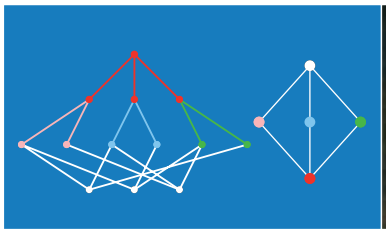
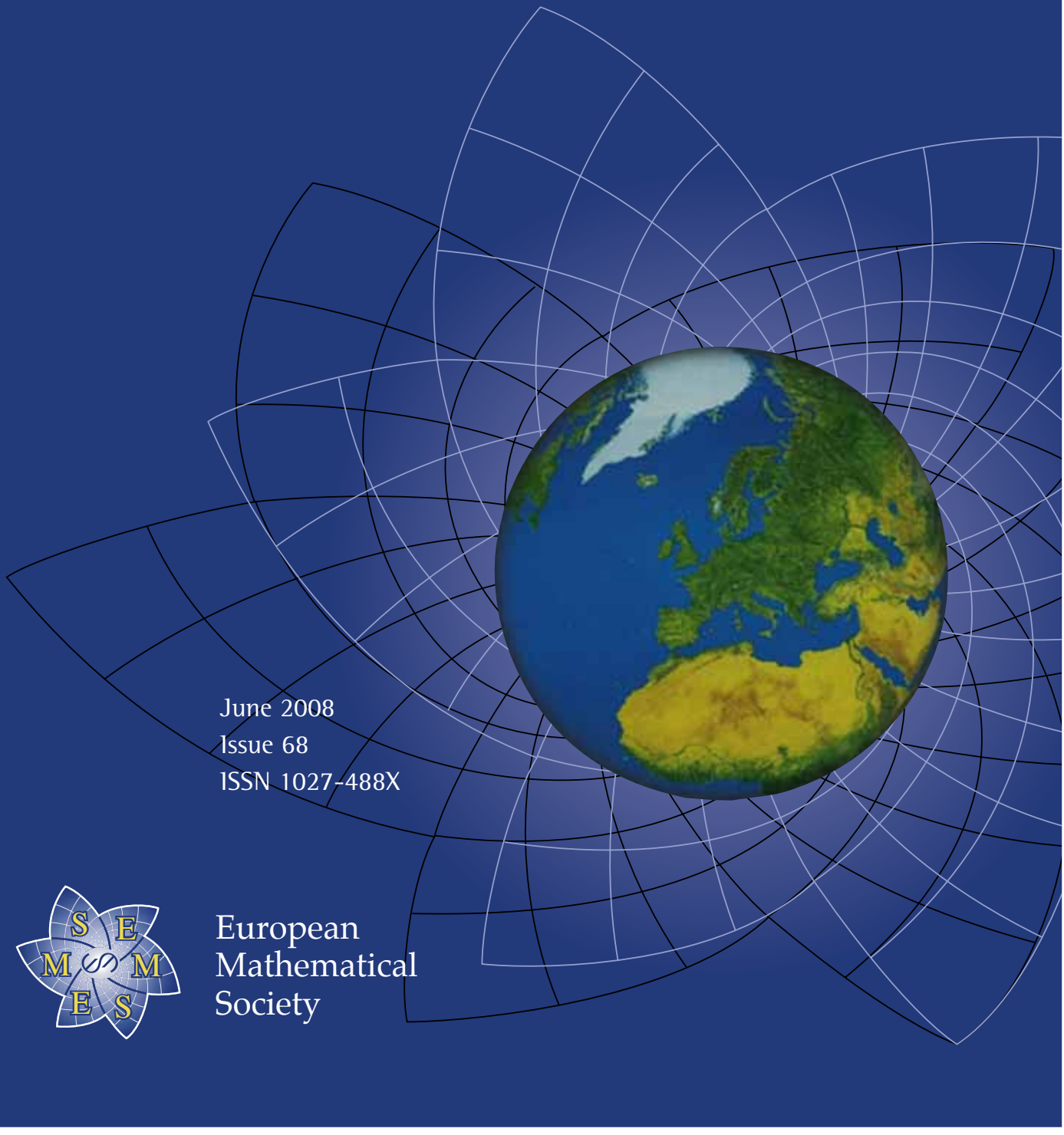
NEWSLETTER

OF THE EUROPEAN MATHEMATICAL SOCIETY







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EMS Executive Committee

EMS Calendar

2008

30 June–4 July
The European Consortium For Mathematics In Industry (ECMI), University College London (UK). www.ecmi2008.org

11–12 July
EMS Executive Committee Meeting, Utrecht (The Netherlands)
Stephen Huggett: s.huggett@plymouth.ac.uk

12–13 July
EMS Council Meeting, Utrecht (The Netherlands)
Stephen Huggett: s.huggett@plymouth.ac.uk; Riitta Ulmanen: ems-office@cc.helsinki.fi
http://www.math.ntnu.no/ems/council08/

13 July
Joint EWM/EMS Workshop, Amsterdam (The Netherlands)
http://womenandmath.wordpress.com/joint-ewmems-worskhop-amsterdam-july-13th-2008/

14–18 July
5th European Mathematical Congress, Amsterdam (The Netherlands). http://www.5ecm.nl

18–22 July
European Open Forum ESOF 2008, session *Can Mathematics help Medicine?* Barcelona (Spain)
http://www.esof2008.org

1 August
Deadline for submission of material for the September issue of the EMS Newsletter
Vicente Muñoz: vicente.munoz@imaff.cfmac.csic.es

3–9 August
Junior Mathematical Congress 8, Jena (Germany)
www.jmc2008.org

16–31 August
EMS-SMI Summer School at Cortona (Italy)
Mathematical and numerical methods for the cardiovascular system
dipartimento@matapp.unimib.it

8–19 September
EMS Summer School at Montecatini (Italy)
Mathematical models in the manufacturing of glass, polymers and textiles
web.math.unifi.it/users/cime/

28 September – 8 October
EMS Summer School at Będlewo (Poland)
Risk theory and related topics
www.impan.gov.pl/EMSsummerSchool/

7–9 November
EMS Executive Committee Meeting, Valencia (Spain)
Stephen Huggett: s.huggett@plymouth.ac.uk

2009

5–8 February
European Student Conference in Mathematics EUROMATH 2009, Cyprus
www.euromath.org

Editorial

Martin Raussen (Aalborg, Denmark)

Dear Newsletter readers,

I have had the privilege to be in charge of the Newsletter of the European Mathematical Society for almost five years, since the autumn of 2003. Time has now come for me to hand over to my successor Vicente Muñoz from Madrid, Spain. He and I are jointly producing this issue and the next and he will take over responsibility after that. I plan to stay on the Newsletter's editorial board and do bits of work here and then. Although I have been very fond of my job, of encouraging and finding interesting articles and assembling them in the Newsletter, I must admit that I am now looking forward to a period with more time for my primary occupation of mathematical research and teaching.

The production of a newsletter like this one is a collaborative task. It could not have been done without a helpful and encouraging editorial board. You can find the list of editors on page 2, and I have to thank all members for their contributions, whether they were produced from their own hands or by their intervention. Some of the editors have been on board much longer than I have and I hope that many of them will continue their good work in the future. This is not to say that the Newsletter could not use "fresh blood", and I would like to encourage volunteers to contact Vicente Muñoz who will compose a new editorial board at the beginning of next year.

Since 2005, the Newsletter has appeared under the EMS Publishing House – in a new format, both in print and electronically. Cooperation with director Thomas Hintermann has been very friendly and efficient. I am aware of the fact that the money the EMS pays for the production of the Newsletter just pays the hard costs and I am therefore particularly grateful for the support from the publishing house. By the way, have a look at the impressive development of the publishing house both in terms of journals and of book publications at www.ems-ph.org! Cooperation with our Swiss layout experts, Sylvia and Micha Lotrovsky, has been swift and friendly; likewise the handling of technical and thus TeXnical articles in the hands of Christoph Eyrich in Berlin. Thanks to all of them!

The main idea with this Newsletter is to give the personal members of the EMS immediate "value" for their membership dues. The concept of the Newsletter has developed over the years; nowadays, it contains one or two feature articles usually surveying a newer mathematical development, one article of a mainly historical character, at least one interview with a well-known mathematician, and a presentation of a national mathematical society or of a mathematical research centre within Europe, and quite often also an article on news from Mathematical Education. Moreover, there are columns with news from the EMS, other interesting (mainly European) mathematical news, a featured book review, a conference listing carefully produced in Romania, the section "Recent Books" from the hands of our Czech colleagues, and finally (biannually) "Solved and Unsolved Problems" with comments and solutions, and a Personal Column.

It has not always been easy for this editor to find volunteers willing to compose interesting feature articles. I am therefore extremely grateful for the support from editors of several membership journals of national mathematical societies who have allowed me to "reuse" some of their articles and thus to make them visible to more mathematicians throughout Europe. Particular thanks go to the French *gazette des mathématiciens*, the German *Mitteilungen der DMV* and (my personal favourite) the Dutch *Nieuw Archief voor Wiskunde*.

It has been my privilege as editor to be invited, two or three times per year, to the weekend meetings of the executive committee of the EMS. These take place in various European cities, usually by invitation of a national mathematical society. The meetings are pleasant because the participants work hard together for a common goal: a better infrastructure and a higher recognition in politics and in the public for European mathematics and mathematicians. Even more could certainly be done if the EMS had more active support (bottom-up) from its members – and from more members!

I do not know whether a leaving editor has the right to pronounce a wish. Anyway, I would like to address three wishes to the readers of this Newsletter issue – which this time is distributed in a higher circulation due to the European Congress in Amsterdam and to a campaign directed to all European departments of mathematics:

- Please inform the new editor-in-chief or one of the other editors about articles that you find interesting for mathematicians at large, be they from your own or from somebody else's pen. Every (email) alert will be gratefully acknowledged.
- The EMS would be able to work more efficiently if it had more personal members – this would also increase the circulation of the Newsletter. Could you not try to convince one or more of your office neighbours? Please have a look at the new EMS web page http://www.euro-math-soc.eu (still under construction). This page already offers many services to the community, e.g. announcements of jobs and conferences in addition to news. Under *Membership* you will find many more reasons to join the EMS; in addition, you can now become an EMS member online.
- If you find this Newsletter worth reading, why not ask your department or your library for a subscription? Refer to http://www.ems-ph.org/journals/subscription.php?jrn=news .

I am grateful for your support in these matters.

Joint mathematical weekend in Copenhagen

Martin Raussen (Aalborg, Denmark)

Following the tradition of joint mathematical weekends that was launched in Lisbon (2003) and continued in Prague (2004), Barcelona (2005) and Nantes (2006), the Danish Mathematical Society (DMF) organised a mathematical weekend in Copenhagen earlier this year starting on Friday 29 February and lasting until Sunday 2 March. More than 160 participants, many of them from abroad, listened to more than 50 lectures, making this the biggest mathematical event held in Denmark for years. To start with, the mayor of Copenhagen had invited the participants for a reception buffet at the city's impressive town hall.

The meeting had been planned by an executive committee consisting of four mathematicians from the Copenhagen area, among them DMF president Søren Eilers, and moreover EMS vice-president Helge Holden. Time was provided for four plenary talks (by Xavier Buff, Toulouse; Nigel Higson, Pennsylvania State; Frank Merle, Cergy-Pontoise; and Stefan Schwede, Bonn) and six sessions:

- Algebraic topology (organizers: Jesper Grodal, Ib Madsen)
- Coding theory (Olav Geil, Tom Høholdt)
- Non-commutative geometry/operator algebra (Ryszard Nest, Mikael Rørdam)
- Dynamical systems (Carsten Lunde Petersen, Jörg Schmeling)
- Algebra and representation theory (Jørn Børling Olsson, Henning Haahr Andersen)
- Partial differential equations (Gerd Grubb, Helge Holden)

A detailed program can be found at http://www.math.ku.dk/english/research/conferences/emsweekend/.

Concentrated audience

Support for the meeting had been granted by the Danish science research council, the Danish and the European Mathematical Societies and the Department of Mathematics at Copenhagen University. A very enthusiastic group of young mathematicians from this department must be thanked for their efficient help with all the practical aspects of the meeting. For example, session talks were synchronized in order to allow participants to switch at the sound of a horn, which was impossible to miss by even the most enthusiastic speaker!

In summary, this was a very nice meeting that was useful for the whole audience, which ranged widely, not only with respect to their mathematical interests but also to their age; the attendees included not only many young PhD students but also several emeritus professors.

The mathematical weekend has established itself as a good framework for a general medium sized mathematics conference. Who is going to organise the next one?

Group photo at the end of the conference

Arthur Besse donates royalties to EMS-Committee

Mireille Martin-Deschamps (Versailles Saint-Quentin, France)

The Friends of Arthur Besse are a group of mathematicians who work in the field of Riemannian geometry. Here is their story. In 1975, Marcel Berger convinced his students to organise a workshop about one of his favourite problems: understanding manifolds all of whose geodesics are closed. The workshop took place in Besse-en-Chandesse, a very pleasant village in the centre of France, and it turned out to be so successful that the decision was made to write a book about the topic. Arthur Besse was born.

The experience was so pleasant and enjoyable that Arthur did not stop there and settled down to write another book. This second book "Einstein manifolds" was eventually published in 1987.

Years have passed since then. Arthur's friends have scattered to various places. As they say "for Arthur himself, who never aimed to immortality, it may be time for retirement".

Nevertheless, a new version of Einstein Manifolds has recently been published and the royalties have been offered to the EMS with the suggestion that this money could be used to help young people from developing countries. Of course this offer was gratefully accepted by the Executive Committee of the EMS, who decided to put this money at the disposal of the Developing Countries Committee.

To give a rough estimate, in the long run these duties could provide 9000 euros.

EMS Executive Committee meeting Copenhagen, Denmark, 3 March 2008

Vasile Berinde, EMS Publicity Officer

Copenhagen town hall

Organized as a continuation of the successful Joint Mathematical Weekend EMS – Danish Mathematical Society (February 29th–March 2nd), the first EC meeting of 2008 was held at the Institute for Mathematical Sciences, University of Copenhagen, on Monday, 3rd of March. This was an unusual working day, for, by tradition, the EC usually only meets at week-ends.

Except for a last minute cancellation by Carlo Sbordone, all members of the Executive Committee were there: Ari Laptev (President, in the Chair), Pavel Exner and Helge Holden (Vice-Presidents), Stephen Huggett (Secretary), Jouko Vaananen (Treasurer), Olga Gil-Medrano, Mireille Martin-Deschamps, Victor Buchstaber, and Klaus Schmidt (members), together with Riitta Ulmanen, our quiet and efficient executive secretary, Martin Raussen, the current Editor-in-Chief of the Newsletter, his successor (starting with the September issue), Vicente Muñoz, who thus made his début at an EC meeting, Mario Primicerio (representing applied mathematics within EC), and myself.

After a healthy and refreshing half hour walk trip from Cabinn Scandinavia to the meeting venue, people felt ready to run over the agenda of the day. Our President, imperturbably relaxed, chaired an extremely dense marathon EC meeting, that started at 9.00 a.m. and lasted until almost 6.00 p.m., only broken for coffee and a quick lunch.

From the business of what was a very pleasant and efficient meeting, I'll mention just a few matters:

- President's report (the effect of his letter to the Presidents of national mathematical societies; his very successful visits to Strasbourg and Brussels; his valuable visit to Serbia, the ISE matters)
- Treasurer's report (on the financial year 2007)
- Publicity Oficer's report (the database of European departments of mathematics, the EMS poster)
- Membership matters (new applications from Montenegro, Serbia, and Turkey; the outline of a fee structure; the new individual members formally accepted by the EC)
- EMS Web Site (the EC thanked Helge Holden by acclaim for the progress with the web site that he demonstrated by taking the EC through the various pages; various suggestions for improvement were also made; our main web site will be freely maintained by University of Bremen, while the fees payment pages would be hosted in Helsinki, and linked to the membership database)
- 5th European Congress of Mathematics (the EMS would have a booth at the 5ECM, shared with the EMS publishing house)
- 6th European Congress of Mathematics (all three bidders – Krakow, Prague and Vienna – would be able to see all three revised bids; at the Utrecht Council, each bid would be given 15 minutes for their presentation, plus some time for questions)
- Reports by standing committees
- Publishing (the EC confirmed the next Editor of the Newsletter, Vicente Muñoz, following an informal meeting the previous day, where he gave a report on his editorial views)
- Closing matters (The President expressed the gratitude of all present to Søren Eilers and to Martin Raussen for the excellent arrangements which they had made for our meeting in Copenhagen).

The next EC meeting, in Utrecht, preceding the EMS Council, would start at 14.00 on the 11th of July, and would continue from 09.00 to 11.00 on the 12th, the day the EMS Council meeting starts. The last EC meeting of 2008 will be in Valencia, 7th–9th of November.

What happened to our friend and colleague Ibni Oumar Mahamat Saleh from Chad?

Aline Bonami (Orléans, France) and Marie-Françoise Roy (Rennes, France)

The French learned societies of mathematics: SMF (Société Mathématique de France), SMAI (Société de Mathématiques Appliquées et Industrielles) and SFdS (Société Française de Statistiques) launched the following petition on 10 March 2008; it can be found at http://smf.emath.fr/PetitionSaleh/.

Mr. President of the Republic of Chad,
Mr. President of the French Republic

We want to know the truth concerning our colleague, the mathematician Ibni Oumar Mahamet Saleh, a Chadian politician and former minister. He was abducted from his home on 3 February 2008 and we have had no news from him since then.

Ibni Oumar Mahamat Saleh is, beyond his political activities, an active member of the mathematical community.

He completed his mathematical education at the University of Orléans, where he defended his PhD thesis in 1978. He was appointed as a professor at the University of N'Djamena in 1985. His numerous positions at the university included:

- Chair of the Department of Mathematics (1985),
- Director of the Center of Scientific Research (1986),
- Rectorship (1990–1991).

In spite of his heavy administrative and ministerial duties, Ibni Oumar Mahamet Saleh always succeeded in maintaining a high level of teaching standards. In order to improve the scientific level of teachers at the University of N'Djamena, he negotiated in 1991 a collaboration between the University of Orléans and the University of N'Djamena, in association with INSA in Lyon and the University of Avignon. This agreement is still in force and has been very successful. In addition to its goal of training, it has allowed Chadian teachers to establish stable and fruitful contacts with European and African Universities. Even when called to other responsibilities, Ibni Oumar Mahamet Saleh was instrumental in the success of the project. Several times he visited the department of mathematics in Orléans as part of this framework.

Since 3 February, contradictory information has circulated about Ibni Oumar Mahamat Saleh. The two other opponents, who were arrested the same day, have been released. One of them thinks that our colleague died, while his family thinks that he is still alive.

We want to know the truth. »

The petition has received over 2450 signatures from the mathematical community around the world, particularly from many mathematicians in Africa who knew Ibni as a colleague or as a professor.

The petition, the list of signatories, messages of information to the signatories and several documents about the case can be found at http://smf.emath.fr/PetitionSaleh/.

A blog of information has been set up by his family and friends at http://prisonniers-politiques.over-blog.com/.

So far we have received no answer from the Chadian and French authorities and we fear that we may not to see our friend and colleague again.

We invite you to sign the petition.

Aline Bonami [Aline.Bonami@univ-orleans.fr] and Marie-Françoise Roy [marie-francoise.roy@univ-rennes1.fr]

The Centre de Recerca Matemàtica (CRM, Bellaterra, Spain) organizes, jointly with the EMS, a scientific session at ESOF2008.

The title of the session is *Can Mathematics help Medicine?* It is part of the activities on the theme "Engineering the Body".

The programme is as follows:
Monday, July 21, 8:30–10:00

Alfio Quarteroni (Politecnico di Milano, Italy and Ecole Polytechnique Fedérale Lausanne, Switzerland)
Mathematical models for the cardiovascular system

Dominique Chapelle (INRIA-Rocquencourt, France)
Modeling and estimation of the cardiac electromechanical activity

Peter Deuflhard (Zuse Institute Berlin, Germany)
The challenge of electrocardiology: model hierarchy and multiscale simulation.

Moreover, ESOF2008 hosts the following plenary talks:

Marcus Du Sautoy (University of Oxford, UK)
Mathematics: creative art or useful science?

Eva Bayer-Flückiger (Ecole Polytechnique Fédérale Lausanne, Switzerland)
The Science of Communication: number theory and coding

For more information, please consult
http://www.esof2008.org .

SIMAI2008

International conference in Rome (Italy) organized in cooperation with SIAM

The Italian Society for Applied and Industrial Mathematics (SIMAI) will hold its 9th Congress in Rome, Italy *from September 15th to 19th* . This international event takes place every two years. This time it is being organized in cooperation with SIAM. The hosting environment will be the beautiful downtown of Rome.

The main (invited) speakers will be Antonio Ambrosetti (SISSA, Trieste), Douglas N. Arnold (University of Minnesota, USA), Nicola Bellomo (Politecnico di Torino), Giovanni Ciccotti (Università di Roma ‚'La Sapienza''), Nicholas J. Higham (University of Manchester, UK), and Alfio Quarteroni (Politecnico di Milano & EPFL Lausanne).

Besides, there will be a number of minisymposia (usually several dozens), round tables, prizes to young mathematicians, and interactions with industrial representatives. More information (in progress) can be found at the SIMAI site http://www.iac.rm.cnr.it/simai/simai2008/ .

Note that all associates to a member society of EMS are entitled to the reduced conference fee as the members of SIMAI.

European Student Conference in Mathematics EUROMATH–2009

5–8 February 2009, Cyprus; www.euromath.org

This is a conference organized by the Cyprus Mathematical Society in cooperation with the European Mathematical Society, the Ministry of Education of Cyprus, the University of Cyprus and the Thales Foundation.
The conference will consist of several workshops/symposiums covering many themes. Suggestions for workshops, symposiums, sessions and exhibitions for the conference are welcome. More information can be found at www.euromath.org; alternatively, please contact the chair of the organizing committee at makrides.g@ucy.ac.cy

The themes of interest are: applications of mathematics, mathematics and sciences, mathematics and life, mathematics and technology, mathematics and social sciences, mathematics and space, fractals and geometry, mathematics and economy, mathematics and literature, mathematics and music, mathematics and law, mathematics and statistics, the history of mathematics, mathematics and society, mathematics and Europe, mathematics and philosophy, mathematics and computer science, and famous numbers.

Students aged between 12 and 18 from any European or international school who may be interested in attending should send a message with their full address, fax and email to the organizing committee. Registration should be completed by 30 November 2008. The deadline for submission of abstracts is 17 October 2008. Presented papers will be reviewed and invited for publication in the proceedings of the conference, which will be published after the event.

The registration fee is 75 euros for students and 150 euros for teachers.

Abel Prize 2008

John Griggs Thompson, Jacques Tits (Photo: University of Florida and Jean-François Dars/CNRS Images)

The Norwegian Academy of Science and Letters has decided to award the Abel Prize for 2008 to **John Griggs Thompson** (Graduate Research Professor, University of Florida) and **Jacques Tits** (Professor Emeritus, Collège de France, Paris)

"for their profound achievements in algebra and in particular for shaping modern group theory".

Modern algebra grew out of two ancient traditions in mathematics, the art of solving equations, and the use of symmetry as for example in the patterns of the tiles of the Alhambra. The two came together in late eighteenth century, when it was first conceived that the key to understanding even the simplest equations lies in the symmetries of their solutions. This vision was brilliantly realised by two young mathematicians, Niels Henrik Abel and Evariste Galois, in the early nineteenth century. Eventually it led to the notion of a group, the most powerful way to capture the idea of symmetry. In the twentieth century, the group theoretical approach was a crucial ingredient in the development of modern physics, from the understanding of crystalline symmetries to the formulation of models for fundamental particles and forces.

In mathematics, the idea of a group proved enormously fertile. Groups have striking properties that unite many phenomena in different areas. The most important groups are finite groups, arising for example in the study of permutations, and linear groups, which are made up of symmetries that preserve an underlying geometry. The work of the two laureates has been complementary: John Thompson concentrated on finite groups, while Jacques Tits worked predominantly with linear groups.

Thompson revolutionised the theory of finite groups by proving extraordinarily deep theorems that laid the foundation for the complete classification of finite simple groups, one of the greatest achievements of twentieth century mathematics. Simple groups are atoms from which all finite groups are built. In a major breakthrough, Feit and Thompson proved that every non-elementary simple group has an even number of elements. Later Thompson extended this result to establish a classification of an important kind of finite simple group called an N-group. At this point, the classification project came within reach and was carried to completion by others. Its almost incredible conclusion is that all finite simple groups belong to certain standard families, except for 26 sporadic groups. Thompson and his students played a major role in understanding the fascinating properties of these sporadic groups, including the largest, the so-called Monster.

Tits created a new and highly influential vision of groups as geometric objects. He introduced what is now known as a Tits building, which encodes in geometric terms the algebraic structure of linear groups. The theory of buildings is a central unifying principle with an amazing range of applications, for example to the classification of algebraic and Lie groups as well as finite simple groups, to Kac-Moody groups (used by theoretical physicists), to combinatorial geometry (used in computer science), and to the study of rigidity phenomena in negatively curved spaces. Tits's geometric approach was essential in the study and realisation of the sporadic groups, including the Monster. He also established the celebrated "Tits alternative": every finitely generated linear group is either virtually solvable or contains a copy of the free group on two generators. This result has inspired numerous variations and applications.

The achievements of John Thompson and of Jacques Tits are of extraordinary depth and influence. They complement each other and together form the backbone of modern group theory.

This citation is taken from www.abelprisen.no

Visit the Abel web site: www.abelprisen.no/en/abel.

Under the auspices of the Abel prize and with EMS vice-president Helge Holden (NTNU, Trondheim) as the driving force, a comprehensive web site collecting together the available historical material about Niels Henrik Abel (1802–1829) has been established. It contains:

- The only known painted portrait of Abel.
- A personal biography (by Arild Stubhaug) and a scientific biography (by Christian Houzel).
- Abel's collected works and related material, scanned and available in pdf format.
- Even several of Abel's original handwritten manuscripts.

Moreover, the web site contains biographical and mathematical literature on Niels Henrik Abel and his work (most of it scanned) and photos of Abel memorabilia (monuments, stamps, banknotes, medals and so on).

Have a look and enjoy!

Mathematics Year 2008 in Germany

Günter M. Ziegler (Berlin)

Wissenschaftsjahr 2008

Mathematik
Alles, was zählt

2008 was officially declared a "Mathematics Year" in Germany. This created an unprecedented opportunity to work on the public's view of the subject. Although Mathematics Year 2008 is primarily "a German affair", I believe that a number of the lessons we have learnt in preparing the Year and in promoting it to the media may be of interest to the international readership of the EMS newsletter.

Since 2000, which was a "Year of Physics" in Germany, the German Federal Ministry of Science and Education has dedicated each year to one particular science. Topics have been the natural sciences like biology, chemistry, geology and computer science, and also humanities in 2007. The Science Years in Germany have now acquired a number of well-tested and successful components:

- Big events, among them the opening and closing gala and the week-long "Science Summer".
- Exhibitions, including a large one on the "Science Ship" that travels on the Rhine, Danube and Elbe rivers all summer.
- A major media and public relations campaign.

A fourth component is new for 2008; much more than in previous science years we are working to reach the schools (teachers, parents and thus students).

The motto for Mathematics Year 2008 is "Mathematics. Everything that counts!". The posters and activities for the schools declare: "You're better at math than you think!".

Four partners carry Mathematics Year 2008: besides the Federal Ministry of Science and the "Science in Dialogue" agency (which represents the German Science Foundation and the major research organizations such as the Max Planck Society), there are the Deutsche Telekom Foundation and the German Mathematical Society (DMV). I am acting as the DMV president; it is important to have an official function when communicating with politicians. We have a budget of roughly 7.5 million euro for the year; that sounds like a lot of money but the money is soon gone when you get into professional public relations, organizing big events, etc.

A professional event and advertising agency in Berlin has designed the look of the Year (logo, print and web design), organized the major events and run the editorial (and campaign) office. However, in contrast to the approach of previous years, we insisted on having an additional "contents office" for the media work. This is where we take advantage of expertise from the community, make sure it is represented in the Year, and make sure that there's "math inside" the publications (and that the mathematics is correct). The hope is that when the Year is over, the mathematics content office will keep running as an active platform for promoting mathematics to the public.

The four major partners that run the year have identified several aims that they would like to attain or that they intend to communicate. One is that mathematics is multi-faceted. It does include "learning to calculate" but also much more – mathematics is high-tech, it is art, it is puzzles, etc. Our main message for the year is: "There is lots to discover!". People who think they don't like mathematics haven't seen much of it. Therefore we try to show people sides of mathematics they have not seen yet – or show them aspects that they had not identified as being connected to mathematics.

About one hundred large and small exhibitions all over Germany present different aspects of mathematics: mathematics institutes show historic objects and science centres have developed hands-on objects for children of different age groups (some exhibitions focus on numbers, i.e. where they come from, what they are good for, numbers in nature, numbers in everyday life, lucky numbers and so on). The Mathematical Research Institute Oberwolfach has developed and promoted an exposition "Imaginary", showing singularities of algebraic surfaces and

Opening session, from left to right: Klaus Kinkel, president of the German Telekom Foundation, Federal Minister of Education and Research Annette Schavan, DMV president Günter M. Ziegler, and Gerold Wefer, president of Science in Dialogue

other visually-striking geometric objects, mostly in three dimensions and partly rendered as colourful plots on plexiglass. With the relevant software – free to download – every visitor has the chance to create objects themselves. A major German weekly newspaper (*DIE ZEIT*) has launched a competition for the most beautiful object created on its web site using the Imaginary software.

