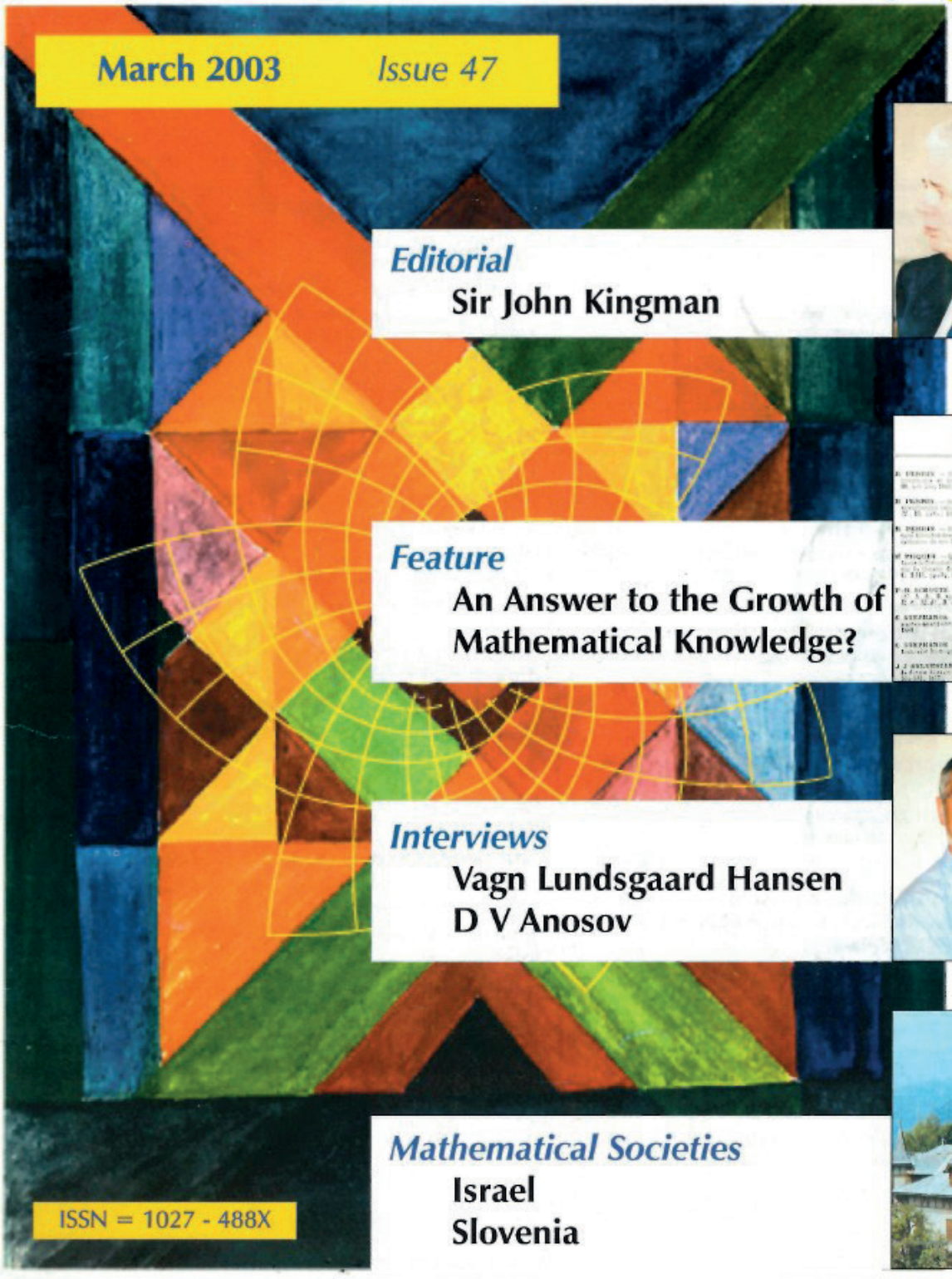
European Mathematical Society



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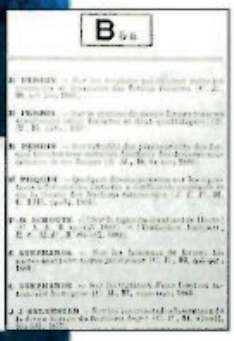

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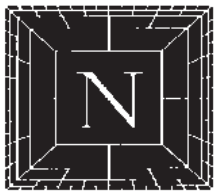
NEWSLETTER

EUROPEAN MATHEMATICAL SOCIETY



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NOTICE FOR MATHEMATICAL SOCIETIES

Labels for the next issue will be prepared during the second half of May 2003. Please send your updated lists before then to Ms Tuulikki Mäkeläinen, Department of Mathematics, P.O. Box 4, FIN-00014 University of Helsinki, Finland; e-mail: makelain@cc.helsinki.fi

INSTITUTIONAL SUBSCRIPTIONS FOR THE EMS NEWSLETTER

Institutes and libraries can order the EMS Newsletter by mail from the EMS Secretariat, Department of Mathematics, P. O. Box 4, FI-00014 University of Helsinki, Finland, or by e-mail: (makelain@cc.helsinki.fi). Please include the name and full address (with postal code), telephone and fax number (with country code) and e-mail address. The annual subscription fee (including mailing) is 80 euros; an invoice will be sent with a sample copy of the Newsletter.

EMS Committee

EMS Agenda

2003

15 May
Deadline for submission of material for the June issue of the EMS *Newsletter*
Contact: Robin Wilson, e-mail: r.j.wilson@open.ac.uk

18-23 May
IPAM-SIAM-EMS Conference in Los Angeles (UCLA Lake Arrowhead Conference Center), USA
Applied Inverse Problems: Theoretical and Computational Aspects
webpage: http://www.ipam.ucla.edu/programs/aip2003

30 June-4 July
EMS Summer School at Porto (Portugal)
Dynamical Systems
Organiser: Maria Pires de Carvalho, *e-mail:mpcarval@fc.up.pt*
webpage: http://www.fc.up.pt/cmup/sds

6-13 July
CIME-EMS Summer School at Bressanone/Brixen (Italy)
Stochastic Methods in Finance
Organisers: Marco Frittelli and Wolfgang J. Runggaldier
e-mail: runggal@math.eunipd.it
webpage: www.math.unifi.it/∼cime

15 August
Deadline for submission of material for the September issue of the EMS *Newsletter*

12-14 September
SPM-EMS Weekend Meeting at the Calouste Gulbenkian Foundation, Lisbon (Portugal)
Organiser: Rui Loja Fernandes, *e-mail: rfern@math.ist.utl.pt*

14-15 September
EMS Executive Committee meeting at Lisbon (Portugal)
Contact: Helge Holden, e-mail: holden@math.ntnu.no

2004

25-27 June
EMS Council Meeting, Stockholm (Sweden)

27 June-2 July
4th European Congress of Mathematics, Stockholm
webpage: http://www.stocon.se/4ecm/

2-6 September
EMS Summer School at Universidad de Cantabria, Santander (Spain)
Empirical processes: theory and statistical applications

Editorial: An Ocean of Mathematics

Sir John Kingman (EMS President)

The European Mathematical Society covers the whole of what is conventionally called pure and applied mathematics, from the most abstract and theoretical to applications in diverse fields of science and technology. Attempts to define or delimit the scope of mathematics always fail to capture the richness of the subject. The best I can offer is the circular definition: mathematics is what mathematicians do, and mathematicians are people who do mathematics.

What is often not sufficiently understood by those outside mathematics is how important it is to see the subject as a whole, and we inside sometimes make the situation worse by putting ourselves into compartments. We set up departments of pure mathematics, applied mathematics, statistics, operational research; we argue about the relative merits of algebra and geometry; we quote G. H. Hardy on the uselessness of mathematics. In doing so, we underplay the interconnected nature of the subject and the extent to which, throughout history, unexpected links and novel applications are discovered.

In thinking about the unity of mathematics, I find it helpful to consider a metaphor in the form of a great ocean. Isaac Newton spoke of himself as playing on a seashore, while the whole ocean of truth lay undiscovered, but my analogy takes mathematics itself as the ocean. The areas to which it is applied, with which it interacts, are the continents and islands against whose shores the ocean breaks. Observers see these shores and admire the foaming breakers, and they see too the surface of the waters far from land, but they miss what is going on in the depths, and the fact that the whole ocean is one great ecosystem in which the health of the life in different parts depends on that of the whole.

When mathematicians attack a problem in physics or biology or economics, they may be able to make progress in a direct and straightforward way, writing down equations and solving them analytically or numerically, but if the problem is at all challenging, obstacles will soon arise that stand in the path and frustrate simple solutions. The mathematician will try to understand these obstacles, assessing how fundamental they are. Often it will be realised that they are similar to difficulties that have arisen in other areas, and that methods developed in those other areas can be fruitfully transferred. A process of abstraction and generalisation can often prove extremely powerful, and may lead to more subtle solutions, or at least to a deeper understanding of why a solution is elusive.

In practice, this process of abstraction will be repeated several times, and other mathematicians with other expertise will transform the original problem into almost unrecognisable form. It is however important that a chain of communication should not be broken, so that those concerned with real problems know what is being done at a more abstract level, and can both use the more general theory and challenge its relevance.

This whole process is very like the way the flora and fauna in different levels of the ocean feed off those in adjacent levels. We may for administrative convenience give distinct names to different levels, but they remain interdependent. In the depths there are strange creatures that never see the sunlight above, while on the surface are those who never venture below, but they all depend on each other, perhaps through long and subtle chains of mutual need.

There also great leviathans of the subject, whales that descend to the deepest water and then rise to the surface with spouts of profound new mathematical understanding. We celebrate this year the centenaries of two such, von Neumann and Kolmogorov, who brought the purest of pure mathematics to bear on a variety of applied fields with a power and authority that defied the distinctions of lesser mathematicians. We need more such who disturb the ocean and shake our preconceptions.

The continents against which the waters lap are very different from one another. The best known is of course that of physics, which has gentle beaches and broad bays in which play amphibious creatures who hardly know or care whether they are mathematicians or physicists. But even here there are penguins, clumsy on land but beautiful swimmers in the water. And there are crocodiles, which lie half submerged in the shallows looking like harmless logs until they spy a target nearby, when they spring ashore with frightening speed and open jaws. I leave my readers to construct their own examples, to describe the variety of behaviour in highly developed fields like mathematical physics.

Unfortunately, there are contrasting continents in which the waves beat against high cliffs of incomprehension, on top of which the inhabitants look down on the mathematicians in the sea, who in turn shout in vain to those on land. In time, some of these cliffs will crumble, but meanwhile we lose opportunities because of an inability to communicate.

On the other hand, there are some areas where mathematics gets inextricably mixed with difficult non-mathematical disciplines. The science of statistics, for example, is neither a subset nor a superset of mathematics, and resembles those landscapes that are neither land nor sea but some admixture of the two.

Meanwhile, far out to sea, it is possible to forget the existence of land altogether, but the nature of the ocean is in fact influenced strongly by the nature of the invisible continents that bound it. And they in turn are sometimes radically affected by what happens over the horizon. In the depths of the ocean an event may show on the surface as a wave a few centimetres high. But as the wave travels towards the land it may grow into a tsunami with dramatic consequences for those on shore.

We live in a world that has been decisively shaped by the applications of mathematics. Mathematics will advance, faster than ever, in response to practical challenges and its internal momentum of mathematical curiosity. New connections will be discovered between apparently different fields, and good mathematicians will continue to spring surprises on their colleagues and on the world.

Executive Committee Meeting

Nice (France), 8-9 February 2003

David Salinger

Our hosts, the French mathematical societies SMF and SMAI, had arranged for good food and pleasant weather, so it was rather a shame to sit indoors and transact the Society's business. All members of the Executive Committee were there, together with Tuulikki Mäkeläinen, our invaluable executive secretary, the energetic figure of our past president, Rolf Jeltsch, saying that he could now sit in a quiet corner, Robin Wilson, the Editor of the *Newsletter* (with a garish two-sided tie), Saul Abarbanel (making sure that applied mathematics was not disregarded) and myself, listening for anything that could be turned into publicity.

Our new President, Sir John Kingman, presided imperturbably over the business of what was a very amicable meeting.

Gentle reader, not even the muses could make all that business interesting. The routine ratification of appointments to the standing committees of the society and decisions about terms of office will be reflected in due course on EMIS. Decisions to support (or not to support) meetings and other activities may not appear here, because the applicants should be informed first. So I shall try to give a general idea of what was discussed and, where I can, of the more important decisions taken, which I shall list at the end.

In a year when subscriptions have risen, it may not be politic to report that the Society made a small surplus overall of 4754 euros. However, this represented an operating loss, principally because of the expense of holding our Council meeting in Oslo. Even the auditors agreed that costs in Oslo could be high. The apparent surplus arose from receiving income on projects whose expenditure was incurred in a different financial year. Income from membership fees had increased, reflecting a significant rise in membership.

The President, Past President, and Vice-Presidents reported on the many meetings at which they had represented, or would represent, the Society. These included scientific meetings, representation on organisations, and meetings to do with European funding. The President also reported on the 'hand-over' meeting in Zürich. He thanked Rolf Jeltsch and David Brannan for their devotion to, and brilliant work for, the EMS.

Under the 6th Framework arrangements, Luc Lemaire explained, the European Union would accept applications only for series of meetings: either large meetings or events such as summer schools for training young researchers. He had therefore issued a call for proposals: some had already been received, and the Committee approved a number of them. He had also asked the Committee for help in drawing up a list of mathematicians who would give the Committee Scientific advice about proposed meetings, and who also could be nominated as a panel of experts for the 6th Framework programme.

Several of the Society's committees reported. The Committee on Eastern Europe was in charge mainly of distributing travel grants to young Eastern European mathematicians. The Committee for Developing Countries was very active and sought working capital from the EMS. The Executive Committee was sympathetic, but it had limited funds at its disposal: however there was an unspent amount that it could allocate. The Education Committee was drawing up position papers on *The preparation of students for university*, *The supply of maths teachers*, *Technology in teaching* and *Popularisation*. The Raising Public Awareness Committee reported that it had received 26 articles for its competition. The Committee for Women and Mathematics reported on a scheme for mentoring young women mathematicians, run by European Women in Mathematics. The Special Events Committee submitted amended rules governing the Diderot Maths Forum. The Committee for Developing Countries has been very active with its book distribution programme, but is also getting new facets of its activities under way.

Ari Laptev joined the committee on Sunday to tell us about progress on 4ecm (see page 5). That day, we moved from an anonymous hotel conference room to the imposing Maison du Séminaire on the sea front.

Rolf Jeltsch reported on his meeting at Berlingen about the project to digitise all past mathematical literature. Although this had been agreed by the IMU, neither the NSF in the USA nor the European Union would fund the main costs of digitisation. An application could still be made to the 6th Framework programme for some aspects, but the main funding would have to come from other sources.

Robin Wilson confirmed that, due to extra responsibilities at the Open University, the June issue of the *Newsletter* would be his last as Editor-in-Chief. The Committee thanked Robin for his work: under his guidance, the *Newsletter* had become a major asset to the Society.

SMAI and SMF and (particularly) Doina Cioranescu, were thanked, not only for their warm welcome and the smooth running of the arrangements for the meeting, but also for their organisation of AMAM03, which promised to be a great success.

Some Decisions

- The Society should have a booth at ICIAM in Sydney.
- The Committee approved academic institutional membership for the Central European University (Budapest) and the Faculty of Mathematics at the University of Barcelona.
- The Committee agreed to support the Cortona Scuola Matematica Interuniversitaria on the same basis as the Banach Centre. The Committee resolved that, in principle, it could provide this kind of support where there was direct EMS input and a measure of internationalisation, but that each application would be considered on its merits.
- It was agreed to accept the bid of the Netherlands Mathematical Society to hold 5ecm in Amsterdam in 2008, subject to a site visit.
- It was agreed to provide 4000 euro as working capital for the Committee for Developing Countries.
- A common letterhead incorporating the logo was agreed.
- It was agreed in principle that EMS should become a full member of the EULER Consortium.
- It was agreed that the Committee should not support individuals for prizes.

Preparations for 4ecm: the Fourth European Congress of Mathematics

4ecm: Stockholm, 27 June – 2 July 2004

The poster for the congress has been distributed.
A letter will be sent to all participants in 3ecm (Barcelona, 2000).
A number of Nobel prizewinners have been asked to speak to the congress about the role of mathematics in their subject.
So far, six expressions of interest in organising satellite conferences have been received.
Fourteen EU networks have responded to the call to hold their network meetings in Stockholm.
The conference fee will be 200 euros, with a 20% discount for EMS members.

Call for Nominations of Candidates for Ten EMS Prizes
Fourth European Congress of Mathematics

Principal Guidelines
Any European mathematician who has not reached his/her 35th birthday on 30 June 2004, and who has not previously received the prize, is eligible for an EMS Prize at 4ecm. A total of 10 prizes will be awarded. The maximum age may be increased by up to three years in the case of an individual with a corresponding 'broken career pattern'.
Mathematicians are defined to be 'European' if they are of European nationality or their normal place of work is within Europe. 'Europe' is defined to be the union of any country part of which is geographically within Europe or that has a corporate member of the EMS based in that country.
Prizes are to be awarded for the best work published before 31 December 2003.
The Prize Committee shall interpret the word 'best' using its judgement: for example, it may refer to innate quality or impressiveness, influence, etc.

Nomination for the Award
The Prize Committee, headed by Prof. Nina Uraltseva (St Petersburg), is responsible for solicitation and evaluation of nominations. Nominations can be made by anyone, including members of the Prize Committee or by the candidates themselves. It is the responsibility of the nominator to provide all relevant information to the Prize Committee, including a resume and documentation.
The nomination for the awards should be reported by the Prize Committee to the EMS President at least three months prior to the date of the awards. The nomination for each award must be accompanied by a written justification and a citation of about 100 words that can be read out at the award ceremony. The prizes cannot be shared.

Description of the Award
The award comprises a certificate including the citation and a cash prize of 5000 euro.

Award Presentation
The prizes will be presented at the Fourth European Congress of Mathematics by the President of the European Mathematical Society. The recipients will be invited to present their work at the conference.

Prize Fund
The money for the Prize Fund will be raised by the organisers of the Fourth European Congress of Mathematics in Stockholm.

Deadline for Submission
Nominations for the prize must reach the office in Stockholm at the following address, no later than 1 February 2004:
4ECM Organising Committee, Prof. Ari Laptev, Department of Mathematics, Royal Institute of Technology, SE-100 44 Stockholm, Sweden.

e-mails: laptev@math.kth.se, uunur@nur.usr.pu.ru
http://www.math.kth.se/4ecm/
fax: +46-8-723-17-88, phone: +46-8-790-84-86

Instructions for Organisers of 4ecm Satellite Conferences

The Organising Committee of the 4ecm offers the following advantages to organisers of satellite activities.
- A summary of information about each satellite activity will be freely distributed through the printed and electronic systems of the 4ecm.
- The reduced registration fee offered to participants of the 4ecm registered before April 2004 will be extended until the beginning of the 4ecm for participants of satellite activities.
- Addresses of satellite activity participants may be included in the mailing list of the 4ecm for distribution of information.

The Organising Committee requires the following information in order to decide if an activity can be considered as a satellite of the 4ecm.
- Title and a short presentation of the activity (periodicity, objectives, etc.).
- Location and dates.
- Organising Committee and Scientific Committee, if applicable.
- Preliminary list of speakers, if applicable.

The experience from previous EMS conferences and other international events shows that it is also convenient to request the following.
- The dates of satellite activities should be close to the dates of the 4ecm (27 June – 2 July 2004).
- People responsible for each satellite activity should provide their participants with information about the 4ecm. In addition, they should assist them in organising their trip to or from Stockholm.

The organisers of the 4ecm will also assist 4ecm participants who are registered in some satellite activity in arranging their travel plans.

Contact details for organisers:
Mikael Passare, *e-mail: passare@matematik.se*
website: http://www.math.kth.se/4ecm/Instructions.htm
The deadline for proposals for satellite activities is 1 February 2004.
We regret that activities communicated after this date cannot be acknowledged by the Organising Committee.

New members 2002

Australia
Matthew Brown

Austria
Herbert Fleischner
Ali Ünlü
Franz Winkler

Belgium
Jan Adriaenssens
Pierre Caprace
Stefaan De Winter
Cindy De Wolder
Sandy Ferret
Nicholas Hamilton
Georges Hansoul
Natalia Katilova
Thierry Lucas
Pierre Mathonet
Cedric Rivière
Koen Thas
Jan van Geel

Bulgaria
Ivailo Mladenov

Canada
Nicolas Juge

China
Huafei Sun

Czech Republic
Pavel Exner

Finland
Seppo Heikkilä
Ilkka Holopainen
Matti Honkapohja
Timo Karvi
Mika Koskenoja
Petri Ola
Matti Rantanen
Leo Salo
Mari Savela
Samuli Siltanen
Eero Tamminen

France
Denis Aubry
Pierre Balvay
Mohammed-Najib Benbourhim
Sylvie Benzoni-Gavage
Nicole Berline
Valérie Berthé
Stéfanella Boatto
Frédéric J. Bonnans
Nicole Bopp
Alain Bretto
Pierre Cartier
Denise Chenais
Guillaume Douard
Jean Charles Gilbert
Vivette Girault
Marc Grandotto
Fabien Granger
Georges Griso
Jean-Claude Guillot
Francois Hamel
Paul-Louis Hennequin
Jacques Istas
Christian Lecot
Bernard Marchand
Victor Filipe Martins da Rocha
Guy Metivier
Régis Monneau
Dumitry Motreanu
Jean-Philippe Nicolas
Ashkan Nikeghbali
Pierre Orenga
Annie Raoult
Bruno Rey
Joel Rivat
Benoit Rottembourg
Raphael Rouquier
Léon Saltiel
Lionel Schwartz
Ngoc Nam Tram
Jacques Levy Vehel
Charles Walter

Germany
Peter Eichelsbacher
Ulrich Pinkall
Nikolai Sapunarow
Norbert Schappacher
Ralf Schumacher
Onnen Siems
Luise Unger

Greece
Chryssa Ganatsiou
S. Molho
N. Papoulas

Hungary
Andras Batkai

Ireland
Eimear Byrne
Michael McGettrick
James T. Ward
David Wilkins

Israel
Flavian Abramovici
Buma Abramovitz
Zvi Artstein
Gill Barequet
Eugene Barsky
David Blanc
Achi Brandt
Daoud Bshouty
Gideon Ehrlich
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Maria Gorelik
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Alexander Ioffe
Shmuel Kantorovitz
Yael Karshon
Meir Katchalski
David Kats
Victor Khatskevich
Juri Kifer
Vladimir Korman
Eran London
Iakov Lutsky
Shahar Mozes
Bernard Pinchuk
Allan Pinkus
Nizar Radwan
Amitai Regev
Andre Reznikov
Joseph Roseman
Mozes Shahar
Yehuda Shalom
Vladimir Shevelev
Eduard Yakubov
Zvi Ziegler

Italy
Elisabetta Alvoni
Maria Artale
Luca Barzanti
Rita Capodaglio
Gaetano Cavallaro
Alfredo Ciano
Paolo Custodi
Franca Degani Cattelani
Gerardo De Maio
Luigi D'Onofrio
Margherita Fasano Petroni
Eva Ferrara Dentice
Marianna Fornasiero
Donato Fortunato
Lorenzo Fucci
Federica Galluzzi
Alessandro Giacomini
Ugo Gianazza
Gian Mario Gianella
Gennaro Infante
Giovanni Landi
Marta Macri
Antonio Manna
Cristina Marcelli
Emanuela Maresi
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Antonino Maugeri
Alessandra Micheletti
Michele Mininni
Luciana Misso
Marco Modugno
Gioconda Moscariello Loianno
Franco Nardini
Paolo A. Oliverio
Carlo Domenico Pagani
Rita Pardini
Fulvio Ricci
Pietro Rigo
Carla Rossi
Rodolfo Salvi
Claudia Scarani in Tampieri
Alessandro Scarselli
Antonino Surdo
Sandra Tucci
Mariacristina Uberti
Antonio Zitarosa

Japan
Takao Matumoto

Luxembourg
Denise Kass-Hengesch
Gérard Lorang

Netherlands
Wilfred W. J. Hulsbergen

Nigeria
J. A. Oguntuase

Norway
Harald Hanche-Olsen
Arne B. Sletsjoe

Poland
Teresa Lenkowska-Czerwinska

Romania
Dan Barbosu
Gheorghe Micula
Constantin Niculescu
Nicolae Pop

Russia
Vyacheslav S. Kalnitsky

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Sonia Esteve Frigola
Jorge Galindo Pastor
Garcia Bellido I.E.S.A.
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Ricard Marti Miras
Carlos Romero Chesa

Sweden
Anders Björn
Jana Björn
Lars Hörmander
Ulf Ottoson
Gunnar Mossberg

Switzerland
Herbert Amann
Demetrios Christodoulou
Norbert Hungerbühler
Wesley Petersen
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Bert Reinold
René Sperb
Michel Thiebaud

Tunisia
Patrick Cabau

Ukraine
Eugene Tokarev

United Arab Emirates
Raymond F. Tennant

United Kingdom
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John Bibby
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H. J. Carvill
Paul J. Flavell
Greig J. Fratus
Ting Guo Ho
S. J. Lewis
R. S. McDermott
E. J. Park
S. C. Roy
Anthony E. Solomonides
J. Trevor Stuart
Ola Törnkvist
Sheung Tsun Tsou
Reidun Twarock
John Wright
Ioannis Zois

United States of America
Francis Bonahon
L. E. Domino
Sigurdur Helgason
Ricardo Perez Marco
Loki Quaeler

Introducing the Committee
(part 1)

Sir John Kingman (*President*) is the Director of the Isaac Newton Institute for Mathematical Sciences in Cambridge, a post he has held since 2001. Cambridge was his first university, which he left in 1965 for professorships at the Universities of Sussex and Oxford. He was Chair of the UK Science and Engineering Research Council from 1981-85, and then served for 16 years as Vice-Chancellor (equivalent to Rector) of the University of Bristol.

Sir John works on probability theory and its applications to random processes in a variety of applications, including population genetics and operational research. He became a Fellow of the Royal Society in 1971, and has been President of both the Royal Statistical Society and the London Mathematical Society. He also chairs the Statistics Commission, which monitors the integrity of official statistics in the UK.

Luc Lemaire (*Vice-President*) received a Doctorat from the Université Libre de Bruxelles in 1975 and a Ph.D. from the University of Warwick in 1977. From 1971 to 1982 he held a research position at the Belgian F.N.R.S., and has been a professor at the Université Libre de Bruxelles since then. His research interests lie in differential geometry and the calculus of variations, with a particular interest in the theory of harmonic maps.

A former chairman of the Belgian Mathematical Society, Luc has been associated with the European Mathematical Society since its creation in 1990, being a member of the Council from 1990 to 1997, a member of the group on relations with European Institutions since 1990, Liaison Officer with the European Union since 1993, Vice-President 1999, and now Chair of the General meetings committee.

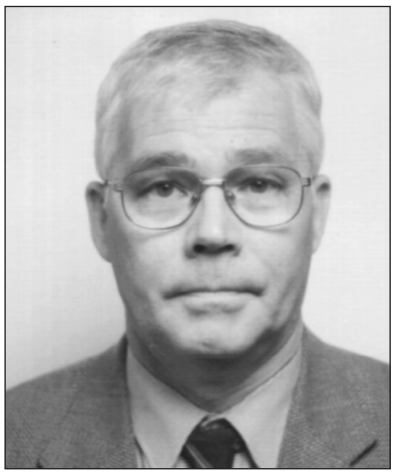
Bodil Branner (*Vice-President*) is a professor at the Technical University of Denmark, Lyngby (Copenhagen). She graduated from the University of Aarhus in 1967 in algebraic topology, but for the last 20 years has concentrated on problems within dynamical systems, in particular in holomorphic dynamics. She has been a visiting professor at Cornell University and the Université de Paris-Sud, and a visitor at the Max-Planck-Institut für Mathematik in Bonn and the Mathematical Sciences Research Institute (MSRI) in Berkeley.

Bodil has been involved in establishing the network of European Women in Mathematics from its beginning in 1986. Since 1992 she has been a delegate of the EMS Council, representing individual members, and has been a member of the Executive Committee since 1997. She was recently President of the Danish Mathematical Society and a member of the Danish Natural Science Research Council. She is currently a member of the EURESCO committee under the European Science Foundation, representing the EMS.

Helge Holden (*Secretary*) was born in Oslo, Norway in 1956. He received his Ph.D. from the University of Oslo in 1985. After a year as a postdoc at the Courant Institute in New York, he accepted a position in Trondheim at the Norwegian University of Science and Technology, where he was promoted to full professor in 1991.

Helge's area of research is partial differential equations. His first work was in the mathematical theory of Schrödinger operators, and he then moved on to stochastic partial differential equations, flow in porous media, hyperbolic conservation laws, and completely integrable systems.

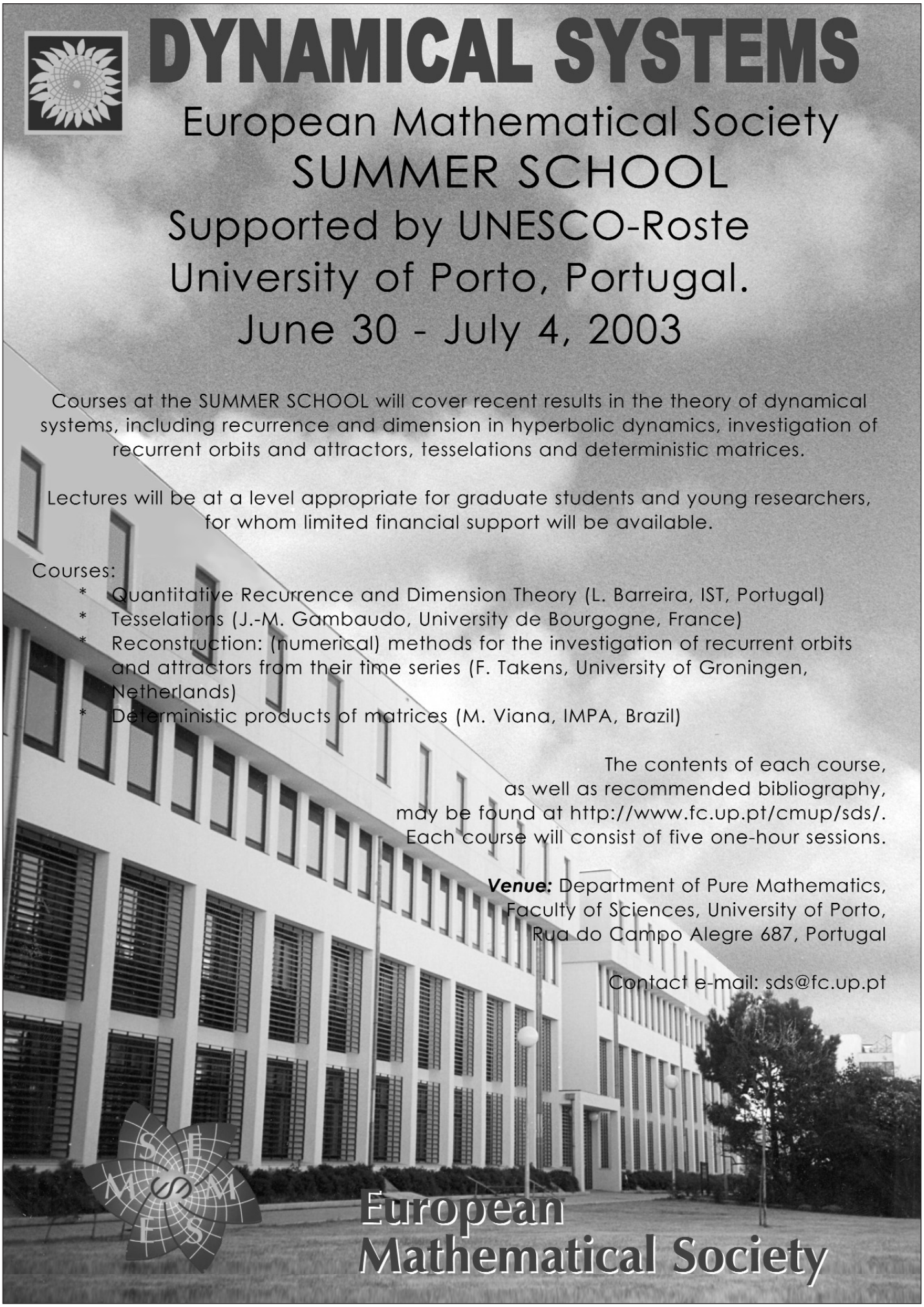
He is currently Vice-President of ECMI, the European Consortium for Mathematics in Industry.



Olli Martio ***(Treasurer)*** received his Ph.D. at the University of Helsinki in 1967. He became an Associate Professor at the University of Helsinki in 1972, a professor at the University of Jyväskylä in 1980, and from 1993 he has been a professor and Head of Department of Mathematics in Helsinki. He has been a visiting professor in the University of Michigan, Norwegian Institute of Technology and Universidad Autonoma de Madrid. He has been an editor of *Mathematica Scandinavica* and *Acta Mathematica*. he is a member of several editorial boards and currently edits the Finnish journal *Ann. Acad. Sci. Fenn. Math.*

His research interests include function theory (quasiconformal maps), non-linear potential theory and associated partial differential equations. He has organised several conferences and edited nine international conference proceedings, starting with the Nordic Summer School in quasiconformal mappings in Helsinki in 1971.

Olli has held various positions in the Finnish Mathematical Society. He has been the President of the Finnish Academy of Sciences and Letters and a member of the Committee for Natural Sciences in the Academy of Finland, as well as a member of several European Union Scientific Panels for Mathematics. He is a honorary doctor of the Linköping Institute of Technology, the University of Volgograd and the University of Jyväskylä, as well as a honorary professor of the University of Brasov.


