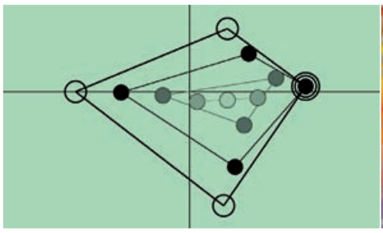
NEWSLETTER

OF THE EUROPEAN MATHEMATICAL SOCIETY



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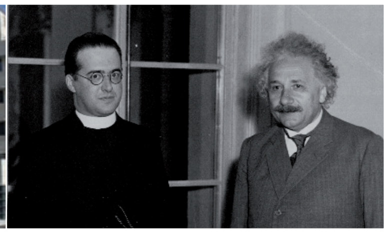

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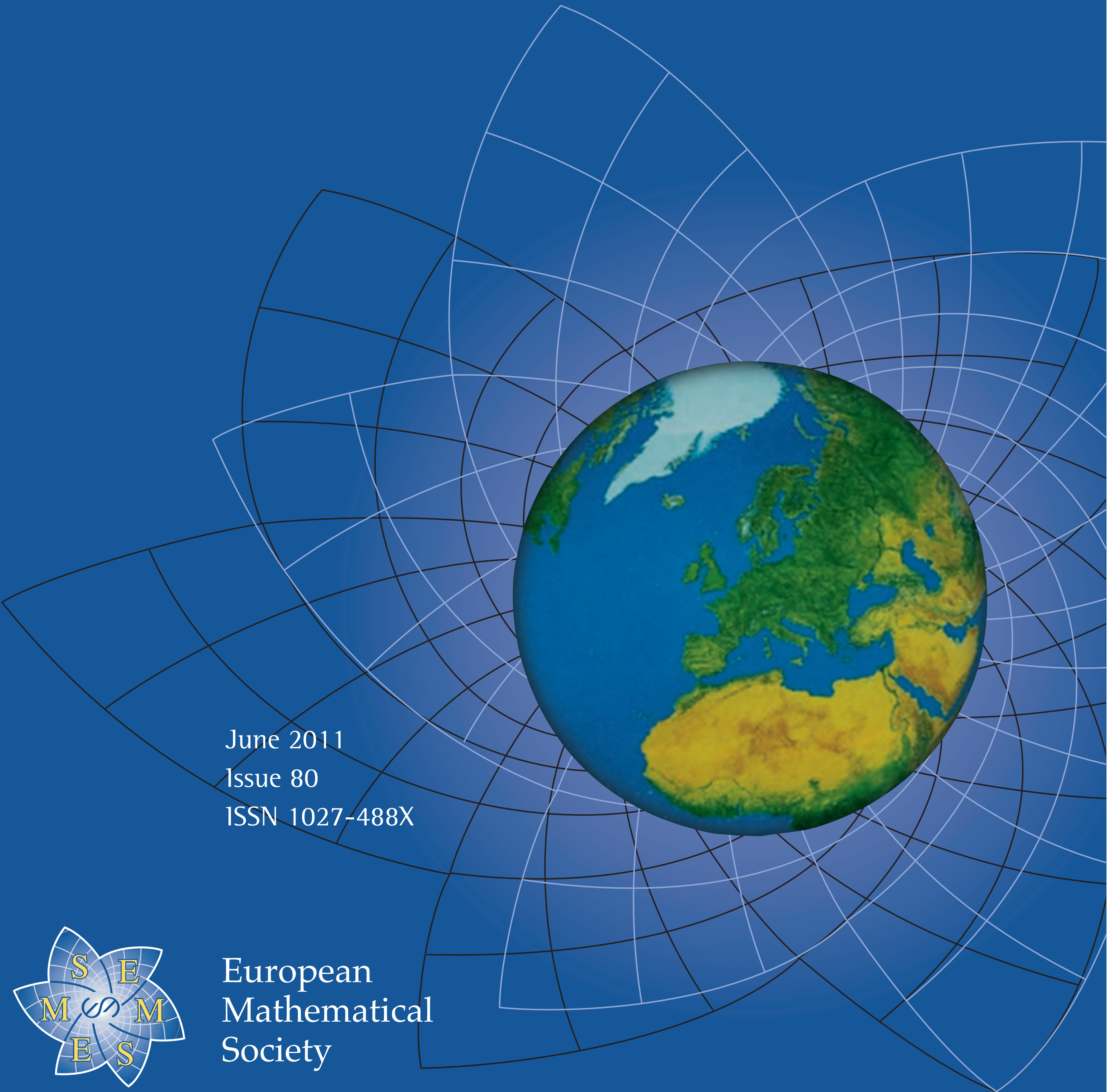

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Editorial Team

EMS Executive Committee

President

Prof. Marta Sanz-Solé
(2011–2014)
University of Barcelona
Faculty of Mathematics
Gran Via de les Corts
Catalanes 585
E-08007 Barcelona, Spain
e-mail:ems-president@ub.edu

Vice-Presidents

Prof. Mireille Martin-Deschamps
(2011–2014)
Département de Mathématiques
Bâtiment Fermat
45, avenue des Etats-Unis
F-78030 Versailles Cedex
France
e-mail: mmd@math.uvsq.fr

Dr. Martin Raussen
(2011–2012)
Department of Mathematical Sciences, Aalborg University
Fredrik Bajers Vej 7G
DK-9220 Aalborg Øst
Denmark
e-mail: raussen@math.aau.dk

Secretary

Dr. Stephen Huggett
(2011–2014)
School of Mathematics
and Statistics
University of Plymouth
Plymouth PL4 8AA, UK
e-mail: s.huggett@plymouth.ac.uk

Treasurer

Prof. Jouko Väänänen
(2011–2014)
Department of Mathematics
and Statistics
Gustaf Hällströmin katu 2b
FIN-00014 University of Helsinki
Finland
e-mail: jouko.vaananen@helsinki.fi
and
Institute for Logic, Language
and Computation
University of Amsterdam
Plantage Muidergracht 24
1018 TV Amsterdam
The Netherlands
e-mail: vaananen@science.uva.nl

Ordinary Members

Prof. Zvi Artstein
(2009–2012)
Department of Mathematics
The Weizmann Institute of Science
Rehovot, Israel
e-mail: zvi.artstein@weizmann.ac.il

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(2009–2012)
Istituto di Matematica Applicata
e Tecnologie Informatiche del C.N.R.
via Ferrata 3
27100, Pavia, Italy
e-mail: brezzi@imati.cnr.it

Prof. Rui Loja Fernandes
(2011–2014)
Departamento de Matematica
Instituto Superior Tecnico
Av. Rovisco Pais
1049-001 Lisbon, Portugal
e-mail: rfern@math.ist.utl.pt

Prof. Igor Krichever
(2009–2012)
Department of Mathematics
Columbia University
2990 Broadway
New York, NY 10027, USA
and
Landau Institute of
Theoretical Physics
Russian Academy of Sciences
Moscow
e-mail: krichev@math.columbia.edu

Prof. Volker Mehrmann
(2011–2014)
Institut für Mathematik
TU Berlin MA 4–5
Strasse des 17. Juni 136
D-10623 Berlin, Germany
e-mail: mehrmann@math.TU-Berlin.DE

EMS Secretariat

Ms. Terhi Hautala
Department of Mathematics
and Statistics
P.O. Box 68
(Gustaf Hällströmin katu 2b)
FI-00014 University of Helsinki
Finland
Tel: (+358)-9-191 51503
Fax: (+358)-9-191 51400
e-mail: ems-office@helsinki.fi
Web site: http://www.euro-math-soc.eu

EMS Publicity Officer

Dmitry Feichtner-Kozlov
FB3 Mathematik
University of Bremen
Postfach 330440
D-28334 Bremen, Germany
e-mail: dfk@math.uni-bremen.de

EMS Agenda

2011

27 June–2 July
CIME-EMS Summer Course on "Current challenges in stability issues for numerical differential equations", Cetraro, Italy
php.math.unifi.it/users/cime/

29 June–5 July
The Seventh Congress of Rumanian Mathematicians, Brasov, Romania
imar.ro/diverse/congmatro7.htm

3–8 July
Third European Set Theory Conference, ESF-EMS-ERCOM Conference, Edinburgh, United Kingdom
www.esf.org/activities/esf-conferences/details/2011/confdetail368.html

3–8 July
Completely Integrable Systems and Applications, ESF-EMS-ERCOM Conference, Erwin Schrödinger Institute, Vienna, Austria
www.esf.org/conferences/11369

24–30 July
ESMTB/EMS summer school "Dynamical Models in Life Sciences", Evora, Portugal
c3.glocos.org/ssmtb/

27 August
Brainstorming meeting with the participation of the EMS EC members and EMS officers, Stockholm, Sweden
Stephen Huggett: s.huggett@plymouth.ac.uk

5–9 September
15th General Meeting of European Women in Mathematics, CRM, Barcelona, Spain
www.crm.cat/ewm/

5–9 September
Fourth European Summer School in Financial Mathematics, Zurich, Switzerland
www.math.ethz.ch/finance/summerschool/

7–9 October
EMS-RSME Mathematical Weekend, Bilbao, Spain

25–27 November
Executive Committee Meeting, Firenze, Italy
Stephen Huggett: s.huggett@plymouth.ac.uk

2012

17–19 February
Executive Committee Meeting, Slovenia
Stephen Huggett: s.huggett@plymouth.ac.uk

30 June–1 July
Council Meeting of European Mathematical Society, Kraków, Poland
www.euro-math-soc.eu

2–7 July
6th European Mathematical Congress, Kraków, Poland
www.euro-math-soc.eu

Editorial

Olav Arnfinn Laudal (University of Oslo/ASSMS)

The Pakistani mathematical community needs international help. Its most important research centre, ASSMS, is fighting for its mathematical survival.

Pakistan is in the news, almost every day, with stories of catastrophes, war and terrorist attacks. This Muslim nation of more than 180 million of a multitude of ethnic entities is a federation of five big provinces, a federal capital territory and several tribal areas, and occupies the territory of the ancient Indus Valley cultural sites that once, during the colonial period, were the pride of the British Empire.

Lahore, the old capital of the English administration of India, is today the intellectual centre, not only of the Punjab province but also of the nation. There are four major universities and a large number of research institutions in and around Lahore, a bustling city of some 8–10 million.

Amongst these research institutions one finds the Abdus Salam School of Mathematical Sciences.

Mathematics had, for quite a long time, been a neglected area in Pakistan when, in 2003, the Pakistani Government established a school of mathematical sciences under the aegis of Government College University, Lahore, to serve as a Centre of Excellence for Advanced Studies and Research in Mathematics.

Nobel Laureate Abdus Salam graduated from Government College Lahore and later taught mathematics there. In his honour, the school got its name, with the acronym ASSMS.

It is a Doctoral School and its main objective is to provide the developing nation of Pakistan with competent young mathematicians to serve in its institutions of higher education and research. At the same time, ASSMS is given the responsibility of promoting mathematics in schools/colleges and also providing the professional enhancement training to the faculty at universities all over the country. ASSMS organises a large number of seminars, colloquia, research schools, intensive courses and lecture series open to Pakistani faculty and researchers. ASSMS also organises a number of events for students of high schools and elementary schools in Pakistan, to encourage students to excel in mathematics.

The school started functioning in December 2003. In seven years, it has had 139 full-time PhD students from all over the country, including the most remote areas of Pakistan.

Students are carefully selected. A first screening is carried out through a written test, which generally takes place in April or early May. The written test date is advertised in the major newspapers of Pakistan as well as on several websites such as the website of the Higher Education Commission (HEC) Pakistan, a website which is most frequently visited by the young science graduates in Pakistan. The admission process and dates are also advertised on the website of ASSMS itself.

Over the last three years, about 350–450 students have taken the written test each year and about 50 students have been selected for interview with an international board of examiners. On the basis of these interviews 17–23 students have been admitted onto the PhD programme every year. Students are also required to achieve a certain level of performance in the international subject Graduate Record Examination (GRE).

Through the selection process and also due to very attractive stipends (by Pakistani standards), ASSMS succeeds in attracting the very best students (from universities all over Pakistan) to the PhD programme in mathematics. However, due to a general weakness in the university education system in Pakistan, even the best students usually have a poor background in several areas of basic university mathematics. ASSMS therefore requires an intensive two year course from all the students admitted to its PhD programme. This two year course is comparable to an international M.S.

The first year is dedicated to basic university mathematics courses, which are taught mostly by European mathematicians. During the second year, students take more advanced and optional courses in diverse areas of mathematics. At the end of their second year, students choose their research area and get associated with one of the research groups at ASSMS.

Presently 22 women are full-time PhD students at ASSMS.

Two-year PhD students are allowed to write their PhD thesis only if at least one of their research papers is accepted for publication in a reputed international journal.

So far 48 students, and amongst them six female students, have finished their PhD degrees. Most of them are now serving at different universities in Pakistan.

ASSMS is housed in a large, newly renovated building, consisting of a conference hall, with a seating capacity of 300, a committee room for meetings of 80-90, 10 classrooms and 35 research offices for professors and postdoctoral fellows.

The school has a library with 5000 books and a number of journals, available in hard copy (76 journals). It is a small but rather effective library and also provides study space for about 100 graduate students. Internet access is available throughout the premises of the school, including two computer labs with a seating capacity of 50.

ASSMS also has a nice garden in the centre of the building. It functions as a very popular meeting-place for faculty and students. During autumn, winter and spring, seminars often take place outdoors, in the midst of beautiful flower arrangements and in the shadow of large oriental trees.

The story of ASSMS is in many ways a success story. Scientifically this is true but the institution is still in big trouble, for the same reasons that make Pakistan front page news almost every day.

ASSMS has recently seen its budget cut in two. The institute was therefore unable to admit new students in 2010 and its situation is now such that its existence as a major regional research institution is in peril.

The financial problems in Pakistan are not only a reflection of the global financial crisis but more fundamentally a consequence of the regional situation, related to poverty, underdeveloped political structures, regional wars and, most recently, a chain of almost intolerable natural catastrophes, that we have all witnessed through the media.

As in the case of immediate human needs related to natural catastrophes, the international community should act. There is, in this era of global economy, little worse for a developing nation than not being able to keep up with the scientific and cultural development at an internationally acceptable level.

Mathematics is, in this context, in a special situation. As the lingua franca for all science, its importance in technological development, which is the basis for today's global economy, is well established. It is, for example, easy to see the relation between the investments of the so-called Tiger States in mathematical education and their rapid technological advancement.

Nevertheless, education in mathematics has, because of its abstract language and its limited media-interest, suffered from the last decade's socio-political development. This is now acknowledged almost everywhere and there are political efforts to re-establish the status of mathematics in public opinion. Evidence for this can be seen in many countries. The establishing of a Nobel Prize equivalent in mathematics (the Abel Prize) by the Norwegian Government in 2002, the Shaw Prize Foundation in Hong Kong and the Chern Medal, jointly funded by the International Mathematical Union and the Chern Medal Foundation, are maybe the most obvious consequences of this new appreciation of mathematics as an operative force in today's cultural and economic reality.

The problems referred to above are, of course, felt more heavily in countries with economies strained by internal or regional conflict, coupled with a poorly developed general living standard.

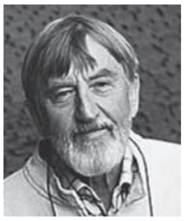
It is not difficult to see the dilemmas faced by any finance minister of a country like Pakistan, weighing renewed support for a well established Mathematical Institution like ASSMS against urgent help for the hundred thousand refugees from the Swat Valley, and for the millions of victims of one of the worst flood catastrophes in its history.

The recent reduction of almost 50% in the state and federal support for ASSMS must be seen in this context.

The fact is, however, that ASSMS is the main functioning mathematical research institution in Pakistan and it is therefore not expendable. If the economic support is not quickly re-established, the stability of the very professional, semi-permanent international staff will be in danger. These competent mathematicians, many of them internationally recognised researchers, have, over the last six years, under the leadership of Professor Alla Ditta Choudary, made this institution a well-operating mathematical research institution and school, producing a series of good PhDs and hosting numerous international conferences and colloquia.

If they are not given the opportunity to continue their work, these professionals will most certainly be lost to ASSMS, as their services are in high demand at several places in the region and elsewhere.

I therefore urge the Federal Government of Pakistan and the State of Punjab to reconsider the cuts in the budget for ASSMS and, at the same time, urge the international community to offer financial help for this institution, through whichever channel one may find.



Olav Arnfinn Laudal
Abdus Salam School of Mathematical Sciences, Pakistan
http://www.sms.edu.pk

6th European Congress of Mathematics Kraków (Poland), 2–7 July 2012 www.6ecm.pl

Dear Colleagues Mathematicians,
The European Mathematical Society (EMS), the Polish Mathematical Society (PTM) and the Jagiellonian University have the pleasure to invite mathematicians from all over the world to participate in the 6th European Congress of Mathematics which will be held in Kraków, 2–7 July 2012. The European Congress of Mathematics, a quadrennial general mathematical meeting, is an important activity of the EMS. Personal meetings of mathematicians are of crucial importance for the development of mathematics, even in the Internet era. The general character of the programme provides attendees with a unique chance of an overlook of contemporary mathematics, beyond their own fields of research. The programme of the Congress maintains between lectures, giving a broad overview of active mathematical disciplines and more specialized talks on recent results. During the Congress several prestigious prizes established by the EMS will be awarded. The Congress will also include round table discussions, poster sessions, and a cultural and social programme. The convenient location of the Congress venue – the modern Auditorium Maximum of the Jagiellonian University – makes it easy to combine scientific activities with exploration of the historic old city of Kraków. In the **First Announcement** below more information concerning the Congress is provided.

We are looking forward to seeing you in Kraków,

Stefan Jackowski
President
Polish Mathematical Society

Marta Sanz-Solé
President
European Mathematical Society

Roman Srzednicki
Dean, Mathematics & Computer Sci.
Jagiellonian University

First Announcement

Scientific Programme. The core of the scientific programme is decided by the Scientific Committee, which is appointed by the EMS. There will be 10 plenary lectures, 36 invited lectures in parallel sections, 12 lectures by Prize winners and approximately 20 mini-symposia as well as contributed poster sessions. Arrangements will be made for informal discussions, talks and small working groups. Candidates for organisers of mini-symposia are encouraged to fill in an application form on the 6ECM website not later than 31 October 2011.

Prizes. At the 6ECM several prizes will be awarded: 10 EMS Prizes, the Felix Klein Prize for an application of mathematics and the Otto Neugebauer Prize in the

Kraków Market Place (Photo by K. Ciesielski)

Auditorium Maximum – the Congress venue (Photo by J.Szczepański)

History of Mathematics. Prize committees have been appointed by the EMS. Only the chairs of prize committees are public until the prizes are awarded. A Call for nominations of candidates for prizes is published on the 6ECM website and appears in this issue of the EMS Newsletter.

Proceedings. The proceedings of the 6ECM will be published by the European Mathematical Society Publishing House. They will be available at a special price for the registered participants.

Satellite Conferences. The organisers of the 6ECM invite mathematicians to organise satellite events (conferences, etc.) close to the dates of the 6ECM. Participants of satellite events will enjoy some privileges in registering for the 6ECM. Information about satellite events will be distributed through the 6ECM information system. Satellite meetings may carry the EMS logo. Applications for status of the 6ECM satellite event can be made online from the 6ECM website. The organisers of the 6ECM may help in finding a venue for satellite events – some institutions in Poland would be willing to host satellite meetings.

Grants and financial support. In order to ensure broad participation in the 6ECM and reduce economic barriers, a limited number of grants will be offered, particularly for young mathematicians. Details of the grant programme will be announced on the website on July 1, 2011.

Exhibitions. Space for expositions will be available at the Congress venue for mathematical societies, publishers and other companies. Detailed information can be found on the 6ECM website.

Registration fee. The regular registration fee until 31 March 2012 will be 1050 PLN (Polish złoty) which is currently about 250 euro; from 1 April 2012 this will rise to 1250 PLN. There will be a reduced fee for EMS individual members and students. Details will be posted on the website when registration begins on 15 October 2011.

Social programme. Social and cultural programmes, promoting informal contacts between congress participants and contact with the rich cultural heritage of Kraków, will be important components of the Congress activities. A welcome reception and conference dinner are planned. Participants and accompanying persons will have free access to several museums. On Saturday 7 July, excursions around Kraków and its vicinity will be offered. A special programme for accompanying persons will be arranged.

Logistics of the 6ECM. Kraków is an ideal conference site, meeting a variety of needs and interests. Kraków is easily accessible by air, train and car. Numerous low-fare airlines maintain connections to Kraków from several European cities. The 6ECM will be held in the Auditorium Maximum of the Jagiellonian University, located close to the attractive, historic old city and the green ring around it. Several rooms for the duration of the Congress will be booked for the participants in hotels and dormitories (of different possible standards) at a convenient distance from the Congress venue. The reservation of these rooms will start in February 2012 through the Congress registration website.

Kraków and University. Kraków is a treasury of Poland's national heritage, the capital of Poland till the end of the 16th century and an important cultural centre with many interesting historic and modern objects. Kraków is on the UNESCO List of World Heritage Sites. The Jagiellonian University is one of the oldest European universities; Nicolaus Copernicus was a student there. In Kraków, Stefan Banach was born and the Polish Mathematical Society was founded.

Pre-registration. Pre-registration at www.6ecm.pl has already begun. Pre-registering mathematicians will be receiving update information. Wishes and comments may help the organisers to prepare the 6ECM according to the expectations of its participants. If you use Facebook, join us at the Facebook website.

Important dates and deadlines. Here are the important deadlines. The 6ECM website will be systematically updated as soon as any information becomes available.

2011-07-01	Announcement of the grant programme
2011-10-15	Beginning of the registration for the 6ECM
2011-10-31	Application deadline for organisers of mini-symposia.
2011-12-31	Announcement of the scientific programme.
2012-02-29	Application deadline for the satellite events.
2012-04-01	Rise in registration fee.
2012-04-30	Deadline for submission of posters.
2012-07-01	Arrival day.
2012-07-02	Opening of the 6ECM; beginning of the scientific programme.
2012-07-06	End of the scientific programme.
2012-07-07	Excursions and departure day.

Contact

For more information visit www.6ecm.pl or write to:

6 ECM Organizing Committee
Institute of Mathematics
Jagiellonian University
Łojasiewicza 6
30-348 Kraków
Poland

E-mail: 6ecm@6ecm.pl
Fax: +48 12 664 6674

Call for Nominations of Candidates for Ten EMS Prizes

Principal Guidelines

Any European mathematician who has not reached his or her 35th birthday on 30 June 2012, and who has not previously received the prize, is eligible for an EMS Prize at 6ECM. Up to 10 prizes will be awarded. The maximum age may be increased by up to three years in the case of an individual with a broken career pattern.

Mathematicians are defined to be European if they are of European nationality or their normal place of work is within Europe. Europe is defined to be the union of any country or part of a country which is geographically within Europe or that has a corporate member of the EMS based in that country. Prizes are to be awarded for work accepted for publication before 31 October 2011.

Nominations for the Award

The Prize Committee is responsible for the evaluation of nominations. Nominations can be made by anyone, including members of the Prize Committee and candidates themselves. It is the responsibility of the nominator to provide all relevant information to the Prize Committee, including a résumé and documentation. The nomination for each award must be accompanied by a written justification and a citation of about 100 words that can be read at the award ceremony. The prizes cannot be shared.

Description of the Award

The award comprises a certificate including the citation and a cash prize of 5000 Euro.

Award Presentation

The prizes will be presented at the Sixth European Congress of Mathematics by the President of the European Mathematical Society. The recipients will be invited to present their work at the congress.

Prize Fund

The money for the Prize Fund is offered by the Foundation Compositio Mathematica.

Deadline for Submission

Nominations for the prize must reach the chairman of the Prize Committee at the following address, not later than 1 November 2011:

Chairman of EMS Prizes Committee
Professor Frances Kirwan FRS, Balliol College, Oxford OX1 3BJ, UK; Email: kirwan@maths.ox.ac.uk

Call for Nominations of Candidates for The Otto Neugebauer Prize for the History of Mathematics

Principal Guidelines

The Prize is to be awarded for highly original and influential work in the field of history of mathematics that enhances our understanding of either the development of mathematics or a particular mathematical subject in any period and in any geographical region. The prize may be shared by two or more researchers if the work justifying it is the fruit of collaboration between them.

For the purposes of the prize, history of mathematics is to be understood in a very broad sense. It reaches from the study of mathematics in ancient civilisations to the development of modern branches of mathematical research, and it embraces mathematics wherever it has been studied in the world. In terms of the Mathematics Subject Classification it covers the whole spectrum of item 01Axx (History of mathematics and mathematicians). Similarly, there are no geographical restrictions on the origin or place of work of the prize recipient. All methodological approaches to the subject are acceptable.

Nominations for the Award

The right to nominate one or several laureates is open to anyone. Nominations are confidential; a nomination should not be made known to the nominee(s). Self-nominations are not acceptable. It is the responsibility of the nominator to provide all relevant information to the Prize Committee, including a CV and a description of the candidate's work motivating the nomination, together with names of specialists who may be contacted.

Description of the Award

The award comprises a certificate including the citation and a cash prize of 5000 Euro

Award Presentation

The prize will be presented at the Sixth European Congress of mathematics by the President of the European Mathematical Society. The recipient will be invited to present his or her work at the congress.

Prize Fund

The money for the Prize Fund is offered by Springer Verlag.

Deadline for Submission

Nominations for the prize should be addressed to the chairman of the Prize Committee, Professor Jeremy Gray (Open University, England). The nomination letter must reach the EMS office at the following address, not later than December 31:

EMS Secretariat
Ms. Terhi Hautala
Department of Mathematics & Statistics
P. O. Box 68 (Gustaf Hällströmink. 2b)
00014 University of Helsinki, Finland
Email: ems-office@helsinki.fi

Call for Nominations of Candidates for The Felix Klein Prize 2012

Background

Nowadays, mathematics often plays the decisive role in finding solutions to numerous technical, economical and organizational problems. In order to encourage such solutions and to reward exceptional research in the area of applied mathematics the EMS decided, in October 1999, to establish the Felix Klein Prize. The mathematician Felix Klein (1849–1925) is generally acknowledged as a pioneer with regard to the close connection between mathematics and applications which lead to solutions to technical problems.

Principal Guidelines

The Prize is to be awarded to a young scientist or a small group of young scientists (normally under the age of 38) for using sophisticated methods to give an outstanding solution, which meets with the complete satisfaction of industry, to a concrete and difficult industrial problem.

Nominations for the Award

The Prize Committee is responsible for solicitation and the evaluation of nominations. Nominations can be made by anyone, including members of the Prize Committee and candidates themselves. It is the responsibility of the nominator to provide all relevant information to the Prize Committee, including a résumé and documentation of the benefit to industry and the mathematical method used. The nomination for the award must be accompanied by a written justification and a citation of about 100 words that can be read at the award date. The prize is awarded to a single person or to a small group and cannot be split.

Description of the Award

The award comprises a certificate including the citation and a cash prize of 5000 Euro.

Prize Fund

The money for the Prize fund is offered by the Fraunhofer Institute for Industrial Mathematics in Kaiserslautern.

Award Presentation

The Prize will be presented at the Sixth European Congress of Mathematics in Krakow by a representative of the endowing Fraunhofer Institute for Industrial Mathematics in Kaiserslautern or by the President of the European Mathematical Society. The recipient will be invited to present his or her work at the congress.

Deadline for Submission

Nominations for the prize should be addressed to the chairman of the Prize Committee, Professor Wil Schilders (Technical University Eindhoven). The nomination letter must reach the EMS office at the following address, not later than December 31, 2011.

EMS Secretariat
Ms. Terhi Hautala
Department of Mathematics & Statistics
P. O. Box 68 (Gustaf Hällströmink. 2b)
00014 University of Helsinki
Finland
Email: ems-office@helsinki.fi

Chairman of the Felix Klein Prize Committee
Prof. W.H.A. Schilders
Technische Universiteit Eindhoven
Department of Mathematics and Computer Science
P.O. Box 513
5600 MD Eindhoven
The Netherlands
Email: w.h.a.schilders@tue.nl

EMS Executive Committee Meeting in Berlin, 19–20 March 2011

Stephen Huggett, Secretary of the EMS

Our meeting took place in the new stable office of the International Mathematical Union, in Berlin, and we were welcomed by Alexander Mielke, Head of the Secretariat there. One of our first decisions was to send a message of sympathy and solidarity to the Japanese Mathematical Society.

Reports

The EC approved the agreement with Springer-Verlag about the Otto Neugebauer Prize in the History of Mathematics, and the co-operation agreement with the Unión Matemática de América Latina y el Caribe. The President introduced the possibility of an agreement with the International Association of Mathematical Physics, which was supported by the EC. It was noted in particular that the IAMP may be able to hold Summer Schools as in our existing arrangements.

Vice-President Martin Raussen gave a detailed report on the web site. Many corrections of details have been made, and now the focus is on making sure all the committee pages are up to date. There will quite soon be a new page for book reviews, and the EC finalized some of the details.

The Publicity Officer described his plans for an EMS presence at some of the larger conferences in Europe. He will prepare a standard pack for a conference booth, including a presentation. He will also start work on an EMS calendar (for 2013), which could be used in various ways, such as during the 6ECM in Krakow.

Individual membership

Vice-President Mireille Martin-Deschamps introduced the paper she had written with Dmitry Feichtner-Kozlov on actions to increase individual membership, emphasising her concern that the EMS could do more to promote European mathematics, and to look after its individual members. This provoked a detailed discussion, and it was agreed above all that we must make our existing work (lobbying, the mobility of young researchers) much clearer to potential members.

Specific actions which the EC agreed include:

- asking the Presidents to nominate corresponding members in each country,
- writing to mathematics departments, inviting them to join,
- setting up an electronic newsletter,
- offering free membership for one year, but with no printed *Newsletter*, to young people recommended by their supervisor or head of department,
- setting up a blog on the web site, and making full use of the opportunity presented by the 6ECM.

European Congresses of Mathematics

The President introduced the report on the preparations for the 6th European Congress of Mathematics. The first announcement of the Congress will appear very soon. The EC discussed the *Proceedings*, and agreed to recommend that people should have a choice between

From left to right: Rui Loja Fernandes, Günter Törner, Martin Raussen, Terhi Hautala, Volker Mehrmann, Jouko Väänänen, Marta Sanz-Solé, Mireille Martin-Deschamps, Mario Primicerio, Franco Brezzi, Stephen Huggett, Zvi Artstein, Igor Krichever, Vicente Muñoz.

a dvd or print version, and that the cost should not be in the registration fee. It was noted that for the second time the EMS prizes are being sponsored by *Compositio Mathematica*, which was very welcome, but it was agreed that in future the EMS should establish its own prize fund.

The EC welcomed the report from the Chair of the Prize Committee, and also briefly discussed the arrangements for the new Otto Neugebauer Prize in the History of Mathematics and for the Felix Klein Prize.

The Scientific Committee had met in Krakow very recently and agreed the plenary speakers, the invited speakers, and the procedure for arranging the minisymposia.

While the EC discussed the 7ECM, Rui Loja Fernandes, Volker Mehrmann, and Mario Primicerio were not present, as preliminary bids had been received from Lisbon, Berlin, and Naples. All three will be invited to submit a full bid.

Committees

Mario Primicerio presented the report of the Applied Mathematics Committee. Links to the 2011 Summer Schools would be put on the EMS web site.

The report of the Committee for Developing Countries was considered, and the EC approved the Abdus Salam School of Mathematical Sciences in Lahore as an Emerging Regional Centre of Excellence. Also, the EC was pleased to learn that Zentralblatt will now be free to all mathematicians in Pakistan. It was agreed to consider ways in which individual EMS members could contribute to the CDC.

