# BeNeLux

## Mathematical Congress

Incorporating the 52nd
*Nederlands Mathematisch Congres*

Amsterdam
22-23 March
2016


More information and registration at:
www.wiskgenoot.nl/bnlmc

Organisers

VU

CWI

Universiteit van Amsterdam

Under auspices of

Belgian Mathematical Society

Koninklijk Wiskundig Genootschap

Société mathématique du Luxembourg
Mathematical Society

Supported by

GQT

NDNS+

NWO
Netherlands Organisation for Scientific Research

DIAMANT

NETWORKS

ELSEVIER

Foundation Compositio Mathematica

# Sponsors

The organizers gratefully acknowledge support from:















# Program of BeNeLux Mathematical Congress 2016

# Amsterdam

Local organizing committee:
André Ran (VU, chair)
Sonja Cox (UvA)
Herman te Riele (CWI)

Scientific organizing committee:
Lenny Taelman (chair)
Jan Bouwe van den Berg
Karel Dekimpe
Bas Edixhoven
Frank den Hollander
Erik Koelink
Martin Schlichenmaier
Yvik Swan
Gabor Wiese

PhD prize committee:
Jan van Mill (chair)
Arjeh Cohen
Jason Frank
Yvik Swan
Anton Thalmaier

Cover designed by Sonja Cox

# Contents

# Word of welcome

Dear Participant,

Welcome to the BeNeLuxMC 2016, organized under joint auspices of the Koninklijk Wiskundig Genootschap, the Belgian Mathematical Society and the Luxembourg Mathematical Society. This congress will incorporate the 52nd Nederlands Mathematisch Congres. The local organization is in the hands of a team of mathematicians from the University of Amsterdam, the Centrum Wiskunde & Informatica and the Vrije Universiteit.
The exciting program is put together by an international scientific organizing committee, and includes plenary lectures by Ellen Baake, James Maynard, who will give the Beeger lecture, and Stefaan Vaes. Semi-plenary lectures will be given by Johannes Nicaise, Ivan Nourdin, Mark Peletier and Marius Crainic, recipient of the first De Bruijn prize.
There will be an exciting evening program on March 22 at the Koninklijk Instituut voor de Tropen, consisting of public lectures by Marcus du Sautoy and Ionica Smeets and a buffet-dinner.
The "Docentendag" on March 22 has been recognized as an official schooling activity (6RU) for teachers. It will focus on the "profielwerkstuk in de wiskunde", including the presentation of the Pythagoras prize for the best high school final project in mathematics.
On Wednesday morning six young researchers will give short presentations on their PhD research, thereby competing for the PhD prize. The prize ceremony will be at the closing ceremony of the congress.
There will be many other activities during this conference, and we hope you will enjoy your stay here!
Should you have any questions or encounter any problems please contact the registration desk.

The local organizers: Sonja Cox, Herman te Riele and André Ran

# General Information

## Venue: Science Park, Universiteit van Amsterdam, Science Park 904, Amsterdam

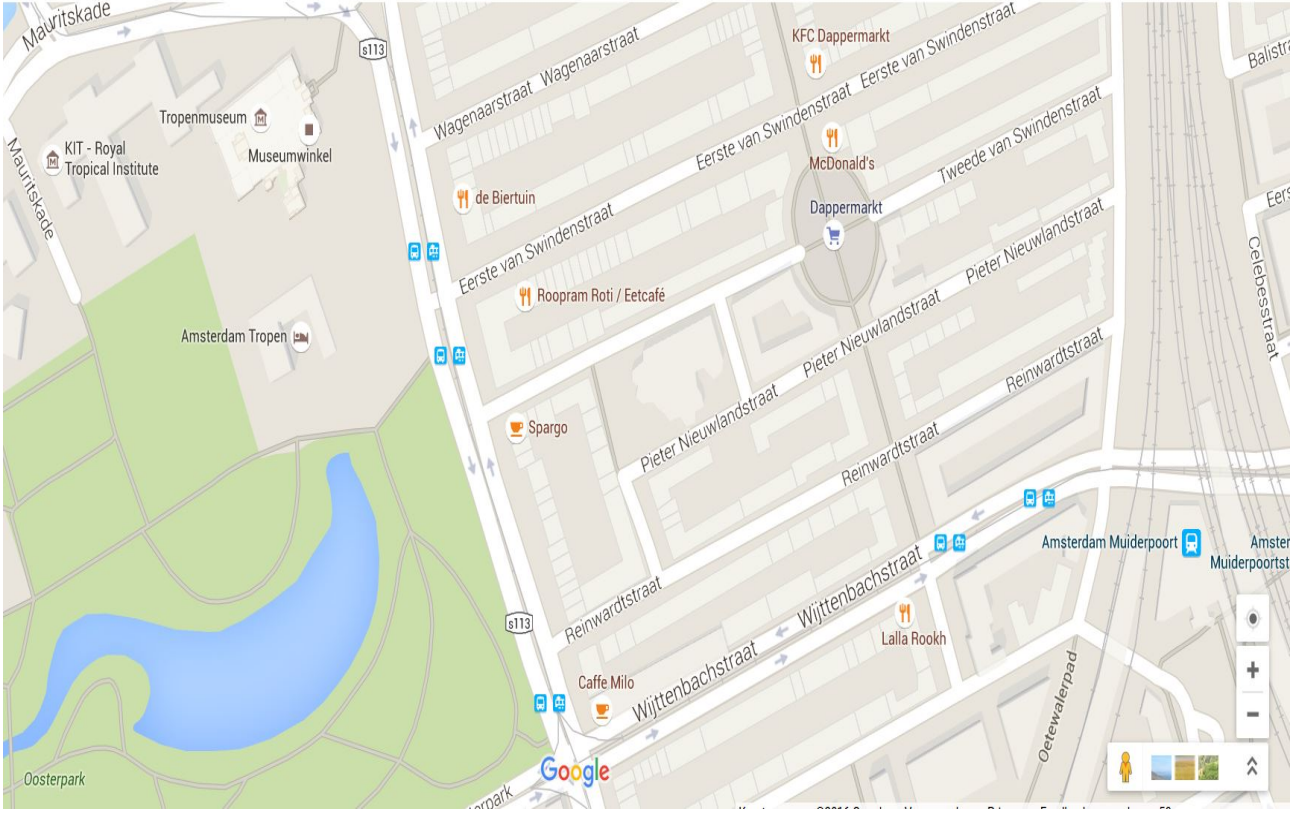
To reach the Science Park from the city center, take a metro or tram 12 to Amstel Station, and from there take bus 40. Exit at the stop Science Park.
There is wireless internet available via eduroam.
For discussions there are small lecture rooms available close to the rooms where the sessions will be held. All lecture rooms are equipped with a blackboard, a computer and a beamer.