DYNAMICAL SYSTEMS
European Mathematical Society
SUMMER SCHOOL
Supported by UNESCO-Roste
University of Porto, Portugal.
June 30 - July 4, 2003
Courses at the SUMMER SCHOOL will cover recent results in the theory of dynamical systems, including recurrence and dimension in hyperbolic dynamics, investigation of recurrent orbits and attractors, tesselations and deterministic matrices.
Lectures will be at a level appropriate for graduate students and young researchers, for whom limited financial support will be available.
Courses:
* Quantitative Recurrence and Dimension Theory (L. Barreira, IST, Portugal)
* Tesselations (J.-M. Gambaudo, University de Bourgogne, France)
* Reconstruction: (numerical) methods for the investigation of recurrent orbits and attractors from their time series (F. Takens, University of Groningen, Netherlands)
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An Answer to the Growth of Mathematical Knowledge?
The *Répertoire Bibliographique des Sciences Mathématiques*

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In March 1885, the *Société Mathématique de France* (SMF) conceived the project of a bibliographical catalogue of nineteenth-century mathematical sciences. Facing the constant increase of mathematical journals and the exponential growth of mathematical knowledge, the SMF members felt the lack of a bibliographical tool for advanced students and mathematicians. The *Répertoire Bibliographique des Sciences Mathématiques* was to be the SMF's answer to the expansion of mathematics.

This long-term bibliographical enterprise – which was directed by Henri Poincaré – rapidly became an international endeavour: for almost 27 years, about 50 mathematicians from 16 different countries went through more than 300 mathematical journals. Between 1885 and 1912, more than 20,000 bibliographical references to mathematical works (articles, books, treatises, etc.) were identified, collected, and published, using a methodical and systematic classification.

This repertoire constitutes an important stage for the history of nineteenth-century science. The reconstitution of its history represents an interpretative key for the study of the internationalisation of science. Moreover, it may be an essential source for investigations concerning the organisation of disciplinary frontiers within mathematical sciences.

The aim of this article is to set out the first elements of an investigation devoted to the history and operation of the *Répertoire Bibliographique des Sciences Mathématiques*. We first describe the scientific and intellectual context of its emergence. Next, we relate the history of its creation. Finally, using a few elements extracted from our computer database, we try to give a general survey of the contribution of this bibliography to the history of mathematics.

Nineteenth-century science: a growing concern for bibliography

During the second half of the nineteenth century, a large number of disruptions affected European science: an unprecedented increase of research and a growing specialisation in every domain; the organisation of institutions in networks; an institutionalisation of research in most European countries via the creation of academies, learned societies and universities; an increase in the number of university students, notably in France after the 1880 and 1890 reforms; and the considerable acceleration of the internationalisation of science (for instance, the organisation of the first international congresses).

Besides these disruptions, one should add an important phenomenon: the exponential growth of the number of scientific journals. At the end of the nineteenth century many scholars perceived the constant increase of printed matter as a serious problem. Two simple figures can give some idea of this situation: in 1890, international statistics of printed matters estimated that 100,000 items a year were published. In 1900, one estimated the annual production at 20,000 books, 76,000 journals and approximately 600,000 articles (see [Goldstein 2001], [Rasmussen 1995], and [Otlet 1900]).

The first scientific journals appeared during the seventeenth century. At that time, these journals were usually published by academies and learned societies, and they didn't exclusively contain mathematical publications (one could find, for instance, articles devoted to botanical or zoological issues): the *Journal des scavants* (1665) or the *Philosophical Transactions of the Royal Society of London* (1665) are two good examples of such publications.

The first issue of Gergonne's *Annales de mathématiques pures et appliquées* was published in 1810, and this was probably the first significant mathematical journal exclusively devoted to mathematics. It ceased in 1831, but several other journals took over: the *Journal für die reine und angewandte Mathematik* (1826), the *Journal de mathématiques pures et appliqués* (1836) and the *Annali di scienze mathematiche e fisiche* (1850). One should add that, during the second half of the nineteenth century, the appearance of various learned societies was followed by the creation of several specialised journals; for instance, the SMF was created in 1872 and the first issue of its journal, the *Bulletin de la Société Mathématique de France*, was published in 1873.

According to Neuenschwander [1994, pp. 1534-5], only 15 journals contained mathematical articles in 1700; in 1900, probably more than 600 journals published mathematical works (see [Gispert 2000]). Facing such an increase, many mathematicians were strongly in favour of the creation of bibliographical catalogues, and bibliography rapidly became a major part of scientific research.

Many bibliographical indices were produced during the nineteenth century. The most important national libraries in Europe started to publish their exhaustive catalogues, and many scholars or members of learned societies tried to set up various bibliographic catalogues for specific fields of knowledge: bibliographical catalogues on index cards; monthly, quarterly or annual bibliographical reviews; chronological, alphabetical and methodical bibliographies; bibliographies centred on a particular discipline such as mathematics or covering a larger field (such as the *International Catalogue of Scientific Literature*, with sections devoted to mathematics, zoology, etc.), or even universal repertoires, such as Paul Otlet's *Répertoire Bibliographique Universel* (see [Rasmussen 1995], [Otlet 1906, 1908, 1918] and [Rayward 1990]).

There were also such bibliographical endeavours before the nineteenth century: for mathematics, at least two bibliographies are significant: J.E. Scheibel's *Einleitung zur mathematischen Bücherkenntnis* (Breslau) 1769-98, and F.W.A. Murhard's *Literatur der mathematischen Wissenschaften* (Leipzig), 1797-1805, each recording about 10,000 mathematical works.

The following table gives an indication of the most important catalogues for mathematics in the second half of the nineteenth century:

Name of the repertoire	Information	Period
Bulletino di bibliografia e di storia delle scienze mathematiche e fisiche.	Published by Boncompagni.	1868-1887
Jahrbuch über die Fortschritte der Mathematik, Berlin.	Successively edited by Carl Ohrtmann, Felix Müller, Albert Wangerin, E. Lampe, Leon Lichtenstein, Georg Feigl, etc.; this journal proposed annual bibliographies for mathematics. In 1932 it merged with the *Revue semestrielle des publications mathématiques.*	1868-1944
Bulletin des sciences mathématiques.	This journal was created by Darboux and Hoüel in 1870 as the Bulletin des sciences mathématiques et astronomique. In 1885, it became the *Bulletin des sciences mathématiques.*	1870-…
Revue semestrielle des publications mathématiques.	Published by the Amsterdam Mathematical Society (each volume recorded about 3000 bibliographical references).	1893-1934
Catalogue of Scientific Papers.	Published by the London Royal Society. It recorded about 40,000 publications (not exclusively devoted to mathematics).	1867-1925
International Catalogue of Scientific Literature (section A, Mathématiques).	This catalogue was the successor of the *Catalogue of Scientific Papers*. It collected about 25,000 bibliographical references.	1902-1921
Bibliographie mathématique de Valentin.	This was compiled by Georg Valentin in Berlin. It probably contained more than 150,000 references but was never published.	1885-1910

The most important mathematical bibliographies (1850-1900)

For further information concerning the bibliographical repertoires devoted to various fields, see [Besterman 1949]. This table should be complemented by the different editions of Poggendorf's *Biographisch-literarisches Handwörterbuch der exakten Naturwissenschaften* and by the *Répertoire Bibliographique des Sciences Mathématiques*. Houzeau's and Lancaster's bibliographies for astronomy ([Houzeau 1878], [Houzeau /Lancaster 1882, 1887]) had a strong influence on the mathematical repertoire

All these bibliographical attempts constitute a sign for a general consensus on scientific research around 1900. Many mathematicians agreed that it was almost impossible to be certain that other scholars had not yet studied their ideas. Moreover, they were increasingly upset by the time lag between the publication of an article and its registration in a mathematical bibliography (up to three years in the *Jahrbuch über die Fortschritte der Mathematik* (see [Neuenschwander 1994, p. 1836]) or in the *Catalogue of Scientific Papers*). Consequently, many mathematical journals paid great attention to bibliographical issues in the 1880s and the 1890s: what is the best bibliographical system for mathematical sciences? what kind of classification should be adopted? who should do the bibliographical work? should mathematicians adopt an alphabetical classification, or should they elaborate a systematic and consensual classification at an international level? (For echoes of these discussions, see [Eneström 1890].)

The first years: 1885-94

The SMF formulated the idea of a bibliographical repertoire for mathematics in 1885, and the Society rapidly diffused a preliminary project within the international mathematical community. A first mention of the project appears in a *lettre circulaire* of March 1885 entitled *Projet de répertoire bibliographique*. This letter began with an acknowledgement of the incapacity of mathematicians regarding the increase of mathematical publications, and continued with a presentation of the different steps of the project: compilation of bibliographical references on individual index cards; ordering of the cards with the help of a suitable classification; and publication. According to Eneström [1890], this proposition was warmly welcomed; consequently, a month later, the SMF sent another circular that gave more precise instructions.

Nevertheless, the project was not defined and accepted until four years later, in 1889, and the first set of a hundred printed index cards was not to be published until 1894. Such a time lag finds its main source in the complexity and the sophistication of the classification adopted.

The intention of the SMF was to differentiate its project from other bibliographical endeavours by proposing a logical classification of items based on a thematic index. This index probably started to circulate in an informal way in 1887: the letters of Poincaré, Perott, Mathieu, Schlegel, Brioschi, Eneström and Mittag-Leffler contain numerous discussions about the logical organisation of mathematical domains in the index. A 67-page *Projet de classification détaillée pour le Répertoire Bibliographique des Sciences Mathématiques* was published by Gauthier-Villars in June 1888. The first edition of the index was finally published in 1893, and several later editions were printed (see [*Commission permanente du Répertoire Bibliographique des Sciences Mathématiques* [1893], [1898], [1908], [1916]).

Noting the occasion of the 1889 World Fair, the commission of the repertoire, chaired by Henri Poincaré, decided to organise the first *Congrès International de Bibliographie des Sciences Mathématiques*. The purpose of the organisers (Paul Appell, Gaston Darboux, Charles Rouché, Jules Tannery and Georges Humbert) was to gather in Paris all those involved in mathematical research and eager to contribute to the project at an international level.

During this congress, which was supported by the Ministry of Trade, Industry and Colonies, several decisions were taken:

- The bibliography should consist of an inventory of the titles of memoirs in pure and applied mathematics published from 1800 to 1889, as well as works concerning the history and the philosophy of mathematics from 1600 to 1889: the purpose was to establish a systematic list of all articles and memoirs published in the most important mathematical journals.
- The titles of memoirs should be classified, not by the authors' names, but according to the logical order of subjects.
- Publications on astronomy already mentioned in the astronomical bibliography of Houzeau and Lancaster in the 1880s should be excluded.
- The titles of works written in languages other than French, Italian, German, Spanish or Latin should be translated into French.

The commission appealed to a general adoption of the classification index by mathematicians and mathematical journals.

Finally, it was decided to establish a permanent commission, based in Paris: its composition was Henri Poincaré, Désiré André, Georges Humbert, Maurice d'Ocagne, Henry (France), E. Catalan (Belgium), D. Bierens de Haan (Holland), Glaisher (Great Britain), G. Gomes-Texeira (Portugal), Holst (Norway), Georg Valentin (Germany), E. Weyr (Austria), Guccia (Italy), G. Eneström (Sweden), J.P. Gram (Denmark), Liguine (Russia) and C. Stephanos (Greece).

However, despite this strong international participation, one should not expect that every country worked at the same level: it is likely that several countries never sent any bibliographical reference to the Paris office. This was certainly the case for Great Britain and United States, partly because they were involved in other bibliographical projects. Moreover, the international dimension of the project was counterbalanced by the fact that the bibliography was created in Paris, directed from Paris, subsidised by French authorities and published in France. It is very difficult to know whether it met with success or was distributed outside of France.

At the beginning, the SMF had planned to publish the bibliography as a book – but this would have implied a very slow publication process, since it would have been necessary to wait for the end of the perusal process before printing anything. Consequently Maurice d'Ocagne and Roland Bonaparte proposed to publish the mathematical bibliography as a collection of printed index cards. This option enabled the publication to start as soon as a sufficient number of bibliographical items had been collected. Despite this arrangement, the publication lasted for almost 20 years: the first set of cards was published in 1894 and the last one (the 20th) in 1912.

The perusal of mathematical periodicals probably began in 1888, but acquired its cruising speed after the 1889 congress. The following procedure was adopted for the preparation and the publication of the series:

- All the memoirs and periodicals of a given country were placed under the responsibility of a member of the permanent commission living and working in the country.
- This representative directed the perusal and redaction of individual bibliographical index cards for each memoir and article that had been identified; for each memoir or article one index card containing its bibliographical references was made.
- Each individual index card contained the common bibliographical information (title, name of review, date, etc.), as well as a classification code corresponding to a specific domain of research (this code was furnished by the *Index du Répertoire Bibliographique des Sciences Mathématiques*).
- Individual index cards were then regularly sent to Paris, and were centralised and prepared for publication.
- The Paris secretariat directed the process of publication, which was very slow: they had to gather together individual cards according to their classification, but the index cards concerning a specific division were not published until they contained a sufficient number of bibliographical references: for instance, if there weren't enough references for the code A1, no card was published and they had to wait for the sending of other bibliographical references concerning this classification code.

Each printed card contained approximately ten references. Each set of 100 index cards contained about 1000 bibliographic items. The illustration on page 11 is a reproduction of a standard index card: the figure in the upper right corner indicates the number of the card and the framed code indicates the classification code according to the index.

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B 5 a

R. PERRIN. — Sur les relations qui existent entre les covariants et invariants des formes binaires (*C. R.*, **96**, 426-430; 1883).

R. PERRIN. — Sur le système de quatre formes binaires simultanées (deux linéaires et deux quadratiques) (*S. M.*, **15**, 45-61; 1887).

R. PERRIN. — Sur l'identité des péninvariants des formes binaires avec certaines fonctions des dérivées unilatérales de ces formes (*S. M.*, **16**, 82-100; 1888).

H. PICQUET. — Quelques développements sur les équations différentielles linéaires à coefficients constants et sur la théorie des fractions rationnelles (*J. E. P.*, **31**, C. LIII, 79-134; 1883).

P.-H. SCHOUTE. — [Sur le signe du covariant de Hesse] (*C. A. A.*, **6**, 190-193; 1889). — (Traduction française, *R. C. M. P.*, **3**, 160-164; 1889).

C. STEPHANOS. — Sur les faisceaux de formes binaires ayant une même jacobienne (*C. R.*, **93**, 994-997; 1881).

C. STEPHANOS. — Sur l'intégration d'une fonction rationnelle homogène (*C. R.*, **97**, 1290-1292; 1883).

J.-J. SYLVESTER. — Sur les invariants fondamentaux de la forme binaire du huitième degré (*C. R.*, **84**, 240-244, 532-534; 1877).

J.-J. SYLVESTER. — Sur la loi de réciprocité pour les invariants et les covariants des quantités binaires (*C. R.*, **86**, 446-448; 1878).

Reproduction of a printed index card

Three main mathematical domains were distinguished in the classification of the index: mathematical analysis, geometry and applied mathematics. Within these domains, several classes were identified and designated by a capital letter (see the table below). For instance, class A contained works devoted to elementary algebra, theory of algebraic and transcendent equations, Galois groups, rational fractions and interpolation. Each class (A to X) was generally divided into subclasses, divisions, sections and subsections: for instance, the code L14cá was used to designate the *class* of conics and surfaces of second degree (L), the *subclass* of conics (1), the *division* corresponding to tangents (4), the *section* dealing with tangents satisfying specific conditions (c) and the *subsection* corresponding to the case of right angles (á).

Mathematical domain	**Classes**
Mathematical analysis	**A-J**
Geometry	**K-Q**
Applied mathematics	**R-X**

Repartition of the classes in each mathematical domain

The repertoire was published from 1894 until 1912, during which 20 series of 100 index cards were published. Each series contained about 1000 bibliographical references, and thus these series represent a list of 20,000 mathematical works. More precisely, we can distinguish three moments in the publication of the series; they correspond to the three attempts to cover the whole classification, as shown in the following table:

Period	**Number of series published**	**Covered classes**
1894-1895	3	A1-X7
1896-1905	12	A1-V9
1906-1912	5	B12-X8

The three periods of publication

Is the mathematical repertoire a new tool for historians of mathematics?

The intention of the SMF was to create a bibliographical tool for scholars in mathematics. Some journals adopted the classification of the index (for instance, the *Bulletin de la Société Mathématique de France*), but it is quite difficult to determine whether the mathematical community really used it. We are in possession of various documents concerning the creation and the publication of this bibliography, but there remain many points about which our information is still fragmentary. How many copies did the *commission permanente* print and sell? Was the bibliography largely distributed outside France? Why is it so difficult to find copies of the index cards in French or foreign libraries? (As far as we know, it is impossible to find a complete set of the 20 series of the repertoire in any library in France, even in the *Bibliothèque Nationale de France*: we had the opportunity to work on a complete set thanks to Jean-Luc Verley.)

There are some further questions concerning the general context of its creation: it would be useful to determine the relationships between this project and the universalistic and internationalist trends at the turn of the nineteenth century. The mathematical repertoire constitutes a modest project, compared to similar attempts in Germany, Belgium and Great Britain: there were three major challengers:

- *The mathematical bibliography compiled by Hermann Georg Valentin*. Valentin was a chief librarian at the Berlin Library and he started the compilation of a mathematical bibliography in 1885, at the same time as the SMF. His aim was to collect *all mathematical publications since the invention of typography*. After several years of strained relations with the representatives of the French bibliography, Valentin finally became a member of the permanent commission (see [Eneström 1911], [Valentin 1885, 1900, 1910]). His bibliography was probably never published, partly because of the First World War.
- *The Universal Bibliographical Repertoire*. The Belgians Paul Otlet and Henri Lafontaine created this repertoire around 1895. It was conceived as a universal bibliography of human thought, and had some success for some years, but French mathematicians had some serious reservations.
- *The International Catalogue of Scientific Literature*. The London Royal Society created this project in the 1890s. Its aim was to publish, at an international level, regular bibliographies on every field of scientific research. Although the French scientific community was involved in this project, professional mathematicians (especially in France) also expressed strong reservations (see [Rasmussen 1995]).

From a scientific point of view, the mathematical repertoire raises the problem of the internal structure of nineteenth-century mathematics. At first glance, this bibliography can constitute an interesting tool for the study of mathematical production over a large period: its 20,000 bibliographical references constitute a valuable source of investigation for historians of mathematics. However, this is probably not the main point. Indeed, with its specific and complex classification, the mathematical repertoire gives an outline of a specific conception of mathematics. It gives access to mathematics, and also to the conception of mathematics constructed by the mathematical community at that time. Does it give an adequate description of nineteenth-century mathematics? In the light of recent works in history of science, should its classification be considered as conservative or modern? Did the classification really take into account all the existing mathematical domains of nineteenth-century mathematics? Did the classification contain gaps, and if so, what were they?

The creators of the project didn't only propose a thematic ordering of mathematical fields; they also elaborated a personal definition of the mathematical corpus that the repertoire should take into account. They were, for instance, convinced that most of the works concerning pure and applied mathematics published since 1800 would be of interest for scholars. On the other hand, they excluded classical works that didn't contain general results, notably those intended for students and for the preparation of examinations. In a similar way, they decided that works in applied mathematics would be mentioned only when they implied progress in pure mathematics. The introduction of such a separation between pure and applied mathematics is quite astonishing, particularly in the context of the development of engineer training in all European countries.

What can historians of mathematics learn from such a bibliographical endeavour? In order to study precisely the structure of the catalogue, we created a computer database. Although we are a long way from the end of the data entry process, we can give an overview of the information that may be extracted from such a database. Our database currently contains 3692 bibliographical items, corresponding to the first four series of the repertoire (400 index files out of 2000). It is accessible on-line, thanks to Laurent Guillopé at the Cellule MathDoc: *http://math-sahel. ujf-grenoble.fr/RBSM/*.

A general investigation covering 1700 index files (17 series) provides information concerning the repartition of bibliographical references within the three main mathematical domains: mathematical analysis (A to J) represents 50% of the references, applied mathematics (R to X) 33%, and geometry (K to Q) 17%. For mathematical analysis, the most important classes are those devoted to algebra (A), theory of functions (D), differential equations (H) and arithmetic (I). For applied mathematics, one can distinguish

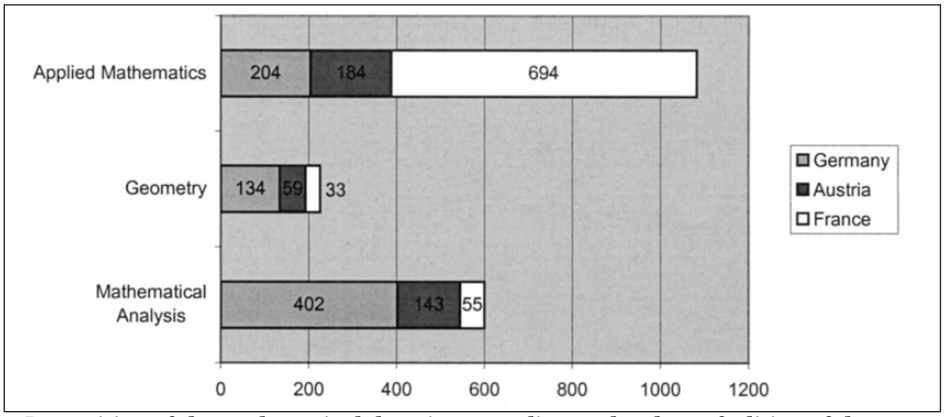
three significant classes: mathematical physics (T), general mechanics (R) and fluid mechanics (S). Finally, the main classes in geometry are those devoted to elementary trigonometry (K), algebraic curves and surfaces (M) and conics (L).

Apart from these general figures, we can give some precise descriptive information concerning the first 300 index files (3 series) of the repertoire. These figures concern only 2723 bibliographical references, and it would be hazardous to claim that they provide an adequate account of the whole repertoire. Nevertheless, these items correspond to the first attempt to cover the whole classification (from A to X), and may be interesting, for two reasons: they furnish some indications about the complexity of this bibliography, and they give some idea of the richness of the classification and of the extent of the work that had been done in 1895. Very significantly, the figures of the repartition of items among the three mathematical fields is similar to the previous ones, which concerned 17 series: mathematical analysis represented 53%, geometry 13%, and applied mathematics 34%.

There are 850 mathematicians listed in the first three series of the repertoire. Although impressive, this figure requires further analysis: in fact, most of these authors have between 1 and 5 bibliographical references, and there are only 120 mathematicians with more than 5 references. The prominent authors of the three series (with 20 items or more) are: A. Cauchy (101), N.H. Abel (55), L. Gegenbauer (49), C.-G.-J. Jacobi (42), M. Chasles (37), A.L. Crelle (31), Sophus Lie (29), F.-J. Studnicka (23), C. Duhamel (23), J. Liouville (22), P. Tannery (21), Th. Clausen (21), A. Cayley (21), E. Heine (20) and S.D. Poisson (20).

The 2723 listed items come from 83 mathematical journals: this figure should be compared with the list of 227 journals of the *Index du repertoire*. Moreover, 62 of these journals contain less than 20 bibliographical references. Only 8 periodicals contain more than 50 references and represent 71% of the total number of items: *Journal für die reine und angewandte Mathematik* (712), *Comptes Rendus des Séances de l'Académie des Sciences* (500), *Sitzungsberichte der Königliche Akademie der Wissenschaften in Wien* (299), *Journal de l'École Polytechnique* (134), *Bulletin de la Société Mathématique de France* (117), *Casopis pro pèstovàni mathematiky a fysiky* (a journal published in Prague, then part of the Austrian territory) (80), *Annales Scientifique de l'École Normale Supérieure* (78), *Journal de mathématiques pures et appliqués* (58). The repertoire also took mathematical monographs (books, treatises, etc.) into account; the first three series contain around 50 items of this type.

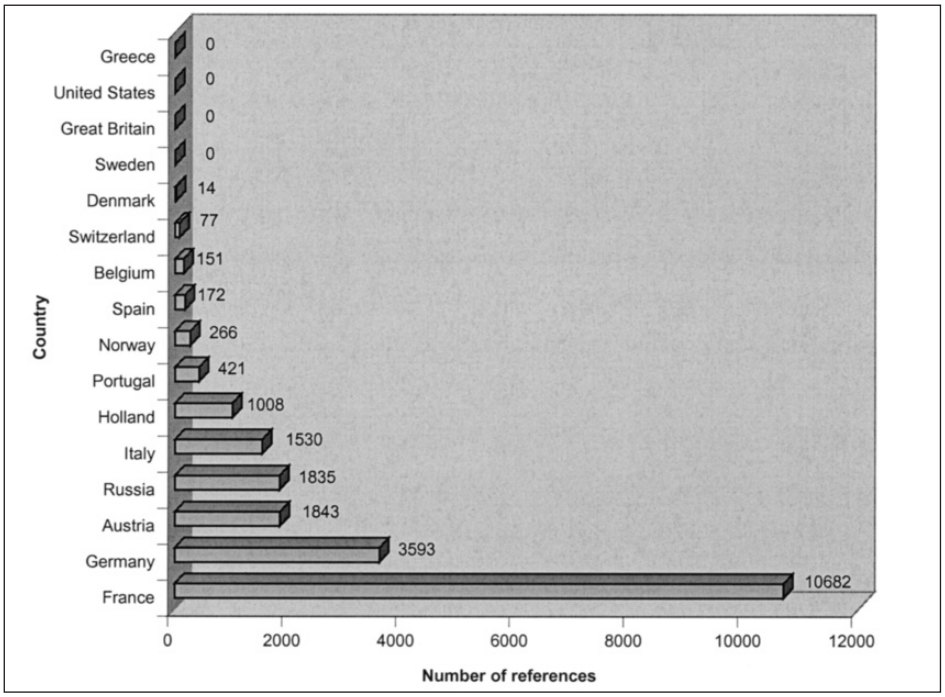
These eight journals were published in Germany, Austria or France, a phenomenon explained by the strong mathematical domination of France and Germany during the nineteenth century. As we will see, the presence of Austria probably finds its origin in the strong activity of Emil Weyr's crew at the beginning of the perusal work. As an illustration, when for each class of the index we take into account the most important journals listed (more than 20 references for each periodical), the only remaining ones are those edited in France, Germany and Austria. We can then give an overview of the repartition of these countries according to the three mathematical fields (see the graph below). Of course, these data are still fragmentary and must be confirmed by a more precise investigation of the whole set of 20 series.



Repartition of the mathematical domains according to the place of edition of the most important journals

The perusal of memoirs and periodicals of a given country was placed under the responsibility of one or several mathematicians living and working in the country. Nevertheless, it is quite clear that, at the beginning of the project, very few countries put a lot of effort into the constitution of the bibliography. Apart from France, Germany and Austria, only four countries sent more than 15 bibliographical references to the Paris office: Portugal (100 items, 3 journals perused), Russia (95 items, 4 journals), Italy (59 items, 1 journal) and Norway (52 items, 1 journal): in contrast, 920 bibliographical references concerned French mathematical journals, 783 were published in German journals and 539 in Austrian periodicals. (Of course, these figures don't furnish any information about the authors' nationality!)

In a 1900 report concerning the progress of the repertoire, Charles Laisant gave some information about the number of bibliographical references submitted by each country. At that time, only the half of the bibliography (ten series) had been printed and the most important suppliers were still France (10,682 items, 6 journals: 7200 references come from the *Comptes rendus de l'Académie des Sciences*), Germany (3593 items, 7 journals) and Austria (1843 items, 8 journals). The graph below provides an overview of the participation of each country: Russia, Italy, Holland, Portugal, Belgium and Spain are the most significant suppliers: these figures come from Charles Laisant's report [Laisant 1900].



Number of bibliographical references submitted by each country in 1900

The absence of Great Britain and United States is not surprising, since the two countries were engaged in a competing project, the International Catalogue of Scientific Literature. The case of Sweden is also quite paradoxical: Eneström was the representative of the country within the *Commission Permanente* and he had written several articles in favour of the constitution of a mathematical bibliography during the 1880s. Nevertheless, he rapidly showed some serious reservations about the French project, partly because of its system of classification. His growing inertia towards the French repertoire is a plausible explanation for the absence of Sweden.

To a great extent, the references sent by Holland, Russia and Spain correspond to the heading *Mémoires ou ouvrages séparés*. These nations were taking part in the broadening of mathematical production, and it is likely that they used the repertoire in order to gain some recognition at an international level. Moreover, one can assume that the mathematicians of these countries judged that their national periodicals were not important enough, and that monographs and books constituted the best illustration of their national production.

Only 157 classification codes were used for the ordering of the first three series, although the *Index du Répertoire Bibliographique des Sciences Mathématiques* proposed around 2000 possible codes. (Moreover, in his report, Charles Laisant [1900] confirmed that the first ten series that had been printed at that time didn't use more than 300 classification codes of the index.) Concerning these 300 index files, it is important to notice that 113 of the 157 codes refer to bibliographical items that were equally published before 1840 as after 1870. We can therefore conclude that most of the mathematical domains designated by these codes were active over a large period of the nineteenth century. Furthermore, 11 classification codes are exclusively devoted to mathematical works published after 1860; 8 of these concern mathematical domains that emerged in the second half of the nineteenth century: determinants (2 codes), Dedekind and Kronecker's arithmetical theory of algebraic functions (2 codes), properties of $\varphi(n)$, Lie's theory of continuous groups, Gyldén's theory and nomography. The presence of two other domains – the properties of general involutions according to Chasles, and one devoted to axonometric or isometric perspective – reveals the active role of Emil Weyr at the beginning of the perusal work, since most of these bibliographical references come from the *Sitzungsberichte der Königliche Akademie der Wissenschaften in Wien*. The last domain (descriptive geometry on curves and surfaces) gives an illustration of the vitality of this old theory: this can be explained by the importance of descriptive geometry training in Engineer Schools and Faculties of Science.

Who was in charge of the perusal process and how was it done? Most of the German and Austrian contributions arises from perusal of the *Journal für die reine und angewandte Mathematik* and the *Sitzungsberichte der Königliche Akademie der Wissenschaften in Wien*. Emil Weyr essentially did this work. He was the Austrian representative in the *Commission permanente* and the leader of a small crew. He was certainly the most dynamic foreign contributor and his work ensured the international representation of the repertoire for the first three series. In a letter to Henri Poincaré (25/04/1892), Weyr wrote: "J'ai l'honneur de vous signaler qu'il nous sera possible de remplir votre demande au moins quant aux principaux recueils allemands. M. Le baron de Lichtenfels, professeur de mathématiques à l'École Polytechnique de Graz s'est chargé de dépouiller avec moi le *Journal de Crelle*. […] Cette collection de fiches déjà finie, concernant les *Sitzungsbericht et les Denksschriften* de Vienne et de Prague, les publications polonaises et quelques autres publications, vous parviendra en quelques jours par la poste". On the other hand, it seems that his work was not at all exhaustive. For instance, according to his collected works, Jacobi published 104 articles in the *Journal für die reine und angewandte Mathematik*, but one can only find 36 references to Jacobi's works in the first three series of the repertoire. Judging from this example (and from several others), it appears that considerations concerning the mathematical domains, the length, or the theoretical importance of publications were not automatically seen as relevant criteria.

Most of the French contribution arises from perusal of the *Comptes rendus de l'Académie des sciences*. This was made by Henri Brocard, who was the director of the Alger Meteorology Institute and one of the French representatives of the commission. His work concerned only publications in applied mathematics (classes R, S, T, U, V, X) – this would require further analysis since the situation is similar for other French journals – but it was exhaustive: in his report, Laisant [1900] noticed that the *Comptes rendus* had been completely perused: "Il n'y a cependant peut-être que les *Comptes rendus de l'Académie des Sciences de Paris* qui soient tout à fait au courant, grâce au dévouement de M. le Commandant Brocard ; c'est lui qui a pris cette si lourde tâche, et il s'en est acquitté avec une exactitude et une régularité véritablement admirable".

To conclude, we note that two major mathematical journals seem to be absent from the whole repertoire: the *Mathematische Annalen* and the *Nouvelles annales de mathématiques*. The former is astonishing, since Weyr announced the beginning of the perusal of this journal to Poincaré in 1892: "Mr le Dr Krohn, Privatdozent dans notre université, s'occupera avec les *Mathematische Annalen*…". The case of the *Nouvelles annales* is quite different, and probably reveals the (intentional?) choice made by French mathematicians for a specific style of mathematical (that is, 'official') academic and professional mathematics, to the detriment of mathematics for education, a domain that was not much recognised.

We believe that this mathematical bibliography can constitute a valuable source for historians of mathematics. In particular, it gives access to the conception of mathematics that was constructed by the nineteenth-century mathematical community. Our analyses will be completed at the end of the data entry process. Moreover, a possible development of this research could consist in a comparison between this bibliography and some other repertoires, such as the Belgian *Répertoire Bibliographique Universel* or the *Jahrbuch über die Fortschritte der Mathematik*. Finally, an understanding of the expectations, difficulties, illusions, etc. raised by this first attempt to organise mathematical activity at an international level might be helpful for contemporary mathematicians, at a time when many international projects are devoted to the numerisation of past or present mathematical works.

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Two Mathematics Digitisation Projects

While the mathematics community gears up to digitise the whole of the mathematics literature, it's a good idea to look at two projects already up and running. These are the *Jahrbuch Project* at Göttingen and the *Cellule MathDoc group* based at Grenoble.

The *Jahrbuch über die Fortschritte der Mathematik* was the first comprehensive journal of reviews of the mathematical literature. It was founded in 1868 and appeared until 1942. The project has as its centrepiece the goal of making the entire *Jahrbuch* electronically available.

Much has already been done. If you go to the EMIS homepage (*www.emis.de*) and click on the *Jahrbuch* project, you can use the search facility, for instance, by author. I typed in 'Hardy, G.H.' and got a list of 314 titles, starting in 1899. From there, it's not hard to access the *Jahrbuch* review for the titles selected.

For some publications, including *Mathematische Annalen*, *Mathematische Zeitschrift* and *Journal de Mathématiques Pures et Appliqués*, the project provides direct access to facsimiles of the articles themselves. This is a fascinating site, a window into both the past and the future of mathematics.

Cellule MathDoc has recently opened a website, *www.numdam.org*. From this page you can search by author, title or keyword summaries of the articles in the *Annales de l'Institut Fourier* and the *Journées équations aux dérivées partielles*. Again, you can summon the articles themselves to your computer screen. This service is entirely free if your institution subscribes to the journals and, in any case, free for the *Annales* for articles up to 1996.