The following people were agreed as new members of the Committee for Eastern Europe: Lucian Beznea (Bucharest), Matej Bresar (Ljubljana), Andrey Dorogovtsev (Kiev), Vladimir Dragovich (Belgrade), Jiri Fiala (Prague), Stefan Jackowski (Warsaw), Frank Neumann (Leicester), and Yulij Ilyashenko (Moscow).

Günter Törner presented a résumé of the written report from the Education Committee, and discussion focussed on the proposed conference of European non-governmental organizations sponsoring projects in mathematics education. The EC agreed that, in spite of the sometimes severe tensions between mathematicians and educationalists, it would be valuable to have such a conference and to be open about any disagreements.

Rui Loja Fernandes reported on the work of the Electronic Publishing Committee. It was agreed to try to make further progress with the online Encyclopedia, which has not been made into a wiki yet.

The President introduced the position paper prepared by the Group of Relations with European Institutions. The EC endorsed the paper and agreed to:

- post it on the Framework Programme 8 web page,
- send it to the DG Research and Innovation,
- post it on our web site, and
- publish it in the *Newsletter*.

National Societies could also express their support for the paper.

The discussion of Meetings Committee business included an agreement to invite an EMS Distinguished Speaker to participate in the Congress of Romanian Mathematicians, and to consider suggesting an EMS Distinguished Speaker at the RSME Mathematical Weekend in Bilbao in October.

Igor Krichever presented the report of the Ethics Committee, which is currently working on a "Code of Practice". It was agreed to invite Arne Jensen to present it to the next meeting of the EC.

European funding

Rui Loja Fernandes introduced the proposal for a "Report on European funding of research in mathematics". It was clear to the EC that this will be an extremely useful resource for anybody arguing the case for the support of mathematics, and we discussed the possible sources of information, both at the European and at the national level.

Thanks

Marta Sanz-Solé thanked Christian Bär, Volker Mehrmann, Alexander Mielke, and Günter Törner for their warm hospitality.

The European Mathematical Society Ethics Committee

Arne Jensen (Aalborg, Denmark)

The Executive Committee of the European Mathematical Society created an Ethics Committee in the Spring of 2010.

The first task of the Committee is to write a Code of Practice, which will establish a set of standards to be followed by European mathematicians in their research and professional life, and by editors and publishers of mathematics. Work on this Code is underway. A draft will be completed by June 2011.

Initially the Code will cover the publication and dissemination of mathematical research. One ethical issue is the correct attribution or lack of attribution in published papers. Another issue is plagiarism, which unfortunately seems to be on the rise in mathematical research.

Many organisations have already taken steps to establish ethical guidelines, e.g. the American Mathematical Society. The Committee is taking these into account in the draft. The topics covered in the draft are:

- Responsibilities of authors.
- Responsibilities of publishers and editors.
- Responsibilities of referees.
- Bibliometric data.

Some examples of ethical issues

The Committee has given a great deal of thought to various aspects of plagiarism in mathematics. This is an issue of substantial concern to many researchers in mathematics.

One form of plagiarism consists of taking results by another researcher and claiming them as one's own, usually through publication, but it could also be during an oral presentation or in a research proposal. If sufficient evidence can be obtained, this is perhaps the easiest form of plagiarism to deal with. Another form is self-plagiarism, i.e. repeating or reclaiming one's own results without proper reference.

In many cases the issue is resolved through a correspondence between the authors involved, leading to the publication of a correction setting priorities right, or the retraction of the paper in question, or both. In some cases the editor or editor-in-chief publishes a correction or retracts the paper.

Great damage to careers can be done by plagiarism. There is a need for the European mathematical community to increase awareness of ethical issues. This is one of the main objects of the European Mathematical Society in establishing its Ethics Committee.

Another ethical issue concerns the listing of co-authors. This is a question where even within mathematics the traditions and the culture vary with the area of research. In mathematics one assumes that all authors of a paper have contributed in a non-trivial way to the results presented and take responsibility for the paper as a whole (unless an exception is stated explicitly). Problems can arise when this is not the case, or when a person contributing substantially to a paper is not included as a co-author.

Committee meeting, Bled, Slovenia, 12–13 February 2011. Left to right: Christine Jacob, Jean-Paul Allouche, Tomaž Pisanski, Arne Jensen, Graziano Gentili, Adolfo Quirós, Tatiana Shaposhnikova, H. Garth Dales. Members Radu Gologan and Igor Krichever not present. (Photo by Sandie Jacob)

The Committee on Publication Ethics and CrossCheck

Publishers are also very concerned with ethical issues and a large number of them have formed the Committee on Publication Ethics. The purpose is to promote integrity in research publication, and towards this they have set standards for journals in dealing with claims of plagiarism or wrongful or incorrect or inadequate attribution. A committee meets regularly and considers submitted cases. A list of recent cases (in anonymised form) is available on their website. The Ethics Committee hopes to be able to collaborate with this committee.

The widespread use of internet archives to disseminate research results prior to formal publication has made it easier to plagiarise research. Publishers are also active in combating this. Several publishers use a program called *CrossCheck* to compare a submitted manuscript with a large database of published papers, in order to find similarities that might indicate plagiarism. An editor is then alerted to the possibility of plagiarism and is expected to take this into account in the evaluation of the manuscript for publication.

Procedures

Once the Code of Practice is adopted by the EMS, and, we hope, also by the national societies, the Committee will consider cases of breach of the Code, by accepting cases for consideration. The Committee is currently formulating the procedures that it will follow to deal with submitted cases.

Enforcement of the Code can only be through moral power, by discouraging the unethical behaviour. If necessary, the Committee may inform the institution employing a mathematician of suspected unethical behaviour. Many institutions have already established procedures for dealing with such cases.

The Ethics Committee

Members 2010–2013

Chairman: Arne Jensen (Aalborg Universitet, Denmark)
Vice-Chairman: H. Garth Dales (University of Leeds, UK)
Executive Committee representative: Igor Krichever (Columbia University, New York, USA)
Members:
Jean-Paul Allouche (Centre National de la Recherche Scientifique and Université Pierre et Marie Curie, France)
Graziano Gentili (Università di Firenze, Italy)
Radu Gologan (Academia Română de Ştiinţe, Bucureşti, Romania)
Christine Jacob (Institut National de la Recherche Agronomique, Jouy-en-Josas, France)
Adolfo Quirós (Universidad Autónoma de Madrid, Spain)
Tomaž Pisanski (Univerza v Ljubljani, Slovenia)
Tatiana Shaposhnikova (Linköpings Universitet, Sweden)

Remit

The Ethics Committee will focus on unethical behaviour in mathematical publications. This includes, for example, plagiarism, duplicate publication, inadequate citations, inflated self citations, dishonest refereeing, and other violations of the professional code. The Committee will be responsible for the following three tasks:

1. To raise the awareness of the problem by preparing a code of practice.
2. To encourage journals and publishers to respond to allegations of unethical behaviour in a conscientious way.
3. To provide a mechanism whereby researchers can ask the Committee to help them pursue claims of unethical behaviour.

The Committee may take up any other relevant questions related to ethics in connection with its work.

References

The Committee on Publication Ethics homepage: http://publicationethics.org.
Information on CrossCheck: http://www.crossref.org/crosscheck/index.html.

Arne Jensen [matarne@math.aau.dk] got his PhD from University of Aarhus in 1979. He has been a professor of mathematics at Aalborg University, Denmark, 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.

Ferran Sunyer i Balaguer Prize 2011

The Ferran Sunyer i Balaguer Prize 2011 winners are:

Prof. Jayce Getz (McGill University, Montreal) and **Prof. Mark Goresky** (School of Mathematics, Institut for Advanced Study, Princeton) for their monograph ***Hilbert Modular Forms with Coefficients in Intersection Homology and Quadratic Base Change***

This is a research monograph which oozes with interesting mathematics, explaining deep phenomena in number theory and algebraic geometry using geometric/topological methods, notably intersection homology. This builds on celebrated work by F. Hirzebruch and D. Zagier. It presents a pleasant equilibrium between the survey/monograph part and the research part: on the one hand it contains interesting results which appear here for the first time, but it also has several chapters which introduce the reader to the different subjects needed to understand the main results.

This monograph will be published by Birkhäuser Verlag in the series *Progress in Mathematics*.

Position Paper of the European Mathematical Society on the European Commission's Contributions to European Research

Executive Summary

The European Mathematical Society recommends that

1. Mathematics appears as an independent priority in the next Framework Programme. Support to broad-based research in Europe cannot neglect the science which provides the language, methods and instruments used in every scientific and technological activity.
2. The FP7 objectives under the categories *People* (Marie Curie Actions) and *Cooperation* be maintained and enhanced. World-wide mobility and cooperation, as well as cross-sector mobility between academia and industry must be boosted to promote research and innovation.
3. The successful ERC instruments of funding be strengthened and further developed, in order to support and stimulate breakthroughs and sound future development of basic research.
4. The commission supports the creation of a *European Institute of Mathematics for Innovation*, a platform for cooperation and cross-fertilization between academia and industry, in order to increase industrial innovation, participation in societal challenges, and to foster further development and applications of basic and new emerging areas in mathematics.
5. The commission properly acknowledges scientific electronic databases as a strategic resource for research, and proposes appropriate actions for its development, preservation and open access to the scientific community.
6. EU research and innovation instruments and procedures be simplified. This applies to all steps of the process from the description of the objectives of the calls to the submission forms, the contract negotiation, the due reports and the financial audits.
7. The Commission includes mathematicians on its various advisory boards, like EURAB and ESFRI.

Introduction

The European Mathematical Society (EMS) acknowledges the potential the EC has to make scientific research a crucial element for European development. It endorses enthusiastically the perspective of a European Research Area, and the central role it very appropriately gives to scientific research in the economic development of our continent. It sees the creation of the European Research Council as a turning point in the EU's scientific strategy.

EMS wants to stress that mathematical research is pursued at a very high level and on a very broad front in Europe, and that, in the competitive world we live in, this position needs to be maintained by appropriate actions. Needless to say, keeping a leading position is cheaper than starting from scratch, but by no means free. This implies that resolute actions have now to be taken in various directions.

The question of human capital is crucial, and a difficult one as Europe is facing a large number of retirements of scientists over a small number of years. Moreover, in the last years international competition to attract the best researchers has become fiercer than ever. Europe still produces world-class mathematicians, and suitable conditions must be met to keep them here. The United States, Brazil, China and India are currently investing heavily in research, notably in mathematics, and Europe seems in fact to be lagging behind by a lack of engagement.

Mathematics has a role to play in most domains critical for economic and scientific developments, and this can only be achieved through new fundamental mathematics and by encouraging mathematicians to interact with specialists of other sciences and industry.

The universality of mathematics is its intellectual strength. Mathematical methods are instrumental in virtually every area of human scientific and technological activity. It takes professional mathematicians to use them in a really efficient way in multidisciplinary projects. At the same time mathematical research per se has to be considered as an independent priority. Without this, one runs the risk of becoming mere users of critical new developments made elsewhere.

Together with theory and experimentation, a third pillar of scientific inquiry of complex systems has emerged in the form of a combination of modelling, simulation, optimization and visualisation. In most of the cases, complex phenomena cannot be replicated in the laboratory. Some mathematical tools make it possible to manage huge volumes of data rapidly and economically. This generates fresh, and sometimes surprising, knowledge that crosses traditional disciplinary boundaries and can provide European companies with an essential tool for the production of innovative new products and for transformation of business and engineering practices, thus giving them the necessary competitive edge in globalised markets.

Through this document, EMS intends to set the basis for a fruitful cooperation with the EC suggesting measures that will be instrumental in helping mathematicians to fulfil their role in the construction of a European knowledge-based society.

1. Why mathematics?

Knowledge has become the main wealth of the advanced world: nations, companies and people. Hence investing in research, innovation and education is now the key-leverage for competitiveness and prosperity in Europe. At the heart and foundation of this challenge, mathematics plays a crucial role as it provides a universal language for science and indispensable tools for the analysis, simulation, optimization, and control of industrial processes.

The role of mathematical sciences in civilization has been of central importance for centuries. The current trend towards a global economy and a knowledge society has placed information and innovation technologies, increasingly dependent on scientific research driven by mathematics, at the forefront. Moreover, besides its role in science and engineering, the domains of application of mathematics have by now grown to include other disciplines like social, environmental, medical and economic sciences. We refer the reader to *www.ceremade.dauphine.fr/FLMI/FLMI-frames-index.html* for an extensive sample of examples.

Mathematics provides the tools to understand and reduce the complexity of the mutual interdependencies and leads the way in predicting, optimizing and controlling the respective systems. It could never be too much stressed that the challenges of emerging technologies, the increasing needs of new algorithms for scientific computing, and the complexity of the systems to be studied, pose problems whose solutions are strongly dependent on progress made in fundamental research.

Development and progress in mathematics have always been driven both by internal forces (to cross the boundary) and by external forces (the need of solving problems arising outside the discipline). The so-called applied mathematics cannot be considered as a field disjoint or the counterpart of the so-called pure mathematics, since on one hand it uses potentially all fields of mathematics and, on the other hand, it is a continuous source of challenges to the fundamental research on structures and methods of mathematics.

The unity of mathematics has always made itself felt with considerable force, and it is one of its strengths. At the dawn of this 21st century, the interplay of mathematical ideas between the different sub-domains has probably reached an all-time high in intensity. This fact sets mathematics apart from many other branches of science, which have split up into multiple specialties, each developing its specific culture and sociology.

The distance between fundamental mathematics and applications has become in many instances very short and is getting shorter both in time and in contents. In many cases, mathematical topics developed for purely internal reasons, have suddenly led to concrete applications. By way of example, we can mention the use of stochastic processes in finance, or of number theory in cryptography, system security and data compression.

2. Mathematics in Europe: a S.W.O.T. analysis

Strengths

Mathematical research in Europe is recognised as one of the best in the world. Several indicators place it even as number one, ahead of that of North America and of Asia.

For example, 14 Fields Medals, one of the highest recognitions in mathematics awarded to scientists under the age of 40, were awarded to Europe-based researchers versus 11 USA-based ones in the period 1980-2010. As for the Abel Prize, the analogue to the Nobel Prize for mathematics, established in 2003 and funded by the Norwegian Government, there have been so far five recipients on each side of the Atlantic.

The European mathematical community has efficient research networks, integrating national and international centres of excellence. These networks have common or collaborative programmes of training, visits, workshops and publications in all branches of mathematics. This is a significant step forward in the creation of a European identity of our scientists.

Traditionally, European scientists in most disciplines have received a sound mathematical background in our high schools and universities. This places European trained scientists in an excellent position to excel in multidisciplinary teams. The function of mathematics as an enabling science is one of the pillars of the European tradition that has to be carefully nurtured and for that purpose supported.

Weaknesses

Fragmentation is one of the points of weakness that has to be considered, as well as the uneven situations in different countries with respect to research. In particular, the use of mathematics in applications and industry is much less developed in some countries compared with others, thus depriving the economy of these countries of a powerful instrument of innovation.

Another major problem is brain drain. Part of the problem comes from insufficient good opportunities and conditions for post-doctoral and tenure-track positions in Europe. The situation is particularly dramatic in Eastern European countries. There, a high mathematical level has been achieved at the training level, as part of a longstanding tradition that remained almost unaffected when restricted access to expensive material caused many problems to other branches of science.

Economic problems affecting some countries nowadays induce a massive exodus and serious concern about the ability of attracting or keeping talented young people in the future. Such a trend would irreversibly damage a remarkable reservoir of talents, that Europe will need in the near future, at a time where innovation is the key to success.

Opportunities

The high level of mathematical training in Europe brings an important opportunity for building interdisciplinary teams to address basic problems in many scientific areas.

In its competition in world markets, European industry can take advantage of the competitive edge that may be gained by using European mathematical expertise.

It is often claimed that computers have brought us into a modern technological era. In industrial innovation – that is essential in today's globalised economy – computer power provides an essential tool. More and more companies recognise that mathematical/computer simulations and optimization may replace experiments in designing products to reduce costs and to improve flexibility. However, specific skills are required if they are to be used effectively. They involve problem identification, a correct mathematical formulation, and mathematical and numerical analysis to reduce the problem to its simplest form for affordable computation. Especially at the leading edge of innovation this implies addressing new fundamental mathematical problems; and the shortcut of using commercial software without the competence of evaluating critically its limitations leads often to a dead end. It is thus a consequence of increased computer power and computer usage that, if computers are to be used efficiently, more and deeper mathematical knowledge is required.

Threats

A fundamental threat that would undermine all the positive aspects mentioned above would be to devote too much effort to applications, and neglect basic scientific training and fundamental research. New problems require new ideas, new methods, new approaches, etc., and these are possible only if there is a continuous deepening and widening of knowledge at the most fundamental level. It is thus crucial to cope with these challenges and to make sufficient investment in the basic theoretical and methodological research areas that underpin this response.

Still confining ourselves to applications, another dangerous attitude would consist of thinking that, since mathematics is a common language in science and engineering, the presence of professional mathematicians in interdisciplinary teams is unnecessary, neglecting the fact that, if mathematics brings tools for a rigorous and exhaustive analysis of problems, in many situations the tools have to be tailored if not developed *ab initio* to tackle the problems at hand, in direct interaction with the users.

It would also be erroneous to think that simulation of natural phenomena and industrial/economic processes can just be done by using commercial packages, i.e. using computers as black boxes. In all kinds of interdisciplinary scientific research, the wealth of data that are nowadays available could be wasted (or at least not properly exploited) if they are not correctly managed and interpreted; indeed, modelling and data mining are to be correctly used to transform data into information.

There is an increasing trend towards a more superficial education in mathematics, and therefore, the quality of the mathematical background provided at most of the European education institutions might suffer from such a negative attitude in the very near future. This would seriously affect profitable exchanges between mathematicians and researchers in, and users of, science and engineering.

3. How best to include mathematics in the next Framework for Future EU Research and Innovation Funding?

In mathematics there is an extremely close relationship between teaching, training and research. In fact, most researchers in mathematics are also teachers, and European support for research has an immediate effect on the improvement of mathematical qualifications in the manpower of the future. It is the appropriate moment to point out that the need for people mastering an advanced mathematical training has broadened enormously. Europe needs a dynamic community of scientists and engineers well trained in mathematical methods if it is to compete in the global market of the future where innovation is the key to success.

Teaching and training

In this age of science and technology, it is obvious that the future of Europe will depend crucially on the level of its researchers and, more broadly, on the level of its whole workforce. We are convinced that the successful initiatives the EU has undertaken to stimulate the multinational training of a new generation of European scientists, starting from the University level (Erasmus), have to be praised and intensified. In particular, we stress the importance of the Marie Curie actions for mobility: the different types of grants and the Initial Training Networks. These actions should be at least kept if not boosted in the next framework programme. We think that a well-supported scheme allowing students from overseas to enter European PhD programmes in mathematics will result in a win-win game for Europe and the countries of origin. The "return phase" format for any type of postdoctoral fellowship, namely a grant allowing one to spend two years in another European country and then a year in one's country of origin, is strongly supported. This format should also allow for spending some time in an industrial research environment.

Postdoctoral positions play a crucial role in helping researchers to build an independent career. They should also facilitate establishing themselves permanently in Europe. Scientists in Europe are often better trained than their counterparts in the United States up to the doctoral level, and this applies in particular to mathematicians. Since such a considerable investment in education and advanced training has been made in our countries, Europe should make every possible effort to keep highly competent young scientists, and to offer good opportunities for a permanent job.

Research

First of all, EMS is glad to praise the success of ERC in supporting the formation and the consolidation of small research groups and in stimulating and supporting senior scientists in the implementation of groundbreaking research projects. We particularly appreciate the bottom-up philosophy that characterises the activity of ERC as well as its scientists-driven strategy. We would very much welcome that ERC could be put in a position of extending its activity to support other forms of research, and in particular network research activities. ERC – a recognised success story – represents one of the most effective instruments European science has. EMS regards ERC's further development and strengthening as a *conditio* sine qua non for the future of European mathematics.

To stimulate a synergy between mathematics and industrial innovation, companies should be offered the possibility of finding a "one stop shop" where information on competencies of different laboratories and groups would be made available (see below a suggestion for a practical implementation of this task). By the same token, European industrial mathematics would be given the possibility of reaching (virtually) the critical mass of expertise to meet the short-term demands of the private sector. This action will promote the vision of mathematics as enabling technology in the European industrial culture.

Concerning top-down programmes, we stress that mathematics should appear in the next Framework Programme as a quality indicator in most interdisciplinary projects (nanosciences, biomathematics, genomics, energy, environment, communications, etc.), but also as a priority in itself, with the possibility of funding networks of a reasonable size. In many instances, mathematics is instrumental not only in giving answers, but also in asking the right questions. Industrial and applied mathematics need to be underpinned by mathematics as a whole. The private sector will always excel in identifying promising technologies and exploiting them, and it will provide corresponding research support, much of it inevitably focused on the short term. Applied mathematicians thrive on the problems posed through contacts with industry and other scientific disciplines. An appropriate investment in the basic theoretical and methodological research areas that underpin their analysis is absolutely necessary for a truly successful response.

It is evident that public bodies bear the major responsibility for long-term investments in mathematical research. Indeed, long term cannot be on the agenda of most industrial companies. Therefore, it is important to develop a publicly funded European area of scientific freedom, where scientists are encouraged to take new initiatives and will create new science following their own approaches. In short, Europe has to give a real chance to the unexpected.

4. Some practical instruments

Research infrastructures

The ESF-EMS Forward Look project "Mathematics and Industry" was recently carried out aiming at identifying ways to establish an efficient synergy between mathematics and companies as well as a more strict involvement of mathematicians in the implementation of long-term projects in the knowledge-based society.

It issued a final report based on the discussions of three working groups, on the involvement of national mathematical communities, and on the results of an electronic survey that received several hundred of answers (see *www.esf.org/publications/forward-looks.html*). Its main conclusion is the recommendation to create a virtual research infrastructure (European Institute of Mathematics for Innovation, EIMI) that should have the following goals: (i) to design a European platform for the academia-industry cooperation, including the selection of best cases, the presentation of prototype software for modelling, simulation and optimization, databases on expertise and experiences of the various laboratories, (ii) to organise common training activities, exchange of researchers, study groups with companies, focused modelling weeks, internships and lifelong training for high tech companies, (iii) to suggest partnerships to tackle challenging problems and support networking research activities, (iv) to stimulate cross-fertilization between disciplines, (v) to provide a "one-stop-shop" for industries, public administrations, banks, insurances, and SMEs to contact when they need cooperation, (vi) to fund appropriate networks for industrial and applied mathematics, e.g. by grants matching industrial contributions, (vii) to provide a "direct line" to scientists from other disciplines to connect with the groups willing and capable of joining multidisciplinary projects. EIMI would also be a primary channel for interaction with EU structures and funding agencies and with non-European funding and research structures.

The already existing mathematical research centres and institutes with a long and outstanding tradition should be financially supported to guarantee their activities and sustainability.

Electronic databases, journals and repositories

Access to electronic databases will be essential for the development of mathematics and its interactions with other disciplines and industry. Europe must be an essential partner in the world competition in this domain. There is already a comprehensive European database of mathematical literature, namely Zentralblatt-MATH, whose content is at par with the American-based one MathSciNet, a product of the American Mathematical Society. EMS is involved in its strategic development. This database is a good example of public-private cooperation, as Springer Verlag and the FachInformationzentrum, a German agency, are involved in its maintenance and development. Support from a French-based unit for software development is also to be acknowledged. For these reasons, EMS presses the EC to make sure that Europe has properly identified scientific electronic databases as a strategic resource and proposes strong action to deal with this issue.

A second critical issue has to do with the future of scientific journals, a tool that is essential to scientific research. The system of scientific information is undergoing major transformations because of the new technological developments that go along with the generalisation of internet access. One of the consequences is a radical change in the economical model underpinning the commercialisation of journals. More may be coming with the new paradigm of “open access”. Right now the new situation causes a number of university libraries to have difficulties coping with the very substantial increases in prices that have been witnessed in the last twenty years. Many cannot acquire the basic necessary tools for their mathematics researchers. It should be noted that mathematics is a discipline in which the role of academic publishing houses is considerable and very complementary to that of commercial companies.

A special feature of mathematics is that documents have a much longer lifespan. Thus present day researchers, as well as practitioners coming from other fields, will effectively need access to the whole of the literature for their work. This makes the request for the transfer of data contained in journals on electronic support a urgent one. The question of their long term availability goes along with it. The EC has to get involved with digitalising efforts initiated on a large scale in the U.S., either by competing with them or, a likely better alternative, by partnering with them. In the latter case, a sufficiently strong position must be reached before hoping for a real partnership in the construction of mathematical repositories. For that purpose, the EC must consider providing financial support for accessing the infrastructure, for research related to its development, and its upgrading. This should lead to the establishment of an extensive European Mathematical Library –an on-going project strongly backed by EMS. Such a project should be one of the main milestones of the programme under definition, as far as the support to mathematics is concerned.

Summer schools

Summer schools and conferences are essential means of training and communication between scientists. In the case of mathematics, they usually cannot be funded by the regular budget of the research teams. In FP5, individual summer schools could be funded on a competitive basis. In FP6, series of conferences and summer schools could be funded, a more effective approach. Unfortunately, this possibility vanished in FP7. The EMS recommends to incorporate the funding of series of summer schools and conferences in the next Framework Programme.

Simplification of procedures

We welcome the rules adopted by ERC to simplify the submission of applications. However, in most other of EU calls, uniform rules do not allow for the maximal efficiency of the programmes. Sometimes, using the same format to cover many different situations leads to situations that are unbearable to scientists. Quite often, questions asked in the application form obstruct the communication between the proposer and the scientific panel. This is in part due to a very restrictive view of subsidiarity: instead of simply saying what research is planned for the panel to read, the proposer will have to answer a series of questions, distinguishing training, research, added European value, externalities, etc. It has gone so far that some high level scientists do not apply anymore, whereas others hire the (paid) services of consulting agencies, which specialise in knowing how to transform a scientific project into a “viable” application, destroying most of the time the real content of the project, and making an informed understanding of what is really at stake impossible.

An additional remark concerns the rule that foresees that part of the first applications for some calls must be anonymous. This procedure may give an impression of impartiality, but in fact to delete the information on the level of expertise of the researchers is to deprive the assessor of a major element of judgement. In a community like the mathematical community, whose level of fairness is acknowledged (partly because the practice of science makes it almost impossible to claim great results without proving them for good in a short interval of time), this becomes another element that puts away the best researchers, something that is totally unacceptable if the EU is really serious about contribution to science at the highest level.

Management procedures of any EC project are unanimously considered by the scientific community as extremely heavy; this perception encompasses every stage: the preliminary negotiations, contract signature, due reports and financial audits.

All this creates a terrible image for the (substantial) contribution the EC makes to the development of science, and a clear departure from this situation has to be announced and implemented. This state of affairs is reflected in the fact that, in several countries, the very best scientists do not consider any more applying for European funding as a viable option, something that is totally unacceptable if the EC is really serious about contributing to the development of science at the highest level in Europe.

Consulting and advisory boards

To best design and coordinate EU scientific policy and actions, it is absolutely necessary to include mathematicians with a strong background (both in basic mathematics and in potential applications) and with a broad scientific vision in the various advisory boards the EC sets up. Very surprisingly, this has not been and is not the case for example in EURAB, ESFRI, and no mathematician is a member of the Governing Board of the European Institute for Technology. This ostracism has to stop as soon as possible for the benefit of science.

Meanwhile, EMS would be very happy to coordinate the participation of the European mathematical community in the process of developing the concepts for the next framework for future EU research and innovation funding. It could do that by sending representatives or suggesting participants to the corresponding committees. It could also be given the charge of coordinating the appropriate actions for the inclusion of up-to-date mathematical technologies in the research programmes of other disciplines, as well as to the transfer of know-how to European industries on all scales.

International Mathematical Union Opens Permanent Office in Berlin

Thomas Vogt, media office of the DMV. Translation: David Kramer.

On the afternoon of 1 February 2011, the permanent office of the International Mathematical Union (IMU) was formally opened near the Gendarmenmarkt in central Berlin.

The ceremony began with Berlin professor of mathematics Martin Grötschel, general secretary of the IMU, greeting the 100 invited guests, among them many leaders in politics and commerce. Dr Georg Schütte, undersecretary in the Federal Ministry of Education and Research, paid tribute to the importance of mathematics in Germany, saying that an important manifestation of this appreciation is support of the new IMU office at both the federal and state levels.

Professor Jürgen Zöllner, Berlin senator for education, science and research, emphasised the great importance of the new location in central Berlin in the history of mathematics. Indeed, the rented rooms in Markgrafen Street are located near the Berlin–Brandenburg Academy of Sciences, founded in 1700 by Frederick III of Brandenburg with the critical support of Gottfried Wilhelm Leibniz. And the great Leonhard Euler, who lived and worked for 25 years in Berlin, had his residence only 800 metres away in Behren Street.

Professor Ingrid Daubechies, president of the IMU, said that she was pleased that there is now a permanent office of the IMU in Germany, and in particular in Berlin, where a number of ministries, research institutes, universities and other important institutions are supporting this project. Daubechies thanked the Weierstrass Institute for Applied Analysis and Stochastics (WIAS), located in central Berlin, for their administration of this project as well as for locating and renting the premises. All in all, it has increased the importance of the IMU secretariat as a focal point for mathematicians and politicians worldwide.

Christian Bär, professor of mathematics and president of the German Mathematical Society (DMV), recalled that beginning with the establishment of the DMV in 1890 and in the first third of the 20th century Germany became an international leader in mathematics. Then during the Nazi period, many famous mathematicians were persecuted, deported and murdered because of their Jewish background. It has taken Germany decades to recover from that tragedy. Bär declared himself happy and indeed a bit proud that mathematics in Germany and in Berlin has again succeeded in achieving international recognition. In closing, the president of the German Mathematical Society assured the IMU of the DMV's continuing support and in the name of the DMV wished the permanent office of the IMU great success in its Berlin establishment.

Photo from the opening ceremony, by Kay Herschelmann, showing Ingrid Daubechies, president of the IMU, together with Dr Schütte and Dr Nevermann from the Berlin Government.

Professor Sprekels, director of WIAS, thanked the many underwriters and partners of the project, who through their joint efforts have brought the IMU office to Berlin. In addition to the above-mentioned ministries and the DMV, Professor Sprekels thanked the Alexander von Humboldt Foundation, the Berlin–Brandenburg Academy of Sciences, the German Research Foundation, the Deutsche Telekom Foundation, the Einstein Foundation and the Stifterverband for German Science. Professor Sprekels promised his audience that they would not regret the trust that they had placed in WIAS and its employees and that WIAS would fulfil the expectations of the International Mathematical Union. A special presentation of the interactive exhibit "IMAGINARY" by the Mathematical Research Institute of Oberwolfach closed the formal part of the festivities. During the reception following the ceremony, guests could explore mathematical visualisations, interactive installations, virtual worlds and three-dimensional objects and their theoretical backgrounds from algebraic geometry and singularity theory.

