# Newsletter

BELGIAN MATHEMATICAL SOCIETY

# **113**, May 18, 2017

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**

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## Contents

## Villani's first steps in politics

After the presidential election, France will have legislative elections in two weeks from now. It was recently announced that the French mathematician Cédric Villani (Fields Medal in 2010) joined the political movement "La République en marche" of the freshly elected president Emmanuel Macron. Villani is on the election lists in the Department of Essonne, just South of Paris and home to many famous institutes like the I.H.E.S., the Ecole Polytechnique, Paris-Sud University, ... A short news video can be found here.

## Still seeking for newsletter content

During the February meeting of the board it was decided to ask all members for news two weeks before appearance of the Newsletter. This had some effect! Thank you to all members who sent us information. **Please keep sending us all information you have.** This small effort helps us tremendously and makes the Newsletter more interesting for everyone.

Examples of information we are seeking are: PhD defenses, seminars, conferences, workshops, meetings, interaction with other sciences or business companies, popular lectures, school initiatives, math exhibitions, ...

Next Newsletter will appear on September 15. The deadline for contributions is September 5. Contact Françoise Bastin <F.Bastin@ulg.ac.be> with all information you want to share!

A recent suggestion was to present departments or research groups in our Newsletter. Many things have changed in the past few years. Universities collaborate with other institutions or private companies and create larger groups. It is difficult to keep track of all changes that happen in Flanders and Wallonia. This is certainly true in the field of math education at high school level but also in universities and research policy. We will shed light on the high school education during our next BMS event next week. I hope to see you there! For the other topics it would be great to have some small articles for the Newsletter. Maybe your department was recently restructured? Or maybe the math curriculum was reformed at your university. I am sure our readers would like to know about all this! Please send us your short (or long) contributions.

The detailed programme of our joint conference with the mathematics teacher's associations can be found in this Newsletter. This unique 3-day joint event will be organised next week in the city centre of Brussels (Maria Boodschap Lyceum, Moutstraat 22, 1000 Brussel) at a few minute's walk from the central railway station.

**And remember...**

You can follow `BelgianMathS` on twitter and tweet announcements or other interesting information to @BelgianMathS.

We also have a facebook page: https://www.facebook.com/BelgianMathS This page is your page! Please help us to keep it up to date and interesting by sending us nice links and information to Yvik Swan yvik.swan@ulg.ac.be

Philippe Cara,
BMS president

# 1 BMS subsidy for initiatives aimed at high school pupils and young mathematics students

## 1.1 Aim

The Belgian Mathematical Society would like to promote mathematics among high school pupils and undergraduate students. To achieve this we propose to sponsor events and initiatives that address that objective. These initiatives can also be organised for or by high school teachers, whom we see as important for awareness of Mathematics among our younger population.

We also encourage applications for local initiatives (i.e. the proposal does not necessarily have to involve the whole Belgian Mathematics community or not even a whole region). The maximum amount of our subsidy is 500 euros.

## 1.2 Procedure

Organisers of qualifying events or initiatives can apply by e-mail to bms@ulb.ac.be. Applications can be written in French, Dutch, German or English.

An application should contain at least the following information:

- a brief description (not more than one A4 page) of the initiative, the targeted audience and the aims;
- the (expected) number of participants;
- a report on previous editions (if any);
- other sources of funding (if any, even pending).

## 1.3 Deadlines

Submit your request by November 1st. BMS decision will be communicated by the end of December.

## 1.4 Spread the news

Please help us by spreading the information about this new source of funding among your high school contacts and colleagues who are involved in such initiatives!!

# 2 Meetings, Conferences, Lectures

## 2.1 May 2017

***Joint congress of BMS with Belgian Mathematics Teachers' Associations VVWL and SBPMef***

***Brussels, May 25th - 27th, 2017***

La Société Belge de Mathématique (SBM) organise, les 25, 26 et 27 mai prochains, un congrès à Bruxelles conjointement avec les associations d'enseignants de mathématiques des deux côtés de la frontière linguistique.

On May 25–27th, 2017, the Belgian Mathematical Society will organise a joint conference in Brussels with the mathematics teachers' associations of Flanders and Wallonia.

Van 25 tot 27 mei 2017 zal het Belgisch Wiskundig Genootschap in Brussel een gemeenschappelijk congres organiseren met de verenigingen voor wiskundeleraren van beide kanten van de taalgrens.

**Location:** Maria Boodschap Lyceum, Moutstraat 22, 1000 Brussel.

**Plenary speakers:**

- Rik Verhulst (former teacher and lecturer, author of many mathematics books)
- Giovanni Samaey (KULeuven)
- Davy Paindaveine (ULB, Godeaux Lecture)
- Jeanine Daems (One of the "Wiskundemeisjes")
- Jean Doyen (ULB)
- Jean Mawhin (UCLouvain)

Each day of the conference will be in a different language (Dutch, English + Dutch + French, French).

**Detailed program:**

Abstracts are available by clicking on titles or at

`http://themathconf2017.be`

**Thursday May 25th:**

**09:30–10:00** Coffee

**10:00–10:10** Welcome + announcements

**10:10–11:10** Rik Verhulst : De unieke wordingsgeschiedenis van de wetenschappelijke methode en haar baanbrekende wonderen

**11:10–11:25** Break + Book Exhibition

**11:25–12:25** Giovanni Samaey : X-Factor: verhalen over de onzichtbare kracht van wiskunde

**12:25–13:30** Lunch + Book Exhibition

**13:30–14:15** Parallelle sessies

- Mark Cuypers : Differentiatie in de eerste graad
- Geert Claes : Sappige wiskundelessen

- Jan Vermeylen : windenergie en wiskunde een win-win (voor de 2de en 3de graad)

**14:15–14:30** Break + Book Exhibition

**14:30–15:15** Parallelle sessies

- Ria Van Huffel : Leerplandoelen realiseren met Kangoeroe
- Koen De Naeghel : Wiskunde in actie
- Michel Roelens : Wanneer cilinders elkaar ontmoeten. . .

**15:15–15:45** Coffee + Book Exhibition

**15:45–16:45** Dirk Huylebrouck : Wiskunst

**16:45–18:00** —

**18:00–19:30** Doors MathsJam in Taverne Greenwich, Kartuizerstraat 7, 1000 Brussel.

**19:30–. . .** MathsJam by Rudi Penne and Paul Levrie

**Friday May 26th:**

**10:00–10:10** Welcome + announcements

**10:10–11:10** Davy Paindaveine (Godeaux Lecture) : Hypothesis testing in non-standard situations

**11:10–11:25** Break + Book Exhibition

**11:25–12:25** Jeanine Daems : History of mathematics in math education

**12:25–13:30** Lunch + Book Exhibition

**13:30–14:30** 20 minute parallel sessions on initiatives from universities for high schools (Dutch — French)

1. STEM Junior College (KULeuven) — Initiatives Liégeoises (ULg)
2. Unimath (UGent) — Du futur étudiant au futur enseignant (UMons)
3. Wiskunnend Wiske (VUB) — Auto-Math, un outil de reméediation en mathématique en ligne (UCL)

**14:30-14:45** Break + Book Exhibition

**14:45-15:25** 20 minute parallel sessions on initiatives from universities for high schools (Dutch — French)

1. Wiskunde-In-Zicht (UA) — La diffusion des maths à l'ULB (ULB)
2. UHasselt@school, teacher@uhasselt (UHasselt) — Minimiser la distance entre le secondaire et l'université (UNamur)

**15:25-15:45** Coffee + Book Exhibition

**15:45-17:00** Parallel round table discussions about the role of mathematics teachers in education

- In Dutch, moderated by Bert Seghers (KVAB)
  Panel: Koen Daniels (Vlaams volksvertegenwoordiger), Natacha Gesquière (STEM-coördinator in Sint-Bavo Gent), Giovanni Samaey (KULeuven), Ellen Vandervieren (Lerarenopleiding UA) en Mark Verbelen (Pedagogisch adviseur wiskunde GO!).