Cellule MathDoc intends, in time and subject to publishers' permission, to make all French mathematical journals available in this way.

David Salinger
EMS Publicity Officer

NSF, *SCIENCE* JOURNAL ANNOUNCE SCIENCE VISUALIZATION CONTEST

The National Science Foundation and the journal *Science* are now accepting entries for the inaugural 2003 Science and Engineering Visualization Challenge.

Winning selections will be featured in a special section of *Science*'s 12 September issue and winners will receive an expenses-paid trip to the foundation for its *Art of Science Project* exhibit and accompanying lecture.

This new international contest will recognise outstanding achievement by scientists, engineers and visual information practitioners in the use of visual media to promote understanding of research results.

The contest is open to individual scientists, engineers, visual information practitioners, and scientific teams – including technicians and support team members – who produce or commission photographs, illustrations, animations, interactive media, video sequences or computer graphics for research.

Entries must have been produced after 1 January 2000. The contest deadline for postmarked entries is 31 May 2003. The contest rules and entry submission instructions are available on the web at

http://www.nsf.gov/od/lpa/events/sevc/

Prospective entrants are encouraged to review the contest rules before submitting an entry. Entry forms are available at that web address as well.

Science is published by the American Association for the Advancement of Science.

EMS Committees

A list of the EMS committees, together with their Chairs, is as follows.

Applied Mathematics Committee [Saul Abarbanel]
Developing Countries [Herbert Fleischner]
Eastern and Central Europe [Andrzej Pelczar]
Electronic Publishing [Bernd Wegner]
Group of Relations with European Institutions [Sir John Kingman (EMS President, *ex officio*]
European Research Centres of Mathematics (ERCOM) [Manuel Castellet]
Education [Tony Gardiner]
Raising Public Awareness [Vagn Lundsgaard Hansen]
General Meetings [Luc Lemaire]
Women and Mathematics [Emilia Mezzetti]
Special Events [Jochen Bruening]
Publications [Rolf Jeltsch]

Interview with Vagn Lundsgaard Hansen

Interviewers: Bodil Branner and Steen Markvorsen (Lyngby)

Vagn Lundsgaard Hansen.

Vagn, please tell us a little about your childhood and background.

I was born in 1940 in the beautiful town of Vejle, lying at the end of one of the Danish fjords along the east coast of Jylland. Close to forests and the fjord, it was an ideal place for children to grow up.

With a working class background, it was unusual at the time to attend secondary school beyond grade 7, and later the gymnasium, but with the full support of my parents, I broke the social barrier, and finished gymnasium in 1960 with excellent results.

It was not always easy – and often rather lonely – to step outside your social class, but altogether, I had a very happy childhood with much love. Outside school, I was an eager soccer player – almost mandatory in my native town, which has fostered several famous soccer players. Many happy hours were also spent as a Scout, where I ended up as group leader.

A musician and music teacher living in the same house as us persuaded my parents to buy a piano. At the time, I was more interested in football and other phenomena exhibiting curvature, but I learned the notes and music became important to me – in particular, jazz. Today I prefer improvisation, and have a special weakness for Fats Waller.

After gymnasium you went to Aarhus to study. Why did you choose mathematics as your main subject?

In September 1960, I matriculated at the University of Aarhus to study mathematics and physics. There was never any real doubt in my mind that these subjects were my favourite subjects and my teachers at school had several times pushed me in this direction.

The 1960s was a tremendous time for mathematics and the natural sciences. In the opening paragraph of the handbook for these studies, it said something like: 'For everyone completing these studies, the future is bright with a multitude of very diverse possible appointments ...'. With such words, you could fully submit yourself to the study of the sciences without any worries for the future. As a matter of fact, I think one could say the same today!

Originally, I thought that I would end up with physics as my main subject. But at the Mathematical Institute reigned Professor Svend Bundgaard, an energetic and all-time-consuming enthusiast for mathematics. After less than three weeks of intensive bombardment with lovely mathematical concepts, mathematics became dominant. Svend Bundgaard has placed his mark on a whole generation of mathematicians in Denmark.

In 1960, Aarhus was still a young university and the Mathematical Institute was only a few years old. There was a pioneering spirit and Svend Bundgaard made the best out of the positive economical situation for the sciences. He made sure that a constant flow of eminent mathematicians visited Aarhus, some of them for long periods. Naturally, this created a very stimulating atmosphere, and also the social life of the institute was legendary.

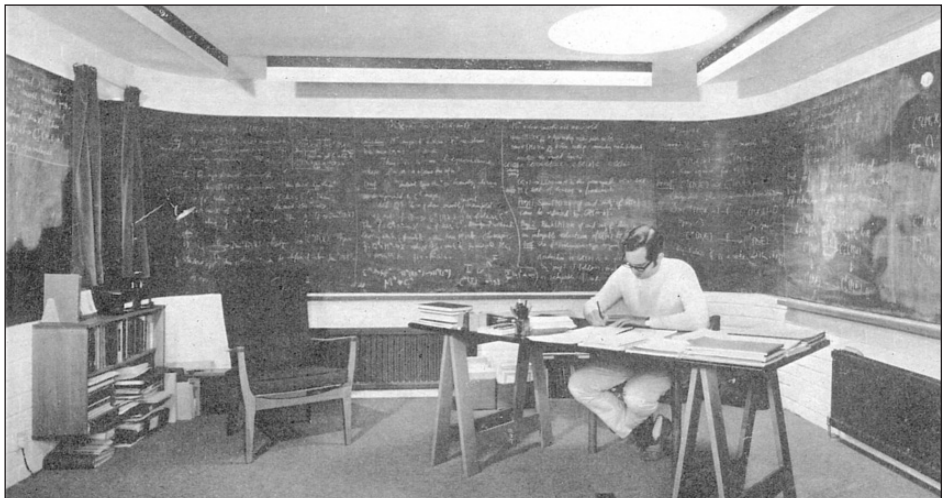
For my final studies of mathematics, I specialised in topology with Professor Leif Kristensen as adviser. The subject for my masters thesis in 1966 was *Morse theory and Smale's proof of the generalised Poincaré conjecture*. This subject was along a different line from the main emphasis in topology in Aarhus, namely algebraic topology, where Leif Kristensen himself was a leading expert on the Steenrod algebra. Leif was not very much older than his students and we had a very friendly relationship with him.

Immediately after obtaining my degree, I was appointed to a temporary position in Aarhus. In the fall of 1967, I was appointed assistant professor with the special task of developping a contemporary and new course in differential geometry for the upper undergraduate level. I wrote a comprehensive set of lecture notes for the course, laying the foundations of smooth manifolds and developing the calculus of differential forms and integration on manifolds, culminating in a complete proof of the generalised Stokes' theorem. It was a rather ambitious course for the given level, but it was a great success and several very good students emerged from the course. Karsten Grove, now professor at the University of Maryland, was one of the very best and went on to make a brilliant career as a research mathematician. In connection with my teaching, Professor Ebbe Thue Poulsen followed the full course. He claimed that it was out of pure interest. Whether this was the full truth or not, I found this caring from an experienced and excellent teacher very comforting.

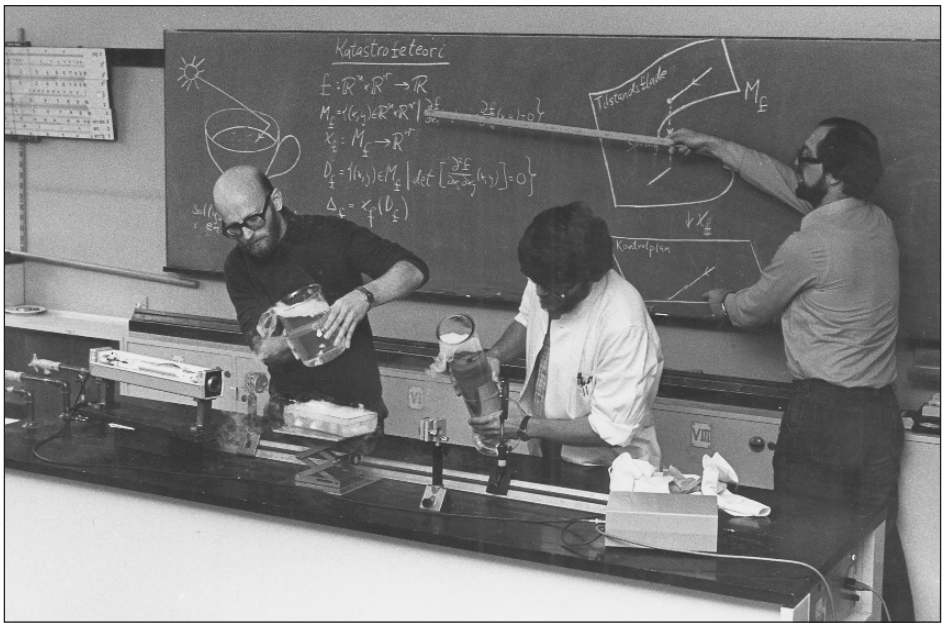
From time to time, I discussed my plans with Svend Bundgaard and he encouraged me to go abroad to do a PhD. I was extremely well motivated for this: my teaching had gone very well and I had written a complete set of lecture notes offering an original introduction to a relatively advanced subject. I really felt eager to do original research in order to qualify myself properly for a permanent university position.

How did England become your choice?

In the summer of 1968, Professor Zeeman (now Sir Christopher) was one of the main lecturers at a Summer School in Aarhus. It hardly comes as a surprise to anyone who



Vagn Lundsgaard Hansen in the Study for House 4, Mathematics Research Centre, University of Warwick. The family lived in this marvellous house during the first year of their stay at Warwick, 1969-72.



Vagn Lundsgaard Hansen presents a lecture on catastrophe theory in connection with an open house arrangement for the public at the Faculty of Sciences, University of Copenhagen, in 1977

knows him that Professor Zeeman made a strong impression on me, and I discussed my interests in mathematics with him to seek his advice. I got, as it turned out, tremendously good advice.

Professor Zeeman was the founder of the Institute of Mathematics at the University of Warwick in Coventry, established in 1964, and was for many years a charismatic leader of the institute. Combining in one person an eminent researcher, a brilliant teacher and a visionary and clever administrator and organiser, the Institute of Mathematics at the University of Warwick under his direction quickly gained a reputation as a very strong research school for mathematics with a large visitors' programme.

From Professor Zeeman, I learned that they were about to hire the American mathematician James Eells as a professor of mathematics at the University of Warwick to develop the then relatively new field of global analysis. Combining strong elements of analysis, geometry and topology, this clearly matched my interests in mathematics, and I eagerly went to Warwick in September 1969 to study with Professor Eells.

This was the best decision in my life, only exceeded by my marriage to Birthe in 1964. Together with our eldest daughter Hanne, we spent three extremely happy and unforgettable years in Warwick. In the second year of our stay, Birthe was appointed mathematics teacher at a grammar school, so we got altogether a magnificent insight into the British school system at the time.

Studying with Jim Eells was an enjoyment. His good spirit and sense of humour were a perfect match for me. He had a way of encouraging you so that you really felt that you could do it. Most often, I found the problems to work on myself, but Jim was there putting it all in perspective and due to his scholarly knowledge of the literature, you felt sure that you were not just reinventing old things.

In Warwick, I found everywhere the bubbling enjoyment of mathematics that I had felt inside myself for years, but somehow had suppressed in Denmark. I came to know many excellent mathematicians and several of them became my very good friends, including many of the young staff members at the institute and some of the foreign visitors.

I defended my thesis in the summer of 1972: it contained work on the topology of mapping spaces. As one of my results, I had succeeded in giving a complete division into homotopy types of the (countably many) components in the space of continuous mappings of the n-sphere for all n. The result is rather surprising, and a paper about it was published in the *Quarterly Journal of Mathematics*, Oxford, 1974.

Then you went back to Denmark?

Yes, but I must first mention that another major result obtained during our stay in Warwick was our second daughter Helle. And then I felt ready for a permanent job. In 1972, the job market in mathematics was tightening up. I got some offers for temporary positions from different countries, but I was relieved when an application for a position as associate professor at the University of Copenhagen was successful. In August 1972 we moved to Copenhagen and a new period in our life began.

The University of Copenhagen is the oldest, and was for hundreds of years the only, university in Denmark. The eminent Danish mathematicians from the past therefore all had relations with this university. Such strong historical traditions add a flavour to a university and gave me valuable experiences, in addition to the experiences I had enjoyed at the younger universities in Aarhus and Warwick.

The senior professors at the University of Copenhagen counted among others Thøger Bang, Werner Fenchel, Bent Fuglede and Børge Jessen, all first-class mathematicians. In addition there were several newly appointed young staff members of high quality. I was very kindly received and quickly accepted.

In addition to research and teaching, I now also became involved in administration and ended up as Chair of the committee of study affairs in the science faculty. At the time, the universities in Denmark were run very democratically, implying that students had 50% of the seats in this influential committee. Obviously, this caused many discussions, but being fond of discussions leading to democratic decisions, I found this stimulating and inspiring.

In connection with a graduate course on singularity theory in 1976, I was inspired to define the notion of polynomial covering maps. In addition to my continued interest and work on the topology of mapping spaces, I now began a study of these special covering maps, defined by projecting the zero sets for parametrised families of complex polynomials onto the parameter space. An account of my work in this field was given in the book *Braids and Coverings*, published by Cambridge University Press in 1989. This book is based on a set of lectures delivered while I was a visiting professor at the University of Maryland, College Park, in the fall of 1986.

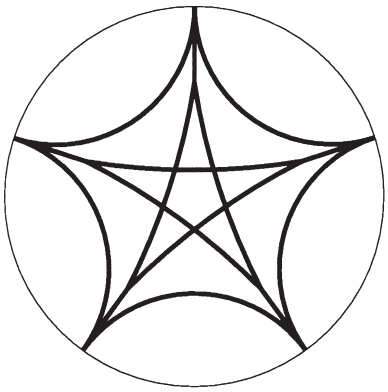
Finally you came to Lyngby.

In 1978, I was contacted by mathematicians from the Technical University of Denmark about whether I would apply for a position as professor at this university. I saw some challenges and promising possibilities at the Technical University of Denmark, situated in Lyngby in the outskirts of Copenhagen, so I applied for the position. At that time, a professor was appointed as a civil servant by the Queen, and the whole process with selection committee, approval by the democratically composed senate of the university, etc., took some time. In 1979, our son Martin had been born. And then, on 1 February 1980 I was appointed professor of mathematics at the Technical University of Denmark.

During the late 1970s the DTU Department of Mathematics went through a somewhat turbulent period of reorganisation. At the same time, it was fighting for survival against the old idea that the staff teaching and doing research in mathematics ought to be distributed into the other departments in order to serve the applied disciplines best. How did you see these challenges and your own possibilities at DTU at that time?

I knew about these difficulties, but I focussed on the fact that the senate of the University, after thorough considerations, had decided that the Department of Mathematics should survive as an independent department. I also had the impression that influential members of the senate during the process had recognised that mathematicians need to be members of a mathematical community in order to maintain a level of mathematical expertise, whereas it was useful for our colleagues in the engineering sciences to consult their

mathematicians with mathematical problems. I think they also recognised that mathematical research is necessary to ensure that the teaching of mathematics should not stagnate.



The logo of the DTU Department of Mathematics shows a geodesic immersion of the Petersen graph into the Poincaré disc of constant negative curvature, emphasising the symbiosis between global analysis and discrete mathematics. Julius Petersen was Reader at DTU from 1871-86 and Jakob Nielsen was one of the founding fathers of global analysis; he was Professor at DTU from 1925-51.

I felt that I had something to offer after the experiences I had gained at other universities, and I appreciated very much the expectations and the great confidence in me shown by my new colleagues. I knew a few of them very well from earlier, and I was sure that the large majority of the staff members would do their utmost to help creating a good department.

As I have said earlier, the universities were run very democratically at the time, and you had to argue your points of view. I went for open discussions of strategies and attitudes, since I am convinced that this kind of leadership is the only one giving lasting results in research institutions with qualified staff members. I tried to be the first in the morning and the last in the evening at work, keeping up positive discussions about mathematics and our duties. I think maybe I functioned as a good catalyser in these discussions, and over the years the department has reached a high degree of consensus about our role as mathematicians at a university with its main emphasis on the engineering sciences. I am very fond and proud of my colleagues: many of them have developed as research mathematicians in a way that could not have been foreseen in 1980. Trust and confidence in people are strong and indispensable tools for keeping up good spirits.

Lately there have been many changes in the university structure in Denmark, moving very far away from a democratic election of leaders. The current mantra appears to be strong leaders of the universities, appointed by small boards dominated by outside members, and the ability for quick decision-making seems to be more valued than the ability to make wise decisions based on arguments presented in public. This may be a good approach in private firms, but is not necessarily good in universities. I am not in favour of this development, but I am still confident in mathematics.

Is it fair to say that the idea behind your construction of the Department's logo was to iconise that mathematics is strongest when considered a unity across the disciplines?

Yes, I think that this is a fair description. I certainly wanted to iconise the major research fields in our department – geometry, analysis and discrete mathematics – as appear together in the logo. At the same time, it gave me the opportunity to connect with some of the major Danish mathematicians who have been associated with DTU – namely, Jakob Nielsen and Julius Petersen. Our department has much to be proud of in the past. This is a good level to strive for.

Problems from applications do not come divided into mathematical specialities from the beginning. So, maybe instinctively, I also wanted to signal that in order to be valuable mathematical members of an engineering community, it is important to be broadly educated in mathematics and to keep an open mind for mathematics on a broader scope than isolation into narrow specialities will admit.

A very special enjoyment has been the many excellent students I have met at DTU. Around 1985, I planned and designed a new course on *Fundamental concepts in modern analysis*; the course material developed eventually into a book with the same title, published by World Scientific in 1999. I have been fortunate to be the adviser at Masters and PhD levels for some of the very best and able students, and in very diverse areas of mathematics. I am happy that they all developped independence and an inner drive to follow their own tracks, some of them with extremely good results. I was deeply touched when for two days in November 2000, many of them delivered excellent and inspired lectures at a symposium organised by my department in collaboration with the association of secondary school teachers of mathematics, in celebration of my sixtieth birthday.

I have had a wonderful time at DTU. I have come to know many first-rate people from other departments. In the period 1988-93, I was Dean of the Faculty of Basic Sciences. In the period 1992-98, I was a member of the Science Research Council of Denmark, four of these years as vice-chair. Also, in this connection, I met some very interesting researchers from other fields. This is also true for the Danish Academy of Natural Sciences, of which I have been president since 1984.

And your own scientific work flourishes as well! Could you tell us about some of the highlights?

In a paper published 1983 in the *Bulletin of the London Mathematical Society*, I succeeded in determining the complete homotopy type of the space of homotopy equivalences of the 2-sphere – that is, the space of maps of degree 1 on the 2-sphere. Earlier in 1926, Kneser had proved that the corresponding space of homeomorphisms has the homotopy type of the orthogonal group SO(3), and in 1959 Smale proved that the same holds true for the smaller space of diffeomorphisms. I think that it is fair to say that topologists had expected that the same would also be true for the larger space of homotopy eguivalences. But, as it turned out, I proved in my paper that the space of homotopy equivalences of the 2-sphere is the product of SO(3) and the double loop space of the 2-sphere, which is a highly non-trivial space. Very recently my work on mapping spaces has

Nordic Summer School on Differential Geometry, Technical University of Denmark, Summer 1985. In the front row from left to right are Jerry Kazdan, Karsten Grove, Flemming Damhus Pedersen, Lone Aagesen (secretary), Vagn Lundsgaard Hansen, Jean-Pierre Bourguignon and Cliff Taubes. In the second row is Jim Eells (third from the left).

A mathematical family photo taken during the symposium 'Facets of Mathematics', held in November 2000 to celebrate the 60th birthday of Vagn Lundsgaard Hansen. Here he is surrounded by several of his students and Jim Eells.

attracted some interest, in connection with topological aspects of the calculus of variations. This is the type of application I have always hoped for.

Around 1980, the Danish Mathematical Society decided to investigate the possibility of publishing the collected mathematical works of the Danish mathematician Jakob Nielsen, renowned for his pioneering work in combinatorial group theory and for his investigations of the fixed-point structure of homeomorphisms of surfaces of genus = 2. Such surfaces are covered by the hyperbolic plane, and you can transfer the investigations to an investigation of homeomorphisms in the hyperbolic plane. This opens possibilities for exploiting methods from non-Euclidean geometry, which Nielsen mastered to perfection. I was happy when the Society asked me to be the editor of the collected works. My research on mapping spaces and covering spaces were not directly related to Nielsen's work, but it did contain some of the same basic ingredients, and Jakob Nielsen had been professor at the Technical University of Denmark for almost 25 years during his career.

The publication of Nielsen's collected works entailed, among other things, the translation of Nielsen's major papers, several of which had monograph size, from German to English. For the actual translation we had highly competent and expedient help by the Australian mathematician John Stillwell. He even translated a few papers from Danish.

The collected works were finally published in a two-volume set by Birkhäuser in 1986. Throughout the whole process, I had an intensive and very close collaboration with Werner Fenchel, who for many years had been a close co-worker of Jakob Nielsen. On many Saturdays, Werner came to our house where we proof-read the translations and had lunch and dinner together. It was very rewarding for me to come to know this noble and modest scholar so well.

You have written several books – bestsellers, like those listed in the references below. Do you find it easy choosing what to write and how to write it?

Writing essays on a narrow and uninspired topic was not my strongest side in school, and spelling was something I had to work hard at: but now and then, when I found the topic engaging, I surprised my teachers. Nevertheless, I never thought about myself as a good writer. Writing is something I had to work at, but over the years it has become an enjoyment and great stimulus to me.

As a child I often went to the local library, sometimes several times a week, to listen to librarians reading aloud novels, etc. I became fascinated by story telling, and I loved short elegant openings where you immediately felt in the middle of events. Like many children and adults all over the world, I was deeply fascinated by the short novels of Hans Christian Andersen: few authors can paint a picture in words so well. Along a different line, the British author W. Somerset Maugham mastered the importance of good openings and the ability to stimulate your imagination in short stories. Without really thinking clearly about it at the time, somehow such writings became an ideal for me.

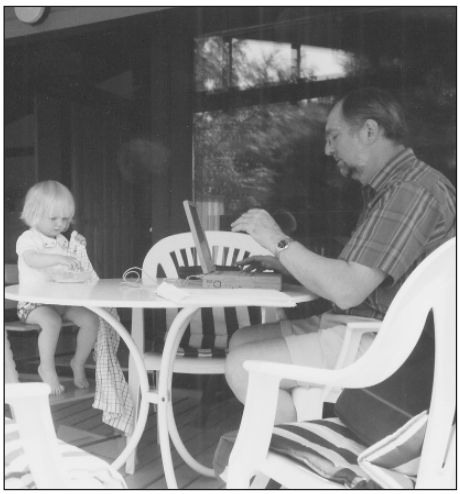
When I started university, mathematics was not a topic you really thought about in connection with pleasure reading or with high-class stylistic exposition: there was no story telling spirit. However, I came to admire the short and precise language of mathematics, and I was often amazed by the amount of information you can put in a few well-selected sentences. Being a topologist, I was particularly keen on the writings of John Milnor: I have read many of his books from cover to cover, enjoying both the mathematics and the elegant exposition.

I suppose I have always been thinking about how to get an element of good story-telling into the precise conceptual world of mathematics, both when lecturing and writing. Good story-telling involves leaving something to the imagination, and good mathematics requires that you give enough precise details in your arguments.

Over the years I have become more and more daring in my attempts to combine story-telling with mathematics. I try to commit myself never to write about mathematics without presenting a concrete mathematical result and elements of a mathematical argument. This is difficult to do, especially when addressing the public. A fruitful way is to combine the abstract structures of mathematics with concrete manifestations of mathematics from the world around us. The symbiosis between the abstract and the concrete is the essence of mathematics for me: I see it like yin and yang in Chinese philosophy – both abstraction and concreteness are necessary ingredients for the health of mathematics and for its vitality.

You have certainly applied this principle with success, not least during World Mathematical Year 2000. How did you get involved?

In 1995, Jean-Pierre Bourguignon, then president of the European Mathematical Society, asked me whether I would be willing to chair the World Mathematical Year committee that the society was about to establish. I agreed to this, and in October



Vagn Lundsgaard Hansen with one of his four grandchildren during holidays 2000.

At a meeting in connection with the World Mathematical Year held during the Third European Congress of Mathematics in Barcelona, Vagn Lundsgaard Hansen presents a Danish poster picturing the bridge over the Great Belt in Denmark, entitled 'Mathematics bridges gaps in culture, science and technology'. (The poster appeared on the back cover of EMS Newsletter ***38*** *(December 2000). The other person in the picture is Kim Ernest Andersen, who designed and implemented the EMS-gallery containing the posters submitted for the poster competition organised by the EMS in connection with the WMY.*

1995 the committee was formally established by the Executive Committee. Among the excellent and energetic members of the committee, I am sure that everybody will allow me to single out Mireille Chaleyat-Maurel as a quite exceptional and dynamical person in this connection. Working with Mireille is a pleasure, and we all owe a lot to her for her positive and highly creative work in connection with the WMY. Quite early in the life of the committee, my old friend Ronnie Brown became a member of the committee, and his extensive experiences with the popularisation of mathematics also became vital to the committee. A special personal benefit for me was that, through Ronnie, I became familiar with the fascinating symbolic sculptures of the Australian-British artist John Robinson.

During my work with the WMY, I came to know many wonderful persons with a deep dedication to mathematics, and the work has given me many inspiring experiences.

Last year you were an invited speaker at the International Congress of Mathematicians in Beijing, where your talk, **Popularising Mathematics: From Eight to Infinity,** ***was extremely well received. You demonstrated once again, that mathematics contains an abundance of concrete topics and results that lend themselves directly to mathematical conversations. [This article will appear in the June issue of the EMS Newsletter.] Could you tell us some of your impressions from the Congress?***

It came as a great and unexpected surprise for me when I was invited to lecture at the International Congress of Mathematicians in Beijing on the popularisation of mathematics. Many people from all over the world have made valuable and inspired contributions to the presentation of mathematics for the public, so I felt greatly honoured by this invitation. For the lecture I chose subjects that I find suitable for conversation on mathematics among people, with my starting point as concrete manifestations of mathematics in nature or civilisation: I think that such conversations may prove a good way of raising the public awareness of mathematics. After my lecture I was interviewed by journalists from the leading Chinese press agency, who wanted to use some of my ideas in future articles about mathematics. I was certainly confirmed in my hopes that the idea of 'mathematical conversations' will catch on.

I was thoroughly impressed by the congress. It was amazing to see the Chinese President, the Vice-Premier of China and the Mayor of Beijing attending the full opening ceremony. I think all participants felt really welcome in China, and our Chinese hosts did everything they could to make it a very special event. It was clear to everybody that mathematics is held in high esteem in China. This gives renewed momentum and hopes for a world-wide and bright future for our subject.

A selection of works by V. Lundsgaard Hansen related to this interview

Geometry in Nature, A. K. Peters, Ltd., 1993.
Shadows of the Circle – Conic Sections, Optimal Figures and Non-Euclidean Geometry, World Scientific, 1998.
Braids and Coverings – Selected Topics, Cambridge University Press, 1989.
Fundamental Concepts in Modern Analysis, World Scientific, 1999.
(ed.) *Collected Mathematical Papers of Jakob Nielsen*, Birkhäuser Verlag, 1986.
'Jakob Nielsen and his contributions to topology', Chapter 37 in *History of Topology* (ed. I. M. James), Elsevier Science B.V. (1999).
'I am the Greatest', *Mathematics in School* **25** (4) (1996), 10-11.
'The Story of a Shopping Bag', *Mathematical Intelligencer* **19** (2) (1997), 50-52.

Obituary: Carlo Pucci

Giuseppe Anichini

Carlo Pucci, one of the most distinguished Italian mathematicians of his generation, died in Firenze on 10 January 2003, at the age of 77.

Carlo Pucci was the Honorary President of the Italian Mathematical Union (UMI). He was born in Firenze in 1925 and, after graduating under the direction of Giovanni Sansone, he worked in Rome under the direction of Mauro Picone. From 1962 until his retirement in 2000 he was full professor in mathematical analysis in Catania, Genova and Firenze. He also worked also in the United States: for two years he was assistant professor in the Institute for Fluid Dynamics, University of Maryland, and was subsequently visiting professor at Rice University, the University of Louisiana at Baton Rouge, and the University of California at Berkeley.

Pucci was a mathematician of remarkable presence and immense energy. He believed that mathematicians' jobs could be wholly fulfilling if world-wide connections could be made as soon as they began their research. So he worked tirelessly to see this goal realised. As President of the National Mathematical Committee of the Italian Research Council he promoted an impressive programme of fellowships for young students in mathematics and for visiting professors, in order to establish strong connections between Italian and foreign mathematics researchers.

Among the most striking aspects of his personality was his long-term vision: he was able to see and pursue ideas that would come to maturity only some years later. So, as President of the UMI and President of the National Institute for Higher Mathematics he later had considerable influence on mathematicians and mathematical institutions and achieved his aims to a very large extent.

The mathematical work of Carlo Pucci was mainly concerned with partial differential equations. He obtained a celebrated maximum principle (simultaneously and independently discovered by A. D. Alexandrov), where sharp analytic and geometric arguments concur to bring about an appealing result. Together with F. John, M. M. Lavrentiev and A. N. Tikhonov, he was also a pioneer in investigating the so-called ill-posed problems in the sense of Hadamard. His work in this field contributed to establishing the basics of the current theory of these problems.

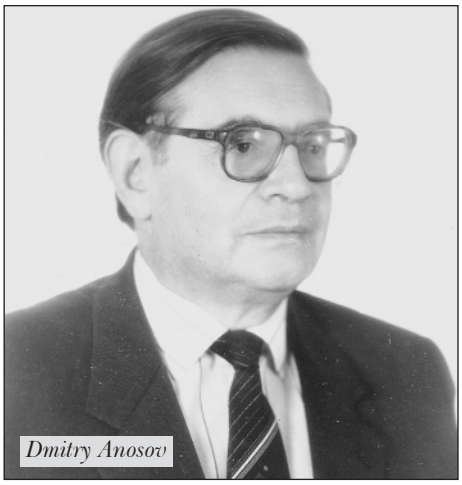
Carlo Pucci was, in many respects, an exceptional person. Generous, open and accessible, particularly with his young students, he had many good ideas and initiatives and the talent (and the physical strength) to understand the people who would implement them. All his students were delighted and amazed at his availability to discuss their mathematical drafts, together and with each of them separately. Many of his students have themselves become well-established mathematicians.

He grew up very close to his uncle Ernesto Rossi, one of the strongest opponents of the fascist dictatorship in Italy, and this legacy was strongly impressed on Carlo Pucci. During World War II he was active in the Resistance, and subsequently had a strong sense of civil commitment. In his last years he devoted himself to the Ernesto Rossi - Gaetano Salvemini Foundation as a historical and cultural heritage of these two major Italian personalities from the last century.

Carlo Pucci will be very much missed by his friends and colleagues.

Interview with D.V. Anosov

interviewer: R. I. Grigorchuk



Dmitry Anosov

This interview is in two parts: the second part will appear in the June issue.

Dmitry Anosov was born in 1936 in Moscow. He graduated from the Department of Mechanics and Mathematics of Moscow State University in 1958, and took postgraduate courses at the Steklov Mathematical Institute in Moscow in 1961. Since then he has worked in that institute, in various positions: he is currently head of the Department of Differential Equations. From time to time he has also worked at the Moscow State University (where he is Honorary Professor and head of the department of Dynamical Systems) and at Moscow Independent University.

He is an expert on dynamical systems and related areas of the theory of differential equations and geometry. His best-known achievement was the active role he played in creating the 'hyperbolic' direction of dynamical systems theory. This was officially recognised by the State Prize of the USSR in 1976 and unofficially by the appearance of his name in Anosov systems, flows, diffeomorphisms and foliations, and quasi-Anosov homeomorphisms. He was an invited section speaker at the International Mathematical Congresses in 1966 and 1974.

What are your most important childhood memories?

I have almost no recollection of the time before Hitler's Germany attacked the USSR in June 1941 – only a few blurry episodes: I cannot say when they took place. During the war my family suffered much less than most other people, but the profound changes in our lives at the beginning of the war and during evacuation in Kazan left such a strong imprint that I remember a lot. I was four-and-a-half at the beginning of the war: later, as I grew, I remembered more.

Tell me about your parents.

My parents were scientists – chemists who reached professorial level. They were from Saratov, and from the 1920s they lived in Leningrad where they worked mainly at the Academy of Sciences (created when the capital of the Russian Empire was St Petersburg). Later they moved with the main body of the Academy to Moscow. During this transition, many Academy employees received rather spacious quarters (even by present-day standards) – for us, it was a three-room apartment for three persons (the third was my grandmother). After that, the fresh Muscovites merrily 'became fruitful and multiplied' (though still not with biblical intensity).

This generosity in accommodating the Academy employees during the move to Moscow was rather exceptional, since the attention of the powers-that-be to science was generally more verbal than real. The salary was not the same as during the post-war period. However, even before the war many talented young people chose a scientific career. For many, science was interesting in itself, but there were at least two other factors. First, in many other professions the salaries were also low. Second, for many young people other choices were closed for administrative reasons, or were unattractive because of ideological or other pressures.

At that time there were not enough competent college instructors (the scale of engineering education expanded dramatically after the beginning of industrialisation), so my father, besides working at the AS, taught simultaneously at three other colleges. This was not due to his desire to share knowledge (which he satisfied after the war by lecturing on more advanced subjects to graduate students of the AS institute), but for extra income. So the family was relatively wealthy, both before the war and during the early war years.

After this, the leadership learned that science was capable of producing valuable fruit, such as radar (information on atomic energy became available at that time, but physically appeared later), and the salary and rations of scientists were increased considerably (the consequences of this, though gradually eaten by inflation, survived until the arrival of so-called 'democracy'). Because of this, we were lucky to live through the war without misery: we evacuated to Kazan where we lived in one room in a former university dormitory.

Since my parents no longer spent as much time at home and my grandmother was constantly busy with housekeeping, I was urgently taught to read so that I had an occupation. Maybe because of that self-study period I acquired a taste for theoretical science.