The ESI open to Business on a New Path

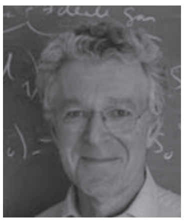
Jakob Yngvason (Vienna, Austria)

As many readers of the Bulletin will know, the Erwin Schrödinger International Institute for Mathematical Physics in Vienna (ESI) faced a serious threat to its existence last year when the Austrian Government announced in November a decision to terminate funding of more than 70 scientific institutions, including the ESI, as of 1 January 2011. Overwhelming support for ESI's case by the international mathematics and physics community, including a large number of IAMP members, was decisive in averting the worst case scenario for the institute, and at present the ESI seems to be sailing into calmer waters. An agreement has recently been signed between the University of Vienna and the Austrian Ministry of Science to the effect that the ESI will become a research centre ("Forschungsplattform") of the University from 1 June 2011, with the same name and at the same location as before. On the positive side the Ministry has promised to fund the new Forschungsplattform by an earmarked contribution to the university budget until 2014 and possibly 2015. Also, the general goal of the Institute to promote research in mathematics and physics at the highest level with emphasis on fruitful interactions between these disciplines remains unchanged. On the negative side is a substantial cut in the previous funding on part of the Ministry, and the long term consequences of the termination of ESI as an independent institute and its integration into the University of Vienna are not foreseeable at this moment.

To put these developments into perspective it is appropriate to look briefly back at the founding history of the ESI and the development of the institute since its official initiation in 1993. The ESI was created in a political window of opportunity shortly after the fall of the Iron Curtain. An important aspect was the idea to establish an institute in Vienna where scientists from the former Soviet Union and other East European countries could meet with colleagues from the West and thus help to reduce the brain drain from the East. The activities of the institute, however, quickly surpassed this limited goal and ESI established itself as the highly regarded international research centre it is today with more than 700 visitors yearly. From the outset the ESI had no permanent scientific staff and focused on thematic research programs with international organisers and participants. The legal structure was that of a society under Austrian law, independent of other academic institutions in Austria, but subsidized by the Ministry of Science on the basis of yearly applications. The activities were gradually broadened with the establishment of a Senior Research Fellows Programme and a Junior Research Fellows Programme. Under the former renowned scientists stay at ESI for several months and give lecture courses for graduate students and postdocs. The Junior Research Fellows Programme supported young predocs and postdocs that participated in the activities of the ESI and interacted with the Senior Fellows and scientists from the local community. The ESI has been evaluated by international panels three times since its founding, the last evaluation being in 2009. All evaluations attested the ESI highest scientific standards and an astonishing cost efficiency.

The transition of the ESI into a research centre of the University brings obvious risks and it is particularly deplorable that the highly successful Junior Research Fellows Programme can no longer be upheld due to lack of funds. Also the administrative details of the transition are not at all trivial and have not been completely sorted out yet. The University has, however, been very cooperative and there are reasons to expect that the visitors of ESI will not notice much change.

The Society Erwin Schrödinger International Institute for Mathematical Physics will continue to exist and promote the Institute. For the time being we can only hope that the ESI will fare well on its new path. The most important message to IAMP members, however, is that ESI is open to business and in particular welcomes proposals for future programs, see http://www.esi.ac.at/call/call.html.



Jakob Yngvason [jakob.yngvason@univie.ac.at] is a professor of mathematical physics at the University of Vienna and Scientific Director of the Erwin Schrödinger International Institute for Mathematical Physics (ESI) in Vienna.

This text originally appeared in the IAMP News Bulletin, April 2011, pp. 16–17. We want to extend the message to IAMP members on to EMS members.

Cooperation agreement between the European Mathematical Society (EMS) and the International Association of Mathematical Physics (IAMP)

The EMS and the IAMP share the common goal of promoting frontier research in a number of mathematical disciplines, in particular those with direct or potential applications in physics. The two societies declare their intention to cooperate towards its accomplishment by exchanging and promoting information and by supporting their members in their professional development.

The EMS and the IAMP will strive at organizing every second year a common school, preferably with the assistance of an ERCOM institute and/or an IAMP Associate member.

Abel in Holland and a few reflections on the Abel Prize

F. Thomas Bruss (Université Libre de Bruxelles)

The Abel Prize of Mathematics has been in existence for eight years. It is seen as the highest distinction for lifelong achievements in mathematics. In contrast to the Fields Medal it has no age constraints. In that respect, as well as from the aspect of financial reward, we should consider it as the Nobel Prize in Mathematics.

Still young, the Abel Prize has already established its rules and traditions. One of the traditions is that the Abel Committee tries to meet every year in a different country and, if possible, in the Norwegian Embassy of that country. We have to say *tries* because, of course, we are all sure that the Abel Prize will last forever so that one day the pigeonhole principle will apply.

Abel in Holland

This year the Abel Committee met in Den Haag on 25 February 2011 and the host was the Ambassador of Norway to the Netherlands Mrs Eva Bugge. It was also the first meeting to have a special addendum. Following a suggestion of Hendrik Lenstra, there was a day of lectures given in Leiden (half an hour's drive from Den Haag) the day before the meeting by the five members of the Abel Committee: David Donoho (Stanford) spoke on compressed sensing and combinatorial geometry, Björn Engquist (Austin, Texas) on numerical approximation of high frequency wave propagation, Hendrik Lenstra (Leiden) on modelling finite fields, Ragni Piene (Oslo) on generating functions and enumerative geometry, and M. S. Raghunathan (Tata Institute, India) on the 1st Betti number of hyperbolic 3-manifolds.

This event, open to everybody and named *Abel in Holland* just for mnemonics, was a rare opportunity for guests to hear talks from those mathematicians who would take the next day one of the important decisions for mathematics in 2011. And it was nice to see that the talks were well prepared. The intention to have first-rate scientists and decision makers showing their own work through ideas rather than technical difficulties was taken seriously. I am glad that I had the opportunity to hear these lectures and think it is safe to say that most people present enjoyed and benefited from them.

Abel Committee 2011. From left to right: H. Lenstra, B. Engquist, R. Piene (Chair), M. S. Raghunathan, D. Donoho

After the event, things reverted to Abel Prize tradition. The committee members and guests drove to Den Haag where Mrs. Bugge had invited them for a reception. She gave a warm welcome speech and was responded by the President of the Norwegian Academy of Science and Letters Øyvind Østerud and the Chairman of the Abel Board Helge Holden. Interesting interactions and conversations as well as delicious amuse-gueules of Norwegian cuisine contributed to a pleasant evening closing *Abel in Holland*.

A few reflections on the Abel Prize

An important rule of the Abel Prize concerns the Abel Committee. It consists, as seen above, of five highly distinguished mathematicians. The committee is *first-degree international* in a sense we should explain. Only the chair of the committee has to be a member of the Norwegian

Academy of Science and Letters. This year this is Ragni Piene (Oslo). The rule is easy to understand and well-justified. It is the Kingdom of Norway and the Norwegian Academy to whom we owe this prize and it is always good to see that the upbringing of a most promising child remains in the hands of loving parents. All members are nominated by the International Mathematical Union and the European Mathematical Society. This makes it clear that the Abel Committee is very international indeed. Evidently, no highly distinguished international prize in science could get and maintain its reputation without the halo-effect of internationality. But why *first-degree*?

This becomes clear by a comparison. The Nobel Prize Committee relies on referees from all over the world and chooses in a very honest way the very best ones they can think of. However, the members of the Nobel Committee are all from the Swedish Academy. Hence the Swedish Nobel Committee chooses the international jury whereas the Abel Committee *is* the international jury. Strictly speaking this is internationality compared to delegated internationality. Of course this is no criticism whatsoever of the rules of other distinguished prizes. Nevertheless, if one believes in internationality, mathematicians are entitled to see the difference as a non-trivial plus for the Abel Prize.

A word about strategies of the Abel Prize

Clearly, a young, important prize needs people who think about strategies to promote public awareness. In my first encounter with the organisers and members of the Committee of the Abel Prize in 2005 in Brussels I concluded: Norway and the people who created the Abel Prize have done thorough thinking and have shown an impressive amount of courage, skill and perseverance. They should earn the highest respect and sincere thanks of the mathematics community (ref. 2005). This was the conclusion of an observer who had no relation whatsoever with Norway or the Norwegian Academy, simply being invited as the Chair of the Mathematics Department ULB Brussels. It was a spontaneous but reasoned conclusion and perhaps as impartial as one may hope for.

If you have the opportunity to interview the Chair of the Abel Committee Ragni Piene on strategic aspects for the reputation of the Abel Prize you may also have your own ideas. So you may ask: Why do you do this? Why don't you do this in this or that way? Hearing Professor Piene's answers I think your conclusion would be similar to mine. Strategic questions for the Abel Prize are taken as seriously as they were at first, they are always on the agenda and are always thought through. Otherwise the answers could not be so quick, clear and convincing.

Today I would no longer call myself impartial. Having observed the Abel Prize since 2005, I have turned into a supporter, modest in what I can offer but firm in what I believe. The Abel Prize is one of the great things which could happen for the future of the mathematics community and it seems to be in excellent hands. Really important creations are, almost by definition, rare. To my mind, the importance of the Abel Prize for the mathematics community cannot be over-estimated. Luckily its creation happened at the beginning of our millennium and we mathematicians should not wait to help to promote awareness of the prize, whenever we can, and by whatever we can do.

Reference

F. Thomas Bruss, *Homage to the Abel Prize, homage to Norway*. Newsletter of the EMS, Issue 56, 9–10 (2005).

Abel Prize 2011

The Norwegian Academy of Science and Letters has decided to award the Abel Prize for 2011 to

John Milnor
Photo: Marco Martens
(www.abelprisen.no/en)

John Milnor
(Institute for Mathematical Sciences, Stony Brook University, New York)

"for pioneering discoveries in topology, geometry and algebra".
The President of the Norwegian Academy of Science and Letters, Øyvind Østerud, announced the winner of this year's Abel Prize at the Academy in Oslo today, 23 March.

John Milnor has received the Abel Prize from His Majesty King Harald at an award ceremony in Oslo on 24 May. The Abel Prize recognizes contributions of extraordinary depth and influence to the mathematical sciences and has been awarded annually since 2003. It carries a cash award of NOK 6,000,000 (close to EUR 750,000 or USD 1 mill.)

John Milnor's profound ideas and fundamental discoveries have largely shaped the mathematical landscape of the second half of the 20th century. All of Milnor's work displays features of great research: profound insights, vivid imagination, striking surprises and supreme beauty. Milnor has also written tremendously influential books, which are widely considered to be models of fine mathematical writing.

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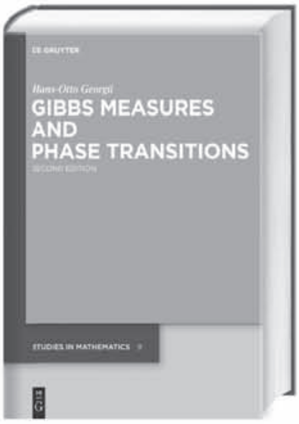

Hans-Otto Georgii

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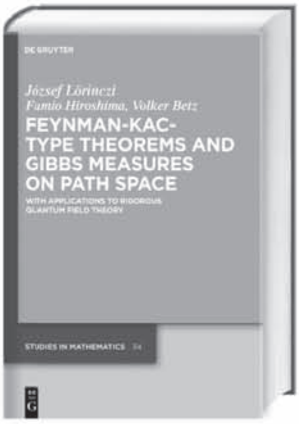
Fredos Papangelou, Zentralblatt MATH



József Lörinczi, Fumio Hiroshima, Volker Betz

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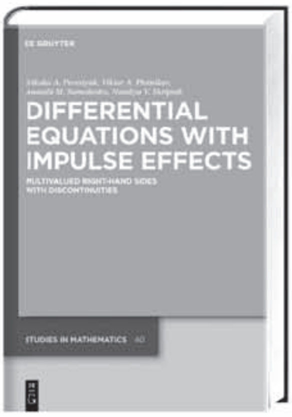

Nikolai A. Perestyuk, Viktor A. Plotnikov, Anatolii M. Samoilenko, Nataliya V.Skripnik

DIFFERENTIAL EQUATIONS WITH IMPULSE EFFECTS

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Let There Be Better Lectures!

Ehrhard Behrends (Freie Universität Berlin, Chair of the RPA Committee of the EMS)

I have now been a professor of mathematics for several decades and, over the years, I have listened to many hundreds of lectures. The demands made on the listener have varied: some lectures have been conceived for specialists while others have been aimed at a broader public. I confess that I have gained little from (too) many of these lectures and have often been annoyed at the poor correlation between time spent and value received.

The present article was written in the naive (and perhaps a bit egotistical) hope that this situation is amenable to improvement. To be sure, others before me have made similar attempts but, nevertheless, the topic, in my opinion, should be given a thorough airing from time to time.

There are many good reasons why one should attend a lecture. For example, one may have the opportunity to meet at last the great X. But let us ignore this special case for, first of all, such speakers, in my experience, give lectures whose quality is well above the average and, secondly, the goal of meeting a famous person is unrelated to the question of how much one gains from the actual content of the lecture.

There remain the many lectures that one attends at conferences or at one's own university from which one hopes simply to learn something – and not necessarily in one's particular speciality – and/or to obtain intellectual stimulation. From a group-dynamical point of view, what is involved is a complex interplay between the roles of host, lecturer and audience.

Here is my wish list:

Dear Host,

I shall pass over my trivial desires (for example, that the lecture room has been suitably set up and is "ready for action") and cut to the chase.

My first wish is that you have informed the speaker about the expected audience. Will they all be specialists or will there be colleagues representing the entire subject area? Will students be present and, if so, what level of knowledge will they be assumed to possess? My next wish is that in addition to the title of the talk, some further information be presented to help those deciding whether to attend in making up their minds. A brief abstract accompanying the announcement of the lecture could serve such a purpose.

I can't wish much about the lecture itself from you – such is the subject of my next wish list – except, perhaps, that you might kindly attempt to place yourself in the other audience members' shoes. Thus if your speaker mercilessly goes into overtime in order to present a proof variant in full detail, this might be of keen interest to you, who may once have attempted such a proof yourself, but many listeners will find themselves in a painful dilemma: should I gnash my teeth and remain out of politeness, even though I have already got everything I could out of the lecture, or with a guilty conscience make a run for it?

I have kept the touchiest point for last and that is the issue of providing feedback to the speaker on the effectiveness of the lecture. In my experience, the struggle between honesty and politeness – if indeed such a struggle there be – is all too frequently decided in favour of the latter. But consider, please, that *you* are perhaps the only person who can provide the speaker with insight so that future lectures might go better than this one did. Therefore I beg you: Do it! (It goes without saying, of course, that you would be better off forgetting about the whole thing if packaging criticism in a diplomatic wrapper is not one of your strong points.)

Dear Speaker,

I begin with a quotation from the first lines of the first part of René Descartes' *Discours de la méthode* (1637):

> *Le bon sens est la chose du monde la mieux partagée: car chacun pense en être si bien pourvu, que ceux même qui sont les plus difficiles à contenter en toute autre chose, n'ont point coutume d'en désirer plus qu'ils ont.*

(Good sense is the most equitably distributed of all things because, no matter how much or little a person has, everyone feels so abundantly provided with it that he feels no desire for more than he already possesses.)

Translated to the present situation, this means that almost all of us believe that we have no need of any advice on improving our lectures. Therefore, I shall offer no advice but merely present my wish list.

My first wish concerns the fact that I would like to be able to put what you are about to present in a suitable context. To express this another way, there is an almost endless number of mathematical theories, results, tricks, methods and so on, and every day that number increases. Thus I would like to know why I should be attending *your* lecture to learn about *these particular* theories, results, tricks, methods and so on. What is the background? Where does it lead? Why are your results new, interesting, perhaps even spectacular? It is certainly unnecessary to provide such information to listeners who work in the same specialized area as you but I often attend lectures that have little, if anything, to do with my main areas of interest (and which are advertised as being appropriate for nonspecialists).

Now we can begin. I know in which corner of the mathematical universe we are rummaging and where we are headed and why. I would be most gratified if on arriving at the end of your lecture, I now had an approximate idea of what methods are used in your part of the world for attacking problems. As an illustration, I can imagine a typical proof in which for me – and I say this quite candidly – the technical details are not of enormous importance.

Don't overtax me! As a lecturer myself, I know of course the temptation to take a couple of pages from my latest preprint, put them on a transparency and use that as the basis of my talk. As a listener, I find it annoying when I am unable to read the material you are presenting, even if I am sitting in the second row. And while we are on the subject of transparencies, let me implore you to use them *very sparingly*. All of us have sat through lectures in which dozens of slides are whisked into and out of the overhead projector, their only purpose apparently being to remind the speaker of the points he wants to make. I would like to be able to read them at a leisurely pace (and perhaps take a few notes). Keep in mind, on the subject of overtaxing, that it is far easier to be alert and concentrated while speaking for an hour than it is to listen attentively for an hour. Thus I always rejoice when after a long and demanding portion of a lecture is over, something a bit more digestible is offered: a summary, an indication of what is to come, an historical note…

I like to be convinced of the truth of something by a variety of methods. I am grateful, when such is offered, for a model that helps me to visualize a topological or geometrical point or a computer simulation that makes vivid what might otherwise have been obscure. Which is not to say that many excellent lectures have been given in which no materials were used beyond a blackboard and a piece of chalk.

Dear Members of the Audience,

Contrary to what is widely believed, you can take an active role in the proceedings. I would like to encourage you to do so. I mean it. You can assist in making it possible for those who have come to hear the lecture to get as much out of it as possible. *You* can usually judge better than the speaker what is understandable to you and your fellow listeners. So raise your hand and ask questions whenever you believe that a significant portion of the audience would be grateful for an explanation yet no one has had the courage to ask ... even if you don't need such an explanation.

This is, to be sure, a delicate matter, since one has to expose one's own lack of knowledge, whether real or simulated. And since there is a general notion of what everyone is expected to know, you might easily embarrass yourself with an impossibly naive question such as: "What is the Lebesgue integral?" Yet how is someone to know that who in fact has no idea what it is? Thus it is those who have the most knowledge and so stand in the least danger of a blunder on whom it is most incumbent to speak up.

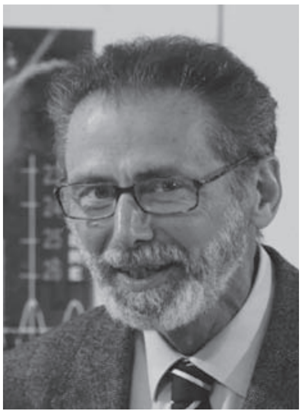
I conclude my wish list with a plea for positive feedback. If you really liked a lecture then say so. The speaker will be happy to hear that their efforts were worthwhile. In closing, I would like to emphasise that a necessary – but not sufficient – requirement of a good lecture is mathematical expertise. I find pedagogical legerdemain skating on thin mathematical ice as unbearable as narcissistic, specialist gobbledegook that leaves the listener in the lurch.

And have you nothing, Herr Behrends, to say that is positive? Indeed I have: I would like to thank the countless colleagues from whose lectures I have learned much and been stimulated by important and interesting ideas.

This article is a translation – by David Kramer – of a lightly edited version of a lecture that appeared several years ago in the Mitteilungen der Deutschen Mathematiker-Vereinigung.

Interview with Yves Meyer

Ulf Persson, Göteborg



The French has an elitist educational system, especially when it comes to mathematics. What do you think are its pros and cons?

Since Fields medals have existed, all French Fields medallists (except Alexander Grothendieck) have been alumni of the "Ecole Normale Supérieure de la rue d'Ulm" (abbreviated to ENS-Ulm). If you enter ENS-Ulm, you know that you are giving up money and power. It is a choice of life. Your life will be devoted to acquiring and transmitting knowledge. I entered ENS-Ulm in 1957 and only 40 students in the sciences and 37 in humanities were admitted. The entrance exam to ENS-Ulm was quite selective. Some of my schoolmates were expecting to become high school teachers.

Before describing our elitist system, let us stress that it only applies to a tiny part of higher education. High school is not selective in France. High school ends with an exam named a "baccalauréat". This exam is quite easy since 80% of candidates succeed. Moreover, every teenager who obtains a baccalauréat is accepted by the university of their choice. Tuitions do not exist. But our open admission system is hypocritical as such since half of the undergraduate students drop out during the first year of college. This is typical of France, a country in which noble ideals run alongside poor management and no attention paid to details. In contrast with this loose system, medicine and engineering are highly selective in France. There are more than 200 engineering schools and most of them are not affiliated to any university. Medicine is a course which is given inside the university but follows completely distinct rules. The number of students admitted in medicine after the first year's exam ranges from 4,000 to 8,000 depending on the job market. Furthermore, the list of French elite schools needs to be completed with the Ecole Nationale d'Administration and business and management schools, like Hautes Etudes Commerciales (HEC). The number of students admitted to one of these elite schools is about 10% of those entering university. You cannot enter one of the elite schools unless you accept two or three years of intense training after the baccalauréat. This training is given in what are called "Classes de Préparation aux Grandes Ecoles". At the end of this training, you take one of the exams and if you succeed you are allowed to enter the corresponding elite school. If you fail the exams then two or three years of your life will be lost. In the sciences, 90% of the students from Classes Préparatoires will enter one of the engineering schools.

Let me try to explain the historical "raison d'être" of the French elitist educational system. It was designed to fight against the extravagant privileges of the French nobility and was consistent with the goals of the French Revolution. The French elitist system is a democratic system, based upon strictly anonymous written exams. Every candidate is labelled with a number. The professors who are marking the written exams do not know the names of the candidates. The choice of the most talented candidates is completely fair and no bias is introduced. However this system is under much criticism nowadays. It is accused of reproducing an elite. That criticism is grounded on the fact that the family of the candidate often plays an important psychological role in helping the candidate to accept the intense training which is needed to enter an elite school. This problem does not only affect France. A UNESCO programme has aimed at understanding the role of "shadow education", especially in mathematics. Shadow education refers to the intellectual training a child receives from the family. A specialist on these issues is Georges Haddad (g.haddad@unesco.org).

As I understand it, you started out as a teacher. Was that in personal terms an advantage? Not starting out with research inhibited by high expectations?

To understand my decision to begin my life as a teacher, I need to evoke the situation of my country in the late '50s. A terrible war was raging in Algeria. The French army responded to the legitimate demands of Algerian nationalists with torture and napalm. All young French men were drafted unless they were graduate students. In other words beginning a PhD had become a cheap trick for avoiding the draft. Otherwise you were forced to fight a cruel and unjust war. Could I claim that my research, which did not even exist at that time, was so important to my country that I should be exempted? No, certainly not! Beginning a PhD to avoid being drafted would be like marrying a woman for her money. I wanted to fall in love with research, not to use it as a clever way to obtain a privilege. I confessed to the board that I was not preparing a thesis. Taking this decision, I felt I was showing some solidarity with people my age. This looks childish today. I was drafted. Then I asked to be a teacher in a military school, a decision which was encouraged by the Army as a military service. I was sent to the Prytanée Militaire de La Flèche. La Flèche is a tiny city located 200 miles south-west of Paris. This school was formerly a college run by Jésuits and is where Descartes once studied. At the time it belonged to the Army and was dedicated to the education of sons of the officers serving in Algeria or in the

French zone of occupation in Germany. I taught there for three years, two years counting as military service. I was not paid, so the Army liked this arrangement. I was 21 years old and my students were 17 or 18. They were separated from their families and were receptive to my sympathy. Many of these students became professional mathematicians and are now my friends. My way of teaching was evaluated twice by truly experienced specialists (Inspecteurs Généraux). They told me that I was not a good teacher. A good teacher at high school level needs to be much more methodical and organised than I was. These Inspecteurs Généraux advised me to apply to the university. I had other problems with my teaching. I eventually felt guilty to be the one who is always right while the pupils are wrong most of the time. To do research is to be ignorant most of the time and often to make the mistakes I corrected in my students' homework. In 1963, I applied for a position at Strasbourg as a teaching assistant. I was 24 years old. I wrote my PhD there.

My experience of teaching in a high school shaped my entire life. I understood that I was more happy to share than to possess. If I read a beautiful novel, I want to share my pleasure with someone. Supervising a thesis has always been a most rewarding experience. It means giving my PhD student the best of myself. I always hoped that they would eventually become a better mathematician than I was. And quite a few of my 50 graduate students became so. My first research student was Aline Bonami. I have kept very strong ties with my former students, as in a family.

My experience of beginning my career as a high school teacher should not be proposed as a model. Life was much more open in the early '60s. When I decided to switch to the university, I immediately found a position as an instructor.

You have moved freely between different disciplines in mathematics. Is there a danger of being trapped in a narrow subfield and a loss of inspiration that too many professional mathematicians fall prey too?

Have I ever said: "Whenever you feel competent about a theory, just abandon it!" as quoted by Professor Ramachandran? That appears so arrogant. My changes of orientation need to be explained more seriously. I am not smarter than my more stable colleagues. I changed several times. I have always been a nomad. I cannot stand more than 10 years in a department of mathematics. I moved from Strasbourg to Orsay, then to Ecole Polytechnique, then to the University of Paris-Dauphine and finally to ENS-Cachan. I also spent two years at the University of Nantes. I do not move because I have problems with my chairman or because I am offered a better job. I am moving because I cannot prevent myself from so doing. It is a kind of disease. I do not belong to a university and I suffer from this inability to stay. I am from Tunis (Tunisia). The Tunis of my childhood was a melting pot where people from all over the Mediterranean had found sanctuary. Italian, Maltese, Sepharades, Berberes, Arabs and French were living together. As a child I was obsessed by the desire of crossing the frontiers between these distinct ethnic groups. But I was limited by my ignorance of the languages which were spoken in the streets of Tunis. I came back to France when I was 17. I am not rooted in France. My sister, who is one year older, could not stand the France of the war in Algeria and moved to Morocco after graduating. She is still living there. During my professional life I obsessively tried to cross the frontiers. I am excited by the move to a new mathematics department. When I move I know I am going to meet new colleagues. We will work on a new subject. For instance when I was hired at Ecole Polytechnique, I was encouraged by Charles Goulaouic to switch from harmonic analysis to partial differential equations. The by-product of my influence on PDEs was the theory of para-differential operators developed by Jean-Michel Bony (see the blog of Terry Tao: http://terrytao.wordpress.com/2010/08/20/spielman-meyer-nirenberg/). When I was hired at Paris-Dauphine, I began an exciting collaboration with Pierre-Louis Lions. We proved a "div-curl lemma". Let me say how this happened. Pierre-Louis entered my office and asked me if the following was true: if both the vector fields B(x) and E(x) belong to $L^2(R^n)$, if E(x) is divergence free and if the curl of B(x) vanishes identically then the pointwise inner product E(x)·B(x) belongs to the Hardy space H^1. I replied to Pierre-Louis: "No, it cannot be true, otherwise I would have known it." Pierre-Louis was surprised. I spent the night working on it and the following morning I had a proof. Pierre-Louis had a vision and I brought my technical skills. I had similar experiences with Raphy Coifman and Alberto Calderón. They had splendid visions. I was fascinated as a child. I was guided by these stars in the night sky. I then worked hard and could prove what they were dreaming about. These stories seem to contradict the way I wrote my PhD. I did not have a supervisor. I am full of contradictions.

Concerning wavelets, the story is quite strange. At Ecole Polytechnique, where I was teaching then, mathematicians and mathematical physicists were sharing the same Xerox machine. Jean Lascoux, a physicist, was making copies of every paper he would receive. If you needed to make a copy, you had to wait until he had finished. I was never irritated. Instead I was happy to discuss with Jean for the half hour it took to make his too many copies. Once he said: "Yves, I am sure this preprint will mean something to you." It was the first Grossmann-Morlet paper on wavelets. I recognised Calderón's reproducing identity and I could not believe that it had something to do with signal processing. I took the first train to Marseilles where I met Ingrid Daubechies, Alex Grossmann and Jean Morlet. It was like a fairy tale. This happened in 1984. I fell in love with signal processing. I felt I had finally found my home.

My move to Navier-Stokes equations occurred 10 years later and was initiated by a demand by Jacques-Louis Lions. I was still working on wavelets when Paul Federbush published a paper with a provocative title:

"Navier and Stokes meet the wavelets". Navier-Stokes equations govern fluid dynamics. Jacques-Louis Lions was puzzled and irritated both by the title and by the contents. He asked my opinion about the relevance of wavelets in this approach to Navier-Stokes equations. I had no experience of this subject but I was fortunate to welcome Marco Cannone, a student of Carlo Cercignani. Marco had acquired a training on nonlinear PDEs in Milan. With the help of Marco, I could understand what Federbush had in mind. As I expected, wavelets were irrelevant in Ferderbush's paper and a conventional Littlewood-Paley approach worked better. With Marco we went further. Fabrice Planchon joined us. We proved the global existence of a Kato's solution when the initial condition is oscillating. A Kato solution to the three-dimensional Navier-Stokes equations is continuous in time with values in $L^3(\xi^3)$. This result was a complete surprise since it says that arbitrarily large initial velocity generates a global solution as long as this initial velocity has enough oscillations. Oscillations are measured with a Besov norm which is much weaker than the L^3-norm. The best results in that direction were eventually obtained by Herbert Koch and Daniel Tataru.

Crossing the frontiers in mathematics is not what Antoni Zygmund advised me to do. When I was preparing my PhD, I had read with extreme pleasure his book "Trigonometric Series". The first edition, published in 1935, was the only one which was available in Strasbourg's mathematical library. The second edition would probably have been discouraging to me. This happened in 1964. To someone used to the Bourbaki style, reading Zygmund's treatise was as refreshing as giving up *L'être et le néant* by Jean-Paul Sartre and switching to *Anna Karenina* by Tolstoy. Zygmund's treatise was decisive in my early scientific orientation. "Trigonometric Series" was a collection of fascinating problems about Fourier series expansions. I truly fell in love with Zygmund's mathematical style. I was 30 years old when I first met Antoni Zygmund. Zygmund treated me as a child who was still in need of advice. I loved him for this attitude. He told me that a problem should always be given its simplest and more concise formulation. Zygmund would advise to treat, whenever it is possible, an illustrative example before attacking the general case. This attitude was strictly forbidden by Bourbaki. Instead, the Bourbaki group ordered to raise a problem to its most general and abstract formulation before attacking it. Today, I know that there exists a third approach which unfortunately cannot be made systematic. This third approach consists of translating a problem into the language of a completely distinct branch of mathematics. It often happens in mathematics that a problem cannot be solved inside the field it has been formulated. One first needs to recast this problem and insert it in a completely new circle of ideas. Then a solution may emerge. That is the way I could solve the problem of the boundedness of the Cauchy kernel on Lipschitz curves. This problem was raised by Alberto Calderón in the late '60s and was formulated in the language of complex analysis, more precisely of holomorphic functions of one complex variable. It is the problem Coifman urged me to attack when I visited Wasington University in 1974. Alan Mc Intosh discovered that Calderón's problem could be reformulated inside a programme in abstract operator theory proposed by Tosio Kato, the same Kato I have already mentioned. More precisely, Kato raised the issue of symbolic calculus on accretive operators. Mc Intosh understood two fundamental facts. He discovered that Kato's conjecture could not be true at the level of generality it had been formulated. In the concrete setting of differential operators in one real variable, Mc Intosh proved that Calderón's problem was identical to Kato's conjecture. I met Alan in a strange way. In 1980, he had a sabbatical year and was visiting the University of Orsay. I was already teaching at Ecole Polytechnique and I was giving a graduate course at Orsay because in 1980 my colleagues at Orsay were refusing to teach graduate courses for obscure political reasons and, at the time, Polytechnique did not have a graduate school. Alan was sitting silently in the last row of the classroom. I was intrigued by this man who was obviously not a student and I invited him to lunch. Then he revealed what he was trying to do. As I said above, Alan had discovered that Calderón's problem was a corollary of a conjecture raised by Kato. We were then on the good track. Six months later I gave the final assault and reached the summit after a visit to Yale and some important discussions with R. Coifman. Tosio Kato was unaware of Calderón's work and vice versa. The full Kato's conjecture on the domain of the square root of accretive second order differential operators in *n* real variables could then be attacked and solved using some improved real variable tools. This was achieved by Pascal Auscher and his collaborators. Unfortunately both Calderón and Kato were dead when Pascal Auscher did it.

