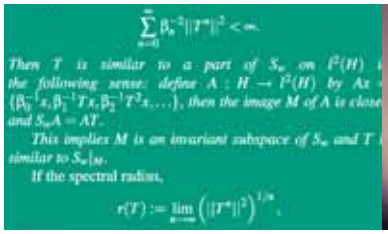
NEWSLETTER

OF THE EUROPEAN MATHEMATICAL SOCIETY

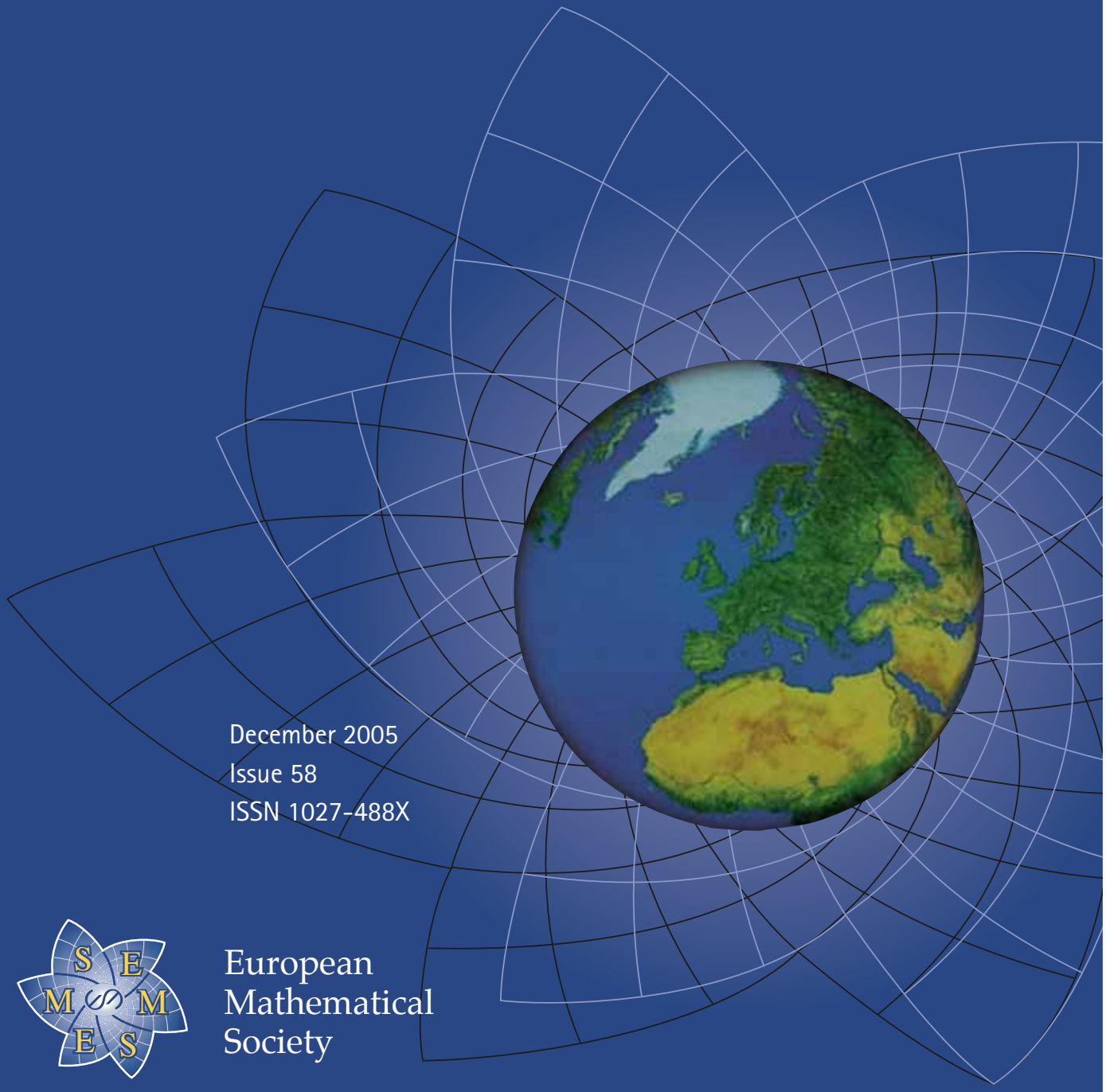


Feature
Invariant Subspaces
p. 19

Biography
Ljudmila Keldysh
p. 25

Interview
Friedrich Hirzebruch
p. 31

ERCOM
Stefan Banach Center
p. 37



December 2005
Issue 58
ISSN 1027-488X

European
Mathematical
Society

Editorial Team

European Mathematical Society

Newsletter No. 58, December 2005

ISSN 1027-488X

Published by the
EMS Publishing House
ETH-Zentrum FLI C4
CH-8092 Zürich, Switzerland.
homepage: www.ems-ph.org

For advertisements contact: newsletter@ems-ph.org

EMS Executive Committee

EMS Calendar

2006

1 February Deadline for submission of material for the March issue of the EMS Newsletter
Contact: Martin Raussen: raussen@math.aau.dk

5–11 March EMS Summer School at Będlewo (Poland)
GAEL-Géométrie algébrigue en liberté: Special varieties
Web site: http://euclid.mathematik.uni-kl.de/~gael/

10–12 March Meeting of the EMS Executive Committee, London (UK) at the invitation of the London Mathematical Society
Contact: Helge Holden: holden@math.ntnu.no

13–17 March EMS-SIAM-SMAI-UMALCA International Congress on the Applications of Mathematics
Venue: the CMM (Centre for Mathematical Modelling), Universidad de Chile, Santiago (Chile)
Web site: http://umalca.usach.cl/icma.htm

6–13 May EMS Summer School at the SIMULA laboratory, Longyearbyen (Norway) *Mathematical model of the heart*
Web site: http://home.simula.no/ems2006/,
contact: sundnes@simula.no

7–20 May EMS Summer School at Liège (Belgium)
Combinatorics, automata and number theory
Web site: http://www.cant2006.ulg.ac.be,
contact: M.Rigo@ulg.ac.be

4–15 June EMS Summer School at Istanbul (Turkey)
Arithmetic and geometry around quantisation
Web site: http://guests.mpim-bonn.mpg.de/agaq,
contact: agaq@mpim-bonn.mpg.de

16–18 June Joint EMS–SMAI–SMF Mathematical Weekend, Nantes (France)
Web site: www.math.sciences.univ-nantes.fr/WEM2006

30 June EMS Executive Committee Meeting, Torino (Italy)
Contact: Helge Holden: holden@math.ntnu.no

1–2 July EMS Council Meeting, Torino (Italy)
Web site: www.math.ntnu.no/ems/council06/

3–7 July *Mathematics and its Applications*: First joint meeting of EMS, SIMAI, SMF, SMAI, and UMI, Torino (Italy)
Web site: www.dm.unito.it/convegniseminari/mathsandapps

9–16 July EMS Conference at CRM Barcelona (Catalunya, Spain) *Recent developments in the arithmetic of Shimura varieties and Arakelov geometry*
Web site: http://www.crm.es/svag, contact: svag@crm.es

22–30 August International Congress of Mathematicians in Madrid (Spain), Web site: www.icm2006.org/

2007

16–20 July ICIAM 2007, Zurich (Switzerland)
Web site: www.iciam07.ch/

2008

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

A complete list of future EMS summer schools can be found on page 11.

Editorial

David Salinger, Leeds (UK)

A Publicity Officer's Apology

When David Brannan asked me, back in 1999, whether I'd like to become EMS Publicity Officer, it didn't take long to make up my mind. A good excuse, I thought, for excellent meals in enjoyable company, for foreign travel, and to cover my expenses for the Beijing ICM. Now that I've finished my term of office, it's time to see how events have measured up to expectation.

I was wrong about the expenses, but more than right about everything else. The EMS is a youthful organisation and doesn't have enough money to do all the things it would like to do. But it more than makes up for that in the enthusiasm of those who try to make it work.

Talking and more talking: but then things happen

As publicity officer, I have attended executive committee meetings. The first, at the Banach Centre's country house at Będlewo, was among the most memorable: Polish hospitality has to be experienced to be believed. Then there was the last meeting of Rolf Jeltsch's presidency, on board the Stockholm-Helsinki ferry, in Helsinki harbour and finishing in the Mittag-Leffler Institute. Or the recent meeting in Capri, where we almost spilled out of the room into the courtyard, to be regularly interrupted by the buses as they changed gear as they climbed round a bend.

The meetings of the executive committee are businesslike. Very occasionally the argument gets heated: at Będlewo, I remember an argument about the founding of the Society which raised passions which spilled over into the next meeting of Council. Then there were the rules on awarding European prizes, which we felt had to be redrawn in the light of criticism at the Barcelona European Congress. But these are very much the exception: the Committee has problems to solve, agendas to move forward and not much time in which to do it.

I attended Council in Barcelona, Oslo and Uppsala. Always, at these gatherings, I am struck by how much agreement there is and how little real dissent (even if we could not agree a common position on the Bologna process). Besides electing officers and executive committee members, and approving (or not) rises in membership fees, Council receives reports from the Society's subcommittees. Members of Council can suggest new initiatives. One such was the establishing of a series of joint Mathematical Weekends with national mathematical societies. Three have now taken place: in Lisboa, Prague and Barcelona. Each has been highly successful and has brought the EMS closer to its members.

The Society has its uses

In my time with the EMS, its most visible achievement has been its Publishing House, now producing books and highly-regarded journals. Though successful in terms of what was planned, it is still a small venture in publishing terms, and it will be a while before it generates funds to support the Society's other activities.

The second big change has been the gaining of European Union funds to support the Society's Summer Schools, which has required recruiting an extra administrator for the programme, based, like our indefatigable secretary Tuulikki Mäkeläinen, in the Helsinki office. The Society is now more embedded in the policy-making of European Scientific, through its access to Commissioners, its support for the European Research Council and through its engagement with the European Science Foundation.

The *Journal of the European Mathematical Society* has established itself as a significant journal, figuring well up in the citation rankings.

There are some disappointments. It has not, in recent years, proved possible to organise the innovative Diderot forums (which linked three cities at a time in mathematical exposition), it has been difficult to elicit suggestions for the EMS lectures (most proposals have come from the Executive Committee), and it has not proved possible, so far, to get EU support for the digitization of mathematical literature.

And so, farewell!

One of the duties of the publicity officer is to make sure that the Society has a booth at the European and International Congresses. There we provide a meeting place for Executive Committee members, display the wares of the Publishing House, and distribute free copies of the Newsletter to encourage membership.

I am disappointed that individual membership remains stuck between 2200 and 2300. I joined the EMS when it was first formed, because it seemed important to support the European mathematical community. For me the EMS is part of 'building Europe'; not the formation of yet another nation state, but the creation of a new sort of hybrid whose very borders are unclear: witness our difficulty of defining 'European mathematician' for the European Prizes. Is a European mathematician a European citizen or someone principally working in Europe, or someone working elsewhere who was formed (as a mathematician) in Europe? Let's hope we can be flexible about these matters, just as we are in defining geographical Europe for membership purposes.

The Executive and Council of the EMS, whose workings I have been privileged to be part of, demonstrate the actuality of people from different national traditions coming together to find ways to support mathematics and mathematicians. It is fascinating to observe the different approaches and heartening to see how those differences are put aside in pursuit of a common goal.

May the EMS continue to thrive!

David Salinger has been Publicity Officer of the EMS since March 2000. He is currently Pro-Dean for Learning and Teaching in the Faculty of Mathematics and Physical Sciences at the University of Leeds.

Introducing the editorial team, part IV

Walter Purkert was introduced in the last issue without a photo. Here he is – and the Newsletter apologizes.

Themistocles M. Rassias is a professor of mathematics at the National Technical University, Athens, Greece. He received his PhD at the University of California at Berkeley in 1976 under the supervision of the Fields Medalist Stephen Smale. He has published more than 180 papers and 6 research books. In addition, he has edited 24 volumes on different research and educational subjects in mathematical analysis, global analysis, geometry, topology and various applications. His research has received more than 2000 citations. An example of Professor Rassias' contribution in the field of mathematical analysis is "Hyers-Ulam-Rassias stability", and in geometry the "Alexandrov-Rassias problem". He has lectured extensively at universities in Europe and North America. Eleven international journals count him as a member of their Editorial Board.

As an educator, he has been awarded teaching prizes such as "Teacher of the Year" (1985/86, 1986/87) and "Outstanding Faculty Member" (1989/90, 1990/91, 1991/92). He has been an active member of the New York Academy of Sciences since 1981 and has been "academico ordinario" of the Accademia Tiberina Roma since 1987. He was elected Fellow of the Royal Astronomical Society of London in 1991.

Themistocles Rassias is married to an Athenian journalist and has two children who are currently students at the University of Cambridge and the National Technical University at Athens.

Martin Raussen was born, raised and educated in Germany. He studied mathematics and computer science at the universities of Saarbrücken and Göttingen, where he obtained his PhD with a thesis on the edge of differential and algebraic topology. During his time as a graduate, he spent nine months in Paris, where he met his future Danish wife. Resulting from this liaison were a number of post-doctorate stays at two Danish universities and his present job as associate professor at Aalborg University in North Jutland, Denmark – 100 km south of the northern tip of the peninsula.

In the last few years, his research efforts have mainly centred on "Directed Algebraic Topology", a new field with motivation from certain models in concurrency theory in theoretical computer science. He teaches and supervises students from freshman to PhD-level. For several years, he was on the Editorial Board of the Danish Mathematical Society's Newsletter "Matilde". Since 2003, he has been editor-in-chief of the Newsletter of the European Mathematical Society.

His wife is also an associate professor at Aalborg University (with a newly-established branch in geography as her main area of responsibility). They have three daughters, aged between 16 and 21. In his spare time, Martin participates in an amateur choir at Aalborg.

Vladimír Souček has been a professor of mathematics at the Charles University in Prague (Czech Republic) since 1999. He obtained his PhD there in 1974 under the supervision of Professor Jindřich Nečas in mathematical analysis. His research interests are now concentrated on differential geometry and global analysis, particularly on properties of solutions of the Dirac equation, invariant differential operators on manifolds and applications of methods of representation theory.

He has had long stays at many mathematical institutions (including University Paris VII, Bologna University, Max-Planck-Institute for Mathematics in Bonn, Oxford University, University of Gent, MSRI at Berkeley and University of Adelaide). He was a member of the Scientific Advisory Board of the E. Schrödinger Institute for Mathematical Physics in Vienna for the period 1993–1996. Since 1980, he has devoted a lot of effort to the organization of a regular winter school: 'Geometry and Physics', trying to promote communication among mathematicians and physicists. He is married with two children and his hobbies include sports and music.

Robin Wilson is a professor of pure mathematics at the Open University (UK) and a part-time fellow in mathematics at Keble College, Oxford University. He studied mathematics at Oxford University and then went to the USA where he obtained his PhD in number theory from the University of Pennsylvania. Since then his main research areas have been graph theory (particularly graph colouring) and the history of mathematics (particularly British mathematics and the history of graph theory and combinatorics). He has written and edited many papers and about thirty books in these areas.

He is very involved with the popularisation of mathematics and enjoys the part-time position of Gresham Professor of Geometry, London (the oldest mathematical Chair in England, dating from 1597), where he gives lectures to the general public. He serves on the EMS Committee on Raising Public Awareness of Mathematics and was editor-in-chief of the EMS Newsletter from 1999-2003. He is currently an associate editor of the Newsletter.

Executive Committee Meeting in Barcelona, 18th and 19th September

David Salinger, Publicity Officer

The meeting took place immediately after the Mathematical Weekend, organised by the Catalan Mathematical Society, which was also our host. The Committee met on the first floor of the Institute of Catalan Studies, a historic building. Coffee and refreshments were taken on the balcony overlooking the central courtyard. The group photographs were taken in the adjoining roof garden.

Organisation

After the opening business, Olli Martio expounded the Society's finances, which were well inside the budget. However, the EU contract for Summer Schools had exposed potential cash-flow problems. In addition, demands on the Society's funds were increasing, both from its subcommittees and from the growing cost of the Newsletter.

Tuulikki Mäkeläinen would be retiring after the Council meeting in July 2006. Some thought had been given to finding a successor. (Tuulikki, the Society's Executive Secretary, has been the Society's greatest asset from the beginning: it is difficult to imagine the EMS without her.)

There had been no new corporate or institutional applications for membership and the number of individual members had fallen back to 2,200. These figures were disappointing and there was some discussion of what to do. Martin Raussen suggested we produce a list of reasons to join which could be distributed by the national societies. Maybe individual members should join via a web page, as well as through their national societies.

Meetings

Discussion of 5ecm in Amsterdam centred around suggestions for members of the Prize Committee, which was finalised, and of the Scientific Committee, to be confirmed at the next meeting of the Executive.

The Society would allocate money to support both the EMS-SMF-SMAI meeting in Nantes in June and the joint EMS Italian and French Societies' meeting in Torino in July.

Doina Cioranescu reported on the arrangements for the UMALCA meeting in Chile. It would be difficult to send a representative of the Society to Santiago.

Subcommittees

Mario Primicerio had accepted the chairmanship of the Committee on Applied Mathematics. A list of possible members had been suggested and further names were added.

Executive Committee and Guests at Institut d'Estudis Catalans

The Committee for Developing Countries reported that the generous support for the transport of books, which had come from ICTP, Trieste, had been suspended at short notice. It was decided to give 2000 to the Committee to plug the gap.

The Education Committee had met and had decided on a plan of action.

The Electronic Publications Committee continued to be active and was, inter alia, currently involved in the preparation of a satellite conference of the ICM. Two journals had been added to the electronic library.

The Raising Public Awareness Committee had submitted a proposal for a symposium "Discovering Mathematics" to the organisers of the Euroscience open forum in Munich. To the regret of the Executive Committee, this was apparently the only proposal in mathematics that had been submitted.

The Committee for Support of East European Mathematicians had received an increased number of applications and had allocated its budget. The Executive granted a small additional sum for 2005, but decided that a decision on the Committee's budget for 2006 would have to await the more thorough discussion of the Society's budget that would take place at the next Executive meeting, in preparation for Council.

Emilia Mezetti was resigning as chair of the Committee for Women and Mathematics and had approached a possible successor, whom the Executive endorsed.

Publications

The publishing house (EMSPH) was performing very successfully, with a steady production of books and journals. Besides *JEMS*, *Commentarii Mathematici Helvitici* and *Elemente der Mathematik* as well as *Rendiconti Lincei* and *Journal for Analysis and its Applications* were now with the publishing house. *Interfaces and Free Boundaries*, its first journal, was moving into profitability.

A joint booth with EMSPH at the Madrid ICM was approved. The Society would attempt to organise a round table, on communicating mathematical advances, as a special activity at the ICM.

A Scientific Users Committee had been formed for *Zentralblatt-MATH*, chaired by Jean-Pierre Bourguignon.

EU Matters

Luc Lemaire was congratulated on obtaining EU funding to support the new Summer School programme. The draft position paper on supporting mathematics research was discussed: comments had been received from a number of sources and it was important to send a clear message if the paper was to serve its purpose of influencing the next Framework programme.

Junior Mathematics Congresses

Some years ago, the Society had expressed support for junior maths congresses, but it had then dropped off the agenda. Ari Laptev spoke about the junior congress that had run in Stockholm at the time of 4ecm. It was agreed to contact the organisers.

Thanks

The Publicity Officer was thanked for his services to the Society. Marta Sanz-Solé and Carles Casacuberta were thanked for their hospitality and that of the Catalan Mathematical Society.

Meeting of the EMS Council Torino July 1 and 2, 2006

The EMS Council meets every second year. The next meeting will be held in Torino July 1 and 2, 2006, at the Torino conference centre, before the Joint EMS-SIMAI-SMF-SMAI-UMI meeting "Mathematics and its Applications" on 3–7 July, 2006. The Council meeting starts at 13:00 on July 1 and ends at noon on July 2.

Delegates to the Council will be elected by the following categories of members, as per the Statutes.

(a) Full Members

Full Members are national mathematical societies, which elect 1, 2 or 3 delegates according to their membership class. Each society is responsible for the election of its delegates. Each society should notify the Secretariat of the EMS in Helsinki of the names and addresses of its delegate(s) no later than 10th March 2006. As of 1st July 2005, there were 57 such societies – which could designate a maximum of 84 delegates.

(b) Institutional Members

Four delegates of the Institutional Members were elected for the period 2004-2007 and they are:
Jean-Pierre Bourguignon, IHES;
Manuel Castellet, CRM;
Stefan Müller, MPI, Leipzig;
Mina Teicher, ENI.
One more delegate is needed.
According to the Statutes, "delegates representing institutional members shall be elected by a ballot organized by the Executive Committee from a list of candidates who have been nominated and seconded, and have agreed to serve."

(c) Individual Members

A person becomes an individual member either through a corporate member, by paying an extra fee, or by direct membership. On 30th June 2005, there were 2241 individual members and, according to our statutes, these members will be represented by 23 delegates.

The present delegates of individual members are:

Anzellotti, Gabriele, 2004–2007
Berinde, Vasile, 2000–2003–2007
Conte, Alberto, 2000–2003–2007
Coti Zelati, Vittorio, 2004–2007
Guillopé, Laurent, 2000–2003–2007
Higgs, Russell, 2004–2007
Marchisio, Marina R., 1998–2001–2005
Margolis, Stuart W., 2004–2007
Milman, Vitali, 1998–2001–2005
Pelczar, Andrzej, 2000–2003–2007
Sodin, Mikhail, 2004–2007
Soifer, Gregory, 2004–2007
Tronel, Gérard, 2000–2003–2007
Wilson, Robin, 2002–2005
Xambo-Descamps, Sebastian, 2002–2005

The mandates of 4 of the present 15 delegates end on 31st December 2005, and so elections must be held for their positions. They are: M.R. Marchisio, V. Milman, R. Wilson and S. Xambo-Descamps.
The first-mentioned two cannot be re-elected because they have served in this capacity for 8 years.

The remaining 11 delegates were elected for the term 2004–2007, so they will continue unless they inform the Secretariat to the contrary by 31st December 2005. A nomination form for delegates is enclosed on page 8.

The Executive Committee is responsible for preparing the matters to be discussed at Council meetings. Items for the agenda of this meeting of the Council should be sent as soon as possible – and no later than 10th March 2006 – to the Secretariat of EMS in Helsinki.

The Council is responsible for electing the President, Vice-Presidents, Secretary, Treasurer and other members of the Executive Committee. The present membership of the Executive Committee, together with their individual terms of office, is as follows:

President:
Sir John Kingman (2003–2006)

Vice-Presidents:
Professor L. Lemaire (1999–2002–2006),
Professor P. Exner (2004–2007)

Secretary:
Professor H. Holden (2003–2006)

Treasurer:
Professor O. Martio (1999–2002–2006)

Members
Professor V. Buchstaber (2001–2004–2008)
Professor D. Cioranescu (1999–2002–2006)
Professor O. Gil-Medrano (2005–2008)
Professor C. Sbordone (2005–2008)
Professor K. Schmidt (2005–2008)

Under Article 7 of the Statutes, members of the Executive Committee shall be elected for a period of 4 years. The President can only serve one term. Committee members

may be re-elected, provided that consecutive service shall not exceed 8 years. D. Cioranescu has served on the Executive Committee for 8 years, so she cannot be re-elected. H. Holden does not wish to continue as Secretary.

It would be convenient if potential nominations for office in the Executive Committee, duly signed and seconded, could reach the Secretariat by 10th March 2006. It is strongly recommended that a statement of intention or policy is enclosed with each nomination. If the nomination comes from the floor during the Council meeting there must be a written declaration of the willingness of the person to serve, or his/her oral statement must be secured by the chair of the Nominating Committee (if there is such) or by the President. It is recommended that statements of policy of the candidates nominated from the floor should be available.

The Council may, at its meeting, add to the nominations received and set up a Nominations Committee, disjoint from the Executive Committee, to consider all candidates. After hearing the report by the Chair of the Nominations Committee (if one has been set up), the Council will proceed to the elections to the Executive Committee posts.

Material on the Council can be found at www.math.ntnu.no/ems/council06.

Elections to the Executive Committee: Nominations

At the end of 2006 there will be vacancies for positions of President, Treasurer, Secretary, and one Vice-President, as well as of an ordinary member of the Executive Committee. At its meeting in Barcelona, the Executive Committee decided to make nominations to all the officer positions, in order to ensure the continued smooth running of the Society. However it has decided not to make a nomination for the remaining position of 'member-at large' on the Executive Committee.

Other nominations may come forward for the officers of the Society, in which case Council will decide by ballot who will fill those posts. But the position of member-at-large will not be filled unless nominations are received. Any member of the Society may be nominated according to the procedures detailed above.

Nomination Form for Council Delegate

NAME: .....

TITLE: .....

ADDRESS: .....

.....

PROPOSER: .....

SECONDER: .....

I certify that I am an individual member of the EMS and that I am willing to stand for election as a delegate of individual members to the Council.

SIGNATURE OF CANDIDATE: .....

DATE: .....

Completed forms should be sent to:
Ms T. Mäkeläinen
EMS Secretariat
Department of Mathematics
P.O. Box 4
FI-00014 University of Helsinki
Finland

to arrive by 1 March 2006.

A photocopy of this form is acceptable.

Mathematics and Its Applications

A Joint Meeting of

Società Italiana di Matematica Applicata e Industriale
Société de Mathématique Appliquée et Industrielle
Société Mathématique de France
Unione Matematica Italiana

Under the Auspices of the European Mathematical Society,
Torino, Italy, July 3–7, 2006

Centro Congressi Unione Industriale Torino
Dipartimento di Matematica del Politecnico di Torino
Dipartimento di Matematica dell'Università degli Studi di Torino

With the support of the Politecnico di Torino,
Università degli Studi di Torino and the Istituto Nazionale di Alta Matematica "F. Severi"

through its national groups: GNAMPA, GNCS, GNSAGA, GNFM

The programme will consist of fourteen general conferences and several special sessions

Plenary speakers

The names will be announced shortly

Scientific Committee

M. Anile, Y. Brenier, G. Buttazzo, C. Canuto, V. Capasso, A. Conte, D. Cioranescu, A. Fasano, S. Gallot, H. Holden, M. Ledoux, N. Lerner, S. Meleard, A. Murli, V. Perrier, C. Sbordone, P. Schapira, N. Touzi

Organizers

C. Canuto, A. Conte, M. Marchisio, P. Tilli

In cooperation with

Accademia delle Scienze di Torino, Città di Torino, Provincia di Torino, Regione Piemonte, Compagnia di SanPaolo, Fondazione CRT, MIUR, Università Italo-Francese

For further information: http://www.dm.unito.it/convegniseminari/mathsandapps/

The aims of the joint meeting are to improve scientific cooperation between individuals and groups of researchers in all fields of mathematics from France, Italy and other European Countries, and to encourage the development of applications of mathematics. The cooperation among French and Italian Schools has an excellent tradition that goes back to the beginning of 19th century. We chose an inspiring personality for the meeting: Joseph-Louis Lagrange, who was born in Torino where he lived for thirty years and founded the Academy of Sciences before spending twenty years in Berlin at the Prussian Academy and finally moving to Paris, in whose Pantheon he is buried, side-by-side with many others prominent French mathematicians and scientists.

There will be fourteen plenary addresses and more than twenty special sessions co-organized by members of the four societies, who will invite a mix of speakers from the two countries. The Scientific Committee will organize some of the sessions but proposals to organize a special session should be submitted to Prof. Carlo Sbordone, the President of UMI (sbordone@unina.it), who, together with Prof. Y. Brenier, will transmit them to the Scientific Committee, not later than January 31st 2006. Every session will last one day from 9am to 6:30pm. The organizers of the special sessions will have to take care of the related expenses. The plenary addresses will take place in the Centro Congressi of Unione Industriale Torino, while the sessions will take place in the mathematics departments of the University of Torino and the Politecnico of Torino.

The Meeting will start on Monday 3rd at 9am and will end on Friday 7th at 1pm.

The first deadline for registration (both for participants, organizers and speakers of the special sessions) is April 30th, 2006.

Facilities will be provided for a number of young participants.

On July 1st and 2nd 2006, prior to the beginning of the joint meeting, the Council of the European Mathematical Society will meet at the Centro Congressi of Unione Industriale Torino (cf. page 7–8).

EMS Summer Schools and Conferences in pure and applied mathematics – Second series

Luc Lemaire, Université Libre de Bruxelles

The EMS is happy to announce that its second series of Summer Schools and Conferences in pure and applied Mathematics has been favourably evaluated by the European Commission. Subject to successful contract negotiation, it will thus be funded as a series of Marie Curie Conferences and Training Courses.

This means in particular that support for travel and living expenses should be available for a substantial number of participants in three categories of eligible researchers:

1) Early stage researchers with up to four years research experience, computed as full-time years of research work after completion of the diploma giving access to a PhD programme. These researchers could be of any nationality. Typically, PhD students would be in this category.
2) Experienced researchers with up to ten years of research experience. Again, these researchers could be of any nationality.
3) Experienced researchers with more than ten years of experience who are nationals of Member States or Associated States and active in research outside these states at the time of the event.

To keep the events inside the European perspective, the organisers will have to insure that at least seventy percent of the participants are nationals of Member States or Associated States and that no nationality is represented by more than thirty percent of the participants.

To clarify the definitions, the Member States are members of the European Union and the Associated States are Bulgaria, Iceland, Israel, Liechtenstein, Norway, Romania, Switzerland and Turkey.

Researchers interested in participation and/or funding for any of these events should contact the organisers mentioned in the list below directly.

With this series of events, built up after an open call for

proposals, the European Mathematical Society has further strengthened its collaboration with the European Regional Committee of the Bernoulli Society, the Centre de Recerca Matematica (CRM) of Barcelona, the Scuola Matematica Interuniversitaria (SMI) of Firenze, the Mathematical Research and Conference Center in Będlewo (Poland) and various groups of mathematicians working in European universities and research centres.

