



# Newsletter

BELGIAN MATHEMATICAL  
SOCIETY

# 145, November 15, 2023

Comité National de Mathématique CNM

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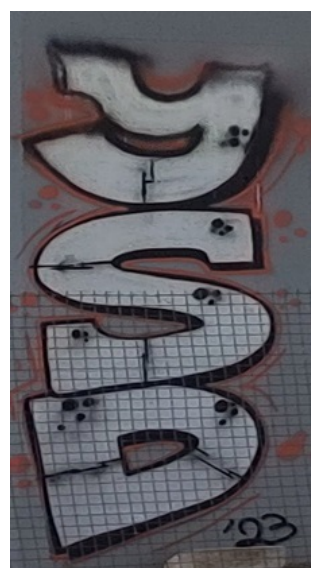
NCW Nationaal Comité voor Wiskunde

## Newsletter of the Belgian Mathematical Society and the National Committee for Mathematics

Belgian Mathematical Society ASBL/VZW  
ULB Campus Plaine, C.P. 218/01,  
Bld du Triomphe, B-1050 Brussels, Belgium

Website: [bms.ulb.ac.be](http://bms.ulb.ac.be)

Newsletter: [wendy.goemans@kuleuven.be](mailto:wendy.goemans@kuleuven.be)



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The next edition of this newsletter appears on January 15. Send your content (on PhD defenses, seminars, conferences, workshops, meetings, interaction with other sciences or companies, popular lectures, school initiatives, math exhibitions, job opportunities, ...) to [wendy.goemans@kuleuven.be](mailto:wendy.goemans@kuleuven.be).

## Foreword

Dear fellow mathematicians, friends and colleagues<sup>1</sup>,

The new academic year is reaching cruising speed. I hope that apart from a lot of work, it also brings you new opportunities, fruitful collaborations and exciting new mathematical results. In this newsletter you will find as usual some news from the various Mathematics departments in our country. Don't hesitate to inform us about any activity you organize in your research group, so that we can spread the word via our newsletter. After all, it is one of the main purposes of our society to increase the interaction between Belgian mathematicians.

It is exactly for this reason that the BMS organizes two events in this academic year. Firstly, it is my pleasure to invite you all to our first "Young Scholar Day", which will take place on December 20, at the U-residence on the VUB campus. You can find more information about this event further in this newsletter. Our general assembly will also take place during that day, and as a BMS member, you are of course invited to participate in this meeting. If you did not register yet for the Young Scholar Day, please do so at your earliest convenience via our website! The deadline for registration is November 30, as we need to know the exact number of participants for the practical organization. As usual, BMS members can register for free, and PhD students can become BMS member for free.

Later this academic year, on May 24, we hope to see many of you during a new edition of our "PhD day" in Antwerp. More information about this event will be given in our next Newsletter.

Enjoy reading our newsletter and see you on December 20!

Joost aka Monsieur le Président

## 1 News from the BMS & NCM

### 1.1 First Young Scholar Day

The first BMS Young Scholar Day will take place at the U-residence on the VUB campus on 20 December 2023.

Registration (free for BMS members) until November 30 via the BMS website:

<https://bms.ulb.ac.be/conferences/young-scholar-day-2023/>

- 09h00 - 09h30: welcome and coffee
- 09h30 - 10h30: Godeaux lecture by Sophie Grivaux
- 10h30 - 11h00: coffee break
- 11h00 - 12h15: parallel sessions
  - 1a: Group theory (Chairs: De Medts and Caprace)  
Corentin Le Coz (UGent), François Thilmany (UCLouvain), Philippe Tranchida (ULB)
  - 1b: Probability (Chairs: Esser and Swan)  
Dimitri Konen (Warwick), Laurent Loosveldt (ULiège), Matthieu Simon (UMons)

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<sup>1</sup>multiple correct answers are possible

- 1c: Differential geometry and dynamical systems (Chairs: Hohloch and Zambon)  
Aldo Witte (UA), Ragini Singhal (ULB), Stephane Geudens (University College London)
- 12h15 - 14h00: Lunch break
- 12h15 - 12h45: Board meeting (decision on YSA '23)
- 13h30 - 14h00: BMS General Assembly - Announcement of YSA winner
- 14h00 - 15h15: parallel sessions
  - 2a: Algebraic geometry (Chairs: Budur and Barros)  
Sasha Viktorova (KU Leuven), Timothy De Deyn (VUB), Pieter Belmans (Luxembourg)
  - 2b: Real and functional analysis (Chairs: De Brouwere and Grosse-Erdmann)  
Frederik Broucke (UGent), Fernando Costa Jr. (Umons), Arman Molla (Uliège)
  - 2c: Logic (Chairs: Weiermann and Michaux)  
Juan Pablo Aguilera (UGent; Vienna), Pierre Vandenhove (UMons; Bordeaux), Nicolas Daans (UA; Prague)
- 15h15 - 15h45: coffee break
- 15h45 - 17h00: parallel session
  - 3a: Operator algebras and operator theory (Chairs: De Commer and Szabo)  
Anna Duwenig (KU Leuven), Jacek Krajczok (VUB), Sigiswald Barbier (UGent)
  - 3b: Partial differential Equations (Chairs: Duerinckx and Olbermann)  
Elise Bonhomme (ULB), Amirali Hannani (KU Leuven), Marianna Chatzakou (UGent)
  - 3c: Combinatorics and discrete mathematics (Chairs: Fiorini)  
Anna Vanden Wyngaerd (ULB), Stijn Cambie (KU Leuven), Pierre Popoli (ULG)
- 17h00 - 18h00: Drink

## 1.2 Call for Young Scholar Award

As you can see above, the BMS board will decide on the winner of the Young Scholar Award (YSA) 2023 on 20 December 2023. For the rules on this prize, see the BMS website <https://bms.ulb.ac.be/bms-prizes/>.

In case you want to propose a candidate, contact one of the board members, a list can be found on <https://bms.ulb.ac.be/about-the-belgian-mathematical-society/>.

## 1.3 Save the date: PhD day 24 May 2024

The next PhD day of the BMS will take place on 24 May 2024 in Antwerp. All information will appear on <https://bms.ulb.ac.be/conferences/phd-day-2024/>.

## 1.4 Bulletin of the Belgian Mathematical Society - Simon Stevin

Starting from Volume 28 the Bulletin of the Belgian Mathematical Society - Simon Stevin only appears online and is not printed any more. As a member of the BMS you have electronic access to all electronically available issues of the bulletin, free of charge. If you have any trouble logging in or accessing the journal, please contact [customer\\_support@projecteuclid.org](mailto:customer_support@projecteuclid.org).