Solving a problem through a rephrasing in a new mathematical language always gave me an intense feeling of happiness. Then people with distinct cultures are able to communicate and understand each other. I enjoyed the same pleasure in my work on wavelets when I understood that my Calderón-Zygmund expertise was useful in signal processing. An unexpected happiness.

When I switched from singular integral operators to wavelets, my students Guy David and Jean-Lin Journé did not follow my move to signal processing. Instead, they made a major breakthrough in the theory of singular integral operators with their celebrated T(1) theorem. Later on, Guy David and Xavier Tolsa solved the famous Painlevé problem. Painlevé wanted to characterize the compact subsets K of the complex plane such that every function F which is holomorphic and bounded in $W = C - K$ is a constant (Liouville theorem for W). Similarly, when I gave up wavelets to study the Navier-Stokes equations, my work on wavelets was completed by the fantastic discovery by Ingrid Daubechies of orthonormal bases of compactly supported wavelets and by the spectacular achievements of Albert Cohen. It is as if my students were saying: "Do not worry, feel free to travel, we will take care of everything at home." What I did in mathematics is negligible compared to what was achieved by my students. This statement evokes the true meaning of my mathematical life.

Would you think of mathematics as part of natural science or as part of the humanities? (Or straddling the middle ground?) In other words, if you had not chosen to become a mathematician, would you have worked as an engineer, or a physicist, or a chemist? Or would you have become a philosopher, an historian or perhaps a writer?

I am happy to answer this question. In the '50s, the best students of the French high schools were studying humanities. I myself took Latin and Greek. I was and still am completely fascinated by the personality of Socrates. I am reading Plato again and again. To me Socrates is an older brother. In Phedon, the argumentation of Socrates is often questioned by Cebes or Simmias. When it breaks down, the argument needs to be repaired by Socrates. This explains my first fascination for mathematics. In mathematics and only in mathematics can a child discover something by himself. As a student, I could say to my teacher that he was wrong or that I had a better proof – like Simmias criticising Socrates' argument. In physics you have to believe. You cannot tell your teacher that the experiment by Michelson and Morley is wrong. Believing this experiment has the same philosophical status as believing in God. You believe something you cannot check by yourself. It is pure faith.

It means something very important. The old tradition in mathematical education stressed the importance of correct proofs. Mathematics was identified with geometry. I was in love with Euler's nine points circle. The bad side-effect was that almost all students believed that mathematics was a field far away from the scientific and industrial development of a country, thus being identified with a dead piece of knowledge. In France, we recently moved from one extreme to another. For reasons that stem from demagogy and populism, there is a tendancy to give up proofs in high schools and to teach mathematics as a natural science. It is a difficult choice.

Finally, any good (and bad?) advice you would like to give to young mathematicians?

When I was preparing my PhD a faculty member of the University of Strasbourg, Peter Gabriel, who is now emeritus at the University of Zürich, told me the following: "Yves, you should give up doing classical analysis and switch to algebraic geometry instead. The language of algebraic geometry has been put upside-down by Grothendieck and people above 40 are completely lost now. Young people can freely work in this field without being challenged by the old generation. In classical analysis [what I was doing] you are fighting against all the older specialists who have accumulated so much training and experience." I did not follow Gabriel's advice and, as he predicted, my PhD was immediately superseded by Elias Stein who was attacking the same problems at the same time with more powerful methods.[1] Let me mention that my thesis was not directed by a supervisor. Studying operator theory on the Hardy space H^1 was my decision. Not until the 11 chapters of my thesis had been written, and subsequently typed by my wife, did I bring it to Jean-Pierre Kahane. My PhD was, in a sense, both a failure and a success. It was a failure since I was not able to prove the results I wanted. But my guesses as to the future developments of harmonic analysis turned out to be correct ones.

Furthermore, I was also advised by established professors: "Do not publish your first paper; you will regret it. Wait a few years more until it is perfect." At that time there were only a few mathematicians in the world. Everyone knew what the others were working on. It meant that the risk of being scooped was low. One communicated by writing letters to the colleagues you knew and respected. Fair game was the rule. I was very impressed by this advice. On the other hand, Jean-Pierre Kahane told me: "Yves, publish your first paper, unless you want to spend the rest of your life improving it, which would be so stupid, since it is just above average." Both sets of advice were right. Indeed, I published my first paper and I am now so ashamed of this poor paper that I have suppressed it from my publication list. Kahane thought that getting a PhD was the beginning of a story, not the end. A PhD does not need to be a masterpiece; it is a 'driving licence' giving permission to journey into the world of mathematics. I like this idea.

My advice to young mathematicians is to disobey and follow their inclinations whatever the advice of older people. You must dig deeply into your own self in order to do something as difficult as research in mathematics. You need to believe that you possess a treasure hidden in the depths of your mind, a treasure which has to be unveiled.

A last advice to young mathematicians is to simply forget the torturing question of the relevance of what they are doing. It is clear to me that the progress of mathematics is a collective enterprise. All of us are needed.

This is an excerpt of a longer interview/essay with Yves Meyer which will be published in the May issue of the Newsletter of the Swedish Mathematical Society (Medlemsutskicket).

1 Stein used Calderón's work. Calderón proved the equivalence between the L^1 norm of the square function of a holomorphic function F in H^1 and the L^1 norm of F. Then Stein could apply to the operator theory on Hardy spaces the tools that Hardy, Littlewood and Marcinkiewicz have been using in the context of L^p spaces. I was not familiar with this piece of mathematics.

On the Casas–Alvero conjecture

Jan Draisma and Johan P. de Jong

The Casas–Alvero conjecture says that a complex univariate polynomial having roots in common with each of its derivatives must be a power of a linear polynomial. In this expository note we review some ideas on this conjecture. In particular, we explain the rather successful algebraic attack by Graf von Bothmer et al., which proves the conjecture in infinitely many degrees, and challenge analysts to come up with new approaches.

1 The conjecture

At the turn of the 21st century, Eduardo Casas–Alvero formulated the following remarkable conjecture involving only high school level mathematical concepts.

Conjecture 1 (Casas–Alvero)**.** *Let f be a monic polynomial in a single variable x of degree $n > 0$ over the complex numbers. Suppose that for all $k = 1, \ldots, n-1$ there exists an $a_k \in \mathbb{C}$ such that $f(a_k) = f^{(k)}(a_k) = 0$, where $f^{(k)}$ denotes the k-th derivative of f with respect to x. Then f equals $(x-a)^n$ for some $a \in \mathbb{C}$.*

Casas–Alvero came to this conjecture in connection with his work on plane curves [2]: if the conjecture is true then this would lead to a convenient criterion for irreducibility of a plane curve defined near the origin by a convergent power series equation in two variables.

A polynomial satisfying the conditions of the conjecture will be called a *Casas–Alvero polynomial*. The condition that f and $f^{(k)}$ have a common zero is equivalent to the condition that the *resultant* of f and $f^{(k)}$ be zero, and this is a closed condition on the coefficients of f. As a consequence, Casas–Alvero polynomials of degree n form a closed subset of the (affine) space of all monic polynomials of degree n. In fact, these $n-1$ polynomial equations in the n non-leading coefficients of f can be analysed algorithmically for small n, and this analysis for $n \leq 7$ by Diaz-Toca and Gonzalez-Vega [3] constituted the first substantial progress on the Casas–Alvero conjecture.

The conjecture can also be formulated for fields other than the complex numbers, replacing the condition that f and $f^{(k)}$ have a common root by the condition that their greatest common divisor be non-trivial. One can show that if the conjecture is true over $\mathbb{C}$ then it is true over all fields of characteristic 0. On the other hand, the conjecture is *not* true in full generality in prime characteristic. For example, consider $f = x^4 + x^2 + 2x$ in characteristic 7, with $f' = 4x^3 + 2x + 2$, $f'' = 12x^2 + 2 = 5x^2 + 2$, $f''' = 24x = 3x$. Then 0 is a common root of f and f''', $-1 = 6$ is a common root of f and f'', and 4 is a common root of f and f'. These two circumstances justify the restriction to the complex case, where one might hope that analytic techniques may give more insight than can be obtained by purely algebraic means.

In fact, the conjecture is even open under the further restriction that $f \in \mathbb{R}[x]$ and that all roots of f are real. The mere fact that the roots of $f^{(i+1)}$ are then interlaced between the roots of $f^{(i)}$ does not suffice to prove the conjecture beyond degree 4 (see Figure 1 below).

In this expository note we review some ideas on the Casas–Alvero conjecture. In particular, in Section 7 we explain the rather successful algebraic attack by Graf von Bothmer, Labs, Schicho and van de Woestijne [4], which proves the conjecture for infinitely many values of n. The first four cases left open by (a slight enhancement of) this result are those where $n = 12, 24, 28, 30$. Their beautiful proof is set in the language of weighted projective schemes but we explain how it can be recast in the more elementary language of fields with a p-adic valuation. Since this proof depends strongly on n being a prime power times some small number, it seems unlikely that this approach will eventually settle the conjecture in full generality. For that reason, in the sections preceding Section 7 we sketch various observations of a more analytic nature. First, in Section 2 we describe the natural symmetries of the conjecture and argue that only slightly more symmetry would already imply the conjecture. Then in Section 3 we recall the elementary Gauss-Lucas theorem on the location of the zeroes of the derivatives of a polynomial and explain how it implies the conjecture in low degrees. In Section 4 we describe a Java applet that gives a hands-on feeling for the conjecture. A result of playing with this applet is a theorem in Section 5 on the existence of almost-counterexamples having only real roots. These are polynomials with only real roots having common zeroes with all derivatives *except one*. It would be interesting to know if such polynomials have applications in the context of Hermite-Birkhoff interpolation. Finally, in Section 6 we sketch a beautifully simple argument for why the set of common zeroes of a Casas–Alvero polynomial f with its derivatives cannot have cardinality two. We challenge more analytically minded readers to come up with more sophisticated arguments settling the conjecture, either in general or for polynomials having only real roots, or even for any specific value of n which has at least two large prime factors.

2 Symmetry

The following elementary observation describes the symmetries of the set of Casas–Alvero polynomials: their roots may be simultaneously scaled or translated.

Lemma 2. *If $f(x)$ is a Casas–Alvero polynomial of degree n then so is $a^{-n} f(ax + b)$ for all $a \in \mathbb{C}^*$ and $b \in \mathbb{C}$.* □

The Casas–Alvero conjecture would imply that the set of Casas–Alvero polynomials of fixed degree n has even more symmetry, namely, that it is stable under all Möbius transformations, generated by the affine transformations above together with the inversion $f(x) \mapsto x^n f(1/x)/f(0)$, where we assume that $f(0) \neq 0$ to ensure that this polynomial is again monic of degree n. In fact, the following converse of this observation is also true.

Proposition 3. *If the set of Casas–Alvero polynomials f of degree n with $f(0) \neq 0$ is closed under inversion then the Casas–Alvero conjecture is true in degree n.*

Proof sketch. Suppose, on the contrary, that f is a Casas–Alvero polynomial with at least two distinct roots; after an affine transformation we may assume that 1 is a root of f of multiplicity $d < n$. Now it is not hard to find a family of Möbius transformations $\lambda(t)$ depending on a parameter $t \in \mathbb{C}^*$ such that $\lambda(t)$ fixes the complex number 1 for all t and such that $\lim_{t\to 0} \lambda(t)c = -1$ for all $c \in \mathbb{C}\setminus\{1\}$. Then $\lambda(t)f$ converges to $(x+1)^{n-d}(x-1)^d$ for $t \to 0$. Since the set of Casas–Alvero polynomials is closed, this limit must be one as well – but it isn't, since its $(n-1)$-th derivative has its root strictly between -1 and 1. □

Unfortunately, proving the implication "f Casas–Alvero $\Rightarrow$ $x^n f(1/x)/c_0$ Casas–Alvero" does not seem any easier than the conjecture itself. The same holds for other symmetry arguments. For instance, Joris van der Hoeven suggested to us to look at the map that squares all roots of a polynomial f. Again, if one can prove that the set of all Casas–Alvero polynomials is closed under this map then one can readily prove the conjecture but this stability seems difficult.

3 Gauss-Lucas

We recall the well-known theorem by Gauss and Lucas.

Theorem 4. *For any $f \in \mathbb{C}[x]$ of positive degree the roots of its derivative f' lie in the convex hull in $\mathbb{C}$ of the roots of f. More precisely, if α is a root of f' then it is either also a root of f (of multiplicity at least 2) or it lies in the relative interior of the convex hull of the roots of f.* □

Here the *relative interior* is a single point if all roots of f coincide, an open line segment if all roots of f lie on a line and an open polygon if they do not lie on a line. Using Gauss-Lucas it is easy to prove that a Casas–Alvero polynomial must have at least one root in the relative interior of the convex hull C of its roots. Indeed, let $x_1, \ldots, x_k$ be the distinct roots of f that are not in the relative interior of C, let $m_1, \ldots, m_k$ be their respective multiplicities and set $m := \max_i m_i$. If $m = \deg f$ then f is an m-th power and there is nothing to prove. Otherwise $m < n$, $f^{(m)}$ has all its roots in the relative interior of C and one of them is also a root of f by assumption.

This readily proves the Casas–Alvero conjecture in degree at most four. For instance, suppose that f is a degree-four Casas–Alvero polynomial. Let x_1, x_2, x_3, x_4 be its roots. Since f and f' have a common root, we may assume that $x_1 = x_2$. By the previous argument we know that either all x_i coincide, or else x_1, x_3, x_4 must be distinct and lie on a line. In the latter case, we may move the roots to the real line by an affine transformation. Now there are two possibilities: either x_1 lies between x_3 and x_4 – in which case $f^{(2)}$ has one root in the open line segment between x_1 and x_3 and one root in the open line segment between x_1 and x_4, a contradiction – or x_3 lies between x_1 and x_4, in which case $f^{(2)}$ must have a zero in x_3 and a zero in the open segment between x_1 and x_3. But then $f^{(3)}$ has no root in common with f, again a contradiction. Beyond degree four, however, such arguments do not suffice to prove the conjecture. Indeed, purely topological arguments cannot rule out the interlacing pattern of roots in Figure 1, even if the conjecture is known to be true in degree five, either by the computational proof in [3] or by the result of Section 7.

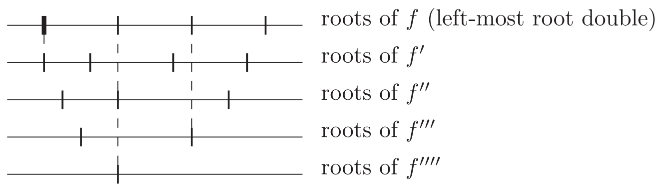


Figure 1. Potential locations of roots of a degree-five polynomial?

4 Casas–Alvero – the game

To get a feeling for the Casas–Alvero conjecture, we wrote a Java applet in which the user can specify and drag the roots of f, while the roots of all derivatives of f are depicted in ever lighter shades of grey and move along when dragging. One can interpret this applet as a one-person game, where the goal is to drag the roots of f such as to let, for each k up to $\deg f - 1$, at least one root of f coincide with a root of $f^{(k)}$. It turns out to be relatively easy to achieve this, without collapsing all roots of f to a point, if one value of k is left out – and this is not surprising, since the polynomial $f(x) = x^n + x^k$ has the root 0 in common with each of its derivatives except for $f^{(k)}$. But if one requires common roots with *all* derivatives then the roots have the tendency first to move to a line and then to collapse to a single point (see Figure 2). The applet, which can be found at http://www.win.tue.nl/~jdraisma/index.php?location=recreational, gives a feeling for the amazing dynamics of the roots of higher derivatives of f as those of f move around in the complex plane.

5 Almost-counterexamples with only real zeroes

Playing with the applet while keeping all roots of f on the real line led to the following observation: there exist *almost-counterexamples* to the Casas–Alvero conjectures having only real roots. That is, there exist polynomials with only real roots that are not pure powers and that have roots in common with all derivatives *except*, possibly, with one specified derivative. This is stated more precisely in the following theorem.

Theorem 5. *For all $n > 1$ and $l = 1, \ldots, n-1$ there exists a polynomial $f \in \mathbb{R}[x]$ with $f(0) = f(1) = 0$, all of whose roots are real and contained in the interval $[0, 1]$, and with the property that f has a common root with $f^{(k)}$ for all $k \in \{1, \ldots, n\} \setminus \{l\}$.*

Proof. If $f \in \mathbb{R}[x]$ is any polynomial having only real roots then the same is true for all derivatives of f. For any pair (k, m) of integers with $1 \leq k \leq n-1$ and $1 \leq m \leq k$ we then write $\alpha_{k,m}(f) \in \mathbb{R}$ for the m-th root of $f^{(k)}$, where the roots of $f^{(k)}$ are ordered (weakly) increasingly. We will prove

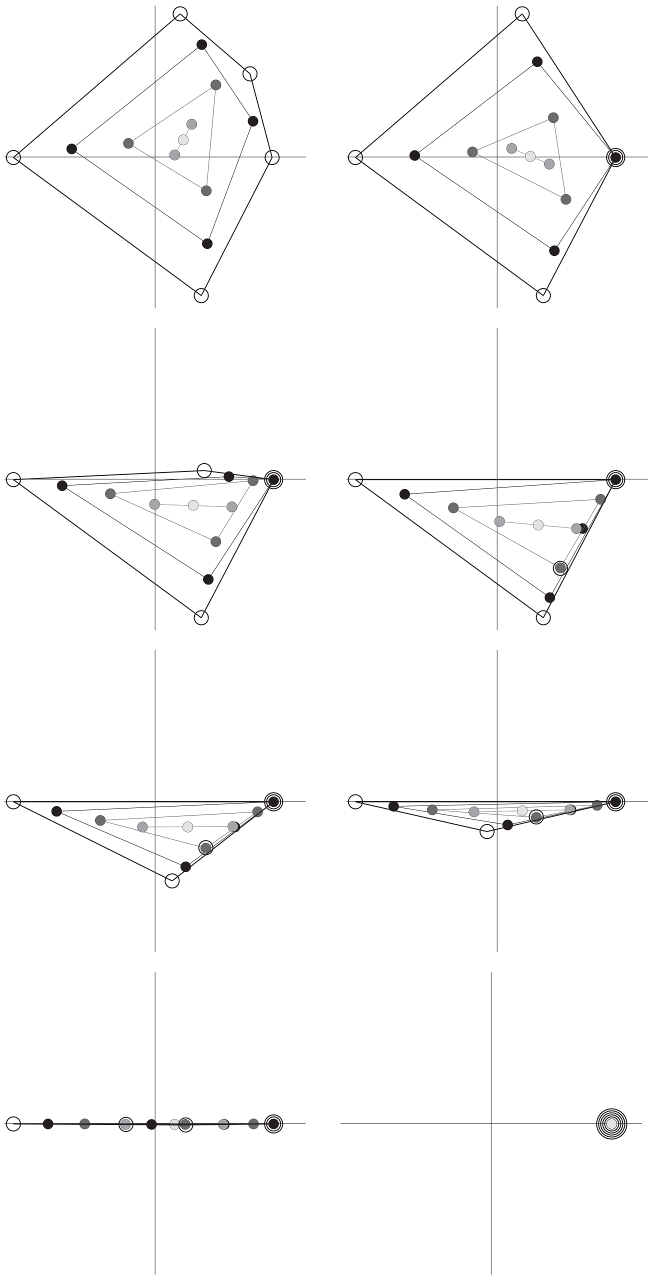


Figure 2. Making roots of f coincide with some of f', f'', f''' and finally f'''' causes them to collapse.

the following stronger statement: fix $n-2$ pairs of integers (k_i, m_i) with $1 \le k_i \le n-1$ and $1 \le m_i \le n-k_i$ for $i = 1, \ldots, n-2$. We claim that there exists a polynomial $f \in \mathbb{R}[x]$ with $f(0) = f(1) = 0$, all of whose roots are real and lie in $[0,1]$, and which has the property that the $\alpha_{k_i,m_i}(f)$ is also a root of f, for all $i = 1, \ldots, n-2$.

To this end consider the map $\Phi : [0,1]^{n-2} \to [0,1]^{n-2}$ which sends the $(n-2)$-tuple $\beta = (\beta_1, \ldots, \beta_{n-2})$ to $(\alpha_{k_1,m_1}(f_\beta), \ldots, \alpha_{k_{n-2},m_{n-2}}(f_\beta))$, where f_β is the polynomial $x(x-1)\prod_{i=1}^{n-2}(x-\beta_i)$. Standard calculus shows that Φ is a continuous map. Hence, by Brouwer's fixed point theorem – which applies since $[0,1]^{n-2}$ is homeomorphic to a ball – there exists a point $(\beta_1, \ldots, \beta_{n-2}) \in [0,1]^{n-2}$ fixed by Φ. But then f_β is a polynomial as required. □

For example, take $n = 5$ and the pairs $(k_1, m_1) = (1,2)$, $(k_2, m_2) = (2,3)$, $(k_3, m_3) = (4,1)$. Then the proof above

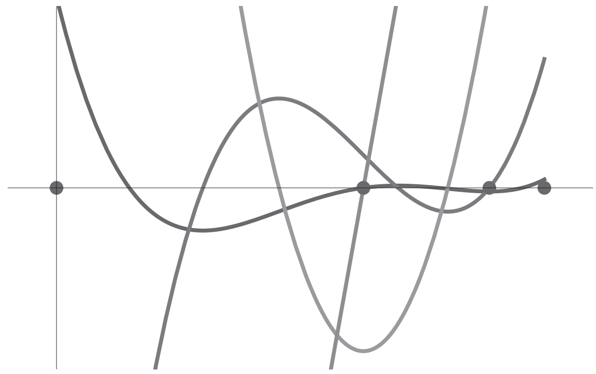


Figure 3. The degree-5 polynomial with roots at the dots (double at the second dot) has roots in common with its first, second and fourth derivatives but not with its third derivative.

shows that there exists a quintic polynomial $f \in \mathbb{R}[x]$ having real roots $0, 1, \beta_1, \beta_2, \beta_3 \in [0,1]$ such that β_1 coincides with the second root of the first derivative f', β_2 coincides with the third (i.e. largest) root of the second derivative f'', and β_3 coincides with the unique root of the fourth derivative f''''. The numbers $\beta_1, \beta_2, \beta_3$ have been found numerically in `Mathematica` by computing the fixpoint of the map Φ, giving $\beta_1, \beta_3 \approx 0.629099$ and $\beta_2 \approx 0.887298$. The graphs of the four derivatives of this polynomial are drawn in Figure 3; actually, the graph of $f^{(i)}$ has been scaled by $1/i!$ to make the plotting ranges compatible. Here is a challenge for algebraically inclined readers: determine the algebraic numbers $\beta_1, \beta_2, \beta_3$ exactly!

Actually, we do not need the full strength of Brouwer's fixed point theorem in the proof above; an argument involving monotonicity and the *root-dragging Theorem* [1] also suffices. It would be very interesting to know if the polynomials emerging this way Φ have useful applications, e.g. in numerical analysis in the context of Hermite-Birkhoff interpolation.

6 Two recycled zeroes

In the next section we will see how the Casas–Alvero conjecture can be proved in infinitely many degrees by reduction modulo a prime. However, it seems unlikely that the methods there will ever settle the conjecture in *all* degrees. Therefore, we believe that arguments exploiting the ordinary absolute value of $\mathbb{C}$, rather than its p-adic absolute values, are needed. We challenge the analysts among our readers to come up with such methods! Here is a first observation along these lines, due to Jan Willem Knopper (from Eindhoven University of Technology) and Jan Draisma.

Proposition 6. *Suppose that f is a Casas–Alvero polynomial of degree n and let a_i, $i = 1, \ldots, n-1$, be a common root of f and its i-th derivative. Then the cardinality of the set $\{a_1, \ldots, a_{n-1}\}$ cannot be two.*

Note that this is a stronger statement than the observation used in the proof of Proposition 3 that f cannot be of the form $(x-a)^k(x-b)^{n-k}$ for $0 < k < n$; indeed, f might well have roots that are not recycled. Note also that if the cardinality equals 1 then f is an n-th power of a linear polynomial, as required.

Proof. Suppose, on the contrary, that the cardinality is two. After an affine transformation, we may assume that the set is $\{0, 1\}$. We prove by induction that $f^{(k)}$ is actually a real polynomial that is either entirely positive or entirely negative on the open interval $(0, 1)$. This is trivially true for $f^{(n)} = n!$. Now suppose that it is true for $f^{(k)}$. By assumption, $f^{(k-1)}$ has a root $x_0 \in \{0, 1\}$ and hence equals the integral $\int_{x_0}^{x} f^{(k)}(t)\mathrm{d}t$. As $f^{(k)}$ assumes only a single sign on the open interval $(0, 1)$, $f^{(k-1)}$ is strictly monotonous on $[0, 1]$ and as $f^{(k-1)}$ is zero at the endpoint x_0 of $[0, 1]$, the polynomial $f^{(k-1)}$ also assumes only a single sign on $(0, 1)$. In particular, we find that $f^{(1)}$ is either entirely positive or entirely negative on the interval $(0, 1)$, so that f itself is strictly monotonous on $[0, 1]$. But then 0 and 1 cannot both be roots of f. □

We have tried to extend this argument to the case of three recycled roots but have failed so far.

7 Reduction-mod-p arguments

The major positive result on the Casas–Alvero conjecture is the following.

Theorem 7 (The Small-multiples-of-prime-power Theorem)**.** *Suppose that n factorises as $n'p^e$ for some $n' \in \{1, 2, 3, 4\}$ and some prime number $p > n'$ with exponent $e \in \mathbb{Z}_{\geq 0}$, and assume that $p \neq 7$ if $n' = 4$. Then the Casas–Alvero conjecture is true in degree n.*

For $n' \in \{1, 2\}$ this result is due to Graf von Bothmer, Labs, Schicho and van de Woestijne [4]. Unfortunately, our extension to the cases where $n' \in \{3, 4\}$ does not settle the case where $n = 12$, since we require that p be larger than n'. However, it does settle the cases where $n = 15, 20, 21$, so that the first four open cases are $n = 12, 24, 28, 30$. The key argument in the proof below is identical to that in [4] but we have replaced the use of *weighted projective schemes* by conceptually more elementary *valuation theory*. Recall that a *valuation* on a field K is a map $v : K \to \mathbb{R} \cup \{\infty\}$ satisfying the following axioms:
(1) $v^{-1}(\infty) = \{0\}$,
(2) $v(ab) = v(a) + v(b)$, and
(3) $v(a + b) \geq \min\{v(a), v(b)\}$
for all $a, b \in K$. We will use the *p-adic* valuation v_p on $K = \mathbb{Q}$, where for $a \in \mathbb{Z}$ the valuation $v_p(a)$ is the number of factors p in a, and $v_p(a/b) = v_p(a) - v_p(b)$.

A fundamental fact in valuation theory, and the only nontrivial fact that we will make use of here, is that any valuation on a subfield of K can be extended to a valuation on K, e.g. see [5, Chapter XII, §4]. In particular, v_p can be extended from $\mathbb{Q}$ to $\mathbb{C}$, and we fix such an extension. Now set $R := \{z \in \mathbb{C} \mid v_p(z) \geq 0\}$; by the axioms above this is a sub-ring of $\mathbb{C}$ in which ideal $M := \{z \in \mathbb{C} \mid v_p(z) > 0\}$ is a maximal ideal. The quotient $K := R/M$ is a field of characteristic p and the fact that $\mathbb{C}$ is algebraically closed implies that so is K.

Instead of the ordinary derivatives of a polynomial $f = x^n + c_{n-1}x^{n-1} + \ldots + c_0$ in $\mathbb{C}[x]$ or in $K[x]$ we will use its *Hasse derivatives*, defined by

$$H_i(f) := \binom{n}{i} x^{n-i} + \binom{n-1}{i} c_{n-1} x^{n-i-1} + \ldots + \binom{i}{i} c_i.$$

For $f \in \mathbb{C}[x]$ the i-th Hasse derivative $H_i(f)$ is just $f^{(i)}/i!$ but for $f \in K[x]$ the i-th Hasse derivative $H_i(f)$ may be nonzero, even if the i-th derivative $f^{(i)}$ is; this happens, for instance, for $f = x^{2p}$ and $i = p$. From now on, f is called a Casas–Alvero polynomial if it is monic of positive degree $n > 0$ and has common roots with each of its Hasse derivatives $H_i(f)$, $i = 1, \ldots, n-1$. For $f \in \mathbb{C}[x]$ this coincides with the earlier notion. Since we will be working with Hasse derivatives of polynomials over the characteristic-p field K, we need the values of certain binomial coefficients modulo p.

Lemma 8 (The Binomial-mod-p Lemma.)**.** *Fix $n' \in \mathbb{Z}_{>0}$, a prime number $p > n'$, an exponent $e \in \mathbb{Z}_{>0}$ and set $n := n'p^e$. Then for $k \in \{0, \ldots, n\}$ we have*

$$v_p\left(\binom{n}{k}\right) > 0$$

unless k is a multiple $k'p^e$ for some $k' \leq n'$, in which case

$$\binom{n}{k} \cong \binom{n'}{k'} \mod p. \quad \square$$

This is a special case of another theorem due to Lucas, which expresses the binomial coefficient $\binom{n}{k}$ modulo p as the product of the binomial coefficients $\binom{n'}{k'}$ where n' and k' run over the (corresponding) digits of n and k in their p-ary expressions (see http://en.wikipedia.org/wiki/Lucas'_theorem).

Proposition 9 (The Reduction-mod-p Proposition [4])**.** *Suppose that $n = n'p^e$ with p a prime larger than n' and suppose that every Casas–Alvero polynomial in $K[x]$ of degree n' is of the form $(x - a)^{n'}$ for some $a \in K$. Then the Casas–Alvero conjecture holds for polynomials of degree n in $\mathbb{C}[x]$.*

Proof. Let $f \in \mathbb{C}[x]$ be a Casas–Alvero polynomial of degree n and assume that f has at least two distinct roots. After a translation we may assume that f has 0 as a root and then, after dividing all roots by the root of minimal valuation, we may assume that f has the form

$$f = x(x-1)(x-x_1)\cdots(x-x_{n-2}) = x^n + c_{n-1}x^{n-1} + \ldots + c_1 x$$

where all x_i are in R, so that all $c_i \in R$. We will indicate reduction modulo M by bars on the symbols. Thus

$$\bar{f} = x(x-1)(x-\bar{x}_1)\cdots(x-\bar{x}_{n-2}) = x^n + \bar{c}_{n-1}x^{n-1} + \ldots + \bar{c}_1 x$$

is a polynomial in $K[x]$ and if $H_i(f)$ has root $0, 1$ or x_j in common with f then $H_i(\bar{f})$ has root $0, 1$ or $\bar{x}_j$ in common with $\bar{f}$. Hence $\bar{f}$ is a Casas–Alvero polynomial.

