
| 5. Dynamical Systems, Ordinary Differential Equations                            | 34, 37, 39                                     | 2                        | 14      | 3             | 12    | 2        | 21    |
| 6. Partial Differential Equations  | 35   | 7                        | 32      | 3             | 12    | 2        | 13    |
| 7. Mathematics in Science & Technology, Mathematical Physics                     | 70, 74, 76, 82, 85, 92                         | 5                        | 9       | 5             | 20    | 1        | 7     |
| 8. Probability, Combinatorics, Statistics  | 05, 60, 62, 91                                 | 7                        | 18      | 5             | 18    | 2        | 24    |
| 9. Numerical Analysis, Scientific Computing                                      | 65, 68   | 4                        | 5       |               |       |          |       |
| 10. History of Mathematics, Mathematics Education, Popularization of Mathematics | 01   | 2                        | 1       |               |       |          |       |
| Total  |  | 46                       | 179     | 24            | 94    | 15       | 155   |