## Evening venue on March 22: Royal Tropical Institute, Mauritskade 63, Amsterdam

The evening lectures on March 22 by Marcus du Sautoy and Ionica Smeets will take place in the Auditorium of the Koninklijk Instituut voor de Tropen (Royal Tropical Institute, KIT). From 16:30 there will be the possibility to chat and meet there over a complimentary drink. The lectures will be from 17:00 to 18:30. This event will be open to the general public (at an entrance fee), but as participant of the BeNeLuxMC you will have free access.
Following the evening lectures, the conference dinner is taking place in the "marble hall" of the Koninklijk Instituut voor de Tropen (Royal Tropical Institute), for those who registered for the dinner. **Please make sure to bring your dinner ticket.**
To reach the Royal Tropical Institute from Science Park by public transport, take the train in the direction Amsterdam CS, exit at the first stop, which is station Amsterdam Muiderpoort. If you want to walk it from there, that will take about 10 to 12 minutes. Alternatively, you can take tram 3 or 7, and exit at halte Linnaeusstraat. From there you have to walk a short bit. See the map on the next page (not quite to scale).

## Lunches, coffee and tea break

Lunches are included in the registration fee. Lunch will be served on the ground floor of the building. Coffee and tea will also be served on the ground floor of the building.


Mauritskade
s113
Tropenmuseum
Museumwinkel
KIT - Royal Tropical Institute
Mauritskade
Amsterdam Tropen
Oosterpark
Wagenaarstraat
Wagenaarstraat
KFC Dappermarkt
Eerste van Swindenstraat
Eerste van Swindenstraat
McDonald's
de Biertuin
Tweede van Swindenstraat
Dappermarkt
Eerste van Swindenstraat
Roopram Roti / Eetcafé
Pieter Nieuwlandstraat
Pieter Nieuwlandstraat
Pieter Nieuwlandstraat
Reinwardtstraat
Spargo
Reinwardtstraat
Amsterdam Muiderpoort
Reinwardtstraat
Wijttenbachstraat
Wijttenbachstraat
Lalla Rookh
Caffe Milo
Oetewalerpad
Google

## Stands

In the main venue of the congress, Science Park 904, there will be stands of the following organizations:

- Ars et Mathesis
- Elsevier
- Epsilon Uitgaven
- Koninklijk Wiskundig Genootschap (KWG)
- Nederlandse Vereniging van Wiskundeleraren (NVvW)
- Platform Wiskunde Nederland (PWN)
- PS Zituaction
- Vierkant voor Wiskunde

Uitgeverij Nieuwezijds will have a stand at the Royal Tropical Institute.

# Program of BeNeLuxMC 2016

## Tuesday, March 22nd

Page number(s) in brackets indicate where corresponding abstracts/information is to be found.

| | | | | |
|---|---|---|---|---|
| 09:45-10:00 | Opening **Karen Maex** and **Kees Oosterlee** C1.110 | | | |
| 10:00-10:50 | Beeger lecture **James Maynard** C1.110 (p. 12) | | | |
| 10:50-11:20 | Coffee break | | | |
| 11:20-12:10 | **Ivan Nourdin** C1.110 (p. 15) | | **Mark Peletier** C0.110 (p. 15) | |
| 12:10-13:15 | KWG meeting in C1.110 (p. 11) | | | |
| 13:00-14:00 | Lunch | | | |
| 14:00-16:00 | **Discrete Math Session**<br>B0.201 (p. 20)<br>14:00-14:40 Laurence Wolsey<br>14:40-15:20 Guido Schaefer<br>15:20-16:00 Samuel Fiorini | **Geometry Session**<br>C1.112 (p. 22)<br>14:00-14:40 Jean-Marc Schlenker<br>14:40-15:20 Tim de Laat<br>15:20-16:00 Simone Gutt | **Stochastics Session**<br>C0.05 (p. 24)<br>14:00-14:40 Anton Thalmaier<br>14:40-15:20 Marc Hallin<br>15:20-16:00 Francis Comets | **Docentendag**<br>C1.110 (p. 29)<br>Saskia van der Jagt<br>Sven Aerts<br>Marijke Mahieu<br>Pythagorasprijs |
| 16:00-17:00 | Transfer to Royal Tropical Institute (see p. 4 for directions) | | | |
| 17:00-18:30 | Public lectures: **Marcus du Sautoy & Ionica Smeets** (p. 14) | | | |
| 19:00-21:00 | dinner | | | |

# Wednesday, March 23rd

| | | | |
|---|---|---|---|
| 9:30-10:20 | **Ellen Baake** C1.110 (p. 12) | | |
| 10:20-10:50 | Coffee break | | |
| 10:50-11:40 | **Johannes Nicaise** C1.110 (p. 16) | **PhD prize lectures** C0.110 (pp. 11, 26) | |
| | | 10:50-11:10 Johan Commelin | |
| | | 11:10-11:30 Thomas Kleyntssens | |
| | | 11:30-11:50 Mihaela Mitici | |
| 11:40-12:45 | N.G. de Bruijn prize C1.110 (pp. 10, 16) | | |
| | 11:40-11:55 Laudatio by Henk Broer | 11:50-12:10 Emil Horobet | |
| | 11:55-12:45 Lecture **Marius Crainic** | 12:10-12:30 Valentijn Karemaker | |
| | 12:45-12:55 Award by Frans de Bruijn | 12:30-12:50 Geoffrey Janssens | |
| 12:45-14:00 | Lunch (Presentation Deltaplan from 13:15-13:45 in C1.110) | | |
| 14:00-16:00 | **Algebra Session** | **Analysis Session** | **Networks Session** |
| | C1.110 (p. 17) | C1.112 (p. 19) | C0.110 (p. 23) |
| | 14:00-14:40 Maryna Viazovska | 14:00-14:40 François Genoud | 14:00-14:40 Bart Jansen |
| | 14:40-15:20 Jack Thorne | 14:40-15:20 Juraj Földes | 14:40-15:20 Benny van Houdt |
| | 15:20-16:00 Tanja Lange | 15:20-16:00 Martina Chirilus-Bruckner | 15:20-16:00 Karen Aardal |
| 16:00-16:30 | Coffee break | | |
| 16:30-17:20 | **Stefaan Vaes** C1.110 (p. 12) | | |
| 17:20-17:40 | PhD prize award & closing C1.110 | | |

# Further information regarding program elements

On the next pages some information is provided regarding the Beeger lecture, the De Bruijn Prize, the PhD Prize, and the yearly meeting of the members of the KWG.