List of the EMS Summer Schools and Conferences

1) **GAEL-Géométrie algébrique en liberté, Special varieties**,
EMS Summer School at Będlewo (Poland),
2006 March 5–11, Main speakers: Frédéric Campana, Claire Voisin, Brendan Hassett.
Website: http://euclid.mathematik.uni-kl.de/~gael,
contact: Andreas.Hoering@ujf-grenoble.fr

2) **Mathematical model of the heart,**
EMS Summer School at the SIMULA laboratory, Longyearbyen (Norway), 2006, May 6–13
Main speakers: Glenn Terje Lines, Piero Colli Franzone, Alexander Panfilov, Joakim Sundnes, Andrew McCulloch, Olaf Dössel, Hans Petter Langtangen.
Website: http://home.simula.no/ems2006/,
contact: sundnes@simula.no

3) **Combinatorics, automata and number theory**,
EMS Summer School at the University of Liège (Belgium), 2006, May 7–20
Main speakers: Boris Solomyak, Juhani Karhumaki, Jacques Sakarovitch, Jeffrey Shallit, Wolfgang Thomas, Jean-Paul Allouche, Yann Bugeaud, Fabien Durand, Peter Grabner, Helmut Prodinger.
Website: http://www.cant2006.ulg.ac.be,
contact: M.Rigo@ulg.ac.be

4) **Arithmetic and geometry around quantisation**,
EMS Summer School at the Galatasaray University in Istanbul (Turkey), 2006, June 4–15
Main speakers: S. Akbulut, D. Bar-Natan, R. Bezrukavnikov, T. Dereli, K. Fukaya, D. Gaitsgory, E. Getzler, S. Gurevich, R. Hadani, A. Klyachko, Yu. I. Manin, M. Marcolli, M. Polyak.
Website: http://guests.mpim-bonn.mpg.de/agaq,
contact: agaq@mpim-bonn.mpg.de

5) **Horizon of combinatorics**,
EMS Summer School at the Renyi Institute in Budapest (Hungary) 2006, July 9–22
Main speakers: S. Shelah, P. Seymour, T. Gowers, R. Graham, J. Spencer, J. Nesetril, A. Schrijver, C. Thomassen, V. Rodl, B. Bollobas, N. Alon, T. Luczak, B. Reed, P. Frankl, Z. Furedi, I. Barany, G.Tardos, Vu Ha Van, G. Kalai, N. Linial.
Contact: ervin@renyi.hu or veve@renyi.hu

6) **Recent developments in the arithmetic of Shimura varieties and Arakelov geometry**,
EMS Conference at CRM Barcelona (Spain),
2006, July 9–16

Main speakers: Ahmed Abbes, Pascal Boyer, Jan H. Bruinier, Laurent Clozel, Henri Darmon, Jürg Kramer, Elena Mantovan, Sophie Morel, Bao Chau Ngo, Michael Rapoport, Damian Roessler, Christophe Soulé.
Website: http://www.crm.es/svag, contact: svag@crm.es

7) **A geometric approach to free boundary problems**,
EMS-SMI Cortona Summer School (Italy),
2006, July 10–31
Main speakers: Luis Caffarelli and S. Salsa.
Contact: dipartimento@matapp.unimib.it

8) **Mathematics in molecular cell biology,**
EMS Summer School at Linz (Austria),
2006, September 10–23
Main speakers: Willi Jäger, Hans Othmer, Alex Mogilner, Wolfgang Nonner and Christof Schütte.
Website: http://www.ricam.oeaw.ac.at/emsschool,
contact: Vincenzo.Capasso@mat.unimi.it or christian.schmeiser@oeaw.ac.at

9) **SEM STAT: Statistics for stochastic differential equations models**,
EMS Summer School – Séminaire Européen de Statistique at La Manga (Cartagena, Spain),
2007, May 6–12
Main speakers: to be announced,
Contact: mathieu.kessler@upct.es or lindner@ma.tum.de

10) **Geometric analysis and nonlinear partial differential equations**,
EMS Conference at Będlewo (Poland),
2007, June 17–24
Main speakers (tentative): J. Ball, B. Dacorogna, S. Mueller, V. Sverak, S. Hildebrandt, F. Duzaar, J. Manfredi, P. Hajlasz, M. Gromov, P. Koskela, K. Astala, C. Sbordone, T. Riviere, N. Garofalo, J. Kinnunen, N. Fusco, M. Struwe, N. Trudinger, N. Uraltseva, S. Pohozhaev, J. Heinonen.
Contact: B.Bojarski@impan.gov.pl or pawelst@mimuw.edu.pl

11) **Mathematical and numerical methods for the cardiovascular system**,
EMS-SMI Cortona Summer School (Italy),
2008, August 16–31
Main speakers: Dominique Chapelle, Piero Colli-Franzone, Alfio Quarteroni.
Contact: dipartimento@matapp.unimib.it

Textbooks Recommended for Course Adoption

Curves and Surfaces

Sebastián Montiel and **Antonio Ros**, *Universidad de Granada, Spain*

This introductory textbook puts forth a clear and focused point of view on the differential geometry of curves and surfaces, emphasizing the global aspects. The excellent collection of examples and exercises will help students learn the material. Advanced undergraduates and graduate students will find this a nice entry point to differential geometry.

This book is jointly published by the AMS and the Real Sociedad Matemática Española (RSME).

Graduate Studies in Mathematics, Volume 69; 2005; 376 pages; Hardcover; ISBN 0-8218-3815-6; List US$59; All AMS members US$47; Order code GSM/69

Elementary Algebraic Geometry

Klaus Hulek, *Universität Hannover, Germany*

A genuine introduction to algebraic geometry; exercises are well-chosen; contains numerous examples to illustrate and motivate the theory.

Student Mathematical Library, Volume 20; 2003; 213 pages; Softcover; ISBN 0-8218-2952-1; List US$35; All AMS members US$28; Order code STML/20

The Knot Book

An Elementary Introduction to the Mathematical Theory of Knots

Colin C. Adams, *Williams College, Williamstown, MA*

A compelling book that will comfortably escort students into the marvelous world of knot theory; lots of exercises; amazingly understandable.

2004; 307 pages; Softcover; ISBN 0-8218-3678-1; List US$29; All AMS members US$23; Order code KNOT

Probability Theory in Finance

A Mathematical Guide to the Black-Scholes Formula

Seán Dineen, *University College Dublin, Ireland*

Introduces advanced undergraduates and beginning graduate students studying the mathematics of finance to the Black-Scholes formula.

Graduate Studies in Mathematics, Volume 70; 2005; 294 pages; Hardcover; ISBN 0-8218-3951-9; List US$55; All AMS members US$44; Order code GSM/70

Probability Theory

S. R. S. Varadhan, *New York University - Courant Institute of Mathematical Sciences, NY*

S. R. S. Varadhan is recognized as a top expert in probability theory. This volume presents topics in probability theory covered during a first-year graduate course given by Varadhan at the Courant Institute of Mathematical Sciences. The necessary background material in measure theory is developed, including the standard topics, such as extension theorem, construction of measures, integration, product spaces, Radon-Nikodym theorem, and conditional expectation.

Titles in this series are copublished with the Courant Institute of Mathematical Sciences at New York University.

Courant Lecture Notes, Volume 7; 2001; 167 pages; Softcover; ISBN 0-8218-2852-5; List US$24; All AMS members US$19; Order code CLN/7

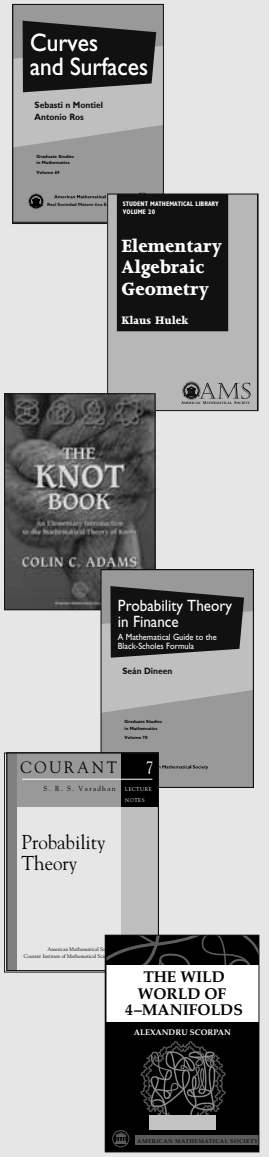
The Wild World of 4-Manifolds

Alexandru Scorpan, *University of Florida, Gainesville, FL*

Gives an excellent overview of 4-manifolds; many figures and historical notes; graduate students, nonexperts, and experts alike will enjoy browsing through it.

2005; 609 pages; Hardcover; ISBN 0-8218-3749-4; List US$69; All AMS members US$55; Order code FOURMAN

COURSE ADOPTION



Members of mathematical societies around the world can become Reciprocity Members of the AMS at discount rates! Learn more at www.ams.org/membership.

1-800-321-4AMS (4267), in the U. S. and Canada, or 1-401-455-4000 (worldwide); fax: 1-401-455-4046; email: cust-serv@ams.org. American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294 USA

AMS BOOKSTORE

For many more publications of interest, visit the AMS Bookstore

www.ams.org/bookstore

AMS AMERICAN MATHEMATICAL SOCIETY

The Erasmus Mundus Master ALGANT

Boas Erez (Bordeaux, France)

A study track in Algebra, Geometry and Number Theory for all students open to moving around Europe.

As a student during the early eighties, I was quite surprised when one of our teachers told us that a career in mathematics allows one to travel. But he was right! And meeting remote colleagues to exchange ideas is of course one of the most exciting and enriching parts of a mathematician's professional life. Since those days, student mobility in Europe has greatly increased; for instance, over one million students have now profited from the Erasmus programme.

Stimulated by the European Commission's launch of the Erasmus Mundus Master (EMM) programme at the end of 2003, we started working within our research community to design a two-year study track built upon the Masters programmes in mathematics offered by the universities in Bordeaux, Leiden, Padova and, subsequently, Paris. The track, christened ALGANT for Algebra, Geometry and Number Theory, leads students through at least two of the partner universities in different countries, and the integrated study programme leads to a multiple degree. With the track, we developed the necessary measures to accompany the students' mobility: tutoring, housing, language training, joint administrative management, etc. The programme is completed with joint activities and special courses taught by invited scholars from around the world.[1]

The track thus defined has been selected as one of the EMM in 2004. So far, 57 EMM have been selected and ours is the only one in pure mathematics.[2] This recognition allows us to offer some 25 two-year scholarships every year to students from countries not in the European Union. Each scholarship amounts to 21,000 a year. This amount helps in attracting very good students, who we hope to see pursuing their studies at the doctorate level in Europe. This year 21 students from 13 countries outside of the European Union are enrolled with us. Of course all European students open to moving around are also invited to follow the ALGANT track. Indeed, we are in a position to offer mobility scholarships to these students too and 7 European students are enrolled this year. We are confident that in the future more students will take advantage of our programme, which offers a unique opportunity to work towards a research activity in an exciting subject and in a truly international environment. **The deadline for applications for enrolment in the year 2006–2007 is January 31st, 2006**.

[1] See http://www.math.u-bordeaux1.fr/ALGANT for a description of the programme.

[2] See http://europa.eu.int/comm/education/programmes/mundus/index_en.html

Boas Erez [erez@math.u-bordeaux1.fr.] obtained his doctorate at Université de Genève in 1987 and held a position at Harvard University before moving to Bordeaux in 1993. His research is currently in arithmetic algebraic geometry.

All ALGANT students met in Bordeaux for a week at the end of October to follow a series of intensive courses.

International Congress of Mathematicians Madrid, Spain – August 22nd–30th, 2006

www.icm2006.org

Second Announcement

The Organising Committee of the next International Congress of Mathematicians is pleased to send, also on behalf of the International Mathematical Union, an open invitation to attend the Congress in Madrid, Spain, from August 22nd to 30th, 2006.

The International Congress of Mathematicians (ICM) is the most important mathematical meeting in the world. It has taken place every four years since 1897. The Spanish mathematical community is proud to host the Congress for the first time in its history. As on previous occasions, the ICM 2006 will be a major scientific event, bringing together mathematicians from all over the globe and demonstrating the vital role that mathematics plays in science and society.

This announcement contains information about the Congress including the list of plenary speakers and instructions for registration and submission of abstracts.

Location of the Congress

The Congress will be held in the Palacio Municipal de Congresos, Campo de las Naciones, Madrid, Spain. This convention centre is located in the north-eastern area of Madrid and is well serviced by public transport, fifteen minutes from Paseo de la Castellana, five minutes from Barajas International Airport and ten minutes from the Chamartín railway station.

Secretariat

ICM 2006 Secretary General, Facultad de Matemáticas, despacho 524, Universidad Complutense de Madrid, Plaza de las Ciencias, 3, Ciudad Universitaria, 28040 Madrid, Spain. Phone: +34 913 944 381; fax: +34 913 944 383; e-mail: secretariaicm2006@mat.ucm.es.

ICM 2006 Technical Secretariat and Travel Agent, UNICONGRESS, Bárbara de Braganza, 12 – 3º D, 28004 Madrid, Spain. Phone: +34 913 104 376; fax: +34 913 195 746; e-mail: icm2006@unicongress.com.

Important Dates

2006	
January 1	Deadline for grant applications
January 1	Opening of registration
January 1	Call for submission of abstracts of short communications, posters and mathematical software contributions
March 30	Deadline for submission of abstracts of short communications, posters and mathematical software contributions
May 15	Deadline for registration at a reduced rate
May 30	Deadline for notification to authors of acceptance or rejection of contributions
August 19–20	General IMU Assembly in Santiago de Compostela
August 21	Registration from 9 am to 8 pm

Scientific Programme

Plenary Lectures

On the recommendation of the Programme Committee appointed by the International Mathematical Union, the Organising Committee of the ICM 2006 has invited 20 outstanding mathematicians to give one-hour plenary lectures. All of them have accepted. Their names and affiliations follow.

Percy Deift, Courant Institute of Mathematical Sciences, New York University, New York, USA
Jean-Pierre Demailly, Université Joseph Fourier, Grenoble, France
Ronald DeVore, University of South Carolina, Columbia, USA
Yakov Eliashberg, Stanford University, Stanford, USA
Étienne Ghys, École Normale Supérieure de Lyon, Lyon, France
Richard Hamilton, Columbia University, New York, USA

Henryk Iwaniec, Rutgers University, Piscataway, USA
Iain Johnstone, Stanford University, Stanford, USA
Kazuya Kato, Kyoto University, Kyoto, Japan
Robert V. Kohn, Courant Institute of Mathematical Sciences, New York University, New York, USA
Ib Madsen, Aarhus University, Aarhus, Denmark
Arkadi Nemirovski, Technion – Israel Institute of Technology, Haifa, Israel
Sorin Popa, University of California, Los Angeles, USA
Alfio Quarteroni, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland
Oded Schramm, Microsoft Corporation, Redmond, USA
Richard P. Stanley, Massachusetts Institute of Technology, Cambridge, USA
Terence Tao, University of California, Los Angeles, USA
Juan Luis Vázquez, Universidad Autónoma de Madrid, Madrid, Spain
Michèle Vergne, École Polytechnique, Palaiseau, France
Avi Wigderson, Institute for Advanced Study, Princeton, USA

Invited Section Lectures

Also on the recommendation of the Programme Committee, 169 lectures of 45 minutes have been scheduled in specific scientific sections. These lectures are intended to be surveys of significant topics in these areas of research. The list of sections follows. Numbers in parentheses indicate the number of lectures scheduled in the corresponding section. Names of speakers are at the Congress website.

1 Logic and Foundations (5)
2 Algebra (7)
3 Number Theory (10)
4 Algebraic and Complex Geometry (9)
5 Geometry (13)
6 Topology (8)
7 Lie Groups and Lie Algebras (12)
8 Analysis (8)
9 Operator Algebras and Functional Analysis (6)
10 Ordinary Differential Equations and Dynamical Systems (11)
11 Partial Differential Equations (11)
12 Mathematical Physics (11)
13 Probability and Statistics (13)
14 Combinatorics (9)
15 Mathematical Aspects of Computer Science (7)
16 Numerical Analysis and Scientific Computing (7)
17 Control Theory and Optimisation (7)
18 Applications of Mathematics in the Sciences (9)
19 Mathematics Education and Popularisation of Mathematics (3)
20 History of Mathematics (3)

The above figures include three joint lectures in Sections 2, 3 and 6. In addition, there will be three panel discussions on hot educational issues in Section 19.

Short Communications, Posters and Mathematical Software

Registered participants will have the opportunity to present their mathematical work in the form of short communications, posters, or contributions on mathematical software. Only one of these three possibilities will be allowed for each participant. Proposals for presentations in one of the scientific sections of the Congress will be considered by the Local Programme Committee, provided that the proposers have registered by March 30, 2006 and indicated on the registration form that they wish to present their work.

Short communications are oral presentations of mathematical work. Sessions will be organised according to the scientific sections of the ICM 2006. Each communication should last up to 20 minutes, including discussion. Rooms for short communications will be equipped with an overhead projector.

The Local Programme Committee strongly recommends scientific contributions in the form of posters and encourages participation in the poster competition (see details below). Poster sessions provide a pleasant interaction between colleagues, offering the possibility of discussion in an informal and relaxed atmosphere.

The main purpose of the sessions on mathematical software is to give an overview of the state of the art, highlighting the current research and its main developments. They are aimed at attracting a broad audience including researchers, students and teachers, with a particular focus on software topics. Sessions will be devoted to presenting mathematical software systems or mathematical applications, either of general scope or focused on particular areas. Implementations of especially designed algorithms solving particular mathematical problems of research interest are also welcome. Contributions should meet the highest standards. Mathematical originality, new solutions to relevant problems, or unusual fields of application will be appreciated. Within this framework, submissions from any mathematical field using software systems will be considered; for instance, numerical analysis, computer algebra, optimisation, mathematical visualisation, mathematical education software, etc. Systems that are available free of charge (e.g. public domain) are particularly welcome and clearly preferred. It should be emphasised that this is a scientific section of the Congress with no commercial aim. Established companies in software systems can offer their products in booths designed especially for commercial exhibitors. Each contribution should last up to 25 minutes, including discussion. The rooms for contributions on mathematical software will be equipped with a video projector and a computer. It is the responsibility of contributors to obtain any required permission and license for material contained in their presentations.

Instructions for Submission of Abstracts

Submission of abstracts for short communications, posters and mathematical software will start on January 1, 2006. Abstracts submitted after March 30 will not be considered. The Local Programme Committee will notify authors of

the acceptance or rejection of their contribution before May 30.

Abstracts of short communications should be written in English using the LaTeX template available on the Congress website. Authors should submit both a LaTeX file and a PDF file. The text of each abstract should contain a clear statement of the results and their context (between 150 and 250 words), and optionally references (no more than five).

Abstracts of accepted communications will be published in the abstract booklet of the ICM 2006.

Poster Competition

The ICM 2006 Local Programme Committee is keen to encourage the presentation of posters during the Congress with the purpose of attracting a large number and wide range of participants. In order to encourage the presentation of posters, competitions in each of the 20 scientific sections of the ICM 2006 will be organised. First and second prizes of 200 and 100 euros, respectively, will be awarded in each section. A diploma will be awarded with each prize.

Rules and Procedure

1 Author(s) of posters must state whether they intend to take part in the competition on submitting their abstracts for inclusion on the Congress website. This statement of intention must be followed up by sending the electronic version of the poster in question before June 30, 2006.
2 The Local Programme Committee will be the jury presiding over the competition.
3 Only those posters accepted for presentation, and whose authors have stated their intention to participate in the competition, will be considered eligible by the jury.
4 The jury will base its decisions on the following criteria:
   a) Visual attractiveness and originality of the presentation.
   b) Clarity of exposition of scientific data.
   c) Quality of mathematical content and suitability of presentation in this form.
5 A list of the prize winners in each section will be made public during the Congress. Diplomas will be awarded in a ceremony. Further details will be announced in due time.
6 The jury reserves the right to declare prizes vacant.

Special Activities

This section gathers other scientific activities mostly promoted or organised by the Local Programme Committee. By October 2005, the following were already scheduled:

- A lecture on the Poincaré Conjecture for a general audience, by John Morgan, Columbia University, New York, USA.
- The ICM 2006 Emmy Noether Lecture, by Yvonne Choquet-Bruhat, Université Pierre et Marie Curie, Paris, France.
- A panel on e-Learning Mathematics, organised by the Spanish Conference of Deans of Mathematics.
- A closing round table, entitled *Are pure and applied mathematics drifting apart?*

Proceedings

Proceedings of the ICM 2006 will be published by the European Mathematical Society Publishing House. The Proceedings will consist of three volumes containing articles based on the plenary lectures and invited section lectures, as well as articles based on the lectures delivered by the recipients of the Fields Medal and the Nevanlinna and Gauss Prizes. The first volume will also contain the speeches of the opening and closing ceremonies and a set of pictures of speakers and participants capturing highlights of the Congress.

Two volumes of the Proceedings will be handed to the participants upon registration at the Congress venue. The third volume will be sent by post mail to the participants within three months. It is the purpose of ICM 2006 to make the scientific content of the Congress as widely available as possible by using all modern communication resources together with the Proceedings books.

Social Programme

Opening Reception

On August 22, an opening reception will be offered to participants in the Palacio Municipal de Congresos immediately after the opening ceremony of the Congress. It will be sponsored by the Madrid City Hall and hence free for Congress participants and registered accompanying persons. Prior registration for the opening ceremony is compulsory.

Dinner Party

On the evening of August 28, a dinner party will be organised for Congress participants and registered accompanying persons in the Botanical Garden of the Universidad Complutense de Madrid. The cost will be advised in due course.

Tourist Programme

Madrid and Spain offer many excellent possibilities for cultural activities and entertainment. See the Congress website for details on the tourist programme around the ICM 2006.

Travel

Madrid can be reached by air, train, bus or car. Detailed information to help preparation of travel arrangements appears on the Congress website.

IBERIA is the official carrier. Tickets are available for domestic flights, European flights and international flights with a 30% discount on business, tourist and excursion fares, subject to route flown and availability. This offer is only valid for return tickets in flights from IBERIA or Air Nostrum. To benefit from this offer, reserva-

Palacio de Congresos

tions and arrangements must be made either at ATLANTA VIAJES (phone: +34 913 104 348; fax: +34 913 195 322; e-mail: madrid@atlantaviajes.es) or at any IBERIA office. Registration to the Congress is required in order to benefit from these discounts.

Registration

Registration is required in order to be admitted to the venue and for participation in the scientific program of the Congress and other ICM 2006 activities.

- **Full registration** includes conference materials, the proceedings of the Congress, free coffee during coffee breaks, a public transport ticket valid for the duration of the Congress, and admittance to the opening ceremony.
- **Students** who have not completed their PhD have the option of registering at a reduced student rate on presentation of an official student certificate from their university. Student registration does not include the proceedings of the Congress.
- **Registration for accompanying persons** includes a badge, a public transport ticket valid for the duration of the Congress, and admittance to the opening ceremony.

Registration forms will be available on the Congress website from January 1, 2006. Online submission of the registration form is encouraged. It will also be possible to retrieve a PDF file from the Congress website and submit it by fax or post. All registrations must be submitted on official registration forms. Please use a separate form for each participant.

Please use only one method for submission of your registration. Otherwise, multiple registrations may occur and such registrations may even be rejected by the operational system. Telephone requests cannot be accepted. The registration will be considered as binding when it is received by UNICONGRESS and payment of the total fees has been received.

Participants wishing to reserve hotel accommodation or tickets for the tourist program must be registered. All registrations processed on or after August 16, 2006 will be delivered on the on-site registration desk. The following credit cards will be accepted for on-site registration: VISA, Eurocard, Mastercard, American Express and Diner's Club.

Opening Ceremony

Prior registration for the opening ceremony is compulsory. The ceremony will be held in Auditorium A. Extra seats will be available in Auditorium B and Polivalente Hall, receiving audio and video from Auditorium A. Placement will be assigned by the Secretariat on receipt of the registration form. In order to attend the opening ceremony, participants must have completed the registration process at the registration counter located at the Palacio Municipal de Congresos, on August 21 or up to 60 minutes before the opening ceremony on August 22. Tickets indicating the room assigned to each participant will be inside the Congress documentation.

Registration Fees

	until may 15	may 16 to aug. 15	from aug. 16[2]
Full registration	260	300	350
Student[1]	120	170	210
Accompanying person	80	100	120

[1] Registration as a student requires the attachment of an official certificate from a university.

[2] From August 16, 2006, all registrations will be considered on-site registrations at the applicable on-site fee.

Methods of Payment

All payments must be in euros and made payable to ICM 2006. No confirmation will be sent until the Congress Technical Secretariat has received the full payment. Remember to state the participant's name and "ICM 2006" on all payments!

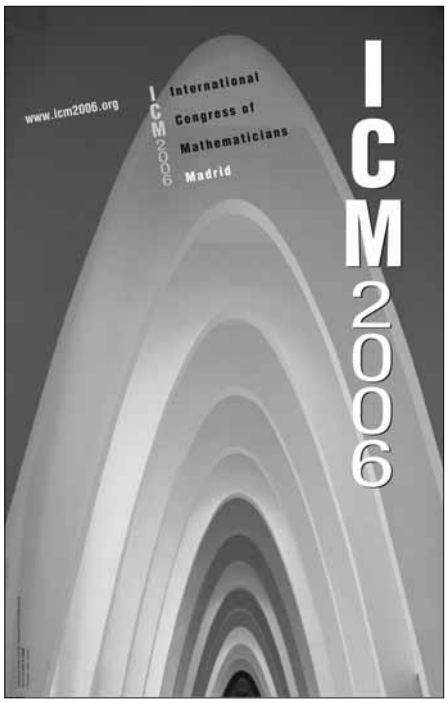
Payment must be remitted as follows:

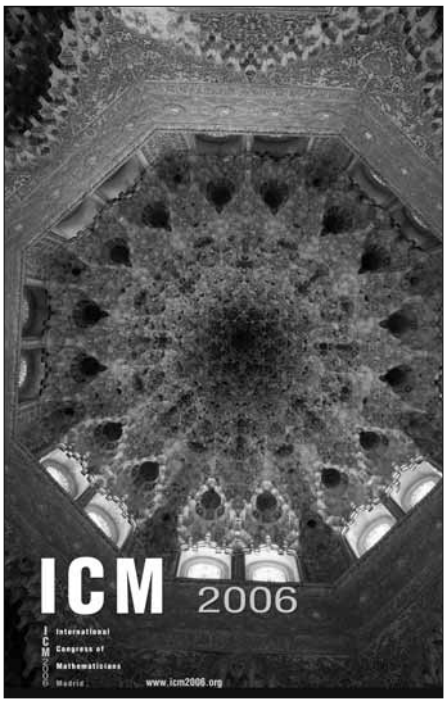
- On-line registration can be paid only by credit card.
- Fax or mail registration can be paid by bank transfer or credit card.
- On-site registration (processed on or after August 16, 2006) can be paid only by credit card or in cash.

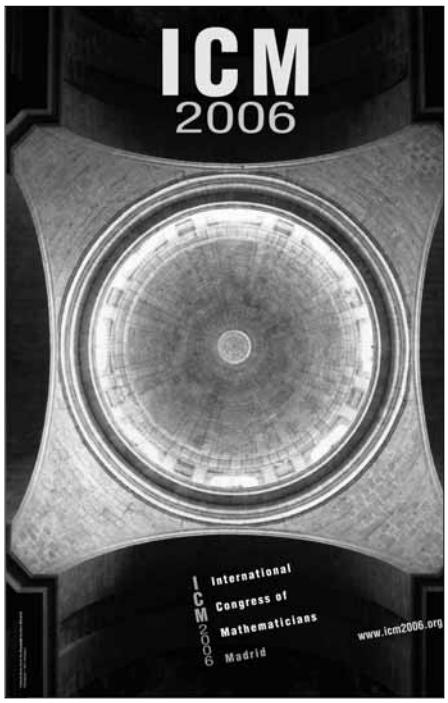
Any bank charges which might be incurred must be met by participants themselves and if still outstanding they will be charged upon registration at the registration counter in Madrid.

Cancellations

A handling fee of 30 € will be charged for any changes in registration. Any change of name will be dealt with as a cancellation and new registration. All cancellations must







be sent to UNICONGRESS in writing (fax, letter or e-mail). In case of cancellations before June 30, 2006, deposits will be refunded less 30 € for administrative costs. No refund will be made for cancellations received after June 30, 2006 or for registered participants who fail to attend the Congress.

Accommodation

UNICONGRESS has reserved a number of rooms at different hotels in three main areas of Madrid, most of them conveniently located on the main transport routes and accessible by subway.

Accommodation forms will be available on the Congress website from January 1, 2006. Online submission of the accommodation form is encouraged. It will also be possible to retrieve a PDF file from the Congress website and submit it by fax or post.

Only prepaid reservations will be processed. Full payment covering the entire stay is required to guarantee the booking. On-line requests can be paid only by credit card. Fax or mail requests can be paid by credit card or bank transfer.

Requests for hotel accommodation received after July 15, 2006 cannot be guaranteed.

Reservations are made on a first-come-first-served basis. Availability of rooms in each category is limited. Names of persons sharing rooms should be stated.

Financial Support to Participants

The International Mathematical Union and the Executive Committee of the ICM 2006 are making efforts to obtain financial support to enable as many mathematicians as possible from developing and economically disadvantaged countries to participate at the ICM 2006. Applicants need not necessarily be from IMU member countries.

The IMU and the Organising Committee have established five different support categories:

1 Young mathematicians from developing and economically disadvantaged countries
2 Senior mathematicians from developing and economically disadvantaged countries
3 Senior mathematicians from Latin America
4 Senior mathematicians from Mediterranean developing countries
5 Young Spanish mathematicians

Eligible countries are listed on the Congress website. Other young and senior mathematicians who do not fall within these groups are asked to refrain from applying for this source of support.

Applicants should preregister for the Congress. The country of the permanent institution of applicants in categories 1, 2, 3 and 4 must be included in the respective list of eligible countries.

All participants who wish to apply for financial support are kindly asked to complete the application form that can be found at www.icm2006.org/financialsupport. There is only one application form, to be used for all five categories of support.

The deadline for receipt of applications in all five categories is January 1, 2006. Applicants will be informed of the decision of the selection committee as soon as possible after May 1.

Satellite Conferences

There will be over 50 satellite conferences around the ICM 2006. An updated list of satellite events can be found at the Congress website.

The Invariant Subspace Problem

B.S. Yadav (Delhi, India)

Does every bounded operator on a Hilbert space have a non-trivial invariant subspace? This question has a positive answer for finite-dimensional and for non-separable spaces. The problem is unsolved for general separable Hilbert spaces, and it is for those known as the invariant subspace problem. This article is a historical overview on various attempts to give partial solutions to the problem.

The invariant subspace problem is the simple question: "Does every bounded operator T on a separable Hilbert space H over $\mathbf{C}$ have a non-trivial invariant subspace?" Here non-trivial subspace means a closed subspace of H different from $\{0\}$ and different from H. Invariant means that the operator T maps it to itself. The problem is easy to state, however, it is still open. The answer is 'no' in general for (separable) complex Banach spaces. For certain classes of bounded linear operators on complex Hilbert spaces, the problem has an affirmative answer.

It seems unknown who first stated the problem. It apparently arose after Beurling [1] published his fundamental paper in Acta Mathematica in 1949 on invariant subspaces of simple shifts, or after von Neumann's unpublished result on compact operators which we shall discuss in the sequel.

A history of the problem

Let H be any complex Hilbert space and T a bounded operator on H. An eigenvalue λ of T clearly yields an invariant subspace of T, namely the kernel of $T-\lambda$. So if T has an eigenvalue, the problem is solved (the special case where T is multiplication by λ being trivial). However, not every bounded operator T on a complex Hilbert space has an eigenvalue. For example, the shift operator T on ℓ^2, the Hilbert space of all square-summable sequences of complex numbers, defined by

$$Tx = (0, x_0, x_1, \ldots)$$

for each vector $x = (x_0, x_1, \ldots) \in \ell^2$, does not have any eigenvalue. However, if H is finite-dimensional, then of course every T on H has an eigenvalue, so the problem is solved for finite dimensional complex vector spaces.

Next, suppose H is infinite-dimensional but not separable. Let T be a bounded operator on H. Take a non-zero vector x and consider the closed subspace M generated by the vectors $\{x, Tx, T^2x, \ldots\}$. Then M is invariant under T and obviously $M \neq \{0\}$. Moreover, M does not coincide with H as this would contradict that H is non-separable. Thus every operator T on a non-separable infinite-dimensional complex Hilbert space H has a non-trivial invariant subspace.

What remains to be examined is actually the invariant subspace problem: does every bounded operator T on an infinite-dimensional separable complex Hilbert space H have a non-trivial invariant subspace?

The solution for Banach spaces

During the annual meeting of the American Mathematical Society in Toronto in 1976, the young Swedish mathematician Per Enflo announced the existence of a Banach space and a bounded linear operator on it without any non-trivial invariant subspace. Enflo was visiting the University of California at Berkeley at that time. However, nothing appeared in print for several years and it was only in 1981 that he finally submitted a paper for publication in Acta Mathematica. Unfortunately the paper remained unrefereed with the referees for more than five years, though its manuscript had a world-wide circulation amongst mathematicians. This happened, as they say, because the paper was quite difficult and not well written. The paper was ultimately accepted in 1985 and it actually appeared in 1987 with only minor changes: [4]. However, he had announced his construction of the counterexample earlier in the "Seminaire Maurey-Schwarz (1975–76)" and subsequently in the "Institute Mittag-Leffler Report 9 (1980)"; see [2], [3].

In the meantime, C.J. Read, following the ideas of Enflo, also constructed a counterexample and submitted it for publication in the Bulletin of the London Mathematical Society. The paper was quickly refereed and it appeared in July 1984 [5] breaking the queue of backlog for publication. A shorter version of this proof was published again by Read in 1986. He also constructed in 1985 [6] a bounded linear operator on the Banach space ℓ^1 without non-trivial invariant subspaces.

The temptation on the part of Read to have precedence over Enflo for solving the problem was considered professionally unethical by many mathematicians. Particularly, because his work was essentially based on ideas of Enflo. For example, the French mathematician Bernard Beauzamy also sharpened the techniques of Enflo and produced a counterexample. He presented it at the Functional Analysis Seminar, University of Paris (VI–VII) in February, 1984. But he declined to publish his result in the Bulletin of the London Mathematical Society, although the Editors offered him the same facilities as they did to Read. Beauzamy's paper appeared later in June 1985 in Integral Equations and Operator Theory.

The ℓ^1-example of [6] was further simplified by A. M. Davie, as can be found in Beauzamy's book (1988).