We continue to show that $\bar{c}_i$ is zero for all i for which p^e does not divide i. We start with $\bar{c}_{n-1}$ and work our way down to $\bar{c}_1$, so when proving the statement for i we may assume that it holds for all larger indices not divisible by p^e. Consider

$$H_i(\bar{f}) = \binom{n}{i}x^{n-i} + \binom{n-1}{i}\bar{c}_{n-1}x^{n-1} + \ldots + \binom{i+1}{i}\bar{c}_{i+1}x + \bar{c}_i.$$

In this expression all terms involving c_k with $k > i$, $p^e \nmid k$, are zero by the induction assumption and all binomial coefficients $\binom{k}{i}$ with $p^e | k$ are zero since $p^e \nmid i$. Hence $H_i(\bar{f})$ is the constant polynomial $\bar{c}_i$ and yet has a root in common with $\bar{f}$. This implies that $\bar{c}_i = 0$. We conclude that

$$\bar{f} = x^n + \sum_{0<k<n, p^e|k} \bar{c}_k x^k.$$

Since K is algebraically closed, we may choose, for each k in the range of the second sum, a p^e-th root d_{k/p^e} of $\bar{c}_k$ in K. Then we have $\bar{f} = g^{p^e}$ with

$$g = x^{n'} + d_{n'-1}x^{n'-1} + \ldots + d_1 x \in K[x]$$

by the *Freshman's dream* (http://en.wikipedia.org/wiki/Freshman's_dream). Moreover, by the Binomial-mod-p lemma, we find that

$$H_k\bar{f} = (H_{k/p^e}g)^{p^e}$$

for all k, $0 < k < n$ divisible by p^e. We conclude that g is a Casas–Alvero polynomial in $K[x]$ of degree n'. By the assumption in the proposition, g equals $x^{n'}$ and therefore $\bar{f}$ equals x^n. But this contradicts the fact that $1 \in K$ is a root of $\bar{f}$. We conclude that the assumption that f has at least two distinct roots must be wrong and the Casas–Alvero conjecture for polynomials in $\mathbb{C}[x]$ of degree n follows. □

Now we can prove the Small-multiples-of-prime-power Theorem.

Proof. Let $n = n'p^e$ with $n' \in \{1, 2, 3, 4\}$ and p a prime larger than n'. By the Reduction-mod-p Proposition it suffices to prove that Casas–Alvero polynomials g of degree n' in $K[x]$ are pure powers. This is a triviality for $n' = 1$ and for $n' = 2$ it follows from the fact that a polynomial over K having a common root with its first derivative in fact has a double root. Next take n' equal to 3 and let $g \in K[x]$ be a cubic Casas–Alvero polynomial. After an affine transformation we may assume that the root which g has in common with its second derivative equals 0. Then g is of the form $x^3 + ax = x(x^2 + a)$ and $H_1 g = 3x^2 + a$. If a is non-zero then a common root of g and $H_1 g$ cannot be zero and must therefore be a root of the factor $x^2 + a$ of g. But then it is also a root of $H_1 g - (x^2 + a) = 2x^2$. Hence, as p is larger than 2, the common root is zero after all, a contradiction. We conclude that a must be zero for g and H_1 to have a common root. This proves the theorem for $n' = 3$.

Finally take $n' = 4$ and let g be a quartic Casas–Alvero polynomial in $K[x]$. After an affine transformation we may assume, as above, that $g = x^4 + ax^2 + bx$. Now the resultants of g with $H_1 g = 4x^3 + 2ax + b$ and with $H_2 g = 6x^2 + a$ equal the determinants of the Sylvester matrices

$$\begin{bmatrix} 1 & 0 & a & b & 0 & 0 & 0 \\ 0 & 1 & 0 & a & b & 0 & 0 \\ 0 & 0 & 1 & 0 & a & b & 0 \\ 4 & 0 & 2a & b & 0 & 0 & 0 \\ 0 & 4 & 0 & 2a & b & 0 & 0 \\ 0 & 0 & 4 & 0 & 2a & b & 0 \\ 0 & 0 & 0 & 4 & 0 & 2a & b \end{bmatrix} \text{ and } \begin{bmatrix} 1 & 0 & a & b & 0 & 0 & 0 \\ 0 & 1 & 0 & a & b & 0 & 0 \\ 6 & 0 & a & 0 & 0 & 0 & 0 \\ 0 & 6 & 0 & a & 0 & 0 & 0 \\ 0 & 0 & 6 & 0 & a & 0 & 0 \\ 0 & 0 & 0 & 6 & 0 & a & 0 \end{bmatrix},$$

which evaluate to $-b^2(4a^3 + 27b^2)$ and $a(25a^3 + 216b^2)$, respectively. Hence we find that either $a = b = 0$ or the determinant $4 \cdot 216 - 27 \cdot 25 = 189 = 3^3 \cdot 7$ equals zero. The latter happens only when $p = 3$ or $p = 7$, which were excluded in the theorem. □

Note that in characteristic 7 there *are* Casas–Alvero polynomials of degree four that are not powers of linear forms, as we saw in Section 1. Such polynomials also exist in characteristic 3; $x^4 + x = x(x + 1)^3$ is a trivial example having common root -1 with its first and second (Hasse) derivatives and common root 0 with its third derivative.

8 Conclusion

While the Reduction-mod-p Proposition is a very powerful tool for proving the Casas–Alvero conjecture in small or even moderately large degrees, the last paragraph of the previous section hints at a weakness in this approach: in a fixed degree n we expect the set of primes modulo which the conjecture is *false* to be finite (indeed, this would follow from the Casas–Alvero conjecture over $\mathbb{C}$) but even for smallish degrees this set turns out to contain largish primes. Graf von Bothmer et al. give more striking examples of this in degree 6. So alternative approaches will be needed to settle the conjecture in all degrees, and it is not unlikely that these will involve typical complex number techniques, e.g. involving residues and path integrals. Once again, we challenge more analytically minded readers to come up with such ideas!

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Jan Draisma [jdraisma@win.tue.nl] is an assistant professor of mathematics at Eindhoven University of Technology. After obtaining his PhD from Eindhoven in 2002, he held a postdoctoral position at the University of Basel until his return to Eindhoven in 2005. In 2010, he received a five-year Vidi grant from the Netherlands Organisation for Scientific Research (NWO).

Johan P. de Jong [J.P.d.Jong@student.tue.nl] is a master's student at Eindhoven University of Technology. He obtained his BSc in Computer Science in 2007 and his BSc in Mathematics in 2010 and is currently doing an MSc in Computer Science.

Nefarious Numbers

Douglas N. Arnold and Kristine K. Fowler

1 Introduction

The impact factor has been widely adopted as a proxy for journal quality. It is used by libraries to guide purchase and renewal decisions, by researchers deciding where to publish and what to read, by tenure and promotion committees labouring under the assumption that publication in a higher impact factor journal represents better work, and by editors and publishers as a means to evaluate and promote their journals. The impact factor for a journal in a given year is calculated by ISI (Thomson Reuters) as the average number of citations in that year to the articles the journal published in the preceding two years. It has been widely criticised on a variety of grounds:[1, 2, 3, 4]

- A journal's distribution of citations does not determine its quality.
- The impact factor is a crude statistic, reporting only one particular item of information from the citation distribution.
- It is a flawed statistic. For one thing, the distribution of citations among papers is highly skewed, so the mean for the journal tends to be misleading. For another, the impact factor only refers to citations within the first two years after publication (a particularly serious deficiency for mathematics, in which around 90% of citations occur after two years).
- The underlying database is flawed, containing errors and including a biased selection of journals.
- Many confounding factors are ignored, for example article type (editorials, reviews and letters versus original research articles), multiple authorship, self-citation, language of publication, etc.

Despite these difficulties, the allure of the impact factor as a single, readily available number – not requiring complex judgments or expert input but purporting to represent journal quality – has proven irresistible to many. Writing in 2000 in a newsletter for journal editors, Amin and Mabe[5] wrote that the "impact factor has moved in recent years from an obscure bibliometric indicator to become the chief quantitative measure of the quality of a journal, its research papers, the researchers who wrote those papers and even the institution they work in". It has become commonplace for journals to issue absurd announcements touting their impact factors, like this one which was mailed around the world by World Scientific, the publisher of the International Journal of Algebra and Computation: "IJAC's Impact Factor has improved from 0.414 in 2007 to 0.421 in 2008! Congratulations to the Editorial Board and contributors of IJAC." In this case, the 1.7% increase in the impact factor represents a single additional citation to one of the 145 articles published by the journal in the preceding two years.

Because of the (misplaced) emphasis on impact factors, this measure has become a target at which journal editors and publishers aim. This has in turn led to another major source of problems with the factor. Goodhart's law warns us that "when a measure becomes a target, it ceases to be a good measure".[6] This is precisely the case for impact factors. Their limited utility has been further compromised by impact factor manipulation, the engineering of this supposed measure of journal quality, in ways that increase the measure but do not add to – indeed subtract from – journal quality.

Impact factor manipulation can take numerous forms. In a 2007 essay on the deleterious effects of impact factor manipulation, Macdonald and Kam[7] noted wryly that "the canny editor cultivates a cadre of regulars who can be relied upon to boost the measured quality of the journal by citing themselves and each other shamelessly". There have also been widespread complaints by authors of manuscripts under review, who were asked or required by editors to cite other papers from the journal. Given the dependence of the author on the editor's decision for publication, this practice borders on extortion, even when posed as a suggestion. In most cases one can only guess about the presence of such pressures but overt instances have already been reported in 2005 by Monastersky[8] in the Chronicle of Higher Education and Begley[9] in the Wall Street Journal. A third well-established technique by which editors raise their journals' impact factors is by publishing review items with large numbers of citations to the journal. For example, the Editor-in-Chief of the Journal of Gerontology A made a practice of authoring and publishing a review article every January focusing on the preceding two years; in 2004, 195 of the 277 references were to the Journal of Gerontology A. Though the distortions these unscientific practices wreak upon the scientific literature have raised occasional alarms, many suppose that they either have minimal effect or are so easily detectable they can be disregarded. A counterexample should confirm the need for alarm.

2 The case of IJNSNS

The field of applied mathematics provides an illuminating case in which we can study such impact factor distortion. For the last few years, the International Journal of Nonlinear Sciences and Numerical Simulation (IJNSNS) has dominated the impact factor charts in the "Mathematics, Applied" category. It took first place in each year 2006, 2007, 2008 and 2009, generally by a wide margin, and came in second in 2005. However, as we shall see, a more careful look indicates that IJNSNS is nowhere near the top of its field. Thus we set out to understand the origin of its large impact factor.

In 2008 (the year we shall consider in most detail), IJNSNS had an impact factor of 8.91, easily the highest among the 175 journals in the applied mathematics category in ISI's Journal Citation Reports (JCR). As controls, we will also look at the two journals in the category with the second and third highest impact factors, Communications on Pure and Applied

Mathematics (CPAM) and SIAM Review (SIREV), with 2008 impact factors of 3.69 and 2.80, respectively. CPAM is closely associated with the Courant Institute of Mathematical Sciences and SIREV is the flagship journal of the Society for Industrial and Applied Mathematics (SIAM).[10] Both journals have a reputation for excellence.

Evaluation based on expert judgment is the best alternative to citation-based measures for journals. Though not without potential problems of its own, a careful rating by experts is likely to provide a much more accurate and holistic guide to journal quality than impact factor or similar metrics. In mathematics, as in many fields, researchers are widely in agreement about which are the best journals in their specialities. The Australian Research Council recently released such an evaluation, listing quality ratings for over 20,000 peer-reviewed journals across disciplines. The list was developed through an extensive review process involving learned academies (such as the Australian Academy of Science), disciplinary bodies (such as the Australian Mathematical Society) and many researchers and expert reviewers.[11] This rating is being used for the Excellence in Research Australia assessment initiative and is referred to as the ERA 2010 Journal List. The assigned quality rating, which is intended to represent "the overall quality of the journal", is one of four values:

A*: one of the best in its field or subfield.
A: very high quality.
B: solid, though not outstanding reputation.
C: does not meet the criteria of the higher tiers.

The ERA list included all but five of the 175 journals assigned a 2008 impact factor by JCR in the category "Mathematics, Applied". Figure 1 shows the impact factors for journals in each of the four rating tiers. We see that, as a proxy for expert opinion, the impact factor does rather poorly. There are many examples of journals with a higher impact factor than other journals which are one, two and even three rating tiers higher. The thick line is drawn so that 20 % of the A* journals are below it; it is notable that 51 % of the A journals have an impact factor above that level, as do 23 % of the B journals and even 17 % of those in the C category. The most extreme outlier is IJNSNS, which, despite its relatively astronomical impact factor, is not in the first or second but rather the third tier. The ERA rating assigned its highest score, A*, to 25 journals. Most of the journals with the highest impact factors are here, including CPAM and SIREV, but of the top 10 journals by impact factor, two were assigned an A and only IJNSNS was assigned a B. There were 53 A-rated journals and 69 B-rated journals altogether. If IJNSNS were assumed to be the best of the B journals, there would be 78 journals with higher ERA ratings, while if it were the worst, its ranking would fall to 147. In short, the ERA ratings suggest that IJNSNS is not only not the top applied mathematics journal but its rank should be somewhere in the range 75–150. This remarkable mismatch between reputation and impact factor begs an explanation.

3 Makings of a high impact factor

A first step to understanding IJNSNS's high impact factor is to look at how many authors contributed substantially to the counted citations and who they were. The top-citing author

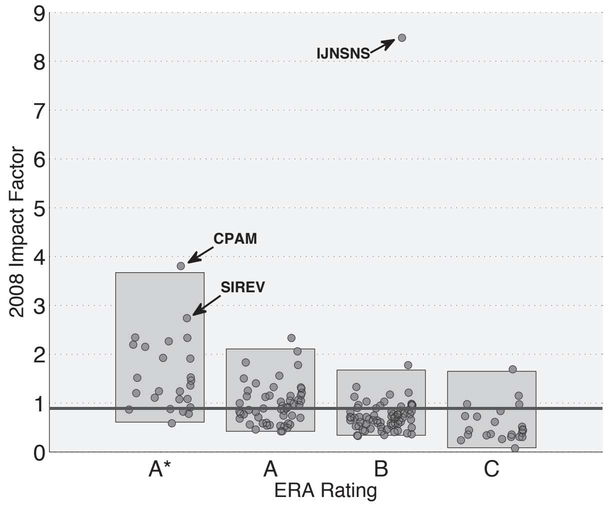

Figure 1. 2008 impact factors of 170 applied mathematics journals grouped according to their 2010 ERA rating tier. In each tier, the band runs from the 2.5th to the 97.5th percentile, outlining the middle 95 %. Horizontal position of the data points within tiers is assigned randomly to improve visibility. The thick line is at the 20th percentile of the A* tier.

to IJNSNS in 2008 was the journal's Editor-in-Chief Ji-Huan He, who cited the journal (within the two-year window) 243 times. The second top-citer, D. D. Ganji, with 114 citations, is also a member of the editorial board, as is the third, regional editor Mohamed El Naschie, with 58 citations. Together these three account for 29 % of the citations counted towards the impact factor. For comparison, the top three citers to SIREV contributed only 7, 4 and 4 citations, respectively, accounting for less than 12% of the counted citations, and none of these authors is involved in editing the journal. For CPAM the top three citers (9, 8 and 8) contributed about 7 % of the citations and, again, were not on the editorial board.

Another significant phenomenon is the extent to which citations to IJNSNS are concentrated within the 2-year window used in the impact factor calculation. Our analysis of 2008 citations to articles published since 2000 shows that 16 % of the citations to CPAM fell within that 2-year window and only 8 % of those to SIREV did; in contrast, 71.5 % of the 2008 citations to IJNSNS fell within the 2-year window. In Table 1, we show the 2008 impact factors for the three journals, as well as a modified impact factor, which gives the average number of citations in 2008 to articles the journals published not in 2006 and 2007 but in the preceding six years. Since the cited half-life (the time it takes to generate half of all the eventual citations to an article) for applied mathematics is nearly 10 years,[12] this measure is at least as reasonable as the impact factor. It is also independent, unlike JCR's 5-Year Impact Factor, as its time period does not overlap with that targeted by the impact factor. Note that the impact factor of IJNSNS drops precipitously, by a factor of seven, when we consider a different citation window. By contrast the impact factor of CPAM stays about the same and that of SIREV increases markedly. One may simply note that, in distinction to the controls, the citations made to IJNSNS in 2008 greatly favour articles published in precisely the two years which are used to calculate the impact factor.

Further striking insights arise when we examine the high-citing journals rather than high-citing authors. The counting of journal self-citations in the impact factor is frequently criticised and indeed it does come into play in this case. In 2008, IJNSNS supplied 102, or 7 %, of its own impact factor citations. The corresponding numbers are 1 citation (0.8 %) for SIREV and 8 citations (2.4 %) for CPAM. The disparity in other recent years is similarly large or larger.

However, it was Journal of Physics: Conference Series which provided the greatest number of IJNSNS citations. A single issue of that journal provided 294 citations to IJNSNS in the impact-factor window, accounting for more than 20 % of its impact factor. What was this issue? It was the proceedings of a conference organised by IJNSNS Editor-in-Chief He at his home university. He was responsible for the peer review of the issue. The second top-citing journal for IJNSNS was Topological Methods in Nonlinear Analysis, which contributed 206 citations (14 %), again with all citations coming from a single issue. This was a special issue with Ji-Huan He as the guest editor; his co-editor, Lan Xu, is also on the IJNSNS editorial board. J.-H. He himself contributed a brief article to the special issue, consisting of 3 pages of text and 30 references. Of these, 20 were citations to IJNSNS within the impact-factor window. The remaining 10 consisted of 8 citations to He and 2 to Xu.

Continuing down the list of IJNSNS high-citing journals, another similar circumstance comes to light: 50 citations from a single issue of the Journal of Polymer Engineering (which, like IJNSNS, is published by Freund), guest-edited by the same pair Ji-Huan He and Lan Xu. However, third place is held by the journal Chaos, Solitons & Fractals, with 154 citations spread over numerous issues. These are again citations which may be viewed as subject to editorial influence or control. In 2008 Ji-Huan He served on the editorial board of CS&F, and its Editor-in-Chief was Mohamed El Naschie, who was also a co-editor of IJNSNS. In a highly publicised case, the entire editorial board of CS&F was recently replaced but El Naschie remained co-editor of IJNSNS.

Many other citations to IJNSNS came from papers published in journals for which He served as editor, such as Zeitschrift für Naturforschung A, which provided 40 citations; there are too many others to list here, since He serves in an editorial capacity on more than 20 journals (and has just been named Editor-in-Chief of four more journals from the newly-formed Asian Academic Publishers). Yet another source of citations came from papers authored by IJNSNS editors other than He, which accounted for many more. All told, the aggregation of such editor-connected citations, which are time-consuming to detect, account for more than 70 % of all the citations contributing to the IJNSNS impact factor.

Table 1. 2008 impact factors computed with the usual two-preceding years window, and with a window going back eight years but neglecting the two immediately preceding.

Journal	2008 impact factor with normal 2006–7 window	Modified 2008 “impact factor” with 2000–5 window
IJNSNS	8.91	1.27
CPAM	3.69	3.46
SIREV	2.8	10.4

4 Bibliometrics for individuals

Bibliometrics are also used to evaluate individuals, articles, institutions and even nations. Essential Science Indicators, which is produced by Thomson Reuters, is promoted as a tool for ranking “top countries, journals, scientists, papers, and institutions by field of research”. However, these metrics are primarily based on the same citation data used for journal impact factors and thus they can be manipulated just as easily, indeed simultaneously. The special issue of Journal of Physics: Conference Series, which He edited and which garnered 243 citations for his journal, also garnered 353 citations to He himself. He claims a total citation count of over 6,800.[13] Even half that number is considered highly noteworthy as evidenced by this announcement in ScienceWatch.com:[14] “According to a recent analysis of Essential Science Indicators from Thomson Scientific, Professor Ji-Huan He has been named a Rising Star in the field of Computer Science … His citation record in the Web of Science includes 137 papers cited a total of 3,193 times to date.” Together with only a dozen other scientists in all fields of science, He was cited by ESI for the “Hottest Research of 2007–8” and again for the “Hottest Research of 2009”.

The h-index is another popular citation-based metric for researchers, intended to measure productivity as well as impact. An individual’s h-index is the largest number such that that many of their papers have been cited at least that many times. It too is not immune from Goodhart’s law. J.-H. He claims an h-index of 39, while Hirsch estimated the median for Nobel prize winners in physics to be 35.[15] Whether for judgment of individuals or journals, citation-based designations are no substitute for an informed judgment of quality.

5 Closing thoughts

Despite numerous flaws, the impact factor has been widely used as a measure of quality for journals and even for papers and authors. This creates an incentive to manipulate it. Moreover, it is possible to vastly increase impact factor without increasing journal quality at all. The actions of a few interested individuals can make a huge difference, yet require considerable digging to reveal. We primarily discussed one extreme example but there is little reason to doubt that such techniques are being used to a lesser – and therefore less easily detected – degree by many journals. The cumulative result of the design flaws and manipulation is that impact factor gives a very inaccurate view of journal quality. More generally, the citations which form the basis of the impact factor and various other bibliometrics are inherently untrustworthy.

The consequences of this unfortunate situation are great. Rewards are wrongly distributed, the scientific literature and enterprise are distorted and cynicism about them grows. What is to be done? Just as for scientific research itself, the temptation to embrace simplicity when it seriously compromises accuracy must be resisted. Scientists who give in to the temptation to suppress data or fiddle with statistics to draw a clearer point are censured. We must bring a similar level of integrity to the evaluation of research products. Administrators, funding agencies, librarians and others needing such evaluations should just say no to simplistic solutions, and approach important decisions with thoughtfulness, wisdom and expertise.

Acknowledgements

The authors gratefully acknowledge the assistance of Susan K. Lowry, who developed and supported the database used in this study, and Molly T. White.

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Douglas N. Arnold [arnold@umn.edu] is McKnight Presidential Professor of Mathematics at the School of Mathematics of the University of Minnesota. His research mostly concerns numerical analysis, partial differential equations, mechanics and the interplay between these fields. He was President of the Society for Industrial and Applied Mathematics (SIAM) in 2009–2010. From 2001 to 2008 he was Director of the Institute for Mathematics and its Applications (IMA) of the University of Minnesota.

Kristine Fowler [fowle013@umn.edu] is the mathematics librarian at the University of Minnesota. She has Master's degrees in physics and library science, both from the University of Illinois at Urbana-Champaign. Her main professional focus is on scholarly communication issues.

Pictures from an exhibition

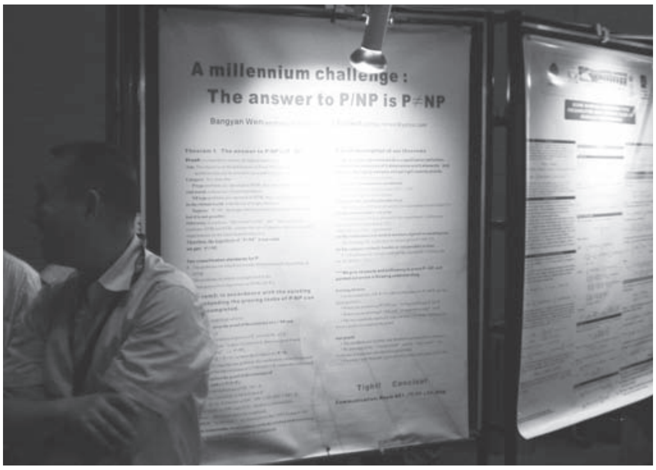
Olaf Teschke (FIZ Karlsruhe)

When, during his opening address at the ICM in Hyderabad, the Governor of Andhra Pradesh pointed out the prominent ranking of the University of Hyderabad due to its high impact factors, he was most likely not aware that many mathematicians in the audience wouldn't accept this evaluation as too conclusive – not just due to a sceptical attitude to political statements but merely caused by their knowledge of weaknesses inherent in oversimplified models. Unfortunately, the governor had already left the opening ceremony when the IMU addressed several questions related to mathematics publishing – above all, the release of the Best Current Practices for Journals[1] (just endorsed by the General Assembly at Bangalore) but also the misuse of citation statistics in research assessment.[2]

Without doubt, the number of mathematical publications has increased dramatically over the past few years (just compare the 78759 entries in the ZBMATH volumes 1000–1024 of 2003 to the 126039 entries in volumes 1175–1199 of 2010; for details, we refer to Bernd Wegner's article in this issue's Zentralblatt Column), to a great extend due to the dynamic scientific development in emerging economies. The ICM has always been a place to integrate the diverse developments in mathematics and to underline the unity and integrity of mathematics – so Hyderabad was a perfect place to discuss the various aspects of publishing, with the exhibition hall arguably being the canonical nexus between mathematicians, societies and companies. Indeed, what was frequently lamented as one of the drawbacks of the 2010 ICM – the isolation of the conference centre – caused several meetings by serendipity; some anecdotes may serve to illustrate the opposites between today's mathematics developments.

1 IMU Best Current Practices for Journals, http://www.mathunion.org/fileadmin/CEIC/bestpractice/bpfinal.pdf.
2 ICIAM /IMS/IMU report: Citation statistics, http://www.mathunion.org/fileadmin/IMU/Report/CitationStatistics.pdf.

Exhibition hall



From the poster session

While *Best practices of the IMU* underlines the principles of transparency, integrity and professionalism in publishing, several examples discussed at the congress seemed to lack some of these attributes. The failures were comparably obvious in the well-known case of the self-published papers of El Naschie but were harder to identify for Ji-Huan He, cross-related to himself by an interwoven coeditor/author/citation relationship. As illustrated in D. Arnold and K. Fowler's "Nefarious Numbers" in this issue, a rather small network was sufficient to push the impact factor of the *International Journal of Nonlinear Sciences and Numerical Simulation* (IJNSNS) and of its editor to a surprising magnitude. Here, a single paper illustrating the application of one of He's numerous methods to a single equation may not be seen as a serious breach of standards – however, a mass of them including many cross-citations seemingly optimized to enlarge bibliometric parameters may lead to strong distortions.

Nevertheless, one of the most frequently asked questions by Indian journal editors was if and how their indexing at Zentralblatt would help them in getting into the Science Citation Index and what could be done to get a high ranking position. The effects of a framework for science relying heavily on content-free parameters became highly visible. Often, the negative effects and distortions of mere citation counts are described from the viewpoint of possible damage to a thriving mathematical community – where, however, many checks and balances do exist. Potentially, much more harm can be done in developing countries where a distorted distribution of resources in a quickly growing scientific community may have extremely negative long-term effects. For a curious example related to India, one might wonder what effects the publication of articles of M. Sivasubramanian[3] and S. Kalimuthu[4] on proving the parallel postulate in a formally rather high-rated journal (impact factor 0.978) could have. True, the first one has since been retracted (to the rare extent that the text is no longer available online, in conflict with the archiving role as pointed out in the IMU guidelines) but it is unclear how it could pass any mathematical peer-review (just like the second article). In any case, the citation behaviour is clearly designed to ensure further impact growth (as is guaranteed by citing them as a negative example, like now).

A comparably strange situation occurred when, during the poster session at the ICM, one could come across elementary proofs of Fermat's Last Theorem and P≠NP (no, not Vinay Deolalikar's approach). According to the organisers, all applications had gone through a strict peer-reviewing process (as pointed out in the case of the 14-year-old Srikar Varadaraj whose co-presentation with his father qualified him for the simultaneous chess match, where his draw with world champion Anand made more headlines).

However, these side effects shouldn't give the wrong impression. The overall impression was the incredible interest in mathematics in India and an overwhelming willingness to pursue research despite often difficult conditions. It is precisely where one hopes for an event like this to give the right stimulus and to counter wrong incentives. Also, one of the most touching scenes took place in the exhibition hall: a modest mathematician, whose then just 15 publications barely qualified him for any quantitative merits, patiently signed hundreds of copies of his most recent *Le Lemme Fondamental pour les algèbres de Lie*. Whether one of the young Indians in the long queue might one day succeed Ngô Báo Châu, time will tell – but the mathematical community should give them as much support and proper guidance as it can provide.

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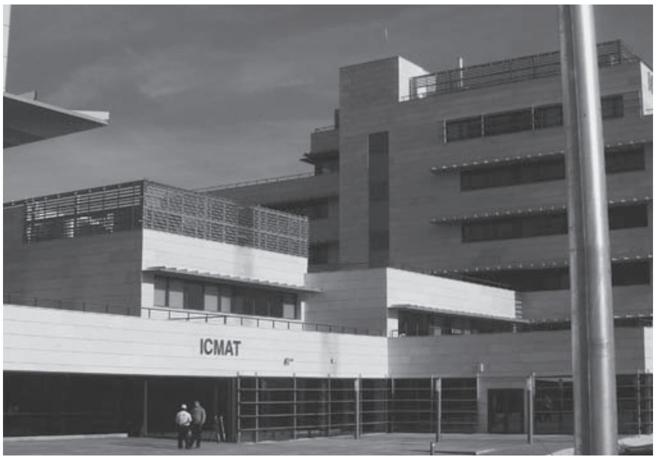
3 New parallel theory [Appl. Math. Lett. 23, No. 9, 1137–1139 (2010; Zbl 1200.51011)].

4 For the origin of new geometry [Appl. Math. Lett. 23, No. 12, 1451–1453 (2010; Zbl 1202.51019)].

The ICMAT Research Centre

The *Instituto de Ciencias Matemáticas* (ICMAT, www.icmat.es) was recently created, as a result of the collaborative efforts of the Consejo Superior de Investigaciones Científicas (CSIC), the Universidad Autónoma de Madrid, the Universidad Complutense de Madrid and the Universidad Carlos III de Madrid. The ICMAT is one of the most important mathematical research infrastructures ever created in Spain.



Main entrance

Historical background

In 1915 the Laboratorio-Seminario Matemático was created within the Junta de Ampliación de Estudios, an institution which had the mission of promoting research and culture in Spain. After the Spanish Civil War, the Junta de Ampliación de Estudios was suppressed and replaced by the CSIC, and the mathematics division became the Instituto de Matemáticas Jorge Juan. Those institutions played an important role in the development of mathematics in Spain until the beginning of the seventies. Unfortunately, the Instituto Jorge Juan was not maintained and was finally dissolved in 1984. Mathematicians in the CSIC were organised in a number of ways from that date until 1992, when the Instituto de Matemáticas y Física Fundamental (IMAFF) was created within the CSIC. Despite the fact that the CSIC is the biggest research institution in Spain, and despite the fact that it covers a very broad spectrum of knowledge (physical sciences, chemistry, life sciences, technology, history, philosophy, etc.), since the disappearance of the Instituto Jorge Juan, mathematicians did not enjoy an independent status in the CSIC.

Fortunately, in recent times the CSIC has realised the relevance of having an independent mathematics institute, and the ICMAT was created on October 29, 2007; as a mixed institute uniting the respective forces of the major mathematics departments in Madrid (the CSIC, the Universidad Autónoma de Madrid, the Universidad Complutense de Madrid, and the Universidad Carlos III de Madrid).

Objectives

The mission statement of the ICMAT contains the following objectives: to undertake high quality mathematical research; to stimulate interdisciplinary research and explore new contexts for its application in basic science and industry; to provide internationally competitive doctoral and postdoctoral training, and to serve as an interlocutor between the scientific community and the technological, industrial, and financial sectors.

Internal structure

The ICMAT faculty currently consists of 14 permanent researchers of the CSIC, and around 25 members of the participating universities. Despite a relatively young average age, the ICMAT faculty enjoys a good scientific reputation; indeed, a number of the members are among the leading experts in their fields. The remainder of the scientific personnel is made up of around 25 postdocs, 10 of them enjoying Ramón y Cajal (close to tenure-track) positions, and around 30 PhD students. Administrative staff constitute approximately 10% of the personnel of the institute. Researchers are divided into pure and applied mathematics divisions; however, such a division is not strict in practice, interaction between researchers of the divisions being commonplace.