## About Beeger, the Beeger lecture, and the Beeger lecturer

*Dr. N.G.W.H. Beeger* was a Dutch mathematician. He was born in Utrecht, in 1884, and he died in Amsterdam, in 1965. He wrote a PhD thesis on Dirichlet series in 1916. Until the age of 65, he worked as a teacher, but in the evening hours he managed to produce about thirty papers and many reviews on elementary and algebraic number theory. One of his last publications was a table of prime numbers in the eleventh million. After his retirement as teacher, he started an extensive correspondence with other mathematicians like Gloden, Golubev, Ferrier, Bianchini, and Lehmer. Beeger had good contacts with the then Mathematical Centre in Amsterdam (now CWI) and he bequeathed part of his inheritance to this government research institute. The returns of this legacy are meant to cover the expenses of the *Beeger lecture*.
This biennial lecture was established in 1989 by the board of trustees of the Mathematical Centre in Amsterdam. Its purpose is to promote research and exchange of ideas in the field of algorithmic and computational number theory. As a rule, the Beeger lecture is delivered during the yearly congress of the Royal Dutch Mathematical Society (KWG). Until now, twelve Beeger lectures have been presented, namely, by Carl Pomerance (1992), Hugh Williams (1994), John Conway (1996), Hendrik Lenstra (1998), Peter Borwein (2000), Bjorn Poonen (2002), Manjul Bhargava (2004), Manindra Agrawal (2006), Dan Bernstein (2008), Florian Luca (2010), Yuri Bilu (2012), and Daniele Micciancio (2014). The thirteenth Beeger lecture will be presented during BeNeLux MC 2016 by*James Maynard* from Oxford.
James Maynard, born June 10, 1987, obtained his BA and masters degree in mathematics from Cambridge University. He then moved to Oxford where he completed a DPhil under the supervision of Prof. Heath-Brown. He joined Magdalen as a Fellow by Examination in 2013. In the academic year 2013-2014 he was on leave of absence from Magdalen as a CRM-ISM postdoctoral fellow at the Université de Montréal. James Maynard is primarily interested in classical number theory, in particular the distribution of prime numbers. His research focuses on using tools from analytic number theory, particularly sieve methods, to study the primes. He plays an important role in the recent developments concerning differences of primes and the question of the existence of infinitely many prime pairs which differ by a given constant. In

November 2013, Maynard gave a different proof of Yitang Zhangs theorem that there are bounded gaps between primes, and he resolved a longstanding conjecture by showing that for any $m$ there are infinitely many intervals of bounded length containing $m$ prime numbers. In particular, from Maynards approach it follows that there infinitely many prime gaps of length at most 600. In August 2014, he resolved a longstanding conjecture of Erdös on large gaps between primes, for which he received the largest Erdös prize ever offered.

## About N.G. de Bruijn, the prize and the N.G. de Bruijn lecturer

*Prof. dr. N.G. de Bruijn* was a Dutch mathematician. He was born in The Hague in 1918, and died in Nuenen in 2012. He studied at Leiden University, where he graduated in 1941. In 1943 he received his PhD from Vrije Universiteit in Amsterdam. His thesis was concerned with modular forms in several variables, his thesis advisor was J.F. Koksma. De Bruijn worked at the University of Amsterdam, where he was professor from 1952 to 1960, before moving to the Technical University Eindhoven, where he remained until his retirement in 1984. He was a member of the Koninklijke Academie van Wetenschappen (Royal Netherlands Academy of Arts and Sciences). De Bruijn was well-known for his fundamental work in several areas of mathematics, as well as for his involvement in the Automath project.

The N.G. de Bruijn Prize was established in 2015 by the KWG, the Dutch Royal Mathematical Society. It will be awarded for the first time at the BeNeLuxMC 2016. The prize is awarded for the best publication in mathematics in the years 2012–2014 by a mathematician of Dutch origin, or one working in the Netherlands. The prize is sponsored by Elsevier, and the prize-medal will be presented by de Bruijn's son Frans. The winner of the first N.G. de Bruijn Prize is *Marius Crainic*.

Marius Crainic, born February 3, 1973 in Aiud, Romania, obtained his masters degree in mathematics in 1996 from the Radboud University in Nijmegen. He then moved to Utrecht University where he received his PhD in 2000, under supervision of Prof. dr. Ieke Moerdijk. He received a number of distinctions, among them the Andre Lichnerowicz Prize in Poisson Geometry in 2008. His research interests lie in the broad area of (differential) geometry and topology, notably in Poisson Geometry.

## About the PhD Prize

On Wednesday morning there will be lectures by candidates for the PhD Prize. The Prize ceremony will be held at the closing of the BeNeLuxMC 2016. Six PhD students will have the opportunity to present their work (at most 20 minutes, including questions). At the end of the day, the winner selected by the jury receives a trophy and a cash prize.
Presentations must be aimed at a general mathematical audience, and the student's ability to make the subject accessible to non-specialists is an important criterion for winning the award. The candidates are currently PhD students (or recently defended their PhD) in mathematics at a university or research institution in the BeNeLux.
The jury consists of Jan van Mill (chair), Arjeh Cohen, Jason Frank, Yvik Swan and Anton Thalmaier.
The PhD Prize is sponsored by Bronstee.com

## Yearly meeting of the members of the KWG

**Tuesday, March 22nd, 12:10-13:15, C1.110**

Founded in 1778, the Dutch Royal Mathematical Society (Koninklijk Wiskundig Genootschap) is the oldest of all present-day national mathematical societies. The society serves as professional organization of the Dutch mathematics community. Besides organizing conferences, it also issues journals and magazines like Indagationes Mathematicae, Nieuw Archief voor Wiskunde and Pythagoras. Together with the Dutch society of mathematics teachers, it participates in PWN (Platform Wiskunde Nederland). The society also represents the Dutch mathematical community internationally in the EMS and IMU.
The yearly meeting of the Dutch Royal Mathematical Society is traditionally held during the NMC.