Cyclic vectors

A vector x in H is called a cyclic vector of a bounded operator T on H if the closure of the span of all $T^n x$ equals H. The operator T has no non-trivial invariant subspaces if and only if every non-zero vector is a cyclic vector of T: if a vector x is non-cyclic, then the closure of the span of all $T^n x$ is a non-trivial invariant subspace of T. And if M is a non-trivial invariant subspace, then every non-zero vector in M is non-cyclic.

Per Enflo

One should not get the impression that all counterexamples which have been produced so far are based directly or indirectly on the techniques developed by Enflo. As a matter of fact, a series of papers written by Read himself after his first paper in 1984 makes a further significant contribution to the subject. For example, the counterexample that he constructed on ℓ^1 in 1985 is characteristically different from and simpler than Enflo's, and could be counted as a major achievement. Again, in yet another paper in 1988, Read constructed a bounded linear operator on ℓ^1 which has no invariant closed sets (let alone invariant subspaces) other than the trivial ones. Not only is this a stronger result, it also gives rise to a new situation: suppose that the invariant subspace problem is solved in the negative one day (as in the case of Banach spaces), one would ask a next question: "Does every bounded operator have a non-trivial invariant closed set?"

Building on his earlier work, Read published in 1997 an example of a quasinilpotent bounded operator (i.e., $\lim ||T^n||^{1/n} = 0$) on a Banach space without a non-trivial invariant subspace. The same result is nicely described in [8].

Normed linear spaces

A vector space X over the field $\mathbf{R}(\mathbf{C})$ of real (complex) numbers is called a normed linear space if each vector $x \in X$ has a 'norm' $||x|| \in \mathbf{R}$, such that $||x|| \geq 0$ and $||x|| = 0$ if and only if $x = 0$, $||\alpha x|| = |\alpha|\ ||x||$ for each scalar α and $||x+y|| \leq ||x|| + ||y||$ for all x, y in X. Every normed linear space X is a metric space with the metric defined by $d(x,y) = ||x-y||$. A Banach space is a normed linear space which is complete (as a metric space). A Hilbert space is a Banach space endowed with the additional structure of an inner product $< x, y >$ such that the norm is related to the inner product by the equality $< x, x >= ||x||^2$. By a bounded operator on a Banach space X one means a linear transformation of X to itself such that there exists a constant $K > 0$ for which $||Tx|| \leq K||x||$ for all $x \in X$. The operator norm of a bounded operator T, denoted $||T||$, is by definition $||T|| := \sup\{||Tx||/||x|| \ ; \ x \neq 0\}$. A normed space X is called separable if it has a countable dense subset.

Von Neumann's unpublished result

John von Neumann (unpublished) showed that every compact operator on a Hilbert space has a non-trivial invariant subspace. The first proof of this result was published by Aronszajn and Smith in 1954. The result was extended to polynomially compact operators by A.R. Bernstein and A. Robinson in 1966 using techniques from non-standard analysis due to Robinson. Halmos translated their proof into standard analysis. Interestingly, his paper appeared in the same issue of Pacific Journal of Mathematics, just after theirs. In 1967, Arveson and Feldman transformed the result in a still more general form by essentially chiselling the technique of Halmos: if T is a quasinilpotent operator such that the uniformly closed algebra generated by T contains a non-zero compact operator, then T has a non-trivial invariant subspace.

The Lomonosov technique

The result of Arveson and Feldman was, in a sense, the climax of the line of action initiated by von Neumann. However, operator theorists were stunned in 1973 when the young Russian mathematician V. Lomonosov obtained a more general result:

If a non-scalar bounded operator T on a Banach space commutes with a non-zero compact operator, then T has a non-trivial hyper-invariant subspace (this means, a subspace which is invariant under every operator that commutes with T).

This theorem was quite exciting for many reasons:

I. Lomonosov used a brand-new technique (namely, an ingenious use of Schauder's fixed point theorem), entirely different from the line of action followed hitherto by other mathematicians.

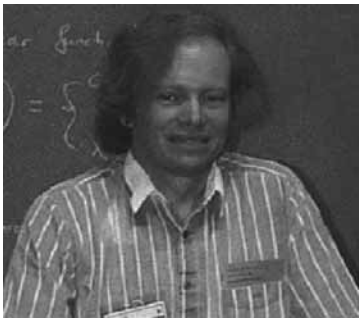
II. His result was much stronger than what was known so far: every polynomially compact operator has a non-trivial invariant subspace.

III. His theorem highlighted another, stronger, form of the 'invariant subspace problem': "Does every bounded linear operator on a Hilbert space have a non-trivial hyper-invariant subspace?"

IV. Many mathematician tried to find alternative proofs of Lomonosov's theorem, say, by replacing the use of Schauder's fixed-point theorem by the Banach contraction principle, but the theorem stands as it was even today. M. Hilden, however, succeeded in proving its special case that every non-zero compact operator has a non-trivial hyperinvariant subspace without using any fixed-point theorem.

In fact, Hilden assumed without any loss of generality a non-zero compact operator also to be quasinilpotent: if a non-zero compact operator is not quasinilpotent, then it must have a non-zero eigenvalue, and hence the eigenspace corresponding to this eigenvalue is a non-trivial hyperinvariant subspace. Hilden exploits the quasinilpotence of the compact operator to finish his proof.

V. Initially it was felt that Lomonosov's theorem might lead to a solution of the general 'invariant subspace problem' in the affirmative. However, seven years after his result, in 1980, Hadvin-Nordgren-Radjavi-Rosenthal gave an example of an operator



C.J. Read

that does not commute with any non-zero compact operator.

VI. A number of extensions and applications of Lomonosov's theorem have been obtained by several mathematicians.

Normal-like non-normal operators

A bounded operator T on a Hilbert space H is called 'normal' if it commutes with its adjoint T^*. It is called 'subnormal' if it is the restriction of a normal operator to an invariant subspace, and 'hyponormal' if $||T^*x|| \leq ||Tx||$ for all $x \in H$. It is not difficult to see that normality $\Rightarrow$ subnormality $\Rightarrow$ hyponormality, but the converse is true in neither case. An important result in operator theory, known as Fuglede's theorem, states that if T is a normal operator and $S \in B(H)$ is such that $TS = ST$, then $T^*S = ST^*$.

Fuglede's theorem implies that every non-scalar normal operator on a Hilbert space has a non-trivial hyperinvariant subspace. To show the existence of non-trivial invariant (hyperinvariant) subspaces of non-normal operators satisfying certain nice conditions has been a fascinating subject for operator theorists. One of the most striking results in this direction was due to Scot Brown who showed in 1978 that every subnormal operator has a non-trivial invariant subspace. J.E. Thomson (1986) found a simple and elegant proof of Brown's result. Consider the Hilbert space $L^2(\mu)$, where μ is a suitable positive Borel measure with compact support in the complex plane. Thomson makes a decisive use of the fact that a cyclic subnormal operator can be modelled as a multiplication by z on the closure of the space of all polynomials in $L^2(\mu)$. (A bounded operator T on the Hilbert space H is called cyclic if there exists $x \in H$ such that the closure of the span of $\{T_x^n;\ n \geq 0\}$ equals H.) As a matter of fact, Thomson's method gives rise to a more general result:

Let A be a subalgebra of $L^\infty(\mu)$ containing z and let H be a subspace of $L^2(\mu)$. If H contains constants and is invariant for A, then there is a non-trivial subspace of H that is A-invariant.

In 1987 Brown, extending his techniques and using descriptions of hyponormal operators due to M. Putinar (1984), proved that every hyponormal operator with the spectrum having a non-empty interior has a non-trivial invariant subspace.

Lastly we mention yet another significant result in this direction due to Brown, Chevreau and Pearcy: every contraction whose spectrum contains the unit circle has a non-trivial invariant subspace.

Heritages of the problem

For an operator T one denotes by Lat$T$ the lattice of all invariant subspaces of T, with set-inclusion as partial order. For a general operator T, it is extremely difficult to describe Lat$T$, particularly when we do not know whether there exists a bounded operator T for which Lat$T$ is isomorphic to the lattice $\{0,1\}$ (this is the invariant subspace problem!). However, for certain special operators T, namely the shifts and the Volterra operators, the structure of Lat$T$ is completely known. We now describe this, and discuss the role of shifts and their invariant subspaces in the structure theory of operators, as initiated by G.-C. Rota.

Let $\{e_n\}_{n=0}^\infty$ be an orthonormal basis for H. The operator U on H such that $Ue_n = e_{n+1}, n = 0,1,2\ldots$ is called the (forward) shift operator. A simple calculation shows that its adjoint S is the backward shift, given by $Se_0 = 0$ and $Se_n = e_{n-1}$ for $n \geq 1$. We shall be concerned with the following concrete representations of U and S.

Let $L^2 = L^2(C,\mu)$ be the Hilbert space of all square-integrable functions defined on the unit circle C, where μ is the normalized Lebesgue measure on C(i.e.$\mu(C) = 1$). If for each integer $n, e_n = e_n(z) = z^n$, then $\{e_n\}_{n=-\infty}^\infty$ is an orthonormal basis of L^2. The Hardy space H^2 is the closed subspace of L^2 generated by the vectors $\{e_0, e_1, e_2, \ldots\}$. We see that the multiplication by $e_1(z) = z$ on H^2 is U.

As a second example, let ℓ^2 be the Hilbert space of all square-summable complex sequences $x = (x_n)_{n=0}^\infty$. Then U and S on ℓ^2 appear as $Ux = (0, x_0, x_1, \ldots)$ and $Sx = (x_1, x_2, x_3, \ldots)$.

Beurling's theorem and its ramifications

In 1949, A. Beurling characterized the invariant subspaces of the shift operator on the Hardy space H^2 on the unit circle. His result is:

If M is an invariant subspace of the shift operator on the Hardy space H^2 on the unit circle C, then there exists an inner function ϕ on C (this means that ϕ is measurable and $|\phi(z)| = 1$ almost everywhere on C), such that $M = \phi H^2$.

If both ϕ_1 and ϕ_2 are such functions, then ϕ_1/ϕ_2 is equal to a constant function almost everywhere.

Compact operators

An operator T on a Banach space X is called 'compact' (completely continuous) if for every bounded subset $A \subset X$, the closure $\overline{T(A)}$ of its image is compact in X. An operator T is called 'polynomially compact' if there exists a polynomial p such that the operator $p(T)$ is compact. Every compact operator is obviously polynomially compact, but the converse is not true; examples can be found in Paul Halmos' *A Hilbert space problem book* (1967).

A bounded operator T is 'quasinilpotent' if $\lim_{n\to\infty} ||T^n||^{1/n} = 0$.

We say that a subalgebra of the algebra of bounded operators on X is *uniformly closed* if it is closed with respect to the operator norm.

John von Neumann (1903–1957)

As Beurling's theorem showed an interplay between the theory of functions and the operator theory, it has naturally had numerous ramifications both in harmonic analysis and functional analysis. Mainly there have been three directions:

I. Replacing the Hardy space of scalar-valued functions by the Hardy space of vector-valued functions;
II. Extending Beurling's characterization to the Hardy space of scalar-valued functions on the torus;
III. Viewing (i) and (ii) in the sense of de Branges, which puts Beurling's theorem as well as its vector-valued generalizations due to Halmos (1961) and others in a more general setting.

Weighted shifts

Shifts form an important class of operators. They have been rightly called the 'Building Blocks' of operator theory. Many important operators are, in a sense, 'made up' of shifts, for example, every pure isometry is a direct sum of shifts and every contraction with powers strongly tending to zero is a 'part' of a backward shift.

More importantly, shifts serve as an unending source of counterexamples. Read uses a shift to construct his counterexample of a bounded operator on a Banach space without a non-trivial invariant subspace.

Let H be a Hilbert space with an orthonormal basis $\{e_n\}_{n=0}^{\infty}$ and let $w=\{w_n\}_{n=1}^{\infty}$ be a sequence of non-zero complex numbers. Consider the weighted forward shift T_w:

$$T_w e_n = w_{n+1} e_{n+1}, \quad n=0,1,2,\ldots$$

and the corresponding weighted backward shift S_w:

$$S_w e_0 = 0,$$

$$S_w e_n = \bar{w}_n e_{n-1}, \quad n=1,2,3,\ldots$$

A weighted forward shift is the adjoint of a weighted backward shift and vice-versa. Note that a subspace M is invariant under an operator T if and only if its orthogonal complement $M^{\perp}$ is invariant under T^*. Hence determining $\mathrm{Lat}S_w$ is equivalent to determining $\mathrm{Lat}T_w$.

Let M_n denote the closed subspace spanned by

$$\{e_0, e_1, \ldots e_n\}.$$

Then $M_n \in \mathrm{Lat}S_w$ for all n. Under certain conditions on the weight sequence w, one can show that $\mathrm{Lat}S_w$ consists of M_n's only: if a weight sequence $w=\{w_n\}_{n=1}^{\infty}$ is such that $\{|w_n|\}$ is monotonically decreasing and

$$\sum_{n=0}^{\infty} |w_n|^2 < \infty,$$

then every non-trivial invariant subspace in $\mathrm{Lat}S_w$ is some M_n.

This result is due to N.K. Nikolskii (1965). The case $w_n = 2^{-n}$ was obtained in 1957 by W.F. Donoghue.

Volterra integral operators

Consider the Volterra integral operator V defined on $L^2(0,1)$ by

$$(Vf)(x) = \int_0^x f(t)dt, \qquad 0 \le x \le 1,$$

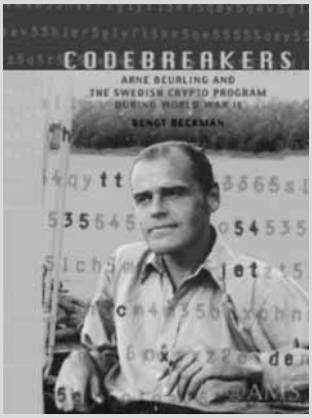
for all $f \in L^2(0,1)$. This operator is another one whose invariant subspaces have been characterized. For each $\alpha \in [0,1]$, let

$$M_\alpha = \{f \in L^2(0,1) : f = 0 \text{ almost everywhere on} [0,\alpha]\}.$$

Obviously, $M_\alpha \in \mathrm{Lat}V$ for all $\alpha \in [0,1]$. In fact,

$$\mathrm{Lat}V = \{M_\alpha : \alpha \in [0,1]\}.$$

This was proven by J. Dixmier (1949) in case of the real space $L^2(0,1)$. W.F. Donoghue and M.S. Brodskii independently settled it in 1957 for the complex space $L^2(0,1)$.



The work of the Swedish mathematician Arne Beurling (1905–1986) has been pace-setting in many directions in abstract harmonic analysis, functional analysis and operator theory. When conscripted in 1931, he reconstructed Swedish cryptology ingeni- ously leading to information vital for the survival of Sweden during the World War II. Although appointed professor at the Institute of Advanced Study, Princeton in 1954, he always missed the right social environment and would not even apply for a Green Card. A review of this book appeared in September 2003 in the Notices of the AMS.
Codebreakers: Arne Beurling and the Swedish Crypto Program during World War II, Bengt Beckman, AMS 2002, ISBN 0-8218-2889-4.

These results have been extended to integral operators K on $L^2(0,1)$ defined by

$$(Kf)(x) = \int_0^x k(x,y)f(y)dy, \quad 0 \le x \le 1,$$

for all $f \in L^2(0,1)$, where $k(x,y)$ is a square-integrable function on $[0,1]\times[0,1]$. The characterization of Lat$K$ in this case may be used to obtain a functional-analytic proof of the famous classical Titchmarsh convolution theorem (G.K. Kalisch, 1962).

Rota's models of linear operators

By a part of an operator T on a Hilbert space H, we mean the restriction $T|_M$ of T to an invariant subspace M of T.

Let $l^2(H)$ denote the Hilbert space of all square-summable sequences $x = (x_0, x_1, \ldots, x_n, \ldots)$ in H. Take a bounded sequence $w = (w_n)$ of positive real numbers. The backward shift S_w on $l^2(H)$ is given by

$$S_w x = (w_1 x_1, w_2 x_2, \ldots, w_{n+1}x_{n+1}, \ldots).$$

Put $\beta_0 = 1$ and $\beta_n = w_1 w_2 \cdot \ldots \cdot w_n$, for $n \ge 1$. One has the following result:

Suppose T is a bounded operator on H and

$$\sum_{n=0}^{\infty} \beta_n^{-2} ||T^n||^2 < \infty.$$

Then T is similar to a part of S_w on $l^2(H)$ in the following sense: define $A : H \to l^2(H)$ by $Ax = \{\beta_0^{-1}x, \beta_1^{-1}Tx, \beta_2^{-1}T^2x, \ldots\}$, then the image M of A is closed and $S_wA = AT$.

This implies M is an invariant subspace of S_w and T is similar to $S_w|_M$.

If the spectral radius,

$$r(T) := \lim_{n\to\infty} \left(||T^n||^2\right)^{1/n},$$

of T is less than 1, then the conditions of the above result are satisfied for the constant sequence $w_n = 1$. This observation leads to the result of G.-C. Rota (1960):

If a bounded operator T on a Hilbert space H has spectral radius $r(T) < 1$, then T is similar to a part of the standard backward shift on $l^2(H)$. In particular, this holds for a strict contraction T, i.e. if $||T|| < 1$.

Since any bounded operator can be 'scaled' so as to be a strict contraction, Rota's work yields a reformulation of the invariant subspace problem: *Are the minimal non-zero invariant subspaces of backward shifts one-dimensional?*

More details on this work initiated by Rota may be found in [7].

References

[1] A. Beurling, 'On two problems concerning linear transformations in Hilbert space', *Acta Math.* **81** (1949), 239–255.

[2] P. Enflo, 'On the invariant subspace problem for Banach spaces', *Seminaire Maurey-Schwarz* (1975–1978).

[3] P. Enflo, 'On the invariant subspace problem for Banach spaces', *Institute Mittag-Leffler, Report* **9** (1980).

[4] P. Enflo, 'On the invariant subspace problem for Banach spaces', *Acta Math.* **158** (1987), p. 213–313.

[5] C.J. Read, 'A solution to the invariant subspace problem', *Bull. London Math. Soc.* **16** (1984), p. 337–401.

[6] C.J. Read, 'A solution to the invariant subspace problem on the space ℓ_1', *Bull. London Math. Soc.* **17** (1985), p. 305–317.

[7] B.S. Yadav and R. Bansal, 'On Rota's models of linear operators', *Rocky Mountain J. of Math.* **13** (1983), p. 253–256.

[8] P. Rosenthal, 'Featured Review of C.J. Read's *Quasinilpotent Operators and the Invariant Subspace Problem*', MR 98m:47004.

B.S. Yadav [bsyadav@indianshm.com] has been Professor and Head of the Department of Mathematics and Dean of the Faculty of Mathematical Sciences at the University of Delhi, India. He has had visiting assignments and has taught at a number of universities in USA and Canada. He has been an invited speaker at several inernational conferences. He has also been a Visiting Professor at the Chinese Academy of Sciences, Beijing. His fields of interest are Functional Analysis, Operator Theoty, Fourier Analysis and History of Mathematics. He has published several research articles in international journals and has edited three reseach monographs.

This article appeared originally in Nieuw Archief voor Wiskunde, vol. 6, no. 2, pp. 148–152. The Newsletter thanks the editor of Nieuw Archief for the permission to reproduce it.

Ljudmila Vsevolodovna Keldysh (To Her Centenary, Part I)

A.V.Chernavsky (Moscow, Russia)

Introduction

Ljudmila Vsevolodovna Keldysh (1904–1976) was a remarkable mathematician. She attacked and solved problems of great complexity with supreme creative effort. But she was also a remarkable woman, a mother of five in a family of scientists with the inner strength to overcome the specific hardships facing Russian intellectuals during the first two thirds of the 20th century.

These days, there is nothing unusual about a woman choosing mathematics as her career and becoming a professional of high quality. However, before the second half of the 20th century this was a rare event, exemplified chiefly by Sophia Kovalevsky and later Emmy Nöther. So the choice of mathematics as a profession by a young woman from a family rather far-removed from science, even though belonging to the Russian intelligentsia, was an act that bespoke an exceptional strength of mind. And Ljudmila Keldysh's life has proved that this choice was not a juvenile whim but a genuine calling.

The research work of L.V. Keldysh splits distinctly into three periods. The first (before World War II) was exclusively devoted to studying the structure of Borel sets and culminated in her doctorate; successfully defended in 1941 (the complete text appeared in Trudy MIAN in 1945).

After the war, she investigated continuous mappings of compact sets in the context of dimension-raising mechanisms. This led her to certain structure theorems as well as to the construction of remarkable examples, which answered basic questions that previously seemed completely inaccessible.

At the end of the 1950s, L.V. turned to geometric topology, a subject that was, at that time, beginning to make progress on basic problems concerning manifolds: combinatorial and topological equivalence, triangulability, classification of embeddings, etc. To this subject matter, L.V. brought the techniques that she was successfully using in her work on continuous mappings, especially the notion of pseudoisotopy which turned out to be very helpful. She organized a seminar on geometric topology, initially within the framework of the Moscow topology seminar of P.S. Alexandrov. In the final decade and a half of L.V.'s life, her seminar played an important role, and in many instances a decisive one, in attaining now classical solutions of these problems.

Family History

Ljudmila Keldysh was raised in the family of a prominent engineer; she was the oldest among seven children. The name 'Keldysh' is of Turkic origin, possibly originating from the word "kel di" = "he has come" (the ending "sh" is a diminutive of endearment), despite no record of Turkic ancestors in the family. Originally, the name could have been given to a long-awaited boy, born after several girls.

Vsevolod Mikhailovich Keldysh

Ljudmila Keldysh as a young girl

Foma Simonovich Keldysh, the great-grandfather of L.V., was a psalm-reader at an orthodox church in Warsaw. His son Mikhail, born in 1839, studied medicine at military academies in Warsaw and St.Petersburg. After graduation, he saw military service in Caucasus and in the war with Turkey. Later, he was engaged in both practical and scientific epidemiology. In particular, he composed a medico-topographic description of the Caspian region. His service was rewarded with the rank of general and a title of nobility. He died in 1920.

His son, Mikhail Keldysh, Ljudmila's grandfather, was married to the first cousin of General Brusilov (known for the famous "Brusilov's breakthrough" in World War I).

Ljudmila's father, Vsevolod Mikhailovich Keldysh, was born in 1878 in Vladikavkaz during Mikhail's endless wanderings around the south of Russia. He graduated from the Polytechnical Institute in Riga as an engineer in structural mechanics. Also in Riga, he married Maria Alexandrovna Skvortsova. For professional reasons, like his father, he had to move from one town to another. Ljudmila Keldysh was born in Orenburg (in the region of Saratov, to the east of the Volga) on March 12th 1904 (the other six children were born in Riga, Helsinki, St.Petersbourg, and Moscow).

Ljudmila's mother Maria (born in 1879) came from a family of Russian nobility. Maria's grandfather, Nikolai Skvortsov, was a general. In the Caucasian wars (1817–1864) he was badly wounded and two Georgian women, mother and daughter, nursed him back to health. He helped the daughter enter the famous Smol'ny Institute in St. Petersburg (a high-level educational institution for

aristocratic young ladies) and later married her. Maria's father was also a general and his wife, Sofia Iosifovna Covzan, had Polish roots.

According to family legend, Maria's great-grandfather, a physician, was once visiting friends in the Ukraine and came upon a sick girl abandoned by gypsies. He cured the girl, left her at the country-seat of these friends and married her when she grew up. One may judge the truth of this legend by the gypsy-like features of some family members, especially Ljudmila's brother Mstislav and, to a lesser extent, L.V. herself.

During World War I, trials and troubles befell the 11-year-old Ljudmila, hitherto a happy girl. When the German troops approached Riga, the Polytechnical Institute was transferred to Moscow. The family had six children, the youngest girl only a year old. They lived in a suburb, the boys commuting to Moscow daily by train to continue school, sometimes on the roof of an overfilled wagon. Food was a problem; on certain days the rations consisted only of roast onion. Gradually life became easier, partly because of help from the ARA, an American welfare organization supporting post-war Russia. A seventh child, a girl, was born to the family in 1920. Vsevolod Keldysh felt that one must have faith in a better future and the family called the last-born daughter Vera, meaning faith.

At the beginning of the 1920s the family lived in Ivanovo (a city north-east of Moscow) where Ljudmila finished her secondary school education. A lecture by N.N. Lusin, then teaching in Ivanovo, determined her choice of profession. She entered the Physics and Mathematics Department of Moscow University where Lusin eventually became her scientific advisor.

N.N. Lusin

N.N. Lusin (1883–1950) was the head of the Moscow mathematical school known by the name of 'Lusitania'. He came to Moscow University in 1901. At that time mathematical life there was very dynamic and he actively participated in it (he was the secretary of a mathematical circle headed by N.E. Zhukovsky). But in 1905, in a period of revolutionary uprisings, the political life in the country and especially in Moscow became extremely insecure and it affected the university. There were student strikes and at one time Lusin had a cache of bombs under his bed! Fortunately his teacher D.F. Egorov, the leading Moscow mathematician of the time, succeeded in arranging for Lusin's departure to France.

The opportunity to hear the glorious French scientists: Poincaré, Hadamard and Darboux, and very intensive work at the Sorbonne library had a profound influence on him. Lusin's work in Hadamard's seminar in 1912 was especially important. There he had personal contact with eminent mathematicians, notably Lebesgue and Borel, whose ideas exerted a strong influence on his thoughts on the foundations of mathematics.

He returned to Moscow in 1914 and began to teach at the mathematics department of the university. He had an exceptional teaching style and was particularly good

Nikolai Nikolaevich Lusin (1883 – 1950)

at attracting disciples to scientific creativity. The work of his seminars never ended when the bell rang and continued up to the door of his apartment and frequently inside it. His students, forming the Lusitania[1] group (including M.Y. Suslin, D.E. Men'shov, A.Y. Khinchin, P.S. Alexandrov, P.S. Uryson, L.A.Lusternik, A.N. Kolmogorov, N.K. Bari, P.S. Novikov and L.V. Keldysh), later became leading researchers in fundamental and applied mathematics and some founded their own schools in many different branches of mathematics.

In the harsh times of the revolutionary crisis of 1917, some Moscow professors, Lusin among them, moved to Ivanovo to teach at the new Polytechnical Institute (without breaking their relationship with Moscow University). He was in Ivanovo from 1918 to 1922 and there Ljudmila Keldysh, still a schoolgirl, met the man who was to orient her future scientific life.[2]

In her Parents' Family

In the 1920s, Vsevolod Keldysh, Ljudmila's father, taught at a military-engineering academy where he was head of the Chair of Ferroconcrete and later head of the Chair of Structural Mechanics. At that time the construction industry was rapidly developing in the Soviet Union and he became one of the leading experts in such important constructions as the Dniepr power plants, the Moscow-Volga Canal and the Moscow metro (underground). He also achieved the rank of general. When the youngsters around him would begin to criticize things in an insolent manner, he would cool them down with the words, "Now you are not satisfied with modern life, but you should know I could not find a job to my liking in the tsarist days and had to go into teaching. And now I have a fascinating professional activity."

[1]It was the name of a grand ocean liner torpedoed by a German submarine in 1915, a famous event of the First World War. One may learn about it at http://www.lusitania.net/. Incidentally, Lusitania was an antique Roman province on the site of what is now Portugal.

[2]Readers may make more detailed acquaintance with Lusin's mathematics, philosophy and religion in a remarkable article, "A comparison of two cultural approaches to mathematics: France and Russia, 1890–1930" by L. Graham and J.-M. Kantor (http://www.math.jussieu.fr/~kantor/).

Ljudmila Keldysh on a hike

The family was big; alongside the seven children, it included Vsevolod's mother and mother-in-law, neither of whom received a pension since they were widows of tsarist generals (not to mention their noble origins!) But the family had sufficient money to live on because the head of the family belonged to a well-paid category. Vsevolod Keldysh retired at the age of 80 and he died suddenly at 87 in 1965. His wife Maria Alexandrovna had died before him in 1953.

The family had strict ethical principles, which was rather typical for the intellectual world of Russia at that time. The mother devoted her whole life to the family, tutoring her children in foreign languages (German and French) and trying to teach them good taste and a love of music. The parents played piano-for-four-hands together, and regularly led family outings to the opera and to concerts of classic music. They did not deprive themselves of such pleasure even in the harsh post-revolutionary times, when they had to return home from Moscow on foot. But only one of the children, Yuri, who spent hours sitting deeply engrossed at the piano, made music his profession, eventually becoming a musicologist (rather than a concert pianist as he had originally hoped). Ljudmila also learned to play the piano and still loved to play later in her life.

The family was not religious. Only grandmother Sophia Iosifovna would take the youngest daughter, Vera, to church; the parents would react by explaining that the daughter "will understand what's what when she grows up." Nevertheless, the family observed the main religious feasts in the traditional orthodox spirit with *paskha*,[3] *kulichi*,[4] and painted eggs for Easter, attending the Church of Christ the Redeemer where the best vocalists from the Bolshoy Theatre sang in the Easter services. L.V. Keldysh once told one of us, her students, that at difficult moments of her life she would enter an empty church and stand there in silence for a short while.

There were frequent parties of young people, mainly friends of the eldest daughter Ljudmila – mathematics students and postgraduates, among them P.S. Novikov, A.N. Kolmogorov and P.S. Alexandrov, all of whom were future full members of the USSR Academy of Sciences, I.V. Arnold, a well-known mathematician, later the father of Vladimir Arnold (another academician to be), and musician friends of Yuri. There were games, laughter and serious conversations.

The determined character of the eldest daughter had a great influence on the other children. Following her example, Mstislav (the future President of the USSR Academy of Science) joined the Mathematics Department of Moscow University against the wishes of his father, who wanted Mstislav to follow in his footsteps and become a construction engineer.

Their father's profession was inherited only by Lyubov, his favourite child. She eventually became the keeper of the family archives. The youngest daughter, Vera, now works at the well-known Aerohydrodynamics Institute. She has written a short history of the family in a book devoted to Mstislav Keldysh, from which I have borrowed some of the family information [1].

In 1934, L.V. Keldysh and P.S. Novikov were married. From the very first days of their life together, L.V. not only became P.S. Novikov's wife and mother of numerous children, but, as one may put it, the guardian angel of her husband's mathematical creativity. With full understanding, she always gave precedence to her husband's work over her own. Among the participants of Lusitania, the two of them were the closest to Lusin himself both in temperament and scientific interest. Together they wrote a remarkable commentary to his book on analytic sets, later analyzed his works in a special article; their first works were aimed at solving problems within Lusin's fields of interest. From 1934, they held positions at the Steklov Mathematical Institute. Later their scientific interests separated but L.V. still tried to keep an eye on the work of P.S., participating in seminars whenever he spoke about his results. She closely followed his proof of the undecidability of the word problem in group presentations. Indeed, with S.I. Adyan, she edited the manuscript written by P.S. Later, she persuaded Adyan to rejoin P.S. and finalize the latter's research on the negative solution of the Burnside problem.

Pre-war Research: Borel Sets

The name of L.V. Keldysh became well-known after her very first result, which Lusin included in the beginning of his famous lecture course in 1930 (see [2]). She constructed a beautiful arithmetical example (using continued fractions) of a set belonging to the fourth Borel class. It was the first serious advance in the Borel classification of sets since 1905 when Baire had given the first non-trivial example of a set of the third class. She loved to remember that when she was introduced to Heinz Hopf, who was visiting Moscow, he exclaimed, "Ah! The fourth class example!"

An important motivation behind descriptive set theory, that is the description of processes to build sets of different Borel classes, is the measurability problem, one of the basic questions in analysis. Borel and Lebesgue gave two definitions of measurability. That of Borel is minimal in a sense; it studies those sets that may be obtained from intervals by applying the union and intersection operations to countable ensembles of sets. (And the measure may be extended by the transfinite process to all these B-sets.) There arises a transfinite classification of such sets. The Lebesgue definition covers a much larger class of sets, although one builds nonmeasurable sets in his sense. These ideas relate

[3]Sweetened curds with butter and various other ingredients such as raisins, shaped as pyramids with crosses imprinted upon them.

[4]A kind of cake made from fancy pastry with raisins and spices and formed into a cylinder.

to the famous Continuum Hypothesis and especially to questions about effectiveness of constructions used when Zermelo's Axiom of Choice is rejected. The construction of a Lebesgue nonmeasurable set was ineffective in this sense but Lebesgue had also given an effective example of a set nonmeasurable in Borel's sense. These problems demanded detailed investigation of the continuum and analysis of the effectiveness of construction processes for different classes of subsets. All this became the object of investigations by Lusin and his school.