**Content Volume 30 (2) September 2023**

- A characterization of minimal Lagrangian submanifolds of the nearly Kähler  $G \times G$  **Rodrigo Aguilar-Suárez; Gabriel Ruiz-Hernández** doi:10.36045/j.bbms.220331
- The Khinchin inequality for multiple sums revisited **Anselmo Raposo; Katuscia B. Teixeira** doi:10.36045/j.bbms.220831
- On the Classification of Torsion-Free Nil Rings of Rank Two **Ryszard R. Andruszkiewicz; Mateusz Woronowicz** doi:10.36045/j.bbms.221123
- On  $P$ -spaces and  $G_\delta$ -sets in the absence of the Axiom of Choice **Kyriakos Keremedis; AliReza Olfati; Eliza Wajch** doi:10.36045/j.bbms.230117
- Chain Lemma, Quadratic Forms and Symbol Length **Adam Chapman; Ilan Levin** doi:10.36045/j.bbms.230123
- A best possible upper bound for the complete elliptic integral of the first kind **Zhong-Xuan Mao; Lan-Xiang Yu; Jun-Yi Li; Jing-Feng Tian** doi:10.36045/j.bbms.230228
- Primes in coverings of indecomposable involutive set-theoretic solutions to the Yang-Baxter equation **Wolfgang Rump** doi:10.36045/j.bbms.230429

For the table of contents of previous issues, see <https://projecteuclid.org/all/euclid.bbms>.

**2 (Online) Meetings, Conferences, Lectures, ...****2.1 November 2023**

**Officially not celebrating Eric's retirement**

November 13, 2023, VUB, Brussels, Belgium

Eric Jespers has played an important role in Mathematics, in particular in numerous aspects of algebras ranging from Ring Theory to the new research area of solutions to the Yang-Baxter equation.

On the occasion of his retirement, we organised a conference to celebrate his career and his contributions to algebra.

Keynote speakers: Ángel del Río, Ann Doms, Łukasz Kubat, Victoria Lebed, Fred Van Oystaeyen

Organizing Committee: Ilaria Colazzo, Arne Van Antwerpen, Leandro Vendramin

Conference Website: <http://www.ilariacolazzo.info/eric/>

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**ICMAM Latin America Satellite Conference on Data Science, AI and Machine Learning**

November 17, 2023, online

See all information on <https://sites.google.com/view/icmam-data-science-and-ml-2023>.

**Chaire de la Vallée Poussin 2023**

November 30 - December 1, 2023, Université catholique de Louvain

Professor Kathryn Hess Bellwald (Ecole Polytechnique Fédérale de Lausanne) will be the recipient of the Chaire de la Vallée Poussin 2023.

The Chaire de la Vallée Poussin was created in honor of the great Belgian mathematician Charles-Jean de la Vallée Poussin (see <https://uclouvain.be/fr/instituts-recherche/irmp/chaire-de-la-vallee-poussin.html>).

Kathryn Hess Bellwald will give a series of lectures on Homotopical perspectives on algebra and geometry at the Institut de Recherche en Mathématique et Physique (<https://uclouvain.be/fr/instituts-recherche/irmp>) of the Université catholique de Louvain.

The first lecture, called the leçon inaugurale and accessible to a wide audience, is scheduled on Wednesday, 29 November, at 4.30 p.m. The title of the inaugural lecture is Hochschild homology: from classical to modern.

The second lecture, entitled Homotopical perspectives on Morita and Hopf-Galois theory, will take place on Thursday 30 November at 4.30 p.m.

The third lecture on Configuration spaces for product manifolds is scheduled on Friday 1st December at 10.45 a.m.

On Friday 1st December at 1 p.m. Kathryn Hess Bellwald will give a lecture in French whose title will be Aventures mathématiques en neurosciences (accessible also to first year students).

The abstracts of the lectures are available on the webpage of this event at the address <https://uclouvain.be/en/research-institutes/irmp/chaire-de-la-vallee-poussin-2023.html>.

**2.2 December 2023**

**Jean Doyen - Les nombres premiers, les graphes aléatoires et le meilleur des mondes selon Leibniz**

9 December 2023 - 10:00 - 11:30, Campus Plaine, Forum, Auditoire E, ULB

See the poster at the end of this newsletter.

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**international workshop on Nonlinear Analysis and its Application (iwNAA 2023)**

December 14-16, 2023, online

The first meeting of the series of International Workshop on NONLINEAR ANALYSIS AND ITS APPLICATIONS (IWNAA 2018) was organized by Juan MARTINEZ-MORENO and Antonio Francisco ROLDAN-LOPEZ-DE-HIERRO on July 7-9, 2018, in Granada University, Spain. The second series was done on September 12-14, 2019, in Bangsaen, Chonburi, Thailand, under the International Workshop on Applied Nonlinear Analysis (IWANA 2019). Due to Covid 19 pandemic, we skipped 2020. In 2021,