# Abstracts

## Abstracts of plenary talks

**James Maynard** (Oxford University)
*Small (and large) gaps between primes* (Beeger lecture Tuesday 10:00-10:50, C1.110)
Many of the most famous and most important questions on the distribution of primes can be cast as solving systems of linear equations with prime variables. The twin prime conjecture, Goldbach's conjecture, k-term arithmetic progressions of primes and most questions about small gaps between primes can all be seen in this manner, as well as several questions with applications to diophantine geometry or cryptography.
We will describe some of the progress on these questions, with a particular emphasis on establishing weak forms of some of these questions which has led to new results on bounded gaps between primes and large gaps between primes, amongst other things.

**Ellen Baake** (Universität Bielefeld)
*Ancestral selection graph meets lookdown construction* (Wednesday 9:30-10:20, C1.110)
Population genetics (the theory of biological evolution at the level of individual genotypes within populations) today relies crucially on mathematical concepts such as ancestral lineages and random genealogies. The talk will provide an overview. It starts from an interacting particle system that describes the joint action of random reproduction, mutation, and selection; then explains the constructions used to trace back the ancestry of individuals and their genealogy, and presents some recent results. In particular, it presents a novel approach that unifies the two established concepts in the field, namely, the ancestral selection graph of Krone and Neuhauser (1997) and the lookdown construction of Donnelly and Kurtz (1999).
The talk will be addressed to a general mathematical audience. No previous knowledge of biology is required, nor is specialised knowledge of probability theory.

**Stefaan Vaes** (KU Leuven)
*Classification of von Neumann algebras and their quantum symmetries* (Wednesday 16:30-17:20, C1.110)
The theme of this talk is the dichotomy between amenability and non-amenability. Because the group of motions of the three-dimensional Euclidean space is non-amenable (as a group with the discrete topology), we have the Banach-Tarski paradox. In dimension two, the group of motions is amenable and there is

therefore no paradoxical decomposition of the disk. This dichotomy is most apparent in the theory of von Neumann algebras: the amenable ones are completely classified by the work of Connes and Haagerup, while the non-amenable ones give rise to amazing rigidity theorems, especially within Sorin Popa's deformation/rigidity theory. I will illustrate the gap between amenability and non-amenability for von Neumann algebras associated with countable groups and with group actions on probability spaces, as well as for their "quantum symmetries", encoded as subfactors in the sense of Jones.

## Abstracts and detailed program of Tuesday evening at the Royal Tropical Institute

| | |
|---|---|
| 17:00-17:10 | Opening |
| 17:10-17:45 | **Ionica Smeets** |
| 17:45-18:20 | **Marcus du Sautoy** |
| 18:20-18:30 | Discussion |

**Marcus du Sautoy** (Oxford University)
*The Secret Mathematician*
From composers to painters, writers to choreographers, the mathematicians palette of shapes, patterns and numbers has proved a powerful inspiration. Artists can be subconsciously drawn to the same structures that fascinate mathematicians as they hunt for interesting new structures to frame their creative process.
Professor du Sautoy will explore the hidden mathematical ideas that underpin the creative output of well-known artists and reveal that the work of the mathematician is also driven by strong aesthetic values.

**Ionica Smeets** (Leiden University)
*Lying with numbers*
Numbers dont lie, but they are excellent for concealing the truth. Ionica Smeets takes you into a world of paradoxes, misleading graphs and weird logic.

## Abstracts of semi-plenary talks

**Ivan Nourdin** (Université du Luxembourg)
*The Gaussian Product Conjecture* (Tuesday 11:20-12:10 C1.110)
Let $Z = (Z_1, , Z_d)$ be any centered Gaussian vector and let $m$ be an integer bigger or equal to 1. The Gaussian Product Conjecture (GPC), which is still open, claims that the $2m$ moment of the product $Z_1 Z_d$ is always bigger than the product of the $2m$ moments. In this talk, I will first explain why this conjecture implies another conjecture from Banach space theory, the so-called Real Polarization Conjecture. Then I will prove an inequality related to GPC involving Hermite polynomials, and I will review several consequences. Based on a joint work with Dominique Malicet (Rio de Janeiro), Giovanni Peccati (Luxembourg) and Guillaume Poly (Rennes).

**Mark Peletier** (TU Eindhoven)
*From dislocations to plasticity: A mathematical upscaling challenge* (Tuesday 11:20-12:10 C0.110)
It is a holy grail in materials science to be able to design 'smart materials' from theory and computation alone, instead of through a costly and time-consuming experimental process. Like all holy grails, this is still very far off. The main challenge is the infamous Multiscale Problem - the difficulty of inferring from microscopic, nano-scale models the behaviour of the material at the macroscopic scale of millimeters and larger.
In this talk I want to discuss the mathematical aspects of a small part of this problem: the rigorous upscaling of material defects in metals called 'dislocations' to their macroscopic consequence of plastic deformation, which is the permanent deformation that metals undergo if one deforms them too much.
Although dislocations are present in incredibly large numbers in metals, which suggests that it should be possible to represent their effect and evolution by density fields, this turns out to be very difficult. In this talk I will describe the few results that we do have, and give examples of the difficulties that we face.
This is work in collaboration with Patrick van Meurs (Kanazawa), Lucia Scardia (Bath), and Adriana Garroni (Sapienza, Rome).

**Johannes Nicaise** (Imperial College)
*From elementary number theory to string theory and back again* (Wednesday 10:50-11:40, C1.110)
I will describe some surprising interactions between number theory, algebraic geometry and mirror symmetry that have appeared in my recent work with Mircea Mustata and Chenyang Xu and that have led to a solution of Veys' 1999 conjecture on poles of maximal order of Igusa zeta functions. The talk will be aimed at a general audience and will emphasize some key ideas from each of the fields involved rather than the technical aspects of the proof.