For Lusin, philosophy of science came before strictly mathematical problems. This broader interest led to a profound involvement in questions about the foundation of mathematics. L.V. Keldysh recalled that Lusin repeatedly stated that the essence of the study of the continuum consists of a groping towards the limits of human set-theoretical knowledge and he predicted the existence of non-provable assertions (for example, the impossibility of proving measurability of his projective sets which was ascertained in 1951 by P.S. Novikov).

The natural beginning to this activity was a detailed study of Borel sets. It is well-known that the first success here was a solution by P.S. Alexandrov and F. Hausdorf of the problem about existence of a perfect core in every uncountable B-set. A new operation invented by Alexandrov gave sets beyond Borel classification, in addition to Borel sets. They were discovered by M.Y. Suslin who gave them the name 'A-sets' but they are also known as 'Suslin sets'.

Lusin specified the Vallée Poussin classification of Borel sets, or B-sets, which is based on the set-theory notion of limits. He has introduced, in particular, a notion of an *element* of the given transfinite class α. Elements are countable intersections that are not countable unions of sets belonging to lower classes. Their countable unions give all sets of the class α. Based on an analogy with uncountable compacts that are homeomorphic to unions of the Cantor set with countable sets of points, he posed in general terms the problem of finding *canonical* elements such that every Borel set be a countable union of canonical elements. But he gave no precise definition of this notion: "We call *canonical* those elements of the given class K_α *that has a sufficiently simple property* and such that one obtains every set of the class K_α taking the union of a countable set of the canonical elements… It would be desirable to have in every class a finite number of kinds of canonical elements such that the elements of the same kind be homeomorphic between them." [2]

L.V. Keldysh succeeded ultimately in building arithmetic examples for *all* countable classes α in this Vallée Poussin classification, and this construction is effective if a is effectively given (that is with a recursive set of lesser transfinite numbers). This construction defines such a set of the given class (in the Baire space of irrational points) with series of conditions on sequences of partial quotients in continued fraction developments of its points. For example, the condition for her initial example of fourth class demands that there be an infinite set of different partial quotients, each of which repeats infinitely many times. (Baire's set of 1905 consists of irrational points whose partial quotients increase unboundedly.) [3, 4, 5]

Together with this construction she formulated a strict notion of canonical elements and with its help gave a rather complete description of any B-set [5]. She called an element A of the given class *canonical* if every open-closed subset is *universal* in this class (that is, it is possible to embed in *A* any other set *B* of this, or lesser, class as a closed subset) and if it has first Baire category on itself[5] in every open-closed subset of its closure. She showed that these elements are homeomorphic for every class (according to a theorem by M.A. Lavrentijev [6], elements of different classes are not homeomorphic, beginning with the third class) and that every element of the given class consists of a canonical element and a countable union of sets belonging to lesser classes. She showed that Baire's construction for the third class and her construction for other classes give precisely the canonical elements in every class. Keldysh's definition of canonical elements, properly speaking, did not exactly answer Lusin's question because countable unions of sets of the first category have themselves the same first category. So this definition and questions that she posed here, and her investigation of elements with second category, eventually engendered a large amount of investigation (see [7] and the detailed paper by A. Ostrovski [8], which contains more references).

Several other important results followed. Her works of that period on descriptive set theory fully displayed her personal style: discovery of the underlying concepts of the chosen subject through an infallible intuition and painstaking construction of the fundamental examples. The geometric viewpoint and descriptive set theory techniques that she used in these studies later facilitated her transition to research in topology.

Stalinism

This first period of L.V.'s research took place in the ghastly period of Stalinism. The first victim of it in the family was Nikolay Alexandrovich, brother of her mother and a former officer in the tsarist army. His past prevented him from reorganizing his life and the family assisted him. He was arrested at the very beginning of that period and became a political prisoner, working during the early 1930s on the construction of the White Sea-Baltic Canal. Later, in wartime, he was arrested again and perished in one of the Stalin camps.

In 1935 L.V.'s mother, Maria Alexandrovna, was arrested and Vsevolod Mikhailovich had to appear before a specially appointed commission before they were allowed to go free. The arrest was within the framework of a campaign for appropriating gold and jewellery from the wealthy before the revolution but they were granted clemency and their property was returned, jokingly declared to be mere trinkets.

The next victim was L.V.'s brother Mikhail. He was part of a large group of about a hundred postgraduates and professors from the History Department of Moscow

[5]That is, it is a countable sum of closed subset nowhere dense in it.

University who were arrested in 1936. Only in the 1990s did the family learn that he was executed in 1937.

Another brother, Alexandr, was arrested in 1938 as a 'French spy'. Fortunately, a change of leadership occurred in the *organs* (as the secret police liked to call themselves) due to which many people, Alexandr among them, regained their liberty. Then the espionage accusation was changed to that of antisemitism but his first wife (an ethnic Jew), and others, testified in his defence. Later he fought in the war and after it, although he had dreamed of becoming a dramatic actor, became an administrator in the state concert foundation and organised theatrical tours all over the USSR.

World War II

The period of the war in Russia was extremely hard for the family. The critical day in Moscow was October 16th 1941. The Germans were on the outskirts of Moscow. L.V. was to leave Moscow with her three sons; the first, Leonid (from her short-lived first marriage) was only ten, while the youngest, Sergey, was three. That day was the last possible chance to board a train going east from Moscow but no one could give the exact destination. Only with the help of A.N. Kolmogorov, who presented them as members of his family, was the family able to move out of Moscow. They first reached Gor'ky by train and then Kazan by a Volga riverboat several days later. Arrangements were made there for personnel evacuated from Academy of Sciences institutes. However, this family did not have the status of *evacuated* personnel but that of *refugees* and were therefore without any provisions or warm clothes, without guarantee of any housing, essentially without means of support. However, they did get a roof over their heads, living with several hundred similar refugees on mattresses in the Kazan University indoor sports facility.

A month later, Petr Sergeevich reached Kazan, gravely ill. He was awaiting serious surgery and physicians had doubts about its outcome. The family obtained a room in the corridor of the university student dormitory. During the next months of the cold and hungry winter and the subsequent spring of 1942, L.V. passed between the dormitory hall where the children waited for her and the hospital ward where she nursed her husband. The distance was ten kilometres and there was no transportation in that part of Kazan.

Besides the daily ration of 300 grams of bread per person and one teaspoonful of granulated sugar, there was just enough money to purchase a 50-kilogram bag of coarsely ground rye flour a month. This flour, boiled in water, became the basic food for the family over the next two years.

After the return to Moscow (in 1943), the family's life returned to normal little by little. The two daughters rejoined their three brothers and once again L.V. Keldysh had to call upon all her energy and force of character in order to efficiently play her family role and continue active research work, without which she could not imagine her life.

Bibliography

[1] Келдыш В.В., Семья Келдышей// В: "М.В. Келдыш. Творческий портрет по воспоминаниям современников. Москва. Наука. 2001, стр. 121–132 [Vera Keldysh. Keldysh Family // In: M.V. Keldysh. His portrait as a creative personality by the recollections of contemporaries. Moscow. Nauka]

[2] Лузин НН, Лекции об аналитических множествах и их приложениях М: ГТИТТЛ, 1953, 359 с. [Luzin N.N. Lectures on analytic sets and their applications. Moscow. – Leçons sur les ensembles analytiques et leurs applications. Paris (edition de Borel) (1930) 1–328]

[3] Келдыш Л.В., Структура В-множеств // Докл. АН СССР, 1941. 31, No. 7, с. 651–653. [Structure of B-sets // Doklady …]

[4] Keldych Ludmila V., Sur la structure des ensembles mésurables B // Матем. Сб. 1944, т. 15, no. 1, с. 71–98.

[5] Келдыш Л.В., Структура В-множеств // Труды МИАН; т. 17. М. Наука. 1945. 76 с. [Structure of B-sets // Trudy MIAN [Structure of B-sets // Trudy MIAN (Proceedings of the Steklov Institute)]

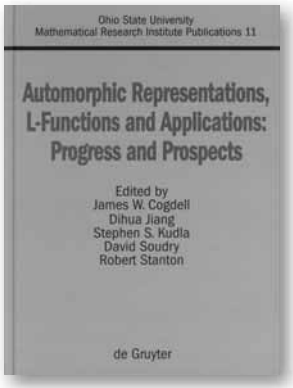
[6] Lavrentijev M.A., Contribution à la théorie des ensembles homéomorphes // Fund.Math. 1924, 6, 149–160.

[7] Островский А.В., К вопросу Л.В. Келдыш о структуре борелевских множеств // Матем. Сб. 1986. 131, no. 3, с. 323–346. [Ostrovski A.V., On L.V. Keldysh's question about structure of Borel's sets. Mat.sb. …].

[8] Островский А.В., Отображения борелевских множеств, Труды МИАН том 252 вып. 1, М. Наука, 2006 с. [Ostrovski A.V., Mappings of Borel sets. Trudy MIAN…]

The final second part of this article is to appear in the next issue of the Newsletter. The author is very grateful to members of L.V. Keldysh's family for acquaintance with their family history and the permission to use it in this outline. Also used with thanks are recollections of L.V. Keldysh's students: L.V. Sandrakova, A.B. Sossinsky and M.A. Stanko. Many thanks go moreover to A.B. Sossinsky and L.C. Siebenmann for their efforts to adapt this text, written by a Russian author, for the understanding of European readers.

Alexey Victorovich Chernavsky [chernav@iitp.ru] (born 1938), a topologist, graduated from Moscow State University and then pursued postgraduate studies at the Steklov Math. Institute (MIAN) under the supervision of L.V. Keldysh. He was on the staff of MIAN until 1974. He is now the head of the laboratory on Bioinformatics at the Institute of Information Transmission Problems (IPPI RAN). His works in mathematics concerns mainly geometric topology of manifolds, homeomorphisms and embeddings.



■ Automorphic Representations, L-Functions and Applications: Progress and Prospects

Proceedings of a conference honoring Steve Rallis on the occasion of his 60th birthday, The Ohio State University, March 27-30, 2003

Ed. by James W. Cogdell / Dihua Jiang / Stephen S. Kudla / David Soudry / Robert J. Stanton

2005. Approx. 440 pages. Cloth. € [D] 148.00 / sFr 237.00 / *US$ 168.00
ISBN 3-11-017939-3 (Ohio State University Mathematical Research Institute Publications 11)

The continuing vigor and diversity of research on automorphic representations and their applications to arithmetic are clearly reflected in this volume. The depth and breadth of Rallis's influence are also discussed.

The papers in this volume represent many of the most recent developments and directions.

Coming soon

■ Projective Varieties with Unexpected Properties

A Volume in Memory of Giuseppe Veronese. Proceedings of the international conference ‚Varieties with Unexpected Properties', Siena, Italy, June 8—13, 2004

Ed. by Ciro Ciliberto / Antony V. Geramita / Brian Harbourne / Rosa Maria Mirò-Roig / Kristian Ranestad

November 2005. Approx. XX, 380 pages. Cloth. € [D] 148.00 / sFr 237.00 / *US$ 168.00
ISBN 3-11-018160-6

This volume contains refereed papers related to the lectures and talks given at a conference held in Siena (Italy) in June 2004. The topic of secant varieties and the classification of defective varieties is central and ubiquitous in this volume. Besides the intrinsic interest of the subject, it turns out that it is also relevant in other fields of mathematics like expressions of polynomials as sums of powers, polynomial interpolation, rank tensor computations, Bayesian networks, algebraic statistics and number theory.

Hellmuth Kneser

■ Gesammelte Abhandlungen / Collected Papers

Hrsg. v. Gerhard Betsch / Karl Heinrich Hofmann

December 2005. Approx. XVI, 923 pages. Cloth. € [D] 248.00 / sFr 397.00 / *US$ 298.00
ISBN 3-11-016653-4

Hellmuth Kneser (1898-1973) was a mathematician of extraordinarily broad vision and insight and thus contributed to many mathematical fields of pure and applied mathematics including foundations, differential equations, operations research, and mathematics education. With the exception of two papers written in French, all of his articles were written in German. Experts in various areas have written English commentaries on aspects of Hellmuth Kneser's work, summarizing what he accomplished, describing the context of his work, and giving outlooks on its aftereffects.

W DE G de Gruyter
Berlin · New York

** for orders placed in North America.*
Prices are subject to change.

Interview with Friedrich Hirzebruch (Bonn)

Interviewers: Wolfgang Lück (Münster, Germany) and Vasco Alexander Schmidt (Sandhausen, Germany)

During the annual conference of the German Mathematical Society (DMV) in 2004 in Heidelberg, Professor Friedrich Hirzebruch was awarded the Cantor medal for his exceptional mathematical accomplishments and his commitment to the mathematical community. The respect for this mathematician, who was born in 1927, is reflected by 13 honorary doctorates and his membership of all seven German Academies of Sciences, of the German Academy of Natural Scientists Leopoldina and of many foreign academies. Hirzebruch was instrumental in the foundation of the Max Planck Institute for Mathematics in Bonn, serving as its director until 1995. He has been witness to some important events in German history and mathematical development during the second half of the 20th century. He started to study mathematics in 1945 immediately after World War II. Both after the construction of the Berlin Wall and during the reunification of the two German states he served as the president of the German Mathematical Society (DMV), and from 1990 to 1994 he was the first president of the newly established European Mathematical Society.

The motivation for the presentation of the Cantor medal to Hirzebruch reads: "His ideas and developments, in particular in connection with the Riemann-Roch theorems and with characteristic classes and K-theory, have paved the way for one of the most important developments of mathematics in the second half of the 20th century. More than any other, he has contributed to the international integration of German mathematics and the bringing together of East and West German mathematicians into a common organisation."

Early research results

Regarding your career, it is fascinating that you were so influential in mathematical terms and at the same time were able to organise a vast part of the mathematical landscape. Already in the fifties you were famous with your proof of the Riemann-Roch theorem. At that time, were you already aware that this was a very important result?

I think so. Many people had worked on this topic. When I lectured on my result at the International Mathematical Congress in Amsterdam in 1954 after two years at the Institute for Advanced Study in Princeton, it attracted immediate attention. Severi, who was in the audience, wrote in a letter to Heinz Hopf that he felt like he was in heaven. Heinz Hopf responded jokingly, commenting that Severi, as a member of the papal academy, should know.

Did you know at that time that your mathematical ideas would fall on extremely fertile ground?

This became very apparent with the Atiyah-Bott-Singer index and fixed point theorem, which is partially based on papers that I had written on the Riemann-Roch theorem. The latter theorem became a particular case of the index theorem, which is much more general and which has an equivariant formulation. It was a great pleasure for me to see the connections between these results. I had worked strictly within algebraic geometry, but now the theorem was suddenly also valid for complex manifolds. I could not prove that back in 1953 since I made use of inductive arguments over the embeddability dimension of a variety in a projective space. I was very happy that the first steps towards the Atiyah-Bott-Singer index theorem were presented by Atiyah at the Arbeitstagung 1962 in Bonn. I should also mention the Riemann-Roch-Grothendieck theorem on which Grothendieck lectured for hours during the first Arbeitstagung in 1957 and for which the formalism of my theorem was essential.

All four mathematicians that were involved in the proof of the index theorem were honoured during a conference in Harvard in 1999.

You can read it off from our publications, in which the development over the years is mentioned many times, that we four – Atiyah, Bott, Hirzebruch and Singer – somehow belong together. We called this conference at Harvard University the Gang-of-Four meeting. We were all presented with a piece of art by Mrs. Poenaru, a poster inscribed with the most important formulae. On my poster you can recognise in the background an excerpt from the original German edition of *Neue topologische Methoden in der algebraischen Geometrie* (Springer 1956).

Research Institutes in Bonn

You were still able to carry out very productive scientific work while you had heavy organisational duties, first as the spokesman of the Bonn Sonderforschungsbereich (SFB) and later as the director of the Max Planck Institute (MPI). How did you succeed?

There were always quieter periods in which I could do research, in the beginning of the seventies for example. The Sonderforschungsbereich was well established since 1969, and the unrest of the students had calmed down. Usually I travelled with my family in summer time, to Berkeley for example, and that was a good opportunity to get things written up. I had particular areas of interest, for example Hilbert modular surfaces and later elliptic genera. I was also very happy that I could give lectures during periods when there was little time for research and these lectures gave rise to books. But my mathematical productivity has decreased in later years. My *Collected Papers* (Springer 1987) fill two volumes; the first comprises work done over twelve years until 1962, but it is just as thick as the second volume that comprises 25 years' work. That can be taken as an indication of a decrease in productivity.

Could you tell us about the foundation of the MPI? Did you have the impression that you had to use this opportunity for mathematics at that time?

In November 1978, some years before the Sonderforschungsbereich had to close, I made an application for an MPI in Mathematics. Earlier, at the end of the fifties, there had been efforts to found an MPI in Mathematics and I had taken an active hand in these attempts. At that time some people considered turning Oberwolfach, which was financially not secure, into a Max Planck Institute. There were plans to construct the MPI in Freiburg, so the researchers would be able to live there together with their families. According to these plans, Oberwolfach would become a conference institute as a branch of the MPI. Plans had progressed quite far and I was to become the director according to the application by the DMV. The Max Planck Society (MPG) had asked for recommendation letters from Courant and Siegel amongst others, and these two opposed (details can be found in Norbert Schappacher's work on the prehistory of the MPI in connection with Oberwolfach: "Max-Planck-Institut für Mathematik – Historical Notes on the New Research Institute at Bonn", *Mathematical Intelligencer* 7 (1985), 41–52). By the time the SFB approached its closing stages, we had accumulated many good experiences including invitations of many guest researchers. All of a sudden, the foundation of the MPI progressed very quickly. The final decision of the MPG's senate was taken during the annual assembly in 1980.

The MPI depends very much on your personality.

During a scientific conference in Innsbruck in 1978 I had the opportunity to have a long conversation with the MPG's president, Reimar Lüst, and I was able to arouse his interest. He asked for example, "Which people would we have to take over?" I answered, "Maybe nobody, at most a secretary or two. The guest researchers will be exchanged all the time." Soon, Zagier joined as a scientific member, followed later by Harder and, at the end of my time as director, Manin and Faltings arrived. Until I retired at the end of October 1995, I was the only director of the MPI. Afterwards, it was directed jointly by Faltings, Harder, Manin and Zagier.

Working Conditions – in Germany and abroad

In 1955 you left for Princeton but shortly after you returned to Germany and stayed in Bonn. Would you exchange Bonn for Princeton nowadays as well?

From 1952 to 1954, I was a member of the Institute for Advanced Study. In this time I achieved the results that we have been talking about. After that I went to Germany for one year for my Habilitation in Münster. From there I returned with my family to Princeton where I became an assistant professor at the university. When we left Germany, with entry visas and green cards, I had already been called to Bonn. I received that call in July 1955, almost exactly fifty years ago. Emil Artin was a professor at Princeton at that time. He approached me and said, "The chairman has asked me to tell you not to return to Germany, but to stay in Princeton. But I have to add that I have decided to return to Germany myself." He went to Hamburg. For us it was quite obvious at that time that we would return, even more for my wife than for myself. I remember that I discussed the matter with Serre. He asked me, "Bonn? Who is there besides Adenauer?" But he was not very well informed. Wolfgang Krull and Ernst Peschl were at the mathematics department there. The situation was not bad; a new building had been constructed and the library that had been destroyed during the war had been built up again. So I had a good start. There were excellent students from the beginning.

In these days some mathematicians ask themselves whether they should return from abroad. Some of them hesitate, in part because of the working conditions at German universities.

Unlike today, with enough enthusiasm, it was easily possible to build up many things and to obtain support from the ministry in Düsseldorf. Whenever I received an offer to accept a position somewhere else and negotiated with the ministry, they were ready to satisfy my requests. However, a mathematician's needs are not that expensive; sometimes I asked for money for the Arbeitstagung or for the library or for an additional assistant position. This was no problem compared to natural scientists with their expensive laboratories. Today many people worry about the new W-positions with a salary that does not increase with seniority. It is still unknown who will decide regularly about merit increases based on excellent research results and good teaching. We have no experience yet, but it is doubtful that there will be enough money for these merit increases. The W-3 salary (without merit increases) cannot compete internationally, for example

The "old" Max-Planck Institute

The "new" Max-Planck Institute

it is about half as high as the minimum salary of a full professor at the ETH Zurich. In Bonn we had already cases of mathematicians who would not come back from abroad because they did not want to accept such a W-position. Apparently we are experiencing the reverse effect to that which was originally envisaged.

Do you think that a professorship at a German university today is less attractive than in previous times?
One should not be too pessimistic. An enthusiastic and energetic person can still move a lot. One has to have new ideas, because many good things already exist. In my times they did not exist and had to be developed, especially concerning conferences and visiting mathematicians. Besides the new ideas one can improve and extend that which already exists. This is a challenge. But there will always be more obstructions than in the old times.

Do you not have the feeling, looking back at the last twenty years, that there have been permanent cuts at the universities and that the situation has deteriorated considerably?
Of course, the situation is worse now. A new arrival can still try to do his/her best, but several conditions have deteriorated. The W-positions are a problem. I would certainly not have returned to Germany for a junior professorship at the age of 28 in 1956. It seems to be more difficult to get a sabbatical and thus to be able to concentrate on research and to improve international contacts. Previously, it was easier to get permanent positions for excellent young people. On the other hand, there are more grants nowadays, like postdoc stipends. Bureaucracy has certainly worsened. At the end of the sixties there were "democratic" reforms that affected our work load because of endless discussions. You could view this as a sickness, as trouble for the soul. In Oberwolfach people used to talk about mathematics; but now they discussed percentages in committees and faculty boards instead: so many percent for the scientists, so many for the students and so many for non-scientific staff… We have overcome these times, but the number and the length of board meetings are still a big nuisance and there are further bureaucratic troubles coming from other directions.

Many complain that the new structure of courses of study (Bachelors/Masters) takes too much effort.
It was also necessary to work on reforms in former days. And then a reform had to be reformed again or cancelled in order to preserve the quality of teaching and research as much as possible. It may be that reforms nowadays are an even heavier burden than before. Teaching may become more complicated and less free. We do not know whether the Bachelor's degree will prove useful in practice or whether the Master's degree will have more or less the same quality as our diploma.

Mathematics – pure and applied

It seems that science has to justify itself mainly through results and applications today.
There are many more evaluations today. There is a danger of exaggeration. But sometimes evaluations can be quite useful. It can be quite helpful to be forced to write things up or to give a survey of past years. In this way it is possible to show that pure mathematics can give interesting results and that one's opportunities have been used in an optimal way. In that sense I have taken the evaluations of the SFB in a positive way. When we write our reports, we do not talk about relations to applications; we write that we have obtained progress in good, beautiful, interesting mathematics. But we are asked more often, "What is it good for, what you are doing?" One may say that mathematics is used everywhere. In my speech at the 100th anniversary of the German Mathematical Society (DMV) I said that already Felix Klein had talked about the nucleus of mathematics that radiates everywhere. The federal ministry decided in 1990, as a birthday present to the DMV, to promote mathematics directly from the ministry's funds in addition to promotion through the Deutsche Forschungsgemeinschaft (DFG). These funds were to be used for mathematics in relation to applications in the sense that research itself should already be linked to

applications, as it is the case, for example, with the Fraunhofer-Institut für Techno- und Wirtschaftsmathematik.

Do you have an interest in mathematics at these institutes?
I find it fascinating that such institutes exist and to see that mathematics is also promoted there.

Do you think that applied mathematics is more successful in that they were able to found new institutions in recent years?
Well, pure mathematics had previously been expanding, whereas applied mathematics held back. In Bonn, one can see that applied mathematics has recovered with respect to institutions. We have the SFB 611 with a very applied orientation. The SFB for theoretical mathematics, established in 1969, was turned into the MPI and there was no SFB to succeed it. But within applied mathematics, the SFB 611 is the third SFB. Moreover, Professor Griebel has built up a department for numerical simulation as an independent institution, comprising several professorships. Applied mathematics in Bonn and elsewhere has been very successful in developing its own institutions. There was originally a critical attitude with respect to theoretical computer science in Bonn. Some pure mathematicians believed that it was not very deep from a mathematical point of view, but that is difficult to say. Nowadays, computer science in Bonn is an active, healthy and comprehensive subject.

The German Mathematical Society – past and future

During your career, you have witnessed German postwar history and you have shaped quite a lot of mathematics. You were president of the German Mathematical Society at two very important occasions: in 1961, the year of the construction of the Berlin Wall, and again during the reunification. Could you tell us about your most significant reminiscences?
The annual conference of the DMV in 1961 took place in Halle in the GDR (the former German Democratic Republic, East Germany). It was the last unified conference, just after the construction of the Wall. In Halle, I was elected as a member of the executive committee, which then elected me as president. In fact, I had to organise two meetings for the committee under my presidency. At that time there was no place in Germany where all the members could meet. West Berlin members were not allowed to go to East Berlin and members from East Berlin could neither go to West Berlin nor to West Germany whilst West Germans could still go everywhere. So I organised two meetings on consecutive days, the first in East Berlin and the second in West Berlin. I described this period when I received my honorary doctorate at the Humboldt University in Berlin in 2000 (*Sitzungsberichte der Berliner Mathematischen Gesellschaft 1997–2000.*)

When I was considered as future president of the DMV back in 1988, the preparation of the 100th anniversary of the DMV in 1990 was in the foreground. Nobody had any inkling at that time that this would also be the year of the German reunification. I had been told that my only duty would be to give a speech at the anniversary congress; everything else would be taken care of. But it turned out that I had to work quite a lot for East-West unification. Quite often I went to Berlin for consultations with the mathematical society of the GDR. That society was then dissolved, its members joining the DMV. I received the last medal of merit of the mathematical society of the GDR. The institutes of the Academy of Sciences of the GDR were dissolved, some of them reopened at their old premises. In particular, the Weierstrass-Institut was closed and then reopened; I was a member of the responsible committee. Nowadays the Weierstrass-Institut is an institute of the Leibniz Society. I was also a member of the structure and appointment committee of the department of mathematics at Humboldt University. Moreover, I participated in the set-up of mathematics at Potsdam University. I also worked for the foundation of the Max Planck Institute for Mathematics in the Sciences in Leipzig.

What are the challenges for the DMV today? What should its president do?
It is important to nurture a positive image of mathematics in public, like Professor Beutelspacher's museum in Giessen. You can arrange lectures for the public; the Berlin mathematicians gave a good example with their evening lectures at the Urania. The DMV should give support and advice to open door arrangements at university departments and at both MPI in Bonn and Leipzig. The DMV could also recommend guidelines to mathematics departments, for example regarding university reforms and the development of Bachelors and Masters study courses. It saves energy if not every department has to work out every single detail.

Right now most members of the DMV are university mathematicians. It has been a long time goal to encourage other people to join the DMV, for example teachers and mathematicians in industry.
I find it important to enlist the particularly interested mathematicians teaching in secondary schools in order to improve contacts with the schools, to promote the advancement of mathematics in these schools and to fight against unhealthy developments. And why not also mathematicians working in industry or in research departments? Or people who have studied mathematics and who are now working in the banking sector or as administrators but would like to keep mathematics as a hobby? They could get many suggestions from the DMV and they could help the DMV in various ways.

Do you also have a vision for the European Mathematical Society?
First of all, as with the German Mathematical Society, raising public awareness. In addition, it is important on the European level to improve relations between member countries and between various mathematical areas. The EMS has tried to act not only as a pure mathematics society but to comprise all of mathematics. Originally it was an important European task to develop contacts with

mathematicians in the former Soviet Union and to help those that had no money to send people abroad. [See the interview by Bodil Branner in the EMS Newsletter of September 1998. This interview also covers other topics of the present interview.]

Thank you very much for the conversation.

Wolfgang Lück studied mathematics and physics at Göttingen University (Germany). After a period as associate professor at the University of Kentucky, Lexington, USA, he returned to Germany, first to the Johannes-Gutenberg-Universität at Mainz. Since 1996, he has been a professor of mathematics at Westfälische Wilhelms-Universität at Münster. He stayed in this position in spite of calls to Bonn University and to ETH Zürich. In 2003, he was awarded the Max-Planck-Forschungspreis for his research results. He is elected vice-president of the German Mathematical Society, starting in office in 2006.

His main interests in mathematics are centred on topology, K-theory, non-commutative geometry and global analysis. In his spare time, he has been an active sportsman; soccer and sailing are his primary areas. His family includes his wife Sybille, two daughters and two sons.

Vasco Alexander Schmidt received his Diplom (master) degree in mathematics in 1996 and his Dr.phil. in linguistics in 2002, both from Freie Universität in Berlin. Since 1996 he has worked as a freelance science writer. In 2002, he joined the German software company SAP AG, currently working as a tech writer in the Research and Development area for banks.

The original German version of this interview appeared in "DMV-Mitteilungen" 13(3), pp. 183–187, of the German Mathematical Society. The Newsletter thanks the editors for the permission to reproduce this translation; thanks for help with the translation to English are due to Jette Matthiesen (Aalborg) and to Chris Nunn (Southampton).

Moreover, the Newsletter wishes to thank the editors of the CIM Bulletin from the Portuguese Centro Internacional de Matemática for their permission to republish the interview "Breakfast with John Horton Conway" in the last issue of the Newsletter.

ERCOM: Stefan Banach International Mathematical Center

The location of the Banach Center till 2001

Stefan Banach

The idea of creating an international mathematical Center was entertained for many years by mathematicians from Central and Eastern European countries. On 13th January 1972, after long discussions and negotiations, a contract was signed in Warsaw between the Academies of Sciences of Bulgaria, Czechoslovakia, GDR, Hungary, Poland, Romania and the USSR, creating the Stefan Banach International Mathematical Center (briefly called the Banach Center). Later the Academies of Vietnam (1979), Cuba (1984) and North Korea (1986) joined the agreement.

From the beginning, the Banach Center was part of the Institute of Mathematics of the Polish Academy of Sciences and was completely financed by the Polish authorities. The purpose of the Center was the promotion and intensification of international cooperation in mathematics, especially between the East and West. In the 1970s and the 1980s, the importance of contacts between the East and West was growing and Poland seemed to be the right choice of site because of its geographical location and its cultural and mathematical traditions.

Semesters and workshops

During the first twenty years of its existence (1972–1992), under the leadership of Czesław Olech, the Banach Center gained world-wide recognition as a Center of collaboration for mathematicians from all over the world. The main forms of activity were three to four month long semesters devoted to various areas of mathematics. Within the period 1972–1992 there were forty such semesters. Although the Center was founded in 1972, its activity started in the spring of 1973. The first two semesters in 1973 were Mathematical Logic organized by A. Grzegorczyk and Mathematical Control Theory organized by R.V. Gamkrelidze and C. Olech. It is impossible to choose the most important semesters from the first twenty-year period; they covered practically all areas of mathematics and each of them made a significant contribution to the development of the respective field. As examples we mention the semesters on approximation theory in 1975 and 1986 organized by Z. Ciesielski, on mathematical physics in 1983 organized by A. Trautman, and on theoretical physics in 1988 organized by I. Białynicki-Birula. The topics of mathematical modelling and numerical analysis attracted considerable interest during the semesters directed by A.N. Tikhonov (1975 and 1980) and N.S. Bakhvalov (1987 and 1991).

From 1993 this form of activity has been replaced by shorter mini-semesters and workshops. In 1993 the agreement of the Academies was terminated and a letter of intent was signed on co-operation with the European Mathematical Society (EMS) adding new perspectives to the activities of the center, including intensive workshops and symposia, conferences, and research groups. Special emphasis is made on the interaction of different fields of mathematics and interdisciplinary meetings. Among more recent conferences one could mention: Number Theory (1997) in honour of the 60th birthday of Andrzej Schinzel, Algebraic Geometry (1998) on the occasion of the 70th birthday of F. Hirzebruch, Functional Analysis (2002) to celebrate A. Pełczyński's 70th birthday and the Alfred Tarski Centenary Conference (2001). The symposia on ergodic theory organized in 1995, 1999 and 2002 by F. Przytycki, knot theory in 1995 and 2003, a series of symposia and workshops on singularity theory and geometry and topology of caustics organized by S. Janeczko and a school on noncommutative geometry and quantum groups in 2001 have attracted great interest from the mathematical community. From modern trends of applications of mathematics we recall the conferences and workshops: Public-Key Cryptology and Computational Number Theory (2000), Mathematical Modelling of Population Dynamics (2002) and Analysis of Random Markets: Products and Prices (2003).