We frankly and actively admit that doing mathematics is difficult. Don't try to say it's all easy – it is not true and people will not believe you. We rather argue that mathematics is difficult but you need it. Since mathematics is difficult it is interesting for the brightest. We state that mathematics is everywhere – it's just that one often doesn't notice it. This has turned out to be an aspect that the media are very interested in. There are various columns in newspapers and magazines that focus on mathematics in everyday life. One point we stress is that every one of us uses mathematics daily without thinking: when comparing prices of goods, handing over the right amount of cash to a salesperson, knowing how long to park or to travel here and there, etc. The other point we make is that mathematics is hidden in many objects in daily use like iPods (compression techniques), automobiles (aerodynamics, navigation, optimization of electronics), communication, medicine, drug design and even sports (tactical manoeuvres, scoring systems).

We also think it is important to show that not only doing mathematics but also watching mathematics can be fun – for instance as part of film plots. An active group of mathematicians connected to my colleague Konrad Polthier from Free University in Berlin have organized a Mathematics Film Festival with international help. They created a database of mathematics films ranging from famous blockbusters to local low budget productions at universities. They negotiated contracts with film distribution companies under which some major movies have become available for free public viewing occasions. Some fifty people and institutions in Germany have now registered on the database and have consequently announced local film festivals consisting of mathematics films from this database.

Even if only a third of the year is over at the time of writing, there are several lessons that we have learned already:

1. Don't try to teach. There's no hope that people will know more mathematics at the end of the year. If many people think of mathematics as something interesting at the end of the year, we will have been very successful.
2. Images, colours, graphics and photographs are important. Several mathematics calendars were produced for the year, with some great images, and they immediately sold out!
3. Faces are also important. A subject is "abstract" for the media as long as they don't have people to talk to and individuals to write about. For all the press materials, we are presenting and portraying mathematicians "to talk to".
4. Talk to the press. Press releases are one thing but you also have to talk to the key editors about topics that you can present especially for them. My experience is that they are interested!
5. Use professionals. For us, the year is an opportunity to get help and learn from an advertising agency but also from all the other major players. For example, the Deutsche Telekom Foundation has been funding mathematics education projects for years and they are also sponsoring new programs for the education and development of mathematics teachers.
6. Make it a community effort. We are working hard to get hundreds of people from all over Germany involved, inviting people to become "math makers" for the Year. This is the only way to have activities all over the country. A "top down" campaign cannot have a broad effect. 560 people had already been registered as "math makers" by the end of April.
7. Use the opportunities. The physics community (represented by the German Physics Society) profited a lot from the Year of Physics 2000 and used it to build infrastructure, enlarge their membership base and professionalize their web, print and media appearance. Mathematicians all over Germany are working hard to grab the opportunities.

Swimming science center with a math exhibition

This is my personal, preliminary collection of lessons learned. It might be revised in the course of the year. Still, many different people and groups and most of the media are stating that the Year of Mathematics in Germany is already a success. It is worth the effort and I would like to encourage mathematicians in Europe to start similar projects. If such opportunities arise for greater, national visibility for mathematics projects then grab them.

A huge campaign like the German Mathematics Year of course takes a lot of effort but it definitely seems to be worth that effort. We've made a major try and have got some major aspects right but we are also eager to learn in the process. Thus, your comments are very welcome!

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Combinatorial Algebraic Topology

Dmitry N. Kozlov (Bremen, Germany)

1 Introduction

Combinatorial Algebraic Topology is a contemporary mathematical discipline which transcends several classical branches of study. Discrete mathematics and algebraic topology should perhaps be mentioned in the first batch, but further connections exist to such areas as algebra and category theory. Outside of classical mathematics there are important applications as well – we mention here connections to theoretical computer science, via complexity theory, and to vision recognition, via point cloud data and persistent homology.

The dramatis personae of Combinatorial Algebraic Topology are cell complexes which are combinatorial both *locally* and *globally*. Being combinatorial locally is a well-studied feature in algebraic topology. It means that the cell attachment maps can be described by discrete data rather than by arbitrary continuous maps. Often one simply considers simplicial complexes, but also more intricate constructions exist. Being combinatorial globally is a feature more intrinsic to Combinatorial Algebraic Topology. Expressed succinctly, it means that the cells are indexed by combinatorial objects and that the cell attachments are encoded by some combinatorial rules, or more generally by algorithms, applied to the combinatorial objects which index the involved cells.

The main aspiration of the subject is then to understand how the *algebraic invariants* of such combinatorial cell complexes, e.g., their Betti numbers, *depend on the discrete data*. At best one may be able to completely describe these algebraic structures in the language of combinatorics; either by using existing gadgets, such as matroids, or by inventing new ones. The mechanisms of computation themselves are sometimes purely combinatorial – such as clever machinations with labellings, orderings, and the like. When these fail, adaptations of central methods of computation used in algebraic topology, such as spectral sequences, can be tried.

Rather than risking to confuse the reader with too many general words, we have chosen to present our subject by means of three examples. In the first one we show how discrete methods can be used in existing topological situations. In the second one the tables are turned: Topological constructions are used to gain knowledge about discrete objects. The last example highlights connections between algebraic topology and complexity theory.

2 Goresky-MacPherson formula in arrangement theory

Combinatorial Algebraic Topology can help to analyze topological spaces which are important elsewhere *if* the invariants of the spaces which we would like to compute are completely determined by the combinatorial data. When they are, we often end up having a meaningful and deep connection between topology and combinatorics.

One representative case is determining some of the most important invariants, i.e., the cohomology groups of certain spaces related to arrangements. To start with recall that a *subspace arrangement* is a collection $\mathscr{A} = \{A_1, \ldots, A_n\}$ of finitely many linear subspaces in $\mathbf{k}^d$, where $\mathbf{k} = \mathbb{R}$ or $\mathbf{k} = \mathbb{C}$, such that $A_i \not\supseteq A_j$ for $i \neq j$. One of the spaces related to such an arrangement is its complement $\mathscr{M}_{\mathscr{A}} := \mathbf{k}^d \setminus \bigcup_{i=1}^n A_i$ whose algebraic invariants are of interest in various applications in such areas as algebraic geometry and singularity theory.

A classical example is obtained by taking the special hyperplane arrangement $\mathscr{A}_{d-1}$, called the *braid arrangement*, consisting of all hyperplanes $x_i = x_j$, for $1 \leq i < j \leq d$. The complement of the braid arrangement $\mathscr{A}_{d-1}$ in $\mathbb{R}^d$ consists of $d!$ contractible pieces, indexed by all possible orderings of the coordinates.

The combinatorial data which is standardly associated to an arbitrary subspace arrangement $\mathscr{A}$ is the so-called *intersection lattice* $\mathscr{L}_{\mathscr{A}}$, which is the set

$$\left\{ K_I = \bigcap_{i \in I} A_i, \text{ for } I \subseteq \{1, \ldots, n\} \right\} \cup \{\mathbf{k}^d\}$$

with the order given by reversing inclusions: $x \leq_{\mathscr{L}_{\mathscr{A}}} y$ if and only if $x \supseteq y$. In particular, the minimal element of $\mathscr{L}_{\mathscr{A}}$ is $\mathbf{k}^d$, denoted $\hat{0}$, and the maximal element is $\bigcap_{K_I \in \mathscr{A}} K_I$. For example, in the case of the braid arrangement, the intersection lattice is the so-called *partition lattice* Π_d. This is the lattice whose elements are indexed by set partitions of $\{1, \ldots, n\}$, with the partial order given by refinement.

It was discovered by Goresky and MacPherson, as a corollary of their Stratified Morse theory, see [GoM88], that the cohomology groups of the complement of a subspace arrangement $\mathscr{A}$ are determined by the combinatorial data $\mathscr{L}_{\mathscr{A}}$:

Theorem 2.1. (Goresky-MacPherson)
For an arbitrary subspace arrangement $\mathscr{A}$ we have

$$\widetilde{H}^i(\mathscr{M}_{\mathscr{A}}) \cong \bigoplus_{x \in \mathscr{L}_{\mathscr{A}}^{\geq \hat{0}}} \widetilde{H}_{\operatorname{codim}_{\mathbb{R}}(x) - i - 2}(\Delta(\hat{0}, x)),$$

where $\Delta(\hat{0}, x)$ denotes the nerve of the interval in $\mathscr{L}_{\mathscr{A}}$ viewed as a category.

The last words of Theorem 2.1 need a little explanation. As defined, $\mathscr{L}_{\mathscr{A}}$ is a partially ordered set, hence so is the interval $(\hat{0}, x)$. The latter consists of all elements y of $\mathscr{L}_{\mathscr{A}}$, such that $\hat{0} < y < x$, equipped with the partial order induced from the one on $\mathscr{L}_{\mathscr{A}}$. Any poset P can be seen as a category whose elements are the elements of P, with a unique morphism from x to y, for $x, y \in P$, whenever $x \geq y$. The transitivity of the partial order guarantees the existence of the composition and the fulfilment of the associativity axiom.

There is a standard way to associate a topological space, in fact, even a structure of a simplicial set, to any category, which is called the *nerve* of that category. In the special case

of a poset we get a simplicial complex, the so-called *order complex*, whose vertices are the elements of the poset, and whose simplices are all chains (fully ordered subsets) of P. There are many combinatorial tools to determine cohomology groups of an order complex of a poset. Thus, in particular, Theorem 2.1 means that the cohomology groups of the complements of specific, combinatorially defined arrangements can often be found by purely discrete methods.

One can turn a real subspace arrangement $\mathscr{A}$ into a complex one $\mathscr{A}^{\mathbb{C}}$ by taking the linear subspaces in $\mathbb{C}^d$ defined by the *same* equations as those in $\mathscr{A}$. Certainly, this new complexified arrangement has the same intersection lattice. We therefore obtain a curious corollary:

Proposition 2.2. *For any real subspace arrangement, the sum of Betti numbers of its complement is equal to the sum of Betti numbers of the complement of its complexification.*

As an example, the complement of an arbitrary real hyperplane arrangement is just the union of the pieces into which the hyperplanes cut the Euclidean space, each of these is contractible. Proposition 2.2 implies that the sum of the Betti numbers of the complement of the complexification of a real hyperplane arrangement is equal to the number of these pieces. For instance, as explained above , the sum of the Betti numbers of the complement of the real braid arrangement is equal to $d!$, and hence, Proposition 2.2 implies that the sum of the Betti numbers of the complement of the complex braid arrangement is equal to $d!$. The latter is an interesting and important topological space studied in particular by Arnold, [Ar69].

Of course the relation of arrangement theory to combinatorics is by no means exhausted by the Goresky-MacPherson formula. For example, a famous result of Orlik and Solomon connects the cohomology algebra of the complement of a hyperplane arrangement to the theory of matroids, see [OS80]. Also the study by DeConcini and Procesi, see [DP95], of resolutions of singularities for a collection of divisors, whose intersections are locally arrangements, leads to subtle and interesting combinatorics of nested sets, see [Fei05, FK04, FK05].

One other notable situation is that of toric varieties where similiar ideas provide connections between algebraic and polyhedral geometry, see [Fu93, MS05].

3 Graph homomorphisms and characteristic classes

Let us now describe one of the many situations in which algebraic topology can be of use for questions in discrete mathematics.

A central notion in combinatorics is that of a graph. For two graphs T and G, a *graph homomorphism* from T to G is a set map between vertex sets $\varphi : V(T) \to V(G)$, such that if $x, y \in V(T)$ are connected by an edge, then $\varphi(x)$ and $\varphi(y)$ are also connected by an edge. An important special case is provided by considering a graph homomorphism to a *complete* graph $\varphi : G \to K_n$, which is the same as a vertex coloring of G with n colors. In particular, the *chromatic number* of G, denoted $\chi(G)$, is the minimal n, such that there exists a graph homomorphism $\varphi : G \to K_n$. It is an important, but difficult task to compute or to estimate chromatic numbers of graphs. We mention the notorious 4-coloring theorem as an example.

The topological approach to graph colorings was pioneered by László Lovász (who is the current IMU President and has turned 60 this year). In 1978 he used homotopy theory to tackle the problem of determining chromatic numbers of Kneser graphs, see [Lov78] for details, and also [dL03] for a nice historical account. Recall that the Kneser graphs are the graphs defined as follows: for fixed k and n, vertices of the corresponding Kneser graph are indexed by all k-element subsets of $[n]$, and two vertices are connected by an edge if the indexing subsets are disjoint.

We note that if $\varphi : T \to G$ and $\psi : G \to H$ are graph homomorphisms, then the composition $\psi \circ \varphi : T \to H$ is again a graph homomorphism, and, since identity maps are also graph homomorphisms, it follows that graphs together with graph homomorphisms form a category called **Graphs**.

More recently it was realized that the set of all graph homomorphisms between graphs T and G can be enriched to form a topological space $\mathtt{Hom}(T,G)$, see [BK06] for details. The construction can be rephrased as follows: let $\Delta^{V(G)}$ be a simplex whose set of vertices is $V(G)$, and let $C(T,G)$ denote the direct product $\prod_{x \in V(T)} \Delta^{V(G)}$, i.e., the copies of $\Delta^{V(G)}$ are indexed by vertices of T.

Definition 3.1. *The complex* $\mathtt{Hom}(T,G)$ *is the subcomplex of* $C(T,G)$ *defined by the following condition:* $\sigma = \prod_{x \in V(T)} \sigma_x \in \mathtt{Hom}(T,G)$ *if and only if for any* $x, y \in V(T)$*, if* $(x,y) \in E(T)$*, then* (σ_x, σ_y) *is a complete bipartite subgraph of* G*.*

Here a complete bipartite subgraph of a graph G is a pair (A,B) of subsets (not necessarily disjoint) of the set of vertices of G, such that any vertex from A is connected by an edge to any vertex from B. An example of the cell complex of all 3-colorings of a 6-cycle is given in Figure 1. The reader should note that several quadrangles have been omitted for the sake of transparency. There should be three maximal quadrangles attached to the grey vertex (only the two shaded ones are shown); the same is the case at the other five vertices at which the maximal cubes touch each other. In total, there are 18 quadrangles which are not part of higher-dimensional cells.

The topology of $\mathtt{Hom}(T,G)$ is inherited from the product topology of $C(T,G)$, in particular, the cells of $\mathtt{Hom}(T,G)$ are products of simplices. It turned out that when T is an odd cycle (a polygon) C_{2r+1}, the topology of this space is related to the chromatic number of G. This is the content of the next theorem, which was proved in [BK04].

Theorem 3.2. (Lovász Conjecture).
For an arbitrary graph G*, and any integers* r *and* k*, such that* $r \geq 1$*,* $k \geq -1$*, we have the following implication:*
if the complex $\mathtt{Hom}(C_{2r+1}, G)$ *is* k*-connected, then* $\chi(G) \geq k+4$*.*

Perhaps a useful way of thinking about this and similar results is to view it as a test: the (higher) connectivity of a certain topological space is being tested, and if that quantity is possible to compute (which of course depends heavily on the space) it provides some information on the chromatic number.

Whenever a loopfree graph T possesses an involution which flips an edge, the topological space $\mathtt{Hom}(T,G)$ has a

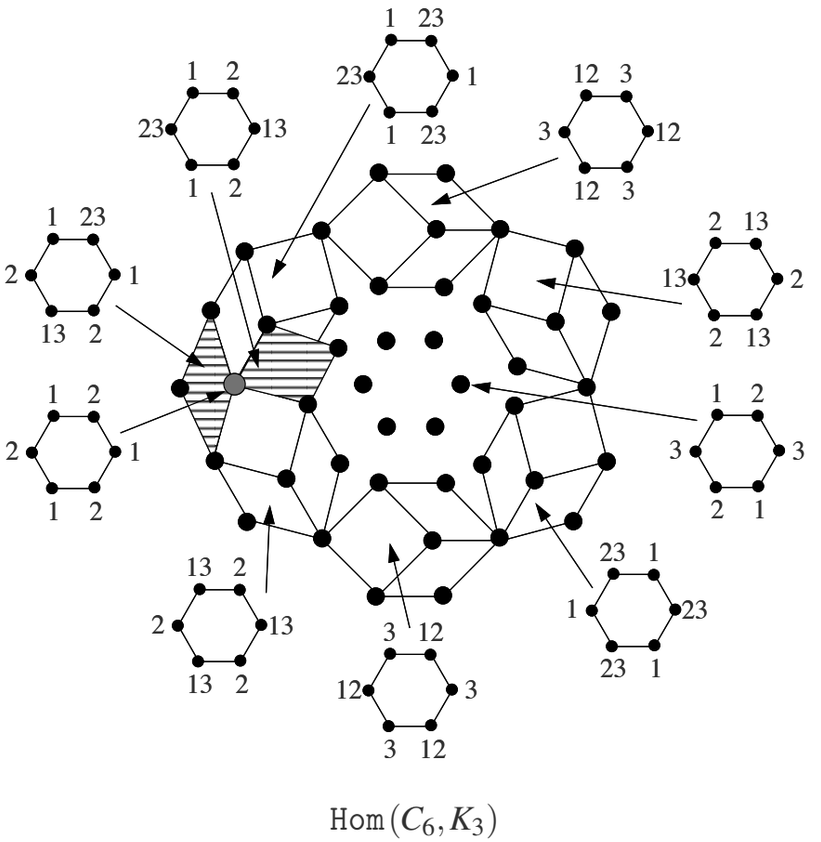

Figure 1. (Essential parts of) the complex $\mathrm{Hom}(C_6, K_3)$

free involution. This allows us to talk about the Stiefel–Whitney characteristic classes in the cohomology of that space, see [Ko05a]. It is an intriguing fact that the chromatic number of G is in fact related to the vanishing of the powers of this characteristic class, and the Lovász Conjecture is one of the indications of that. These connections can be analysed directly, or by using spectral sequences, we refer to [Ko07, Ko05b] for further details.

4 A topological approach to evasiveness

In the last section we would like to illustrate ties which exist between Combinatorial Algebraic Topology and theoretical computer science, more specifically – complexity theory.

Let us fix n and consider the set of *all* graphs with n vertices. A particular graph is then characterized by the set $E(G)$ considered as a subset of the set of ordered pairs $\{(i,j) \mid 1 \leq i < j \leq n\}$. Recall that a graph property is called *monotone* if the set of graphs which satisfy this property is closed under removal of edges; examples include planarity and the property of being disconnected. Given such a monotone property $\mathscr{G}$, we can construct a simplicial complex $\Delta(\mathscr{G})$ by taking ordered pairs (i,j), for $1 \leq i < j \leq n$, as vertices, and saying that a set of such pairs forms a simplex in $\Delta(\mathscr{G})$ if the corresponding graph has the property $\mathscr{G}$.

Let us now consider the following algorithmic situation. We are given a certain graph property $\mathscr{G}$, which we know, and a certain graph G, which we do not know. However, we can ask the *oracle* questions of the type: *Is the edge* (i,j) *in* G*?* Our task is to decide whether the graph G satisfies the property $\mathscr{G}$ or not. We would like to ask as few questions as possible. More precisely, we are interested in knowing the so-called *worst-case complexity*, that is: how many questions do we have to ask in the worst case scenario? For example, if the graph property is trivial (meaning that either no graphs or all graphs satisfy it), then we do not need to ask any questions at all. On the other hand, if the property is being a complete graph, then we might be forced into asking $\binom{n}{2}$ questions: this would happen if the answers to the first $\binom{n}{2} - 1$ questions are all positive.

Definition 4.1. *A graph property $\mathscr{G}$ of graphs on n vertices is called* **evasive***, if we need to ask $\binom{n}{2}$ questions in the worst case in the course of the algorithm described above; otherwise, we say that $\mathscr{G}$ is* **nonevasive**.

Certainly not all non-trivial properties are evasive. Consider for example the property of being a so-called *scorpion graph*. Here a graph G on n vertices is called a scorpion graph if it has 3 vertices s, t, and b, such that

(1) the vertex s, called the *sting*, is only connected to vertex t,
(2) the vertex t, called the *tail*, is only connected to vertices s and b,
(3) the vertex b, called the *body*, is connected to all vertices, but s.

This notion is illustrated on Figure 2. It is a nice exercise in complexity theory to verify that this property is actually nonevasive.

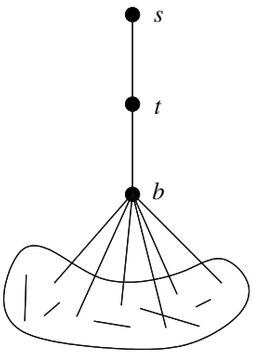

Figure 2. An example of a scorpion graph

Clearly, if an edge is removed from a scorpion graph, the obtained graph does not have to be a scorpion graph anymore: being a scorpion graph is not a monotone graph property. In fact, the following is perhaps the most important open question pertaining to evasiveness of graphs.

Conjecture 4.2. (Evasiveness Conjecture, also known as Karp Conjecture)
Every nontrivial monotone graph property for graphs on n vertices is evasive.

It is mind-boggling that so far, the Evasiveness Conjecture has been verified in the case when n is a prime power, and, additionally, when $n = 6$, using topological techniques only; see [KSS84]. The proof in these cases relies on the interplay of algebraic invariants of the complex $\Delta(\mathscr{G})$ mentioned above and the action of the symmetry group $\mathscr{S}_n$ and its subgroups. It is difficult to imagine that whether n is a prime power or not is essential for the validity of the Evasiveness Conjecture, and it is still not understood what topology has to do with it.

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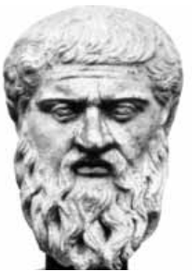
On Platonism

Reuben Hersh (University of New Mexico, USA)



"Platonism" can mean a lot of different things. Even "Platonism in mathematics" can mean a lot of different things. In my writings on the philosophy of mathematics, I have been concerned about the philosophical stance or preconceptions of practicing mathematicians, whether explicitly formulated or not. As I have written, this usually involves some choice or combination or alternation of "formalism" and "Platonism", both of them in rough-and-ready, naïve versions. Their "Platonism" says mathematical objects exist independently of our knowledge or activity, and mathematical truth is objective, with the same status as scientific truth about the physical world. This may be boiled down to the phrase "out there." That's where mathematical entities are, meaning, not "in here."

As for "formalism", that is taken to mean that math is no more than logical deduction from formally stated "axioms," so that the "facts" about mathematical objects are nothing more than statements that one formal sentence follows logically from some other formal sentence; there is no "meaning" or "reference," just logical manipulation of logical formulas.

These two points of view are incompatible, yet it seems that most mathematicians oscillate between the two. My purpose in writing about this has been to argue that both notions are false. Formalism is wildly incompatible with the actual practice of mathematics, whether in research or in teaching. Platonism is incompatible with the standard view of the nature of reality, as held by the majority of scientists and mathematicians: there is only one universe, one real world, which is physical reality, including its elaboration into the realm of living things, and elaborated from there into the realm of humankind with its social, cultural, and psychological aspects. I have argued that these social, cultural and psychological aspects of humankind are real, not illusory or negligible, and that the nature of mathematical truth and existence is to be understood in that realm, rather than in some other independent "abstract" reality.

My view of Platonism – always referring to the common, every-day Platonism of the typical working mathematician – is that it expresses a correct recognition that there are mathematical facts and entities, that these are not subject to the will or whim of the individual mathematician but are forced on him as objective facts and entities which he must learn about and whose independent existence and qualities he seeks to recognize and discover. The fallacy of Platonism is in the misinterpretation of this objective reality, putting it outside of human culture and consciousness. Like many other cultural realities, it is external, objective, *from the viewpoint of any individual*, but internal, historical, socially conditioned, *from the viewpoint of the society or the culture as a whole*.

(One might note, in passing, that other socio-cultural phenomena, like the divine right of kings, the innate natural inferiority of slaves, etc etc have also been regarded for centuries as part of the objective order of the Universe.)

The recent article by Davies[1] declares death to Platonism, on the grounds of neurophysiological discoveries about arithmetical and geometrical thinking. Researchers are now able to observe blood flow into specific sections of the brain associated with various mental processes, including mathematical ones. These discoveries add a lot of empirical weight to our previous general belief, that thinking is something that happens mostly in the brain. What new philosophical insights do we gain? Well, Platonism requires some mental faculty by which the mathematician can connect to the abstract external non-physical realm where the objects he is studying are supposed to exist. This faculty can be labeled "intuition," but such a label is not an explanation. In fact, the dualism that is forced by Platonism – the division of reality into two realms, one physical, including the brain of the mathematician, and the other "abstract," "out there," neither physical nor social nor psychological, just "abstract" and "out there" – is a fatal flaw, much the same as the flaw in Descartes' dualism of mind and matter. It seems that Davies regards the evidence that thinking takes place in the brain as proof that there is no such "intuition", in the sense of a special mental faculty for connecting to "out there." But with or without neurophysiological evidence, it is pretty clear that the posited "intuition" is an ad hoc artifact, lacking any specificity or clear description, let alone empirical evidence. It is nothing more than something that, for the Platonist, "has to" be available to the mathematician, since he/she evidently is able to discover mathematical facts, and these facts are "out there," not "in here."

If by Platonism one simply means the rejection of formalism – the conviction that the things we are studying are real, and that they have objective properties which we can discover – then there is no doubt that this conviction is supportive, indeed perhaps even necessary, for mathematical research. While one is proving a theorem or finding a counterexample, one is not in the mode of considering the statement of the theorem or counterexample meaningless! But it is not necessary, either logically or psychologically, to locate this meaning in some eternal, inhuman, abstract reality.

I once took a vote in a talk at New Mexico State University in Las Cruces. The question was, "Was the spectral theorem on self-adjoint operators in Hilbert space true before the Big Bang, before there was a universe?" The vote was yes, by a margin of 75 to 25. But there were no self-adjoint operators, no Hilbert space, before the twentieth century! So no statement about them could be true or false or meaningful (it could not *refer* to anything) before these concepts had been established in the consciousness of mathematicians. However, it is true that mathematical

[1] Let Platonism die, EMS-Newsletter 64 (2007), 24–25.

theories like the theory of self-adjoint operators in Hilbert space, while they come into existence historically (and can even go out of existence historically) *are* time-independent, in the sense that they do not refer to or in their content include or make note of any non-mathematical, external data, including the particular century of their birth. We construct mathematics without reference to non-mathematical data, including spatial (in what country was the mathematician who proved the theorem?) and temporal. The spectral theorem's content or reference excludes any spatial-temporal data of ordinary daily life.

I have compared this to a movie, which we know is just shadows and colors projected on a screen. This factual knowledge in no way conflicts with seeing the movie as it is intended to be seen, as a (fictional) reality which we fully understand, participate in, and can reason about. There are objective facts relating to the *content* of the movie, without relegating it to an abstract realm "out there." At the same time, the movie has a *physical reality* in terms of lights and shadows, and cannot exist except on the basis of this or some other comparable physical reality. Similarly, the content of mathematical theorems and concepts is real, we do have reliable knowledge of it. That content is part of human culture and consciousness, and is contingent on the existence and activity of the species *homo sapiens*. With this understanding, full acceptance and acknowledgment of the reality and meaningfulness of mathematics does not contradict or conflict with the ordinary scientific view of reality. The mental, social and cultural, including the mathematical, are grounded in the physical – the flesh and blood of past and present humans, especially mathematicians. We can recognize this, even while the detailed nature of this grounding – just how our thoughts are carried out by our brains – may never be completely understood.

The puzzle for us to resolve is the universality of mathematics. Unlike other cultural realms, there is a universality or commonality of mathematical facts – the "laws" of arithmetic, for instance – which is strikingly different from the great variations in other cultural realms – language, religion, music, family structure, etc, in different cultures around the world. Why is this? Well, to begin with, the facts of elementary arithmetic, the small natural numbers, are physical facts, they describe the behavior of collections of stable, non-interacting, discrete objects like coins or buttons. These are as independent of culture as other parts of physics, like the fact that a stone will fall to the ground. The ability to develop logical consequences also seems to be to a great extent culture – independent, which suggests a possible basis in our brain structures, just as linguists have postulated some basis in our brain structures for the universal features that all human languages seem to share. Certainly, along with physical reality, we must consider the special features of the human brain, if we want to understand more deeply the nature of mathematics. This is a major project for empirical science – not for philosophy! From this point of view, the facts presented by Davies are relevant and interesting. They do not refute Platonism, they are part of the scientific program that one focuses on after rejecting Platonism.

To put the matter as simply as possible: everyone agrees that mathematics is a historically derived cultural activity. I say, there is no need to give it any other "metaphysical" description. As a cultural activity it has certain puzzling features: its seeming "certainty," and "universality." Platonists account for this puzzle by postulating a special existential realm, with matching mental faculty ("intuition"). They simply disregard the strange incompatibility of such a realm and faculty with our common understandings of both philosophy of science and philosophy of mind. I consider it more promising to regard the nature of mathematics as a problem for a multi-disciplinary empirical investigation, analogous, for example, to the nature of language, where an empirical science, linguistics, is thriving. The best example of such investigation is the fascinating work of Stanislas Dehaene [D]. My recent edited book was intended as a contribution to this enterprise [H1].

My most persistent opponent has been Martin Gardner, who is a theist, a believer in the efficacy of prayer, and who has declared that I am on the "slippery slope" to solipsism (in one review) and to Stalinism (in another review). Others have seen a resemblance to Jung's "collective unconscious". I see nothing Jungian here, but Jungianism is not so bad, compared to solipsism and Stalinism! I have also been honored by a critique from William Tait, who is described on the jacket of his book as "one of the most eminent philosophers of mathematics of his generation" [T]. He finds my description of Platonism rather ridiculous, and seems not to know the difference between my saying what some other people seem to think and saying what I myself think. (He proposes a distinction between "realism" and what he calls "hyperrealism." "Realism" is OK, says William Tait. The absurdities of Platonism, he explains, are attributes of "hyperrealism.")

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Reuben Hersh [rhersh@math.unm.edu] has published research on partial differential equations, random evolutions, and probability. He lives in Santa Fe, New Mexico, in the USA. He was a student of Peter Lax, and a co-author with Phil Davis, Martin Davis, Paul Cohen, Richard J. Griego, Jim Donaldson, Tosio Kato, George Papanicolaou, Mark Pinsky, Priscilla Greenwood, and others. With Vera John-Steiner, he has a forthcoming book entitled "Loving and Hating Mathematics: Inside Mathematical Life."