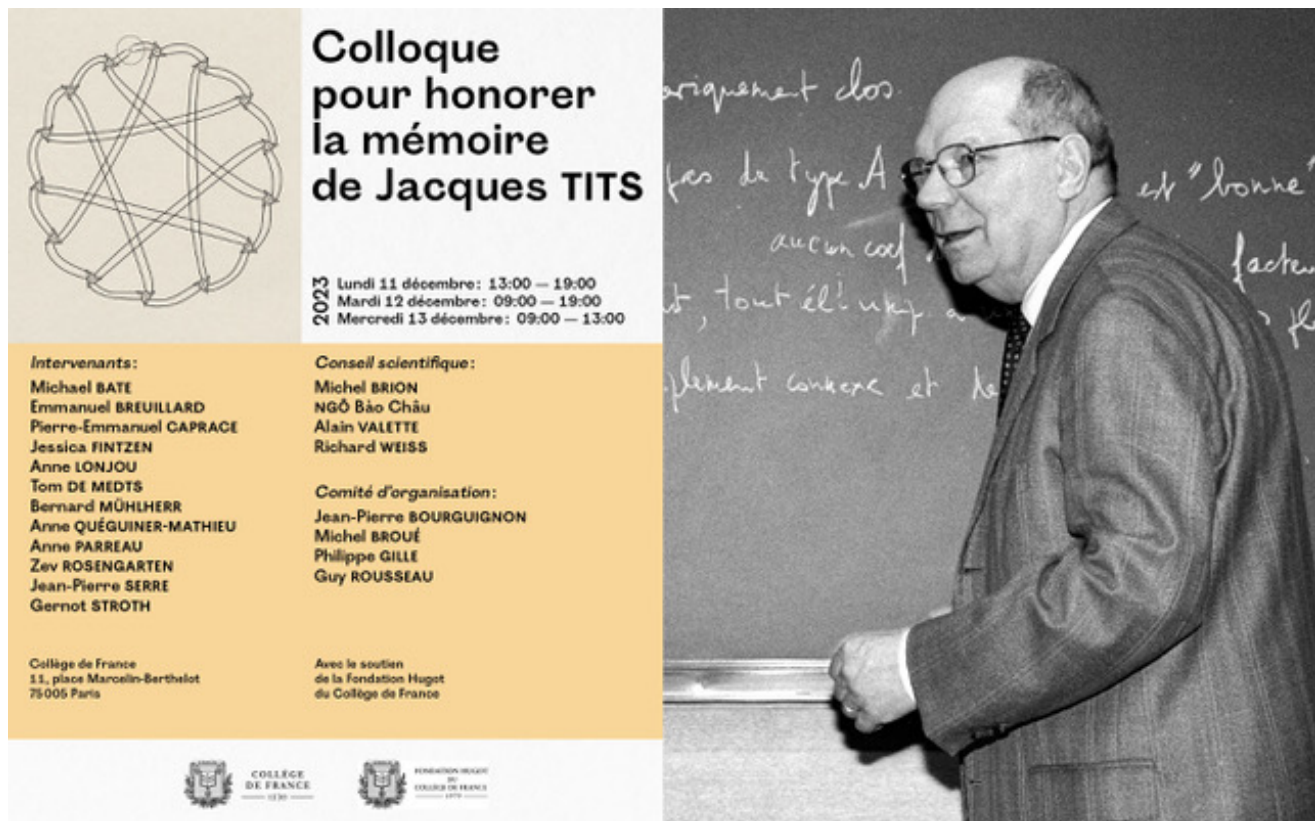
we organized the third one virtually and decided to continue under the International Workshop on NONLINEAR ANALYSIS AND ITS APPLICATIONS (IWNAA). The third edition, IWNAA 2021, was organized by Marija CVETKOVIC from the 13th to the 16th of October at the Faculty of Science and Mathematics, University of Niš. Mahpeyker ÖZTÜRK organized the fourth edition from the 12th to the 15th of October at Sakarya University of Applied Sciences and Sakarya University.

Anita TOMAR will organize the fifth meeting of the series IWNAA2023 from the 14th to the 16th of December, virtually.

See all information on <https://iwnaa2023india.wordpress.com/>.

## Colloque pour honorer la mémoire de Jacques Tits

December 11-13, 2023, Paris



The poster features a geometric diagram of a spherical polyhedron on the left. The main text is in French, detailing the event's dates and times: Monday 11 December (13:00-19:00), Tuesday 12 December (09:00-19:00), and Wednesday 13 December (09:00-13:00). It lists the scientific committee (Michel BRION, NGÔ Báo Châu, Alain VALETTE, Richard WEISS) and the organizing committee (Jean-Pierre BOURGUIGNON, Michel BROUÉ, Philippe GILLE, Guy ROUSSEAU). The event is organized by the Collège de France and supported by the Fondation Hugot. A black and white photograph of Jacques Tits is shown on the right, standing in front of a chalkboard with mathematical notes.

**Colloque pour honorer la mémoire de Jacques TITS**

2023  
Lundi 11 décembre: 13:00 – 19:00  
Mardi 12 décembre: 09:00 – 19:00  
Mercredi 13 décembre: 09:00 – 13:00

**Intervenants:**  
Michael BATE  
Emmanuel BREUILLARD  
Pierre-Emmanuel CAPRACE  
Jessica FINTZEN  
Anne LONJOU  
Tom DE MEDTS  
Bernard MÜHLHERR  
Anne QUÉGUINER-MATHIEU  
Anne PARREAU  
Zev ROSENGARTEN  
Jean-Pierre SERRE  
Gernot STROTH

**Conseil scientifique:**  
Michel BRION  
NGÔ Báo Châu  
Alain VALETTE  
Richard WEISS

**Comité d'organisation:**  
Jean-Pierre BOURGUIGNON  
Michel BROUÉ  
Philippe GILLE  
Guy ROUSSEAU

Collège de France  
11, place Marcelin-Berthelot  
75 005 Paris

Avec le soutien  
de la Fondation Hugot  
du Collège de France

### 2.3 Seminars and colloquia

**Analysis & Geometry Seminar**  
UAntwerpen  
(usually Wednesdays 16-17h during term)

This is the weekly research seminar of the analysis & geometry-interested people in Antwerp. During the semester, we have once per week a research talk in analysis and/or geometry and/or related

topics. The list of speakers comprises researchers from Antwerp as well as other universities. Details (schedule, speakers, titles, abstracts, seminar room/ online/ hybrid etc.) can be found on the seminar webpage <https://www.uantwerpen.be/nl/personeel/sonja-hohloch/private-webpage/seminars/analysis-geometry/>

To be added/deleted from the mailing list, please send an email to:  
sonja dot hohloch AT uantwerpen dot be

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**Seminar on Quantum groups, Hopf algebras and monoidal categories**  
Louvain-La-Neuve, Université Libre de Bruxelles and Vrije Universiteit Brussel

We welcome everyone to our seminar on quantum groups, Hopf algebras and monoidal categories. This seminar treats all topics related to quantum groups in the broad sense (Hopf algebras, tensor categories, non-commutative symmetries, ...). The seminar alternates between the universities of Louvain-La-Neuve, Université Libre de Bruxelles and Vrije Universiteit Brussel. The seminar takes place once every month, with on average two sessions per seminar. The concrete schedule can be found on the following website:

<https://hopfalg.b.uilb.be/index.html>

We hope to see you soon!

Kenny De Commer (VUB), Pedro Vaz (UCL), Joost Vercauteren (ULB)

### 3 PhD theses

#### Fixed points of multimaps on infra-nilmanifolds

**Charlotte Deconcinck**

**KU Leuven**

*August 28, 2023*

Thesis advisors: Prof. Dr. Karel Dekimpe (KU Leuven) and Prof. Dr. Christopher Staecker (Fairfield University)

#### Summary:

Infra-nilmanifolds are determined up to diffeomorphism by their fundamental group, which is a finitely generated torsion-free nilpotent-by-finite group and moreover all such groups do appear as the fundamental group of such an infra-nilmanifold. It follows that many geometric properties of these manifolds can be determined from the algebraic structure of their fundamental group. Via this PhD project I focused on this algebraic approach in the study of multimaps. These are maps for which any element has several images, just like for example taking the square root in the complex plane is a 2-valued map (if one excludes the origin). We developed methods to compute Nielsen type numbers for such multimaps, from which we can then deduce information on fixed points, periodic points, ...