Do you remember Moscow life in the late-1930s?

I don't remember anything, and could not know much: I know only from the stories of older people. The initial ignorance of the importance of science had a positive side to it – the repression at the end of the 1930s affected others. This was clear in our apartment building, where some sections were occupied by AS employees and some by the employees of the Federal Bank, mainly those who worked abroad.

When did your mathematical talents become evident?

To a certain extent my interest in mathematics became apparent in the middle of secondary school. But at that time I was more attracted to physics. During the early post-war years it undoubtedly became the dominant part of the natural sciences: atomic energy, rockets, radar, and also television (this had been invented earlier but entered our life in the 1950s – even ordinary radio receivers were not widespread until the early post-war years). The quality of popular scientific literature in physics and astronomy was quite high at that time.

In 9-10th grades I went to the physical circle (study group) at the University, supervised by G. D. Petrov: I was less interested in the mathematical circles. I reckoned that the next step after high-school maths was higher mathematics which was taught in colleges, and what they did in the mathematical circles was not very important. I now think I was half-right and half-wrong, which agrees with R. Courant's point of view in his book *What is Mathematics?* (with H. Robbins). I studied more on my own then. I had average success in Olympiads, no brilliance: I understand that I am not alone in this respect – success in such competitions is not necessary to reach the level of an RAS member. Of course, there were competition winners who later became famous mathematicians at the highest level – such as V. I. Arnold, who was one year younger than me; I did not have contact with him then.

In my later grades I gave more attention to mathematics, since I came to understand that the great book of the universe 'is written in mathematical language' (Galileo). Gradually I became interested in mathematics itself.

How did you enter the Moscow State University?

I graduated from high school in 1953 with a gold medal (high honours) and so needed only to pass an interview. If it had gone badly, I would have had another chance by taking the entrance examinations – but it went well. I was interviewed by L. N. Bolshev and V. G. Karmanov, who asked something mathematical – had I ever been interested in something beyond the high-school curriculum? I remember a question which sounded like 'Are there more rational numbers or irrational ones?' Then

they proceeded to general questions. I said that I liked classical music. They asked whether I liked Prokofiev, and I replied honestly that I liked only the Classical Symphony. The interviewers grinned – 'you will have to grow up': they were right.

The year 1953 was very important for our country – Stalin died in March, and in the summer his right-hand man Beria was arrested (later he was put on trial and shot). Life became freer, though people in the West would not have considered it free. (This is not only my opinion.) Many years later, A. N. Kolmogorov told Arnold that he 'got a glimpse of hope' at that time and that it partly stimulated a rush in his scientific activity in the mid-1950s.

The year 1953 is also memorable for Moscow University, because it acquired a new building – the famous (more than 30-storey) building that became almost as much a symbol of Moscow as the Kremlin. The University was fortunate that I. G. Petrovsky had become rector shortly before that: he was quite influential at the time and for a few years later. Of course, the communist party group made many of the decisions, but from time to time Petrovsky managed to stand his ground: I think that the highest party leaders trusted him and did not have much respect for their party servants. (Unfortunately, he later lost his influence, in the middle of the Brezhnev period, and the influence of the party group grew.) Petrovsky could not change the situation in social sciences or biology, but could (and did) do things in other fields.

Tell me about your first two student years?
At first I was rather disappointed: I was well prepared and could have been taught faster and more intensively. On the other hand, nobody prevented me from studying more intensively by myself – quite the opposite. During my freshman year I. R. Shafarevich started a study seminar in algebra. By the spring, only Yu. I. Manin, E. A. Golod and I still attended the seminar: by that time we had reached the elements of Galois theory.

Also, during my freshman year, E. F. Mishchenko supervised recitation sessions in analytic geometry. He told me that there was a famous mathematician, L. S. Pontryagin (I had heard of him independently), who would lecture to us the following year and would hold a special seminar. That is where I went. I was grateful to Shafarevich for the algebra (later I took topics courses from him), but I was more attracted to analysis, and to some extent to geometry.

Many people expressed the opinion that the 1950s to 70s were the blossom time for the MSU Department of Mechanics and Mathematics. This prosperity had no analogue elsewhere in our country, or possibly in the whole world; it was manifested in the abundance of topics courses and seminars covering all of mathematics. I dived into that sea during my third year, and for the first two years was satisfied with what I described.

Anosov as a student

Which MSU professors had the most influence on you?
First was Pontryagin (see below) and his coworkers (not yet professors) Boltyansky, Gamkrelidze and Mishchenko. I have already mentioned Shafarevich, one of the best, if not the best, lecturer I have ever heard. During my third year a group of relatively young mathematicians started a lecture-and-seminar series on new areas of topology (mainly, homotopic topology): these were Boltyansky, Gamkrelidze, Onishchik, Postnikov, Shafarevich and Schwarz. They were joined by E. B. Dynkin, who did not take part in the educational aspects but studied some things with the others, and in particular worked on a collection of translations, 'Fibre Bundles and their Applications', which appeared in 1958 and played an important role in our country. I never heard of a similar undertaking among MSU mathematicians or elsewhere to study a whole field. Not all of the students who took to the new wind stayed in science, and not all of those who remained worked in algebraic or differential topology or in the adjacent area of algebraic geometry: this was also true of our teachers. But, I think, nobody was hurt by the acquired culture.

The announcement (by A. S. Schwarz?) of this enterprise for students said something like 'one can study simple properties of complex spaces or complex properties of simple spaces'. This phrase irritated P. S. Aleksandrov, the chair of topology and geometry, who was generally an important person who had switched to general topology. He did not oppose the new areas, but neither did he support them, trying instead to make room for general topology. Several years later, at an all-union topology conference in Tashkent, he said that according to Kolmogorov (a scientist with a wide range) algebraic and differential topology had not attained as wide an importance in mathematics in general as general topology, in spite of all their remarkable achievements. To a certain degree, Kolmogorov was right – continuity is encountered more often than (say) some bordisms or others. However, the addition of integers is encountered still more often.

At the beginning, smooth manifolds did not play a special role in our education. But in 1955 (coinciding with the start of our topological education), Pontryagin's book *Smooth Manifolds and Their Applications in Homotopy Theory* appeared; its first chapter was the first ever textbook on smooth manifolds. (G. de Rham's book *Differentiable Manifolds*, which came out in 1953 and appeared in Russian in 1956, could not play such a role: it brought the reader too quickly to its main subject – homology theory based on differential forms and currents – without giving the reader time to get used to manifolds. Maybe de Rham did not have this educational goal in mind, while Pontryagin did.)

When Pontryagin's book appeared, I hesitated – was it worth buying? Books were cheap then in Russia, the price was not a problem even for a poor student, and I was not poor – my parents had a good income. But I knew that Pontryagin's achievements in homotopic topology were surpassed by the French, so how good was his book? Fortunately, Gamkrelidze came up to me at that moment: he could not imagine that I doubted the value of the book. He thought I had no cash and kindly offered to lend me some money. That convinced me that the book was worthy and I bought it. Thanks to Revaz Valerianovich for his advice!

During my fourth student year, Gamkrelidze started a seminar with 'smooth' orientation. Of special importance to me was learning the area that Serge Lang later called 'the no-man's land between the great three differential theories' (differential topology, differential geometry and ordinary differential equations). Very quickly I learned to think in invariant terms, with the corresponding underlying notions, and to bring to general position by small perturbations using Sard's theorem. (Sard's work appeared during the war and was not known in Moscow for a long time; his theorem was later rediscovered by Dubovitsky, whose name we attached to it.)

Later, at the Steklov graduate school, S. P. Novikov and I became interested in calculus of variations in the large, and we read the monograph on it by M. Morse. We later used our acquired knowledge differently. For me, the main thing was not the calculus of variations in the large itself, but rather seeing how a far-reaching mixed analytical and geometrical theory is developed. By that time I had not enjoyed the supervising and directing influence of senior colleagues, but I had very useful contacts with S. I. Alber who then worked in Gorkii (Nizhnii Novgorod).

The middle of the 1950s saw the remarkable achievements of A. N. Kolmogorov in the theory of dynamical systems. Somewhat later (in 1958-59, when I was a graduate student), these were included in a topics course that he gave (only once) and in a related seminar.

In many respects Kolmogorov had his own 'style' which made him very different from the rest. In particular, unlike Pontryagin, Gelfand and many others, including scientists of my generation, Kolmogorov did not conduct a permanent seminar that would reflect the changes in

his scientific interests. I think that there was a 'central' seminar on probability theory to which Kolmogorov devoted more time than to anything else; but after becoming interested in other things, he did not change the direction of that seminar but rather started a new seminar which ran for only a year or two. As far as I remember, the entropy approach in ergodic theory, which he invented, was not mentioned either in the course or in the seminar, although some other aspects of 'abstract' (purely metric) ergodic theory were considered, such as the spectrum and dynamical systems with discrete spectrum; I think that there was some discussion of systems with unusual spectral properties, but I do not remember this well; in any case, some random processes were considered as dynamical systems.

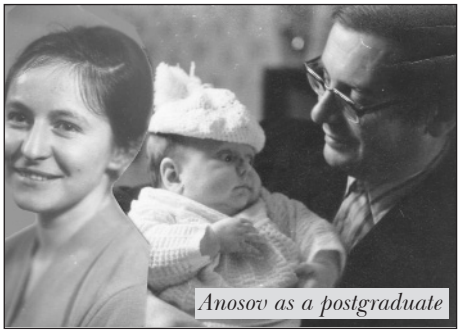
However, another of Kolmogorov's achievements – now called the KAM theory – was covered. Strangely, Kolmogorov never wrote a detailed exposition of these results – it was done by Arnold. Of course, KAM is difficult to present, and it would not have been surprising if it had not appeared for several years. Pontryagin and P. S. Novikov (my friend's father) spent several years writing full expositions of their achievements in topology and group theory (with Novikov finishing this work in collaboration with his student S. I. Adian). But Kolmogorov never wrote a full text on his results in KAM, although he was not tight-lipped – he wrote several papers on different subjects in the period between his first KAM announcements and Arnold's publications.

Kolmogorov has over 500 publications, but his high reputation is based on a few 'pearls' whose number is naturally smaller. In the middle of the 1950s he had a rush of scientific activity – I have already mentioned dynamical systems, but he also suggested using entropy notion in the theory of functional spaces. (Entropy dimension to some extent was discussed by Pontryagin and Shnirelman, but they had no applications.) His whole entropy enterprise was new and important. As for KAM, he may have hoped to obtain other new results in this area and then write about it. Curiously, when preparing a full collection of his works at the end of his life, he was very selective and included only a few things.

I was very impressed by Kolmogorov's lectures and seminars, but I did not understand many things. His lecturing style was difficult for the audience. I don't know if he overestimated us or purposefully aimed exclusively at the best prepared and capable in the audience. Only later did I remember something I had heard, thought it through anew and began to understand.

I was also very interested in N. V. Efimov's course on differential geometry in the large: this was mainly on the rigidity of surfaces of different types. Efimov's most famous result on the non-existence of complete surfaces in $\mathbf{R}^3$ with negative curvature separated away from 0 had not yet been obtained, but Efimov was 'approaching' it and talked about some partial results in that direction. I have never dealt with direction in my work, so in this case one should rather talk about impressions rather than influences.

The last topics courses in which I had great interest were those run by Arnold and Sinai on KAM and 'abstract' ergodic theory. I took other courses as well, but was mostly influenced by those I have described.



Anosov as a postgraduate

Tell us about your teachers.

I shall talk mainly about Lev Semyonovich Pontryagin. It is well known that he was blind – he lost his sight at 13 in an accident. For a blind person to get higher education is quite a feat, and he became one the most important mathematicians of his time. Of course, we reckon that our main work is done in the brain and paper scribbling only helps, but it is a significant help and anyone deprived of it must be under considerable stress. This does not come for free. Pontryagin was a workaholic, and with time this took its toll.

Unfortunately, memories of his last years are overshadowed by several circumstances. One talks about his anti-Semitism, but not about his trying to judge things that he could not keep track of (and those were not his private views – he played an active administrative role too). Undoubtedly, he was used. Several years after his death Shafarevich even remarked in print that if LSP had lived longer, he would have moved away from ruling Areopagus. But even during that period there were two significant bright moments in his life. First, he actively fought turning the rivers. (A giant hydro-technical project involving transferring water from the northern rivers to Middle Asia and partly to the Volga had been suggested: the economical soundness of this project was unconvincing, and the ecological consequences would have been catastrophic.) Second, as head of the commission on secondary mathematical education, he helped to correct the consequences of the careless reforms of the end of the late-1960s and early-1970s.

My personal memories are from an earlier period – we had almost no contact during his final years. But I have to say that when evaluating the life and career of a person, one should take into account his whole life, and not only the last years. Those who speak of his anti-Semitism during his last years should remember that he had several Jewish students, and that furthermore he tried to help V. A. Rokhlin, which was unsafe at the time. (Aleksandrov and Kolmogorov also tried to help him. All three also tried to help Efremovich, who was not Jewish, so this does not say anything about their attitude towards Jews, but it required the same valour as for Rokhlin.) I think the latter outweighs.

Apart from these two paragraphs I see no need to discuss LSP's non-mathematical activities. In the end, these people are worth talking about only from the viewpoint of their scientific and educational activities.

I was LSP's undergraduate and graduate student, and then worked in his department. I was never as close to him as his three co-workers mentioned above, but it is hard to overestimate his influence on me. However, I think this influence was somewhat unusual.

Pontryagin never taught me systematically, and apart from the first few months of our acquaintance, not even non-systematically. But he offered me several topics to work on, first simple (not far beyond the level of exercises), then more and more difficult: these turned out to be important for my growth. There were also a couple of topics that he did not suggest but which I 'caught' in the ambient creative atmosphere around him. The influence of his general approach to mathematics may have been more important, but that is difficult to describe.

Shortly before I became a student at the MSU, LSP decided to abandon topology and switch to ordinary differential equations. Actually, ODEs were not something new for him. Many years before that, there were contacts between Pontryagin and Andronov (a physicist, at least by education, who majored in physics at the MSU in the 1920s). Around 1930 Andronov moved to Nizhnii Novgorod (then Gorkii), and the transformation of this city into a significant centre for mathematics and physics is largely due to him and his co-workers. (Incidentally, they also established that Lobachevsky was born in Nizhnii Novgorod, but his scientific development started later – there was no university there at that time; after his childhood Lobachevsky lived, studied and worked in Kazan.) The collaboration between Pontryagin and Andronov resulted in four papers: two by Pontryagin himself, one a joint paper with Andronov, and the last a joint paper with Andronov and another physicist, A. A. Vitt, a student of Andronov. (Vitt was a victim of Stalin's repression.)

A little later he wrote two papers on the zeros of quasipolynomials. Formally this is not ODEs, but the stability of ODEs with delay depending on the distribution of those zeros. However, all these works were episodes for LSP, although they were not episodic for the theory of ODEs. He now decided to switch to ODEs completely, since he had no new ideas in topology and some French papers with very strong new topological results appeared at that time: the first announcements of these were short and the gist of the new methods was difficult to judge. Who knows: if Pontryagin could have established contact

with French topologists, he might have come up with new ideas, or at least combined his old ideas with those of the French. His approach was more geometrical, and we know that more geometrical ideas, some going back to LSP's works, were later added to the French algebraic methods. But he was not permitted to go to France.

After his switch to ODEs, LSP had no chance to work with Andronov – the latter died in 1952. But the first topic in ODEs that LSP started to work on was 'inherited' from Andronov – the theory of singular perturbations. Many different situations arise in this theory. Some require 'only' premises that are easy to guess, but from the very beginning Pontryagin concentrated on the more difficult question (in which Andronov was also interested), where the answer was difficult to guess – the asymptotics of solutions of differential equations describing relaxation oscillations close to discontinuous. While I was an undergraduate student, he offered me a simpler statement which I managed to prove. Independently, the same was done by L. Flatto and N. Levinson, whose work was published earlier, but I considered a slightly more difficult version of the problem. I think that they purposely restricted their paper to the simpler version, because it required the same main ideas: if necessary they could have proved my theorem. I do not know anything about Flatto, but Levinson was a well-known analyst and it was an honour to do what he did. Still, my work was a success for an undergraduate student: it was 'a sophisticated exercise' that was useful for my development. Formally, it did not depend on anyone else, but in essence it was not based on new ideas and methods.

Pontryagin lectured on ODEs to my class (it was a required part of the curriculum): this was the first time he had lectured on this subject, or had taught a required course to a large audience. (Although he had worked at the University before the Academy's move to Moscow, there were probably more students in one lecture hall than in the whole department of mechanics and mathematics before – and topology, which he also taught at the Academy, was not a required course and did not have a large enrolment.) At the same time he was preparing his well-known ODE textbook, and by the end of the school year we received a present – mimeographed copies of the book. Publishing a book was different then – now you use a computer to write anything you want and then print it out. The process then was much longer and required more work, in addition to the administrative logistics. Many years later, when I began lecturing, I sometimes wrote out my lecture notes, but had only fragments by the end of the course. So, I cannot help but admire LSP's responsibility and ability to work.

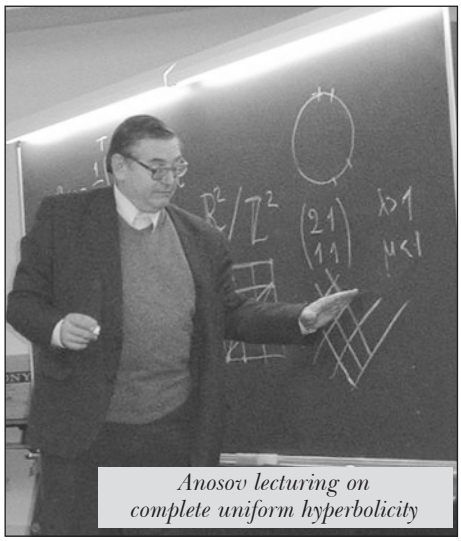
Today's ODE courses (at least at major universities) more-or-less follow the highlights established by LSP, which became standard. However, upon checking earlier textbooks, it is clear that Pontryagin's course was new, certainly in the USSR. (S. Lefschetz and V. Gurevich had already written somewhat similar books that were unknown in the USSR. Although these first attempts to modernise the ODE course did not have followers in the West, it was only after Pontryagin's book appeared that the situation started to change. Lefschetz himself later turned his book into a longer graduate-level text.)

Pontryagin carefully prepared his lectures and tried to be comprehensible to most of his students. Still, from time to time his lectures were difficult for quite a few. It was related in part to LSP's lack of teaching experience – before that, he had taught only topics courses in a different subject. There are still places in his book that are worth changing – but these are isolated shortcomings that could easily have been removed in subsequent editions; unfortunately, he did not do it.

LSP took a responsible attitude towards his duties as a professor. For example, before exams there were review sessions during which students asked questions if they had not understood something in the course. Usually this involved straightening out some issues, but LSP considered it necessary to repeat one or two of his lectures.

After a couple of years he got tired of teaching a required course. He did not lecture poorly, but refused to teach the course and created a new one.

From the second half of the 1950s, Pontryagin worked mainly on optimal control and later on differential games. I did not take part in that work, since by then I had found my own field. I learned classical ODEs mainly by reading myself – only towards the end was it complemented by the topics courses of Kolmogorov, Arnold and Sinai, but that was not the classical theory.



Anosov lecturing on complete uniform hyperbolicity

But the first nudge was from LSP, who recommended that I read the mathematical parts of Andronov and Khaikin's *Theory of Oscillations*. (It originally had Vitt as a third author, but after he was arrested his name disappeared from the first edition. At first the cover page read 'A. A. Andronov, A. A. Vitt and S. E. Khaikin'. When the cover page was reprinted, they removed 'Vitt', but forgot to delete the comma. Not to encourage politically wrong conclusions, the suspicious comma was scraped off with a razor, but if one looks carefully, there is less space after 'and' than before, where there are visible traces of scraping. I suspect that those who forgot about the comma were penalized.)

This book had an extremely profound influence on me – I had probably not been so impressed by any other book. I think there were two reasons for this. First, for the first time I was reading not a text book but a monograph written by scientists, one a luminary and the other an exceptionally gifted educator (besides being a good scientist). Second, the two-dimensional qualitative theory is quite impressive initially. (Before Pontryagin, there was almost no discussion of this field in a regular ODE course. It was covered in Poincaré's collection *On curves defined by differential equations* – Andronov urged its publishing – which contained detailed comments, and in *Qualitative theory of Ordinary Differential Equations* by Nemytsky and Stepanov. Since the first book was 'too special', I read it only several years later; the second, though undoubtedly rich in content (for its time) always bored me, I don't know why, to the same extent that as the *Theory of Oscillations* absorbed me.) Later generations of students were not as impressed by the mathematical chapters of *Theory of Oscillations*, since elements of the two-dimensional qualitative theory were soon covered in many textbooks and courses; after this, the *Theory of Oscillations* became a source with a more complete exposition of a subject whose basics were already known.

I studied many other aspects of the theory of ODEs by myself, from the works of Lyapunov, Perron and Bogolyubov. I practised searching the literature on subjects of interest to me, which was also useful. As I read, I tried to evaluate the work using Pontryagin's criteria: is it new in principle? or is it a useful refinement of known ideas and techniques? or neither?

I still believe that LSP's best achievements were in topology, and I caught him in decline – but the beginning of the decline was slight and the level still very high. My only critical comment on that period relates less to his scientific activity than to a certain mood that overcame him. He used to say that he studied real-life problems (which he naively called 'physical'; what kind of physics is it when one does not have to know a single fundamental physical law?); it was rather explicit, although not in the open, that others such as Petrovsky, Bogolyubov or Gelfand had previously worked on important applied problems but could not talk about them at that time: at different times, and to a different degree, all three were involved with the Soviet atomic project. However, on the surface everything looked decent. I remember only one criticism of these remarks of LSP. It was by Kolmogorov, who was also involved with physics and some applications (the theory of shooting; turbulence, some questions connected to fluid dynamics and some applications of

statistics of random processes, created by him and N. Wiener). He said that there is a nice model for ordinary differential equations – the geometrical picture of the behaviour of trajectories in the phase space (Andronov coined the expressive term *phase portrait*), which carries so much information that there is no need for anything else, unlike partial differential equations, which require the knowledge of the physics they originated from.

I was far removed from higher circles, but I have the impression that Petrovsky was not particularly enthusiastic about LSP's new direction. To some extent, he disliked the emergence of a competitor in a field that he had ruled earlier (being the university rector, he had no time for research, and at best could only follow what was happening in mathematics); and I cannot judge to what degree he felt that LSP's shortcomings, which for a while appeared rather innocently in conversations, but which later became more prominent: I am making the risky assumption that the former played the main role at that time. LSP himself, after giving the restructured ODE course a couple of times and written the corresponding textbook, did not make too much effort to overcome Petrovsky's guarded attitude. But he had achieved his goal – this course, when offered at a serious level, is now taught in the style of Pontryagin everywhere in the world. In addition to giving the new required ODE course, LSP and his coworkers held an accompanying seminar. This was initially a study group, but later became a research seminar and moved from the MSU to MIAN. Its direct descendent is the current seminar of MIAN's DE department.

Who were your student friends?

Primarily these were the people with whom I studied the new field. First was S. P. Novikov. There were others among the regular participants of our topological seminars whose contribution to science (not necessarily to topology) was real, though not as great as Novikov's: Averbuch, Vinogradov, Ivanovsky, Moishezon, Tyurina, and Fuks. I do not remember how regularly, but Zhizhchenko and Melnikov also came; Manin and Golod participated in one of the study groups, but they were attracted to algebra, and soon got pulled into it. It was only later that I drew closer to Arnold, Sinai and Alekseyev.

New research centre in Berlin

The German Science Foundation *Deutsche Forschungsgemeinschaft* (*DFG*) has established a new research centre in Berlin:

Mathematics for key technologies: Modelling, simulation, and optimisation of real-world processes.

The Centre is funded by DFG with 5 million euro per year, and is operated and cofinanced with 3 million euro per year by the three Berlin Universities, the Free University (FU), Humboldt University (HU) and the Technical University (TU) as leading institution, together with the two research institutes, the Konrad-Zuse Zentrum für Informationstechnik (ZIB) and the Weierstrass Institute for Applied Analysis and Stochastics (WIAS). The centre was opened on 20-22 November 2002 at the Technical University of Berlin with a three-day workshop that started with a *Mathematical firework*. This firework, with talks for the general public including 3-D mathematical visualisations, drew a spectacular audience of more than 1000 people and received a large and enthusiastic echo from both audience and media.

History of the Centre

In August 2000 the *DFG* (as a result of funding obtained through the UMTS licence auction) started a new programme to establish several centres of excellence in research in Germany. The first call was open to all fields of research and drew more than eighty proposals. In the first round three centres were granted, with the topics *Ocean rims* in Bremen, *Functional nanostructures* in Karlsruhe, and *Experimental biomedicine* in Würzburg.

The second call in early 2001 was more specific and was devoted to the topic of *Modelling and simulation in science, engineering and social science*. A joint mathematics proposal was written by mathematicians from the Berlin universities and research centres, and coordinated by Martin Grötschel (TU and ZIB, Chair of the Centre), Volker Mehrmann (TU, Vice-Chair of the Centre), Peter Deuflhard (FU and ZIB), Hans Föllmer (HU) and Jürgen Sprekels (HU and WIAS). There were 14 strong competitors, many of them with participation from other mathematics departments. In July 2001 we learned that we were among the three finalists, who then had to prepare a detailed proposal (a densely packed book of 400 pages). In January 2002 the finalists had to defend their proposals in competition before an international group of reviewers. The final decision in May 2002 was based on the rule *the winner takes all*. It saw two very strong but disappointed runners-up who had spent as much time and energy on their applications as we had.

Since the decision was made, the activity within the Centre has grown immensely. The administration of the Centre had to be set up and the facilities for the Centre are being prepared (it will occupy a large part of the mathematics building of TU Berlin). Furthermore, and most important, about 60 researchers, 7 assistant professors and 7 full professors, covering the areas of *applied analysis, numerical analysis, stochastics, optimisation, visualisation, discrete mathematics* and *scientific computing* have to be hired. The current grant is for four years and it has a maximum lifetime of 12 years, with two evaluations on the way.

Mission of the Centre

Since modern key technologies need more and more complex modelling, simulation and optimisation techniques, and since innovation cycles in technological development get shorter and shorter, it is essential to have flexible mathematical models that allow to master complexity, to react quickly, and to explore new smart options. Such models can be obtained only via abstraction. This line of thought provides our global vision: *innovation needs flexibility, flexibility needs abstraction, abstraction is mathematics*. But mathematics is not only the language of science, it provides theoretical insight, efficient algorithms and optimal solutions. Thus, key technologies and mathematics interact in a joint innovation process. We think that new products in key technologies should carry the stamp '**Mathematics**' inside.

The mission of the Centre is to strengthen the role of mathematics in this interactive process. In order to achieve this, the Centre's research program is application-driven, but we do basic research in mathematics and we envision that it will also have a strong impact on the development of many other areas of mathematics. We also hope that the Centre's activities will increase inner-mathematical, inter-disciplinary and trans-disciplinary cooperation.

The Centre focuses on the mathematical fields of *optimisation and discrete mathematics, numerical analysis and scientific computing, and applied and stochastic analysis* and, building on existing cooperations, it will address the following key technologies:

- *Life sciences* (computer-assisted surgery; patient-specific therapies; protein data base analysis; protein conformation dynamics)
- *Traffic and communication networks* (planning of multi-level and multi-layer communication networks, planning of the UMTS radio interface, line planning, periodic time-tabling, and revenue management in public transport)
- *Production* (shape memory alloys in airfoils, production of semiconductor crystals, methanol fuel cell optimisation, online production planning)
- *Electronic circuits and optical technologies* (quantum-mechanical modelling of optoelectronic devices, design of nano-photonic devices, integrated circuits for future chip generations)
- *Finance* (measurement and hedging of risks, interaction models for asset price fluctuation)
- *Visualisation* (discrete differential geometry, image processing).

The Centre is not only a mathematical research institution, but also aims at cooperation with other sciences, engineering and economics, and in particular with partners in commerce and industry. Furthermore, the Centre will also put a strong emphasis on changing the public awareness for mathematics and will contribute to mathematical education at all levels.

The Centre has just begun to design and develop its web-presentation; for further information see: *http://www.math.tu-berlin.de/DFG-Forschungszentrum*

The Israel Mathematical Union

Mina Teicher

The Israel Mathematical Union (IMU) represents 300 members, most of whom are individual members of the EMS.

Mina Teicher

The body of members includes faculty members from the seven research universities (Bar-Ilan University, Ben-Gurion University, Haifa University, Hebrew University, Tel-Aviv University, the Technion, and the Weizmann Institute graduate school), from other institutions for higher education in Israel such as the Open University and undergraduate colleges, many of which also conduct research. Teachers' colleges (involved in the training of mathematics teachers for elementary schools) are also included among those represented in the IMU. Graduate students from research universities are also members: many of them are mathematicians (having received their Ph.D. degrees) who are currently employed in Israel by the high-tech, banking and aviation industries. The IMU has a high concentration of members from the former Soviet Union. It became a member of the EMS in 1991.

Some IMU members are internationally recognised mathematicians of the highest level. Included among these are Wolf Prizewinners Ilya Piatetski-Shapiro and Saharon Shelah, Turing Prizewinners Michael Rabin and Amir Pnueli, Harvey Prizewinners Israel Aumann, Michael Rabin and Hillel Furstenbe, and the Nevanlinna Prize recipient Avi Wigderson. Three IMU members are recipients of the European Prize for Young Mathematicians: Leonid Polterovich (at ECM2), Dennis Gaitsgory (ECM3) and Semyon Alesker (ECM3). About 50 other IMU members have given plenary and invited addresses at various International Congresses of Mathematics (ICMs) and European Congresses of Mathematics (ECMs).

Every two years new officers of the IMU are chosen, rotating among the different research universities. The current positions are held by Tel-Aviv University faculty members Prof. Milman (President), Dan Haran (Secretary) and Gadi Fibich (Treasurer). The newly appointed positions, from the Technion, include Alan Pinkus who will become the next President, along with the incoming Secretary Eli Elias and Budget Officer Eli Aljadeff. Since the IMU became a member of the EMS, the following presidents have held office: Yosef Zaks of Haifa University (geometry), Larry Zalcman of Bar-Ilan University (complex analysis), Steve Gelbart of the Weizmann Institute (automorphic forms) and Miriam Cohen of Ben-Gurion University (algebra).

Despite the small size of the country, mathematical activity in Israel is very intense. This intensity is evidenced by our specialised research institutes (located in different departments), several hundred graduate students, and five mathematical journals published in Israel: *Israel Journal of Mathematics* (Hebrew University), *GAFA* (Tel-Aviv University), *Journal d'Analyse Mathématique* (Bar-Ilan University), *Integral Equations and Operator Theory* (Ariel College), and *Israel Mathematical Conference Proceedings* (Bar-Ilan University). In addition, Israel is host to international postdoctoral fellowship programmes, many distinguished lecture series, visitor programmes, and international workshops and conferences.

Israeli mathematicians are involved in many European Networks. On the international scene, several international collaborations exist at governmental level, with research support and exchange programmes with countries such as Germany, Italy, France, the USA, India and China.

For the most part, new Ph.D. recipients may opt to take a 1- or 2-year postdoctoral position in Europe or the USA. Unfortunately, however, there are not enough positions in academia and as of late some students are not returning to Israel, indicating a small brain drain. During the high-tech bubble period, academia lost some manpower, but lately it seems to have stabilised.

The topics covered in Israel represent all disciplines of modern mathematics – pure and applied, as well as mathematical education. At the last EMS council meeting in Oslo, the IMU was upgraded to third category (meaning three representatives on the Council).

One of the festive events of the mathematical life in Israel (from the late 1970s) is the annual Wolf Prize ceremony, which takes place in the Knesset (the Israel Parliament). Friedrich Hirzebruch, the first President of the EMS, received the prize in 1988, and Lennart Carlson, the President of the scientific committee of 4ECM, received the prize in 1992. Other mathematicians from EMS member states who have received the prize include Izrail M. Gelfand (Russia), Carl L. Siegel (Germany), Jean Leray (France), Henri Cartan (France), Andrei N. Kolmogorov (Russia), Mark Grigor'evich Krein (Russia), Paul Erdős (Hungary), Lars Hormander (Sweden), Ennio De Giorgi (Italy), John G. Thompson (USA and UK), Mikhael Gromov (France), Jacques Tits (France), Jurgen K. Moser (Switzerland), Laszló Lovász (USA and Hungary), Jean-Pierre Serre (France), Vladimir I. Arnold (Russia and France).

The central IMU activity is the annual 2-day meeting, covering many areas with invited addresses on 'hot' topics, frequently given by distinguished mathematicians from abroad; the Erodes Prize for Young Mathematicians is awarded during this event. In addition to the annual meetings, the IMU also holds regional specialised workshops. The most recent annual meeting took place at the picturesque and beautiful desert location of Mitspe Ramon, not far from the observatory.

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F. Hirzebruch receives the 1988 Wolf Prize in Mathematics from the President of the State of Israel, the late Chaim Herzog, at the Knesset (parliament) in Jerusalem, on 12 May 1988.

Society of Mathematicians, Physicists and Astronomers of Slovenia

Peter Legiša

dMFA

History of the Society

The Society was founded in 1949 with three aims: to publish, improve teaching, and unify terminology.

At that time, teachers in our elementary and secondary schools were often qualified to teach both mathematics and physics. Now secondary school teachers, as a rule, specialise. There have accordingly been recent attempts to break the Society into two or three parts. But in Slovenia, with two million inhabitants, we find it more rational to work together, at least for now. This article will, of course, focus on the mathematical achievements of the Society.