Mathematical Platonism and its Opposites

Barry Mazur (Harvard University, Cambridge MA, USA)

We had the sky up there, all speckled with stars, and we used to lay on our backs and look up at them, and discuss about whether they was made or only just happened – Jim he allowed they was made, but I allowed they happened; I judged it would have took too long to make so many.

mused Huckleberry Finn. The analogous query that mathematicians continually find themselves confronted with when discussing their art with people who are not mathematicians is:

Is mathematics discovered or invented?

I will refer to this as *The Question*, acknowledging that this five-word sentence, ending in a question mark – and phrased in far less contemplative language than that used by Huck and Jim – may open conversations, but is hardly more than a token, standing for puzzlement regarding the status of mathematics.

If you engage in mathematics long enough, you bump into The Question, and it won't just go away.[1] If we wish to pay homage to the passionate felt experience that makes it so wonderful to think mathematics, we had better pay attention to it.

Some intellectual disciplines are marked, even scarred, by analogous concerns. Anthropology, for example has a vast, and dolefully introspective, literature dealing with the conundrum of whether we can ever avoid – wittingly or unwittingly – clamping the templates of our own culture onto whatever it is we think we are studying: how much are we discovering, how much inventing?

Such a discovered/invented perplexity may or may not be a burning issue for other intellectual pursuits, but it burns exceedingly bright for mathematics, and with a strangeness that isn't quite matched when it pops up in other fields. For example, if you were to say "Priestley discovered oxygen but Lavoisier invented it" I think I know roughly what you mean by that utterance, without our having to synchronize our private vocabularies terribly much. But to intelligently comprehend each other's possibly differing attitudes towards circles, triangles, and numbers, we would also have to come to some – albeit ever-so-sketchy – understanding of how we each view, and talk about, a lot more than mathematics.[2]

For me, at least, the anchor of any conversation about these matters is the experience of doing mathematics, and of groping for mathematical ideas. When I read literature that is ostensibly about The Question, I ask myself whether or not it connects in any way with my felt experience, and even better, whether it reveals something about it. I'm often – perhaps always – disappointed. The bizarre aspect of the mathematical experience – and this is what gives such fierce energy to The Question – is that one feels (I feel) that mathematical ideas can be hunted down, and in a way that is essentially different from, say, the way I am currently hunting the next word to write to finish this sentence. One can be a hunter and gatherer of mathematical concepts, but one has no ready words for the location of the hunting grounds. Of course we humans are beset with illusions, and the feeling just described could be yet another. There may be no location.

There are at least two standard ways of – if not exactly answering, at least – fielding The Question by offering a vocabulary of *location*. The colloquial tags for these locations are *In Here* and *Out There* (which seems to me to cover the field).

The first of these standard attitudes, the one with the logo *In Here* – which is sometimes called the Kantian (poor Kant!) – would place the source of mathematics squarely within our faculties of understanding. Of course faculties (Vermögen) and understanding (Verstand) are loaded eighteenth century words and it would be good – in this discussion at least – to disburden ourselves of their baggage as much as possible. But if this camp had to choose between discovery and invention, those two too-brittle words, it would opt for *invention*.

The "Out There" stance regarding the discovery/invention question whose heraldic symbol is Plato (poor Plato!) is to make the claim, starkly, that mathematics is the account we give of the timeless architecture of the cosmos. The essential mission, then, of mathematics is the accurate description, and exfoliation, of this architecture. This approach to the question would surely pick *discovery* over invention.

Strange things tend to happen when you think hard about either of these preferences.

For example, if we adopt what I labelled the Kantian position we should keep an eye on the stealth word "our" in the description of it that I gave, hidden as it is among behemoths of vocabulary (Vermögen, Verstand). Exactly *whose* faculties are being described? Who is the *we*? Is the we meant to be each and every one of us, given our separate and perhaps differing and often faulty faculties? If you feel this to be the case, then you are committed to viewing the mathematical enterprise to be as variable as humankind. Or are you envisioning some sort of distillate of all actual faculties, a more transcendental faculty, possessed by a kind of universal or ideal we, in which

[1] Garrison Keillor, a wonderful radio raconteur has in his repertoire a fictional character, Guy Noir, who tangles indefatigably with "life's persistent questions." This is all to the good. We should pay particular honour to the category of persistent questions even though – or, especially because – those are the chestnuts that we'll never crack.

[2] For a start: you and I turn adjectives into nouns (red cows → red; five cows → five) with only the barest flick of a thought. What is that flick? Understanding the differences in our sense of what is happening here may tell us lots about our differences regarding matters that can only be discussed with much more mathematical vocabulary.

case the Kantian view would seem to merge with the Platonic.[3]

If we adopt the Platonic view that mathematics is discovered, we are suddenly in surprising territory, for this is a full-fledged theistic position. Not that it necessarily posits a god, but rather that its stance is such that the only way one can adequately express one's faith in it, the only way one can hope to persuade others of its truth, is by abandoning the arsenal of rationality, and relying on the resources of the prophets.

Of course, professional philosophers are in the business of formulating anti-metaphysical or metaphysical positions, decorticating them, defending them, and refuting them.[4] Mathematicians, though, may have another – or at least a prior – duty in dealing with The Question. That is, to be meticulous participant/observers, faithful to the one aspect of The Question to which they have sole proprietary rights: their own imaginative experience. What, precisely, describes our inner experience when we (and here the *we* is you and me) grope for mathematical ideas? We should ask this question open-eyed, allowing for the possibility that whatever it is we experience may delude us into fabricating ideas about some larger framework, ideas that have no basis.[5]

I suspect that many mathematicians are as unsatisfied by much of the existent literature about The Question as I am. To be helpful here, I've compiled a list of Do's and Don't's for future writers promoting the Platonic or the Anti-Platonic persuasions.

For the Platonists

One crucial consequence of the Platonic position is that it views mathematics as a project akin to physics, Platonic mathematicians being – as physicists certainly are – describers or possibly predictors – not, of course, of the physical world, but of some other more noetic[6] entity. Mathematics – from the Platonic perspective – aims, among other things, to come up with the most faithful description of that entity.

This attitude has the curious effect of reducing some of the urgency of that staple of mathematical life: *rigorous proof*. Some mathematicians think of mathematical proof as the certificate guaranteeing trustworthiness of, and formulating the nature of, the building-blocks of the edifices that comprise our constructions. Without proof: no building-blocks, no edifice. Our step-by-step articulated arguments are the devices that some mathematicians feel are responsible for bringing into being the theories we work in. This can't quite be so for the ardent Platonist, or at least it can't be so in the same way that it might be for the non-Platonist. Mathematicians often wonder about – sometimes lament – the laxity of proof in the physics literature. But I believe this kind of lamentation is based on a misconception, namely the misunderstanding of the fundamental function of *proof* in physics. Proof has principally (as it should have, in physics) a rhetorical role: to convince others that your description holds together, that your model is a faithful *re*-production, and possibly to persuade yourself of that as well. It seems to me that, in the hands of a mathematician who is a determined Platonist, proof could very well serve primarily this kind of rhetorical function – making sure that the description is on track – and not (or at least: not necessarily) have the rigorous theory-building function it is often conceived as fulfilling.

My feeling, when I read a Platonist's account of his or her view of mathematics, is that unless such issues regarding the nature of proof are addressed and conscientiously examined, I am getting a superficial account of the philosophical position, and I lose interest in what I am reading.

But the main task of the Platonist who wishes to persuade non-believers is to learn the trade, from prophets and lyrical poets, of how to communicate an experience that transcends the language available to describe it. If all you are going to do is to chant credos synonymous with "the mathematical forms are out there," – which some proud essays about mathematical Platonism content themselves to do – well, that will not persuade.

For the Anti-Platonists

Here there are many pitfalls. A common claim, which is meant to undermine Platonic leanings, is to introduce into the discussion the theme of *mathematics as a human, and culturally dependent pursuit* and to think that one is actually conversing about the topic at hand. Consider this, though: If the pursuit were *writing a description of the Grand Canyon* and if a Navajo, an Irishman, and a Zoroastrian were each to set about writing their descriptions, you can bet that these descriptions will be culturally-dependent, and even dependent upon the moods and education and the language of the three describers. But my having just recited all this relativism regarding the three descriptions does not undermine our firm faith in the existence of the Grand Canyon, their common focus. Similarly, one can be the most ethno-mathematically

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[3] A more general lurking question is exactly how we are to view the various ghosts in the machine of Kantian idealism – for example, who exactly is that little-described player haunting the elegant concept of *universally subjective judgments* and going under a variety of aliases: *the sensus communis* or the *allgemeine Stimme*?

[4] A very useful – and to my mind, fine – text that does exactly this type of lepidoptery is Mark Balaguer's *Platonism and Anti-Platonism in Mathematics*, Oxford Univ. Press (1998).

[5] When I'm working I sometimes have the sense – possibly the illusion – of gazing on the bare platonic beauty of structure or of mathematical objects, and at other times I'm a happy Kantian, marvelling at the generative power of the intuitions for setting what an Aristotelian might call the *formal conditions of an object.* And sometimes I seem to straddle these camps (and this represents no contradiction to me). I feel that the intensity of this experience, the vertiginous imaginings, the leaps of intuition, the breathlessness that results from "seeing" but where the sights are of entities abiding in some realm of ideas, and the passion of it all, is what makes mathematics so supremely important for me. Of course, the realm might be illusion. But the experience?

[6] "inner knowing", a kind of intuitive consciousness – direct and immediate access to knowledge beyond what is available to our normal senses and the power of reason.

conscious mathematician on the globe, claiming that all our mathematical scribing is as contingent on ephemeral circumstance as this morning's rain, and still one can be the most devout of mathematical Platonists.

Now this pitfall that I have just described is harmless. If I ever encounter this type of mathematics-is-a-human-activity argument when I read an essay purporting to defuse, or dispirit, mathematical Platonism I think to myself: human activity! what else could it be? I take this part of the essay as being irrelevant to The Question.

A second theme that seems to have captured the imagination of some anti-Platonists is recent neurophysiological work – a study of blood flow into specific sections of the brain – as if this gives an insider's view of things.[7] Well, who knows? Neuro-anatomy and chemistry have been helpful in some discussions, and useless in others. To show this theme to be relevant would require a precisely argued explanation of exactly how *blood flow* patterns can refute, or substantiate, a Platonist – or any – disposition. A satisfying argument of that sort would be quite a marvel! But just slapping the words *blood flow* – as if it were a poker-hand – onto a page doesn't really work.

Sometimes the mathematical anti-Platonist believes that headway is made by showing Platonism to be unsupportable by rational means, and that it is an incoherent position to take when formulated in a propositional vocabulary.

It is easy enough to throw together propositional sentences. But it is a good deal more difficult to capture a Platonic disposition in a propositional formulation that is a full and honest expression of some flesh-and-blood mathematician's view of things. There is, of course, no harm in trying – and maybe a good exercise. But even if we cleverly came up with a proposition that is up to the task of expressing Platonism formally, the mere fact that the proposition cannot be demonstrated to be true won't necessarily make it vanish. There are many things – some true, some false – unsupportable by rational means. For example, if you challenge me to support – by rational means – my claim that I dreamt of Waikiki last night, I couldn't.

So, when is there harm? It is when the essayist becomes a *leveller*. Often this happens when the author writes extremely well, super coherently, slowly withering away the Platonist position by – well – the brilliant subterfuge of making the whole discussion boring, until I, the reader, become convinced – albeit momentarily, within the framework of my reading the essay – that there is no "big deal" here: the mathematical enterprise is precisely like any other cultural construct, and there is a fallacy lurking in any claim that it is otherwise. The Question is a non-question.

But someone who is not in love won't manage to definitively convince someone in love of the non-existence of eros; so this mood never overtakes me for long. Happily I soon snap out of it, and remember again the remarkable sense of independence – autonomy even – of mathematical concepts, and the transcendental quality, the uniqueness – and the passion – of doing mathematics. I resolve then that (Plato or Anti-Plato) whatever I come to believe about The Question, my belief must thoroughly respect and not ignore all this.

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[7] like the old Woody Allen movie *Everything you wanted to know about sex but were afraid to ask*

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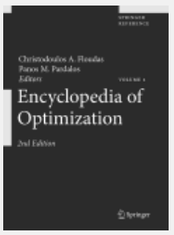

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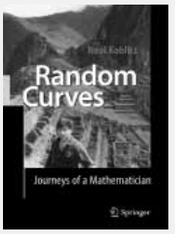

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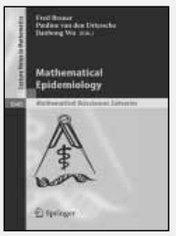

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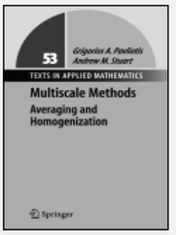

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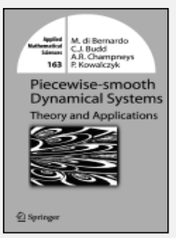

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The meeting at Wernigerode

Arild Stubhaug (Hyggen, Norway)

Karl Weierstrass (1815–1897)
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Sonja Kovalevsky (1850–1891)
© Institut Mittag-Leffler

Gösta Mittag-Leffler (1846–1927)
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Vito Volterra (1860–1940)

The following is an excerpt from Arild Stubhaug's biography of the Swedish mathematician Mittag-Leffler (1846–1927) chosen by the author himself and translated by Ulf Persson, who is one of the editors of the EMS Newsletter. The biography (to be reviewed elsewhere in this issue) has appeared in its original Norwegian and as a Swedish translation (by K.O. Widman) last year. An English edition in preparation with Springer-Verlag and due 2009 (independent of the excerpt below).

The excerpt takes place in August 1888 in the Harz Mountains in Northern Germany, still a popular 'Spa-type' destination. Wernigerode is a small, touristy town situated in the north, sporting medieval half-timbered houses and a castle with a wide view of the surroundings. The visitor will find here an ample offering of both culture and nature but I doubt any references to its mathematical history.

Since the beginning of July 1888, Weierstrass had been staying in Wernigerode in the Harz. He rented a number of rooms at Müllers Hotel for himself and his two sisters. Sonja Kovalevsky had also come here from London and Paris. She was putting the final touches to the treatise that would eventually get her the Bordin prize and she hoped that by being around Weierstrass she would be able to conclude her work.

On 3 August Mittag-Leffler arrived in Wernigerode, or rather at a station one hour away by train from it, where he was met and welcomed by Weierstrass and Sonja. Weierstrass looked well and Sonja 'smashing', he noted in his diary. For Mittag-Leffler, the main purpose of meeting Weierstrass was to discuss and assess the twelve papers submitted for the mathematical prize of Oscar II. But he also entertained plans of asking Weierstrass to present his latest results so that they would not be lost to posterity should Weierstrass not find the time to edit them.

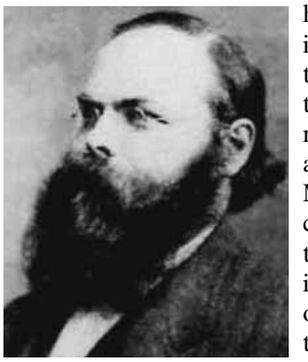
When he told Sonja about his plan the first evening, she implored him to abstain. She badly needed Weierstrass' time and attention in order to complete her own work. Besides the old master had solemnly asked her to come so he could relay to her what he no longer felt able to edit himself.

The next day Mittag-Leffler noted in his diary: 'Mathematical discussions [with Weierstrass and Sonja] of high interest'. In the evening Volterra also arrived at Wernigerode and for the next few days, Weierstrass divided his time between his three former students. In the morning he listened to and commented on Volterra's generalizations of Abel's theorem for multiple integrals; in the afternoon he expounded at length on the three-body problem to the other two. In addition they went on shorter or longer walks, sometimes all together and sometimes two and two. Weierstrass expressed to Mittag-Leffler his concern of whether Sonja would get her work completed – so much still remained in order to bring it into shape.

When Volterra left Wernigerode after three days, it was cold and raining. Mittag-Leffler took some short walks, first with Weierstrass and then with Sonja. Sonja told him about her relationship with Maxim Kovalevsky – that she did not want to marry him but would rather live with him clandestinely. In this way she hoped to have a hold on him and make him remain the 'devoted lover' she had always wanted to have. Maxim on the other hand had always claimed that anything but marriage would denigrate her. But such a view, she thought, was just brought about by his vanity; the real reason he wanted her as a wife was just to be able to keep mistresses on the side. On top of everything he would rather be the most famous of the two. She continued to talk about wanting to be a mistress, not a wife, and thus it was sad to realize that men only respected her in such a way that the mere thought of her as a mistress appeared impossible. And when she started to suggest that in the vacations she would not mind having one, or better still several intellectually well-endowed men as her lovers, while during the semesters she would rather prefer to be left alone

Georg Cantor (1845–1918)
© Institut Mittag-Leffler

Adolf Hurwitz (1859–1919)
© Institut Mittag-Leffler



Herman Schwarz (1843–1921)

and work, Mittag-Leffler could not help but remark that 'this is not how it usually comes across during the actual semesters' and he added that unfortunately for her she lacked those physical attributes a man demands of a mistress. On the other hand she was probably richly equipped with those attributes a man would want in a wife. 'But unhappy the man who had her for his wife,' he added because the egotism Sonja had developed to such a high degree and her indifference, concealed under a lively and engaging temperament, would rather soon bring a husband to the end of his wits. 'With her, everything is head and imagination but her heart has not yet vibrated', he wrote, and thought of her terrible temper and the scenes she was capable of creating, as well as her total absence of any sense of duty and responsibility, which she so openly admitted to. He concluded that Sonja was probably completely in the right. It would be best for her not to get married at all.

About a week after Mittag-Leffler's arrival in Wernigerode, Cantor came as well. In the meantime both professor Tietgen from Berlin and professor Hettner, who did not live too far away, had dropped by.

Cantor turned out to prove himself an eager companion and Mittag-Leffler went on many a walk together with him and Sonja. One day they climbed de Brocken, the highest mountain in the Harz and stayed overnight there. The next day, when they returned to Möllers Hotel, they found out that Adolf Hurwitz had arrived. The next few days were filled with what Mittag-Leffler referred to as talks and conferences – mostly with Weierstrass – as well as walks with Cantor, Sonja and Hurwitz. Mittag-Leffler found Hurwitz to be a modest young man filled with new and good ideas, with a genuine love for his science. 'Sonja has mobilized her full battery of coquettish charms aimed at his simple innocence,' he added.

At the dinner table on 16 August, Sonja started a discussion concerning the liberation of women, something which would turn out to be very unpleasant for Mittag-Leffler. Present at the table, in addition to Sonja and Mittag-Leffler, were Hurwitz, Cantor and the two sisters of Weierstrass; Weierstrass himself never had his dinners there. Mittag-Leffler, according to his diary notes, did nothing but develop his own ideas that women should also have the right to vote, when Sonja suddenly interrupted him and started to talk about how much more than him she did and achieved in Stockholm. She lectured twice as much and had written several treatises; she had never had a leave of absence and had never been sick. Mittag-Leffler responded calmly that he did not want to defend himself but noted in his diary that he had been on the verge of remarking that included among his duties in Stockholm was all the work involved in maintaining the position for his female colleague. Cantor on the other hand reacted to Sonja's outburst by pointing out that she had forgotten all the work Mittag-Leffler did with Acta Mathematica. But this was sprightly dismissed by Sonja, who claimed that the work with the journal did not make more demands on his time than did her own domestic chores on hers, and besides he had a secretary.

A bit later in the day he realized that Sonja had also spoken disparagingly of him to Weierstrass. And from Weierstrass he learned that Schwarz, who was due in Wernigerode two days later, thought of Mittag-Leffler as his adversary. The reason was supposedly that everyone believed that Mittag-Leffler was fishing for a position in Berlin, an ambition, he insisted in his diary, that had not been admitted to his thoughts, although it certainly would be worth thinking over. His most fervent desire for the coming winter was only to get enough energy to work with mathematics, he noted, and concluded discouraged at the end of that day: 'But it will not be so. Things are just getting worse and worse and it will probably soon end as it did for my father.[1]

Through daily meetings with Weierstrass the assessment of the submitted treatises progressed. The work of Poincaré was in particular discussed and Mittag-Leffler was continually struck by the penetrating acuity of Weierstrass' mind, his unusual powers of recollection and how easily he quenched even the most difficult of questions.

Schwarz' presence in Wernigerode led to several unpleasant scenes. Both Sonja and Weierstrass had written to Schwarz and asked him to come and take part in constructing a model for the body of rotation with which she was working for her prize-winning essay. In addition Weierstrass had asked Schwartz to come in order to try to bring about reconciliation between him and Mittag-Leffler. At the first meeting at the dinner table, Schwarz bowed to him several times and Mittag-Leffler thought that he had looked very embarrassed. Later in the evening, however, after Schwarz had retired and just Sonja and Cantor remained, Mittag-Leffler was for the first time told about the details of the rumours Schwarz had spread about him during the last few years and he

[1] Mittag-Leffler's father had a mental breakdown and was committed for the rest of his life to an institution, while Mittag-Leffler was still in his youth [translator's note]

started to grasp what the persistent strain in his relations with Schwarz was really founded on. Everywhere in Germany, France and Italy, Schwarz had disseminated the rumour that Mittag-Leffler was a lecher, a *Wüstling*, leading a life of debauchery – so morally depraved that he had married Signe while he was still suffering from syphilis. That was why she had not been able to give birth and that was why she had consulted doctors all over Europe. To substantiate his claims he had bragged that he had sought out Mittag-Leffler's doctor in Helsinki. Cantor confessed that after having heard this he had refused to shake hands with Schwarz and that he would rather not have anything at all to do with such a person. And when Schwarz had spread the same rumours in Paris, Poincaré had reacted very strongly and forbidden anyone to badmouth his friend Mittag-Leffler and that the rumours, even if there were some substance to them, were the sole business of Mittag-Leffler himself and no one else. Both Poincaré and Picard had threatened to have him evicted out of the country if he would not give up his slanderous allegations.

Cantor continued the next day to reveal more about Schwarz and how the story about the syphilis had been expanded upon. Cantor was curious as to what steps Mittag-Leffler would take. Cantor was also able to relate that when Schwarz was newly engaged to Kummer's daughter, he had asked for advice about whether he should tell his future father-in-law that as a soldier in 1866 he had had a severe episode of syphilis.

'Did not sleep during the night,' Mittag-Leffler noted in his diary. He had decided to confront Schwarz with what he had learned. At the dinner table on 20 August he asked Schwarz for a meeting between four eyes and just after dinner he escorted Schwarz to his room. Mittag-Leffler started by remarking that he had expected an unconditional apology. When that did not come about, he minced no words in telling him that he could expect something very unpleasant. In Germany such defamations would be punished and so many witnesses could be brought up from Germany, France and Italy that there should be no doubt as to the outcome. He would be condemned to at least six months in some correctional institution, in addition to being saddled with paying indemnities. According to Mittag-Leffler, Schwarz only stuttered something about having come to Wernigerode only because Weierstrass had asked him to and that Mittag-Leffler was to do what he thought just. Much more was not said as Schwarz was then asked to leave.

Mittag-Leffler went right away to Weierstrass to tell him what had transpired but as he found him asleep, he instead sought out Sonja. She showed indignation as to the behaviour of Schwarz but thought nevertheless that Mittag-Leffler should not have brought about such a scene. She meant that Mittag-Leffler had only thought of himself, not on how the affair would affect Weierstrass. He countered that he had not thought of himself but of his wife Signe. Had it not been for the lies spread about her, he would have done nothing. Sonja was nevertheless not fully satisfied, something Mittag-Leffler related to her need of Schwarz for help in her own work.

When Weierstrass was later filled in on what had happened, he thought that Mittag-Leffler had acted in the right way, even if he found the whole thing very embarrassing and painful. He may not have believed that Mittag-Leffler would be satisfied with what had already been said and he took it upon himself to force Schwarz to give a full apology. In his diary Mittag-Leffler noted that since a Swede could not duel – and since he had now upbraided Schwarz so strongly, was it not rather Schwarz who could demand satisfaction? – there remained nothing but a legal process. But he did not look forward to bringing about such a scandal.

The same evening Weierstrass succeeded in extracting an apology from Schwarz and his word of honour that he had not spread such stories during the last few years and that he would never ever do it again. Mittag-Leffler who desired to accommodate Weierstrass decided to let matters rest for his sake and declared that he accepted the apology. Cantor, on the other hand, thought that Mittag-Leffler ought to have demanded an apology in writing, something Mittag-Leffler admitted he would have done had it not been for Weierstrass – anyway he would 'treat Schwarz as air' until he came around and personally asked for forgiveness.

The next day Mittag-Leffler noted in his diary that he slept extremely well during the night. During the afternoon Weierstrass told him that he had had another talk with Schwarz, who in the presence of Weierstrass would like to ask for forgiveness. Schwarz once again swore that during the last year, he – after Weierstrass had admonished him during the Easter of 1887 – had not told anyone the story, whose veracity he no longer believed in. But he had heard the story from the Finn Neovius, who had relayed the contents of a Finnish short story in which this had been told and had been informed that Mittag-Leffler had been the model for it.

In the evening Weierstrass took the two of them for a walk but when, after the evening meal, he tried to bring about a reconciliation, Schwarz excused himself saying he was tired and wanted to retire to bed. Not until the next afternoon did Schwarz arrive along with Weierstrass and present his apology for what had happened. Mittag-Leffler promised to forget all about it and hoped that in the future they could work without hostility and with a mutual desire toward common scientific goals. He expressed a certain understanding that because of the strong competition between mathematicians in Germany, there could arise such back-stabbing but that he, who was above all such things, ought to be allowed to live in peace with everybody else. Schwarz started then to claim that he did not begrudge anyone nor compete with anyone but was stopped by Weierstrass who said he should not talk about things that were not true.

During a walk in which everybody took part Schwarz expressed his intention to give a talk, which he later wanted to write down and send to Acta as a proof for all the world to see of their reconciliation. Next afternoon Schwarz did give a lecture but it seems never to have been sent to Stockholm.

The next days in Wernigerode were devoted to further

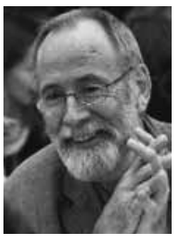
discussions of the manuscripts for the prize of King Oscar II and both Schwarz and Hettner participated actively in these. In addition Mittag-Leffler and Weierstrass tried to help Sonja in integrating a differential equation that had arisen in connection with her problem. Weierstrass was also working on the stability of the *n*-body problem.

A kind of serene sense of consensus seemed to have descended on them those last days at the Müllers Hotel. When Schwarz left on 15 August, he showered Mittag-Leffler with declarations of friendship. The only things that created some discord and kept conflicts alive were the machinations of Sonja. And Mittag-Leffler thought that the reason that Sonja had been so unpleasant was her jealousy of the kindness Weierstrass had shown him. Many times their old teacher had turned to Mittag-Leffler before he had addressed himself to her. Now she did not want to hear anything about Mittag-Leffler's plans to invite him to Sweden next summer. As she was not going to be in Sweden at the time, there was no reason why Weierstrass should be either.

Weierstrass told Mittag-Leffler that he strongly disapproved of Sonja's plans to get a position in Paris and he resented her lack of tact in that she exploited every opportunity to speak disparagingly of Stockholm. He had always reminded her that no other country would have done as much for her as Sweden. On 26 August, Mittag-Leffler concludes his diary with the following.

> *My decision is made; I will try to bring it to the point that she [Sonja] will be if not personally indifferent to me, at least far more distant than up to now. Only then can I endure all those pains that she inflicts on me. So long as she is so personally close to me, as she has been up to now, she tortures the life out of me. I can put up with much from those whom I am indifferent to but nothing at all from the few who are really close to me.*

On one of the last evenings, Mittag-Leffler and Cantor went down to the centre of Wernigerode, where a large crowd of people had congregated and where festivities had been arranged in connection with the silver jubilee of the wedding of the local prince Graf Otto zu Stolberg-Wernigerode. The bridal couple, accompanied by servants, were driven through the town in elegant wagons towards the castle. 'The whole made a tragicomic impression,' Mittag-Leffler wrote in his diary. On 28 August, he left Wernigerode.



Arild Stubhaug is an established literary writer in his native Norway. Among mathematicians, he is known world-wide for his biographies of Niels-Henrik Abel and Sophus Lie. Both books have been translated to English, French, German and Japanese; the first metioned one, moreover, to Russian and Chinese.

Interview with Preda Mihăilescu

Göttingen (Germany)

from left to right: Samuel J. Patterson, Preda V. Mihăilescu, Axel Munk and Hanno Ehrler

***Preda V. Mihăilescu**, born in Bucharest, Romania, is best known for his proof of Catalan's conjecture. After leaving Romania in 1973, he settled in Switzerland. He studied mathematics and informatics in Zürich and then pursued a career as a mathematician in the Swiss banking sector. While still working in industry, he received his PhD from ETH Zürich in 1997. His thesis, titled Cyclotomy of rings and primality testing, was written under the direction of Erwin Engeler and Hendrik Lenstra.*

Mihăilescu started to work in academia as a research professor at the University of Paderborn, Germany. Since 2005 he has been a professor at the Georg-August University of Göttingen (Germany).

This interview took place on 3 December 2007 at the Mathematisches Institut of the University of Göttingen. It was prepared by Axel Munk (Mu) and Samuel Patterson (Pa), both from the University of Göttingen, who also participated; it was conducted by Hanno Ehrler from Deutschlandfunk, a German public broadcasting channel.

Childhood and education, Romania and Switzerland

First of all, I would like to ask you to tell us a little about your curriculum vitae, starting with your childhood. I read in an article that you had a talent for mathematics and numbers very early on.