- In French, moderated by Christian Michaux (UMons)
  Panel: Pierre Masai (Toyota Motors Europe), Thierry Libert (Chercheur, agrégation à l'ULB), Alain Baudhuin (professeur de maths au Collège St Pierre), Claude Voglet (Ancien directeur d'école, conseiller au cabinet Schyns).

**17:00–...** Drink BMS

**Saturday May 27th:**

**10:00–11:15** Jean Doyen : *Itérées de fonctions : de Conway à Mandelbrot en passant par Syracuse et les prévisions météo*

**11:15–11:30** Break + Book Exhibition

**11:30–12:30** Ateliers en parallèle

- Isabelle Berlanger, Thérèse Gilbert et Pierre Pierson (GEM) : Les angles et les outils de métiers (niveau DI)
- Évelyne David (UNamur) : *Pratique manuelle du cercle trigonométrique* (niveau DS)

**12:30–13:30** Lunch + Book Exhibition

**13:30–14:45** Jean Mawhin : *Nombres premiers : des éléments d'Euclide à la conjecture de Riemann*

**14:45–15:00** Break + Book Exhibition

**15:00–16:00** Ateliers en parallèle

- Laure Ninove et Isabelle Wettendorff (GEM) : Variations à partir d'un oiseau en origami (niveau DI)
- Marie-France Guissard et Pauline Lambrecht (CREM) : Maths & Manips : des manipulations pour aborder la dérivée et l'optimisation (niveau DS)

**16:00–...** End of conference

**Organising committee:** Michel Sebille, Christian Michaux, Isabel Goffa, Filip Moons, Yvik Swan, Philippe Cara.

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**Celebration of 90 years Georges Lemaître at KULeuven and UCLouvain**

**May 30–31, 2017**

All information at

https://www.kuleuven.be/apps/mailtemplates/previews/8074-5911dd5d9fc65.html
https://uclouvain.be/fr/decouvrir/events/hommage-lemaitre.html

## 2.2 May-June 2017

**Chaire de la Vallée Poussin**

**May 30-31 and June 1, 2017**

**UCL**

**Professor George Janelidze**

We are very pleased to inform you that this May, Professor George Janelidze will be the recipient of the prestigious Chaire de la Vallée Poussin 2017 (see http://www.uclouvain.be/784661.html) at the Université catholique de Louvain.

On this occasion, professor Janelidze will give a series of invited lectures entitled

*From Galois theory to commutative Hopf algebras and finite topological spaces*

Abstract
These lectures are about Galois theory, which begins with field extensions, makes several steps of wide generalization, and eventually arrives at a purely category-theoretic level, where it gets new motivation and many new expected and unexpected examples. These examples will be described, with special remarks on commutative Hopf algebras that appear as Galois groups, and the whole last lecture devoted to algebraic topology of finite spaces, where the Galois theory of covering spaces works especially well.

Schedule

- Tuesday, May 30, 16:30: "Evolution of Galois theory"
- Wednesday, May 31, 11:00: "Categorical foundation"
- Wednesday, May 31, 16:30: "Concrete Galois theories"
- Thursday, June 1, 10:00: "Algebraic topology of finite spaces"

Then, a workshop will follow

**Workshop on Categorical Methods in Non-Abelian Algebra**

**June 1st to 3rd, 2017**

Please, let us know as soon as possible if you want to participate by sending a message to

tim.vanderlinden@uclouvain.be

Participants are warmly invited to present talks. The deadline for registration and abstract submission is April 30, 2017.

Further information can be found at the workshop webpage

http://www.mat.uc.pt/~mmc/mcana/MCANAfifthworkshop.html

Looking forward to seeing you in Louvain-la-Neuve,

The organizers

Alan Cigoli
Maria Manuel Clementino
Marino Gran
Tim Van der Linden
Joost Vercruysse
Enrico Vitale

See also the poster at the end of the Newsletter

### 2.3 June 2017

**Fourth Young Mathematicians Colloquium**

**Friday June 2, 2017 at the Vrije Universiteit Brussel**

For the fourth time we organize the Young mathematicians colloquium (YMC) which gathers PhD students and post-doctorants from Belgium and from the North of France. The colloquium will take place during a full day at the Vrije Universiteit Brussel. The goal of the day is to bring together applied and pure young mathematicians from all fields of Mathematics from different neighbouring universities. The day will consist of 3 broad (mathematical) public talks of 1hour delivered by confirmed researchers. Moreover, there will be as well a round table held by former PhD students in mathematics on the topic: "What are the career opportunities after a PhD degree in Mathematics?". More details and registration on the website of the colloquium

http://www.mathconf.org/ymc2017

Speakers:

- Christophe Ley, Ghent University: "Does one have to be normal to be normal?".
- Thomas Rey, University Lille 1: "Kinetic theory of gases: from Boltzmann to Hilbert's 6th Problem".
- Luc Vrancken, University of Valenciennes, "The Magid-Ryan Conjecture".

Looking forward to meeting you at this colloquium!

Best Wishes,

The organizers

Loïc Gaillard, Alfonso Garmendia
Geoffrey Janssens, Marilena Moruz
Miruna-Stefana Sorea and Antoine Zurek

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**Meeting of the FNRS Functionl Analysis group**

**June 8-9, "Domaine des Masures", Han-sur -Lesse**

The list of invited speakers is the following (alphabetical order)

- T. CIAS ( Poznan)
- L. DEMEULENAERE (ULg)
- J. FALCO (post doct UMons)
- D. GARCIA (Valencia)
- D. JORNET (Valencia)
- T. KALMES (Chemnitz)
- S. SCHLUETERS (Oldenburg)

Informations: Françoise Bastin (F.Bastin@ulg.ac.be) or Catherine Finet (Catherine.Finet@umons.ac.be)

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***Groups, Rings and the Yang-Baxter equation***

***Spa, June 18th - 24th, 2017***

A conference on "Groups, Rings and the Yang-Baxter equation" will be held at Domain Sol Cress in the beautiful town of Spa, Belgium. The international conference focusses on recent developments in the areas of ring theory, group theory and the new structure, called braces, that recently has attracted a lot of attention because of its role in a description of set-theoretic solutions of the Yang-Baxter equation. Special emphasis is given on the relations between these areas and in particular on topics where a mixture of methods (involving these theories) has been used. Some topics of particular interest are: group rings, unit groups, (graded) rings and also various algebraic structures used in the context of the Yang-Baxter Equation.

See poster at the end of this newletter and http://homepages.vub.ac.be/abachle/gryb/

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**First days of nonlinear elliptic PDE in Hauts-de-France**

**26 -29 juin 2017, ISTV, Valenciennes,**

See the web page at the address https://sites.google.com/site/edpnlvalenciennes062017/ and the poster at the end of the Newsletter.

## 2.4 July 2017

**Summer School ALGAR 2017: Quadratic forms and local global principles**

**3–-7 July 2017**

**What?** Lecture series and talks on classical and recently proven local-global principles for isotropy of quadratic forms over different fields. Guest lecturers: A. Auel, R. Parimala, V. Suresh.

**Where?** Stadscampus, University of Antwerp, Belgium.

**Who?** The main target group consists of Master students and PhD students in fundamental mathematics. More advanced mathematicians are also welcome to participate.

**Registration fee**

Regular registration (not incl. accommodation): €300

Early registration incl. accommodation in student rooms (Deadline 26 April): €360

Early registration (not incl. accommodation), students (Deadline 26 April): €220

University of Antwerp students: €180 (University of Antwerp students are entitled to a refund of €150)

**Support**

Students without funding may apply for support. For details please contact the organising committee.

**More Information:** http://www.uantwerp.be/algar-2017

## 2.5 August 2017

**ICCA11: International Conference on Clifford Algebras and Their Applications in Mathematical Physics**

**Gent, August 7–11, 2017**

This conference constitutes the 11th edition in this series of conferences which was initiated in 1985 by the late Roy Chisholm of the University of Kent at Canterbury.

The ICCA series is dedicated to the study of Clifford algebra and its applications in geometry, mathematical analysis, mathematical and theoretical physics and mechanical and electrical engineering. Over the years, it has further broadened and diversified its scope to include a.o. numerical analysis, integral transforms, signal processing, group representation theory, Lie (super)algebras,robotics, geographic information systems (GIS), cosmology, virtual reality, 3D camera optics, medical imaging, neural computation, etc.