Directors and Council

Since 1992 the director of the Institute of Mathematics of the Polish Academy of Sciences has also been the director of the Banach Center, with one of his deputies (scientific director) in charge of the Banach Center's activities. The directors of the Banach Center have been Bogdan Bojarski (1992–2002) and Stanisław Janeczko (2002–).

The scientific program of the Banach Center is determined by the Scientific Council. From 1972 to 1993, the council consisted of two representatives of each signatory academy of sciences plus the director of the Center. Since 1993, the council has had three representatives from the EMS, three representatives from the countries that were founders of the Center and four representatives from Poland. The council meets periodically (usu-

The IMPAN building in Śniadeckich

ally once per year) and agrees upon the main activities of the Banach Center. The former chairmen of the Scientific Council are Lubomir Iliev (Bulgaria) 1972–1976, Akos Csaszar (Hungary) 1977–1980, Klaus Matthes (East Germany) 1981–1982, Kazimierz Urbanik (Poland) 1983–1986, Romulus Cristescu (Romania) 1987–1989, Sergei M. Nikolskii (USRR) 1990–1992, Friedrich Hirzebruch (Germany) 1993–2001 and Rolf Jeltsch (Switzerland) (2002–2005). Parts of the scientific activities of the Banach Center have been recorded in the Banach Center Publications series. It is a series of proceedings volumes containing research and survey papers. Already sixty eight volumes have appeared in the series.

Buildings

In the period 1972–2001 the Banach Center was located in an old baroque building on Mokotowska Street in downtown Warsaw.

In June 2001, the building was returned to the previous owners and consequently the Banach Center moved to the fourth and fifth floor of a reconstructed building on the main premises of the Institute of Mathematics of the Polish Academy of Sciences at 8 Sniadeckich Street. Count J. Potocki donated the building to the Societas Scientiarum Varsoviensis in 1911. In 1913, Maria Curie-Skłodowska organized a radium laboratory there that worked until 1939. In 1948 the State Mathematical Institute, which in 1952 transformed into the Institute of Mathematics of the Polish Academy of Sciences, was located in this building.

Beginning in 2001, larger Banach Center conferences and workshops have been organized at the conference Center in Będlewo. In 1997, the Institute of Mathematics acquired a neogothic palace and a nine hectare park in the village of Będlewo near Poznań and built a number of hotel and conference pavilions there.

The palace in Będlewo was built by Bolesław Potocki in 1866. On the ground floor, some historical rooms are used for conferences and meetings and part of the basement and the ground floor serves as dining rooms for guests, including some rooms with beautiful ceilings.

The hotel and conference pavilions are situated near the palace and some are conversions of old farm buildings.

Larger scientific events such as conferences and workshops are organized in Będlewo where there are four lecture rooms and single and double rooms for 120 participants.

Smaller Banach Center workshops, research groups and seminars are usually organized in Warsaw, on the fourth floor of the building on Śniadeckich Street, making use of the main auditorium hall, a small cafeteria and the Banach Center Office. The building also has lodging facilities (eighteen small apartments) on the fifth and sixth floors.

An important factor that stimulates research in Warsaw is the Central Mathematical Library, which is located on the second floor of the building on Śniadeckich Street, with over 70,000 volumes and over 650 current journal titles, including Internet access to over 230 journals.

Activities. Applications

The basic forms of activity of the Banach Center are semesters or mini-semesters devoted to various subjects of mathematics, conferences, workshops, research groups, i.e. meetings of small groups devoted to a particular scientific problem, topical forums (regular conferences devoted to specialized subjects generally organized every two years), Banach Center Conversatoria (lectures by leading specialists), instructional lectures for PhD students, i.e. condensed courses by renowned specialists.

For meetings of at least twenty participants, an application should be sent by email to the Banach Center Office (office@impan.gov.pl) before the end of March, to be evaluated by the Scientific Council of the Banach Center (which usually meets in May). Applications for smaller meetings can be sent at any time to the Banach Center Office and are evaluated by the scientific director in charge of the Banach Center.

Information about applications can be found at http://www.impan.gov.pl/BC/.

It is expected that each conference/workshop will have a Polish representative in the organizing committee.

The Scientific Council of the Banach Center (for the period 2002–2005) consists of:

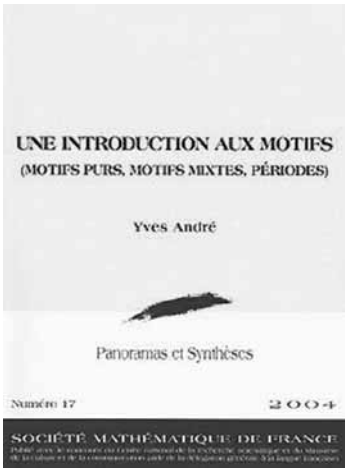
Piotr Biler (Wrocław),
Andrei Bolibrukh, since 2004 Sabir Gusein Zade (Moscow),
Stefan Jackowski (Warsaw),
Rolf Jeltsch (Zurich) – chairman,
Jerzy Kaczorowski (Poznań),
Olli Martio (Helsinki), since 2005 Carlo Sbordone (Pisa),
Marta Sanz-Solé (Barcelona),
Jan Slovak (Brno),
Vera T. Sos (Budapest),
Łukasz Stettner (Warsaw) – scientific director in charge of the Banach Center.

In recent times, the Banach Center has organized between 22 and 28 conferences and workshops per year (16-20 of them in the conference Center in Będlewo). The activities of the Banach Center are financed by the Institute of Mathematics, Polish Academy of Sciences.

A list of selected conferences and workshops organized by the Banach Center in 2006 can be found at http://www.impan.gov.pl/BC/.

Book review

Ignasi Mundet i Riera (Barcelona, Spain)



Yves André
Une introduction aux motifs – (Motifs purs, motifs mixtes, périodes)
Panoramas et Synthèses 17 (2004), xii+261 pages
SMF – Société Mathématique de France.
ISBN: 2-85629-164-3, ISSN: 1272-3835

The notion of motive in algebraic geometry was introduced in the 60's by Grothendieck as a way to systematize and explain the essential properties of the cohomology of algebraic varieties. Motives are expected to provide a universal cohomology theory giving rise by the choice of a realization to all existing Weil cohomologies such as Betti, étale or crystaline cohomology, and all universal properties of such cohomologies should reflect properties of motives. A key idea of Grothendieck is that the category of motives should be constructed using algebraic cycles (endowed with a suitable equivalence relation) to define morphisms as correspondences. Motives have been a constant and fruitful source of inspiration in the development of algebraic geometry of the latest decades, and although their most important properties conjectured by Grothendieck remain so far unproved, there have been several very important advances in the last 15 years which have begun to displace motive theory away from a completely conjectural status.

This book is an excellent exposition addressed to the nonspecialist giving a general overview of the present status of the theory of motives, including a careful explanation of the exciting recent developments on motivic cohomology. The book is divided in three parts: pure motives (projective smooth varieties), mixed motives (arbitrary varieties), and periods (an example of application of the ideas of motives).

The first part begins with an introductory chapter, briefly explaining the ideas and results which led to the notion of motive: enumerative geometry, cohomology of algebraic varieties (considered by Weil as a tool to prove his conjectures on zeta functions of varieties over finite fields) and Galois theory. The next two chapters present the notions and results on which the definition of Grothendieck's pure motives is based: Chapter 2 reviews Tannakian categories, and Chapter 3 deals with algebraic cycles and several possible equivalence relations among them (including both the classical rational, algebraic, homological and numerical equivalences, denoted by $\sim_{\mathrm{rat}}, \sim_{\mathrm{alg}}, \sim_{\mathrm{hom}}, \sim_{\mathrm{num}}$, and the not so classical nilpotent equivalence $\sim_{\mathrm{nil}}$ introduced by Voevodsky). In Chapter 4 Grothendieck's pure motives are defined for any of the possible equivalence relation between cycles, and some main properties (such as functoriality and universality of Chow motives) are explained. The chapter finishes with Jannsen's famous result, conjectured by Grothendieck, that the category of numerical motives, which *a priori* is only pseudoabelian, is in fact abelian and semisimple. The proof of this result (which appeared in the beginning of the 90's) was a big surprise since, in contrast to what was expected, it avoided using any of the standard conjectures.

Chapter 5 is devoted to the standard conjectures: the conjecture of Künneth type, which claims that the projections from the cohomology ring to each of its homogeneous components is given by an algebraic correspondence, and which implies that homological motives carry a natural graduation (the weight); the conjecture of Lefschetz type, saying that the isomorphism in hard Lefschetz theorem comes from an algebraic correspondence; the conjecture of Hodge type about the positivity of a certain pairing defined on the space of cycles up to homological equivalence; and the standard conjecture $\sim_{\mathrm{hom}}=\sim_{\mathrm{num}}$ (which implies that the category of numerical motives provides a universal cohomology theory, in the sense that any Weil cohomology functor factors through it). The relations among these conjectures are carefully explained, as well as the present status of knowledge about each of them.

Chapter 6 is devoted to the motivic Galois group. Assuming the standard conjecture $\sim_{\mathrm{hom}}=\sim_{\mathrm{num}}$, any choice of Weil cohomology gives a fibre functor on the Tannakian category of numerical motives (endowed with a twisted product *à la Koszul*, so as to make the rank of any object a positive integer), and the motivic Galois group is the group of automorphisms of this functor, which is pro-reductive because the category of numerical motives is semisimple. The motivic Galois group is a vast generalization of the absolute Galois group (which arises applying this construction to the category of zero-dimensional motives) and is intimately related with algebraic cycles. Considering the category of motives generated by a given variety X one obtains the motivic Galois group of X, whose knowledge gives a lot of information about algebraic cycles on X and its cartesian powers.

The most powerful available techniques to compute motivic Galois groups are based on the plenitude conjectures (which include the famous Hodge and Tate conjectures), to which Chapter 7 is devoted. The Weil cohomology of a given variety comes usually equipped with a richer structure than that of a graded ring (e.g. the Galois action on étale cohomology), hence it takes values in a tensor category $\mathcal{A}$ having such enriched rings as objects. The plenitude conjectures say that the functor from the homological motives to $\mathcal{A}$ is full. They imply that the motivic Galois group coincides with the Tannakian group of $\mathcal{A}$ with fibre functor the forgetful functor to the category of vector spaces. Chapter 7 also explains Grothendieck's conjecture about the relation among periods

of varieties. In Chapter 8 the problem of effectivity (whether a given pure motive is isomorphic to an effective motive) is addressed, as well as its relation with a generalization of Hodge and Tate conjectures.

Chapters from 9 to 13 are devoted to recent developments on the theory of pure motives: results (due to André and Kahn) on how to avoid the standard conjectures by modifying the definition of the category of motives (e.g. using *cycles motivés*, defined by inverting formally the isomorphism in Lefschetz's hard theorem) and some applications (e.g. to the motivic nature of parallel transport); conjectures of Bloch–Beilinson and Murre about the existence of certain natural filtrations on the Chow ring of smooth projective varieties, and Voevodsky's conjecture $\sim_{\mathrm{nil}}=\sim_{\mathrm{num}}$ (implying in particular the standard conjecture $\sim_{\mathrm{hom}}=\sim_{\mathrm{num}}$), and relations among them (results of Jannsen and O'Sullivan); results about the structure of the category of motives for general equivalence relation on cycles (work of O'Sullivan and others); and finally, construction of the virtual pure motive of an arbitrary variety (works of Gillet–Soulé and Guillén–Navarro-Aznar).

The second part of the book begins in Chapter 14 with some general considerations about extending the notion of pure motive (associated to smooth projective varieties) to that of mixed motive (arbitrary varieties). A first observation is that while the notion of weight in pure motives corresponds to a graduation, for mixed motives it should correspond to a non necessarily split filtration (as is the case of mixed Hodge structures). Thus there is no point in expecting the category of mixed motives to be semisimple as that of pure numerical motives.

Generalizing the constructions described in the first part of the book, one would like to build a category of mixed motives and give a notion of mixed Weil cohomology which works for arbitrary varieties and which plays the role of realizations of mixed motives. The first task remains for the moment unsolved. In fact, there has been so far no construction, not even conjectural, of the category of mixed motives along the lines of Grothendieck's definition of pure motives, and there are some reasons (related to the Koszul sign rule necessary for the category to be Tannakian) to expect that this cannot be done, see §21.1.2. In contrast, Deligne suggested that instead of constructing the abelian category of mixed motives, it should be easier to construct the corresponding derived category, through which all realization functors should factor. This has recently been done independently by Hanamura, Levine, Rost and Voevodsky, and the resulting triangulated categories have been proved to coincide (in some cases after tensoring by $\mathbf{Q}$). Passing from Weil cohomologies to mixed Weil cohomologies is not an obvious problem: one would expect that a mixed Weil cohomology theory satisfies properties like homotopy invariance $H(X)\simeq H(X\times\mathbf{A}^1)$ and Mayer–Vietoris, but these properties are completely absent in the definition of Weil cohomology because they necessarily involve non projective varities. An example of mixed Weil (co)homology, which has played a prominent role in the work of Voevodsky, has been constructed by Suslin inspired by Dold–Thom's theorem on the relation between homotopy and homology groups.

Chapters 15 to 17 describe the construction of Voevodsky's triangulated category $DM_{\mathrm{gm}}(k)$ of mixed motives over a field k and of motivic cohomology. One begins with the category $\mathcal{L}(k)$ of smooth k-schemes of finite type, and defines its linearization $c\mathcal{L}(k)$ by extending the notion of morphism to finite correspondences. This allows to define the homotopy category $\mathcal{H}^b(c\mathcal{L}(k))$ of bounded complexes with coefficients in $c\mathcal{L}(k)$. The triangulated category $DM_{\mathrm{gm}}^{\mathrm{eff}}(k)$ of effective mixed motives is constructed as the pseudo abelian envelope of the quotient of $\mathcal{H}^b(c\mathcal{L}(k))$ by the smallest thick subcategory containing certain complexes associated to Mayer–Vietoris pairs and complexes of the form $X\times\mathbf{A}^1\to X$ for any object $X\in c\mathcal{L}(k)$. One has a canonical functor $M:\mathcal{L}(k)\to DM_{\mathrm{gm}}^{\mathrm{eff}}(k)$ which sends a variety X to the class represented by the complex $X[0]$. Furthermore, for any variety X the morphism $M(X\times\mathbf{A}^1)\to M(X)$ is an isomorphism (homotopy invariance) and M gives rise for any covering $X=U\cup V$ to a distinguished triangle (Mayer–Vietoris). Finally, $DM_{\mathrm{gm}}(k)$ is obtained from $DM_{\mathrm{gm}}^{\mathrm{eff}}(k)$ by formally inverting the reduced motive of the projective line. Motivic cohomology $H^i(X,\mathbf{Z}(r))$ is defined as the morphisms in $DM_{\mathrm{gm}}^{\mathrm{eff}}(k)$ from $M(X)$ to $\mathbf{1}(r)[i]$, where $\mathbf{1}(r)=\widetilde{M}(\mathbf{P}^1)[-2]^{\otimes r}$ is a power of the shifted reduced motive of $\mathbf{P}^1$. Chapter 17 finishes with the definition and computation of the first Chern class of a line bundle and a description of $M(\mathbf{P}(\xi))$ for any vector bundle ξ over a variety $X\in\mathcal{L}(k)$.

Chapter 18 states some fundamental properties of $DM_{\mathrm{gm}}(k)$: Gysin formula and a formula for M of a blow up, the fact that in zero characteristic the natural functor $DM_{\mathrm{gm}}^{\mathrm{eff}}(k)\to DM_{\mathrm{gm}}(k)$ is fully faithful, the relation with the category of Chow motives $CHM(k)$ through a fully faithful functor $CHM(k)^{\mathrm{op}}\to DM_{\mathrm{gm}}(k)$, a duality theorem *à la* Poincaré (rigidity of $DM_{\mathrm{gm}}(k)$ as a tensor category), and comparison with Suslin homology groups, with Bloch higher Chow groups and with algebraic K-theory. The proofs of Chapter 18 rely on deep results of Voevodsky on the embedding of the category $DM_{\mathrm{gm}}^{\mathrm{eff}}(k)$ within a category of motivic sheaf complexes, and this is explained in Chapter 19. A key role is played by Nisnevich topology (which lies between Zariski and étale topologies). Chapter 20 deals with two examples of mixed motives: Deligne 1-motives and mixed Tate motives.

Chapter 21 comes back to the problem of constructing the category of mixed motives $MM(k)_{\mathbf{Q}}$. Its expected properties are explained: the subcategory of its semisimple objects should coincide with the numerical motives $NM(k)_{\mathbf{Q}}$, it should carry a weight filtration extending the weight graduation of $NM(k)_{\mathbf{Q}}$, and there should be a functor $\mathfrak{h}:\mathcal{V}ar(k)\to MM(k)_{\mathbf{Q}}$ playing the role of a universal mixed Weil cohomology. A possible way to construct $MM(k)_{\mathbf{Q}}$ would be defining a suitable motivic t-structure on the triangulated category $DM_{\mathrm{gm}}(k)$ and taking the corresponding core. The second part of the book finishes with Chapter 22, which discusses the notion of enriched realisation in the mixed case following works of Huber and Levine, the related concept of regulator, and its relation with L function of mixed motives.

The third part of the book explains how the philosophy of motives can be applied to concrete problems in number theory through some conjectures on periods. The periods of a variety are the coefficients of the comparison isomorphism between de Rham and Betti cohomologies, taken with respect to suitable basis of both spaces. Grothendieck conjectured that all

relations between the periods of a smooth projective variety defined over **Q** come from endomorphisms of the motive of its powers. In Chapter 23 this conjecture is extended to the mixed case, and in Chapters 24 and 25 it is shown how all known algebraic relations between values of the Γ function and of polyzeta numbers, all of which are periods of quasiprojective varieties, have an interpretation in terms of mixed motives.

As this review hopefully reflects, André's book contains a huge amount of information. Understandably, there are some subjects directly related to the recent developments of mixed motives which are not discussed the book: notably, the spectacular applications of the triangulated category of mixed motives, such as Voevodsky's proof of Milnor's conjecture. In our opinion the author succeeds wonderfully in his aim of providing an exposition to non experts. The style is often austere, but the reader finds in the text both illuminating details and well explained intuitions. We certainly recommend this book to all those looking for an introduction to the theory of motives and its recent developments.

Ignasi Mundet i Riera [ignasi.mundet@ub.edu] got his PhD in 1999 from the Universidad Autònoma de Madrid and he is currently Assistant Professor at the Departament dÀlgebra i Geometria of the Universitat de Barcelona (Spain). His main interests are in the fields of Gauge Theories and Symplectic Geometry. His work has been mainly related to Hamiltonian actions, Gromov-Witten invariants and Quantum cohomology, moduli spaces of bundles and Higgs bundles, and moduli spaces of representations of the fundamental group of surfaces into Lie groups.

Personal column

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

Awards

One of the 25 EURYI (European Young Investigator) awards from the European Science Foundation ESF in 2005 went to **Snorre Christiansen** (Oslo, Norway) for his work in numerical analysis on the simulation of geometric wave equations.

The Fermat Prize 2005 for Mathematics Research has been awarded jointly to **Pierre Colmez** for his contributions to the study of L functions and p-adic Galois representations and to **Jean François Le Gall** (both Paris-Jussieu) for his contributions to the fine analysis of planar Brownian motion, his invention of the Brownian snake and its applications to the study of non-linear partial differential equations.

The Maurice Audin Prize has been given by the French Societies SMF and SMAI to **Anne de Bouard** (CNRS, Paris-Sud) and to **Sidi Mohammed Bouguima** (Tlemcen, Algeria).

The Physics-Astronomy-Mathematics Division of the Special Libraries Association has decided to distinguish by its yearly award the Jahrbuch Project represented by the database editors **Keith Dennis** (Cornell Univ.) and **Bernd Wegner** (TU Berlin), both members of the Electronic Publishing Committee of the EMS.

The Hungarian Academy of Sciences has awarded its János Bolyai International Mathematical Prize to **Misha Gromov** (IHES, Bures-sur-Yvette, France) for his book *Metric structures for Riemannian and non-Riemannian spaces*, published by Birkhäuser Boston, Inc., Boston, MA, 1999.

The 2005 Levitzki Prize in Algebra has been awarded to **Yehuda Shalom** (Tel Aviv, Israel) in recognition of his achievements in the study of discrete subgroups of Lie groups.

The Srinivasa Ramanujan Prize has been awarded (for the first time) in 2005 to **Marcelo Viana**, (IMPA, Brazil), who has made major contributions to the field of dynamical systems.

Giorgio Parisi (Univ. Rome) has been awarded the Dannie Heineman Prize for Mathematical Physics for his fundamental theoretical discoveries in broad areas of elementary particle physics, quantum field theory and statistical mechanics.

The 2005 Spring Prize of the Mathematical Society of Japan (MSJ) was awarded to **Takeshi Tsuji** of the Tokyo University for his distinguished contributions to the study of p-adic Hodge Theory.

The 2005 Algebra Prize of MSJ was awarded to **Kohji Matsumoto** of Nagoya University for his outstanding contribution to the study of the analytic behaviour of zeta functions and to **Iku Nakamura** of Hokkaido University for his outstanding contribution to the study of moduli spaces of abelian varieties and the Hilbert Scheme.

Lucien Birgé (Univ. Paris VI) has been awarded the 2005 L.E.J. Brouwer Medal of the Royal Dutch Mathematical Society for his research on fundamental aspects of the asymptotic theory of statistics.

Frank den Hollander, scientific director of EURANDOM and chair of probability at Eindhoven University of Technology and Leiden University, has been elected to the Royal Dutch Academy of Sciences.

Stanisław Janeczko (Warsaw) was awarded the Ważewski Great Prize of the Polish Mathematical Society for his research papers on symplectic geometry and singularities.

Łukasz Stettner (Warsaw) was awarded the Steinhaus Great Prize of the Polish Mathematical Society for his papers on applied mathematics and his important contributions to the development of applied mathematics in Poland.

Grzegorz Bobiński and **Tomasz Schreiber** (both Toruń) were awarded the Kuratowski Prizes.

Wojciech Kryński and **Piotr Przytycki** (both Warsaw) were awarded the first Marcinkiewicz Prizes of the Polish Mathematical Society for students' research papers.

Benoit Mandelbrot (Yale Univ.) was awarded the Sierpiński Medal (given by the Warsaw Branch of the Polish Mathematical Society and Warsaw University).

The Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel 2005 was awarded to **Robert J. Aumann** (Jerusalem, Israel) and to **Thomas C. Schelling** (Maryland, USA) for having enhanced our understanding of conflict and cooperation through game-theory analysis.

The Schock Prize in Logic and Philosophy was awarded to **Jaakko Hintikka** (Boston Univ.) for his pioneering contributions to the logical analysis of modal concepts. The Schock Prize in Mathematics was given to **Luis A. Caffarelli** (Univ. of Texas, Austin) for his important contributions to the theory of nonlinear differential equations.

A portrait entitled "Prof **Bernard de Neumann** – The Mathematician" by John Wonnacott, won the Royal Society of Portrait Painters' annual show (2005) at the Mall Galleries, The Mall, London.

Sir Michael Berry, FRS, of the University of Bristol was awarded the Pólya Prize in recognition of his many profound and highly innovative contributions to diverse areas of mathematics and mathematical physics.

Ben Green of the University of Bristol was awarded a Whitehead Prize for his breakthrough results in combinatorics and combinatorial number theory. He has also received the Salem Prize for 2005.

Bernd Kirchheim of the University of Oxford was awarded a Whitehead Prize for his fundamental work in several areas of real analysis. **Neil Strickland** of the University of Sheffield was awarded a Whitehead Prize for his contributions to algebraic topology. **Peter Topping** of the University of Warwick was awarded a Whitehead Prize for his work on non-linear partial differential equations in geometric analysis.

Iain Gordan of Glasgow University was awarded the Berwick Prize for his paper 'Baby Verma modules for rational Cherednik algebras', published in the Bulletin of the LMS 35 (2003), 321–336.

Keith Moffatt, FRS, of the University of Cambridge was awarded the Senior Whitehead Prize for his outstanding contributions to applied mathematics, especially in the field of theoretical fluid mechanics.

Deaths

We regret to announce the deaths of:

Isabelle Attali (France, 26.12.2004)
Bernd Aulbach (Germany, 14.1.2005)
Hayk Badalyan (Armenia, 27.10.2004)
Stanisław Balcerzyk (Poland, 5.3.2005)
Helmut Florian (Austria, 13.5.2005)
Haya Freedman (UK, 19.7.2005)
Herbert J. Godwin (UK, 4.4.2005)
Jack van Lint (Netherlands, 28.9.2004)
Mircea Mișicu (Romania, 23.3.2005)
Douglas Northcott (UK, 8.4.2005)
Leopold Schmetterer (Austria, 24.8.2004)
Lee A. Segel (Israel, 31.1.2005)
Igor V. Skrypnik (Ukraine, 2.2005)
Friedrich Stummel (Germany, 17.2.2005)
Sauro Tulipani (Italy, 8.3.2005)
Dimitrie Ugrin-Sparac (Croatia, 24.12.2004)
Kazimierz Urbanik (Poland, 29.5.2005)

Solved and Unsolved Problems

Themistocles M. Rassias (Athens, Greece)

Inspired by the success of the "Problem Corner" of this Newsletter, a new column entitled "Solved and Unsolved Problems" will appear in this journal, aimed primarily at university students and mathematics educators.

In his 1900 lecture to the International Congress of Mathematicians in Paris, David Hilbert concluded as follows:

"The problems mentioned are merely samples of problems, yet they will suffice to show how rich, how manifold and how extensive the mathematical science of today is, and the question is urged upon us whether mathematics is doomed to the fate of those other sciences that have split up into separate branches, whose representatives scarcely understand one another and whose connection becomes ever more loose. I do not believe this nor wish it. Mathematical science is in my opinion an invisible whole, an organism whose vitality is conditioned upon the connection of its parts. For with all the variety of mathematical knowledge, we are still clearly conscious of the similarity of the logical devices, the relationship of the ideas in mathematics as a whole and the numerous analogies in its different departments. We also notice that the farther a mathematical theory is developed, the more harmoniously and uniformly does its construction proceed and unsuspected relations are disclosed between hitherto separate branches of the science."

Following David Hilbert's ideas on the tight interaction of the various mathematical branches (as well as similar ideas of other eminent mathematicians of all times), we introduce this new "Solved and Unsolved Problems" column in the spirit of unification of mathematics, BUT each issue will concentrate on a specific branch of mathematics. Specifically, the problems presented and their solutions (which will follow in subsequent issues of the Newsletter) will focus on a particular subject in each issue, such as problems in Mathematical Analysis, Algebra, Number Theory, Topology, Geometry, Discrete Mathematics and Applications. In addition, in this new "Solved and Unsolved Problems" column, we also include two open problems in a simple and widely understood formulation. This will hopefully stimulate young university students to test their abilities in original research and cultivate their ambition.

It should be emphasized here that we do not separate pedagogy from research. After all, the great ones developed their theories based on specific exercises, examples or counterexamples.

Four Problems – solutions solicited

Solutions will appear in a subsequent issue.

1. Determine all C^2 functions $f:\mathbb{R}\to\mathbb{R}$ satisfying the functional equation $f(x+y)f(x-y)=f(x)^2+f(y)^2-1$, for all $x,y\in\mathbb{R}$. (W. S. Cheung, Hong Kong)

2. Determine all functions $f:\mathbb{R}^2\to\mathbb{R}$ satisfying the functional equation f(ux - vy , uy - vx) = f(x, y) + f(u, v) + f(x , y) f(u , v) for all $x,y,u,v\in\mathbb{R}$. (P. K. Sahoo, USA)

3. Suppose $f:\mathbf{R^n}\to\mathbf{R^n}(n\geq 2)$ satisfies $\|f(x)-f(y)\|_2=1$ whenever $\|x-y\|_2=1$, and $\|f(x)-f(y)\|_2=2$ whenever $\|x-y\|_2=2$, where $x,y\in\mathbf{R^n}$.
Is it true that $\|f(x)-f(y)\|_2=\|x-y\|_2$, for all $x,y\in\mathbf{R^n}$?
(For $a=(a_1,a_2,\cdots,a_n)\in\mathbf{R^n}$, $\|a\|_2$ denotes the Euclidean norm, namely $\|a\|_2^2=\sum_{i=1}^n a_i^2$). (S. Xiang, China)

4. Suppose $f:\mathbf{R^n}\to\mathbf{R^n}(n\geq 2)$ satisfies $\|f(x)-f(y)\|_2=1$ whenever $\|x-y\|_2=1$, and $\|f(x)-f(y)\|_2=\sqrt{3}$ whenever $\|x-y\|_2=\sqrt{3}$, where $x,y\in\mathbf{R^n}$.
Is it true that $\|f(x)-f(y)\|_2=\|x-y\|_2$, for all $x,y\in\mathbf{R^n}$?
(For $a=(a_1,a_2,\cdots,a_n)\in\mathbf{R^n}$, $\|a\|_2$ denotes the Euclidean norm, namely $\|a\|_2^2=\sum_{i=1}^n a_i^2$). (S. Xiang, China)

Three Problems – solutions included

5. Let $\mathbb{R}_0=\mathbb{R}\setminus\{0\}$. Suppose $s,t\in\mathbb{R}_0$ are two fixed parameters. Find the general continuous solution of the functional equation

$$f(sx)+f(tx)=c \tag{1}$$

for all $x\in\mathbb{R}$, where c is a real constant. (P. K. Sahoo, USA)

Solution by the proposer of the problem. The general solution of the functional equation (1) is

$$f(x) \;=\; \begin{cases} \phi(x)+\frac{c}{2} & \text{if } s=-t \\ \frac{c}{2} & \text{otherwise} \end{cases} \tag{2}$$

where $\phi:\mathbb{R}\to\mathbb{R}$ is an arbitrary continuous odd function.

It is easy to check that (2) satisfies (1). Now we show that (2) is the only solution of (1). If $s=-t$, then from (1), we get $f(-tx)+f(tx)=c$ for all $x\in\mathbb{R}$. Replacing x by $\frac{x}{t}$, we see that $f(-x)+f(x)=c$ for all $x\in\mathbb{R}$. Define $\phi(x)=f(x)-\frac{c}{2}$. Then $\phi(-x)+\phi(x)=0$ for all $x\in\mathbb{R}$. Hence $\phi(x)$ is an odd function in $\mathbb{R}$ and $f(x)=\phi(x)+\frac{c}{2}$.

Next suppose $s=t$. Then from (1), it is easy to see that $f(x)=\frac{c}{2}$. So we find the solution of (1) when $s^2\neq t^2$. We may assume that $t^2<s^2$, and hence $\frac{t^2}{s^2}<1$. Replacing x by $\frac{x}{t}$ in (1), we obtain

$$f(x)+f\left(\frac{s}{t}x\right)=c. \tag{3}$$

Similarly, replacing x by $\frac{x}{s}$ in (1), we see that

$$f\left(\frac{t}{s}x\right)+f(x)=c. \tag{4}$$

Hence from (3) and (4), we have

$$f\left(\frac{s}{t}x\right)=f\left(\frac{t}{s}x\right) \tag{5}$$

for all $x\in\mathbb{R}$. Hence

$$f(x)=f\left(\frac{t^2}{s^2}x\right) \tag{6}$$

for all $x\in\mathbb{R}$. Replacing x by $\frac{t^2}{s^2}x$ in (6) we obtain

$$f(x)=f\left(\left(\frac{t^2}{s^2}\right)^2 x\right). \tag{7}$$

By induction it can be shown that

$$f(x)=f\left(\left(\frac{t^2}{s^2}\right)^n x\right) \tag{8}$$

for all $n \in \mathbb{N}$. Thus

$$f(x) = f\left(\lim_{n\to\infty}\left(\frac{t^2}{s^2}\right)^n x\right) = f(0) \tag{9}$$

since $\frac{t^2}{s^2} < 1$. Using (9) in (1), we have $f(x) = \frac{c}{2}$. ♢

6. Suppose $f \in C^{2n}[a,b]$ satisfies $f^{(k)}(a) = f^{(k)}(b) = 0$ for $k = 0, 1, \ldots, n-1$. Show that

$$\left|\int_a^b f(x)dx\right| \le \frac{(n!)^2 M}{(2n)!(2n+1)!}(b-a)^{2n+1},$$

where $M = \max\left\{|f^{(2n)}(x)| : x \in [a,b]\right\}$.