The game with numbers indeed started about the age of four, and before I was five I had the reputation of the child who multiplies three digit numbers. I liked the game and could not understand what others found so astonishing about it – a little bit like listening to music that not many appear to notice. There were variations; friends of the family who were engineers visited and verified my 237×523, say, with a slide rule – and I found it quite awkward when I looked at "the competition". I saw all these lines at varying distances on the slide ruler and realized that it could never yield the precise 6 digits of the result, since the maximum accuracy was 5 digits. So I knew that the verification was only approximate – yet I knew that my result was precise. It was different on the playground; only much later did I learn that the older people whom I did not know and who came making their challenges – sometimes they even tried to teach me to perform multiplications on paper – had actually made bets with their friends.

Of course this gave a predisposition for mathematics, but it was not cultivated in any particular way for quite a while. Humanities came first in my early life.

What other important recollections do you have from your childhood?

My childhood was relatively protected at a time of intense dictatorship. My parents did not hide from us all of what was happening. Thus we knew that an uncle was in a camp and that others had no job or worked as street dog catchers (it happened), having been poets and philosophers before that. We knew that twice a year my grandfather visited his former professor and master, who had recently finished his camp sentence, taking him a large dried sausage, which made the old man cry. Then they had several hours of discussions, which brought them back into the spiritual fields of their youth; I sensed a particular intensity in my grandfather when he was coming back from these visits, like a veil was raised for a brief period of time over a world I would never encounter in my own life.

We knew that we had to be careful about what we said and we feared the power – but in fact I had little direct contact with "those guys" as a child. The parades, the songs and the doctrines were visible but not so tangible as the family circle that was offering comfort. Eventually, when going to school, a third category emerged: the school teachers, some of whom were really nice – yet they were employed by "them" so one could not be sure. For us, Stalinization came to an end towards the mid-60s, although it formally ended in 1956. In the 60s there was, on the one hand, an amnesty and many people came out of camps, and on the other hand … there was "Strawberry fields" and "Penny Lane". If I recall correctly, we heard the first Beatles songs even on public radio. By the time I was able to consciously ask the question: 'why did one grandfather die under untold conditions while the other one lives with us to the greater joy of all, why did uncles disappear, and whether or not we had been close to such a destiny?' a sort of a warmer wind was blowing.

And then, when I became a teenager I was elected, as a good pupil, to some leading communist youth role in the school. I thought I was choosing a smart way out by basically saying at the meetings that one should try to be oneself even within this organization because according to what they said, they actually expected this from the youth – and not, like everybody knew, frightful obedience and indoctrination. The words were not exactly these but the meaning was quite clear, and after several

calls to order in offices of higher ranking "comrades", I came to understand that I did not have all one needs for civil disobedience. This may be one of the personal experiences that made me choose, four years later, to seek asylum in Switzerland.

And there you studied mathematics?
And there I studied mathematics and entered a new life that was challenging in all directions.

There were two things that led me to the choice of doing applied mathematics: one was the pragmatic estimate of survival odds for the inexperienced refugee that I was. But this could never suffice, not without the feeling of being in a world where one could do things, a lack of limitations that had to be experienced. So I went to do something that none of the males of my family had done, at least in the last three generations – become practical. They had all ended up teaching in one way or another; I was going to work in some productive area – quite ironic, looking back now, isn't it? It is probably from my mother that I have learned a love for very practical, well done things. She was a gynaecologist and a surgeon. Delivering babies under the most difficult conditions, both medical and physical, was an unspoken, penetrating passion for her. From her I think I received the love for things with a practical purpose – developing a project like delivering a child, bringing something new to life…

Industrial career

So it is quite natural that you studied applied mathematics and then went into industry. What did you do there? What kind of work did you have to do?
There are two periods of my industrial career. After the second "Vordiplom" in mathematics until the end of my computer science Masters degree, I worked, with interruptions, in a company in the machine industry. I applied numerical analysis and developed methods and programs for designing models of turbine blades so that the gas flow around these blades could be computed exactly. It is a typical application meant to provide reference data for testing larger software packages. From the desire for a visual interaction with these models, I was led to several visualisation applications; in the end, I even developed a visual interface for software that computes load flow and short-cut simulations in large electrical networks. It was an effective sales argument for that specialized, professional software and my first application that had an impact on the market. That was also in the very early beginnings of graphical interfaces so I had to invent many of the tools I needed pretty much from scratch.

Then, after completing my computer science studies, I switched to information security. I worked in that domain first in banks and later in a consulting and development company. I would say that in the productive phases of my industry life, I was peacefully conceiving projects and bringing them to life, and there was nothing spectacular about it. The security of online ATM system in Switzerland, for example, which has been running since 1990 with some natural renewals and no essential changes to the core, has withstood the test of time and represents the silent success behind that work.

What does "information security" mean? Were you concerned with security systems?
Yes – security of information. That means protecting data on the net against intrusion or modification, protecting identities – in the sense that the identity of a person may be associated with documents or "electronic signatures" in an inalterable and irrevocable way – and variations of these basic problems of confidentiality and identity. The methods used belong to the field of cryptography, which uses number theory, and this is why a mathematician was preferred. The mathematical background was certainly useful so that the cryptographic issues were easily accessible. From my point of view – and probably not only mine – the challenge of the job was to supervise a large system so that no security gaps arose. Gaps due to organizational reasons rather than purely cryptographic ones often played the most important role; cryptography is well under control due to the theory.

It was also the beginning of public key cryptography and I had a lot to do helping potential users be a bit more sensible. Primarily, security made the life of the normal programmer or computer user slightly harder, not only because of the numerous password protected applications one had to sign into sometimes dozens of times a day but also because a secured application could, at that time, be logically slower. One had to convince co-workers to accept such inconveniences to enforce the security of the internal network.

At one stage, I was employed in the most important bank in Switzerland, which had the ambition of being ahead of its time in IT; it could also afford to pursue this goal. At that time the term "single sign-on" was starting to be coined as a desirable alternative to the multiple applications asking for a password on the desk of every employee. The technology answering the expectations of this time was only developed over five years later.

I was asked if I "could develop a single sign-on system" for the company's network. What I was doing practically at that time was cryptographically securing the communications in the bank. This was very useful and could be done with the manpower available. I was unsuccessful in using a detailed technical argument to explain that "single sign-on" was not at that time within reach. On that occasion, I learned that sometimes a negative proof is not accepted as a basis for a decision. Maybe that experience made me wish for an environment where a negative proof is well regarded; anyhow, years later I was able to present a negative proof, which confirmed Catalan's conjecture, and that one was very well accepted.

Pure mathematics during spare time…

So we are back to pure mathematics. As I know, you also had time for studying pure mathematics; after all, you solved Catalan's conjecture. How was it possible to

have this job in the bank and the work in industry and at the same time be concerned with pure mathematics? Is it some kind of hobby or an inner drive?
The inner drive was there and mathematics was also helpful for my mental balance. For instance, I used to work at the weekends or in the evenings at or around my PhD.

And the PhD was about…
The PhD was about primality testing and was thus in applied number theory with an explicit application to cryptography too. It was completed during my time at the bank. I then liked designing efficient algorithms. Some of the ideas from that time came to fruition later, for instance recently in the fastest general primality test for large numbers.

…and as a main occupation

But at some time you decided to move from your industry job into research. Why did you make this decision?
Probably the feeling had accumulated that I wanted to do more mathematics. It happened that I was offered a position at the RSA labs, the research group of a major cryptography company in the USA, and, at the same time, at a university. Doors were open in both directions; in fact, I first went to RSA for several months and after that I accepted the university position, at Paderborn University in Germany. I guess my inner voice told me that I wanted to do academic research and teaching too. In Boston, I was already working at Catalan in the evenings – one may speculate whether this had an impact on my decision too … it is probably just speculation!

Pa: ***Did the university come to you or did you apply for a university position at this time?***
I corresponded with Professor von zur Gathen (Paderborn University, Germany), who had invited me before to give some seminar lectures on the results of my PhD. We kept in touch after that and in fact he offered me a position that was also connected to some cryptographic applications, yes.

Catalan's conjecture[1]

Let's speak shortly about Catalan's conjecture. How did it come that you were concerned with this particular problem and how did you solve it?
This is more than one question…

Maybe you could tell us how you got involved with the problem and on which scientific shoulders your solution was built upon.
Let's try to break this down into several questions. Firstly, why did I get concerned with Catalan? I came across it at a conference in Rome during an interesting talk by Guillaume Hanrot. Returning to Paris where I was spending a summer doing research, I found myself alone and I worked several days to understand more about Hanrot's methods. I did not stop until I had more than a proof of that conjecture! It happened that within a week or two, I could do a step that was then considered to be non-negligible; I proved the so-called "double Wieferich conditions". That was encouraging and may have strengthened my tenacity. Then I was in Paderborn, where I had the peace of mind to think over a longer period about this problem – it was different from the evenings of mathematics after work.

You were asking about the "shoulders" on which I was standing. I would at first answer that I was jumping from shoulders to shoulders. At the beginning it was the shoulders of various people who had investigated Catalan's conjecture in the last 30 years; there's a long list. After Bugeaud and Hanrot, who gave me a taste for the question, I got acquainted with Maurice Mignotte, who was very active in the area. I had to understand the ideas of Inkeri and Schwarz, and Bennet, Glass and Steiner, Tijdeman, and, of course, the consequences of the work of Baker. At the base of all practical results there was an analytic simplification made by Cassels in the 1950s – everybody needed that result as a starting point. I certainly forget half of the important names… However, today I would claim that the shoulders that still hold the present proof are those of Kummer, Leopoldt and Thaine, who gave the fundamental facts from cyclotomy that are used.

Perspectives of number theory

Catalan's conjecture is in the field of number theory. What are the perspectives of number theory today?
Pa: I'm glad this question has been asked of you. (*smiles*)
Mi: Glorious as ever … I am sorry; on the one hand, I do not retain the authority to expand on this question – there are much more competent people to do that. And I can imagine they would also be very careful with prognostics. But since I stand here as one who has worked applying mathematics and who has also done research, I would like to recall one impressive example. Algebraic geometry in positive characteristic was born with Weil and Grothendieck (pursuing work done by Dedekind and Weber, and Kronecker and Artin) as I see it – being the amateur expert that I am – in the second half of the last century. It took some time to be established among geometers themselves. In the 80s however, with Schoof's algorithm for fast counting of points on elliptic curves defined over (large) finite fields, the topic became in a short time a domain of intensive research in algorithmic number theory with practical applications in cryptography. It is hard to say where such phenomena happen or predict how they will happen again in the future, but they certainly will!

[1] Mihăilescu's theorem (formerly Catalan's conjecture) was conjectured by the mathematician Eugène Charles Catalan in 1844 and proved in 2002 by Preda Mihăilescu. It states that the only solution of the equation $x^a - y^b = 1$ for $x, a, y, b > 1$ is $x = 3, a = 2, y = 2, b = 3$. The proof appeared under the title *Primary cyclotomic units and a proof of Catalan's conjecture*, J. Reine Angew. Math. 572 (2004), 167–195.

The Göttingen tradition

We are here at the University of Göttingen and, as Professor Munk told me, there's a tradition at this university of combining pure and applied mathematics. Professor Patterson, could you tell us a little bit about the tradition of this university and about the state of art today.

Pa: Well, the origins of mathematics in Göttingen really have to be traced back to Carl Friedrich Gauss, who was the director of the Sternwarte (the observatory here) for a very long period of time. He wasn't actually a professor of mathematics – he was a professor of astronomy – but he was regarded as the leading mathematician in Europe at the same time. So at this point you have someone who was, for example, doing very practical work during the triangulation of the Kingdom of Hannover, and on the other hand developing, using this experience, the abstract area of differential geometry. And the tradition of Gauss has essentially inspired everybody in Göttingen since then, in one way or another. One of the people who took this up most strongly was Felix Klein, who was very, very much involved in the connections between mathematics and industry. He didn't get much gratitude. Such questions were hotly debated about 110 years ago. Klein was involved in a whole series of public arguments. This was part of the development of the Prussian state and industry.

Mathematisches Institut Göttingen at the times of Courant and Hilbert and today

New buildings under construction for Institut für mathematische Stochastik

And at present? Is there some kind of tradition that leads to the present in the university here?

Pa: Well, we are like most universities. We are quite small as a university, as far as mathematics is concerned, but there are three mathematical institutes inside the faculty. One is called, for historical reasons, the Mathematisches Institut, which is merely pure mathematics now, and then there are the two applied mathematics departments: the Institutes for Numerical and Applied Mathematics and the Institute for Mathematical Stochastics. If I may allow myself a personal opinion here, I would like to see, within a reasonable amount of time, all of these under one roof and working together with one another. At the moment this is not about to happen and the present planning is to move to a new building in about nine years.

The perception of mathematics in industry

In your biography you had both: on the one hand, you worked in applied mathematics in industry and on the other hand, you were working in research and now in academia. I would be interested to hear a little bit about how industry views mathematics?

Let me give some partial answers and perspectives. First, there are those domains that are traditional "customers" of mathematics: mechanical and electrical engineering, financial and insurance mathematics and a few more. There, mathematics is probably supposed to be an important tool for the precision and accuracy of the required application and the image of what one can expect from mathematics generally has precise contours. This is simply due to tradition.

And outside these traditional branches?

There have been many more recent applications born with the development of the computer. From statistics and information theory to the very dynamical branches of computer science – they are encountered almost everywhere, from the pharmaceutical industry to transportation scheduling, from the food industry to, say, flood and earthquake prediction.

And what is the reception of mathematics here?

Frankly, I would not know the answer. An educated guess may be that every domain reaches a degree of complexity beyond which the immediate solutions are not sufficient and some mathematical understanding is called for.

And this would then have a positive impact on the image of mathematics!?

In principle, yes, depending on how widespread the awareness is that a change was brought about by mathematics. After all, maybe to a large extent, people in industry care less about the distinctions between various scientific disciplines, as long as things work… Therefore,

there is a difference between the image of mathematics and the image of mathematicians. Maybe the latter is more distinct and I believe they are, in general, well regarded for their ability to structure complex problems, identify possible solutions and modify targets so that they become affordable.

You mean that mathematicians are asked for in industry?
I mean they are well regarded. There is often the principle of learning by doing in industry. You may find a physicist solving integer programming problems or a number theorist becoming a software manager or a bank manager. So, mathematicians have a good reputation for coming around to problems on which they are trained and those for which they are not. They soon have to discover that they belong to a micro-culture to which absence of proof is close to illusion. This is a positive contribution to the collective, especially when they do not expect that the others adhere to the same standards of formal consistency. It is a good habit to explain convictions, even obtained by some proof reasoning, in terms closer to common language. Most people may resent an excess of precision and accuracy of expression as a kind of snobbery.

How did you experience the change from industry to academia?
The time frames are certainly different in industry and it is sometimes hard to pursue an important idea over a longer period of time. My taste and my own history make me long for places where the two meet or it is foreseeable that they could meet. To an extent, I was offered this opportunity in Göttingen for this reason. Here it is possible to pursue both theoretical research in number theory at the Mathematical Institute and practical research in biometrics at the Institute for Mathematical Stochastics.

Biometrics

Mr. Munk, in your institute you work jointly with Mr. Mihăilescu on biometrics. Are there many groups in mathematics that are working on biometrics?
Mu: No – interestingly, this is not the case. Worldwide, there are many groups, either in academia or in industry, who work on that issue, of course, but usually their background is from computer science, in particular pattern recognition or electrical engineering. The group here is, as far as I know, the only larger group in a mathematical department that deals extensively with those issues – and that certainly makes it unique. Indeed, in our group we bring together experts from several areas. Preda Mihăilescu has a background in cryptography, on the one hand, and on the other hand, in biometrical identification analysis. We combine his expertise with my statistical knowledge and our knowledge in pattern recognition, image processing and enhancement and specific aspects of geometry. Actually, our research process itself gradually increased the insight that many interesting mathematical questions are inherent to biometric issues.
Mi: There is a nice historical analogue to what we are doing. At the beginnings of data transmission with modems, the data were transmitted in clear text and the transmission rate was low. There is a fundamental law of information theory, Shannon's law, that states that one cannot transmit data over a channel at a rate beyond the so called "*channel capacity*", which is essentially limited by the physical channel used: wires, radio, etc. That physical limitation was hard to relax, so nobody knew how to reach better transmission rates for modems. Some people believed this was not possible without improving the physical channels – and that belief was scientifically backed up by Shannon's law. Yet, Liv and Zempel looked at the problem from a different perspective and found that one does not have to send more text at a time in order to increase the rate. It suffices to increase the information that the text contains – and for this, one can compress the text before sending it on the physical channel and then decompress it, since in fact most of the data sent over the net have a high rate of redundancy! By using compression, the transmission rate suddenly increased, without changing the physical channels and without contradicting Shannon's law.

Fingerprints

Mi: In fingerprint security we are in a somewhat similar situation now. Our group has proved that the security based on the currently used fingerprint data is bounded and in fact insufficient. Using presently extracted data, one can – by state of the art methods – never reach the degree of security required for internet transactions. The proof is based on statistical evidence from the literature, evidence we want to back up by our own extended field research. But the order of magnitude is quite reliable. So, by changing the perspective, as Ziv and Lempel did, one is led to the observation that the finger contains a wealth of information that is currently not used in AFIS (Automated Fingerprint Identification Systems). The human operator uses this passive information, so she can sort out evidence in cases in which the machine does not. Obviously, we need new algorithms capable of extracting and structuring such information; this will also increase the security rate. This was one major goal for our group from the start. We first thought only of improving the identification rate – now it shows that the same work can help improve the security systems based on biometry.

I think it would be interesting for the readers to describe the different credentials that are present in the Institute for Mathematical Stochastics; moreover, what are people actually working on?
Mu: In fact, we combine the expertise of various people with different backgrounds. As I said before, Preda Mihăilescu has an expertise in cryptography and practical biometrics. Then we have somebody whose background is from differential geometry, obviously an area of pure mathematics, that turns out to play a very important role in the modern analysis of fingerprints. My own background is statistics; we have people with a degree in computer science and even a degree in both computer science and

Screenshot from fingerprint development and analysis software

mathematics. We collaborate with people from physics and from biology. This makes such an area more attractive for me personally; it is interdisciplinary in the true sense.

At the end of the day, I think mathematical modelling plays a very important role, and this can and has to be done by mathematicians. This is probably the particular strength of our group: we tackle various applications from the perspective of mathematics. Our major focus is mathematical modelling and the understanding of mathematical structures that we use for fingerprint identification, for example. This is then combined with statistical issues, e.g. the investigation of the distribution of the main characteristics of a fingerprint on the finger. Just view your own finger tip and you experience a nice flow field of ridges and bifurcations with fascinating random patterns – a living geometry!

Human vs. machine expertise

Talking about biometrics, where do you see the major challenges in the near future where mathematical ideas will make the difference?

Mu: An important issue, which I think will play a major role in the next few years in the whole area, is the intersection between biometric identification systems and security issues, i.e. security issues in the sense of cryptography. Here, Preda will certainly play a prominent role in our group. Furthermore, statistical ideas are required. Traditional cryptography uses reproducible information – any password or secret key is a unique chain of characters from an alphabet. In contrast, fingerprints have an inherent variability that has to be taken into account and cannot be avoided. This leads to a paradoxical situation: security under variability of the key. This seriously limits the potential security of biometrical systems! It appears that the state of the art approaches are unaware of this limitation in various applications, in particular in 'soft biometrics', where time and money often imposes restrictions to security. However, I believe that a combination of thorough statistical understanding of these limitations and innovative use of additional fingerprint information, which so far has been neglected as well, will improve both reliability and security of such systems – a great challenge for the future! It is by thorough understanding of the nature of limitations that one can, like in the case of Liv and Zempel, find a way to bypass them.

Mi: I'd like to add that this is a domain of an intellectual nature where there is some unknown mathematics. It is interesting that computer scientists who have worked in "expert systems" have repeatedly faced the problem of learning from human experts. Some simple general rules can be easily understood and transformed into algorithms but then running "man against machine" on some specific decision problem, one finds that human experts tend to be better, yet they cannot explain to the computer scientist the choices behind their decision processes. This is a complex problem and certainly the human has a wide capacity to integrate – let me use the word *holistically* – complex, even apparently irrelevant data, and therefore improve the decision. We are thus trying to improve the algorithmic integration of the layers of information by learning from humans. If we make some step ahead in this direction, certainly the immense processing capacity of the computer will then make it possible to use the machine for double-checking expert decisions in critical contexts; experts do make errors too!

Mathematics has the capacity of modelling. Situations like this one teach us a certain kind of humility, since the major, powerful tools of mathematics don't get to the facts. There is a need for some interaction with the object that approaches a mathematical and machine understanding of what man was doing before. We are in this process, and it brings up new notions and new ideas, which then offer a feedback to the possibility of bringing more well-known – or possibly new – domains of mathematics into the game. We are at this turning point.

Can you give an example of what man did before the machine?

Yes, certainly. If you look at fingerprints, it was defined in a somehow conventional way that the so called minutiae identify the fingerprint and thus the person. Minutiae are, for instance, line endings and line bifurcations on the finger. Matching sufficiently many of them (12–18, say, according to domestic laws of various countries) identifies a person in court. However, an expert looks at the whole image of the finger and he uses everything he sees there for the orientation and thus for the matching of minutiae. The machine was (essentially) only taught to use the actual location of minutiae. So the integrative process will probably need to take ridge connections, curvatures and further visual impressions into account, which the expert may use in case of uncertainty.

Mu: But there is another aspect, and maybe this clarifies why we require this broad range of expertise: from statistics, imaging, pattern recognition and cryptography. If you, for example, simply raise the question of how secure a fingerprint identification system can potentially be, various issues have to be considered. One is the pattern recognition part, which means how accurate the informa-

tion is that the algorithms extract in order to optimize the identification rate. The other issue, and no machine can answer this question, is how good the quality of fingerprints are in nature in order to make these things work, i.e. what are the inherent natural limitations of the achievable error rates in biometrics. This is not very well understood, albeit of great practical relevance.

For example, we have recently started a project with the Bundeskriminalamt – the German Criminology Agency – where we investigate statistically how fingerprints transform over a lifetime. There appears to be a problem in quality with prints of elderly people and very young people. Fingerprints change during relatively short time periods in these age groups and this is not understood at all.

This causes difficulties for the minutiae – based approach, which is used in AFIS nowadays, because there is some physical distortion of the finger, especially with teenagers. It is not easy to identify the same person over a gap of two to three years because of finger growth. But you can do it if you use the background information that we are extracting, since the line connections are still the same; it is just the rectangular reference grid of the minutiae that is distorted, like one of those popular paintings of Vasarely.

Pa: ***I'm just wondering here – fingerprints have been used for 100 years. Was this not a problem before now?***
Mi: As I explained, the human expert had less of this problem. On the other hand, the human can never process the huge amount of data that a machine can. We wish to teach the machine to use more information in uncertain cases and thus approach the differentiated attitude of the human, while keeping its specific high performance.

Mu: And there is another issue that is very important. At the end of the day, the target of your identification system is to guarantee certain error rates, irrespective of the particular method used or even of the fact that human experts are involved or not. However, the requirements set for these error rates logically depend on the application. Thirty years ago, fingerprints were mainly used in forensics but nowadays we are talking about fingerprint identification in a variety of applications, including commercial systems like access control to personal computers or cell phones, where the security does not need to reach forensic standards. In contrast, other commercial applications involving financial transactions require very low error rates and are only just developing.

Security issues

A particular problem of your research is probably to estimate the security of biometrical systems?
Mu: How secure is the method? Certainly, we are investigating the limitations of technologies. To be more constructive, we believe that we can occasionally bring some new mathematical ideas into the business, which really can help to improve the identification systems – and which to some extent also explore the possible limits of technologies.

Mi: As I said, some leading methods that are currently proposed have insufficient security. I explained why we are optimistic about the possibilities of improvement. It belongs to the purpose of research that one tries to prove lower bounds to the security that one can offer. This requires more work (in statistical modelling too). It is a difficult task that we take upon us.

But we cannot provide the certainty that a deployed system doesn't have gaps in the security conception and guidelines. The conception of the system is very important and it has to reduce the risks in a hierarchical structure. I know from earlier experience in the industry that security is not only a matter of the cryptography used but also of the risk hierarchies. The first project I developed was the security of online ATM systems in Switzerland. There you have a hierarchy of keys and the ultimate keys are, by design, unknown to anybody. They are born, kept and used in a tamperproof security box. This is a computer whose memory is instantly deleted when you shake it or physically tamper with it. The next hierarchy of keys are known to a very few well-trusted people, etc. Actually I believe that the management did not completely trust this technology, so they also printed out the core key, making it accessible to a designated bank director; maybe this is better. However, the most important keys should be known to a minimal number of people. This is a matter of design; it's not a matter of cryptography or of biometrics.

There is a very strong connection between this research and the applied aspect, the aspect of concrete applications in industry, in bank systems. You told us that the mathematical aspect is very important in biometrics. Are there concepts or aspects that you can take from pure mathematics and then apply in your research? Could you describe some of these?
Mu: In our institute, we are of course not only concerned with biometrics. To give you an example, we have recently started to work on growth modelling of biological objects such as trees and leafs. This is supported by the German Science Foundation and we collaborate closely with colleagues from the forest science department, who perform field experiments. This practical problem has initiated fundamental research towards principal component analysis on manifolds, which we call geodesic principal component analysis. Here we benefit a lot from discussions with colleagues from differential geometry and optimization.

Mathematics and Applications

Pa: There's one comment I'd like to make on this: the notions of pure mathematics and applied mathematics are not terribly firm or precise. When I was a student, applied mathematics was very much associated with physics but what is now stated as applied mathematics, for example in cryptography, is very, very much what in those days was considered as pure mathematics; it was number theory. Number theory was considered, let us say, in the late 1960s as one of the purest areas of mathematics; nowadays it is one of the most applied areas of mathematics.

Mi: Exactly, for instance the algebraic geometry over finite fields that I mentioned.

Conversely, do you think that there is also some payback from applications of mathematics, fostering new theoretical research?

Mi: Mathematics progresses both by the impulse from questions raised in physics – and nowadays from a much wider domain of applications – and from questions arising in the mathematical research itself. An important aspect is that the period it takes for some new fundamental mathematical insight to find an application – a reflection in the sensible world, I would say – is long, usually very much longer than, for instance, the time it takes for a discovery in experimental physics to be translated into a revolutionary technology.

Sometimes, this process is iterative. I am far from being an expert but here I think for instance of Riemannian geometry used in relativity theory, whose further development has continuous impacts on mathematics and physics, as I understand it.

Pa: I think it actually seems to occur on a rather slow, almost geological, time scale. What happens is that you find a student coming up, and she or he learns two or more different areas either from different teachers or from books or something like that and then brings them together in her or his person. And then the development takes place. Each generation of mathematicians has got this essentially dialectic aspect that brings together new connections and this is exactly what keeps mathematics alive. Just as a single line, it would die out.

Public awareness – in Germany

2008 is the year of mathematics in Germany. How do you think the awareness of mathematics is in the real world, in the public?

Mu: Personally, I would say that a major challenge for the mathematical community is to focus the attention of society on the benefits it draws from mathematical research. When something in mathematics is invented, typically it takes a very long time until it is recognized in society as a value or a contribution. Moreover, when a mathematical result is at the heart of a practical invention it is not recognized as such anymore. In other disciplines this goes faster and this process is much more direct. Inventions in molecular biology or in medicine, let's say, are first of all recognized as inventions of these disciplines. At the beginning of the 20th century Radon developed what nowadays is called the Radon transform, and about 60 or 70 years later people used it for tomography. Of course, nobody in the public related these two things anymore. And there are many other examples: the mathematics of financial markets that is used in every investment bank nowadays is founded on the famous Ito-calculus from the early 50s, which itself is based on Brownian motion developed by Einstein and Wiener in the first quarter of the last century. This has been very successfully applied in the 70s to option pricing, and the Noble prize in economy was awarded for this development. These very long periods of time prevent the public from appreciating the value of mathematics and how it really matters to us.

Pa: Can I say something about my experience here? Much of modern mathematics started in Germany during the 19th century and it came to me as a huge surprise to discover how negative many people in Germany are about mathematics. It is a very strange experience: when one says one is a mathematician here, one usually gets the answer, 'I was never any good at mathematics at school,' or something of this nature. In fact, the attitude is quite different, let's say, in the UK or in France where there are many programs in the media about mathematics, on the BBC or in other places. We've just been involved here in a program that is being made by Marcus du Sautoy for the BBC. One might hope, though it's a rather weak hope, that in the course of the Year of Mathematics one might actually change this a little; it seems to be a specifically German attitude that you do not find in other countries.

May I come to my last question – do you think that the special work you're doing in biometrics, which combines some aspects of academics and some aspects of industry and applicability may have an effect on the recognition of mathematics in the public?

Mi: If it succeeds in reaching the goals that we have set… Our goals are to improve technological systems, on the one hand, and to develop some theoretical models that can prove something positively in areas that are poorly understood, on the other hand. Maybe the best hope is that solutions found for this specific problem may call for some new mathematics, if we develop concepts that can be used in similar problems. This is the best I can hope for, and then let the waves go the way the waves go. It's always a matter of who hears at the other end of the channel. It's never the whole public.

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Personal column

Please send information on mathematical awards and deaths to the editor.

Awards

The 2007 Oberwolfach Prize for Excellent Achievements in Algebra and Number Theory was awarded to **Ngô Bao Châu** (Paris-Sud/Orsay).

The 2008 Clay Research Awards has been given to **Cliff Taubes** (Harvard University, Cambridge MA, USA) for his proof of the Weinstein conjecture in dimension three, and to **Claire Voisin** (CNRS, IHES, and the Institut Mathématique de Jussieu, Paris, France) for her disproof of the Kodaira conjecture.

Gitta Kutyniok (Giessen University, Germany) has been selected to receive this year's von Kaven Prize in Mathematics for her outstanding work in the field of applied harmonic analysis. This prize is awarded by the von Kaven Foundation, which is administered by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation).

Andreas Neuenkirch (University of Frankfurt, Germany) has been awarded the 2007 Information-Based Complexity Award for Young Researchers.

Newsletter editor **Themistocles Rassias** (National Technical University of Athens, Greece) has been awarded a Doctor Honoris Causa from the University of Alba Iulia (Romania). Congratulations!