The conference also welcomes four mini-symposia, on (1): ”New Frontiers in Harmonic Analysis and Geometry over Non-commutative Structures”, (2): “Lie-superalgebras”, (3): “Engineering Topics in Clifford and Quaternion Algebras” and (4): “Quaternion and Clifford Fourier Transforms and Related Integral Transforms in Theory and Applications”.

Further information is to be found on the website http://www.icca11.ugent.be, which is constantly updated.

We hope to welcome you at our conference and send you our best regards,

Hennie De Schepper

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**Pure and Applied Differential Geometry - PADGE 2017**

**Leuven, August 21st - 25th, 2017**

This conference is organized by the geometry section of KU Leuven and will cover topics from

- Riemannian geometry, Lorentzian geometry, submanifold theory
- Poisson geometry, symplectic geometry, foliation theory

All information on this conference can be found on the website:

http://wis.kuleuven.be/events/padge2017

Confirmed invited speakers are

- Ilka Agricola (Philipps-Universität Marburg)
- Bang-Yen Chen (Michigan State University)
- Josef Dorfmeister (Technische Universitä t München)
- Rui Loja Fernandes (University of Illinois)
- Haizhong Li (Tsinghua University)
- Ionut Marcut (Radboud Universiteit Nijmegen)
- Eva Miranda (Universidad Politecnica de Catalunya)
- José Senovilla (Universidad del Pais Vasco)
- Andrew Swann (Aerhus University)

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**Brussels Summer School in Mathematics**

**Brussels, August 28th – September 1st, 2017**

The Brussels Summer School of Mathematics is organised every year during the first week of August at the Université libre de Bruxelles. It consists in a full week of courses on a wide range of mathematical topics (algebra, calculus, geometry, differential geometry, logic, probability, statistics, topology, mathematical physics, ...). Courses are taught in French or English, and the speakers are researchers (phd, postdoc or professor) working in a Belgian university or from abroad.

The courses are intended to be accessible to any person with a basic knowledge of mathematics. The purpose of the BSSM is not to provide a formal introduction to any particular theory but rather to give the audience a chance to glimpse the workings, beauty and importance of cutting-edge mathematical research. In order to achieve this goal the emphasis of most talks is put on important or intriguing problems which allow for short and enthralling solutions.

The BSSM is not intended for specialists nor is it a vulgarization exercise. The aim of this summer school is to bridge the gap between these two important modes of scientific expression, by inviting a non-specialized audience (of students, teachers, professionals and amateurs) to discover the joys and beauty of advanced mathematical research.

Registration and programme on http://bssm.ulb.ac.be/en/program.html

# 3 PhD theses

### Application of wavelet transforms to geosciences: Extraction of functional and frequential information

**Adrien DELIEGE, ULg**

*Date and place of public defense : May 18 2017, 10h45, Institute of Mathematics ULg*

Thesis advisor : S. Nicolay (ULg)

Summary

It is now well-known that there exist functions that are continuous but nowhere differentiable. Still, it appears that some of them are less "irregular" than others. The pointwise regularity of a function can be characterized by its Hölder exponent at each point. For the sake of practicability, it is more appropriate to determine the "size" of the sets of points sharing a same exponent, through their Hausdorff measure. By doing so, one gets the multifractal spectrum of a function, which characterizes in particular its monofractal or multifractal nature.

The first part of this work is based on the so-called "wavelet leaders method" (WLM), recently developed in the context of multifractal analysis, and aims at its application to concrete situations in geosciences. First, we present the WLM and we insist particularly on the major differences between theory and practice in its use and in the interpretation of the results. Then, we show that the WLM turns out to be an efficient tool for the analysis of Mars topography from a unidimensional and bidimensional point of view; the first approach allowing to recover information consistent with previous works, the second being new and highlighting some areas of interest on Mars. Then, we study the regularity of temperature signals related to various climate stations spread across Europe. In a first phase, we show that the WLM allows to detect a strong correlation with pressure anomalies. Then we show that the Hölder exponents obtained are directly linked to the underlying climate and we establish criteria that compare them with their climate characteristics as defined by the Köppen-Geiger classification.

On the other hand, the continuous version of the wavelet transform (CWT), developed in the context of time-frequency analysis, is also studied in this work. The objective here is the determination of dominant periods and the extraction of the associated oscillating components that constitute a given signal. The CWT allows, unlike the Fourier transform, to obtain a representation in time and in frequency of the considered signal, which thus opens new research perspectives. Moreover, with a Morlet-like wavelet, a simple reconstruction formula can be used to extract components.

Therefore, the second part of the manuscript presents the CWT and focuses mainly on the border effects inherent to this technique. We illustrate the advantages of the zero-padding and introduce an iterative method allowing to alleviate significantly reconstruction errors at the borders of the signals. Then, we study in detail the El Niño Southern Oscillation (ENSO) signal related to temperature anomalies in the Pacific Ocean and responsible for extreme climate events called El Niño (EN) and La Niña (LN). Through the CWT, we distinguish its main periods and we extract its dominant components, which reflect well-known geophysical mechanisms. A meticulous study of these components allows us to elaborate a forecasting algorithm for EN and LN events with lead times larger than one year, which is a much better performance than current models. After, we generalize the method used to extract components by developing a procedure that detects ridges in the CWT. The algorithm, called WIME (Wavelet-Induced Mode Extraction), is illustrated on several highly non-stationary examples. Its ability to recover target components from a given signal is tested and compared with the Empirical Mode Decomposition. It appears that WIME has a better adaptability in various situations. Finally, we show that WIME can be used in real-life cases such as an electrocardiogram and the ENSO signal.

**Identities of Affine Algebras and Their Asymptotic Behaviour**

**Geoffrey Janssens, Vrije Universiteit Brussel**

*Date and place: Friday May 19th at 16h in aula D2.01 at VUB*

Supervisors: Prof. Dr. Eric Jespers and Dr. Alexey Gordienko

Summary:

Given two algebras $A$ and $B$, one of the most natural questions one can ask is

*"how can we see that the algebras $A$ and $B$ are actually isomorphic?"*

Or more generally, given a set $\mathcal{A}$ of algebras, how can one distinguish one algebra from the others? A classical way to approach such 'distinguishing problems' is my means of invariants. In this dissertation we will associate to any finite dimensional algebra two invariants and be interested in the information they contain.

Actually we do this for the more general class of algebras satisfying a polynomial identity, in short PI algebras. Recall that any algebra $A$ is defined by generators and relations. Some relations, e.g. commutativity ($xy - yx = 0$) and nilpotency of degree $n$ ($x_1 \dots x_n = 0$), 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. An algebra satisfying such a polynomial is called PI. For example all finite dimensional algebras are PI.

So in this dissertation we study which algebraic information is deliverd by polynomial identities. More precisely to any PI algebra $A$, over field of characteristic 0, we associate the so called *codimension sequence*, denoted $(c_n(A))_n$. It is known that $(c_n(A))_n$ grows asymptotically as the function $f(n) = cn^t d^n$ for some constants $c, t$ and $d$ depending on $A$. Surprisingly the invariant $t$ is an half-integer and the invariant $d$ even an integer. Intuitively $c_n(A)$ counts the number of mutlilinear polynomials of degree $n$ that are not polynomial identities of $A$.

Whereas in 1998 Giambruno and Zaicev proved a concrete, computable, formula for $d$, the invariant $t$ remained a black box. In the first part of the thesis we give a concrete interpretation for $t$ for the 'building blocks of PI theory', so called basic algebras. Subsequently we investigate algebras over $\mathbb{Z}$ where different 'codimension sequences' appear into the picture. In the second part of the thesis we also take into account more refined information such as (semi)group-gradings and algebra actions.