(W. S. Cheung, Hong Kong)

Solution by the proposer of the problem.
Define $p_n(x) := (x-a)^n(x-b)^n$, $x \in [a,b]$. By integration by parts, we have

$$\begin{aligned}&\int_a^b p_n(x)f^{(2n)}(x)dx\\ &= p_n(x)f^{(2n-1)}(x)\Big|_a^b - \int_a^b f^{(2n-1)}(x)p_n'(x)dx\\ &= -\int_a^b f^{(2n-1)}(x)p_n'(x)dx.\end{aligned}$$

Applying integration by parts again, we have (since $p_n^{(2n)}(x) = (2n)!$)

$$\begin{aligned}&\int_a^b p_n(x)f^{(2n)}(x)dx\\ &= -p_n'(x)f^{(2n-2)}(x)\Big|_a^b + \int_a^b f^{(2n-2)}(x)p_n''(x)dx\\ &= \int_a^b f^{(2n-2)}(x)p_n''(x)dx.\end{aligned}$$

Continuing this process inductively, we have

$$\begin{aligned}&\int_a^b p_n(x)f^{(2n)}(x)dx\\ &= \int_a^b f(x)p_n^{(2n)}(x)dx\\ &= \int_a^b f(x)(2n)!\,dx\\ &= (2n)!\int_a^b f(x)dx.\end{aligned}$$

Hence

$$\begin{aligned}\left|\int_a^b f(x)dx\right| &= \frac{1}{(2n)!}\left|\int_a^b p_n(x)f^{(2n)}(x)dx\right|\\ &\le \frac{M}{(2n)!}\int_a^b |p_n(x)|dx\\ &= \frac{M}{(2n)!}\int_a^b (x-a)^n(b-x)^n dx\\ &= \frac{M(n!)^2}{(2n)!(2n+1)!}(b-a)^{2n+1}.\end{aligned}$$

♢

7. If $0 \le x_1 < x_2 < \cdots < x_n \le 1$ ($n \ge 2$) and $k \ge 1$ is an integer, show that

$$\left[\frac{\Gamma(k+x_2)}{\Gamma(k+x_1)}\right]^{\frac{1}{x_2-x_1}}\left[\frac{\Gamma(k+x_3)}{\Gamma(k+x_2)}\right]^{\frac{1}{x_3-x_2}}\cdots \left[\frac{\Gamma(k+x_n)}{\Gamma(k+x_{n-1})}\right]^{\frac{1}{x_n-x_{n-1}}} \le (k+1)^{n-1},$$

where $\Gamma(\cdot)$ is Euler's Gamma function. (M. Bencze, Romania)

Solution by the proposer of the problem. Let $f(x) = \frac{(k+1)^x}{\Gamma(k+x)}$, $0 \le x \le 1$. Taking the logarithm of both sides and differentiating yields

$$\frac{f'(x)}{f(x)} = \ln(k+1) - \Psi(k+x),$$

where $\Psi(x) = \frac{\Gamma'(x)}{\Gamma(x)}$.

It is known that the psi function Ψ is strictly increasing on the interval $(0,+\infty)$ and that

$$\Psi(x) = \ln x - \frac{1}{2x} - 2\int_0^\infty \frac{tdt}{\left(t^2+x^2\right)\left(e^{2\pi t}-1\right)}.$$

Hence $\Psi(k+x) \le \Psi(k+1) < \ln(k+1)$ which implies $f'(x) > 0$ for $0 \le x \le 1$. Therefore f is increasing.

If $0 \le x_1 < x_2 < \ldots < x_n \le 1$ then $f(x_1) \le f(x_2) \le \ldots \le f(x_n)$ which gives:

$$\frac{(k+1)^{x_1}}{\Gamma(k+x_1)} \le \frac{(k+1)^{x_2}}{\Gamma(k+x_2)} \quad \text{and thus} \quad \left(\frac{\Gamma(k+x_2)}{\Gamma(k+x_1)}\right)^{\frac{1}{x_2-x_1}} \le k+1.$$

Also

$$\frac{(k+1)^{x_2}}{\Gamma(k+x_2)} \le \frac{(k+1)^{x_3}}{\Gamma(k+x_3)} \quad \text{and thus} \quad \left(\frac{\Gamma(k+x_3)}{\Gamma(k+x_2)}\right)^{\frac{1}{x_3-x_2}} \le k+1.$$

$\ldots$

$$\frac{(k+1)^{x_{n-1}}}{\Gamma(k+x_{n-1})} \le \frac{(k+1)^{x_n}}{\Gamma(k+x_n)} \quad \text{and thus} \quad \left(\frac{\Gamma(k+x_n)}{\Gamma(k+x_{n-1})}\right)^{\frac{1}{x_n-x_{n-1}}} \le k+1.$$

Multiplying the above inequalities we obtain

$$\left(\frac{\Gamma(k+x_2)}{\Gamma(k+x_1)}\right)^{\frac{1}{x_2-x_1}}\left(\frac{\Gamma(k+x_3)}{\Gamma(k+x_2)}\right)^{\frac{1}{x_3-x_2}}\cdots \left(\frac{\Gamma(k+x_n)}{\Gamma(k+x_{n-1})}\right)^{\frac{1}{x_n-x_{n-1}}} \le (k+1)^{n-1}.$$

♢

Two Open Problems

8*. Examine if there exists a mapping $T : \mathbf{R^2} \to \mathbf{R^3}$ that preserves unit distance but is not an isometry.

(Th. M. Rassias, Greece)

9*. Let X and Y be normed linear spaces and $T : X \to Y$ be a continuous and/or surjective mapping that preserves unit distance. Is T necessarily an isometry? (Th. M. Rassias, Greece)

We wait to receive your solutions to Problems 1–4 of this issue and ideas on the two open problems. Please send your solutions either by email to trassias@math.ntua.gr or by ordinary mail to Themistocles M. Rassias, Department of Mathematics, National Technical University in Athens, Zografou Campus, GR-15780 Athens, Greece.

We also solicit your new problems with their solutions for the next "Solved and Unsolved Problems" column, which *will focus on inequalities*.

Forthcoming conferences

compiled by Vasile Berinde (Baia Mare, Romania)

Please e-mail announcements of European conferences, workshops and mathematical meetings of interest to EMS members, to one of the following addresses ***vberinde@ubm.ro*** *or* ***vasile_berinde@yahoo.com****. Announcements should be written in a style similar to those here, and sent as Microsoft Word files or as text files (but not as TeX input files). Space permitting, each announcement will appear in detail in the next issue of the Newsletter to go to press, and thereafter will be briefly noted in each new issue until the meeting takes place, with a reference to the issue in which the detailed announcement appeared.*

January 2006

2–6: Third International Conference on Complex Analysis and Dynamical Systems, Galilee, Israel
Information: web site: http://braude.ort.org.il/conference/math2006/

2–February 18: Arithmetic Algebraic Geometry, Erwin Schroedinger International Institute for Mathematical Physics, Vienna, Austria
Topic: Geometry, Algebraic and Complex Geometry
Organizer: Erwin Schroedinger International Institute for Mathematical Physics (Wien, Austria)
Programme Committee: S. Kudla, M. Rapoport, J. Schwermer
Information: e-mail: secr@esi.ac.at;
web site: http://www.esi.ac.at/activities/future-prog.html

5–7: K-Théorie, Homologie cyclique et Opérades. A conference on the occasion of Jean-Louis Loday's sixtieth birthday, Strasbourg, France
Information: web site: http://www-irma.u-strasbg.fr/irma/seminaires/autres/loday/

6: UKIE SIAM Annual Meeting, Cardiff, UK
Information: web site: http://www.ma.hw.ac.uk/~gabriel/ukie-siam/

11–14: Third Sheffield Homotopy Mini-Conference, Sheffield, UK
Information: web site: http://www.shef.ac.uk/personal/p/pm1saw/SHM-C.htm

23–26: Recent Progress in Wavelet Analysis and Frame Theory, Bremen, Germany
Information: e-mail: teschke@math.uni-bremen.de;
web site: http://www.mathematik.uni-marburg.de/~dahlke/ag-numerik/workshop/

23–28: C*-algebras and elliptic theory. II, Banach Center, Będlewo, Poland
Topic: Main topics: K-theory of C*-algebras, index theory, noncommutative geometry, algebras of pseudodifferential operators on singular manifolds, infinite Grassmannians and Fredholm pairs, deformation quantization.
Information: e-mail: bedlewo2006@higeom.math.msu.su;
web site: http://higeom.math.msu.su/bedlewo2006/

February 2006

6–10: Recent Trends in Nonlinear Science 2006, Gijon, Spain
Information: e-mail: rtns2006@dance-net.org;
web site: http://www.dance-net.org/rtns2006/

9–12: 71st Workshop on General Algebra together with 21st Conference for Young Algebraists, Będlewo, Poland
Information: web site: http://www.math.tu-dresden.de/~aaa/

12–15: Fractal2006, Vienna, Austria
Topic: Complexity and Fractals in Nature; 9th International Multidisciplinary conference
Information: web site: http://www.kingston.ac.uk/fractal

13–17: Barcelona Conference in Planar Vector Fields, Centre de Recerca Matemática, Bellaterra, Spain
Information: e-mail: PlanarVectorFields@crm.es;
web site: http://www.crm.es/PlanarVectorFields
[For details, see *EMS Newsletter 57]*

20–25: Advanced Course on Arakelov Geometry and Shimura Varieties, Centre de Recerca Matemática, Bellaterra, Spain
Information: e-mail: ShimuraVarieties@crm.es;
web site: http://www.crm.es/ShimuraVarieties
[For details, see *EMS Newsletter 57]*

27–May 12: Diophantine Approximation and Heights, Erwin Schroedinger International Institute for Mathematical Physics, Vienna, Austria
Information: e-mail: secr@esi.ac.at;
web site: http://www.esi.ac.at/activities/future-prog.html

March 2006

1–July 31: Stochastic Analysis, Stochastic Partial Differential Equations and Applications to Fluid Dynamics and Particle Systems, Centro Di Ricerca Matematica Ennio De Giorgi, Pisa, Italy
Information: e-mail: crm@crm.sns.it;
web site: http://www.crm.sns.it/stochastic/

April 2006

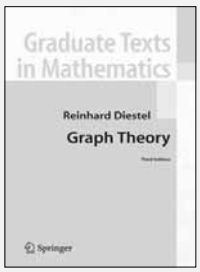
20-22: Workshop on Logic, Models and Computer Science LMCS06
Information: web site: http://dmi.unicam.it/merelli/LMCS06/

23–May 7: Rigidity and Flexibility, Erwin Schroedinger International Institute for Mathematical Physics, Vienna, Austria
Information: e-mail: secr@esi.ac.at;
web site: http://www.geometrie.tuwien.ac.at/esi/

Springer
the language of science

springer.com

Textbooks from Springer



Graph Theory

R. Diestel, University of Hamburg, Germany

From the reviews of the first two editions (1997, 2000) ► *This outstanding book cannot be substituted with any other book on the present textbook market. It has every chance of becoming the standard textbook for graph theory* ► Acta Scientiarum Mathematiciarum

3rd ed. 2006. XVI, 410 p. (Graduate Texts in Mathematics, Vol. 173) Softcover
ISBN 3-540-26183-4 ► **€ 39,95 | £ 30,50**
Hardcover edition
ISBN 3-540-26182-6 ► **€ 69,95 | £ 54,00**

Analysis I

Convergence, Elementary Functions

R. Godement, Université Paris VII, France

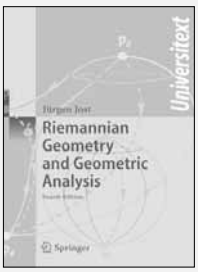
2004. XXI, 430 p. (Universitext) Softcover
ISBN 3-540-05923-7 ► **€ 44,95 | £ 34,50**

Analysis II

Differential and Integral Calculus, Fourier Series, Holomorphic Functions

From the reviews of the original French edition ► *... The content is quite classical ... The treatment is less classical: precise although unpedantic ..., it contains many interesting commentaries of epistemological, pedagogical, historical and even political nature...* ► J. Mawhin in Zentralblatt Mathematik (1999)

2005. VII, 448 p. 20 illus. (Universitext) Softcover
ISBN 3-540-20921-2 ► **€ 44,95 | £ 34,50**



Riemannian Geometry and Geometric Analysis

J. Jost, Max Planck Institute for Mathematics in the Sciences, Leipzig Germany

From the reviews ► *This book provides a very readable introduction to Riemannian geometry and geometric analysis. The author focuses on using analytic methods in the study of some fundamental theorems in Riemannian geometry...* ► Math. Reviews

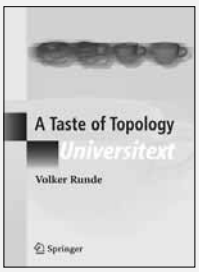
4th ed. 2005. XIII, 566 p. 14 illus. (Universitext) Softcover
ISBN 3-540-25907-4 ► **€ 44,95 | £ 34,50**

Python Scripting for Computational Science

H. P. Langtangen, Simula Research Laboratory, Lysaker, and University of Oslo, Norway

The author teaches you how to develop tailored, flexible, and efficient working environments built from small programs written in Python. The focus is on examples and applications of relevance to computational science.

2nd ed. 2006. Approx. 750 p. (Texts in Computational Science and Engineering, Vol. 3) Hardcover
ISBN 3-540-29415-5 ► **€ 49,95 | £ 38,50**

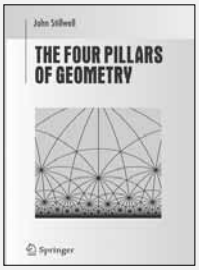


A Taste of Topology

V. Runde, University of Alberta, Edmonton, AL, Canada

The present book grew out of notes for an introductory topology course at the University of Alberta. It provides a concise introduction to set theoretic topology.

2005. X, 176 p. 17 illus. (Universitext) Softcover
ISBN 0-387-25790-X ► **€ 32,95 | £ 25,50**



The Four Pillars of Geometry

J. Stillwell, University of San Francisco, CA, USA

This new textbook approaches geometry in four different ways, spending two chapters on each. This makes the subject accessible to readers of all mathematical tastes, from the visual to the algebraic. Not only does each approach offer a different view; the combination of viewpoints yields insights not available in most books at this level.

2005. XII, 229 p. 138 illus. (Undergraduate Texts in Mathematics) Hardcover
ISBN 0-387-25530-3 ► **€ 39,95 | £ 29,50**

Postmodern Analysis

J. Jost, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany

This is an introduction to advanced analysis at the beginning graduate level that blends a modern presentation with concrete examples and applications, in particular in the areas of calculus of variations and partial differential equations. The third edition contains several improvements including an introduction to covering theorems in analysis.

2005 3rd ed. XV, 371 p. 14 illus. (Universitext) Softcover
ISBN 3-540-25830-2 ► **€ 39,95 | £ 30,50**

Easy Ways to Order for the Americas ► **Write:** Springer Order Department, PO Box 2485, Secaucus, NJ 07096-2485, USA ► **Call: (toll free)** 1-800-SPRINGER ► **Fax:** +1(201)348-4505 ► **Email:** orders-ny@springer.com or **for outside the Americas** ► **Write:** Springer Distribution Center GmbH, Haberstrasse 7, 69126 Heidelberg, Germany ► **Call:** +49 (0) 6221-345-4301 ► **Fax :** +49 (0) 6221-345-4229 ► **Email:** SDC-bookorder@springer.com
► Prices are subject to change without notice. All prices are net prices.

012107x

May 2006

6–11: International conference on Fourier and Complex analysis, classical problems-current view, Protaras, Cyprus
Information: e-mail: skoumand@ucy.ac.cy

8–19: CANT'2006 International School and Conference on Combinatorics, Automata and Number Theory, Liège, Belgium
Information: e-mail: M.Rigo@ulg.ac.be;
web site: http://www.cant2006.ulg.ac.be
[For details, see EMS Newsletter 57]

8–July 31: Gerbes, Groupoids, and Quantum Field Theory, Erwin Schroedinger International Institute for Mathematical Physics, Vienna, Austria
Information: e-mail: secr@esi.ac.at;
web site: http://www.esi.ac.at/activities/future-prog.html

17–19: Conference of Applied Statistics in Ireland, Cork, Ireland
Information: e-mail: kingshuk@stat.ucc.ie

21–25 : Dynamique et alea, Merlimont plage, France
Information: e-mail: frederic.paccaut@u-picardie.fr;
web site: http://www.lamfa.u-picardie.fr/Colloques/alea2006/index.html

25–27: Complex and Harmonic Analysis, Thessaloniki, Greece
Information: e-mail: betsakos@math.auth.gr;
web site: http://www.auth.gr/comhar/

30–June: 8th international Spring School on Nonlinear Analysis, Function Spaces and Applications (NAFSA 8), Prague, Czech Republic
Information: e-mail: nafsa8@math.cas.cz;
web site: http://www.math.cas.cz/~nafsa8; http://adela.karlin.mff.cuni.cz/nafsa/2006
[For details, see EMS Newsletter 56]

31–4 June: EUROMATH-2006: South-Eastern European Conference on Mathematics Education and Applications – 2006, Cyprus
Information: e-mail: makrides.g@intercollege.ac.cy;
web site: http://www.euromath.info;

31–4 June: MASSEE International Congress on Mathematics, MICOM-2006, Cyprus
Information: e-mail: makrides.g@intercollege.ac.cy; web site: http://www.cms.org.cy; http://www.massee-congress2006.info;

June 2006

1–3: International Conference on Computers and Communications, Baile Felix Spa, Oradea, Romania
Topic: ICCC 2006 is organized to celebrate 100 years since the birth of Grigore C. Moisil (1906–1973), the single Romanian scientist who received the "Computer Pioneer" prize awarded by IEEE Computer Society in 1996. General topics of interest include, but are not limited to, the following: 1. Artificial Intelligence 2. Automata and Formal Languages 3. Computational Mathematics 4. Cryptography and Security 5. E-Activities 6. Fuzzy Systems 7. Informatics in Control 8. Information Society – Knownledge Society 9. Natural Computing 10. Network Design & Internet Services 11. Multimedia & Communications 12. Parallel and Distributed Computing
Information: e-mail: idzitac@univagora.ro;
web site: http://www.iccc.univagora.ro/index.htm

4–10: Dynamics, Topology and Computations DyToComp2006, Będlewo, Poland
Information: web site: http://www.ii.uj.edu.pl/DyToComp2006/

5–9 : Workshop on Fourier Analysis, Geometric Measure Theory and Applications, Barcelona, Spain
Information: web site: http://www.crm.es/Research/0506/AnalysisEng.htm

7–9: Boltzmann's Legacy 2006, Erwin Schroedinger Institute for Mathematical Physics, Vienna, Austria
Information: e-mail: secr@esi.ac.at;
web site: http://www.esi.ac.at/activities/Boltzmann2006.html

9–14: Eight International Conference on Geometry, Integrability and Quantization, Sts. Constantine and Elena resort (near Varna), Bulgaria
Information: e-mail: mladenov@obzor.bio21.bas.bg;
web site: http://www.bio21.bas.bg/conference/

13–16: Mathematics of Finite Elements and Applications (MAFELAP 2006), Brunel University, UK
Information: web site: www.brunel.ac.uk/bicom/mafelap2006
[For details, see EMS Newsletter 56]

19–23: Conference "Modern stochastics:theory and applications", Kyiv National Taras Shevchenko University, Kyiv, Ukraine
Information: e-mail: probab.conf.2006@univ.kiev.ua;
web site: http://www.mechmat.univ.kiev.ua/probability/ Events/2006/informletterengl.html
[For details, see EMS Newsletter 57]

21–23: 6th International Conference on Mathematical Problems in Engineering and Aerospace Sciences, Budapest, Hungary
Information: e-mail: info@icnpaa.com; seenithi@aol.com;
web site: www.icnpaa.com
[For details, see EMS Newsletter 56]

23–26: 2006 International Conference on Topology and its Applications, Aegion, Greece
Information: web site: http://www.math.upatras.gr/~aegion/

26–July 8: Course on On Limit Cycles of Differential Equations, Barcelona, Spain
Information: web site: http://www.crm.es/Conferences/0506/Limitcycles/limitcycles.htm

July 2006

7–10: 2nd International Conference "From Scientific Computing to Computational Engineering" (2nd IC-SCCE 2006), Athens, Greece
Information: e-mail: ic-scce2006@upatras.gr;
web site: http://ic-scce2006.upatras.gr

10–12: 6th Meeting on Game Theory and Practice dedicated to development, natural resources and the environment, Zaragoza, Spain
Information: web site: http://www.iamz.ciheam.org/GTP2006/

10–15: Conference on Arithmetic of Shimura Varieties and Arakelov Geometry, Barcelona, Spain
Information: web site: http://www.crm.es/Conferences/0506/ConferenceShimura/conferenceshimura.htm

12–13: Eighth International Workshop on Deontic Logic in Computer Science (DEON2006), Utrecht, The Netherlands
Information: web site: http://www.cs.uu.nl/deon2006/

17–21: Stochastic Processes and Applications (SPA XXXI), Paris, France
Theme: Probability Theory and Applications
Aim: to provide an updated overview of recent developments in probability theory and its applications, Scope: to present the state of the art and design the current trend in the field
Topics: All topics related to probability theory
Plenary speakers: R. Durrett (Cornell), N. El Karoui (Paris), H. Foellmer (Berlin), N. Fournier (Creteil), H. Kesten (Cornell), M. Ledoux (Toulouse), Z. Hu Li (Bejin), S. Meyn (Illinois), T. Mikosch (Copenhagen), E. Mossel (Berkeley), J. San Martin (Santiago), M. Sanz-Sole (Barcelona), T. Speed (Berkeley and Melbourne), M.-E. Vares (Rio de Janeiro), C. Villani (Lyon), B. Virag (Toronto)
Format: Plenary talks, invited talks and contributed presentations during parallel sessions.
Sessions: There will be 16 plenary talks and a large number of parallel sessions (invited and contributed)
Scientific committee: M.F. Chen, A.M. Etheridge, A. Guionnet, E. Numelin, E.A. Perkins, J. Pitman, P. Protter, V. Sidoravicius, A.-S. Sznitman, D. Talay, S. Tavare, B. Toth, E.C. Waymire
Organizing committee: J. Bertoin, M. Chaleyat-Maurel, A. Estrade, E. Le Pennec, S. Meleard, Y. Rozenholc
Location: Centre Universitaire des Saints-Peres of University Paris 5, 45 rue des Saints Peres, F 75005 Paris, France
Deadlines: Registration: May 15th 2006; Abstracts for contributed talks: April 15th 2006
Information: e-mail: spa2006@math-info.univ-paris5.fr;
web site: http://www.proba.jussieu.fr/pageperso/spa06/index.html

18–21: 13th ILAS Conference, Amsterdam, The Netherlands
Information: web page: http://staff.science.uva.nl/~brandts/ILAS06/

24–27: Joint GAMM-SIAM Conference on Applied Linear Algebra (ALA 2006), Düsseldorf, Germany
Information: web page: http://www.ala2006.de/

25–30: 9th International Vilnius Conference on Probability Theory and Mathematical Statistics, Vilnius, Lithuania
Information: e-mail: conf2006@ktl.mii.lt;
web page : http://www.mii.lt/vilconf9/

August 2006

11–21: Methods of Integrable Systems in Geometry. London Mathematical Society Durham Symposium, Durham, UK
Information: web page: http://maths.dur.ac.uk/events/Meetings/LMS/2006/IS/

14–18: MCQMC 2006 Seventh International Conference on Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing, Ulm, Germany
Information: web page: http://mcqmc.uni-ulm.de/

22–30: International Congress of Mathematicians (ICM2006), Madrid, Spain
Information: e-mail: icm2006@unicongress.com;
web site: http://www.icm2006.org

31–September 2: Geometry and Topology of Low Dimensional Manifolds, El Burgo de Osma, Spain
Information: web page: http://mai.liu.se/LowDim/

31–September 2: Advanced Course on Combinatorial and Computational Geometry: trends and topics for the future, Alcalá de Henares, Spain
Information: web page: http://www.crm.es/Conferences/0607/CCGeometry/combinatorial_index.htm

31–September 5: Workshop on Geometric and Topological Combinatorics, Alcalá de Henares, Spain
Information: web page: http://www2.uah.es/gtc06/

September 2006

1–4: Topics in Mathematical Analysis and Graph Theory, Belgrade, Serbia and Montenegro
Topic: Classical mathematical analysis, including inequalities and convexity, Graph theory and combinatorics, Special functions, Differential equations, Functional analysis, Numerical analysis, Complex analysis, Probability and Statistics, Mathematical aspects of computer science, Differential geometry and related topics, Number theory, Applications of mathematics in Electrical Engineering and Telecommunications
Information: e-mail: pefmath@etf.bg.ac.yu;
web site: http://magt.etf.bg.ac.yu

4–8: Groups in Geometry and Topology Málaga 2006. The First Group Action Forum Conference, Málaga, Spain
Information: web site: http://agt.cie.uma.es/~ggt06/

4–29: The Painleve Equations and Monodromy Problems, Isaac Newton Institute for Mathematical Sciences, Cambridge, UK
Topic: ODE and Dynamical Systems

Information: e-mail: s.wilkinson@newton.cam.ac.uk;
web site: http://www.newton.cam.ac.uk/programmes/PEM/

6–8: The Second International Workshop on Analysis and Numerical Approximation of Singular Problems, Karlovassi, Samos, Greece
Information: e-mail: iwanasp06@aegean.gr;
web site: http://www.tech.port.ac.uk/staffweb/makrogla/conf/IWANASP06/samos06.html

10–17: Parabolic and Navier-Stokes Equations, Będlewo, Poland
Information: web site: http://www.impan.gov.pl/~parabolic/

11–13: 21st British Topology Meeting, Powys, Wales, UK
Information: web site: http://www-maths.swan.ac.uk/btm21/

21–24: ICAM5 – 5th International Conference on Applied Mathematics. In honour of Professor Ioan A. Rus with the occasion of his 70th birthday, Baia Mare, Romania
Information: e-mail: marieta.gata@rdslink.ro; vberinde@ubm.ro
web site: http://www.ubm.ro/ro/icam5/

October 2006

23–December 15: Stochastic Computation in the Biological Sciences, Isaac Newton Institute for Mathematical Sciences, Cambridge, UK
Information: e-mail: s.wilkinson@newton.cam.ac.uk;
web site: http://www.newton.cam.ac.uk/programmes/SCB/

January 2007

8–June 29: Analysis on Graphs and its Applications, Cambridge, UK
Topic: Topology, Real and Complex Analysis, Probability and Stochastics, Mathematics in Engineering and the Sciences
Information: e-mail: swilkinson@newton.cam.ac.uk;
web site: http://www.newton.cam.ac.uk/programmes/AGA/index.html

15–July 06: Highly Oscillatory Problems: Computation, Theory and Application, Cambridge, UK
Topic: ODE and Dynamical Systems, PDE and Potential Theory, Numerical Analysis and Scientific Computing, Mathematics in Engineering and the Sciences
Information: e-mail: swilkinson@newton.cam.ac.uk;
web site: http://www.newton.cam.ac.uk/programmes/HOP/index.html

July 2007

1: Summer Conference on Topology and its Applications 2007, Castellón, Spain
Information: web site: http://www.sumtop07.uji.es

23–December 21: Strong Fields, Integrability and Strings, Cambridge, UK
Topic: Differential Geometry, Mathematics in Engineering and the Sciences
Information: e-mail: swilkinson@newton.cam.ac.uk;
web site: http://www.newton.cam.ac.uk/programmes/SIS/index.html

September 2007

3–December 21: Phylogenetics, Cambridge, UK
Topic: Mathematics in Engineering and the Sciences, Others
Information: e-mail: swilkinson@newton.cam.ac.uk;
web site: http://www.newton.cam.ac.uk/programmes

Recent books

edited by Ivan Netuka and Vladimir Souček (Prague)

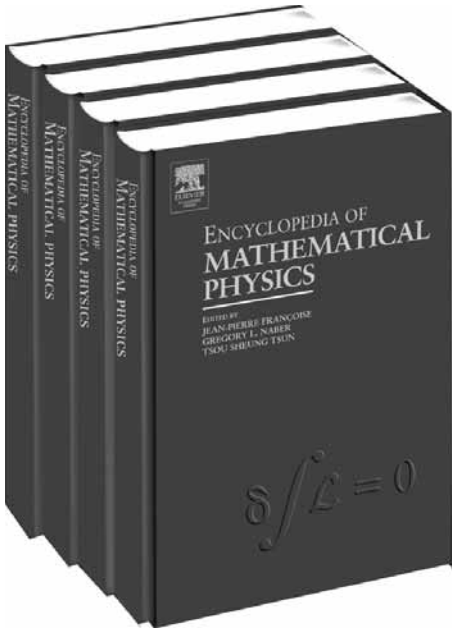
Books submitted for review should be sent to the following address: Ivan Netuka, MÚUK, Sokolovská 83, 186 75 Praha 8, Czech Republic

J. L. Bell: Set Theory. Boolean-Valued Models and Independence Proofs, third edition, *Oxford Logic Guides 47, Oxford University Press, Oxford, 2005, 191 pp., GBP 75, ISBN 0-19-856852-5*
This is the third edition of the author's book from 1977 and 1985. The contents is extended again and reads as follows: 0. Boolean and Heyting Algebras: The Essentials; 1. Boolean-valued Models of Set Theory: First Steps; 2. Forcing and Some Independence Proofs; 3. Group Actions on V(B) and the Independence of Axiom of Choice; 4. Generic Ultrafilters and Transitive Models of ZFC; 5. Cardinal Collapsing, Boolean Isomorphism, and Applications to the Theory of Boolean Algebras; 6. Iterated Boolean Extensions, Martin's Axiom, and Souslin's Hypothesis; 7. Boolean-valued Analysis; 8. Intuitionistic Set Theory and Heyting-Algebra-Valued Models; Appendix. Boolean and Heyting Algebra-Valued Models as Categories. The book serves as an introductory course to forcing and completely omits the rapid development in this area during the last 25 years. Instead, it pays some attention to intuitionistic set theory and presents a brief outline of category theory in order to show Boolean and Heyting algebra-valued models as toposes. (psim)

A. T. Benjamin, J. J. Quinn: Proofs that Really Count. The Art of Combinatorial Proof, *Dolciani Mathematical Expositions, vol. 27, The Mathematical Association of America, Washington, 2003, 208 pp., USD 43,95, ISBN 0-88385-333-7*
The goal of the Dolciani Mathematical Expositions series is to foster the ideal of excellence in mathematical exposition by publishing books selected for their lucid expository style and stimulating mathematical content. The books are intended to be sufficiently elementary for the undergraduate and even the mathematically inclined high-school student. The book under review fully realises these intentions. In many situations and

Encyclopedia of Mathematical Physics
5 Volumes

First comprehensive encyclopedia in mathematical physics



"An impressively comprehensive storehouse of our current body of knowledge and understanding concerning the mathematical laws governing the behaviour of our universe. Students and researchers alike will continue to benefit greatly from this work for a good many decades into the future."
Roger Penrose

Edited by:
Jean-Pierre Françoise,
Université Pierre et Marie Curie, France
Gregory L. Naber,
Drexel University, Philadelphia, USA
Tsou Sheung Tsun,
University of Oxford, UK

- Contains several undergraduate-level introductory articles to facilitate acquisition of new expertise
- Thematic index and extensive cross-referencing to provide easy access and quick search functionality
- Also available online with active linking.

ISBN: 0-12-512660-3
Pub. date: May 2006
Imprint: Elsevier / Academic Press
Pages: Approx. 3,500
Articles: Approx. 400

Readership:
Research students, researchers and professionals who are seeking an authoritative source of information about any particular aspect of mathematical physics.

Including special introductory offer!