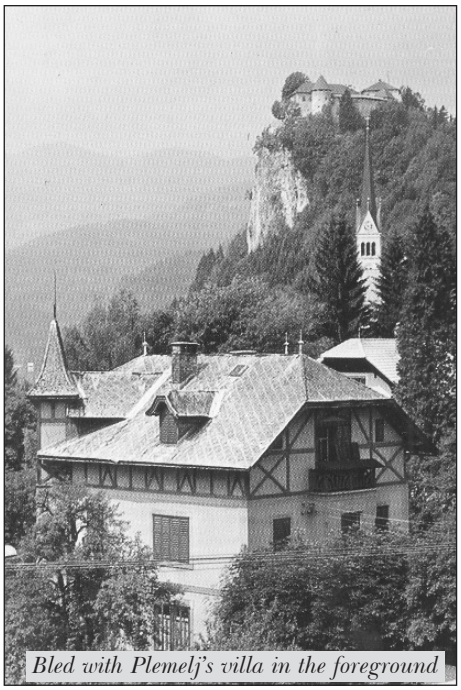
Slovenians have the mixed blessing to be the westernmost South Slavic nation, wedged between Italy in the west and Austria in the north.

Two stamps featuring Jurij Vega

Several distinguished mathematicians of the past came from Slovenia. Jurij (Georg) Vega (1754-1802) produced improved logarithmic tables that were immensely popular, with the total number of editions going into hundreds. His four-volume course in mathematics and mechanics was translated into several languages and was a source of knowledge, for example, for young János Bolyai. Vega was essentially a self-taught mathematician, who through a military career managed to advance from a poor Slovenian peasant family to aristocracy. Next year we plan to celebrate the 250th anniversary of his birth with several events.

Franc Moènik (1814-92) wrote a best-selling series of high-quality mathematical textbooks (in German) for elementary and secondary schools. These texts were translated into many languages and used for decades: the last revisions were printed just before WWII. Moènik, as an administrator, significantly increased the teaching of Slovenian in our schools, then part of the Austrian Empire, which otherwise favoured the German language.

Josip Plemelj



Bled with Plemelj's villa in the foreground

Josip Plemelj (1873-1967) was a first-class mathematician. He worked in integral and differential equations, as well as in potential theory and analytic functions. When the University of Ljubljana opened just after WWI, he became its first rector. Plemelj won two major prizes for his work, a German and an Austrian one. These enabled him to build a villa in his home place, the famous lake resort of Bled. Plemelj donated the villa to our Society.

Ivo Lah (1896-1979) was a demographer and statistician and an expert in actuarial mathematics. The Lah numbers in combinatorics are named after him.

Plemelj's student Ivan Vidav (born in 1918) made a quantum leap in Slovenian mathematics. He had sixteen PhD students and managed to direct them into several fields of mathematics, while doing good research himself. (He was still publishing original work four years ago.) Plemelj and Vidav set very high standards for lecturing at university level and I am proud to say that the tradition goes on. The Institute of Mathematics, Physics and Mechanics (IMFM, *www.ijp.si*) in Ljubljana is an umbrella organisation for mathematical research. Its 2001 yearbook listed more than a hundred publications in (mostly high-quality) international research journals.

Periodicals

Since 1951, the Society has published its own magazine, *Obzornik za matematiko, fiziko in mehaniko*. Six editions every year present survey articles in Slovenian, as well as articles on education and reports on the activities of the Society, sometimes also original scientific work. Most of the 1100 members of our Society are teachers who often complain about the high level of the survey articles.

In 1973 the Society started to publish *Presek (Intersection)*, a periodical for young mathematicians, physicists and astronomers. It was an instant success, with a circulation of 20,000 every two months and special issues as well. Although we have managed to keep the price low and the quality high, the circulation has now plummeted to 2600. University lecturers and teaching assistants write most of the contents. It is rather difficult to find interesting material for readers in elementary schools, and many articles turn out to be for the age group 17-18.

Books and teaching material

Publishing used to be an integral part of the Society. Now there is a separate publishing house (DMFA-Založništvo, *www.fmf.uni-lj.si/~zaloznistvo/*), supervised by our Society and the School of Mathematics and Physics (FMF) of the

University of Ljubljana. The popular SIGMA series started with Ivan Vidav's *Solved and Open Problems in Mathematics*, which is still in print. Most of the 72 books (about 45 of them still available) are suitable for bright students at secondary schools. Most of these books are mathematical and original work. Recently, we have had more translations.

Even more university textbooks and manuscripts have been printed. The classic one is Vidav's *Higher Mathematics*, and the author donated the royalties to the publishing house. Two monographs are in English (J. Vrabec, *Bordism, Homology, and Stiefel Whitney numbers* and P. Pavešiæ, *The Hopf Invariant One Problem*).

Handbooks and exercise collections for elementary and secondary schools earn a profit. D. Felda's book *40 National Math Olympiads in Slovenia* gives in English the texts of problems in the national competitions, a topic to which we will return.

Education

The Society helps to organise seminars and workshops for teachers of mathematics. It presents summer schools for the most gifted pupils, often in Plemelj's villa at Bled. The Society has actively participated in curriculum changes in secondary schools, ensuring that no hasty decisions were made.

For many years the Society provided special courses and lectures for students of secondary schools, given by university lecturers and students. In my earlier years I attended an excellent course on probability. The instructor (Prof. R. Jamnik) first made clear to us that there would be an exam at the end. He adapted to our lower level and the course was a remarkable success – it convinced even those who otherwise did not like mathematics but unexpectedly joined the course. The best participants earned books as prizes.

But I also listened to a mathematician who did not care about the reaction of the listeners and was too fast even for the brightest – a very frustrating experience for me and certainly not a good way to attract young people to mathematics.

Competitions

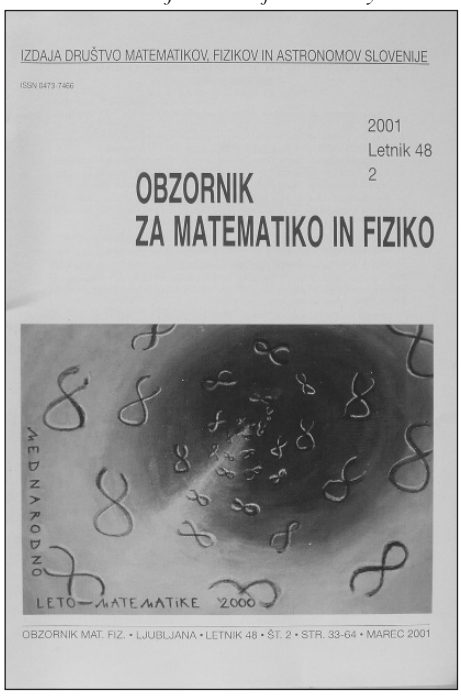
The most popular activities of the Society are competitions for pupils and students of secondary schools. These have been going right from the beginning, and have expanded enormously.

In the past, there were debates on the impact of competitions. It turned out that some of the best competitors never got a university degree. Quick successes, arising from their talents, did not prepare them for the strenuous work at higher level. This now seems to be less of a problem, but the best competitors do not always choose mathematics as their field of study.

Every year, about 60,000 pupils (50 per cent of those who attend elementary schools) participate in school competitions, which are now integrated in the European Kangaroo. [For further information about the European Kangaroo, see Paul Jaint'a article in issue 45] About ten per cent of those in the 6th, 7th, and 8th class enter regional qualifications. The crème de la crème – ten per cent of the best – compete at national level. About half of them win prizes.

At high-school level, about 5000 students participate in a similar three-level competition, but the prizes are more structured and limited.

The two journals of the Society



Recently, we started separate competitions for students of technical schools (aged 15-18, about 3000 participants) and for students of vocational schools (aged 15-17, 1600 competitors).

The 14th competition in Recreational Mathematics attracted several hundred competitors. It was supplemented by the third competition in Space Visualisation.

In these competitions we collect a fee of about 1 euro per participant. This enables us to maintain the on-line registration scheme, print the diplomas, and so on.

Most of the budget of our Society comes from the government (usually with delays), and most of it is spent on competitions, the lion's share on the cost of sending a team to the Mathematical Olympiad.

Events

Every year the Society holds a meeting, lasting two or three days. We organise it in different regions of the country, so local members can attend it without cost. The meeting includes survey lectures, mostly on elementary mathematics and mathematical education, but also on applied mathematics. I listened to several very interesting talks, given by mathematicians, physicists and astronomers to a general audience. This is definitely one of the advantages of working together.

Each year we reward distinguished teachers and schools that excel in mathematical education. The Society has helped to erect monuments or memorial plaques to several Slovenian mathematicians. It also helps to maintain the memorial room for Vega in his birthplace Zagorica, and an exposition on Plemelj in his villa.

Links

For many years the Society has maintained excellent connections with mathematicians in neighbouring Zagreb (Croatia). We have occasional contacts with colleagues from Skopje (Macedonia) and now again with colleagues from the (shrunken) Yugoslavia. (Slovenia was part of Yugoslavia from 1918 to 1990.)

In my view Italy and Austria have so far been mainly interested in attracting talented students from our territory, but recently, there has been research cooperation with a centre in Austria (Leoben). Contacts directly across the border are weak: this is probably linked to the fact that there are Slovenian populations in neighbouring areas of those two countries, a fact that some people find hard to admit. If Slovenia joins the EU next year, we hope that the situation will improve.

The homepage of our Society is *www.dmfa.si*.

Problem Corner
Contests from Bulgaria, Part II

Paul Jainta

The philosophy behind an emphasis on problem solving is the educational truism that telling is not teaching and listening is not learning. I am a strong advocate of the precept that mathematics is not a matter for immediate consumption: one can only derive benefit from this subject if one is doing it!

So, it is increasingly important for teachers and lecturers to offer new opportunities for youngsters to stimulate their interest by coaching them in doing mathematics. A vast supply of ideas, methods and techniques lie dormant in problems of Olympiad type. By attacking competition problems, students can develop their talents for mathematical thinking. Mathematical talent and problem-solving ability are needed in today's world in engineering, physics, chemistry and many other sciences. In fact, with the applications of mathematics in business, communications, and the social sciences, there is hardly a field that does not require a good background in mathematics.

This has been known in Bulgaria for more than 100 years, where they found it increasingly important to invest time and resources in developing the mathematical skills of a small but particularly talented section of its young persons. We can learn a lot about the imaginativeness of the Bulgarian pioneers for encouraging particularly gifted pupils and students. In the second part of his series, Prof. Sava Grozdev, from the Institute of Mechanics, Bulgarian Academy of Sciences, Sofia, describes the essential role that mathematics journals and summer camps play in this continual national task of fishing out those splendid young persons, in order to further their mathematical abilities.

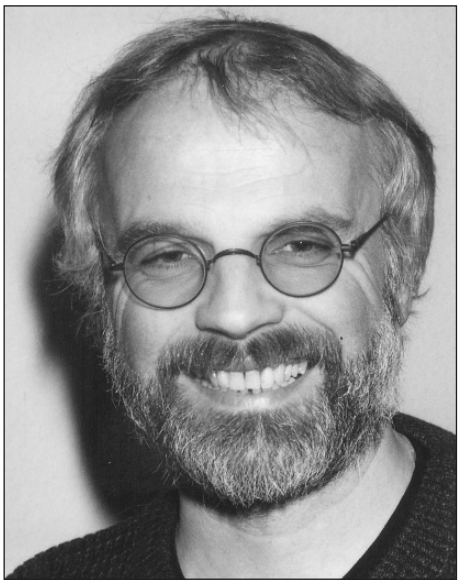
Accompanying Measures (Sava Grozdev)

The home journal *Mathematics Plus* plays a lead in recruiting apt students. Its main goal is to identify highly talented boys and girls, and for this purpose the journal organises each year a junior contest for pupils from grades 4-7. The trial is held in three rounds, each comprising three questions. Each stage is preceded by two small articles in this journal, addressed first and foremost to those students who participate in the contest. The articles feature special topics that are usually not on the curriculum; for example, squares and square numbers, induction in geometry, the finite element principle, Euler's formula, some invariants, and mathematical games. These articles are meant to be studied by the young reading public, independently or with the help of parents and teachers, at home or outside lessons. Usually, these extra lessons are used in mathematics circles or special classes that have been established in various Bulgarian cities and towns and are frequented by students who are highly motivated to problem-solving and eager to do maths.

At least one of the problems in each round is closely connected to the item appearing in the journal at the same time. While working carefully through the articles the contestants are provided with fresh knowledge and some tools necessary for solving the corresponding problem or a similar one. In addition to the nine questions presented to the different age groups, junior contestants especially are confronted with a problem that 'steps out of line'. This '*Tenth Problem*' requires ingenious ideas and asks participants to go exploring. It usually allows challenging and deep generalisations that can be found after some hard work and concentrated examination.

Apart from individuals, groups of students and mathematical circles are encouraged to submit solutions. The teachers in charge of a circle or working-group also play another significant part – for example, they give their young protégés a hand when struggling with one of those fiddly Tenth Problems and provide advice in coping with the difficult task writing down solutions to problems: this assistance is useful for them, too. So, solving a Tenth Problem is an activity that involves the whole team; teachers and pupils together learn new mathematical facts and are thus stimulated by fruitful ideas and tools. Sometimes, highly complicated tenth problems forge a close bond between coaches and their flock – but even a teacher may have to give up a particularly stubborn problem.

The 'Mathematics Plus' junior contest is carried out by written communication between participants and corresponding markers. A special jury grades the papers, giving priority to the tenth problem. Those students who have worked well on all problems are invited, with their teachers, to a Summer Camp organised every July. The Camp is free of charge for those selected. Some outstanding Bulgarian mathematicians are regularly asked to lecture on a special topic in this relaxed setting. These courses are usually enriched with general challenges and classical mathematical problems, and include curious facts connected with the history of mathematics and the life of famous mathematicians. The Summer Camp always ends in a festival, when many guests, students and teachers, can establish contacts among themselves, or become friends. Most importantly, during their stay the young mathematicians will grow into the world of mathematical science and society.



Later, a considerable percentage of those who found their way into one of these Summer Camps become members of the Bulgarian team participating in international Olympiads – and after graduating from prestigious universities like Harvard, Princeton, MIT and others, they may start careers as a highly qualified mathematicians. The timely motivation of junior students has doubtless activated them towards individual research.

As a kind of levelling rod for the achievements of students at this early age, it is useful to know how they have performed in the Junior Balkan Mathematics Olympiad. In all five contests held up to now, Bulgaria has been represented by 26 students, and all came back with a medal. The other regular guests in the Balkan Olympiad are young people from Albania, Bosnia, Cyprus, Greece, Macedonia, Moldova, Romania, Turkey and Serbia. Since 2001 each participating country has put forward a six-person team.

Already while a senior at school, many of these students publish interesting treatises on specialist topics or create original problems. It is not unusual to encounter an author of several articles and challenging questions in *Mathematics Plus* who is still attending school. The Junior contest, and its counterpart for Senior students, appear in the journal as parallel contests. Each issue contains six problems for each age group: these are well known for their increasing level of difficulty, and 'breathe the spirit' of an Olympiad. Usually, many of the new problems come from the students. Their brainpower is impressive, as you can see from the questions in the last Problem Corner (**issue 45**).

The next six problems have been taken from the professionals.

146 (S. Grozdev, 1987: Winter Competition)
Given 4 arcs on a circle, such that each pair of arcs has exactly one point in common, prove that at least one arc contains the midpoint of another arc.

147 (S. Grozdev, 1988: Atanas Radev Tournament Special Prize)
Given 100 positive integers $x_1, x_2, \ldots, x_{100}$, such that $1/\sqrt{x_1} + 1/\sqrt{x_2} + \ldots + 1/\sqrt{x_{100}} = 20$, prove that at least two of the integers must be equal.

148 (S. Savchev, 1990: Winter Competition)
Let S be an infinite set of points in the plane with the following property: if A, B, C are different points of S, then the distance from A to the line BC is an integer. Prove that all the points of S are collinear.

149 (S. Grozdev, 1989: Spring Tournament)
A triangle ABC cannot be covered by any two smaller triangles that are similar to it. Find the angles of the triangle ABC.

150 (A. Ivanov, 2000: Atanas Radev Tournament Special Prize)
Given 4 points in the plane, such that the distance between any two of them is an integer, prove that at least one of the distances is divisible by 3.

151 (S. Grozdev, 1994: Atanas Radev Tournament Special Prize)
In a city all tramway routes have the following properties: there are at least 2 stops on each line; at least one line connects each pair of stops; each pair of lines has exactly one stop in common.
Prove that there are the same number of stops on each tram route.

Editor's note: Unfortunately, the problem numbers in issue 45 were incorrect: they should have been 140-145.

Solutions to some earlier problems

134 Prove that there exist at least 2000 triples of positive integers (a,b,c) such that $a^{15} + b^{15} = c^{16}$.

Combined solution by Gerald A. Heuer, Moorhead, MN, USA and J.N. Lillington, Dorchester, UK.
Also solved by Erich N. Gulliver, Schwäbisch Hall, Germany and Dr Z Reut, London, UK.

The observation that $2^r + 2^r = 2^{r+1}$ leads to the infinite family of solutions
$(a, b, c) = (2^{16n+1}, 2^{16n+1}, 2^{15n+1})$, for all $n \geq 0$:
we have $a^{15} + b^{15} = 2^{(16n+1)15} + 2^{(16n+1)15} = 2 \cdot 2^{(16n+1)15} = 2^{16n \cdot 15+16} = 2^{(15n+1)16} = c^{16}$.

Second solution by Alexandra Reinl, Schwetzendorf, Germany.
Let n be a positive integer, and define $a_n = (n^{15} + 1)n$, $b_n = n^{15} + 1$, $c_n = n^{15} + 1$.
Then we obtain
$a_n^{15} + b_n^{15} = (n^{15} + 1)^{15} n^{15} + (n^{15} + 1)^{15} = (n^{15} + 1)^{16}$ and $c_n^{16} = (n^{15} + 1)^{16}$.
Consequently, the equation $a_n^{15} + b_n^{15} = c_n^{16}$ is satisfied.
If i and j are different positive integers, then (a_i, b_i, c_i) and (a_j, b_j, c_j) are different triples of positive integers.
Thus we find an infinitely many triples (a, b, c) that satisfy the given condition.

(More generally, Niels Bejlegaard, Copenhagen, Denmark, has found the following solutions of the form (a, b, a), for $n = 1,2,3, \ldots$. Let $a = p_1^n p_2^n \ldots p_k^n + 1$, with p_i $(i = 1,2,\ldots,k)$ as the first k prime numbers. Since $b^n = a^n(a-1)$, for $a = c$, the solutions are $\{p_1^n p_2^n \ldots p_k^n + 1;\ p_1 p_2 \cdots p_k (p_1^n p_2^n \ldots p_k^n + 1);\ \ldots;\ p_1^n p_2^n \ldots p_k^n + 1\}$. The infinity of primes assures the infinity of solutions.)

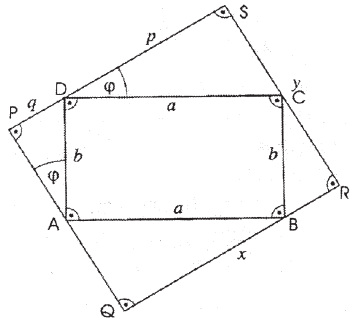
135 Let a and b be real numbers that satisfy both $a^3 - 3ab^2 = 44$ and $b^3 - 3a^2b = 8$. Determine $a^2 + b^2$.

Solution by Gerald A. Heuer. Also solved by Niels Bejlegaard, J.N. Lillington, Alexandra Reinl, Schwetzendorf, and Dr Z Reut.

A simple approach succeeds by using complex numbers. From the equation
$(a + bi)^3 = (a^3 - 3ab^2) + (3a^2b - b^3)i = 44 - 8i$,
we see that
$a^2 + b^2 = |a + bi|^2 = |44 - 8i|^{2/3} = (2000^{1/2})^{2/3} = 10 \cdot 2^{1/3}$.

PROBLEM CORNER

136 A given rectangle with sides a and b is circumscribed by another rectangle of area m^2; determine all possible values of m.



Solution by Ranjeet Kaur Sehmi, Department of Applied Sciences, PEC, Chandigarh, India. Also solved by Niels Bejlegaard, Gerald A. Heuer, J.N. Lillington, Alexandra Reinl and Dr Z Reut.

Let ABCD be the given rectangle with sides a and b, and let PQRS be the rectangle circumscribing it as shown.
Let $\angle$ DAP = φ; then PQ = a sin φ + b cos φ and QR = b sin φ + a cosφ.
So m^2 = (a sin φ + b cos φ) (b sin φ + a cos φ) = ab + $(a^2 + b^2)$ sin φ cos φ
= ab + $(a^2 + b^2)$ (sin 2φ) /2.
Now, $0 \le \sin 2\varphi \le 1$, therefore $ab \le m^2 \le ab + (a^2 + b^2)/2$.
Thus m lies between $\sqrt{ab}$ and $(a + b)/\sqrt{2}$.

137 Given a right triangle with angles α and β, legs a and b and hypotenuse c.
Prove the inequality: $\cos^2(\alpha - \beta)/2 \ge (2ab)/c^2$.

Solution by Niels Bejlegaard. Also solved by J.N. Lillington, Alexandra Reinl, Ranjeet K. Sehmi and Dr Z Reut.

Since $\cos^2(x/2) = (1 + \cos x)/2$
and since, by the Pythagorean Theorem $c^2 = a^2 + b^2 \ge 2ab$, or $1 \ge 2ab/c^2$,
we have:
$\cos^2[(\alpha - \beta)/2] = [1 + \cos(\alpha - \beta)]/2 = \frac{1}{2}(1 + \cos\alpha\cos\beta + \sin\alpha\sin\beta)$
$= \frac{1}{2}(1 + 2ab/c^2) \ge \frac{1}{2}(2ab/c^2 + 2ab/c^2) = \frac{1}{2}\, 4ab/c^2 = 2ab/c^2$.

138 You have coins worth 1, 2, 5, 10, 20, 50 and 1 kuna (= 100 lipa).
Prove that if you can pay a bill for *M* lipa with *N* coins, then you can pay another bill for N kuna with M coins.

Combined solution by Alexandra Reinl, Dr Z Reut and Ranjeet K. Sehmi. Also solved by Niels Bejlegaard and J.N. Lillington.

Let $x_1, x_2, x_5, x_{10}, x_{20}, x_{50}$ and x_{100} be the number of coins worth 1, 2, 5, 10, 20, 50 lipa and 1 kuna, that are required to pay a bill for *M* lipa. Then:
$x_1 + x_2 + \ldots + x_{100} = N$ and $x_1 + 2x_2 + 5x_5 + 10x_{10} + 20x_{20} + 50x_{50} + 100x_{100} = M$. (*)
Therefore,
$100x_1 + 100x_2 + \ldots + 100x_{100} = 100N$
or
$100x_1 + 50(2x_2) + 20(5x_5) + \ldots + 2(50x_{50}) + 1(100x_{100}) = 100N$.
So, if we use $x_1, 2x_2, \ldots, 50x_{50}, 100x_{100}$ coins worth 1, 2, 5, 10, 20, 50 lipa and 1 kuna, respectively,
then we can pay a bill for 100*N* lipa, or *N* kuna.
Moreover, the total number of these coins is
$x_1 + 2x_2 + \ldots + 100x_{100} = M$, by (*).
Thus we can pay a bill for *N* kuna using *M* coins.

139 A square is given in the plane with vertices $T_1(1, 0)$, $T_2(0, 1)$, $T_3(-1, 0)$ and $T_4(0, -1)$.
For each n, let T_{n+4} be the midpoint of the line segment T_nT_{n+1}.
If the sequence of points $\{T_n\}$ has a limit point, what are its coordinates?

Combined solution by Alexandra Reinl and Niels Bejlegaard. Also solved by J.N. Lillington and Dr Z Reut.

For two points $P_1(x_1, y_1)$, $P_2(x_2, y_2)$, define a 'point sum' as follows: $P_1 + P_2 = (x_1 + x_2, y_1 + y_2)$.
Let us consider the sequence of quadrilaterals $T_1T_2T_3T_4$, $T_5T_6T_7T_8$, … .
A useful idea to find a limit point T is to take up the concept of an invariant.
From the fact that $T_{n+4} = \frac{1}{2}(T_n + T_{n+1})$, it follows immediately that, for example,
$\frac{1}{2}x_{n+1} + x_{n+2} + x_{n+3} + x_{n+4} = \frac{1}{2}x_{n+1} + x_{n+2} + x_{n+3} + \frac{1}{2}x_n + \frac{1}{2}x_{n+1}$
$= \frac{1}{2}x_n + x_{n+1} + x_{n+2} + x_{n+3}$;
that is, both sums $\frac{1}{2}x_n + x_{n+1} + x_{n+2} + x_{n+3}$ and $\frac{1}{2}y_n + y_{n+1} + y_{n+2} + y_{n+3}$ are constant,
so $\frac{1}{2}T_n + T_{n+1} + T_{n+2} + T_{n+3}$ is invariant by translation.
In particular, we have:
$\frac{1}{2}x_1 + x_2 + x_3 + x_4 = \frac{1}{2} + 0 - 1 + 0 = -\frac{1}{2}$ and $\frac{1}{2}y_1 + y_2 + y_3 + y_4 = 0 + 1 + 0 - 1 = 0$.
Denoting $x = \lim_{n\to\infty} x_n$ and $y = \lim_{n\to\infty} y_n$, we have $^7/_2\, x = -\frac{1}{2}$ or $x = -^1/_7$, and $^7/_2\, y = 0$ or $y = 0$.
The limit point is $T(-^1/_7, 0)$.

This completes another *Problem Corner*.
Please send me your solutions as well as Olympiad Contests for use in this column.

Mathematical Biography

IOAN JAMES

It is now over sixty years since Eric Temple Bell set out to write about mathematicians in a way which would grip the imagination of the educated public. His immensely readable book *Men of Mathematics* [4] was first published in 1937 and is still in print. He was a man of strong opinions, not simply reflecting the prejudices of a bygone age, for example: 'There is no more vicious academic hatred than that of one Jew for another when they disagree on purely scientific matters. When two intellectual Jews fall out they disagree all over, throw reserve to the dogs, and do everything in their power to cut one another's throats or to stab one another in the back.' Moreover, he was not above distorting the facts in the interests of making a good story. Although his book is looked down upon by the historians of mathematics, it continues to influence the impression that ordinary mathematicians have of the history of their subject.

In his introduction Bell begins by emphasising that his book is not intended, in any sense, to be another history of mathematics, and goes on: 'The lives of mathematicians presented here are addressed to the general reader and to others who might wish to see what sort of human beings the men were who created modern mathematics.' He continues: 'Two criteria have been applied in selecting names for inclusion: the importance for modern mathematics of a man's work; the human appeal of the man's life and character. ... When these criteria clash ... the second has been given precedence, as we are primarily interested here in mathematicians as human beings.'

Mathematical biography is a growing industry these days. At least fifty of the great mathematicians of the past have been the subject of a full-scale treatment, usually either a *Life and Work* or a *Life and Times*, and there are many more who merit the attention of a biographer. Most of these books have been written by historians of mathematics, who tend to write primarily for other historians. These seem to me too specialised to appeal to the ordinary mathematician, but others have been written for a rather wider readership. For example, we have the biography of Cauchy [3] by Bruno Belhoste, which combines a good account of his life with an evaluation of his contribution to the development of mathematics; such books are of interest to anyone with some knowledge of mathematics and its cultural history.

There are also a number of biographies which avoid technicalities and emphasise the human side, such as the life of Hamilton by Hankins [6], of Galois by Laura Toti Rigatelli [19], of Courant [17] and Hilbert [18] by Constance Reid, of Hadamard [14] by Vladimir Maz'ya and Tatyana Shaposhnikova, of Pólya [1] by G. L. Alexanderson, and of Zariski [16] by C. Parikh. Some of these books are more scholarly than others, but the best have been carefully researched and.one should not be put off by catchy titles. The biographies of Sonya Kovalevskaya by Don Kennedy [12] and Ann Koblitz [13], that of Ramanujan [11] by Robert Kanigel, that of Stefan Banach [10] by Roman Kaluza, and those of Abel [21] and Lie [22] by Arild Stubhaug are also of this type. The authors have some mathematical background, although not all would claim to be professional mathematicians: Kaluza, for example, is a journalist and Stubhaug a writer. The life [15] of the Nobel Laureate John Nash by Sylvia Nasar is another such example. The author is an economist, now professor of journalism at Columbia University. Bell, of course, was a pioneer of science fiction as well as a professional mathematician.

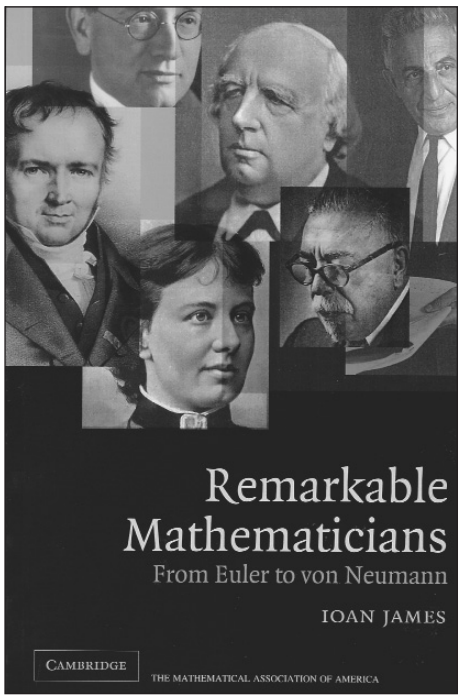
Sometime ago I began to think about writing a *Men and Women of Mathematics* which might, I hoped, provide an alternative to Bell's book. This work has now appeared, under the title *Remarkable Mathematicians* [7]. For each of sixty subjects it provides a brief life which takes account of recent scholarship. They were chosen from mathematicians born in the eighteenth, nineteenth and early twentieth centuries. Among them, twelve different European countries are represented, including Russia. France and Germany are very heavily represented. While Bell does not venture outside Europe, I have included mathematicians from India and Japan, as well as several from the United States. I start with Euler and end with von Neumann, whereas Bell begins in antiquity and finishes with Cantor.

After digesting the relevant literature I chose the subjects of the profiles with an eye to diversity and contrast. Most of them made important discoveries, but I included some who contributed in other ways, for example Mittag-Leffler, Courant and Veblen. The majority spent at least some time teaching, with various degrees of success; several were the authors of successful textbooks. In the eighteenth century, when there were hardly any university posts for mathematicians, some occupied chairs in other subjects, such as astronomy. Several made a living in quite different professions, for example as engineers or lawyers or administrators. Like Bell I have tried to bring out the human side, avoiding too much technical detail which can generally be found elsewhere.

The general question of whether an aptitude for the kind of abstract thought required for mathematics is in any sense inherited, and if so how, is an intriguing one. There is some evidence in favour; Francis Galton, in *Hereditary Genius* [5] discusses the case of the Bernoullis, and there are other less striking examples. A possible reason why a genetic factor could be involved may be found in the medical literature. Asperger syndrome [8] is a mild form of autism. Asperger people are attracted to mathematics; autistic tendencies run in families. It would be interesting to try and identify which of the great mathematicians of the past were Asperger people, like Newton, Einstein, Ramanujan, and possibly Dirac.

The only woman mathematician who appears in *Men of Mathematics* is Sonya Kovalevskaya, who is included in the profile of Weierstrass. The prevailing prejudice against women in science has taken a long time to break down, and unfortunately the process is still not complete. Until the end of the nineteenth century and even beyond there were all kinds of obstacles which made it difficult for a woman to become a scientist. Exceptional determination was required; men were believed to have a monopoly of abstract thought. As a result, of my sixty subjects, only three are women, but there can be no doubt that many other women had no opportunity to develop their mathematical gifts.

Galton also mentions the common belief that the mothers of great men are more influential on their development than the fathers. Gauss, Poincaré and Hilbert believed that their mathematical gifts came from their mother's side of the family rather than the father's side.



Regrettably, far too little is known about the mothers of the great mathematicians, although some of them were clearly remarkable women. The mother of Galois was described as 'intelligent, lively, headstrong, generous and eccentric', the mother of Ramanujan as 'shrewd, cultured and deeply religious', and the mother of. Kolmogorov as 'liberal and independent'. Others are simply stated to have been well-to-do, or from a wealthy family, or to have been well educated. Often we just know their names, sometimes not even that.

Mathematical autobiography seems to be quite a recent phenomenon, although various novels of Sonya Kovalevskaya are based to a large extent on her own life. Another Russian who gave a vivid account [2] of his life story is P. S. Alexandroff. Other important examples are those of Laurent Schwartz [20] and André Weil [23]. The idiosyncratic autobiography by Norbert Wiener [24], [25] should also be mentioned. As Hans Freudenthal commented: 'Wiener never had the slightest idea of how he appeared in the eyes of others.' An autobiography is no substitute for a biography.

A companion volume to *Remarkable Mathematicians*, entitled *Remarkable Physicists* [9], will follow shortly. Fourier and Laplace appear in both books; of course, many physicists contributed greatly to mathematics, and mathematicians to physics. Because the interaction between the two branches of science has been so important I am thinking of combining the most interesting profiles from the two books into a third one in which mathematicians and physicists are treated together.

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NONLINEAR DYNAMICS AND SYSTEMS THEORY

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(Joint course with the European Mathematical Society)
Course directors:
Profs. Marco Frittelli (Univ. di Firenze) and Wolfgang Runggaldier (Univ. di Padova).
Lectures:
Kerry Back (St. Louis): *Partial and asymmetric information*.
Tomasz Bielecki (Northeastern Illinois): *Stochastic methods in credit risk modeling, valuation and hedging*
Christian Hipp (Karlsruhe): *Finance and insurance*
Shige Peng (China): *Nonlinear expectations and risk measures*.
Walter Schachermayer (Vienna): *Utility maximization in incomplete markets*

14-21 July: Hyperbolic Systems of Balance Laws, Cetraro, Cosenza
Course director:
Prof. Pierangelo Marcati (Univ. de L'Aquila)
Lectures:
A. Bressan (Trieste): *Viscosity solutions of systems of conservation laws*
C.M. Dafermos (Providence): *Conservation laws on continuum mechanics*
D. Serre (Lyon): *Shock profiles in scalar conservation laws*
M. Williams (North Carolina): *Stability of multidimensional viscous shocks*
K. Zumbrun (Indiana): *Planar stability criteria for multidimensional viscous shock Waves*

1-6 September: Mathematical Foundation of turbulent Viscous Flows, Martina Franca, Taranto
Course directors:
Profs. M. Cannone (Univ. de Marne-la-Vallée) and T. Miyakawa (Kobe Univ.)
Lectures:
P. Constantin (Chicago): *TheNavier-Stokes equations of viscous fluids and questions of turbulence theory*
G. Gallavotti (Rome): *Incompressible fluids and strange attractors*
A. Kazikhov (Novosibirsk): *The theory of strong approximation of weak limits via the method of averaging with applications to Navier-Stokes equations*
Y. Meyer (Paris): *Size estimates on solutions of nonlinear evolution equations and consequences*
S. Ukai (Yokohama): *The asymptotic analysis theory of fluid equations*.