## Point vortex dynamics and symplectic Dirac operators

**Guner Muarem**  
**UAntwerpen**  
*September 5, 2023*

Thesis advisors: Prof. Dr. Sonja Hohloch (UAntwerpen) and Prof. Dr. David Eelbode (UAntwerpen)

### Summary:

The CCR (canonical commuting relation) and CAR algebras (canonical anticommuting relation) are fundamental algebras in theoretical physics used for the study of bosons and fermions. From a mathematical viewpoint, these algebras are named the Weyl algebra (or symplectic Clifford algebra) and Clifford algebra. These algebras can be constructed in a very analogous way. The Clifford algebra is constructed on a vector space equipped with a symmetric bilinear form, whereas the Weyl algebra requires an even dimensional vector space equipped with a skew-symmetric bilinear form (or symplectic form). There is, however, a fundamental difference: the Clifford algebra is finite-dimensional, whereas the Weyl algebra is infinite-dimensional. Using the generators of the Clifford (resp. Weyl) algebra, one can associate a natural first order spin (resp. metaplectic) invariant differential operator by contracting the Clifford algebra elements using the bilinear form (resp. the symplectic form) with derivatives. The theory which studies the solutions of the Dirac operator is known as Clifford analysis and can be seen as a hypercomplex function theory. In the first part of the thesis, we will study the symplectic Dirac operator, from an orthogonal point of view. By this we mean that we will focus on the subalgebra  $so(m)$ , as this will allow us to derive branching rules for the space of  $k$ -homogeneous polynomial solutions for the symplectic Dirac operator. To arrive at this result we use techniques from representation theory, including the notion of transvector algebras and tensor products of (Verma modules). In addition, we provide the foundations of what we will call a 'hermitian variant' of symplectic Clifford analysis, where we incorporate the additional datum of a compatible complex structure and study the associated solution space using algebraic techniques and arrive at a Fischer decomposition.

In the second part of the thesis, we provide tools to study the dynamics of point vortex dynamics on the complex projective spaces and the six-dimensional flag manifold. These are the only Kähler twistor spaces arising from 4-manifolds. We give an explicit expression for Green's function on the projective space which enables us to determine the Hamiltonian (the energy of the system) and the equations of motions for the point vortex problem. Moreover, we determine the momentum map on the flag manifold, which is a key ingredient in understand the dynamics better.

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## Diagnosing and Calibrating the Multi-Century Sunspot Number Series

**Shreya Bhattacharya**  
**ULB**  
*September 25, 2023*

Thesis advisors: Prof. Dr. Maarten Jansen (ULB)

### Summary:

For centuries, scientists have explored the intricacies of the Sun, often measured through sunspot counts. These counts, archived in the International Sunspot Number (ISN), track the Sun's behaviour



over time, aiding in understanding its 11-year solar cycle and long-term variability. However, historical sunspot observations present gaps and inconsistencies, hindering the construction of a reliable solar activity record.

This thesis aims to leverage extensive historical sunspot data, notably the World Data Center SILSO's (<https://www.sidc.be/SILSO/home>), database, containing over 500,000 observations spanning centuries. It seeks to comprehend scale differences among past observers, normalizing observations to a consistent scale. Addressing various inhomogeneity factors, dedicated statistical models, such as overdispersed, zero-inflated Poisson models, cater to inherent variability, enhancing accuracy. Employing techniques such as local polynomial regression and generalized linear models, this research smoothens and estimates sunspot intensities over time, aligning with sunspot data properties. Graphical models aid in comparing diverse sources, accommodating observational variability and uncertainty, and offering robust tools for comprehensive historical sunspot analysis. This thesis strives towards reconstructing the Sunspot Number series (SN Version 3) by rectifying data quality, consistency, and accuracy concerns. Introducing novel methods, it delves into historical observations, introduces corrections and enhancements, and presents modelling approaches to scrutinize sunspot dynamics across eras. Ultimately, this research stands as a significant stride towards comprehensively understanding solar activity through the Sunspot Number series, addressing data intricacies, and advancing modelling

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## Partial Algebraic Quantum Groups

Johan Konings  
Vrije Universiteit Brussel  
*September 27, 2023*

Thesis advisors: Prof. Dr. Kenny De Commer (Vrije Universiteit Brussel)

### Summary:

To every finite discrete group, one can associate two distinct algebras. The first one is the set of complex-valued functions on the group. The group operation then induces a comultiplication, so that this algebra becomes a Hopf algebra. This Hopf algebra will always be commutative. Dually, one can consider the group algebra, whose multiplication reflects the group structure. This Hopf algebra will always be cocommutative. However, there exist Hopf algebras which are not necessarily commutative or cocommutative, but which share many other properties of the above examples. Such Hopf algebras are called quantum groups.

In the first part of the thesis, we discuss a generalisation of algebraic quantum groups, which were introduced by Van Daele. An important remark is that our objects, the partial algebraic quantum groups, are no longer Hopf algebras. This is because we also want to be able to work with infinite groupoids in our framework, instead of just finite groups. We regularly take inspiration from the theory of weak multiplier Hopf algebras, as introduced by Van Daele and Wang. The partial algebraic quantum groups we introduce are indeed examples of weak multiplier Hopf algebras.

In the second part of the thesis we study two special types of coactions of Hopf algebras. These are the homogeneous and Galois coactions. If a Hopf algebra corresponds to a group, a coaction of this Hopf algebra corresponds to an action of the group. The two special types correspond to ergodic, resp. transitive actions. We show that the two types of coactions are in one-to-one correspondence to each

other, modulo Morita equivalence. We also focus on coactions which are simultaneously Galois and 'almost' homogeneous.

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### **Modeling the intracardiac electrogram and its application to the characterization of the cardiac tissue**

**Lore Leenknecht**  
**KU Leuven**  
*October 5, 2023*

Thesis advisors: Prof. Dr. Hans Dierckx (KU Leuven) and Prof. Dr. Alexander Panfilov (Universiteit Gent)

#### Summary:

The heart contracts because of electrical signals that activate the tissue wherever the signal passes. This signal can be measured with electrodes close to the cardiac wall and are then called intracardiac electrograms. There is limited fundamental understanding on what gives these signals their different shape and sizes.

In this project, mathematics and physics was used to derive an analytical expression for the electrograms. In this way, we could determine that the higher the thickness of the cardiac wall, the larger the measured electrical signal. Within the wall, the cardiac muscle cells are organized in a fiber-like structure. These fibers were assumed to be parallel, but could form an angle with the direction in which the electrical signal propagated. We found that these angles can reduce the amplitude of the electrogram by a factor three. From these findings, we concluded that these effects should be taken into account when interpreting the amplitude of the electrogram during clinical procedures. Our analytical formula could also be compared to experimentally measured data and from this comparison, properties like the wall thickness could be determined. In addition, our mathematical insights were used to help interpret the connection between the amount of sick heart tissue and the measured voltage in a clinical collaboration.