The institute is expected to grow in the coming years (slowed slightly by the economic crisis) in accordance with the following percentages: CSIC (36%), UAM (36%), UC3M (7%), UCM (21%). The ICMAT works to attract the best possible young researchers through several kinds of positions using its own funding schemes, seeking to attract the best national and international candidates for PhD and postdoc positions. Strategic high-level permanent positions are also being offered in order to start a new research line or to reinforce an existing one.

Areas of research

Research in the ICMAT is broad; the research lines include:

Algebraic Geometry and Mathematical Physics, Moduli Spaces, Number Theory and Group Theory

In this line we cover topics of algebraic geometry, algebra, and their applications which nowadays include various fields of physics. Within algebraic geometry, some of us work in a systematic study of singularities, from resolution of singularities to the geometric, topological and homological study of singularities of varieties and

Auditorium

Blue Lecture Room

mappings, and the deep relations of singularity theory techniques with other areas of mathematics. Researchers in arithmetic geometry were recently appointed to the institute. In pure algebra, we are at the moment focusing on group theory and on homological algebra and simplicial techniques. There is also a strong interest in algebraic geometry in relation to physics, following the thread that in the last three decades has applied ideas of high energy physics to algebraic geometry. Research includes the study of moduli space of vector bundles and related objects (Higgs bundles, holomorphic pairs coming from the vortex equation, etc), and also work in the geometric Langlands program.

Differential Geometry, Symplectic Geometry and Geometric Mechanics

The research of the group is divided into two lines, one corresponding to the differential geometric aspects of symplectic geometry, and the other centering on its applied aspects, with a focus on geometric mechanics and control theory. The first line fits broadly into the study of the global aspects of manifolds, including topological properties of symplectic and contact manifolds, manifolds with special holonomy, rational homotopy theory of differentiable manifolds, and geometric structures of non-Riemannian type (path geometries, etc.). The second line of research focuses on geometric mechanics and control theory. Research themes include geometric field theories, Poisson geometry (groupoids, algebroids, etc.), symplectic integration and numerical linear algebra (algorithms for matrix computations), and nonlinear dynamics (matrix analysis, matrix polynomials, etc.). A common interest in gauge theoretic problems and techniques unites the two lines of research.

Mathematical Analysis, Differential Equations and Applications

The institute has several researchers working in this line, and in a wide spectrum of subjects covering theoretical subjects like harmonic analysis and basic aspects of the theory of partial differential equations, to more applied topics such as fluid mechanics, analysis of singularities, kinetic equations, statistical physics and mathematical biology. A number of the researchers work in the numerical simulation of partial differential equations.

New research lines are also being created, as for example in number theory and combinatorics.

Scientific life, doctoral and postdoctoral training

There is a colloquium and several seminars being run on a regular basis in several of the topics referred to above. This scientific activity is enriched through the frequent organisation of research schools, conferences and thematic periods. In the last few years, trimesters and semesters have been held on Quantum Control and Quantum Information, Moduli Spaces, Geometric Mechanics and Control Theory, and Contour Dynamics and Incompressible Fluids.

The ICMAT also has a yearly summer programme (the so called JAE intro) addressed to talented undergraduates in the final years of their studies. It is also open to any international student. It consists of two months of training, including a summer school in which researchers from the ICMAT give a course in their research topics, and a period of individual work under the direction of a member of the institute. The best participants of the JAE intro programme often return to undertake their PhD research at the ICMAT.

Members of the ICMAT participate in and often organise activities of popularization and dissemination of mathematics at the national level, and in education programmes at High School level (mathematical olympiads, programmes for detection of mathematical talent, Ciencia en Acción). Indeed, the ICMAT is possibly the most active body in mathematical outreach in Spain, organising a series of public lectures (Matemáticas en la Residencia, in collaboration with the CSIC and the somewhat famous Residencia de Estudiantes), lectures and round tables for secondary students during the Science and Technology Week, mathematical graffiti, publication of books in the CSIC-La Catarata series ¿Qué sabemos de?, the blog Matemáticas y sus Fronteras, and many others.

Location and facilities

The ICMAT is located in a new building with outstanding facilities for mathematical research. It is located on the campus of the Universidad Autónoma de Madrid, and the proximity with the mathematics department of the Autónoma facilitates interaction between the researchers.

The building boasts six conference theatres (hosting up to 30, 40, 50, 80, or 140 people), and a luxurious auditorium with a capacity for 270 people. They are all equipped with blackboards, screens, overhead projectors, beamer and internet access, and multimedia equipment that allows for the recording of the lectures.

The ICMAT has over a hundred fully equipped offices with capacity for almost 200 people. A number of these offices (more than 15) are reserved for visitors. In addition, the ICMAT has a large communal room equipped with 24 tables and computers, so that the ICMAT can host as many as 50–60 visitors at a time.

The 1100 square metre library houses the historical archives of the old Jorge Juan Institute of Mathematics as well as the materials acquired since its dissolution in 1984. In addition to its library, the ICMAT plans to have a Mathematical Documentation Centre (CDocMath) in which the Instituto de Estudios Documentales sobre Ciencia y Tecnología (IEDCYT-CSIC) and the Coordination Unit of the Network of Libraries of the CSIC will participate. The goal is to make CDocMath a fundamental resource for mathematical documentation in Spain, providing a service to the entire Spanish mathematical community.

Equipment and IT Infrastructure

The Computing Service Centre (CSC) is in the basement of the building and provides general purpose (network access, wifi, web publishing, e-mail, security, software licensing, fax and printing) and scientific computational support to the ICMAT. It has a room for large capacity continuous power supplies (CPS) and related devices, a workshop room to repair computers, and a well equipped room to host PC clusters belonging to either individual researchers or to the institute as a whole. Moreover, it has a large format photocopying service.

The ICMAT has some specialized staff for the maintenance of clusters. The institute already has at its disposal some computing infrastructure, the cluster ODISEA, co-financed by the Madrid regional government, which provides 104 cores for computation. ICMAT researchers also have access to the Supercomputer FINIS TERRAE at CESGA (Santiago de Compostela), which has been co-financed by the CSIC.

Funding

The regular budget issuing from the CSIC and the participating universities covers the existing permanent positions, the regular consolidation of tenure-tracks, the maintenance of the needed infrastructure and a supply of PhD and postdoc positions. The CSIC runs the programme JAE, which offers yearly grants for those participating in the JAE intro program, several PhD positions (JAE pre) and postdoc positions (JAE doc). Over and above this, the participating universities also offer PhD positions that can be enjoyed at the ICMAT.

Furthermore, ICMAT researchers are usually very competitive in obtaining research grants both from national and international programmes. This provides support for travel as well as additional PhD, postdoc and invited research positions. Currently, most of our researchers enjoy research grants, which rank in the top ten from the national funding scheme.

As regards the main national programme for appointing senior postdocs (Programa Ramón y Cajal), the ICMAT has attracted more than 30% of the selected researchers from the beginning of the programme. Seven of these Ramón y Cajal researchers have since acquired a permanent position, while three of them are holders of the ERC Starting Grants, the only three mathematicians in the whole of Spain; this represents 25% of the ERC Starting Grants of the CSIC.

Strategic plans

In 2004 the CSIC embarked upon a new way of planning and distributing personnel and economical resources, and an ambitious strategic plan for 2005-2009 was put forward, aiming to be a landmark in the history of Spanish science. The strategic plan for mathematics was evaluated by an international committee and ICMAT was created as a consequence of the panel's recommendations.

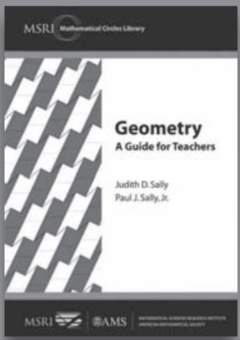
In 2009 the ICMAT put forward a second strategic plan for 2010-2013, in which a substantial growth of permanent and temporary positions was envisioned. Again this was evaluated internationally and the highest mark was obtained.

National and international relations

The ICMAT is one of the five nodes of the Spanish project Consolider Ingenio Mathematica i-MATH. ICMAT holds a cooperation agreement with the Centre de Recerca Matematica (CRM) in Barcelona and other Spanish and European centres. The ICMAT wishes to be part of ERCOM and we will forward our application in the coming months; our desire is to participate and collaborate with the rest of the mathematical centres in Europe.

In addition, the ICMAT promotes many scientific collaborations with research institutions around the world through the CSIC bilateral agreements.

AMERICAN MATHEMATICAL SOCIETY



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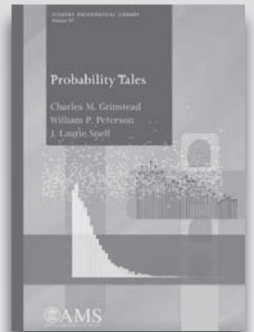

PROBABILITY TALES

Charles M. Grinstead, *Swarthmore College,* William P. Peterson, *Middlebury College &* J. Laurie Snell, *Dartmouth College*

Explores four real-world topics through the lens of probability theory. It can be used to supplement a standard text in probability or statistics. Most elementary textbooks present the basic theory and then illustrate the ideas with some neatly packaged examples. Here the authors assume that the reader has seen, or is learning, the basic theory from another book and concentrate in some depth on the following topics: streaks, the stock market, lotteries, and fingerprints. This extended format allows the authors to present multiple approaches to problems and to pursue promising side discussions in ways that would not be possible in a book constrained to cover a fixed set of topics.

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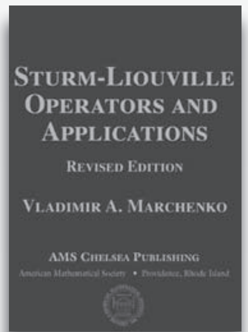

STURM-LIOUVILLE OPERATORS AND APPLICATIONS

Vladimir A. Marchenko, *Verkin Institute for Low Temperature Physics and Engineering*

The spectral theory of Sturm-Liouville operators is a classical domain of analysis, comprising a wide variety of problems. Besides the basic results on the structure of the spectrum and the eigenfunction expansion of regular and singular Sturm-Liouville problems, it is in this domain that one-dimensional quantum scattering theory, inverse spectral problems, and the surprising connections of the theory with nonlinear evolution equations first become related. The main goal of this book is to show what can be achieved with the aid of transformation operators in spectral theory as well as in their applications. The main methods and results in this area (many of which are credited to the author) are for the first time examined from a unified point of view.

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Isaac Newton Institute for Mathematical Sciences – The next five years

Ben Mestel, Isaac Newton Institute Deputy Director, posed several questions to John Toland, the new Director from October 2011. John's responses to the questions are given below.

John Toland

Ben Mestel

Next year, the Institute will celebrate its 20th anniversary. What do you think are the principal achievements of the Institute over its first 20 years?

Although the work was not done here, a rather prominent incident in the history of the Institute to date was the announcement by Andrew Wiles of his ultimately successful assault on Fermat's Last Theorem. Of course, that particular event was not in the original plan but the intention always has been, and will remain, to create and develop one of the premier mathematical institutes of its kind, cultivating research of the very highest quality, attracting the best scientists and mathematicians from around the globe. At first, I think the Institute was regarded by UK colleagues with suspicion, as an elite institution with programmes that benefited Cambridge most. Twenty years later, when large numbers of UK mathematicians have benefited from its ever-widening portfolio of activities, the mood has changed. That represents real success in what it set out to do.

What is your vision for the Institute over the next 20 years?

Over the next 20 (or fewer) years, the Institute will have to confront a broad range of difficult issues, some of which are commented upon in responses to subsequent questions. On the one hand it is small but at the same time expected to deliver high quality, visible mathematical achievements across a huge range of mathematical activity. On the other it has to continue its support for the individual researcher, working alone or in collaboration, on fundamental problems in diverse areas, to achieve research outputs of the highest international quality. It has to be alert to new developments and prepared to pump prime emerging ideas, and it has to recognise that not all will be equally successful. The role of the director is to maintain an atmosphere and promote a culture of creativity. On a related note, I hope that in 20 years' time there will be a much larger proportion of women participants than now. The Institute needs to make its activities accessible through a broad range of measures.

What do you think are the challenges and opportunities for the Institute in the next five years?

Challenges: to maintain the high quality and level of the Institute's activities in the information age, when there are many more institutes worldwide than 20 years ago and when travel costs, visa issues, availability of long-term participants and the green agenda impinge on its everyday activities. This is to say nothing of the financial threat following cutbacks in public funding in real terms.

Opportunities: The Newton Institute is well placed to play a prominent role in what is undoubtedly a golden age for mathematics and it is the only Institute of its kind serving colleagues across the UK with long-stay programmes of such breadth and depth. It has an increasingly successful fund-raising Development Committee. The opportunity to support and extend its work must be grabbed with both hands.

The UK's 2010 International Review of Mathematical Sciences has published its draft report. How do you think the Institute can help with the development of the mathematical sciences in the UK?

This is a very big question, parts of which have been answered in response to other questions and I will say

Isaac Newton Institute for Mathematical Sciences

only this: I think the Institute aspires only to support the best mathematics being done today in whatever context in which it is to be found.

The Institute is an active member of ERCOM, the European Research Centres on Mathematics, and has links with MSRI and the Fields Institute. How do you see international collaboration developing between the research institutes?

Within the UK the Institute has a complementary relationship with ICMS and creative relations with other institutes worldwide. With modern technology, there seems no reason why activities should not be shared between institutes and delivered to participants in the developing world who lack the resources to travel. At the same time, there is no substitute for personal contact and the visitors programme is essential, most particularly for early career mathematicians. The opportunities created in this Institute and similar buildings cannot be replicated by electronic means.

How do you think the Institute can respond to the 'Impact' agenda?

I believe that a significant concern for mathematics in the context of Impact is that in law you cannot patent a theorem. When a good and entirely original mathematical idea becomes 'a method', without attribution as so often happens, its impact cannot be tracked and credit is attributed to the science in which the final outcomes are described. This is inevitable and it was always thus. Mathematicians need to maintain confidence that the value of their work is not diminished by the lack of auditable impact and to recognise that its all pervasive influence and relevance across science and technology is beyond question. They should also be conscious of the need, where possible, to explain what they are doing, sometimes at public expense, to a wider audience, including politicians.

What are your thoughts on the Institute's new Cross-Disciplinary Research initiative?

I realise that within the mathematical community there is some concern that mathematics could be pushed out of the mathematical sciences institute by this initiative. However, it can equally be argued that the cross-disciplinary agenda is seeking no more than formal recognition of a status quo in which cross-disciplinary research absorbs a significant proportion of the Institute's resources, perhaps not always with proper acknowledgement (and I refer you to my response to the previous question).

The Institute is formally part of the University of Cambridge but sees itself as a part of the UK, European and World mathematical sciences communities. How do you see this tripartite relationship developing in the future?

These three facets of the Institute's role are familiar to me from my time at ICMS where I learned they are equally important. In particular, Cambridge must not feel neglected because of the Institute's national and international vocation which, at the end of the day, is its raison d'être. The benefits to Cambridge of a leading international institute at its door are apparent. However, involvement of the Institute in support of activities in Cambridge might bring resources and thereby benefit its national and international agenda. Indeed a good working relation with groups in Cambridge is essential for the best performance of the Institute.

Fundraising from philanthropic and charitable sources has become increasingly important for the Institute. What can be done to broaden the Institute's funding base?

Under the leadership of Howard Covington, the Development Committee has made huge strides with fund raising from non-governmental sources in a very short time. It seems to me that the Institute must now be prepared to invest time and resources in support of this activity.

You have had a distinguished academic career and you have led both the London Mathematical Society and the International Centre for Mathematical Sciences in Edinburgh. Which of your achievements are you most proud of?

I don't accept the premise of your question but I was very grateful for the opportunity to work at ICMS. The foundations had been laid by my predecessor Angus MacIntyre and his colleagues, with stalwart support from two universities in Edinburgh. During my time a lot was achieved, from widening the scientific programme to moving the headquarters from the house in which Maxwell was born in the New Town to larger, more suitable premises in the university precinct of the Old Town. Outside research, this was the most rewarding period in my professional life to date.

The Belgian Mathematical Society

F. Bastin, A. Bultheel, S. Caenepeel and L. Lemaire

Chapter 1: The notebooks (1921–1946)

The statutes

The early history of the Belgian Mathematical Society is documented through two thick notebooks – handwritten between 1921 and 1946 – of minutes of the meetings of the society. They provide an interesting and nostalgic view of the birth of the society and of the context of mathematical research at the time.

The first page is dated 14 March 1921 and presents the decision to create a "Mathematical Circle where all questions concerning pure and applied mathematics would be considered, by lectures, communications and discussions" (all quotes here are loose translations of the original French text). Nine people were present, the best known being Th. De Donder, L. Godeaux and A. Errera.

The next meeting gathered 22 members for adoption of temporary rules and two lectures, by A. Errera and Th. De Donder. The official statutes were adopted in November and the name "Circle" was replaced by "Society" in January 1922.

Here are some excerpts of the statutes.

Article 2: "The aim of the Society is to contribute to progress and diffusion of mathematics in Belgium. It is concerned with mathematics, pure and applied, in the broadest sense. It will try to establish a permanent link between secondary school and university." Presumably, these aims could be expressed in the same way today, and the relations between pure and applied mathematics and between different levels of teaching remain present day questions.

Article 3 states that there will be a meeting every month (except August and September) and article 7 states that the membership fee is 10 francs (25 euro cents) for members living in Brussels but 5 francs for others!

These articles survived changes in the statutes in 1923 and 1936. To our knowledge, they were not officially modified before 1998. The fact is that nobody bothered about the statutes (or knew about them), even when the monthly meetings vanished for lack of participants in the 70s or when the membership fee rose to the (still cheap) amount of 20 euro (the same for everyone!).

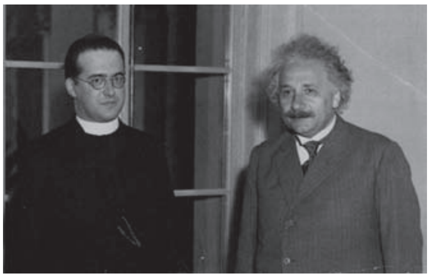
The last article specifies that in case of termination of the society "the assets are given to the poor". Note that the sentence "l'avoir est remis aux pauvres" means to all the poor, no definition or algorithm being given to identify them.

At the time, the society didn't start a journal but its records appear in brief supplements of a journal of the period: Mathesis.

The meetings

For every meeting, the handwritten minutes describe the topic of the lecture and summarise the discussion. Most of the lectures were given by Belgian mathematicians, and it is interesting that they felt the need for these monthly contacts and maintained them for many years. Some foreign speakers were of course also invited. Quite regularly, lectures were supplemented by reports on results announced in international congresses, where one (but maybe only one) member was able to go.

Two aspects are striking. These monthly meetings were maintained throughout a long period (except during World War 2) and this must reflect a time when information did not flow easily and when meetings were fairly rare. The subjects treated were extremely varied and, in fact, established links between pure and applied mathematics, and between university and secondary school, in a way forgotten today. Indeed, there are lectures on mathematical physics (with, for example, De Donder), astrophysics (Lemaître), algebraic geometry (Godeaux),



Lemaître and Einstein

Lucien Godeaux[1]

De la Vallée-Poussin[1]

analysis (De la Vallée-Poussin, Lepage), engineering (van den Dungen), mathematics of insurance and secondary school mathematics (with A. Mineur, sharply remembered by generations of Belgian schoolchildren for his treatise on descriptive geometry).

Amongst the foreign speakers, let us just pick two curios. On top of various lectures on integration, Lebesgue gave a talk in 1925 on ruler and compass constructions. In 1922, Millikan gave a lecture comparing his ideas on the electron with those of Planck and De Donder. The minutes specify that he was asked a question by Henriot on the capacity of the electron to spin and that he didn't know the answer.

The notebooks end in June 1946. We don't know if further books were lost or if records were interrupted. This is possible because the society started the publication of its bulletin the following year.

1 The image of L. Godeaux is a burin engraving by J. Bonvoisin 1947, courtesy of the print cabinet of the Royal Library of Belgium. The image of De la Vallée-Poussin is courtesy of the archive of the K.U.Leuven.

Chapter 2: The Guy Hirsch period (1947–1993)

The first volume of the "Bulletin de la Société Mathématique de Belgique" (a single issue of 46 pages) appeared in 1947–48 but is not called number 1, maybe because it was unclear whether others would follow. In fact, the numbering starts only with volume 6 in 1953.

Also in 1947, Guy Hirsch was elected deputy secretary, the first step of his lifelong involvement with the society. Hirsch, a top class topologist (think of the Leray–Hirsch theorem) and philosopher of science, became so active in the society that for many years one could say he was the society. Indeed, from 1953 to 1993, the official address of the society was that of his apartment, from which he handled all the administration with the help of his wife and son, acting both as secretary and treasurer. The bulletin had a small editorial board from 1951 to 1955 but it dissolved that year, leaving Guy Hirsch with full editorial control of the bulletin – a situation which lasted until 1977!

After that, the bulletin was split into two series, Hirsch keeping full editorial control of the first one until his death in 1993. Singlehandedly, he managed to develop the society, thanks to his huge mathematical culture and his patient work.

A curio for this period is a paper of Lucien Godeaux: Les recherches mathématiques en Belgique dans ces dernières années, (1949–50) pp. 32–40, in which he lists what he sees as the best work of the time in Belgium. Presumably, if publication of such a paper was contemplated today, a committee would sit for two years arguing about choices and getting nothing written.

In the 70s, the situation began to change. The monthly meetings vanished for lack of participants – they simply did not fit the needs of the mathematicians anymore. At the same time, the mathematical community wanted to take more part in the society, hence the second series of the bulletin, started by A. Warrinnier and continued by Y. Felix and J.-P. Tignol, with a strict system for the editorial board. P. Henrard then J. Leroy, and S. Caenepeel as treasurer, took on the task of transforming the very personal secretarial system of G. Hirsch (all the exchange programme of the bulletin for 30 years used only two pages, filled with coloured dots that seemed to converge at the end of the lines because for lack of space they were written closer and closer) into a well regulated, computerised system.

An annual meeting was launched in 1979 and met with great success from the beginning. But again, after a few years attendance diminished. In the hectic schedule of university life, between teaching, research and administration, between numerous specialized meetings and large international conferences, such nonspecialized national meetings obviously had no priority, and the society went looking for another formula.

Chapter 3: The present period (1994 up to…)

Publications

Since 1994, the society has had a new series of its bulletin, coming from the merger of the two series and of another journal, Simon Stevin (globalisation is everywhere in Europe). It works according to a strict refereeing process and papers on all mathematical subjects can be sent to the appropriate editor – the list being given on the website *bms.ulb.ac.be/cgi/bull_general.php#board*. Under the leadership of H. Van Maldeghem, the bulletin publishes five issues per year and on average one supplement.

Since 2003, the bulletin has been electronically published by the Euclid project projecteuclid.org and all issues of the bulletin older than five years are placed on the BMS website with free access.

In collaboration with the National Committee for Mathematics from the Academy, the society also runs a newsletter for its members and an electronic version on the society's website is updated in real time.

Congresses

A rebirth of the congresses came with the start of a series of joint meetings. The first one, with the American, Dutch and Luxembourg Mathematical Societies, brought 500 mathematicians together in Antwerp in 1996 (an all-time record for Belgium). This success triggered a regular series of meetings, namely:

- a joint meeting with the London Mathematical Society (LMS) in Brussels in 1999,
- a joint meeting with the Deutsche Mathematiker Vereinigung (DMV) in Liège in 2001,
- a joint study day with the National Committee of Mathematics on "Mathematics and Genomic" in 2003,
- a joint Congress with the Dutch Mathematical Society in Tilburg (WG) in 2004,
- a joint Congress of the Société Mathématique de France and the three BeNeLux partners in Ghent in 2005,
- a joint meeting with the National Committee of Mathematics on "The mathematics of ranking" in 2008,
- a joint Congress with the London Mathematical Society in Louvain in 2009,

to be followed by a meeting with the Société Belge des Professeurs de Mathématique d'expression française and the Vlaamse Vereniging voor Wiskundeleraars (secondary school teachers) in 2011 and with the Real Sociedad Matemática Española and the Luxembourg mathematical society in 2012.

Since 2005, the BMS has organised every other year a "PhD Day", during which PhD students and young researchers have the opportunity to present their work through posters and short communications.

Organisation

The society has around 170 members, of which around 45% are also members of the EMS. It is a founding member of the EMS and has reciprocity agreements with other mathematical societies (AMS, SMF, WG, LMS, RSME). Details can be found on the BMS website *bms.ulb.ac.be/*.

The aim is for the composition of the executive committee to include representatives of most of the Belgian universities. The current executive committee (until October 2011 when elections will take place) is as follows:

Stefaan Caenepeel (VUB) (president)
Françoise Bastin (ULg) (vice-president and editor of the BMS-NCM Newsletter)
Jan van Casteren (UA) (secretary)
Guy Van Steen (UA) (treasurer)
Hendrik Van Maldeghem (UGent) (editor-in-chief of the bulletin)

Pierre Bieliavsky (UCL), Frédéric Bourgeois (ULB), Adhemar Bultheel (K.U.Leuven), Philippe Cara (VUB, webmaster), Timoteo Carletti (FUNDP), Eva Colebunders (VUB), Camille Debiève (UCL) (managing editor of the bulletin), Freddy Dumortier (UHasselt), Yves Félix (UCL) (book review editor), Catherine Finet (UMons), Paul Godin (ULB), Gentiane Haesbroeck (ULg), Christian Michaux (UMons), Frank Sommen (UGent), Stefaan Vaes (K.U.Leuven), Michel Van den Bergh (UHasselt), Jean Van Schaftingen (UCL).

Societies Corner is a column concerning mathematical societies in European countries. The articles in this column might, for instance, describe the history of a particular society or discuss some events (historical as well as modern) or people currently connected with the society.

Nevertheless, a society's life does not only consist of its history and current active work. Several events happen in the everyday life of a society.

Do you remember the general assembly of your society from three years ago or a fascinating discussion during the assembly? A farewell party or an exciting toast by the president? Anecdotes concerning famous mathematicians or former presidents of the society, connected with their work in the society? A controversial decision undertaken by the council last year? And what about your society's competition for the paper written by schoolchildren and the papers presented there? What about another activity? Funny stories or important stories?

Don't keep them to yourself! Please write about them and submit them to the Society column. Let others enjoy your stories! Let others know about the everyday life of your society! If it is not written down now, it may be forgotten in a few years.

If you feel that anything about your society would interest others, please do not hesitate to contact Krzysztof Ciesielski (Krzysztof.Ciesielski@im.uj.edu.pl).

Presidents of the Belgian Mathematical Society

Mathematical Circle

14/3/1921–14/01/1922	Théophile De Donder (1872–1957)

Belgian Mathematical Society

1923–1925	Henri Bosmans (1852–1928)
1925–1927	Alphonse Demoulin (1869–1947)
1927–1929	Charles Jean de La Vallée Poussin (1866–1962)
1929–1931	Adolphe Mineur (1867–1950)
1931–1933	Lucien Godeaux (1887–1975)
1933–1935	Alfred Errera (1886–1960)
1935–1937	Émile Merlin (1875–1930)
1937–1939	Fernand Simonart (1888–1966)
1939–1945	Bony
1945–1947	Henri Germay (1894–1954)
1947–1949	Georges Lemaître (1894–1966)
1949–1951	Théophile Lepage (1901–1991)
1951–1953	Fernand Backes (1897–1985)
1953–1955	Octave Rozet
1955–1957	Louis Bouckaert (1909–1988)
1957–1959	Paul Libois (1901–1991)
1959–1961	Julien Bilo (1914–2006)
1961–1963	Henri Garnir (1921–1985)
1964–1965	Robert Ballieu (1914–1980)
1966–1967	Eduard Franckx (1907–)
1968–1969	Pol Burniat (1902–1975)
1970–1971	Carl Clement Grosjean (1926–2006)
1972–1973	René Lavendhomme (1928–2002)
1974–1975	Henri Breny (1923–1991)
1976–1977	Alfred Warrinier (1938)
1978–1979	Robert Debever (1915–1998)
1980–1981	Franz Bingen (1932)
1982–1983	José Paris
10/1983–10/1986	Richard Delanghe (1940)
10/1986–10/1988	Paul van Praag
10/1988–1992	Alain Verschoren (1954)
1993–10/1996	Luc Lemaire
10/1996–10/1999	Freddy Dumortier (1947)
10/1999–10/2002	Jean Schmets (1940)
10/2002–10/2005	Adhemar Bultheel (1948)
10/2005–10/2008	Cathérine Finet
10/2008–10/2011	Stefaan Caenepeel (1956)

ICMI Column

Mariolina Bartolini Bussi

ICME-12 in Seoul (2012)

The 12th International Congress on Mathematical Education will be held in Seoul (Korea) in 2012 (8–15 July). The welcome to participants, signed by Sung Je Cho, Chair of the International Programme Committee, appears on the homepage of the Congress Website (http://www.icme12.org/). The website offers rich and detailed information about the congress (the major event of the International Commission on Mathematical Instruction) which is held every four years in a different part of the world (previous congresses have been held in Mexico in 2008 and Denmark in 2004). It is not the first time that ICME has moved to the Far East (ICME 9 was held in Japan in 2000). However, a quick look at the scientific programme shows that since then the awareness of the existence of a different cultural tradition in mathematics education has increased. The publication in 2006 of the volume of the 13th ICMI Study on *Mathematics Education in Different Cultural Traditions: a Comparative Study of East Asia and the West* and, more recently, the outstanding results in mathematics of PISA issued in December 2010 have raised a lot of interest among mathematics educators all over the world.[1,2]

The data on mathematics proficiency of students shows clearly that the countries/regions of the Far East outstrip the others (with only a few exceptions): in top places one finds Shanghai-China, Finland, Korea, Hong Kong-China, Liechtenstein, Singapore, Macao-China, Canada, Japan, Estonia, Chinese Taipei, the Netherlands, Switzerland, New Zealand and Australia. This congress in Korea offers a unique chance to be in touch with Far Eastern mathematics education within an international context.

The programme is dense and appealing (see http://www.icme12.org/ for details): 6 plenary lectures and 2 plenary panels; 5 Survey Teams (ST) which will work until the congress to survey the state-of-the-art with respect to a certain theme or issue, with particular regard to identifying and characterizing important new knowledge, recent developments, new perspectives and emergent issues; 78 regular lectures given by prominent mathematics educators from different parts of the world who have been invited by the International Programme Committee; 37 Topic Study Groups (the major arena for participation) to gather a group of congress participants who are interested in a particular topic in mathematics education; a number of Discussion Groups created in response to a proposal submitted by a group of up to five persons representing a diverse region of the world, to discuss, in a genuinely interactive way, certain challenging, controversial or emerging issues and dilemmas of interest to an international or regional audience; 4 national presentation (Korea, Singapore, USA and India) and a regional presentation (Spanish Cultural Heritage); workshops, posters, exhibitions and reports from affiliated organisations; and reports on the ICMI studies and the Klein project. Surely it is a very good occasion to be informed about the progress of mathematics education in the world; hopefully not only mathematics teachers and educators but also policy makers will exploit this unique event.

News from the ICMI

The permanent Secretariat in Berlin

In February 2001, a permanent office for the International Mathematical Union and the ICMI was opened in Berlin. Lena Koch is the ICMI's administrator in the new IMU Secretariat in Berlin (icmi.cdc.administrator@mathunion.org).

More details can be found at http://www.mathunion.org/icmi/news/details/?tx_ttnews%5Btt_news%5D=64&tx_ttnews%5BbackPid%5D=795&cHash=de736076c1 and on page 18 of this issue of Newsletter of the EMS.