2-10 September: Symplectic 4-Manifolds and Algebraic Surfaces, Cetraro, Cosenza
Course directors:
Profs. Fabrizio Catanese (Bayreuth) and Gang Tian (M.I.T.)
Lectures:
B. Siebert and Gang Tian (Bochum and M.I.T.): *Pseudo holomorphic curves and symplectic isotopy*
M. Manetti (Rome): *Smoothing of singularities and deformation and differentiable type of surfaces*
D. Auroux and I. Smith (M.I.T. and Cambridge): *Lefschetz pencils, branched covers and symplectic invariants*
P. Seidel (London): *Lagrangian spheres and Dehn twists in dimension 4*
F. Catanese (Bayreuth): *Classification and deformation types of complex and real manifolds*

CIME can offer some fellowships. An on-line application form appears on the page for each CIME course: website
C.I.M.E. courses are made possible thanks to the generous support received from:
- Istituto Nazionale di Alta Matematica
- Ministero Affari Esteri, Dir. Gen. Per la Promozione e Cooperazione Culturale
- Ministero dell' Istruzione, dell'Università e della Ricerca Scientifica e Tecnologica

Forthcoming conferences

compiled by Vasile Berinde

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.*

April 2003

27-May 3: Spring School on Analysis: Variational Analysis, Paseky nad Jizerou, Czech Republic
Information:
e-mail: paseky@karlin.mff.cuni.cz
website: http://www.karlin.mff.cuni.cz/katedry/kma/ss/apr03/ss.htm
[For details, see EMS Newsletter 46]

28-June 20: Bimestre Intensivo: Microlocal Analysis and Related Subjects, Torino, Italy
Topics: short courses and specialist talks on the following topics are scheduled: Perturbative methods in non-linear analysis; Pseudo-differential methods for evolution equations; Quantization and harmonic numerical analysis; Elliptic and hypoelliptic equations.
Scientific Committee: P. Boggiatto, I. Fujita, T. Gramchev, G. Monegato, A. Parmeggiani, J. Pejsachowicz, L. Rodino, A. Tabacco.
Sponsor: INdAM (Istituto Nazionale di Alta Matematica), Italy.
Location: Department of Mathematics, University of Torino; Department of Mathematics, Politecnico of Torino.
Information: e-mail: indam@dm.unito.it
website http://www.dm.unito.it/convegniseminari/indam/bimestri.htm

May 2003

2-3: X Encuentro de Topologia, Bilbao, Spain
Information: e-mail: xet@lg.ehu.es,
website: http://www.ehu.es/xet
[For details, see EMS Newsletter 46]

11-16: International Conference on General Control Problems and Applications (GCP-2003), Tambov, Russia
Information: e-mail: aib@tsu.tmb.ru, uaa@hmb.nnn.tstu.ru
website: http://www.opu2003.narod.ru
[For details, see EMS Newsletter 44]

11-18: Conference on Topological Algebras, their Applications, and Related Topics, Bedlewo, Poland
Information: e-mail: ta2003@amu.edu.pl
website: : http://main.amu.edu.pl/~ta2003
[For details, see EMS Newsletter 44]

12-17: 23rd International Seminar on Stability Problems for Stochastic Models, Pamplona, Navarra, Spain
Information: e-mail: stochastic@unavarra.es
website: http://www.unavarra.es/stochastic
[For details, see EMS Newsletter 46]

25-31: Workshop on Singularity Theory, Edinburgh, UK
Organisers: International Centre for Mathematical Sciences
Information: e-mail: icms@maths.ed.ac.uk
website : http://www.ma.hw.ac.uk/icms/meetings/2003/singth/index.html

26-30: Fifth International Conference on Sampling Theory and Applications (SampTA03), Strobl, Austria
Information: web site: www.univie.ac.at/NuHAG/SampTA03/
[For details, see EMS Newsletter 45]

June 2003

1-6: International Conference on Group Theory, Gaeta, Italy
Dedicated to Slava Grigorchuk on the occasion of his 50th birthday
Theme: combinatorial, geometric, and dynamical aspects of infinite groups
Aim: presentation of recent developments concerning combinatorial, geometric and dynamical aspects of group theory
Scope: to bring together leading experts and younger researchers to discuss recent developments
Topics: geometric group theory; ergodic theory; groups acting on trees and boundaries; random walks; amenability; growth of groups, languages, and automata; groups and fractals; $L2$-cohomology; bounded cohomology; branch groups; groups generated by finite automata; calculus of spectra; problems of Burnside type; combinatorics of words.
Main speakers: D. Anosov (Moscow); G. Baumslag (New York); M. Burger (Zürich); H. Furstenberg (Jerusalem); E. Ghys (Lyon); R. Grigorchuk (Texas and Moscow); M. Gromov (Paris); F. Grunewald (Düsseldorf); P. de la Harpe (Geneva); V. Jones (Berkeley); A. Lubotzky (Jerusalem); W. Lück (Münster); G. Margulis (Yale); A. Ol'shanskii (Vanderbilt Moscow); G. Pisier (Texas and Paris); S. Sidki (Brasília); A. Valette (Neuchâtel); A. Vershik (St. Petersburg); E. Zelmanov (San Diego and Yale);
Format: plenary talks, invited talks
Sessions: plenary lectures and parallel sessions
Languages: English and French
Organisers: L. Bartholdi, T. Ceccherini-Silberstein, Tatiana Smirnova-Nagnibeda and A. Zuk
Local organisers: T. Ceccherini-Silberstein, A. Machi, F. Scarabotti and F. Tolli
Proceedings: The conference proceedings will be published in a special issue of the *International Journal of Algebra and Computation*. Deadline for submission is 1 October 2003.
Location: Hotel Serapo, Spiaggia di Serapo, 04024 Gaeta
Grants: support for a limited number of participants
Deadlines: deadline for abstract submission was 1 March
Information:
gaeta@mat.uniroma.it; gaeta@math.kth.se
website: http://www-old.math.kth.se/math/users/gaeta/

1-7: Spring School in Analysis: Function Spaces and Applications, Paseky nad Jizerou, Czech Republic
Information:
e-mail: pasejune@karlin.mff.cuni.cz
website: http://www.karlin.mff.cuni.cz/katedry/kma/ss/jun03/ss.htm
[For details, see EMS Newsletter 46]

2-6: Workshop on Derived Categories, Edinburgh, UK
Organisers: International Centre for Mathematical Sciences
Information: e-mail icms@maths.ed.ac.uk
website: http://www.ma.hw.ac.uk/icms/meetings/2003/dercat/index.html

13-22: Poisson Geometry, Deformation Quantisation and Group Representations (PQR2003), Brussels, Belgium
Information: e-mail: pqr2003@ulb.ac.be;
website: http://homepages.ulb.ac.be/~pqr2003/
[For details, see EMS Newsletter 46]

18-19: Two-day Colloquium in honour of Enrico Magenes, Pavia, Italy
Topic: On the occasion of the 80th birthday of Professor Enrico Magenes, his former students at the University of Pavia are organising a two-day colloquium in his honour in Pavia. The programme consists of seven lectures by the following speakers: C. Baiocchi (Rome); J. M. Ball (Oxford); L. A. Caffarelli (Texas); G. Geymonat (Montpellier); P.-L. Lions (Paris); C. Verdi (Milano); A. Visintin (Trento).
The Colloquium at the University of Pavia or at one of the University Colleges (to be announced later) will take place from 18 June at 3 pm to 19 June at 6 pm.
Deadline: Those interested in participating should register by 15 April.
Information:
e-mail: magenes80@dimat.unipv.it
phone/fax: +39 0382 505620 / +39 0382 505602
website: http://www.imati.cnr.it/~magen80/eng.html
mail address: Prof. Marco Luigi Bernardi, Dipartimento di Matematica 'F. Casorati', Università di Pavia, Via Ferrata n.1, I-27100 Pavia, Italy

18-28: Instructional Conference in the Mathematical Analysis of Hydrodynamics, Edinburgh, UK
Organisers: International Centre for Mathematical Sciences

Information:
e-mail: icms@maths.ed.ac.ukwebsite: http://www.ma.hw.ac.uk/icms/meetings/2003/hydro/index.html

19-22: 66th Workshop on General Algebra / 66. Arbeitstagung Allgemeine Algebra (AAA66), Klagenfurt, Austria
Topics: universal algebra, classical algebra and applications of algebra
Format: invited talks and contributed presentations
Sessions: plenary lectures and parallel sessions
Registration: online registration form available by the end of February 2003
Organisers: H. Kautschitsch, W. More and J. Schoißengeier
Proceedings: it is intended to publish the proceedings of the conference as Volume 15 in the series *Contributions to General Algebra*. All papers will be refereed.
Location: University of Klagenfurt, A-9020 Klagenfurt, Austria
Grants: probably support for participants from countries in a difficult economic situation
Information: e-mail: aaa66@uni-klu.ac.at; web site: www.uni-klu.ac.at/AAA66

20-27: Intermediate problems of model theory and universal algebra, Novosibirsk, Russia
Information: web site: WWW2.nstu.ru/deps/algebra/erlogol
[For details, see EMS Newsletter 46]

21-28: X International Summer Conference on Probability and Statistics (ISCPS) and the Seminar on Statistical Data Analysis (SDA 2003), Sozopol, Bulgaria
Topics: Stochastic processes, limit theorems, financial mathematics, combinatorial analysis, theoretical and applied statistics, applications in industry, economics, biology and education of statistics
Organisers: Institute of Mathematics and Informatics of the Bulgarian Academy of Sciences, Faculty of Mathematics and Informatics of Sofia University and the Bulgarian Statistical Society.
Organising committee: N. Yanev (chair of ISCPS), D. Vandev (chair of SDA 2003), E. Pancheva, L. Mutafchiev, P. Mateev, M. Bojkova (secretary), E. Stoimenova.
Location: Hotel Dolphin just on the beach of the gulf of Sozopol
Information:
website: http://stochastics.fmi.uni-sofia.bg

22-25: Conference on Applied Mathematics and Scientific Computing (ApplMath03), Brijuni, Croatia
Theme: Numerical analysis and differential equations in applied mathematics
Aim: exchange of ideas, methods and problems between various disciplines of applied mathematics
Scope: to present the state of the art in the field
Topics: Splines and wavelets with applications to CAGD, CAD/CAM, computer graphics and differential equations
Main speakers: L. Schumaker (USA), P. Costantini (Italy), J. J. H. Miller (Ireland)
Format: keynote lectures, invited talks and contributed presentations
Sessions: plenary lectures and two parallel sessions
Call for papers: If you wish to present a contributed presentation, please submit an abstract according to the web instructions
Programme committee: L. Schumaker (USA), P. Constantini (Italy), J. H. Miller (Ireland), Z. Tutek (Croatia), L. Sopta (Croatia), R. Scitovski (Croatia), K. Veselic (Germany), A. Mikelic (France)
Organising committee: M. Marusic, M. Rogina, S. Singer, J. Tambaca (all from Croatia)
Proceedings: to be published by Kluwer publ. co.
Location: Island Brijuni, near Pula (Croatia)
Grants: none so far
Deadlines: for registration and abstracts, 30 April; for manuscript 31 October 31
Information: e-mail: ApplMath03@math.hr website: http://www.math.hr/∼rogina/ApplMath03

23-27: Workshop on Extremal Graph Theory (Miklos Simonovits is 60), Lake Balaton, Hungary
Information: e-mail: extgr03@renyi.hu, website: http://www.renyi.hu/∼extgr03
[For details, see EMS Newsletter 45]

23-27: Equations aux derivees partielles et quantification, Colloque en l'honneur de Lous Boutet de Monvel
Location: Institut de Mathématiques de Jussieu, Paris
Information: website: http://www.institut.math.jussieu.fr/congres-lboutet/

23-28: Tools for Mathematical Modelling St Petersburg, Russia (MATHTOOLS '2003)
Information:
e-mail: lidiya_linchuk@mail.ru, website: www.neva.ru/journal
Mailing address: Lidiya Linchuk, MATHTOOLS'2003, Dept. of Mathematics, State Technical University, Polytechnicheskaya st. 29, St Petersburg, 195251, Russia
[For details, see EMS Newsletter 46]

23-29: The Fifth International Conference 'Symmetry in Nonlinear Mathematical Physics, Kyiv (Kiev), Ukraine
Topics: Classical, non-classical, conditional, approximate and other symmetries of equations of mathematical physics, Symmetry in quantum mechanics, Quantum field theory, Gravity, Fluid mechanics, Mathematical biology, Mathematical economics, Symbolic computations in symmetry analysis, Supersymmetry and its generalisations, Representation theory, q-algebras and quantum groups, Dynamical systems, Solitons and integrability, Superintegrability and separation of variables
Scientific committee: A. Nikitin and A. Samoilenko (Co-Chairs, Institute of Mathematics, Kyiv), J. Beckers (Liège), G. Bluman (Vancouver), J. Carinena (Zaragoza), P. Clarkson (Canterbury), E. Corrigan (York), N. Debergh (Univ. of Liege, Belgium), H.-D. Doebner (Technical Univ. of Clausthal, Germany), G. Gaeta (Milan), G. Goldin (Rutgers), B.K. Harrison (Utah), N. Ibragimov (Blekinge), V. Kadyshevsky (Dubna), J. Krasil'shchik (Moscow), A. Klimyk (Kyiv), M. Lakshmanan (Tiruchirappalli), P. Leach (Durban), W. Miller (Minneapolis), J. Niederle (Prague); P. Olver (Minneapolis), G. Pogosyan (Yerevan, Cuernavaca and Dubna), I. Skrypnyk (Kyiv), M. Tajiri (Osaka), P. Winternitz (Montreal,), Yehorchenko (Kyiv), R. Zhdanov (Kyiv)
Deadline: for registration 22 May
Information:
e-mail: appmath@imath.kiev.ua
website: http://www.imath.kiev.ua/∼appmath/conf.html
or mirror http://www.bgu.ac.il/∼alexzh/appmath/conf.html

24-27: Days on Diffraction '03, St Petersburg, Russia
Information:
e-mail: grikurov@mph.phys.spbu.ru,
website: http://mph.phys.spbu.ru/DD
[For details, see EMS Newsletter 45]

25-28: International Congress 'Mathematics in the XXI Century. The Role of the Mathematics Department of Novosibirsk University in Science, Education, and Business', Novosibirsk Akademgorodok, Russia
Information: e-mail mmf@math.nsc.ru**,**
website: http://www-sbras.nsc.ru/ws/MMF-21/index.en.html
[For details, see EMS Newsletter 46]

25-28: 7th WSEAS CSCC International Multiconference on Circuits; Systems; Communications and Computers, Corfu Island, Greece
Information: website: http://www.wseas.org/conferences/2003/corfu

25-28: Current Geometry 2003, Naples, Italy
Subject: Current geometry 2003, the IV edition of the international conference on problems and trends of contemporary geometry.
Invited Speakers (provisional)**:** E. Arbarello (Rome), M. Berger (Paris), P. Griffiths (Princeton), A. Sossinski (Moscow), A. Vinogradov (Salerno)
Scientific Committee: E. Arbarello (Rome), F. Baldassarri (Padova), U. Bruzzo (Trieste), C. Ciliberto (Rome), A. Collino (Torino), M. Cornalba (Pavia), C. De Concini (Rome), B. Dubrovin (Trieste), L. van Geemen (Pavia), P. Griffiths (Princeton), V. Kac (Boston), K. O'Grady (Rome), C. Procesi (Rome), J. Stasheff (Chapel Hill), A. Vinogradov (Salerno).
Organising Committee: A. De Paris (Naples), G. Rotondaro (Naples), G. Sparano (Salerno), A. Vinogradov (Salerno), R. Vitolo (Lecce).
Sponsors: Istituto Italiano per gli Studi Filosofici, Naples; Università degli studi di Salerno; Gruppo Nazionale per le Strutture Algebriche, Geometriche e le loro Applicazioni; Dipartimento di Matematica ed Applicazioni dell'Università degli Studi di Napoli 'Federico II'
Deadline: 15 May
Information: e-mail: curgeo@diffiety.org or curgeo@diffiety.ac.ru
website: http://www.diffiety.ac.ru/conf/curgeo03
or http://www.diffiety.org/conf/curgeo03 (mirror)

29- July 5: Workshop on Physics and Geometry of Three-dimensional Quantum Gravity, Edinburgh, UK
Organisers: International Centre for Mathematical Sciences
Information: e-mail: icms@maths.ed.ac.uk

website: http://www.ma.hw.ac.uk/icms/current/index.html

30-July 4: EMS School on Dynamical Systems, Porto, Portugal
Theme: Dynamical systems
Aim: A one-week training programme on dynamical systems and ergodic theory, leading to an understanding of recent developments in these areas
Topics: Quantitative recurrence and dimension theory; tessellations; reconstruction: (numerical) methods for the investigation of recurrent orbits and attractors from their time series; deterministic products of matrices
Main speakers: L. Barreira (Portugal), J.-M. Gambaudo (France), F. Takens (Netherlands), M. Viana (Brazil)
Format: Four intermediate-level courses
Sessions: Five one-hour sessions
Organising committee: J. Alves, V. Araújo, M. Carvalho, F. Moreira, J. Rocha (Portugal)
Sponsors: EMS
Location: Department of Pure Mathematics, Faculty of Sciences, University of Porto - Rua do Campo Alegre, 687, 4269-007 Porto, Portugal
Grants: Expected, but not yet confirmed, financial support from UNESCO.
Information: e-mail: sds@fc.up.pt
website: http://www.fc.up.pt/cmup/sds

July 2003

1-5: EuroConference VBAC 2003, Porto, Portugal Dedicated to Andrei Tyurin
Topics: the meeting will cover a range of topics in the area of vector bundles on algebraic curves, with special emphasis on moduli spaces and topology
Main speakers: J. Andersen (Aarhus), S. Bradlow (Urbana-Champaign), V. Balaji (Chennai), W. Goldman (Maryland), T. Hausel (Austin), L. Jeffrey (Toronto), L. Katzarkov (Irvine), F. Kirwan (Oxford), M. Reid (Warwick), M. Thaddeus (Columbia).
Scientific Committee: L. Brambila-Paz, O. Garcia-Prada, P. Gothen, D. Hernandez Ruiperez, F. Kirwan, H. Lange, P. Newstead (Chair), W. Oxbury, E. Sernesi, C. Sorger
Organisers: Carlos Florentino (cfloren@math.ist.utl.pt) and Peter Gothen (pbgothen@fc.up.pt).
Sponsors: European Commission, High-Level Scientific Conferences, Contract HPCF-CT-2001-00248; Research Training Networks EAGER and EDGE; Centro de Matematica da Universidade do Porto; Centro de Matematica e Aplicacoes (Instituto Superior Tecnico, Lisbon); Fundacao para a Ciencia e a Tecnologia (Portugal) (*); Reitoria da Universidade do Porto (*); Departamento de Matematica Pura, Faculdade de Ciencias, Universidade do Porto; (*) to be confirmed.
Deadlines: to give a talk and/or apply for financial support, registration deadline was 1 March; other registration 15 April
Information: website: http://www.math.ist.utl.pt/~cfloren/VBAC2003.html

1-10: PI-rings: structure and combinatorial aspects (summer course), Bellaterra, Barcelona (Catalonia)
Aim: to introduce the students in the structural and combinatorial theory of algebras satisfying polynomial identities (PI-algebras)
Lecturers: V. Drensky (Bulgarian Academy of Sciences); E. Formanek (Pennsylvania State University)
Topics: Structure theorems of Kaplansky, Posner and Artin; ring of generic matrices; generic division ring and its relation with the theory of central simple algebras; structure of the centre of the generic division ring; Amitsur-Levitzki theorem; construction of central polynomials for matrices; polynomial identities of matrices and their relation with invariant theory; Nagata-Higman theorem; Shirshov theorem; Regev theorem
Coordinator: Ferran Cedó
Scientific Committee: Pere Ara, Dolors Herbera
Organising Committee: Rosa Camps, Ferran Cedó
Grants: a limited number of grants for registration and accommodation for young scientists and scientists from less favoured countries
Deadlines: applications for financial support, 25 April; registration and payment, 31 May
Information: e-mail: PI-rings@crm.es
website: http://www.crm.es/PI-rings

3-8: Wavelets and Splines, St Petersburg, Russia
Theme: wavelets and splines as tools for approximation theory and applications
Aim: to exchange information on many problems related to the wavelet and spline theory
Topics: wavelets and wavelet methods, signal processing, spline theory and its applications, related topics
Main speakers: B. Kashin (Russia), A. Ron (USA), L. Schumaker (USA), P. Wojtaszczyk (Poland), Yu. Brudnyi (Israel), N. Din (Israel), A. Pinkus (Israel), M. Unser (Switzerland)
Format: plenary 60- and 45-minute lectures, 20-minute presentation and posters
Sessions: plenary sessions, parallel sessions, special session on bivariate splines
Call for papers: an electronic copy of the abstract should reach the organising committee before 1 May. The abstract should be LaTeX-formatted in the style Article, should not exceed one page, and should contain title, names of the authors, official address and e-mail address
Organisers: St Petersburg branch of Steklov Mathematical Institute and St Petersburg State University
Programme committee: A. Averbuch (Israel), O. Davydov (Germany), Yu. Demjanovich (Russia), R. DeVore (USA), L. Gori (Italy), D. Leviatan (Israel), V. Malozemov (Russia), I. Novikov (Russia), A. Petukhov (USA), V. Zheludev (Israel), V. Zhuk (Russia)
Organising committee: M. Skopina (Chair, Russia), S. Kislyakov (Vice-Chair, Russia), V. Malozemov (Russia), A. Petukhov (USA)
Location: Euler International Mathematical Institute, Pesochnaya nab.-10, 197022 St Petersburg
Deadlines: for registration, 1 March; for abstracts, 1 May
Information: e-mail: ws@imi.ras.ru
website: http://www.pdmi.ras.ru/EIMI/2003/ws

6-12: Journées Arithmétiques XXIII, Graz, Austria
Topics: all branches of number theory
Main speakers: J.-P. Allouche (France), Ch. Bachoc (France), M. Bhargava (USA), Ch. Breuil (France), J. Brüdern (Germany), A. Lauder (UK), K. Soundararajan (USA), S. Wewers (Germany), U. Zannier (Italy).
Call for papers: participants are invited to present a contributed talk of 20 minutes; abstract submission via Altas Mathematical Conference Abstracts (http://atlas-conferences.com/), deadline 31 May
Programme committee: E. Bayer Fluckiger (Switzerland), P. Debes (France), J.-M. Deshouillers (France), G. Frey (Germany), R. Heath-Brown (UK), H. W. Lenstra (Netherlands), P. Sarnak (USA), R. Tijedeman (Netherlands)
Organising committee: S. Frisch, A. Geroldinger, P. Grabner, F. Halter-Koch, C. Heuberger, G. Lettl, R. Tichy (Graz)
Proceedings: special issue of *Journal de Théorie des Nombres de Bordeaux*
Location: Karl-Franzens Universität Graz
Deadlines: for early registration (at lower rates) 30 April; for registration: 15 June; for submission of abstracts: 31 May
Information: e-mail: ja03@tugraz.at
website: http://ja03.math.tugraz.at/

9-12: XV Italian Meeting on Game Theory and Applications, Urbino, Italy
Information:e-mail: XVimgta@uniurb.it,
website: www.econ.uniurb.it/imgta
[For details, see EMS Newsletter 46]

13-28: VI Diffiety School in the geometry of Partial Differential Equations, Santo Stefano del Sole (Avellino), Italy
Theme: two series of courses, one for beginners and one for veterans, will be given. The beginners' courses consist of a general introduction, analysis on manifolds and observables, introduction to differential calculus in commutative algebras. Detailed programmes have been published on our web site. The veterans' courses will discuss modern geometric and homological methods in PDEs (including the elements of secondary calculus) and their applications to integrable systems and equations of mathematical physics. We will also organise a scientific session on the research interests of the participants and to discuss starting programmes, intended to involve interested participants into our research projects
Lecturers and tutors of the School: A. De Paris (Napoli), S. Igonin (Moscow), J. Krasil'shchik (Moscow), A. Verbovetsky (Moscow,), A. Vinogradov (Salerno), M. Vinogradov (Diffiety Institute), R. Vitolo (Lecce)
Organising committee: D. Catalano Ferraioli, A. De Paris, C. Di Pietro, G. Manno, R. Piscopo, G. Rotondaro, A. Vinogradov, R. Vitolo.
Sponsors: Diffiety Institute (Russia), Istituto Italiano per gli Studi Filosofici, Municipality of Santo Stefano del Sole (AV), Italy
Deadline: 10 June
Participation fee: 100 euro, to cover lodging and living expenses
Information: e-mail: school@diffiety.org;
website: http://www.diffiety.ac.ru or http://www.diffiety.org.

14-18: International Conference on Algebras, Modules and Rings, Lisboa, Portugal [in memory of António Almeida Costa, on the centenary of his birth]
Information: e-mail: lisboa03@cii.fc.ul.pt;

web site: http://caul.cii.fc.ul.pt/lisboa2003/
Subscribe to the conference mailing list at
http://caul.cii.fc.ul.pt/alg.announce.html
[For details, see EMS Newsletter 46]

20-27: Hodge Theory in a New Century: A Euro Conference celebrating the Centenary of Sir William Hodge (1903-1975), Edinburgh, UK
Organisers: International Centre for Mathematical Sciences
Deadlines: Registration 18 April; financial support, passed
Information: e-mail: icms@maths.ed.ac.uk
website: http://www.ma.hw.ac.uk/icms/meetings/2003/HODGE/index.html

21-25: W³adys³aw Orlicz Centenary Conference and Function Spaces VII, Poznañ, Poland
Topics: Banach space, geometry and topology of Banach spaces, operators and interpolations in Banach spaces, Orlicz spaces and other function spaces, decomposition of function, approximation and related topics
Main speakers:
Conference in Honour of Orlicz: G. Bennet (USA), J. Diestel (USA), P. Domañski (Poland), F. Hernandez (Spain), N. Kalton (USA), B. Kashin (Russia), H. König (Germany), S. Konyagin (Russia), J. Kurzweil (Czech Republic), A. Pinkus (Israel), K. Urbanik (Poland), P. Wojtaszczyk (Poland);
Function Spaces VII: J. Appell (Germany), D. Pallaschke (Germany), L. Persson (Sweden), B. Sims (Australia), T. Sukochev (Australia), H. Triebel (Germany)
Call for papers: for an oral 20-minute communication, submit before 31 March an abstract of up to 200 words (.doc or .rtf extension) using the form at or mail to: Faculty of Mathematics and Computer Science, Adam Mickiewicz University, Umultowska 87, 61-614 Poznan, Poland, with postscript *"Orlicz100"*.
Programme committee:
.for the Conference in Honour of Orlicz: Z. Ciesielski (Poland), L. Drewnowski (Poland), W. Johnson (USA), F. Hernandez (Spain), J. Lindenstrauss (Israel), N. Kalton (USA), J. Musielak (Poland), G. Pissier (France), A. Pe³czyñski (Poland), P. Ulyanov (Russia);
for Funcion Spaces VII: J. Musielak, H. Hudzik and L. Skrzypczak (all Poland)
Organising committee: Z. Palka (Chair), B. Bojarski (Vice-Chair), S. Janeczko (Vice-Chair), L. Skrzypczak (secretary), P. Domañski , H. Hudzik, J. K¹kol, I. Kubiaczyk, M. Masty³o, P. Pych-Tyberska, S. Szufla, R. Urbañski, J. Werbowski, A. Waszak, W. Wnuk (all from Poland)
Proceedings: to be published
Location: the main building of the Faculty of Mathematics and Computer Science, Adam Mickiewicz University, Poznan
Deadlines: for abstracts, 31 March; for registration, 31 May
Information: e-mail: orlicz@amu.edu.pl
website: httm://orlicz.amu.edu.pl

August 2003

3-9: Third International Conference: Creativity in Mathematics Education and the Education of Gifted Students, Rousse, Bulgaria.
Aim: to formulate the problem and define globally the directions of the developing of creative education in mathematics and informatics of gifted students
Topics: see the website
Proceedings: to be published before the conference
Programme Committee: President: P. Vlamos (Greece); Scientific secretary: E. Velikova (Bulgaria); Members: H. Meissner (Germany), A. Agnis (Latvia), A. Warren (Australia), J. Becker (USA), F. Bellot-Rosado (Spain), V. Berinde (Romania), S. Bilchev (Bulgaria), M. Bartolini Bussi (Italy), C. Daniel (New Zealand), J.-C. Deledicq (France), S. Dimitrova (Bulgaria), S. Dodunekov (Bulgaria), I. Ganchev (Bulgaria), A. Gardiner (UK), M. Georgieva (Bulgaria), E. Gerganov (Bulgaria), D. Grammatikopoulos (Greece), K. Grigorova (Bulgaria), S. Grozdev (Bulgaria), M. Isoda (Japan), S. Kantcheva (Bulgaria), P. Kenderov (Bulgaria), K. Kreitht (USA), C. Lozanov (Bulgaria), K. Manev (Bulgaria), A. Momchilova (Bulgaria), O. Mushkarov (Bulgaria), D. Pavlov (Bulgaria), N. Rajkov (Bulgaria), N. Rovoz (Russia), I. Sharygin (Russia), E. Silver (USA), A. Soifer (USA), E. Stoyanova (Australia), J. (Bulgaria), P. Taylor (Australia), I. Tonov (Bulgaria), A. Ulovec (Austria), E. Vlamou (Greece)
Organising Committee: B. Tomov (President); E. Velikova, S. Chernev, S. Bilchev (Vice-presidents); Members: R. Alexieva; G. Atanasova; K. Bankov; M. Beikov; A. Bojadzhiev; P. Bonchev; E. Buhm (Germany); M. Dikova; S. Dimitrov; J. Donkers (Netherlands); M. Drakakakis (Greece); G. Dushkov; V. Evtimova; A. Gardiner (UK); A. Georgiev; M. Georgieva; V. Gocheva; D. Grammatikopoulos (Greece); P. Hristova; V. Iliev; V. Jordanov; E. Kalcheva; J. Kandilarov; M. Karailieva; R. Kasuba (Lithuania); M. Kezas (Greece); N. Knoche (Germany); A. Kopankova; T. Kopcheva; M. Kunchev; M. Lambrou (Greece); M. Makiewicz (Poland); D. Milanova; T. Mitev; A. Momchilova; E. Perzycka (Poland); M. Petkova; N. Popivanov; M. Popova; A. Poulos (Greece); E. Rappos (Greece); P. Rashkov; T. Rashkova; E. Rashkova; R. Russev; A. Smrikarov; N. Strateva; J. Svrcek (Czech Republic); M. Teodosieva; V. Tsonev; S. Tsvetanova; M. Todorova; A. Ulovec (Austria); V. Vaneva; V. Velikov; P. Vlamos (Greece); V. Voinohovska; A. Vrba (Czech Republic).
Organisers: Univ. of Rousse (Bulgaria), Union of Bulgarian Mathematicians (Rousse), 'V-publications' (Greece), Vlamos Preparatory School (Greece), Research Center for Culture and Innovation (Greece), World Federation of National Mathematics Competitions (Australia), Ministry of Education and Science (Bulgaria), Mathematical High School (Rousse), Univ. of Veliko Turnovo (Bulgaria)
Location: University of Rousse, Bulgaria
Grants: there will probably be support for participants from countries in a difficult economic situation, young gifted and PhD students
Deadlines: for registration, 30 June; for abstracts, 30 April
Information: e-mail: conf_orgcom@ami.ru.acad.bg or emily@ami.ru.acad.bg
website: www.cmeegs3.rousse.bg, www.ami.ru.acad.bg/conference2003/ www.nk-conference.ru.acad.bg

5-10: Workshops Loops '03, Prague, Czech Republic
Theme: lectures on quasigroups, loops and Latin squares
Lectures and Lecturers: Loop rings (E. Goodaire); self-distributive quasigroups, trilinear constructions and cocyclic modules (T. Kepka, P. Nemec); Moufang loops and 3-nets (G. Nagy, P. Vojtechovsky); latin trades and Hamming distances (A. Drapal); automated reasoning in loop theory (J. D. Phillips); introduction to smooth loops (M. Kinyon).
Format: four 90-minute lectures each day
Programme and Organising Committee: D. Bedford (UK), O. Chein (USA), A. Drapal (Secretary, Czech Rep.), M. Kinyon (USA), G. Nagy (Hungary), M. Niemenmaa (Finland), H. Pflugfelder (Honorary Chair, USA), J. D. Phillips (USA), V. Shcherbacov (Moldova), P. Vojtechovsky (USA)
Local Organising Committee: A. Drapal (Chair), S. Holub (social programme), P. Jedlicka (visas), T. Kepka (finances), P. Nemec (accommodation), D. Stanovsky (website, abstracts), P. Vojtechovsky (website, registration, abstracts)
Sponsors: Charles University and the Czech University of Agriculture
Location: Czech University of Agriculture, Prague
Notes: see also Loops '03
Deadlines: for registration: 20 June
Information:
e-mail: loops03@karlin.mff.cuni.cz
website: http://www.karlin.mff.cuni.cz/~loops/workshops.html

10-17: Loops '03, Prague, Czech RepublicTheme: quasigroups, loops, latin squares, and related topics**Aim:** to highlight new results in quasigroup theory, and to foster connections to combinatorics**Main speakers:** Galina B. Belyavskaya (Moldova), M. Kikkawa (Japan),
A. Kreuzer (Germany), K. Kunen (USA), C. C. Lindner (USA), G. L. Mullen (USA), D. A. Robinson (USA), J. D. H. Smith (USA)
Format: standard; contributed talks 30 or 15 minutes long
Programme and Organising Committee: as for previous conference (above)
Local Organising Committee: as for previous conference (above)
Sponsors: Charles University and Czech University of Agriculture
Proceedings: will be published in *Commentationes Mathematicae Universitatis Carolinae*, and in *Quasigroups and Related Systems*
Location: Czech University of Agriculture, Prague
Notes: see also Workshops Loops '03
Deadlines: for registration and abstracts: 20 June; for survey papers: 15 April; for proceedings papers: 10 October
Information:
e-mail: loops03@karlin.mff.cuni.cz
website: http://www.karlin.mff.cuni.cz/~loops