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### **Categorical Resolutions of Filtered Schemes**

**Timothy De Deyn**  
**Vrije Universiteit Brussel**  
*October 20, 2023*

Thesis advisors: Prof. Dr. Michel Van den Bergh (Vrije Universiteit Brussel)

#### Summary:

This thesis is situated in the branch of mathematics known as noncommutative algebraic geometry. In algebraic geometry, the focus is on studying the properties of varieties; these are geometric spaces which are given by the solutions to polynomial equations. They are governed by commutative structures. Noncommutative algebraic geometry on the other hand can be seen as both the geometric study

of abstract noncommutative structures and as the application of these abstract structures to geometric spaces.

An important concept in algebraic geometry is ‘resolutions of singularities’. Roughly, this is the operation of approximating badly behaved spaces by better behaved spaces. In noncommutative algebraic geometry, an analogue of this operation is given by categorical resolutions of singularities. Categorical resolutions, of various kinds, are a valuable tool for better understanding the properties of varieties, shedding new light even when commutative resolutions are known to exist.

In this thesis we extend results on the existence of categorical resolutions of singularities to the setting of ‘filtered schemes’. This seems to be a more natural framework for constructing these resolutions and, moreover, allows us to weaken the assumptions needed to construct them. Kuznetsov and Lunts proved that any separated scheme of finite type over a field of characteristic zero admits a categorical resolution of singularities. Their construction makes use of the fact that every variety (over a field of characteristic zero) can be resolved by a finite sequence of blow-ups along smooth centres. We merely require the existence of (projective) resolutions. The categorical resolution is then constructed by gluing together differential graded categories obtained from a hypercube of finite length filtered schemes.

In addition, this work fits into a larger picture of attempting to better understand the interplay between commutative and noncommutative geometry. As the thesis allows for a more general approach to categorical resolutions it lays important foundational work for the construction of categorical resolutions of noncommutative spaces. The weakening of assumptions is particularly interesting from the point of view of noncommutative birational geometry; the approach given in this thesis will be applicable to construct geometric categorical resolutions of orders over schemes (types of coherent sheaves of (non-commutative) algebras over schemes).

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## **Phase defects as a new paradigm to understand and control electrical patterns in the heart**

**Louise Arno**  
**KU Leuven**  
*October 27, 2023*

Thesis advisors: Prof. Dr. Hans Dierckx (KU Leuven)

### Summary:

Heart failure is still the leading cause of death in the world. It is partially due to cardiac arrhythmias. Researchers make use of mathematical models and techniques to understand these heart rhythm disorders.

The heart is electrically conductive in which arrhythmias are organized by rotating electrical waves. Up till now, it was thought that these waves revolve around a center consisting of 1 point. With this research we try to show that these waves do not rotate around a point, but around a line. We call this a phase defect line.

In this research, we try to predict properties and the behavior of these phase defect lines, with the goal to better understand heart rhythm disorders.

## Contributions to the theory of surfaces in almost complex spaces

**Kristof Dekimpe**

**KU Leuven**

*October 31, 2023*

Thesis advisors: Prof. Dr. Joeri Van der Veken (KU Leuven) and Prof. Dr. Luc Vrancken (Université Polytechnique Hauts-de-France and KU Leuven)

### Summary:

Historically, the study of surfaces from a differential geometric perspective began with examining surfaces in Euclidean space, equipped with the standard inner product. A surface within this ambient space naturally allows us to measure the lengths of vectors tangent to it, since the inner product of two tangent vectors at a point on the surface is simply the usual inner product as defined in Euclidean space.

Gauss made a significant contribution in 1827 by introducing the concept of Gauss curvature at a point on the surface. The Gauss curvature measures the deviation of the surface from its tangent plane at that point. In the same work, Gauss proved his famous “Theorema Egregium”, which states that the Gauss curvature remains unchanged under local isometries, making it an intrinsic invariant. As a result, the curvature of the surface becomes independent of its specific embedding in Euclidean space. Riemann further advanced this idea in 1854 by generalizing Gauss’s concepts to smooth manifolds  $M$ , which locally resemble the Euclidean space. Riemann’s insight allowed for the generalization of the Euclidean inner product to a smooth inner product on each tangent space of the manifold, effectively endowing the manifold with a metric tensor.

Semi-Riemannian submanifold theory then concerns itself with the classification of submanifolds of a given ambient space, satisfying certain geometric properties. In this thesis, we analyze surfaces in ambient semi-Riemannian manifolds with additional geometric structures, particularly almost complex structures, which are generalizations of the well-known complex structure of the complex space. In this thesis we are mostly interested in the family of nearly Kähler manifolds, particularly in the semi-Riemannian nearly Kähler  $SL(2, \mathbb{R}) \times SL(2, \mathbb{R})$ . Nearly Kähler manifolds have two important classes of surfaces, the almost complex surfaces and the totally real surfaces. In both cases we obtain classifications when the surfaces are subject to additional geometric conditions.

We also explore the question of immersibility of a Riemannian manifold into a given ambient Riemannian manifold in this thesis. Nash’s famous embedding theorem from 1956 states that every Riemannian manifold can be isometrically embedded in a Euclidean space of sufficiently high dimension. This led to the hope that viewing a Riemannian manifold as a submanifold of a larger Euclidean space would allow the use of extrinsic geometry to study its intrinsic geometry. In this context, Chen introduced the delta-curvatures and its related inequalities for submanifolds of complex manifolds. Submanifolds attaining equality in the aforementioned inequalities are then referred to as ideal. In this thesis we study ideal submanifolds in the complex space and obtain a correspondence with surfaces in the quaternionic projective space.

## Equivariant Jiang-Su stability for actions of amenable groups

Lise Wouters

KU Leuven

November 13, 2023

Thesis advisors: Prof. Dr. Gabor Szabo (KU Leuven)

### Summary:

Operator algebras were introduced in the early 20th century in part to provide a framework for quantum physics, but subsequently developed into an important branch of functional analysis. The main focus for this PhD were  $C^*$ -algebras, which can be viewed as noncommutative generalizations of topological spaces (more specifically locally compact spaces) by the Gelfand-Naimark theorem. More specifically, we focused on their innate symmetries, which in the context of this PhD are group actions on classifiable  $C^*$ -algebras. An immediate obstruction toward the classification of such actions is given by a dynamical version of so-called Jiang-Su stability, which has been at the heart of the ordinary classification theory of  $C^*$ -algebras in recent years. The main goal of the PhD was to determine the possible redundancy of this dynamical version of Jiang-Su under certain simpler conditions. In summary, we obtained two types of positive results, depending on the structure formed by the traces (a noncommutative analog of probability measures) of the given  $C^*$ -algebra. In case this structure is sufficiently well-behaved, we showed that actions of the integers on classifiable  $C^*$ -algebras are automatically Jiang-Su stable. In the general case, we established an equivalence with another abstract property, called uniform equivariant property  $\Gamma$ , which in turn yields new tools to handle information captured by traces, even if they form complicated structures.