### Intrinsic Sobolev maps between manifold

**Alexandra CONVENT, UCL**

*Date and place of public defense : June 19, 2017 at CYCL01, Bâtiment Marc de Hemptinne, Chemin du Cyclotron 2, 1348 Louvain-la-Neuve.*

Thesis advisor : J.Van Schaftingen (UCL)

Summary

Sobolev spaces between manifolds are a natural tool to study variational problems for maps between manifolds, arising in nonlinear physical models or in geometry. For $k, p \geq 1$, the Sobolev space $W^{k,p}(M, N)$ between the manifolds $M$ and $N$ can be defined by the set of all maps $u : M \to N$ such that $\iota \circ u$ belongs to the Sobolev space $W^{k,p}(M, \mathbb{R}^\nu)$, where $\iota \in C^k(N, \mathbb{R}^\nu)$ is an isometric embedding of the target manifold $N$. However, in the higher-order case $k \geq 2$, this definition is *not intrinsic*: it depends on the choice of the embedding. In the first-order case $k = 1$, the definition by embedding is also equivalent to the definition of Sobolev spaces into metric spaces. However definitions of Sobolev spaces into metric spaces do not provide *any notion of weak derivative* and thus do not seem adapted to a further definition of higher-order Sobolev spaces by iteration. As a consequence, in the first part of this thesis, we suggest a robust intrinsic definition of first-order Sobolev maps in which the weak derivative plays a central role. This new definition is equivalent to the definition by embedding and to the one of Sobolev maps into metric spaces. We also endow the Sobolev spaces with various intrinsic distances that induce the same topology and for which the space is complete. In the second part of this thesis, in the same spirit of the first order, we define and study intrinsic higher-order weak derivatives and Sobolev spaces. The previous new definition is not equivalent in general with the definition by embedding. In particular, if the manifolds are compact, the intrinsic space is a larger space than the one obtained by embedding. In this setting, we investigate the problem of density of smooth maps. We prove that a necessary condition for the density of smooth maps in the intrinsic space $\dot{W}^{k,p}(M, N)$ is that the $\lfloor kp \rfloor$-homotopy group of $N$ is trivial. Will you defend your PhD soon? Do you have a student who is about to obtain his PhD?

### Grab the opportunity to announce it in our Newsletter!

Next Newsletter will appear on September 15. The deadline for contributions is September 8. Contact Françoise Bastin <F.Bastin@ulg.ac.be> with title, abstract and defense date/place.

# 4 News from the universities

## 4.1 SIAM Outstanding Paper Prize for Raf Vandebril from KULeuven

The SIAM Outstanding Paper Prize is awarded every three years, beginning in 1999, for outstanding papers published in any of the SIAM journals. The paper should exhibit originality. For example, papers that bring a fresh look at an existing field or that open up new areas of applied mathematics.

In 2017, the selected paper was

> Jared L. Aurentz, Thomas Mach, Raf Vandebril, and David S. Watkins, Fast and Backward Stable Computation of Roots of Polynomials, SIAM Journal on Matrix Analysis and Applications, Vol. 36, Issue 3 (2015), pp. 942-973

**Raf Vandebril** is at the department of computer science at the KU Leuven.

**Abstract:** A stable algorithm to compute the roots of polynomials is presented. The roots are found by computing the eigenvalues of the associated companion matrix by Francis's implicitly shifted QR algorithm. A companion matrix is an upper Hessenberg matrix that is unitary-plus-rank-one, that is, it is the sum of a unitary matrix and a rank-one matrix. These properties are preserved by iterations of Francis's algorithm, and it is these properties that are exploited here. The matrix is represented as a product of 3n-1 Givens rotators plus the rank-one part, so only $O(n)$ storage space is required. In fact, the information about the rank-one part is also encoded in the rotators, so it is not necessary to store the rank-one part explicitly. Francis's algorithm implemented on this representation requires only $O(n)$ flops per iteration and thus $O(n^2)$ flops overall. The algorithm is described, normwise backward stability is proved, and an extensive set of numerical experiments is presented. The algorithm is shown to be about as accurate as the (slow) Francis QR algorithm applied to the companion matrix without exploiting the structure. It is faster than other fast methods that have been proposed, and its accuracy is comparable or better.

Read More: http://epubs.siam.org/doi/abs/10.1137/140983434

About Outstanding Paper Award Prizes see https://www.siam.org/prizes/sponsored/outstanding_paper.php

## 4.2 From UCL

The **Excellence Scholarship Programme** by the *Institut de Recherche en Mathématique et Physique* (https://uclouvain.be/fr/instituts-recherche/irmp) is designed for students with a Study Diploma giving access to a Master Programme in *Sciences Mathématiques* or in *Sciences Physiques* at the Université Catholique de Louvain.

The Excellence Scholarship consists of

- a €1500 study grant awarded upon evaluation of the candidate's CV and paid at the time of enrolment in one of the above-mentioned Master programmes;
- a €1000 prize for a master thesis to be written under the supervision of an academic mentor or a tenured investigator at the *Institut de Recherche en Mathématique et Physique*.

The deadline for receipt of application files is July, 7, 2017. More information concerning these scholarships is available at the address
https://uclouvain.be/fr/instituts-recherche/irmp/actualites/bourses-d-excellence-de-l-irmp.html
Contact: Marino Gran (president-irmp@uclouvain.be)

See also the poster at the end of this Newsletter

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

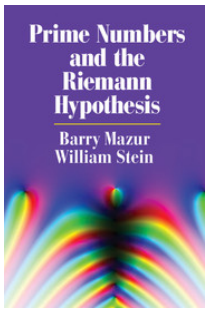
## 5.1 Adhemar's corner

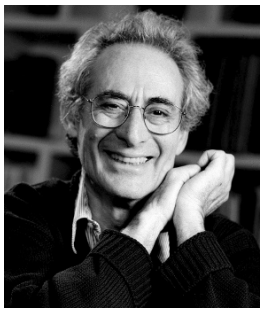
And as usual, but always to be read with great pleasure, here are two reviews from Adhemar Bultheel.

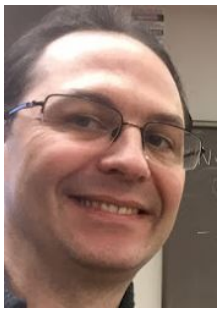
The first one concerns books about Riemann hypothesis.

Raymond Smullyan (a logician) passed away on 6 February 2017 (he had his birthday on that day... he was 97 years old); the second review is a kind of obituary ...

**Prime numbers and the Riemann hypothesis**, *Barry Mazur & William Stein*, Cambridge University Press, (2016) ISBN 978-1107499430 (pbk), xii+142 pp

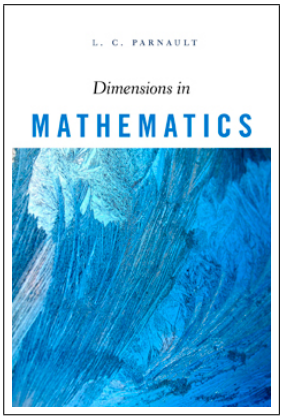




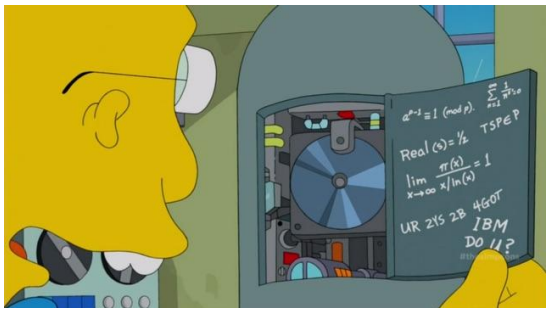
B. Mazur & W. Stein

A popular book about mathematics is most often dealing with prime numbers or has at least a chapter devoted to it. The choice is obvious because anybody knows what the positive integers are and almost everybody has an idea of what prime numbers are. And that is usually where it stops for the average (wo)man in the street. At best, they have heard about the proof of Fermat's Last Theorem by Andrew Wiles in 1994. The possibility you find somebody who knows or can formulate the Riemann Hypothesis is extremely small, unless you are asking people at the exit of a mathematics building at lunch time.