2005 List price: EUR 1,795 USD 1,990 GBP 1,245
Introductory Price*: **EUR 1,395 USD 1,495 GBP 995**
**Valid through the end of the 3rd month after publication*

www.elsevier.com/emp

from different points of view it demonstrates the power of combinatorial proof by counting in two different ways. Most of the material is really suitable for advanced high-school classes and the book itself could do a great job of attracting bright students to mathematics. More mature mathematicians will also find themselves amused by unexpected twists – "mathemagical" tricks – in surprisingly simple proofs of not so innocent looking formulas. The topics covered in the text include basic combinatorial number theory such as (generalized) Fibonacci, Lucas, Stirling and harmonic numbers, the inclusion-exclusion principle, binomial coefficients, linear recurrences and continued fractions. (jkr)

E. R. Berlekamp, J. H. Conway, R. K. Guy: Winning Ways for Your Mathematical Plays, *vol. 4, second edition, A.K. Peters, Wellesley, 2004, 801-1004 pp., USD 39, ISBN 1-56881-144-6*
This book is the second edition of the last volume of the famous quadropaedia on mathematical games. The last volume is focused on one-player games. One chapter is devoted to a detailed discussion of the Solitaire game, involving various aspects like problem decomposition algebraic evaluation, etc. In the next chapter, the authors discuss and give hints to a variety of well-known puzzles like the Hungarian cube, Lloyd's 15, Hanoi towers and dozens of others. The last chapter is devoted to the game of Life, starting with simple examples of interesting configurations and ending with a discussion of the power of cellular automata. This excellently written book is not just a comprehensive monograph on recreational mathematics. It presents various mathematical concepts in a natural (and sometimes humorous) way that would also be understandable to a reader without a strong mathematical background. (lp)

P. Berthelot, J.-M. Fontaine, L. Illusie, K. Kato, M. Rapoport, Eds.: Cohomologies p-adiques et applications arithmétiques (III), *Astérisque 295, Société Mathématique de France, Paris, 2004, 299 pp., EUR 57, ISBN 2-85629-158-9*
The third (and last) volume of the Proceedings of the p-adic semester at Institut Poincaré in 1997 contains two long articles. The first, by J.-M. Fontaine, treats several topics from the theory of p-adic Galois representations: Sen's theory of C-representations, its generalization to B_{dR}-representations, a sketch of the proof by Colmez and Fontaine of the fundamental conjecture: "weakly admissible implies admissible", and some remarks on the period rings. The second article is the long-awaited paper of K. Kato, which concludes the proof of one of the most spectacular number theory results from the 1990s, namely "one half" of the Main Conjecture of Iwasawa Theory for classical modular forms and its applications to the p-adic conjecture of Birch and Swinnerton-Dyer (and its generalizations). (jnek)

O. Biquard, Ed.: AdS/CFT Correspondence: Einstein Metrics and Their Conformal Boundaries, *IRMA Lectures in Mathematics and Theoretical Physics 8, European Mathematical Society, Zürich, 2005, 252 pp., EUR 38, ISBN 3-03719-013-2*
The topic of this book has been intensively studied recently by both physicists and mathematicians. The first explicit idea of the AdS/CFT correspondence was formulated by Maldacena almost ten years ago and it immediately created a strong wave of interest among physicists working in string theory. The reason is that it suggests a duality between a theory with quantum gravity in a spacetime and a conformal field theory on its boundary. The same correspondence had already been used in mathematics for special purposes for two decades. The meeting, organized at IRMA in Strasbourg in 2003, brought together mathematicians and physicists working in a quickly expanded field. The book is the proceedings of the conference. The mathematical contribution are: a review of geometrical aspects by M. T. Andersen; obstruction tensor and Q-curvature by R. Graham and K. Hirachi; new static solutions of Einstein equations in higher dimensions by M. T. Anderson, P.T. Chrusciel and E. Delay; a construction of AdS/CFT spacetimes by Ch. Frances; a concept of mass for asymptotical hyperbolic manifolds by M. Herzlich. The string theory contributions are written by J. de Boer, L. Maoz and A. Naqvi (a review of some aspects of the correspondence in physics), I. Papadimitriou and K. Skenderis (a Hamiltonian approach to holographic renormalization), S. N. Solodukhin (holographic description for Minkowski space), and J. P. Gauntlett, D. Martelli, J. Sparks and D. Waldram (supersymmetric AdS5 solutions of M-theory). The book collates recent results covering many different aspects of AdS/CFT correspondence and it is a very useful addition to the literature both for mathematicians and physicists interested in the field. (vs)

M. Brin, B. Hasselblatt, Y. Pesin, Eds.: Modern Dynamical Systems and Applications, *Cambridge University Press, Cambridge, 2004, 458 pp., GBP 55, ISBN 0-521-84073-2*
This volume consists of more than twenty papers covering all the important areas of contemporary research on dynamical systems. The contributing authors are leading experts in the field and the articles, though mostly of expository nature, are also of a high scientific level. The book is formally divided into two parts. In the first, we can read about mixing, entropy, ergodic theory, symbolic dynamics, averaging, normal forms and rigidity theory. The second part is devoted to topics connected with hyperbolic dynamics. The volume is dedicated to Anatole Katok on the occasion of his 60th birthday. The volume starts with an introductory article (written by the editors) briefly describing his life and scientific work. (dp)

C. M. Campbell, E. F. Robertson, G. C. Smith, Eds.: Groups St. Andrews 2001 in Oxford, *London Mathematical Society Lecture Note Series 304, Cambridge University Press, Cambridge, 2003, 306 pp., GBP 35, ISBN 0-521-53739-8*
This is the first of a two-volume book collecting together selected papers from another conference in a successfully continuing series of 'Groups St Andrews'. It covers many different directions of research, which have been carried out in the theory of groups during the twenty years after the classification of the finite simple groups. The volumes contain short research articles as well as accessible surveys. In particular it contains summaries of five invited lecture courses given at the conference, which are rather hidden among the alphabetically ordered papers. They include contributions from M. Conder (Group actions on graphs, maps and surfaces with maximum symmetry), P. Diaconis (An introduction to random walk on finite groups - character theory and geometry), P. Palfy (Groups and Lattices), M. du Sautoy (Zeta functions of groups and counting p-groups), and M. Vaughan-Lee (Lie methods in group theory). The book is an excellent source describing the current status of the field. (sh)

B. Cipra, E.D. Demaine, M. L. Demaine, T. Rodgers, Eds.: Tribute to a Mathemagician, *A K Peters, Wellesley, 2004, 262 pp., USD 38, ISBN 1-56881-204-3*

This is a wonderful book of puzzles and other pieces of recreational mathematics. It is the third book in a series devoted to Martin Gardner, the most famous author and collector of puzzles and the 'father of recreational mathematics', who used to run the highly popular puzzle column 'Mathematical Games' in Scientific American from 1957 to 1982. The column popularized recreational mathematics and has inspired and attracted many mathematicians. Since 1993, conferences known as Gatherings for Gardner (G4G) have been organized every few years. The most recent (fifth) meeting (G4G5) was held in Atlanta in April 2004. The first and second volumes in the series, *The Mathemagician and Pied Puzzler* (1999) and *Puzzler's Tribute: A Feast for the Mind* (2002), were based on the first four meetings. This third volume is based on presentations given at the last meeting. In each of the three books, the reader will find a collection of articles written by mathematicians, puzzlers and magicians that Gardner inspired. Following the tradition, the theme related to the number of the actual meeting (number five in this case, hence pentagon, pentagram etc.) appears in several of the articles. In particular, the logo in the form of a lovely five-pointed star composed of Gardner's name appears on the cover of the book. The main content of the book is organized into six sections: Braintreasures, Brainticklers, Brainteasers, Braintempters, Braintaunters and Braintools. The contributors include some very famous authors such as Raymond Smullyan, M. Oskar van Deventer and even Martin Gardner himself. The presentations cover all kinds of puzzles and recreational problems: Chinese ceramic puzzle vessels, Mongolian interlocking puzzles, fold-and-cut magic, cryptic crossword puzzles, computer puzzles, algorithmic puzzles and many, many more. Four articles in the opening section of the book commemorate the memory of two great puzzlers, Edward Hordern and Nobuyuki Yoshigahara, who both died prematurely in 2004. This book is a great read and is supremely ingenious, amusing and inspiring. (lp)

A. Collino, A. Conte, M. Marchisio, Eds.: The Fano Conference, *September 29-October 5, 2002, Dipartimento di Matematica dell'Universita di Torino, Torino, 2004, 804 pp., ISBN 88-900876-1-7*

The Fano Conference was held in Torino in October 2002. It was organized to commemorate the 50th anniversary of the death of Gino Fano (1871–1952). He was a pioneer in the investigation of 3-dimensional algebraic varieties with the property that their anticanonical systems are ample. They are now called, together with their generalizations, Fano varieties. New results concerning these varieties began a new wave of interest in their study in the 70s. The organizers of the conference succeeded in inviting the majority of leading specialists in the field to the conference. As a result of their effort, we get a collection of forty very interesting papers presenting the contemporary state of the research. This means naturally that the collection is quite indispensable for every specialist in the field of Fano varieties. On the other hand it is obvious that it is not possible to read these papers without certain knowledge of algebraic geometry. I would like to mention only one of these forty papers. The article written by A. V. Pukhlikov (birationally rigid Fano varieties) clarifies to a great extent the historical development of the subject. There is one additional paper completing the collection describing the life of Gino Fano (written by his son Robert Fano). (jiva)

U. Daepp, P. Gorkin: Reading, Writing and Proving. A Closer Look at Mathematics, *Undergraduate Texts in Mathematics, Springer, Berlin, 2003, 408 pp., 49 fig., EUR 64,95, ISBN 0-387-00834-9*

This book is intended for undergraduate students beginning their mathematical career or attending their first course in calculus. The book starts from the very beginning (quantifiers, basic set theory) and, little by little, the reader is led to more difficult parts of analysis (ordering of real numbers, the concept of functions, sequences, finite and infinite sets, countable and uncountable sets, and metric spaces). The book is concluded by eleven projects to be worked out through independent but guided study. These include the problem of the irrationality of e and π, the structure of the Cantor set, the Cauchy-Schwarz Inequality and the properties of algebraic numbers. Throughout the book, the so called Polya's fourth-step process is applied; students are encouraged to 1) learn to understand the problem, 2) devise a plan to solve the problem, 3) carry out that plan, and 4) look back and check what the results told them. This concept is very valuable. The book not only presents the facts but also tries to show what mathematics really is: the very concepts of definition, theorem, example and comment are introduced. The fact that mathematics consists of careful *reading* and *writing* is emphasized, with special stress on the concept of *proving* facts in a rigorous way. Additional material to the book, i.e. corrections and other documentation, can be found, as the authors suggest, on the web page http://www.facstaff.bucknell.edu/udaepp/readwriteprove/. The book is written in an informal way, which will please the beginner and not offend the more experienced reader. The reader will find a lot of problems for independent study as well as a lot of illustrations encouraging him/her to draw pictures as an important part of the process of mathematical thinking. (mrok)

J.-M. Deshouillers, K. Kawada, T.D. Wooley: On Sums of Sixteen Biquadrates, *Mémoires de la Société Mathématique de France, no. 100, Société Mathématique de France, Paris, 2005, 120 pp., EUR 26, ISBN 2-85629-171-6*

Let Bs be the set of those positive integers that can be written as a sum of s biquadrates. In 1939, H. Davenport showed that the complement of B_{16} in N is finite. The main result of this book states that every integer $N > 10^{216}$ that is not divisible by 16 is contained in B_{16}. It can be combined with results of a companion paper of Deshouillers, Hennecart and Landreau (which relies on heavy computations) to get the implication that every integer $n > 13792$ lies in B_{16} (this result is optimal, as 31.16^m is not included in B_{15}). The proof involves a combination of the Hardy-Littlewood method with several identities involving biquadrates and squares. (jnek)

A. Dimca: Sheaves in Topology, *Universitext, Springer, Berlin, 2004, 236 pp., EUR 39,95, ISBN 3-540-20655-5*

This book covers a majority of basic notions and results in the theory of constructive sheaves on complex spaces and it provides a rich amount of geometrical examples and applications. The author takes the reader from simpler, older results to the most powerful and general results currently available. Due to the modest size of the book, some proofs have been omitted and substituted with references to other sources. In the first chapter, a brief introduction to the theory of derived categories and derived functors is given, including an example of derived categories of coherent

sheaves on algebraic varieties. The second chapter starts with a general discussion of sheaves and hypercohomology. It contains various versions of the de Rham theorem, a discussion of direct and inverse images of sheaves and the Leray spectral sequences, and basic properties of local systems (both topological and analytical aspects). In the third chapter, the author treats Poincaré-Verdier duality and related topics. The fourth chapter describes constructible sheaves and their properties, including characteristic cycles on a smooth manifold. Perverse sheaves form a main topic of the book; they are presented in the fifth chapter. Basic properties of perverse sheaves and an explicit description of germs of perverse sheaves on a smooth curve in terms of easy linear algebra are given (including a brief introduction on the theory of D-modules). The last chapter contains several applications of perverse sheaves in geometry. The book is well written and I would like to recommend it to anybody interested in the topic. (jbu)

O. Druet, E. Hebey, F. Robert: Blow-up Theory for Elliptic PDEs in Riemannian Geometry, *Mathematical Notes, Princeton University Press, Princeton, 2004, 218 pp., GBP 29,95, ISBN 0-691-11953-8*

This book represents an important contribution to the analysis of elliptic partial differential equations on compact manifolds. For the sake of clarity, the authors restrict themselves to the Yamabe equation and its generalizations, including the Schrödinger operator on the left-hand side and the critical (from the point of view of the embedding) nonlinearity on the right hand side. The structure of Sobolev solutions to such problems has been known for more than twenty-five years and is characterized as the sum of three items; the first part is a solution of the limit equation, the second consists of a finite sum of bubbles and the third term vanishes strongly in the Sobolev space. The authors develop a theory based on pointwise estimates that results in verifying the validity of the same asymptotic structure in the space of continuous functions. Before doing so, the authors provide the basic facts on Riemannian geometry and nonlinear analysis on manifolds, present the existence of Palais-Smale sequences and the existence of strong solutions of minimal and arbitrary energies for the Yamabe equation, and recall the decomposition of Sobolev solutions (mentioned above). This all makes the book self-contained and, despite the technicalities, readily accessible to the interested reader. (jmale)

S. V. Duzhin, B. D. Chebotarevsky: Transformation Groups for Beginners, *Student Mathematical Library, vol. 25, American Mathematical Society, Providence, 2004, 246 pp., USD 39, ISBN 0-8218-3643-9*

This is a slow-paced introduction to transformation groups intended for undergraduate students. The original version was published in Russian in 1988 under the title *From Ornaments to Differential Equations*. For the English translation, the original text was revisited and expanded. The book is divided into seven chapters. The first introduces coordinate systems in the plane and the algebraic operations on points of the plane. The second introduces various elementary transformations of the plane. The third chapter acquaints the reader with the concept of a group of transformations of the plane including further concepts like conjugated transformations, generators and relations for transformation groups. The fourth chapter is about abstract groups and the Lagrange theorem and the fifth applies results of the previous chapters to the classification of ornaments and to crystallographic groups. Chapter six introduces further types of transformations in the plane like projective transformations, inversions and hyperbolic transformations and the final chapter is about symmetries of differential equations and how they can be used to solve the equations. The book is well written and it contains a lot of exercises with hints and solutions. (jtu)

L. D. Faddeev, L. A. Khalfin, I. V. Komarov, Eds.: Selected Works V.A. Fock: Quantum Mechanics and Quantum Field Theory, *Chapman & Hall/CRC, Boca Raton, 2004, 567 pp., USD 99,95, ISBN 0-415-30002-9*

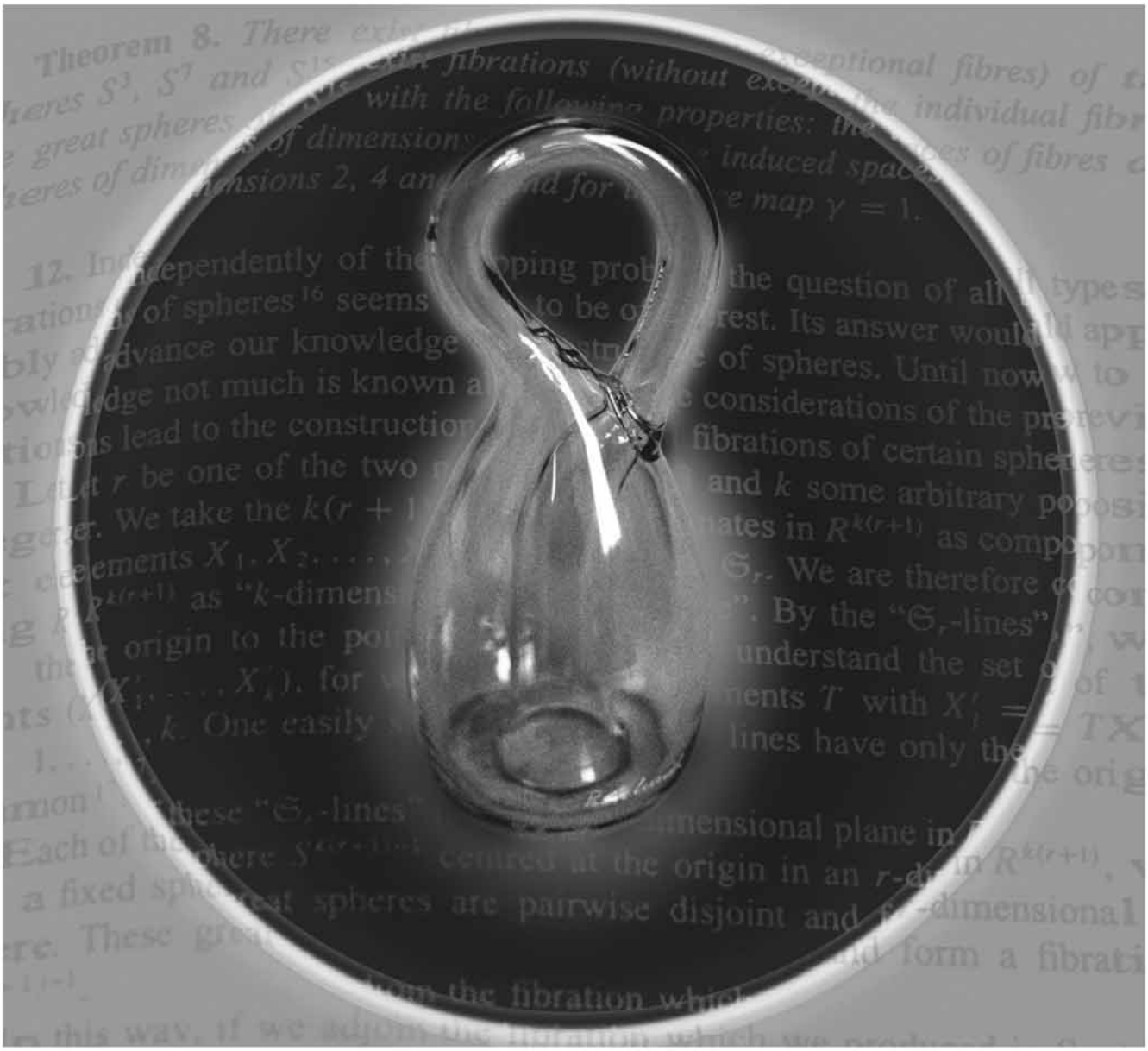
This book is devoted to the good description of the scientific activity of Vladimír Aleksandrovich Fock, one of the leading theoretical physicists of the last century. It is not necessary to introduce him because the concept of "Fock space" is well-known to anyone interested in theoretical physics. The book illustrates that V. A. Fock contributed to many areas of quantum mechanics and quantum field theory as well as to classical mechanics and there are some mathematical papers included. He wrote his papers in Russian, German and French but the English translations are included in the book. The book presents nicely the quality and importance of his extraordinary contribution to quantum theory. Nevertheless, such a collection of original papers has nowadays mainly historical interest. (jso)

S. R. Finch: Mathematical Constants, *Encyclopedia of Mathematics and its Applications 94, Cambridge University Press, Cambridge, 2003, 602 pp., GBP 65, ISBN 0-521-81805-2*

This voluminous book (about 600 pages) is divided into eight chapters. The first deals with the most popular constants (including e, π and the Golden Mean). The remaining chapters are devoted to the constants associated with number theory, analytic inequalities, approximation of functions, discrete structures, functional iteration, complex analysis and geometry. At the lowest level, the books consist of relatively short subsections (about three pages), each treating a particular constant (or a host of similar constants). The motivation, definition and an overview of known results and the relation to other constants as well as some historical background are given but no proofs are provided at all. Each subsection is followed by a detailed bibliography, which directs the reader to other sources she/he would be interested in. The book certainly brings a huge amount of material that is very interesting to a wide mathematical audience. (dpr)

V. Franjou, E. M. Friedlander, T. Pirashvili, L. Schwartz: Rational Representations, The Steenrod Algebra and Functor Homology, *Panoramas et Syntheses, no. 16, Société Mathématique de France, Paris, 2003, 132 pp., EUR 25, ISBN 2-85629-159-7*

These notes represent a sequel to a series of lectures delivered in Nantes, December 12–15, 2001 for the Société Mathématique de France's "État de la Recherche" session. They contain the following five articles: T. Pirashvili: Introduction to functor homology; E. M. Friedlander: Lectures on the cohomology of finite group schemes; L. Schwartz: Algèbre de Steenrod, modules instables et foncteur polynomiaux; L. Schwartz: L'algèbre de Steenrod et topologie, and V. Franjou & T. Pirashvili: Stable K-theory is bifunctor homology (after A. Scorichenko). The introduction (written by V. Franjou) together with the first paper by T. Pirashvili introduce a reader into the domain of problems



The Department of Mathematics of ETH Zurich

invites applications for several

Heinz Hopf Lectureships

beginning 1st of October 2006 or earlier. The positions are awarded for a period of 3 years, with the possibility of an extension by 1 year.

Duties of Heinz Hopf lecturers include research and teaching in mathematics. Together with the other members of the department, the new lecturers will be responsible for undergraduate and graduate courses for students of mathematics, natural sciences, and engineering. The moderate teaching load leaves ample room for further professional development. Courses at Master level may be taught in English.

Applicants should have proven excellence in research in any area of mathematics and possess potential for further outstanding achievements. Some research and teaching after the Ph. D. is usually expected.

Applications with curriculum vitae and a list of publications should be submitted to the chairman of the Department of Mathematics, ETH Zentrum, 8092 Zurich, Switzerland, by January 9, 2006. Later applications can be considered for remaining positions. In addition, three letters of recommendation supporting the application should be sent directly to us. ETH Zurich specifically encourages female candidates to apply.

Department Mathematik

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

under consideration and make him/her familiar with necessary notions. Using polynomial functors introduced in the first article, E. M. Friedlander investigates in his article the cohomology of finite group schemes. The main result states that the cohomology of a finite group scheme is finitely generated. The first article by L. Schwartz presents a completely algebraic description of the Steenrod algebra (over any prime) and deals with unstable modules over this algebra. Again the polynomial functors play an important role here. The second article by L. Schwartz is devoted to the role of the Steenrod algebra in the topological framework. It is only a short note. The last article by V. Franjou & T. Pirashvili brings a result due to A. Scorichenko (with a proof) that shows that stable K-theory is functor homology. The whole book represents a nice introduction to the circle of problems described above. The articles contain the classical results as well as the most recent ones. They are all very well written and I think that everybody who desires to understand them, and is ready to devote a necessary effort, will finally comprehend them. It is a relatively short but excellent book. (jiva)

S. Gallot, D. Hulin, J. Lafontaine: Riemannian Geometry, third edition, *Universitext, Springer, Berlin, 2004, 322 pp., EUR 34,95, ISBN 3-540-20493-8*
This book is based on a graduate course on Riemannian geometry and analysis on manifolds that was held in Paris. It covers the following topics: differential manifolds and elements of global analysis, Riemannian geometry, affine and Riemannian connections, properties of geodesics (including global properties) in general and on special manifolds, the Riemannian curvature tensor, the arc-length and energy, Jacobi vector fields, and Riemannian submersions; curvature and its connection with topology, volume and fundamental group; hyperbolic and conformal geometry, manifolds with boundary and Stokes theorem, inequalities by Bishop and Heintze-Karcher, differential forms and cohomology, the Hodge-de Rham theorem, basic spectral geometry and examples, the minimax principle, eigenvalues estimates, Paul Levy's isoparametric inequality, Riemannian submanifolds, curvature and convexity, and minimal surfaces. Classical results on the relations between curvature and topology are treated in detail. The book is almost self-contained, assuming in general only basic calculus. It contains numerous nontrivial exercises with full solutions at the end. Properties are always illustrated by many detailed examples. The first edition appeared in 1987. For the third edition, some topics on geodesic flow and Lorentzian geometry have been added and worked out in the same spirit as the rest of the book. (ok)

C.G. Gibson: Elementary Euclidean Geometry: An Undergraduate Introduction, *Cambridge University Press, Cambridge, 2004, 174 pp., GBP 32,50, ISBN 0-521-83448-1*
This is an elementary introduction to the geometry of lines and conics in the Euclidean plane. Classical invariants of the conics and intersection properties of conics and lines are studied. Centres, focuses, tangents and normals of conics are discussed and classification of conics is presented. Properties of individual types (parabolas, ellipses, hyperbolas) of conics are described in details. The polarity is defined and used for several constructions. Toward the end, congruence of conics with respect to motions in the plane is considered and normal forms of conics are introduced. Conics are also studied as conical sections in three-dimensional space. There are many examples and exercises included. (jbu)

M. C. Golumbic, A. N. Trenk: Tolerance Graphs, *Cambridge Studies in Advanced Mathematics 89, Cambridge University Press, Cambridge, 2004, 265 pp., GBP 40, ISBN 0-521-82758-2*
Geometric representations of graphs are intensively studied for their practical motivation, but also for a wealth of interesting and elegant properties. Many generally hard optimization problems become tractable when restricted to these classes of graphs. The stress on computational tractability and applications in bioinformatics make research in this area immensely popular. Graph theorists look for generalizations of classical tractable classes of structures and the notion of tolerance graphs has been around for more than 20 years. The authors thought the time was ripe for publishing a survey of related results and topics and I can only agree. The first author has published a successful book in the area before (*Algorithmic Graph Theory and Perfect Graphs*, Academic Press, 1980) and the book under review is written in a similar fresh and readable style. It covers a lot of material on variants of tolerance graphs, interval probe graphs and other generalizations of interval graphs, comparability invariants and algorithmic aspects of these. But if the reader is time constrained, selected topics can easily be isolated since many of the chapters can be read (almost) independently of the others. Another advantage of the book lies in the decision of the authors to include most of the proofs, thus making the text as self-contained as possible. The book can be used as a textbook for a specialized graduate course in combinatorics and graph theory as well as a source of many open research problems gathered in the last section. This book is recommended for researchers and PhD students working in this area. (jk)

S. J. Gustafson, I. M. Sigal: Mathematical Concepts of Quantum Mechanics, *Universitext, Springer, Berlin, 2003, 249 pp., 35 fig., EUR 39,95, ISBN 3-540-44160-3*
This is really a very beautiful book on the mathematical structure of quantum mechanics. It is very useful for mathematically oriented students because they can see functional analysis and spectral theory at work. The authors describe lesser-known ideas (scattering states, many-particle systems, density matrices, Feynman path integrals, quasi-classical analysis, resonances, elementary parts of quantum field theory and renormalization groups). The book will also be very useful for physicists. It shows which beautiful facets of mathematics are connected to the well-known parts of quantum mechanics. I must say that it has been difficult to find a good textbook containing both the physics and the mathematics of quantum mechanics. I think that this book solves the problem of how to teach quantum mechanics to mathematically oriented students in an optimal way. Congratulations must go to the authors. (jso)

M. Hazewinkel, Ed.: Handbook of Algebra, vol. 3, *Elsevier, Amsterdam, 2003, 1036 pp., EUR 195, ISBN 0-444-51264-0*
The *Handbook of Algebra* is the third volume of a series devoted to contemporary algebra. The content of the algebraic research is divided into nine sections: 1. Linear algebra, fields, algebraic number theory; 2. Category theory, homological and homotopical algebra, methods from logic (algebraic model theory); 3. Commutative and associative rings and algebras; 4. Other algebraic structures, non-associative rings and algebras, commutative and

associative rings and algebras with extra structure; 5. Groups and semigroups; 6. Representations and invariant theory; 7. Machine computation, algorithms, tables; 8. Applied algebra; 9. History of algebra. The current volume deals with the first five sections. The first presents linear algebra over commutative rings. The second introduces category theory, algebraic K-theory and model theoretic algebra. Some ideas from commutative and associative rings and algebras and coalgebras belonging to the third section are investigated. The last two sections of the book are devoted to lattices and partially ordered sets, varieties of algebras and groups, Lie algebras and algebras with additional structures, and groups and semigroups. It should be emphasized that at the beginning of the book, the outline of all three volumes of this Handbook is presented in detail. (lbi)

P. Hell, J. Nešetřil: Graphs and Homomorphisms, *Oxford Lecture Series in Mathematics and its Applications 28, Oxford University Press, Oxford, 2004, 244 pp., GBP 45, ISBN 0-19-852817-5*
Discrete mathematics has been flourishing in the last few decades, hand in hand with the development of computer science, and graph theory has now become a well-established discipline within discrete mathematics. Algebra, on the other hand, is a more classical discipline. The two disciplines converge in this excellent book, where graphs are studied with algebraic and categorical methods. The book is written by world-renowned experts on structural and computational aspects of graph homomorphisms. As the first monograph is systematically devoted to the subject, it will undoubtedly become a cornerstone of this theory. Graph homomorphisms generalize the notion of graph colouring in a natural way and the book starts with graph colourings, initially with examples and concluding with a review of special variants of the notion (fractional, circular and acyclic colourings). On the way to this conclusion, the reader is led through the classical categorical approach of products and retracts in chapter 2, notions of duality, gaps and density in the homomorphism partial order of graphs in chapter 3, the concept of rigidness and endomorphisms in chapter 4 and computational aspects of graph homomorphisms (related to the Constrained Satisfaction Problem) in chapter 5. The exposition is self-contained and is complemented with numerous exercises and remarks. Stemming from personal experience of the authors at several renowned world universities, this is an excellent textbook for graduate courses but can serve equally well as a prime source of references and a source of open problems to researchers actively working in the area. (jk)

D. F. Holt, B. Eick, E. A. O'Brien: Handbook of Computational Group Theory, *Discrete Mathematics and its Applications, Chapman & Hall/CRC, Boca Raton, 2005, 514 pp., USD 89,95, ISBN 1-58488-372-3*
This book is a comprehensive survey of algorithms for computation in groups. It contains the present status of most branches of computational group theory, with a strong emphasis on computation in finite permutation groups and in finitely presented groups. It also covers algorithmic aspects of the theory of representations, computation in polycyclic groups, use of rewriting systems in groups and automatic groups. One chapter is devoted to existing libraries and databases (such as the atlas of finite groups). The authors emphasise algorithms that are fast in practice rather than the ones that are best asymptotically. A detailed discussion of complexity of presented algorithms is beyond the scope of the book but references are provided. The introduction contains a list of the most powerful recent and older computer systems for computing in groups. This book is accessible to graduate students and it can be recommended to all mathematicians interested in the field, both as a textbook and as an extensive reference book. (dst)

A. A. Ivanov: The Fourth Janko Group, *Oxford Mathematical Monographs, Clarendon Press, Oxford, 2004, 233 pp., GBP 60, ISBN 0-19-852759-4*
This book is a research monograph on the finite simple group known as the fourth Janko group. The existence of the group was discovered by Zvonimir Janko in 1976 and constructed by a group of authors (D. J. Benson, J. H. Conway, S. P. Norton, R. A. Parker and J. G. Thackakray) in Cambridge in 1980. The aim of the book is to provide a geometric characterization of the fourth Janko group. The group is characterized as the only group X acting transitively on incident vertex-edge pairs of a connected regular graph _ of valency 31 satisfying further local properties. The properties are encoded in the structure of the stabilizers in X of a vertex of Ξ and of an edge containing this vertex and in the way these two subgroups intersect. The union of the two stabilizers generates a subgroup Y of X. If the graph Ξ is a tree, then the subgroup is the free amalgamated product of the two stabilizers amalgamated over their intersection. It appears that there are only two further isomorphism types of the subgroup Y. These two types correspond in a highly nontrivial way to a complete bipartite graph or to the Petersen graph. The main theorem of the book states that the fourth Janko group corresponds to the Petersen graph. This book can be recommended to anyone interested in the geometries behind sporadic simple groups. (jtu)