11-15: Workshop on Finsler Geometry and Its Applications, Debrecen, Hungary
Theme: Finsler geometry, spray geometry, Lagrange geometry, their generalisations and applications in physics, biology, control theory, finance, psychometry, etc.
Advisory Board: P. Antonelli (Edmonton); G. S. Asanov (Moscow); D. Bao (Houston); S. S. Chern (Tianjin); P. Foulon (Strasbourg);

R. S. Ingarden (Torun); R. Miron (Iasi); G. Patrizio (Firenze); Z. Shen (Indianapolis); H. Shimada (Sapporo); Z. I. Szabo (New York); L. Tamassy (Debrecen).
Local organisers: S. Bacso, L. Kozma, and J. Szilasi (Debrecen)
Information: e-mail: kozma@math.klte.hu website: http://www.math.klte.hu/finsler/

18-22: ENUMATH 2003, The European Conference on Numerical Mathematics and Advanced Applications, Prague, Czech Republic
Theme: numerical mathematics with applications
Aim: analysis of numerical algorithms as well as their application to challenging scientific and industrial problems
Main speakers: A. Bermudez (Spain), R. Blaheta (Czech Republic), T. Gallouet (France), J. Haslinger (Czech Republic), R. Hiptmair (Germany), T. J. R. Hughes (USA), J. Rappaz (Switzerland), A. Russo (Italy), V. Schulz (Germany), A. Tveito (Norway)
Format: invited talks and contributed presentations
Sessions: there will be plenary lectures, mini-symposia and contributed presentations
Call for papers: to present a contributed presentation, please submit an extended abstract of up to one page in TeX or LaTeX
Organisers: Charles University Prague, Faculty of Mathematics and Physics, Institute of Chemical Technology Prague, Department of Mathematics
Programme Committee: F. Brezzi (Italy), M. Feistauer (Czech. Rep.), R.Glowinski (France/USA), R. Jeltsch (Switzerland), Yu. Kuznetsov (Russia/USA), J. Periaux (France), R. Rannacher (Germany).
Scientific Committee: O. Axelsson (Netherlands), C. Bernardi (France), C.Canuto (Italy), M. Griebel (Germany), R. Hoppe (Germany), G. Kobelkov (Russia), M. Krizek (Czech Republic), P. Neittaanmaki (Finland), O.Pironneau (France), A. Quarteroni (Italy/Switzerland), C. Schwab (Switzerland), E. Suli (Great Britain), W. Wendland (Germany)
Organising Committee: V. Dolejsi, M. Feistauer, J. Felcman, P.Knobloch, K. Najzar, E. Plandorova, J. Segethova (Czech. Rep.)
Proceedings: to be published
Location: Institute of Chemical Technology Prague
Grants: probable support for participants from countries in a difficult economic situation and young mathematicians
Deadlines: for registration, 30 April; for abstracts, 31 March
Information:
e-mail: enumath@karlin.mff.cuni.cz
website: http://www.karlin.mff.cuni.cz/~enumath/

18-22: 7th International Symposium on Orthogonal polynomials, Special Functions and Applications, Copenhagen, Denmark
Information: e-mail: opsfa@math.ku.dk, website: http://www.math.ku.dk/conf/opsfa2003
[For details, see EMS Newsletter 46]

September 2003

2-5: Symposium on Cartesian Set Theory, Paris, France
Information:
e-mail: editions.europeenne @wanadoo.fr
[For details, see EMS Newsletter 46]

2-6: Barcelona Conference on Asymptotic Statistics, Bellaterra, Barcelona, Catalonia
Information: e-mail: bas2003@crm.es
website: http://www.crm.es/bas2003
[For details, see EMS Newsletter 46]

12-16: International Conference of Computational Methods in Sciences and Engineering (iccmse 2003), Kastoria, Greece
Theme: computational methods in sciences and engineering
Aim and Scope: In recent decades many significant insights have been made in several areas of computational methods in sciences and engineering. New problems and methodologies have appeared. There is a permanent need in these fields for the advancement of information exchange. This undoubtedly beneficial practice of interdisciplinary and multidisciplinary interactions should be expressed by an appropriate conference on such computational methods. ICCMSE 2003 aims at playing the above role and for this reason the aim of the conference is to bring together computational scientists and engineers from several disciplines in order to share methods, methodologies and ideas
Topics: these include (but are not limited to) computational mathematics, computational physics, computational chemistry, computational engineering, computational mechanics, computational finance, computational medicine, computational biology, computational economics, high performance computing, mathematical methods in sciences and engineering, industrial mathematics, etc.
Main speakers: H. Ågren (Sweden), J. Vigo-Aguiar (Salamanca); D. Belkic (Stockholm); E. Brändas (Uppsala); J. C. Butcher (Auckland); S. C. Farantos (Greece); U. Hohm (Braunschweig); A. Q. M. Khaliq (Illinois); G. Maroulis (Patras); A. Mylona-Kosma (Ioannina); S. Wilson (UK)
Format: Plenary lectures (by invitation); original papers (selection based on extended abstracts of 3-4 A4 pages); posters (selection similar to original papers)
Sessions: to be announced
Call for papers: send your abstract or description of session to iccmse@uop.gr
Organisers: European Society of Computational Methods in Sciences and Engineering (ESCMCE), Department of International Trade Technological Educational Institution of Western Macedonia, Greece
Programme (Scientific) committee: H. Agren, H. Arabnia (Georgia, USA), J. Vigo-Aguiar, D. Belkic, K. Belkic (Southern California), E. Brandas, J. C. Butcher, A. Q. M. Khaliq (Illinois), G.Maroulis, S. Wilson, J. Xu (Pennsylvania)
Organising committee: Th. Monovasilis, Eleni Ralli, Secretary of ICCMSE, I. Sinatkas, E. Siskos, Th. Themelis, K. Tselios, N. Tsounis
Sponsors: European Regional Development Fund, Region of Western Macedonia, Greece
Proceedings: Extended abstracts will be published in a special volume of World Scientific Publishing Company. The following journals have accepted to publish selected Proceedings of ICCMSE 2003: *Computational Materials Science* (Elsevier Science), *Journal of Supercomputing* (Kluwer), *Journal of Mathematical Chemistry* (Kluwer), *Communication in Mathematical and in Computer Chemistry* (MATCH), *Journal of Computational Methods in Sciences and Engineering* (JCMSE) (Cambridge International Science Publishing), *Mathematical and Computer Modelling* (Elsevier Science), *Communications in Nonlinear Science and Numerical Simulation* (Elsevier Science)
Location: Kastoria, Greece
Grants: No grants available at this time
Deadlines: registration 30 April; abstracts passed
Information: iccmse@uop.gr
website: http://www.uop.gr/~iccmse/ or http://kastoria.teikoz.gr/~iccmse/

15-21: First MASSEE Congress, Borovetz, Bulgaria
Aim: to revive the traditional collaboration in mathematics and informatics (computer science) among south-east European countries
Topics: I. Mathematical structures: logics and foundations; algebra; topology; analysis; differential equations; geometry; stochastics and probability theory; other related topics
II. Applications of mathematics and informatics (computer science): mathematical modelling; operations research; wavelets analysis and image processing; computational and numerical analysis; other related topics
III. Mathematical foundations of informatics (computer sciences): theory of computing; discrete mathematics in relation to computer science; computing methodologies and applications; algorithms; data mining; mathematical linguistics; other related topics
IV. History and education in mathematics and informatics: didactics of mathematics and informatics (blackboard techniques and hypermedial methods); mathematical heritage of south-east Europe; detecting and developing mathematical talent; attracting talent to science; other related topics
Format: The congress will incorporate a series of mini-symposia that emphasise topics of specific interest for the region:
Organiser: the Mathematical Society of South-East Europe (MASSEE): a recently registered organisation comprising mathematical societies from Albania, Bulgaria, Bosnia-Herzegovina, Cyprus, Greece, Macedonia, Moldova, Romania and Yugoslavia
Location: Hotel Samokov, at the heart of the famous summer and winter resort of Borovetz (55km south-east of Sofia)
Information: website: http://www.math.bas.bg/massee2003/

16-20: Barcelona Conference on Set Theory, Bellaterra, Barcelona, Catalonia
Information: e-mail: set-theory@crm.es, web site: http://www.crm.es/set-theory
[For details, see EMS Newsletter 46]

17-19: Conference on Computational Modelling in Medicine, Edinburgh, UK
Organisers: International Centre for Mathematical Sciences
Information: e-mail: icms@maths.ed.ac.uk website: http://www.ma.hw.ac.uk/icms/current/index.html

Recent books

edited by Ivan Netuka and Vladimír Souček

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

K. Alster, J. Urbanowicz and H. C. Williams (eds.), ***Public-Key Cryptography and Computational Number Theory,*** *Walter de Gruyter, Berlin, 2001, 331 pp., DM 256, ISBN 3-11-017046-9*

These proceedings are dedicated to the memory of Rejewski, Rózycki and Zygalski, who broke the military version of Enigma in 1933 and gave its reconstructed version to the British and French in 1939. The book contains their photographs, but no paper describing their activity. There are 20 papers in the proceedings, relating to various aspects of the scope of the conference.

Buchmann and Hamdy survey IQ cryptography, and Schnorr surveys the security of DL-cryptosystems and signatures against generic attacks. Patarin presents the concept of secret public-key schemes, where (in the case of encryption) anybody can encrypt, but where both the key to decipher and the exact algorithm to decipher are secret. There is also a 30-page carefully written overview of the XTR public key system by Lenstra and Verheul. Kucner and Kutylowski present a stochastic method of testing against stealing attacks by manufacturers of cryptographic devices. S. Müller is concerned with security proofs based on the factorisation problem in the sense of IND-CCA (the indistinguishability-chosen cipher text attack). Jacobson, Scheidler and Williams investigate key exchange protocols that use real quadratic fields. Hoffstein and Silverman describe optimisation for NTRU, which is a cryptosystem based on ring theory. Niederreiter exhibits in a short survey several interactions of cryptography and the theory of error-correcting codes.

The other papers are more or less purely mathematical. Couveignes discusses connections between algebraic groups and the discrete logarithm, while Teske surveys algorithms to compute discrete logarithms. Elliptic and hyperelliptic curves are the subject of contributions by Enge, Galbraith, Müller and Pethö. The remaining three papers deal with number theory: te Riele discusses the size of solutions n or the inequality $\varphi(an + b) < \varphi(an)$, a and b coprime, Kubiak develops a procedure which speeds up the extended binary gcd algorithms, and Dilcher surveys computational and theoretical work done in the areas of Fermat and generalised Fermat numbers, Wieferich and Wilson primes, and Fermat and Wilson quotients for composite moduli. (ad)

Y. André and F. Baldassarri, ***De Rham Cohomology of Differential Modules on Algebraic Varieties,*** *Progress in Mathematics* ***189****, Birkhäuser, Basel, 2001, 214 pp., DM 118, ISBN 3-7643-6348-7*

The main topic of this book is the theory of differential modules on algebraic varieties. The book offers fundamental results on direct images of regular differential modules by a smooth morphism (proofs of finiteness, base change, regularity and monodromy theorems). There is also an algebraic treatment of the theory of regularity and irregularity in several variables, leading to elementary proofs of main results on de Rham cohomology of differential modules. The authors use a new definition of relative algebraic de Rham cohomology with compact support and prove that it coincides with the Dwork algebraic dual theory. The final result of the book is a complete proof of general non-archimedean comparison theorem for de Rham cohomology. As a corollary, it is shown that the functor of p-adic analytification of connections is fully faithful.

The book will be of interest to specialists in arithmetic algebraic geometry, and may also be used as an introduction to the topics described above. (jbu)

G. E. Andrews, R. Askey and R. Roy, ***Special Functions,*** *Encyclopedia of Mathematics and its Applications* ***71****, Cambridge Univ. Press, 1999, 664 pp., £55, ISBN 0-521-62321-9*

An introductory chapter presents many facts on gamma and beta functions, which form the necessary basic tools for further treatment of special functions, including a short information on their finite field analogues. Later (in Chapter 8), the Selberg multi-dimensional versions of beta integrals (including its finite field analogue) are described. The next two chapters describe properties of the basic case of hypergeometric series ${}_{p+1}F_p$ (mostly for $p = 1$ or 2). A detailed study of Bessel functions appears in Chapter 4. The following three chapters are devoted to properties of various orthogonal polynomials, and Chapter 9 studies spherical harmonics (including the relation of special functions to representation theory). Chapter 10 introduces a q-generalisation of hypergeometric series, and includes q-versions of the gamma and beta functions, the q-binomial theorem, Ramanujan formulas and a treatment of elliptic and theta functions. Relations to the theory of partitions form the subject of Chapter 11. The final chapter is devoted to identities of the Rogers-Ramanujan type. There are six appendices summarising various tools used in the book. Each chapter is followed by a number of exercises.

The book is full of beautiful and interesting formulae, as was always the case with mathematics centred around special functions. It is written in the spirit of the old masters, with mathematics developed in terms of formulas. There are many historical comments in the book. It can be recommended as a very useful reference. (vs)

L. Barreira and Y. B. Pesin, ***Lyapunov Exponents and Smooth Ergodic Theory,*** *University Lecture Series* ***23****, American Math. Society, Providence, 2001, 151 pp., US$29, ISBN 0-8218-2921-1*

This is a book on smooth dynamical systems with a hyperbolic structure, written by two experts; in particular, several crucial results were proved by the second author. The classical theorems of Lyapunov and Perron on the stability of non-autonomous systems of ODEs have started investigations into the Lyapunov exponents and their regularity.

The story is described in Chapters 1 and 2 – including, for example, the multiplicative ergodic theorem of Oseledets. Chapter 3 is devoted to two main examples of (non-uniform) hyperbolic systems, which stimulated the development of hyperbolic theory, namely Anosov diffeomorphisms and geodesic flows on Riemannian manifolds. The last two chapters are based on Pesin's results, and form the heart of the book. Local stable manifolds are constructed in Chapter 4, where their absolute continuity (in the sense of Anosov) is proved. This is one of the main tools for the ergodic theory of smooth dynamical systems, and plays an important role in investigations of ergodic properties of invariant hyperbolic measures in Chapter 5.

The book contains many technically rather complicated results and is written for well-prepared readers (such as advanced graduate students working in dynamical systems) with a good knowledge of ODEs, differential topology and measure theory. Such a reader will surely benefit by studying these lectures. (jmil)

E. R. Berlekamp, J. H. Conway and R. K. Guy, ***Winning Ways for Your Mathematical Plays,*** ***1****, 2nd ed., A K Peters, Natick, 2001, 276 pp., US$49.95, ISBN 1-56881-130-6*

This first volume of a four-volume series is an elementary introduction to the theory of combinatorial games, elementary in the sense that concepts, such as games, values, etc., are defined naively rather than rigorously.

The book contains 8 chapters. Chapter 1 introduces certain games and calculates their values in complicated positions. Chapter 2, among others, introduces the game of Nim and the values of its positions – nimbers. Chapter 3 continues the exposition of value arithmetic, studying nimber addition and introducing the values of ↑ (up) and ↓ (down). Chapter 4 illustrates these ideas with a series of examples: Dowson's chess, Treblecross etc. Chapter 5 introduces switch values, their temperature and their arithmetic, while Chapter 6 shows how to deal with hot and big games. Chapter 7 discusses various versions of Hackenbush in more detail, and Chapter 8 introduces the atomic weight of all-small games and related concepts. Each chapter ends with references to further reading.

The book introduces numerous games with colour illustrations. It does not assume any particular mathematical knowledge on part of the reader, but requires a certain degree of abstract thinking and patience. (ab)

F. Borceux and G. Janelidze, ***Galois Theories,*** *Cambridge Studies in Advanced Mathematics* ***72****, Cambridge Univ. Press, 2001, 341 pp., £50, ISBN 0-521-80309-8*

This book is based on a French manuscript, written by the first author as a record of his ideas; it is largely completed by results of the second author and his coauthors.

The authors briefly introduce the reader to classical Galois theory and its tools, formulated in modern mathematical language. The rest of the book aims to provide deeper insight into more advanced parts, such as the Galois theory of Grothendieck. The reader will find here a well organised proof of the Galois theorem. The next part focuses on infinitary Galois theory. The true core of the book consists of the categorical Galois theory of commutative rings (Stone duality, Pierce representation of a commutative ring, the adjoint of the spectrum functor, descent morphisms, etc.). The techniques of the second author are also used in the chapter on covering maps. The concluding chapter is devoted to thenon-Galoisian Galois theory, where the reader will find the famous Joyal-Tierney theorem. The book is carefully arranged and can be useful to anybody interested in algebraic methods. (lbe)

C. J. Budd and C. J. Sangwin, *Mathematics Galore,* *Oxford Univ. Press, 2001, 254 pp., £14.95, ISBN 0-19-850769-0 and 0-19-850770-4*

The aim of this book is to enthuse, inspire and challenge young people in mathematics. The material in this book is not covered by a typical school syllabus. The main ideas are accessible to children from the age of eleven, while some parts of the book should interest and challenge older school and university students, as well as their teachers and parents. The book consists of eight independent chapters, each formulating problems motivated by real life and developing mathematical ideas that can be used to solve them. Many exercises are included.

In Chapter 1 mazes and labyrinths are studied. After some short historical remarks, connections to graph theory, the problem of the bridges of Königsberg and the general method for solving all mazes are described. Chapter 2 links group theory to study of patterns in dancing, bell-ringing and knitting. Chapter 3 contains some results in trigonometry. In Chapter 4 some interesting mathematical theorems (mostly expressions of ð) are mentioned, with some examples of magic tricks and the mathematics behind them. Chapter 5 shows how mathematics can apply to a problem of the best design of castles: ideas on the isoperimetric inequality are presented, and the book looks at properties of later designs of castles and more modern fortifications. Chapter 6 deals with codes, ciphers and the mathematics used to break the codes: the Caesar and Viginère ciphers are mainly discussed, with some remarks about modern methods based on prime factorization. Chapter 7 studies ways of representing numbers, with properties of different number bases (including negative ones). Chapter 8 introduces the properties of logarithms. (ab)

I. Chavel, *Isoperimetric Inequalities: Differential Geometric and Analytic Perspectives,* *Cambridge Tracts in Mathematics* ***145****, Cambridge Univ. Press, 2001, 268 pp., £50, ISBN 0-521-80267-9*

The classical isoperimetric inequality compares the volume $V(\Omega)$ of a domain Ω in $\mathbf{R}^n$ and the surface area $A(\partial\Omega)$ of its boundary. There are several ways of interpreting the quantity $A(\partial\Omega)$ – Hausdorff measure, perimeter and Minkowski area – and the corresponding approaches to the proof of the isoperimetric inequality are presented. The Faber-Krahn inequality on the smallest eigenvalue for the Laplace operator is deduced: among domains with equal volumes, the minimum is attained for a ball. After this, the author turns to generalisations to manifolds. He develops the method of discretization and studies also isoperimetric constants for graphs, and relates isoperimetric inequalities, Nirenberg-Sobolev inequalities, Nash-Sobolev inequalities and Faber-Krahn inequalities. Then he studies the large time heat diffusion on manifolds: the method of proof again uses a discretisation.

The book is very useful in two ways. First, it nicely explains the story of the classical isoperimetric inequality, a result with a big disproportion between the ease of formulation and difficulty of the proof. It is very useful that the reader can compare different approaches. Second, it presents a topical and interesting part of global analysis on manifolds, relating the asymptotic behaviour of the isoperimetric inequality for large domains and large-time heat diffusion. This second part contains deep results obtained by the author. (jama)

I. Chiswell, *Introduction to Lambda Trees,* *World Scientific Publishing, Singapore, 2001, 315 pp., £48, ISBN 981-02-4386-3*

In a connected graph there is a natural distance function, the minimum number of edges in a path connecting given vertices. If the graph is a tree, this distance has certain specific properties. Generalising them to distances with values in a general ordered abelian group L (instead of the group of integers), one obtains the notion of a L-tree. Part of the book (less than a quarter) is devoted to an analysis of the notion and properties of L-trees as metric spaces. Most of the text is concerned with their isometries, group actions on L-trees in general, and actions of special groups; in conclusion, Rip's theorem is discussed.

The book is divided into six chapters. Chapter 1 introduces basic notions. Chapter 2 is devoted to the definition and basic properties of L-trees, and to R-trees (which play an important role in the theory). Chapter 3, presents some basic facts on isometries of L-trees (special features of individual isometries and their pairs, group actions as group of isometries, etc.). Chapter 4 is concerned with more involved questions of group actions. Some special action groups are introduced and analysed, and the spaces of actions on R-trees are discussed. Chapter 5 is devoted to actions of free groups. Finally, Chapter 6 contains a thorough discussion of Rip's theorem (characterising finitely generated R-free groups) that can be approached using isometry groups on R-trees.

In the quarter-century since L-trees (and Tits' R-trees) were introduced, the theory has developed considerably. This monograph is timely and useful. (ap)

M. Cwikel, M. Engliš, A. Kufner, L.-E. Persson and G. Sparr (eds.), *Function Spaces, Interpolation Theory and Related Topics,* *Walter de Gruyter, Berlin, New York, 2002, 462 pp., EUR 138, ISBN 3-11-017117-1*

Interpolation theory is an important field of functional analysis, which can be, roughly speaking, divided into its classical and modern parts. The main landmarks of the classical interpolation theory are the 1926 M. Riesz's convexity theorem, furnished later with the celebrated complex-variable proof of O. Thorin (1939/48), and the 1939 theorem of J. Marcinkiewicz. Modern interpolation theory, whose foundations were laid in the early 1960s, has several fathers, including E. Gagliardo, A. Calderón, J.-L. Lions, S. G. Krein and J. Peetre. The last of these, Prof. Jaak Peetre of Lund, reached his 65th birthday on 29 July 2000, and a delightful conference was held in Lund a month later. The special spirit of this meeting can be felt from the conference website.

This book, containing the conference proceedings, is organised equally well. It has an interesting introductory part, consisting of the Editors' preface, an opening address by H. Wallin from which the reader can learn interesting facts (such as Peetre's impressive personal record in marathon races), a picture of Peetre in his rose garden, a beautiful article 'Jaak Peetre, the man and his work' by M. Cwikel, L.-E. Persson, R. Rochberg and G. Sparr, giving a comprehensive review of Peetre's work (including an unbelievable list of 289 publications), and an essay 'On the development of interpolation – instead of a history three letters', edited and/or translated by Peetre, including letters by O. Thorin, A. Zygmund and M. Cotlar that give a very interesting insight to the beginnings of interpolation theory.

The main part of the book contains contributions from J.-L. Lions; A.B. Aleksandrov, S. Janson, V.V. Peller and R. Rochberg; J. Arazy and H. Upmeier; J. Brandman, J. Fowler, B. Lins, I. Spitkovsky and N. Zobin; M.J. Carro and J. Martín; M. Cotlar and C. Sadosky; D. Cruz-Uribe, SFO and M. Krbec; M. Engliš; T. Figiel and N. Kalton; V. Gol'dshtein and M. Troyanov; S. Kaijser and P. Sunehag; D. Lukkassen and G.W. Milton; V.G. Maz'ya and I.E. Verbitsky; C. Michels; E. Nakai; L. Pick; S.Yu. Tikhonov; H. Triebel; and a list of the 73 talks given at the conference. The topics covered by these contributions range from interpolation theory, through function spaces, to applications in operator theory. (lp)

O. Debarre, *Higher-Dimensional Algebraic Geometry,* *Springer, New York, 2001, 233 pp., 16 fig., DM 96, ISBN 0-387-95227-6*

This book describes certain topics on the progress in classifying algebraic varieties of dimension at least 3. The first two chapters are devoted to the standard definitions and results on nef, big and ample Cartier divisors and spaces of morphisms of a fixed algebraic curve to a fixed algebraic variety. Chapters 3, 4 and 5 deal with various aspects of the geometry of smooth algebraic varieties with many rational curves – in particular, uniruled or rationally connected varieties. It is proved, for example, that Fano varieties are rationally connected. Chapters 6 and 7 take a first step toward the Mori minimal model programme of classifying algebraic varieties, proving the cone and contraction theorems. (pso)

P. Dolbeault, A. Iordan, G. Henkin, H. Skoda and J.-M. Trépreau (eds.), *Complex Analysis and Geometry: International Conference in Honor of Pierre Lelong,* *Progress in Mathematics* ***188****, Birkhäuser, Basel, 2000, 241 pp., DM 118, ISBN 3-7643-6352-5*

This is a collection of 18 papers written in honour of the 85th birthday of Pierre Lelong. The meeting, organised on this occasion in Paris, was also the closing conference for the European network 'Complex analysis and analytic geometry'.

The first contribution (by H. Skoda) describes the main topics of Lelong's research, and includes his complete bibliography. Further papers are written by J. Siciak, J.-P. Demailly, G. Bassanelli, M. Christ, K. Diederich and T. Oshawa, K. Diederich and J. McNeal, G. Herbort, U. Hiller, S. Webster, C. Laurent-Thiébaut and J. Leiterer, T.C. Dinh, P. Dingoyan, E. Mazzilli, E. Bedford and M. Jonsson, G. Tomassini, F. Berteloot and J. Duval, C. Epstein and G. Henkin. At the end is a list of ten open problems in the field, formulated by participants at the meeting. The book will be of interest to mathematicians working in the field. (vs)

L. T. Fernholz, S. Morgenthaler and W. Stahel (eds.), *Statistics in Genetics and in the Environmental Sciences,* *Trends in Mathematics, Birkhäuser, Basel, 2001, 183 pp., DM 130, ISBN 3-7643-6575-7*

This book is a collection of twelve papers, based on contributions to the 1999 Workshop on Statistics and Science, held at the Centro Stefano Franscini in Ascona. It provides further proof of the crucial role of statistics in modern genetics and environmental science, and will be useful for anyone interested in statistical applications or methodology in this area of research. The articles range from applied statistics to theoretical results with tied

connection to environmetrics.

The book starts with three articles on applied stochastical genetics. This part covers quantitative genetics, with applications to plant breeding, DNA microarray analysis after standardisation, and variance component estimation with an uncertain link between individuals and their parents. The next four articles present non-trivial statistical applications in chemistry. The authors face problems of censored data and severe outliers, when estimating chemical concentration, risk under low dose exposure, age-dependent risk of carcinogenesis, and atmospheric chemistry. The applied part of the proceedings concludes with an analysis of the problem of small objects on the Earth's orbit. The last four papers can be classified as theoretical: written with applications to the environmental sciences in mind, these articles deal mainly with multivariate data and robust techniques. Here one can find treatments of robust principal components, robust inverse regression, regression depth or τ-estimate for linear regression.

The book provides a sample of possible applications of statistics for statisticians interested in how their methods are used. Others from different areas can learn how to use statistics in their work. (dh)

H. Freistühler and G. Warnecke (eds.), ***Hyberbolic Problems: Theory, Numerics, Applications,*** *8th Internat. Conference in Magdeburg February/March 2000, Vols. I, II, International Series of Numerical Mathematics, 140/141, Birkhäuser, Basel, 2001, 472 and 469 pp., EUR 80 each volume, ISBN 3-7643-6709-1 and 3-7643-6710-5*

The book, in two volumes, is the Proceedings of the Eighth International Conference in Magdeburg, in 2000. It contains about one hundred refereed papers presented at this conference. Most of these are concerned with non-linear hyperbolic equations of conservation laws.

The papers can be divided into three groups. Those from the first group are concerned with such theoretical aspects of hyperbolic problems as the existence and uniqueness of solutions, asymptotic behaviour, large-time stability or instability of waves and structures, various limits of solutions, the Riemann problem, etc. In particular, non-linear conservation laws are treated. One can see a considerable progress in mathematical theory on the one hand, but the results published here indicate that mathematicians are struggling with a number of difficult open problems. The second group of papers is devoted to numerical analysis of hyperbolic problems – for example, development of numerical schemes, investigation of their stability and convergence. These papers study finite differences, finite element and finite volume schemes, investigate schemes with special properties, and pay attention to adaptivity, domain decomposition, multi-resolution and artificial dissipation. The third group of articles is oriented to a wide range of applications, such as one-phase and multiphase flow, shallow water problems, high-speed flow, relativistic magnetohydrodynamics, low Mach number flow, elasticity, thermodynamics, electromagnetic fields, etc.

The books contain a large amount of material and give an excellent overview of the contemporary state of art in the area of hyperbolic problems. They will be of interest to researchers and students of applied and numerical mathematics, computational fluid dynamics and computational physics, scientists and engineers engaged in applied mathematics and scientific computing. (mfei)

S. Feferman, J. W. Dawson, Jr., S. C. Kleene, G. H. Moore, R. M. Solovay and J. van Heijenoort (eds.), ***Kurt Gödel: Collected Works, Vols. I and II****, Oxford Univ. Press, 2001, 473 and 407 pp., each volume £26.50, ISBN 0-19-514720-0 and 0-19-514721-9*

These two volumes present a comprehensive edition of all Kurt Gödel's published works in the period 1929-74. The first volume covers the period 1929-36 and begins with his dissertation, previously available only through the University of Vienna. Each article or group of articles is preceded by an introductory note placing it into historical context and clarifying it. The members of the editorial board, and some outside experts, are the authors of these notes. Each article originally written in German is printed with an English translation. The first volume starts with Solomon Feferman's bibliographical essay on Gödel's life and work. In each volume, there are extensive lists of references, as well as interesting photographs.

The books are carefully and beautifully produced and offer rich material, illuminating not only the outstanding work of Gödel, but also the whole mathematical logic of the twentieth century, including some philosophical and historical aspects. Some questions from physics are also discussed. (jmlc)

M. Gardner, ***Gardner's Workout: Training the Mind and Entertaining the Spirit,*** *A K Peters, Natick, 2001, 319 pp., US$35, ISBN 1-56881-120-9*

This is a remarkable book. It is a collection of 41 articles that the author wrote for academic journals and popular magazines. It also contains ideas of the author on 'how to teach math to pre-college students without putting them to sleep'. Let us pick out a few characteristic points.

• There is an old picture of a baker, who baked a square cake and sold a quarter of it. Four hungry kids enter the shop to buy the rest of it. Could they tell how to cut it into four pieces of the same size and shape?

• Another problem: 'Cut an equilateral triangle into three similar parts, no two congruent' is easily solved. It is probably unique, though no proof is known.

• One afternoon, while sitting in a car waiting for my wife to finish supermarket shopping, I located a pencil and paper and drew on the sheet the unique lo shu, or magic square made with distinct digits 1-9. … Back home I began experimenting… (How typical of a married mathematician!).

It remains for the reader to find a lonely island, an unlimited quantity of paper and an eternal pencil, together with this book. It will surely produce a paradise for anybody who wants to enjoy the pleasure of the creative work in his brain. (lbe)

J. M. Gracia-Bondía, J. C. Várilly and H. Figueroa, ***Elements of Noncommutative Geometry,*** *Birkhäuser Advanced Texts, Birkhäuser, Boston, 2001, 685 pp., DM 138, ISBN 0-8176-4124-6 and 3-7643-4124-6*

The branch of mathematics now called noncommutative geometry is a far-reaching generalisation of the Gelfand-Naimark theorem stating that, for a commutative **C***-algebra A, there is an isometric *-isomorphism between the algebra A and the set of continuous functions on the set of characters of A. In a sense, any non-commutative **C***-algebra gives rise to an algebra of functions on a non-commutative topological space constructed as the spectrum of A.

The book is divided into four parts, comprising 14 chapters. The first part contains a summary of the basics of **C***-algebras, such as the Gelfand-Naimark theorem, the Tannaka-Krein reconstruction theorem, Serre-Swan categorical equivalence between vector bundles and projective modules over unital commutative algebras, K-theory and its Bott periodicity for **C***-algebras, Morita equivalence of **C***-algebras, etc. The second part contains some constructions of universal algebras that are behind the real analysis foundations of non-commutative geometry – in particular, universal forms and connections, cycles and their Chern characters, together with Hochschild cohomology. The third part is devoted to ingredients of non-commutative Spin geometry, built upon the notion of a spectral triple. The fourth part discusses possible applications of this machinery in the realm of mathematical and theoretical physics, including descriptions of non-commutative gauge theories and perturbative quantum field theories. The book contains proofs of almost all assertions, as well as many explicit examples illustrating the theoretical developments described. (pso)

M. R. Grossinho, M. Ramos, C. Rebelo, L. Sanchez, Eds., ***Nonlinear Analysis and its Applications to Differential Equations,*** *Progress in Nonlinear Differential Equations and Their Applications* ***43****, Birkhäuser, Boston, 2001, 380 pp., DM 188, ISBN 0-8176-4188-2 and 3-7643-4188-2*

The book contains many of the talks delivered at the Autumn School on Non-linear Analysis and Differential Equations, held at the CMAF, University of Lisbon, in 1998. The school consisted of short courses and a seminar.