April's fool blog 2013
of Harvard U. Press

Millions have read Stieg Larsson's *Millennium* trilogy or seen the movie(s), but they probably did not quite understand why in volume 2 Lisbeth Salander starts thinking about FLT after reading *THE* book about mathematics, *Dimensions in Mathematics*, a 1200 page mathematical bible by L.C. Parnault, pleasant to read and amply illustrated, where you read about *'Archimedes, Newton, and Martin Gardner, and dozens of other classical mathematicians'*. (Un?)fortunately such book only exists in fiction. At some point Salander even has the same insight as Fermat had, when he wrote that he *discovered a truly marvelous proof of this, which this margin is too narrow to contain.* She suddenly realizes that '*The answer was so disarmingly simple.* [...] *No wonder mathematicians were tearing out their hair.*' She however got shot in the head, and later could not immediately recall her solution. She lost interest anyway since she had solved it at some point, and then there was no more motivation to re-solve the riddle. How trendy can mathematics be if it can make it as a nonsense item in a #1 bestseller.




In *The Simpsons and their Mathematical secrets*
S. Singh discusses RH in Simpsons-Futurama

But back to the RH. Asking around, you might find some people who know that the distribution of prime numbers has some strange regularities, yet behaves totally unpredictable, somewhat like the digits of $\pi$. Formulating the RH would still be a problem, in particular since its usual formulation does not look like it has anything to do with prime numbers. Suppose your interviewee were interested to learn about it, then the booklet by Mazur and Stein is precisely what you should recommend. The RH is not in Larsson's Millennium trilogy, but it is one of the *Millennium Prize Problems* of the *Clay Mathematical Institute* in 2000, a century after David Hilbert had listed it among the most important mathematical problems in 1900. Trying to solve it is still one of the most difficult ways to earn yourself a million dollars.

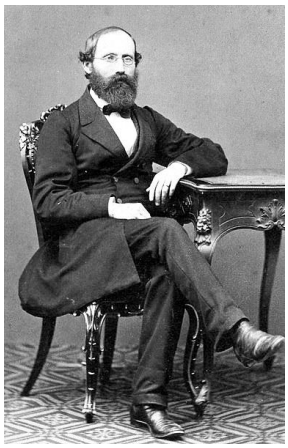
There are several ways to introduce the RH. In most cases one starts from the summation $\sum_{k=1}^{\infty} 1/k^s$ to define it as the function $\zeta(s)$, after extending this to complex $s$ values, everywhere in $\mathbb{C}$ except $s = 1$ (perhaps introducing the surprising fact that $\sum_{k=1}^{\infty} k = -1/12$) and finally arrive at the problem about proving the location of its nontrivial zeros on the axis $\mathrm{Re}\, s = 1/2$ in the complex plane. In this approach, it comes as a surprise that this has anything to do with prime number distribution. Then one needs to introduce the marvelous Euler formula $\zeta(s) = \prod_{p \text{ prime}} 1/(1-p^{-s})$. This is more or less the approach taken by E. Frenkel in his Numberphile video blog[1].

This is not the approach taken by the authors of this marvelous booklet. They start from prime numbers and stick to this idea till the end. The book is written for a broad audience, but it has some parts that

[1] https://www.youtube.com/watch?v=d6c6uIyieoo

require more mathematics. That is why they have subdivided their text in four parts. The first part is intended for the non-mathematician. It takes about half of the book and goes all the way from the history and importance of the RH and prime numbers, to the staircase function $\pi(x)$ counting all primes less than $x$, its square root approximations, namely Gauss' $x/(\log x - 1)$ and Riemann's logarithmic integral $Li(x)$. Then $\pi(x)$ needs a modification to include powers of primes and the use of logarithmic scales to obtain a function $\psi(x)$ introduced by Chebyshev which looks approximately like a straight line at a 45 degree angle. Eventually Fourier analysis is used to hint that the spectrum of a related distribution will reveal the distribution of the prime numbers. That is where the reader of part I is left, with Fourier as teaser to read on.

But the continuation requires more mathematics. So part II is preparatory, introducing generalized functions or distributions and their Fourier transforms. Some manipulation of the $\psi(x)$ will give a function $\Psi$ whose derivative gives spikes at the positions of the logarithm of prime numbers and their integer multiples. The details are less easy to follow, but it is clear that its spectrum defines the location of the primes and their powers. Riemann's approach via the zeta function is only introduced in the trailing chapters of part IV. It then takes the approach of Frenkel as sketched above to come to the link between the nontrivial zeros of the zeta function and the distribution of the primes.

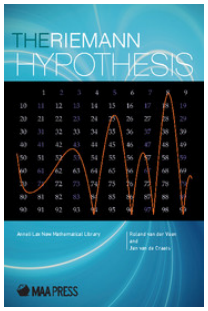


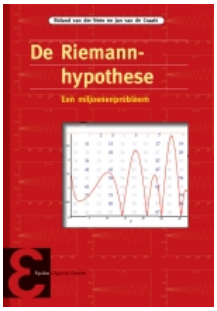
Bernhard Riemann

It is a nice, amply illustrated, little booklet that contains surprisingly much information brought at a level accessible for many kinds of readers. The mathematics are somewhat smuggled under the carpet but there are many graphs that should somehow convince the reader. It may become a bit fuzzy near the end for readers not well prepared. It does illustrate the importance of the RH since many very different yet equivalent theorems exist and many other theorems start with 'Assume that the RH is true, then...'. And of course, there is still one million dollars waiting for you if you are interested.

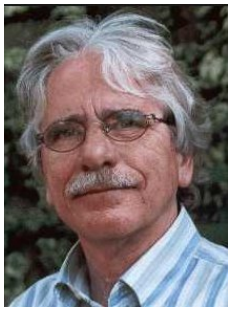
**The Riemann Hypothesis. A Million Dollar Problem**, Roland van der Veen, Jan van de Craats, MAA Press, (2015) ISBN 978-0883856505 (pbk), xi+144 pp.

The million dollars is used in the subtitle of the second book. This is actually a translation of the Dutch Epsilon publication *De Riemann-hypothese: Een miljoenenprobleem* (2011). That grew out of an intensive online course to introduce (talented) secondary school students to the problem. The course was given during four weeks and had many exercises with online support. These four weeks correspond to the four parts in the book Each part is sprinkled with many exercises. Thus although accessible at secondary school level, it is not leisurely reading, and one has to work to assimilate the material. At the end of each part somewhat more demanding exercises are added. Solutions are provided in an appendix.




R. vander Veen



J. van de Craats

Additional information is provided in several appendices. It is briefly mentioned that large prime numbers are important for RSA encryption For computer support one is referred to the Wolfram Alpha website or the Sage package. Given this software several of the exercises can be revisited. There is also a (short) list of books (some are listed below) and websites for further reading.

The topics treated are precisely what you would expect. The first part introduces the prime counting function $\pi(x)$ and starts with several attempts to approximate it, which leads to logarithms and eventually the prime number theorem and Chebyshev's $\psi(x) = \sum_{p \le x} \lfloor \log_p x \rfloor \log p$ ($p$ prime).

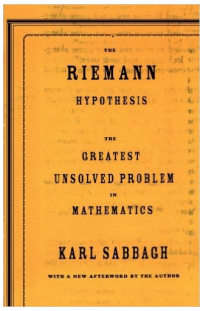
In the second part, the main dish is the Riemann-zeta function $\zeta(x) = \sum_k 1/k^x$ which requires to

explain the convergence of infinite sums and functions defined by power series. Euler's product formula makes the link with prime numbers. The infinite product for the sinc function allows to evaluate $\zeta(2)$ but a proof of Euler's formula has to wait till the start of part three.

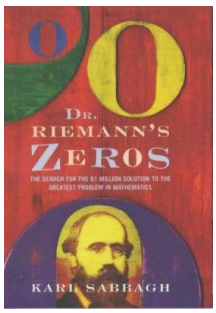
The proof of Euler's formula being given, it is time to extend the zeta-function to the complex plane. That triggers a crash course on complex numbers and complex functions which eventually allows a formulation of the RH.