László Lovász (Eötvös Loránd University, Budapest, Hungary and current president of the International Mathematical Union IMU) has been awarded the Bolyai Prize, one of the highest honours in Hungarian scientific life.

The 2008 Steele Prize for a Seminal Contribution to Mathematical Research has been awarded to **Endre Szemerédi** (Budapest, Hungary, and Rutgers, USA) for the paper "On sets of integers containing no k elements in arithmetic progression", *Acta Arithmetica* XXVII (1975).

One of the 2008 Maxime Bôcher Memorial Prizes has been awarded to **Alberto Bressan** (Italy and State College, PA, USA) for his fundamental works on hyperbolic conservation laws.

The 2008 Doob Prizes have been given to **Enrico Bombieri** (Italy and IAS Princeton, USA) and **Walter Gubler** (Switzerland and Humboldt University, Berlin, Germany) for their book "Heights in Diophantine Geometry" (Cambridge University Press, 2006).

The Autumn Prize of the Mathematical Society of Japan (MSJ) for 2007 has been awarded to **Tadahisa Funaki** (University of Tokyo, Japan) for his outstanding contribution to stochastic analysis on large scale interacting systems.

The 2007 MSJ Geometry Prizes have been awarded to **Shigeyuji Morita** and **Kenichi Yoshikawa** (both from the University of Tokyo, Japan). The award to S. Morita has been made in recognition of his fundamental research on mapping class groups; the award to K. Yoshikawa has been made for his outstanding research on Ray-Singer analytic torsion and its behaviour on various moduli spaces.

The MSJ Analysis Prizes have been awarded to **Shigeki Aida** (Osaka University, Japan) for his contributions to stochastic analysis in infinite dimensional spaces, to **Toshiaki Hishida** (Niigata University, Japan) for his contributions to new developments in Fujita-Kato theory for the Navier-Stokes equations, and **Takeshi Hirai** (Kyoto University, Japan) for his contributions to representation theory of infinite symmetric groups.

Zbigniew Błocki (Kraków, Poland) was awarded the Zaremba Great Prize of the Polish Mathematical Society for his papers on complex analysis.

Grzegorz Świątek (Warsaw, Poland and Pennsylvania) was awarded the Banach Great Prize of the Polish Mathematical Society for his papers on dynamical systems.

Teresa Ledwina (Wrocław, Poland) was awarded the Steinhaus Great Prize of the Polish Mathematical Society for her papers on mathematical statistics.

Adam Skalski (Łódź, Poland) was awarded the Kuratowski Prize.

Radosław Adamczak (Warsaw, Poland) was awarded the Prize of the Polish Mathematical Society for young mathematicians.

Luis Barreira (Instituto Superior Técnico, Lisbon, Portugal) was the 2008 winner of the Ferran Sunyer i Balaguer Prize. He was acknowledged for his book "Dimension and Recurrence in Hyperbolic Dynamics".

George Lusztig (Romania and MIT, Boston, USA) has been awarded the 2008 Steele Prize for Lifetime Achievement.

The Adams Prize of Cambridge University has been awarded jointly to **Tom Bridgeland** (University of Sheffield, UK) and **David Tong** (University of Cambridge, UK).

The 2007 SASTRA Ramanujan Prize has been awarded to **Ben Green** (University of Cambridge, UK). This annual prize, which was established in 2005, is for outstanding contributions to areas of mathematics influenced by Srinivasa Ramanujan.

Ulrike Tillmann (Oxford University, UK) has been selected as the recipient of a Friedrich Wilhelm Bessel Research Award. This award is conferred in recognition of lifetime achievements in research.

Deaths

We regret to announce the deaths of:

Karl-Heinz Diener (Germany, 18 September 2007)
Henry R. Dowson (UK, 28 January 2008)
Anders Frankild (Denmark, 10 June 2007)
Helmuth Gericke (Germany, 15 August 2007)
Karl Gruenberg (UK, 10 October 2007)
Samuel Karlin (UK, 18 December 2007)
David Kendall (UK, 23 October 2007)
Richard Lewis (UK, 26 July 2007)
Farkas Miklos (Hungary, 28 August 2007)
Georg Nöbeling (Germany, 16 February 2008)
Alex Rosenberg (Germany and USA, 27 October 2007)
Jean-Luc Verley (France, 25 October 2007)

Journal of the European Mathematical Society

Aims and Scope

Journal of the European Mathematical Society (*JEMS*) is the official journal of the EMS. The Society, founded in 1990, works at promoting joint scientific efforts between the many different structures that characterize European mathematics. *JEMS* will publish research articles in all active areas of pure and applied mathematics. These will be selected by a distinguished, international board of editors for their outstanding quality and interest, according to the highest international standards. Occasionally, substantial survey papers on topics of exceptional interest will also be published. Starting in 1999, the Journal has been published by Springer-Verlag until the end of 2003. Since 2004 it is published by the EMS Publishing House. The first Editor-in-Chief of the Journal was J. Jost, succeeded by H. Brezis in 2003.

Subscription information

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Interview with JEMS editor-in-chief Haïm Brezis

Conducted by Thomas Hintermann (EMS Publishing House, Zurich, Switzerland)

What publishing experience did you have before you started working for JEMS?

Shortly after I got my PhD, in the early seventies, I was invited to serve on the board of several journals, including the Journal of Functional Analysis, the Archive for Rational Mechanics and Analysis, and others. I learned much from the chief editors of those journals, particularly Jacques-Louis Lions, Paul Malliavin, Irving Segal and Jim Serrin. I am currently on the board of about 25 journals, but of course with various levels of involvement. I initiated Communications in Contemporary Mathematics ten years ago together with Xiao-Song Lin. Moreover, I am a chief editor for two book series published by Birkhäuser and CRC Press.

How long have you been managing JEMS?

I was asked in 2003 by Rolf Jeltsch, then President of the EMS, to take over from Jürgen Jost, the first chief editor of JEMS, who had done a very good job but was eager to step down. This was around the time when the EMS had decided to transfer JEMS from Springer to the newly created EMS Publishing House. At first, I was reluctant to accept, being already engaged with many other projects. I discussed the matter with some colleagues who were closely involved with the EMS, among them Mina Teicher, Doina Cioranescu and Jean-Pierre Bourguignon. They convinced me that it was important to carry on this project, which was originated by the first president of the EMS, F. Hirzebruch. The change of publisher offered a unique opportunity to shape the journal and build on the good reputation the journal had already acquired before my time. Your own encouragement, Thomas, was another factor in my decision to accept the challenge.

Please describe your cooperation with the other editors and the refereeing process for JEMS.

It is my principle to allow individual editors as much freedom in their activities as possible. In my experience, the more responsibility an editor of a journal is given, the more active and reliable he becomes. Usually, the editors of JEMS receive or solicit manuscripts and contact reviewers entirely on their own, and then forward them to me with a well-documented recommendation. Of course, the ultimate decision lies in my hands but it is very rare that I challenge the advice of an editor. The editors are aware of this policy and they act with utmost care because they feel responsible for the quality of JEMS. This is not always the policy for other journals; I know examples where the chief editor has a much tighter hand on the process, often soliciting additional opinions that might conflict with the original advice. As a result, members of the board become less involved and sometimes are even reluctant to communicate great papers out of fear that their enthusiasm might be challenged.

When I took over, I reshaped the board. My primary concern was to bring in leading figures, at the peak of their creativity and connected to young people – the most natural source of papers! From my past experience with other journals I knew who was taking seriously his/her mission of editor; I avoided distinguished mathematicians who do not reply to email!

Since JEMS is a general mathematical journal, it was important to have a good distribution in terms of topics. Geography also played a role: one of our goals was to increase the visibility of the European Mathematical Society within the international mathematical community. Most of the members of the board are based in Europe but we also have many European "expatriates" working in other countries, notably the United States. Everyone on the board understands that the excellent ranking of JEMS – among the top ten – is a direct result of his/her

personal activity. Moreover, my policy is to encourage our editors to publish some of their own work in JEMS. I know that this is considered "politically incorrect" in some editorial circles. But our journal is young and I feel that this is the best way to send a strong signal to authors about the quality of JEMS.

You are a prolific mathematical author (nonlinear functional analysis and PDEs and more) yourself. How do you find the time necessary to manage the JEMS enterprise?
Finding the time is indeed a big problem and often requires compromise. On the other hand, I view this task as an integral part of my scientific activity. It also provides an excellent opportunity to become acquainted with new developments, particularly those outside my immediate field of research. It is a unique observatory; the information I receive at JEMS becomes very useful when I take part in committees awarding prizes, e.g. at the Académie des Sciences.

Are journals still as important as in the past, in times where preprints are freely circulating on the Internet and in preprint archives? Please comment on the added value of refereeing!
With all the preprints circulating via email, it is really hard to say where we are heading. Publishing in a respectable journal, and particularly in a top journal like JEMS, endows any paper with a quality stamp most authors find very desirable. For young people it is often necessary on their CV. It is the ultimate sign that a paper has been found correct and worthy of attention by the mathematical community. One should not underestimate the psychological impact on some talented people who work in isolation and sometimes under difficult conditions.

JEMS is a general mathematical journal, accepting papers from all areas. However, are there particularly strongly represented fields?
My specialty is nonlinear PDEs and it is inevitable that my own field is well represented. For example, we decided to publish a special issue dedicated to Antonio Ambrosetti, one of our board members, who is a leading figure in nonlinear PDEs. This tilted the balance towards analysis. However, we took care to readjust matters in later issues of the journal. I am closely acquainted with several editors from other fields and I encourage them to compensate my personal bias towards analysis. As it stands now, I think we can say that JEMS is a truly interdisciplinary journal within mathematics.

Do you think that JEMS is representing the EMS in the eyes of mathematicians, or is it perceived as just a top journal disconnected from the society?
It is the fate of most mathematical journals to be disconnected from their "owners". The journals of the AMS are not especially linked with the society in the eyes of the public. The same can be said of the CRAS or the Annales de l'ENS. Communications on Pure and Applied Mathematics, which is an NYU journal, is an exception.

In the case of JEMS the situation is slightly different. The EMS is a rather young society closely connected with the emergence of Europe as a major scientific power and it is natural for the EMS to increase its visibility through a leading journal. I am pleased with the wide geographical distributions of authors (about two thirds from Europe and one third from the rest of the world). One of the goals of JEMS is to become the "flagship" of the EMS.

In the last few years, JEMS has more than doubled the number of published papers, and the development is likely to continue. What makes JEMS so attractive for authors? What are, in your experience, the most important factors for authors when deciding on the journal for their article? The EMS is a not-for-profit organization; do you think that this is an important detail for authors and editors?
I suppose that the excellent reputation of the members of the board (as leading scientists) and their efficient personalities plays a role. Also, many active young European mathematicians have enjoyed the support of European exchange networks in their formative years. They had the opportunity to meet and collaborate with colleagues from other European countries. Not surprisingly, they have sympathy for a European journal. In addition, there is increasing discomfort among authors and editors toward the profit-making giants in the publication industry; this is also a factor in favour of JEMS.

Any final comments?
I derive much pleasure from my activities at JEMS and the friendly collaboration of all the members of our board. The working relationship with the whole editorial team of the EMS has been superb, especially when a major overflow of high-class papers required a substantial increase in the size of the journal. I am very grateful to you, Thomas, for your continued enthusiasm during these "pioneering times" for JEMS.

Haïm Brezis [brezis@math.rutgers.edu] is professor emeritus at the Université Pierre et Marie Curie (Paris VI), visiting distinguished professor at Rutgers University, USA, and at the Technion – Israel Institute of Technology. He is the editor-in-chief of the Journal of the European Mathematical Society.

Thomas Hintermann [hintermann@ems-ph.org] is the director of the EMS Publishing House.

The 100th anniversary of ICMI

Symposium, Rome, 5–8 March 2008
The first century of the International Commission on Mathematical Instruction (1908–2008)
Reflecting and shaping the world of mathematics education

Maria G. (Mariolina) Bartolini Bussi (Modena, Italy)

The logo of the symposium reproduces the floor of the Capitol Square in Rome, which was designed by Michelangelo.

At the beginning of March, in Rome, the centennial of the ICMI was celebrated. In this short paper, rather than covering all of the scientific components of the symposium, I shall try to convey the emotion of being there. The website of the symposium (http://www.unige.ch/math/EnsMath/Rome2008/) contains a lot of information about the program and also photos of the scientific and the social events.

The symposium was held in two historical buildings: the Corsini Palace, which dates back to the 16th century and hosts the Academy of Lincei; and the Mattei Palace (again 16th century), which hosts the Institute of Enciclopedia Italiana.

The Academy of Lincei is the most ancient learned society in the world. It was established as an international society in 1603 by Federico Cesi and others (a Dutch scientist among them). Galileo Galilei added his name and fame to the society a few years later (in 1611) and the number of academicians increased steadily with the addition of Italians and non-Italians from the worlds of science, poetry, law and philology. In front of the Corsini Palace there is a villa called "The Farnesina", built between the 15th and the 16th centuries; it has a beautiful garden and has famous Raffaello's frescoes inside. The villa belongs to the academy, which holds occasional formal celebrations there.

Both the Corsini and Mattei Palaces are in the city centre, within walking distance of the Vatican and other famous sites in Rome. In particular, Corsini Palace is in Trastevere, a well-known district along the river Tevere and an area beloved by tourists; most of the district is for pedestrians only and visitors can enjoy the narrow streets with low, old houses and famous restaurants on the ground floor.

The ICMI was established in 1908, during the International Congress of Mathematicians held in Rome, with the aim of supporting and expanding the interest of mathematicians in teaching in schools. Its first president was Felix Klein. Something similar was attempted in many different subjects but only in mathematics was there success in obtaining widespread international collaboration, in order to face problems relating to the social image of mathematics, to difficulties in learning and to links with research and applications. Some years ago the idea of celebrating the centennial in the same place where the commission had been established was launched. In spite of the many difficulties of hosting a large congress in a city crowded with tourists all through the year, Ferdinando Arzarello and Marta Menghini accepted the challenge and designed a celebration that aimed to evoke the original event as much as possible: only a few days separated the true birthday from the dates of the symposium; the palace was the same (the Palace of the Academy of Lincei); and even the social program was the same, with a beautiful banquet and excursion to the famous villas of Tivoli (Villa Adriana and Villa d'Este). The scientific committee (chaired by Arzarello) was composed of researchers from every continent who were well-known figures in the field of the didactics of mathematics, both for the research that they had carried out and for the institutional positions they held. The local organising committee was made up of professors from Italian Departments of Mathematics.

Everything worked in a wonderful way. It was not easy in Rome to leave the beautiful surroundings to go into the Corsini Palace to take part in the symposium. Yet the program was so interesting that the large room of the meeting was always crowded.

When a society turns one hundred, the memories are usually to be reconstructed by historians. Yet the organizers succeeded in interviewing (and in most cases also inviting to Rome) some of the most relevant mathematicians and mathematics educators who bear witness to this long history. The culmination of effort for the event has produced a website that will constitute an extraordinary source for the future (http://www.icmihistory.unito.it/). In the section 'Interviews and film clips' many eyewitnesses utter their thoughts, e.g. Emma Castelnuovo, Trevor Fletcher, Maurice Glaymann, Geoffrey Howson, Jean-Pierre Kahane, Heinz Kunle, André Revuz and Bryan Thwaites. Others have been evoked by the invited lecturers. Hyman Bass (the ex-president of the ICMI) opened the symposium with a speech on *'Moments in the history of the ICMI'*. The closing plenary was given by Michèle Artigue, the president of the ICMI, on the theme *'One century at the interface between mathematics and mathematics education – reflections and perspectives'*. Between them the following themes were addressed in plenary speechs: *The development of mathematics education as an academic field; Intuition and rigour in mathematics education; Perspectives on the balance between application & modelling and 'pure' mathematics in the teaching and learning of mathematics; The relationship between research and practice in mathematics education – international examples of good practice; The origins and early incarnations of the ICMI; the ICMI Renaissance – the emergence of new issues in mathematics education*; and *Centres and peripheries in mathematics education*, the *ICMI's challenges and future*.

This list of titles conveys the idea that the celebration was not just reminiscing in history but was open to the future directions of research in mathematics education and the possible action to be taken to improve the level of scientific culture in various countries. Other scientific activities were the working groups and short talks. Details may be found on the website mentioned above.

More than 180 invited participants were present in Rome from all over the world. Besides the representatives of the Italian institutions that supported the event and some of the past officers of the ICMI, it is worthwhile to note the attendance of the president Lazlo Lovasz and the vice-president Claudio Procesi of the IMU and of the president of the ICTP (International Centre for Theoretical Physics) Ramadas Ramakrishnan, on behalf of UNESCO. Most participants were accompanied by relatives and friends, as Rome is always appealing for a spring holiday.

The proceedings are in progress and will be ready in a few months. There is no doubt that they will constitute an indefeasible source for all the mathematics educators who feel the need to know about the roots of their academic field and also for the organizers of the next centennial symposium in Rome in 2108!

ICMI AWARDS

In 2000, the ICMI decided to create two awards for research in mathematics education: the Felix Klein Medal, from the name of the first president of the ICMI, and the Hans Freudenthal Medal, from the name of its eighth president. The first two medals were announced in 2003 and were awarded to Guy Brousseau, France (Klein medal) and Celia Hoyles, UK (Freudenthal medal). The citations are available at http://www.icme10.dk/pages/081icmi-award.htm. The medallists for 2005 were Ubiratan D'Ambrosio, Brazil (Klein medal) and Paul Cobb, USA (Freudenthal medal). The citations are available at http://www.univ-paris-diderot.fr/2006/04-icmi.pdf. The medallists for 2007 are Jeremy Kilpatrick, USA (Klein medal) and Anna Sfard, Israel (Freudenthal medal). At ICME11 (Monterrey, Mexico, 5-13 July 2008) the last four medals (2005-2007) will be presented. Short citations of the 2007 medals follow:

Jeremy Kilpatrick, University of Georgia, Athens, GA, USA

It is with great pleasure that the ICMI Awards Committee hereby announces that the Felix Klein Medal for 2007 is given to Professor Jeremy Kilpatrick, University of Georgia, Athens, GA, USA, in recognition of his more than forty years of sustained and distinguished lifetime achievement in mathematics education research and development. Jeremy Kilpatrick's numerous contributions and services to mathematics education as a field of theory and practice, as he prefers to call it, are centred around his extraordinary ability to reflect on, critically analyse and unify essential aspects of our field as it has developed since the early 20th century, while always insisting on the need for reconciliation and balance among the points of view taken, the approaches undertaken and the methodologies adopted for research. It is a characteristic feature of Jeremy Kilpatrick that he has always embraced a very cosmopolitan perspective on mathematics education. Thus he has worked in Brazil, Colombia, El Salvador, Italy, New Zealand, Singapore, South Africa, Spain, Sweden and Thailand, in addition to being, of course, extraordinarily knowledgeable about the international literature. Throughout his academic career, Jeremy Kilpatrick has published groundbreaking papers, book chapters and books – many of which are now standard references in the literature – on problem solving, on the history of research in mathematics education, on teachers' proficiency, on curriculum change and its history, and on assessment.

Anna Sfard, University of Haifa, Israel, and the Institute of Education, University of London, UK (also affiliated to Michigan State University).

It is with great pleasure that the ICMI Awards Committee hereby announces that the Hans Freudenthal Medal for 2007 is given to Professor Anna Sfard, University of Haifa, Israel, and the University of London, UK, in recognition of her highly significant and scientifically deep accomplishments within a consistent, long-term research programme focused on objectification and discourse in mathematics education, which has had a major impact on many strands of research in mathematics education and on numerous young researchers. In addition to publications related to the above-mentioned research programme, Anna Sfard has published numerous other papers and book chapters within a broad range of topics. It is a characteristic feature of Anna Sfard's scientific achievements that they are always very thorough, original and intellectually sharp. She often uncovers the tacit if not hidden assumptions behind notions, approaches and conventional wisdom, and by turning things upside-down she usually succeeds in generating new fundamental and striking insights into complex issues and problems.

Mogens Niss, Chair, The ICMI Awards Committee, mn@ruc.dk.

People who are interested in being informed about ICMI activities are invited to subscribe to the ICMI News (free). There are two ways of subscribing to ICMI News:
1. Click on http://www.mathunion.org/ICMI/Mailinglist with a Web browser and go to the "Subscribe" button to subscribe to ICMI News online.
2. Send an email to icmi-news-request@mathunion.org with the subject-line: Subject: subscribe.
Previous issues can be seen at http://www.mathunion.org/pipermail/icmi-news.

In the issue 67 of this Newsletter (p. 18) the ICMI study n. 19 on Proof and Proving in Mathematics Education was announced. The address of the website of the study has been changed and is now:
http://www.icmi19.com
The deadline for submissions is still June 30, 2008.

Mariolina Bartolini Bussi *[bartolini@unimo.it] is the Newsletter Editor within Mathematics Education. A short biography can be found in issue 55, page 4.*

ERCOM: Mathematisches Forschungsinstitut Oberwolfach

The Mathematisches Forschungsinstitut Oberwolfach (MFO) was founded in 1944 and has developed over the years into an international research centre. In mathematical research, interchange of ideas plays a central role. The high degree of abstraction of mathematics and the compact way it is presented necessitate direct personal communication. Although most new results are nowadays quickly made available to the mathematical community via electronic media, this cannot replace personal contact among scientists. The importance of personal contact increases with the constant increase of specialization.

Therefore, the institute concentrates on cooperative research activities of larger (workshop programme) or smaller (mini-workshop programme and Research in Pairs) groups. Leading representatives of particularly relevant research areas from all over the world are invited to Oberwolfach (about 30% coming from Germany and 40% from elsewhere in Europe) offering them the opportunity to pursue their research activities. The institute's premises offer free accommodation (full board) for about 55–60 invited visitors. In all activities, participation of promising young scientists plays an important role.

Henri Cartan at the original Oberwolfach building

Scientific Programmes

The MFO has two large, central tasks: the weekly workshop programme and the Research in Pairs programme for longer-term research stays. Additionally, there are further activities of the MFO that address young researchers. The scientific programme is operated annually over 50 weeks and covers all areas in mathematics, including applications.

1. The Workshop Programme. The main scientific programme consists of about 40 week-long workshops per year, each with about 50 participants. Alternatively, there can be two parallel workshops of half that size (about 25 participants). The workshops are organised by internationally leading experts of the respective fields. The participants are personally invited by the director after recommendations by the organizers. A special characteristic feature of the Oberwolfach Workshops is a research orientation. Very often the guest researchers appreciate the stimulating atmosphere. Many significant research projects owe their origins to the realisation of a workshop in Oberwolfach.

2. The Mini-Workshop Programme. This programme offers 12 week-long mini-workshops per year, each with about 15 participants. These mini-workshops are aimed especially at junior researchers who have a focused subject, and allow them to react on recent developments since the subjects are fixed only half a year before the mini-workshop takes place.

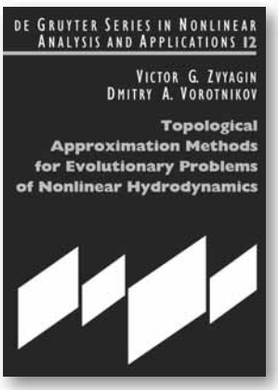
3. The Oberwolfach Arbeitsgemeinschaft. The idea of the Arbeitsgemeinschaft for young as well as for senior researchers is to learn about a new active topic by giving a lecture, guided by leading international specialists. The Arbeitsgemeinschaft meets twice a year for one week and is organized by Professor Christopher Deninger and Professor Gerd Faltings.

4. The Oberwolfach Seminars. The Oberwolfach Seminars are week-long events taking place six times a year. They are organised by leading experts in the field and address post-docs and PhD students from all over the world. The aim is to introduce 25 participants to a particularly hot development.

5. The Research in Pairs Programme. The Research in Pairs (RiP) Programme aims at small groups of 2–4 researchers from different places working together at the Mathematisches Forschungsinstitut Oberwolfach for anything from 2 weeks to 3 months on a specific project.

6. Oberwolfach Leibniz Fellows. The focus of this new postdoctoral programme, which has been set up for the first time from 2007 to 2010, is to support excellent young researchers in an important period of their scientific career by providing ideal working conditions in an international atmosphere. Outstanding young researchers can apply to carry out a research project, individually or in small groups, for a period from two to six months. They may propose for co-workers to visit Oberwolfach for shorter periods. Oberwolfach Leibniz Fellows should be involved in an active research group at a university or another research institute. It is also possible to make an application to the European Post-Doctoral Institute (EPDI).

Just published / Coming soon

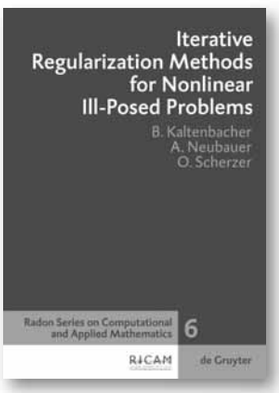


Victor Zvyagin / Dmitry Vorotnikov

■ Topological Approximation Methods for Evolutionary Problems of Nonlinear Hydrodynamics

June 2008. XII, 230 pages. Hardcover.
RRP € [D] 98.00 / * US$ 128.00.
ISBN 978-3-11-020222-9
de Gruyter Series in Nonlinear Analysis and Applications 12

The authors present functional analytical methods for solving a class of partial differential equations. The results have important applications to the numerical treatment of rheology (specific examples are the behaviour of blood or print colours) and to other applications in fluid mechanics.
A class of methods for solving problems in hydrodynamics is presented.

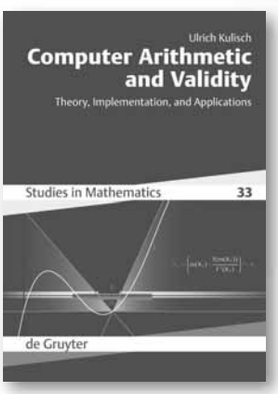


Barbara Kaltenbacher / Andreas Neubauer / Otmar Scherzer

■ Iterative Regularization Methods for Nonlinear Ill-Posed Problems

May 2008. Approx. VIII, 196 pages. Hardcover.
RRP € [D] 78.00 / * US$ 115.00.
ISBN 978-3-11-020420-9
Radon Series on Computational and Applied Mathematics 6

Nonlinear inverse problems appear in many applications, and typically they lead to mathematical models that are ill-posed, i.e., they are unstable under data perturbations. Those problems require a regularization, i.e., a special numerical treatment. This book presents regularization schemes which are based on iteration methods, e.g., nonlinear Landweber iteration, level set methods, multilevel methods and Newton type methods.



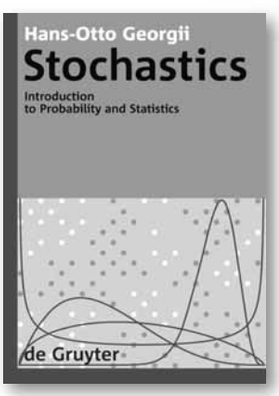
Ulrich Kulisch

■ Computer Arithmetic and Validity

Theory, Implementation, and Applications

May 2008. Approx. XVIII, 410 pages. Hardcover.
RRP € [D] 78.00 / * US$ 108.00.
ISBN 978-3-11-020318-9
de Gruyter Studies in Mathematics 33

The present book deals with the theory of computer arithmetic, its implementation on digital computers and applications in applied mathematics to compute highly accurate and mathematically verified results. The aim is to improve the accuracy of numerical computing (by implementing advanced computer arithmetic) and to control the quality of the computed results (validity). The book can be useful as high-level undergraduate textbook but also as reference work for scientists researching computer arithmetic and applied mathematics.



Hans-Otto Georgii

■ Stochastics

Introduction to Probability and Statistics

Transl. by Marcel Ortgiese / Ellen Baake / Hans-Otto Georgii

February 2008. IX, 370 pages. Paperback.
RRP € [D] 39.95 / * US$ 49.00.
ISBN 978-3-11-019145-5
de Gruyter Textbook

This book is a translation of the third edition of the well accepted German textbook 'Stochastik', which presents the fundamental ideas and results of both probability theory and statistics, and comprises the material of a one-year course. The stochastic concepts, models and methods are motivated by examples and problems and then developed and analysed systematically.

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Publications and Further Activities

1. The **Oberwolfach Reports** (OWR) began in 2004 as a new series of publications of the institute in collaboration with the EMS Publishing House. The four issues comprise more than 3000 pages per year. The OWR are formed of the official reports of every workshop, containing extended abstracts of the given talks, from one to three pages per talk, including references. The aim is to report periodically upon the state of mathematical research, and to make these reports available to the mathematical community.

2. The book series **Oberwolfach Seminars** (OWS) is published in cooperation with Birkhäuser. In this series, the material of the Oberwolfach seminars is made available to an even larger audience.

3. The **Oberwolfach Preprints** (OWP) mainly contain research results related to a longer stay in Oberwolfach. In particular, this concerns the Research in Pairs Programme and the Oberwolfach Leibniz Fellows.

4. Once every three years the **Oberwolfach Prize** is awarded by the Gesellschaft für mathematische Forschung e.V. and by the Oberwolfach Stiftung to young mathematicians. The prize is awarded for excellent achievements in changing fields of mathematics.

5. The **John Todd Fellowship** is awarded every three years by the **Oberwolfach Foundation** and the Mathematisches Forschungsinstitut Oberwolfach to young excellent mathematicians working in numerical analysis.

6. On a two year rotation, a **training week for school teachers** (and librarians on the alternate years) of the State of Baden-Württemberg takes place.

7. The institute also hosts the annual **final training week** for especially gifted German pupils to prepare for the International Mathematical Olympiad.

Buildings

The **buildings**, which were mainly financed by the Volkswagen-Stiftung, do not only offer accommodation facilities for visitors but also form an excellent and stimulating frame for research activities at the institute. Besides the well-adapted scientific infrastructure it is also the institute's remote location, and the excellent service with board and lodging in the guest house close to the conference and library building, that guarantees efficient and concentrated working conditions for the guests.