The ICMI Database Project

The ICMI Executive Committee decided in its February 2011 meeting, held in Beijing (China), to launch the Database Project, whose ultimate goal is to build and update a database of mathematics curricula all over the world. For the first phase of this project all ICMI representatives were asked to send a link to the webpage(s) of their country where anybody could find the official mathematics curricula at all levels of instruction (pre-primary, primary, elementary, middle, secondary, vocational, etc.). Only a few countries from Europe have answered. Details can be found at http://www.mathunion.org/icmi/other-activities/database-project/introduction/.

The ICMI on Facebook

The International Commission for Mathematical Instruction (ICMI) has joined Facebook in order to spread the word about the ICMI and its activities to a larger audience and new networks as well as to inform our current networks about new developments, activities, conferences and calls for papers. At the homepage (http://mathunion.org/icmi/home) there is a window with all the relevant information to join the ICMI on Facebook.

1 http://www.oecd.org/dataoecd/54/12/46643496.pdf.
2 ecd.org/dataoecd/34/45/46581016.pdf.

ERME Column

Tim Rowland

The Seventh Congress of ERME

The Seventh Congress of the European Society for Research in Mathematics Education (ERME) took place 9–13 February 2011 at Rzeszów in Poland. ERME came into being at its first congress in Osnabrueck, Germany, in 1998. Thereafter, congresses have taken place every two years since CERME2 in 2001. From its inception, great emphasis has been placed on promoting participation by all who attend the congress, with a deliberate shift from the succession of parallel, 40-minute PowerPoint research presentations that characterise most international scientific conferences. Thus, the vast majority of CERME time is devoted to discussion and debate within thematic Working Groups (WGs). CERME participants must commit themselves to membership of just one such group and to 6 or 7 sessions of 90–120 minutes *working* with the group. The number of WGs increased to 17 at CERME7 and the number of participants in each was around 25–30 on average, including about 4 WG leaders. The WG themes were as follows:

Argumentation and proof.
Teaching and learning of number systems and arithmetic.
Algebraic thinking.
Geometry teaching and learning.
Stochastic thinking.
Applications and modelling.
Mathematical potential, creativity and talent.
Affect and mathematical thinking.
Mathematics and language.
Diversity and mathematics education.
Comparative studies in mathematics education.
History in mathematics education.
Early years mathematics.
University mathematics education.
Technologies and resources in mathematics education.
Different theoretical perspectives and approaches in research in mathematics education.
From a study of teaching practices to issues in teacher education.

Research paper and poster proposals must be submitted to a *Group* and are then subject to peer review within the WG and a decision about acceptance by the WG leaders. This structure results in significantly devolved and distributed responsibility for the organisation of the congress and, hopefully, a sense of belonging to their chosen WG for all participants. All accepted papers are posted on the CERME website some weeks before the congress and each participant is expected to read all of those related to their WG – typically 15 or more – *in advance* of the congress. At the congress itself, it is then possible to devote *all* of the time allotted to each paper to discussion, rather than the usual monologue presentation. In this way, opportunities for interaction and participation are maximised.

The success of the ERME movement can be measured, in part, by the numbers of participants and presentations at recent meetings. In Rzeszów, 453 participants came from 50 countries and were involved in 17 Working Groups, coordinated by 75 leaders. 293 research papers were accepted and 69 posters. Interest in CERME continues to grow, with participants this time coming from 17 countries beyond Europe (such as Canada, US, Brazil, Singapore and Australia).

The ERME 'spirit' of communication, cooperation and collaboration is explicitly enshrined in its aims and vision. *Inclusion* is central to its ethos and the way that the WGs organise their activity. At the same time, ERME must promote and support scientific *Quality* if it is to be useful to its members and credible on the international stage. At times the two goals, inclusion and quality, seem to pull in different directions, creating tension and sometimes dissatisfaction when, for example, a research paper is not accepted for presentation, despite formative feedback and revision, and the author is then unable to access funds to attend the congress. Thus, by upholding a notion of necessary 'standards' of scientific quality, someone is effectively denied participation in the congress. This tension has recently been addressed in collaborative research by Barbara Jaworski (UK), João Pedro da Ponte (Portugal) and Maria Alessandra Mariotti (Italy), resulting in the publication of a book chapter; a related paper can be accessed from the CERME7 website http://www.cerme7.univ.rzeszow.pl/?id=quality_and_inclusion.

In addition to the WG activities, the sense of belonging to the *whole* congress is fostered in a number of plenary scientific activities and in a varied social and cultural programme. The opening ceremony of CERME7, held in the splendid surroundings of the Rzeszów Philharmonic Concert Hall, included a plenary address by Anna Sierpinska on her recent research into elementary mathematics methods courses in pre-service teacher education. For many years Anna has lived and worked in Quebec, Canada, but she maintains close links with mathematicians and mathematics educators in her native Poland. Two other plenary talks later in the conference recognised the work of two CERME WGs across several congresses and were given by researchers who had led these WGs until recently. Thus, the address of Markku Hannula (Finland) was on the Structure and Dynamics of Affect in Mathematical Thinking and Learning and Maria Alessandra Mariotti's title was Proof as an Educational Task. Another notable event in the plenary programme was a session introducing the current work of the Education Committee of the European Mathematical Society, in particular the project to itemise 'solid findings' in mathematics education. This session included fruitful discussion about the nature and warrants of such findings and their relationship to the work of ERME and its members.

The vision and ethos of ERME is also distinctive in its support for 'young' researchers in the field of mathematics education, notably those undertaking doctoral research or in post-doctoral positions. Every CERME conference is preceded by two half-days of YERME ('Young-ERME') discussion groups and workshops. At CERME7 these were led by Professors Paolo Boero, Pessia Tsamir, Dina Tirosh, Barbara Jaworski, João Pedro da Ponte and Heinz Steinbring. We are fortunate to have such experts willing to freely give of their time for the benefit of the future leaders of ERME.

More information about CERME7 can be found at http://www.cerme7.univ.rzeszow.pl/.

We extend sincere thanks to Ewa Swoboda and all the local organisers for their hard work and to the University of Rzeszów for making us so welcome at the first CERME to be held in Eastern Europe. The next CERME will take place in February 2013 in Antalya, Turkey.

Tim Rowland
University of Cambridge, UK
Chair, CERME7 Program Committee

Completeness of reference databases, old-fashioned or not?

Bernd Wegner (TU Berlin and FIZ Karlsruhe)

Summary

The growing number of publications in mathematics is a challenge for reference databases to catch up with. Hence maintaining completeness of coverage is a permanent matter of discussion for these services. On the other side, complete reference services will very soon be the only integrating factor for the large variety of mathematical publications. Reducing coverage will damage the integrity of mathematical research and make a fair mutual acknowledgement of research results impossible.

1. Early days and tradition of reviewing services

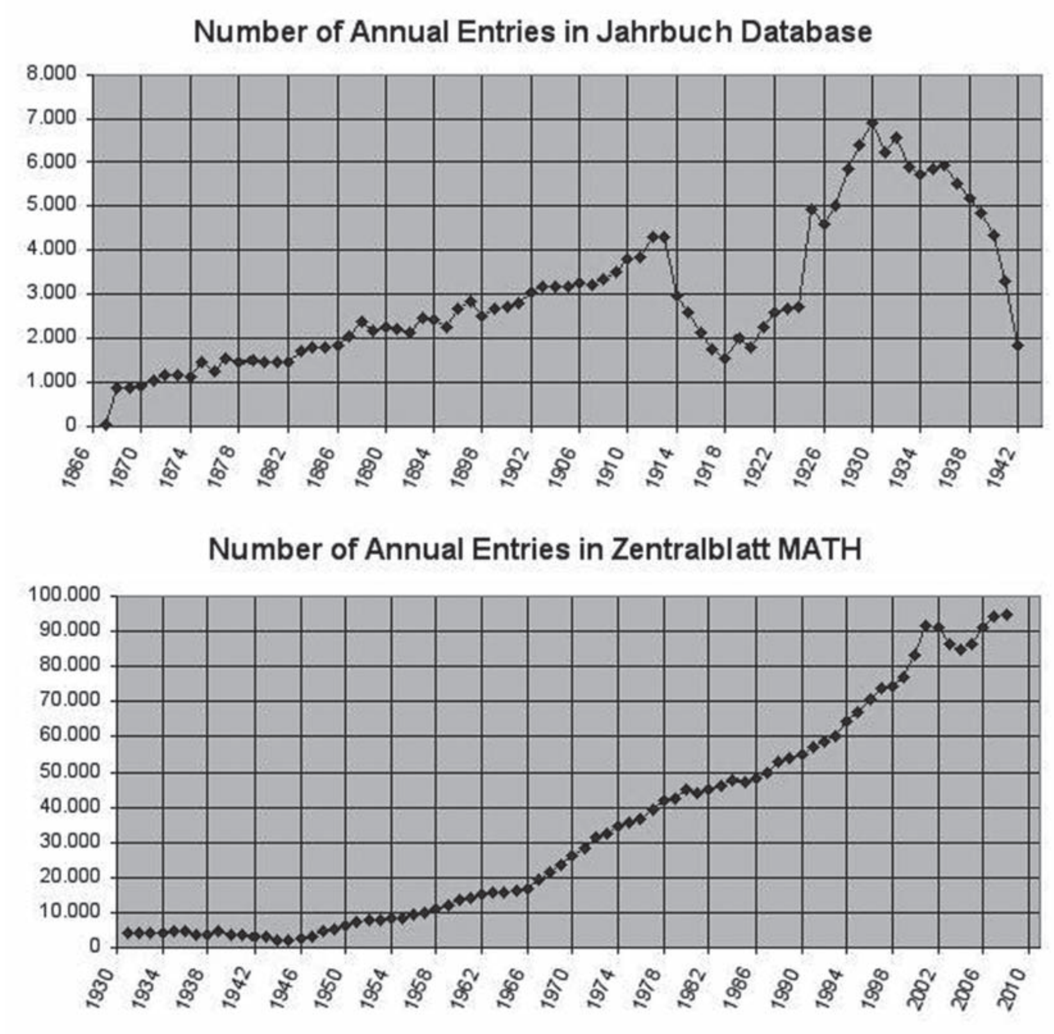
About 150 years ago, the first comprehensive documentation service in mathematics, the Jahrbuch über die Fortschritte der Mathematik, was founded. In addition to various lists of mathematical publications, the Jahrbuch had the aim of offering bibliographic data and reviews for all mathematical publications published in the same year. At that time the number of mathematical papers published in a year had reached a level at which it would have been impossible to get a comprehensive view of all developments in mathematics without such a service. Trying to collect all reviews for papers published in a year in one volume made the service slow. But, nevertheless, the Jahrbuch very soon became a reliable source of information on research in mathematics and its applications.

Later, foundations like Zentralblatt MATH, Mathematical Reviews and Referativnyi Zhurnal Matematika from VINITI followed the same principle of completeness though trying to speed up the process by publishing the reviews as soon as they were available. There was no restriction on countries, languages, mathematical subjects or the quality of journals, whatever one may understand that to mean. Confronted with these offerings no documentation service covering a restricted area could survive and compete for any length of time. The only exceptions were applied areas like statistics where the documentation was extended by a lot of subjects not primarily dealing with mathematics.

2. Where is the borderline of mathematics?

In order to see if the coverage of a mathematical reference service is complete, we have to define the domain to be covered. For Zentralblatt MATH, this definition has two aspects: a formal one and a thematic one. The formal one requires that the publication should have successfully passed a peer-reviewing procedure. That this procedure is applied systematically is guaranteed by a corresponding editorial notice in a journal having an editorial board or by a book publisher employing peer-reviewers before deciding to publish a book. Preprints do not satisfy these requirements and in most cases are not considered as a final publication of mathematical research. As a consequence, the reviewers of Zentralblatt MATH can rely on research which has been checked by an independent expert thoroughly, and in general they are only supposed to give a description of the content and the relation of the paper to other research.

The thematic aspect is a little more complicated because one has to decide if the publication deals with research mathematics or not. Education in mathematics has its own service, MathEduc. Like other classification schemes the MSC 2010 (Mathematics Subject Classification) provides a complete list of subject areas belonging to mathematics. But this is only a first step. The name of Zentralblatt MATH initially contained the phrase "Mathematik und ihre Grenzgebiete". Hence, from the beginning, not only pure and applied mathematics belonged to the scope but also publications about applications of



Growing for centuries: Annual publications indexed in JFM and ZBMATH

mathematics to other sciences – and this principle is still valid. The difficulty is in deciding which of these publications are still of interest for mathematics. There is no clear-cut answer. The subject editors of Zentralblatt try to take this decision in accordance with the interests of the potential users of this service. As a consequence, Zentralblatt had to cover about 120,000 publications in 2010.

3. Current availability of mathematical publications

The large majority of these publications are articles in journals; several are from proceedings volumes and only a few more than 3000 are monographs, which is still a lot if some library wants to purchase a large portion of them. The journals are owned and published by different types of stakeholders of different sizes: scientific publishing houses, academic institutions, scientific societies and other groups supporting mathematics. There is the same diversity in models of how to subscribe to these journals. On one side there are high-priced subscriptions, where a lot of arguments are given to justify the price. On the other side there are journals where somebody else covers the publication costs and access is free. In between there are open access models where the author pays for the publication.

About 20 years ago the first electronic journals or electronic versions of printed journals appeared in mathematics, making their articles available for the user without having a printed copy in a local library. Step by step, publishers and editors caught up by providing electronic versions of their journals. In the next phase several retro-digitization projects made older printed publications digitally available, enabling journals to provide their whole publication period through a web service. Without exception, new foundations of journals are based on an electronic version, sometimes offering a printed version as an additional option. The collection of digitally available publications may be considered as the basis of the so-called World Digital Mathematics Library (WDML). It covers more than 50% of the published mathematical heritage worldwide and almost 100% of the current publications in mathematics.

4. Current and future access to mathematical publications

In principle, the WDML would be the ideal structure to provide every mathematician or professional interested in mathematics with access to the full range of mathematical publications. Reference databases like Zentralblatt MATH (ZBMATH) offer links to all digital mathematical publications and serve as an easily searchable catalogue for the WDML, where the catalogue is combined with several additional facilities for navigating in the world of these publications. For this purpose complete coverage is a basic requirement for ZBMATH. The decision to enter the WDML as a mathematical research publication is made by the journal editors in cooperation with the peer-reviewers. ZBMATH does not have any additional restriction on the selection by some kind of disputable quality of a journal or article, by complying with the ideas of regional or national interest groups of potential users or by subjects that are currently more fashionable than others. The database also has to cover articles from mathematicians in the developing world even if they are not considered as important by influential mathematicians in the developed world.

There is an additional argument for why reference databases should cover mathematical publications comprehensively: the reason why the WDML will remain only an attractive idea in the near future is that the main stakeholders so far do not and probably will not agree to a common access model. The reference databases are providing a link. To get access to an article is sometimes easy but most times an access licence is needed. In the cases where the user is located at an institution that has purchased such a licence through a local library, the open URL system will redirect him to his library and provide him with a copy of the requested article. Otherwise the user will be stuck.

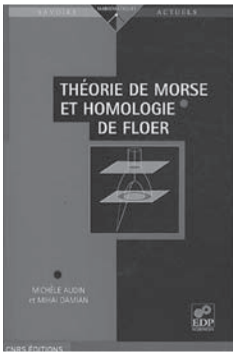
Increasing journal prices and the growing number of journals has led to a situation where a library can only purchase a smaller portion of all access licences. In the recent past, offering licences in big bundles of journals has led to smaller, independent journals suffering from cancellations even though they are quite economic and publish articles of interest for many mathematicians. These journals survive on a smaller level, losing attention in many parts of the world. The same applies to the impact of the Science Citation Index (SCI), which pretends that only about 20% of the journals publishing mathematics are of interest, and in many countries libraries only view these journals as worth purchasing. This effect is exacerbated by administrations where the mathematicians are not consulted anymore and where the decisions on which journals and subscriptions should be purchased depends exclusively on impact figures.

At present, we are entering a period where even bigger libraries cannot afford a simultaneous subscription to the big bundles anymore even though they have already swallowed the budgets previously available for the smaller independent journals. They have to make a choice and they will not be able to offer a relevant part of the mathematical publications anymore. Even if they take the SCI as a measure of what has to be purchased, they will provide only a small window of recent mathematical publications to their users. And very soon the SCI will be complemented by other journal ranking lists taking into account the interest of mathematical communities not well represented by the SCI ranking.

In conclusion, the reference databases will be the only tool to provide a fair view on current mathematical developments. Hence, for them, comprehensiveness is the most important requirement to guarantee the integrity of mathematical research in the future.

Bernd Wegner
Editor-in-Chief of Zentralblatt MATH
TU Berlin and FIZ Karlsruhe

Book Reviews



Michèle Audin and Mihai Damian

Théorie de Morse et homologie de Floer

(Language: French)
EDP SCIENCES
Collection Savoirs Actuels, 2010
978-2759805181
548 pages

Reviewer: Denis Auroux

Michèle Audin and Mihai Damian's book "*Théorie de Morse et homologie de Floer*" is a very well-written and self-contained text on Morse theory and Hamiltonian Floer homology.

Floer homology, first introduced by Andreas Floer in the late 1980s in order to prove Arnold's conjecture on fixed points of Hamiltonian diffeomorphisms, plays a central role in modern symplectic topology. It can be construed as an infinite-dimensional analogue of Morse theory, studying critical points of the *action functional* on the loop space of a symplectic manifold; for this reason, most treatments of Floer homology begin with a discussion of (finite-dimensional) Morse theory, and this book is no exception. However, Floer homology is actually defined in terms of finite energy solutions to a perturbed Cauchy-Riemann equation. In the most general setting, the construction presents considerable technical difficulties due to the occurrence of bubbling phenomena. For simplicity, the book is restricted to the case of symplectically aspherical manifolds, where bubbling can be excluded *a priori*; even then, the definition of Floer homology involves subtle analytic and geometric considerations.

The first part of the book (just over 100 pages long) is a beautifully written, self-contained text about Morse theory. While there are other good sources for this material (first and foremost John Milnor's celebrated *Morse theory*), the updated, modern treatment given here is thorough, enjoyable to read and contributes to making this book an excellent reference for students. The material starts at a very elementary level (existence of Morse functions), then proceeds to construct the Morse complex and its homology. The local structure of the moduli space near broken trajectories is explained carefully, as is the invariance of Morse homology.

The presentation of the subject begins to significantly diverge from other texts on Morse theory when we reach Chapter 4. Here the authors set out to state and prove various classical results of algebraic topology, purely within the context of Morse homology. In fact, the reader is not expected to have any knowledge of singular (or cellular) homology and the isomorphism between Morse homology and other homology theories is only hinted at (in subsection 4.8.e). While this makes it possible to use the book in a course aimed at students who have had no prior exposure to algebraic topology, it may also leave students with a stronger background wanting for more.

The second part of the book is more substantial (nearly 400 pages) and is devoted to Hamiltonian Floer homology. Here again the authors are careful to keep it accessible to students with a very limited background. For example, the material begins with a quick tour of symplectic geometry but is restricted to what is immediately relevant to the topic at hand and any reference to cohomology is carefully avoided.

The book finally gets into the heart of things in Chapter 6, which not only introduces Arnold's conjecture and Floer's equation but also proves compactness of the moduli spaces of finite energy trajectories (under the assumption that the manifold is symplectically aspherical). The argument given here makes Gromov compactness seem almost painless!

The subsequent chapters cover the other key ingredients of the construction of Floer homology, as well as the proof of its invariance and isomorphism with Morse homology. In particular, a substantial amount of space is devoted to the analysis of the linearization of Floer's equation and its transversality, to the structure of the moduli space near broken trajectories and to the invariance of Floer homology with respect to the choice of Hamiltonian and almost-complex structure. The book then concludes with a short chapter on elliptic regularity and a longer one containing technical lemmas. While the last chapter will not be as widely read as the rest, it accomplishes the elusive goal of having a completely self-contained treatment of the subject: not a single proof is left to the reader.

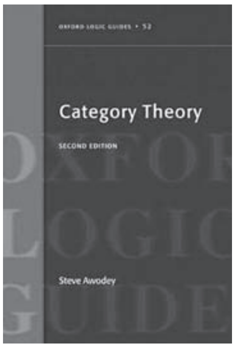
The appendix, entitled "Ce qu'il faut savoir pour lire ce livre" ("What one must know to read this book"), reflects once more the authors' desire to assume essentially no prerequisites and provides quick primers on the relevant background material in geometry, algebra and analysis. While one certainly hopes that the reader is already familiar with this material, the presence of the appendix is a very nice touch, making the book truly accessible to a beginning graduate student with almost no prior exposure to advanced mathematics.

The counterpart of the accessibility and completeness of this book is that its scope is necessarily limited. Besides restricting themselves to the symplectically aspherical case, the authors also omit any discussion of algebraic structures such as the pair-of-pants product or the Piunikhin-Salamon-Schwarz isomorphism. These decisions are very sensible considering the target audience of the book but once again some readers may be left wanting for more.

In summary, this is an excellent graduate text on Morse theory and Floer homology, a topic of considerable interest and one that many graduate students are eager to learn. While Hamiltonian Floer homology is mentioned in several other books (for instance, Dusa McDuff and Dietmar Salamon's *J-holomorphic curves and symplectic topology* or Helmut Hofer and Eduard Zehnder's

Symplectic invariants and Hamiltonian dynamics), this is to our knowledge the first book to specifically focus on this topic and give such a systematic treatment. The book's reader-friendly and well-organised structure, and its lack of assumed prerequisites, makes it an ideal reference for a graduate course on Floer homology or for students who wish to learn the subject on their own. This reviewer's only regret is that the book's prerequisites, as limited as they may be, might not be an ideal match for beginning graduate students at international institutions, whose command of algebraic topology usually surpasses that of the French language. Those who nonetheless attempt to read this beautifully written book will find it a very rewarding experience. For the others, we hope that an English translation will be forthcoming.

Denis Auroux [auroux@math.berkeley.edu] is a professor of mathematics at the University of California, Berkeley. He obtained his PhD at École Polytechnique in 1999 and subsequently held positions at CNRS and at MIT before moving to Berkeley. His research focuses on symplectic geometry and its applications to low-dimensional topology and mirror symmetry.



Steve Awodey

Category Theory
Second Edition

Oxford Logic Studies 52
Oxford University Press, 2010
ISBN: 978-0-19-958736-0

Reviewer: Pere Pascual

Categories and functors appeared in print for the first time in 1945 in the paper *General Theory of Natural Equivalences* [4] by S. Eilenberg and S. MacLane as a tool to tackle natural isomorphisms. Initially, categories were a convenient language in which to express certain properties encountered in homological algebra and algebraic topology, allowing the unification of various branches of mathematics. After the influential works of A. Grothendieck [5], D. Kan [6] and L. W. Lawvere [7], to cite three turning points in its development, category theory grew rapidly and found applications far beyond the subjects that originated it, from algebraic geometry and algebraic topology to set theory, and afterwards to computer science, logic and physics. Nowadays, there is intensive work in many different directions, for example the relations to homotopy theory through higher topos theory [8] and the recent connections between type theory and homotopy [2].

There are several good books on category theory, most of them focusing on some specialised aspect, of which undoubtedly the most influential has been MacLane's *Categories for the working mathematician*, first published in 1971 [9]. It is a superb book, used by almost any mathematician with a desire to know the basis of the theory over the last 40 years. Since its appearance, any new book on category theory has inevitably been compared with it. Now, an expert on the subject, Steve Awodey, offers us a new book (in fact its 2nd edition, following the first in 2006). How does it compare with MacLane's? Perhaps the best way of answering is to cite Awodey's preface: "What is needed now, after 30 years of spreading into various other disciplines and places in the curriculum, is a book for everyone else." Jokingly, one could suggest a new title for Awodey's book, *Categories for everyone*.

Category theory is in some sense elementary. There are few prerequisites to its study but for its full comprehension one needs a good collection of examples to test the abstraction of its concepts and results. It is Awodey's purpose to circumvent this situation by writing a book for students with only an elementary background in calculus, linear algebra, combinatorics and logic. This objective is achieved with a very careful presentation of the main ideas and results and the systematic analysis of some easy examples, like posets and monoids, complemented with some views to applications, particularly to propositional calculus and λ-calculus.

The book is divided into ten chapters of approximately the same length, about 25 pages each, except the chapter on adjoint functors (Chapter 8), which is longer. Each chapter ends with a collection of exercises and a final section of the book provides hints for the solution of some of them, making it very useful as a textbook or for self-study. A more detailed inspection of the contents yields:

1. Categories.
2. Abstract structures.
3. Duality.
4. Groups and categories.
5. Limits and colimits.
6. Exponentials
7. Naturality.
8. Categories of diagrams.
9. Adjoints.
10. Monads and algebras.

For those who already know MacLane's book, in short Awodey's *Category Theory* covers approximately the first six chapters of the former, making it easy to read for the non-mathematically trained.

Roughly speaking, the idea underlying the first six chapters is that of the universal mapping property (UMP) and its usefulness in presenting some category theory definitions, like products, equalizers, pullbacks and their duals. This presentation culminates in Chapters 5 and 6. The main point of Chapter 5 is the introduction of limits and colimits and the identification of the concepts mentioned above as a particular limit, or colimit. Aside from this, in this chapter we find that a representable functor preserves all limits and the notion and some examples of functors creating limits. Chapter 6 is dedicated to exponentials as a construction defined by a UMP which is not a limit, and to Cartesian closed categories. The relevance of Cartesian closed categories is pointed out in some of the applications appearing in this chapter, with sections like Heyting algebras, propositional calculus, λ-calculus and variable sets. These sections are not completely self-contained but they give hints for future reading in this field.

It is not till Chapter 7 that we encounter the notion of natural transformation between two functors and of equivalence of categories, which is a more natural condition than that of isomorphism of categories. Having introduced naturality, Chapter 8 is dedicated to the study of categories of diagrams. There we find one of the most useful results of category theory, the Yoneda lemma, and the analysis of the constructions of the previous chapters (like limits and exponentials) in categories of diagrams. In particular, we find a proof that for any small category $\mathbf{C}$ every object P in the functor category ($\mathbf{C}^{\mathbf{op}}$, **Sets**) is a colimit of representable functors. The chapter ends with the notion of topos and the proof that for any small category $\mathbf{C}$ the category of diagrams ($\mathbf{C}^{\mathbf{op}}$, **Sets**) is a topos. At this point one may wonder why natural transformations and the Yoneda lemma, so basic in category theory, appear so late in the book. Certainly it is a question of taste and the chosen presentation does proceed smoothly along through the text.

As can be read in the introduction of Chapter 9 on adjoint functors: "this chapter represents the high point of this book, the goal towards which we have been working steadily." The chapter begins with the definition of adjoint functor and the identification of many category constructions as adjoints and, more specifically, the identification of quantifiers as adjoints, as recognised by Lawvere in the 60s. The two main results of the chapter are the RALP property and the Freyd adjoint theorem. The RALP property establishes that right adjoints preserve limits, a very useful property of adjoints which is applied to prove the UMP of the Yoneda embedding from a category into a cocomplete category and to base change in locally Cartesian categories. The Freyd adjoint theorem answers the natural question: 'When does a functor have an adjoint?' and is applied to establish the equivalence of three properties for a functor U: $\mathbf{C} \to \mathbf{Sets}$ where $\mathbf{C}$ is a small complete category: preserving limits, having a left adjoint and being representable.

The book ends with a chapter on monads and algebras. The main objective of the chapter is the Eilenberg-Moore theorem which establishes that every monad arises from an adjunction. To this end, given a monad T on a category $\mathbf{C}$, Awodey introduces the Eilenberg–Moore category of T-algebras $\mathbf{C}^{\mathrm{T}}$ and the adjunction given by the free algebra and forgetful functors F: $\mathbf{C} \longleftrightarrow \mathbf{C}^{\mathrm{T}}$: U. The final section presents a weakened variation of T-algebras: the algebras for an endomorphism P: $\mathbf{C} \to \mathbf{C}$ of a category $\mathbf{C}$, which include some very basic algebraic structures, for example the group structures as the P-algebras for $P(X) = 1 + X + X \times X : \mathbf{Sets} \to \mathbf{Sets}$, thinking on them as operations without imposing the group equations, as associativity or inverses. The section concludes with a criterion for P-algebras to be equivalent to T-algebras coming from a monad T.

The writing of Awodey is very careful and thorough, providing complete details for proofs or asking the reader to do so as an exercise when the proof follows an already presented scheme or a dual result. Many concepts are first discussed for sets, introducing them in an element like presentation and looking for an element free characterization, and afterwards getting the categorical notion. Moreover, any time there is a new concept, there is a set of examples for familiarisation, some of them with the warning that they presuppose some knowledge of general topology or type theory. The introduction of generalized elements of an object in a category in Chapter 2 permits one to recover many category concepts in a classic element style.

As an example of the detailed discussion that the author proposes when introducing new concepts, let me mention the chapter on adjoint functors. The definition of adjoint functor occupies several pages. Beginning with the example of the UMP of free monoids, the author defines a (preliminary version of an) adjunction between two functors $F : \mathbf{C} \rightleftarrows \mathbf{D} : U$ as a natural transformation $\eta : 1_C \to UF$ with the corresponding UMP. From this, he derives the usual bijection $\mathrm{Hom}_D(FC,D) \approx \mathrm{Hom}_C(C,UD)$ for any $C \in \mathbf{C}$ and $D \in \mathbf{D}$, and finally takes care of the naturality of this isomorphism in both C and D. This results in a leisurely pace of presentation, stressing the main points of the categorical definition for the benefit of those encountering categories for the first time.

The references in the book are reduced to eight items. Due to its textbook character, it seems reasonable to give a small list of references, some of them for historical importance, like Eilenberg-MacLane [4] or Lawvere [7], and others as the author's preference, mainly focused on topos theory and logic. However, it would also have been desirable to cite some other standard manuals such as Borceaux's [3].

This second edition differs from the first in the exercises and a section on monoidal categories. It is a good idea to include these exercises and also the appendix sketching the solutions of some of them. Note that Exercises 4 and 5 of Chapter 5, pp. 115–116, are equal. It is almost impossible to publish a book without typographical errors, and this book is but one more example. Nevertheless we have to be thankful to the author for providing us with a list of corrections on his webpage [1] just months after its publication.

In summary, the book is well organised and very well-written. The presentation of the material is from the concrete to the abstract, proofs are worked out in detail and the examples and the exercises spread throughout the text mark a pleasant rhythm for its reading. In all, Awodey's *Category Theory* is a very nice and recommendable introduction to the subject.

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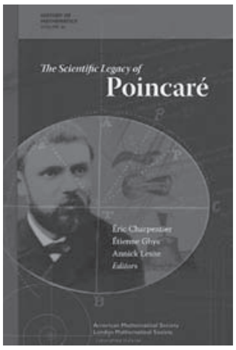
Pere Pascual [pere.pascual@upc.edu] is a professor of mathematics at the Universitat Politècnica de Catalunya. He obtained his PhD in mathematics in 1983. His main interests are in algebraic geometry and algebraic topology. Recently, he has worked on some aspects of categorical algebra and its applications to geometry, and also on descent variants of the algebraic K-theory of schemes.