**Marius Crainic** (Universiteit Utrecht, N.G. de Bruijn Prize Lecture)
*Conn's linearization theorem- an invitation to Poisson Geometry* (Wednesday 11:55-12:45, C1.110)
Poisson structures came to life through the work of Lagrange and Poisson on motions of planets in the solar system (1808-1810), as computational tools. Poisson structures also emerged as the mathematical structures that underlies Hamilton's formulation of Mechanics (1834-1835). Jacobi noticed their conceptual importance and discovered their main properties (in particular his famous identity) around 1838. The fact that there is geometry behind these structures emerged from Lie's famous work on transformation groups (around 1880). The work of Lichnerowicz and Weinstein marked the start of Poisson Geometry (around 1980). As any other part of geometry, it came with its fundamental "linearization problem": conjectured by A. Weinstein (1983), the result was proven soon after by J. Conn using hard analytic tools (1985). Since then, the search for a geometric proof and understanding of the result has been one of the main driving forces in Poisson Geometry. During this time, due to the discovery of rather spectacular interactions with many other parts of geometry (foliations, Cartan pseudogroups and Ehresmann's groupoids, van Est isomorphisms), more geometric tools became available. These finally led to the desired geometric proof (joint work with R.L. Fernandes). The plan for the lecture is: a journey that starts with Lagrange and Poisson and ends with an outline of our geometric approach.

## Abstracts of parallel session talks

The scientific organizing committee has done its best to organize the sessions in such a way that they are thematically focussed. However, with the exception of the session "Docentendag" it is possible to switch between sessions.

### Algebra, Number Theory and Cryptology Session

**Wednesday 14:00-16:00, C1.110**
**Organizers: Gabor Wiese and Bas Edixhoven**

**Maryna Viazovska** (Humboldt University Berlin)
*Minimal energy problems on a sphere and in Euclidean space*
In this talk we will discuss several classical optimization problems such as minimal equal-weight quadratures (spherical designs), sphere packing, and minimal energy problems. We will consider the lower upper bounds for these problems. We will focus on the cases where lower and upper coincide and therefore the problem can be solved explicitly or asymptotically. In particular, we will explain the proof of Korevaar-Meyers conjecture on the minimal number of points in a spherical design.

**Jack Thorne** (Cambridge University)
*Recent progress in arithmetic aspects of the Langlands program*
The last 10 years have seen amazing progress in the Langlands program and its application to problems in number theory. I will discuss some recent work in this direction.

**Tanja Lange** (TU Eindhoven)
*Post-quantum cryptography*
Online banking, e-commerce, telemedicine, mobile communication, and cloud computing depend fundamentally on the security of the underlying cryptographic algorithms. Public-key algorithms are particularly crucial since they provide digital signatures and establish secure communication without requiring in-person meetings.
Essentially all applications today are based on RSA or on the discrete-logarithm problem in finite fields or on elliptic curves. Cryptographers optimize parameter choices and implementation details for these systems and build protocols on top of these systems; cryptanalysts fine-tune attacks and establish exact security levels for these systems. Alternative systems are far less visible in research and unheard of in practice.
It might seem that having three systems offers enough variation, but these systems are all broken as soon as large quantum computers are built. The

EU and governments around the world are investing heavily in building quantum computers and these investments are paying off in more stable qubits and better quantum-error correction, meaning that large, scalable quantum computers look more and more realistic in the medium term future. Society needs to be prepared for the consequences, including cryptanalytic attacks accelerated by these computers. Long-term confidential documents such as patient health-care records and state secrets have to guarantee security for many years, but information encrypted today using RSA or elliptic curves and stored until quantum computers are available will then be as easy to decipher as Enigma-encrypted messages are today.
This talk will explain post-quantum cryptography, cryptography that is designed not only to resist current attacks but also future attacks by quantum computers, and present signature and encryption systems that are thought to resist attacks by quantum computers. The talk also explains why those systems are not commonly used in practice, yet, and present some open problems.

**Analysis/Dynamical Systems and Partial Differential Equations Session**

**Wednesday 14:00-16:00, C1.112**
**Organizers: Jan Bouwe van den Berg and Denis Bonheure**

**François Genoud** (TU Delft)
*Bifurcation of stable solitons in nonlinear optical waveguides*
Nonlinear waveguides are central objects in digital communications, e.g. in optical fibers and integrated optics. Nonlinear Schrdinger equations (NLS) play a fundamental role in their mathematical modelling. In fact, the physics of nonlinear waveguides and the mathematical analysis of NLS have a long-standing and deeply intertwined history.
In the first part of the talk, I will present the so-called paraxial approximation, from which an NLS can be derived, which governs the propagation of laser beams in a waveguide. I will then present an overview of rigorous existence and stability results for guided nonlinear waves in various inhomogeneous planar waveguides. Some of the results surveyed are joint works with C.A. Stuart, B.A. Malomed and R.M. Weishupl.

**Juraj Földes** (Université libre Bruxelles)
*Statistical solutions for equations of fluid dynamics*
Due to sensitivity with respect to initial data and parameters, individual solutions of the basic equations of fluid mechanics are unpredictable and seemingly chaotic. However, some of their statistical properties are robust and these will be discussed by during the talk.
Our approach relies on an addition of a stochastic forcing and an investigation of invariant measures for the Boussinesq and MHD equations. More precisely, we show existence, uniqueness, ergodicity, and attractivity of invariant measures and their behaviour with respect to physical parameters.

**Martina Chirilus-Bruckner** (Leiden University)
*Collision of light pulses - a mathematical study*
The propagation of light pulses in optical fibers can be modeled by wave packet solutions for a nonlinear wave equation. This talk explains how the temporal evolution of such solutions is governed by a Nonlinear Schrdinger equation, which can be rigorously justified as a reduced model - often referred to as amplitude equation. We conclude by using this technique to give a detailed description of the collision of two wave packets.