The first part of the book contains the following short courses: An overview of the method of lower and upper solutions for ODEs (C. De Coster and P. Habets); On the long-time behaviour of solutions to the Navier-Stokes equations of compressible flow (E. Feireisl); Periodic solutions of systems with p-Laplacian-like operators (J. Mawhin); Mechanics on Riemannian manifolds (W. M. Oliva); Twist mappings, invariant curves and parabolic differential equations (R. Ortega) and Variational inequalities, bifurcation and applications (K. Schmitt). The second part contains 21 contributions from various topics, related in one way or another to either ordinary or partial differential equations. The topics in the ODE part include spectral theory for the 1-dimensional p-Laplacian, application of a time-map in boundary-value problems, non-linear oscillations, non-linear resonance, and more. The topics in the PDE part include symmetries of positive solutions to equations involving the higher-dimensional p-Laplacian, bifurcation theory and its applications to the Monge-Ampère operator, application of the dual method to the Tricomi problem, the telegraph equation, an abstract concentration-compactness method, and degree and index theories on the Nielsen numbers. In both parts, problems from the calculus of variations and optimal control appear naturally – for example, in Lipschitz regularity of minimisers (ODE part) or optimal control for some elliptic equations of logistic type (PDE part). Finally, we mention the dynamics of delayed systems which appears in connection with asymptotic expansion and Hopf bifurcation. (lp)

P. Hájek (ed.), ***Gödel '96, Lecture Notes in Logic 6,*** *A K Peters, Natick, 1996, 322 pp.,*

US$50, ISBN 1-56881-153-5
This volume contains the proceedings of a conference held in Brno on the 90th anniversary of the birth of Kurt Gödel. It is divided into two parts: the first, 'Invited papers', contains 9 papers, and the second part, 'Contributed papers', has 13 papers. The contributions reflect many areas substantially influenced or touched by Gödel's work. They mainly illuminate or develop some of Gödel's results and ideas concerning mathematical logic and the foundations of mathematics. Some contributions discuss aspects of his results and opinions in physics, as Ellis's 'Contributions of K. Gödel to Relativity and Cosmology' and Stöltzner's 'Gödel and the Theory of Everything'. Other contributions refer to Gödel's philosophical opinions, as, for example, 'Gödel's Ontological Proof Revisited' by Anderson and Gettings. The authors of invited papers are S. Feferman, M. Baaz, G.F.R. Ellis, B.A. Kushner, C. Parsons, P. Pudlák, W. Sieg and J. Byrnes, G. Takeuti and M. Yuasumoto, and A. Wisser. A wide area of Gödel's work is covered, and the contents could inspire a large community of researchers. (jmlc)

V. P. Havin and N. K. Nikolski (eds.), *Complex Analysis, Operators, and Related Topics,* *Operator Theory Advances and Applications* ***113****, Birkhäuser, Basel, 2000, 408 pp., DM 198, ISBN 3-7643-6214-6*
This book is dedicated to the memory of a famous analyst, S. A. Vinogradov. The first paper (by V. P. Havin and N. K. Nikolski) describes Vinogradov's life and mathematical work and includes his complete list of publications. The next two papers are English translations of two of his articles (summaries of the main results of his Ph.D. and doctoral theses). There are 27 contributed papers from various branches of real, complex and harmonic analysis, using points of view and methods from functional analysis and operator theory. There are both survey papers and research papers, and one short paper is of a personal character. (vs)

H. Hedenmalm, B. Korenblum and K. Zhu, *Theory of Bergman Spaces,* *Graduate Texts in Mathematics* ***199****, Springer, New York, 2000, 286 pp., 4 fig., DM 109, ISBN 0-387-98791-6*
Although Bergman spaces (spaces of square-integrable holomorphic functions) resemble the familiar Hardy space on the unit circle, they are much less manageable and their theory is still far from being complete. This book deals exclusively with the Bergman space on the unit disc and presents an exposition of the current state of the theory, including several recent advances that took place in the 1990's.

After introducing the basic tools and concepts (Bergman projections, the Berezin transform, Carleson measures), the main topics discussed are the factorisation theory and zero divisors on the Bergman space (due to the first author), zero sets and the growth spaces $A^{-\alpha}$ (due to the second author), interpolation and sampling (the work of Seip and others), invariant subspaces of higher index and the Beurling-type theorem of Aleman, Richter and Sundberg, the construction of invertible non-cyclic functions (after Borichev and the first author), and the solution of the domination problem via weighted biharmonic Green functions with respect to log-subharmonic weights. (This last result, due to Hedenmalm, Jakobsson and Shimorin, appears here for the first time in full.) The authors deliberately abstain from treating the operator-theoretic aspects, thus avoiding overlap with the third author's book *Operator theory in function spaces* (Marcel Dekker, New York 1990).

The exposition is beautifully organised and very lucid and well written. Although some important topics close to the spirit of the book have been omitted (such as the recent proof of the so-called Korenblum conjecture), the book is surely indispensable for anyone actively working in the area of Bergman spaces, while making good reading for any mathematical analyst. (meng)

H. Heuser, *Lehrbuch der Analysis, 1**, 14. Auflage, B.G. Teubner Verlag, Stuttgart, 2001, 643 pp., EUR 29,90, ISBN 3-519-52233-0*
This outstanding textbook covers all basic topics of first-year mathematical analysis at universities: differential and integral calculus, and related topics such as sequences, series, and an introduction to differential equations. Besides the theory, the book offers numerous applications in physics, chemistry, biology, agriculture, technics, medicine, psychology, warfare, etc. The purpose is to show how powerful a mathematical approach is and how rich the applications can be, as well as to show what a stimulating influence these sciences can have for mathematics. There are about 1000 exercises and problems in the text (the more difficult ones are marked), some of them solved at the end of the textbook.

The three chapters on applications are really worth while: it is easy to have run through 'dry' theory without a single application. A question then arises, as to whether readers can apply anything from what they have just learned. The depth, width, skill and refinement make this book highly valuable, not only for students of pure mathematics and students of other areas that need it, but also for professional mathematicians and lecturers who can find here a lot of inspiration. Of course, we can hardly expect less from a book that has attained its fourteenth edition and has thereby proved beyond any doubt its high standard and popularity. (jdr)

J. W. P. Hirschfeld (ed.), *Surveys in Combinatorics, 2001,* *London Mathematical Society Lecture Note Series* ***288****, Cambridge Univ. Press, 2001, 301 pp., £27.95, ISBN 0-521-00270-2*
This volume contains nine invited talks presented at the 18th British Combinatorial Conference, held at the University of Sussex in July 2001. It also contains a memoir of C. Nash-Williams, who died in January 2001, written by J. Sheehan, and the list of Nash-Williams's publications. Four survey articles deal with graph theory and matroids, three with combinatorial designs and finite geometries, one with computational Pólya theory, and one with the Penrose polynomial.

B. Mohar surveys classical and recent results related to graph minors and graphs on surfaces. M. Molloy discusses progress on two problems in random structures: how many edges must be added to a random graph until it is almost surely k-colorable, and the analogous question for satisfiability in the random k-SAT problem. J. Oxley writes on the interplay between graphs and matroids (2-connectedness, removable circuits, minors and infinite antichains, branch-width). D.R. Woodall describes results on list colorings: in the first part he surveys mostly proper colorings, and in the second part he gives a number of new proofs and conjectures on improper list colorings. I. Anderson discusses results on combinatorial designs with cyclic structure. A. R. Calderbank and A. F. Naguib describe applications of quadratic forms in wireless communication problems: the bridge between the two subjects are orthogonal designs (known also as space-time block codes), and Hurwitz' famous theorem of classifying normed algebras (reals, complex numbers, quaternions, and octonions) finds its way into applied mathematics! J. A. Thas focuses on the most important results on partial m-systems and m-systems of finite classical polar spaces. L. A. Goldberg's contribution is concerned with the computational difficulty of three problems: for a permutation group acting on a finite set, to count the orbits exactly and approximately, and to choose an orbit uniformly at random. M. Aigner 'surveys in a leisurely pace' connections of the Penrose polynomial, developed as a tool for attack on the 4-colour problem, to graph theory, binary space, Tutte polynomial, Gauss problem, Hopf algebras, and invariants in knot theory. (mkl)

J. Hong and S.-J. Kang, *Introduction to Quantum Groups and Crystal Bases,* *Graduate Studies in Mathematics* ***42****, American Math. Society, Providence, 2002, 307 pp., USD$49, ISBN 0-8218-2874-6*
This book deals with some aspects of quantum groups, defined as the spectra of no-commutative Hopf algebras given by one-parameter deformations of universal enveloping algebras of Kac-Moody algebras. In the first part, the Lusztig representation theory of deformed universal enveloping algebras is recalled. Chapters 4 and 5 develop the theory of crystal bases, following the combinatorial approach of Kashiwara and geometric approach of Lusztig. The next chapters discuss the structure of crystal graphs of finite-dimensional integrable representations of deformed universal enveloping algebras via semistandard Young tableaux. The final three chapters describe a connection between representation theory of deformed universal enveloping algebra of affine algebras and solvable lattices and vertex models. (pso)

A. A. Ivanov and S. V. Shpectorov, *Geometry of Sporadic Groups II: Representations and Amalgams,* *Encyclopedia of Mathematics and its Applications* ***91****, Cambridge Univ. Press, 2002, 286 pp., £50, ISBN 0-521-62349-9*
This is the second half of a two-volume set, which contains the proof of the classification of the flag-transitive P- and T- geometries. The geometries involved are those in the sense of Tits: an incidence system of subsets of different types.

The existence of the geometries was established in the first volume of the treatise. The main theorem of the second volume consists in the proof that the amalgam of maximal parabolics obtained from a flag-transitive automorphism group of a P- geometry or T-geometry is isomorphic (as an amalgam) to the amalgam of maximal parabolics obtained from one of the known cases. The book is written with obvious care and the arguments are usually not difficult to follow. The authors have also taken care with summaries and overviews that ease understanding of the general strategy of the proof. The only deficiency worth mentioning seems to be the index, which contains too few items: it also contains no list of symbols, which means that a considerable amount of time can be wasted searching for the first appearance of a symbol or a notation convention. (ad)

T. Iwaniec and G. Martin, *Geometric Function Theory and Non-linear Analysis,* *Oxford Mathematical Monographs, Clarendon Press, Oxford, 2001, 552 pp., £75, ISBN 0-19-850929-4*

Geometric function theory studies mappings f from an open set Ω in $\mathbf{R}^n$ to $\mathbf{R}^n$. If f has integrable Jacobian $J(x, f)$ and satisfies the distortion inequality $|Df|^n \le K(x)\, J(x, f)$ a.e., where K is a non-negative finite measurable function and Df is the weak gradient in the sense of Sobolev, then f is said to be a mapping of finite distortion. Such mappings appear naturally as minima of various variational problems, or elements of classes of deformations. Their topological and geometric behaviour recalls the behaviour of holomorphic functions. The first historical step towards this theory was the generalisation from conformal to quasiconformal mappings. In the 1960s, Reshetnyak developed the theory of quasiregular mappings (mappings with bounded distortion). His class of mappings allows branching, and thus provides a joint generalisation of the theory of holomorphic functions and the quasiconformal theory. Geometric function theory is now a significant part of analysis, with links to many other parts of mathematics (differential geometry, global analysis on manifolds, topology, partial differential equations, calculus of variations, and harmonic analysis).

The book begins with an overview of the theory. After some preliminary material, the authors prove the generalised Liouville theorem, and then study continuity and its modulus for mappings of finite distortion. The part on compactness of families of mappings of finite distortion is related to polyconvex calculus of variation, with results important in the theory of elasticity. As a preparation for further treatment, large parts of the theories of differential forms, Beltrami equations, and Riesz transforms are developed. The authors present the Hardy estimate of the Jacobian and the Gehring result on reverse Hölder estimates. After an excursion to theory of non-linear elliptic PDEs, they return to the theory of mappings of bounded distortion and prove their properties (openness, discreteness, positivity of the Jacobian, branching behaviour, removable singularities, and theorems of Picard and Montel type).

The approach of the authors is entirely analytical, relying on methods of PDE theory, geometric measure theory, the theory of function spaces and harmonic analysis. They skip the method of moduli of curve families, which is well covered by other books. This book discusses all important results of the theory. Notwithstanding, most of the material is new, at least in the degree of generality or in the methods of proof. This book makes life easier for all mathematicians interested in quasiconformal theory and all its generalisations, analysis of mappings between Euclidean spaces or manifolds, and all related areas. Even specialists in quite distant fields can find inspiration by studying the far-reaching methods here. The book is well written and may comfortably be read by advanced students. (jama)

L. Kérchy, C. Foias, I. Gohberg and H. Langer (eds.), ***Recent Advances in Operator Theory and Related Topics,*** *Operator Theory Advances and Applications* ***127****, Birkhäuser, Basel, 2001, 669 pp., DM 330, ISBN 3-7643-6607-9*

A conference in memory of B. Sz.-Nagy (1913-98) was held in Szeged in August 1999. This volume in the Birkhäuser series on operator theory contains 35 articles, partly proceedings and partly research papers by the conference participants. One special article, by L. Kérchy and H. Langer, briefly describes the scientific results of Sz.-Nagy, who was one of the founders of modern operator theory. A third of the papers describe the current state of the method of unitary dilatations. This theory and its later extensions to functional models (done by Sz.-Nagy with C. Foias) provide one of the main research directions in modern operator theory. Other papers are devoted to further parts of operator theory, such as operator inequalities and orderings, spectral theory, Banach algebras and their applications to physics, stochastic processes and system theory. Several papers emphasise the connections between complex function theory and operator theory.

This book is oriented mainly to experts, but its scope is wide enough to show the richness of problems and methods of operator theory to other interested readers. (jmil)

E. Kleinert, ***Units in Skew Fields,*** *Progress in Mathematics* ***186****, Birkhäuser, Basel, 2000, 79 pp., DM 68, ISBN 3-7643-6293-6*

This book presents the theory of arithmetic groups. In particular, it includes a treatment of unit groups of orders in skew fields, which are finite-dimensional and central over the rational field. The goal is, in the author's words, 'to stimulate the interest in the topic by presenting a synopsis of methods and results'.

The book starts with a description of skew fields, which are considered in the subsequent theory. The necessary theorems on simple algebras over global fields are stated but not proved. The exposition proceeds with Hey's theorem and Weyl's reduction theory. The following chapters touch several features of the studied groups, such as Zariski-density, the finiteness theorem of Margulis and Kazhdan's property. The final chapters use crossed products and results by Tits to construct important examples and show some methods for finding units. The main open problems are discussed. The book is not of an introductory character, and will be appreciated mainly by researchers in arithmetic groups and neighbouring areas. (rb)

K. P. Knudson, ***Homology of Linear Groups,*** *Progress in Mathematics* ***193****, Birkhäuser, Basel, 2001, 192 pp., DM 118, ISBN 3-7643-6415-7*

This is a highly specialised monograph designed for researchers and postgraduate students preparing themselves for work on the homology of linear groups. It is well known that the main impetus for this study were the higher algebraic K-groups of rings introduced by D. Quillen.

In Chapter 1 the author presents results, now already considered classical, on the cohomology of the general linear groups: these are linked with famous mathematicians like A. Borel, Dwyer, Friedlander, Lichtenbaum and Quillen. Chapter 2 deals with stability results concerning the homology of general linear groups: t he main result here is the important theorem of W. van der Kallen. Chapter 3 then concentrates on the description of low-dimensional homology (up to dimension 3). The main theme of Chapter 4 is groups of rank one. Finally, Chapter 5 is a survey on results concentrated around the Friedlander-Milnor conjecture (homology of algebraic groups made discrete).

Reading this book requires a lot of prerequisites, especially from algebraic topology, group cohomology, algebra and algebraic geometry. On the other hand, the author has succeeded in writing a lively text and has tried his best to make the reading easier, so that a reader with possible gaps in his knowledge can proceed further and is ready to learn more in order to understand this book. He also advises a reader how to understand some notions without too much preparation (for instance, using specific examples instead of general notions), and has added three appendices on the homology of discrete groups, classifying spaces and K-theory, and étale cohomology. Each chapter is followed by exercises (some quite difficult). The bibliography has 134 items up to the year 2000. This book represents a very good introduction into contemporary research in this interesting field. (jiva)

I. Lasiecka and R. Triggiani, ***Control Theory for Partial Differential Equations: Continuous and Aproximation Theories II. Abstr. Hyperbolic-like Systems over a Finite Time Horizon,*** *Encyclopedia of Mathematics and its Applications* ***75****, Cambridge Univ. Press, 2000, pp. 645-1067, £60, ISBN 0-521-58401-9*

This is the second part of an intended three-volume treatise on the state-space approach to quadratic optimal control theory for linear partial differential equations in Hilbert state spaces. While the first volume was devoted to parabolic-like equations yielding analytic semigroups in abstract formulations, this second volume considers autonomous hyperbolic equations and the Petrovski-type equations, and the finite-time horizon case (the infinite horizon will appear in Volume 3). A semigroup approach to a control problem depends on regularity properties of the input-state map – the trace regularity in the authors' terminology.

The first chapter of this volume (actually Chapter 7, since the numbering is through the whole treatise) contains various formulations of this hypothesis. Chapters 8-10 study the resulting differential Riccati equation, giving pointwise feedback synthesis of an optimal control, within three different frameworks, which differ by continuity or discontinuity of the input-state map and the observation operator. These special cases come from different hyperbolic-like equations: typically, Neumann boundary control and Dirichlet boundary observation for the second-order hyperbolic equations (Chapter 8), a coupled system of a wave equation and a Kirchhoff equation with point control (Chapter 9), Dirichlet boundary control for the second-order hyperbolic equation and the Schrödinger equation (Chapter 10). Like the first volume, this part is mainly based on numerous results of the authors, on both abstract and concrete equations.

The reader will find much important information on various aspects of semigroup theory and on the regularity of solutions of hyperbolic equations. Most of the proofs are carefully presented, but some preliminary knowledge of PDE techniques (such as interpolation theory) is needed. A review of the first volume appeared in EMS *Newsletter* **38**. (jmil)

P. Lounesto, ***Clifford Algebras and Spinors,*** *London Mathematical Society Lecture Note Series* ***239****, Cambridge Univ. Press, 1997, 306 pp., £27.95, ISBN 0-521-59916-4*

This is the second edition of a book that first appeared in 1997. It offers a systematic and detailed treatment of many topics connected with Clifford algebras and the corresponding spinor spaces. Different parts of the book can be used for different purposes.

The first chapters are suitable for beginners, starting with repetitions of complex numbers, vectors, scalar products, bivectors, exterior product and quaternions. Relevant topics from theoretical physics are reviewed in the next few sections (electromagnetic theory, special relativity, the Dirac equation, various types of spinors, Fierz identities). Real Clifford alge-

bras are introduced in the second half of the book, where all their basic properties are shown, including a discussion of Witt rings and Brauer groups. Matrix realisations of Clifford algebras, periodicity questions and the use of Clifford numbers in the Vahlen description of conformal maps form the next topic. The book ends with a short summary of basic facts from Clifford analysis, the Chevalley construction of Clifford algebras (including characteristic 2) and relations between octonions and triality.

The first part of the book is elementary and can be used for undergraduate study, while the second part is more advanced and can be warmly recommended to students or researchers interested in the topic. (vs)

K. Matsuki, *Introduction to the Mori Program*, *Universitext, Springer, New York, 2002, 478 pp., 61 fig., EUR 74,95, ISBN 0-387-98465-8*
The aim of this book is to introduce the Mori programme, which can be regarded as an effective approach toward the biregular and/or birational classification framework of higher-dimensional algebraic varieties. The first part of the book is devoted to the Enriques classification of algebraic surfaces in the framework of the Mori programme. Unlike algebraic curves, in the case of algebraic surfaces there are many non-singular representatives in each birational equivalence class. The operations of blowing up and blowing down lead in two complex dimensions to the machine of the minimal model programme, producing either a minimal surface or a ruled surface. The important characterisation of the minimal model is that its canonical divisor is nef. Various features of the Mori programme in dimension 3 or higher are discussed in the rest of the book. Here the classification naturally and inevitably forces the extension of category of the non-singular varieties to the varieties with some specific singularities. The most important are the notions of canonical and terminal singularities, together with their logarithmic generalisations. The relation between any two of various minimal models is that they are connected by a sequence of flops, the codimension 2 operations with close connection to flips. (pso)

E. Menzler-Trott, *Gentzens Problem. Mathematische Logik im Nationalsozialistischen Deutschland*, *Birkhäuser, Basel, 2001, 411 pp., EUR 43, ISBN 3-7643-6574-9*
This is the most extensive and detailed biography of Gerhard Gentzen (1909-45), based on an enormous number of documents, extracts from correspondences, personal recollections and communications, reviews of Gentzen's papers, and Gentzen's reviews of papers of other logicians – all carefully reproduced and commented on. It also partially elucidates his last days: his arrest in May 1945 in Prague and his death in prison in August 1945. The development of his proof theory and natural deduction are discussed at length. The book also contains three Gentzen's lectures on the concept of infinity, the consistency of mathematics, and the foundations of mathematics (published, but not easily available), and an Appendix gives a concise introduction to the proof theory, written by Jan von Plato. All this is embedded in the general political and ideological situation in Germany during the national-socialistic regime. The history of the relationship between logic and mathematics on one hand, and politics and ideology on the other, is carefully described and well documented, and general philosophical implications are discussed. There are many photographs, tables, documents and a detailed bibliography. This is a really valuable book. (jfi)

J. Oikkonen and J. Väänänen (eds.), *Logic Colloquium '90*, *Lecture Notes in Logic* **2**, *A K Peters, Natick, 1993, 305 pp., US$50, ISBN 1-56881-132-2*
This volume contains the proceedings (including invited speakers) of the 1990 European Summer Meeting of the Association for Symbolic Logic, held in Helsinki. There are eighteen papers, some of them devoted to new or generalised logic foundations, intuitionistic, modal and temporal logic. Among the others are Hintika's 'New foundations for mathematical theories' and Gabbay's 'Labelled deductive systems: a position paper'. Other papers cover further branches of mathematical logic, such as model theory, proof theory, computability theory and set theory, including Buchler and Newelski's 'On the geometry of U-rank 2 type' and Cooper's 'Definability and global degree theory'. The papers cover a wide spectrum of topics. (jmlc)

J.-P. Pier (ed.), *Development of Mathematics 1900-1950*, *Birkhäuser, Basel, 1994, 729 pp., DM 118, ISBN 3-764-32821-5 and 0-817-62821-5*
To write comments on the history of mathematics in the second half of the 20th century is a difficult task, due to the enormous growth in the number of working mathematicians. The aim of this book is to contribute to such a project with a collection of essays on evolution in certain fields.

A few contributions are devoted to the foundation of mathematics, set theory, logic and topology and their applications in various parts of mathematics (J.-Y. Girard, J.-P. Ressayre, B. Poizat, F.W. Lawvere and S. Sorin). Papers by E. Fouvry, M. Waldschmidt, J.-L. Nicolas and C. Ciliberto discuss topics from number theory and its applications. Graphs and their applications in other fields are discussed by C. Berge. Riemannian geometry is the topic of a paper by M. Berger. A paper by M.-F. Roy surveys results in real algebraic geometry. Various versions of K-theory are discussed by M. Karoubi. Two papers by V. Arnold are devoted to the local theory of critical points of functions and to dynamical systems. Relations between thermodynamics and chaotic dynamical systems are studied by V. Baladi. B. Mandelbrot discusses questions in fractal geometry. A review by J. Dieudonné is devoted to mathematics during the last 50 years in France, while one by V. M. Tikhomirov discusses Moscow mathematics in this period. A paper by M. Smorodinsky treats questions in information theory, and I. Chalendar and J. Esterle discuss some questions in functional analysis. Fourier analysis is treated by P.L. Butzer, J.R. Higgins and R.L. Sten, and wavelets by S. Jaffard. PDEs are discussed by J. Sjöstrand and R. Temam (microlocal analysis, Navier-Stokes equations). The calculus of variation is the topic of a paper by F.H. Clarke. Several complex variable theory and plurisubharmonic functions are discussed by P. Dolbeault and C. Kiselman. Random processes, branching processes, Brownian motion, random walks, statistics and stochastic analysis are treated by P.-A. Meyer, M. Yor, J.-F. Le Gall, Y. Guivarc'h, K.D. Elworthy, G.R. Grimmett, L. Le Cam and B. Prum. The book concludes with interviews with A. Douady, M. Gromov and F. Hirzebruch, and various bibliographic and other data. It is important to know our own history, and this book contributes very well to this aim. (vs)

F. Schweiger, *Multidimensional Continued Fractions*, *Oxford Univ. Press, 2000, 234 pp., £70, ISBN 0-19-850686-4*
This is a well-written monograph, written by one of the leading experts in the field. It contains a study of the properties of multidimensional continued fractions, which can be described by fractional linear maps, together with their relations to other fields of mathematics and its applications. The author describes individual algorithms (due to Jacobi-Perron, Güting, Brun, Selmer, Poincaré, etc.) and studies their periodicity and convergence properties. There is an interesting discussion on the Schweiger generalisation of the Kuzmin theorem to higher dimensions. The book ends with chapters on the dimension of exceptional sets (a generalisation of Good's theorem) and some applications. It can be warmly recommended to all readers interested in this difficult theory. (bn)

S. Yu. Slavyanov and W. Lay, *Special Functions. A Unified Theory Based on Singularities*, *Oxford Mathematical Monographs, Oxford Univ. Press, 2000, 293 pp., £65, ISBN 0-19-850573-6*
There are various ways of treating a very broad field of special functions in a systematic way. This book uses the classifications based on singularities of the corresponding differential equation, and is written in a very nice and systematic way.

Basic facts about linear second-order ordinary differential equations with polynomial coefficients in the complex plane are explained in the first part of the book. This includes a discussion of regular and irregular singularities, confluence and reduction processes, and a generalised Riemann scheme for description of type of the considered equation. The next two chapters form the core of the book, where the authors treat the classical hypergeometric class of equations and the Heun class of equations. A number of applications to problems in physics is given in Chapter 4. In the final chapter, the authors show that Painlevé equations of different types are Euler-Lagrange equations for quantum systems described by different types of Heun equations.

The main aim of the book is to be a tool for practical use for applied mathematicians, physicists and engineers. It offers a very systematic treatment, without too many proofs, and can be complemented by software that is available separately. The book has a lot of helpful pictures, diagrams and tables. (vs)

I. J. Sobey, *Introduction to Interactive Boundary Layer Theory*, *Oxford Applied and Engineering Mathematics* **3**, *Oxford Univ. Press, 2000, 332 pp., £45, ISBN 0-19-850675-9*
This book is devoted to a better understanding of the laminar steady plane flows of a Newtonian fluid in the presence of the boundary. Due to two-dimensional geometries, the flow is described by the stream function which is then constructed via asymptotic expansions (matched asymptotic analysis techniques). In particular, the triple deck method proves to be a useful tool in understanding the behaviour of fluid near the points of laminar separation. The following special flowsare studied in detail: flow around a flat plate (infinite or finite), external flow about a circular cylinder, and flows in (symmetric and asymmetric) channels; the historical development of each problem is underlined. From the point of view of

mathematical analysis of fluid mechanics equations, the content of the book is closely related to an interesting open problem: whether in two spatial dimensions the solutions of the Navier-Stokes equations subjected to the no-slip boundary conditions converge, as the viscosity vanishes, to the solution of Euler equations with zero normal component of the velocity on the boundary. This book provides various physical/engineering/historical insights on this topic. (jomal)

R. P. Stanley, ***Enumerative Combinatorics, 2****, Cambridge Studies in Advanced Mathematics* ***62****, Cambridge Univ. Press, 1999, 581 pp., £45, ISBN 0-521-56069-1*

The book is a continuation of Volume 1 (1986), starting with Chapter 5 (Trees and the composition of generating functions) and continuing with Chapter 6 (Algebraic, D-finite, and noncommutative generating functions) and Chapter 7 (Symmetric functions). The final chapter has two appendices on Knuth equivalence, jeu de taquin, and the Littlewood-Richardson Rule (by S. Fomin) and the characters of $GL(n, \mathbf{C})$). Each chapter has its own set of exercises with solutions – altogether 261 of them, but in fact many more when subexercises are counted. The references to these and the bibliographies to the chapters constitute a giant survey of the literature on enumerative combinatorics.

What else can be added to the comments upon this excellent book? Perhaps a quotation from G.-C. Rota's foreword: 'Every once in a long while, a textbook worthy of the name comes along; (...) Weber, Bertini, van der Waerden, Feller, Dunford and Schwartz, Ahlfors, Stanley.' The paperback edition contains a new short section with errata and addenda to some of the exercises. (mkl)

J. Tanton, ***Solve this: Math Activities for Students and Clubs,*** *Classroom Resource Materials, Math. Assoc. of America, Washington, 2001, 218 pp., £20.95, ISBN 0-88385-717-0*

This is a collection of problems and exercises from recreational mathematics, and is divided into three parts. Thirty chapters in Part I contain many funny and interesting problems, from sharing a pile of candies, via 'interesting' surfaces and turning one's T-shirt inside out with one's hands clasped together, to map colouring and chessboard problems. Parts II and III then contain hints, solutions, further thoughts and further reading on the problems of Part I. This book is accessible to anyone interested in recreational mathematics. (ab)

H. Triebel, ***The Structure of Functions,*** *Monographs in Mathematics* ***97****, Birkhäuser, Basel, 2001, 422 pp., DM 196, ISBN 3-7643-6546-3*

For more than the past three decades, books by Prof. Hans Triebel of Jena have been landmarks of the theory of function spaces, differential operators and interpolation, which nobody seriously interested in the area could possibly dream of overlooking. They formed an important part of the literature that I was advised to study as a research student almost twenty years ago, and still appear among the recommendations to my own students nowadays. These books have always been well known for the precise way in which they are written, for the incredible amount of information they contain, and for the original style of exposition (recall the 'Steps' of proofs, to name just one example). Over the years, I have seen only one objection that could possibly be made about the author's style, that certain parts of one book or another are a bit difficult to read. The book under review has no such weakness, and in my opinion the way the material is presented is 'limiting' in the following sense: if any mathematical author were given the same amount of information to be covered, it would be a very hard challenge (if not impossible) to write a better text. The mathematical ideas are exposed in a witty, reader-friendly, narrative style which makes reading of the book a very pleasant experience. All the important results, deep as they are, are followed by a thorough discussion of the subject, putting it into historical context and revealing plenty of links to other, often seemingly distant, areas – links that would probably be overlooked otherwise. Occasionally, alternative proofs are given in order to improve the reader's insight into the subject. The historical context is often complemented by a touch of geography; the author has an impressive knowledge of both western and eastern, mainly Russian, literature. The reader can thus learn more about the well-known fact that many important results published in Russian journals passed unnoticed, only to be rediscovered independently in the West a few years later. These parts of the book are of independent interest, even for a non-mathematician.

The main theme of the book is a constructive approach to function spaces (here called the 'Weierstrassian approach') and its applications. Some parts of the book might be considered a continuation of the author's earlier book *Fractals and Spectra*, but in general the book is self-contained. As the author assures us in the preface, the four chapters of the book are devoted to the study of links between quarkonial decompositions of functions on one side, and three other contemporary topics (sharp inequalities and embeddings, fractal elliptic operators, and regularity theory for certain semi-linear equations) on the other. The author states that the book is based on recent research carried out by him and his co-workers. One would have therefore thought that the book is more a scientific monograph than, say, a textbook for Ph.D. students, but the book is so well written that it can also be a good aid for an interested reader who might not be an expert in the field of function spaces but who is willing to spend a little effort to study this wonderful and interesting book. (lp)

A. Uchiyama, ***Hardy Spaces on the Euclidean Space,*** *Springer Monographs in Mathematics, Springer, Berlin, 2001, 305 pp., DM 171, ISBN 4-431-70319-5*

This book is based on a typewritten manuscript completed by Akihito Uchiyama in 1990. The author died prematurely in 1997 before he could publish the material, and several of his friends and colleagues then proceeded with the publication. Through their efforts the book is now available for a broad mathematical public.

An excellent preface should not be skipped by the reader. It is a witty, moving and cleverly written essay which takes us to early-1980s Chicago when Fourier analysis was undergoing a stormy development and an impressive group of the world's top superstars in the area were gathered there (A. Calderón, A. Zygmund, R. Fefferman, F. Browder, W. Beckner, to name just a few). The description of the atmosphere is very convincing.

The book is devoted to the study of Hardy spaces by real-variable methods. The text is clearly meant more as a scientific monograph than, say, as lecture notes for beginners: the exposition is rather technical and does not contain too much verbal explanation. Having said this, a reader who is willing to put in some effort will obtain an explanation of the ideas, methods and main results in Fourier analysis during the last three decades, including the ground-breaking duality result of C. Fefferman. In an introductory section, there is a graphical description of the cross-dependence of the sections, as well as advice as to which of the sections might be safely skipped by the reader. The book has 28 sections, an appendix, and an impressive list of references, including an (even more impressive) list of significant contributions by the author, published in first-class journals. The introduction is well written, giving a perfect description of what should be expected from the subsequent text, and also presenting a brief and very useful introduction to the world of Hardy spaces. The first thirteen chapters contain several characterisations of the H^p spaces, including those involving certain special convolution operators, culminating with the perhaps most notorious one (on the real line), which involves the Hilbert transform. Within the material lie deep sophisticated methods developed since the 1970's, including the arguments, now considered classical, which employ all kinds of variations on maximal operators, atomic decomposition, Hardy-Littlewood-Fefferman-Stein inequalities, good λ-inequalities, subharmonicity of functions, basic concepts of the Littlewood-Paley theory, and much more. The characterization of a Hardy space on a real line by the Hilbert transform is a point of departure for the analysis that follows, aimed (among plenty of other things) at a generalisation of this result to a higher-dimensional situation: this material can be found in the subsequent fourteen sections (14-27). The last eight sections (21-28) contain the main results of the book, connected with the decomposition of BMO due to Fefferman and Stein. The author gives a constructive proof of this result that enables him to obtain surprisingly deep extensions. (lp)

V. I. Voloshin, ***Coloring Mixed Hypergraphs: Theory, Algorithms and Applications,*** *Fields Institute Monographs* ***17****, American Math. Society, Providence, 2002, 181 pp., $49, ISBN 0-8218-2812-6*

This book is a collection of results (obtained mostly by Vitaly Voloshin himself) on a new type of hypergraph colouring, the so-called 'mixed hypergraphs'. A proper vertex-colouring of a given mixed hypergraph must respect two types of opposite constraints: some of the edges must not be monochromatic, while some of the edges must not be rainbow.

Mixed hypergraphs were introduced by the author in 1992, and since then the field has grown significantly and many interesting connections to other colouring problems have been discovered; the last chapter of the book is devoted to these connections. In some aspects, colouring mixed hypergraphs is analogous to the usual colouring, while in others it is completely different – for example, there exists a mixed hypergraph on six vertices that can be coloured with two and four colours but has no proper coloring with exactly three colours. The field is developing so rapidly that the author could not include some recent results, and several problems listed as open have since been solved.

The book is self-contained and very readable. It is clearly organised: each of the twelve chapters is devoted to a single concept or a single class of mixed hypergraphs. Anybody interested in graph or hypergraph colouring will find this book interesting. (dkr)