The **library building** is located immediately downhill from the guest house. It has replaced the former building (the old castle) and was inaugurated in 1975. Comprising the library, two lecture halls, several small discussion rooms and numerous computer stations, it offers excellent working conditions for scientific research. The offices of the scientific administration are also part of this building. The library, the discussion rooms and the cafeteria are open day and night and offer scientists the possibility to work at any time, an option that is eagerly taken up.

The **guest house** was inaugurated in 1967. Each scientist is housed in a single room with its own bathroom. In addition, eight apartments and five bungalows enable a longer stay at the MFO within the Research in Pairs and the Oberwolfach Leibniz Fellows programmes. Due to their age, the maintenance of the buildings is of greatest importance. The refurbishment of the guest house and the bungalows is going on until 2010.

Infrastructure

The basis for the successful realisation of the research programmes described above is an excellent infrastructure. Traditionally in mathematics, the **library** plays the main role. The Oberwolfach Library, which some years ago was ranked by the AMS as the best mathematical library outside the USA, contains about 45,000 issues of books, proceedings, etc. and subscribes to approximately 500 print journals and 3,000 electronic journals. The library can be used by the guest researchers 24 hours a day. By an enlargement in 2007, which was financed by the Klaus Tschira Foundation and the Volkswagen Foundation, the MFO is able to provide new capacity for about the next 20 years.

During the last few years the **computer pool** has been improved significantly and is now up-to-date.

The MFO owns a large collection of more than 9,000 **photographs** of mathematicians, which are also available online. Professor Konrad Jacobs, Erlangen, is one of those who have contributed to this photo collection. Special thanks go to Springer-Verlag Heidelberg for helping organize the digitalization of the photos.

During the last twenty years, mathematical software has developed into an established tool for mathematical research and education. In some fields, its importance is comparable to that of mathematical literature. However, collections of information about mathematical software so far only exist in a rudimentary form. The intention of the **Oberwolfach References on Mathematical Software** (ORMS) project is to fill this gap. This includes a web-interfaced collection of detailed information and links and a classification scheme for mathematical software eventually aiming to cover all thematic aspects of mathematical software.

Institutional Structure and Statutes of the MFO

Since 2005, the MFO has been registered as a **non-profit corporation** (gemeinnützige GmbH). The MFO is headed by a director supported by a vice-director. The sole associate of the MFO is the **Gesellschaft für Mathematische Forschung** e.V. (GMF), represented by its board. The GMF is also a non-profit society and was founded in Freiburg, 1959, in order to set up legal representation and scientific back-

ing for the institute. Financing of the MFO is shared by the Federal Republic of Germany and the Federal States with emphasis on the local state of Baden-Württemberg. Being a member of the **Leibniz-Gemeinschaft** is a prerequisite for the common financing. The financial partners are represented in the **Administrative Council** of the MFO, which in its function as most important supervisory panel decides on the medium-term and long-term finance and budget planning. The institute and the administrative council are supported by the **Scientific Advisory Board**, which is composed of 6-8 internationally renowned mathematicians.

The **statutes** of the MFO and of the GMF contain the following aims, to be achieved with an international scope:

- The promotion of research in mathematics.
- The intensification of scientific collaboration.
- The intensification of education and training in mathematics and related areas.
- The promotion of young scientists.

The director of the institute decides on the scientific programme in cooperation with the **scientific committee** of the GMF. For the scientific programme, this is the most important panel of the institute. It is based on the honorary work of about 20 mathematicians, covering all areas of mathematics. The scientific committee examines all scientific events at the institute prior to their approval. The programme is fixed in a competitive procedure according to strictly scientific criteria.

For the planning and realization of the scientific programme of the MFO approximately 20 **staff positions** are

Participants of the 2004 mini workshop Geometry and Duality in String Theory

provided in various divisions, such as scientific and administration management, library, IT-service, guest service and housekeeping.

The **Förderverein** (Friends of Oberwolfach) of the MFO has more than 700 members and provides additional financial support for the MFO by its membership fees. The Oberwolfach Foundation, a foundation of public utility within the Förderverein, provides long-term financial support by building up an endowment. Within the Oberwolfach Stiftung the **Horst Tietz Fund** plays an important role by providing special funds.

Please consult the web side of the MFO (www.mfo.de) for further, more detailed information concerning the scientific programme and the various committees and boards. A short guide for applications is online at http://www.mfo.de/programme/ProposalGuide2008.pdf .

Book review

Arne Jensen (Aalborg, Denmark)

Att våga sitt tärningskast
Gösta Mittag-Leffler 1846–1927
Arild Stubhaug
Translated from Norwegian by Kjell-Ove Widman
Atlantis 2007
ISBN 978-91-7353-185-6

This book is a biography of Gösta Mittag-Leffler comprising more than 750 pages. It was written by Arild Stubhaug, who is also the author of biographies of Niels Henrik Abel and Sophus Lie and originally published in Norwegian under the title "Med viten og vilje" (Aschehoug 2007); an English edition is in preparation with Springer-Verlag and due in 2009. Arild Stubhaug has a background both in mathematics and literature, making him ideally suited to embark on the monumental task of writing a biography of such a complex and at times controversial person as Gösta Mittag-Leffler.

The book starts in the middle of events, with a description of a visit to Egypt by Gösta Mittag-Leffler and his wife Signe. They were also accompanied by a personal physician. Mittag-Leffler was 53 years old and his wife was 38. The trip lasted from the end of 1899 until Easter 1900. The main reason for the trip was Mittag-Leffler's health problems (in particular stomach problems). This is a recurring theme throughout the biography. The dry desert air seems to have had a beneficial influence.

As can be inferred from this short summary of the introductory chapter, the biography brings us very close to Mittag-Leffler and his daily life, routines and cares. The biography is based on the wealth of material that Mittag-Leffler left behind. Some documents are kept in the National Library of Sweden (Kungliga biblioteket), Stockholm, while other documents are at the Mittag-Leffler Institute in the suburb of Djursholm. The docu-

ments include diaries, letters, newspaper clippings, etc. Arild Stubhaug has carefully researched this wealth of material and distilled out of it a fascinating account of a complex personality.

Mittag-Leffler was born in 1846, the son of Johan Olof Leffler and Gustava Wilhelmina, née Mittag. He had one sister Anne Charlotte (born 1849) and two brothers Fritz (born 1847) and Arthur (born 1854). His father developed a mental disorder and was committed to care from 1870 until his death. This illness might be one of the reasons why Gösta Mittag-Leffler had no children. He was very close to his mother and wrote her many letters. From these letters (and the replies) Arild Stubhaug has gained access to some of his personal thoughts during formative periods of his life. This has given a view of him that would otherwise not be available.

Mittag-Leffler received his doctorate from Uppsala University in 1872. His thesis was on some results in complex analysis. One characteristic of this biography is that it does not provide any details on his mathematical achievements. As a mathematician one may regret this. However, it is not for his mathematical achievements that he deserves a well researched biography.

Probably one of the most important events in his life was the award of a travel grant (Bysantinska resestipendiet) in 1873, allowing him to visit mathematicians in Paris and Berlin. In Paris he visited Hermite and also became acquainted with other French mathematicians. These contacts were to play an important role in his career, for example leading to a close acquaintance with Hermite's student Poincaré. After a semester in Paris he moved to Berlin and met Weierstrass. This connection was to determine the direction of many of his activities in the future. In particular, he heard about Sonja Kovalevsky for the first time.

Mittag-Leffler was called to a professorship at the newly established Stockholms Högskola (later Stockholm University) in 1881 and from that time his base was Stockholm. However he kept up contacts with a large number of European mathematicians during the rest of his career. He often travelled and reports on his travels take up a large part of the biography. See the accompanying translation of a selected chapter in this newsletter issue.

Many of the high points of his career after returning to Stockholm are probably known to many mathematicians. He managed to get Sonja Kovalevsky appointed to a professorship at Stockholms Högskola, he founded the journal Acta Mathematica, and he educated and promoted a number of brilliant Swedish mathematicians, including I. Fredholm. All this, and much more, is meticulously related. Many details are added that most of us probably never knew. For example that the economy of Acta Mathematica was precarious for many years and that Mittag-Leffler paid part of the expenses from his own funds.

Apart from mathematics Mittag-Leffler also had a career as a business man. He invested in many businesses and made and lost money. This is a fascinating part of his life that is exposed in detail for the first time. Again the wealth of written material makes this possible.

At some points in his career he was very wealthy. Towards the end of his life he had very little left. In 1916 on his 70th birthday he and his wife Signe announced in a testament the formation of Makarna Mittag-Lefflers Matematiska Stiftelse under the Royal Academy. The purpose was the formation of a mathematical research institute.[1] The donation included his library and his villa in Djursholm. Extracts of the testament were published in *Acta Mathematica*.

Downturns in his financial situation and other events meant that the vision was not realized for many years. It is fortunate that the donation in 1916 of the library and the villa put those out of reach of his creditors. It was only in the late 1960s that Lennart Carleson managed to secure funding for turning the villa in Djursholm into a world class mathematical research institute.

The impression one gets after reading this comprehensive account is of a very complex personality. So many facets are revealed that it is clear he must have been at times both very charming and able to get close to people of very different personalities, for example Hermite, Painlevé and Weierstrass, and at other times not a person one would like to go up against.

I will not say anything about Gösta Mittag-Leffler and Alfred Nobel. To find out about this you will have to read the book. The account given changed the picture I had of the two and their relations.

The reader is also rewarded with a lively picture of the life and social activities of the upper segment of Swedish society during that period. It is important to see the mathematics and the mathematicians in their contemporary context.

I enjoyed reading this book very much and hope you will do the same.

Arne Jensen *[matarne@math.aau.dk] got his PhD from the University of Aarhus in 1979. He has been a professor of mathematics at Aalborg University since 1988. He served as acting director of the Mittag-Leffler Institute from 1993 to the beginning of 1995. In 2000–01 he was a visiting professor at the University of Tokyo. His research interests are spectral and scattering theory for Schrödinger operators.*

[1] A report on the present Mittag-Leffler Institute appeared in the Newsletter issue 56 (June 2005), pp. 29–30.

Forthcoming conferences

compiled by Mădălina Păcurar (Cluj-Napoca, Romania)

Please e-mail announcements of European conferences, workshops and mathematical meetings of interest to EMS members, to one of the addresses madalina.pacurar@econ.ubbcluj.ro or madalina_ pacurar@yahoo.com. Announcements should be written in a style similar to those here, and sent as Microsoft Word files or as text files (but not as TeX input files).

June 2008

1–7: Applications of Ultrafilters and Ultraproducts in Mathematics (ULTRAMATH 2008), Pisa, Italy
Information: ultramath@dm.unipi.it;
http://www.dm.unipi.it/~ultramath

2–6: International Conference on Random Matrices (ICRAM), Sousse, Tunisia
Information: abdelhamid.hassairi@fss.rnu.tn;
http://www.tunss.net/accueil.php?id=ICRAM

2–6: Thompson's groups: new developments and interfaces, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

3–6: Chaotic Modeling and Simulation International Conference (CHAOS2008), Chania, Crete, Greece
Information: skiadas@asmda.net; http://www.asmda.net/chaos2008

5–6: 12th Galway Topology Colloquium, Galway, Ireland
Information: aisling.mccluskey@nuigalway.ie;
http://www.maths.nuigalway.ie/conferences/topology08.html

6–11: Tenth International Conference on Geometry, Integrability and Quantization, Sts. Constantine and Elena resort, Varna, Bulgaria
Information: mladenov@bio21.bas.bg;
http://www.bio21.bas.bg/conference/

8–14: Mathematical Inequalities and Applications 2008, Trogir – Split, Croatia
Information: mia2008@math.hr; http://mia2008.ele-math.com/

8–14: 34th International Conference "Applications of Mathematics in Engineering and Economics", Resort of Sozopol, Bulgaria
Information: mtod@tu-sofia.bg;
http://www.tu-sofia.bg/fpmi/amee/index.html

9–11: International Conference "Modelling and Computation on Complex Networks and Related Topics" (NetWorks 2008), Pamplona, Spain
Information: networks2008@unav.es;
http://www.fisica.unav.es/networks2008/default.html

9–13: Geometric Applications of Microlocal Analysis, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

9–13: Conference on Algebraic and Geometric Topology, Gdańsk, Poland
Information: cagt@math.univ.gda.pl;
http://math.univ.gda.pl/cagt/

9–13: Educational Week on Noncommutative Integration, Leiden, Netherlands
Information: mdejeu@math.leidenuniv.nl;
http://www.math.leidenuniv.nl/~mdejeu/NoncomIntWeek_2008

9–14: II International Summer School on Geometry, Mechanics and Control, La Palma (Canary Islands), Spain
Information: gmcnet@ull.es;
http://webpages.ull.es/users/gmcnet/Summer-School08/home1.htm

9–14: Colloquium of Non Commutative Algebra, Sherbrooke, Québec, Canada
Information: Ibrahim.Assem@USherbrooke.ca;
http://www.crm.umontreal.ca/~paradis/Sherbrooke/index_e.shtml

9–19: Advances in Set-Theoretic Topology: Conference in Honour of Tsugunori Nogura on his 60th Birthday, Erice, Sicily, Italy
Information: erice@dmitri.math.sci.ehime-u.ac.jp;
http://www.math.sci.ehime-u.ac.jp/erice/

9–20: GTEM/TUBITAK Summer School: Geometry and Arithmetic of Moduli Spaces of Coverings, Istanbul, Turkey
Information: gamsc.school@gmail.com;
http://math.gsu.edu.tr/GAMSC/index.htm

15–22: ESF-MSHE-PAN Conference on Operator Theory, Analysis and Mathematical Physics, Będlewo, Poland
Information: ablondeel@esf.org;
http://www.esf.org/conferences/08279

15–24: CIMPA-School Nonlinear analysis and Geometric PDE, Tsaghkadzor, Armenia
Information: imprs@mis.mpg.de;
http://www.imprs-mis.mpg.de/schools.html

16–17: Fifth European PKI Workshop, Trondheim, Norway
Information: sjouke.mauw@uni.lu;
http://www.item.ntnu.no/europki08/

16–19: 2nd International Conference on Mathematics & Statistics, Athens, Greece
Information: atiner@atiner.gr;
http://www.atiner.gr/docs/Mathematics.htm

16–20: Workshop on population dynamics and mathematical biology, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

16–20: Homotopical Group Theory and Homological Algebraic Geometry Workshop, Copenhagen, Denmark
Information: http://www.math.ku.dk/~jg/homotopical2008/

16–20: Fourth Conference on Numerical Analysis and Applications, Lozenetz, Bulgaria
Information: http://www.ru.acad.bg/naa08/

16–20: Conference on vector bundles in honour of S. Ramanan (on the occasion of his 70th birthday), Miraflores de la Sierra (Madrid), Spain
Information: oscar.garcia-prada@uam.es;
http://www.mat.csic.es/webpages/moduli2008/ramanan/

16–20: 15-th Conference of the International Linear Algebra Society (ILAS 2008), Cancún, Mexico
Information: ilas08@star.izt.uam.mx; http://star.izt.uam.mx/ILAS08/

16–20: The 11th Rhine Workshop on Computer Algebra, Levico Terme, Trento, Italy
Information: michelet@science.unitn.it;
http://science.unitn.it/~degraaf/rwca.html

16–21: International Scientific Conference „Differential Equations, Theory of Functions and their Applications" dedicated to 70th birthday of academician of NAS of Ukraine A.M.Samoilenko, Melitopol, Ukraine
Information: conf2008@imath.kiev.ua;
http://www.imath.kiev.ua/conf2008/

17–20: Structural Dynamical Systems: Computational Aspects, Capitolo-Monopoli, Bari, Italy
Information: sds08@dm.uniba.it;
http://www.dm.uniba.it/~delbuono/sds2008.htm

17–22: International conference "Differential Equations and Topology" dedicated to the Centennial Anniversary of Lev Semenovich Pontryagin, Moscow, Russia
Information: pont2008@cs.msu.ru; http://pont2008.cs.msu.ru

22–27: CR Geometry and PDE's – III, Levico Terme, Trento, Italy
Information: michelet@science.unitn.it;
http://www.science.unitn.it/cirm/AnnCR2008.html

22–28: Combinatorics 2008, Costermano (VR), Italy
Information: combinatorics@ing.unibs.it;
http://combinatorics.ing.unibs.it

23–27: Homotopical Group Theory and Topological Algebraic Geometry, Max Planck Institute for Mathematics Bonn, Germany
Information: admin@mpim-bonn.mpg.de;
http://www.ruhr-uni-bochum.de/topologie/conf08/

23–27: Hermitian symmetric spaces, Jordan algebras and related problems, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

23–27: Conference on Differential and Difference Equations and Applications 2008 (CDDEA 2008), Strečno, Slovak Republic
Information: cddea@fpv.uniza.sk; http://www.fpv.uniza.sk/cddea/

23–27: Workshop on Geometric Analysis, Elasticity and PDEs, on the 60th Birthday of John Ball, Heriot Watt University, Edinburgh, UK
Information: morag.burton@icms.org.uk;
http://www.icms.org.uk/workshops/pde

23–27: First Iberoamerican Meeting on Geometry, Mechanics, and Control, Santiago de Compostela, Spain
Information: gmcnet@ull.es;
http://www.gmcnetwork.org/eia08

23–27: Phenomena in High Dimensions, 4th Annual Conference, Seville, Spain
Information: phd@us.es;
http://www.congreso.us.es/phd/

24–26: Current Geometry, the IX Edition of the International Conference on problems and trends of contemporary geometry, Naples, Italy
Information: http://school.diffiety.org/page82/page82.html

25–28: VII Iberoamerican Conference on Topology and its Applications, Valencia, Spain
Information: cita@mat.upv.es; http://cita.webs.upv.es

30–July 3: Analysis, PDEs and Applications, Roma, Italy
Information: mazya08@mat.uniroma1.it;
http://www.mat.uniroma1.it/~mazya08/

28–July 1: 3rd Small Workshop on Operator Theory, Krakow, Poland
Information: swot08@ar.krakow.pl;
http://www.zzm.ar.krakow.pl/swot08/

30–July 3: Analysis, PDEs and Applications. On the occasion of the 70th birthday of V. Maz'ya, Roma, Italy
Information: mazya08@mat.uniroma1.it;
http://www.mat.uniroma1.it/~mazya08/

30–July 4: Joint ICMI/IASE Study; Teaching Statistics in School Mathematics. Challenges for Teaching and Teacher Education, Monterrey, Mexico
Information: batanero@ugr.es;
http://www.ugr.es/~icmi/iase_study/

30–July 4: Geometry of complex manifolds, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

30–July 4: The European Consortium for Mathematics in Industry (ECMI2008), University College, London, UK
Information: lucy.nye@ima.org.uk; http://www.ecmi2008.org/

30–July 5: 9th Conference on Geometry and Topology of Manifolds, Krakow, Poland
Information: robert.wolak@im.uj.edu.pl;
http://www.im.uj.edu.pl/gtm2008/

July 2008

1–4: VIth Geometry Symposium, Bursa, Turkey
Information: arslan@uludag.edu.tr;
http://www20.uludag.edu.tr/~geomsymp/index.htm

2–4: The 2008 International Conference of Applied and Engineering Mathematics, London, UK
Information: wce@iaeng.org;
http://www.iaeng.org/WCE2008/ICAEM2008.html

2–11: Soria Summer School on Computational Mathematics: "Algebraic Coding Theory" (S3CM), Universidad de Valladolid, Soria, Spain
Information: edgar@maf.uva.es; http://www.ma.uva.es/~s3cm/

3–8: 22nd International Conference on Operator Theory, West University of Timisoara, Timisoara, Romania
Information: ot@theta.ro; http://www.imar.ro/~ot/

7–10: The Tenth International Conference on Integral Methods in Science and Engineering (IMSE 2008), University of Cantabria, Santander, Spain
Information: imse08@unican.es, meperez@unican.es; http://www.imse08.unican.es/

7–10: International Workshop on Applied Probability (IWAP 2008), Compiègne, France
Information: nikolaos.limnios@utc.fr,joseph.glaz@uconn.edu; http://www.lmac.utc.fr/IWAP2008/

7–11: VIII International Colloquium on Differential Geometry (E. Vidal Abascal Centennial Congress), Santiago de Compostela, Spain
Information: icdg2008@usc.es; http://xtsunxet.usc.es/icdg2008

7–11: Spectral and Scattering Theory for Quantum Magnetic Systems, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr; http://www.cirm.univ-mrs.fr

7–11: Algebraic Topological Methods in Computer Science (ATMCS) III, Paris, France
Information: atmcs08@lix.polytechnique.fr; http://www.lix.polytechnique.fr/~sanjeevi/atmcs

7–11: Set Theory, Topology and Banach Spaces, Kielce, Poland
Information: topoconf@pu.kielce.pl; http://www.pu.kielce.pl/~topoconf/

7–12: New Horizons in Toric Topology, Manchester, UK
Information: Helen.Kirkbright@manchester.ac.uk; http://www.mims.manchester.ac.uk/events/workshops/NHTT08/

7–12: International Conference on Modules and Representation Theory, Cluj-Napoca, Romania
Information: aga_team@math.ubbcluj.ro, aga.team.cluj@gmail.com; http://math.ubbcluj.ro/~aga_team/AlgebraConferenceCluj2008.html

13: Joint EWM/EMS Workshop, Amsterdam (The Netherlands)
Information: http://womenandmath.wordpress.com/joint-ewm ems-worskhop-amsterdam-july-13th-2007/

14–17: International Conference on Differential and Difference Equations, Veszprem, Hungary
Information: ddea2008@szt.uni-pannon.hu; http://www.szt.uni-pannon.hu/~ddea2008

14–18: Fifth European Congress of Mathematics (5ECM), Amsterdam, Netherlands
Information: http://www.5ecm.nl

14–18: Efficient Monte Carlo: From Variance Reduction to Combinatorial Optimization. A Conference on the Occasion of R.Y. Rubinstein's 70th Birthday, Sandbjerg Estate, Sønderborg, Denmark
Information: oddbjorg@imf.au.dk; http://www.thiele.au.dk/Rubinstein/

15–18: Mathematics of program construction, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr; http://www.cirm.univ-mrs.fr

15–19: The 5th World Congress of the Bachelier Finance Society, London, UK
Information: mark@chartfield.org; http://www.bfs2008.com

17–19: 7th International Conference on Retrial Queues (7th WRQ), Athens, Greece
Information: aeconom@math.uoa.gr; http://users.uoa.gr/~aeconom/7thWRQ_Initial.html

17–August 1: XI Edition of the Italian Diffiety School, Santo Stefano del Sole (Avellino), Italy
Information: http://school.diffiety.org/page3/page0/page64/page64.html

18–22 : European Open Forum ESOF 2008: Science for a better life, Barcelona, Spain
Information: http://www.esof2008.org

20–23: International Symposium on Symbolic and Algebraic Computation, Hagenberg, Austria
Information: franz.winkler@risc.uni-linz.ac.at; http://www.risc.uni-linz.ac.at/about/conferences/issac2008/

21–24: SIAM Conference on Nonlinear Waves and Coherent Structures, Rome, Italy
Information: meetings@siam.org; http://www.siam.org/meetings/nw08/

21–25: Operator Structures and Dynamical Systems, Leiden, the Netherlands
Information: mdejeu@math.leidenuniv.nl; http://www.lorentzcenter.nl/lc/web/2008/288/info.php3?wsid=288

21–25: Summer School "PDE from Geometry", Cologne, Germany
Information: gk-admin@math.uni-koeln.de; http://www.mi.uni-koeln.de/~gk/school08

21–August 29: CEMRACS, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr; http://www.cirm.univ-mrs.fr

24–26: Workshop on Current Trends and Challenges in Model Selection and Related Areas, University of Vienna, Vienna, Austria
Information: hannes.leeb@yale.edu; http://www.univie.ac.at/workshop_modelselection/

August 2008

3–9: Junior Mathematical Congress, Jena, Germany
Information: info@jmc2008.org; http://www.jmc2008.org/

13–19: XXVII International Colloquium on Group Theoretical Methods in Physics (Group27), Yerevan, Armenia
Information: pogosyan@ysu.am; http://theor.jinr.ru/~group27

14–19: Complex Analysis and Related Topics (The XIth Romanian-Finnish Seminar), Alba Iulia, Romania
Information: rofinsem@gmail.com; http://www.imar.ro/~purice/conferences/Ro-Fin-11/rofin11sem.html

16–31: EMS-SMI Summer School: Mathematical and numerical methods for the cardiovascular system, Cortona, Italy
Information: dipartimento@matapp.unimib.it

18–22: International conference on ring and module theory, Ankara, Turkey
Information: http://www.algebra2008.hacettepe.edu.tr

19–22: Duality and Involutions in Representation Theory, National University of Ireland, Maynooth, Ireland
Information: involutions@maths.nuim.ie;
http://www.maths.nuim.ie/conference/

21–23: International Congress of 20th Jangjeon Mathematical Society, Bursa, Turkey
Information: cangul@uludag.edu.tr, hozden@uludag.edu.tr, inam@uludag.edu.tr; http://www20.uludag.edu.tr/~icjms20/

25–28: The 14th general meeting of European Women in Mathematics (EWM), Novi Sad, Serbia
Information: ewm2009@im.ns.ac.yu;
http://ewm2009.wordpress.com/

25–29: Function spaces, Differential Operators and Nonlinear Analysis, Helsinki, Finland
Information: ljp@rni.helsinki.fi; http://mathstat.helsinki.fi/fsdona

27–29: Journées MAS de la SMAI: Modélisation et Statistiques des Réseaux, Rennes, France
Information: jian-feng.yao@univ-rennes1.fr;
http://mas2008.univ-rennes1.fr/

28–September 2: 9ème Colloque Franco-Roumain de Mathématiques Appliquées, Braşov, Romania
Information: colloque2008@unitbv.ro;
http://cs.unitbv.ro/colloque2008/site/

29–September 2: The International Conference of Differential Geometry and Dynamical Systems (DGDS-2008) and The V-th International Colloquium of Mathematics in Engineering and Numerical Physics (MENP-5, mathematics sections), Mangalia, Romania
Information: dept@mathem.pub.ro; vbalan@mathem.pub.ro
http://www.mathem.pub.ro

31–September 5: The 22nd Summer Conference on Real Functions Theory, Stara Lesna, Slovakia
Information: http://www.saske.sk/MI/confer/lsrf08.html

31–September 6: Summer School on General Algebra and Ordered Sets, Trest, Czech Republic
Information: http://www.karlin.mff.cuni.cz/~ssaos

September 2008

1–5: Representation of surface groups, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

1–5: Conference on Numerical Analysis (NumAn 2008), Kalamata, Greece
Information: numan2008@math.upatras.gr;
http://www.math.upatras.gr/numan2008/

1–6: School (and Workshop) on the Geometry of Algebraic Stacks, Trento, Italy
Information: michelet@science.unitn.it;
http://www.science.unitn.it/cirm/

1–12: School on Algebraic Topics of Automata, Lisbon, Portugal
Information: patricia@cii.fc.ul.pt;
http://caul.cii.fc.ul.pt/SATA2008/

2–5: X Spanish Meeting on Cryptology and Information Security, Salamanca, Spain
Information: delrey@usal.es;
http://www.usal.es/xrecsi/english/main.htm

2–7: International Conference on Geometry, Dynamics, Integrable Systems, Belgrade, Serbia
Information: gdis08@mi.sanu.ac.yu;
http://www.mi.sanu.ac.yu/~gdis08/

6–14: First European Summer School in Mathematical Finance, Dourdan near Paris, France
Information: euroschoolmathfi@cmap.polytechnique.fr;
http://www.ceremade.dauphine.fr/~bouchard/ESCMF/

8–12: Chinese-French meeting in probability and analysis, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

8–10: Calculus of Variations and its Applications From Engineering to Economy, Universidade Nova de Lisboa, Caparica, Portugal
Information: cva2008@fct.unl.pt;
http://ferrari.dmat.fct.unl.pt/cva2008/

8–12: International Workshop on Orthogonal Polynomials and Approximation Theory 2008. Conference in honor of professor Guillermo López Lagomasino's 60th birthday, Universidad Carlos III de Madrid, Leganés, Spain
Information: iwopa08@gmail.com;
http://www.uc3m.es/iwopa08

8–19: EMS Summer School: Mathematical models in the manufacturing of glass, polymers and textiles, Montecatini, Italy
Information: cime@math.unifi.it;
http://web.math.unifi.it/users/cime//

9–12: INDAM Workshop on Holomorphic Iteration, Semigroups and Loewner Chains, Rome, Italy
Information: iterates@mat.uniroma2.it;
http://www.congreso.us.es/holomorphic/

10–12: Nonlinear Differential Equations (A Tribute to the work of Patrick Habets and Jean Mawhin on the occasion of their 65th birthdays), Brussels, Belgium
Information: node2008@uclouvain.be;
http://www.uclouvain.be/node2008.html

12–15: Mathematical Analysis, Differential Equations and Their Applications, Famagusta, North Cyprus
Information: fabdul@mersin.edu.tr;
http://madd2008.emu.edu.tr/contact.php

14–18: 7th Euromech Fluid Mechanics Conference, Manchester, UK
Information: http://www.mims.manchester.ac.uk/events/workshops/EFMC7/

15–19: Geometry and Integrability in Mathematical Physics, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

15–19: International Conference on K-Theory and Homotopy Theory, Santiago de Compostela, Spain
Information: regaca@usc.es;
http://www.usc.es/regaca/ktht/
15–19: 9th SIMAI Congress, Rome, Italy
Information: simai2008@iac.rm.cnr.it; http://www.simai.eu/

16–20: International Conference of Numerical Analysis and Applied Mathematics 2008 (ICNAAM 2008), Psalidi, Kos, Greece
Information: tsimos@mail.ariadne-t.gr; http://www.icnaam.org/

18–21: 6th International Conference on Applied Mathematics (ICAM6), Baia Mare, Romania
Information: vberinde@ubm.ro; http://www.icam.ubm.ro

18–29: Crimean Autumn Mathematical School-Symposium, Batiliman, Ukraine
Information: pavelstarkov@list.ru