The Scientific Legacy of Henri Poincaré
Eric Charpentier, Étienne Ghys, Annick Lesne (Editors)
(Translation by Joshua Bowman)

American Mathematical Society, Series: History of Mathematics, vol. 36, 396 pages, 2010
ISBN: 9780821847183

Reviewer: Michèle Audin

'Euler-Poincaré characteristics, Poincaré-Bendixson theorem, Poincaré-Birkhoff theorem, Poincaré-Birkhoff-Witt theorem, Poincaré conjecture, Poincaré's disk, Poincaré duality, Poincaré group,[1] Poincaré groupoid, Poincaré's half-plane, Poincaré-Hopf theorem, Poincaré sphere…' Although incomplete, this list of mathematical objects, concepts and statements shows the universality of Henri Poincaré (1854–1912) as a scientist. He was one of the last mathematicians to have mastered all the areas in mathematics and mathematical physics,[2] including the philosophy of sciences.

He was, in his time, very famous. For instance, he was elected, in 1908, as a member of the Académie Française[3] (he was a member of the Academy of sciences from 1887). He was also the "reference" mathematician. For instance, he was the scientific authority who showed that the allegedly "scientific" proofs against Alfred Dreyfus had been fabricated on purpose.[4] In a lighter mood, he would also be asked to scientifically dismantle such-and-such a "medium".[5] He had the opportunity to prove his rigour when, as a young engineer of 25, he had to go down in a mine where a firedamp explosion had killed 16 workers and write a report on the catastrophe – which is still a model.

His written work is considerable. It comprises ten volumes of complete works, not including his books, in particular the three volumes of his *New methods in celestial mechanics*.

This book is a translation into English of a book that appeared in French in 2006 (as far as I know, there was no review of the original version so I am very happy to have the opportunity to say how much I enjoyed reading it). The series is called *History of Mathematics*, and the book illustrates an interesting way of speaking about history. The idea is to take the contributions of Poincaré to mathematics, physics, philosophy, etc. and to look at what happened to them. Needless to say, this is quite impressive.

There are 19 chapters and it has taken 21 mathematicians,[6] often the top specialists of the topics – nobody would, nowadays, cover all the areas of knowledge presented here. For an analogous reason, not all the subjects treated in this book can be discussed here… Instead, here is another incomplete list, picking at (some of) the topics considered in the book.

Fuchsian functions

There is a famous story told by Poincaré [1] of the sudden flash of inspiration that inspired him to discover the theory of Fuchsian functions while he was entering a tramway (and if you don't know it, it can be read in Chapter 2, by Nicolas Bergeron). This is about the mixing of geometry, hyperbolic geometry (and non-Euclidean geometries), the theory of automorphic functions and analytic number theory, and differential equations with algebraic coefficients… which, in today mathematics, is quite a lot. The first chapter, Poincaré and his disk, by Etienne Ghys, can be recommended to readers:

- Who want to learn the subject "Poincaré's disk and modern hyperbolic geometry".
- Who want to learn how to write an introductory paper that non-specialists can read – even though it contains recent and even difficult results.

Moreover, this chapter is beautifully illustrated (by, for example, a hyperbolic lettuce and a hyperbolic skirt).

Dynamical systems and celestial mechanics

Chapter 6 is especially enjoyable, covering periodic orbits in the "three-body-problem" and providing a short but efficient introduction to the history of the "motion of the Moon", from Newton raising the question to the new periodic orbits discovered by Moore and explained by Chenciner and Montgomery, through Lagrange, Hill and (of course) Poincaré, who gave several proofs of the existence of periodic orbits in this problem and showed their importance.

The three body problem (Sun and Earth, plus the Moon) was the subject of a memoir of Poincaré which won the Prize of King Oscar II of Sweden. The question was that of the stability of the system. One of the new ideas was that, although there is no "formula" giving the general solution of the differential system, it is possible to say something about the behaviour of the solutions. There was an error in the crowned memoir,[7] and correcting this error led Poincaré to a new discovery: the stable and unstable manifolds may become entangled. The fruitfulness of Poincaré's error was also explained by Jean-Christophe Yoccoz, for a large audience, in [6]. Here, in Chapter 8, by François Béguin, recent results of Laskar and Crovisier are quoted to show the importance of this discovery.

Several complex variables

It seems that Poincaré was also one of the first mathematicians to investigate functions of two complex variables.

He thus opened the way to the theory of several complex variables,[8] which are considered in Chapter 11 from the "residues and duality" point of view.

The Poincaré conjecture

This is a problem which gave work to mathematicians for a century. It is a rather short section in the book, in a chapter devoted to a beautiful sketch of Perelman – 13 inspired pages in all (by Laurent Bessières, Gérard Besson and Michel Boileau). The history of the problem, which is evoked in the introduction, perhaps deserved more space: it includes the way Poincaré invented the fundamental group and understood it as different from the first homology groups (using, here, modern and rather anachronistic terms), the counter-example (the Poincaré sphere, a non simply connected manifold with the same homology as the sphere) he found to the first statement of the conjecture, and the subsequent story of all the attempts throughout the 20th century to prove the Poincaré conjecture, which failed but at the same time helped develop 3-dimensional topology, Thurston's geometrization, etc.

Probability theory, physics, philosophy, etc.

All these topics are also considered in the book and it is a shame not to spend more time on them.

A last remark is that the book deals with the history of mathematics but still in the perspective of topical, living mathematics and that it is written for mathematicians.

To summarise, I hope that the readers of the Newsletter will rush to read this beautiful book and that they will enjoy reading it as much as I did.

1. Which should be written twice as there are two of them.
2. Perhaps Jacques Hadamard (1865–1963), 11 years younger, was as universal. In any case, when Hadamard started his legendary seminar in 1913 (the very first mathematics seminar in France) it was about ... Poincaré's works.
3. Times have changed. It was not uncommon to elect scientists to the Académie Française – for instance, the physiologist Flourens was preferred to Victor Hugo in 1840 and, much later, in 1924, Emile Picard, the mathematician, was also elected there.
4. On Poincaré's role in the Dreyfus affair, see the article [4] or the short version [5] on the website http://images.math.cnrs.fr. Note that, contrary to Jacques Hadamard and Paul Painlevé, for instance, Poincaré had not openly taken sides for Dreyfus.
5. See the talk Poincaré gave in 1909, Le libre examen en matière scientifique, in [3].
6. It would be unfair to name some but not all of them. Therefore, in alphabetic order: Nalini Anantharaman, François Béguin, Nicolas Bergeron, Laurent Bessières, Gérard Besson, Guido Boffetta, Michel Boileau, Pierre Cartier, Dominique Cerveau, Jean-Pierre Françoise, Étienne Ghys, Pierre-Paul Grivel, Ger-hard Heinzmann, Emmanuel Kowalski, Guglielmo Lacorata, Michel Le Bellac, Jean Mawhin, Michel Mendès-France, Michael Nauenberg, Yves Pomeau, Angelo Vulpiani, Alain Yger.
7. And the romantic story of Phragmn preparing the paper for the printer and making a list of "obscure points", of Poincaré, trying to answer him and finding an error… just a little too late, of Mittag-Leffler trying to get back all the copies of Acta mathematica already sent to the subscribers, and of Poincaré paying the expenses, an amount very similar to what he got for the prize ... see the correspondence between Mittag-Leffler and Poincaré in [2].
8. And to analytic spaces, thus being an important issue for 20th century mathematics (Cartan, Serre, etc.).

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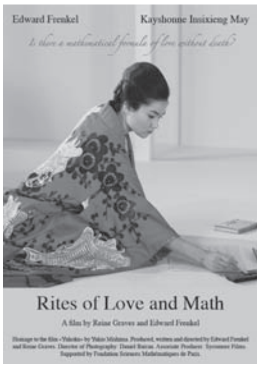
[6] J.-C. Yoccoz – "Une erreur féconde du mathématicien Henri Poincaré", *Gazette des mathématiciens* 107 (2006), p. 19–26.

Michèle Audin [michele.audin@math.unistra.fr] is professor at the University of Strasbourg. She is a specialist of symplectic geometry, and the author, with Mihai Damian, of "Théorie de Morse et homologie de Floer", EDP-Sciences, 2010. She is also interested in history of mathematics, and the author of several books on the subject, including "Fatou, Julia, Montel, the Great Prize of mathematical sciences of 1918 and beyond", Springer, 2011.



Rites of Love and Math
A film by Reine Graves and Edward Frenkel

Homage to the film "Rite of Love and Death" by Yukio Mishima
With Edward Frenkel and Kayshonne Insixieng May
26 minutes,
Supported by Fondation Sciences Mathématiques de Paris
Available at:
http://ritesofloveandmath.com/

Reviewer: Julie Rehmeyer

The climax of the new film "The Rites of Love and Math" comes – both literally and figuratively – when the Mathematician has just finished tattooing his formula of Love onto his beloved's belly in a passionate, mathematical frenzy. She writhes from the jabs of his bamboo tattooing pen, finally breaking through the silence to cry out in pain, ecstasy, something.

Mathematics, we're supposed to see, is an erotic art.

While that idea might induce giggles and embarrassed glances around the departmental common room at teatime, it has a noble pedigree. Socrates taught that the first moment of longing after a sexy body is also the first step in learning to love absolute, unchanging, unembodied truth. Loving one beautiful body naturally leads to adoring beautiful bodies in general and then to loving all beautiful things and then to loving most the most beautiful things of all. For Socrates that means philosophy, with only a brief stop along the way at mathematics. But we mathematicians can perhaps forgive him for a slight misapprehension of what lies at the very peak of human endeavours in order to consider how his conception may illuminate the experience of doing mathematics.

As absurd as the juxtaposition of mathematics and erotic ecstasy might seem, mathematicians do love doing mathematics passionately. A mathematical problem can seduce: sometimes instantly and totally, in the mathematical version of love at first sight, and sometimes more slowly, like a striptease, as the problem reveals more of itself over time. Coaxing the problem into succumbing demands one's full powers of creativity, attention and devotion. A puzzle can obsess one much as a lover does, present even when absent, occupying the mind while the body blankly pushes change into the parking meter or refills the coffee cup.

Of course, non-mathematicians rarely get a glimpse of this. There are few things less erotic, after all, than a mathematics exam returned covered in red ink.

"The Rites of Love and Math" undertakes the noble task of baring the erotic side of mathematics to all and its co-creator, mathematician Edward Frenkel, was so committed to the effort that he was willing to bare his own erotic side to all – along with much of his front and back – in the process. He plays the Mathematician, who has resolved that he must kill himself to protect his discovery of the formula of Love from the forces of Evil that would somehow use it as a "weapon against Humanity". But first he makes highly stylized love to his secret girlfriend Mariko (Japanese for "Truth"), moving slowly from one erotic pose to the next as Wagner's Tristan operatically questions the meaning of life. His final task is to keep his formula alive but safely concealed after his death by tattooing it onto his beloved's belly. The music shifts to a cacophony of electric guitars and Mariko and the Mathematician lock eyes as she submits to the rapturous pain of being indelibly marked with mathematics. She writhes in some unknowable combination of agony and pleasure as he becomes lost in frenzied concentration, no longer aware of anything beyond her beautiful, increasingly mathematical belly. He brings his effort to a climax with its final $d\varpi$ as her masochistic pleasure reaches its own crescendo. Finally, revealed in blue ink on her lustrous flesh is beauty itself: the formula of Love (which is taken from Frenkel's own work on the Langlands program).

Having finished his task – and still without so much as a glance at his beloved's face – the Mathematician stabs himself with the bamboo pen. Mariko, meanwhile, is too absorbed in her own recovery to notice. Once she's come to, she kisses his dying body and slowly, artfully pulls on her kimono, glancing back as she walks away from her fading lover, her body now carrying his mathematical seed.

The plot raises basic questions that it never answers like: What the heck is a "formula of Love" anyway? How could it be used as a weapon against humanity? And how does tattooing it on Mariko's body help matters? Instead of narrative thrust, the film aims to develop an aesthetic vision of mathematics. The events unfold on a Japanese Noh stage, with no dialogue, a minimum of props and, with the exception of the tattooing scene, only the slowest and most controlled movements. It is trying to be a kind of visual poem, with the brushstrokes of scene and plot pointing toward some allusive (and elusive) whole.

Frenkel and his co-director Reine Graves meant the film as an homage to the 1966 Japanese short film "The Rite of Love and Death", in which the main character is a Japanese lieutenant played by Yukio Mishima, a three-time nominee for the Nobel prize in literature who also wrote, directed and produced the film. At the start of that film, the lieutenant is in a nasty fix. He had planned but then not participated in a coup that has now failed and, as a member of the Imperial Guard, he will be required to kill his comrades the following day. The only honourable path, he decides, is suicide before morning. His bride Reiko resolves to join him in the everlasting, welcoming death so completely that she "feels as she did on her wedding night". As in Frenkel's version, they make love, showing off the effects of Mishima's bodybuilding in a series of beautifully framed poses. The lieutenant then disembowels himself, lingering as he pushes down his loincloth to find the ideal spot to thrust the sword into his perfectly muscled abdomen. He sweats and grimaces as he pulls the sword across his belly, his intestines finally spilling from his body. Meanwhile Reiko (and the camera) follows his sufferings in gory detail, achieving an intensity of communion that far exceeds the lovemaking. Reiko helps him finish the job by thrusting the sword into his neck and then cuts her own throat.

The original film, though disturbing, bizarre and nearly unwatchable, presents a vision of life as a work of art: pure, austerely beautiful, uncompromising, honed sharp as a sword. The film embodies the same aesthetic itself and this unity gives it a powerful resonance even while Mishima's obsessions in the movie – the blurring between sex and violence, the rigid sense of honour, the almost inhuman physical strength and the extreme narcissism – leave the viewer feeling simultaneously reproached for being soft and disgusted by the film's self-destructive and over-simplified ideal. Mishima embraced his vision so thoroughly that four years later, he attempted a coup himself and committed hara-kiri upon its failure. (One certainly hopes that Frenkel doesn't plan a reprise.) Mishima's widow destroyed all copies of the film and it was only 35 years later that the negatives were discovered in a tea box.

The remake takes on the spare outer aesthetic of the original, imitating it shot by shot, while dispensing with the inner aesthetic. The Mathematician's self-sacrifice comes not from an inner compulsion for honour but from an altruistic desire to protect the world. In the original, sex and violence are interwoven by the demands of the aesthetic but in Frenkel's version it becomes an accident of a peculiar moment, as the eroticism of the lovemaking bleeds into the scene of tattooing and suicide. The enjoyment the characters derive from the intermingling then becomes a strange, cringeworthy bit of oversharing. The physical beauty of the movie becomes an illustration of the abstract beauty of mathematics but its physical manifestation is no longer central to the film's vision of the world. The allegory of the original turns into caricature, its diamond-hard inner core replaced with a mash-up of contrived ideas and a dash of mathematics.

This could be forgiven if the film presented a coherent vision of the erotic nature of mathematics. After all, Frenkel is a mathematician, not a professional actor or filmmaker and the movie is at its core an open love-letter to mathematics. But what could the vision be? That mathematics is something burned into the flesh of a woman, causing her pain and delight? Or, if we take the act of writing the formula as a stand-in for the discovery of it, that doing mathematics is far more engaging than sex, so compelling that a mathematician will ignore his beloved while doing it? (One hopes that mathematics' potent charms do not inevitably leave its practitioners so disengaged.) As a picture of mathematical collaboration, the vision is one-sided, with Mariko apparently knowing nothing of the mathematical content and being only a passive repository for it – a piece of paper. Even if we see the Mathematician's beloved as a stand-in for mathematics itself, it's hard to come away with anything beyond the claim that mathematics is sexy.

Socrates offered a deeper analysis two thousand years ago. Though his preferred department in the academy is philosophy (literally, "love of wisdom"), by substituting a few words his comments can easily be read as applying to mathematicians:

> *"He who in youth has the seed of ~~wisdom and virtue~~* mathematics *implanted in him and is himself inspired, when he comes to maturity desires to beget and generate. He wanders about seeking beauty that he may beget offspring… above all when he finds a fair and noble and well-nurtured soul, he embraces [him], and to such an one he is full of speech about ~~virtue~~* mathematics *and the nature and pursuits of a good ~~man~~* mathematician*; and he tries to educate him… and they are married by a far nearer tie and have a closer friendship than those who beget mortal children, for the children who are their common offspring are fairer and more immortal. Who, when he thinks of ~~Homer and Hesiod and other great poets~~* Hilbert and Hardy and other great mathematicians*, would not rather have their children than ordinary human ones?" (Plato's* Symposium*, Benjamin Jowett translation, 209b – 209d)*

Or, to put it more simply, one of the greatest erotic encounters (though, assuredly, a chaste one) is that between an advisor and a student. A more explicit cultural understanding of the role of the erotic in mathematics might help protect students from Eros gone wrong.

More generally, this points to a little-known aspect of mathematics: it is a social sport. While occasionally an Andrew Wiles will lock himself in the attic for seven years to crack a great problem, most mathematicians work out their ideas by talking about them. They teach their students, they bounce ideas off one another, they nurture their love of mathematics through sharing it. Out of the bond of joint exploration and joy in mathematics grow mind-children carrying the genetic material of both parents, unlike the sterile seed of Frenkel's equation spilled on Mariko's belly.

One of the most uncomfortable aspects of the film is that it creates an erotic relationship between Frenkel and the viewer, whether the viewer wants it or not. Frenkel is acting as the older man, striving to share his love of mathematics and to seduce the viewer into joining him in that love. But this time, Eros has failed him.

Julie Rehmeyer [jrehmeyer@gmail.com]
Freelance math and science writer.

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Personal column

Please send information on mathematical awards and deaths to Madalina Pacurar [madalina.pacurar@econ.ubbcluj.ro]

Awards

John W. Milnor (Stony Brook, New York, USA) has been awarded the **Abel Prize 2011** by the Norwegian Academy of Sciences and Letters.

The **AMS Cole Prize** in Number Theory has been awarded to **Chandrashekhar Khare** (UCLA, USA) and **Jean-Pierre Wintenberger** (University of Strasbourg, France). The **AMS Eisenbud Prize** has been awarded to **Herbert Spohn** (TU Munich, Germany).

Jacob Palis (Instituto de Matemática Pura e Aplicada, Rio de Janeiro, Brazil) has received the **Balzan Prize 2010** for mathematics (pure or applied).

Jean Tirole, Scientific Director of the Industrial Economics Institute (IDEI) and Member of the Toulouse School of Economics, has been awarded the 2010 **CME Group/MSRI Prize** in Innovative Quantitative Applications.

Bill Morton (University of Oxford, UK) has won the 2010 **De Morgan Medal** of the London Mathematical Society.

Joaquim Serra Montolí (Universitat Politècnica de Catalunya, Spain) has been awarded the **Prize Évariste Galois** by the Societat Catalana de Matemàtiques. **Celia Hoyles** (University of London, UK) has been awarded the **Kavli Education Medal** for her outstanding contribution to research in mathematics education.

Sílvia Barbeiro (Centro de Matemática, Universidade de Coimbra, Portugal) has been awarded the **Medalha de Honra L'Oréal** Portugal for Women in Science.

The Oberwolfach Foundation and the MFO have awarded the **Oberwolfach Prize** 2010 for excellent achievements in analysis and applied mathematics jointly to **Nicola Gigli** (Nice, France) and **László Székelyhidi** (Bonn, Germany).

The **Philip Leverhulme Prizes** have been awarded to **Dr Caucher Birkar** (Department of Pure Mathematics and Mathematical Statistics, University of Cambridge, UK), **Dr Timothy Browning** (School of Mathematics, University of Bristol, UK), **Dr Tom Coates** (Department of Mathematics, Imperial College London, UK), **Dr Radek Erban** (Mathematical Institute, University of Oxford, UK) and **Dr Nicolai Meinshausen** (Department of Statistics, University of Oxford, UK).

The 2010 **Ramanujan Prize** has been awarded to **Professor Yuguang Shi** (School of Mathematical Sciences, Peking University, China). The Ramanujan Prize is awarded annually by the ICTP, Trieste.

Michael Aschbacher (Caltech, US) has been awarded **The Rolf Schock Prize** in Mathematics.

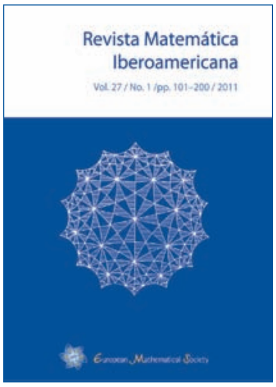
Deaths

We regret to announce the deaths of:

Claudio D'Antoni (29 October 2010, Italy)
Gavin Brown (25 December 2010, UK)
Philip Chatwin (10 September 2010, UK)
Alejandro Fernández Margarit (4 April 2011, Spain)
Lorenzo Ferrer Figueras (6 November 2010, Spain)
Joaquim Font Arjó (18 November 2010, Spain)
Alan Jeffrey (6 June 2010, UK)
Nigel Kalton (5 September 2010, UK)
Tamás Kövári (12 September 2010, Hungary)
Peter J. Hilton (6 November 2010, UK)
Enrico Magenes (2 November 2010, Italy)
Patrick Martineau (17 November 2010, UK)
Allan Muir (17 October 2010, UK)
Alfred Jacobus van der Poorten (9 October 2010, UK)
Ian Porteous (30 January 2011, UK)
Daniel Gray Quillen (30 April 2011, UK)
Francisco Javier Quintana (18 February 2011, Spain)
Zbigniew Romanowicz (22 December 2010, Poland)
Juan Sancho de San Román (12 January 2011, Spain)
Tomasz Schreiber (1 December 2010, Poland)
Anatoliy V. Skorokhod (3 January 2011, Ukraine)
Zofia Szmydt (26 November 2010, Poland)

New journals published by the

European Mathematical Society



Published by the EMS Publishing House as of 2012 (formerly Real Sociedad Matemática Española and Euclid)

ISSN print 0213-2230
ISSN online 2235-0616
2012. Vol. 27. 3 issues
Approx. 1100 pages. 17.0 x 24.0 cm
Price of subscription:
298 € online only / 358 € print+online

Editors-in-Chief:
Antonio Córdoba Barba and
José Luis Fernández Pérez (Universidad Autónoma de Madrid, Spain)

Aims and Scope
Revista Matemática Iberoamericana publishes original research articles on all areas of mathematics. Its distinguished Editorial Board selects papers according to the highest standards. Founded in 1985, *Revista* is the scientific journal of Real Sociedad Matemática Española.

New in 2012

ISSN print 1664-039X
ISSN online 1664-0403
2012. Vol. 2. 4 issues
Approx. 400 pages. 17.0 x 24.0 cm
Price of subscription:
198 € online only / 238 € print+online

Editor-in-Chief:
E. Brian Davies (King's College, London, UK)
Deputy Chief Editor:
Ari Laptev (Imperial College, London, UK)

Aims and Scope
The *Journal of Spectral Theory* is devoted to the publication of research articles that focus on spectral theory and its many areas of application. Articles of all lengths including surveys of parts of the subject are very welcome.
The following list includes several aspects of spectral theory and also fields which feature substantial applications of (or to) spectral theory:
Schrödinger operators, scattering theory and resonances; eigenvalues; perturbation theory, asymptotics and inequalities; quantum graphs, graph Laplacians; pseudo-differential operators and semi-classical analysis; random matrix theory; the Anderson model and other random media; non-self-adjoint matrices and operators, including Toeplitz operators; spectral geometry, including manifolds and automorphic forms; linear and nonlinear differential operators, especially those arising in geometry and physics; orthogonal polynomials; inverse problems.

Published by the EMS Publishing House since 2010

ISSN print 0034-5318
ISSN online 1663-4926
2012. Vol 48. 4 issues
Approx. 800 pages. 17 x 24 cm
Price of subscription:
298 € online only / 348 € print+online

Editor-in-Chief: S. Mukai

A journal of the Research Institute for Mathematical Sciences of Kyoto University

Aims and Scope
The aim of the *Publications of the Research Institute for Mathematical Sciences* (PRIMS) is to publish original research papers in the mathematical sciences. Occasionally surveys are included.

ISSN print 1663-487X
ISSN online 1664-073X
2011. Vol. 2. 4 issues
Approx. 400 pages. 17.0 x 24.0 cm
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Editor-in-Chief:
Vladimir Turaev (Indiana University, Bloomington, USA)

Aims and Scope
Quantum Topology is dedicated to publishing original research articles, short communications, and surveys in quantum topology and related areas of mathematics. Topics covered include in particular:
low-dimensional topology, knot theory, Jones polynomial and Khovanov homology, topological quantum field theory, quantum groups and Hopf algebras, mapping class groups and Teichmüller space, categorification, braid groups and braided categories, fusion categories, subfactors and planar algebras, contact and symplectic topology, topological methods in physics.

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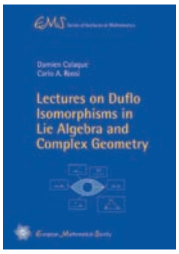
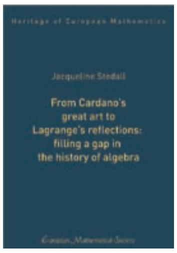


Damien Calaque (ETH Zurich, Switzerland) and Carlo A. Rossi (Max Planck Institute for Mathematics, Bonn, Germany)
Lectures on Duflo Isomorphisms in Lie Algebra and Complex Geometry (EMS Series of Lectures in Mathematics)

ISBN 978-3-03719-096-8. 2011. 114 pages. Softcover. 17 x 24 cm. 24.00 Euro

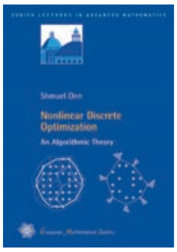
Duflo isomorphism first appeared in Lie theory and representation theory. It is an isomorphism between invariant polynomials of a Lie algebra and the center of its universal enveloping algebra, generalizing the pioneering work of Harish-Chandra on semi-simple Lie algebras. Later on, Duflo's result was refound by Kontsevich in the framework of deformation quantization, who also observed that there is a similar isomorphism between Dolbeault cohomology of holomorphic polyvector fields on a complex manifold and its Hochschild cohomology. The present book, which arose from a series of lectures by the first author at ETH, derives these two isomorphisms from a Duflo-type result for Q-manifolds.
The book is well-suited for graduate students in mathematics and mathematical physics as well as for researchers working in Lie theory, algebraic geometry and deformation theory.



Jacqueline Stedall (University of Oxford, UK)
From Cardano's great art to Lagrange's reflections: filling a gap in the history of algebra (Heritage of European Mathematics)

ISBN 978-3-03719-092-0. 2011. 236 pages. Hardcover. 17 x 24 cm. 68.00 Euro

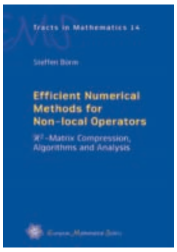
This book is an exploration of a claim made by Lagrange in the autumn of 1771 as he embarked upon his lengthy *Réflexions sur la résolution algébrique des équations*: that there had been few advances in the algebraic solution of equations since the time of Cardano in the mid sixteenth century. That opinion has been shared by many later historians. The present study attempts to redress that view and to examine the intertwined developments in the theory of equations from Cardano to Lagrange. A similar historical exploration led Lagrange himself to insights that were to transform the entire nature and scope of algebra.
The book is written in three parts. Part I offers an overview of the period from Cardano to Newton (1545–1707) and is arranged chronologically. Part II covers the period from Newton to Lagrange (1707–1770) and treats the material according to key themes. Part III is a brief account of the aftermath of the discoveries made in the 1770s. The book attempts throughout to capture the reality of mathematical discovery by inviting the reader to follow in the footsteps of the authors themselves.



Shmuel Onn (Technion – Israel Institute of Technology, Haifa, Israel)
Nonlinear Discrete Optimization. An Algorithmic Theory (Zurich Lectures in Advanced Mathematics)

ISBN 978-3-03719-093-7. 2010. 147 pages. Softcover. 17 x 24 cm. 32.00 Euro

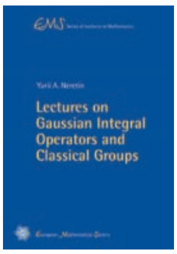
This monograph develops an algorithmic theory of nonlinear discrete optimization. It introduces a simple and useful setup which enables the polynomial time solution of broad fundamental classes of nonlinear combinatorial optimization and integer programming problems in variable dimension. An important part of this theory is enhanced by recent developments in the algebra of Graver bases. The power of the theory is demonstrated by deriving the first polynomial time algorithms in a variety of application areas within operations research and statistics, including vector partitioning, matroid optimization, experimental design, multicommodity flows, multi-index transportation and privacy in statistical databases.
The monograph is intended for graduate students and researchers. It is accessible to anyone with standard undergraduate knowledge and mathematical maturity.



Steffen Börm (Kiel University, Germany)
Efficient Numerical Methods for Non-local Operators. $\mathcal{H}^2$-Matrix Compression, Algorithms and Analysis (EMS Tracts in Mathematics Vol. 14)

ISBN 978-3-03719-091-3. 2010. 441 pages. Hardcover. 17 x 24 cm. 58.00 Euro

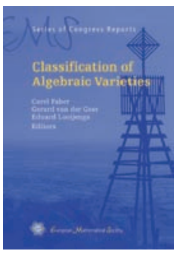
Hierarchical matrices present an efficient way of treating dense matrices that arise in the context of integral equations, elliptic partial differential equations, and control theory. $\mathcal{H}^2$-matrices offer a refinement of hierarchical matrices: using a multilevel representation of submatrices, the efficiency can be significantly improved, particularly for large problems.
This books gives an introduction to the basic concepts and presents a general framework that can be used to analyze the complexity and accuracy of $\mathcal{H}^2$-matrix techniques. Starting from basic ideas of numerical linear algebra and numerical analysis, the theory is developed in a straightforward and systematic way, accessible to advanced students and researchers innumerical mathematics and scientific computing. Special techniques are only required in isolated sections, e.g., for certain classes of model problems.



Yurii A. Neretin (University of Vienna, Austria; Institute for Theoretical and Experimental Physics and Moscow State University, Moscow, Russia)
Lectures on Gaussian Integral Operators and Classical Groups (EMS Series of Lectures in Mathematics)

ISBN 978-3-03719-080-7. 2011. 571 pages. Softcover. 17 x 24 cm. 58.00 Euro

This book is an elementary self-contained introduction to some constructions of representation theory and related topics of differential geometry and analysis. Topics covered include the theory of various Fourier-like integral operators as Segal–Bargmann transforms, Gaussian integral operators in L^2 and in the Fock space, integral operators with theta-kernels, the geometry of real and p-adic classical groups and symmetric spaces. The heart of the book is the Weil representation of the symplectic group (real and complex realizations, relations with theta-functions and modular forms, p-adic and adelic constructions) and representations in Hilbert spaces of holomorphic functions of several complex variables.
The book is addressed to graduate students and researchers in representation theory, differential geometry, and operator theory. The reader is supposed to be familiar with standard university courses in linear algebra, functional analysis, and complex analysis.



Classification of Algebraic Varieties (EMS Series of Congress Reports)
Carel Faber (Royal Institute of Technology, Stockholm, Sweden), Gerard van der Geer (University of Amsterdam, The Netherlands) and Eduard J.N. Looijenga (University of Utrecht, The Netherlands), Editors

ISBN 978-3-03719-007-4. 2010. 346 pages. Hardcover. 17 x 24 cm. 78.00 Euro

Fascinating and surprising developments are taking place in the classification of algebraic varieties. Work of Hacon and McKernan and many others is causing a wave of breakthroughs in the Minimal Model Program: we now know that for a smooth projective variety the canonical ring is finitely generated. These new results and methods are reshaping the field.
Inspired by this exciting progress, the editors organized a meeting at Schiermonnikoog and invited leading experts to write papers about the recent developments. The result is the present volume, a lively testimony of the sudden advances that originate from these new ideas. It will be of interest to a wide range of pure mathematicians, but will appeal especially to algebraic and analytic geometers.

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