## 4 News from the universities and other societies

### 4.1 Yvik Swan (ULB) received the Bernoulli Prize for an Outstanding Survey Article in Probability or Statistics

See <https://sciences.ulb.be/la-recherche/actualites/yvik-swan-recoit-le-bernoulli-prize-for-an-outstanding-survey-article-in-probability-or-statistics>.

Congratulations!!

## 5 History, maths and art, fiction, jokes, quotations ...

### 5.1 Problem of the week

Ali Imad Raad ([ali.imadraad@kuleuven.be](mailto:ali.imadraad@kuleuven.be)) runs a "Problem of the week", see below the solution of the problem in newsletter 143 and this week's problem and instructions on how to be put on the mailing list to receive this weekly in your mailbox.

## Problem of the Week

### *Paint the Polygon SOLUTION*

Week 20 2023

To subscribe to the mailing list, send an email to [listserv@ls.kuleuven.be](mailto:listserv@ls.kuleuven.be) with the message (in place of Your Name you put your actual name):

SUBSCRIBE ProblemOfTheWeek Your Name

It is impossible for Soham to achieve his desired colour configuration. We will argue by contradiction, so assume it was possible. Let red be represented by 0, blue by 1, and green by 2. We are assuming Soham can convert the string  $p = (0101 \dots 012)$  to the string  $q = (0101 \dots 021)$  by changing numbers subject to Lise's constraint of not having consecutive numbers being the same. Note that any string  $s$  consisting of 0's, 1's and 2's generates a new one which we will call  $f(s)$  where the  $i$ -th digit in  $s$  is replaced by that digit minus the digit to its right (modulo 3). The digit to the right of the last digit is declared to be the first digit. For instance  $f(p) = (2121 \dots 222)$ , whilst  $f(q) = (2121 \dots 111)$ . For a string  $s$  we let  $S(s)$  denote the sum of its digits. Note that if a string  $s_1$  is changed to a string  $s_2$  by changing a digit (subject to Lise's constraints) then  $S(f(s_1)) = S(f(s_2))$ . Indeed take the example of  $s_1 = (101)$  changing to  $s_2 = (121)$ . Then  $f(s_1) = (120)$  and  $f(s_2) = (210)$  and both strings have the same sum of digits. This idea then easily generalizes to all strings. Hence if  $p$  is converted to  $q$  by a sequence of moves allowable by Lise's constraints, then  $S(f(p)) = S(f(q))$ , but this is clearly false.

## Problem of the Week

### *abc Problem*

Week 46 2023

To subscribe to the mailing list, send an email to [listserv@ls.kuleuven.be](mailto:listserv@ls.kuleuven.be) with the message (in place of Your Name you put your actual name):

SUBSCRIBE ProblemOfTheWeek Your Name

Let  $a, b$  and  $c$  be positive real numbers. Prove that

$$(a + b)(b + c)(c + a) \geq 8abc.$$

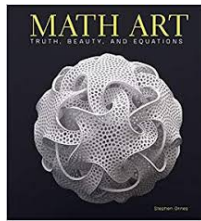
### 5.2 Adhemar's corner

For those of you looking for an original Christmas gift, here follows a review by Adhemar of three books about art and artists interacting with mathematics and mathematicians, *Math Art* of Stephen Ornes, *Illustrating Mathematics* of Diana Davis and *Do not erase* of Jessica Wynne.

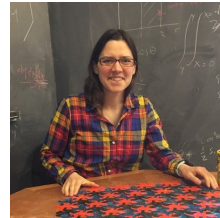
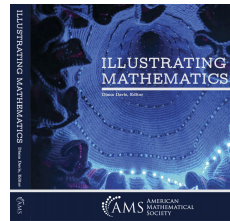
**Math Art**, *Stephen Ornes*, Sterling Publishing, 2019 (208 p.) isbn: 978-1454930440.

**Illustrating Mathematics**, *Diana Davis*, AMS, 2020 (174 p.) isbn 978-1470461225.

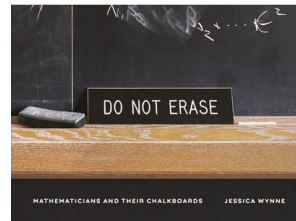
**Do not erase**, *Jessica Wynne*, Princeton University Press, 2021 (240 p.), isbn 978-0691199221.



Stephen Ornes



Diana Davis

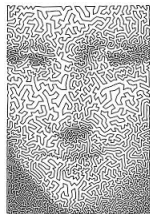


Jessica Wynne

There is definitely some link between mathematics and art. Of course everybody knows the graphics of M.C. Escher and the tessellations of the Alhambra and there are many examples where architects, painters, and sculptors have used mathematics in their work. The *Bridges Organization* promoting the connection between mathematics and art, music, architecture, and culture organizes an international conference every year since 1997. Recall the Springer book series *Mathematics and Culture* edited by M. Emmer containing the proceedings of the eponymous conferences. And there is so much more. Some of my previous reviews in this Newsletter were discussing books that focussed on the interaction between mathematics and art.



**Robert Fathauer**  
*Trifurcation*  
A fractal construction.



**Robert Bosch**  
*Da Vinci curve*  
Mona Lisa drawn as a closed connected curve.

Since the connection is here between mathematics and visual art, there are obviously many pictures that form the main contribution, but there is also some short introduction about the artist/mathematician, sometimes more about the mathematics behind it or the origin of their work and possibly how it was realized. There is however a certain gradation in this triplet of books. The first one has contributions mainly from artists whose work has a mathematical grounding, the second is showing work of mathematicians who appreciate the artistic aspects of their work and the last one is by Wynne, a photographer, who is fascinated by the blackboards that mathematicians produce while presenting or discussing their results.

The first book has mainly text but with a lot of illustrations. For each of the 19 artists (although some of them are professional mathematicians), there is first a text explaining the ideas and the work of the artist which is probably the result of an interview. In a second part, some mathematics that is behind the work of the artist is explained. The type of artwork is very diverse (from monumental sculptures, to weaving, computer generated curves, quilts, 3D-printed objects, wood carving, or crocheting), as diverse as the mathematics discussed ( $\pi$ , the golden ratio, Euclidean solids, Fibonacci numbers, fractals, chaos, complexity theory, and more). Some of the designs are used in the production of lamp shades or common utensils, like the Klein Bottle tool that is actually for removing bottle caps.