**Discrete Mathematics, Operations Research and Decision Theory Session**

**Tuesday 14:00-16:00, B0.201**
**Organizers: Nikhil Bansal and Frits Spieksma**

**Laurence Wolsey** (CORE, Université catholique de Louvain)
*Deriving Tight Formulations for Some Simple Mixed Integer Programs*
Given a family of integer or mixed integer linear programs, it is natural to ask if the associated optimisation problem can be solved in polynomial time and, if so, whether one can find a "good" polyhedral description of the convex hull of feasible solutions either in the original space of variables or as the projection of a polyhedron (extended formulation) in some higher dimensional space. Whereas techniques for tackling pure integer programs have been much studied, much less is known about mixed integer programs and, as we shall see, the main techniques available involve reduction to pure integer problems. The aim of this talk is to present a couple of the most useful results for tackling MIPs as well as an answer to a more specific question about the structure of the facet-defining inequalities. The examples are taken from lot-sizing, network design and mixed integer knapsack problems.

**Guido Schäfer** (CWI and Vrije Universiteit Amsterdam)
*Optimization in network routing games*
Network routing games have proven useful in studying the effect of selfish route choices in networks (e.g., traffic networks). It is known that such choices may lead to equilibrium outcomes that are highly inefficient and a lot of research has gone into the design of algorithms to reduce this inefficiency. In this talk, we review some of these results for non-atomic network routing games. In particular, we discuss recent results on the problem of computing optimal tolls in networks with restrictions. This line of research gives rise to new optimization problems which are challenging to tackle. We also draw some connections to the analysis of network routing games with risk-averse players.

**Samuel Fiorini** (Université libre de Bruxelles)
*Sizes of Approximate Linear Programming Formulations*
What is the most efficient way to formulate a given combinatorial optimization problem with a linear program? This question has rich connections, for instance, with discrete geometry, theoretical computer science, and machine learning. A wonderful observation due to Mihalis Yannakakis relates the question directly to the nonnegative rank of matrices, a measure of which our understanding has much progressed in the past few years. In my talk, I

will focus on two recent results that illustrate these sometimes surprising connections: (i) a tight impossibility result for approximating the Vertex Cover problem with polynomial-size linear programs, (ii) the construction of the first quasi-polynomial size linear program approximating the Minimum Knapsack problem.

**Geometry Session**

**Tuesday 14:00-16:00, C1.112**
**Organizers: Erik Koelink and Martin Schlichenmaier**

**Jean-Marc Schlenker** (Université du Luxembourg)
*Anti-de Sitter geometry and polyhedra inscribed in quadrics* Anti-de Sitter geometry is a Lorentzian analog of hyperbolic geometry. In the last 25 years a number of connections have emerged between 3-dimensional anti-de Sitter geometry and the geometry of hyperbolic sufaces. We will show how the study of ideal polyhedra in anti-de Sitter space leads to an answer to a question of Steiner (1832) on polyhedra that can be inscribed in a quadric. Joint work with Jeff Danciger and Sara Maloni.

**Tim de Laat** (KU Leuven)
*Coarse embeddability of expanders into Banach spaces*
Expanders are sequences of highly connected finite sparse graphs. They play an important role in several areas of mathematics. The explicit construction of expanders was one of the major applications of Kazhdan's property (T), which is an important property for groups that stands at the roots of many rigidity results. Key examples of groups with property (T) are the groups $SL(n, Z)$ with $n > 2$, and more generally, higher rank lattices. It is an important open problem whether the expanders coming from higher rank lattices admit a coarse embedding into certain Banach spaces, i.e. an embedding that respects the large scale geometry. After an introduction to this problem, I will explain a joint work with Mikael de la Salle, in which we prove that given a Banach space satisfying certain natural conditions on its geometry, it follows that the expanders constructed from $SL(n, Z)$ do not admit a coarse embedding into the given Banach space if n is sufficiently large.

**Simone Gutt** (Univeristé Libre Bruxelles)
*A symplectic analogue to spaces of constant curvature*
We show how symmetric symplectic spaces whose canonical connection has a Ricci-type curvature are natural analogues to Khler manifolds of constant holomorphic curvature. We describe their totally geodesic symplectic submanifolds and show how this yields a framework for Radon-type transforms. (This is joint work with Michel Cahen and Thibaut Grouy.)

**Networks Session**

**Wednesday 14:00-16:00, C0.110**
**Organizers: Michel Mandjes and Frank den Hollander**

**Bart Jansen** (TU Eindhoven)
*Fine-grained complexity analysis of computational problems on networks*
This talk gives an introduction to fine-grained complexity analysis, which classifies the computational complexity of problems on a finer scale than the traditional distinction between polynomial-time solvable and NP-complete problems. In recent years there have been tremendous advances in our understanding of the best-possible running time to solve classic problems on networks such as finding (all-pairs) shortest paths and detecting triangles. These new developments are based on new hypotheses about the running time of fundamental optimization problems, together with a web of intricate reductions relating the complexities of various problems to each other. The goal of the presentation is to give an accessible overview of some key results in this area concerning networks, and to give examples of the reductions that are used. For example, we will see that from the right perspective the problem of computing all pairs of shortest path distances in a graph is equivalent to the problem of finding a triangle whose sum of edge weights is negative.

**Benny van Houdt** (University Antwerpen)
*Explicit back-off rates for achieving target throughputs in CSMA/CA networks*
CSMA/CA networks have often been analyzed using a stylized model that is fully characterized by a vector of back-off rates and an undirected conflict graph. Further, for any achievable throughput vector under this model the existence of a unique vector of back-off rates that achieves this throughput vector has been proven. In this talk we uncover the set of conflict graphs for which a simple explicit expression can be obtained for this unique vector of back-off rates.

**Karen Aardal** (TU Delft and CWI Amsterdam)
*Approximability of facility location problems*
Facility location problems are well-known in combinatorial optimization.
We describe results on approximability of important versions of facility location problems and give some open problems. We also give a brief description of a recent application in emergency vehicle location.

**Probability and Statistics Session**

**Tuesday 14:00-16:00, C0.05**
**Organizers: Yvik Swan, Ivan Nourdin and Eric Cator**

**Anton Thalmaier** (Université du Luxembourg)
*Brownian motion, curvature and entropy formulas*
We discuss notions of stochastic differential geometry in the framework of static manifolds and manifolds evolving along a geometric flow. In this context we deal with Brownian motions, basic functional inequalities, and entropy formulas for positive solutions of heat equations.