19–26: International Conference on Harmonic Analysis and Approximations IV, Tsaghkadzor, Armenia
Information: mathconf@ysu.am;
http://math.sci.am/conference/sept2008/conf.html

21–24: The 8th International FLINS Conference on Computational Intelligence in Decision and Control (FLINS 2008), Madrid, Spain
Information: flins2008@mat.ucm.es;
http://www.mat.ucm.es/congresos/flins2008

22–25: Symposium on Trends in Applications of Mathematics to Mechanics (STAMM 2008), Levico, Italy
Information: stamm08@gmail.com;
http://mate.unipv.it/pier/stamm08.html

22–26: 10th International workshop in set theory, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

22–28: 4th International Kyiv Conference on Analytic Number Theory and Spatial Tessellations, Jointly with 5th Annual International Conference on Voronoi Diagrams in Science and Engineering (dedicated to the centenary of Georgiy Voronoi), Kyiv, Ukraine
Information: voronoi@imath.kiev.ua;
http://www.imath.kiev.ua/~voronoi

29–October 3: Commutative algebra and its interactions with algebraic geometry, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

29–October 8: EMS Summer School: Risk theory and related topics, Będlewo, Poland
Information: stettner@iman.gov.pl;
www.impan.gov.pl/EMSsummerSchool/

October 2008

3–5: II Iberian Mathematical Meeting, Badajoz, Spain
Information: imm2@unex.es; http://imm2.unex.es

5–12: International Conference "Differential Equations. Function Spaces. Approximation Theory" dedicated to the 100th anniversary of the birthday of S.L. Sobolev, Novosibirsk, Russia
Information: sobolev100@math.nsc.ru;
http://www.math.nsc.ru/conference/sobolev100/english

6–10: Partial differential equations and differential Galois theory, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

9–11: Algebra, Geometry and Mathematical Physics, Tartu, Estonia
Information: agmf@astralgo.eu; http://www.agmf.astralgo.eu/tartu08/

9–12: The XVI-th Conference on Applied and Industrial Mathematics (CAIM 2008), Oradea, Romania
Information: serban_e_vlad@yahoo.com; http://www.romai.ro

13–17: Hecke algebras, groups and geometry, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

20–24: Symbolic computation days, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

22–24: International Conference on Modeling, Simulation and Control 2008, San Francisco, USA
Information: wcecs@iaeng.org;
http://www.iaeng.org/WCECS2008/ICMSC2008.html

26–28: 10th WSEAS Int. Conf. on Mathematical Methods and Computational Techniques in Electrical Engineering (MMACTEE 8), Corfu, Greece
Information: info@wseas.org;
http://www.wseas.org/conferences/2008/corfu/mmactee/

26–28: 7th WSEAS Int. Conf. on Non-Linear Analysis, Non-Linear Systems and Chaos (NOLASC 8), Corfu, Greece
Information: info@wseas.org;
http://www.wseas.org/conferences/2008/corfu/nolasc/

26–31: New trends for modeling laser-matter interaction, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

27–31: New trends for modeling laser-matter interaction, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

November 2008

3–7: Harmonic analysis, operator algebras and representations, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

5–7: Fractional Differentiation and its Applications, Ankara, Turkey
Information: dumitru@cankaya.edu.tr;
http://www.cankaya.edu.tr/fda08/

5–7: Modern Problems of Differential Geometry and General Algebra, Saratov City, Russia
Information: vagner2008@bk.ru;
http://mexmat.sgu.ru/vagner2008.php?lang=en

10–14: The 6th Euro-Maghreb workshop on semigroup theory, evolution equations and applications, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

17–21: Geometry and topology in low dimension, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

21–22: International Conference on Nolinear Analysis and Applied Mathematics, Targoviste, Romania
Information: dteodorescu2003@yahoo.com;
http://icnaam.valahia.ro/

24–28: Approximation, geometric modelling and applications, CIRM Luminy, Marseille, France
Information: colloque@cirm.univ-mrs.fr;
http://www.cirm.univ-mrs.fr

December 2008

1–5: Homology of algebra: structures and applications, CIRM Luminy, Marseille, France
information: colloque@cirm.univ-mrs.fr; http://www.cirm.univ-mrs.fr

8–12: Latent variables and mixture models, CIRM Luminy, Marseille, France
information: colloque@cirm.univ-mrs.fr; http://www.cirm.univ-mrs.fr

15–19: Meeting on mathematical statistics, CIRM Luminy, Marseille, France
information: colloque@cirm.univ-mrs.fr; http://www.cirm.univ-mrs.fr

16–18: Eighth IMA International Conference on Mathematics in Signal Processing, Cirencester, UK
Information: pam.bye@ima.org.uk;
http://www.ima.org.uk/Conferences/signal_processing/signal_processing08.html

February 2009

5-8 : European Student Conference EUROMATH 2009, Cyprus
Information: www.euromath.org

March 2009

15-20: ALGORITMY 2009 – Conference on Scientific Computing, High Tatra Mountains, Podbanske, Slovakia
Information: algoritm@math.sk; http://www.math.sk/alg2009

July 2009

6–10: 26th Journées arithmétiques, Saint-Etienne, France
Information: ja2009@univ-st-etienne.fr;
http://ja2009.univ-st-etienne.fr

Recent Books

edited by Ivan Netuka and Vladimír Souček (Prague)

Books submitted for review should be sent to: Ivan Netuka, MÚUK, Sokolovská, 83, 186 75 Praha 8, Czech Republic.

C. D. Aliprantis, R. Tourky: Cones and Duality*, Graduate Studies in Mathematics, vol. 84, American Mathematical Society, Providence, 2007, 279 pp., USD 55, ISBN 978-0-8218-4146-4*
Ordered vector spaces and cones were introduced in mathematics at the beginning of the 20th century and were developed in parallel with functional analysis and operator theory. Since cones are employed to solve optimization problems, the theory of ordered vector spaces is an indispensable tool for solving a variety of applied problems appearing in areas such as engineering, econometrics and the social sciences.

The aim of this book is to present the theory of ordered vector spaces from a contemporary perspective, which has been influenced by a study of ordered vector spaces in economics as well as other recent applications. The material is spread out in eight chapters. The first chapters start with fundamental properties of wedges and cones and illustrate a variety of remarkable results from the connection between the topology and the order. The role of the Riesz decomposition property and normal cones is pointed out. The next section studies in detail cones in finite dimensional spaces and polyhedral cones. The authors proceed with a presentation of the fixed points and eigenvalues of Krein operators. Further chapters contain material on K-lattices, Riesz-Kantorovich functionals and piecewise affine functions, which is a topic that has not been included in any monograph before. The last chapter serves as an appendix on linear topologies and their basic properties.

At the end of each section, there is a list of exercises of varying degrees of difficulty designed to help the reader to better understand the material. This aim is further supported by the provision of hints to selected exercises. Since the topics discussed in the book have their origins in problems from economics and finance, the book will be valuable not only for students and researchers in mathematics but also for those interested in economics, finance and engineering. (jsp)

J. Appell, M. Väth: Elemente der Funktionalanalysis, *Vieweg, Wiesbaden, 2005, 349 pp., EUR 24,90, ISBN 3-528-03222-7*
This book provides an elementary introduction to both linear and nonlinear functional analysis. The authors emphasize the variability of infinite dimensional spaces and highlight the role of compactness. The linear part of the book covers classical means of doing functional analysis (normed linear spaces and operators, the criteria of compactness in varied spaces and the Riesz-Schauder theory of compact operators). The second part of the book concentrates mainly on fixed point theorems (Banach, Brouwer, Schauder, Darbo, Borsuk). The appendix includes the Baire category theorem, bases in Banach spaces, the Weierstrass approximation theorem and the Tietze-Urysohn and Dugundji extension theorems.

Each chapter ends with many exercises and problems of varying difficulty, which give further applications and exten-

sions of the theory. The book is easily understandable and it can be warmly recommended to graduate students in mathematics, physics, biology, chemistry and engineering as a neat introduction to functional analysis. (jl)

***G. Balkerma, P. Embrechts: High Risk Scenarios and Extremes**, Zurich Lectures in Advanced Mathematics, European Mathematical Society, Zurich, 2007, 375 pp., EUR 48, ISBN 978-3-03719-035-7*

The problem of multivariate extremes and their financial application is of central interest in the field of quantitative risk management and it is the main topic of this monograph. The book is divided into five parts and twenty chapters. After a description of motivations, the first part contains an introduction to the theory of point processes and their applications in extreme value theory. The second part covers the classical univariate and multivariate extreme value theories. The coordinate-wise approach and max-stable distributions are discussed here.

The main part of the book comprises parts III and IV. In the third part a modern geometric (coordinate free) approach to multivariate extremes is broadly studied. Particular interest is paid to heavy tailed distributions and to the generalized Pareto distribution (candidate multivariate extension of the GPD). Extreme value theory is often based on threshold exceedance, which is studied in the fourth part of the book. There is no unique threshold in the multivariate case and the authors study two classes (horizontal and elliptic) of thresholds. In the last part of the book, some open problems in the theory and statistical applications of multivariate extremes are summarized.

The book is written with a broad audience of theoretical and applied mathematicians in mind. Problems are mostly motivated by examples from insurance and finance (portfolio theory) but their solution is purely mathematical. The level of rigour in the book is very high and to understand all the techniques of modern extreme value theory, a solid mathematical background is required. On the other hand, if one just needs to apply the results, the proofs and technical sections may be skipped. The book can also be recommended as the basis for an advanced course on multivariate extreme value theory. (dh)

***W. Byers: How Mathematicians Think. Using Ambiguity**, Contradiction, and Paradox to Create Mathematics, Princeton University Press, Princeton, 2007, 415 pp., USD 35, ISBN 978-0-691-12738-5*

A lot has been said and written about the philosophy of mathematics, yet not enough. There are too many unanswered questions. For example, is mathematics discovered or created? There still seems to be room for a good book in this field, and this one is wonderful, a must-read for everyone interested in mathematics, philosophy and/or history. One of the most pervasive myths about mathematics is that it is a dull technocratic discipline carried out by grim computer-like minds that have no feelings and who work without intuition, ambiguity or doubt and produce strictly formal algorithms and theorems free of contradictions, conflicts and paradoxes. Such myths, unfortunately still rather common among 'outsiders', call for such a book.

The author, a great mathematician and philosopher, and also a practitioner of Zen-Buddhism, shows how essential non-logical qualities are in mathematical research and creativity and that the secret of successful mathematics is not in its logical structure, or at least not only there. Excellent discussions are presented about ambiguity, contradiction, paradox and their central role in the world of mathematical discovery. (lp)

***A. Carbery et al., Eds.: Complex and Harmonic Analysis**, Proceedings, May 25-27, 2006, Thessaloniki, DEStech Publications, Lancaster, 2007, 327 pp., USD 89,50, ISBN 978-1-932078-73-2*

This book represents the proceedings of the international conference on complex and harmonic analysis, which was held in May 2006 at the Aristotle University of Thessaloniki. The volume contains 23 articles from a broad range of topics including geometric function theory, complex iteration, function spaces, composition operators, extremal problems, potential theory, maximal functions, analysis on manifolds and others. The conference was dedicated to the memory of Nikos Danikas (a member of Thessaloniki University) who died in 2004. The introductory paper on the mathematical work of Nikos Danikas is written by W.K. Hayman and it is followed by an article on Danikas measures written by V. Nestoridis. The book can be recommended to students and researchers in the area. (jl)

***A. D. D. Craik: Mr Hopkins' Men. Cambridge Reform and British Mathematics in the 19th Century**, Springer, Berlin, 2007, 405 pp., 78 fig., EUR 99.95, ISBN 978-1-84628-790-9*

This book gives a fascinating view of Cambridge University during the Victorian era. It is divided into two parts. The first part "Educating the Elite" describes the system of education in Cambridge, its dramatic changes in the 19th century and its role in the development of the mathematical sciences in Britain. The author describes the evolution of curricula and reforms leading to Cambridge's dominance of British higher education. The Cambridge reforms are analysed in a comprehensive context (the role of political decisions, the influence of the church and parliament, the development of the town and colleges in Cambridge, life at the university, social interest in higher education and scientific work, and so on). A detailed biography of William Hopkins, the most remarkable tutor in Cambridge in the mid-19th century, and an appreciation of his mathematical achievements have been created with the help of a study of archival sources. Brief biographies of Hopkins' top students from 1829 up to 1854 are added at the end of the first part. Pencil and watercolour portraits of top students from Hopkins' own collection (attributed to the artist T. C. Wageman, who created them between 1829 and 1852) are published here for the first time.

The second part "Careers of the Wrangles" is devoted to a description of the careers of some top students and graduates (so-called Wrangles) including many famous scientists and mathematicians, professors at English and Scottish universities and colleges, first professors in Australia, official educators overseas and throughout the colonies, tutors of prominent people (for example an Indian maharajah), churchmen, etc. Detailed biographies of four excellent scientists (G. Green, J. C. Adams, G. G. Stokes and H. Goodwin) are included. At the end of the second part, the author describes the transformation of Cambridge from an unimportant institution into a world centre for mathematical and physical sciences and education. Various topics are discussed (growth of a research community, the birth of journals, the development of scientific institutions, the analysis of achievements in mathematical sciences before 1830 and then from 1830 up to 1880).

The book can be recommended to people who are interested in the history of Victorian Britain in general and in the history of Cambridge University, mathematical education, mathematics, and scientific life and work, as well as the connections of science and religious belief, politics, etc. (mbec)

P. Daskalopoulos, C.E. Kenig: Degenerate Diffusions. Initial Value Problems and Local Regularity Theory*, Tracts in Mathematics, vol. 1, European Mathematical Society, Zürich, 2007, 198 pp., EUR 48, ISBN 978-3-03719-033-3*

This book is devoted to the study of nonnegative solutions of the Cauchy initial value problem or the Dirichlet boundary value problem for a class of nonlinear evolution differential equations $\partial u/\partial t = \Delta\, \varphi(u)$ on R^n x (0,T) or on a cylinder B x (t1,t2), where the nonlinearity φ is assumed to be continuous and increasing with $\varphi(0) = 0$, and is assumed to satisfy the growth condition $a \le [u\, \varphi'(u)]/[\varphi(u)] \le 1/a$ for all $u > 0$ for a in (0,1) and the normalization condition $\varphi(1) = 1$. This class forms a natural generalization of the power case $\varphi(u) = u^m$ and has a wide range of applications both in physics and in geometry. In 1940, D. Widder characterized the set of all nonnegative weak solutions of the Cauchy problem for the heat equation on the strip R^n x (0,T) by five fundamental properties.

The authors are interested in analogues of these properties for the nonlinearities φ described above. The results are divided into two groups according to the growth of φ. The first group concerns the case of "slow diffusion" and it is characterized in the power case by the condition $m > 1$. The second group includes the supercritical "fast diffusion" case, which generalizes the case $\varphi(u) = u^m$ for $(n-2)/n < m < 1$. Besides the items mentioned above, the book collects together local regularity results in chapter 1 (a priori L^∞ bounds, the Harnack inequality and equicontinuity of solutions to the slow diffusion case) and a proof of continuity of weak solutions to the porous medium equation in the final (fifth) chapter.

The book gives an up-to-date, clear and concise overview of results concerning degenerate diffusion together with powerful methods and useful techniques for studying existence and qualitative properties of solutions. A number of comments and discussions of various topics, a brief summary of further known results and some open problems are listed in the last section of each chapter and an up-to-date bibliography will be appreciated by both researchers and graduate students with a background in analysis and partial differential equations. (jsta)

P. Drábek, J. Milota: Methods of Nonlinear Analysis. Applications to Differential Equations*, Birkhäuser Advanced Texts, Birkhäuser, Basel, 2007, 568 pp., EUR 74.79, ISBN 978-3-7643-8146-2*

In many cases, existence problems in the theory of differential equations and in the calculus of variations refer to results of nonlinear analysis in abstract infinite-dimensional spaces. For example, the problem of finding stationary points of a functional in the calculus of variations may lead to an abstract saddle point theorem. To prove existence of a solution of a problem in the theory of partial differential equations, fixed points and other topological tools of nonlinear operator theory are often useful. The book shows methods of how to apply abstract nonlinear analysis to specific problems. Thus both nonlinear functional analysis and application sections are well developed.

The list of all the topics would be too long so we will only mention the main themes. The exposition of differential calculus in normed linear spaces discusses the inverse function theorem and the implicit function theorem. Some further topics are specific to finite dimensions; they include the rank theorem, finite-dimensional bifurcation theorems, integration of differential forms on manifolds with Stokes' theorem and the Brouwer degree. The topological methods in nonlinear analysis are based on infinite-dimensional generalizations of the degree. The Leray-Schauder degree is available for compact perturbations of the identity operator. Another extension of the concept of degree can be used for monotone operators and their generalizations. Applications include fixed point theorems, global bifurcation theorems and existence theorems based on subsolutions and supersolutions.

The exposition of variational methods starts with a classical analysis of extrema on infinite dimensional spaces and direct methods of the calculus of variations. The analysis of stationary points covers bifurcation of potential operators, the mountain pass lemma, the Lusternik-Schnirelmann method and other tools for searching saddle points. Finally, the last chapter is devoted to a systematic treatment of classical and weak solutions of partial differential equations, demonstrating techniques developed in the preceding text. The authors reveal the fruits of their long and rich teaching experience. The presentation is self-contained and covers all the fundamental tools of nonlinear analysis. On the other hand, they also organize advanced excursions, mostly as appendices, to topics of interest and some parts are developed up to recent research level. Consequently, this volume can be used as a reference book or a textbook, especially as an important source of knowledge and inspiration for university students and teachers of all levels. (jama)

H. Dym: Linear Algebra in Action, Graduate Studies in Mathematics*, vol. 78, American Mathematical Society, Providence, 2007, 541 pp., USD 79, ISBN 978-0-8218-3813-6*

This is a book on linear algebra, playing an important role in pure and applied mathematics, computer science, physics and engineering. The book is divided into 23 chapters and 2 appendices. The first six chapters and some selected parts from chapters 7-9 are based on classical linear algebra topics. The reader will find here many interesting principles and results concerning vector spaces, Gaussian elimination and its applications, determinants, eigenvalues and eigenvectors, Jordan forms and their calculations, normed linear spaces, inner product spaces and orthogonality, and symmetric, Hermitian and normal matrices. The next three chapters are devoted to singular values and related inequalities, pseudoinverses and triangular factorization and positive definite matrices.

Chapter 13 treats difference equations, differential equations and their systems. Chapters 14-16 contain applications to vector valued functions, the implicit function theorem and extremal problems. The subsequent chapters deal with matrix valued holomorphic functions, matrix equations, realization theory, eigenvalue location problems, zero location problems, convexity and matrices with nonnegative entries. Two appendices describe useful facts from complex function theory. The book offers basic and advanced techniques of linear algebra from the point of view of analysis. Each technique is illustrated by a wide sample of applications and it is accompanied by many exercises of

varying difficulty, which give further extensions of the theory. The book can be recommended as a general text for a variety of courses on linear algebra and its applications, as well as a self-study aid for graduate and undergraduate students. (mbec)

***H.-D. Ebbinghaus: Ernst Zermelo – An Approach to His Life and Work**, Springer, Berlin, 2007, 356 pp., EUR 49.95, ISBN 978-3-540-49551-2*

This book gives the first English, detailed scientific biography of Ernst Zermelo (1871–1953), a German mathematician best known for a formulation of the axiom of choice and for an axiomatization of set theory. He is considered to be one of the greatest logicians in the first half of the 20th century. In five chapters, the author describes Zermelo's life and his scientific achievements from his youth through his studies, works, teaching and scientific activities. The author also analyses Zermelo's conditions for scientific study and research before, during and after World War II, his isolation during the war and his activities after the war. Zermelo's major scientific contributions (in set theory, the calculus of variations, the theory of games, the theory of rating systems, applied mathematics) are discussed without assuming a detailed mathematical knowledge of the field in question.

The presentation of Zermelo's works explores his motivations, aims, acceptance and influence on the development of mathematics. The book is based on a study of unknown and unpublished sources, archival materials, private letters, family documents, previously unpublished notes, interviews and memoirs. The main text is followed by a schematic curriculum vitae of Ernst Zermelo summarizing the most important events of his life. The book concludes with an appendix containing a German version of Zermelo's unpublished ideas and parts of his works (for example selected proofs), his original letters, notes and samples of his literary activities. The book contains more than 40 photos and facsimiles, a large list of references and an index. It gives new light to all facets of Zermelo's life and mathematical achievements and it can be recommended to a wide audience. The book is suitable for mathematicians, historians of mathematics and science, students and teachers. (mbec)

***J. Friberg: A Remarkable Collection of Babylonian Mathematical Texts**, Sources and Studies in the History of Mathematics and Physical Sciences, Springer, Berlin, 2007, 533 pp., EUR 99.95, ISBN 978-0-387-34543-7*

This fascinating book presents 121 unpublished mathematical clay tablets from the Norwegian Schøyen Collection including many interesting tablets from the Early Dynastic III period (circa 2600–2350 BC) up to the Late Kassite period (circa 14th–13th century BC). Based on descriptions, transliterations, translations, interpretations, analysis and synthesis of the mathematical cuneiform texts and their comparison with previously published mathematical clay tablets, the author has made numerous amazing discoveries and has created a new comprehensive treatment of Old Babylonian mathematical texts. The book is divided into 12 chapters, 10 appendices, a vocabulary for MS texts, an index of subjects, an index of texts and a large list of references.

The author starts with an introduction explaining how to better understand mathematical cuneiform texts. He explains mathematical terminology, cuneiform systems of notations for numbers and measures, operations with sexadecimal numbers (addition, subtraction, multiplication, division, and an ingenious factorization method for the computation of reciprocals and square roots). Then he explains the use of the Old Babylonian standard tablets of squares, square roots, cube roots and reciprocals, as well as the non-standard tablets of "quasi-cube roots". The next chapters are devoted to a discussion of Old Babylonian metrological systems (standard types for volumes, area, length and weight are described).

A large part of the book analyses some typical Babylonian geometrical problems (computation of the area of a triangle, a trapezoid or a circle; computation of the diagonals of the sides of a square; the problem of how to inscribe and circumscribe circles, triangles and squares, how to divide figures into other figures with given special properties, and how to change figures to other figures, while retaining the area; computation of the volume of prisms, cubes and cylinders; construction of labyrinths, mazes, decorative patterns and ground plans of palaces), some typical algebraic problems (arithmetic and geometric progressions, solutions of linear and quadratic equations and their systems) and some problems from daily life (construction of walls, building of a ramp, dividing works, money and so on). Many pictures, drawings and coloured photos of the most interesting tablets are also included. The book opens up Babylonian mathematics to a new generation of mathematicians, historians of science and mathematics, teachers and students. It can therefore be recommended to a wide audience. (mbec)

***B. Fristedt, N. Jain, N. Krylov: Filtering and Prediction – A Primer,** Student Mathematical Library, vol. 38, American Mathematical Society, Providence, 2007, 252 pp., USD 39, ISBN 978-0-8218-4333-8*

This book is mainly intended as an introduction to the problem of filtering and prediction in time homogeneous Markov chains and the Wiener process. The problem of how to estimate an unobservable signal based on an available observation of response (a signal corrupted by noise) is known as filtering. Prediction means estimating the future of a random process based on its history.

The first two chapters of the book are introductory and deal with basic probability concepts and discrete Markov chains. In the third chapter, the discrete Markov chains are used as the simplest model for an introduction of the filtering problem. In chapter 4, the conditional expectation is introduced as a necessary tool for continuous (in space and/or time) processes. The continuous space Markov chains are then discussed in chapter 5; the famous Kalman filter is described and the chapter closes with linear filtering. Chapter 6 covers filtering for the Wiener process and the continuous time Kalman filter is introduced in a classical setting. The last two chapters deal with the prediction problem in stationary random sequences.

The book is written in an elementary way (no special knowledge of probability and statistics is needed to read the book) but it is still mathematically rigorous. The book can be recommended to all students interested in stochastic models. Since the book contains many problems and remarks, it can also be recommended as the basis of a one semester introductory course; almost all theorems are proved and problems may be used as homework assignments although some of the problems are more challenging than others. (dh)

***M. Giaquinta, G. Modica: Mathematical Analysis – Linear and Metric Structures and Continuity**, Birkhäuser, Boston, 2007, 465 pp., EUR 119, ISBN 978-0-8176-4374-4*

This book provides a comprehensive explanation of the background of functional analysis and its origins. It is divided into three parts. It begins with a careful and inspiring exposition of basic ideas on linear and metric structures. The second part is dedicated to the role of general topological notions in the framework of metric spaces. These two parts help the reader to prepare for the main principles of functional analysis, which are then explained in the third part of the book. At each step, theory is accompanied by important examples and applications. Carefully chosen exercises stimulate the reader to work actively with the text. On the whole, this self-contained and up-to-date book can be very useful not only to the advanced undergraduate or graduate student but also to anybody who wants to systemize their knowledge on the elements of the subject. (oj)

***J. J. Gray, K. H. Parshall, Eds.: Episodes in the History of Modern Algebra (1800–1950)**, History of Mathematics, vol. 32, American Mathematical Society, Providence, 2007, 336 pp., USD 69, ISBN 978-0-8218-4343-7*

This book offers new light on the development and history of modern algebra. The book brings together suitably revised, chapter-length versions of twelve lectures that were given at the workshop on the history of 19th and 20th century algebra held at the Mathematical Sciences Research Institute in Berkeley in 2003.

The introduction and chapters written by prominent mathematicians and historians of mathematics (J. J. Gray, K. H. Parshall, E. L. Ortiz, S. E. Despeaux, O. Neumann, H. M. Edwards, G. Frei, J. Schwermer, D. D. Fenster, Ch. W. Curtis, L. Corry, N. Schappacher, S. Slembek, C. McLarty) provide complex and detailed overviews of the evolution of modern algebra from the early 19th century work of Ch. Babbage on function equations through to the description of the development of calculus operations (British research done before and documented within the Cambridge Mathematical Journal), the analysis of divisibility theories in the early history of commutative algebra (contributions by C. F. Gauss, E. E. Kummer, E. I. Zolotarev, L. Kronecker, D. Hilbert, E. Noether, etc.), a presentation of Kronecker's fundamental theorem on general arithmetic, a description of advances in the theory of algebras and algebraic number theory (works by J. H. M. Wedderburn, A. Hurwitz, R. Brauer, H. Hasse, E. Noether, H. Minkowski, K. Hensel, L. Dickson, A. A. Albert, etc.) and in the analysis of the foundations of algebraic geometry and its arithmetization and development (results of H. Hasse, E. Noether, F. Severi, A. Grothendieck, etc.).

The topics discussed represent the long and difficult process of the changing organization of the main subjects, the changing algebraic themes, ideas and concepts, as well as the results of mathematical communication and collaboration within and across national boundaries. A comprehensive list of references as well as many detailed notes are added at the end of each chapter. The book can be recommended to readers who are interested in the history of modern mathematics in general and modern algebra in particular. It is suitable for mathematicians, historians of mathematics and science, teachers and students. (mbec)

***M. Greenacre: Correspondence Analysis in Practice**, 2nd edition, Chapman and Hall/CRC, Boca Raton, 2007, USD 79,95, ISBN 1-58488-616-1*

The previous edition, published in 1993, has been totally revised and extended. Like the first edition, this book is intended to be practically oriented and didactic. The author's wish is to represent in each of the 25 chapter (and five appendices) a fixed amount of material. As a result, each chapter is exactly eight pages in length to offer a fixed amount of material both for reading and teaching. However, this does not always have pleasant consequences in some chapters, where more information would be useful for the reader. A short summary of the main points in the form of a list concludes each chapter.

As in the first edition, the book's main thrust is toward the practice of correspondence analysis, so that most technical issues and mathematical aspects are gathered in appendix A. The theoretical part here is more extensive than that of the first edition, including additional theory on new topics such as canonical correspondence analysis, transition and regression relationships, stacked tables, subset correspondence analysis and the analysis of square tables. Concerning computational issues, a very strong feature of this edition is the use of the R program for all computations. The lengthy appendix B (45 pages) summarizes (on examples) possibilities of relating macros from R. In addition to that, three different technologies are described enabling the creation of the graphical displays presented in the book. No references at all are given in the 25 chapters; a relatively brief bibliography in appendix C is given to point readers toward further reading containing a more complete literature guide. A glossary of the most important terms and an epilogue with some final thoughts conclude the book.

Summarizing, this is a nice book for all those who wish to acquaint themselves with a versatile methodology of correspondence analysis and the way it can be used for the analysis and visualization of data arriving typically from the fields of social, environmental and health sciences, marketing and economics. Numerous examples provide a real flavour of the possibilities of the method. (jant)

***D. D. Haroske, H. Triebel: Distributions, Sobolev Spaces, Elliptic Equations**, EMS Textbooks in Mathematics, European Mathematical Society, Zürich, 2007, 294 pp., EUR 48, ISBN 978-3-03719-042-5*

Many problems in mathematical physics reduce to elliptic differential equations of second order and their boundary value problems, and also to the spectral theory of such operators. Central role are played by the Dirichlet problem, the Neumann problem and the eigenvalue and eigenfunction problem. The main aim of the book is to develop the L_2 theory of the listed problems on bounded domains with smooth boundaries in Euclidean space. This is done in a reader-friendly way at a moderate level of difficulty, aiming at graduate students and their teachers.

Among the topics covered, we find the classical theory of the Laplace-Poisson equation, the theory of distributions, the theory of Sobolev spaces on domains, abstract spectral theory in Hilbert and Banach spaces and compact embeddings. One of the principal assets of the book is a very good, friendly and accessible introduction to various aspects of function space theory and their applications in the theory of partial differential

equations. The book is richly furnished with interesting exercises and a thorough set of notes is attached to each chapter. This is an ideal book for both students and teachers of a modern graduate course on partial differential equations. (lp)

***M. Hata: Problems and Solutions in Real Analysis**, Series on Number Theory and Its Applications, vol. 4, World Scientific, New Jersey, 2007, 292 pp., USD 42, ISBN 978-981-277-949-6*

As is well-known, we learn mathematics by trying to solve problems. A fascinating thing about mathematics is that even when we do not succeed in actually solving a given problem, we can still gain something by trying to solve it, for example by learning or developing new techniques.