The final part of course has to explain the missing link between the function $\zeta(z)$ and the prime counting $\psi(x)$. Via the functional equation for $\zeta(x)$, the trivial zeros are easily obtained. Assuming the RH is true, an explicit expression linking $\psi$ and the zeros of $\zeta$ is derived. A sketch of the proof of the prime number theorem is given by showing that none of the critical zeros can be on the boundary of the critical strip $0 < |z| < 1$.

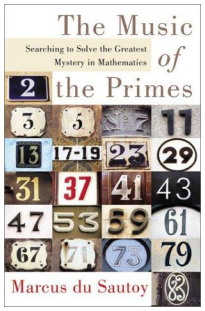
There are of course many other books on the Riemann Hypothesis. Here are a few popular ones:



J. Derbyshire

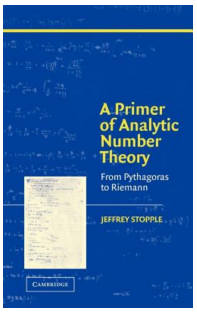


K. Sabbagh

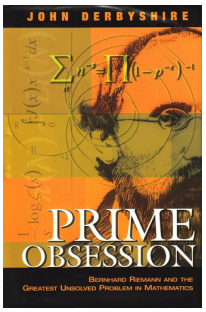


M. du Sautoy

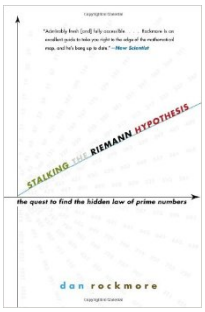
**K. Sabbagh**, *The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*, Farrar, Straus, and Giroux, 2002
**K. Sabbagh**, *Dr.Riemann's Zeros*, Atlantic Books, 2003
**M. du Sautoy**, *Music of the Primes*, Harper, 2003



J. Stopple



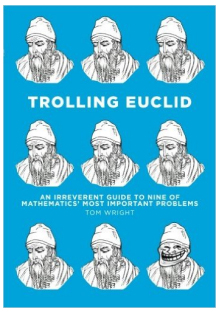
J. Derbyshire



D. Rockmore

**J. Stopple**, *A Primer of Analytic Number Theory: From Pythagoras to Riemann*, Cambridge University Press, 2003.
**J. Derbyshire**, *Prime Obsession: Bernhard Riemann and the Greatest Unsolved Problem in Mathematics*, Joseph Henry Press, 2003.
**D. Rockmore**, *Stalking the Riemann Hypothesis: The Quest to Find the Hidden Law of Prime Numbers*, Vintage, reprint 2006

**Trolling Euclid**, *Tom Wright*, CreateSpace Independent Publishing Platform (2016) ISBN 978-1523466467 (pbk), 206 pp.





Tom Wright

The third book, *Trolling Euclid* is a bit similar because it is an airy collection of short chapters introducing the reader to a number of open problems in mathematics. Tom Wright is a number theorist at the Wofford University in Spartanburg, SC. The reason for his book sounds familiar to mathematicians: when people ask him about his job and he says he's a mathematician, he gets some frowns, and when he confirms that he does number theory, not immediately recognized as applied mathematics that is useful for anything practical, he has to explain. So he wrote this book, not to be preachy or teaching the mathematics. Instead he is entertaining, telling his thing in a conversation-like way, and with a lot of humor and self-reflection, like small-talking during a reception. So it is more entertaining and less convincing than the previously reviewed book, but on the other hand it touches on more types of mathematical problems.

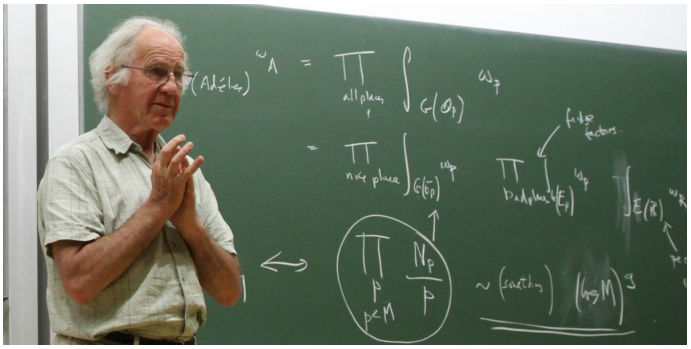
The Riemann Hypothesis and its generalization are the first two problems considered. Here the start is directly from the zeta function. Chapter titles like "*The zeta function: Magical, mystical, and... dear god, what is this thing?*" or "*Wait, wait, that's it? The question of when some esoteric function hits zero is*

*the most important problem in math?*" set the tone of the book. More examples to follow. Also here some more mathematical parts, like for example analytic continuation, are extra chapters labelled 'Appendix' that can be skipped. The connection to prime numbers is seen as an application. This link is restricted to the formulation of the fact that $\pi(x)$ and $Li(x)$ will never differ by more than about $\sqrt{x}\ln x$ if and only if the RH holds.

The second problem is the GENERALIZED RH ("*How much harder can we make this stupid thing, anyway?*"). What if we replace the numerators 1 in $\sum_k(1/k^s)$ by some pattern like a sequence of alternating 0 and 1, or a repetition of the pattern $\chi_5 = (1, i, -i, -1, 0)$ and consider one of Dirichlet's L-functions $L(s, \chi_n)$, with $\chi_n$ periodic of length $n$? The GRH is formulated by Adolf Piltz in 1884. Wright claims that "*Piltz, as you no doubt recall, was not the most adroit when it came to manipulation of these functions, so he did the next best thing; he grabbed $L(s, \chi_n)$, put it in chokehold, and said 'TELL ME WHERE YOUR ZEROS ARE!'. Unfortunately Piltz was a bit too strong for his own good, and $L(s, \chi_n)$ was only able to respond 'Mmfghh wmmph thfffff...' before passing out*'. Anyway the GRH says that these functions have properties very similar to $\zeta(s)$ with nonnegative zeros all on the same vertical axis at $\mathrm{Re}\, s = 1/2$. If true, it gives extra information about the prime number distribution. Consider a fixed number $m$ and denote by $\pi(x, m, n)$ the number of primes less than $x$ of the form $n (\mathrm{mod}\ m)$, then $\pi(x, m, n_1)$ and $\pi(x, m, n_2)$ do not differ by more than $\sqrt{x}$ which generalized the Prime Number Theorem. And there are a number of other consequences that are also discussed like the maximal gap between prime numbers.

Shinichi Mochizuki

The next open problem is the ABC CONJECTURE ("*What the alphabet looks like when D through Z are eliminated*"). This is relatively recent (formulated in 1985 by Joseph Oesterlé and later by David Masser). Denote $\mathrm{rad}(n)$ for the product of all the *different* primes that divide $n$. If three coprime numbers satisfy $a + b = c$ then for all $\epsilon > 0$ there are only finitely many triples such that $c > \mathrm{rad}(abc)^{1+\epsilon}$. In 2012 Shinichi Mochizuki announced a proof using a totally original approach called inter-universal Teichmüller theory (IUT). An error was detected in his proof, but nobody was familiar with IUT, since it was a private Mochizuki invention, it will take a while to verify or possibly complete his proof. Again some consequences of the ABC conjecture are listed among which FLT. Unfortunately it doesn't hold the other way around. In an appendix chapter, it is shown that deriving FLT is an easy consequence since $x^n + y^n = z^n$ is indeed of the form $a + b = c$. In fact ABC-type claims hold for many other equations of the form $a + b = c$ outside number theory.