**Marc Hallin** (ECARES and Université libre de Bruxelles)
*Monge-Kantorovich Ranks and Signs*
Unlike the real line, the real space $\mathbb{R}^K$, $K \geq 2$ is not "naturally" ordered. As a consequence, such fundamentals univariate concepts as quantile and distribution functions, ranks, signs, all order-related, do not straightforwardly extend to the multivariate context. Since no universal pre-existing order exists, each distribution, each data set, has to generate its own—the rankings behind sensible concepts of multivariate quantile, ranks, or signs, inherently will be distribution-specific and, in empirical situations, data-driven.
Many proposals have been made in the literature for such orderings—all extending some aspects of the univariate concepts, but failing to preserve the essential properties that make classical rank-based inference a major inferential tool in the analysis of semiparametric models where the density of some underlying noise remains unspecified: (i) exact distribution-freeness, and (ii) asymptotic semiparametric efficiency, see Hallin and Werker (2003).
Ranks and signs, and the resulting inference methods, are well understood and well developed, essentially, in two cases: one-dimensional observations, and elliptically symmetric ones. We start by establishing the close connection, in those two cases, between classical ranks and signs and measure transportation results, showing that the rank transformation there actually reduces to an empirical version of the unique gradient of convex function mapping a distribution to the uniform over the unit ball.
That fact, along with a result by McCann (1995), itself extending the celebrated *polar factorization Theorem* by Brenier (1991), is then exploited to define fully general concepts of ranks and signs—called the *Monge-Kantorovich ranks and signs* coinciding, in the univariate and elliptical settings, with the traditional concepts, and enjoying under completely unspecified (absolutely continuous) $d$-dimensional distributions, the essential properties that make traditional rank-based inference an essential part of the semiparametric inference.
Based on joint work with Victor Chernozhukov, Alfred Galichon, and Marc Henry.

**Francis Comets** (Université Paris Diderot)
*Localization for directed polymers in random medium*
Directed polymers in random environment are known to localize when the disorder is strong. This is another form of Anderson localization. After a general review, we will analyse this phenomenon in a precise manner for an exactly solvable model: the nearest neighbor polymer in one space dimension in log-gamma distributed environment with boundary conditions, introduced by Timo Seppäläinen. In the equilibrium case, as the length increases, the end point of the polymer converges to a distribution proportional to the exponent of a zero-mean random walk.

**PhD Prize**

**Wednesday 10:50-12:50, C0.110**
For information on the prize, see p. 11.

**Johan Commelin** (Radboud Universiteit)
*The Mumford- Tate conjecture for the product of an abelian surface and a K3 surface*
The Mumford-Tate conjecture is a precise way to say that two invariants of an algebraic variety $X$ (over a number field) convey the same information. The two invariants in question are (1) the Hodge structure on the singular cohomology of the complex analytic variety associated with $X$; and (2) the Galois representation on the l-adic etale cohomology of $X$.
In this talk I will explain the conjecture, and how it fits in a bigger framework of conjectures, like the Hodge conjecture and the Tate conjecture.
I will state the Mumford-Tate conjecture for the product of an abelian surface and a K3 surface; and if time permits, I will elaborate on the ingredients of the proof.

**Thomas Kleyntssens** (Université de Liège)
*Wavelet-based methods to study the regularity of a signal: from theory to practice*
The most natural tools to study the pointwise regularity of a function are the notions of continuity and derivability. However, in many applications (such as fully developed turbulence), these notions are not sufficient. For example the function $f : x \mapsto |x|^h$ is continuous and not differentiable at 0 if $h \in ]0, 1[$ but the knowledge of the exponent $h$ gives an additional information about of the regularity of $f$ at 0. The Hölder exponent $h_f(x)$ formalizes this idea. For a very irregular signal $f : \mathbb{R}^n \to \mathbb{R}$, the value of $h_f(x)$ may change widely from a point to another. Therefore, it is more interesting to estimate the "size" of the set of points sharing the same Hölder exponent, i.e. to compute the following function:

$$d_f : [0, +\infty] \to \{-\infty\} \cup [0, n],\ h \mapsto \dim_{\mathcal{H}}\{x \in \mathbb{R}^n : h_f(x) = h\}$$

where $\dim_{\mathcal{H}}$ is the Hausdorff dimension. The function $d_f$ gives global information about the pointwise regularity of $f$. Unfortunately, in most of the practical cases, the function $d_f$ is impossible to compute. It is thus estimated using heuristic methods, called multifractal formalisms. From a mathematical point of view, a multifractal formalism is a numerical method leading to an upper bound of $d_f$ for which the equality is "often" obtained for functions belonging to certain functional spaces.
In this talk, I will use the notion of wavelet to design multifractal formalisms. I will present the theoritical results obtained and the first implementation

of some formalisms ([3, 2] and references therein). Finally, I will show the utility of these formalisms and I will also apply these methods on a practical example: the Mars topography [1].
(Joint work with my supervisor, Samuel Nicolay)


1. A. Deliège, T. Kleyntssens, and S. Nicolay. Mars Topography Investigated Through the Wavelet Leaders Method: a Multidimensional Study of its Fractal Structure. *Submitted*, 2016.
2. C. Esser, T. Kleyntssens, and S. Nicolay. A multifractal formalism for non-concave and non-increasing spectra: The leaders profile method. *Applied and Computational Harmonic Analysis*, 2016.
3. T. Kleyntssens, C. Esser, and S. Nicolay. A multifractal formalism based on the $S^\nu$ spaces: From theory to practice. *Submitted*.


**Valentijn Karemaker** (Utrecht University)
*The Inverse Galois Problem for symplectic groups*
We study the symmetries of algebraic equations defining geometric objects, and ask: if we are given a group of symmetries, can we find a geometric object that has exactly these symmetries? This is the Inverse Galois Problem, which has received a lot of attention over the past decades.
We have shown that for a six-dimensional symplectic group, we can always find a geometric object with this group as symmetries. This solves the Inverse Galois Problem for an infinite family of groups. The geometric object we construct is the Jacobian of a curve, where the curve is prescribed to have a special shape.