Y. Jabri: The Mountain Pass Theorem: Variants, Generalizations and Some Applications, *Encyclopedia of Mathematics and Its Applications 95, Cambridge University Press, Cambridge, 2003, 382 pp., GBP 65, ISBN 0-521-82721-3*
This book presents various aspects of the famous Mountain Pass Theorem (by Ambrosetti and Rabinowitz) as powerful tools for variational methods in nonlinear analysis. From the beginning, the reader is led from the easily accessible results of variational principles on almost critical points, through finite dimensional considerations, to more complicated results. We learn about standard topics (the classical and dual Mountain Pass Theorem, topological index theory, the role of symmetry) as well as the more non-standard techniques (the non smooth and/or geometrically constrained Mountain Pass Theorem). The question of numerical approaches is also touched upon. The book will be valuable both for specialists and graduate students starting their scientific career in the field. However, the style of writing is clear and concise and therefore the book can be recommended as a first reading to members of the broad mathematical community who desire some knowledge of the field. (mrok)

A. Jeffrey: Essentials of Engineering Mathematics: Worked Examples and Problems, *second edition, Chapman & Hall/CRC Press, Boca Raton, 2004, 882 pp., USD 59,95, ISBN 1-58488-489-4*
This book is the second edition of a successful and widely popular reference book that was first published in 1992. It contains all of the topics typically covered in first and second-year undergraduate mathematics courses taught at technical universi-

ties, and more. Its contents is admirably wide; it includes everything from basic concepts of algebra, analysis, geometry and even logic, to some rather deep and difficult mathematics such as Fourier and Laplace transforms and differential calculus of several spatial variables. Even so, the book is quite concise and it doesn't contain anything that would make it unreadable for a mathematical layman. The principal achievement of the book is its great style; it is written so that anyone (often not a mathematician themselves but somebody in whose work mathematics plays an important role), who needs particular information on any of the many topics covered, will obtain this information quickly and clearly. The many worked examples are carefully chosen in order to cover the typical situations, so the risk of nasty surprises in the future is decreased to a minimum. The book is organized into short, pleasant sections that make it easy to obtain required references. Any unnecessary heavy, abstract mathematics that would obscure the main idea of a topic and scare a potential reader is excluded. Compared with the first edition, there is plenty of new material included in this version. It provides many new examples and new theoretical material (such as new problems involving the mean value theorem for derivatives, extension of the theory of extremes of functions of several variables, the concept of direction fields of a first-order ordinary differential equation, Laplace transform, etc.). The most important improvement is an introduction to the use of the symbolic software packages Maple and Matlab in engineering. This is an excellent reference book that anybody interested in either pure, or especially applied, mathematics should not ignore. (lp)

V. V. Kozlov: Dynamical Systems X. General Theory of Vortices, *Encyclopaedia of Mathematical Sciences, vol. 67, Springer, Berlin, 2003, 184 pp., EUR 84,95, ISBN 3-540-42207-2*
This is a very interesting, nicely written book on deep mathematical analogies between hydrodynamics, geometric optics and mechanics. The author shows that the concept of a vortex has a long and extremely rich history, in addition to more modern developments, in the natural sciences and mathematics. After an historical introduction (Descartes, Leibniz, Newton, Bernoulli, Voltaire, Maupertuis, Clairaut, Helmholtz, Thompson, etc.), chapter 1 discusses hydrodynamics, geometric optics and classical mechanics. A general vortex theory is discussed in chapter 2 and geodesics on Lie groups with a left-invariant metric are covered in chapter 3. The last chapter includes a discussion of the vortex method for integrating Hamilton equations. In the supplements, the reader can find various topics (vorticity invariants and secondary hydrodynamics, quantum mechanics and hydrodynamics, and vortex theory of adiabatic equilibrium processes). The book will surely be of interest to researchers and postgraduate students in mathematical physics and mechanics. (mz)

S. G. Krantz: Real Analysis and Foundations, second edition, *Studies in Advanced Mathematics, Chapman & Hall/CRC, Boca Raton, 2004, 454 pp., USD 89,95, ISBN 1-58488-483-5*
This book is the second edition of a text that was first published in 1991. The text was revised and new material was added (e.g. basics of wavelet theory, including a comparison of the Fourier and Haar series used on a particular example). The main aim of the author was to write a book that would be sufficiently rigorous as well as attractive to students. Its style is very different from usual calculus books; everything is presented carefully, with rigorous proofs, but still in a different way to that of monographs on similar subjects. The book contains many well-chosen examples and each of the fifteen chapters is followed by almost 500 exercises. More demanding exercises are marked but even unmarked ones contain deeper results (e.g. countability of the set of discontinuities of the first kind or the Dini theorem on uniform convergence). Illustrative pictures are instructive and the design of the book makes reading it a real pleasure. The book can be recommended for university libraries, teachers and students. (jive)

F. Le Roux: Homéomorphismes de surfaces, théoremès de la fleur de Leau-Fatou et de la variété stable, *Astérisque 292, Société Mathématique de France, Paris, 2004, 120 pp., EUR 26, ISBN 2-85629-153-8*
The author gives a clear and systematic answer to certain basic questions in a study of surface homomorphisms. He considers an isolated fixed point of a homomorphism and its Lefschetz index. In this setting, the author proves analogues of classical results from complex and hyperbolic dynamics. In particular, if the index n of the fixed point is bigger than one, he proves an analogue of the Leau-Fatou flower theorem (i.e. he is giving a construction of a family of p attractive and p repulsive petals, where $p=n-1$). If the index n of the fixed point is smaller than one, he describes an analogue of the stable manifold theorem (i.e. he constructs a family of p stable and p unstable local branches, where $p=1-n$). He also gives a new proof of the fact (due to M. Brown) that the index of a fixed point x is the same for a homeomorphism f and for its power f^n. The methods used come from a study of global dynamics on the sphere. (vs)

D. Li, H. Queffélec: Introduction à l'étude des espaces de Banach, *Cours spécialisés 12, Société Mathématique de France, Paris, 2004, 627 pp., EUR 72, ISBN 2-85629-155-4*
This monograph is devoted to the study of Banach spaces with the focus on the interplay of functional analysis and probability theory. It starts with a brief overview of basic facts from Banach space theory and from probability theory. Thirteen chapters are then devoted to more specialist subjects: Schauder bases, unconditional convergence, Banach space valued random variables, type and cotype of Banach spaces and factorization of operators through a Hilbert space, p-summing operators, properties of spaces L^p, properties of the space L^1, euclidean sections and the Dvoretzky theorem, separable spaces without approximation property, gaussian processes, reflexive subspaces of L^1, applications of the method of selectors and Pisier's space of almost surely continuous functions. In the appendix, basic facts on Banach algebras and compact abelian groups are given. (okal)

B. B. Mandelbrot: Fractals and Chaos. The Mandelbrot Set and Beyond, *Springer, New York, 2004, 298 pp., EUR 49,95, ISBN 0-387-20158-0*
This book is a collection of early papers by Benoit B. Mandelbrot, combined with additional papers written by the author for this book. The aim of the collection is not only to describe the historical context and background of the theory of fractals but also to give a self-contained presentation of the topic. Twenty-five papers are divided into five sections. Each of the first four sections starts with introductory papers written in 2003 followed by a collection of the original papers form the early 1980s. The fifth part is then devoted to the background and history of the

MEET THE MATHEMATICIAN AT OUR WEBSITE

Read Something Different

Optimization

Insights and Applications

Jan Brinkhuis and Vladimir Tikhomirov

The focus of this self-contained textbook is on analytically solving optimization problems with a finite number of continuous variables. The authors provide introductions to classical and modern numerical methods of optimization and to dynamic optimization. Most problems may be solved by the direct application of the theorems of Fermat, Lagrange, and Weierstrass, and the intuition for each of the theoretical results can be supported by simple geometric figures. The book can be used for courses on continuous optimization, from introductory to advanced, for any field for which optimization is relevant.

Princeton Series in Applied Mathematics
Ingrid Daubechies, Weinan E, Jan Karel Lenstra, and Endre Süli, series editors
Cloth $79.50 £51.95 0-691-10287-2

Quadrangular Algebras

Richard M. Weiss

Richard Weiss introduces a new class of non-associative algebras related to certain exceptional algebraic groups and their associated buildings. This book develops a theory of these "quadrangular algebras" that opens the first purely algebraic approach to the exceptional Moufang quadrangles. It contains the complete classification of quadrangular algebras starting from first principles. It also shows how this classification can be made to yield the classification of exceptional Moufang quadrangles as a consequence.

Mathematical Notes
Phillip A. Griffiths, John N. Mather, and Elias M. Stein, series editors
Paper $45.00 £29.95 0-691-12460-4 Due December

Moments, Monodromy, and Perversity

A Diophantine Perspective

Nicholas M. Katz

In *Moments, Monodromy, and Perversity*, Nicholas Katz develops new techniques, resolutely global in nature, for determining geometric monodromy groups. They are based on the theory of perverse sheaves and Larsen's Alternative. These two vital methods, neither of which existed at the time of Deligne's first proof of his general equidistribution theorem, are first developed and then used to calculate the geometric monodromy groups attached to some quite specific universal families of (L-functions attached to) character sums over finite fields.

Annals of Mathematics Studies
Phillip A. Griffiths, John N. Mather, and Elias M. Stein, series editors
Paper $59.50 £38.95 0-691-12330-6
Cloth $99.50 £65.00 0-691-12329-2

Max Plus at Work

Modeling and Analysis of Synchronized Systems:
A Course on Max-Plus Algebra and Its Applications

Bernd Heidergott, Geert Jan Olsder, and Jacob van der Woude

Max Plus at Work is the first textbook on max-plus algebra, providing a concise and self-contained introduction to the topic. Max-plus algebra is a framework used to model Discrete Event Systems, which are well suited to describe the ordering and timing of events. Applications of max-plus algebra abound in the world around us. Traffic systems, computer communication systems, production lines, and flows in networks are all based on discrete event systems, and thus can be conveniently described and analyzed by means of max-plus algebra.

Princeton Series in Applied Mathematics
Cloth $50.00 £32.50 0-691-11763-2 Due December

100 *Celebrating 100 Years of Excellence*
PRINCETON *University Press*
(0800) 243407 U.K. • 800-777-4726 U.S.
math.pupress.princeton.edu

field from the point of view of the 21st century. In such a way, we gradually learn about quadratic Julia and Mandelbrot sets, non quadratic rational dynamics, iterated functional systems and Kleinian groups, multifractal invariant measures and many other phenomena connected to fractals and chaos. The reader will surely appreciate the number of pictures and illustrations, including the first "famous" picture of a Mandelbrot set (a "turtle set"), obtained by the author in early 1980s. The book will be valued by both mathematicians and physicists who are interested in the field. It is written in a clear and straightforward way whilst pointing out lots of applications. A non-mathematician will appreciate the minimal number of formulas used throughout the book. On the other hand, the mathematician's eye will be pleased by the exactness of the presentation. (mrok)

D. McDuff, D. Salomon: J-holomorphic Curves and Symplectic Topology, *AMS Colloquium Publications, vol. 52, American Mathematical Society, Providence, 2004, 669 pp., USD 79, ISBN 0-8218-3485-1*

The recent intensive interaction between mathematics and theoretical physics has brought to mathematics a number of new important structures. An excellent example of this phenomenon is the mirror symmetry conjecture and, in particular, the Gromow-Witten invariants and quantum cohomology. This monograph concentrates on the theory of J-holomorphic curves, their role in symplectic topology, and their relation to new structures from physics. In the monograph, the reader will find a careful description of the foundation of the theory of J-holomorphic curves. The first part of the book describes the Fredholm theory and compactness results for J-holomorphic spheres and discs. The second part starts with the definition of Gromow-Witten invariants. Locally, Hamiltonian fibrations over Riemann surfaces are used in the definition of the Gromow-Witten invariants for arbitrary genus and for various applications of the theory. The gluing theorem is proved and used for a study of quantum cohomology, the Gromow-Witten potential and Frobenius manifolds. Some prerequisities (properties of linear elliptic operators, the Fredholm theory and implicit function theorem for Banach manifolds, the Riemann-Roch theorem for manifolds with boundary, the moduli space of stable curves of zero genus and positivity of intersections and the adjunction inequality for J-holomorphic curves in four dimensions) are covered in the appendices. The book offers a systematic treatment of one of the important new fields in mathematics and should be available in every library. (vs)

S. Mirica: Constructive Dynamic Programming in Optimal Control. Autonomous Problems, *Editura Academiei Romane, Bucuresti, 2004, 413 pp., ISBN 973-27-1068-3*

This book presents a collection of recent concepts and results that lead to algorithms for solving optimal control problems in the framework of dynamic programming. The use of dynamic programming approaches in concrete examples consists of three main steps: finding possibly optimal trajectories, computing the corresponding value function and then the use of an appropriate verification procedure to decide on the optimality of trajectories. According to this programme the author presents several verification theorems in chapter 3. The previous chapter contains auxiliary results, which are often of independent interest (e.g. monotonicity of real functions). Chapter 4 introduces tools for computing (describing, characterizing) fields of extremals to which a verification theorem can be applied. The theoretical results of chapters 3 and 4 are summarized in chapter 5 and then used in the last chapter for the famous examples: brachystochrone, minimal surfaces of revolution, the soft landing problem, rotating radar antenna and the minimal-time problem for linear systems. Many results presented in the book are based on the author's results published during the last thirty years. The presentation assumes that the reader is familiar with principles of classical calculus of variations and non-smooth analysis. The book will be of interest to graduate students and researchers in theoretical and applied control theory. (jmil)

V. Paskunas: Coefficient Systems and Supersingular Representations of GL_2 (F), *Mémoires de la Société Mathématique de France, no. 99, Société Mathématique de France, Paris, 2004, 84 pp., EUR 26, ISBN 2-85629-165-1*

In spite of the recent surge of activity related to the p-adic and mod p Langlands correspondence, little is known beyond representations of $GL_2(Q_p)$. In this article, the author constructs a finite set of irreducible supersingular $\overline{\mathrm{F}}_p$ representations of $GL_2(\mathrm{F})$ (where F is a finite extension of Q_p) admitting central character, which should conjecturally exhaust, up to an unramified twist, all such representations. (jnek)

Y. Pesin: Lectures on Partial Hyperbolicity and Stable Ergodicity, *Zürich Lectures in Advanced Mathematics, European Mathematical Society/SFG, Zürich, 2004, 122 pp., EUR 28, ISBN 3-03719-003-5*

This book is based on lectures given by the author in ETH Zürich in 2003. The lectures provide a unified and systematic approach to partial hyperbolicity and stable ergodicity, recently developed branches of dynamical systems. The text consists of ten chapters. After the two introductory ones, the Mather spectrum is introduced and used for an investigation of stability of partially hyperbolic maps in chapter 3. In chapters 4, 5 and 6, various aspects of stability are discussed: constructions of invariant foliations and their stability under small perturbations, branching phenomena for intermediate foliations and criteria for integrability of central distributions. Chapters 7 and 8 are devoted to technical tools for studying ergodic properties, namely to absolute continuity and stable accessibility. The last two chapters contain basic and recent results in the Pugh-Shub stable ergodic theory and applications to Anosov flows and, in particular, geodesic flows. These lectures are accessible to graduate students in smooth dynamical theory. Since they are written by one of the founders of the theory, experts may also find them interesting. (jmil)

T. Roblin: Ergodicité et équidistribution en courbure négative, *Mémoires de la Société Mathématique de France, no. 95, Société Mathématique de France, Paris, 2003, 96 pp., EUR 25, ISBN 2-85629-147-3*

The main aim of this booklet is to extend a number of results (various versions of the ergodicity theorem), which are already known in the setting of compact Riemann surfaces with constant negative curvature, to a general setting of so called CAT(-1) spaces. The ergodicity theorem is proved for a number of cases, including the horospherical foliations, the mixing of geodesic flow, orbital equidistribution of the group and equidistribution of primitive closed geodesics. A general unique ergodicity theorem is proved for the horospherical foliation for groups with

finite Boen-Margulis-Sullivan measure. For proofs, the author uses elementary methods. (vs)

K. Seip: Interpolation and Sampling in Spaces of Analytic Functions, *University Lecture Series, vol. 33, American Mathematical Society, Providence, 2004, 139 pp., USD 29,34, ISBN 0-8218-3554-8*

This book is based on a series of lectures made by the author at the University of Michigan. The topic treated in the book is geometry of interpolating and sampling sequences in Hilbert and Banach spaces of analytic functions on a domain ζ in C. In the first two chapters, the author presents the Carleson theorem and its relation to the Nevanlinna-Pick interpolation. Interpolation and sampling sequences in Bergman spaces are studied in the third chapter. The fourth chapter is devoted to interpolation in Bloch space and the last two chapters deal with Paley-Wiener spaces. Almost all the results in the book are proved. A basic knowledge of the field (complex and functional analysis and basic facts from H^p and BMO theories) is assumed. The book offers a nice overview of the field. (vs)

Séminaire Bourbaki, vol. 2002–2003, exposés 909–923, *Astérisque 294, Société Mathématique de France, Paris, 2004, 470 pp., EUR 82, ISBN 2-85629-156-2*

This volume contains fifteen articles surveying some of the most exciting recent developments in pure mathematics, ranging from set theory (Woodin's work on the continuum hypothesis), through geometric group theory (new results on Kazhdan's property, Gromov's work on random groups, and elementary theory of free groups) and algebraic geometry (amoebas and tropical geometry, Pop's work on the birational anabelian conjecture, and congruences for the number of points of algebraic varieties over finite fields) to number theory (proof of Catalan's conjecture, results on irrationality of the values $\zeta(2n + 1)$ of the zeta function, deterministic primality testing in polynomial time, and Kato's work on the p-adic conjecture of Birch and Swinnerton-Dyer). (jnek)

J. Tilouine, H. Carayol, M. Harris, M.-F. Vignéras, Eds.: Formes automorphes I, *Astérisque 298, Société Mathématique de France, Paris, 2005, 410 pp., EUR 86, ISBN 2-85629-172-4*

This first volume of the Proceedings of the Automorphic semester, held at Institut Poincaré in 2000, contains long articles by M. Harris (a self-contained account of his work with R. Taylor on bad reduction of unitary Shimura varieties), H. Hida (the theory of p-ordinary automorphic forms and Igusa towers for certain PEL Shimura varieties), D. Soudry (a survey of the joint work with D. Ginzburg and S. Rallis on lifts and backward lifts between automorphic forms on $GL(n)$ and other classical groups), M. Rapoport (bad reduction of Shimura varieties with parahoric level structure) and shorter articles by K. Buzzard (slopes of classical modular forms), F. Oort (proof of a conjecture of Grothendieck on deformations of p-divisible groups), L. Saper (proof of a conjecture of Rapoport and Goresky-MacPherson), and M. Strauch (local Jacquet-Langlands correspondence via conjectural Lefschetz trace formula in rigid geometry). (jnek)

F. E. Udwadia, H. I. Weber, G. Leitmann, Eds.: Dynamical Systems and Control, *Stability and Control: Theory, Methods and Applications, vol. 22, Chapman & Hall/CRC, Boca Raton, 2004, 437 pp., USD 89,96, ISBN 0-415-30997-2*

This book contains papers that were presented at the 11th International Workshop on Dynamics and Control in Rio de Janeiro, October 2000. The book is divided into three parts. The first deals with advances in dynamics, dynamical systems and control (6 contributions). The second deals with applications to a variety of problems: control of cars and robots, dynamics of ships and suspension bridges, optimal spacecraft trajectories (altogether 12 papers). The third part (with 6 contributions) contains papers related to social, economic and biological issues such as models of epidemics, economic games and neural networks. The meeting was a successful attempt to bring together scientists working on the theoretical side of the topic with those interested in applications in engineering, economics and biology. The proceedings reflect this fact. (pku)

K. Wehrheim: Uhlenbeck Compactness, *EMS Series of Lectures in Mathematics, vol. 1, European Mathematical Society, Zürich, 2004, 220 pp., EUR 39,50, ISBN 3-03719-004-3*

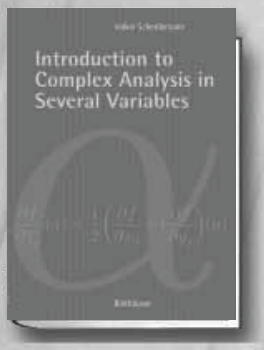
The main topic of this book is a careful and detailed exposition of the two main Uhlenbeck theorems for gauge fields, together with their full proofs. Necessary prerequisities are covered in the first part of the book (regularity and existence problems for L^2 and L^p spaces for the Neumann problem) and in five appendices (notation for gauge theories, basic estimates, the Sobolev spaces of sections of vector bundles, the Sobolev embedding and trace theorems, L^p–multipliers, Poisson kernels, and basic functional analysis). The two main chapters contain full proofs of the weak and strong compactness theorems. The statements are generalized from closed manifolds to manifolds with boundaries. The proof of the weak compactness theorem follows the original proof of Uhlenbeck. The proof of the strong compactness theorem uses an alternative approach by Salamon and a lot of attention is paid to the local gauge theorem and patching constructions. This book is surely a useful addition to the literature. (vs)

List of reviewers for 2005

The Editor would like to thank the following for their reviews this year:

J. Anděl, M. Bečvářová-Němcová, L. Bican, J. Bureš, R. Černý, P. Drábek, J. Drahoš, M. Engliš, J. Felcman, M. Feistauer, Š. Holub, J. Hora, M. Hušek, J. Jelínek, J. Ježek, O. John, O. Kalenda, P. Kaplický, J. Kratochvíl, T. Kepka, L. Klebanov, V. Koubek, O. Kowalski, A. Kučera, P. Kůrka, J. Lukeš, J. Malý, M. Markl, P. Mayer, J. Málek, J. Milota, J. Mlček, E. Murtinová, K. Najzar, J. Nekovář, I. Netuka, Z. Pawlas, L. Pick, D. Pražák, P. Pudlák, P. Pyrih, Š. Porubský, Z. Práčková, M. Rokyta, P. Simon, P. Somberg, J. Souček, V. Souček, D. Stavovský, J. Stará, R. Šámal, J. Štěpán, J. Trlifaj, J. Tůma, J. Vanžura, Z. Vlášek, J. Veselý, M. Zahradník, L. Zajíček, J. Zichová, K. Zimmermann, J. Zítko, J. Žemlička.

All of the above are on the staff of the Charles University, Faculty of Mathematics and Physics, Prague, except: M. Engliš, M. Markl, P. Pudlák and J. Vanžura (Mathematical Institute, Czech Academy of Sciences), M. Bečvářová-Němcová, Š. Porubský (Technical University, Prague), P. Drábek (University of West Bohemia, Pilsen) and J. Nekovář (University Paris VI, France).



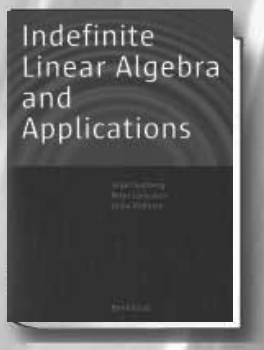
Scheidemann, V., Marburg, Germany

Introduction to Complex Analysis in Several Variables

2005. VIII, 171 p. Softcover
€ 25.– / CHF 38.–
ISBN 3-7643-7490-X

The book gives a comprehensive introduction to complex analysis in several variables. One major focus of the book is extension phenomena alien to the one-dimensional theory (Hartog's Kugelsatz, theorem of Cartan-Thullen, Bochner's theorem). The book primarily aims at students starting to work in the field of complex analysis in several variables and teachers who want to prepare a university lecture. Therefore, the book contains many examples and supporting exercises.

Focused on students Requires minimum of prerequisites More than 50 examples, over 100 exercises



Gohberg, I., Tel Aviv University, Israel /
Lancaster, P., University of Calgary, Canada /
Rodman, L., College of William and Mary, Williamsburg, USA

Indefinite Linear Algebra and Applications

2005. XII, 357 p. Softcover
€ 38.– / CHF 64.–
ISBN 3-7643-7349-0

This graduate text provides a careful treatment of the theory and applications of matrices in the presence of an indefinite inner product. The theory is a natural extension of the classical theory of hermitian and unitary matrices in linear algebra. Applications of the theory to differential equations, difference equations and systems theory are included.

Thorough treatment of indefinite inner product spaces Combining modern linear algebra with systems theory Suitable as reference work for scientists and engineers

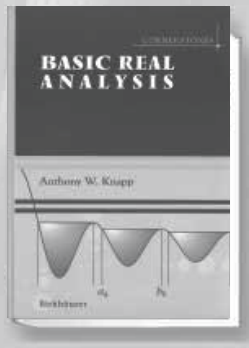
** € prices are net prices. All prices, dates and descriptions quoted are subject to change without previous notice.*

New Bookseries:

COR – Cornerstones

Advisory board:
Anthony W. Knapp, State University of New York at Stony Brooks, USA
Charles L. Epstein, University of Pennsylvania, Philadelphia, USA
Steven G. Krantz, Washington University, St. Louis, USA

Cornerstones comprises textbooks that focus on what students need to know and what faculty should teach regarding various select topics in pure and applied mathematics and related subjects. Aimed at aspiring young mathematicians at the advanced undergraduate to the second-year graduate level, books that appear in this series are intended to serve as the definitive advanced texts for the next generation of mathematicians. By enlisting only expert mathematicians and leading researchers in each field who are top-notch expositors with established track records, *Cornerstones* volumes are models of clarity that provide authoritative modern treatments of the essential subjects of pure and applied mathematics while capturing the beauty and excitement of mathematics for the reader. The Series Editors themselves are accomplished researchers with considerable writing experience, and seek to infuse each text with excellence and purpose through a collaborative, yet highly rigorous selection and reviewing protocol.



Knapp, A.W., State University of New York at Stony Brook, NY, USA

Basic Real Analysis

2005. XXI, 653 p. 10 illus.
Hardcover
€ 58.– / CHF 92.–
ISBN 0-8176-3250-6
COR – Cornerstones

Knapp, A.W., State University of New York at Stony Brook, NY, USA

Advanced Real Analysis

2005. XXII, 465 p. 6 illus.
Hardcover
€ 48.– / CHF 78.–
ISBN 0-8176-4382-6
COR – Cornerstones

Basic Real Analysis and Advanced Real Analysis Set

2005. 2-volume-set
€ 72.– / CHF 112.–
ISBN 0-8176-4407-5

Krantz, S.G., Washington University, St. Louis, MO, USA
Geometric Function Theory

Explorations in Complex Analysis

2006. XIV, 314 p. 41 illus.
Hardcover
€ 58.– / CHF 88.–
ISBN 0-8176-4339-7
COR – Cornerstones

For orders originating from all over the world except USA and Canada:
Birkhäuser Customer Service
c/o SDC
Haberstrasse 7
D-69126 Heidelberg
Tel.: +49 / 6221 / 345 0
Fax: +49 / 6221 / 345 42 29
e-mail: orders@birkhauser.ch

For orders originating in the USA and Canada:
Birkhäuser
333 Meadowland Parkway
Secaucus
NJ 07094-2491 / USA
Fax: +1 201 348 4505
e-mail: orders@birkhauser.com

http://www.birkhauser.ch

Birkhäuser

Springer
the language of science

springer.com

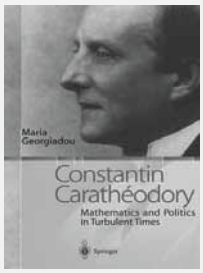
The vast world of Mathematics

Mathematical Events of the Twentieth Century

V. I. Arnold, Steklov Math.Inst., Moscow, Russia and Ceremade, France; **L.D. Faddeev**, **V.B. Filippov**, Steklov Math.Inst., St. Petersburg, Russia; **Yu. I. Manin**, Max-Planck-Inst. for Math., Bonn, Germany; **V.M. Tikhomirov**, Moscow State Univ., Russia; **A. M. Vershik**, St. Petersburg State Univ., Russia; **A.A. Bolibruch**, Steklov Math. Inst., Moscow, Russia; **Y.S. Osipov**, Russ.Acad. Sc., Moscow, Russia; **Y. G. Sinai**, Princeton Univ., USA (Eds.)

This book contains several contributions on the most outstanding events in the development of twentieth century mathematics, representing a wide variety of specialities in which Russian and Soviet mathematicians played a considerable role.

2006. VIII, 545 p. 96 illus. Hardcover
ISBN 3-540-23235-4 ► **€ 99,95 | £ 77,00**



Constantin Carathéodory

Mathematics and Politics in Turbulent Times

M. Georgiadou, Stuttgart, Germany

In a thought-provoking approach, Maria Georgiadou devotes to Constantin Carathéodory all the attention such a personality deserves. With breathtaking detail and the appropriate scrutiny she elucidates his oeuvre, life and turbulent political/historical surroundings. The interdisciplinary nature of the text allows easy access for both scholars and readers with a general interest in mathematics, politics and history.

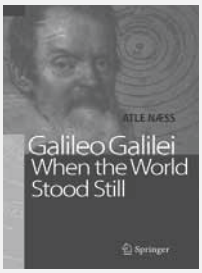
2004. XXVIII, 651 p. 87 illus. Softcover
ISBN 3-540-20352-4 ► **€ 39,95 | £ 30,50**

18 Unconventional Essays on the Nature of Mathematics

R. Hersh, University of New Mexico, Albuquerque, NM, USA (Ed.)

From the reviews ► *A wonderful collection of essays on the philosophy of mathematics, some by mathematicians, others by philosophers, and all having significant things to say. Most readers will be informed, some will be infuriated, but all will be stimulated* ► John H. Conway, John von Neumann Distinguished Professor of Mathematics, Princeton University

2006. XXII,. 330 p. Softcover
ISBN 0-387-25717-9 ► **€ 39,95 | £ 30,50**

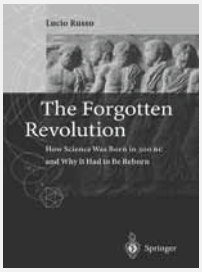


Galileo Galilei – When the World Stood Still

A. Naess, Ski, Norway

From the reviews ► *Naess weaves an excellent account of the story of Galileo. Addressed to the sophisticated general reader, it is an account that is alive, articulate, and well constructed, and one that provides the important larger context that surrounds the drama itself. This reviewer recommends it highly to anyone interested in a succinct and comprehensive look at the "saga" of Galileo* ► MAA Online book review columne, Alexander J. Hahn, October 2005

2005. VIII, 222 p. 21 illus. Hardcover
ISBN 3-540-21961-7 ► **€ 29,95 | £ 19,50**



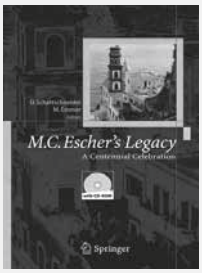
The Forgotten Revolution

How Science Was Born in 300 BC and Why it Had to Be Reborn

L. Russo, Università di Roma, "Tor Vergata", Rome, Italy; **S. Levy**, Mathematical Sciences Research Institute, Berkeley, CA, USA

From the reviews ► *A comprehensive and in-depth review of Hellenistic science. … The novelty of [its] conclusions is such that one might be tempted to react with plain disbelief....The reader should, however, avoid such a reaction, because the scholarly support is unquestionably impressive* ► Notices of the American Mathematical Society

2004. IX, 487 p. Softcover
ISBN 3-540-20396-6 ► **€ 29,95 | £ 19,50**



Now in soft-cover

M.C. Escher's Legacy

A Centennial Celebration

D. Schattschneider, Moravian College, Bethlehem, PA, USA; M. Emmer, University of Rome "La Sapienza", Rome, Italy (Eds.)

From the reviews of the hardcover edition ► *In summary, the book is entirely challenging in the sense that it provides a multi-faceted exploration of the work of a man whose life was a continuum of artistic and mathematical achievement. …* ► P.N.Ruane, The Mathematical Gazette March 2005

1st ed. 2003. 2nd printing 2005. XVI, 458 p. 520 illus., 20 in color. With CD-ROM. Softcover
ISBN 3-540-20100-9 ► **€ 39,95 | £ 25,00**

Easy Ways to Order for the Americas ► **Write:** Springer Order Department, PO Box 2485, Secaucus, NJ 07096-2485, USA ► **Call: (toll free)** 1-800-SPRINGER ► **Fax:** +1(201)348-4505 ► **Email:** orders-ny@springer.com or **for outside the Americas** ► **Write:** Springer Distribution Center GmbH, Haberstrasse 7, 69126 Heidelberg, Germany ► **Call:** +49 (0) 6221-345-4301 ► **Fax :** +49 (0) 6221-345-4229 ► **Email:** SDC-bookorder@springer.com
► Prices are subject to change without notice. All prices are net prices.

012108x