Bryan Birch

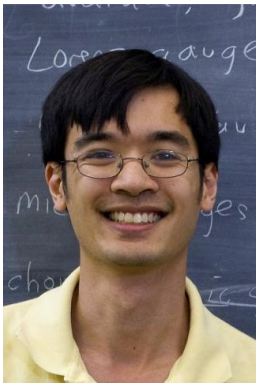
Peter Swinneton-Dyer

The BIRCH-SWINNERTON-DYER CONJECTURE is another of the Millennium Problems, formulated in the 1960's. Wright gives the following loose introduction. Consider an elliptic curve $E$ of the form $y^2 = x^3 + Ax^2 + Bx + C$ with $A, B, C$ integers. The problem is to know whether there are infinitely many rational points on $E$. Gauss proved that if there is no solution modulo $n$, then there is no solution at all. But what if there are some? Let $N_p$ be the number of solutions modulo a prime number $p$. These numbers are smuggled into a formula of the type of the Dirichlet L-functions. Let's call this $L_E(s)$. It is defined for every $s$, even $s = 1$ ("*Put that in your pipe and smoke it, Riemann*"). In fact BSD says that $L_E(1) = 0$, if and only if $E$ has infinitely many rational points. One direction is proved in the Coates-Wiles[2] theorem which says that if $L_E(1) \neq 0$ then there are not infinitely many rational points.

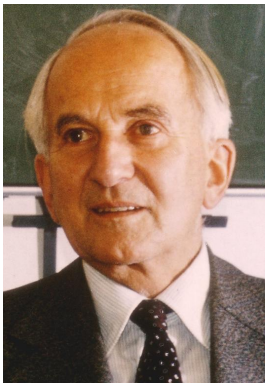
[2] Andrew Wiles from FLT.

After this preliminary version, Wight moves on to a more detailed version of BSD, trying to clarify and relate '*what is the structure of the infinite set?*' and '*how zero is zero?*'. Therefore he defines the rank of $E$ (the number of solutions required to generate all the rational solutions) and the order of a zero. The BSD then says that these are the same: the order of the zero at $s = 1$ for $L_E(s)$ equals the rank of $E$. The Coates-Wiles theorem was superseded in 2015 by a paper of Bhargava and Shankar who proved that a considerable part of elliptic curves have rank 0 and therefore satisfy BSD.

One of the Erdős conjectures is about arithmetic progression. If the sum of the inverses of the numbers in a subset $A$ of positive integers diverges to infinity, then $A$ contains an arithmetic sequence of any length. When $A$ is a set of primes (the sum of reciprocals diverges), then the Green-Tao theorem (2004) says that, no matter how large you choose $n$, you will always find a sequence of $n$ successive equally spaced primes. Terence Tao received the Fields Medal in 2006. The conjecture thus says that such statement should hold for any set of positive integers, not only primes. Erdős offered in 1976 a prize of 5000 dollar for a proof of his conjecture although he never cared about where to find the money when he awarded such prizes, but the amount somehow reflected a level of importance of the problem.



Terrence Tao



Lothar Collatz

To conclude, the book lists problem "*easy to understand but impossible to solve*". Erdős once said "Children can ask questions about primes which grown men cannot answer". So there are some more problems that are less in the focus of mathematicians, mostly because nobody has a clue on how to tackle them. There is the Collatz conjecture ("*1930's version of angry birds*"). "*Back in the 1920's and 30's, the world was populated by savages who hadn't yet discovered the massive societal value of devoting hundreds of hours to noble endeavors like Angry Birds or Addiction Solitaire. To waste time [...] they had to find a simple mathematical problem that was as addictive as it was impossible*". Collatz's algorithm goes as follows. Pick a number $x$ (positive integer), if it is even, divide by 2 and if odd, replace it by $3x+1$ and repeat. The claim is that this will always arrive at 1 and thus end with the cycle 1, 4, 2. It is an illustration of nonlinear dynamics create by a simple algorithm producing quite unpredictable behavior. It is the number theoretic version of a chaotic dynamical system.

Goldbach's conjecture appears in a 1742 letter that Christian Goldbach wrote to Euler: Every even integer $> 2$ can be written as the sum of two primes. He also had a weaker ternary version: Every integer $> 7$ can be written as the sum of 3 primes. But that is trivial, since subtracting 3 gives an even number that can be written as the sum of two primes by the even version. So it remains to prove the original one. The proof of the weak version was however given independently for all odd numbers larger than an impossible large number. In 2013, this bound was reduced to $10^{30}$ and the finitely many remaining cases could be treated by a computer. QED.

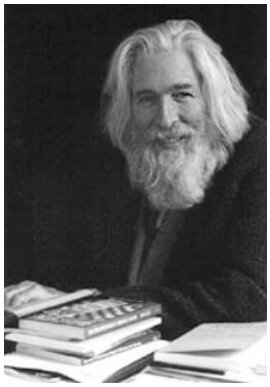
Christian Goldbach

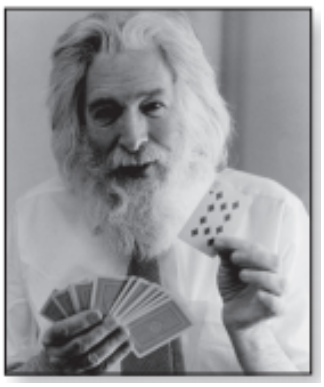
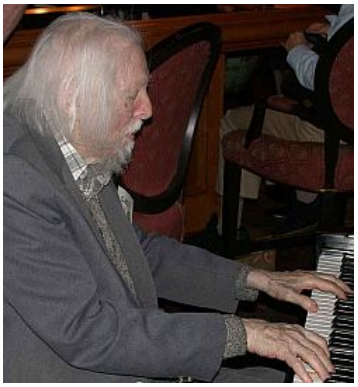
The twin prime conjecture is about the existence of infinitely many prime numbers that differ by 2, a question already raised by Euclid. No progress was made for 2000 years. Then in 1849 de Polignac generalized the problem for pairs of successive primes that differ by some $k$. These got names like 'twins' (2), 'cousins' (4), 'co-workers' (8). While for 16, Wright calls them '*two people that saw each other on the street but haven't really talked to each other but wouldn't oppose to it*'.

Perfect numbers are numbers that are equal to the sum of their proper divisors. These numbers are rather rare. A list of 49 is known in June 2016. It starts with 6 and the 49th has 44,677,235 digits but it is conjectured there are infinitely many perfect numbers. There is a relation with Mersenne primes, i.e., primes of the form $2^n - 1$ for particular integers of $n$. It is known that if $2^n - 1$ is a Mersenne prime, then $2^{n-1}(2^n - 1)$ is a perfect number. Only, it is not known that there are infinitely many Mersenne primes. Neither is it known if there exists an odd perfect number.

Adhemar Bultheel

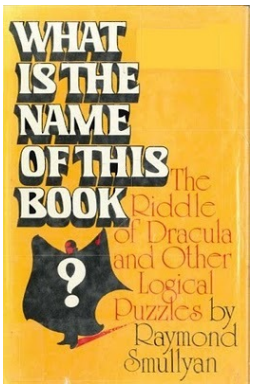
**Raymond Smullyan (1919 - 2017)** *Mathematician, Writer, Magician, Philosopher, Pianist*

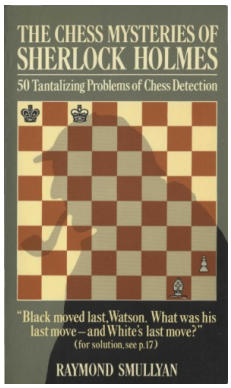


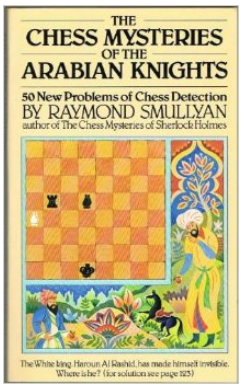



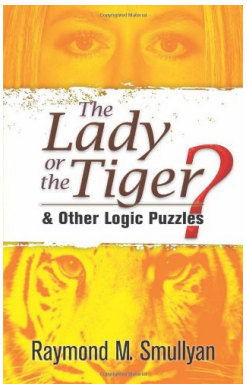
Raymond Merrill Smullyan

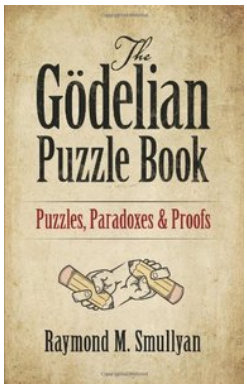
In the book reviews of this Newsletter it may have become clear that I am a great fan of Martin Gardner's writings on recreational mathematics[1]. If you share this fascination, then you might as well be interested in the books by Raymond Smullyan (and you probably already know them). Gardner and Smullyan both became popular with their publications on recreational mathematics, magic, philosophy and religion. Yet there were differences. While Gardner never got an advanced degree in mathematics, Smullyan earned a PhD from Princeton under the supervision of Alonzo Church on formal systems and Gödel's incompleteness theorems. He had an academic career and he published several academic books on mathematics and logic. His studies were somewhat meandering along strange paths and suffered from several drop-outs. He has also a talent for music and is a skilled pianist. He recently passed away on 6 February 2017 at the age of 97. His final book: *A Beginner's Further Guide to Mathematical Logic* was just published in January.