**Emil Horobet** (TU Eindhoven)
*Orthogonal and unitary tensor decomposition*
Unlike matrices, which always have a singular value decomposition, higher-order tensors typically do not admit a decomposition in which the terms are pairwise orthogonal. The ones which do admit such a decomposition are called orthogonally decomposable (odeco) tensors. In general, tensor decomposition is NP-hard, but the decomposition of odeco tensors, can be found efficiently. Because of their efficient decomposition, odeco tensors have been used in machine learning, in particular for learning latent variables in statistical models, hence testing whether a tensor is odeco is rather useful. Odeco tensors form a semi-algebraic set, a finite union of subsets described by polynomial equations and (weak or strict) polynomial inequalities. However, in this talk we will see that in fact, only equations of low degree are needed. A key feature of our approach is a surprising connection between orthogonally decomposable tensors and semisimple algebras.

**Mihaela Mitici** (Univeresity of Twente)
*Performance Analysis of Data Retrieval in Wireless Sensor Networks*
Sensors are employed in a wide range of areas such as environmental monitoring, surveillance and public safety, and smart homes. However, several challenges need to be addressed such as ensuring the reliability of sensor data, timely retrieval of data and efficient consumption of sensor energy.
We provide several examples where sensors and mathematics meet to address the above mentioned challenges. We first considered the situation where end-users retrieve data about a monitored area by means of queries, i.e., by requesting information about a monitored area. The interest is in retrieving data in a timely manner and without compromising the quality (freshness) of the data. We consider a Discrete Time and State Markov Decision Process, derived by non-standard, exponential uniformization, to obtain an optimal query processing strategy. We also consider the case when several sensor measurements must be retrieved to acquire an accurate and timely overview about a monitored area. In this case, we characterize the performance of the sensor network in terms of the retrieval time of data and the energy consumption of sensors by means of a novel multi-class queueing model and combinatorics of permutations.
The results provide a theoretical support for the design and implementation of wireless sensor network applications in relation with the reliability of data, its retrieval time and the energy consumption of the sensors.

**Geoffrey Janssens** (Vrije Universiteit Brussel)
*Identities of algebras and groups and their asymptotic behaviour*
Any algebra $A$ is defined by generators and relations. Some relations, e.g commutativity ($xy - yx = 0$) and nilpotency of degree $n$ ($x_1...x_n = 0$), are polynomials and valid for all the elements of the algebra. These relations are called Polynomial Identities and are the equivalent of laws/group identities in group theory. Example given, all finite dimensional algebras satisfy a PI.
In this talk we are interested in the general problem of classifying algebras up to PI-equivalence (i.e. up to satisfying the same polynomial identities). The main tool presented will be the so-called codimension sequence $(c_n(A))_n$, which is an invariant, and its asymptotics. It is proved that $c_n(A) \simeq cn^{t(A)}(e(A))^n$ for some constants $c \in R, t(A) \in \frac{1}{2}\mathbb{Z}$ and $e(A) \in \mathbb{Z}$ (where $f \simeq g$ if $\lim \frac{f}{g} = 1$). We will explain recent results concerning the algebraic information delivered by the polynomial growth rate (the constant $t(A)$) and the exponential growth rate (the constant $e(A)$). Further we will describe how these constants can be used towards the problem of classifying algebras up to PI-equivalence.
Connections with the word growth of a finitely generated group will also be mentioned.

**Docentendag**

**Dinsdag 14:00-16:00, C1.110**
**Organisatoren: Willem Hoekstra en Derk Pik**

De docentendag heeft als thema *Het profielwerkstuk in de middelbareschool-wiskunde*. De organisatie is in handen van Willem Hoekstra (Vrije Universiteit) en Derk Pik (Universiteit van Amsterdam, JSG Maimonides en Pythagoras). Er zijn drie lezingen van elk dertig minuten. Tevens vindt de uitreiking van de Pythagorasprijs voor het beste profielwerkstuk in de wiskunde plaats.

**Saskia van der Jagt** (Vrije Universiteit, Amsterdam; Coornhert Gymnasium, Gouda)
*Kwantitatief onderzoek door middelbare scholieren*
We gaan in op het effectief begeleiden van kwantitatief onderzoek bij het profielwerkstuk. Hoe leren we leerlingen om te gaan met nauwkeurigheid, betrouwbaarheid en validiteit?

**Sven Aerts** (4e Gymnasium, Amsterdam)
*Wisconstighe Werkstukken*
Hoewel wel eens beargumenteerd wordt dat de wiskunde een te ver geëvolueerde discipline is om nog belangrijke bijdrages van jonge mensen te mogen verwachten, biedt wiskunde unieke perspectieven voor het maken van profielwerkstukken. Aan de hand van voorbeelden uit de praktijk lichten we toe hoe breed het scala van wiskundige of wiskunde gerelateerde profielwerkstukken wel niet is. In het bijzonder gaan we in op de rol van de begeleider in het tot stand komen van deze werkstukken.

**Marijke Mahieu** (Stedelijk Gymnasium Leiden)
*Reverspectief*
Hoe krijg je Wiskunde C-leerlingen zo gemotiveerd voor je vak dat ze een profielwerkstuk over Wiskunde gaan maken? Slimme vwo-leerlingen worden al jarenlang afgescheept met een soort slap aftreksel van wiskunde A omdat het anders te moeilijk voor ze zou zijn. Gelukkig is in het nieuwe examenprogramma Wiskunde C veel meer ruimte voor een heel eigen benadering van de C&M leerling.
Gebruik makend van de mogelijkheden van het oude programma, heb ik met mijn leerlingen de raakvlakken opgezocht van wiskunde met geschiedenis en met kunst. Ik werd beloond met prachtige CE-resultaten en met een indrukwekkend profielwerkstuk: een kunstwerk in Reverspectief.

**Pythagoras Profielwerkstuk Prijs**
Een belangrijk onderdeel van de docentendag is de uitreiking van de Pythagorasprijs voor het beste profielwerkstuk in de wiskunde. De prijs wordt dit jaar voor het eerst uitgereikt. De drie beste leerlingen zullen een korte voordracht houden waarna het publiek het beste, mooiste meest interessante werkstuk mag uitkiezen.

# Index