The author presents over 150 very interesting mathematical problems and their detailed solutions. The majority of the questions belong to real analysis, while some of them are taken from analytic number theory (such as those concerning the uniform distribution or a proof of the prime number theorem, which a reader accesses in an elementary way through several exercises). The book is divided into 18 chapters, each of which starts with a list of some basic knowledge in the field followed by problems and their solutions. Topics include sequences and limits, infinite series, continuous functions, differentiation, integration, improper integrals, series of functions, approximation by polynomials, convex functions, the formula evaluating the Riemann zeta function at 2, functions of several variables, the uniform distribution, Rademacher functions, Legendre polynomials, Chebyshev polynomials, Gamma functions and the prime number theorem.

The standard of problems varies from easy, aimed at undergraduate students of calculus and linear algebra, to deep and complex, which could challenge experts. The text contains many useful and interesting historical comments on various significant mathematical results in real analysis, and is accompanied with corresponding references. (lp)

***L. Hathout: Crimes and Mathdemeanors,** A.K. Peters, Wellesley, 2007, 196 pp., USD 14.95, ISBN 978-1-56881-260-1*

As the title suggests, this book is something of a detective story with a mathematical slant. Fourteen chapters contain fourteen cases with more or less criminal plots, solved by a fourteen year old Ravi, a brilliant high school student and mathematics genius who is able to reduce tangled criminal cases that baffle police and lawyers to mathematics, logic and probability, and to solve them. Amazingly, the author is a high school student himself. He has managed to hide intriguing math problems within cleverly written criminal mysteries including murder and fraud. Readers are invited to challenge their own wits and try to solve the mysteries themselves. Each case is followed by an analysis, in which the mathematical or logical background of the crime is clearly formulated. Ravi's brilliant solution comes next, followed by an extension to more general or more complicated mathematical questions.

Only high school mathematics (combinatorics, finite probability, elementary inequalities, geometry, algebra, etc.) and physics is needed for solving all the problems, except one for which a bit of integration is required. Therefore the book will bring pleasure to a very broad (not necessarily mathematical) public of interested readers who like mysteries and solving conundrums. (lp)

***P. M. Higgins: Nets, Puzzles, and Postmen. An Exploration of Mathematical Connections,** Oxford University Press, Oxford, 2007, 247 pp., GBP 15.99, ISBN 978-0-19-921842-4*

In this lovely and fascinating book, the author describes the world and the main functions of networks, which are all around us (from age-old examples, such as family trees, to the modern phenomena of the Internet and the World Wide Web). Beginning with structures of chemical isomers, family trees, simple mathematical puzzles (for example tic-tac-toe, familiar logic games, exotic squares, Sudoku) and famous mathematical problems (the bridges of Königsberg, the hand-shaking problem, the Hamilton cycle, the party problem), the author explains how networks are represented, how they work, and how they can be described, deciphered and understood. After some puzzles and games, the author introduces examples and applications of networks from natural sciences, social sciences, technology, economics, transportation sciences and genetics. Various topics are discussed (the four-colour map problem, guarding the museum, the Brouwer fixed point theorem, the Chinese postman problem, nets as machines, automata, planning routes, maximizing profits, the quick route, spanning networks, secret codes, RNA reconstructions, labyrinths and mazes and so on).

Understanding the book does not require a deep mathematical knowledge. For the reader wanting to study these topics from a mathematical point of view, the final chapter "For Connoisseurs" can be recommended. The book will open the eyes of the reader to hidden networks, hence it can be recommended to people wanting to discover a remarkable new view of our world. (mbec)

***A. Iosevich: A View from the Top. Analysis, Combinatorics and Number Theory**, Student Mathematical Library, vol. 39, American Mathematical Society, Providence, 2007, 136 pp., USD 29, ISBN 978-0-8218-4397-0*

The author has based this nice little book on a capstone course that he has taught to upper division undergraduate students, the main objective of which was to explain, in a visual way, a unity of mathematics and interactions between its fundamental areas such as analysis, algebra, number theory, topology, basic counting and probability theory. Such courses are unfortunately taught rather rarely; the book will thus be a tremendous asset and an endless source of inspiration to anyone who has a course like that in mind.

Starting with basic inequalities of Cauchy-Schwarz and Hölder, the author proceeds by pursuing their applications in geometry, then turns attention to the Besicovitch-Kakeya conjecture on a connection of the size of a set with a number of contained line segments with different slopes, a central problem in contemporary harmonic analysis, and then presents some brilliant ideas concerning basic counting (combinatorics, the binomial theorem, expected values, random walks, etc.) and probability reasoning, and finishes with oscillatory integrals, trigonometric sums and Fourier analysis with applications to geometry and number theory. The basic idea is to get the reader enthusiastic about mathematical research by observing the evolution of ideas. Most of the book requires no prerequisites (just high school mathematics) but for some chapters the reader is supposed to have certain knowledge about functions of several variables. (lp)

***M. Jarnicki, P. Pflug: First Steps in Several Complex Variables – Reinhardt Domains**, EMS Textbooks in Mathematics, European Mathematical Society, Zürich, 2008, 359 pp., EUR 58, ISBN 978-3-03719-049-4*

This book gives a nice introduction to some parts of the theory of several complex variables. It concentrates on a study of the properties of a special class of domains called Reinhardt domains.

Some basic notions in the theory (domains of holomorphy, holomorphic convexity, pseudoconvexity) can be nicely introduced and studied in the setting of Reinhardt domains without too many technical details. In the first chapter of the book, the authors present such an introduction to problems arising in connection to the holomorphic continuation of holomorphic functions in several complex variables. Biholomorphisms of domains and the Cartan theory in the setting of Reinhardt domains are treated in the second chapter. A short third chapter contains a discussion of S-domains of holomorphy for various special classes S of holomorphic functions. The last chapter is devoted to a study of holomorphically contractible families on Reinhardt domains and it includes a lot of explicit calculations in specific cases. Many results presented in the book are based on research by both authors. (vs)

***N. L. Johnson, V. Jha, M. Biliotti: Handbook of Finite Translation Planes**, Pure and Applied Mathematics, vol. 289, Chapman & Hall/CRC, Boca Raton, 2007, 861 pp., USD 99.95, ISBN 978-1-58488-605-1*

This book is something of a compendium of examples, processes, construction techniques and models of finite translation planes. A translation plane is an affine plane that admits a group of translations acting transitively on its points. The guiding principle of the authors is to present an atlas of translation planes. The tremendous variety of translation planes makes any attempt at classification rather difficult. So the authors provide a combination of descriptions and methods of construction to give an explanation of various classes of planes. Since interest in certain translation planes arises primarily from their place within certain classification results, the authors also provide comprehensive sketches of the major classification theorems together with outlines of their proofs. The bulk of the book is a comprehensive treatment of known examples of the planes in more than 800 pages and 105 chapters, culminating with the atlas of planes and construction processes. (jtu)

***I. Kononenko, M. Kukar: Machine Learning and Data Mining. Introduction to Principles and Algorithms**, Horwood Publishing, Chichester, 2007, 454 pp., GBP 50, ISBN 978-1-904275-21-3*

Recent advances in machine learning have had a strong impact on rapid developments in related areas like data analysis, knowledge discovery and computational learning theory. This (already well-established) research discipline has found many applications in expert and business systems, data mining, databases, game playing, text, speech and image processing, etc. However, due to the rather interdisciplinary character of this new field, many books on machine learning currently appearing are quite specialised to the considered discipline. In that sense, this book differs from several other excellent books on machine learning and data analysis, as its authors have succeeded in providing a detailed, yet comprehensive, overview of the field. The entire textbook consists of fourteen chapters and can be divided into five parts.

The introductory part of the book encompasses the first two chapters, which provide an historical overview of the field and outline philosophical issues related to machine and human learning, intelligence and consciousness. The following four chapters deal with the basic principles of machine learning, representation of knowledge, basic search algorithms used to search hypothesis space, and attribute quality measures used to guide the search. The next two chapters set practical guidelines for preparing, cleansing and transforming the processed data. Chapters 9 – 12 are devoted to a description of the respective learning algorithms: symbolic and statistical learning, artificial neural networks and cluster analysis. The last two chapters introduce formal approaches to machine learning: the problem of identification in the limit and computational learning theory.

The attached appendix reviews some theoretical concepts used in the book. Although oriented primarily towards advanced undergraduate and postgraduate students, each section of the textbook is relatively self-contained and only requires a background knowledge in calculus. The discussed topics are explained in an interesting way with a lot of illustrative figures and supporting graphs. Each chapter is accompanied with a summary of the concepts taught. For these reasons, this book represents both a valuable teaching resource for students and a good reference source of applicable ideas for a wide audience including researchers and application specialists interested in machine learning paradigms. (im)

***E. Maor: The Pythagorean Theorem. A 4,000-Year History**, Princeton University Press, Princeton, 2007, 259 pp., USD 24.95, ISBN 978-0-691-12526-8*

This interesting book is devoted to the Pythagorean theorem, which is the most frequently used theorem in all branches of mathematics and which is learnt in geometry at school. The author shows the long route the Pythagorean theorem has taken through cultural history and he analyses its role in the development of mathematical thinking, research and teaching.

The book starts with a description of the earliest evidence of knowledge of the theorem, which was known to the Babylonians over 4000 years ago. It continues with an analysis of the work of the Greek mathematician Euclid, which immortalized this theorem as Proposition 47 in the first book of his famous Elements. Then the book describes the role of the theorem in Greek mathematics (Archimedes, Apollonius, etc.) and its positions in pure and applied mathematics, as well as its influence on the arts, poetry, music and culture through the Arabic world, the Middle Ages, the Renaissance and the New Age in Europe up to Einstein's theory of relativity. The most beautiful proofs of the theorem are shown and explained. The book contains an index and many interesting photos and pictures. It can be recommended to readers who want to learn about mathematics and its history, who want to be inspired and who want to understand important mathematical ideas more deeply. (mbec)

***E. Menzler-Trott: Logic's Lost Genius – The Life of Gerhard Gentzen**, History of Mathematics, vol. 33, American Mathematical Society, Providence, 2007, 440 pp., USD 89, ISBN 978-0-8218-2550-0*

This book gives (for the first time in English) a detailed scientific biography of Gerhard Gentzen (1909-1945), a German mathematician who was one of the founders of modern structural

proof theory and who is considered to be one of the greatest logicians from the first half of the 20th century. In six chapters, the author describes Gentzen's life and his scientific achievements from his youth, through his studies, works, teaching and scientific activities, and his military service as well as his political ideas, until his arrest and tragic death in Prague in 1945. The author also analyses Gentzen's conditions for scientific study and research in National Socialist Germany before and during World War II, his fights for "German logic", and his battles with colleagues and the political system. The book is based on a study of unknown and unpublished sources, archive materials, private letters, family documents and memoirs.

The book ends with four interesting appendices. The first and second appendix (written by C. Smoryński – Gentzen and Geometry, Hilbert's Programme) contain a short essay on Gentzen's results in geometry and a deeper analysis of Hilbert's programme showing relations to ideas and mathematical results of Hilbert, Brouwer, Weyl, Gödel and Gentzen. In the third appendix, there are (for the first time in English) three lectures by G. Gentzen (The Concept of Infinity in Mathematics, The Concept of Infinity and the Consistency of Mathematics, and The Current Situation in Research in the Foundation of Mathematics), which were presented by G. Gentzen to a wide mathematical public in Münster (1936), at the Descartes Congress in Paris (1937) and in Bad Kreuznach (1937). The fourth appendix (written by John von Plato) explains in detail the Gentzen mathematical program, his ordinal proof theory, his work on natural deduction and his calculus, and it gives a general survey of later developments in structural proof theory.

The book can be recommended to a wide audience; it is suitable for mathematicians, historians of science, students and teachers. (mbec)

***R. E. Moore, M.J. Cloud: Computational Functional Analysis**, second edition, Horwood Publishing, Chichester, 2007, 180 pp., GBP 27.50, ISBN 978-1-904275-24-4*

This book is devoted to a brief survey of basic structures and methods of functional analysis used in computational mathematics and numerical analysis. It is an introductory text intended for students at the first year graduate level; despite its occasional lack of depth and precision, it provides a good opportunity to get acquainted with the rudiments of this powerful discipline. The main emphasis is on numerical methods for operator equations – in particular, on analysis of approximation error in various methods for obtaining approximate solutions to equations and system of equations.

The book could be loosely divided into two parts; the former concentrates on linear operator equations, the latter on nonlinear operator equations. After introducing the basic framework used in functional analysis (such as linear, topological, metric, Banach and Hilbert spaces), the authors move on to linear functionals and operators and several types of convergence in Banach spaces. Special chapters are devoted to reproducing kernel Hilbert spaces and order relations in function spaces.

The first part of the book finishes with basic elements of the Fredholm theory of compact operators on Hilbert spaces and with approximation methods for linear operator equations. The second part (concentrating on nonlinear equations) starts with interval methods for operator equations and basic fixed point problems. After introducing Fréchet derivatives in Banach spaces and its elementary properties, their applications in Newton's method and its variant in infinite dimensional spaces are presented. The last chapter is devoted to a particular example of a use of the theory in a "real-world" problem; the authors choose a hybrid method for a free boundary problem. The topics are mostly discussed without proofs but each chapter is accompanied by a series of exercises that are designed to help students to learn how to discover mathematics for themselves. Hence the book serves as a readable introduction to functional analytical tools involved in computation. (jsp)

***A. Neeman: Algebraic and Analytic Geometry**, London Mathematical Society Lecture Note Series 345, Cambridge University Press, Cambridge, 2007, 420 pp., GBP 40, ISBN 978-0-521-70983-5*

To explain basic principles of modern algebraic geometry to undergraduate students with a standard education is a very difficult task. Nevertheless, Amnon Neeman has succeeded in this book in showing that it is possible. The book is based on his own teaching experience and the basic idea is simple. He has chosen to present a formulation and the proof of Serre's famous theorem on 'géométrie algébriques and géométrie analytique' (GAGA) as the ultimate aim of the book. On the way to this goal, he introduces a lot of notions and tools of modern algebraic geometry (e.g. the spectrum of a ring, Zariski topology, schemes, algebraic and analytic coherent sheaves, localizations, sheaf cohomology). The whole book shows to the reader a beautiful mixture of analysis, algebra, geometry and topology, all used together in the modern language of algebraic geometry and, at the same time, nicely illustrating its power.

The book is written in a very understandable way, with a lot of details and with many remarks and comments helping to develop intuition for the field. It is an extraordinary book and it can be very useful for teachers as well as for students or non-experts from other fields. (vs)

***R. Niedermeier: Invitation to Fixed-Parameter Algorithms**, Oxford Lecture Series in Mathematics and its Applications 31, Oxford University Press, Oxford, 2006, 300 pp., GBP 55, ISBN 0-19-856607-7*

Theoretical computer science as the borderline between mathematics and computer science is a wonderland of fast evolving theories, challenging open problems and plentiful algorithmic and complexity results, all backed up by practical motivation and applications in computing. One of the recently opened and intensively studied directions is the so-called Fixed-Parameter Complexity, designed and developed in the 1990s by Downey and Fellows. Peppered with practical questions of solving problems with small parameter values, problems that are computationally hard in general, this is a surprisingly rich theory, where computational classes are defined based on precise logic constructions. It has immediately become popular among researchers; every major computer science conference gets a number of presentations from this area, and specialized workshops are now regularly organized. And yet, only one monograph devoted to this topic was available until recently; the book under review organically complements this previously published monograph (Downey-Fellows, Parametrized Complexity, 1999).

Downey and Fellows, the gurus of FPT (Fixed Parameter Tractability), introduce the theory by concentrating more on

structural definitions and properties whilst Nidermeier comes in with numerous samples of FPT algorithms for particular problems. Moreover, a lot has happened since the Downey-Fellows monograph was published. The book under review is an excellent survey of new results, focused primarily on algorithmic issues.

The book is divided into three chapters. The first chapter provides necessary definitions accompanied by motivating examples and a broad exposition of the philosophy of Fixed Parameter Complexity. Don't skip this chapter if you are a novice in this area or if you want to enjoy learning new views on it. The second chapter provides a thorough catalogue of the methodology of fixed parameter algorithms. This is an encyclopaedia of methods such as kernelization, depth-bounded search trees and graph decompositions, all thoroughly explained with many examples. The third chapter gives examples of hardness reductions in Fixed Parameter Complexity Theory and describes the W[t] classes, with most attention paid to W[1] and W[2], which is where most of the natural problems lie.

The last section, called "Selected Case Studies", is a Madame Tussauds Museum of FPT. The difference is, you do not find any wax problems here; all of them are alive and developing at the time you read about them. The exposition here is influenced by the famous NP-completeness bible of Garey and Johnson: "Computers and Intractability – A guide to the Theory of NP-completeness" (1979), and the problems are described as carefully from the FPT perspective as Garey and Johnson did from the P-NP one. And not only because of this section is the book becoming as useful as Garey-Johnson's monograph.

This is an advanced textbook intended and well-suited both for researchers and graduate students in theoretical computer science. You will enjoy reading it whether you want to do research in the area or just want to learn about it. And while merrily intending the latter, you are most likely going to end up doing the former when you finish reading it. (jkrat)

V. V. Prasolov: Elements of Homology Theory, *Graduate Studies in Mathematics, vol. 81, American Mathematical Society, Providence, 2007, 418 pp., USD 69, ISBN 978-0-8218-3812-9*

This book is a translation of the Russian original (published in 2005). It is a continuation of the author's earlier book "Elements of Combinatorial and Differential Topology". It is convenient to have the companion volume at hand because the book refers to it for basic definitions and concepts. In the first half of the book, the author builds the theory of simplicial homology and cohomology and describes some of its applications (most of the space being devoted to characteristic classes in the simplicial setting). It is followed by a description of singular homology. The penultimate chapter defines Čech cohomology and de Rham cohomology and it proves the de Rham theorem and its simplicial analogue. The last chapter "Miscellany" contains material on invariants of links, embeddings and immersions of manifolds, and a section on cohomology of Lie Groups and H-Spaces.

The book contains 136 problems (mostly in the chapters on simplicial homology and cohomology and their applications). For the majority of problems, there are solutions or hints in a 37-page appendix. Together with its companion volume, the book can be recommended as a basis for an introductory course in algebraic topology. (dsm)

G. Royer: An Initiation to Logarithmic Sobolev Inequalities, *SMF/AMS Texts and Monographs, vol. 14, American Mathematical Society, Providence, 2007, 119 pp., USD 39, ISBN 978-0-8218-4401-4*

Classical Sobolev inequalities constitute an extremely important part of functional analysis with a surprisingly wide field of applications. The study of certain specific topics such as quantum fields and hypercontractivity semigroups requires an extension of a classical Sobolev inequality to the setting of infinitely many variables. This is a difficult problem because the Lebesgue measure in infinitely many variables is meaningless. A solution was discovered by Leonard Gross in his famous pioneering paper from 1975, where he replaced the Lebesgue measure with the Gauss measure. In the end, the power integrability gain known from classical inequalites is replaced by a more delicate logarithmic growth – hence the name. Gross' logarithmic Sobolev inequalities have found, again, an impressive range of applications.

The book under review provides an introduction to logarithmic Sobolev inequalities and to one of its specific applications in the field of mathematical statistical physics, more precisely to the example concerning real spin models with weak interactions on a lattice. A proof of the uniqueness of the Gibbs measure is given based on the exponential stabilization of the stochastic evolution of an infinite-dimensional diffusion process, a generalization of the Ising model. The author begins with the background material on self-adjoint operators and semigroups, then proceeds to logarithmic Sobolev inequalities with applications to Kolmogorov diffusion processes, and finishes with Gibbs measures and the Ising models. The text is complemented with exercises and appendices that extend the material to related areas such as Markov chains. (lp)

A. A. Samarskii, P. N. Vabishchevich: Numerical Methods for Solving Inverse Problems of Mathematical Physics, *Inverse and Ill-Posed Problems Series, Walter de Gruyter, Berlin, 2007, 438 pp., EUR 148, ISBN 978-3-11-019666-5*

In this monograph, the authors consider the main classes of inverse problems in mathematical physics and their numerical treatment. They include in the book many numerical illustrations and codes for their realization. They give a rather complete treatment of basic difficulties for approximate solutions of inverse problems. They use minimal mathematical apparatus (in particular, basic properties of operators in finite-dimensional spaces). Russian mathematicians contributed in a substantial way to solutions of theoretical and practical questions studied in inverse problems in mathematical physics (pioneering work in this direction was done by Andrei Nikolaevich Tikhonov).

The main topics treated in the book are boundary value problems for ordinary differential equations and elliptic and parabolic partial differential equations, methods of solutions for ill-posed problems and evolutionary inverse problems. The book is intended for graduate students and scientists interested in applied mathematics, computational mathematics and mathematical modelling. (knaj)

C. G. Small: Functional Equations and How to Solve Them, *Problem Books in Mathematics, Springer, Berlin, 2007, 129 pp., EUR 32.95, ISBN 978-0-387-34539-0*

This book is devoted to functional equations of a special type, namely to those appearing in competitions like the Interna-

tional Mathematical Olympiad for high school students or in the William Lowell Putnam Competition for undergraduates. Its aim is to present methods of solving functional equations and related problems and to provide basic information on its history. The intention limits the generality of the treatment; more complicated cases are omitted to keep the exposition understandable for secondary school students. To give a feeling of how it is done I will describe the content of the first two chapters. In the introductory part, contributions by Nicole Oresme, Gregory of Saint Vincent, Cauchy, d'Alembert, Babbage and Ramanujan are presented together with some facts from their lives. Also, a simultaneous solution of two equations is found and then the terminology is fixed. The chapter ends with some simple problems testing understanding of the subject.

The second chapter starts with the Cauchy equation for additive functions and with Jensen's equation. Some generalizations like Pexider's and Vincze's equations are treated. Cauchy's inequality for subadditive functions is studied as well as the Euler and d'Alembert equations. The author is able in such a way to show important types of equations and ways/tricks necessary for dealing with problems containing them. The book contains many solved examples and problems at the end of each chapter. More than 25 pages at the end of the book offer hints and briefly formulated solutions of those problems. Also a short appendix on Hammel basis is included. The book has 130 pages, 5 chapters and an appendix, a Hints/Solutions section, a short bibliography and an index. It has a nice and clear exposition and is therefore a very readable book, accessible without special or highly advanced mathematics. The book will be valuable for instructors working with young gifted students in problem solving seminars. (jive)

***L. Smith: Chaos – A Very Short Introduction**, Oxford University Press, Oxford, 2007, 180 pp., GBP 6.99, ISBN 978-0-19-285378-3*

Chaos is everywhere. It is a behaviour that looks random but is not random. It is also an important area of contemporary mathematical research, studying situations where very small changes at the beginning of a certain process cause huge errors at the end. This is not only about weather forecasting or five-year economy planning that has been used by communist systems. The idea of a small mistake having enormous consequences after some time is intuitive, yet it leads to new ways of understanding physical sciences. Chaos is a scientific discipline, which has recently been developing rapidly with interesting facts being discovered. It is also littered with pervasive myths such as the one about non-predictability of chaotic systems, which calls for explanation.

Everyone interested in such an explanation as well as in questions, like whether the flap of a butterfly's wing can affect a hurricane on the other side of the world, should read this book. The author provides an excellent introductory explanation to the fascinating topic of chaos, on an accessible level and in a highly entertaining way. (lp)

***T. Timmermann: An invitation to quantum groups and duality. From Hopf algebras to multiplicative unitaries and beyond**, EMS Textbooks in mathematics, EMS Publishing House, Zürich, 2008, 407 pp., EUR 58, ISBN 978-3-03719-043-2*

The Pontrjagin duality for locally compact Abelian groups is the best setting for a generalization of classical harmonic analysis and Fourier transforms. Dual objects to compact Abelian groups are discrete groups. To have a suitable analogue for non-commutative locally compact groups, it is necessary to find a larger category containing both groups and their duals. Such a broader scheme was recently developed under the influence of new ideas coming from physics (quantum groups). It gives an interpretation of quantum groups in the setting of C*-algebras and von Neumann algebras. The compact case (developed by Woronowicz) is included as a special case.

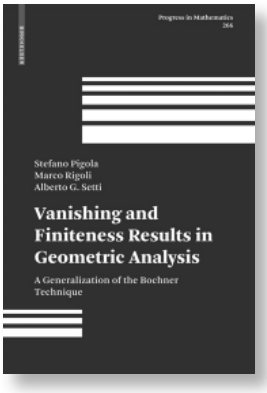
This book is devoted to a description of this theory. It has three parts. The first part treats quantum groups (and their duality) in a purely algebraic setting. It contains a description of the Van Daele duality of algebraic quantum groups (giving a model for further generalizations) and a discussion of the Woronowicz compact quantum groups. In the second part, quantum groups are treated in the setting of C*-algebras and von Neumann algebras. In particular, it contains a presentation of the Woronowicz of C*-algebraic compact quantum groups and a study of multiplicative unitaries. The last part contains several topics. One is the cross product construction and the duality theorem (due to Baaj and Skandalis), the other is pseudo-multiplicative unitaries on Hilbert spaces. The last chapter contains the author's results on pseudo-multiplicative unitaries on C*-modules.

The book is nicely written and very well organized. It offers an excellent possibility for students and non-experts to learn this elegant new part of mathematics. (vs)

***K. Zhu: Spaces of Holomorphic Functions in the Unit Ball,** Graduate Texts in Mathematics, vol. 226, Springer, Berlin, 2005, 268 pp., EUR 69,95, ISBN 0-387-22036-4*

This book is devoted to the study of various spaces of holomorphic functions on the unit ball. The main tool used for their study is an explicit form of the Bergman and Cauchy-Szëgo kernels. There is a lot of different spaces of that sort and the author has chosen some of them for a detailed study. There is always one chapter of the book devoted to one type of function spaces. The spaces treated in the book are Bergman spaces, Bloch space, Hardy spaces, spaces of functions with bounded mean oscillation (BMO), Besov spaces and Lipschitz spaces. The author discusses the various characterizations, atomic decompositions, interpolations, and duality properties of each type of function space in turn. To read the book, knowledge of standard complex function theory is expected but the theory of several complex variables is not a prerequisite. Results presented are standard but their proofs are often new. (vs)

BIRKHÄUSER



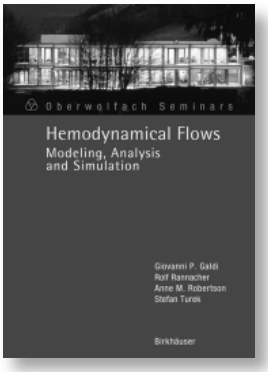
Vanishing and Finiteness Results in Geometric Analysis

A Generalization of the Bochner Technique

Pigola, S., Università dell'Insubria, Como, Italia / **Rigoli, M.**, Università di Milano, Italia / **Setti, A.G.**, Università dell'Insubria, Como, Italia

2008. XIV, 282 p. Hardcover
EUR 49.90 / CHF 89.90
ISBN 978-3-7643-8641-2
PM — Progress in Mathematics, Vol. 266

This book presents very recent results involving an extensive use of analytical tools in the study of geometrical and topological properties of complete Riemannian manifolds. It analyzes in detail an extension of the Bochner technique to the non compact setting, yielding conditions which ensure that solutions of geometrically significant differential equations either are trivial (vanishing results) or give rise to finite dimensional vector spaces (finiteness results). The book develops a range of methods from spectral theory and qualitative properties of solutions of PDEs to comparison theorems in Riemannian geometry and potential theory.
All needed tools are described in detail, often with an original approach. Some of the applications presented concern the topology at infinity of submanifolds, Lp cohomology, metric rigidity of manifolds with positive spectrum, and structure theorems for Kähler manifolds. The book is essentially self-contained and supplies in an original presentation the necessary background material not easily available in book form.



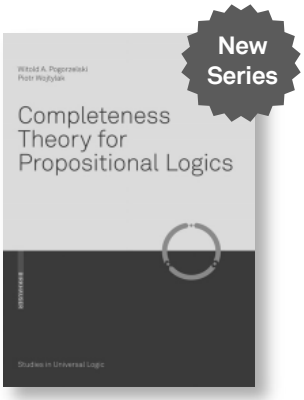
Hemodynamical Flows

Modeling, Analysis and Simulation

Galdi, G.P., University of Pittsburgh, PA, USA / **Rannacher, R.**, Universität Heidelberg, Germany / **Robertson, A.M.**, University of Pittsburgh, PA, USA / **Turek, S.**, Universität Dortmund, Germany

2008. XII, 501 p. Softcover
EUR 49.90 / CHF 65.00
ISBN 978-3-7643-7805-9
OWS — Oberwolfach Seminars, Vol. 37

This book surveys results on the physical and mathematical modeling as well as the numerical simulation of hemodynamical flows, i.e., of fluid and structural mechanical processes occurring in the human blood circuit. The topics treated are continuum mechanical description, choice of suitable liquid and wall models, mathematical analysis of coupled models, numerical methods for flow simulation, parameter identification and model calibration, fluid-solid interaction, mathematical analysis of piping systems, particle transport in channels and pipes, artificial boundary conditions, and many more.
Hemodynamics is an area of active current research, and this book provides an entry into the field for graduate students and researchers. It has grown out of a series of lectures given by the authors at the Oberwolfach Research Institute in November, 2005.



Studies in Universal Logic

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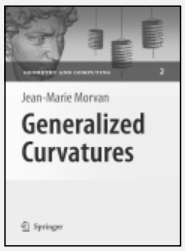

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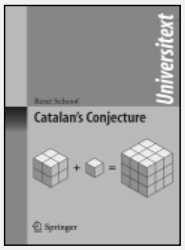

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R. Schoof, Università di Roma, Italia

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