His father was Russian but came at a young age to Belgium so that his native language was French. His mother was English, and since they moved to the US shortly after marriage, Raymond was born in the States as the youngest of three children. His mother soon recognized that his musical skills and the fact that he had perfect pitch. He won silver at a piano competition at the age of 12 and gold the next year.

His interest in logic came at an early age when one April 1, his brother said he would fool him like he never did before, but actually never did anything. Raymond stayed vigilant the whole day, but when at the end of the day nothing had happened, he was wondering whether he had been fooled or not.

During his school days he was interested in mathematics, but was not an role model, in fact he dropped out and studied Galois theory an invented Boolean algebra on his own. He entered and left several Colleges, not knowing whether to engage in music or in mathematics. He became interested in retrograde chess problems and be performed as a magician.

[1] This Newsletter, issue 52, March 2005 and issue 99, September 2014.


Rudolf Carnap from the University of Chicago recommended him for a post in Dartmouth College. He was awarded a PhD at the age of 40 on the *Theory of Formal Systems* at Princeton, supervised by Alonzo Church. His retrograde chess problems, were accidentally discovered and with some delay got his books on this topics published *The Chess Mysteries of Sherlock Holmes* (1979) and *he Chess Mysteries of the Arabian Knights* (1981). As the titles suggest, he did not just posed the problems, but wrapped them up in some stories faithful to a Sherlock Holmes and Dr. Watson staging or queen Scheherazade.

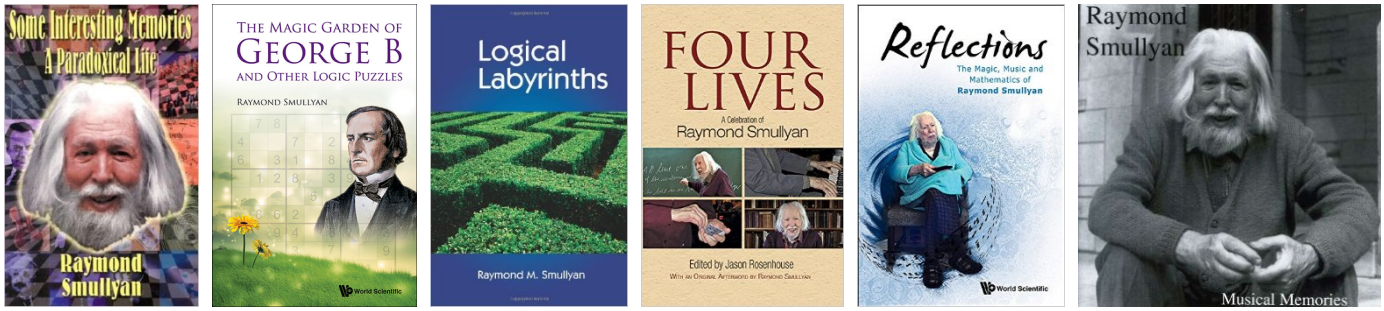
When a former student of his was asked to write a puzzle book, he forwarded the invitation to Smullyan. He proposed his chess problems but they were not interested. So he wrote *What is the name of this book?* (1978) and when Martin Gardner wrote a very positive review, he was invited to write more like this, and all of a sudden his chess books became interesting too. He wrote some dozen puzzle books since which became very popular. Usually they are set in some sceneries that he uses repeatedly. For example there are the Knights (who always speak the truth) and the knaves (who always lie) end there are several other characters reappearing with characteristic properties. Like his chess problems, they are wrapped up so that they read as short stories, regularly spiced with a joke.

Besides these puzzles, Smullyan also wrote on philosophy, religion and Taoism. In fact *The Tao is silent* (1977) was his first non-mathematical book (I do not discuss his academic books in this review). The book is not an introduction to Taoism but it contains a set of Smullyan's reflections on Taoism, trying to understand the paradoxes that arise when organizing your life, following the Tao (i.e. 'path'), that is vague, formless, leisurely, and not imperative in any way. Several other books on philosophical and religious topics followed, but also here Smullyan is always witty and uses a lot of humor.

Tao Ruspoli made a film documentary about Smullyan's life in 2001 called *This Film Needs No Title*, winking to the essay collection *This Book Needs No Title* (1980), a sequel to his Toa book. This film may have triggered Smullyan to write his autobiography *Some Interesting Memories* (2002). He is then 83. It is a survey of his previous writings with some reflections, jokes, and anecdotes from his personal life.

In 2006, his Belgian wife Blanche, by 14 years his elder, passed away at the age of 100. She played the piano very well and had been a music teacher. She designed the house in which they retired, up in the Catskill Mountains, some 160 km North of New York. He conquered her love with a bet that he could kiss her without touching her. He lost.

Raymond continues publishing books and recording his music. In 2007 *The Magic Garden of George B. And Other Logic Puzzles* was made available by an Italian open access publisher *Polymetrica*. Since it does not exist anymore, World Scientific republishes it in 2015. It consists of the usual collection of puzzles, but in a second part, an introduction is given to propositional logic and Boolean algebra. It is a preparation for a more elaborated book *Logical Labyrinths* (2009) that goes much further and includes an introduction to first order logic. Two more puzzle books appear *King Arthur in Search of his Dog* (2010) and *The Gödelian Puzzle Book* (2013).




For his 95th birthday, Jason Rosenhouse edited a book *Four Lives: A Celebration of Raymond Smullyan* (2014). It consists of salutations from his many friends, followed by some longer essays related to his work, and a large part is a 'the-best-of' selection from his puzzles, riddles, and paradoxes.

*Reflections* (2015) is another attempt to write an autobiography, but it is mainly a recycling of existing material with again many jokes, anecdotes and puzzles, smuggling in some serious stuff about undecidability, incompleteness, provability, and these Gödelian issues. It reads like the script for the performance of a stand-up comedian. Every event has some connection to an anecdote, which reminds him of a joke, that is like another story that happened to somebody else, which triggers more jokes,... You can imagine him, not standing up, but sitting in an easy chair with a growing company of listeners flocking around him, while he is entertaining them. This format cannot be maintained during 200 pages, so there is some variation. Sometimes there are short (fun) poems dedicated to some person. It also has letters and emails from him or addressed to him, some lists of riddles with pun answers (like 'What philosopher couldn't do things?' Answer: 'Immanuel Can't'), etc.

A large chapter is devoted to the *Piano Society*[2]. This society has a website where you can find biographies of composers and pianists. Many recordings from their members are made freely available. The website has also a discussion forum and since Smullyan posted there some fun definitions (style *Cellist:* One who greets one with "Cello".) and puzzles. Other members (some are also mathematicians or are at least interested in the logic needed to solve them) got hooked and some lively discussions sometimes took place. There was some competition to be the first to solve them. So this chapter gives a list of all the joking definitions and some of the discussions related to his puzzles. At the website you can of course also listen to several of his recordings. An alternative is to buy his album *Musical Memories* (2004) that appeared shortly after his (first) autobiography. Smullyan admits gracefully that he is blatantly immodest, but he accepts it as being genetic and beyond his control. This might irritate some readers since it somewhat shows throughout the text. Another of his vices is that he is an incorrigible flirter and lover of women. He urges to add that it is always a complimentary flirtation, and he never has the intention to seduce. The last chapter of his *Reflections* is devoted to happy memories for several women he has known.

Raymond Smullyan 1968
Picture by Paul Halmos

A. Bultheel

[2] pianosociety.com

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