The second book consists of about 70 double pages. The left page is a picture of one or more pieces of art and the right page has a picture of the mathematician(s) that produced the work with a short text explaining why and how they did it and to what kind of mathematics it is related.



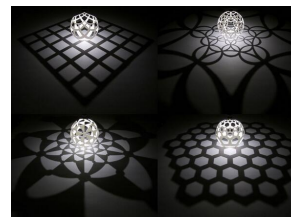
**John Sims**  
*Seeing Pi*  
Quilt. The colours represent the digits of  $\pi$ .



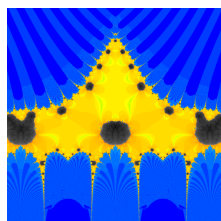
**Bathsheba Grossman**  
*Lamp shade*  
3D print.



**Helaman Ferguson**  
*Umbilic torus NC*  
Silicon bronze



**Henry Segerman**  
*Grids*  
The plane projection of the spherical object are regular grids.



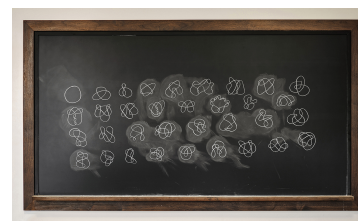
**David Rainford**  
*Re and Im of  $\zeta(s, 0.75)$*   
Computer plot.



**Daina Taimina**  
*Pseudosphere*  
Crocheted wool.



**Carlo Séquin**  
*3-level star-cylinder on icosahedral tangle of 3D-circular borders*  
3D print.

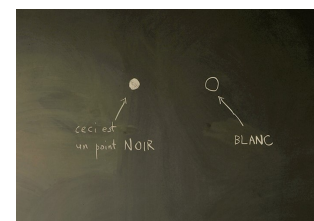


**Jessica Wynne**  
*Knots* (drawn by Sahar Khan).  
Photograph.

In both of these books the artists and their work are grouped in parts. In the first one the grouping is rather loose. For example John Smit (see pics above) falls in the first part “making sense of nature”, Bathsheba Grossman, Helaman Ferguson, and Robert Fathauer are found in the part “stranger shapes”, Robert Bosch is classified under “Journeys” (his Jordan curve can be seen as a traveling salesman problem), Carlo Séquin and Daina Taimina are examples of “(nearly) impossibilities”. This book with hard cover and glossy pages has the allures of a coffee table book, although it contains a lot of text with explanations about the mathematics.

The second book however is a soft-cover book, also printed on glossy paper but where the contributions are almost all by (and for) mathematicians. The explanation about the mathematics is really short and different for every contribution. These contributions are often coming from a published paper or they are taken from a website where often animated versions can be found. So it is worth to read more explanation in the paper or to look up the websites. The grouping is here by the technique used like, drawings, laser cutting, video and VR, 3D printing, etc. There is little overlap between the two books since the first one presents mostly artists while the second has mostly mathematicians, but there is obviously more overlap in the subjects (fractals, tessellations, minimal surfaces, different geometries,...) and in techniques (crocheting here by Maria Trnkova, 3D printing, computer graphics,...).

The third book has a structure that is similar to the second one: a picture on the right page and on the left a short text about the mathematician and his work. The photographer Wynne has travelled the world to visit universities and research institutes to talk to mathematicians and take pictures of the blackboards they have written on. Some of the blackboards were especially prepared for the picture, others were just taken as they were at the moment of arrival. Here the work of art is this project by Wynne to collect the many diverse pictures. The sole condition for the picture was that it had to be blackboards and it had to be written on with chalk.



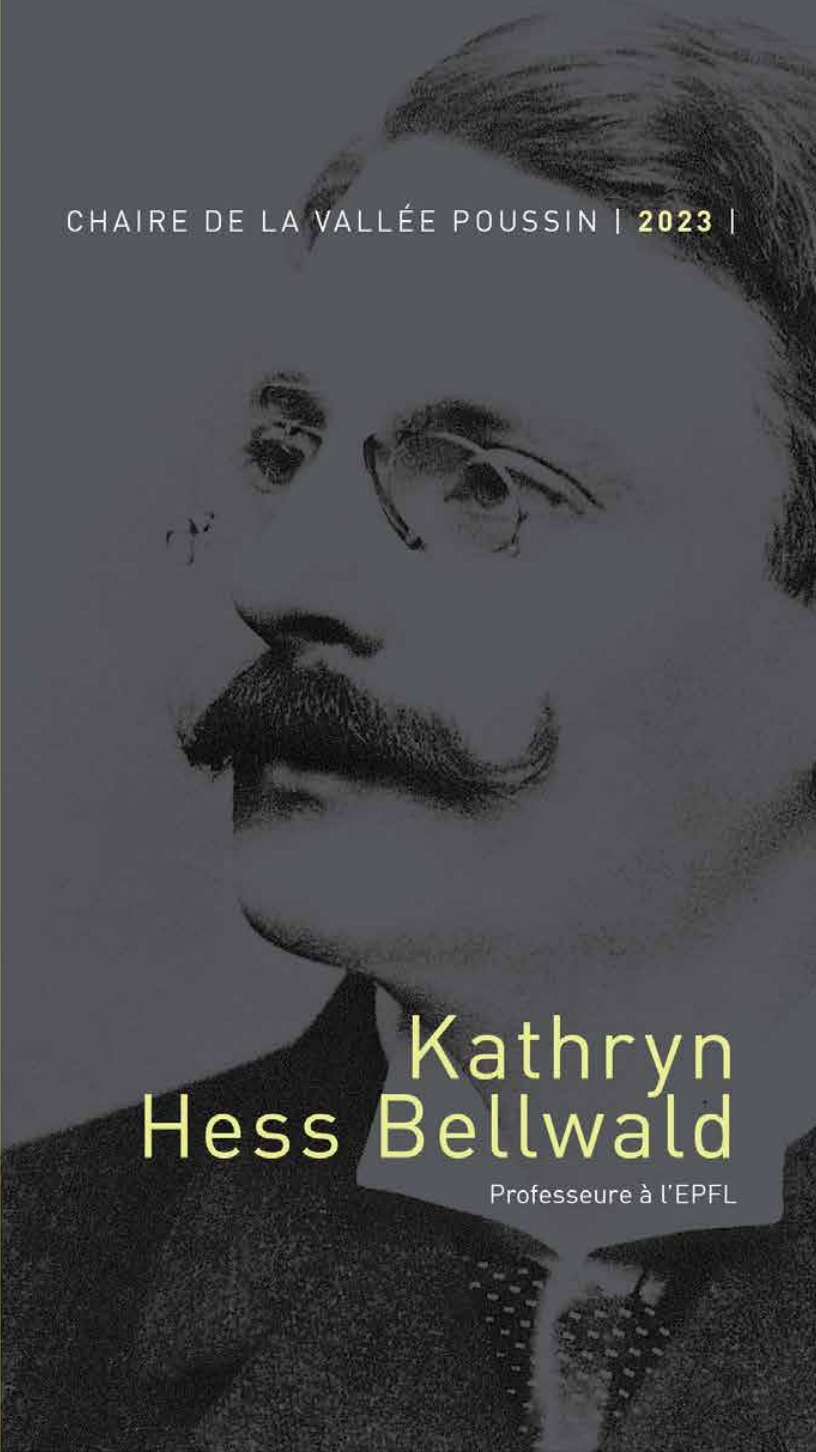
**Jessica Wynne**  
Drawing Tadashi Okieda.

Three marvelous picture books that will be appreciated as a present by any mathematician (and some artists).

Adhemar Bultheel



CHAIRE DE LA VALLÉE POUSSIN | 2023 |



Kathryn  
Hess Bellwald

Professeure à l'EPFL

 **UCLouvain**

Institut de recherche en mathématique et physique



© Eddy Mottaz, Le Temps

**Kathryn Hess Bellwald** is a prominent algebraic topologist, full professor at the *Ecole Polytechnique Fédérale de Lausanne*. Her important scientific contributions in homotopy theory highlight the interplay between algebra and geometry. She has created the *Laboratory for topology and neurosciences* at the EPFL and developed some new applications of algebraic topology to understand structures in neuroscience and in material sciences. She is a member of the *Swiss Academy of Engineering Sciences* and a Fellow of the *American Mathematical Society*.

# Homotopical perspectives on algebra and geometry

Kathryn Hess Bellwald

Mercredi 29 novembre à 16h30

## **Inaugural Lecture**

*followed by a reception*

### **Hochschild homology: from classical to modern**

📍 Auditoire de la Vallée Poussin (CYCL 01)

Jeudi 30 novembre à 16h30

## **Lecture ②**

### **Homotopical perspectives on Morita and Hopf-Galois theory**

📍 Auditoire de la Vallée Poussin (CYCL 01)

Vendredi 1<sup>er</sup> décembre à 10h45

## **Lecture ③**

### **Configuration spaces for product manifolds**

📍 Auditoire Sud 09

Vendredi 1<sup>er</sup> décembre à 13h

## **Lecture ④**

### **Aventures mathématiques en neurosciences**

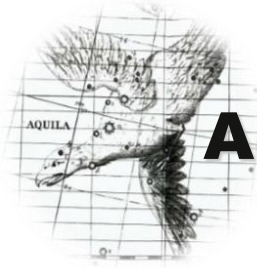
[Exposé grand public en français]

📍 Auditorios des Sciences A.03



*The lectures will be presented in the*  
AUDITOIRE DE LA VALLÉE POUSSIN (CYCL 01),  
CHEMIN DU CYCLOTRON 2  
AUDITOIRE SUD 09,  
PLACE CROIX DU SUD  
AUDITOIRES DES SCIENCES A.03,  
PLACE DES SCIENCES 2  
*Louvain-la-Neuve, Belgium*

More information : [www.uclouvain.be/irmp](http://www.uclouvain.be/irmp)  
Institut de recherche en mathématique et physique  
010 47 31 74 or [secrtaire-irmp@uclouvain.be](mailto:secrtaire-irmp@uclouvain.be)

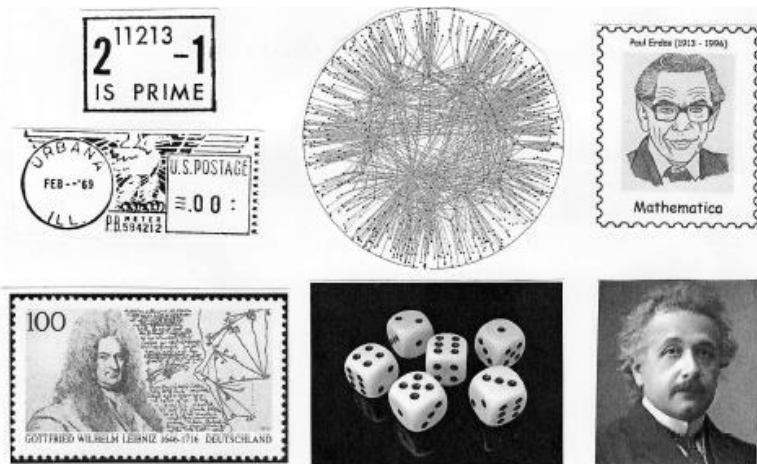


**ALTAÏR**



## Jean Doyen (ULB)

# Les nombres premiers, les graphes aléatoires et le meilleur des mondes selon Leibniz



Dans un texte de 1697, le mathématicien allemand Leibniz (un des créateurs du calcul infinitésimal) expose sa théorie du meilleur des mondes possibles, en précisant les conditions auxquelles il devrait satisfaire: création par le hasard, beauté, variété des formes intéressantes qu'on y trouve.

Dans les années 1960, des mathématiciens hongrois qui étudiaient les graphes aléatoires découvrent un modèle d'univers "à la Leibniz".

Ce modèle infini est étonnant car ses propriétés sont tout à fait contraires à l'intuition et au bon sens. L'exposé, qui comprend plusieurs digressions historiques, est accessible aux étudiants de fin du secondaire.

**Samedi 9 décembre 2023, de 10h00 à 11h30**  
Campus Plaine, Forum, **Auditoire E**

*Entrée : 5 €, gratuit pour les étudiants et les membres Altaïr*

WEDNESDAY DECEMBER 20 2023

# YOUNG SCHOLAR DAY OF THE BELGIAN MATHEMATICAL SOCIETY



VUB CAMPUS ETTERBEEK  
U-RESIDENCE

The **Belgian Mathematical Society** is happy to invite you to its « *Young Scholar Day* » which will take place on **Wednesday December 20 2023**.

Welcome and coffee from 9:00.

- 9:30-10:30 Godeaux lecture by **Sophie Grivaux** (Université de Lille)

- 11:00-12:15 Parallel sessions

*Group theory - Probability - Differential geometry and dynamical systems*

- 13:30-14:00 **General Assembly** (*only for effective BMS members*)

- 14:00-15:15 Parallel sessions

*Algebraic geometry - Real and functional analysis - Logic*

- 15:45-17:00 Parallel sessions

*Operator algebras and operator theory - Partial differential equations - Combinatorics and discrete mathematics*

**Coffee breaks** at 10:30 and 15:15, **Lunch** at 12:15 and **drink** from 17:00.

Registration is free for BMS members !

Register now on <http://bms.ulb.ac.be>

